Exhibit 1 – Ag Land Trust Exhibits -

Board of Directors bios.

AG LAND TRUST
Preserving Farm Land Since 1984

Ag Land Trust Board of Directors

President Aaron Johnson

Mr. Johnson is a partner of the law firm Partner at L+G, LLP Attorneys At Law. With over 15 years of practice specializing in representing major agricultural business enterprises on the Central Coast, he has extensive real property, transactional, and litigation experience, particularly related to agricultural business and mineral rights.

Vice President David Gill

Co-owner and Founder of Rio Farms, Mr. Gill oversees current operations of over 14,500 acres of specialty vegetable crop production. He is a past president of the Western Growers Association of California. Mr. Gill is recognized nationally as an expert in California agricultural production and management systems.

Treasurer Louis Frizzell

Mr. Frizzell is a Certified Public Accountant and Certified Financial Planner who provides accounting and financial planning services to many of the largest agri-business enterprises in Central California. He joined the Board of Directors in 2007, and has served as Treasurer since that time, helping to manage the Ag Land Trust's finances, including serving as the chief liaison for audits.

Secretary Kellie Morgantini

Ms. Morgantini is an attorney, a founding member of the Board of Directors, and the decendent of a century old farming family in Monterey County. She formerly served as the Director of Planning for the City of Greenfield, and served in the coastal planning unit for the County of Monterey. She is currently the Executive Director of Legal Services for Seniors, Inc. of Monterey County.

Managing Director Sherwood Darington

A founding member of the Ag Land Trust and currently serving as Managing Director, Mr. Darington is a retired Vice-President of Bank of America specializing in agricultural finance and lending for Central California. His family has lived in Monterey County for over 150 years. Mr. Darington is a Licensed Certified Appraiser, specializing in agricultural properties and currently the Public Member on the Local Agency Formation Commission of Monterey County.

Member Ed DeMars

A founding member of the Ag Land Trust Board of Directors, he served as the first Planning Director of Monterey County (33years). Additionally, he co-founded both the Big Sur Land Trust and the Elkhorn Slough Foundation.

Member Richard Nutter

Recognized throughout California as an expert in the areas of cultivated agriculture, pesticide regulations, and agricultural groundwater supply and quality protection, Mr. Nutter served as the President of the California Agricultural Commissioners Association. He served with distinction on NOAA's Monterey Bay National Marine Sanctuary advisory council for over a decade addressing coastal land use and water quality policies and protection strategies. Mr. Nutter served as Agricultural Commissioner for Monterey County from 1971 to 1998 (27 years). Mr. Nutter is now a partner at Agricultural Services Certified Organic, Inc., a company providing technical expertise to organic agri-business concerns throughout California.

Member Marc Del Piero

Mr. Del Piero, a Founder and the first President of the Ag Land Trust, is an attorney specializing in environmental and water law issues. He served formerly as the attorney member and Vice-Chair of the California State Water Resources Control Board (SWRCB 1992-1999), and is recognized throughout California as an expert in the areas of groundwater rights and the "public trust doctrine". From 1981-1992, he served on the Monterey County Board of Supervisors and co-authored the North Monterey County Local Coastal Plan that established the first mandatory groundwater protection policies within the coastal zone of Monterey County. An adjunct professor of water law at Santa Clara University School of Law from 1992-2011, he has represented public water agencies throughout California. For eight years, he represented the California Environmental Protection Agency on NOAA's Monterey Bay National Marine Sanctuary advisory council. He is best known for having produced the SWRCB Decision 1631 (The Mono Lake Decision - 1995) that ordered the Los Angeles Department of Water and Power to reduce its diversions and to restore the eco-systems of the lake and its tributary streams.

Member Virginia Jameson

Formerly the Associate Director of the Ag Land Trust, Ms. Jameson is recognized as an expert in multi-national agricultural production, international business, and "fair trade" issues. She holds a master's degree from American University in international economics and has formerly worked for both governmental agricultural organizations and NGO's both in Central America and in Monterey County.

Exhibit 2 – Ag Land Trust Exhibits

Maps

A. Map of North Monterey County LCP area (yellow) and Ag Land Trust farm (Armstrong Ranch zoned "Coastal Agricultural Preserve" CAP) outlined in RED. Proposed Cal-Am "test well" site shown in black. Ag Land Trust "Big Well" shown in black.

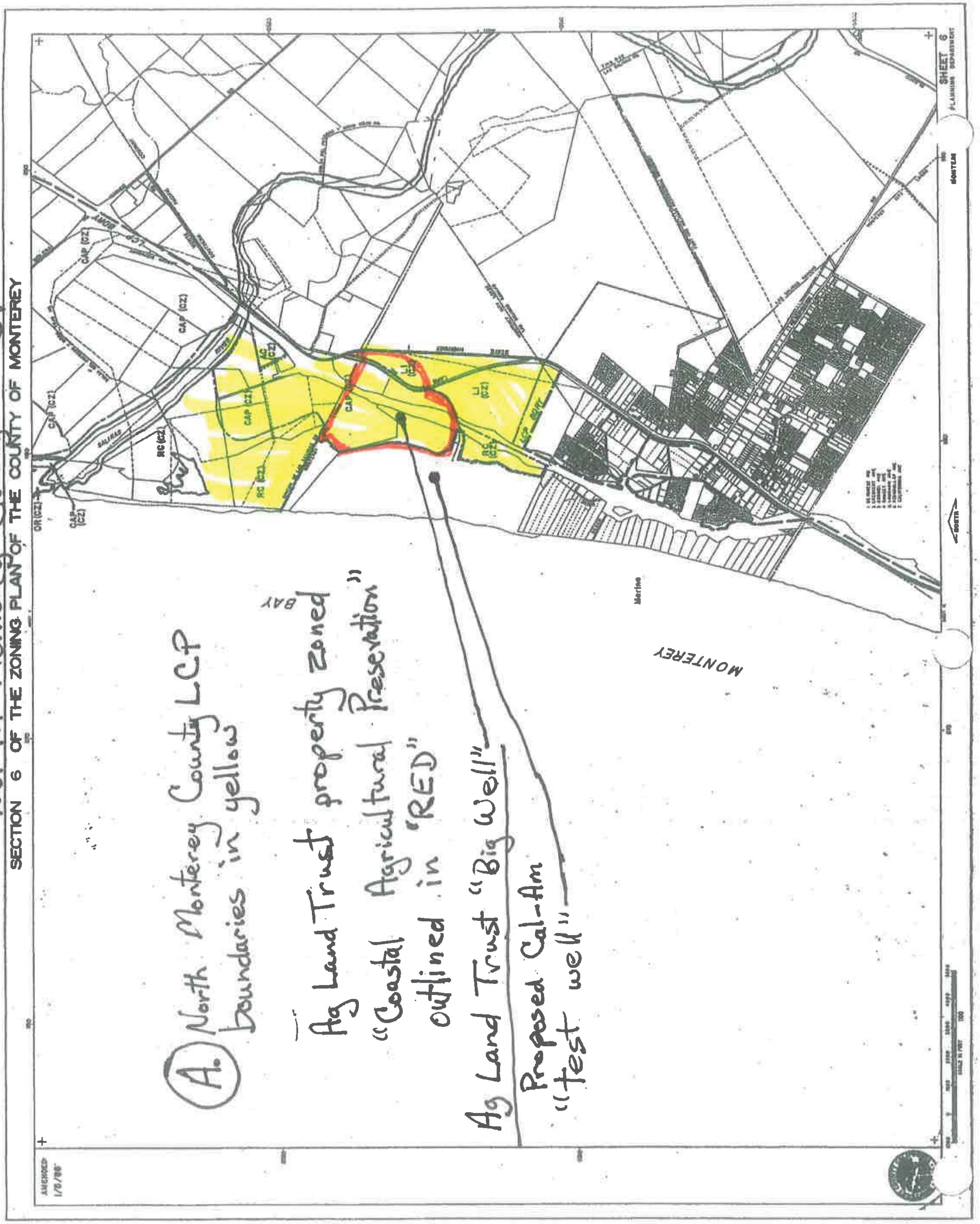
B. Ag Land Trust Armstrong Ranch in YELLOW; early proposed alternate seawater wells locations by Cal-Am

C. Cal-Am map that misrepresents the proposed location of the "test well" and the "drawdown" contours of the "cone of depression" from the "test well". Map fails to identify Ag Land Trust "Big Well" west of Highway 1 and within cone of depression and subject to seawater contamination from Cal-Am's proposed pumping.

D. Cal-Am map with notation of corrected location for "test well" and location of Ag Land Trust "Big Well". Adjusted "cone of depression" covers 75% of the Ag Land Trust property and shows seawater intrusion into "Big Well".

E. Cal-Am map that falsely indicated Ag Land Trust property as within the designated "Project Area". Insert is not to scale.

Ag Land Trust – Letter 1 (ALT1) - Exhibits



A.

Ag Land Trust – Letter 1 (ALT1) - Exhibits

B

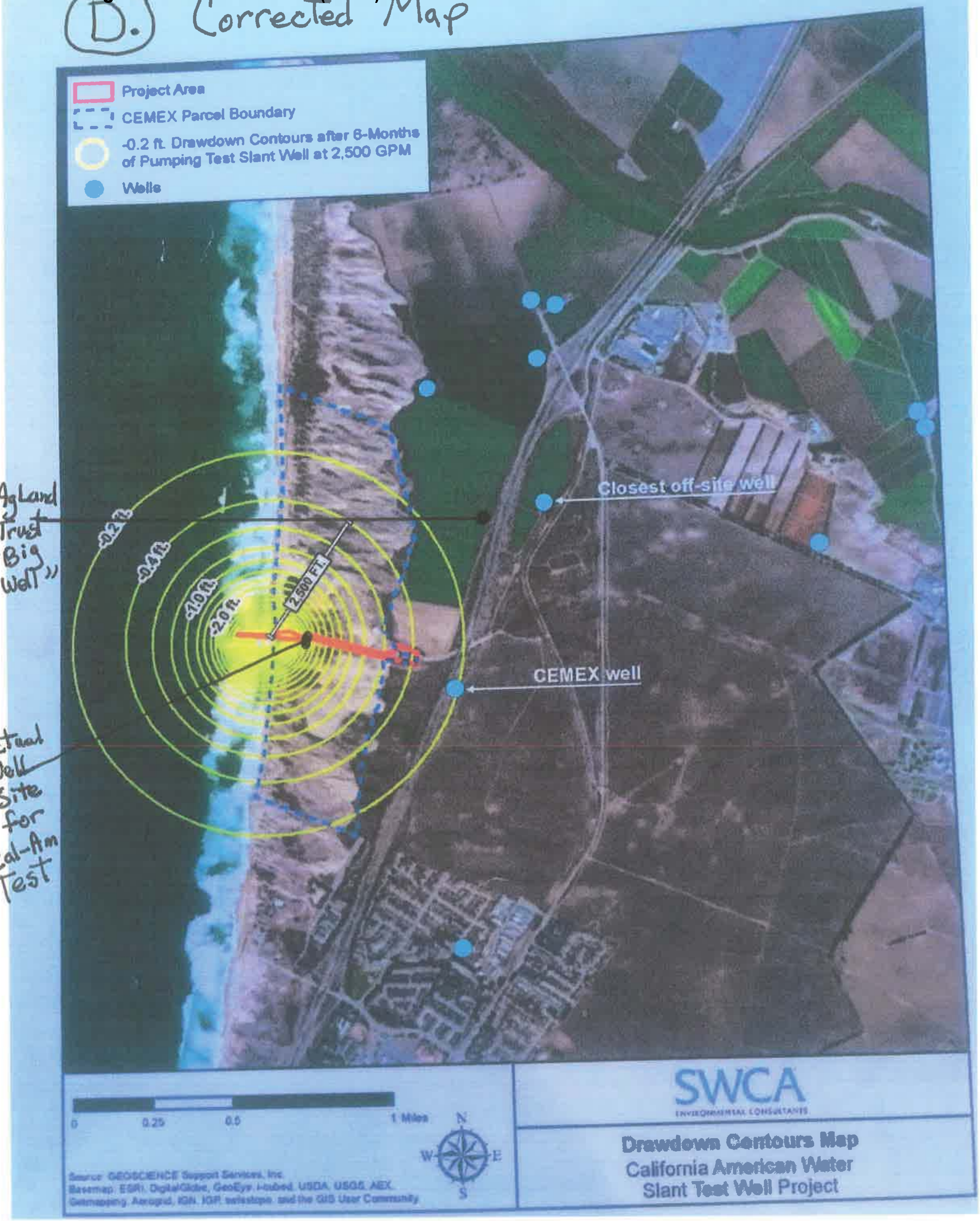
Yellow— Ag Land Trust (Monterey County Agricultural and Historic Land Conservancy) properties.

Pale Blue and Brown -- potential sea water wells and pipeline locations as extracted from Coastal Water Project FEIR Revised Figure 5-3.

NOTE: EIR Revised Figure 5-3 provides only a generalized representation of the sea water well areas with no references to properties included within their boundaries. Precise spatial data was not provided by the applicant or available from the EIR preparer.
This document was professionally prepared by a GIS Professional, using spatially accurate imagery, known physical features and property lines to provide a reliable representation of the Conservancy properties as they relate to the proposed sea well areas. Lack of access to the spatial data, if any, used in Revised Figure 5-3, has required some locational interpretation, which was performed using professional best practices.

Ag Land Trust – Letter 1 (ALT1) - Exhibits

C.


D.) Corrected Map
Project Area
CEMEX Parcel Boundary
-0.2 ft. Drawdown Contours after 6-Months of Pumping Test Slant Well at 2,500 GPM
Wells
Ag Land Trust "Big Well"
Actual Well Site for Cal-Am Test
-0.2 ft.
-0.4 ft.
-1.0 ft.
-2.0 ft.
2,500 FT.
Closest off-site well
CEMEX well
0
0.25
0.5
1 Miles
N
W
E
S
Source: GEOSCIENCE Support Services, Inc.
Basemap: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
SWCA
ENVIRONMENTAL CONSULTANTS
Drawdown Contours Map
California American Water
Slant Test Well Project

Ag Land Trust – Letter 1 (ALT1) - Exhibits

A-3-MRA-14-0050 / 9-14-1735
EXHIBIT 2

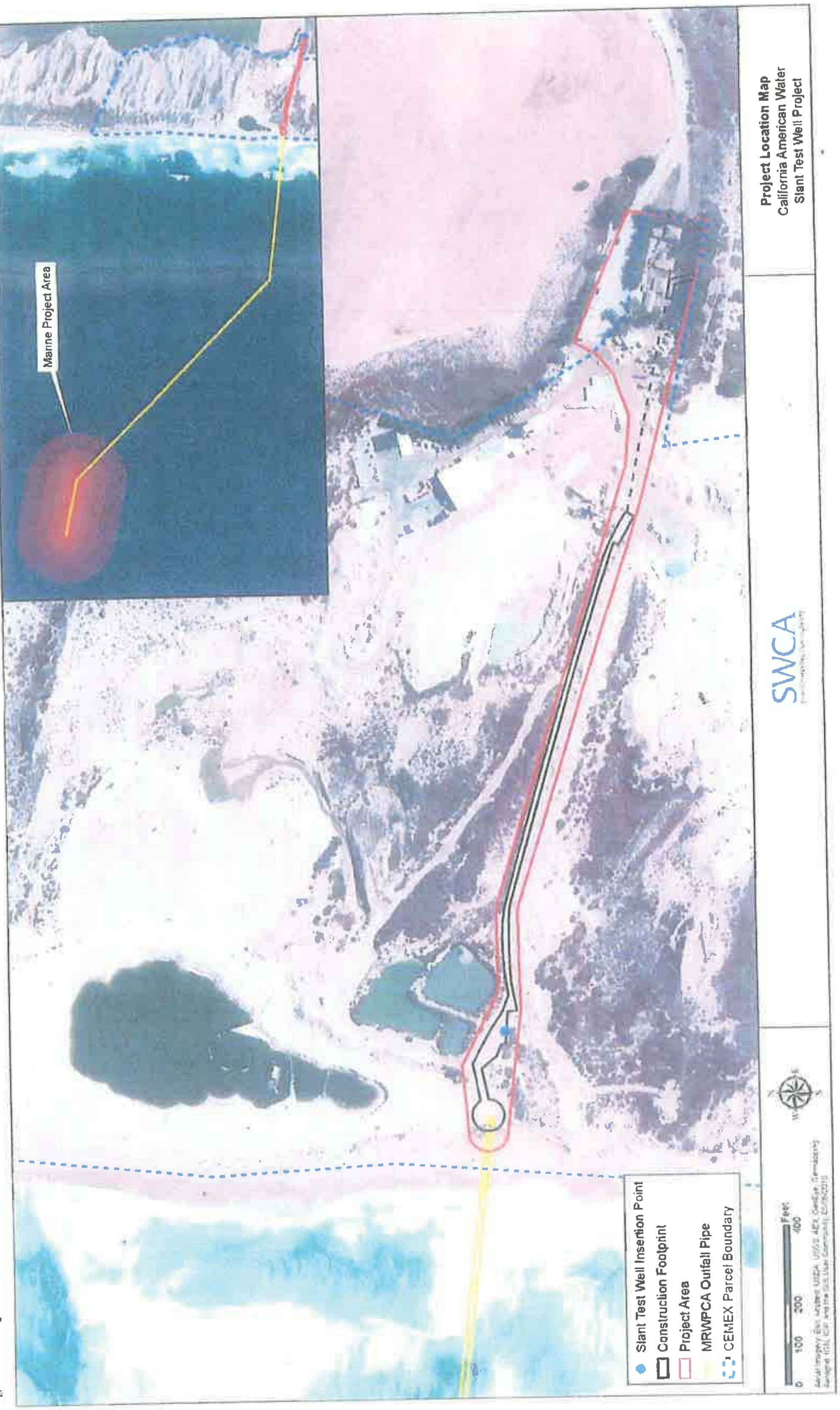


Figure 2. Project Location Map

AG LAND TRUST
Preserving Farm Land
Since 1984

www.AgLandTrust.org
Location: 1263 Padre Drive | Salinas, CA
Mail Address: P.O. Box 1731 | Salinas, CA 93902
Tel.: 831.422.5868

12 NOVEMBER 2014

AGENDA ITEM 14 – copies provided to staff

TO: The California Coastal Commission

RE: Opposition to Proposed California American Water Company (Cal-Am) Appeal/Application to Acquire a Well Site to Violate Mandatory Policies of the Certified Local Coastal Plan and to Prescriptively Take Groundwater from the Overdrafted Salinas Valley Groundwater Basin

The Ag Land Trust is strongly objecting to the subject appeal and application because Cal-Am and the commission staff are asking the Commission to participate in an illegal project that violates an unprecedented number of coastal protection policies and state laws. The Coastal Commission, if it follows their wrongful advice, will be taking an "ultra vires" act and approving an illegal "test well" which violates CEQA, which fails to address the cumulative adverse impacts of the project as a whole, and which will result in an unlawful "taking" of groundwater rights from the Ag Land Trust and other rights holders.

We are writing this correspondence to you based upon our collective professional experience of over 80 years working in Monterey County on county groundwater rights and legal issues, California Coastal Act issues, agricultural water supply and water quality issues, potable water supplies and public health issues, and based upon our technical expertise in the areas of California groundwater rights law, agricultural regulatory and water supply issues, and environmental and public health issues related to potable groundwater supplies.

The Ag Land Trust of Monterey County (the Monterey County Agricultural and Historic Lands Conservancy) is a 501(c)(3) NON-PROFIT CORPORATION organized in 1984 for the purposes of owning, protecting, and permanently preserving prime and productive agricultural lands in Monterey County and within the California Coastal Zone. It is now the largest and most successful farmland preservation trust in the State of California, and it owns, either "in fee" or through permanent conservation easements, over 25,000 acres of prime farmlands and productive coastal agricultural lands throughout Monterey County and the Central Coast of the state. (**See attached Board of Directors roster – Exhibit 1**). Further, and of more particular importance, The Ag Land Trust has been the farmland conservancy that the California Coastal Commission has sought out to accept the dedications of prime and productive coastal farmlands in Monterey and San Mateo Counties as mitigations for the Coastal Commission's issuance of development permits within those Local Coastal Planning areas.

The Ag Land Trust owns, in fee, the prime and productive coastal farmland (the Armstrong Ranch), and all of the overlying percolated groundwater rights thereunder, that is located immediately adjacent to (within 50 yards of) the California American Water Company's (Cal-Am) proposed well site on the CEMEX property. Our ranch was acquired with grant funds from the State of California and the United States (USDA) expressly to preserve its protected and irreplaceable prime and productive coastal farmland from development. We have over 160 acres under cultivation and use our potable groundwater wells for irrigation water.

Our property is in the unincorporated area of Monterey County. Our ranch lies within, and is subject to, the policies and regulations of the certified North Monterey County Local Coastal Plan area. Cal-Am has publicly stated that the huge cone of depression that will be created by its' massive proposed test well, and the excessive duration (two (2) years) of Cal-Am's intended proposed pumping, will result in the contamination of our wells and the unlawful "taking" of our potable groundwater from beneath our property in direct violation of the certified policies protecting our farmland in the North Monterey County Local Coastal Plan (NMCLCP – certified 1982). The appeal/application and the commission's staff analysis are fatally flawed because they have ignored the test well's immitigable operational and environmental violations and failed to address conflicts with the NMCLCP policies that Cal-Am's own documents have disclosed. **The proposed "test well" appeal/application directly violates the following policies/mandates of the certified North Monterey County Local Coastal Plan that the Coastal Commission is required to uphold and enforce:**

"NMCLCP 2.5.1 Key Policy
The water quality of the North County groundwater aquifers shall be protected, and new development shall be controlled to a level that can be served by identifiable, available, long term-water supplies. The estuaries and wetlands of North County shall be protected from excessive sedimentation resulting from land use and development practices in the watershed areas.

NMCLCP 2.5.3 Specific Policies
A. Water Supply
1. The County's Policy **shall** be to protect groundwater supplies for coastal priority agricultural uses with emphasis on agricultural lands located in areas designated in the plan for exclusive agricultural use.

2. The County's long-term policy shall be to limit ground water use to the safe-yield level. The first phase of new development shall be limited to a level not exceeding 50% of the remaining buildout as specified in the LUP. This maximum may be further reduced by the County if such reductions appear necessary based on new information or if required in order to protect agricultural water supplies. Additional development beyond the first phase shall be permitted only after safe-yields have been established or other water supplies are determined to be available by an approved LCP amendment. Any amendment request shall be based upon definitive water studies, and shall include appropriate water management programs.

3. The County **shall** regulate construction of new wells or intensification of use of existing water supplies by permit. Applications shall be regulated to prevent adverse individual and cumulative impacts upon groundwater resources."

Cal-Am's proposed illegal pumping and then its "wasting/dumping" of our protected potable groundwater resources will result in significant cumulative adverse impacts, immitigable permanent damage, a continuing nuisance, and irreversible seawater intrusion into the potable groundwater resources and aquifers that belong to and which underlie the Ag Land Trust's Armstrong Ranch. Further, it will cause irreparable damage to our protected prime coastal farmlands in violation of our certified Local Coastal Plan. Cal-Am has no groundwater rights in the Salinas Valley and the North Monterey County Local Coastal Plan area and, pursuant to California groundwater rights law, is flatly prohibited from acquiring such rights in an overdrafted basin. **Importantly, Cal-Am's proposal, and Commission staff's recommendations directly violate the new mandates of Governor Brown's groundwater legislation that specifically identifies (and prohibits) "significant and unreasonable seawater intrusion" as an "Undesirable Result" that must be avoided in the management of potable groundwater basins, and specifically in the Salinas Valley. (See AB 1739 (Dickinson); SB1168 (Pavley); and SB 1319 (Pavley) signed by Governor Brown in October, 2014). The express legislative intent of these important pieces of legislation, in part, includes "respecting overlying and other proprietary rights to groundwater" by rights holders like the Ag Land Trust as against parties like Cal-Am (a junior, non-overlying, would-be prescriptive appropriator). Further, Cal-Am's proposed "test well", and its operation recommended by Commission staff, directly violates the new definition of "GROUNDWATER SUSTAINABILITY" as embodied in Governor Brown's new legislation.**

By this letter, the Board of Directors of the Ag Land Trust unanimously objects to the proposed coastal permit appeal and the application to the Commission initiated by the California American Water Company (Cal-Am) for a well site on the CEMEX property for Cal-Am's stated and prohibited reasons of wrongfully extracting potable groundwater from the overdrafted Salinas Valley Groundwater basin and our property. A significant portion of the groundwater that Cal-Am has expressly indicated it intends to wrongful "take" with its proposed "test well", without providing compensation for their resultant irreparable damage to our potable groundwater aquifers, belongs to the Ag Land Trust **(See attached Exhibit 2 - MAPS - by Cal-Am showing its' "drawdown" of groundwater by Cal-Am's well pumping on the adjacent Ag Land Trust property; Exhibit Map showing Ag Land Trust property in yellow right next to the proposed "test well"; Exhibit Maps (two copies - original and corrected) of Cal-Am maps misrepresenting the actual location of the proposed "test well" site, misrepresenting the actual impact area of Cal-Am's well pumping "cone of depression"; and failing to identify the closest agricultural well on the Ag Land Trust property which is in the "cone of depression" area.).**

Cal-Am has been denied the prerequisite permits for a ground water well twice by both the City of Marina Planning Commission and the City Council of the City of Marina due, in part, to Cal-Am's failure to produce even one shred of evidence that it has any legal property or water right to pump groundwater from the overdrafted Salinas Valley Groundwater Basin, or that it can overcome its intended express violations of the farmland and groundwater protection policies of the certified North Monterey County Local Coastal Plan (NMCLCP). Unfortunately, these direct violations of existing mandatory NMCLCP protection policies are ignored in your staff report, in spite of the woefully inadequate condition that groundwater within 5000 feet of the well site be monitored for seawater intrusion. Further, there is no evidence produced by Cal-Am or the Commission's staff that the CEMEX well site is entitled to enough groundwater to satisfy Cal-Am's uncontrolled demand even if Cal-Am is successful in acquiring the well permit, and your staff has failed to disclose this issue for public review.

UNDER CALIFORNIA GROUNDWATER RIGHTS LAW, ACQUISITION OF A SURFACE WELL SITE DOES NOT RESULT IN THE ACQUISITION OF WATER RIGHTS TO PUMP GROUNDWATER FROM THE UNDERLYING OVERDRAFTED PERCOLATED GROUNDWATER BASIN. The over-drafted aquifers that are proposed to be exploited and contaminated by Cal-Am's self-serving pumping and dumping are required to be used by the NMCLCP "to protect groundwater supplies for coastal priority agricultural uses". **Has Cal-Am or the Commission staff explained how their proposed project does not violate the mandate to prevent adverse cumulative impacts upon coastal zone groundwater**

resources (North County LCP Sec. 2.5.3 (A) (3))? We can find no reference or consideration of this issue in your staff report. Moreover, the proposed appeal by Cal-Am, which is now being pushed by staff, directly violates the mandates of the certified North Monterey County Local Coastal Plan Sections 2.5.1, and 2.5.2.3, and 2.5.3.A.1-3; and 2.5.3.A.1.6, and 2.6.1; and 2.6.2.1; and 2.6.2.2; and 2.6.2.6. The impacts of the Cal-Am test well, by Cal-Am's own filings, will directly violate these policies in spite of the failure to have evaluated these significant and immitigable adverse impacts. We object to these obvious failures to comply with these mandated coastal protection policies and CEQA.

The Ag Land Trust objects to the Cal-Am appeal and application because Cal-Am, by omission, seeks to deceive the Commission as to its actual intent in pursuing the acquisition of the proposed "test well". Further, Cal-Am knows, but has failed to disclose to the Commission, that it intends to wrongfully and surreptitiously contaminate a potable groundwater aquifer and "take" the real property rights and the potable water rights of the Ag Land Trust, without compensation and in violation of over 100 years of California groundwater rights law. Cal-Am has been advised of this concern for at least eight (8) years by the Ag Land Trust. **(Exhibit 3 - See attached letters of objection from the Ag Land Trust).** Cal-Am intends to, and has admitted, that it intends to pump water from beneath the Ag Land Trust's property over the objection of the Trust since 2006. **(See Exhibit 2 - attached Cal-Am pumping map).**

Although our objections are not limited to those enumerated herein, The Ag Land Trust further objects to the Cal-Am proposal to use the CEMEX well site for the following reasons:

1. Cal-Am's assertions that it intends to pump seawater from the proposed "test well" is untrue. Cal-Am has conducted water quality sampling that already shows that its proposed extended pumping of that test well will intentionally and significantly draw water from "fresh", potable aquifers (180 ft. and 400 ft.) that underlie the Ag Land Trust property, and aggravate seawater intrusion below the Ag Land Trust property, thereby implementing a wrongful, uncompensated "taking" of our real property (aquifer storage and our well water) rights for Cal-Am's financial benefit. Cal-Am has disclosed this information to the City of Marina City Council. Moreover, Cal-Am has indicated that it intends to not use, but intends to "dump" the water it pumps from its "test well", including our potable water, back into the ocean, thereby constituting a prohibited "waste of water" and a direct violation of Article X, Sec.2 of the Constitution of California and the Doctrine of Reasonable Use (Peabody v. Vallejo 2 Cal. 2nd 351-371 (1935)). "The use of groundwater is a legally protected property right." (See Peabody). Cal-Am intends to do this to intentionally contaminate the aquifer and our wells so that it can avoid the legal penalties and financial consequences of its plan to illegally, prescriptively, and permanently take control of the groundwater aquifers underlying the Ag Land Trust's productive farmland for Cal-Am's sole economic benefit. Moreover, the granting of this appeal and the issuance of a permit by the Commission, now that this intended violation of the law has been disclosed, will likely expose the Coastal Commission to nuisance claims and "vicarious liability" for the taking of our groundwater rights, and the resultant damages flowing therefrom, along with Cal-Am (See Aransas v. Shaw 756 F.3rd 801 (2014). Further, granting Cal-Am's appeal will directly violate Governor Brown's landmark groundwater legislative package that prohibits the taking of other parties' groundwater rights and prohibits the intentional contamination of identified potable groundwater supplies.

2. The Salinas Valley groundwater basin has been identified as being in overdraft by the California Department of Water Resources, the California Coastal Commission, and the Monterey County Water Resources Agency (MCWRA) for over 60 years. The sole source of recharge to the aquifer is rainfall and water percolated into the Salinas River from water supply projects paid for, pursuant to Proposition 218 requirements and provisions of the California Constitution, by overlying land owners (assesses) within the basin, including the Ag Land Trust. The overlying water rights holders have paid tens of millions of dollars to protect and restore their groundwater supplies. Cal-Am has not paid anything to protect and preserve the aquifers, and has acquired no groundwater rights in the basin or from those projects.

3. The overdraft was initially identified in Monterey County studies of the basin in the 1960's and 1970's, and has been repeatedly identified by more recent MCWRA hydrologic and hydro-geologic studies (U.S. ARCORPS, 1980; Anderson-Nichols, 1980-81; Fugro, 1995; Montgomery-Watson, 1998). The universally identified remedy for seawater intrusion specified in these studies is the reduction of well pumping near the coast. Further, the overdraft in the North County aquifers has been publicly acknowledged for decades by both the Monterey County Board of Supervisors and the California Coastal Commission in the certified "North County Local Coastal Plan" (1982), the "Monterey County General Plan" (1984 and 2010) and the "North County Area Plan" (1984).The Ag Land Trust and all other land owners within the basin have spent millions of dollars over the last sixty years to build water projects to reverse and remedy the overdraft and recharge the aquifers. Cal-Am has not spent anything to protect the groundwater resources of the Salinas Valley. Unfortunately, Cal-Am, in its continuing wrongful pursuit of "taking" other people's water rights, has failed to disclose to the Commission how it intends to violate the laws of groundwater rights that govern the basin. Moreover, Cal-Am and Commission staff, without any evidence to back up their assertions, now asks the Commission to blindly ignore 50 years of detailed hydro-geologic and engineering studies by independent, impartial public agencies, and asks the Commission to rely on Cal-Am's "voo doo hydrology" that its "test well" pumping results will not aggravate seawater intrusion in the Salinas Valley or "take" our potable water resources and water rights.

4. California law holds that, in an overdrafted percolated groundwater basin, there is no groundwater available for junior appropriators to take outside of the basin. In an over-drafted, percolated groundwater basin, California groundwater law holds that the Doctrine of Correlative Overlying Water Rights applies (Katz v. Walkinshaw 141 Cal. 116 (1902)). In an over-drafted basin, there is no surplus water available for new, junior "groundwater appropriators", except those prior appropriators that have acquired or gained pre-existing, senior appropriative groundwater water rights through prior use, prescriptive use, or court order. The clear, expansive, and often re-stated law controlling groundwater rights in an over-drafted basin has been reiterated by California courts for over a century (Katz v. Walkinshaw, 141 Cal. 116; Burr v. Maclay 160 Cal. 268; Pasadena v. Alhambra 33 Cal. 2nd 908; City of Barstow v. Mojave 23 Cal. 4th 1224 (2000)). This is the situation in the over-drafted Salinas Valley percolated groundwater basin, there is no "new" groundwater underlying the over-drafted Salinas aquifers. Cal-Am is a junior appropriator that has

no rights to groundwater in the Salinas Valley, and can't get any. Moreover, Cal-Am's unsubstantiated assertions that it needs to drill a test well to satisfy the SWRCB ignores the fact that Cal-Am's actual intent and conduct is aimed at avoiding the SWRCB Cease and Desist order on the Carmel River (that has resulted from its constant illegal diversions of water over the past twenty years) by creating an even greater illegal diversion of "other peoples'" groundwater from the overdrafted Salinas Valley. Cal-Am's shameless propensity to violate both the requirements of California water law and the water rights of other innocent property owners is legend, and is the reason that the SWRCB issued its enforcement SWRCB Order 95-10 and the Cease and Desist order against Cal Am.

5. Further, it is important for the Commission to know that the SWRCB is specifically prohibited by the Porter-Cologne Act (1967) from having any jurisdictional authority of non-adjudicated percolated groundwater basins like the Salinas Valley. Moreover, neither the CPUC, nor the Coastal Commission, nor the SWRCB can grant groundwater rights to Cal-Am. Such an approval would be a direct violation of California groundwater rights law. The SWRCB cannot, and has no authority to, order the installation of slant wells so that Cal-Am can wrongfully take other people's water and water rights without a full judicial adjudication of the entirety of the Salinas Valley groundwater basin among all landowners and existing water rights holders therein. Cal-Am's request for a test well site seeks to hide by omission the irrefutable legal impediments to its planned illegal taking of groundwater.

6. The Cal-Am desalination plant, and its proposed test wells and the appeal to which we object, are illegal and directly violate existing Monterey County Code Section 10.72.010 et seq (adopted by the Board of Supervisors in 1989) which states in part:

Chapter 10.72 - DESALINIZATION TREATMENT FACILITY (NMC LCP)

Sec. 10.72.010 - Permits required.

No person, firm, water utility, association, corporation, organization, or partnership, or any city, county, district, or any department or agency of the State shall commence construction of or operate any Desalinization Treatment Facility (which is defined as a facility which removes or reduces salts from water to a level that meets drinking water standards and/or irrigation purposes) without first securing a permit to construct and a permit to operate said facility. Such permits shall be obtained from the Director of Environmental Health of the County of Monterey, or his or her designee, prior to securing any building permit.

Sec. 10.72.030 - Operation permit process.

All applicants for an operation permit as required by Section 10.72.010 shall:

A. Provide proof of financial capability and commitment to the operation, continuing maintenance replacement, repairs, periodic noise studies and sound analyses, and emergency contingencies of said facility. Such proof shall be in the form approved by County Counsel, such as a bond, a letter of credit, or other suitable security including stream of income. For regional desalinization projects undertaken by any public agency, such proof shall be consistent with financial market requirements for similar capital projects.

B. Provide assurances that each facility will be owned and operated by a public entity.

Cal-Am, by its own admission is not a "public entity", as defined under the Monterey County Code and the California Government Code. Cal-Am is a privately owned, for-profit corporation which is a regulated private company and taxed as a private company by the Internal Revenue Service. Further, the California Public Utilities Commission's power of eminent domain, which Cal-Am invoked to pursue its devious acquisition of the CEMEX well site, may not be used or invoked to take actions that are violations of existing state or local laws, ordinances, or regulations. **Under California law, eminent domain may not be used to acquire unlimited groundwater pumping rights in an overdrafted basin.** Cal-Am is attempting to pursue acquisition of a well site for a project that it is prohibited from owning and operating, and for which it has no groundwater rights. Neither Cal-Am nor the CPUC have pursued an action in declaratory relief. Further, the CPUC cannot grant groundwater rights nor waive the requirements of a local ordinance so as to exercise its power of eminent domain, either directly or indirectly. It certainly cannot grant other peoples' groundwater rights to Cal-Am for the sole financial benefit of Cal-Am. Nor can the SWRCB. Nor can the Coastal Commission. The granting of this appeal and application for the well site expressly to illegally appropriate and "take/steal" tens of thousands of acres feet of "other people's groundwater" from the overdrafted Salinas Valley groundwater basin, for a project that Cal-Am is legally prohibited from owning and operating, would constitute an illegal, "ultra vires" act that may not be facilitated by the Commission.

7. Cal-Am's appeal also fails to disclose to the Commission the legal limitations that will apply to its so-called "test well". The Doctrine of Correlative Overlying Water Rights, as created and interpreted by the California Supreme Court in Katz v. Walkinshaw 141 Cal. 116, and as re-iterated for the last 110 years (most recently in City of Barstow v. Mojave 23 Cal. 4th 1224 (2000)), prohibits any land owner in an over-drafted percolated groundwater basin from pumping more than that land owner's correlative share of groundwater from the aquifer as against all other overlying water rights holders and senior appropriators. CEMEX is only allowed to pump a fixed (correlative) amount of water for beneficial uses solely on its' property. Given the size of the small easement pursued by Cal-Am, the Commission must limit the amount of water that Cal-Am may pump annually from that easement to that small fraction of the total available water amount that may be used by CEMEX pursuant to its deed restriction in favor of the Marina Coast Water District and the other land owners in the Salinas Valley basin and pursuant to the Doctrine as mandated by state law. If the Commission were to grant Cal-Am's appeal, it would be necessary to specifically, and in writing, limit the temporary permitted extraction to insure that Cal-Am does not conveniently forget its legal obligations like it has on the Carmel River for the past 20 years.

Uncontrolled pumping of Cal-Am's "test well" can and will reverse years of efforts to recharge and restore our aquifer, violate existing mandatory LCP policies, violate state groundwater law, and leave us permanently without a groundwater supply for our farm.

8. Cal-Am's proposed well and its uncontrolled pumping plan will intentionally contaminate the potable groundwater aquifers beneath the Ag Land Trust property and the potable aquifers of the Salinas Valley in violation of state law. Cal-Am, by its appeal for a well site, intends to intentionally contaminate a potable groundwater supply in violation of multiple state regulations and water quality laws. The California Regional Water Quality Control Board – Central Coast (CCRWQCB) is a division of the SWRCB and created pursuant to an act of the legislature known as the Porter-Cologne Act. One of the duties delegated to the CCRWQCB is the adoption and enforcement of the Water Quality Control Plan for the Central Coastal Basin. The Plan is mandated to meet the requirements of the federal Clean Water Act and the Porter-Cologne Act. It was adopted after numerous public hearings in June, 2011. This Plan is mandated by law to identify the potable groundwater resources of the Central Coast and Monterey County. At Chapter 2, Page II-1, the Plan states, "Ground water throughout the Central Coastal Basin, except for that found in the Soda Lake Sub-basin, is suitable for agricultural water supply, municipal and domestic water supply, and industrial use. Ground water basins are listed in Table 2-3. A map showing these ground water basins is displayed in Figure 2-2 on page II-19." This reference specifically included the potable groundwater supplies/aquifers under the Ag Land Trust property, adjacent to the CEMEX site, which is sought to be exploited by Cal-Am to supposedly pump "seawater". The Plan goes on to quote the SWRCB Non-Degradation Policy adopted in 1968 which is required to be enforced by the CCRWQCB. "Wherever the existing quality of water is better than the quality of water established herein as objectives, such existing quality shall be maintained unless otherwise provided by the provisions of the State Water Resources Control Board Resolution No. 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California," **(See Exhibit 3)** including any revisions thereto. Cal-Am, in pursuing its well site, knowingly has ignored the above stated facts and law and withheld this information from the Commission so as to avoid having to compensate the Ag Land Trust for its irreparably damaged property, wells, and water rights and to avoid further legal enforcement actions against Cal-Am by federal and state regulatory agencies.

9. Cal-Am's flawed and self-serving real estate appraisal of the proposed well site and easement fails to evaluate, quantify, and value the exploitation of groundwater resources and the value of permanently lost water supplies and rights due to induced seawater intrusion into the potable aquifers by Cal-Am's wrongful pumping and its illegal exploitation of the Ag Land Trust's percolated, potable groundwater supply. The full price of Cal-Am's actions and "takings" has been significantly underestimated expressly for Cal-Am's prospective economic benefit.

10. Our wells (two wells) and pumps on our ranch adjacent to the location of the proposed well field are maintained and fully operational. **Cal-Am has failed to identify and disclose in their exhibits to the Commission the location of our largest well (900 ft.) which is located west of Highway 1 and within the "cone of depression" area of Cal-Am's proposed "taking" of our groundwater (See Exhibit 2). Its' water will be taken and contaminated by Cal-Am's actions that are endorsed by Commission staff.** We rely on our groundwater and our overlying groundwater rights to operate and provide back-up supplies for our extensive agricultural activities. Our property was purchased with federal grant funds and the U.S. Department of Agriculture has a reversionary interest in our prime farmland and our water rights and supplies that underlie our farm. Neither Cal-Am, nor the CPUC, nor the Coastal commission can acquire property or groundwater rights as against the federal government by regulatory takings or eminent domain. Cal-Am has intentionally omitted these facts from its appeal so as to avoid uncomfortable environmental questions that would invariably disclose Cal-Am's intended illegal acts and proposed "takings". Cal-Am's proposed "takings", as supported by Commission staff, will

intentionally and wrongfully contaminate our protected potable groundwater supplies, resources, and wells. Cal-Am's and staff's intent on "eliminating our right of use (through "public trust" inspired pumping to protect unidentified marine organisms) is akin to the drastic impact of physical invasion on real property, which categorically warrants compensation" (Loretto v. Teleprompter Manhattan 458 U.S. 419,421 (1982) (physical occupation of property requires compensation). Hence, such an impact on water rights should merit the same categorical treatment. (See Josh Patashnik, Physical Takings, Regulatory Takings, and Water Rights, 51 Santa Clara Law Review 365,367 (2011)).

11. The staff report admits that the test well site is an environmentally sensitive habitat area (ESHA) and that the project is not a resource dependent use. (Only resource dependent uses are permitted in ESHA). That should end the discussion and result in denial of the project. But, the staff report then states that this project qualifies for an exception under the Coastal Act for "industrial facilities." This is not an industrial facility under the Coastal Act. It might be a public works facility, except Cal-Am is not a California public/government agency. Cal-Am is a division of a for-profit, privately owned corporation from New Jersey. The Staff is relying on section 30260 which allows such industrial facilities if alternative locations are infeasible, it would be against the public welfare to not approve the project, and the impacts are mitigated to the maximum extent feasible. That exception is for industrial facilities, not public works facilities. This project is not an industrial facility. It is a privately owned water well. Section 30260 states that industrial facilities may be permitted contrary to other policies in the Coastal Act "in accordance with this section (30260) and Sections 30261 and 30262..." These latter sections concern oil and gas facilities. Public works are addressed in a different Article of the Coastal Act. The staff report at p. 57 characterizes the test well as an industrial activity because "It would be built within an active industrial site using similar equipment and methods as are currently occurring at the site." This is an unsustainable stretch of the definition. The staff report refers to a Santa Barbara County LCP provision regarding public utilities concerning natural gas exploration as support for the notion that the test well is an industrial facility. But, the Santa Barbara County provision notably concerns natural gas. Thus, development of the test well in ESHA would violate the Coastal Act.

12. Finally, Cal-Am touts its "so-called" settlement agreement with a few non-profit entities and politicians as some kind of alleged justification for the Commission to ignore Cal-Am's intended violations of law and approve their illegal taking of our property/water rights. Not one of the parties to the so-called settlement agreement holds any groundwater rights in the Salinas Valley that will be adversely taken by Cal-Am's proposed conduct. None of them have offered to compensate the Ag Land Trust for the "theft" of our groundwater rights that they have endorsed. Cal-Am has a history of unapologetic violations of California's water rights laws. Cal-Am's contrived reliance on "endorsements" by uninformed and unaffected parties to the "so-called" settlement agreement is akin to a convicted thief asserting a defense that his mother and grandmother both agree that he is "a good boy" who really did not mean to steal.

Since 1984, The Ag Land Trust's Board of Directors has been committed to the preservation of California's prime and productive farmland and the significant environmental benefits that flow therefrom. The Trust does not want to "pick a fight" with the Commission staff with whom we have worked cooperatively and successfully for many years. But the Commission staff and Cal-Am have produced no environmental evidence or facts to justify ignoring the mandates of the City of Marina in requiring the preparation of a full Environmental Impact Report (EIR) pursuant to the California Environmental Quality

Act (CEQA) prior to drilling a well meant to knowingly contaminate our water resources and wells. The staff has cited the Santa Barbara LCP to try to rationalize its recommendation, but they have produced no evidence to justify ignoring the multiple mandates of the North Monterey County Local Coastal Plan (just 50 yards from the well) that will be violated. The Commission's review of the test well must comply with CEQA since its' review is the functional equivalent of CEQA review. The staff report does not provide analysis of the impacts of the project on groundwater supply and rights. The Commission must perform analysis of the adverse effects of the project on the groundwater of adjacent overlying land owners and senior water rights holders. The test well is being used in place of environmental review. Its' significant, if not irreversible, adverse effects will not be identified until after the permanent damage to our aquifer and wells is done. This is antithetical to CEQA which requires the analysis to be performed prior to beginning the project. A test well that will operate for two years, without analysis of potential impacts, violates CEQA. Indeed, the City of Marina City Council (which includes three attorneys) recognized this fact when it voted to require an EIR prior to the considering the CDP.[1] Cal-Am and the staff have produced no comprehensive evidence that the damage that will result to protected coastal resources from the proposed "test well" is less than the damage that may be caused by other alternative sources of seawater. Further, Commission staff and the CPUC can no longer intentionally avoid the CEQA mandates of a full alternatives analysis in the EIR of all potential seawater sources, including seawater intakes at Moss Landing as identified as the "preferred site" for all of Monterey Bay (see directives, mandates, and findings of the California Legislature of Assembly Bill 1182 (Chapter 797, Statutes of 1998) which required the California Public Utilities Commission to develop the Plan B project, and the CPUC *Carmel River Dam Contingency Plan – Plan B Project Report* which was prepared for the Water Division of the California Public Utilities Commission and accepted and published in July, 2002 by the California Public Utilities Commission." "Plan B" identifies the Moss Landing Industrial Park and the seawater intake/outfall on the easement in the south Moss Landing Harbor as the optimal location for a regional desalination facility.) The staff report has chosen to ignore long standing and mandatory coastal protection policies to try to force us to give up our farm's water rights for the sole economic benefit of Cal-Am. This political position by staff is misguided and is a failure of the environmental protection policies and laws that are intended to protect all of our resources from immitigable, adverse effects of improperly analyzed and poorly considered development projects. The Coastal Commission staff simply has to do a lot more than take a political position at the expense of otherwise innocent adjacent land owners with real groundwater rights that are about to be wrongfully taken.

The cumulative impacts section of the staff report ignores the cumulative impacts of drawing more water from an overtaxed aquifer and the loss of prime farmland. This is a violation of CEQA. The cumulative impact analysis only addresses the impacts to dune habitat and it also addresses this cumulative impact in a very localized fashion. This is a special and rare habitat and the impacts to this habitat in the entire dune complex extending down to the Monterey Peninsula should be examined.

Furthermore, an EIR is being prepared by the PUC for the project. The Coastal Commission is approving the test well without really addressing the impacts of the project as a whole. Either the PUC should be the lead agency and finish the EIR, or the Commission should analyze the entire project as one. The

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[1] The staff report makes an unwarranted and unfair assertion that the City of Marina set "poor precedent" when the City of Marina denied the CDP without making LCP consistency findings. The reason the findings were not made is because the Council was simply complying with CEQA and requiring adequate environmental review before making a final decision. The Commission's premature assumption of jurisdiction and lack of appropriate and detailed analysis simply thwarts the City's attempt to comply with CEQA, and the Commission's staff report fails to adequately address environmental impacts as the functional equivalent CEQA document.

Commission buries the analysis about the project as whole in the cumulative impacts section. (See p. 60-62). This is illegal piecemeal environmental review pursuant to CEQA.

In the case of Bennett v. Spear (520 U.S.154, at 176-177 (1997)), the United States Supreme Court ruled the following in addressing the enforcement of the protection of species under the federal Endangered Species Act: "The obvious purpose of the requirement that each agency "use the best scientific and commercial data available" is to ensure that the ESA not be implemented haphazardly, on the basis of speculation or surmise. While this no doubt serves to advance the ESA's overall goal of species preservation, we think it readily apparent that another objective (if not indeed the primary one) is to avoid needless economic dislocation produced by agency officials zealously but unintelligently pursuing their environmental objectives." The Ag Land Trust believes that, absent preparation of a full and complete EIR with a full and complete seawater intake alternatives analysis BEFORE any well is permitted or drilled, the staff recommendation violates the laws of California and will result in the unlawful taking of our property rights for the benefit of a private party.

The Ag Land Trust understands that there is a water shortage on the Monterey Peninsula. We have not caused nor have we contributed to that problem. It has gone on for decades. The Ag Land Trust also recognizes that Coastal Commission staff desires an absolute prohibition of seawater intakes for desalination plants. The water shortage that is of Cal-Am making (by its failure to produce a water supply project in over 20 years) does not justify the Commission staff's proposed illegal taking of our groundwater and property rights, and the intentional contamination of our potable aquifers and wells, for the sole and private economic benefit of Cal-Am.

We hereby incorporate by reference all facts, statements, and assertions included in the documents, cases, laws, and articles referred to herein, and included in the attachments and exhibits hereto.

We ask that the Commission deny the Cal-Am's appeal and application and require that a full and complete EIR be prepared before any permit is considered by your Commission and for the other reasons stated herein.

Most Respectfully for the Ag Land Trust,

Marc Del Piero,

Attorney at Law

Richard Nutter, Monterey County

Monterey Co. Agricultural Commissioner (ret.)

cc: California Coastal Commission staff

Exhibit 3 – Ag Land Trust Exhibits -

Opposition correspondence – 2006 - Present

AG LAND TRUST
Preserving Farm Land
Since 1984

www.AgLandTrust.org
Location: 1263 Padre Drive | Salinas, CA
Mail Address: P.O. Box 1731 | Salinas, CA 93902
Tel.: 831.422.5868

3 September 2014

To: City Council of the City of Marina

From: Board of Directors of the Monterey County Ag Land Trust

RE: Cal-Am slant well application/Mitigated Negative Declaration

Dear Council members:

The Ag Land Trust owns prime irrigated farmland adjacent to the property where Cal-Am proposes to construct and operate a test well that is designed to remove approximately 8,000.0 acre feet of groundwater from the overdrafted Salinas Valley groundwater basin during its test period. The Ag Land Trust has met with the representatives of Cal-Am and others in an effort to develop a mitigation agreement if and when damage is caused to the Ag Land Trust's property and well water supply by the test well and future well field operation. No agreement has been reached at this time. Therefore, due to the lack of action and mitigation agreement between Ag Land Trust and Cal-Am, the Board of Directors of the Ag Land Trust is forced to re-iterates its opposition to the appeal by Cal-Am of the denial of Cal-Am's slant well application by the Planning Commission of the City of Marina.

We hereby incorporate by reference each and every prior submission provided by our attorneys and us to the City of Marina, and its consultants and staff, as correspondence and/or exhibits in opposition to the pending Cal-Am slant well application. We oppose the Cal-Am slant well application and test wells because these applications fail to comply with CEQA and totally lack any groundwater rights in the overdrafted groundwater basin. We further agree with and incorporate by reference, and adopt as our additional comments, all of the statements included in the letter of objection written to the City of Marina dated September 3, 2014 from the law firm of Remy, Moose, and Manley LLC on behalf of the Marina Coast Water District.

Due to the absence of mitigation agreement the Ag Land Trust continues to object to the application by Cal-Am, in part, based upon the following reasons:

1. The California American Water Company has no groundwater rights in the overdrafted Salinas Valley groundwater basin. As a proposed junior appropriator, and as a matter of both California case law and statutory law, Cal-Am cannot acquire groundwater rights in that overdrafted basin, and is prohibited from exporting any groundwater, including the water pumped from their proposed test well, from that basin. The statutory prohibition is absolute. Cal-Am's so-called "physical solution" is prohibited by statute. The proposed "test wells" are a shame to obfuscate Cal-Am's lack of property/water rights to legally pursue its proposal. Moreover, Cal-Am's application poses grave and unmitigated adverse impacts (including, but not limited to loss of agricultural productivity, loss of prime farmland, loss of existing jobs, loss of potable water supplies and ground water storage capacities, loss of beneficial results from regionally funded and publicly owned seawater intrusion reversal capital projects (i.e. CSIP and the "Rubber Dam"), and intentional contamination of potable groundwater supplies) upon the privately held overlying

groundwater rights, water supplies and resources, and property rights of the Ag Land Trust, other overlying land owners with senior groundwater rights in the Salinas Valley, and of the residents of the City of Marina and the Salinas Valley.

2. The current Cal-Am slant wells/test wells application has identified no mitigation for the groundwater contamination that it will induce into the Ag Land Trust's underlying groundwater resources and storage aquifers. Cessation of wrongful pumping by a non-water rights holder in an overdrafted basin IS NOT MITIGATION FOR THE DAMAGE THAT WILL BE INDUCED TO OUR GROUNDWATER RESOURCES. Failure to identify an appropriate mitigation for the groundwater contamination that will result from the pumping of the 8,000.0 acre feet of groundwater from the test wells is a violation of CEQA. Further, Cal-Am's plan of intentionally inducing seawater into a potable groundwater aquifer that underlies our property is an intentional violation of both the 1968 SWRCB Resolution 68-16, the California Non-Degradation Policy, and the Basin Plan as adopted by the Central Coast California Regional Water Quality Control Board. Such intentional "bad acts" may be prosecuted both civilly and criminally against parties who are complicit in such intentional potable water supply contamination.

3. The 1996 agreement between the City of Marina, the MCWD, the land owners of the CEMEX site, the Armstrong family and the County of Monterey/MCWRA prohibits the extraction of more than 500 acre feet of groundwater annually from any wells on the CEMEX site as a condition of the executed agreement/contract. It further mandates that such water be used only on-site at the CEMEX property, within the Salinas Valley groundwater basin, as mandated by statute. The Ag Land Trust is a third party beneficiary of this 1996 agreement because Ag Land Trust pays assessments to the County of Monterey expressly for the seawater intrusion reversal projects known as CSIP and "the Rubber Dam". Cal-Am is prohibited from pursuing its project because of this prior prohibition and because Cal-Am's proposed acts will cause an ongoing nuisance, will directly injure Ag Land Trust property rights, and will irreparably compromise the beneficial public purposes of the above reference publicly owned capital facilities.

4. The granting of Cal-Am appeal will result in a loss of groundwater resources by the City and MCWD, massive expenses to the residents of Marina, and the effective transfer of water resources to a private company that provides no benefit or service to the City of Marina or its citizens.

We respectfully request that the Cal-Am appeal be denied, and if not, that as a condition of approval, the approval is subject to a signed mitigation agreement between Cal-Am and the Ag Land Trust prior to the construction of any well or wells. Furthermore, we believe that the Marina Planning Commission's denial of the Cal-Am application was well reasoned and correct. If the Council chooses not to deny the Cal-Am application, the Ag Land Trust respectfully requests that a full and complete EIR on the proposed slant wells (and their significant and unmitigated impacts and threats to regional groundwater supplies and the communities of Marina and the Salinas Valley as well as the determination of Cal-Am's groundwater rights) be prepared as mandated by CEQA. Failure to fully and completely require Cal-Am to comply with CEQA by requiring a full EIR will expose the City and its residents to the loss of public funds due to attorney's fees, litigation expenses, damages awards, and costs that provide no benefit to the City or to its citizens.

Respectfully,

S Darington

Sherwood Darington
Managing Director
Ag Land Trust

Ag Land Trust – Letter 1 (ALT1) - Exhibits

Yellow— Ag Land Trust (Monterey County Agricultural and Historic Land Conservancy) properties.

Pale Blue and Brown -- potential sea water wells and pipeline locations as extracted from Coastal Water Project FEIR Revised Figure 5-3.

NOTE: EIR Revised Figure 5-3 provides only a generalized representation of the sea water well areas with no references to properties included within their boundaries. Precise spatial data was not provided by the applicant or available from the EIR preparer.
This document was professionally prepared by a GIS Professional, using spatially accurate imagery, known physical features and property lines to provide a reliable representation of the Conservancy properties as they relate to the proposed sea well areas. Lack of access to the spatial data, if any, used in Revised Figure 5-3, has required some locational interpretation, which was performed using professional best practices.

MONTEREY COUNTY AGRICULTURAL AND HISTORICAL LAND CONSERVANCY
P.O. Box 1731, Salinas CA 93902

August 11, 2011

TO: California Coastal Commission

From: The Ag Land Trust of Monterey County

RE: Groundwater Rights and Submerged Lands

Tom Luster asked the question "Who owns the groundwater in the 180 ft. aquifer under the ocean?"

The answer is that, under California case law which controls the ownership and use of potable (fresh) groundwater rights in our state, each property owner with land that overlies a percolated fresh groundwater aquifer (including the State of California as the "public trust owner" of submerged lands that are overlying the Salinas Valley potable groundwater aquifer that extends into the Monterey Bay National Marine Sanctuary) is entitled only to its correlative share of the safe yield of the fresh groundwater that may be used without causing additional over-draft, adverse effects, waste and/or damage to the potable water resource or to the water rights of the other overlying land owners. (Katz v. Walkinshaw (141 Cal. 116); Pasadena v. Alhambra (33 Calif.2nd 908), and reaffirmed in the Barstow v. Mojave Water Agency case in 2000). The Commission has no right to authorize or allow the intentional contamination and waste of a potable aquifer which is also a Public Trust resource (see below), and such an act would be "ulta vires" and illegal.

The proposed slant "test" wells are intended to violate these laws and significantly induce saltwater and contamination into an overdrafted freshwater aquifer (a Public Trust resource) thereby causing depletion, contamination, waste, and direct and "wrongful takings" of the private water rights of other overlying land owners and farmers. Further, the project proponents, by their own admission, have no groundwater rights in the Salinas Valley aquifer because they are not overlying land owners. Such a "taking" will constitute a direct and adverse impact and impairment of the public's health and safety by diminishing a potable groundwater aquifer and a Public Trust resource. It will also adversely affect protected coastal priority agricultural enterprises.

In an overdrafted potable groundwater basin, no property owner or user of water is entitled to pump or take any such actions as to waste, contaminate, impair, or diminish the quality or quality of the freshwater resource. The overdrafted Salinas Valley fresh water groundwater aquifer that extends under the Monterey Bay National Marine Sanctuary is identified as a potable water resource by the State and is governed the SWRCB Groundwater Non-Degradation Policy, which finds its source in the California Constitution:

CALIFORNIA CONSTITUTION
ARTICLE 10 - WATER

SEC. 2. It is hereby declared that because of the conditions prevailing in this State the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare.

In other words, the state has determined that the subject Salinas Valley potable groundwater aquifer is a protected natural resource. The state may use the fresh groundwater only to the extent that it has a correlative right that accrues to its public trust lands as against all other overlying land owners that are exercising their rights and using the fresh groundwater for beneficial uses, as mandated and protected in the California Constitution. Further, the 1968 SWRCB Non-Degradation Policy absolutely prohibits the intentional contamination and/or "waste" of a potable groundwater aquifer by any party. (See attached Resolution No. 68-16) The fact that the Salinas Valley aquifer is a potable supply is definitively established in the Central Coast Regional Water Quality Control Board "Basin Plan" for Central California

Additionally, the mandatory requirements of the California Coastal Act also control the conduct, powers, and authority of the Calif. Coastal Commission when addressing these Public Trust resources and this application.

The California Coastal Act - Section 30231 (California Public Resources Code Section 30231) requires of the Commission that:

Sec. 30231 - The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored through, among other means, minimizing adverse effects of waste water discharges and entrainment, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface water flow, encouraging waste water reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams.

The proposed test wells directly and intentionally violate the mandatory statutory requirements, duties, and obligations imposed upon the California Coastal Commission by Section 30231 of the Coastal Act to protect and preserve and restore this potable water resource and protected coastal resource. The Salinas Valley potable groundwater aquifer, which is proposed to be wrongfully exploited by the project applicants' slant test wells, is a "coastal water", is producing potable water which is used and recognized for human consumption and coastal priority agricultural production, and shall be "protected from depletion" by the express language of the Coastal Act.

Finally, in the landmark Public Trust case of National Audubon Society v. Superior Court of Alpine County (1981), the California Supreme Court confirmed as part of its "Public Trust Doctrine" that the State retains continuing supervisory control over the navigable waters of California and the lands beneath them. This prevents any party from acquiring a vested right to appropriate water in a manner harmful to the uses protected by the Public Trust.(California Water Plan Update 2009, Vol. 4, Page 2 (1)).

The proposed slant test wells are designed to intentionally deplete, contaminate, and waste a protected potable water supply and a Public Trust resource. The project will violate statutory and regulatory mandates of the California Coastal Act, the California Water Code, the

California Public Resources Code, the California Constitution, and over 100 years of case law governing groundwater rights and the Public Trust Doctrine. It will result in the wrongful taking of water rights from farmers who are beneficially using the water for protected, coastal priority agricultural production and for human consumption. Besides that, the project applicants, by their own admission, have no appropriative groundwater rights. They should not even be entitled to a hearing.

This project should be denied, or at the very least continued until the Monterey County Superior Court can rule on the two lawsuits that are pending over these issues.

Marc Del Piero

STATE WATER RESOURCES CONTROL BOARD

RESOLUTION NO. 68-16

STATEMENT OF POLICY WITH RESPECT TO
MAINTAINING HIGH QUALITY OF WATERS IN CALIFORNIA

WHEREAS the California Legislature has declared that it is the policy of the State that the granting of permits and licenses for unappropriated water and the disposal of wastes into the waters of the State shall be so regulated as to achieve highest water quality consistent with maximum benefit to the people of the State and shall be controlled so as to promote the peace, health, safety and welfare of the people of the State; and

WHEREAS water quality control policies have been and are being adopted for waters of the State; and

WHEREAS the quality of some waters of the State is higher than that established by the adopted policies and it is the intent and purpose of this Board that such higher quality shall be maintained to the maximum extent possible consistent with the declaration of the Legislature;

NOW, THEREFORE, BE IT RESOLVED:

1. Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies.

2. Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained.

3. In implementing this policy, the Secretary of the Interior will be kept advised and will be provided with such information as he will need to discharge his responsibilities under the Federal Water Pollution Control Act.

BE IT FURTHER RESOLVED that a copy of this resolution be forwarded to the Secretary of the Interior as part of California's water quality control policy submission.

CERTIFICATION

The undersigned, Executive Officer of the State Water Resources Control Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on October 24, 1968.

Dated: October 28, 1968

Kerry W. Mulligan
Executive Officer
State Water Resources
Control Board

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July 26, 2011

Via Email
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Dan Carl, District Manager
Michael Watson, Coastal Planner
California Coastal Commission
Central Coast District Office
725 Front Street, Suite 300
Santa Cruz, CA 95060

Subject: Water Rights Issues Related to the Regional Desalination Project; Downey Brand letter of May 20, 2011

Dear Mr. Luster, Mr. Carl and Mr. Watson:

This Office represents Ag Land Trust, which owns agricultural properties in the Salinas Valley. For years, Ag Land Trust has pointed out that the Regional Desalination Project does not have valid water rights. The environmental documents to date have failed to point to valid groundwater rights for the project, and instead took various inconsistent positions on water rights.

This letter responds to new claims made by Downey Brand LLP, attorneys for the proponents of the Regional Project, in a letter dated May 20, 2011 to Lyndel Melton, P.E., of RMC Water and Environment. The Downey Brand letter was submitted to the Coastal Commission as part of the Regional Project proponents' response to the Commission's incomplete letter.

The Downey Brand letter raises various claims which may have superficial appeal but in reality do not identify any usable water rights for the Regional Project under California law. The claims made in the letter's discussion of "water rights and the groundwater basin" (Downey Brand letter, sec. 1, pp. 1-4) are addressed briefly here. Of the four different Downey Brand claims, none has merit, and none provides the necessary proof of water rights.

Downey Brand's General Claims about Water Rights

Monterey County Water Resources Agency has no groundwater storage rights, no overlying groundwater rights, and no "imported water rights." The Salinas Valley is

not an adjudicated groundwater basin. The Salinas Valley Groundwater Basin is severely overdrafted, as demonstrated by the seawater intrusion which has reached inland to within 1500 feet of the City of Salinas, according to the latest (2009) mapping. (Historic Seawater Intrusion Map
Pressure 180-Foot Aquifer, attached as Exhibit A to this letter.)

The EIR for the Coastal Water Project did not comprehensively or adequately examine the issue of water rights for the Regional Project. The EIR did not include the key admission by Monterey County Water Resources Agency ("MCWRA") that it does not have water rights that would support the pumping of groundwater by the wells for the Regional Project. (See March 24, 2010 letter from MCWRA to Molly Erickson admitting that MCWRA does not have any documented water rights for the Regional Project, and MCWRA General Manager Curtis Weeks' statement that "Water rights to Salinas basin water will have to be acquired" in the Salinas Californian, March 31, 2011 [http://www.thecalifornian.com/article/20100331/NEWS01/3310307/280M+-desalination-plant-10-mile-pipeline-agreed-on-for-Monterey-Peninsula].) The Regional Project intake wells would be owned and operated by MCWRA.

The Coastal Commission should not be misled by the claims of Downey Brand, starting with the claim that the source water "will" be 85% seawater and 15% groundwater. (Downey Brand letter, p. 1.) In fact, the EIR's Appendix Q predicted percentages of up to 40% groundwater in the source water throughout the 56-year modeled simulation period, which is two and two-thirds times greater than Downey Brand admits. (Final EIR, App. Q, p. ____.)

The general claims made in the Downey Brand letter about water rights (at p. 1, bottom paragraph) should be disregarded because they are devoid of specific citation to law or to specific water rights. The specific claims made on the subsequent pages are addressed below, in order.

<u>Downey Brand's Claim (a) – The "Broad Powers" of MCWRA</u>

Downey Brand's claim (a) is that MCWRA "has broad powers." (Letter, p. 2) While that may be true, MCWRA's powers do not include groundwater rights that it can use to pump water for the Regional Project. MCWRA holds only limited surface water rights (used for the dams and reservoirs some 90 miles south of the Monterey Bay), but intentionally abandons and "loses management and control" of that surface water when the MCWRA releases the water into the rivers and subsequently lost to percolation. "Management and control" are prerequisites to maintain the use of any right to water. In its letter, Downey Brand mixes inapplicable references to surface water rights and imported water cases. The issue here is native groundwater, not surface water or imported water. Downey Brand's approach is inconsistent with basic California groundwater law which holds that waters that have so far left the bed and other waters of a stream as to have lost their character as part of the flow, and that no longer are what the Regional Project would do. An overlying right is the owner's right to take water from the ground underneath for use on his land within the basin. An overlying right it is based on the ownership of the land and is appurtenant thereto. (*City of Barstow v. Mojave Water Agency*, *supra*, 23 Cal.4th 1224, 1240.)

Downey Brand's Claim (b) – A Right to "Developed" Groundwater

Claim (b) is that MCWRA has a right to withdraw groundwater "because its water storage operations augment groundwater supplies." (Downey Brand letter, p. 2.) There is no cognizable legal support given by Downey Brand for that claim in the sole case it cites: the California Supreme Court in *City of Los Angeles v. City of San Fernando* (1975) 14 Cal.3d 199. That case dealt with imported water, as is evident from the quote cited ("an undivided right to a quantity of water in the ground reservoir equal to the net amount by which the reservoir is augmented by [imported water]"). Imported water is "foreign" water from a different watershed – in the case of the *City of Los Angeles*, Los Angeles imported water from the Owens Valley watershed. (*City of Los Angeles, supra*, 14 Cal.3d at 261, fn. 55.) Because MCWRA does not import water from a different watershed, MCWRA cannot benefit from the rule that an importer gets "credit" for bringing into the basin water that would not otherwise be there (*ibid.,* at p. 261).

Under California law, rights to imported or foreign water are those rights which attach to water that does not originate within a given watershed. (*City of Los Angeles v. City of San Fernando*, *supra*, 14 Cal.3d 199, 255-256; *City of Los Angeles v. City of Glendale* (1943) 23 Cal.2d 68, 76-77.) Rights to imported water are treated differently from rights to "native water," which is water that originates in the watershed.

MCWRA's two reservoirs do not contain imported water. The reservoirs store native water from the Salinas Valley watershed. MCWRA argues that when the stored water is released, it recharges the basin. Although it may be true that the released water recharges the basin, MCWRA does not have a unilateral right to get the water back after the water has been released from the reservoirs. "Even though all deliveries produce a return flow, only deliveries derived from imported water add to the ground supply." (*City of Los Angeles, supra,* 14 Cal.3d at 261.)

The *City of Los Angeles* opinion does not help MCWRA, because the opinion applies only to imported water, and MCWRA does not import water. Downey Brand does not cite any other case in support of its claim of "developed" water. The claim fails.

Downey Brand's Claim (c) – the Doctrine of "Salvaged" Water

Downey Brand's third claim is that "[t]he doctrine of salvaged water demonstrates that seawater-intruded groundwater is available for the Regional Project." (Downey Brand letter, p. 3.) Under California law, salvaged water refers to water that is saved from loss from the water supply by reason of artificial work. Salvaged water encompasses only waters that can be saved from loss without injury to existing vested water rights. (Wells A. Hutchins, The California Law of Water Rights (1956) at pp. 383-385.) Appropriative rights to salvaged water depend on the original source of the water supply. (*Pomona Land and Water Company v. San Antonio Water Company* (1908) 152 Cal. 618.) The salvage efforts of native water supplies are bound by all the traditional considerations that are applicable to the exercise of the salvager's water right and the interests of other vested rights must be protected. (*Ibid*., at p. 623.)

The Regional Project must respect existing vested water rights. Here, because MCWRA does not have a water right, and because the interests of the existing vested rights – of the overlying property owners in the Salinas Valley – must be protected, and because there is not sufficient water in the overdrafted basin to satisfy those overlying claims, MCWRA's claim to salvaged water fails.

Downey Brand cites the doctrine of salvaged water as discussed in *Pomona Land and Water Company v. San Antonio Water Company, supra*, 152 Cal. 618 (*Pomona*), but that case does not help the Regional Project. *Pomona* involved a dispute between two water companies who appropriated water from a creek. The companies had existing water rights and a contractual agreement on how the waters flowing in the creek were to be divided between them. San Antonio Water built a pipeline in the creek and "saved" some water that would otherwise had been lost due to seepage, percolation, and evaporation. When Pomona claimed half of this saved water, San Antonio argued that because Pomona was still receiving the same amount of "natural flow," San Antonio should be allowed to keep the extra amount it saved through its own efforts. The Court ruled for San Antonio, holding that Pomona was entitled only to the natural flow, and that San Antonio was entitled to any amount saved by its economical method of impounding the water.

The Regional Project has no similarities to *Pomona*. The Regional Project does not involve the "saving" of water by implementation of conservation methods. Rather, it involves pumping water from the overdrafted Salinas Groundwater Basin – water which is fully appropriated. Unlike the parties in *Pomona* who held existing rights, MCWRA has no groundwater rights it can apply to the Regional Project.

The doctrine of salvaged water does not help the Regional Project proponents. The claim fails.

Downey Brand's Claim (d) – Use of "Product" Water

The claim regarding the use of desalinated water (Downey Brand letter, pp. 3-4) is not material to the issue of water rights. The claim is apparently meant to distract the Coastal Commission from the true issue. The Regional Project must have water rights in order to pump groundwater from the basin and take it to the desalination plant.

The Water Purchase Agreement is merely a contract between the Regional Project proponents and owners. And none of the Regional Project proponents and owners holds groundwater rights that can be applied to the Regional Project. The Water Purchase Agreement does not award water rights to anyone.

Conclusion

None of the Downey Brand claims provide proof of groundwater rights. In an overdrafted basin, proof of water rights is essential before groundwater can be appropriated. The Coastal Commission does not have the authority to grant groundwater rights or to grant approval of a project that relies on the illegal taking of groundwater that belongs solely to the overlying landowners of the Salinas Valley. We urge the Coastal Commission to consult with its own expert water rights counsel with regard to this critical issue.

Thank you for the opportunity to respond to the Downey Brand letter. Feel free to contact me with any questions.

Very truly yours,

LAW OFFICES OF MICHAEL W. STAMP

Molly Erickson

Exhibit A: "Historic Seawater Intrusion Map Pressure 180-Foot Aquifer" showing intrusion as of 2009, dated November 16, 2010 (available at http://www.mcwra.co.monterey.ca.us/SVWP/01swi180.pdf)

Exhibit B: Salinas Californian article, March 31, 2011

Exhibit C: Letter from MCWRA to Molly Erickson, March 24, 2010

FAX TRANSMISSION

MONTEREY COUNTY WATER RESOURCES AGENCY
P. O. BOX 930
SALINAS, CA 93902
831.755.4860
FAX: 831.424.7935

FOR IMMEDIATE DELIVERY	DATE: 3/25/10
To: Molly Erickson	From: David Kimbrough
C/O:	
FAX: 373-0242	( )
Re: PRAR - 3/3/10	

MONTEREY COUNTY

WATER RESOURCES AGENCY

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CURTIS V. WEEKS
GENERAL MANAGER

STREET ADDRESS
893 BLANCO CIRCLE
SALINAS, CA 93901-4455

March 24, 2010

Molly Erickson, Esq.
LAW OFFICES OF MICHAEL W. STAMP
479 Pacific Street, Suite 1
Monterey, CA 93940

Re: Your Letter of March 22, 2010

Dear Ms. Erickson:

You were wrong in considering MCWRA's response to your March 3, 2010 Public Records Request as "disingenuous." Consider the following:

At the Board hearing of February 26, 2010, Mr. Weeks addressed the development of basin water; that is water that the proposed Regional Desalination Project will produce. The project will rely upon the removal of sea water, which will most likely contain some percentage of ground water. Whatever percent is ground water will be returned to the basin as part of the project processing. As a result, no ground water will be exported. Mr. Weeks' comment to "pump groundwater," refers to this process. The process is allowable under the Agency Act. See the Agency Act (previously provided) and the EIR for the SVWP, which I believe your office has, but if you desire a copy, they are available at our offices for $5.00 a disc. In addition, a copy of the FEIR for the Coastal Water Project and Alternatives is also available for $5.00 a copy. Further, MCWRA intends to acquire an easement, including rights to ground water, from the necessary property owner(s) to install the desalination wells. These rights have not been perfected to date, hence no records can be produced.

As to MCWD, it was previously annexed into Zones 2 & 2A and as such has a right to ground water. These documents are hereby attached PDF files.

As for the reference to "every drop of water that we pump that is Salinas ground water will stay in the Salinas Ground Water Basin," this was a reference to the balancing of ground water in the basin. The development of the Salinas River Diversion Project is relevant, as it will further relieve pressure on the ground water wells. As such, it is a component of the overall plan to protect and enhance the ground water supply, keep it in the basin, and prevent salt water intrusion. In your letter of March 22nd, you did not consider this project as relevant. Nevertheless these records are available for your review

Looking forward, one additional document is the staff report yet to be finalized for the Board's consideration in open session of the Regional Project. When available, this will be provided.

Very truly yours,

David Kimbrough
Chief of Admin Services/Finance Manager

Encls.

cc: Curtis V. Weeks

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March 3, 2010

Via Facsimile

Les Girard
Assistant County Counsel
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Salinas, CA 93901

Irv Grant
Deputy County Counsel
Monterey County Water Resource Agency
168 W. Alisal Street, 3d Floor
Salinas, CA 93901

Subject: Public Records Request

Dear Mr. Girard and Mr. Grant:

This Office would like to inspect the following County records and County Water Resources Agency records, and possibly copy some of them.

1. All records that reference the groundwater rights held by Monterey County Water Resources Agency or by Marina Coast Water District, as asserted at the Board of Supervisors hearing on Friday afternoon, February 26, 2010, by Curtis Weeks, General Manager of the County Water Resources Agency.

   As further information, we seek all records on which Mr. Weeks based his response to Supervisor Calcagno's question regarding whether the Water Resources Agency has rights to pump groundwater for the proposed Regional Project. Mr. Weeks responded as follows:

   > "As to wells that are developing basin water, both ourselves and Marina Coast Water District are organizations that can pump groundwater within the Salinas basin. Every drop of water that we pump that is Salinas groundwater will stay in the Salinas groundwater basin. After the implementation, which will begin . . . actually, the operation of the Salinas Valley Water Project on the 22nd of April, we'll be fully in balance. There will be no harm to any pumpers in the Salinas Valley."

2. All records that show that after the initiation of the operation of the Salinas Valley Water Project, the Salinas Groundwater basin will "be fully in balance," as Mr. Weeks asserted.

The request includes all email communications of all kinds, including those, for example, residing on personal computers, on shared drive(s), and in archived form. We request access to the emails in the same format held by the County. (Gov. Code, § 6253.9, subd. (a).) Instead of printing out electronic records, please place them on CDs. If the records are kept individually, please copy them as individual emails, and include attachments attached to the respective emails.

If you produce an EIR or any lengthy documents in response, please identify the specific pages on which the responsive information is presented.

If there are records that you think might be eliminated from the County production, please let me know. If the County has any questions regarding this request, please contact me. We will be happy to assist the County in making its response as complete and efficient as possible.

I draw the County's attention to Government Code section 6253.1, which requires a public agency to assist the public in making a focused and effective request by (1) identifying records and information responsive to the request, (2) describing the information technology and physical location of the records, and (3) providing suggestions for overcoming any practical basis for denying access to the records or information sought.

If the County determines that any or all or the information is exempt from disclosure, I ask the County to reconsider that determination in view of Proposition 59, which amended the state Constitution to require that all exemptions be "narrowly construed." Proposition 59 may modify or overturn authorities on which the County has relied in the past. If the County determines that any requested records are subject to a still-valid exemption, I ask that: (1) the County exercise its discretion to disclose some or all of the records notwithstanding the exemption, and (2) with respect to records containing both exempt and non-exempt content, the County redact the exempt content and disclose the rest.

Should the County deny part or all of this request, the County is required to provide a written response describing the legal authority on which the County relies.

Please respond at your earliest opportunity. If you have any questions, please let me know promptly. Thank you for your professional courtesy.

Very truly yours,

Molly Erickson

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December 16, 2009

Via Email
Michael R. Peevey, President,
and Members of the Commission
California Public Utilities Commission
505 Van Ness Avenue
San Francisco, CA 94102

Subject Coastal Water Project EIR Does Not Comply with CEQA; Illegal Piecemealing of Environmental Review; Potential Takings Claim

Dear President Peevey and Member of the California Public Utilities Commission:

This Office represents the Ag Land Trust, which owns property that would be affected by the proposed Regional Project. (See attached figure.) The Ag Land Trust was formerly known as the Monterey County Agricultural and Historic Land Conservancy. On the Commission's December 17, 2009 agenda, there is a request to certify the Environmental Impact Report (EIR) for the Coastal Water Project.

The Ag Land Trust urges the Commission to delay the proposed certification of the EIR for many reasons, including these:

1. If the CPUC certifies the EIR now, local public agencies plan to use it to approve one of the project alternatives, thereby taking away the authority of the CPUC to select a project based on this EIR.

2. The Public has had inadequate time to review the EIR, which is over 3,100 pages and is not available in hard copy anywhere in Monterey County. The Public was told that the EIR certification would be considered in January 2010. The certification was expedited to December 2009 with inadequate notice to the Public.

3. The EIR is deeply flawed. The public needs more time to advise the Commission as to the flaws, so the EIR can be corrected to address key issues adequately.

<u>As Soon as the EIR is Certified, the Local Agencies Plan to Jump Ahead of the CPUC and Approve the Regional Project</u>.

The Regional Project is the third of the three projects analyzed in the EIR. As soon as the CPUC certifies the EIR, the local public agencies that are the proponents of the Regional Project plan to rely on the EIR to approve the Regional Project on an expedited basis, as the attached December 9, 2009 powerpoint documents show (see p. 5). The project proponents have already determined that the CPUC's EIR is inadequate as to specific known potential impacts, including brine disposal. Given the EIR omission, a local agency plans to issue a supplemental environmental document to address brine disposal, and the local agencies can then be under way with the Regional Project, making the CPUC's future scheduled action to select a project meaningless.

The local agencies would be able to do this because they are not subject to CPUC authority. They are seeking grant funding which would provide project financing. Once the local agencies approve the Regional Project, the CPUC would not be able to rely on its certified EIR to select either of the two projects proposed by Cal Am. The reason is that to select either of the Cal Am projects would mean the CPUC would be allowing a second project to be built, in addition to the Regional Project. The EIR does not evaluate the environmental impacts of two projects being built. It addresses the impacts of only one of three projects being built. If the local agencies approve the Regional Project first, as they plan to do, then when the CPUC in April 2010 considers selecting a project, the CPUC could not rely on its own EIR to do so because the EIR does not envision two projects being built. A second project would have significant cumulative and growth-inducing impacts that have not been analyzed in the EIR.

The CPUC cannot certify an EIR for a project over which it has no jurisdiction. Under CEQA, "lead agency" is defined as "the public agency which has the *principal* responsibility for carrying out or approving a project which may have a significant effect upon the environment." (Pub. Resources Code, § 21067, italics added.) The CPUC is not the lead agency for the Regional Project, because the CPUC would have no role in approving or carrying out the desalination plant, the source water wells and pipelines, or the brine disposal, which are the principal facilities of the Regional Project. The desalination plant would be owned and operated by the Marina Coast Water District (MCWD), a local public agency. Monterey County Water Resources Agency (MCWRA) would own and operate the wells. The brine disposal would be through facilities owned by the Monterey Regional Water Pollution Control Agency (MRWPCA). The public agencies would carry out and approve the project. The lead agency for the Regional Project should be a local agency.

As the Court of Appeal held in addressing the issue of the lead agency, "Our threshold question here is which agency . . . has the principal responsibility for the activity." (*Friends of Cuyamaca Valley v. Lake Cuyamaca Recreation and Park District* (1994) 28 Cal.App.4th 419, 427.) The specific facts of a case determine who is lead agency. (*Id.*, at p. 428.)

> The Legislature enacted CEQA in 1970 as a means to force public agency decisionmakers to document and consider the environmental implications of their actions. (§ 21000,

> 21001; *Friends of Mammoth v. Board of Supervisors* (1972) 8 Cal.3d 247, 254-256, criticized on another ground in *Kowis v. Howard* (1992) 3 Cal.4th 888, 896.) CEQA and its Guidelines (Cal. Code Regs., tit. 14, § 15000 et seq.) constitute a comprehensive scheme to evaluate potential adverse environmental effects of discretionary projects proposed to be carried out or approved by public agencies. (§ 21080, subd. (a); *Citizens for Quality Growth v. City of Mt. Shasta* (1988) 198 Cal.App.3d 433, 437.) "The foremost principle under CEQA is that the Legislature intended the act 'to be interpreted in such manner as to afford the fullest possible protection to the environment within the reasonable scope of the statutory language.' " (*Laurel Heights Improvement Assn. v. Regents of University of California* (1988) 47 Cal.3d 376, 390, quoting *Friends of Mammoth v. Board of Supervisors, supra*, 8 Cal.3d at p. 259.)
>
> The issue here is . . . [which public agency] was the public agency required under the act to evaluate potential adverse environmental effects of this activity. Or, using the applicable terms of art under CEQA, the issue is whether the District was the "lead agency."

(*Friends of Cuyamaca Valley v. Lake Cuyamaca Recreation and Park District, supra,* 28 Cal.App.4th 419, 426, internal parallel citations omitted.)

Under CEQA, a local agency must be lead agency for the Regional Project due to (1) the CPUC's lack of jurisdiction over the Regional Project's primary components, (2) the local agencies' ownership interests in the proposed desalination plant, source wells and pipeline, and brine disposal, and (3) the local agencies will be the first to act on the project approvals (see FEIR Figure 5-6 and presentations attached to this letter for reference).

<u>EIR Discussion of "Lead Agency" is Inconsistent and Misleading</u>.

The EIR does not clearly present this issue. Instead, the EIR discussion of agency roles under CEQA is inaccurate and fails to disclose the material facts or the issues. The EIR lacks the required comprehensive discussion of the issues to inform the public and decisionmakers. At best, the EIR creates a significant ambiguity.

The EIR repeatedly describes the CPUC as the lead agency, and the local agencies (such as the MCWD. MCWRA, and MRWPCA) as responsible agencies (e.g., FEIR Master Response 13.3). The EIR does not directly address whether those roles would be different for any of the project alternatives. Instead, in discussing the Regional Project, the EIR merely alludes to the CPUC as not having direct authority or jurisdiction over the project proponents. The EIR never addresses a key CEQA issue: that the CPUC is not the lead agency for the Regional Project. The EIR never identifies which agency would be lead agency for the Regional Project.

<u>The ALJ'S Draft Decision Compounds the Problems.</u>

Perhaps as a result of the EIR's confusing discussion, the draft decision before the CPUC to certify the EIR contains similar important ambiguities. For example, the draft decision states that Phase 2 of the Regional Project is not subject to the CPUC's approval at this time. (Draft Decision, rev. 1, p. 19.) However, the draft decision fails to clarify that Phase 1 of the Regional Project is also not subject to the CPUC's approval – either now or in the future – because the project proponents are not subject to CPUC jurisdiction. The project proponents – the local public agencies – can and plan to approve and carry out the Regional Project without CPUC involvement.

Only one week after the EIR was released, the ALJ issued a proposed draft decision certifying the EIR, which was later revised with minor non-substantive changes. The draft decision proposes that the CPUC make findings that are not authorized by CEQA, and proposes an order for which the CPUC has no authority. The Order states that the EIR is "certified for use by . . responsible agencies in considering subsequent approvals of the project, or for portions thereof." (Draft decision, p. 24.) The CPUC does not have authority to make that order, and no supporting reference is provided. If local agencies approve the project or project components first, before the CPUC does or can, then the first local agency to act becomes the lead agency under CEQA. (See *City of Sacramento v. State Water Resources Control Board* (1992) 2 Cal.App.4th 960; *Citizens Task Force on Sohio v. Bd. of Harbor Commissioners of the Port of Long Beach* (1979) 23 Cal.3d 812.)

The draft decision asserts (p. 20) without legal support that "the lead agency must find that the document was (or will be) presented to the decisionmaking body for review and consideration prior to project approval." There is nothing in CEQA that requires a finding that the document "will be" presented to the decisionmaking body, and such a finding is both misleading and confusing. Further, with regard to the Regional Project, the CPUC has no authority over what documents will be presented to the various decision-making bodies who will act on project components. As another example, the proposed finding of fact #1 fails to state that the CPUC is not the lead agency for review of the Regional Project alternative. The CPUC has no authority over the local agencies who are the proponents of that project. The draft decision is also inaccurate in key respects, including the claim that the FEIR states that the Monterey Peninsula has experienced seawater intrusion for decades. The Monterey Peninsula has no documented problems with seawater intrusion. Throughout this proceeding, the lack of familiarity with the on-the-ground conditions has been a significant problem.

The Final EIR Is Deeply Flawed and Does Not Comply with CEQA.

The project description has changed dramatically from the Notice of Preparation to the Draft EIR to the Final EIR. This violates the basic CEQA tenet that "An accurate, stable and finite project description is the sine qua non of an informative and legally sufficient EIR. (*Concerned Citizens of Costa Mesa v. 32nd Dist. Agric. Ass'n.* (1986) 42 Cal.3d 929, 938, internal citations, quote marks and punctuation omitted.) Here, the changes from the Notice of Preparation, to the Draft EIR, to the Final EIR have violated this basic principle. As one example, a project alternative (the Regional Project) that was not proposed to be built by the project applicant (Cal Am) and was not subject to the CPUC's jurisdiction was added after the EIR was under way. Under the circumstances, the EIR's inclusion of the Regional Project was highly unusual and not adequately explained in the EIR, either substantively or procedurally. Other examples of the significant EIR flaws are provided here.

Lack of Compliance with Monterey County Code: No Alternative Water Supply: The EIR fails to disclose Monterey County's requirement that each desalination plant include an alternative source of water supply (Monterey County Code, Ch. 10.72). The code requires that a permit be obtained for all desalination facilities (10.72.10), and states that the permit application shall include:

> a contingency plan for alternative water supply which provides a reliable source of water assuming normal operations, and emergency shut down operations. Said contingency plan shall also set forth a cross connection control program.

(Monterey County Code, § 10.72.020.F, attached for reference.) None of the three proposed projects includes a "contingency plan for alternative water supply." As proposed, the City of Marina and the majority of the Monterey Peninsula population would rely on the project for their water supply. If that supply fails, either for a short term or for a long term, the community will not have a water supply. The EIR does not analyze the projects' inconsistencies with the County requirement for an alternative water supply. In response to the comment that the project should include an operations plan and a contingency plan, the EIR merely states "comment noted." (FEIR, G-SVWC-13 and response thereto.)

The EIR omission is significant due to CEQA's requirement that in order to fulfill CEQA requirements, environmental review is mandated "at the earliest possible stage." (*Bozung v. Local Agency Formation Com.* (1975) 13 Cal.3d 263, 282.) By failing to include consideration of an alternative water supply in the project description, the EIR is piecemealing the environmental review, because such alternative supply is required.

The EIR omission is also significant due to the magnitude of the health and safety risk to the community which is the County Code intends to address. (See attached County documentation supporting the creation of Chapter 10.72.) Desalination plants have a very poor record of operations and maintenance. There is no record of any desalination plant of any size, such as proposed here, operating for any reliable period of time in the United States. The few that have been constructed have had very serious design, construction, and maintenance issues. For this reason, the success of the three proposed projects is pure speculation. If, as proposed, the vast majority of the Monterey Peninsula population and all of Marina -- including residents, industry and business -- rely on the desalination plant for their water supply, and the supply stops, or is interrupted, there would be very significant impacts and risks to public health and safety. The EIR does not address this issue.

Incorrect and Misleading Statements: The EIR contains incorrect and misleading material statements. The inaccuracies extend to basic information about the current environmental setting. For example, section 1.6 Project Setting (pp. 1-7 and 1-8) contains significant misstatements of fact. No support is provided for these misstatements which include (1) the claim that the MCWRA is a primary custodian of water supplies in North Monterey County (when in fact, MCWRA is not a water supplier and, critically, does not have appropriative rights), (2) the claim that the Salinas Valley Water Project will "stop seawater intrusion and provide adequate water supplies to meet current and future (2030) needs" (when in fact the SVWP EIR admits it may not achieve those goals), and (3) the claim that the San Clemente Dam is "the major point of surface water diversion from the [Carmel] river" (when in fact the San Clemente Dam provides no water supply because it is fully silted up and is proposed to be removed). These three examples early in the EIR set the stage for the myriad errors and misrepresentations that permeate the EIR document. There are many other problems which the public has been unable to present to the CPUC staff.because of the expedited schedule, the length of the EIR, and the lack of availability of a hard copy of the EIR. The EIR preparer should correct all errors before the EIR is considered for certification.

As another material example, the EIR incorrectly identifies and discusses Zone 2C in a way that is misleading to the public and to decisionmakers. (See, e.g., FEIR, p. 6.2-16.) Zone 2C is not a groundwater scheme. It is a zone created for the purposes of tax assessments, and delineates the boundary of the area that would purportedly benefit from -- and therefore be assessed for -- the Salinas Valley Water Project, which is a surface water project. The distinction is critical.

Failure to Adequately Analyze Potential Environmental Impacts of Project; Failure to Adequately Describe or Analyze Environmental Setting; Failure to Adequately Describe or Analyze Cumulative and Growth-Inducing Impacts: These failures take many forms. As one significant example, the FEIR fails to adequately disclose that the local agencies' hybrid Regional Urban Water Augmentation Project (RUWAP) would produce up to 3,000 AFY, which is expected to be online between 2008 and 2015. The EIR describes the RUWAP as producing only 1,000 AFY. It fails to identify or investigate the additional 2,000 AFY of RUWAP supply that is currently under active implementation, and that would be provided to the MCWD and the Peninsula. As a result, the EIR fails to adequately analyze the potential growth-inducing environmental impacts of the proposed projects, fails to adequately describe or analyze environmental setting, and fails to adequately describe or analyze cumulative impacts. (See attachments for further documentation of the hybrid RUWAP project currently under way by local agencies.)

Failure to Adequately Investigate or Disclose Brine Disposal Impacts: The EIR fails to analyze the potential impacts of the proposed ocean outfall disposal of the brine that would be produced by the desalination plan. As one material example, the Regional Project proposes to use the treated water wastewater outfall owned by the MRWPCA. Studies indicate that MRWPCA's outfall capacity may not be available for all outfall flow conditions. It is unknown whether the outfall could accommodate all outfall operating parameters if the Regional Project is built. It is foreseeable that brine discharge would exceed outfall capacity during high-flow periods. There is no analysis of the availability of wastewater for the various demands of multiple projects. It is foreseeable that if all wastewater is used for disposal and brine dispersion, that commitment would cause significant impacts on the RUWAP (which uses recycled water from the MRWPCA) and the Ground Water Replenishment project that is an essential part of the Regional Project.

The EIR fails to disclose or investigate these issues or their potential significant impacts. The EIR fails to investigate important issues including: the capacity of the existing outfall to accommodate increased brine flow; the potential sacrifice of outfall capacity allocated for future development in the area in favor of allocating unused capacity for brine; minimization of stormwater capacity in the outfall and how this might be mitigated (e.g., storage tanks, ASR well, if mitigation is even possible, etc.); or blended water quality in light of applicable water quality parameters, including NPDES discharge limits for TDS. Further, the EIR fails to adequately describe or investigate the fate of desalination-facility cleaning chemicals and other project waste streams. This is not new information. It has been openly and publicly discussed since at least early 2008. (See February 20, 2008 report to MPWMD, attached.)

The local agencies have acknowledged that the CPUC's EIR does not adequately address brine disposal through their own actions to address the omission.

Even before the comment period on the CPUC's Draft EIR closed, one agency had already begun to prepare a separate environmental review of brine issues that should have been included in the CPUC's EIR. This fractured approach to environmental review of project components is piecemealing, which is prohibited by CEQA. The local agency's work is intended to allow the local agencies to move ahead with the Regional Project without the active involvement of the CPUC, and even if the CPUC intends to select a different project of the three analyzed in the EIR.

Piecemealing of Project Review: Another example of the EIR's inadequacy and piecemealing is the project description's failure to include the known cogeneration facility that is part of the project. That facility has been proposed at least since 2008, before the Draft EIR was released. (See attached references, including March 2009 presentation by Curtis Weeks of Monterey County Water Resources Agency.) As a result of this failure, the EIR fails to analyze the potential environmental impacts of that facility. The very brief EIR discussion (FEIR pp. 5-45 and 5-46) contemplates the new facility, but defers analysis to a future date. The new facility is foreseeable and would be built as part of the Regional Project, to enable the project. The environmental analysis should not have been deferred, and should have been included in the FEIR.

Unanalyzed Impacts on Overdrafted North County Aquifers: The FEIR is claiming the "modeling" indicates there will be no impacts of pumping 24,000+ AFY out of the 180-foot aquifer. However, a review of the well locations upon which the EIR modeling is based shows that none of them are located within any of North County's hydrological subareas.[1] For this reason, the wells could not show impacts to North County wells, because that information was not part of the model. The Salinas Valley Water Project was approved by the voters based on claims that it would improve the North County aquifers, which are uphill from the Salinas Valley Groundwater Basin. Several times, MCWRA general manager Curtis Weeks has publicly described that claim by likening the basin to a bathtub into which North County aquifers run, and when the water level of the bathtub increases, the aquifers do not run downhill to the same extent. Here, the EIR fails to analyze whether the pumping of 24,000+ AFY – or 88,000 AFY, as is foreseeable – on the North County hydrological subareas.

EIR Relies on False Assumption: The EIR uses the modeling presented by the project proponents. According to the EIR, project proponent's Regional Project impact analysis relied on a modeling assumption that the SVWP Phase II would be in place.

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[1] This can be determined by reviewing the mapping of North County's subareas in relation to major roadways, and comparing that information to the figures showing well locations in the EIR appendices in relation to those same roadways.

> The SVIGSM modeling used to evaluate impacts of the Regional Project was based on a future baseline condition that assume complete implementation of Phase II of the SVWP.

(FEIR, p. 14.5-145.) However, no "Phase II of the Salinas Valley Water Project" is in place, and it is unclear what the EIR means. A second SVWP phase is not proposed, approved, funded or built. The Salinas Valley Water Project EIR did not use the term "Phase II," but it did envision an expanded distribution system to address the continuing water supply challenges in the Salinas Valley (e.g., SVWP EIR, p. 2-294). Because the modeling of the SVWP indicated that the SVWP may not halt seawater intrusion, the MCWRA contemplated a future expanded distribution system. Presumably that future expanded system is what the CWP EIR means when it refers to "Phase II of the SVWP." The SVWP EIR projected a cost of more than $40 million for this distribution system, which presumably voters would need to approve, just as voters were required to approve the initial SVWP phase currently under construction. Since then, every distribution scheme the MCWRA has discussed dwarfs the $40 million estimate found in the EIR.

The CWP EIR describes what is calls "Phase II" of the SVWP as "Increased diversion. Delivery could be directly to urban or could be expanded to CSIP with equivalent amount of pumped groundwater to urban." The CWP EIR also describes it as "urban supply." (FEIR, p. N-44.) The purported "Phase II" is also addressed at page 6.2-18. It is unclear to which Regional Project phase the CWP EIR discussion applies.

The EIR does not identify all of the assumptions used by the project proponents for their modeling, which is a significant concern. As a result, the public and the decision makers are not informed of the project proponents' assumptions, which can make a critical difference in the outcome of the modeling on which the EIR relied. The modeling and reliability is no better than the reliability of the underlying assumptions, and the assumptions are not adequately described.

<u>Inadequate Investigation and Disclosure of Impacts to Overlying and Adjacent Properties</u>: The EIR does not adequately investigate or discuss the impacts on overlying or adjacent properties. For this reason, the EIR fails as an informational document under CEQA.

The EIR even fails to clearly identify where the projects would be located, which is another aspect of the inadequate and changing project description. There is no reliable information as to where the wells or the pipelines would be located. Revised Figure 5-3 is the EIR's best depiction of the well and pipeline locations for the proposed seawater intake. The poster figure is a blurry generalized drawing. The figure fails to identify the difference between the blue swath and the brown swath. The EIR does not identify property, parcels, or locations.

The EIR inappropriately defers that crucial investigation to a future date, and does not contemplate further CEQA review of that information. That was verified by Janet Brennan on December 11, 2009, in email communications with Eric Zigas, ESA (attached).

This deferred analysis is inappropriate under CEQA for several reasons. As one example, it fails to adequately address and identify the potential environmental impacts on the properties or potential property rights or taking issues. The Ag Land Trust has identified potential impacts and issues several times in its communications with the CPUC and ESA. It has not received any response other than a cursory and inadequate one in the EIR response to comments. The Ag Land Trust, which owns property underlying the blue swath on Figure 5-3, and possible the brown swath as well, has important property interests at stake, but never received notice from the CPUC, Cal Am, or the local agencies of the proposed certification of the EIR on December 17, 2009. The EIR claims that contacts were made with overlying landowners, but the Ag Land Trust was not contacted. (See the attached figures to show the Ag Land Trust properties with respect to the proposed Regional Project.)

In a related example, the EIR fails to adequately disclose or consider the projects' potential impacts on sensitive habitat. For example, the Martin Dunes property is included in the blue swath that identifies well locations and pipeline locations for the Regional Project (see FEIR Revised Figure 5-3 and figures attached to this letter).[2] The Martin Dunes property contains one of California's most ancient and intact dune ecosystems. It is located south of the Salinas River National Wildlife Refuge. At least six federally or state listed species are known to occur at the site, including Western snowy plover, Smith's blue butterfly, Monterey spineflower, Monterey gilia, Menzies' wallflower, and California legless lizard, as well as other special-status species. Maritime chaparral, which is also sensitive habitat, is also on the Martin Dunes site. The Martin Dunes are owned by the Big Sur Land Trust, which has made significant efforts to restore and protect the property and its resources. The North Monterey County Land Use Plan specifically addresses the site in several sections, including key policy 2.3.1, and specific policy 2.3.3.A.6, and recommended action 2.3.4.5, attached for reference. The EIR fails to identify or discuss these issues, which is a failure to adequate describe the environmental setting, as well as a failure to investigate potential

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[2] That figure is not specific as to parcels or properties. When mapping information was requested of the EIR preparer ESA, ESA responded was that there was no more specific information available for the project location other than as shown on Revised Figure 5-3.

impacts. The EIR mitigations do not adequately mitigate for potential impacts. There are no mitigations to potential impacts on Western snowy plover, Monterey spineflower, Monterey gilia, Menzies' wallflower, and California legless lizard. Mitigation measure 4.4.1a proposed for Smith's blue butterfly are inadequate, because it is permissive and not mandatory. Subsections (2) and (3) merely state that certain actions "should" be made, without accountability by the project applicant or public agency if they do not happen, and without identifying the potential impacts if the actions are not taken. Further, FEIR Table 7-1 states that the expansion of the Salinas River Diversion Facility would be in Phase I of the Regional Project. That is incorrect; the expansion is in phase 2 of the Regional Project. FEIR Table 5-1 clearly shows the diversion facility in Phase 2. The internal inconsistencies in the EIR, like this one, make parts of the EIR impossible to understand because the information cannot be reconciled. For this reason as well, the EIR fails as an informational document.

Separately, the EIR figures are inconsistent with project depictions presented just last week to the local cities and agencies by Jim Heitzman, General Manager of MCWD and Curtis Weeks, General Manager of MCWRA. (See attached December 9, 2009 powerpoint presentation.) These agencies are the ones who will be implementing the project. If the EIR figures are inaccurate, as they appear to be, that also causes the EIR to fail as an informational document.

The Regional Project Would Export Groundwater from the Salinas Valley Groundwater Basin, Which is Prohibited by Law.

The MCWRA Act prohibits groundwater exportation due to concern about the "balance between extraction and recharge" within the Salinas Valley Groundwater Basin (MCWRA Act, § 52-21; FEIR p. 4.2-28). The EIR does not dispute that the Salinas Valley Groundwater Basin is in overdraft and has been increasingly in overdraft for decades, as shown by the steady inland progression of seawater intrusion. One of the three projects reviewed in the CWP EIR – the Regional Project – would pump groundwater directly from the overdrafted Salinas Valley Groundwater Basin. Another of the projects – the Cal Am North Marina project – would pump groundwater indirectly.

These two projects would violate the MCWRA Act because the project would extract groundwater and not recharge the basin. Instead, the groundwater would be put to use. The EIR claims that the amount of groundwater pumped would be returned in the same volume to the basin, either by providing the water for irrigation through CSIP (the Cal Am North Marina project) or for consumptive use by MCWD customers (the Regional Project). However, use of the "returned" water for irrigation would allow only 50% of that amount to recharge the basin. The County uses a 50% return water factor for irrigation in its standard water calculations. Both of these two methods – irrigation and consumption – would violate the Act's requirement for a "balance between extraction and recharge" because any recharge of the basin would be much less than the amount extracted from the basin. Use of the pumped groundwater for MCWD connections would also violate the MCWRA Act, because such use results in far less than a 50% return to the basin, because much water is lost through irrigation and sewers. The EIR fails to adequately discuss these issues, impacts and inconsistencies.

The proposed desalination project would export Salinas Valley groundwater to the Monterey Peninsula. The proposed way around the prohibition on groundwater exportation is to "return" an "annual average" to the Salinas Valley Groundwater Basin by placing it in the 80-AF CSIP pond for irrigation of Salinas Valley agricultural lands. There are multiple problems with the EIR's analysis.

There is no question that Salinas Valley Groundwater would be exported to the Monterey Peninsula. Such groundwater would be pumped "at unspecified volumes" (FEIR, pp. 4.2-50, 6.2-16), desalinated, and sent through the Cal Am pipes to the Peninsula. It is misleading for the EIR to claim that the groundwater would stay in the basin. The groundwater would be mixed with the seawater as it comes up the pumps, through the pipelines, and through the treatment plant. The groundwater molecules cannot be separated from the seawater molecules. The treated water would be a blend of both kinds of water, and that blended water would be exported to the Monterey Peninsula.

The EIR does not describe how the "annual average" will be calculated, or who will verify it. The proposed use of an "average" means that in some years more water will be exported to the Peninsula than "returned" to the Salinas Valley basin, which means that in those years the basin would be further imbalanced (causing attendant harm) through the operation of the proposed project. The EIR fails to analyze this inconsistency with the MCWRA prohibition, and fails to analyze the potential environmental impacts of the scheme.

The EIR repeatedly uses the 85% seawater/15% groundwater proportions, although those proportions are projected only for the first 10 years (FEIR, Appendix Q, p. 24). The EIR fails to adequately discuss or investigate whether the proposed actions are feasible or effective in future project years, when the proportions change significantly to 60% seawater and 40% groundwater, or what potential impacts those actions may have. For example, in the years when the 24,870-AFY of pumped water is 40% groundwater, that 40% would be 9,947 AFY of desalinated water that must be returned to the SVGB. The desalination plant is intended to produce 10,700 AFY, under full operating conditions. The Monterey Peninsula (Cal Am system) will be depending on receiving 8,800 AFY of that amount during normal weather years. If 9,947 AF are returned to the SVGB, and Marina takes its 1,700 AF, that leaves only 553 AF for the Monterey Peninsula, far less than it would be depending on. Even if Marina decides to pump from its unsustainable Deep Aquifer during that year, and thereby does not use its 1,700, that would leave only 2,253 AF for the Monterey

Peninsula system, which is only a small fraction of Cal Am's needs under Order 95-10 and the Seaside Basin adjudication. This is a foreseeable scenario which the EIR fails to address.

The EIR states that Salinas Valley groundwater extracted by the Cal Am North Marina project would be returned using the CSIP 80-AF pond (FEIR p. 13.6-8). The EIR fails to investigate or explain whether the proposed "return" method can be accommodated by the 80-AF pond in all years through the life of the project, for all volumes of foreseeable water, both in wet and dry years, and what the environmental impacts would be. The water "returned" to the Salinas Valley would be surface water, and the recipients of that surface water may not have rights to that water.

For the Regional Project, the EIR states that the pumped Salinas Valley groundwater would be delivered to the MCWD service area within the Salinas Valley basin (FEIR p. 13.6-8). The EIR fails to discuss how the water in excess of the 1,700 AF required for use within the MCWD would be returned to the SVGB. In some years, the volume of the water to be returned would far exceed 1,700 AF. The EIR omits any analysis of whether adequate water rights are held by the proposed appropriator of the Salinas Valley groundwater for such actions.

Under the predicted 60% seawater/40% groundwater scenario, in order to provide the 8,800 AF to the Monterey Peninsula (Cal Am system), the intake wells would have to pump 88,000 AFY. Of that 88,000 AFY, the 40% to be returned to the Salinas Valley Groundwater Basin would be 35,200 AFY. Of that 88,000 AFY, the desalination plant would produce 44,000 AF of desalinated water. The proposed "return" to the Salinas Valley Groundwater Basin would be 35,200 AF. Assuming the MCWD 1,700 AF is part of the amount returned to the Salinas Valley Groundwater Basin, that would leave 8,800 AF for the Monterey Peninsula. The EIR fails to investigate this foreseeable scenario, or what the impacts would be of 88,000 AFY of pumping, or the fact that the desalination plant is not designed to process 88,000 AFY of untreated water or to produce 44,000 AF of desalinated water. And there is no discussion of whether returning 35,200 to the Salinas Valley Groundwater Basin is feasible, or how it would be done. There is no question this foreseeable scenario would cause significant impacts, none of which has been addressed in the EIR.

The EIR fails to analyze any potential impacts for the times when the EIR indicates that the proportions of the pumped water will be approximately 60% seawater and 40% groundwater. (FEIR Appendix E and Appendix Q [modeling shows TDS concentrations of from 21,300 mg/L to 34,500 mg/L over a 56-year period].) The EIR fails to investigate whether the project would be able to pump or deliver sufficient water to provide 12,500 AFY to the Monterey Peninsula every year under the foreseeable scenario requiring a "return" of up to 40% of the pumped water to the CSIP or requiring the distribution of up to 40% to the MCWD service area within the Salinas Valley basin for years at a time. There is no evidence that there is current demand for 40% of the pumped water within that MCWD service area. Thus, at times, only 60% of the water would be available for export to the Monterey Peninsula, when that area requires – and is planned to receive under the proposed project – 85% of the desalinated water, assuming perfect and uninterrupted plant operations. The EIR fails to investigate or explain how the difference between the available desalinated water and the area's water demand will be met over the life of the project, and the potential impacts over time. The evidence is that the current MCWD demand within the Salinas Valley Groundwater Basin is less than the 40% of the pumped water that would be delivered to that MCWD area. The EIR has failed to investigate or disclose the impacts of the forced delivery of that amount of water to that area. That forced delivery would foreseeably cause growth which has not been analyzed in the EIR.

Another significant issue is the lack of accountability for the amount of groundwater pumped. As one example, for the North Marina project, the EIR assumes that Cal Am will keep track of the amount of water pumped, and the salinity of that water. There are no requirements with regard to frequency of monitoring, and no provision or mitigation requiring Cal Am to report its pumping and water quality information to any public agency. Therefore, Cal Am would not be accountable to any public agency, and could keep its number secret and unverified by the public and the government.

<u>The Project Proponents' Assumption of Continuous Pumping Is Unsupported and Unreasonable</u>.

The EIR uses only modeling scenarios that assumed continuous pumping. (See, e.g., p. E-31, Appendix E, Appendix Q.) The models were prepared and submitted by the project proponents. The EIR claims that the applicants' models of continuous pumping of the desalination intake wells show the creation of an underground trough in the water level due to the volume of water being pumped. The EIR claim is that over time the pumping will decrease and/or halt the progression of inland seawater intrusion because the pumps will be sucking up seawater faster than the seawater intrudes. There was no modeling for anything other than continuous pumping, or cessation, including any scenario for the likely interruption of pumping (at any time, including at end of the project's lifetime).

An assumption of continuous pumping is not reasonable. Desalination facilities simply are not reliable. There are very poor track records of the two similarly sized plants in the United States (the Tampa Bay desalination plant and the Yuma Desalter). Large desalination plants as proposed here have proved to be unreliable and have been non-operable for long periods of time, and none has ever operated at full capacity. The EIR fails to investigate or disclose this information, or what would happen if the proposed plant is non-operable for long periods of time (or even for short periods), and if it never operates at full capacity.

In addition to failing to adequately investigate the potential environmental impacts of non-continuous pumping throughout the life of the project, the EIR also fails to discuss the potential environmental impacts that may occur at the end of the plant's useable life, which the EIR anticipates to be approximately 50-56 years.

Groundwater has several unknowns. Unknown variables require assumptions to be made in each analysis. The unknowns and assumptions can be reduced through testing the groundwater system through pumping and monitoring wells. This has not been done here to the level that would provide usable data for reliable conclusions. The testing that was done for the EIR was minimal and based on an insufficient number of wells and locations. For that reason, the EIR conclusions are not reliable or adequate information. Even after test wells are used to validate assumptions, there remains the variable of time. Things change over time, yet the EIR does not recognize that basic fact of nature.

If water is removed from the aquifer by wells, then an equivalent amount of water will move in from one side or the other to fill the vacated space. Given the proximity of the ocean to the location of the wells, it is far more likely that the vacated space will be filled in by seawater than by groundwater. If the replacement water comes from off shore, that means increased seawater intrusion. The EIR claims that the replacement water will come from inland, which will halt or reverse seawater intrusion. However, that scenario can only occur if there is already a net flow of water from inland to offshore in the vicinity of the wells. Based on over 50 years of data (the seawater intrusion figures presented by Monterey County), that will not be the case unless either it is a temporary condition that occurs only in very wet years or the wells are located in an area that does not already have seawater intrusion. The EIR acknowledges that the wells will be located in an area that has seawater intrusion. Accordingly, the only time that the EIR claim would be valid would be during very wet years, when there is a net flow of water from inland to offshore in the Salinas Valley Groundwater Basin. In the vast majority of years – in other words, all years that are not "very wet" – the EIR claim would not be valid. The EIR fails to disclose or discuss these issues, and draws its conclusions based on its flawed assumption of continuous operations.

The EIR claim of a "trough" that would halt seawater intrusion is inconsistent with the theory behind the Castroville Seawater Intrusion Program (CSIP). The CSIP goal is to reduce pumping by coastal agricultural property owners because by doing so, the theory goes, seawater intrusion will be slowed. That theory is opposite to the one proposed in the CWP EIR, which is that significant continuous pumping at the coast will halt seawater intrusion. Both theories cannot be correct, and the EIR has failed to address the inconsistencies.

Critically, the EIR does not use any model runs that assumed a multi-year drought, which is a foreseeable scenario in the semi-arid Central Coast. The project impacts on the aquifers may be very different under those scenarios. The rigid assumptions used by the models relied upon by the EIR are not reasonable under the circumstances and the known likely variables.

It appears that the EIR uses only modeling runs presented by project proponents. For example, the July 25, 2008 model run was prepared by Geoscience, Cal Am's consultant. The June 5, 2009 and September 11, 2009 reports were prepared by RMC Water and Environment, which represents the Regional Project proponents. CEQA requires independent investigation and review of materials submitted by project proponents, to rest their validity and reliability. It appears that was not done here.

<u>The EIR Responses to Comments Are Inadequate.</u>

The responses to comments do not meet the requirements of CEQA for good faith, reasoned responses. There are many examples of this violation of CEQA mandates. For example, the response to L-PSMCSD-2(b) fails to answer the issue and question clearly raised, and instead uses a semantic pretense about dates. As another example, the response to L-PSMCSD-2(a) merely regurgitates the testimony of an attorney for a project proponent for more than two pages, without a reasonable independent investigation or discussion of the issues. In that response, the claimed legal basis is highly suspect and has not been confirmed under California law.

As another example, the responses to The Open Monterey Project (TOMP) comments are nonresponsive. For example, a TOMP comment is that future expansion of project facilities would be easier. The FEIR response (p. 14.5-201) states, "Therefore, construction of the plant would not substantially alter the character of the areas and any future expansion would required additional permitting and review." This inadequate response fails to address the ease of expansion from a technical, environmental and financial perspective, and the related growth-inducing impacts. Desalination plants are very costly to construct. Once the initial expense is invested, the expansion of the plant to accommodate increased production is relatively much less costly. This also means that the Peninsula ratepayers would be subsidizing growth for other areas in Monterey County.

The EIR Discussion of Water Rights is Inadequate under CEQA.

On November 6, 2006, and again on April 15, 2009, the Ag Land Trust notified the Public Utilities Commission of certain key flaws in the Coastal Water Project EIR. Specifically, the first full paragraph on page two of the Trust's November 6, 2006 letter (identified as "G_AgLTr-3" in the FEIR) states that Cal-Am, a water appropriator under California law, has no groundwater rights to appropriate water from the overdrafted Salinas Groundwater Basin. In an overdrafted, percolated groundwater basin, California groundwater law clearly and definitely holds that the doctrine of correlative overlying water rights applies (*Katz v. Walkinshaw* (1903) 141 Cal. 116), whereby no surplus water is available for new groundwater appropriators.

The FEIR response claims that an analysis of water rights is not necessary because "CalAm claims no rights to groundwater" and that "no Salinas Valley groundwater will be exported from the Basin." The FEIR attempts to bypass a central issue – the EIR's failure to analyze legal water rights – by claiming that the issue does not exist. On the contrary, the issue of legal water rights exists and should be analyzed.

Because the extracted water would be composed of both saltwater and groundwater, Cal-Am (under the North Marina project) or Monterey County (under the Regional Project) would be extracting groundwater from the overdrafted Salinas Valley Groundwater Basin. Those actions would represent an illegal appropriation of water. The EIR claims that water can be appropriated from under privately owned land in the overdrafted basin, so long as it promises to return the same amount of pumped groundwater to the basin. That claim is not enforceable, not subject to oversight and does not change the fact that the extraction of the water would be an illegal appropriation. In essence, the Cal Am North Marina desalination project and the Regional Project would rely on illegal extraction and appropriation of groundwater from the basin. The EIR does not analyze the significant impact of an illegal taking of groundwater from overlying landowners. Instead, the FEIR accepts as unquestionably true the flawed rationale that a purported return of a portion of the water somehow allows the illegal extraction of groundwater from the overdrafted basin. This deficiency in the EIR must be addressed, and the EIR should identify mitigations for the adverse impacts and proposed illegal actions and takings.

The principle is established that the water supply in a source may be augmented by artificial means. (See *Pomona Land & Water Co. v. San Antonio Water Co.* (1908) 152 Cal. 618.) We do not question that general statement of law.

However, when getting to the specifics of the abilities and limitations in regard to the augmented or developed water proposed for the Project, the EIR defaults on the necessary discussion. Instead of addressing the entire doctrine of water rights applicable here, the FEIR (14.1-94, n. 4) defers entirely to the MCWD's legal counsel for the discussion of the essential factors. From page 14.1-94 to 14.1-96, MCWD's legal argument is presented without critical analysis or further comment as the FEIR's discussion. There is no independent review of the legal argument.

California law on the ability of an agency to claim the right to salvage any or all of any developed water in the circumstances here, and any limits on that claim, has not yet been defined by the Courts. The citations in the FEIR overstate the situation, and do not point to any California court case where the analysis presented in the FEIR has been upheld by the Court. The two cases relied upon by the MCWD's counsel (and therefore the FEIR) are cited in footnote 10 of FEIR page 14.1-96: *Pajaro Valley Water Mgt. Agency v. Amrhein* (2007) 150 Cal.App.4th 1364, 1370 and *Lanai Company, Inc. v. Land Use Commission* (S. Ct. Ha. 2004) 97 P.2d 372, 376. The citations in both cases are to portions of the introductory factual recitations in the cases, and not to Court holdings or legal analysis, and thus are not fairly considered precedents or statements of settled law. Other FEIR citations are to legal claims asserted in a staff report by the head of the Monterey County Water Resources Agency, who is not an attorney.

At the very least, the FEIR was required to evaluate the claims of MCWD and MCWRA, test them analytically, and provide the decisionmakers and the public with the analysis. Without the reasoned good faith analysis, the EIR fails as an informational document. (See, e.g., *Santa Clarita Organization for Planning the Environment v. County of Los Angeles* (2003) 106 Cal.App.4th 715, 722.) "It is not enough for the EIR simply to contain information submitted by the public and experts." In particular, water "is too important to receive such cursory treatment." (*Id.*) CEQA requires a detailed analysis of water rights issues when such rights reasonably affect the project's supply. Assumptions about supply are simply not enough. (*Id.*, at p. 721; *Save Our Peninsula Committee v. County of Monterey* (2001) 87 Cal.App.4th 99, 131-134, 143 [EIR inadequate when it fails to discuss pertinent water rights claims and overdraft impacts]; see also, *Cadiz Land Co. v. Rail Cycle* (2000) 83 Cal.App.4th 74, 94-95 [groundwater contamination issues].) The reasoning of the Court in *Cadiz* would also apply to the proper analysis of the rights associated with the overdraft here.

At the very least, the determinations of safe yield, surplus, the rights of the MCWRA, and of "persons with land in the zones of benefit for the projects" must be identified, discussed and analyzed. The analysis must be independent, and cannot simply be "extracted" (FEIR, p. 14.1-94, n. 4) from the argument of the attorney for the MCWD, a proponent of the Regional Project and potential owner of the desalination plant component of that project. Whether the project may take salvaged or developed water originating from onsite supplies depends on whether injury will result to existing lawful users or those who hold vested rights. The FEIR response to comments does not fairly consider or investigate the actual on-the-ground issues.

<u>Recirculation of the EIR Is Required.</u>

Under CEQA Guidelines section 15088.5, the EIR should be recirculated because it contains significant new information. The Final EIR contains significant newly identified impacts and new information that leads to new unanalyzed impacts. Several examples of the unanalyzed impacts are identified throughout this letter.

The FEIR identifies new significant and unavoidable impacts that had not been disclosed in the Draft EIR. These impacts include greenhouse gases and air quality (PM10). The FEIR finds that PM10 construction emissions would exceed the local Air District thresholds. Greenhouse gas emissions and construction PM10 impacts of the Regional Project would be outside of the CPUC's jurisdiction. Both impacts would be significant and unavoidable. However, the EIR treats the two impacts differently and inconsistently. The EIR inappropriately pre-determines that the local agencies might find that the Regional Project's PM10 mitigation measures would be infeasible because of the "potential need to accelerate the construction schedule" for the project (e.g., p. ES-19). The EIR attempts to place mitigations on the Regional Project which are unenforceable, because the CPUC has no jurisdiction over the Regional Project. (E.g., FEIR p. 6.8-4, Mitigation Measure 6.8-11a.) The EIR approach is confusing and inconsistent, and misleads the public and decisionmakers as to which mitigations it can enforce and which it cannot enforce. This confusion continues in the EIR discussion of the environmentally superior alternative, where the EIR makes unsupported assumptions about mitigations and mitigation monitoring in order to affect its determination of the superior alternative. (FEIR p. 7-67.) Further, the EIR's announcement of new significant and unavoidable impacts is inconsistent with its response to the League of Women Voters' comments that there are no significant project impacts.

As a separate reason for recirculation, the FEIR reduced the DEIR's conclusions about the RUWAP project production from 1,700 to 1,000 AFY. That is significant new information, because it significantly affects the determination of the Regional Project water supply. In fact, the selected project now under way, the hybrid RUWAP, will produce 3,000 AFY. The FEIR used an incorrect 1,000-AFY figure to analyze cumulative and growth-inducing impacts, and the EIR analysis is incorrect. As another reason for recirculation, the EIR fails to include the planned cogeneration plant in the project description, or to analyze its impacts.

SWRCB Antidegradation Policy; CRWQCB Basin Plan.

The EIR fails to adequately investigate and disclose the extent of the proposed projects' violation of the State Water Resources Control Board's Antidegradation Policy. This policy, formally known as the Statement of Policy with Respect to Maintaining High Quality Waters in California (SWRCB Resolution No. 68-16), restricts degradation of surface and ground waters. The policy protects water bodies where existing quality is higher than necessary for the protection of beneficial uses. Under the Antidegradation Policy, any actions that can adversely affect water quality in all surface and ground waters must (1) be consistent with maximum benefit to the people of the State, (2) not unreasonably affect present and anticipated beneficial use of the water, and (3) not result in water quality less than that prescribed in water quality plans and policies. Any actions that can adversely affect surface waters are also subject to the Federal Antidegradation Policy (40 Code of Federal Regulations [CFR] section 131.12) developed under the Clean Water Act. The Central Regional Water Quality Control Board's Basin Plan implements the antidegradation policy. The EIR also fails to adequately investigate and disclose the proposed projects' violation of the Basin Policy.

Potential Takings Claims.

In comments to the DEIR, it was pointed out that it is reasonably possible that the proposed project, if approved, would result in the deterioration in, or elimination of, valuable water rights of the Armstrong Ranch property owned by the Ag Land Trust. Such action would result in a compensable taking of the Ag Land Trust's property. On a related point, the stripping of the water rights from this productive agricultural land is a physical change to the environment which must be addressed in the FEIR and, when feasible, mitigated to a level of insignificance or considered as part of the alternatives analysis of the FEIR. The FEIR fails to fairly consider and address these impacts. To the best the public can discern from the MCWRA's seawater intrusion depictions, the Ag Land Trust property overlies a part of the 400-foot aquifer that is not seawater intruded. (See attached figure.) The Regional Project could significantly affect the water quality in the 180-foot and 400-foot aquifer. The Ag Land Trust would lose valuable property rights if its ground water rights were affected.

The EIR fails to identify the potential eminent domain authority or actions that could be used to implement the project, or even to present the fact that eminent domain may be used or necessary for project implementation. For example, the FEIR (p. 5-50) states merely that private landowners may be affected by sale or lease of their property for project purposes. In fact, the public agency proponents of the project have eminent domain authority, and may choose to exercise it to implement the project. An eminent domain action is a "project" under CEQA (Pub. Resources Code, § 21065) and must be reviewed at the earliest possible stage for potential impacts. Because such eminent domain action is foreseeable, it should be disclosed and evaluated in the EIR.

<u>Problems with Access to Final EIR.</u>

CEQA states that draft EIRs for proposals of unusual scope or complexity should normally be less than 300 pages. (CEQa Guidelines, § 15141.) Here, the Draft EIR was approximately 1,500 pages, and the Final EIR is over 3,100 pages and contains significant new information. The Final EIR is not available in hard copy anywhere in the Monterey County. The local agencies, including Monterey County and Marina Coast Water District, have the FEIR available on disk only. For these reasons, it has been extremely difficult for the public to access and review the over 3,100 pages, much of which contained complex and interrelated new information, within the available time.

<u>Efforts to Obtain and Provide Further Information.</u>

Last week we contacted the project manager for the Coastal Water Project EIR[3] and requested a return call, hoping to share these concerns with regard to the Coastal Water Project EIR. We did not receive a return call. On December 30, 2009, our Office made a records request to the CPUC, in accordance with the records request guidelines on the CPUC website. Our clients sought access under the California Public Records Act (Gov. Code, § 6250 et seq.) to the records for the Coastal Water Project EIR. The CPUC was required to respond to our request within ten days. (Gov. Code, § 6253, subd. (c).) We did not receive a response, and were not provided with an opportunity to inspect or copy documents.

Thank you for the opportunity to comment on the Coastal Water Project EIR.

Very truly yours,

LAW OFFICES OF MICHAEL W. STAMP

Michael W. Stamp
Molly Erickson

Attorneys for Ag Land Trust

cc: Andrew Barnsdale

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[3] Years ago, when the CPUC took over as lead agency, our Office was informed that the CPUC had not previously managed the preparation of an EIR on a water supply project, which is why the task was handled by an Energy staff member.

References attached by email:

- Figures showing Ag Land Trust Properties in relation to proposed Regional Project
- Presentation on the Regional Water Supply Project presented by Curtis Weeks, Monterey County Water Resources Agency, and Jim Heitzman, Marina Coast Water District, made at the City and Agency Managers' meeting, December 9, 2009 (this and the other presentations in similar format are identified in the electronic file properties as being prepared by RMC)

All other references to be delivered to the CPUC in hard copy on December 17, 2009.

Ag Land Trust – Letter 1 (ALT1) - Exhibits

Yellow— Ag Land Trust (Monterey County Agricultural and Historic Land Conservancy) properties.

Pale Blue and Brown -- potential sea water wells and pipeline locations as extracted from Coastal Water Project FEIR Revised Figure 5-3.

NOTE: EIR Revised Figure 5-3 provides only a generalized representation of the sea water well areas with no references to properties included within their boundaries. Precise spatial data was not provided by the applicant or available from the EIR preparer.

This document was professionally prepared by a GIS Professional, using spatially accurate imagery, known physical features and property lines to provide a reliable representation of the Conservancy properties as they relate to the proposed sea well areas. Lack of access to the spatial data, if any, used in Revised Figure 5-3, has required some locational interpretation, which was performed using professional best practices.

AG LAND TRUST

Monterey County Agricultural and Historic Land Conservancy

P.O. Box 1731, Salinas CA 93902

www.aglandconservancy.org

Phone: 831-422-5868 Fax: 831-758-0460

April 25, 2009

TO: Monterey County Board of Supervisors

FROM: Monterey County Ag Land Trust

RE: Opposition to proposed MOU's for Monterey Regional Supply Planning and Coastal Water Project

By this letter, the Board of Directors of the Ag Land Trust unanimously and vehemently objects to the proposed MOUs and the Coastal Water Project that are recommended for your approval by the staff of the MCWRA. These proposed MOUs and the project that they expressly advance are wrongful, illegal acts that propose to take and convert our water and water rights for the benefit of a private company. We hereby incorporate by reference into this letter (as our own) each, every, and all facts, objections, statements, references, legal citations, and assertions located within each and every Attachment herewith attached to this correspondence. **Before your Board takes any action on these matters that will expose you to significant litigation from landowners with senior overlying percolated groundwater rights, you need to ask the question and receive a written answer from your staff, "If the Salinas Valley percolated groundwater basin has been in overdraft for sixty years, whose percolated groundwater and overlying percolated groundwater rights are you proposing that we take without compensation to benefit Cal-Am?'**

1. The proposed MOUs, and the projects which they include, violate and will result in an illegal, wrongful, "ultra vires", and unlawful "taking" of our percolated overlying groundwater rights. Our Trust owns (in fee) the large ranch (on which we grow artichokes and row crops) that lies between the ocean and the proposed "well field" that the California-American Water Company (a private, for profit appropriator) proposes to use to illegally divert percolated groundwater from the overdrafted Salinas groundwater basin. The so-called "environmentally superior alternative" in the Coastal Water Project EIR is based upon the illegal taking of our water rights and pumping of our percolated groundwater for the economic benefit of Cal-Am. The Salinas basin has been in overdraft for over 60 years and California law holds that, in an overdrafted percolated groundwater basin, there is no groundwater available for junior appropriators to take outside of the basin. In an over-drafted, percolated groundwater basin, California groundwater law holds that the Doctrine of Correlative Overlying Water Rights applies, (Katz v. Walkinshaw 141 Cal. 116). In an over-drafted basin, there is no surplus water available for new "groundwater appropriators", except those prior appropriators that have acquired or gained pre-existing, senior appropriative groundwater water rights through prior use, prescriptive use, or court order. This is the situation in the over-drafted Salinas percolated groundwater basin, there is no "new" groundwater underlying the over-drafted Salinas aquifers. Moreover, no legal claim or relationship asserting that water from a distant water project (over 6 miles from the proposed Cal-Am well field to the rubber dam) may be credited for the over-drafted Salinas percolated

groundwater basin can be justified or sustained. California groundwater law refutes such "voo doo hydrology" by holding that "Waters that have so far left the bed and other waters of a stream as to have lost their character as part of the flow, and that no longer are part of any definite underground stream, are percolating waters" (Vineland I.R. v. Azusa I.C. 126 Cal. 486). Not only does Cal-Am have no right to take ground water from under our lands, but neither does the MCWRA. **MCWRA HAS NO PERCOLATED OVERLYING GROUNDWATER RIGHTS THAT IT MAY USE TO GIVE TO CAL-AM FOR EXPORT OUT OF THE BASIN.** Our first objection to this illegal project and conduct was filed with the CPUC and MCWRA on November 6, 2006 (see herein incorporated Attachment 1). Your staff has not responded and our concerns have been ignored.

2. The recommended MOUs before the Board of Supervisors is a project under CEQA and the MCWRA staff recommendations to the Board violate the California Environmental Quality Act and the California Supreme Court decision in the "Tara" case. The California Supreme Court's decision in *Save Tara v. City of West Hollywood*, Case No. S151402 (October 30, 2008), provides specific direction to public agencies entering into contingent agreements. In this opinion, the Supreme Court held that the City of West Hollywood ("City") had violated CEQA by entering into a conditional agreement to sell land and provide financing to a developer before undertaking and completing environmental (CEQA)review. This is exactly what the MCWRA staff is asking the Board to do. They want you to approve their project without a certified EIR from the CPUC. One of the proposed MOUs even references the fact that it is contingent on the certification of the FEIR by the CPUC. Monterey County abdicated its role as the "lead" agency under CEQA years ago when it agreed to allow the CPUC to prepare the EIR on the Coastal Water Project. Monterey County is now a "responsible agency" and must wait while the CPUC staff deals with the fact that its draft EIR is woefully inadequate because of its failure to address that fact that none of the public agencies in Monterey County have the rights to pump groundwater from an overdrafted basin for the economic benefit of Cal-Am(see Attachment 2). Further, the Draft EIR acknowledges that the proposed MOUs and Coastal Water Project violate MULTIPLE provisions of the Monterey County General Plan, and the North County Local Coastal Plan, and contradicts the express purpose (ELIMINATION OF SEAWATER INTRUSION) of every water development project for which land owners have been assessed and charged (and continue to be charged) by Monterey County and the MCWRA for the past 50 years, including the Salinas Valley Water Project.

3. It is clear that the MOUs and the Coastal Water Project are being advanced by MCWRA staff and Cal-Am jointly as if they are already one entity. In fact, the proposed MOUs advanced by MCWRA staff advocate a governmental structure (JPA) that would be completely immune for the voters' constitutional rights of initiative, recall, and referendum. Moreover, this plan to deny the Monterey County public's right to public ownership of any new water project was also secretly advanced this month in Assembly Bill AB 419 (Caballero) wherein Cal-Am lobbyists got the Assemblywoman to try to change one hundred years of state law by "redefining a JPA with a private, for-profit utility (Cal-Am) member" as a "public agency". (See Attachment 3). These actions by MCWRA staff and Cal-Am to circumvent and "short-circuit" the mandatory CEQA process for the MOUs and the Coastal Water Project are further reflected in Attachment 4 wherein counsel for MCWRA requested an extension of time from the SWRCB (on permits issued to address water shortages in the Salinas Valley) to develop "alternative plans". Although the letter says that "there will be no export of groundwater outside of the Salinas basin", that is exactly what the MOUs and the Coastal Water Project proposes… to pump and export thousands of acre feet of groundwater out of the Salinas basin for the benefit of Cal-Am.

4. Our wells and pumps on our ranch adjacent to the location of the proposed well field are maintained and fully operational. We rely on our groundwater and our overlying groundwater rights to operate and provide back-up supplies for our extensive agricultural activities. MCWRA nor the CPUC has never contacted our Board of Directors that includes farmers (including past

presidents of the Grower-Shippers Assn.), bankers, attorneys, and agricultural professionals to get our input on this proposed taking of our water rights. As a result of this lack of concern for our property rights, we must assume that the County has now assumed an adversary position toward our Land Trust and our groundwater rights. In 2001-2002, MCWRA staff recommended that you include the Gonzales area in the assessment district for the SVWP. The Gonzales farmers objected, your MCWRA staff ignored them, you got sued and the taxpayers ended up paying the bill. From 1999 – 2005, the owner of Water World objected to the conduct of MCWRA staff and was ignored by your staff. Thirty (30) million dollars later, you lost the lawsuit and the taxpayers paid the bill. When will the taxpayers stop having to pay for poorly conceived ideas from MCWRA and Cal-Am?

5. The draft CPUC EIR marginalizes the grave and significant environmental impacts on groundwater and groundwater rights, violations of the General Plan and Local Coastal Plan policies, and the illegal violations and takings of privately owned, usufructory water rights upon which the Coastal water Project depends. **These and the illegal appropriations of thousands of acre feet of groundwater from under privately owned land in an overdrafted basin ARE NOT A LESS THAN SIGNIFICANT IMPACTS! This is the project that the staff of the MCWRA staff wants the Board to approve without a certified EIR.** (see Attachment 5). Further, the Marina Coast Water Agency has used up all of its full allocation of groundwater from the Salinas Valley groundwater basin, and as an appropriator is not entitled to any more water from the overdrafted basin, contrary to the information presented to the Growers-Shippers Association by Mr. Curtis Weeks of MCWRA (see Attachment 6)..

The Ag Land Trust understands that there is a water shortage on the Monterey Peninsula. It has gone on for decades. That shortage does not justify the illegal taking of our water rights for the economic benefit of Cal-Am. We ask that the Board not approve the MOUs or the Coastal Water Project for the reasons stated herein.

Respectfully,

Ed DeMare, Sr.

The Board of Directors of the Monterey County Ag Land Trust

CC: CPUC, MCWD, California Coastal Commission, and California-American Water Co.

Ag Land Trust
P.O. Box 1731
Salinas, CA 93902
tel. 831 422 5868
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To: California Public Utilities Commission
C/O CPUC Public Advisor
505 Van Ness Avenue, Room 2103,
San Francisco, CA 94102
Fax: 415.703.1758
Email: public.advisor@cpuc.ca.gov.

April 15, 2009

Comments on Coastal Water Project Draft EIR

Dear Commissioners:

On behalf of the Monterey County Ag Land Trust, we hereby submit this comment letter and criticisms of the draft EIR that your staff has prepared for the Coastal Water Project located in Monterey County. Herewith attached is our letter to your commission dated November 6th, 2006. We hereby reiterate all of our comments and assertions found in that letter as comments on the Draft Environmental Impact Report.

The Draft EIR is fatally flawed because of your staff's intentional failure to address the significant environmental and legal issues raised in our November 6th 2006 letter. The project as proposed violates and will results in a taking of our Trust's groundwater rights. Further, although we have requested that these issues be addressed, it appears that they have been ignored and it further appears that the CPUC is now advancing a project (preferred alternative) that constitutes an illegal taking of groundwater rights as well as violations of existing Monterey County General Plan policies, existing certified Local Coastal Plan policies and Monterey County Environmental Health code.

The EIR must be amended to fully address these issues that have been intentionally excluded from the draft. Further, the EIR must state that the preferred alternative as proposed violates numerous Monterey County ordinances, and California State Groundwater law. Failure to include these comments in the EIR will result in a successful challenge to the document.

Respectfully,

Virginia Jameson
Ag Land Trust

`MONTEREY COUNTY AGRICULTURAL AND HISTORICAL LAND CONSERVANCY
P.O. Box 1731, Salinas CA 93902

November 6, 2006

Jensen Uchida
c/o California Public Utilities Commission
Energy and Water Division
505 Van Ness Avenue, Room 4A
San Francisco, Ca. 94102
FAX 415-703-2200
JMU@cpuc.ca.gov

SUBJECT: California-American Water Company's Coastal Water Project EIR

Dear Mr. Uchida:

I am writing to you on behalf of the Monterey County Agricultural and Historic Lands Conservancy (MCAHLC), a farmland preservation trust located in Monterey County, California. Our Conservancy, which was formed in 1984 with the assistance of funds from the California Department of Conservation, owns over 15,000 acres of prime farmlands and agricultural conservation easements, including our overlying groundwater rights, in the Salinas Valley. We have large holdings in the Moss Landing/Castroville/Marina areas. Many of these acres of land and easements, and their attendant overlying groundwater rights, have been acquired with grant funds from the State of California as part of the state's long-term program to permanently preserve our state's productive agricultural lands.

We understand that the California-American Water Company is proposing to build a desalination plant somewhere (the location is unclear) in the vicinity of Moss Landing or Marina as a proposed remedy for their illegal over-drafting of the Carmel River. On behalf of our Conservancy and the farmers and agricultural interests that we represent, I wish to express our grave concerns and objections regarding the proposal by the California-American Water Company to install and pump beach wells for the purposes of exporting groundwater from our Salinas Valley groundwater aquifers to the Monterey Peninsula, which is outside our over-drafted groundwater basin. This proposal will adversely affect and damage our groundwater rights and supplies, and worsen seawater intrusion beneath our protected farmlands. We object to any action by the California Public Utilities Commission (CPUC) to allow, authorize, or approve the use of such beach wells to take groundwater from beneath our lands and out of our basin, as this would be an "ultra-vires" act by the CPUC because the CPUC is not authorized by any law or statute to grant water rights, and because this would constitute the wrongful approval and authorization of the illegal taking of our groundwater and overlying groundwater rights. Further, we are distressed that, since this project directly and adversely affects our property rights, the CPUC failed to mail actual notice to us, and all other superior water rights holders in the Salinas Valley that will be affected, as is required by the California Environmental Quality Act (CEQA). The CPUC must provide such actual mailed notice of the project and the preparation of the EIR to all affected water rights holders because California-American has no water rights in our basin.

Any EIR that is prepared by the CPUC on the proposed Cal-Am project must included a full analysis of the legal rights to Salinas Valley groundwater that Cal-Am claims. The Salinas Valley percolated groundwater basin has been in overdraft for over five decades according to the U.S. Army Corps of Engineers and the California Department of Water Resources. Cal-Am, by definition in California law, is an appropriator of water. No water is available to new appropriators from overdrafted groundwater basins. The law on this issue in California was established over 100 years ago in the case of Katz v. Walkinshaw (141 Calif. 116), it was repeated in Pasadena v. Alhambra (33 Calif.2nd 908), and reaffirmed in the Barstow v. Mojave Water Agency case in 2000. Cal-Am has no groundwater rights in our basin and the CPUC has no authority to grant approval of a project that relies on water that belongs to the overlying landowners of the Marina/Castroville/Moss Landing areas.

Further, the EIR must fully and completely evaluate in detail each of the following issues, or it will be flawed and subject to successful challenge:

1. Complete and detailed hydrology and hydrogeologic analyses of the impacts of "beach well" pumping on groundwater wells on adjacent farmlands and properties. This must include the installation of monitoring wells on the potentially affected lands to evaluate well "drawdown", loss of groundwater storage capacity, loss of groundwater quality, loss of farmland and coastal agricultural resources that are protected by the California Coastal Act, and the potential for increased and potentially irreversible seawater intrusion.
2. A full analysis of potential land subsidence on adjacent properties due to increased (365 days per year) pumping of groundwater for Cal-Am's desalination plant.
3. A full, detailed, and complete environmental analysis of all other proposed desalination projects in Moss Landing.

On behalf of MCAHLC, I request that the CPUC include and fully address in detail all of the issues and adverse impacts raised in this letter in the proposed Cal-Am EIR. Moreover, I request that before the EIR process is initiated that the CPUC mail actual notice to all of the potentially overlying groundwater rights holders and property owners in the areas that will be affected by Cal-Am's proposed pumping and the cones of depression that will be permanently created by Cal-Am's wells. **The CPUC has an absolute obligation to property owners and the public to fully evaluate every**

reasonable alternative to identify the environmentally superior alternative that does not result in an illegal taking of third party groundwater rights. We ask that the CPUC satisfy its obligation.

Respectfully,

Brian Rianda

Brian Rianda, Managing Director

The Carmel Pine Cone

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TRUSTED BY LOCALS AND LOVED BY VISITORS SINCE 1915

Pipe break floods Cheese Shop, other businesses

By MARY SCHLEY

'NOAH DIDN'T have as much water as we did."

That's the way Kent Torrey, owner of The Cheese Shop in Carmel Plaza, described the flood that hit his store after a pipe broke on the upper level of the shopping center early Sunday morning.

PHOTO/KERRY BELSER

A broken pipe sent torrents of water into the Cheese Shop early Sunday, but things are drying out and the owner hopes to reopen in time for Memorial Day

The break also affected L'Occitane and the vacant space next to it on the second floor, as well as the Wrath tasting room, Impressions jewelry and part of Bistro Beaujolais on the ground floor, according to Torrey. The bistro's kitchen wasn't damaged, so it fortunately could remain open and serve guests on the outdoor patio, just not inside. Wrath and the Cheese Shop were the two spaces still closed Monday due to the leak.

"We're effectively shut down," said Torrey, who received a call from Carmel Plaza officials at around 7 a.m. Sunday about the pipe break and rushed down to find water pouring from above, with inches of it on the floor — even in the walk-in refrigerator where his large inventory of domestic and imported cheeses spends each night.

"It was literally raining in the store and was 2 to 3 inches deep in the back," he said. The Monterey Fire Department was already on scene, having arrived around 6:45 a.m., and Torrey said the firefighters were "fantastic" in their help getting the water out of his shop.

While many of the shop's cheeses, some of which sell for nearly $60 per pound, escaped harm,

See FLOOD page 7A

Desal EIR takes steam out of claims of harm to aquifer

By KELLY NIX

THE ENVIRONMENTAL Impact Report for Cal Am's proposed desal plant in Marina says that it won't have any impact on farmers' groundwater supplies in the Salinas Valley, despite claims to the contrary in an agricultural group's lawsuit.

In a suit filed last December, the Ag Land Trust alleges that Cal Am's proposed full-scale desal facility in Marina, and even the test well operating now, will cause numerous adverse impacts, including irreversible seawater intrusion into the Salinas Valley. The suit asks a judge to compel Cal Am to shut down its test operation, and to block the future desal plant altogether.

"The test well project and desal plant could have multiple significant adverse impacts on the Salinas Valley Groundwater Basin, including permanent contamination and taking of water from other users in the basin," according to the group's lawsuit, which was consolidated with a similar suit by Marina Coast Water District.

Furthermore, the suit claims that Cal Am's desal plant,

See WELLS page 8A

This photo from an online blog purports to show Marc Del Piero and an agricultural group's water well, but experts say the device is actually a pump for a recycled water project.

Chief: Parking vouchers are not for workers

By MARY SCHLEY

GIVEN THE chance, some people will cheat — a fact Carmel Police Chief Mike Calhoun was reminded of when he discovered that some of the free-parking vouchers he gave to Ocean Avenue businesses for their customers were, in fact, being used by the employees and shop owners.

"It wasn't a shock to me, but it was disappointing," Calhoun said Tuesday.

The coupons are good for two hours of free parking, a value of $4, and are intended to reward customers for shopping downtown and entice them to return. They're part of the paid-parking program the city is testing on Ocean Avenue — a program intended to get downtown employees to park somewhere besides on the city's main street.

Calhoun personally distributed 10 vouchers to each of the roughly 60 businesses on Ocean Avenue.

"They have the opportunity to promote future business by paying for parking for their customers," Calhoun said. "They were from the City of Carmel basically thanking the customers for coming into town."

But some of the coupons weren't being given to customers, Calhoun said. And, because the computerized paid-parking system logs license plate numbers and shows how often any particular car is parked in any particular location on Ocean Avenue, a report Calhoun ran a few weeks ago revealed that one employee used all of her shop's vouchers for herself, parking right in front of the store where she works, and a business owner used three.

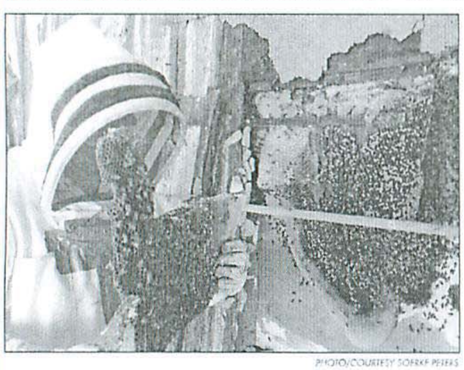
When Calhoun approached the first woman, she told him

See VOUCHERS page 16A

The endless fascination of bees, hives and honey

By ELAINE HESSER

FROM A lavender farm in Carmel Valley, to a vineyard in South County, to rooftops and urban gardens, beekeeping is becoming increasingly common — and with good reason. Beekeepers have better gardens, contribute to a healthy environment, harvest honey and beeswax, and find their tiny charges endlessly fascinating.



PHOTO/COURTESY SOERKE PETERS

No, it's not Oh-Bee-Wan Kenobi – just chef and restaurant owner Soerke Peters rescuing some bees in South County

John Russo, who owns Carmel Lavender on Tassajara Road, started keeping honeybees about nine years ago. He grows lavender and distills essential oils for various uses, and thought the bees would be a good, complementary venture.

He has 50 hives that produce about 1,000 pounds of honey annually. He's utterly intrigued by the bees, particularly their organization and specialization within the hives.

There are three kinds of bees in a colony, starting with the queen. Her job is to lay eggs — lots of eggs. Up to 1,500 a day. Drones are the only males in the hive, and their sole function is to mate with the queen. (Insert a sexist joke of your choice.)

Female worker bees make up the rest of the colony. Some collect nectar and pollen and produce honey. Some just fan the comb where honey is stored to reduce the amount of moisture before sealing the honey for future use.

There are guard bees at the entrance that ensure only members of their own colony are allowed in, and bees that tend baby bees in the nursery. Russo said there are even "undertaker bees," which remove dead bees from the

See BEES page 9A

Laub makes case that she really is owner of Dametra

■ But judge leaves restraining order in place

By KELLY NIX

FACED WITH a restraining order that keeps her away from a restaurant she says she owns, Connie Dudley Laub this week rejected claims that she's trying to abscond with Dametra Cafe from Bashar Sneeh and Faisal Nimri.

Laub and her attorney, Susan Goldbeck, were in court Wednesday to try to convince Monterey County Superior Court Judge Susan J. Matcham to reconsider the restraining order she issued against Laub last week. Matcham, though, rejected the motion and set a court hearing for May 28.

The order was granted after Nimri and Sneeh filed a 29-page lawsuit alleging that Laub has been trying to "steal" the restaurant from them.

Nimri and Sneeh also contend that Laub has tried to "extort rent and profits" well in excess of their contractual agreements with her, "dispossess" them from the property, and "abscond with the entire business." To prevent Laub

See DAMETRA page 14A

Ag Land Trust – Letter 2 (ALT1) - Attachments

Burnett invites state water board members to visit Peninsula to see 'progress'

By KELLY NIX

MAYOR JASON Burnett has invited members of a state agency that imposed a strict water cutback order on the Monterey Peninsula to find out firsthand what local officials are doing to develop an alternative water supply to the Carmel River.

In the May 5 letter to State Water Resources Control Board Chair Felicia Marcus, Burnett said a trip to the Peninsula would allow local officials to tell Marcus and other board members about the Monterey Peninsula Water Supply Project — which, if approved, would allow California American Water to reduce its pumping from the Carmel River, which has been the Peninsula's primary water source for more than a century.

"A site visit would allow us to demonstrate to you and your board the community's continued progress on our portfolio of water supply projects," Burnett wrote in the three-page letter that he hand delivered to Marcus.

The proposed water supply project consists of a desal plant in Marina, expanded use of reclaimed water and storage underground. Cal Am is operating a test well in Marina it says will provide crucial data for its proposed full-scale desal facility.

In the letter, Burnett told Marcus the water projects are sized to enable Cal Am to stop its illegal pumping from the Carmel River, and also to comply with the reductions in pumping from the Seaside groundwater basin.

The project would also provide water for building on lots of record and infill development.

"We believe we are pursuing desalination in the proper context," Burnett wrote. "Specifically, we have focused on water conservation first, reducing per-capita water consumption to less than 55 gallons per person per day," which represents one of the state's lowest averages for water use.

The state water board's visit to the Peninsula is also being done at the request of the Monterey Peninsula Water Management District, the County of Monterey and the Monterey Peninsula Regional Water Authority. Burnett said an ideal time to visit would be June, July or August.

The state water board's cutback order was issued in 1995, and the current deadline for meeting it is the end of next year. Though Cal Am can't make the deadline, there's a possibility the state board will extend it if it can be shown solid steps are being taken to develop a new water source.

"The [water board cutback order] is serving its purpose, and the community is making substantial progress toward bringing online a portfolio of new water supplies," Burnett said. He also said there's a "broad consensus" in the community about how to solve its water problem.

"While water debates on the Monterey Peninsula have historically been fraught with acrimony, discord and inaction," Burnett said, "in the past several years, we have worked hard to bring a sustained focus to solving the problem, informed by good data and science."

Burnett also recommended the water board take a field trip to the San Clemente Dam, since removal of the dam resumes this month.

Besides Marcus, the other board members are Dorene D'Adamo, Frances Spivy-Weber, Steven Moore and Tam Dudoc, who was the only member to vote against the Peninsula water cutback order because she felt it didn't go far enough.

WELLS

From page 1A

and even the test well, will irreparably damage prime coastal farmlands and groundwater resources and "permanently and forever harm, injure, degrade and impact the environmental values of Monterey County and the State of California."

However, the 1,789-page draft EIR released April 30 concluded something else.

While the EIR acknowledges that Cal Am's desal plant would cause noise and traffic during construction, and have an indirect impact on climate change, the project "would not result in a significant impact to groundwater resources" including exacerbating seawater intrusion.

"It would not reduce, or affect at all, the availability of fresh water," according to the EIR. Nor would it "lower groundwater levels in the basin so as to affect the water supply of any groundwater users [or] alter or reduce groundwater quality."

Environmental Science Associates, the San Francisco consulting firm hired by the California Public Utilities Commission to write the EIR, also found "that it appears reasonable to conclude" that the proposed desal project "would not result in harm or injury to the water rights of legal users of water in the basin in terms of fresh water supply or water quality."

No active wells?

The EIR also questions the existence of active wells that Ag Land Trust argues would be harmed by Cal Am's desal operations.

"This property contains two large agricultural wells in the vicinity of the test well project that have the potential to be permanently contaminated" by the test operation, according to the group's complaint.

To support the lawsuit, Ag Land Trust board member and founder Marc Del Piero, in a Jan. 20 declaration, said that the group has a "big well" that "is operational and provides much needed water for irrigation of the Armstrong Ranch," the name of a property the ag trust owns that's about one mile from Cal Am's desal operation.

However, according to the EIR, the team that worked on the document couldn't find any active Ag Land Trust wells. "Efforts to physically locate the well have been unsuccessful," according to the document.

Not satisfied with the EIR's findings, a group of anti-Cal Am activists in a May 1 online blog point to a purple pipe off Highway 1 in Marina as being one of the wells. The site also included a photograph of Del Piero standing near the pipe, which the blog writer calls the ag land trust's "primary well."

But Eric Zigas, the EIR consultant, told The Pine Cone that the "well" shown in the photo is not a well at all, but is actually a booster pump for the Castroville Seawater Intrusion Project — a project that delivers recycled water to about 12,000 acres of farmland. Purple pipes indicate reclaimed or recycled water.

And while Zigas said there is a well near the reclaimed water pump, that well is capped and it has long been "permanently disconnected."

"There is a well there," Zigas said, "but it's inactive."

The online blog, run by a former editor of the Monterey County Herald newspaper, had not corrected the error as of Thursday morning.

Time is running out for Marina Coast and the Ag Land Trust to convince a judge to halt Cal Am's test well operation. The water company prevailed in two recent hearings seeking injunctions to stop pumping for its test well. Another hearing in a Santa Cruz courtroom is set in July after the Ag Land Trust and Cal Am submit briefs arguing the merits of the full case.

Ag Land Trust – Letter 2 (ALT1) - Attachments

Burnett invites state water board members to visit Peninsula to see 'progress'

By KELLY NIX

MAYOR JASON Burnett has invited members of a state agency that imposed a strict water cutback order on the Monterey Peninsula to find out firsthand what local officials are doing to develop an alternative water supply to the Carmel River.

In the May 5 letter to State Water Resources Control Board Chair Felicia Marcus, Burnett said a trip to the Peninsula would allow local officials to tell Marcus and other board members about the Monterey Peninsula Water Supply Project — which, if approved, would allow California American Water to reduce its pumping from the Carmel River, which has been the Peninsula's primary water source for more than a century.

"A site visit would allow us to demonstrate to you and your board the community's continued progress on our portfolio of water supply projects," Burnett wrote in the three-page letter that he hand delivered to Marcus.

The proposed water supply project consists of a desal plant in Marina, expanded use of reclaimed water and storage underground. Cal Am is operating a test well in Marina it says will provide crucial data for its proposed full-scale desal facility.

In the letter, Burnett told Marcus the water projects are sized to enable Cal Am to stop its illegal pumping from the Carmel River, and also to comply with the reductions in pumping from the Seaside groundwater basin.

The project would also provide water for building on lots of record and infill development.

"We believe we are pursuing desalination in the proper context," Burnett wrote. "Specifically, we have focused on water conservation first, reducing per-capita water consumption to less than 55 gallons per person per day," which represents one of the state's lowest averages for water use.

The state water board's visit to the Peninsula is also being done at the request of the Monterey Peninsula Water Management District, the County of Monterey and the Monterey Peninsula Regional Water Authority. Burnett said an ideal time to visit would be June, July or August.

The state water board's cutback order was issued in 1995, and the current deadline for meeting it is the end of next year. Though Cal Am can't make the deadline, there's a possibility the state board will extend it if it can be shown solid steps are being taken to develop a new water source.

"The [water board cutback order] is serving its purpose, and the community is making substantial progress toward bringing online a portfolio of new water supplies," Burnett said. He also said there's a "broad consensus" in the community about how to solve its water problem.

"While water debates on the Monterey Peninsula have historically been fraught with acrimony, discord and inaction," Burnett said, "in the past several years, we have worked hard to bring a sustained focus to solving the problem, informed by good data and science."

Burnett also recommended the water board take a field trip to the San Clemente Dam, since removal of the dam resumes this month.

Besides Marcus, the other board members are Dorene D'Adamo, Frances Spivy-Weber, Steven Moore and Tam Dudoc, who was the only member to vote against the Peninsula water cutback order because she felt it didn't go far enough.

WELLS

From page 1A

and even the test well, will irreparably damage prime coastal farmlands and groundwater resources and "permanently and forever harm, injure, degrade and impact the environmental values of Monterey County and the State of California."

However, the 1,789-page draft EIR released April 30 concluded something else.

While the EIR acknowledges that Cal Am's desal plant would cause noise and traffic during construction, and have an indirect impact on climate change, the project "would not result in a significant impact to groundwater resources" including exacerbating seawater intrusion.

"It would not reduce, or affect at all, the availability of fresh water," according to the EIR. Nor would it "lower groundwater levels in the basin so as to affect the water supply of any groundwater users [or] alter or reduce groundwater quality."

Environmental Science Associates, the San Francisco consulting firm hired by the California Public Utilities Commission to write the EIR, also found "that it appears reasonable to conclude" that the proposed desal project "would not result in harm or injury to the water rights of legal users of water in the basin in terms of fresh water supply or water quality."

No active wells?

The EIR also questions the existence of active wells that Ag Land Trust argues would be harmed by Cal Am's desal operations.

"This property contains two large agricultural wells in the vicinity of the test well project that have the potential to be permanently contaminated" by the test operation, according to the group's complaint.

To support the lawsuit, Ag Land Trust board member and founder Marc Del Piero, in a Jan. 20 declaration, said that the group has a "big well" that "is operational and provides much needed water for irrigation of the Armstrong Ranch," the name of a property the ag trust owns that's about one mile from Cal Am's desal operation.

However, according to the EIR, the team that worked on the document couldn't find any active Ag Land Trust wells. "Efforts to physically locate the well have been unsuccessful," according to the document.

Not satisfied with the EIR's findings, a group of anti-Cal Am activists in a May 1 online blog point to a purple pipe off Highway 1 in Marina as being one of the wells. The site also included a photograph of Del Piero standing near the pipe, which the blog writer calls the ag land trust's "primary well."

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The Carmel Pine Cone

Volume 101 No. 21 On the Internet: www.carmelpinecone.com May 22-28, 2015

TRUSTED BY LOCALS AND LOVED BY VISITORS SINCE 1915

Bernahl, Weakley dismiss lawsuits against each other

By KELLY NIX

THE HIGH-PROFILE legal fracas between restaurateurs David Bernahl and Rob Weakley is over, Bernahl told The Pine Cone this week.

Bernahl, who founded the culinary company Coastal Luxury Management with Weakley eight years ago, sued Weakley in March, claiming that his former partner and close friend "sabotaged" CLM during a "malicious campaign" after being terminated last year. His suit was in response to one from Weakley in December 2014 alleging that Bernahl's new business partner, Charles Banks, had failed to pay Weakley for his share of the company.

Bernahl told The Pine Cone that he and Weakley formally dropped the suits in April, just after this year's Pebble Beach Food & Wine event, but "had come to terms some time before that."

"We were able to arrive at a mutually beneficial agreement given all that had transpired," Bernahl said. "We have a lot of history together, and I was always confident we'd be able to work through our differences amicably."

When asked whether there was a chance he and Weakley would regain their once-strong friendship despite the ugly legal battle, Bernahl said, "Rob and I created a lot of unforgettable memories together that I'll always cherish."

See **SETTLE** *page 27A*

PUT YOUR HANDS UP!

PHOTO/COURTESY RENE LONG

Police services officer Lisa Johnson and officer Jesse Juarez broke out their snake-wrangling gear to capture a wayward reptile on San Carlos Street. The snake had been hiding in the engine compartment of a parked car. See page 10A

Ross retires to avoid fight with city over timecards

By MARY SCHLEY

STU ROSS, who worked in public works for nearly four decades, retired Wednesday, rather than staying on to fight allegations he "recorded hours on his city timesheet that he did not actually work," according to a settlement agreement he and city administrator Doug Schmitz signed May 20. Ross is accused of playing golf when his time sheets claimed he was at work as the city's public works superintendent.

After receiving an anonymous packet of information about Ross, city officials hired an investigator to look into the matter, and the results indicated he received $4,860.92 in pay for hours he did not actually work, according to the

See **ROSS** *page 13A*

Local history librarian to become city clerk

By MARY SCHLEY

AS THE woman in charge of the Local History Room at Carmel Library, Ashlee Wright knows how important documents are when it comes to tracking a town's development and progress. So, it stands to reason she would approach the task of managing current records with the same respect and detail. That fact, and others, played into city administrator Doug Schmitz' decision to hire her as the new city clerk, a move he announced Tuesday.

Wright, who came to work for the city in 2009 as an entry-level librarian and was promoted to local

See **CLERK** *page 26A*

Ashlee Wright

Valve fails and sewage spills near Lovers Point

By KELLY NIX

JUST HOURS after 220,000 gallons of raw sewage flowed into the highly scenic waters off Pacific Grove Monday, Mayor Bill Kampe said that there would be a "thorough review" of the incident.

Shortly after 10:30 a.m. May 18, contractors with Monterey Regional Water Pollution Control Agency were working on a pump station at Ocean View and 15th Street when a discharge valve failed to seal properly, which caused sewage to begin flowing into the pump station. Rather than allow the waste to ruin the costly facility, the workers decided to let it flow into the ocean, where harbor seals, otters, whales and other wildlife are common.

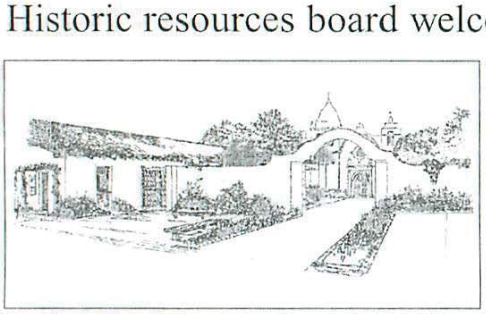
"All of our electrical equipment and everything else is down there, so our crews had no choice but to bypass [the sewage] into the bay," MRWPCA deputy general manager Paul Sciuto told The Pine Cone at the scene Monday, about three hours after the discharge began.

While workers from the MRWPCA and the City of Pacific Grove's public works department, including superintendent Daniel Gho, responded quickly to try to pump some of the sewage into holding trucks, it took nearly seven hours to stop the spill. At that point, more than 200,000 gallons had already flowed into the ocean.

"It was a very tough decision," to intentionally discharge the sewage into the bay, Sciuto said. However, if workers hadn't allowed the sewage to discharge into the ocean, it would have filled up and ruined the facility — which he estimated to be worth roughly $500,000 — and the wastewater would have

See **SEWAGE** *page 26A*

Historic resources board welcomes next phase of Mission restoration



The arch over the main entrance to the Carmel Mission will be replaced as part of a $20 million renovation

By MARY SCHLEY

THE SECOND round of renovations planned for the Carmel Mission easily received the historic resources board's approval Monday afternoon, paving the way for improvements to the gift shop, courtyards, parking areas, walls and other buildings on the complex at the south end of town.

"I think this is a very, very good project," observed board member Kathryn Gualtieri. "It's been thoroughly studied, and I think the architect and structural engineer have done a very thorough job."

The Mission is owned by the Diocese of Monterey, which is the formal applicant for the renovation project, although the nonprofit and non-religious Carmel Mission Foundation, which raised the $5.5 million for the Basilica restoration and has set out to collect $20 million for the second phase, is the moving force behind it.

Aptos-based architect Brett Brenkwitz was hired by the diocese to mastermind the latest update of the Carmel Mission — which was constructed in 1797 but includes many buildings and elements added in the early-to-mid-1900s.

While the Phase I restoration completed in 2013 focused on the seismic retrofit of the Basilica itself, the next phase will involve slight modifications to the Convento Museum (which includes the room where Junipero Serra died in 1784 and is the exit for the Mission complex), the Jo Mora Chapel Gallery (which

See **MISSION** *page 27A*

Ag Land Trust – Letter 2 (ALT1) - Attachments

Group disputes EIR's conclusions about desal's impact on wells

By KELLY NIX

A MEMBER of the Ag Land Trust this week rejected findings in the environmental impact report for California American Water's proposed desalination plant that the group doesn't have any active wells near the desal project's site.

The environmental review released at the end of April indicated that there weren't any active Ag Land Trust wells near the desal test well — an assertion that might help the desal project clear environmental hurdles, but which Ag Land Trust member Marc Del Piero strongly rejected.

"There are two agricultural wells on the Ag Land Trust property," Del Piero told The Pine Cone. "They were constructed pursuant to well permits issued by the County of Monterey prior to the trust's acquisition of the farm, which began in 1993. Neither of these wells has ever been capped. They are both operable and have been since the trust acquired the farm."

Del Piero's response was made in response to comments from EIR consultant Eric Zigas, who told The Pine Cone last week that the EIR team could not find an active Ag Land Trust well.

But Del Piero contends the trust's "big well," located on the west side of Highway 1, is, in fact, operational and provides irrigation water for Armstrong Ranch in Marina. The well, he said, is located about 200 to 300 yards northeast of the property where Cal Am is operating its desal test well.

The trust, Del Piero said this week, also has a "small well" on the east side of Highway 1 that is "capable" of producing about 2,000 gallons per minute.

"We have run the small well multiple times to demonstrate to members of the public, reps of organizations, etc., that our well is operable," he said, "and that Cal Am lawyers and representatives have been misrepresenting its operable condition and the quality of water produced therefrom."

He also accused The Pine Cone of being a "cheerleader" for Cal Am and called the California Public Utilities Commission, which is processing Cal Am's desal application, "the gang that couldn't shoot straight."

However, Martin Feeney, a hydrogeologist and a member of the team evaluating water-quality data from Cal Am's test desal operation, told The Pine Cone that while there is a well on the east side of Highway 1 — near a booster pump that delivers recycled water to farmland — that well is not connected to any irrigation system and is not used for farming because the groundwater has long been intruded with saltwater. And though water from the well is sometimes used for dust control, it can't be used to water plants, Feeney said.

"How can someone be concerned about damaging the aquifer when it's already been damaged to the point where it's not of beneficial use?" Feeney said.

In a declaration Del Piero submitted in support of an application for a restraining order to stop Cal Am from operating the test well, he claimed that, "over 160 acres are under cultivation and use groundwater wells on the property for irrigation."

But a separate declaration from Monterey County Water Resources Agency deputy general manager Robert Johnson pointed out that the big well "is not currently operational or connected to any irrigation system."

"Based on water resources agency reports, which I have reviewed," according to Johnson, "there has been no pumping of water for any purpose reported from the big well, or any other well on this property, as required by the water resources agency's 1997 contract with the landowner."

In his email to The Pine Cone this week, though, Del Piero tacitly acknowledged that the big well doesn't have a pump, but claimed it could be used "with a portable pump and irrigation pipe."

See WELLS page 16A

Ag Land Trust – Letter 2 (ALT1) - Attachments

DRONES

From page 12A

Not so fast. Remember that restriction against flying above 400 feet? The Monterey Bay National Marine Sanctuary has designated "overflight prohibition zones," where motorized aircraft are prohibited below 1,000 feet above the water.

Happily, the wide swath of waterfront from the Salinas River to the Carmel River isn't included, thanks to a variance required for the Monterey Peninsula Airport's operations. There's a map of the zones on the sanctuary's website.

Scott Kathey, who handles regulatory issues for the sanctuary, said the rule's there to protect wildlife. Anyone can apply for an exception, if they have a good reason that will also benefit the sanctuary. For example, the first — and so far only — one granted went to the National Marine Fisheries Service to conduct research.

While Kathey said he wants people to watch and learn about animals, and certainly understands their desire to do so, they should respect the creatures' individual "safety zones." Even where there are no restrictions on aircraft, there are laws against disturbing or chasing wildlife.

Kathey said that last year, a couple of guys — clearly out-of-towners — brought two drones to the rec trail in Pacific Grove and buzzed the seals, causing a chaotic stampede of mothers and babies into the ocean. Although the droneheads were not identified, they were soundly scolded by others on the trail and beat a hasty retreat.

Just like harbor seals, people sometimes react strongly to drones, perhaps because it's not immediately clear who's filming and why. Even though an abundance of cameras and phones already record people in public places, some people still feel there's an "ick" factor when it comes to drones.

Ivey thinks that feeling shows a need for education. For example, he said, drones aren't good for surveillance. Most can only fly 15-20 minutes before the battery needs to be changed, and, he said, "You can hear them from 100 yards away." So spying on someone with a drone just wouldn't work.

Additionally, First Amendment advocates point out that photography with a drone is still photography, and should have the same protections.

California's Legislature and the governor so far agree, passing legislation last year making it illegal to film someone with a drone only if the person had a reasonable expectation of privacy. More legislation regulating small, unmanned aircraft is being considered this year.

While hobbyists and private enterprise continue to explore the uses of drones, regulators and legislators continue to hover nearby, trying to keep up.

WaterPlus lawsuit challenge to $800K seed money fails in court

By KELLY NIX

A GROUP that sued the Monterey Peninsula Water Management District in 2013 over $800,000 in desal-plant seed money lost its case in a Monterey courtroom last week.

WaterPlus, which is backed by businessman Nader Agha, filed suit against the water district arguing it violated the California Environmental Quality Act when it agreed to reimburse DeepWater Desal for work associated with its proposed desal project. WaterPlus said the district didn't evaluate potential environmental impacts of the project nor allow for public input.

But concluding a roughly 45-minute hearing on May 15, Monterey County Superior Court Judge Thomas W. Wills granted a motion by the water district for summary judgment — a ruling without a full trial. The activist group had hoped Wills would set aside the water district agreement with DeepWater Desal and find it invalid.

Following the hearing, water district general manager Dave Stoldt said Wills' decision affirmed the district's contention that the public agency did not need an exhaustive environmental impact report in order to enter into an agreement with DeepWater.

"We held all along that we don't need an EIR to help fund an EIR," Stoldt told The Pine Cone Monday. "It was potentially a drain on our revenues, which ultimately comes from Peninsula water users."

In August 2013, water district directors voted 5-1 for the cost-sharing agreement between the district and DeepWater Desal. According to the deal, the two parties were to split the environmental and permitting work costs, which were expected to be roughly $1.6 million.

DeepWater Desal's proposed operation in Moss Landing — which would draw seawater from about 100 feet below the surface — is to serve as a contingency plan if water

See **FAILS** *page 26A*

WELLS

From page 6A

He also said the big well is secured with a combination lock and representatives from the county water agency "have never been able to even look into the well, let alone do a water-quality analysis."

Del Piero also said "the failure by Zigas and the California Public Utilities Commission to identify and evaluate the existence and condition of the trust's wells is a major and intentional flaw in the draft EIR." He accused Zigas of "lying to protect his job," but didn't elaborate. Zigas could not be reached for comment.

Del Piero also accused the CPUC of ignoring the Ag Land Trust's concerns regarding its water rights in the area Cal Am wants to build its desal plant.

"The trust has sent multiple letters of objection to the CPUC representatives between 2006 and last year," he said. "The trust has never received the courtesy of even a responsive phone call or letter acknowledging our effort to raise the issues of our groundwater rights in our multiple letters of objection."

He added that the groundwater below the trust's farm was "designated as a potable supply in 2012 by the Central Coast Regional Water Quality Control Board and certified by the State Water Resources Control Board."

Meanwhile, the release of the 1,789-page draft EIR on April 30 marked the beginning of the 60-day public-comment period. The CPUC said it would review and consider all comments and public testimony for possible inclusion in the final EIR.

A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 09-198-030 CLIENT: 5404-D

DATE SAMPLED: / /
DATE RECEIVED: 07/17/09
DATE COMPLETED: 07/24/09
SUBMITTED BY:

SEND TO: ROY ALSOP PUMP & DRILLING
1508 ABBOTT ST.
SALINAS, CA 93901

CUSTOMER: PO#47685/SEA MIST FRMS-SAN JON

DATE OF REPORT: 07/24/2009

WATER ANALYSIS REPORT

PAGE: 1

Sample ID	Lab Number	Sodium Na ppm	Calcium Ca ppm	Magnesium Mg ppm	Carbonate CO_3 ppm	Bicarbonate HCO_3 ppm	Chloride Cl ppm	Conductivity E.C. mmhos/cm	pH	Copper Cu ppm	Iron Fe ppm	Manganese Mn ppm	Zinc Zn ppm
B-A #1	67793	233	475	214	0	201	1338	5.07	7.5				
B-A #3	67794	232	475	214	0	201	1338	5.08	7.5				
							*						

Sample ID	Phosphorus P ppm	Potassium K ppm	Nitrate NO_3 ppm	Sulfate SO_4 ppm	Boron B ppm	Dissolved Solids ppm	Total Hardness ppm	Bacteriological MPN/100ml Total Coliform	Fecal Coliform
B-A #1	0.00	10.7	3	112	0.05	3245	2087		
B-A #3	0.15	10.7	2	112	0.09	3238	2087		

Comments:

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

Robert Butterfield
A & L WESTERN LABORATORIES, INC.

Ag Land Trust – Letter 3 (ALT1) - Attachments

STATE OF CALIFORNIA

STANDARD AGREEMENT - APPROVED BY THE ATTORNEY GENERAL
STD.2(REV.5-91)

CONTRACT NUMBER	AM. NO.
88-027	5

TAXPAYERS FEDERAL EMPLOYER IDENTIFICATION NUMBER

THIS AGREEMENT, made and entered into this 7 day of November, 19 97, in the State of California, by and between State of California, through its duly elected or appointed, qualified and acting

TITLE OF OFFICER ACTING FOR STATE: Executive Officer
AGENCY: State Coastal Conservancy, hereafter called the State, and

CONTRACTOR'S NAME: Monterey County Agriculture and Land Conservancy, hereafter called the Contractor.

WITNESSETH: That the Contractor for and in consideration of the covenants, conditions, agreements, and stipulations of the State hereinafter expressed, does hereby agree to furnish to the State services and materials as follows: *(Set forth service to be rendered by Contractor, amount to be paid Contractor, time for performance or completion, and attach plans and specifications, if any.)*

The State Coastal Conservancy ("the Conservancy") and the Monterey County Agriculture and Historic Land Conservancy ("the grantee") agree to amend their Existing Agreement No. 87-027 as follows:

SCOPE OF AGREEMENT

Add to this section after Task V, the following Task VI:

(Continued on the following page)

CONTINUED ON ________ SHEETS, EACH BEARING NAME OF CONTRACTOR AND CONTRACT NUMBER.

The provisions on the reverse side hereof constitute a part of this agreement.
IN WITNESS WHEREOF, this agreement has been executed by the parties hereto, upon the date first above written.

STATE OF CALIFORNIA	CONTRACTOR
AGENCY: State Coastal Conservancy	CONTRACTOR *(If other than an individual, state whether a corporation, partnership, etc.)*: Monterey County Agriculture & Land Conserv.
BY (AUTHORIZED SIGNATURE): [signature]	BY (AUTHORIZED SIGNATURE): Brian Rianda [signature]
PRINTED NAME OF PERSON SIGNING: Steve Horn	PRINTED NAME AND TITLE OF PERSON SIGNING: Brian Rianda
TITLE: Executive Officer	ADDRESS: P.O. Box 1731, Salinas, CA 93902

AMOUNT ENCUMBERED BY THIS DOCUMENT: $ 1,500,000.00	PROGRAM/CATEGORY (CODE AND TITLE): Capital Outlay		FUND TITLE: '84 SCC Fund, Federal Trust Fund, Habitat Conserv. Fund	*Department of General Services Use Only*
PRIOR AMOUNT ENCUMBERED FOR THIS CONTRACT: $ 995,000.00	(OPTIONAL USE): Monterey County Agriculture			
TOTAL AMOUNT ENCUMBERED TO DATE: $ 2,495,000.00	ITEM	CHAPTER	STATUTE	FISCAL YEAR
	3760-301-0730(1)86=660,319.50	186	1986	86/87
	3760-301-730(1)87=334,680.50	006	1987	87/88
	3760-301-0890	282	1997	97/98
	3760-301-0262 = $1,500,000 [illegible handwriting]	282	1997	97/98
	OBJECT OF EXPENDITURE (CODE AND TITLE) [illegible handwriting]: Ag/Enhancement			

I hereby certify upon my own personal knowledge that budgeted funds are available for the period and purpose of the expenditure stated above.	T.B.A. NO.	B.R. NO.
SIGNATURE OF ACCOUNTING OFFICER: [signature]	DATE: 11-7-97	

☐ CONTRACTOR ☐ STATE AGENCY ☐ DEPT. OF GEN. SER. ☐ CONTROLLER

SCOPE OF AGREEMENT (CONT.)

Task 6: Acquisition of the remaining two-thirds undivided property interest in the West Armstrong Farm, Monterey County Assessors Parcel Nos. 203-011-10,11,13 and 14

The Conservancy hereby grants to the grantee an additional sum not to exceed one million five hundred thousand dollars ($1,500,000) to purchase the remaining two-thirds undivided property interest in the property described in Exhibits C and D as the West Armstrong Farm (the "property"). Funds shall be disbursed by the Conservancy directly into escrow subject to advance review, for consistency with the conditions precedent to disbursement set forth below, and approval by the Executive Officer of all escrow instructions, deeds, title reports and other closing documents. The grantee shall provide five-hundred thirty-two thousand dollars ($532,000) towards the acquisition of the property, and shall be responsible for all closing costs, including costs of title insurance to be obtained on the property to at least the amount of $1,500,000. Conformed copies of the deed and other documents recorded through escrow shall be provided to the Conservancy directly at the close of escrow, along with evidence of title insurance when issued.

The grantee acknowledges that funding for this Task 6 acquisition will be provided from the United States of America, Commodity Credit Corporation and Natural Resources Conservation Service Farm Protection Program, and agrees to comply with all applicable Farm Protection Program requirements, as set forth in this Amendment 5.

The grantee shall manage the property in accordance with a conservation plan prepared by the Natural Resources Conservation Service and approved by the Monterey County Resource Conservation District, and shall ensure that the property is preserved in agricultural use in perpetuity.

The grantee shall submit biannual reports for review and approval of the Executive Officer, detailing revenues, management and improvement costs associated with property acquired with the funds granted under this Agreement. Any revenues in excess of costs shall be used by the grantee solely for agricultural preservation purposes, and shall be detailed in the biannual report.

CONDITIONS PRECEDENT TO DISBURSEMENT

Revise condition (3) and add new condition (4) as follows:

At the end of subsection (3)(d), after the phrase "State of California", insert the phrase "and the United States of America".

CONDITIONS PRECEDENT TO DISBURSEMENT (CONT.)

Delete subsection (3)(f) in its entirety and replace it with the following:

"f. If any essential term or condition of this Agreement is violated, title to all interests in the

property shall immediately vest in the State or, to the extent required pursuant to its "Contingent Right", in the United States of America. For purposes of this Agreement, the "essential terms and conditions" are those set forth in the "ESSENTIAL DEED PROVISIONS" Section of this Agreement."

Add new subsection (4) as follows:

"(4) The acquisition of the remaining two-thirds interest in the West Armstrong Farm property pursuant to Task 6 is subject to the following Additional Conditions:

a. The grantee shall provide all additional funds required to complete the purchase of the property including but not limited to the balance of the purchase price, and all title, escrow and closing costs.

b. The grantee shall execute an amendment to the "IRREVOCABLE OFFER TO DEDICATE" recorded on March 6, 1992, at Reel 2766 Page 712 of Monterey County Records, or other document acceptable to the Executive Officer, sufficient to incorporate the ESSENTIAL DEED PROVISIONS as set forth in this Amendment 5, to be recorded through escrow in conjunction with the deed conveying the property to the Grantee."

COST AND DISBURSEMENT

Delete the first three sentences and replace with the following:

"The Conservancy agrees to provide the Grantee a sum not to exceed a total of two million, four hundred ninety-five thousand dollars ($2,495,000) for projects implementing the program. The sum of one million five hundred thousand dollars ($1,500,000) toward the purchase of the property interest to be acquired under Task 6 of this Agreement shall be paid by the Conservancy directly into escrow following at least thirty (30) days' advance written notice by Grantee, provided the other conditions of this Agreement have been met."

COMPLETION AND TERMINATION DATE

The date in lines one and two of the first paragraph of this section is changed to May 30, 1998. The date in line one of paragraph four of this section is changed to May 30, 2018.

FUNDING AUTHORIZATION

This section shall be deleted in its entirety and replaced with the following paragraph:

"The signature of the Executive Officer of the Conservancy on this agreement certifies that at its August 16, 1984, October 18, 1991, and June 25, 1997 meetings, the Conservancy adopted the resolutions included in the staff recommendations attached and incorporated by reference as Exhibits A, C, and D, respectively. This agreement is executed pursuant to those authorizations."

ESSENTIAL DEED PROVISIONS

Revise subsections 1 and 3, and add a new subsection 6 as follows:

In subsection 1 after the word "agriculture", insert the phrase "and coastal dune habitat". *

In subsection 3, add the following phrase at the end of the sentence, after the word "successor": "and the prior consent of the Secretary of the United States Department of Agriculture and payment of consideration to the United States."

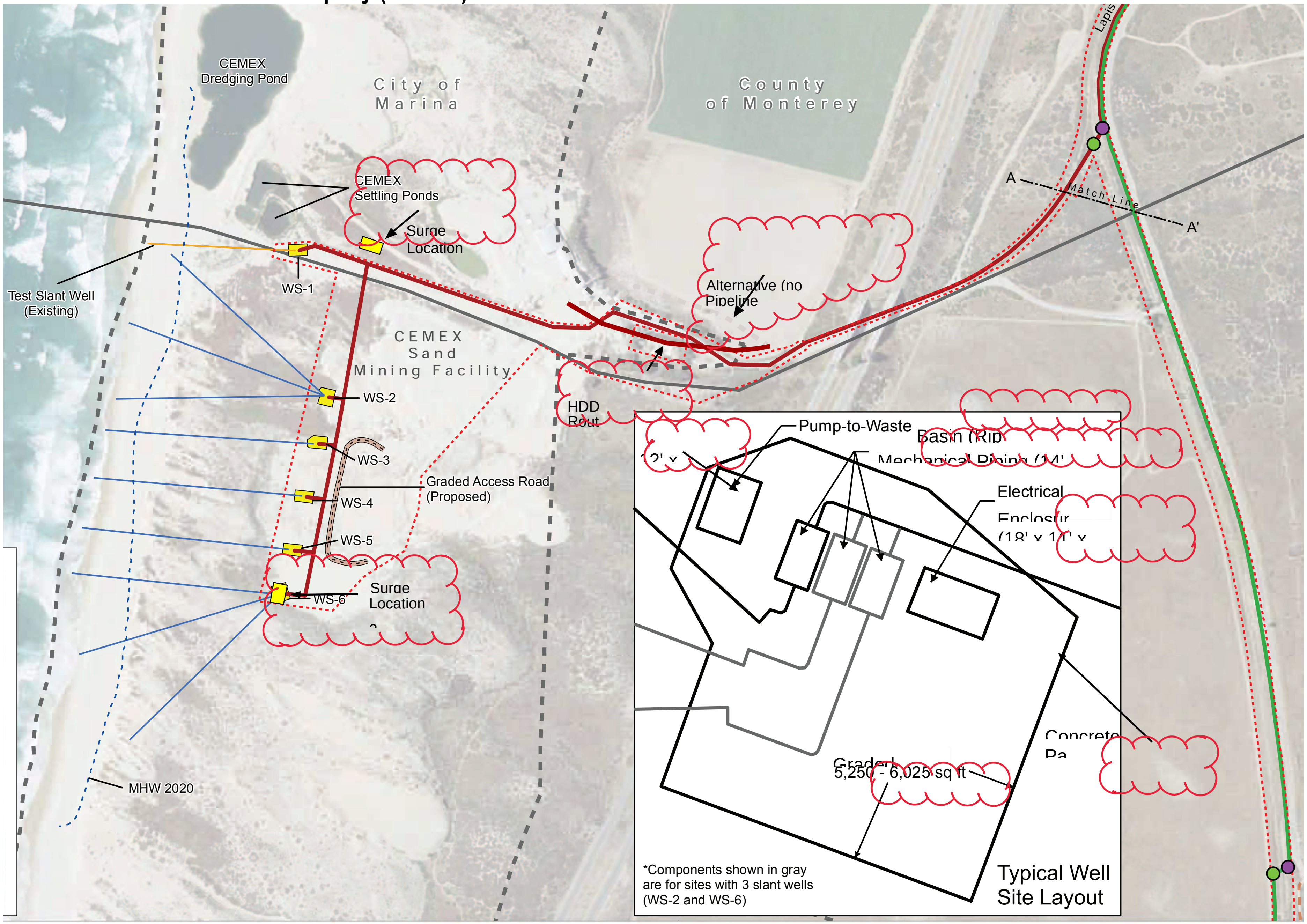
Add new subsection 6:

"6. This acquisition shall be subject to the following Contingent Right in the United States of America:

In the event that the grantee fails to prevent the property from being converted to non-agricultural uses, as determined in the sole discretion of the Secretary of the United States Department of Agriculture, the said Secretary of Agriculture and his or her successors and assigns shall have the right to enforce the agricultural restrictions of this Offer through any and all authorities available under Federal or State law.

In the event that the grantee attempts to terminate, transfer, or otherwise divest itself of any

California-American Water Company (Cal-Am) - Exhibits



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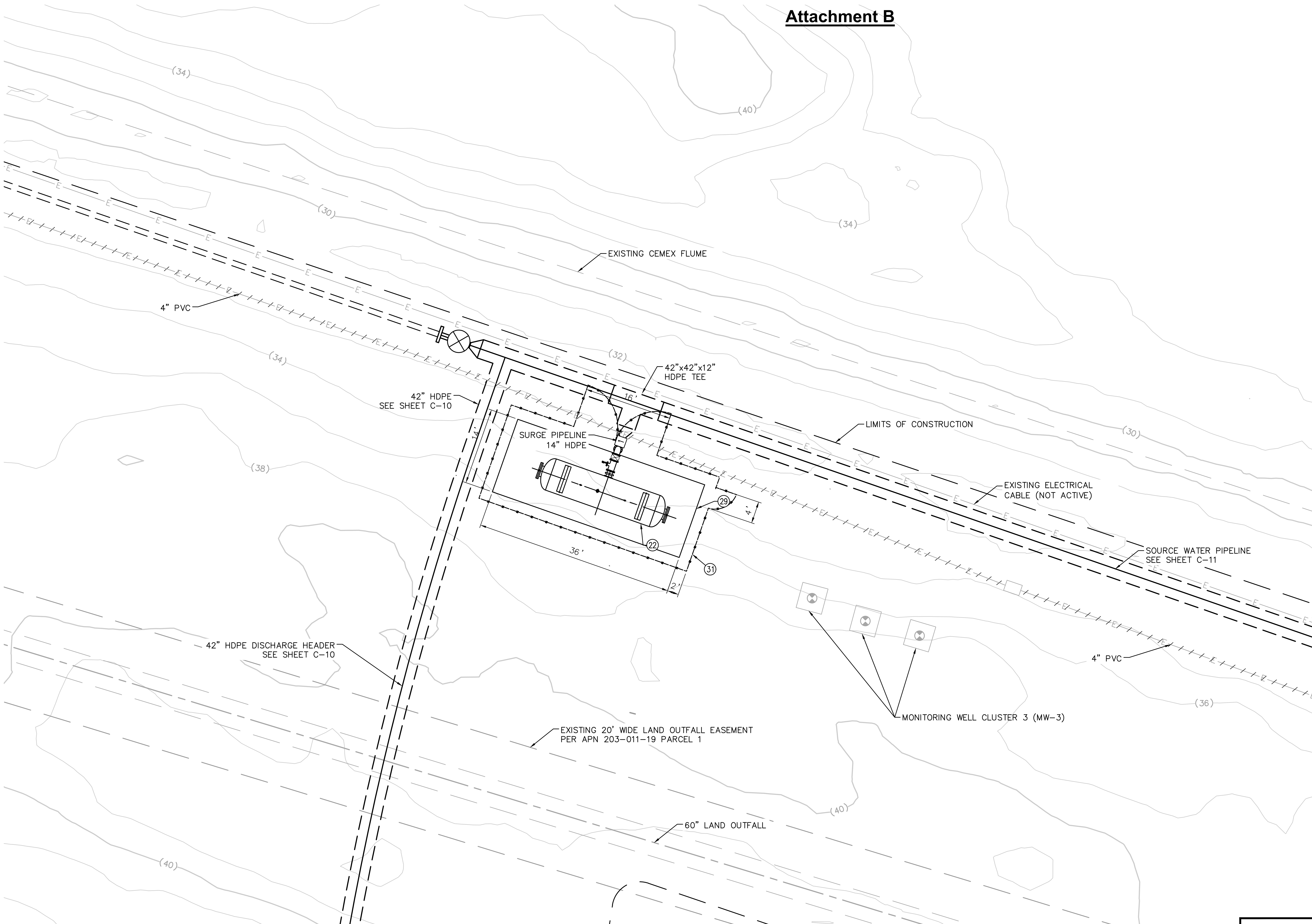
:tion related disturbance would occur.

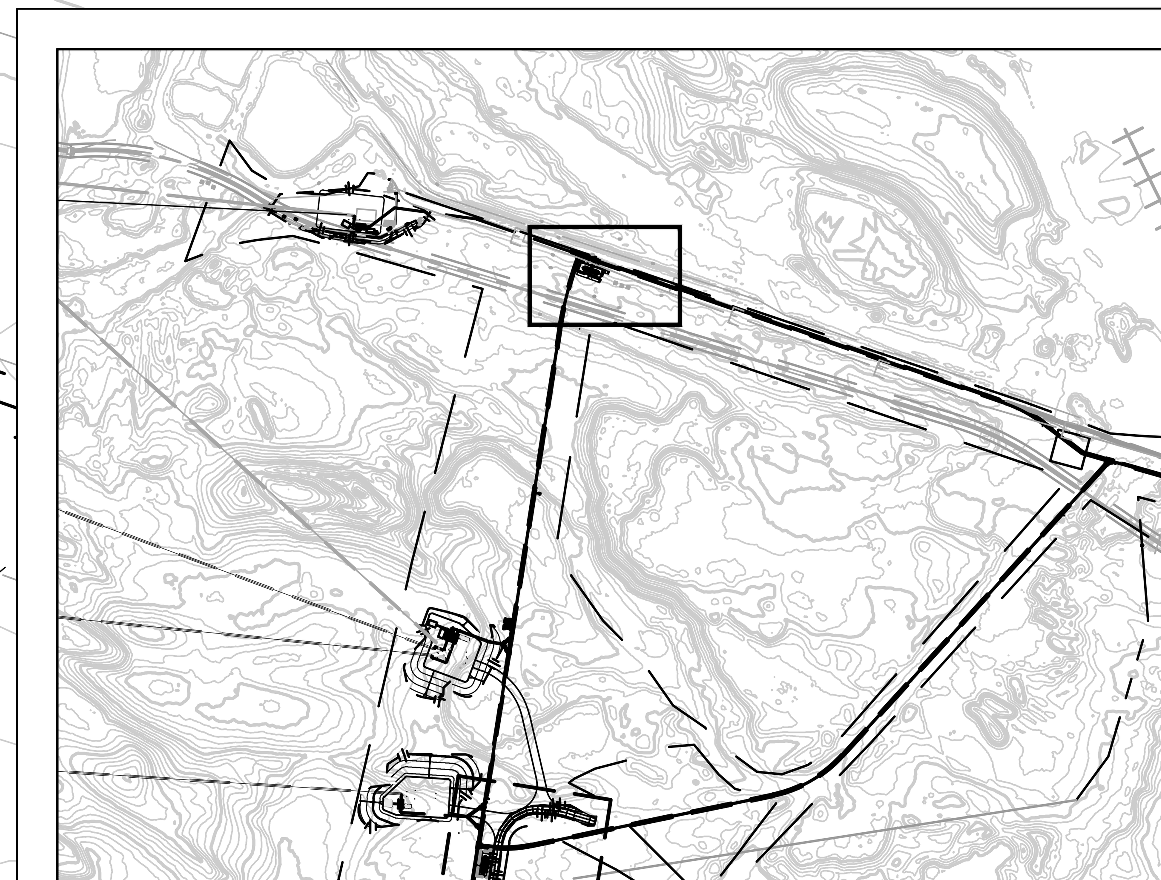
Attachment A

Attachment B



CONSTRUCTION NOTES

(22) INSTALL SURGE TANK PER DETAILS ON SHEET M-4
(29) INSTALL CONCRETE PAD PER DETAILS ON SHEET S-1
(31) 8' TALL CHAIN LINK FENCE WITH TAN (SAND) COLORED PRIVACY SLATS



KEY MAP
NTS

WATER DATA TABLE

NO	BEARING/DELTA	RADIUS	LENGTH	NOTE
1	N 19°26'01" E	--	1.35'	14" HDPE DR-17 (125 PSI)

10 5 0 10 20 30
SCALE: 1"=5'

Michael Baker
INTERNATIONAL

REGISTERED PROFESSIONAL ENGINEER
MAKROM H. SHATILA
No. 76421
Exp. 12/31/18
CIVIL
STATE OF CALIFORNIA

REVISIONS

MONTEREY PENINSULA WATER SUPPLY PROJECT
SLANT WELL INTAKE SYSTEM

SURGE TANK SITE PLAN

CALIFORNIA AMERICAN WATER COMPANY
MONTEREY

MICHAEL BAKER INTERNATIONAL
9755 CLAIREMONT MESA BLVD
SAN DIEGO, CA 92124
858-614-5000

CALIFORNIA AMERICAN WATER

DRAWN BY
PROJECT ENG'R MAKROM SHATILA DATE 12/29/2016
APPROVED PROJECT MPWSP
USE DIMENSIONS ONLY
SCALE 1"=10'

USE APPROVED DRAWINGS ONLY FOR CONSTRUCTION PURPOSES
19
C-16

90%- NOT FOR CONSTRUCTION

H:\PDATA\148903\CADD\WATER\DLV\XX_148903_CXX.DWG GREG.POSTLEWAITE 11/21/16 3:39 pm

Attachment C: Table of onshore/offshore well lengths for 2015 and 2020 MHW

Well No.		Depth of Well Casing (ft)	Well Length (ft, Plan)	2015		2020	
				Well Length Onshore (ft, Plan)	Well Length Offshore (ft, Plan)	Well Length Onshore (ft, Plan)	Well Length Offshore (ft, Plan)
1	TSW	263	684	610	74	535	149
2		242	970	857	113	781	189
3		242	970	897	73	824	146
4		242	970	922	48	855	115
5		242	970	879	91	815	155
6		242	970	827	143	764	206
7		242	970	793	177	735	235
8	Stand-by-1	242	970	970	0	929	41
9	Stand-by-2	242	970	854	116	788	182
10	Stand-by-3	242	970	970	0	970	0

Water Rights for the Monterey Peninsula Water Supply Project

The issue of California American Water Company's ("Cal-Am") ability to develop groundwater rights for the proposed Monterey Peninsula Water Supply Project ("Project") has been raised by a number of parties and stakeholders over the past several years, and some clarification of Cal-Am's ability to develop water rights for the Project would benefit the California Public Utilities Commission's consideration of the Project. This paper summarizes Cal-Am's ability to develop groundwater rights for the Project, and also addresses a few related issues regarding Cal-Am's ability to develop source water for the Project.

The small amount of brackish groundwater that Cal-Am may pump from the Salinas Valley Groundwater Basin[1] ("SVGB") will be "salvaged" water that creates a "surplus" available for Cal-Am to appropriate without adversely impacting the basin or paramount right holders. This process of salvaging water to create a surplus that can be appropriated and put to beneficial use is supported by and furthers California water policy to maximize the beneficial use of water and prevent waste. Further, the operation of the Project is not restricted by Section 21 of the Monterey County Water Resources Agency Act ("Agency Act") or the 1996 *Annexation Agreement and Groundwater Mitigation Framework for Marina Area Lands* ("Annexation Agreement"). Finally, to the extent that Cal-Am's incidental pumping of a small amount of brackish groundwater from the SVGB could potentially cause injury to paramount right holders, a physical solution could be implemented to mitigate the adverse impacts and allow for the Project to proceed.

I. <u>Project Configuration</u>

The Project will include a system of "slant wells" constructed on property owned by CEMEX north of the City of Marina, between the Pacific Ocean (Monterey Bay) and Highway 1. Water pumped from the slant wells will be conveyed by pipe to a desalination plant to be constructed on vacant and disturbed land adjacent to the Monterey Regional Water Pollution Control Agency's Regional Treatment Plant. Cal-Am will deliver water produced at the desalination plant directly to the Monterey Peninsula for municipal uses within Cal-Am's service area, or to the Seaside Basin for aquifer storage, recovery and subsequent municipal use in Cal-Am's service area. An amount of water equal to the percentage of brackish groundwater in the source water will be "returned" to the SVGB for use by the Castroville Community Services District and the Castroville Seawater Intrusion Project (as discussed in Section III. A below) to meet requirements of the Agency Act.

The Project's slant wells will be configured at an angle to extend out from the shoreline and will draw water from beneath the seafloor and coastal area. The wells were designed and will be constructed using modified vertical well construction methods to allow the wells to extract water with higher salinity than can be produced with conventional vertical wells. The angled drilling results in increased screen length, as compared to conventional vertical wells. Water produced by the slant wells will include mostly seawater (90% - 97%), and the

[1] The Salinas Valley Groundwater Basin is also referred to as the Salinas River Groundwater Basin.

remaining volume will be brackish[2] groundwater (i.e. contaminated groundwater exhibiting chemical characteristics of seawater and groundwater), originating from the SVGB. The slant wells will penetrate and draw water from the Dune Sand Aquifer and the 180 Foot Equivalent Aquifer[3] below it. (See, Project Draft EIR/EIS, Figure 4.4-2 [showing a graphic representation of the hydrogeologic setting at and near the CEMEX property], p. 4.4-7.) These aquifers are unconfined[4] with no aquitard[5] between them. (*Id*. at § 4.4.1.2, p. 4.4-11; § 4.4.1.4, p. 4.4-22.) Beneath the 180 Foot Equivalent Aquifer, the 180/400 Foot Aquitard separates the 180 Foot Equivalent Aquifer from the 400 Foot Aquifer. (*Id*. at Figure 4.4-2, p. 4.4-7; § 4.4.1.2, p. 4.4-11.) The slant wells will not penetrate the 180/400 Aquitard. (*Id*.) Seawater has intruded into the Dune Sand Aquifer, the 180 Foot Equivalent Aquifer, and the 400 Foot Aquifer. (*Id*. at § 4.4.1.2, pp. 4.4-8, 4.4-11; § 4.4.1.4, p. 4.4-31; § 4.4.5.2, p. 4.4-59). Further, water level data show that the direction of groundwater flow is from the ocean to inland. (*Id*. at § 4.4.1.3, p. 4.4-14.) Thus, groundwater in these coastal areas of the SVGB is highly contaminated with seawater that has intruded many miles inland from the coast, and any water withdrawn from this area of the SVGB will likely be replaced by similarly contaminated water. This contaminated water in the SVGB generally is not suitable for beneficial uses without significant treatment and desalination.

In order to address the requirements of the Agency Act, the Project proposes to return to the SVGB a volume of desalinated water equal to the amount of SVGB groundwater included in the Project source water. Cal-Am will return this water to the SVGB by delivering it to the Castroville Community Services District and the Castroville Seawater Intrusion Project, both of which will use the water in lieu of pumping groundwater from the SVGB.

II. <u>Project Water Rights</u>

As a threshold matter, Cal-Am does not require a water right to develop, treat and use

[2] "Brackish" water "is defined as groundwater within the seawater intrusion zone that contains chloride levels greater than 500 ppm. Water with chloride concentrations less than 500 mg/L is considered fresh water." (State Water Resources Control Board, Final Review of California American Water Company's Monterey Peninsula Water Supply Project ("SWRCB Report"), §5.4.2, FN. 40, p. 29.) "Saline water is water that has the approximate salinity of seawater, while brackish water is more saline than fresh water, but not as saline as seawater." (Cal-Am Monterey Peninsula Water Supply Project Draft EIR/EIS ("Project Draft EIR/EIS), §4.4.1.2, FN. 6, p. 4.4-8.) "Brackish groundwater can contain Total Dissolved Solids (TDS) concentrations ranging from that of seawater (about 35,000 mg/L) down to 500 mg/L near the leading edge of the inland seawater intrusion front." (*Id*. at § 4.4.1.4, p. 4.4-28.)

[3] While the 180 Foot Equivalent Aquifer is composed of deposits that underwent a different depositional process than the 180 Foot Aquifer, it "is at the same depth interval and is considered to be connected and equivalent to the 180-Foot Aquifer." (*Id*. at §4.4.1.2, p. 4.4-11.)

[4] "The water table in an unconfined aquifer does not have an impermeable aquitard lying over it, and thus pressure is exerted by the overlying water and the atmosphere. Groundwater under these unconfined conditions flows from areas of high groundwater elevation to areas of low groundwater elevation. Under confined conditions, vertical flow from or to the aquifer is restricted by overlying aquitards. Groundwater under confined conditions flows from areas of high pressure to areas of low pressure and is influenced by the pressure, weight, and confining nature of the overlying sediments; water entering the aquifers from areas of recharge; and water leaving the aquifers through natural discharge or through the pumping of supply wells. When a well penetrating a confined aquifer is pumped, internal aquifer pressure is reduced, which can in turn increase the flow of water towards the well." (*Id*. at § 4.4.1.1, pp. 4.4-2, 4.4-4.)

[5] An "aquitard" is a hydrogeologic formation (made up of fine-grained materials such as clay and silt) that restricts the flow of groundwater from one aquifer to another. (*Id*. at p. 4.4-2.)

ocean water pumped from the ocean beneath the sea floor.[6] (SWRCB Report, § 6, p. 33.)

To the extent that Cal-Am requires a water right to pump a small volume of brackish groundwater from the SVGB as part of the Project, that right would be appropriative in nature given that the water will be exported for public use. Groundwater rights, like surface water rights, are usufructuary, giving the rightholder only a right to use the water. (*Santa Maria v. Adam* (2012) 211 Cal.App.4th 266, 278 ["[w]ater rights holders have the right to 'take and use water,' but they do not own the water and cannot waste it"].) Absent such a right to use, no one can claim ownership of water in a groundwater basin. "Courts typically classify water rights in an underground basin as overlying, appropriative, or prescriptive." (*Id*. [internal quotations omitted.]) Overlying rights are tied to ownership of land overlying the groundwater basin and the use of the water on that land. (*Id*.) "Appropriative rights, on the other hand, are not derived from land ownership but depend upon the actual taking of water." (*Id*.) The public use of groundwater supplied by a municipal agency or water supplier is typically classified as an appropriative use, not an overlying, use. (*San Bernardino v. Riverside* (1921) 186 Cal. 7, 25; See also, Hutchins, The California Law of Water Rights ("Hutchins") (1956), at pp. 458.)

In California, appropriative groundwater rights in non-adjudicated basins like the SVGB are established through the diversion (i.e., pumping) and beneficial use of groundwater without the oversight of a permitting agency, court or watermaster needed to establish the right. A valid appropriation includes the following elements: (1) [t]he intent to appropriate water and apply it to a beneficial use; (2) the actual . . . extraction from a ground-water basin; and (3) the application of water to a beneficial use within a reasonable time." (*Turlock Irrigation District v. Zanker* (2006) 140 Cal. App. 4th 1047, 1054; See also, Hutchins, at p. 108.) Thus, for a public agency to claim a right to sell water through a municipal system, it must, like any appropriator, begin pumping and put the water to beneficial use. (See, 1 Slater, California Water Law and Policy (2017) ("Slater"), § 2.15[1], at p. 2-99 ["the only way one can obtain an appropriative right to percolating groundwater is by extracting percolating groundwater and applying it to a beneficial use"] [citing various cases].) Appropriative groundwater rights cannot be claimed in advance of actual pumping and beneficial use. (*Id*. at 2.11[2], at p. 2-35 [[t]itle to an appropriative right is not perfected until water is actually applied to a beneficial use"] [citing various cases].) Without an existing appropriative right, an individual or entity who may desire to make use of groundwater at some time in the future cannot claim current "ownership" (i.e., the right to use) and thereby preclude others from making use of surplus water. To do so would violate the constitutional mandate, set forth in Article X, Section 2 of the California Constitution, "that the water resources of the State be put to beneficial use to the fullest extent of which they are capable," and that waste be prevented.

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[6] California surface water rights laws apply only to waters flowing or present in lakes, rivers and streams - including subterranean streams flowing in known and definite channels. (See, Wat. Code §§ 1200, 1201.) California's groundwater rights laws apply only to "percolating groundwater," which is generally defined as water found beneath the ground surface that is not flowing within a "subterranean stream." (See, e.g., *Los Angeles v. Pomeroy* (1899) 124 Cal. 597.) Percolating groundwater is found in geologic formations known as "groundwater basins," which have been defined as "an alluvial aquifer or a stacked series of alluvial aquifers with reasonably well-defined boundaries in a lateral direction and a definable bottom." (See, Bulletin 118 (2003), Ch. 6, p. 88.) The ocean and ocean waters lack the essential geologic and physical characteristics of surface water or percolating groundwater, as those terms have long been defined and interpreted in California.

Overlying groundwater rights are paramount to the rights of an appropriator. (*Pasadena v. Alhambra* (1949) 33 Cal. 2d 908, 926.) With respect to appropriative rights, "the one first in time is the first in right, and a prior appropriator is entitled to all the water he needs, up to the amount that he has taken in the past, before a subsequent appropriator may take any." (*Id*.) However, "neither an overlying owner nor an appropriator is injured by a diversion of surplus waters only – that is, waters in excess of the reasonable beneficial requirements of the paramount and prior rights. Consequently the holders of the paramount or prior rights may not prevent the taking of surplus waters by an appropriator." (Hutchins, at p. 481 [citing various cases].) Thus, an appropriative right can be developed without actionable injury to a paramount right holder if a surplus exists.

Cal-Am can develop an appropriative right to the brackish SVGB groundwater, even if the Basin is in overdraft because the small amount of brackish water that Cal-Am may pump from the SVGB will be "salvaged" water that is "surplus" to the demands and uses of SVGB groundwater users and thus is available for appropriation. Such an appropriation would not injure the rights of any paramount right holders because the salvaged water is not water previously used (or currently usable) by paramount right holders (i.e., it is in excess of the reasonable beneficial requirements of paramount right holders) due to its high salinity, which makes it largely unsuitable for beneficial use without desalination and treatment.

A. The small amount of brackish water that Cal-Am may pump from the SVGB will be "salvaged" water.

Available data, modeling and other technical analyses indicate that the slant wells cannot pump source water consisting of 100% seawater due to the location of the wells and the geology of the Project area. As a result, the Project wells are assumed and expected to pump source water that includes some groundwater originating in the seawater intruded areas of the SVGB. This "brackish" water that Cal-Am may pump from the SVGB will be "salvaged"[7] water because it is unusable by paramount right holders (i.e., will be lost absent Cal-Am's efforts to salvage it) and can be pumped without injuring paramount right holders or adversely impacting the basin.

"Salvaged water refers to water that is created by efforts to make existing water use practices more efficient or otherwise to add to the amount of water that was previously available." (1 Slater, § 2.08[10], at p. 2-22.) Under the salvaged water doctrine, "full recognition is afforded of the right to water of one who saves as well as of one who develops it." (*Pomona Land and Water Co. v. San Antonio Water Co*. (1908) 152 Cal. 618, 624-625.) The cases articulating the salvaged water doctrine establish the following principles demonstrating Cal-Am's ability to develop a right to the brackish groundwater as part of the Project: (1) water saved

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[7] The principles of "salvaged" water and "developed" water are similar, the terms often used interchangeably, and "[t]he general rules governing rights to the use of salvaged and developed water are the same, viz., that the person who by his own efforts makes such waters available is entitled to use them, provided that in doing so he is not infringing on the prior rights of others." (Hutchins at p. 383.) The technical difference between the two is that salvaged water refers to water that is saved from the supply and developed water refers to new water that is added to the supply. (*Id*.) The term "salvaged" water is used herein.

from being lost or wasted is "salvaged" water; and (2) the person responsible for salvaging water acquires a priority right to the water.

The relatively recent case of *Santa Maria v. Adam* discussed the salvaged water doctrine. In that case, the court addressed the rights to water captured by dams during high flow events that was used to recharge groundwater supplies. (*Id*. at 280-281.) Without the dams, most of the high-water flows would have been lost to the sea. (*Id*.) In addressing the rights to this water, the court stated as follows:

> Simply stated, salvaged water is water that is saved from waste as when winter floodwaters are dammed and held in a reservoir. As is the case with return flows, a priority right to salvaged water belongs to the one who made it available. This is not a new rule. In *Pomona etc. Co. v. San Antonio etc. Co.* (1908) 152 Cal. 618, 620 [93 P. 881], it was determined that from one point on a stream to the point at which the plaintiffs accessed the stream for their supply the stream naturally lost 19 percent of its flow to seepage, percolation, and evaporation. The defendant installed a dam at the upper point, claimed 19 percent of the flow, and sent the rest downstream to the plaintiffs in a pipe. (*Ibid*.) The plaintiffs claimed a right to some of the salvaged 19 percent but the Supreme Court rejected the claim holding that, so long as the plaintiffs received the water to which they were entitled, the waters that were "rescued" by the defendants "were essentially new waters, the right to use and distribute which belonged to defendant." (*Id*. at p. 623.)
>
> There is no dispute that appellants have overlying rights to pump native groundwater from the Basin. But the priority of the overlying right does not extend to water made available by the efforts of another. Salvaged water may be native to the extent it would naturally flow within the stream to which it is released but it is "foreign in time." (See Attwater & Markle, Overview of California Water Rights and Water Quality Law (1988) 19 Pac. L.J. 957, 966.) It would not find its way into the Basin absent a reclamation project to divert it, store it, and release it on a schedule to augment natural recharge. It is rescued water; the rescuer has the prior right to it.

(*Santa Maria*, 211 Cal.App.4th at 304-305 [emphasis added]; See also, *Wiggins v. Muscupiabe Land and Water Company* (1896) 113 Cal.182, 196 [finding that the defendant was entitled to salvaged water that would have been lost by absorption and evaporation absent salvage efforts]; *Cohen v. La Canada Land & Water Co*. (1861) 151 Cal. 680.)

Here, Cal-Am's slant wells will be developed to extract seawater and contaminated groundwater that will be treated and put to beneficial use (i.e., salvaged).[8] The technical record,

[8] By virtue of the Project and the technology it will employ, Cal-Am will be able to salvage the brackish water by

including monitoring data from Cal-Am's test slant well, demonstrates that the source water wells will salvage and reuse this contaminated groundwater without any negative impact to other current groundwater users – because the supply is so degraded that it cannot be beneficially used by other pumpers. Nor will the Project deplete the supply currently available to other groundwater users in the SVGB – in fact, some analysis suggests that the Project wells will assist to retard seawater intrusion by creating a seaward gradient in the contaminated aquifers that will halt or reverse the current landward movement of seawater intrusion into the SVGB.

B. The "salvaged" water that Cal-Am may pump from the SVGB creates a "surplus" that Cal-Am can appropriate for the Project.

The brackish groundwater that Cal-Am will salvage from the SVGB is "surplus" to existing SVGB uses because the brackish supply is unusable by paramount right holders and can be pumped without adversely impacting the basin or paramount right holders. "Any water not needed for the reasonable beneficial use of those having paramount rights is excess or surplus water and may rightly be appropriated on privately owned land for non-overlying use, such as devotion to public use or exportation beyond the basin or watershed." (*Barstow v. Mojave Water Agency* (2000) 23 Cal. 4th 1224, 1241; see also, *Pasadena,* 33 Cal.2d at 925-926; *Stevinson Water District v. Roduner* (1950) 36 Cal.2d 264, 270 ["whenever water in a natural stream or watercourse. . . is not reasonably required for beneficial use by the owners of paramount rights, whether the water is foreign or part of the natural flow, such owners cannot prevent use of the waters by other persons, and the water must be regarded as surplus water subject to appropriation by those who can beneficially use it".) The paramount right holder's "right extends only to the quantity of water that is necessary for use on his land, and the appropriator may take the surplus." (*Katz v. Walkinshaw* (1903) 141 Cal. 116, 135-136.) The court in *Peabody v. Vallejo* (1935) 2 Cal.2d 351 discussed this principle in the context of surface water:

> [I]s there then water wasted or unused or not put to any beneficial use? If so, the supply or product of the stream may be said to be ample for all, a surplus or excess exists, no injunction may issue against the taking of such surplus or excess [Citation], and the appropriator may take the surplus or excess without compensation.

(*Id*. at 368-369.)

With respect to the Project, the small amount of contaminated SVGB groundwater that Cal-Am may salvage at the source water system is "surplus" and available for appropriation. That highly-contaminated brackish water is unusable by other pumpers and SVGB right holders and is thus not "needed for the reasonable beneficial use of those having prior rights." (*Barstow*, 23 Cal. 4th at 1241.) Stated differently, the rights of paramount right holders do not extend to the subject water because the water is "not necessary" for use on their land. (*Katz*, 141 Cal. at 135-136.) The water cannot be used on their land by reason of its degraded quality. Because the brackish water cannot be used by paramount right holders, it is necessarily "wasted or unused or not [being] put to any beneficial use." (*Peabody*, 2 Cal.2d at 368.) As discussed above, Cal-Am

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desalting and treating it to a quality suitable for irrigation, and returning the water to public agencies to distribute for beneficial uses in the SVGB in lieu of that volume of water being pumped for overlying uses.

can "salvage" this water that would otherwise be lost.

It has been suggested that there is no surplus water available for appropriation in an overdrafted groundwater basin. While that general principle may be true in some cases involving closed (i.e., without a hydrologic connection to the ocean) inland groundwater basins, Cal-Am's situation is distinguishable because: (1) there is no evidence that Cal-Am's use of the brackish groundwater will deplete the supplies available to legal groundwater users; and/or (2) the additional pumping of groundwater is not adversely impacting the groundwater basin. (*Compare*, *Los Angeles v. San Fernando* (1975) 14 Cal.3d 199, 277-278 ["A ground[water] basin is in a state of surplus when the amount of water being extracted from it is less than the maximum that could be withdrawn without adverse effects on the basin's long term supply. …Overdraft commences whenever extractions increase, or the withdrawable maximum decreases, or both, to the point where the surplus ends. Thus on the commencement of overdraft there is no surplus available for the acquisition or enlargement of appropriative rights."]; *Corona Foothill Lemon Co. v. Fisher* (1937) 8 Cal.2d 522 [groundwater pumping for export properly enjoined where evidence showed there was no surplus and that pumping substantially lowered water levels in the basin]. As discussed above, the areas of the SVGB from which Cal-Am may pump groundwater are hydrologically connected to the ocean and intruded with seawater. Any water that Cal-Am may extract from the SVGB below the CEMEX property will be highly contaminated with seawater and will be replaced with similarly contaminated water given the extent of seawater intrusion into the SVGB. As such, the typical issues that arise in overdrafted inland groundwater basins that are not hydrologically connected to the ocean (e.g., the depletion of a usable groundwater supply that results in injury to paramount right holders) do not apply with respect to the Project.

While the Project presents unique circumstances that have not been squarely addressed in previous cases, the law governing water rights supports Cal-Am's ability to salvage degraded groundwater in a manner that does not adversely impact the basin or paramount rights holders to create a surplus available for appropriation. Under the unique circumstances associated with the Project, it cannot be fairly stated that the entire safe yield of the SVGB is being put to reasonable beneficial use by overlying pumpers, nor could it be fairly argued that Cal-Am's salvage of small quantities of brackish groundwater will impact any reasonable beneficial use being made by those pumpers. Therefore, the salvaged water is thus properly characterized as "surplus" and available for appropriation by Cal-Am.

C. Salvaging water to create a surplus that can be appropriated and put to beneficial use is supported by and furthers California water policy.

The Project's proposal to salvage a relatively small quantity of contaminated groundwater from the SVGB to create surplus water available for appropriation, provided there is no unreasonable impact to paramount right holders or the groundwater basin or a depletion of the basin supply, is supported by and furthers the policy set forth in Article X, Section 2 of the California Constitution to foster maximum beneficial use of water and to avoid waste. (See, *Barstow*, 23 Cal. 4th at 1244 ["Public interest requires that there be the greatest number of beneficial uses which the supply can yield, and water may be appropriated for beneficial uses subject to the rights of those who have a lawful priority"]; *Pasadena*, 33 Cal.2d at 926 ["It is the policy of the state to foster the beneficial use of water and discourage waste, and when there is a surplus, whether of surface or ground water, the holder of prior rights may not enjoin its appropriation"]; *Burr v. Maclay Rancho Water Co*. (1908) 154 Cal. 428, 436 ["It is not the policy of the law to permit any of the available waters of the country to remain unused, or to allow one having the natural advantage of a situation which gives him a legal right to water to prevent another from using it, while he, himself, does not desire to do so"]; *Peabody v. Vallejo* (1935) 2 Cal.2d 351, 370-371 [same].) Brackish groundwater in the Project sphere of influence cannot otherwise be used by paramount right holders or potential appropriators because of its degraded quality, and its use by Cal-Am will not injure the SVGB or other right holders. Further, the majority of water pumped by the slant wells will be delivered to Cal-Am's service area for municipal uses, less an amount of water equal to the percentage of water determined to originate from the SVGB. The SVGB water will be treated and delivered to Castroville Community Services District and the Castroville Seawater Intrusion Project for overlying uses in the SVGB, in lieu of a like volume of groundwater being pumped from the SVGB. Thus, the Project involves the potential development of a small amount of otherwise unusable water from the SVGB in order to create a substantial water supply for the Monterey Peninsula while also increasing the amount of usable groundwater supply in the SVGB for all existing basin groundwater users. As such, the Project is supported by and advances the policy of "maximum beneficial use of water" mandated by Article X, Section 2 of the California Constitution.

III. <u>Related Issues</u>

A. The Project is consistent with Section 21 of the Agency Act.

Section 21 of the Agency Act prohibits the export of SVGB groundwater from the Basin and authorizes the Monterey County Water Resources Agency ("MCWRA") to seek an injunction for violations thereof.[9] Despite questions about the applicability of this statute to the Project's proposed source water system, Cal-Am specifically designed the Project to "return" to the SVGB a volume of water equal to the percentage of groundwater (verses seawater) in the Project source water so that no "export" occurs**.**

To the extent the Project pumps groundwater from the SVGB, Cal-Am will return such water to the SVGB by delivering treated water to the Castroville Community Services District and the Castroville Seawater Intrusion Project for their respective beneficial uses on lands within the SVGB. Moreover, these entities will use the Project return water in lieu of pumping

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[9] Section 21 states:

> The Legislature finds and determines that the Agency is developing a project which will establish a substantial balance between extraction and recharge within the Salinas River Groundwater Basin. <u>For the purpose of preserving that balance, no groundwater from that basin may be exported for any use outside the basin</u>, except that use of water from the basin on any part of Fort Ord shall not be deemed such an export. If any export of water from the basin is attempted, the Agency may obtain from the superior court, and the court shall grant, injunctive relief prohibiting that exportation of groundwater.

(Wat. Code Appendix § 52-21 [emphasis added].)

groundwater from the SVGB; the Project essentially adds a source of fresh water to the SGVB. Additionally, as indicated in Section 21, MCWRA is the agency responsible for interpretation and enforcement of the Agency Act and the entity that may pursue an injunction if it believes the Act is being violated. As a party to the Return Water Settlement Agreement,[10] MCWRA has endorsed the calculation of the return water volume and the process for returning water to the basin as consistent with the requirements of the Agency Act.

B. The Annexation Agreement does not restrict Cal-Am's ability to develop an appropriative right for the Project.

The Annexation Agreement entered into by, among others, Marina Coast Water District ("MCWD"), MCWRA, and RMC Lonestar (i.e., the predecessor owner of the CEMEX property), includes a provision stating that "[c]ommencing on the effective date of this Agreement and Framework, Lonestar shall limit withdrawal and use of groundwater from the Basin to Lonestar's historical use of 500 afy [acre-feet per year] of groundwater."[11] (Annexation Agreement, ¶ 7.2.) RMC Lonestar's "historical use" was 500 acre-feet per year on its property (i.e., an overlying use).[12] (*Id*. at ¶ 3.4.) Questions have arisen about whether the Annexation Agreement limits Cal-Am's ability to acquire appropriative rights in the SVGB by pumping groundwater from the CEMEX property.

Even assuming that the groundwater withdrawal restriction in Paragraph 7.2 of the Annexation Agreement applies to CEMEX and the CEMEX property,[13] there is no basis to interpret the Annexation Agreement as affecting the Project or otherwise restricting Cal-Am's ability to appropriate groundwater from the SVGB via wells located on the CEMEX property. First, the Project proposes to return the volume of groundwater that originates from wells located on the CEMEX property, thereby creating a new supply to the SVGB. Second, the limitation in Paragraph 7.2 of the Annexation Agreement applies to CEMEX's overlying rights and uses, not to appropriative rights that a third-party may develop through pumping from the SVGB via access from the CEMEX property. Whatever limitations and restrictions the Annexation Agreement may impose with respect to the use of groundwater by CEMEX (as a successor to

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10 The Return Water Settlement Agreement is an agreement among Cal-Am, MCWRA, Coalition for Peninsula Businesses, LandWatch Monterey, Monterey County Farm Bureau, Monterey Peninsula Regional Water Authority, Monterey Peninsula Water Management District, Monterey Regional Water Pollution Control Agency, Planning and Conservation League Foundation, and the Salinas Valley Water Coalition that sets forth the terms under which Cal-Am will deliver desalinated water to the Castroville Community Services District and the Castroville Seawater Intrusion Project for their use in lieu of groundwater pumping from the SVGB.

11 The Annexation agreement provides that it "and all the terms, covenants, agreements and conditions [therein] contained shall inure to the benefit of and be binding upon the successors and assigns of the Parties . . .." (Annexation Agreement, ¶15.)

12 Documents prepared by MCWD confirm the overlying nature of RMC Lonestar's water use and note the withdrawal limit as applying to water for use on the property (i.e., overlying uses). (MCWD 2010 Urban Water Management Plan, § 3.2.1, p. 14 ["the CEMEX Property, for which there are no near-term development plans, has a groundwater allocation under the annexation agreement of 500 afy, *corresponding to current estimated use on that property*" (emphasis added)]; § 4.2.2, p. 31[stating that 500 afy is the "groundwater available" for the Lonestar Property]; See also, MCWD 2005 Urban Water Management Plan, §§ 2.1, 3.2.2.)

13 There is some dispute as to the "effective date" of the Annexation Agreement and whether the restriction in Paragraph 7.2 applies to CEMEX and the CEMEX property given that the property has not been annexed to MCWD.

RMC Lonestar) on the CEMEX property (i.e., on CEMEX's overlying rights), it has no application to the Project's reliance on appropriative rights to brackish groundwater. Overlying or contractual groundwater rights, and associated uses and limitations, are legally distinct from appropriative groundwater rights and uses. (See, *Pasadena*, 33 Cal.2d at 925 ["[a]ppropriation" refers "to any taking of water *other than* riparian or overlying uses" (emphasis added)].) "Unlike ... overlying rights, [an] appropriative right is not dependent upon the ownership of real property. The right to use water under an appropriative right is distinct from the property through which the water flows or the land where the water is ultimately placed to beneficial use." (1 Slater, § 2.16, at p. 2-102; See also, *Santa Maria*, 211 Cal.App.4th at 278 ["The overlying right, like the riparian right, is associated with the ownership of land. Overlying rights are special rights to use groundwater under the owner's property. Appropriative rights, on the other hand, are not derived from land ownership but depend upon the actual taking of water"].) Thus, assuming Cal-Am establishes an appropriative groundwater right in connection with the Project, that right would be legally distinct from the overlying or contractual groundwater rights (and any limitations thereon) that may be appurtenant to the use of groundwater on the CEMEX property.

C. A "physical solution" would mitigate any potential injury to paramount groundwater right holders.

While the technical record demonstrates that the Project's source water wells will salvage and reuse contaminated groundwater without any negative impact on paramount right holders or the SVGB, a physical solution relating to the Project's return of water to the SVGB could be implemented to address any potential injury.

"The phrase 'physical solution' is used in water rights cases to describe an agreed-upon or judicially imposed resolution of conflicting claims in a manner that advances the constitutional rule of reasonable and beneficial use of the state's water supply." (*Santa Maria*, 211 Cal. App. 4th at 287-288.) "A physical solution is an equitable remedy designed to alleviate overdrafts[14] and the consequential depletion of water resources in a particular area, consistent with the constitutional mandate to prevent waste and unreasonable water use and to maximize the beneficial use of this state's limited resource. (Cal. Const., art. X, § 2.) Courts are vested with not only the power but also the affirmative duty to suggest a physical solution where necessary, and they have the power to enforce such solution regardless of whether the parties agree." (*California American Water v. Seaside* (2010) 183 Cal. App. 4th 471, 480.)

Assuming for purposes of discussion that Cal-Am's incidental pumping of a small amount of brackish groundwater from the SVGB would cause injury to paramount right holders, a physical solution could be implemented to mitigate the adverse impacts. Specifically, Cal-Am could use the Project's return of water to the SVGB to address any injury to paramount right holders associated with its pumping of contaminated water from the SVGB. This approach, recognized by the SWRCB, would protect paramount right holders while serving the mandate of Article X, Section 2 of the California Constitution to prevent waste and maximize the beneficial use of water. (See, SWRCB Report, § 6.3, pp. 40-46; See also, Project Draft EIR/EIS, § 2.6.2, p. 2-39 ["this proposed return water plan would improve groundwater conditions in the 400-Foot

[14] "Although [the courts] may use physical solutions to alleviate an overdraft situation, there is no requirement that there be an overdraft before the court may impose a physical solution." (*Santa Maria*, 211 Cal.App.4th at 288.)

Aquifer underlying the CSIP, CCSD and adjacent areas because water levels would increase as a result of in-lieu groundwater recharge, and would benefit each of the aquifers by either reducing the area of influence of the MPWSP or by increasing groundwater levels in other areas"].)

IV. Conclusion

Based on the above, Cal-Am can develop appropriative groundwater rights for the Project with respect to any water that it may incidentally pump from the SVGB as part of the Project. The SWRCB Report confirms this conclusion insofar as it discusses the validity of the principles addressed above and concludes that "[s]o long as overlying users are protected from injury, appropriation of water consistent with the principles previously discussed in this report should be possible." (SWRCB Report, § 6.4, p. 47.)

Attachment A

CEMEX - Attachment

MITCHELL CHADWICK

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September 30, 2015

VIA U.S. MAIL

Andrew Barnsdale
California Public Utilities Commission
c/o Environmental Science Associates
550 Kearny Street, Suite 800
San Francisco, CA 94108
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Re: CalAm Monterey Peninsula Water Supply Project Draft EIR, April 2015

Dear Mr. Barnsdale:

I am submitting this letter on behalf of my client, CEMEX, for consideration by the California Public Utilities Commission (the "Commission") as the lead agency under the California Environmental Quality Act ("CEQA") regarding the Draft Environmental Impact Report (the "DEIR") prepared for California American Water Company's ("CalAm") proposed Monterey Peninsula Water Supply Project (the "Project" or "MPWSP"). If approved by the Commission, the Project would consist of, among other components, ten subsurface slant wells and a desalination plant with capacity to produce 10,627 acre feet per year ("afy") and 9.6 million gallons per day ("mgd") of desalinated water.

CalAm has already constructed a test slant well on a portion of my client's 400-acre property (the "Lapis Site") in the northern part of the City of Marina (the "City"). Importantly, CEMEX has been actively and continuously mining the Lapis Site since 1906 under a constitutionally-protected vested right, which right various agencies have previously recognized. (*See, e.g.*, Lapis Site Reclamation Plan approved by the City of Marina in August 1989.) If the Project is built out, CalAm would construct the remaining subsurface slant wells on the Lapis Site as well. The Project would also include an aboveground electrical control panel and building on the Lapis Site and a source water pipeline to the desalination plant that generally follows CEMEX's access road for the Lapis Site. In other words, CalAm proposes to co-locate a number of critical infrastructure for the Project on the Lapis Site which my client owns and currently uses for active mining operations.

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The failure of this letter to comment on any other DEIR inconsistencies with CEMEX's operational processes and rights and CEMEX's property rights should not be considered agreement by CEMEX with any such misstatements or construed as a waiver of any rights or remedies to which CEMEX may be entitled. In this context I submit the following comments for the Commission's consideration.

I. The DEIR Should Be Revised to Ensure That Mitigation for Biological Resource Impacts Will Not Interfere With CEMEX's Operations and Obligations

A. Mitigation Measures for Biological Resource Impacts Should Be Revised in Coordination with CEMEX

DEIR discussion for Impact 4.6-1 concludes that impacts due to construction of the subsurface slant wells and the source water pipeline will result in a significant impacts for certain species. (*See Id.* at pp. 4.6-100 to 4.6-106; pp. 4.6-108 to 4.6-109.) The DEIR concludes that these impacts can be reduced to less than significant upon implementation of certain mitigation measures. (*Id.* at pp. 4.6-105, 4.6-106.)

As a general matter, DEIR discussion of these Mitigation Measures does not address whether implementation of the Mitigation Measures are consistent with or otherwise will not interfere with CEMEX's pre-existing mining operations on the Lapis Site. Therefore, CalAm should revise these Mitigation Measures in coordination with CEMEX. At a minimum, the Mitigation Measures for Impact 4.6-1 applicable to construction of the subsurface slant wells and the source water pipeline should be revised to account for CEMEX's pre-existing mining operations on the Lapis Site as follows:

- Avoidance and minimization measures required under Mitigation Measure 4.6-1c (general avoidance and minimization measures) should not affect mining and reclamation activities.

- Seasonal construction limitations under Mitigation Measure 4.6-1d should not interfere with, and should be distinguished from, existing mining operations.

- The habitat mitigation and monitoring plan under Mitigation Measures 4.6-1e (avoidance and minimization measures for special-status plants) and 4.6-1n should be reviewed and developed for consistency with CEMEX's already-existing habitat mitigation and monitoring plan.

- Any habitat restoration efforts under Mitigation Measure 4.6-1f that are proposed to occur onsite at the Lapis Site should be coordinated with CEMEX as CalAm does not own the Lapis Site and has limited rights with respect to its activities on the Lapis Site and its ability to encumber the site.

- Any relocation efforts under Mitigation Measure 4.6-1g that are proposed to occur onsite at the Lapis Site should be coordinated with CEMEX as CalAm does not own the Lapis Site and has limited rights with respect to its activities on the Lapis Site and its ability to encumber the site.

In addition, all biological mitigation measures need to be consistent with CEMEX's usage of existing mine areas and access roads. For example Mitigation Measures 4.6-1d, 4.6-1e, and 4.6-1f all call for restoration of habitat impacted during construction. These Mitigation Measures should be revised in coordination with CEMEX to ensure that any rehabilitation or restoration efforts do not improperly affect the portions of the Lapis Site that CEMEX uses for its active mining operations (*e.g.*, no rehabilitation of the mining access road).

Similarly, the Project Description section of the DEIR states that for site clearing and preparation generally, "[u]pon completion of construction activities, the construction contractor would … contour the construction work areas and staging areas to their original profile, and hydroseed or repave the areas, as appropriate." (DEIR, p. 3-46.) CalAm has not consulted with CEMEX regarding the timing, location, or scope of any proposed reclamation or re-contouring of the Lapis Site. The DEIR should be revised to require that, after full construction buildout on the Lapis Site, CalAm must reclaim the Project area to an appropriate end use consistent with CEMEX's existing use or otherwise coordinate with CEMEX regarding its role and share of responsibility/obligations under a reclamation plan amendment. (*See* discussion below.)

B. <u>CalAm's Construction Ground Disturbance Will Need to Be Addressed in a Reclamation Plan Amendment</u>

Disturbance of land proposed by CalAm for construction of the subsurface slant wells and the source water pipeline on the Lapis Site will need to be accounted for and addressed by a reclamation plan amendment in effect for CEMEX's mining operations pursuant to the state Surface Mining and Reclamation Act ("SMARA"). (*See* Pub. Res. Code § 3502(d).) The DEIR does not appear to address any aspects of this unresolved issue (*e.g.*, coordination, cost, burden of undertaking). If the Project does impact CEMEX's actual mine reclamation obligations, the DEIR does not specify whether CalAm will undertake reclamation itself on the portions of the Lapis Site which the Project will impact or whether CalAm will simply indemnify CEMEX for the monetary cost of any increase in CEMEX's reclamation obligations.

C. Mitigation for Impacts to Biological Resources Needs to Be Reviewed and Revised for Consistency with the Mine Safety and Health Administration Requirements

The DEIR does not address how CalAm will ensure compliance with the federal Mine Safety and Health Administration's ("MSHA") and the California Division of Occupational Safety and Health (also known as "Cal/OSHA") mine safety requirements.

The proposed siting of the Project on an active mine site requires compliance during construction, operation, and decommissioning with MSHA and Cal/OSHA. The DEIR fails to address site-specific safety issues in any appreciable detail. For example, the DEIR must include a mitigation measure that commits CalAm to chocking tires of parked construction vehicles.

Considering the fundamental importance of safe operations on an active mine site and CEMEX's potential MSHA liability for CalAm's actions relating to the Project, the Commission must ensure through a condition of approval or other legal instrument that CalAm both indemnifies CEMEX for its actions and seek its own Mine Identification Number from MSHA, so that CalAm will be the entity cited for any potential violations it commits, rather than CEMEX.

II. The 1996 Annexation Agreement Speaks for Itself

The DEIR states that an "issue to be resolved" and an "area of controversy" regarding CalAm's proposed use of subsurface slant wells to withdraw source water for the Project includes "whether CalAm has the legal right to extract groundwater from the Salinas Valley Groundwater Basin (SVGB)." (DEIR, p. ES-80.)

In turn, this issue implicates the *Annexation Agreement and Groundwater Mitigation Framework for Marina Area Lands* (the "Annexation Agreement") executed in 1996 by the Marina Coast Water District ("MCWD"), the Monterey County Water Resources Agency ("MCWRA"), the owners of the Armstrong Ranch, RMC Lonestar ("RMC," CEMEX's predecessors in interest for the Lapis Site), and the City of Marina.

The DEIR analysis of whether CalAm has the legal right to extract groundwater from the SVGB is in DEIR section 2.7. The DEIR discusses the effect of the Annexation Agreement and concludes that there is no current indication that the Annexation Agreement poses a feasibility issue to the project's use of water. (DEIR, p. 2-48.)

The DEIR need not include what the Commission interprets the Annexation Agreement to say as that Agreement speaks for itself. CEMEX does not consider the DEIR's interpretations to be binding in any way regarding that Agreement.

III. The DEIR Should Be Revised to Sufficiently Analyze and Address Project Drawdown Impacts on the Lapis Site

A. The Groundwater Monitoring Program Should Be Expanded to Account for CEMEX's Water Supply Well

DEIR discussion for Impact 4.4-3 ("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 during operations so as to expose well screens and pumps") concludes that drawdown of less than 0.2 foot (2.4 inches) will not result in a significant impact to CEMEX's water supply well (the "CEMEX Well") because the CEMEX Well is screened in the 400-foot aquifer, whereas "[t]he slant wells would extract groundwater from the offshore portion of the Dune Sand and 180-Foot Equivalent Aquifers and not the 400-Foot Aquifer." (DEIR, p. 4.4-65.)

The DEIR calculated a 0.2 foot drawdown based on eight months of pumping the one test well at 2,500 gpm and then determined its non-significance conclusion for the CEMEX Well by extrapolating the test results to full buildout and operations of eight (plus two standby) subsurface slant wells. (*Id.*) Despite the non-significance conclusion, the DEIR includes applicant-proposed Mitigation Measure 4.4-3 (groundwater monitoring and avoidance of well damage) to expand an existing regional groundwater monitoring program to include the Dune Sand Aquifer and the 180-Foot Equivalent Aquifer. (*Id.* at p. 4.4-74.)

Although the DEIR suggests that Project impacts to groundwater at the CEMEX Well will be less than significant, CalAm must revise Mitigation Measure 4.4-3 to clarify that the expanded regional groundwater monitoring program includes the 400-Foot Aquifer, in addition to the Dune Sand Aquifer and the 180-Foot Equivalent Aquifer, to ensure anticipated impacts will actually be less than significant during Project operations.

B. DEIR Analysis of Impacts to CEMEX's Dredging Pond May Not Be Sufficient

1. *The DEIR Geologic Description of CEMEX's Dredging Pond is Not Accurate*

The DEIR also analyzed Impact 4.4-3 "to determine whether the proposed project would have an adverse impact on its recharge or on the current sand mining operations." (DEIR, p. 4.4-76.) As a preliminary matter, the DEIR states that the water level for CEMEX's dredging pond (the "Dredging Pond") is influenced by ocean tides and sand mining operations, and is further assumed to be 10 to 20 feet deep. (*Id.* at p. 4.4-77.)

The DEIR geologic description of the Dredging Pond and the smaller washing ponds is not accurate. The depth of the Dredging Pond is allowed to 30 feet, not 10 to 20 feet as assumed in the DEIR. (*Id.* at p. 4.4-77.) Furthermore, as depicted on Figure 4.4-3 of the DIER, the entire Lapis Site to at least 50 feet below sea level constitutes either "Dune Sand" or "Older Dune Sand." (*Id.* at 4-49.)

2. *The DEIR Does Not Accurately Model Impacts to the Dredging Pond*

The DEIR asserts that: "Tidal changes occur in the dredge pond, which are the same as the tidal changes in the ocean." (DEIR, p. 4.4-77.) However, groundwater level changes due to tidal forces in beach sand are ***not*** "the same as tidal changes in the ocean." Groundwater level changes in the Dredging Pond occur near the elevation of the highest tides, attenuate in magnitude with increasing distance from the shore, and have a time delay. This specific issue has been addressed by and within the Hydrogeology Working Group (the "HWG").

The DEIR next explains that in September 2014 CalAm simulated test slant well pumping for eight months at 2,500 gpm and determined a one-foot drawdown at the Dredging Pond. (DEIR, p. 4.4-77.) The localized model "simulates the response of the Dune Sand Aquifer in its second, third, and fourth vertical layers," and the DEIR asserts the depth of the Dredging Pond falls within the second and third layers. (*Id.*) Based on measured results, the DEIR suggests: "There is a possibility that additional drawdown would occur in the pond during operation of [] all of the proposed slant wells, which would operate at the combined pumping rate of 24.1 mgd or about 16,736 gpm. However, when compared to the daily tidal fluctuations in the dredge pond water levels of up to eight feet throughout the year, the decline in the water surface of any depth would be masked by the consistent recharge from the ocean." (*Id.*)

Table 4.4-10 of the DEIR shows the layers of the localized model, but does not list the thickness of the layers, so it is not possible to verify which layers correspond to a depth of 10 to 20 feet (the DEIR's assumed depth of the Dredging Pond). Although the DEIR states that the depth of the Dredging Pond corresponds to the second and third layers, suggestions were made in HWG meetings that the Dredging Pond may be better assigned to the first layer ("Ocean Floor"). Modeling to date has focused on the aquifer response instead of attempting to accurately model the Dredging Pond response. Maximum drawdown in the larger Project-wide model is more than five feet at the Dredging Pond location and CalAm has not provided the localized modeling results, despite multiple requests by the HWG for CalAm to provide the data.

As shown on the DEIR Figure 4.4-13, the maximum modeled drawdown at the Dredging Pond location is more than 30 feet. Furthermore, tidal fluctuations in the Dredging Pond are ***not*** eight feet. Eight feet represents the maximum amplitude of the open ocean tide. Discrepancies such as these call into question the DEIR correlation of the Dredging Pond with the modeled layers.

The DEIR next states that CalAm simulated another test in April 2015 by constantly discharging the test slant well for five days which, considered with water level transducer data collected since

March 2015: "indicat[ed] that the water level in the CEMEX pond is not being influenced by the pumping of the test slant well. This also indicates that as the pond is dredged, the water levels quickly recover with seawater seeping through the loose sand on the beach." (*Id.* at pp. 4.4-77, 78.) The DEIR ultimately concludes that Project drawdown impacts on the Dredging Pond are less than significant and "would not inhibit sand mining operations by depleting available water supplies to the pond."

If, as the DEIR states, the Dredging Pond water levels are not influenced by test slant well pumping, this does not accord with the prior statement in the DEIR that test slant well pumping has resulted in a one-foot drawdown (*see* DEIR, p. 4.4-77), or else the pumping has not continued long enough to identify the drawdown.

Finally, the DEIR concludes that drawdown impacts to the Dredging Pond will be less than significant based on a drawdown of one foot resulting from eight months of pumping at one test slant well at 2,500 gpm extrapolated across eight slant wells operating at full buildout with a combined pumping rate of 16,736 gpm. It is not clear that the measured results of operating one slant test well for eight months and discharging the slant test well for five days is scalable to eight slant wells operating 24 hours per day, 365 days per year. (*Id.* at p. 3-51.) In other words, the DEIR has not presented the localized modeling results for full-scale pumping, but has only alluded to modeling for the test slant well. The modeling results to date do not accurately represent the situation at the Dredging Pond.

The DEIR does not explain on what basis it can conclude that the fully built-out drawdown response will not "inhibit sand mining operations." CalAm has not discussed with CEMEX's plant operators whether full operational drawdown – whether one foot or five feet – will inhibit CEMEX's sand mining operations. At a minimum, CEMEX recommends that the groundwater monitoring program required by Mitigation Measure 4.4-3 be extended to the Dredging Pond to ensure that Project operations going forward will not result in significant impacts. Specifically, Mitigation Measure 4.4-3 states: "Seven clusters of monitoring wells were recently completed on and near the CEMEX property. These well clusters monitor various depths within the Dune Sand Aquifer, the 180-Foot Aquifer, and the 400-Foot Aquifer and shall be included in the monitoring network." (DEIR, p. 4.4-75.) This provision should be revised to also include ongoing monitoring of the water level transducer in the Dredging Pond.

IV. CEMEX Disagrees With the DEIR's Characterization of Jurisdictional Water Features on the Lapis Site

The DEIR states: "The CEMEX dredging pond and settling ponds are located approximately 250 and 30 feet north of the western end of the CEMEX access road, respectively, and are mapped as freshwater ponds by the NWI [National Wetlands Inventory]. Additionally, three drainage features mapped as freshwater emergent wetlands by the NWI are located approximately 600, 1,000, and 1,200 south of the CEMEX access road." (DEIR, p. 4.6-21.) The DEIR further states: "A potential wetland, mapped as freshwater emergent wetland by the NWI, occurs approximately 250 feet west of Lapis Road and 1,300 feet north of the CEMEX access road near the proposed Source Water Pipeline." (*Id.*)

However, the DEIR also acknowledges: "***A formal wetland delineation has not been conducted for the project***" (*Id.* at p. 4.6-159 (emphasis added)) and later characterizes these features as "***potential*** waters of the U.S. and/or waters of the State" (*Id.* at pp. 4.6-160 to 4.6-162 (emphasis added)). CEMEX disagrees with any implication in the DEIR that these areas are wetlands and with the DEIR's overall characterization of waters on the Lapis Site as jurisdictional. In addition, the DEIR statements regarding the water features on the Lapis Site are unwarranted because none of the described water features are within the Project's construction/ground disturbance footprint. (*See* DEIR Figure 4.6-1a, p. 4.6-6.)

In any case, the DEIR concludes that impacts to all described features would either be less than significant or reduced to less than significant following implementation of mitigation measures. (*See generally* DEIR Impact 4.6-3, pp. 4.6-160 to 4.6-162.)

V. CEMEX Disagrees With the DEIR's Characterization of Structures on the Lapis Site as Significant Cultural Resources

The DEIR states that the direct and indirect area of potential effects ("APE") for the source water pipeline encompasses the Lapis Sand Mining Plant Historic District (the "Mining District"), which the DEIR considers a significant cultural resource. (*See* DEIR, pp. 4.15-39, 4.15-40.) CEMEX disagrees with the premise set forth in the DEIR that the Mining District is a significant cultural resource for purposes of CEQA. All pre-existing structures co-exist with CEMEX's ongoing mining operations at the Lapis Site. CEMEX does not believe that the site is properly considered a historic district, especially considering that it has been a working facility up to the present and modified over time.

VI. Any Plans Required as Mitigation Must Be Approved Prior to Construction

As currently drafted, measures specified in the DEIR requiring implementation of a mitigation plan are not written in a way as to be sufficiently enforceable prior to construction buildout of the Project on the Lapis Site.

For example, Mitigation Measure 4.4-3 (groundwater monitoring and avoidance of well damage) for Impact 4.4-3 ("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 during operations so as to expose well screens and pumps") states: "Immediately following project approval, the project applicant, working with the MCWRA, shall fund and develop a groundwater monitoring and reporting program that expands the current regional groundwater monitoring network to include the area near the proposed slant wells." (DEIR, p. 4.4-74.)

Given the ambiguously-drafted language of Mitigation Measures such as 4.4-3, the DEIR must be revised to ensure that CalAm not only develops and submits all requisite plans prior to Project commencement, but that the requisite agency also ***approves*** the submitted plans prior to Project commencement.

Thank you for your consideration of these comments.

Sincerely yours,

MITCHELL CHADWICK, LLP

Patrick G. Mitchell

cc: Michael Egan
Jerae Carlson
Ron Wilson

MONTEREY COUNTY WEEKLY

Saline Solution

Company says it can flip one of desal's biggest problems, brine discharge, into an asset.

Kera Abraham Jul 16, 2015 0

Saline Solution

c/o Effluent Free Desalination Corp.

Robbi Magnuson, president of Effluent Free Desalination Corp., stands in front of the company's partially-built salt-extracting machine - which EFD needs $5 million to finish and test.

Salt: the new gold. That was essentially the pitch from Stephen Keese of Sacramento-based Effluent Free Desalination Corp., who presented in June during a Monterey Bay International Trade Association event linking marine-tech entrepreneurs with potential investors in Moss Landing.

EFD executives are targeting three big Monterey Bay desalination proposals – California-American Water's Monterey Peninsula Water Supply Project, The People's Moss Landing Water Desal Project and DeepWater Desal in Moss Landing – as potential buyers of its technology, which would extract salt from the brine byproduct.

EFD promises big profits. Using Cal Am's figures, 1 acre-foot of seawater can produce about a half acre-foot of drinking water valued at roughly $1,800. The other half acre-foot of brine contains 48 tons of salt worth at least $1,800, according to Keese. Extracting that salt leaves another half acre-foot of de-salted water worth $1,800 more.

Of course, there are major hitches. The salt-extraction plant would cost even more to build than the desal plant, Keese says, and the natural gas needed to power it would cost about $1,200 per acre-foot of seawater.

"That's crazy," says Rich Svindland, Cal Am's vice president of operations, about the projected costs. "There's no way that makes any sense to us."

Keese insists a desal/salt operation is more lucrative than desal alone: "For approximately double the original capital cost, they will get triple the revenue."

Despite its profit potential, EFD is critically lagging in the Monterey Bay desal race. Keese says the company needs another $5 million just to finish and test its demo unit.

"They came to us pretty late in the game," Svindland says. "We didn't know about this four years ago."

But he says Cal Am is willing to let EFD park a semi-truck with a salt-extraction unit outside Cal Am's relatively tiny, 300-acre-foot desal plant in Sand City, where EFD Vice President of Engineering Mike Lord hopes to stage a proof-of-concept demo early next year.

"Once the demonstration is in place, we think people will be comfortable with this technology," Lord says.

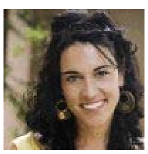
"Everybody's having the same problem with brine."

Carol Reeb, a research associate at Stanford University's Hopkins Marine Station, has been speaking out about the brine problem for years. Cal Am's project would discharge 13 million gallons of brine per day from an existing wastewater pipe 90 feet under the ocean surface, running two miles into the Monterey Bay National Marine Sanctuary. The brine would spray from diffusers along the last 1,000 feet of pipe.

Then, Reeb says, it would sink and form an oxygen-starved layer that suffocates marine life. "Brine layers the seafloor like Saran Wrap," she says. "Hypoxia is lethal to squid eggs, halibut, Dungeness crab and anything else that lives on the sandy seafloor."

Lord is banking state regulators will agree, driving huge business to EFD.

But Svindland points out Cal Am's draft environmental impact report (EIR) found no significant impacts from the brine, which would discharge at rates allowed under the California Ocean Plan. The EIR's public comment was extended to September due to concerns about a potential conflict of interest.



Kera Abraham

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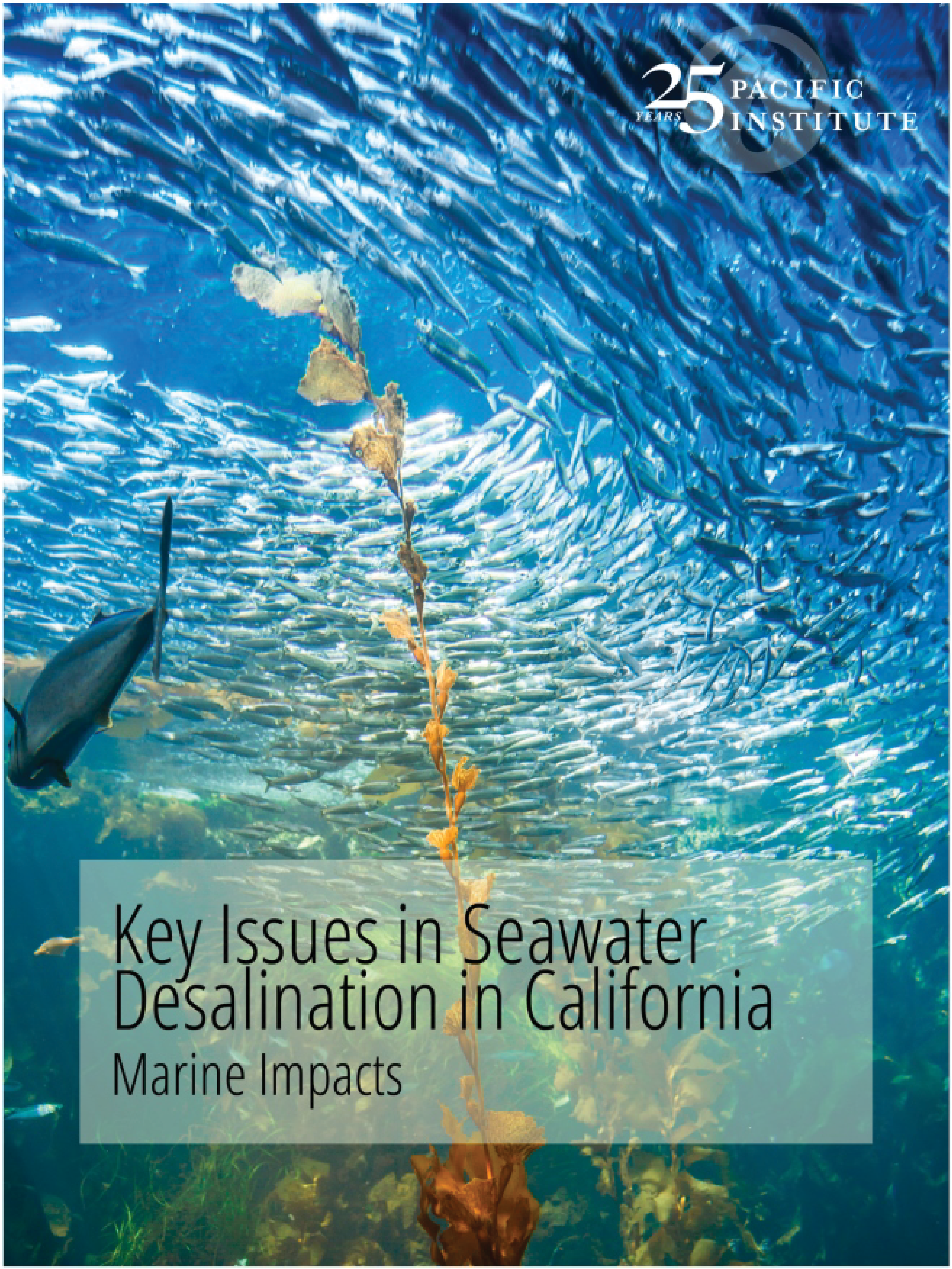

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Key Issues in Seawater Desalination in California

Marine Impacts

KEY ISSUES IN SEAWATER DESALINATION IN CALIFORNIA

Marine Impacts

December 2013

Authors: Heather Cooley, Newsha Ajami, and Matthew Heberger

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1 Introduction

In June 2006, the Pacific Institute released Desalination, With a Grain of Salt, an assessment of the advantages and disadvantages of seawater desalination for California. At that time, there were 21 active seawater desalination proposals along the California coast. Since then, only one project, a small plant in Sand City, has been permitted and built. A second, much larger project is now under construction in Carlsbad, 35 miles north of San Diego, and is scheduled to go online in 2016. Interest in seawater desalination remains high in California, and several agencies are conducting technical and environmental studies and constructing pilot projects to determine whether to develop full-scale facilities.

In 2011, the Pacific Institute began a new research initiative on seawater desalination. As part of that effort, we conducted some 25 one-on-one interviews with industry experts, environmental and community groups, and staff of water agencies and regulatory agencies to identify some of the key outstanding issues for seawater desalination projects in California. This is the fourth in a series of research reports that addresses these issues. The first report, released in July 2012, describes the 19 proposed projects along the California coast. The second report, released in November 2012, discusses the costs, financing, and risks related to desalination projects. The third report, released in May 2013, describes the energy requirements of seawater desalination and the associated greenhouse gas emissions and the impact of short-term and long-term energy price variability on the cost of desalinated water.

In this report, we describe the marine impacts of seawater desalination plants. We focus on plants that use reverse osmosis, because that is the technology that would be used for all proposed plants in California. Chapter 1 provides a brief introduction to the study. Chapter 2 describes the impacts of intakes withdrawing large volumes of water from the ocean. This chapter includes a review of our current understanding about these impacts and an overview of some of the technological, operational, and design measures that have been developed to reduce marine impacts, including subsurface intakes. Chapter 3 focuses on the discharge of concentrated brine produced by desalination plants and includes a review of brine studies that have been conducted at recently completed plants and a description of observed impacts, and identifies research gaps. Chapter 4 describes the processes for regulating seawater intakes and brine disposal as it is evolving in California, with an emphasis on those processes controlled by the State Water Resources Control Board. Finally, Chapter 5 provides conclusions and recommendations for minimizing the impacts of seawater desalination plants on the marine environment.

2 Seawater Intakes

Modern seawater reverse-osmosis desalination plants, such as those planned or proposed on the California coast, take in large volumes of seawater, pass it through fine-pored membranes to separate freshwater from salt, and discharge the hyper-saline brine back into the ocean. Seawater intakes generally fall into two categories: direct intakes and indirect intakes. Figure 1 shows the categories and relationships of intakes in use or proposed for desalination plants around the world. Direct intakes – also referred to as open water intakes – extract seawater directly from the ocean. These intakes may be located at the surface, in deep water, or less commonly, on a flotation plant. The vast majority of existing desalination plants uses surface intakes, which typically consist of a set of intake screens to exclude marine life, trash, and debris; a conveyance pipeline; and a wet well or other mechanism for housing the pumps (Mackey et al. 2011). These intakes generally require some sort of pre-treatment system to remove silt, algae, dissolved organic carbon, and other organic material that may clog the membranes.

A small but growing number of desalination plants use indirect intakes, also referred to as subsurface intakes. While not suitable in all locations, they have the advantage of virtually eliminating marine life impacts associated with

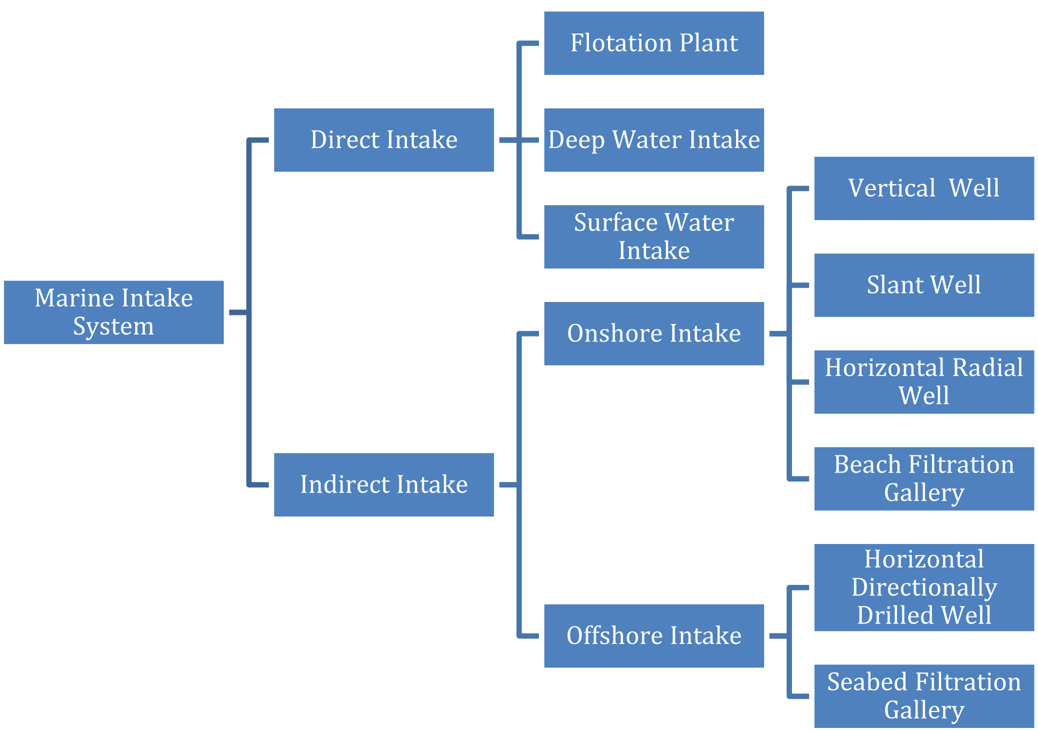

Figure 1. Marine Intake Systems for Seawater Desalination Plants.
Source: Adapted from Pankratz 2008

the intakes and reducing pretreatment requirements. Subsurface intakes extract seawater from beneath the seafloor or a beach and may be located on- or off-shore. They typically consist of buried pipes and/or wells and do not generally require a pre-treatment system because sand acts as a natural filter. Several design configurations of subsurface intakes are available and are described in more detail beginning on page 9 of this report.

Marine Impacts of Seawater Intakes

On average, seawater desalination plants withdraw two gallons of water for every gallon of freshwater produced. As noted in a 2005 California Energy Commission analysis, "seawater… is not just water. It is habitat and contains an entire ecosystem of phytoplankton, fishes, and invertebrates" (York and Foster 2005). As a result, the intake of seawater from the ocean results in the impingement and entrainment of marine organisms. Impingement occurs when fish and other large organisms are trapped on the intake screen, resulting in their injury or death. Entrainment occurs when organisms small enough to pass through the intake screens, such as plankton, fish eggs, and larvae, are killed during processing of the salt water. Entrained organisms are killed by pressure and velocity changes caused by circulating pumps in the plant, chlorine and other chemicals used to prevent corrosion and fouling, and predation by filter feeders like mussels and barnacles that line the intake pipes and themselves are considered a fouling nuisance (Mackey et al. 2011).

The impacts of impingement and entrainment from desalination plants on the marine environment are not well understood. Much of what is known has been drawn from studies on coastal power plants that use once-through cooling (OTC) systems. In an analysis of coastal and estuarine power plants in California, York and Foster (2005) find that "impingement and entrainment impacts equal the loss of biological productivity of thousands of acres of habitat" (York and Foster 2005). But while it is widely acknowledge that these systems damage the marine environment, the full extent of these impacts "may never be fully understood because comprehensive monitoring and evaluation of the surrounding ecosystems was not done" (Kelley 2010).

Further, OTC studies along the California coast have found that impingement and entrainment at coastal power plants vary considerably based on the location, year, and even time of year. For example, the state's two largest nuclear power plants, Diablo Canyon and San Onofre, withdraw similar quantities of water, but their impact on marine life differed dramatically. In an average year, Diablo Canyon entrains 1.8 billion fish and fish larvae and impinges about 400 fish and one large marine animal. San Onofre, by contrast, annually entrains 5.6 billion fish and fish larvae and impinges 3.5 million fish (SWRCB 2008). The differences in impact are not due to a single cause, but "arise from the plants' local marine environments, respective designs, and intake and discharge technologies" (McClary et al. 2013). Even for a single facility, impingement and entrainment rates may be subject to daily, seasonal, annual, and even decadal variation. Because of this variability, site-specific analyses are needed to determine the type and extent of impingement and entrainment (see Box 1 for two analyses conducted in California).

Project developers typically conduct impingement and entrainment studies to inform plant design and to obtain the permits needed for operation. Sampling studies and monitoring at pilot plants can provide useful information, but neither can paint a full picture of the actual impacts a desalination plant will have on marine life over its lifetime of operation. As previously noted, the distribution and abundance of a fish

Box 1: Case Studies

Several desalination project developers in California have recently built and operated small pilot projects to determine the feasibility of the projects and to test various design configurations. In several cases, project developers have conducted impingement and/or entrainment studies. Two of these are described below.

Santa Cruz

The City of Santa Cruz Water Department and Soquel Creek Water District have proposed to build a 2.5 million-gallon-per-day (MGD) desalination plant on California's central coast, at the tip of the Santa Cruz Bight at the northern end of Monterey Bay. The agencies operated a 50 gallon-per-minute (gpm, or 0.07 MGD) pilot desalination plant in Santa Cruz for 13 months from 2008-2009. To estimate impingement and entrainment, scientists collected samples at offshore locations and at a test intake at the end of a downtown pier and used video cameras to monitor intakes for impinged fish and invertebrates. In its 2013 Draft Environmental Impact Report for the project, the agency found that impingement and entrainment impacts were "less than significant" (SCWD2 2013). That is, the agency estimated impacts would occur, but that they do not rise to the level that requires any mitigation under California's environmental laws. One reason for the "less than significant" designation is that no endangered or threatened species were found during sampling. The study, by Tenera Environmental, concluded that intakes would kill some fish and invertebrate species (including gobies, croakers, anchovies, halibut, rockfishes, shrimp, and crabs), but the numbers killed are not likely to exceed "about six-hundredths of one percent of their populations (0.0006%) within the source water at risk of entrainment" (Tenera Environmental 2010a).

San Francisco Bay

In the San Francisco Bay Area, five large water utilities are jointly exploring the development of a regional desalination project. With some funding the from California Department of Water Resources, the project partners built and operated a 50 gpm (0.07 MGD) pilot plant from October 2008 to April 2009 near Pittsburgh, California. The pilot plant was located in an estuary, with widely fluctuating salinity levels and relatively high biological productivity compared to the open ocean. The plant's source water is home to the Delta smelt (*Hypomesus transpacificus*), listed as an endangered species by the state and federal governments, and the longfin smelt (*Spirinchus thaleichthys*), listed as threatened under the California Endangered Species Act (Tenera Environmental, Inc. 2010b). A 2010 study, also performed by Tenera Environmental, found both types of smelt during sampling. An estimated 13 Delta smelt were identified during a 30-minute survey in March 2009 that filtered about 240,000 gallons of water. While Delta smelt eggs adhere to substrate and are not likely to be entrained, the larvae are planktonic and susceptible to entrainment (Tenera Environmental, Inc. 2010c). The presence of an endangered species in the proposed plant's source water means it would likely have a "significant" environmental impact, and mitigation plans would be required.

species may change dramatically from one year to the next, or at different times during the year. This variability may not be adequately captured with short-term studies. For desalination projects in California, ongoing monitoring will likely be required to evaluate impingement.[1] Monitoring will better show how these impacts occur, when these impacts occur, and which species are affected. This information is useful for "adaptive management," allowing us to better manage those projects that are developed. Additionally, it will help us to plan for and design future projects so that they have less impact. As previously noted, marine impact data related to actual desalination operations have rarely been collected in California or elsewhere, and this information will be of use to regulators, policymakers, and the general public.

Minimizing Marine Life Impacts from Intakes

Various technological, design, and operational measures are available to reduce the marine impacts of seawater intakes. These are described in more detail in this section. While several measures are available to reduce impingement, fewer measures are available to minimize entrainment losses. As a result, habitat restoration is often used to mitigate these losses (Strange 2012). Box 2 describes the methodology commonly used in California to estimate the area of habitat needed to produce the organisms lost to entrainment.

Design and Operational Measures

The majority of desalination plants in operation around the world employ surface intakes. For these intakes, there are several design and operational measures that can reduce impingement and entrainment, e.g., locating the intake in areas of low biological productivity, such as in deep waters or outside of bays and estuaries (Ferry-Graham et al. 2008, NRC 2008). Deeper intakes, however, are not a panacea. In particular, they may not be effective in areas where fish spawn in deeper water or strong tidal currents distribute larvae throughout different depths. For example, California's San Onofre Nuclear Generating Station has the longest and deepest intake of any California power plant but also the highest impingement rate. The intake pipeline itself seems to be part of the cause, as "biologists and regulators seem to agree that […] the long intake pipe is attractive to marine animals as a place of refuge, potentially for food, and possibly for other reasons not yet determined" (Ferry-Graham et al. 2008).

Improving the recovery rate of a desalination facility can also reduce impingement and entrainment. Typically seawater desalination plants are designed to recover (turn into freshwater) 45 to 55% of the seawater collected by the intake. Designing the plant to operate closer to the upper limits of recovery (i.e., 50 to 55%) would require withdrawing less water and as a result, would reduce both impingement and entrainment. Other design and operational measures include installing low-velocity intakes that allow some organisms to swim out of the current or temporarily reducing pumping or intake velocity during critical periods for marine organisms, such as during spawning or important larval stages.

Technological Measures

Several technologies are available to reduce impingement and entrainment from surface intakes. These measures generally fall into two broad categories: physical barriers and behavioral deterrents. In the following section, we provide additional detail on some of these measures. We

[1] It is generally believed that entrainment impacts are fairly well understood due to the data available from power plants operating along the California coast.

Box 2: Quantifying and Mitigating Entrainment Losses through Habitat Restoration

In California, entrainment impacts are commonly compensated for or "offset" by creating or restoring fish habitat at a nearby location. The concept of offsets to mitigate the environmental impact of projects has been required by many regulators in the US and Europe since the 1970s. Under this approach, a project aims to achieve a "net neutral" impact on fish populations by creating habitat where fish feed and reproduce to make up for those killed by a project's construction and operations. The size and type of habitat required is estimated by fisheries biologists using a method referred to as the Area Production Foregone, or APF. This method is used by the California Energy Commission, California Coastal Commission, and other state regulatory entities.

The APF provides an estimate of the area of habitat needed to produce the organisms lost to entrainment and is intended to balance entrainment losses with the gains expected from a restoration project (Strange 2012). It is calculated using the area of habitat from which the larvae could be drawn into the intake (referred to as the "source water area") and is based on a determination of the period that the larvae are vulnerable to entrainment and the distance the larvae could have traveled during that period. The source water area is then multiplied by the percentage of larvae that are actually pulled into the intake to obtain the APF.[a] This calculation is repeated for all *meroplankton* – organisms that grow out of the larval stage to larger adult stages – entrained within the intake, and the results are averaged. The restored habitat may be of a different type or quality than the impacted habitat, and thus some conversion factor is typically applied. For example, one acre of highly productive wetlands may be restored to offset losses from 10 acres of open-ocean habitat. In a recent analysis for the California Energy Commission, Strange (2012) provides several cautions about the method. In particular, while the APF method may be reliable for bay and estuary settings, they are not reliable for the open coast. Additionally, monitoring is needed to ensure that the restoration projects provide the benefits expected.

[a] This percentage is based on the number of larvae entrained, larval density and abundance, and the proportion of sampled source water to total source water.

also describe the application of subsurface intakes and some of the advantages and disadvantages of these systems.

Physical barriers

Physical barriers are intended to block fish passage into the desalination plant and, depending on their design, can reduce both impingement and entrainment. Physical barriers have been used on power plant intakes for over a century. The earliest versions were essentially metal bars, or "trash racks," designed to keep large debris out of the intakes. Today, open intakes are typically equipped with primary coarse screens, which have openings of 20 mm to 150 mm, and smaller, secondary screens with openings of 1 mm to 10 mm. The coarse screens are stationary, whereas the secondary screen may be stationary (passive) or move periodically (active).

Barrier nets are suspended from booms or buoys and can exclude some marine organisms from intakes. Barrier nets are relatively inexpensive and easy to employ but are only effective in reducing impingement and do not reduce entrainment because larvae are able to pass through the nets (Ferry-Graham et al. 2008). As with many types of screens with small openings, barrier nets are subject to fouling, and cleaning clogged or fouled nets in the marine environment can be difficult (Hogan 2008). Additionally, barrier nets may impede navigation and eliminate some benthic and open-water habitat (Mackey et al. 2011).[2]

Travelling screens are mesh screens that are in continuous movement. The screens are equipped with mesh panels, and as the panels move out of the flow of water into the desalination plant, a high-pressure spray dislodges the accumulated debris and washes it into a trench for disposal in a landfill or back into the ocean (Figure 2). These screens have been employed on seawater intakes since the 1890s (Pankratz 2004). Originally intended to prevent trash from entering the intake, traveling screens were designed to impinge items, including organisms, on the mesh screens. These screens, however, have been modified to reduce entrainment and impingement, including by using angled or Risotroph screens (Ferry-Graham et al. 2008).

Figure 2. Example of a Travelling Screen Over an Intake

Ristroph screens are simple modifications of conventional traveling screens, by which water-filled buckets collect the impinged organisms and return them to the source water body by a sluiceway or pipeline. Impinged fish, however, may suffer lacerations or other mechanical damage to their gills or fins. Additionally, the locations where fish are returned to the environment often turn into a "fish feeding station for larger fish and birds." According to a recent study, "The effectiveness of such systems…is relatively easy to measure, but the survival and ecological success of the returned organisms is difficult to observe or quantify" (Mackey et al. 2011). In most cases, Ristroph screens and other fish-collection systems are not commonly employed and are often still

[2] Benthic habitat refers to the ecological zone on the sediment surface and in some sub-surface layers.

considered experimental (Ferry-Graham et al. 2008).

Wedgewire screens are passive screens that combine a fine-mesh screen with low-velocity intakes (Figure 3). Although they have been shown to be effective in reducing impingement and entrainment, wedgewire screens are susceptible to clogging and must be cleaned periodically with bursts of compressed air to dislodge material from the screens, where natural currents then remove the dislodged material (Mackey et al. 2011). These currents are commonly found in riverine systems but are less common in the marine environment. As a result, wedgewire screens may have limited application for seawater desalination plants. These screens, however, have been tested at several pilot and demonstration plants in California, including in Santa Cruz, Marin, and Los Angeles. In Santa Cruz, wedgewire screens with 2-millimeter (mm) openings were found to eliminate impingement and reduce entrainment of by 20%. For the pilot study, the natural currents exceeded the intake velocity (0.33 feet per second), which helped to clean the intake screens and reduce impingement (Tenera 2010c). A full-scale plant would operate at a higher intake velocity, suggesting that impingement would be higher.

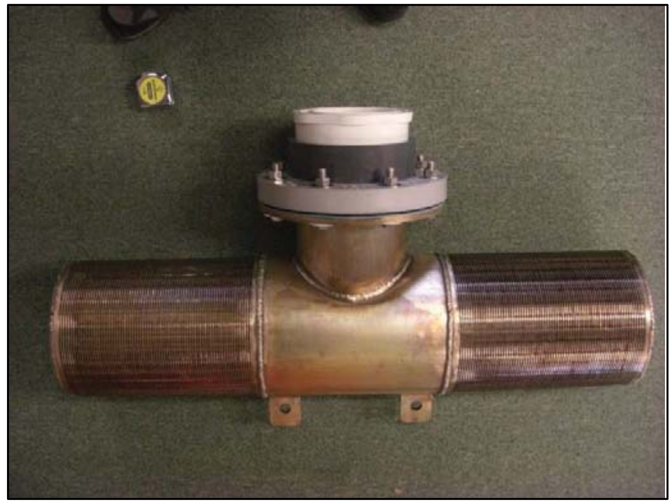

Figure 3. Wedgewire Screen Module Used in Testing During Studies for Santa Cruz and Soquel Creek Water Districts in 2009 and 2010
Source: Tenera 2010c

Behavioral Deterrents

Behavioral deterrents can be installed near intakes to discourage fish from entering the area or to encourage them to enter a bypass. In general, these devices may reduce impingement but have no effect on entrainment (Hogan 2008, Mackey et al. 2011, Foster et al. 2012). Behavioral deterrents include sound generators, strobe lights, air bubble curtains, and velocity caps.

Air bubble curtains are created by pumping air through a diffuser to create a continuous curtain of bubbles. Most studies have found that air bubble curtains are not effective, although a handful of studies suggest they may be effective at some sites and for some species (EPRI 2005).

Strobe lights and sound generators have been used to illicit an avoidance response from power plants and other water intake structures. However, a 2008 study by the Electric Power Research Institute (EPRI) on strobe-light and subsonic sound systems at cooling water intakes found that "there is no evidence that the impinged total fish numbers or impinged individual species numbers were reduced when the deterrent systems were operating." EPA (2001) notes that sound systems may be effective at targeting particular species, such as alewife, but are ineffective for others.

A **velocity cap** is essentially a device placed over an open intake pipe that creates variations in horizontal flow, triggering an avoidance response in fish and signaling it to step away from the intake. Studies have shown that velocity caps reduce impingement but there is some debate about whether they reduce entrainment (EPA 2001, Ferry-Graham et al. 2008). Velocity caps, which are usually combined with other devices, have been used at many offshore intakes, including at several power plants in California and at the desalination plant in Sydney, Australia (EPA 2001, Ferry-Graham et al. 2008, Pankratz 2008).

The effectiveness of behavioral deterrents is highly varied. The EPA finds that most studies "have either been inconclusive or shown no tangible reduction in impingement or entrainment" (EPA 2001). Indeed, some critics have noted that behavioral deterrents may cause undue stress to marine organisms, with an unknown effect on marine ecosystems. Most behavioral deterrents, with the possible exception of velocity caps, are not widely employed or recommended as a means for reducing impingement and entrainment, although they may be employed in combination with other measures or to target a specific species (Chow et al. 1981, EPA 2001, Pankratz 2004).

Subsurface Intakes

Subsurface intakes extract seawater from beneath the seafloor or a beach. These intakes, which include vertical, slant, and horizontal wells and galleries, may be located onshore or offshore. Here, we provide a short summary of the various subsurface intakes currently in use in desalination plants around the world and some of the advantages and disadvantages of these systems.

Vertical beach wells consist of a series of shallow wells near the shoreline that use beach sand or other geologic deposits to filter water (Figure 4). Each well has a yield of 0.1 to 1.0 MGD (Pankratz 2004), and several wells may be needed at a desalination plant to meet its source water requirements. Beach wells may need to be located sufficiently far from shore so that they are not intercepting fresh groundwater, either because of quality concerns or an obligation not to cause salinization of freshwater aquifers. The largest plant using vertical beach wells is the Sur Desalination Plant in Oman, which has a production capacity of 21.2 MGD (Pankratz 2008).

Slant wells, also sometimes referred to as angle wells, are drilled at an angle such that the wellhead and related infrastructure may be onshore, while the well extends below ocean sediments and draws seawater through the seabed. With this technology, the wellhead can be located some distance from the beach to minimize "loss of shoreline habitat, recreation access, and aesthetic value" (Mackey et al. 2011).

Compared to vertical wells, slant wells have a larger surface area in contact with the aquifer, which allows for higher yields (Williams 2008). While slant wells have been used for some applications, they have not yet been employed at a full-scale desalination plant. They are, however, currently being evaluated in field tests and research studies (Missimer et al. 2013). The Municipal Water District of Orange County (MWDOC), for example, pilot-tested a slant well intake system at Doheny State Beach in Dana Point, California. The 12-inch diameter well

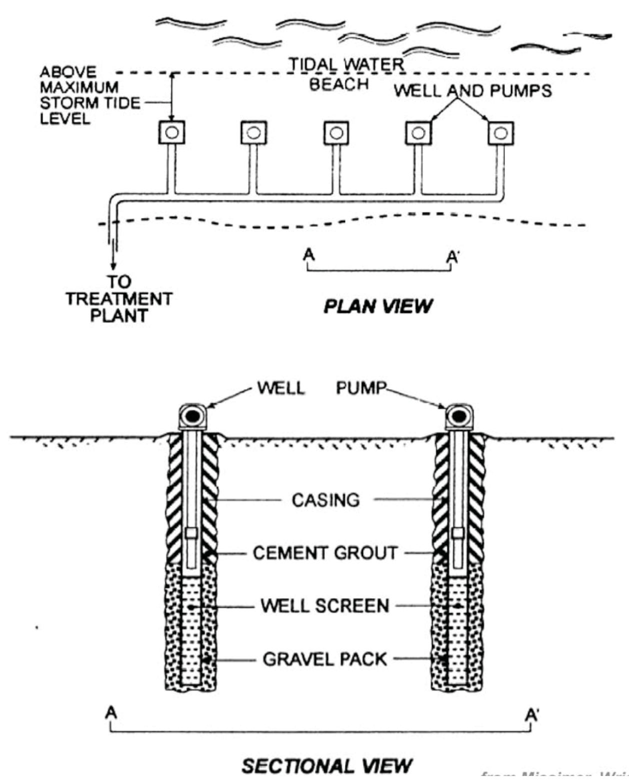

Figure 4 Beach Well Conceptual Design
Source: Wright and Missimer (1997)

withdrew 3 MGD of source water, and the "pump and aquifer performed exceptionally well" (MWDOC 2013). Based on the results from the pilot plant, it is expected that the full-scale plant could withdraw 30 MGD of water through a slant beach well system consisting of nine wells.

Horizontal directionally drilled (HDD) wells are non-linear slant wells. While slant wells are drilled at an angle from the surface, HDD wells typically begin as vertical wells before changing direction. Fluid and pressure are used to drill a pilot hole which is usually reamed to sufficient diameter before installation of the pipeline and screen. HDD wells are more difficult to install in areas with unconsolidated cobbles or boulders, which can drive the drill bit off course (Williams 2008). HDD well technology is used extensively by the oil exploration industry and has been used in desalination plants. The 34 MGD San Pedro del Pinatar (Cartagena) plant in Spain is the largest desalination plant using this technology. The HDD intake system, which has operated successfully for several years, consists of 9 wells that provide about half of the source water requirements for the plant (Mackey et al. 2011). Hydrological constraints necessitated the use of open intakes for the remainder of the source water requirements for the plant (WateReuse Association 2011a).

Horizontal radial wells, also referred to as radial collector wells or Ranney collectors, consist of a central chamber, called a caisson, from which several collector wells extend laterally as much as 300 feet. The collector wells can be oriented radially (like a bicycle wheel) or in some other formation toward the source water. The higher capacity of horizontal radial wells relative to vertical wells results in fewer wellheads and potentially less visual and construction-related impacts on the beach environment. This increases the options for siting the pumping station, something that can be difficult in coastal areas with high populations or sensitive ecosystems. Horizontal radial wells are designed to induce vertical flow, resulting in a greater yield per well (Missimer et al. 2013). Indeed, each horizontal collector well is typically designed to withdraw from 0.5 MGD to 5 MGD of source water (Mackey et al. 2011).

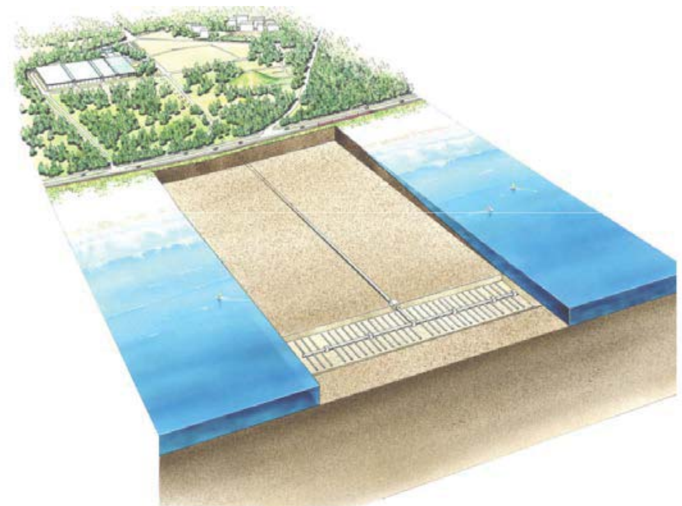

Figure 5. Infiltration Gallery Design at the Fukuoka District Waterworks, Japan.
Source: Reprinted from Pankratz 2008

Infiltration galleries are typically constructed by removing soil or rock, placing a screen or network of screens within the excavated area, and then backfilling the area with a porous media to form an artificial filter around the screens. A pipe then connects the intake screens to an on-shore pump. Infiltration galleries can be located on the beach near or above the high tide line, within the intertidal zone of the beach, or in the seabed. These systems are best suited for sandy areas without significant concentrations of mud (Missimer et al. 2013). Seabed galleries have been used in a limited number of desalination plants, the largest of which is the 13 MGD Fukuoka desalination plant in Japan (Figure 5). The seabed gallery, which has been in operation since 2006, has an intake flow of 27 MGD and covers an area of 5 acres (Pankratz 2008), or slightly less than the size of three football fields. Over the past eight years of operation, the gallery system has not required cleaning, and the filter membranes have required only minimal maintenance (Missimer et al. 2013). The City of Long Beach, California has also been operating a pilot seabed gallery for several years, and several other systems around the world are in design or have been proposed. Subsurface intakes provide several important advantages. By using sand and sediment as a natural filter, they virtually eliminate impingement and entrainment (Hogan 2008). Subsurface intakes also provide significant water quality improvements, reducing the complexity of the pre-treatment system, lowering the energy requirements of the system, and improving the operational reliability of the plant (e.g., by avoiding production losses that could occur during algal blooms). In a recent review of subsurface intakes, Missimer et al. (2013) find that while the capital costs of subsurface intakes can be slightly to significantly higher than open-ocean intakes, the overall operating costs are 5 to 30% lower, resulting in significant cost saving over operating periods of 10 to 30 years.

Subsurface intakes, however, may not be appropriate in all locations because their installation depends on having the proper geology and sediment characteristics, such as sand and gravel with a sufficiently high porosity and transmissivity. However, with new drilling technologies, e.g., directional drilling, it may be possible to find a pocket with the right conditions surrounded by generally unfavorable ones. A report by the Middle East Desalination Research Center noted that subsurface intakes should be explored even where they are initially assumed to be infeasible because "an adequate geological configuration may be encountered, even within the most precipitous coastal environment, in some deltaic deposits, river outlets, closed harbors and short sandy shores" (Schwarz et al. 2000).

Subsurface intakes have several other disadvantages. Among the concerns are the higher construction costs relative to surface intakes, and the cost and complexity of survey methods to determine site properties and evaluate the feasibility of subsurface intakes (Schwarz et al. 2000). As described above, subsurface intakes tend to have lower treatment costs, which can reduce total project cost over the life of the plant. However, the presence of inorganic minerals, such as iron and manganese, in the source water can necessitate pre-treatment and additional cost (Mackey et al. 2011). Finally, some plant operators and designers argue that the technology is new and untested, although this is changing as subsurface intakes are being used in a growing number of plants around the world.

3 Brine Disposal

The seawater desalination process produces two major waste streams: brine and spent cleaning solutions. The cleaning solution, which is produced intermittently and in relatively small amounts, typically contains chemicals used in the cleaning process and contaminants removed during this process. The brine, also referred to as concentrate, is produced continuously and in relatively large amounts. One of the key features of the concentrate is elevated salinity levels, which depend on the salinity of the source water, the desalination method employed, and the recovery rate of the plant. In addition to elevated salinity levels, brine from a seawater desalination plant has the following characteristics:

Natural Constituents of Seawater: The process of desalting seawater concentrates constituents normally found in seawater, such as magnesium, boron, calcium, and sulfate (Water Consultants International 2006).

Chemical Additives: A variety of chemicals are used throughout the desalination process. For example, coagulants, such as ferrous chloride and aluminum chloride, are used to remove suspended matter from the source water (Lattemann and Höpner 2008, NRC 2008). Antiscalants, including polyphosphates and phosphonates, are added to the feedwater to prevent the formation of scale precipitates and salt deposits on the desalination equipment (NRC 2008). Other chemicals used include biocides, anti-foaming additives, and detergents. The majority of these chemicals are added during the pretreatment process to prevent membrane fouling (Amalfitano and Lam 2005). Some of these chemicals can be toxic to marine organisms, even at low concentrations.

Heavy Metals: Desalination equipment can corrode during operations, resulting in the release of heavy metals, such as copper, zinc, and nickel, into the waste stream. Corrosion chemicals are unlikely to be a major concern for reverse osmosis (RO) plants, although RO plants will discharge minor amounts of iron, chromium, nickel, and molybdenum in their concentrate from stainless steel (Lattemann and Höpner 2008). While these elements may occur in seawater in trace amounts, higher concentrations can be toxic to the aquatic environment and can impair biological communities (Jenkins et al. 2012, NRC 2008, Water Consultants International 2006).

Temperature: Desalination plants may produce brine that is warmer than the receiving waters, although this is of greater concern for plants using thermal desalination technologies than for those using membrane technologies, e.g., reverse osmosis. Typically, brine for reverse osmosis plants are usually within 1°C of the ambient seawater temperature and will not likely have an impact on the marine environment (Water Consultants International 2006). Even for RO plants, however, temperature can be an issue if the brine is mixed with cooling water from a power plant, industrial process water, or effluent from a wastewater treatment plant.

Brine Disposal

There are several options available to dispose of the concentrate produced from a desalination plant. Concentrate from inland desalination plants – which is typically less saline than that from a seawater desalination plant and of lesser volume than for a similar-sized seawater desalination plant – can be disposed via evaporation ponds; deep well injection; land application (e.g. used for lawns, parks, golf courses, or crop land); solar energy ponds; or sewer system (this is also an option for small coastal plants). Disposal options for seawater desalination plants include discharge into evaporation ponds, the ocean, or saline rivers that flow into an estuary, or injection into a confined aquifer (NRC 2008, Cooley et al. 2006). An inland or coastal desalination plant may also be equipped with a zero liquid discharge (ZLD) system that evaporates water from the concentrate, leaving a salt residue for disposal or reuse. Disposal options, and their associated cost, depend on site-specific factors, such as hydrologic conditions, low season flows, permitting requirements, the concentration of chemicals, and the toxicity of the brine (NRC 2008). Disposal options should also be informed by the brine tolerance thresholds of native marine species inhabiting the discharge site, although the scientific information needed to define these thresholds is often limited.

Each disposal method has a unique set of advantages and disadvantages. Large land requirements make evaporation ponds uneconomical for many developed and urban areas. Sites along the California coast, for example, tend to have high land values, and coastal development for non-coastal-dependent industrial processes is discouraged by regulators. Injection of brine into confined groundwater aquifers is technically feasible, but it is both expensive and unless comprehensive and competent groundwater surveys are done, there is a risk of unconfined brine plumes appearing in freshwater wells. Discharges into estuaries and the ocean can disrupt natural salinity balances and cause environmental damage to marine ecosystems, especially sensitive marshes and fisheries. Currently, all seawater desalination plants of significant capacity worldwide discharge brine into oceans and estuaries (NRC 2008), and all of the proposed plants in California, would discharge brine in this manner.

Brine from a seawater desalination plant is typically twice as saline as the ocean. Because of its relatively high salt concentration, brine has a greater density than the waters into which it is discharged, and when released from an outfall, tends to sink and slowly spread along the ocean floor. There is typically little wave energy on the ocean floor to mix the brine, and as a result, dilution occurs more slowly that at the surface. The result is a layer of brine with an elevated salt concentration near the outfall. As has been observed in Perth and in other shallow bays, dissolved oxygen levels can also become depleted near the outfall (Hodges et al. 2011,Spigel 2008), further increasing stress for marine organisms along the seafloor.

There are several proven methods to disperse concentrated brine. For example, multi-port diffusers can be placed on the discharge pipe to promote mixing. Brine can also be diluted with effluent from a wastewater treatment plant or with cooling water from a power plant or other industrial user, although these approaches have their own drawbacks. All of these options are discussed in more detail on page 14 of this report.

Marine Impacts of Brine Disposal

Field-based monitoring as well as field and laboratory experiments can be used to evaluate the marine impacts of brine discharge. Despite the long history of seawater desalination plants operating in some regions, however, data on their ecological impacts are limited (NRC 2008). The majority of studies conducted thus far focus on a limited number of species over short time periods with no baseline data (Roberts et al. 2010, Fernández-Torquemada and Sánchez-Lizaso 2007). In a recent review, Roberts et al. (2010) identified 62 peer-reviewed research articles concerned with brine discharge in marine waters and found that the majority (44%) of articles are discussions or opinion pieces with little quantitative data. Likewise, Jenkins et al. (2012) find that studies on the impacts of brine on California biota in particular are "extremely limited, often not peer-reviewed, not readily available, or have flaws in the study design."

Because of a lack of baseline ecological data, most of the available studies are based on a comparative analysis of environmental conditions at the discharge location and at least two other nearby locations believed to be unaffected by brine discharge. Most of these studies report some sort of environmental degradation due to exposure to desalination discharge (Fernandez-Torquemeda et al. 2005, Gacia et al. 2007,Sanchez-Lizaso et al. 2008, Ruso et al. 2007, 2008). In a recent review, Roberts et al. (2010) conclude that both laboratory and field studies "clearly demonstrate the potential for acute and chronic toxicity and small-scale alterations to community structure in marine environments."

The few studies available indicate that the ecological impacts of brine discharge vary widely and are a function of several factors, including the characteristics of the brine, the discharge method, the rate of dilution and dispersal, and the sensitivity of organisms. For example, brine discharge can cause widespread changes in the benthic community in shallow and/or semi-enclosed bays, whereas impacts can be undetectable in areas with heavy wave activity or significant flushing. Based on a literature review, Jenkins et al. (2012) find that some species are affected by salinity increases of only 2-3 parts per thousand (ppt) above ambient, while others are tolerant of salinity concentrations of up to 10 ppt above ambient. They further note that sub-lethal effects of desalination discharges have not been well studied in the field or in the laboratory.

Minimizing Impacts of Brine Disposal

As noted above, the common practice for large coastal seawater desalination plants is to discharge brine into oceans or estuaries. Over 90% of the large plants in operation today dispose of brine through a new ocean outfall specifically designed and built for the desalination plant (Voutchkov 2011). The addition of *diffusers* can promote mixing and improve dilution of the brine and are commonly used at desalination plants worldwide, including at all of the recently constructed plants in Australia and for many plants in Spain, the Middle East, Africa, South America, and the Caribbean (WateReuse Association 2011b). The diffusers may consist of a single port at the end of the pipe or multiple ports along a section of the pipe and are generally angled upwards to promote mixing. Recent research and modeling efforts suggest that a discharge angle of 30º–45º enhances mixing and dilution in moderate-to-steep coastal waters (Bleninger and Jirka 2008, Jirka 2008, Maugin and Corsin 2005). There is also general consensus among modeling studies that optimal mixing is achieved by discharging the brine in sub-tidal, off-shore environments with persistent turbulent flow (Roberts et al. 2010). However, the length and location of the pipe and the placement of the diffusers are typically determined by modeling for the conditions at the discharge location (WateReuse Association 2011b).

Brine dilution prior to disposal is also being used by some plants to reduce the potential marine impacts. The Carlsbad desalination plant, for example, will mix the brine with cooling water from the adjacent Encina Power Station prior to discharge into a lagoon leading to the ocean. Recently, the State of California adopted new standards for implementing Section 316(b) of the Clean Water Act that effectively prohibits California power plants from using once-through cooling systems. Thus, cooling water will not be available for dilution in the near future. In order to comply with its discharge permit, the Carlsbad plant will withdraw additional seawater for dilution, a practice referred to as "in-plant dilution." This approach produces a more dilute brine discharge, which may reduce some of the environmental risks associated with brine discharge. However, it requires a larger amount of water to be withdrawn from the ocean, increasing the environmental risks associated with intakes, i.e., impingement and entrainment.

Dilution can also be achieved by mixing brine with treated wastewater effluent. Co-discharge of brine and wastewater effluent is still fairly uncommon but is practiced by several large-scale seawater desalination plants, including a 50 MGD plant in Barcelona and a 30 MGD plant in Japan (WateReuse 2011b). This approach is being considered for nearly a quarter of the proposed plants in California (Cooley and Donnelly 2012). Co-discharge of brine and wastewater effluent raises several concerns. First, if the combined mixture is denser than seawater, it may introduce nutrients to the seafloor, a zone with limited mixing. Second, while brine production is relatively constant, wastewater flows are variable and are especially low at night. To account for this variability, desalination plants may need to adjust operations or construct brine storage facilities (WateReuse Association 2011b). Moreover, California's goal to increase the use of recycled water by at least one million acre-feet by 2020 and at least two million acre-feet by 2030 (SWRCB 2009) would reduce the availability of wastewater effluent to dilute brine discharges. Finally, there may be synergistic effects associated with combining brine with wastewater effluent that are not yet well understood (Kämpf 2009, Jenkins et al. 2012).

Reducing the amount of chemicals used in the desalination process can decrease the environmental impact of brine discharge. In particular, pretreating the source water with membrane technologies, such as microfiltration or ultrafiltration, can reduce the use of chemicals throughout the desalination process (Elimelech and Phillip 2011, Peters and Pinto 2008). Developing membranes resistant to fouling can reduce the need for anti-fouling chemicals (Elimelech and Phillip 2011). Additionally, as described previously, subsurface intakes use sand as a filter, reducing the complexity of the pre-treatment system and the amount of chemicals required during the pretreatment process (Missimer et al. 2013).

Finally, a coastal desalination plant may be equipped with a zero liquid discharge (ZLD) system that evaporates water from the concentrate, leaving a salt residue for disposal or reuse. Reducing the volume and increasing the salinity of the discharged brine might enable the harvesting of salts and minerals from drying ponds to be feasible. In a modeling and bench-scale experiment, Davis (2006) evaluated a process to use electrodialysis on the brine to further concentrate the waste stream and improve the recovery of the desalination plant.[3] Generally, the process has been shown to be technically feasible, but has not yet proven to be economically feasible.

[3] Electrodialysis is an electrochemical separation process that uses electrical currents to move salt ions selectively through a membrane, leaving fresh water behind.

Case Studies

As described previously, comprehensive monitoring data are not available for the vast majority of desalination plants that have been constructed around the world, in part because many of these plants have been built in places and at times when environmental concerns were not at the fore. This is changing, and several recently constructed plants have monitoring programs in place to evaluate environmental impacts associated with brine discharge. In this section, we provide case studies of the monitoring programs in place at two desalination plants built in Florida and Australia, and the results of these programs. Results from the Tampa Bay desalination plant suggest that some of the short-term impacts of brine discharge can be addressed through dilution. In Australia, however, while diffusers may help to minimize some of the impacts of brine discharge, monitoring and adaptive management are needed to evaluate short- and mid-term impacts. In all cases, additional monitoring is needed to evaluate the long-term impact of discharges on the marine environment.

Tampa Bay Desalination Plant

The 25 MGD Tampa Bay desalination plant is located in the southeastern part of Tampa Bay, Florida. Initial operation of the plant began in 2003, although the facility was taken offline between 2005 and 2007 for remediation. The plant was brought back online in 2007. Seawater for the desalination plant is obtained by diverting cooling water from the adjacent TECO Big Bend Power Station, which discharges an estimated 1.4 billion gallons of cooling water per day. At full capacity, the desalination plant produces 19 MGD of brine, which is mixed with cooling water from the power plant in a ratio of 70:1 prior to discharge into Hillsborough Bay (PBS&J 2010).

The National Pollution Discharge Elimination System (NPDES) permit issued by the State of Florida specifies effluent limits and monitoring requirements for the operation of the plant. Monitoring is conducted by Tampa Bay Water independently of the plant operator, American Water-Acciona Agua, and data are submitted to the Florida Department of Environmental Protection. Tampa Bay Water also conducts supplemental monitoring not required by the permit.

The monitoring program has biological and water quality components (PBS&J 2010). Biological monitoring includes an analysis of seagrass, benthic macroinvertebrates, and fish. Benthic invertebrates are sampled quarterly along three transects near the facility discharge. Data on fish and seagrass communities are collected by other ongoing monitoring programs in the area. The water quality monitoring program includes continuous monitoring of conductivity, salinity, dissolved oxygen, and temperature for a 72-hour period every two months. Grab samples are also collected to measure chloride and pH levels. Three continuous water-quality monitoring stations were established near the intake, discharge, and a nearby embayment (PBS&J 2010). Additional water quality testing occurs near the biological monitoring sites.

Monitoring of the plant commenced in 2002, about a year before the initial operation of the plant (McConnell 2009). The water quality sampling indicates that there were small differences in salinity levels between the intake and discharge canals but that these differences were likely not ecologically significant, even at maximum production (PBS&J 2010). The Shannon Diversity Index was used to determine the biological integrity at each of the sampling locations, and a change in the index in excess of 25% relative to the control site was defined as a change in the biological integrity. The difference in the diversity of benthic, fish, and seagrass communities at the sampling locations was less than the 25% benchmark during operation and no-operation periods in each of the three designated monitoring zones (PBS&J 2010).

Perth Seawater Desalination Plant, Australia

The 38 MGD Perth desalination plant supplies over 17% of the drinking water for Perth, a city of 1.9 million, and the largest city on Australia's west coast. The plant, which began operating in 2006, is located in Cockburn Sound, a shallow inlet of the Indian Ocean with limited natural mixing. Cockburn Sound is the most intensely used embayment in Western Australia and is the site of a diverse mix of activities, including military operations, commercial industries, commercial and recreational fishing, mussel farming, and recreational diving and swimming (Environmental Protection Authority 2009).

To reduce the impacts of brine discharge, the plant is equipped with a discharge pipe that extends 1,500 feet offshore and includes a 40-port diffuser along the last 600 feet of pipe. The diffusers are located 1.5 feet above the seabed at a 60-degree angle (Water Reuse 2011b). Solids from the sludge that accumulate on the backwash filter are not discharged with the brine; rather, they are disposed of in a landfill. This reduces the turbidity of the brine discharge and minimizes the visible impact of the effluent on the Cockburn Sound.

Environmental permits were required before the plant could begin operations. The plant's operational permit, issued by the Department of Environment and Conservation (DEC), specifies that the brine discharge will meet a dilution factor of 45 at a distance of 50 meters in all directions from the diffuser (the edge of the defined mixing zone). The permits also required implementation of a monitoring program, which includes computer modeling for diffuser design and validation, Rhodamine dye testing, toxicity tests with local species, real-time dissolved oxygen and brine monitoring, and surveys of sediment characteristics and benthic macrofauna. A baseline survey of nearby sites in the Cockburn Sound was conducted six months before the plant went online to map the spatial pattern of the benthic communities.

The monitoring program began in 2006. The impacts of the plant, and the monitoring program put in place to evaluate those impacts, have been subject to significant debate. Dissolved oxygen levels are a key concern. A drop in dissolved oxygen levels has been observed at the ocean bottom, and these levels fell below the limit set in the operating permit twice in 2008. As stipulated in the permit, the plant reduced production during those periods.[4] The Water Corporation has asserted that the plant does not affect oxygen levels in the deep portions of the Sound and poses no significant risk to Cockburn Sound (Water Corporation 2008). In a subsequent review, however, the National Institute of Water & Atmospheric Research (NIWA) concluded that the desalination plant has "an effect on dissolved oxygen concentrations in Cockburn Sound. The effect may be small or even negligible much of the time; it may become significant only infrequently; and it may be so localised geographically that affected areas are recolonised over time. But it undoubtedly adds a further increment to existing stress on the Cockburn Sound ecosystem" (Spigel 2008, 3). The author further finds that the impact of the desalination plant may be masked by natural variability and unable to be resolved through modeling alone; therefore, additional monitoring and measures are required. These findings were supported by the Western Australia Environmental Protection Authority (WA EPA 2009) and monitoring is ongoing.

[4] All other water quality parameters were below the permit requirements.

4 Regulatory Framework

Project developers must obtain several permits from state and federal agencies for the construction and operation of seawater intake and brine disposal facilities. A full analysis of the permitting requirements for these facilities is beyond the scope of this paper. In this section, we focus on the requirements set forth by the State Water Resources Control Board (State Board) covering seawater intake and brine disposal facilities in California.

The State Board, under the federal Clean Water Act and the Porter-Cologne Water Quality Control Act, has regulatory authority for protecting the water quality of California's lakes, bays and estuaries, rivers and streams, and about 1,100 miles of coastline. Porter-Cologne, passed in 1969 and codified in the California Water Code, addresses water quality and waste discharge. In particular, it authorizes the State Board to adopt statewide water quality control plans (including the Ocean Plan to protect the state's ocean waters) and directs each of the nine Regional Boards to adopt regional water quality control plans. Additionally, as required under the federal Clean Water Act, the Water Boards (both state and regional) issue National Pollution Discharge Elimination System (NPDES) permits that have requirements for intakes and discharges to surface waters.

As part of its charge to protect water quality, the State Board has the authority to regulate seawater intakes for industrial facilities, including for desalination plants. Specifically, Section 13142.5(b) of the California Water Code requires each new or expanded coastal power plant or other industrial facility 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." In May 2010, amid growing concern about the impacts of power plant intakes on coastal ecosystems, the State Board promulgated new standards to reduce impingement and entrainment from existing power plants. The new policy defines recirculating cooling systems, also referred to as "closed-loop" cooling systems, as the best available technology. As a result, power plants operators will have to reduce impingement and entrainment to a level commensurate with those achieved with recirculating cooling systems. This, in effect, forces operators to shut down OTC systems. While they could have applied this standard to desalination intakes, the State Board decided to address desalination intakes through a separate policy (SWRCB 2010).

Ocean Plan Amendments

The Ocean Plan, first adopted in 1972 and most recently updated in 2009, sets water quality objectives and policies to protect ocean waters. The Plan prohibits diluting brine with seawater prior to discharge, but does not "have an objective for elevated salinity levels in the ocean, nor does it describe how brine discharges are to be regulated and controlled, leading to permitting uncertainty" (Jenkins et al. 2012). Additionally, the Ocean Plan does not address impacts to marine life from desalination intakes. These issues have been raised during several Ocean Plan reviews but have not yet been resolved due to staff limitations and other priorities, namely the once-through cooling policy. However, the 2011-2013 Ocean Plan Triennial Review determined that an evaluation of desalination intakes and brine disposal regulations was a very high priority.

The State Board is currently developing amendments to the Ocean Plan, as well as the Enclosed Bays and Estuaries Plan, to address the impacts of desalination facilities. These amendments will have five components: (1) best available intake siting and design requirements, including identifying the best available technology; (2) mitigation requirements for surface water intakes; (3) a narrative salinity water quality objective; (4) implementation of the salinity objective; and (5) monitoring requirements. The State Board initiated three studies to gather scientific data and obtain technical input on key issues, including two expert panels (one on intakes and one on brine) and a salinity toxicity study on several test species. It was anticipated that the amendments would be complete by 2013, however, the deadline has been extended into 2014.

5 Conclusions and Recommendations

Desalination, like other major industrial processes, has environmental impacts that must be understood and mitigated. These include effects associated with the construction of the plant and, especially, its long-term operation, including the effects of withdrawing seawater from the ocean and discharging the highly concentrated brine. Environmental impacts are also indirectly associated with the substantial use of energy, which is discussed in more detail in Cooley and Heberger (2013).

Seawater Intakes

One of the key environmental impacts of seawater reverse-osmosis desalination plants is associated with their intakes, which generally withdraw two gallons of water for every gallon of freshwater produced. The majority of desalination plants extract water directly from the ocean through open water intakes which have a direct impact on marine life. Fish and other larger marine organisms are killed on the intake screens (impingement); organisms small enough to pass through the intake screens, such as plankton, fish eggs, and larvae, are killed during processing of the salt water (entrainment). The impacts of impingement and entrainment on the marine environment are not fully understood but are likely to be species- and site-specific. Additionally, impingement and entrainment rates, even for a single desalination plant, may be subject to daily, seasonal, annual, and even decadal variation.

Several operational, design, and technological measures are available to reduce impingement and entrainment from open water intakes. These measures generally fall into two broad categories: physical barriers and behavioral deterrents. Physical barriers, e.g., mesh or wedgewire screens, block fish passage into the desalination plant and may be coupled with some sort of fish collection and return system. Behavioral deterrents, e.g. strobe lights or air bubble curtains, provide a signal to keep fish and other organisms away from the intake area or prevent them from crossing a threshold where they may be impinged. Additionally, subsurface intakes offer an alternative to open water intakes and can virtually eliminate impingement and entrainment.

The choice of intake design will ultimately be site-specific. While some project developers contend that subsurface intakes are infeasible due to their higher construction costs, desalination plants in many other countries have made use of these systems, including beach wells and onshore and offshore infiltration galleries. Subsurface intakes, however, may not be appropriate in all locations because their installation depends on having the proper geology and sediment characteristics, such as sand and gravel, with a sufficiently high porosity and transmissivity. However, with new drilling technologies, e.g., directional drilling, it may be possible to find a pocket with the right conditions surrounded by generally unfavorable ones. When the appropriate site conditions are present, the advantages are clear. These systems can virtually eliminate impingement and entrainment; they also provide a level of pre-filtration that can reduce plant chemical and energy use and operating costs over the long term.

Brine Disposal

Safe disposal of the concentrated brine produced by desalination plants presents a major environmental challenge. All large coastal seawater desalination plants discharge brine into oceans and estuaries. Brine, by definition, has a high salt concentration, and as a result, it is denser than the waters into which it is discharged. Once discharged, brine tends to sink and slowly spread along the ocean floor. Mixing along the ocean floor is usually much slower than at the surface, thus inhibiting dilution and resulting in elevated salt concentrations near the outfall. Diffusers can be placed on the discharge pipe to promote mixing. Brine can also be diluted with effluent from a wastewater treatment plant or with cooling water from a power plant or other industrial user, although these approaches have their own drawbacks.

The impacts of brine on the marine environment are largely unknown. The majority of studies available focus on a limited number of species over short time periods and lack baseline data which would allow a comparison to pre-operation conditions. The laboratory and field studies that have been conducted to date, however, indicate the potential for acute and chronic toxicity and changes to the community structures in marine environments. The ecological impacts of brine discharge, however, vary widely and are a function of several factors, including the characteristics of the brine, the discharge method, the rate of dilution and dispersal, and the sensitivity of organisms.

Despite the long history of seawater desalination plants operating in some regions, data on their ecological impacts are limited. Several recently constructed plants, including plants built in Tampa Bay, Florida and Perth, Australia, have monitoring programs in place to evaluate impacts associated with brine discharge. These studies suggest that the short-term impacts of brine discharge can be addressed through dilution and use of multi-port diffusers. However, additional monitoring is needed to evaluate mid- and long-term impacts.

Regulatory Framework

There is considerable uncertainty about the regulatory requirements for seawater intakes and brine disposal, especially as it relates to those requirements set forth in the federal Clean Water Act and the Porter-Cologne Water Quality Control Act. The State Water Resources Control Board has the authority to regulate seawater intakes for industrial facilities, including for desalination plants, and to protect the water quality of California's lakes, bays and estuaries, rivers and streams, and about 1,100 miles of coastline. Water quality objectives and implementation policy for the protection of ocean waters are set forth in the state's Ocean Plan. As noted by the State Board, however, this plan "does not currently have an objective for elevated salinity concentrations, nor does it specifically describe how brine is to be regulated and controlled, leading to permitting uncertainty and possible delays."

The State Board is currently developing amendments to the Ocean Plan, as well as the Enclosed Bays and Estuaries Plan, to address the impacts of desalination facilities, including the best available intake technology, siting, and design requirements; mitigation requirements for surface water intakes; a salinity water quality objective; and monitoring requirements. It was anticipated that the amendments would be complete by 2013; however, the deadline has been extended into 2014. Once complete, these amendments will provide greater clarity on the regulatory requirements and theoretically allow for a more effective and efficient regulatory process.

Recommendations

This report examines the impacts of seawater desalination on the marine environment. We conclude with a series of recommendations.

Surface seawater intakes result in impingement and entrainment of marine organisms, which may pose a serious threat to the marine environment.

- Intake pipes should be located outside of areas with high biological productivity and designed to minimize impingement and entrainment.
- For all desalination projects, proponents should thoroughly investigate the feasibility of subsurface intakes, including the evaluation of alternative siting and reduced design capacity of the project.

Desalination produces highly concentrated salt brines that contain other chemicals used throughout the desalination process. Steps should be taken to ensure its safe disposal.

- Water managers should avoid disposing of brine in close proximity to sensitive habitats, such as wetlands and some benthic areas.
- Water managers should carefully monitor, report, and minimize the impacts of brine disposal on the marine environment.
- More comprehensive studies are needed to determine the impacts of brine on the marine environment and to mitigate these impacts.

More research is needed to fill gaps in our understanding about the impacts of seawater intakes and brine disposal on the marine environment.

- Studies should examine the sub-lethal and chronic effects of brine exposure and the toxicity of brine effluent mixtures, i.e., brine and wastewater effluent.
- Studies should be conducted under a range of climatic conditions to evaluate seasonal and inter-annual differences to species response.
- Given differential response among species, more research is needed on those species found along the California coast.
- To evaluate the accuracy of existing models, comparisons are needed of early modeling efforts with field observations once the plant is in operation.

Monitoring of existing and proposed desalination plants is vital to improving our understanding of the sensitivity of the marine environment and can help to promote more effective operation and design to minimize ecological and biological impacts.

- Regulators should require desalination plant operators to develop adequate monitoring programs that include multiple sites, adequate replication of samples, and baseline data.
- Monitoring should account for natural seasonal and inter-annual variability.
- Monitoring data should be subject to third-party validation and be made easily available at no cost by internet in an accessible format, e.g. data files rather than PDF summaries where appropriate, to all concerned parties, including the general public.

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MAKING WATER

Desalination: option or distraction for a thirsty world?

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for WWF's Global Freshwater Programme
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Making water

Option or distraction for a thirsty world

Seawater desalination is rapidily emerging as one of the major new sources of freshwater for the developed and some areas of the developing world, raising significantly the overall energy intensity, potential climate impact and cost of water supplies. This dramatic upscaling of the industry is occurring against a backdrop of unresolved questions on the potential environmental impacts of large scale processing of seawater habitat and the discharge of increasing volumes of concentrated brine wastes. WWF is concerned that as large desalination plants become "the new dams" attention is being diverted from less costly and more environmentally benign alternatives – water conservation, water use efficiency improvements and water recycling. WWF believes that better economic and environmental outcomes would flow from improved and consistent processes to assess water needs and the optimum mix of both supply and demand side measures that could be deployed to meet them. Where seawater desalination is established to be a part of meeting a real water need in the most cost effective and least damaging way, desalination plants need to be sited, constructed and operated to best minimise or mitigate their environmental impacts.

As the world increasingly comes to the realisation that a combination of population increases, development demands and climate change means that freshwater will be in chronically short supply in rich and poor areas of the world alike, there is increasing interest in desalination as a technique for tapping into the vast and infinitely tempting water supplies of the sea.

This is no new dream, and it has been technically possible to separate the salt and the water for centuries. But widespread desalination for the purpose of general water supply for land-based communities has been limited by its great expense and it is notable that the area where desalination currently makes by far the greatest contribution to urban water supplies is in the oil-rich and water poor States around the Persian Gulf.

Now, however, improvements in the technology of desalination, coupled with the rising cost and increasing unreliability of traditional water supplies, are bringing desalinated water into more focus as a general water supply option with major plants in operation, in planning or under consideration in Europe, North Africa, North America, Australia, China and India among others.

In 2004, it was estimated that seawater desalination capacity would increase 101 per percent by 2015, an addition of an additional 31 million m3 a day. The dominant membrane based technologies would also be used extensively in desalinating brackish waters and recycling water generally. But these forecasts, regarded as bold at the time, seem certain to be exceeded by wide margins. In one example, the forecast was for China and India to be desalinating 650,000 m3/day by 2015, but China alone has recently announced plans to be desalinating 1 million m3 of seawater a day by 2010 increasing to 3 million m3 a day by 2020.

But those who look to desalination as the future panacea to the world's water problems may be glossing over considerable environmental, economic and social difficulties. Despite improved techologies and reduced costs, desalinated water remains highly expensive and sensitive in particular to increases in energy costs. Our knowledge of impacts is largely based on limited research from relatively small plants operating in relative isolation from each other. The future being indicated by public water authorities and the desalination industry is of ever larger plants that will frequently be clustered together in the relatively sensitive coastal environments that most attract extensive settlement.

The difficulties are both direct and indirect, but they warrant closer attention than they seem to be receiving from some of the desalination industry's most enthusiastic proponents and some of the regulatory bodies currently considering large scale desalination.

Direct problems include the still significant problem of cost, the pollution emitted by desalination plants and the energy they consume. Seawater, it has been pointed out, is also habitat. The larvae and small organisms most vulnerable to disappearing up a poorly designed desalination plant inlet pipe play key roles in marine ecosystems. And our knowledge of the impacts and behaviours of the concentrated brines and diverse other chemicals issuing from the outlet pipe is far from comprehensive, both generally and in relation to particular sites.

There are also serious greenhouse gas emission implications in driving the energy intensive plants, which could thereby contribute a key driving factor behind the looming chronic water shortages in many of the areas where desalination is being actively considered.

Less directly, the quite possibly mistaken lure of widespread water availability from desalination also has the potential to drive a major misdirection of public attention, policy and funds away from the pressing need to use all water wisely. Desalination in these terms is firmly in the long established tradition of large infrastructure supply side solutions to an issue in which the demand side of the equation is usually poorly considered – as are the needs of the environment and the people who might be in the way.

There is also the question of equity to consider. Desalination through its cost and technical requirements is likely to be mainly used in addressing the water worries of the already wealthy. There are few indications that a growing desalination industry left to its own devices will pay much attention to the more pressing water needs of the many people in developing nations living in arid areas with brackish or contaminated groundwater supplies. This may be an issue of particular importance to the many millions living in areas of developed countries where overdrawing of groundwaters has allowed the oxidation and mobilisation of dangerous soil elements such as arsenic and flourides. The reverse osmosis membrane technologies used increasingly in desalination have been used successfully in a limited way in parts of India to remove dangerous contaminants from rural drinking water – there are clear humanitarian reasons to deploy the technology much more widely.

Reverse osmosis membrane technologies have great potential for increasing water use efficiency through recycling, for decontaminating water and for environmental repair through purifying or providing water for such purposes as rejuvenating wetlands, augmenting streamflows and recharging aquifers. Manufacturing or recycling water can also relieve the pressure on overstressed natural water sources, allowing them the opportunity for recovery. Indeed as the economic and energy costs of manufacturing water are closely related to the level of contaminants, desalination of seawater is commonly more expensive than desalination of brackish water or treatment and recycling of waste water.

The considered view of WWF is that seawater desalination has a limited place in water supply, which needs to be considered on a case by case basis in line with integrated approaches to the management of water supply and demand. Central to such an approach is the protection of the natural assets of catchments, rivers, floodplains, lakes, wetlands, aquifers and vapour flows which ultimately provide, store, supply, and purify water and provide the best and most comprehensive protection against extreme or catastrophic events.

Given the rapidly occurring convergence of technologies seawater is best regarded as just one of a number of potential feedstocks for an end product of "manufactured water". Manufactured water, particularly that sourced from waste waters, can play a significant role in supplying water while reducing pressure on natural systems.

To that end, WWF proposes an approach similar to that recommended for large dams by the World Commission on Dams that says that proponents should first assess the need and then consider all options to select the best solution. Desalination plants, accordingly, should only be constructed where they are found to meet a genuine need to increase water supply and are the best and least damaging method of augmenting water supply, after a process which is open, exhaustive, and fully transparent and in which all alternatives, especially demand side and pollution control measures, are properly considered and fairly costed in their environmental, economic and social impacts.

WWF is calling on governments, financing agencies and relevant areas and peak bodies of the water industry to work to endorse and help develop specific protocols that start from these premises. We also note that we are not alone in this. The prestigious Pacific Institute made recommendations to this general effect in relation to California and similar comments have been made to the industry by a senior World Bank official.

Desalination – a current summary

WWF's survey of world desalination trends shows that while desalination capacity is mounting, so are the related problems and awareness of possible environmental impacts. Developments in specific areas are covered in more detail later in this report.

In **the Middle East** large scale desalination from some of the world's saltiest and more enclosed seas has long been a necessary component of water supplies and is becoming more so as the scale of contamination and depletion of groundwater supplies becomes apparent. The area continues to be a major focus of new desalination investment along with a swathe of new entrants in **North Africa.** The water continues to be heavily subsidised for the majority of users for economic and social reasons, and the proportion of agricultural use is high in some areas. The capital and energy requirements of soaring water demand are challenging to the area, even for nations like Saudi Arabia and Israel. Despite the region's abundant supplies of conventional energy sources, nuclear power is being actively canvassed as an option for meeting future water supply needs.

In **the United States**, a dramatic increase in proposed seawater desalination projects is running into increasing opposition on environmental and cost grounds, not helped by the well publicised difficulties experienced in bringing some much vaunted new generation projects on-line. Government agencies hold that desalination is necessary for the high growth, water poor areas of the south and west, but also concede it is generally uneconomic. While municipalities lobby for increased federal funds, the former head of California's inquiry into desalination is now arguing there are better, cheaper, and more environmentally benign ways of ensuring water security in the State.

Spain's long experience with desalination has given Spanish companies a prominent role in the world desalination industry. The abandonment of large scale but controversial plans to transfer water from the wetter to drier areas of the country has fuelled proposals for a rapid doubling of its already considerable desalination capacity to make up the shortfall. But while other countries struggle to reconcile the high cost of desalinated water to urban water users, plans are approved to devote an astonishing and increasing proportion of Spain's desalinated water to agriculture. These plans are running into difficulties in getting agriculture to take (and pay for) desalinated water supplies while there is groundwater left, even if it is illegal to pump it. Spain's real problems however lie in a lack of effective development controls in high growth but dry areas and inefficiently controlled water use generally. The country is perhaps a leading first world example of how a long history of investments in water supply infrastructure has failed to provide water security.

As major **Australian** cities face an increasingly tenuous water future its first large scale desalination plant is now operating in one State, two other States are going ahead with large plants and two further states are considering desalination options. But while conditions are relatively favorable to expanding desalination capacity and while it could build needed diversification into water supply systems, water conservation in the driest continent still has a long way to go and would be a better priority in many areas.

In the **UK,** London's major water supplier – part of a conglomerate that includes a major Spanish desalination industry player - believes a major desalination plant is a key requirement for future water supplies but the city's mayor disagrees, castigating the company for losing vast quantities of water through leaking mains. The issue of the plant's approval has been before a planning tribunal. However, the cost of desalinating seawater is generally deterring some other UK water authorities that have examined the issue. Studies show UK citizens using considerably more water than continental Europeans in an equivalent climate, indicating considerable potential remains in cost effective conservation and efficiency measures.

Significant actual and looming water shortages have led **China** into a rush to develop large scale desalination to complement existing massive plans to divert water from the south to the north of the country. On a slightly lesser scale and with a greater component of nuclear desalination, the same is happening in **India**. But the growth in water decontaminating capacity is generally not extending to the extensive areas in India and south and south east Asia where arsenic and flouride contamination of water is a major health and humanitarian issue. In both countries, optimistic and recent world wide industry investment projections from only a few years ago look certain to be exceeded several fold and China is gearing up to potentially challenge the US, French and Spanish domination of desalination equipment and infrastructure provision.

WWF position on desalination

The considered view of WWF is that seawater desalination has a limited place in water supply, which needs to be considered on a case by case basis in line with integrated approaches to the management of water supply and demand. Central to such an approach is the protection of the natural assets of catchments, rivers, floodplains, lakes, wetlands, aquifers and vapour flows which ultimately provide, store, supply, and purify water and provide the best and most comprehensive protection against extreme or catastrophic events.

Resource planning *before* large infrastructure planning

Better water resource planning and management should precede major water infrastructure developments of any sort, including desalination and other water manufacturing plants. Seawater desalination plants will need additional consideration in the context of marine resource management plans. The need to increase water supplies, as opposed to reducing demand, must be justified before assessing the best options for doing so. If enabling industry, irrigated agriculture or urban growth is advanced as the principal reason for the need to increase supplies, it is essential that effective land use planning schemes exist in which sustainability is given a high priority. These should include optimum and mandatory water and energy efficiency requirements for all new development.

Consultative and transparent assessment for large scale infrastructure

Assessment of major water infrastructure, including desalination plants, should be comprehensive, consultative and transparent. All alternative means of supply should receive equitable consideration, including especially gains from water efficiency and conservation measures, water recycling and supporting the functioning of natural water supply systems. Desalination is most properly regarded as one of a number of related processes using increasingly similar technologies to produce "manufactured water". Decision makers need to consider the overall role for manufactured water and various possible options for manufacturing water before considering desalination possibilities. Manufacturing water through the recycling of wastewater is commonly both economically and environmentally superior to desalinating seawater.

Minimising environmental impacts of large scale desalination plants

Desalination plants should be sited, planned and operated to minimise environmental impacts. The design of intake systems should proceed from the premise that seawater is also habitat. Outflows for concentrated brines need to avoid sensitive marine areas and incorporate adequate dilution, mixing and dispersal elements. Where possible, effluent flows should be reduced to "zero spill" solid wastes for safe storage or possible use. Adequate impact monitoring against assessed baselines should be mandatory.

Climate-neutral desalination

Desalination plants need to be designed to be climate neutral, obtaining 100 percent of their considerable energy needs from additional renewable energy, green energy purchases or through Gold Standard carbon offsets and taking maximum advantage of evolving energy efficiency and energy recovery technologies.

Subsidy-free desalination

No subsidies should be applied to the price of desalinated water, to avoid market distortions that would reduce incentives to conserve and use water efficiently. Where subsidies are thought necessary for social reasons they should be applied transparently in ways that do not impact on water prices.

Consider the downstream effects

Decisions on desalination plants need to consider "downstream effects" which can include support of unsustainable or environmentally damaging development such as water wasting irrigated agricultural or tourism developments, or support for outdated and environmentally damaging power generation technologies.

Address the research gaps

The research base on the cumulative environmental impacts of large scale desalination is clearly inadequate. Research is needed particularly on the long term consequences of intake structures on concentrations of small marine organisms, on behaviour and impacts of concentrated brines and on impacts of diverse other chemicals including biocides and anti-fouling treatments. Further research may improve the prospects for finding economic uses for for brine wastes.

The Freshwater Crisis

There is growing realisation that much of the world is now facing or will soon face chronic shortages of the freshwater without which life is not possible. Nor is this an issue solely for the developing world, where it is estimated that 1.1 billion people are currently forced to live without adequate water supplies and more than twice that number without adequate sanitation. Some first world cities have clearly hit crisis levels with their water supplies and many if not most others are facing difficult choices on securing their future water supplies in the immediately forseeable future.

A lack of a commodity as basic as water has a cascade of effects elsewhere. As WWF recently noted in the report Rich Countries, Poor Water : "From Seville to Sacremento to Sydney, water is now a key – sometimes the key - political issue at the local, regional and national level." Whole industries and cities which have grown up on the premise of abundant and cheap water are now finding that neither is the case. Dramatic increases in the cost of so basic a commodity are impacting on the whole economy and will do so increasingly in the future.

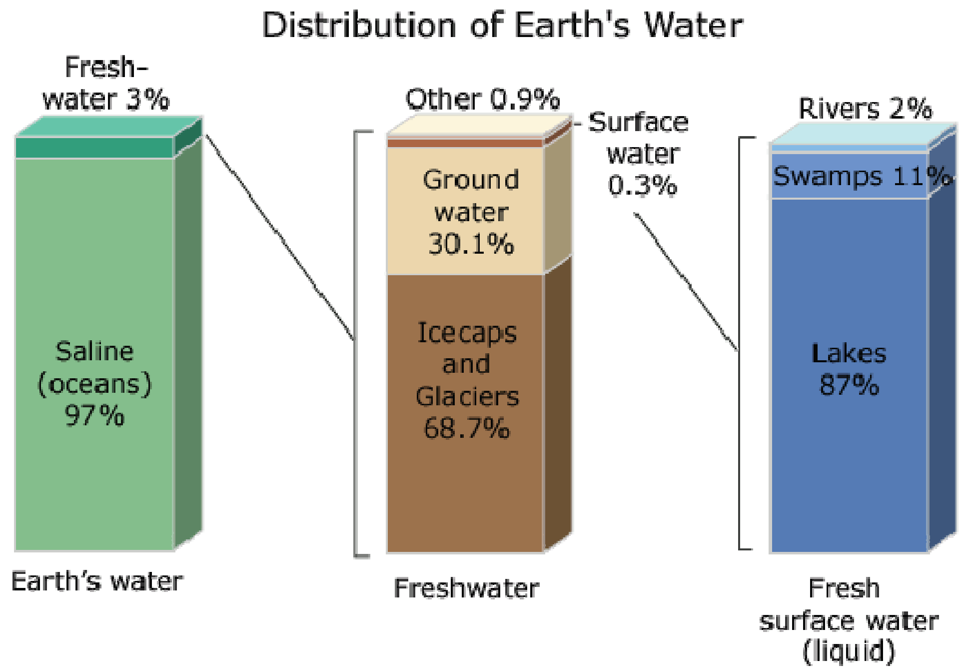
There is increased interest also in the highly contentious issue of how much of the water needed by the poorest of the poor is being eaten, worn or otherwise consumed by the world's wealthy in the form of the "virtual water" embodied in food, fibre and even jewellry. A cotton T-shirt for instance - even one with an ecologically friendly message – is the product of 4100 litres of water from someone else's river system or aquifer.

The health of the river systems and aquifers is also forcing its way to the forefront of public consciousness as whole landscapes lose their ability to absorb, provide and purify water. This not only threatens water supplies but also increases risks and impacts associated with pest species, disease vectors and catastrophic weather events. The environment, we now know to our cost, must also have its share of available water.

Also, and perhaps even more ominously, humanity in recent decades has made unprecedented alterations to global hydrological cycles that we barely understand – dramatically reducing the flow of rivers, plundering ancient groundwater supplies, and disrupting vapour and sediment flows. Scientists are still trying to work out what this might mean, with some predicting the consequences may rival and will worsen the adverse climate consequences of unintended and uninformed human changes to the composition of the atmosphere.[1]

Water, water everywhere. Nor any drop to drink

It is hardly surprising then that looming shortages of freshwater have encouraged many to look more seriously to where the overwhelming majority of the water is – the sea, source of the famous lament "Water, water everywhere. Nor any drop to drink"[2]. It has been technically possible to take the water and leave the salt ever since seawater was boiled in one vessel and the vapour condensed into another. The water produced this way is too pure for human health and is commonly remineralised to some degree for human consumption mainly by being mixed with other water supplies in the supply chain.



U.S. Geological Survey
http://ga.water.usgs.gov/edu/waterdistribution.html

In addition to the sea, there is a potential water supply in vast reserves of naturally brackish ground and surface water. Indeed, the lower concentration of salts means that the desalination of brackish water is often a more economic desalination proposition than pure seawater. As well, there are large reserves and flows of water that have been contaminated by human activity or use, with irrigation being the main contaminating activity and salt being the most significant contaminant.

In some areas, drainage works or excessive draw down of ground waters have meant that common but fixed soil elements are subject to oxidation and mobilisation within the soil profile. This can contaminate surface and groundwaters with significant concentrations of acids and elements such as iron, copper, arsenic and flouride. These contaminants can also be associated with water brackishness, particularly in arid areas. Such contaminated waters are a serious health and humanitarian issue in some soutern and southeastern Asian countries where excessive wells were sunk on the advice of and with the assistance of aid agencies.

The revolution in manufactured water

Water and waste water treatment are now well established technologies that have arguably made greater contributions to human health than most medical breatkthroughs. Making water, while technically possible, was historically mainly restricted to ships, islands and particular applications where very pure water was required. As the process relied on boiling water, energy use was significant and the costs of large scale water manufacturing prohibitive. The costs could be reduced by combining water production with other processes producing heat, with the most common pairing being combined power generation and brackish or seawater desalination. Even with some technical innovations such as using multiple chambers and lowering pressure so water boiled at temperatures as low as 45° C, large scale thermal water desalination has been almost entirely restricted to the wealthy, energy rich and water poor countries surrounding the Arabian Gulf.

Large scale desalination's move beyond the Arabian Gulf is occuring not only due to increased water shortages in other wealthy areas but also to a revolution in membrane technologies which has dramatically lowered the cost of desalination. But the same revolution is transforming water decontamination generally and providing a boost to water recycling. Essentially, water can now be manufactured from a variety of feedstocks from wastewater to seawater using the same basic technologies and processes. Manifestations of this technical convergence are rapidly beginning to mount, from industry giants such as Veolia Water trading on their general water competence and the US municipal desalination lobby - the US Desalination Coalition - transforming itself recently into the New Water Supply Coalition to "seek congressional support for the development of new water supply projects nationwide including water recycling, seawater and brackish groundwater desalination and groundwater reclamation projects".[3]

The cost and complexity is related to the number, variety and concentration of contaminants in the feedstock and the required level of treatment. Borrowing terms from waste water treatment, levels of treatment are being described as primary, secondary and tertiary, with tertiary treated "manufactured water" being, for all practical purposes, pure water.

More and more a matter of membranes

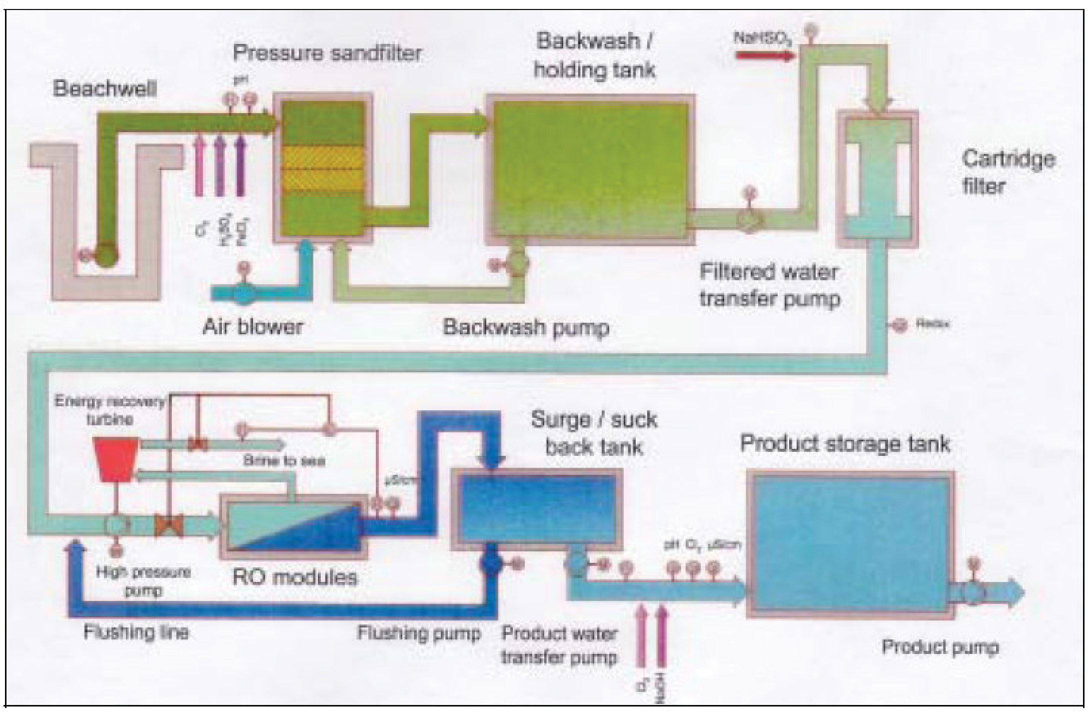
Historically, desalinated water was derived from thermal processes. This can be done on a large scale and produces the highest quality output water but energy costs are high. In general, large scale thermal desalination is restricted to being a cooperative venture with power generation in the energy rich and water poor Arabian Gulf states, but still accounts for around 40 percent of worldwide distillation capacity. Most plants carry out the distillation in multiple chambers where pressure is manipulated to reduce the boiling temperature. Variations on this theme include the thermal distillation industry leader Multi Stage Flash (MSF), the older Multiple Effect Distillation (MED) now undergoing a modest revival, and technologies applying heat through vapor compression (VC or MVC). Low energy, low technology thermal distillation is possible using energy sources such as the sun (solar distillation), but the area required for large scale water production is generally prohibitive and facilities remote from their markets can lose any energy savings in pumping costs. However, small scale solar distillation can augment the water supplies of small communities and has been successfully trialled in Botswana.[4] Greenhouses and residential units that combine space heating with passive solar distillation of low quality water have been trialled in Spain and Germany[5].

Although large scale thermal desalination plants continue to be built in Arabian Gulf states, the great majority of the world's new and planned desalination capacity is based around the use of membranes which allow or exclude the passage of molecules between two bodies of liquid. The most significant by far of the membrane technologies is reverse osmosis (RO), now widely used in water decontamination, purification, recycling and desalination.

Osmosis is a natural process in which adjacent cells are kept in liquid chemical balance by the movement of water molecules into the more concentrated solution. The membranes used in Reverse Osmosis (RO) allow the passage of water molecules while barring the passage of salt or other contaminant molecules. In RO, pressure is applied to the concentrated solution to force freshwater molecules through the membrane. Costs increase with the level of contaminants and for the level of treatment required. RO seawater desalination remains expensive and energy intensive, but is much less so than any large scale thermal distillation. Other advantages are the modular design of the plants. Plant capacity increases are possible for increased product volumes and increased levels of treatment and it is possible and relatively common to add additional stages to the process both before and after the membrane sequences. The RO process can be utilised from the scale of small hand held and powered units to ever larger manufacturing plants. At 320,000 m3/day the world's currently largest RO facility at Ashkelon, Israel is now not far behind the world's largest desalination plant, the 455,000 m3/day MSF facility at Shuweihat in the United Arab Emirates. It is becoming increasingly common to build and commission RO desalination plants in stages – Sydney Water in Australia for instance is commissioning a 125,000 m3/day plant that can be rapidly scaled up to 500,000 m3/day; Spain is adding Carboneras 2 to Europe's current largest plant the Carboneras 1.

Another membrane-based technology is **Electrodialysis** where electrical currents are used to move charged salts through membranes. A small proportion of worldwide desalination capacity is based on this technology, mainly in smaller and specialised contexts.

Membrane distillation is a combination of thermal and membrane technologies, where water vapor, usually produced as a result of the application of low grade energy, is separated and collected through a membrane. Commercially it is of little significance.



Desalination plant configuration

Desalination: The environmental impacts

Like any large scale industrial process, making water has a number of actual or potential environmental impacts. In brief, water is extracted from a source supply on a large scale, considerable amounts of energy are used in evaporating this source water or forcing it through filters and membranes, and at the end of the process large volumes of liquid or less commonly solid waste concentrates are released. Along with issues of siting and constructing the plants these might be regarded as the direct impacts of the process. In the view of many researchers however, the key environmental issues may relate to two key indirect impacts – the greenhouse gas and other implications of the considerable energy requirements of making water, and the environmental impacts of the subsequent development enabled by the availability of manufactured water.

Manufacturing water also has some potential environmental benefits. New membrane technologies can mitigate the one way flow of water from source to human use to waste through supporting much higher rates of water recycling. Manufacturing water can reduce demands on natural water sources and the need for other damaging infrastructure such as dams and water transfers. Water manufacturing processes can also be used for environmental purposes such as treating contamination, augmenting stream flows and recharging aquifers.

Direct impacts

Water intake issues

Source waters for water manufacturing processes can vary from waste waters to contaminated brackish ground or surface waters to seawater. The concern with seawater and some other source waters are that they are also habitat for a variety of marine or aquatic life. Appropriate intake design can mitigate many of the potential impacts on larger life forms but the key long term cumulative impact may be with the removal of small life forms such as plankton, eggs and fish larvae.

Discharge issues

Anything in the source waters can be expected to show up in a more concentrated form in the discharges from water manufacturing plants, along with any chemicals added during the treatment processes or from other processes such as corrosion. There may also be thermal issues with the discharges. In the case of seawater desalination, the main discharge issues can included elevated levels of salt and other constituents of seawater such as boron, dead sea life which consumes oxygen while decomposing, chemicals added to change the composition of the water for processing and to reduce contamination and clogging of filters and membranes, corrosion byproducts and the heat added for or during processing.

Plant siting and construction issues.

Water manufacturing plants compete for land with other uses. To reduce costs, it is usually preferable to site plants near to where the water is to be used, which means they are often in areas of already intensive use where overall impacts on often sensitive environments are already high or unsustainable. These issues should be but are often not addressed during normal land use planning assessment, but a particular additional issue with water manufacturing plants is the construction of intake and outlet structures in or across sensitive coastal or marine environments.

Indirect impacts

Energy use effects

Generally, water manufacturing is a highly energy intensive process. Depending on energy sources, large scale water manufacturing therefore has the potential to add significantly to the greenhouse gas emissions held largely responsible for climate change.

Downstream effects

Water availability is a constraining influence on development in many environmentally sensitive areas around the world. Water manufacturing can reduce this constraint, promoting unsustainable levels of other development. Politically, the potential availability of manufactured water can negatively impact on efforts to conserve water, use water more efficiently and recycle waste water.

Processing habitat – intake issues

One analysis of desalination has suggested that depletion of marine life "may represent the most significant direct adverse effect of seawater desalination".[6]

These conclusions are generally drawn from experience with coastal power stations using seawater for cooling purposes. In technical terms, marine life can suffer *impingement* effects from death or injury from contact with intake structures or death from *entrainment* if they are taken into the water manufacturing process. However, the issue is difficult to study and is not well studied either generally or in relation to specific sites and proposals. A California Energy Commission (CEC) study for instance noted that:

"Only seven of the 21 coastal power plants have recent studies of entrainment impacts that meet current scientific standards; all of these recent studies have found adverse impacts of entrainment. Entrainment losses quantified in these studies are equivalent to the loss of productivity of thousands of acres of coastal habitat. Impingement impacts add to the entrainment losses because often the same species that lose early life stages to entrainment lose adults and larger juveniles to impingement."[7]

A Californian Coastal Commission study found the impacts are highly site specific and variable according to the design of intake structures. [8] From the point of view of reducing impacts to marine life, "beach wells" where seawater infiltrates through sand into the intake system is clearly preferable to all forms of open ocean intakes. However, beach wells reduce flows and the water volumes available for treatment, and are consequently not favoured by the industry for larger desalination plants. They also need careful design and construction to avoid damage to coastal aquifers. A noteworthy trial of underocean floor intake and discharge for seawater desalination is proposed for the City of Long Beach in California. Proponents hope that the demonstration system will reduce costs as well as impacts, through reducing filter and membrane flushing and cleaning requirements, plant down times and the need for chemical additives.[9]

Entrainment losses can also be reduced by not taking water from close to the ocean surface where there are the greatest concentrations of small marine life, but this increases impingement losses to economically valuable species and involves greater construction costs and damage potential.

WWF endorses the CEC view that "seawater . . . is not just water. It is habitat and contains an entire ecosystem of phytoplankton, fishes, and invertebrates." It also finds the lack of studies on this subject alarming – in contrast to the consideration given to desalination plant discharges, the issue of entrainment losses of sealife is often not raised at all or raised in a highly superficial way in the consideration of specific desalination plants. Clearly, there is a requirement that the issue of the subtraction of marine life receives more study and that the issue is specifically considered in the assessment of individual desalination plant proposals. As impacts will only manifest themselves over an extended period, approval conditions should include baseline studies and periodic reviews.

As a matter of policy, intakes should seek to minimise both construction and operation impacts on marine life. Beach well intakes are clearly preferable where feasible, but where not, feedwater intakes should be located in areas of low biological content.

Beach well/WWF Spain

The brine issue

The main waste of desalination plants is brine. Common practice with seawater desalination plants is to discharge the concentrated brine back to sea. Generally, the industry maintains this can be done safely; in reality, there is much we do not know about salinity in the oceans and perhaps more pertinently in semi-enclosed seas.

On the grand scale, NASA Oceanography is looking forward to the release in about two years of the first satellite capable of real-time world-wide measures of sea surface salinity. The Aquarius mission will in fact gather more sea surface salinity readings in its first two months of recording than have been collected in the last 125 years.

Notes the programme "few know that even small variations in Sea Surface Salinity (SSS) can have dramatic effects on the water cycle and ocean circulation. Since 86% of global evaporation and 78% of global precipitation occur over the ocean, SSS is the key variable for understanding how freshwater input and output affects ocean dynamics. By tracking SSS we can directly monitor variations in the water cycle: land runoff, sea ice freezing and melting, and evaporation and precipitation over the oceans. "[10] Indeed, sea surface salinity is regarded as a key but largely missing indicator in climate research, with NASA commenting that "Global SSS data will allow us to create unprecedented computer models that bridge ocean-atmosphere-land-ice systems, with the goal of predicting future climate conditions".

One of the unknowns is how sensitive the ocean's salinity systems are, and whether they could ever be affected by a relentlessly growing desalination industry discharging more and more brine. But while open ocean effects might seem more in the realm of the improbable, it would seem logical to go looking for indicators in more enclosed water bodies that have been hosting extensive desalination operations for decades.

Researchers in 2000 noted that the Gulf of Aqaba was "one of the most delicate places for desalination" but "unfortunately, this region is also one of the few urban and industrial centers in the study area where the water demand is high and new plants are under preparation". The Gulf is naturally more saline than the Red Sea, which is itself more saline than the general salinity levels of the Indian Ocean. One key finding of the research from the Gulf of Aqaba suggests that organisms living in elevated salinity levels may already be living near their salinity limits.

The Arabian Gulf has some of the most threatened coral reefs in the world, with rising temperatures and high salinity levels implicated in the loss of reefs. A large proportion of global desalination capacity is located around the shores of the Gulf and this capacity is set to increase significantly. Most plants are linked power and thermal desalination plants and some local effects of outlets on reefs have been noted, but these are attributed as much to the heat as the salinity of the discharges. Although the salinity of the Gulf has been increasing and saline plumes have been associated with fish kills in the northern Gulf, desalination is only one of a number of possible contributing factors. Others include reduced river flows, coastal landworks and land use changes and oil industry discharges.

Brine output/ WWF Spain

Young plants of Posidonia oceanica © WWF-Shoreline

Some key coastal marine vegetation is known to be highly sensitive to salinity. *Posidonia oceanica* is a sea grass unique to the Mediterranean region, which forms "prairie" meadows in shallow waters near the coast. It plays a key role in the sustainability of the Mediterranean ecosystem by retaining the soil and ensuring more than one thousand different species feed and reproduce themselves. *Posidonia* prairies are listed as priority habitats under the European Union's Habitat Directives. For the *Posidonia* to thrive, two essential conditions are required: sun, for which it needs to grow in low-depth waters close to the coast, and a constant level of salinity. Unfortunately, *Posidonia* prairies have come into conflict with the rapid expansion of seawater desalination in Spain.

Conteracting brine behaviour

Concentrated brines are negatively bouyant in seawater, giving them a tendency to sink and spread along the seabottom, displacing normally saline water from hollows. This can have a devastating effect on seabottom life which impacts more broadly on the entire bay or shallows ecosystems.

These effects can be mitigated by adequate dispersal and mixing of concentrated brine wastes. On occasion, brine flows are mixed with other waste water flows, such as power plant cooling water discharges, to dilute them before discharge.

Where liquid disposal of concentrated brines is required this should involve adequate dilution, mixing and dispersal, should be restricted to areas of low biological sensitivity and should be subject to adequate monitoring regimes. Disposal at surface level is preferable to seabottom disposal

The solid option?

WWF Spain has suggested that "zero spill" waste treatment – generally by reducing brine concentrates to solid or minimal volume wastes - should be considered the preferable way of treating the brine wastes of desalination. Among the safe disposal options are former salt mines and in some cases would be valuable inputs for the chemical industry. This would minimise a major concern with desalination. Research into more efficiently and economically concentrating wastes should be a priority.

Clearly, more research needs to be done on the salinity tolerances of organisms and ecosystems and caution needs to be exercised on the possible cumulative effects of multiple desalination proposals for waters that are partly enclosed, where the seas are relatively shallow and where the dispersal effects of waves or currents are relatively low.

Keeping the membranes clean

Membrane performance is affected by chemical scaling from impurities in water, by biological growth and by simple clogging of the membranes. The widespread use of chemicals to overcome these issues is another potential issue with discharges from desalination plants.

As described in assessment documentation for one plant a typical pretreatment process to prevent fouling of the membranes includes the removal of suspended solids, chlorination or disinfection of the water, the addition of iron chloride as a coagulant and sulphuric acid to adjust pH. Several times an hour the filtration system is backwashed with a 12 percent solution of sodium hypochlorite, a biocide. On the way to the membranes the feedwater is treated with an antiscalant (phospinocarboxylic acid) at a rate that depends on the quality of intake water – in this case it was forecast at about 4-6 mg/L. The antiscalant is discharged with the brine. The product water is then treated with lime to bring its acidity into line with drinking water standards. Sodium metabisulphite is added to the discharge water to neutralise any free chlorine. A broad-spectrum biocide (containing 2,2 dibromo–3–nitrilopropionamide) is added to the filtration and RO systems at approximately weekly intervals to prevent growth of microorganisms. Two to four times a year depending on the degree of membrane fouling, both filtration and RO membranes undergo "chemically enhanced cleaning" with acidic detergents. Most if not all of these treatments are discharged with the waste brine stream, although the discharge of the cleaning wastes to sewer was raised as a possibility for this particular plant. Gross characteristics of the discharge water compared to the intake water include a small increase in temperature, increased acidity, a doubling of suspended solids and increased iron and sulfate content. The biocides used are described as breaking down in relatively short periods and most are described as having a low potential for bioaccumulation.[11]

Perth's desalination plant however is one where a relatively high level of attention was paid to environmental issues. In many cases the level of documentation and assessment of the chemical regimes for treating water, filters and membranes is far less specific. If there are persistent membrane issues, something that sometimes shows up in practice, operators can be tempted to use more damaging chemicals in heavier concentrations. Florida's troubled Tampa Bay desalination plant was found in violation of sewer discharge permits for just these reasons, while chemical discharges from many other desalination plants are unlikely to be subject to stringent monitoring.

For thermal desalination plants there are some added complications, related to the heat of the discharge and the presence of metal corrosion byproducts, including copper. To date, these corrosion byproducts and the thermal pollution characteristic particularly of linked power station cooling and thermal distillation discharges have been of more concern than the cleaning and defouling chemicals used in RO desalination systems. Thermal distillation sequences are also more commonly including membrane elements, which introduces traces of anti-fouling, scaling and cleaning chemicals to discharges.

Watering the greenhouse: the climate change implications of large scale desalination

Any major expansion of an energy intensive process such as desalination carries the risk of supporting a significant expansion of greenhouse gas emissions. Indeed, in some areas, this indirect impact of desalination has emerged as both a key policy concern and an issue increasingly raised in opposition to large scale desalination plant proposals.

To put it in context it should be noted that the energy intensity of water in most nations is both significant and increasing as water is sourced from deeper or further away. More marginal water in many areas has meant increases in water treatment costs and there is a long term trend to increase the level of wastewater treatment. Energy production is also a water intensive process with large power generating facilities requiring large quantities of water for steam and cooling purposes in particular. It is notable that unanticipated water shortages around the world in recent years have reduced or threatened power generation from hydro, nuclear and coal powered generating facilities. Many jurisdictions are now anxious over the long term impacts on power generating capabilities of long term changes in water availability from the degradation of water sources or climate change. In other words, energy and water issues need to be considered together.

Seawater desalination, in most cases the most energy intensive of potential water sources, will add in a significant way to an existing process. Precise figures depend on the location but to take one example, the Pacific Institute estimated that the water sector was responsible for 19 percent of electricity use and 32 percent of natural gas use in California in 2001. The Institute calculated that the then current proposals to provide six percent of the State's water through seawater desalination would have increased water-related energy use by five percent over 2001 levels.[12] Spain's Carboneras desalination plant uses one third of the electricity supplied to Almeria province.[13]

In a general sense, the increased demand for energy for desalination implies a commensurate increase in the carbon emissions linked to climate change. Worldwide, the electrical power generating sector is the world's most significant single generator of carbon emissions, responsible for 37 percent of global emissions. Always operating large scale desalination plants are also generally unsuited for variable power sources and tend to add to the base load power requirements most likely to be generated by burning fossil fuels. A comparison of the emissions intensity of various desalination technologies – using an average European fuel mix for power generation – showed the great advantage of RO (1.78kg CO_2 per m3 of produced water) over the thermal distillation technologies of multistage flash (MSF) (23.41 kg CO2/m3) or multiple effect distillation (MED) (18.05 kg CO2/m3).[14]

Actual contributions to carbon emissions of individual desalination plants or proposals are however, highly variable with power requirements, the use of energy recovery technologies and, most significantly, the fuel mix used to generate power. The differences can be dramatic as the following examples show.

> The analysis of emissions intensity of various desalination technologies showed that MSF distillation emissions could be as low as 1.98kg CO2/m3 if the process was 100 percent driven by waste heat (Most MSF facilities are coupled with power generation plants). Likewise RO emissions varied considerably with the fuel mix used for power generating, from 0.08 kg CO2/m3 (Norway) to 3.08 kg CO2/m3 (Portugal)
>
> The emissions intensity of California power is lower than the US average, reflecting more use of natural gas and less of coal.[15] The Pacific Institute estimated an average seawater desalination energy demand of 3.4 kWh per m3, which would translate to carbon emissions of 0.94 kg per m3. Performing a similar exercise for the other US high growth low water states however produces much higher emissions of 2.2 kg CO2 per m3 (Texas) and 2 kg CO2 per m3 (Florida).
>
> An Australia Institute analysis of the greenhouse impact of Sydney's ultimately proposed 500,000 m3/day RO plant held that the energy demands would be 4.93kWh per m3 and emissions would equate to 5.2 kg of CO2 equivalent per m3 from the State's mainly coal fired power stations. Annual greenhouse

emissions would be 945,000 tonnes of CO_2 equivalent – in more colourful terms the institute noted "The emissions are the equivalent of putting another 220,000 cars on the road, or burning 2 litres of petrol for every 1,000 litres of water."[16]

Across Australia, the WA Water Corporation's newly operational Kwinana desalination plant is setting new records as the largest so far constructed in the southern hemisphere and the largest anywhere to be powered by renewable energy. The 130,000 m3/day plant uses the same power as 30,000 homes and increased the corporation's energy use by 50 percent, but purchases the equivalent of all its power requirements from a newly constructed windfarm.

Clearly, the West Australian precedent is to be preferred if desalination is not going to become a key contributor to the climate change problems.

Posidonia oceanica, Cres, Croatia © WWF-Mediterranean/P. Kruzic

Flow on effects of large scale desalination

The concern of many communities and environmental lobbies however is less with the processes of desalination than with what it enables. It is a concern shared by some official bodies such as California's Monterey Bay National Marine Sanctuary (MBNMS), which noted:

"Clearly the most contentious and controversial issue surrounding desalination is its potential to induce community growth. Along most of California's central coast, freshwater supply is the limiting factor for community growth. With the addition of an unlimited source of freshwater, growth can be allowed to occur. While this issue is not addressed directly by Sanctuary regulations, it is of major concern. Increased development of the coastline adjacent to the MBNMS could lead to degradation of water quality and many other challenges to the protection of Sanctuary resources. It is up to local jurisdictions to ensure that a proliferation of desalination facilities does not lead to unsustainable community growth, through responsible planning, and limitations in plant capacities."[17]

California, it should be noted, has much more extensive development controls than the great majority of the areas where desalination is now being touted as a solution to real or forecast water shortages. In the Mediterranean and Middle East in particular, the desalination survey conducted for this report showed a high correlation between desalination and unsustainable urban and tourism development and horticulture and high levels of existing environmental damage – particularly to natural water sources. Indeed, a lack of effective land use planning mechanisms is commonly associated with a lack of effective water extraction and use mechanisms, resulting in a free for all where urban development, tourism and agriculture all take what they can get. Natural reserves in such areas have to contend with continual encroachments from unregulated or poorly regulated development and side effects such as effluent flows, falling water tables and sometimes illegal development within the reserve area itself.

Adding additional water supplies to areas without adequate land use planning or water use controls only perpetuates and extends environmental damage. It is often also difficult to believe in such circumstances that desalination plants will be planned, constructed and operated to mitigate their environmental effects.

WWF does not believe that large scale desalination should be contemplated in the absence of effective land use planning schemes in which sustainability is given a high priority.

A new lease of life for ageing power stations?

Coastal power stations using seawater in flow through cooling systems have long been a controversial issue in California, with opponents maintaining their intake and outflow systems do unacceptable damage to the marine environment. A number of high profile desalination plants propose to operate in tandem with such power stations, to make use of the existing intake and outflow structures, to save costs through the lower energy requirements of using warmed seawater as feedstock and to use the power station outflow to dilute brine wastes. This has fed community concern that desalination will give a new lease of life to the power stations.

Fuelling the nuclear option

Desalination is emerging as a major driver for nuclear power, particularly in Asia, the Middle East and North Africa. Among nations considering nuclear power to produce water are the currently non-nuclear States of the Gulf Co-operation Council countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates), Jordan, Libya, Algeria, Tunisia, Italy, Turkey, Syria and Indonesia. Current nuclear energy states France, Israel, India and Pakistan, China, Japan, Russia, Kazakhstan, and the USA are also involved in their own or the IAEA's nuclear desalination projects[18].

Programmes in Iran and North Korea, the current focii of world concern on nuclear weapons proliferation, are not nearly as well canvassed by the International Atomic Energy Agency or the World Nuclear Association but there is little doubt that Iran would seek to use nuclear power to produce water. As far back as 1977, a large 200,000 m3/day desalination facility was proposed for Iran's Bushehr nuclear power plant but lapsed in the long construction delays.

Desalination: An industry and its economics

World interest in desalination is rising sharply. The size of the global desalination industry is reported in many publications with an astonishing degree of precision – for instance, it can be read that in 2005 the 10,402 desalination plants worldwide were producing 35,627,374 m3 of water a day. Rarely is it mentioned that this figure is a compilation which can include "plants that have been built but never operated, operated but then shut down, or are still operating" and also can "include plants scheduled for completion by 2004 that were never completed".[19] The proportion of plants in these categories is quite high – in an allied listing of the 100 largest desalination plants proposed, operating or under construction, over half of the US plants indicated as operational are not.[20]

Even greater complexities bedevil the task of getting comparable cost figures for water produced by desalination compared to other water production or savings methods. Such comparisons are usually conducted on the basis of the cost of product water, with the most efficient (and largest) RO plant at Ashkelon, Israel initially producing water at $US 0.52/m3. However, the land for Ashkelon was provided at no cost by the Israeli government, and the Pacific Institute legitimately queried how production costs could be compared with California plants where expensive coastal land was a significant cost factor. However, in turn, the California project most likely to go ahead was quoted as producing water at $US 0.57/ m3 – after subsidy assistance of $US 0.20/m3. In addition to subidies, other issues in comparing desalination plants include varying capital amortization periods and rates.

Figures produced by and about the desalination industry accordingly should be treated with a great deal of caution. What can be said with confidence on desalination costs is that:

> Local and site specific factors have a large influence on costs, with energy costs being the major factor. Also important are the salinity and other characteristics of the feedstock water, coastal land costs and costs of mitigating environmental impacts.
>
> Energy costs are the largest component of the operating costs of desalination plants. On 2003 estimates by the US Bureau of Reclamation, energy accounted for 44 percent of the "typical" costs of an RO desalination plant and close to 60 percent of the costs of a "typical" large thermal distillation plant. The energy proportion of total costs rises with energy costs.
>
> Desalinated seawater is expensive water compared to most alternatives in most locations.
>
> To some extent the high cost of desalinated water can be offset by the greater reliability of supply. However it has not generally been economic to maintain sizeable desalination plants as a reserve capacity to be activated as needed in times of drought.
>
> Rising energy costs are now counteracting or overwhleming the benefits of incremental improvements in desalination technology. This is a trend that is likely to continue.

Looking for the breakthrough technology

Reverse Osmosis (RO) is the desalination technology of choice for the great majority of current proposals outside the Arabian Gulf where thermal distillation based on cheap and subsidised energy has historically supplied the bulk of freshwater requirements, and is now significant there as well.

RO is essentially the product of many years of intensive research undertaken with public funding and a high level of government support in the United States from the 1950s to the 1980s. It is currently regarded as a mature technology, exhibiting continuous incremental improvements in materials, methods and overall efficiency – estimated at a commendable four percent efficiency improvement a year by the US Bureau of Reclamation.

But the Bureau, commissioned to draw up a plan for desalination and related technologies to fill a general US water shortfall without significant increases in water costs, concluded that "continuing along this path will result in future evolutions of current-generation technologies that continue to produce water that is too expensive for many applications". In other words, the technical solution to the US water supply problem was dependent on a greatly accelerated research programme "that will result in cost-effective, efficient revolutionary desalination and water purification technologies that can meet the nation's future needs"[21].

An official review of the Bureau's "roadmap" for desalination endorsed its views on the need for a breakthrough technology, with a number of contenders including intelligent membranes and nanotechnology being mentioned. But it also noted that "current funding levels within the federal government for non-military application of desalination are insufficient to fund research efforts that would trigger a step change in performance and cost reduction for desalination technologies".[22]

There is the possiblity that some breakthrough on the technical or cost front will be an outcome of research in other areas such as Europe or China. In the industry, levels of research investment are not high. A perusal of the papers in the journal "Desalination" supports a view of incremental improvement in theoretical knowledge and practice occurring in a number of key areas.

The more enthusiastic projections of the industry should therefore be viewed with some scepticism. Although a desalination plant is more and more often raised as a possible inclusion in a water plan and is more and more tempting as an electoral promise, the reality is that desalinating seawater remains an expensive water supply option, closely tied to energy costs.

Desalination and alternative water supplies

Valid comparisons of water supply options are clearly highly dependant on locality factors like rainfall, topography and the characteristics of natural surface and underground water systems as well as other factors like energy availability and cost. Many cities have also exhausted the immediately neighbouring and readily available natural water supply options. The take on rivers and aquifers may be at or beyond capacity and potential reservoir sites are commonly already utilised, As cities and regions source their water from deeper underground or further away, water transport costs have also begun to loom much larger in the general water supply equation.

Consultants to the Australian Prime Minister on water supply options for Australian cities noted that low cost water supply options depended on "favourable locations and situations" for the options. Seawater desalination costs over three Australian cities accordingly could vary from AUD $1.15 to $3.00 a m3 of product water (USD $0.95- 2.50). Options with a noticeably lower mid-point in their range included demand management, irrigation water purchases, stormwater re-use, groundwater extraction and dams. Noticeably more expensive options were to augment supply through household rainwater tanks and long distance pipelines.[23]

The Pacific Institute's analysis of desalination in California analysed the energy content of competing water supplies. Seawater desalination was the most energy intensive of water sources in San Diego county, a multiple of 1.3 times the energy intensity of water sourced from the State water grid, twice that of the Colorado River Aqueduct, four times that of brackish water desalination and eight times as energy intensive as groundwater or reclaiming waste water.[24] Energy costs are increasingly reflective of overall water costs.

The US Desalination Coalition (now the New Water Supply Coalition, a lobby composed of US municipal authorities), proposed a 2005 bill for qualified desalination facilities to be eligible for payments of $0.62 for every thousand gallons of freshwater produced for the initial ten years of a project's operation.

The US Congressional Budget Office opposed the subsidy, on the basis that the real issue was that payments for water by US consumers rarely reflected supply costs and additional subsidies "would compound the distortion of price signals. An alternative means of improving the viability of desalination would be to allow prices charged to water users and received by water producers in general to more fully reflect the cost of supply."[25]

According to a World Bank official conversant with the Bank's studies of desalination, "Saving water rather than the development of new sources is often the best "next" source of water both from and economic and from an environmental point of view. Water demand management can include a reduction of a prevention in the further growth, of final water demand through improved public awareness, universal and more reliable metering, control of illegal connections and more appropriate water tariffs. It can also include measures to reduce levels of physical leakage in the distribution network, which are often very high. Desalinated water should only be a last resort, after all appropriate water demand management measures have been implemented and after carefully evaluating alternative options for conventional bulk water supply, which usually consist of long-distance transfers of surface water or groundwater" [26]

The economics of desalinated agriculture

Desalinated seawater is or is intended to be an important agricultural input in some Mediterranenan or Middle Eastern areas, although actual extent of agricultural use is sometimes obscure. This project was informed, for instance, that a significant number of Spanish farmers are shunning desalinated water in favor of continuing to illegally pump groundwater. In other areas, such as Saudi Arabia, groundwater based agriculture is facilitated by utilising sometimes distant desalination water to provide cities with potable water supplies.

Particularly in the face of increasing energy costs, it seems highly unlikely that desalinated agriculture is economic anywhere. According to a 2005 study by the UN Food and Agriculture Organisation (FAO), "applying water desalination technology to agriculture is generally cost-ineffective; in particular, water desalination is currently much less economical than the re-use of treated wastewater in agricultural applications" and its application was "effectively used only in the case of certain high-value crops and when capital costs are subsidized by governments"[27] .

Additional subsidies may take the form of preferential water pricing for farmers and production subsidies for crops.

Loading the bases: an inadequate basis for desalination

The large scale supply side answer to water supply problems regrettably involves a long history of loading the bases so that the answer to a perceived, forecast or sometimes even manufactured water crisis is invariably a large scale infrastructure project. With all large infrastructure projects, there are dangers in the authorities and industries that build and operate such facilities being frequently the key entities exerting influence on evaluation and decision making processes. Key elements of poor decision making on water infrastructure can involve :

- Denying public access to information
- Excluding key interested parties from involvement in decision making processes
- Consideration of no alternatives or limited alternatives
- Considering alternatives in a distorted way by for instance exaggerating their cost in comparison to unrealistically low costings of the preferred project
- Systemic overestimation of benefits and underestimation of costs of projects
- Neglect or underestimation of social and environmental costs of projects
- Outright corruption – the purchase of favorable decisions

It would be encouraging to believe that large scale desalination projects will be approached differently. However, in many of the cases studied in this brief it was apparent that demand side responses to water supply issues had received only cursory attention.
Sydney Water Corporation, the proponent of a large scale desalination plant, conducted an analysis of the relative merits of similar sized potable water recycling and desalination plants. The analysis shows

potable water recycling to be by far the most expensive option – after it included and costed a requirement for the recycled product to be piped and pumped from the coast to be mixed with the waters of a distant dam.[28]

The desalination industry

In preparing this report, WWF approached both the international desalination industry associations for information. No response was received, even to the question as to why there were two competing international industry and research associations both based in the United States. It is interesting to note that the Pacific Institute, in its examination of desalination in California, also noted that "repeated attempts to contact private companies about the status of their desalination plants were ignored" (Cooley et al p.25).

The industry also seems to be undergoing something of a transformation as the number and size of projects increases and the size of projects increases. The former dominance of water supply authorities and specialist water companies is being replaced rapidly by partnerships between diverse infrastructure companies and construction conglomerates. This adds the risk that often underfunded and resourced regulators will find it difficult to adequately address environmental and other community concerns in the face of development interests clamoring for water and large and politically influential corporations clamoring for contracts.

As a study of Saudi Arabia's water supply system noted, "Foreign manufacturers of desalination plants, irrigation systems, pumps, pipelines, earth-moving equipment etc… associate closely with the power elites. Non-economic and environmentally unsound schemes like food self-sufficiency are packaged attractively with slogans that evoke national sentiment. In the absence of a free press, environmental groups and other ethicist egalitarian non-governmental organizations find it difficult to introduce into water policy a balancing economic or environmental perspective. Consequently, there has been no effective voice saying that desert agriculture was a seriously negative economic and environmental option. Once the high-water-using irrigation schemes were in place, domestic water supply requirements had to be addressed via desalination and pipeline technologies. This outcome benefited not only the new farming entrepreneurs but also the desalination equipment and pipeline suppliers along with their local sponsors (Elhadj 2004, p.17). Elsewhere in the region, it has been noted that Israeli and Jordanian construction companies have been among the strongest proponents of the Red Sea-Dead Sea water supply and desalination proposal over other alternatives such as allowing or supplementing Jordan River flows.

Desalination - a world view

Many of the conclusions to which this study of desalination comes have been informed by a survey of current desalination developments and their context in key regions. It is not an exhaustive survey, but it does illustrate:

The rapid growth of desalination capacity generally, and the trend to larger and larger desalination plants

The extent to which the technology is regarded with misgivings in some countries.

The degree to which desalination as a supply side technology continues to prevail over more serious consideration of demand management.

The degree to which desalinated water is subsidised to end users.

The degree to which desalination is linked to unsustainable urban, tourism and agricultural development in some areas.

Full steam ahead in the Middle East

The world's most significant desalinators – by a clear margin – are the oil rich but water poor nations around the Arabian Gulf, with some estimates being that around 60 percent of the area's water needs are met through desalination and that more than 50 percent of the world's total desalination capacity is located around the Arabian Gulf and a large proportion of the remainder takes water from the Red Sea and eastern Mediterranean. Many of the plants combine seawater distillation with power generation but although plants of this type are still being constructed there is now a pronounced move towards large Reverse Osmosis plants.

Despite the already large capacity, massive increases are planned as nations grapple with soaring water demand. In various measures there are common elements in depletion and contamination of the area's limited other freshwater resources, agricultural enterprises which are looking for new water after having substantially contributed to this degradation, rapid urbanisation and burgeoning tourism development.

Saudi Arabia – struggling to keep up with demand

The Saudi Government owned Saline Water Conversion Company (SWCC) is the world's largest desalination enterprise with 30 plants producing more than 3 million m3/day and 5000 mW of power – 50 percent of the kingdom's water needs and 20 percent of its power needs. Over the next 20 years, according to SWCC, the kingdom will need an additional 6 million m3/day of water and 30,000 more mW of power generating capacity.[29] SWCC itself is to be privatised, which may be one indication that providing for Saudi Arabia's water needs is expected to be challenging. The investment community certainly thinks so, with one influential analysis concluding that "Growth in the region would be stronger but for concerns about Saudi Arabia's ability to finance its required capacity within the timeframe."[30] Other organisations with reservations about the general Arabian Gulf and Red Sea desalination model include the World Bank, which has noted that subsidised natural gas underpins much of the combined thermal distillation and power generation, "Energy subsidies distort the choice of desalination processes in favor of energy-inefficient technologies," a bank spokesman said[31].

Confused outlook on environmental issues

In theory, the long established desalination industry on the relatively enclosed seas surrounding the Arabian peninsular should have provided the ideal real world laboratory for examining some of desalination's environmental impacts. Continuing work in the Gulf of Aqaba, the most enclosed water body in the area which already hosts significant desalination capacity and has more proposed, may yet provide such data with researchers pointing to the possiblity that much of the marine growth and life in seas of already elevated salinity may be near the limits at which any further increases in salinity can be tolerated.[32] There have been reports of increased salinity causing fish deaths in the Arabian Gulf, but the main reason for the Gulf's elevated salinity is low run-off and high evaporation rates. Dumping of saline water, whether as a byproduct of oil production or extensive desalination works is held less responsible than dam building and irrigation works on the Tigris and Euphrates Rivers. One notable feature of the Arabian Gulf is that "a counterclockwise ring-shaped residual water current links all the (desalination) locations, and the plants receive their feed water from a water body which is under the influence of the upstream plants". Thermal pollution from the discharges of joint power station/desalination plants have been raised as a risk factor for increasing the possibility of coral bleaching in the Arabian Gulf.[33]

Individual projects undergo various levels of environmental assessment but strategic or cumulative impact assessment is uncommon. In some areas, as the World Bank has noted, "the legal basis and institutional capacity for environmental asessments in general is weak".[34] However there are many activities that impact on the Arabian Gulf and it would be difficult to isolate the impact of desalination plants and the power plants they are most usually associated with. The level of damage from land reclamation activities is likely to be the largest and most immediate environmental issue in the Arabian Gulf, although the availability of water from desalination undoubtedly facilitates current high levels of unsustainable coastal and island development.

Not surprisingly for such dry countries there is a long tradition of water use restrictions, some of which are supported by religious traditions. However, these useful traditions began to break down under conditions of rapid development which, particularly in agriculture, were underwritten by large scale groundwater abstractions. It is hard not to agree that "given the inefficiency of agricultural production in desert environments, it is anomalous to deplete mainly non-renewable groundwater reserves in the Riyadh and Qaseem Regions so that farms in the forbiddingly arid and hot Najd plateau are irrigated, while desalinated water for household use is piped from hundreds of kilometers away."[35] A key weakness is the combination of some of the world's lower water tariffs with its highest water production and distribution costs. These are justified on social grounds. There are undoubtedly large potential gains from conservation and efficiency measures but they will need support from the pricing system and some investment in addition to the well used exhortations for Saudis to use water more frugally.

Desalination in Israel

Israel has been looking to large scale desalination as its main way of resolving a water crisis brought on according to one government report by "a policy of brinkmanship . . . guided by short term economic considerations". Elements of the crisis included reductions in both the quality and quantity of water supplied to Israelis, contamination and depletion of natural water sources and successive droughts in the early part of the century. Recurrent droughts, fears of the future impact of climate change and water related provisions in international agreements between Israel and other states in this highly volatile area also complicated the position. "Delay in introducing desalination" and "delay in adjusting demand and water prices to the desalination era" were also identified as contributing factors[36]. A master plan adopted in 2002 called for the construction of major seawater RO desalination plants to supply 400 million m3 of water in 2005-2006, with a foreshadowed 750 million m3 of capacity to be provided by 2020.

Not mentioned in this analysis however were the prodigious water demands of Israeli agriculture, which like Spain (see below), is growing unsuitably thirsty crops in fundamentally dry areas – substantially for export. The inevitable result has been a dramatic drop in groundwater levels and associated stream flows.

This then is the background to Ashkelon, currently the largest seawater RO plant in the world with a capacity of 320,000 m3/day (100 million m3 a year). The plant, powered with its own dedicated gas turbine power station, is at the cutting edge of efficiency and produces water for about $US 0.52 a m3. Notes an industry source: "Ashkelon produces around 13% of Israel's domestic consumer demand – at one of the world's lowest ever prices for desalinated water. It has been suggested that it could be many years before this plant's achievement is matched."[37]

Israel plans to use its desalinated water not only to fulfil shortfalls in supply but also to facilitate replenishment of its natural reservoirs. Associated plans include the restoration of damaged or contaminated natural water sources and infrastructure and commitments to lift an already high level of water and effluent recycling.

Pollution of rivers and the marine environment is becoming an increasing issue in Israel but effluent desalination plants are a long way down the list of concerns, behind raw sewage from a lack of treatment facilities in Gaza and overflows and inadequate treatment from Israeli facilities and industrial and water treatment sludge from Israeli facilities.[38] Indeed, there is a concern that the flows of pollution into the Mediterranean will increase desalination costs, which are related to the quality of intake water and more frequent membrane servicing[39].

Desalination for the sake of a dying Dead Sea

Schemes to link the Mediterranean, the Dead Sea and the Red Sea have a considerable history. Now those plans have been revived under the umbrella of the peace treaty between Israel and Jordan as a way of providing desalinated water to needy cities such as Amman while rescuing the shrinking Dead Sea. The two governments and the Palestinian Authority recently agreed to participate in a feasibility study of a "peace conduit" from the Gulf of Aquaba to the Dead Sea, with a large desalination facility powered by renewable hydrostatic energy close to the Dead Sea.

However, the project has its opponents, some of whom would prefer to see desalinated water from Israel's northerly Mediterranean facilities used to help address over-extractions and low flows in the Jordan River as the key cause of the Dead Sea's woes. There are also concerns that imported Red Sea water will harm the delicate Dead Sea ecosystem.

Dead Sea region

Salts from the Dead Sea

Battling over desalination in the USA

The world's desalination industry owes a massive debt to US taxpayers and administrations for the long decades of research effort that underpin its current technologies. Up until now, the main benefits have been enjoyed in the Middle East and Spain, but a looming water supply crisis in the USA has seen desalination come back into favor. But implementing President John F Kennedy's dream of endless freshwater from the ocean is still problematic, partly because of the gap between what is technically possible and what is economically feasible, and partly because plans for more and more large desalination plants are beginning to arouse community concerns on environmental impacts. It has not helped the industry that some of the initial headline projects have run into difficulties.

Per capita, the US is the world's largest water user, with the US Bureau of Reclamation forecasting that "assuming continued per capita water use, 16 trillion additional gallons (60 billion m3) per year will be required in the United States by 2020 for municipal and light industrial uses". [40] Fully half the projected future population growth is predicted for just three already water-stressed states – California, Texas and Florida. Texas is proceeding cautiously with a major emphasis on brackish water desalination, while Florida's initial unhappy experience with desalination has helped fuel fierce debates in California which are now holding up a number of major proposals. Of 11 US plants listed among the world's 100 largest existing or proposed plants in 2005, most are still pending.

Trouble at Tampa Bay

America's first, much heralded new generation desalination plant, a 95,000 m3/day facility at Tampa Bay, Florida was approved in 1999 and scheduled to be supplying water at a competitive cost of less than $0.50 /m3 in late 2002. A succession of contractor bankruptcies, and technical difficulties with both filters and membranes have meant the plant has never operated at anything like its planned capacity. The $US 110 million plant closed for repairs in 2005 and began regular water production again in April 2007, although it was scheduled to take some time to reach its operating capacity. Liability for the $48 million repair bill – mostly linked to failures of filters and membranes to perform adequately – is before the courts. [41] The manifest failures of Tampa Bay have proved to be a potent example to California communities opposing desalination plants.

Debating desalination in California

Interest in desalination has developed rapidly in California over recent years, but there has also been a rise in the level of community and institutional misgivings about desalination. Some of the community concern has grown on the back of campaigns to close down coastal power stations that use flow-through cooling systems likely to damage marine ecosystems as some of the desalination proposals have envisaged working in tandem with these unpopular power stations. However the number of new proposals also took many by surprise, with the Monterey Bay Marine National Sanctuary for instance listing desalination as a management issue on noting that their three existing plants (one very small) could possibly be joined by "approximately ten additional facilities in the Sanctuary region that are in some stage of initial consideration."[42] The Pacific Institute (see below) noted in 2006 that "In the past five years, public and private entities have put forward more than 20 proposals for large desalination facilities along the California coast. If all of the proposed facilities were built, the state's seawater desalination capacity would increase by a factor of 70, and seawater desalination would supply 6% of California's year 2000 urban water demand."

In response to both the rising interest and the rising concern, the State directed its Department of Water Resources to conduct a study of the possibilities for desalination, the possible impediments to desalination and the role that the State should assume. It was chaired by DWR Deputy Director Jonas Minton and concluded that sea and brackish and seawater desalination "where economically and environmentally appropriate" could be included "as as an element of a balanced water supply portfolio, which also includes conservation and water recycling to the maximum extent practicable". It also usefully recommended that cumulative impacts had to be considered where a number of plants were considered for an area, as did desalination's impacts on growth.[43]

California's long list of desalination proposals have however not enjoyed any smooth path to approval, construction and operation. Part of the considerable community opposition has been related to the co-location of most large seawater desalination proposals with coastal power stations which were already controversial for the effects of flow through cooling structures on the marine environment:

> Proponents of the Carlsbad City 189,500 m3/day desalination plant in the San Diego area, have received municipal level approvals and have water supply contracts in place and are now awaiting final State level authorisations. The plant, co-located with the Encina power station, was originally scheduled for construction beginning in 2005 and completion in 2008. Its proponents now maintain it will be operational in 2009.
>
> Huntington Beach desalination plant, like Carlsbad a co-located 189,500 m3/day plant proposed by private operator (and original Tampa Bay developer) Poseidon Resources, has also now received most of its permits over fierce community opposition. Construction was originally scheduled to begin in 2004 and the plant to be operational in 2006, but Poseidon is now forecasting construction beginning this year (2007) and completion in 2009.
>
> Pilot plants have been constructed by the Marin Municipal Water District drawing water from San Francisco Bay and for one of two contending desalination proposals to be constructed at Moss Landing on the Montery Peninsular, as a possible prelude to larger scale proposals.

In one innovative project, Long Beach Water has been operating a pilot plant to test whether multiple passes of seawater through nanofiltration membranes could be a viable alternative to RO desalination. Initial results have been promising both in terms of the water quality and an up to 30 percent saving in energy. The experimental plant is also conducting research on the feasibility of subsurface intake and discharge wells which has the potential to address some key environmental difficulties with desalination. The US Bureau of Reclamation, which drew up the desalination roadmap, is involved in the trialling of what is now know as the "Long Beach method" .

However, the necessity of some large scale water supply projects – including desalination – is also being questioned. California's Planning and Conservation League (PCL) in 2004 estimated California's additional water needs to account for both population increase to 2030 and environmental restoration (a need to return 1.2 million Ml to the environment) amounted to 3.7 -4.2 million Ml of water. Of this requirement, PCL quoted Pacific Institute calculations that 2.4-2.8 million Ml would be available through urban water conservation savings, 1.8 million Ml through water recycling and up to 740,000 Ml through continuing agricultural efficiency improvements. Considerable additional water could be made available through groundwater desalination or other decontamination and stormwater capture.

A limited role was forseen for small coastal desalination plants using beach well intake systems, but PCL said unscreened large scale ocean desalination had "unacceptable environmental impacts and is not as cost-effective as other available options".[44] Among those involved in the assessment was PCL water policy advisor Jonas Minton, the former chairman of the State desalination study.

The Pacific Institute study similarly concluded that that "most of the recent seawater desalination proposals in California appear to be premature. Among the exceptions may be desalination proposals where alternative water-management options have been substantially developed, explicit ecosystem benefits are guaranteed, environmental and siting problems have been identified and mitigated, the construction and development impacts are minimized, and customers are willing to pay the high costs to cover a properly designed and managed plant"[45].

A third stream of opposition to large scale desalination in California relates to concern that it will further drive what is already seen to be coastal over-development. The Monterey Bay National Marine Sanctuary has labelled this "clearly the most contentious and controversial issue surrounding desalination"[46].

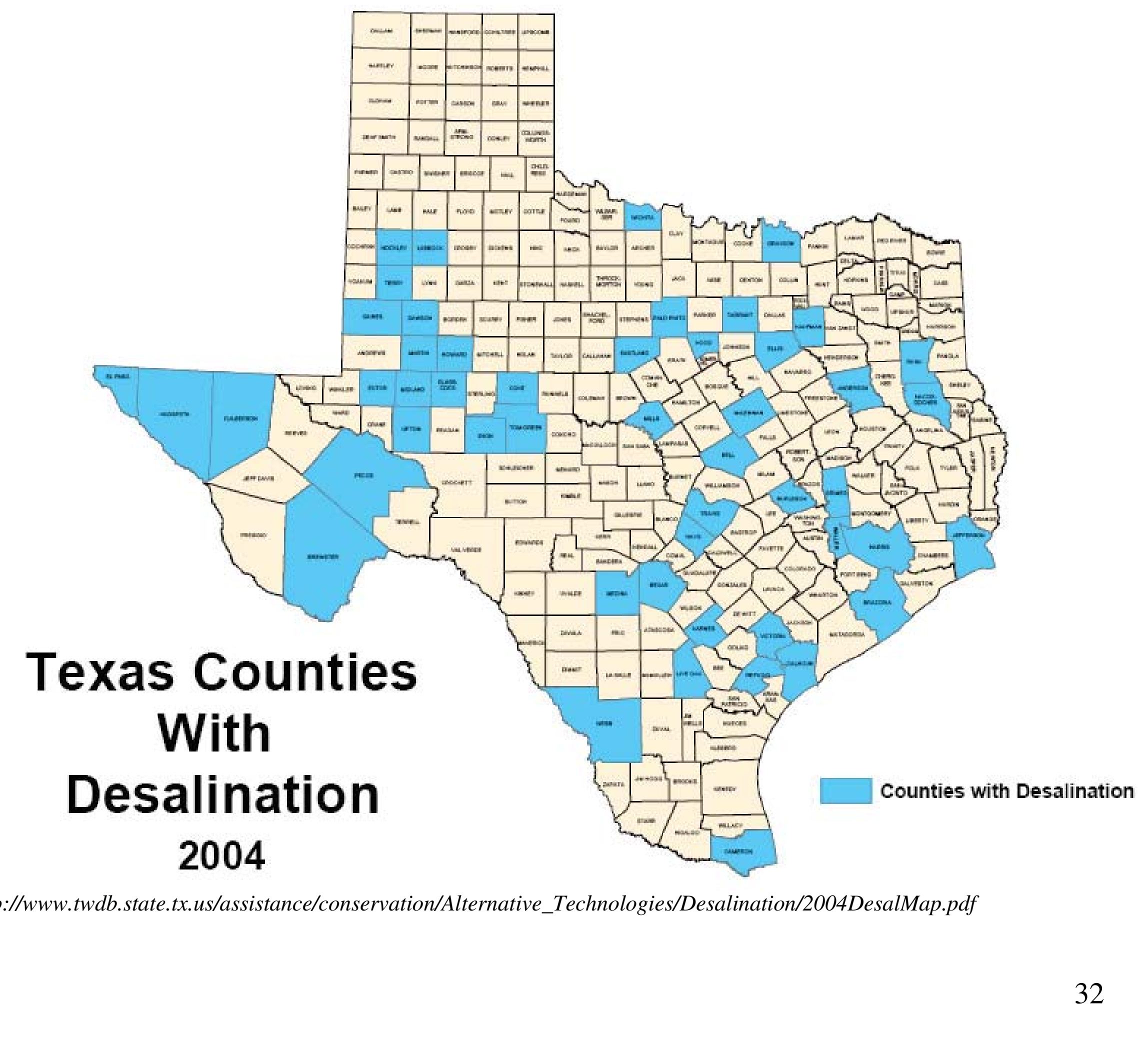
Seeking subsidies in Texas

Texas is also the site of multiple large seawater desalination proposals that have stalled, although here there is little evidence of the controversy over desalination that is surrounding many California proposals and expense seems to be the main issue. The State is no stranger to desalination – in 2004, there were 100 desalination plants processing mainly brackish ground and surface water with a total capacity of about 151,400 m3/day. Excluding industrial installations, 24 areas were getting all or part of their municipal water from desalination, for a total municipal capacity of 87,000 m3/day.[47]

In 2002, the State governor signalled a move to substantial seawater desalination and a flurry of proposals were launched even as the Texas Water Development Board (TWDB) was ordered to examine and report on the issue. By 2005 the international listing of the world's 100 largest existing or proposed desalination plants included four Texas plants.

- A 104,088 m3/day brackish water desalintion plant in El Paso, to have been operating in 2004
- 94,625 m3/day seawater plants for Brownsville (2005), Freeport (2005), and Corpus Christi (2006)[48]

As of 2007, only one of these large plants was approaching construction, let alone operation . An alternative 28,400 m3/day brackish water desalination plant had been constructed at Brownsville in 2004 and the El Paso plant is scheduled to proceed in partnership with the Defence department in the near future. In December 2006, the TWDB recommended that a $70 million grant and a $45 million low interest loan be provided to the Brownsville Public Utilities Board to construct a "full-scale seawater desalination demonstration plant" by 2010. Interestingly, the TWBD added as additional reasons for this investment "the potential to help meet environmental flow needs, and in particular, the environmental flow needs of the Rio Grande" and the non-economic issue that seawater "is relatively free of the increasingly contentious ownership and allocation issues associated with groundwater and surface water in Texas".[49]



http://www.twdb.state.tx.us/assistance/conservation/Alternative_Technologies/Desalination/2004DesalMap.pdf

Spain – a new way of endlessly chasing supply

Spain has the largest desalination capacity in the western world and its desalination industry is a key player world wide, with Spanish companies involved in developing the desalination capacities of the US, the UK and the Middle East among others. One recent accounting of capacity was "more than 700 plants producing 1,600,000 cubic metres each day, or enough for about 8 million inhabitants"[50] while another was for 900 plants producing 1.5 million m3/day.[51] According to these reports, this capacity was set to double with the urgent construction of around 20 new plants. However, other reports put the number of new plants as high as 29 by 2009.[52]

Behind the frenetic construction was the 2004 cancellation of the controversial Ebro River transfer project, once the centrepiece of Spain's National Hydrological Plan. This had been criticised as likely to repeat the experience of the previous Tagus-Segura River transfer which had worsened conditions in both the donor and receiving basins. (Indeed, there is now a proposal for a desalination plant to prop up this system). Spain has also long ranked highly among the nations most committed to large dams;however many of these dams remain continually at chronically low capacities.

In one sense, therefore, the new rush of enthusiasm for desalination is consistent with Spain's traditional approach to securing water in one of Europe's driest countries – a long history of massive investments in water supplies. But more and more voices are expressing a view that Spain's real water problems lie more with unrealistic expectations and poor water management.

Desalination plant in Alicante/ WWF Spain

Carboneras – highly subsidised water for heavily subsidised agriculture?

While other developed nations baulk at the high cost of desalinated water for urban uses, Spain is devoting an astonishing proportion of its desalinated water to agriculture – at 22 percent the highest level in the world, according to Jose Antonio Medina, president of the Spanish Desalination and Water Re-Use Association AYEDR. At that stage he predicted the then about to be constructed Carboneras plant with a planned capacity of 145,000 m3/day, was to be 90 percent allocated to agricultural supply.[53] However, these and other claims around the amount of desalinated water going to agriculture are subject to some dispute. WWF Spain noted that farmers continued to access groundwater even when its use was illegal while in the growing debate surrounding the construction of desalination plants, it was more acceptable to announce that water is intended for agriculture rather than tourism or urban development.

The 120,000 m3/day capacity plant at Carboneras was completed in 2004 and is claimed to be Europe's largest seawater reverse osmosis plant[54]. Operated by a consortium of Spanish desalination companies it was in 2006 judged to be the "greatest achievement" of the industry - but the opening was delayed by funding disputes with the Almeria farmers it was principally designed to serve.

But the key background is the transformation of the dry Almeria hinterland into Europe's most concentrated sea of horticultural glasshouses in the period 1987-2004.[55] In 1996, the three key aquifers of the Almeria coastal plain were listed as over-exploited, there were fears of saltwater intrusion into the seaward margins of the aquifers and problems of contamination with agricultural chemicals in surface and subsurface waters.[56]

Depending on the level of illegal and unregulated extractions, the existing, new and proposed desalination plants in the area may help relieve pressure on the aquifers. But the cost of desalinated water even from new generation RO usually precludes its use in agriculture. Precise Almeria figures are elusive, but one general study of Spain notes that "since 1983, the Spanish Government has been supporting water desalination to obtain a price of drinking water similar to the average price of water used by households," [57] The study notes that the agricultural water price was just 3 percent of the urban water price, and that in drought periods "water at 'market price' was 'sold' by agriculture concessionaires to urban concessionary companies". In 2006, the Director-General of Acuamed, a government company which commissions desalination plants and buys and distributes the product water, was quoted as saying that desalinated water from new plants would not be subsidised "for golf courses or for human consumption". According to this interview, farmers would be supplied at a charge of 30 euro cents a cubic metre plus the transport costs, while the cost of producing the water was estimated at 50 euro cents a cubic metre.[58] However, other research indicated that farmers were effectively paying 12-25 euro cents/m3 for water; some might thus be inclined to not take the desalinated water or only take enough to improve the quality of contaminated groundwater.[59]

One possible conclusion that desalination in Spain, for all its technical excellence, is but another way of pouring highly subsidised water into irrigated agriculture with an option for farmers in receipt of such water to sell it on - in effect spreading the subsidy into unsustainable urban and tourism development.

Watering the golf estates

Spain's burgeoning tourism industry has in recent years become significantly more water intensive, with more and more emphasis on second home development in resort settings, often arranged around 18 hole golf fairways. In the Almeria area it is difficult to avoid mention of the extensive water features of appropriately titled golf resort Desert Springs[60] to the north of Carboneras. A more general overview of the prospects for desalination notes that "Spain built a record-breaking 800,000 new properties in 2005, most concentrated along the southern coast; that figure is higher than the combined new properties built in France, Germany and the UK."[61] There seems to be little practical recognition of the reality that Spain's driest areas are set to become drier.

What Spain exhibits is an over-riding emphasis on finding supply, high levels of illegal and unregulated water extractions, slipshod efforts at enforcement and negligent land use planning. Perhaps most perversely, the perceived availability of water has underwritten a significant move for the traditional dryland Mediterranean staples of olives and grapes to become intensively irrigated crops producing market surpluses. Spain's natural environment, many of its nature reserves and indeed, the natural assets found so attractive by many of the foreign residents and tourists are being damaged by development which is underwritten by an assumption that water will always be available and be made available – whatever the economic, environmental and political costs.

Conflicts of interest in Spain's water debate

Not surprisingly, the developed nation with the most developed capacity in desalination also has an extensive dialogue on the costs and benefits of the technology. On one side, the call for a new approach is being led by the New Water Culture Foundation which was established during the debate over the National Hydrological Plan and the Ebro water transfer proposal. The NWCF has the support of WWF, which has formulated a set of proposals for the installation of new desalination plants. (See box)

However, Spain suffers in its ability to conduct a dispassionate debate on desalination because the environment ministry also includes the government-owned entity charged with dramatically boosting the nation's desalination capacity. The Aguas de las Cuencas Mediterráneas S.A.- a company more commonly known as AcuaMed - has policy, environmental and commercial roles but there is little doubt that its major preoccupations are the supply of additional water and the associated "contracting, construction, acquisition and operation of all types of hydraulic works".[62] Fully 50 percent of the augmented supply is envisaged as coming from desalination.

WWF-Spain's recommendations for installation of new desalination plants:

Revised demand estimates which includes consideration of the effects of controlling illegal consumption, implementation of demand management and cost recovery charging.

Full environmental assessment at the levels of the revised National Hydrological Plan, the basin or regional impacts, and project level (including desalination plant proposals)

A more gradual increase in desalination capacity, in line with revised demand estimates. This would also take advantage of improvements in desalination technologies.

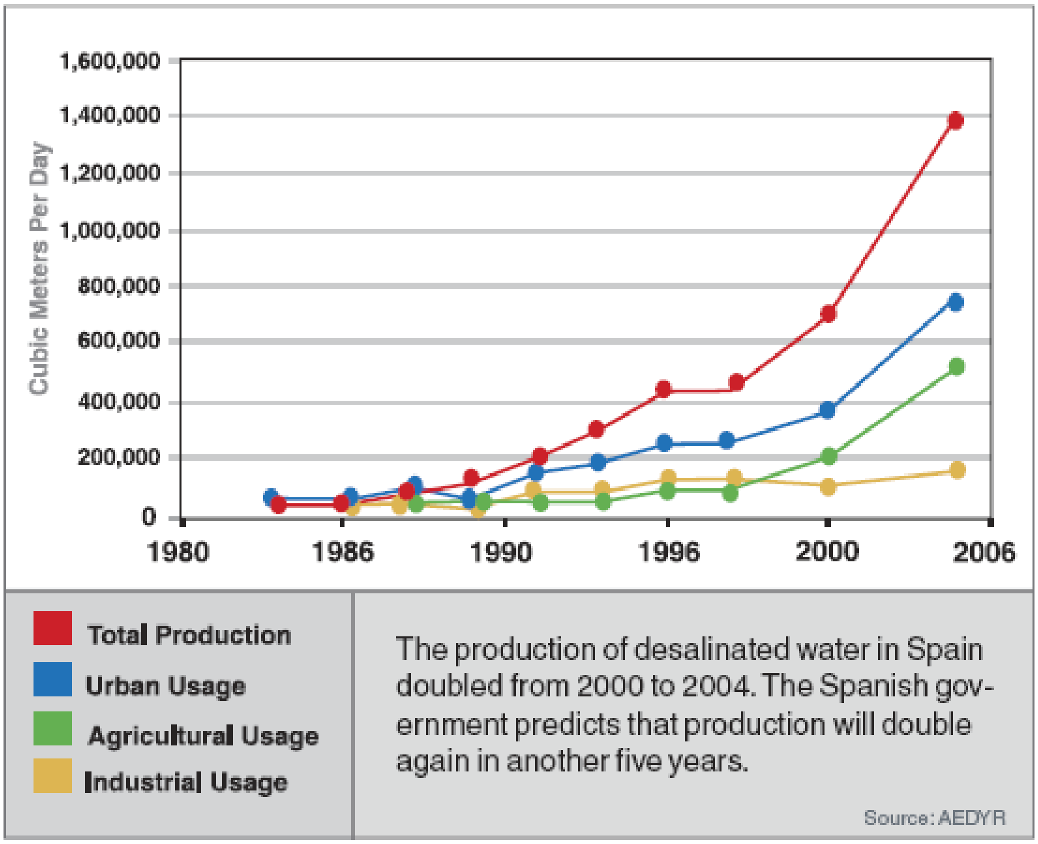
Restricting plants to existing industrial areas of Spain's Mediterranean coast. No construction permitted in natural areas, near reserves or onshore from *Posidonia* sea grass areas.

New desalination plants to be powered with renewable energy to avoid large increases in the greenhouse impacts of supplying water.

Examination of zero spill options for brine waste from desalination plants, including finding uses for the salt or transfering it to existing salt mines.

Where zero spill is not feasible or until it is feasible, brine should be disposed of in the least damaging topography, at surface rather than seabed level and with sufficient diffusing and mixing with seawater.

Use of Desalinated Water in Spain



The production of desalinated water in Spain doubled from 2000 to 2004. The Spanish government predicts that production will double again in another five years.

Source: AEDYR

Explosive growth in India and China

Desalination growth is outstripping all expectations, even greatly optimistic ones, in India and China, where water problems affect large areas containing extremely large populations. According to projections by Veolia Water, one of the world's largest water treatment and desalination companies, the two rapidly developing nations are "gearing up to launch major projects with a view to achieving a production capacity of 650,000 m3/day by 2015". This may be modest by Middle East standards, but it could also be a considerable underestimate. China alone recently announced plans to be desalinating nearly double that volume five years earlier.

India – desalinating booms as decontamination needs remain unmet

It is generally conceded that India is facing immense problems meeting its water needs in a period of rapid development. Issues include variable rainfall and population distribution and a high reliance on groundwater supplies which are becoming severely depleted. In large areas, dropping water levels have exposed dangerous soil elements to oxidation, introducing contaminants such as arsenic and flourides into the water supplies of millions.

Until recently, desalination and related technologies were mainly used in industry to provide water or in waste water treatment and re-use, and this is accelerating. India's burgeoning nuclear power sector is also seeing synergies in producing water as well as power. The under-construction Kudankalum nuclear power station in Tamil Nadu State for instance has two associated desalination plants for its own needs and those of an associated industrial park, including what is described as India's first multi-vapour compression desalination facility.

Small scale reverse osmosis plants have been used to render drinking water safe by removing contaminants such as arsenic and flouride compounds, but there have been many problems with keeping the equipment maintained and operating in small or remote communities with sometimes erratic power supplies. India's central Salt and Marine Chemicals Research Institute has developed an ox-powered desalination and decontamination unit capable of producing 0.7 m3 of water an hour. But, apart from a few demonstration plants, there is as yet little sign across south or south east Asia of any mass deployment of desalination-like technologies to address what may well be the world's largest single case of mass poisoning. As aid agencies took a prominent role in advising and funding the sinking of numerous wells that contributed to exposing dangerous elements to oxidation and mobilisation in the soil profile, there would seem to be a moral case for them to assist in effectively deploying water decontamination technologies.

Water short China embraces desalination

By world standards, China is relatively short of water with per capita supplies of less than a quarter of the world average. Moreover, water distribution and population distribution are mismatched, a factor behind extravagant plans to transfer southern river water to the populous but much drier north of the country. Additionally, some 40 percent of China's population lives in the coastal areas that form only 13 percent of the country's land area – another mismatch that is stoking interest in seawater desalination.

A 2005 list of "large" seawater RO desalination plants in China contained 22 plants ranging from just 30 m3/day to two of a still quite modest 5000 m3/day. The same publication listed 18 prospective plants ranging from 200 to 200,000 m3/day including a 160,000 m3/day nuclear desalination facility at Yantai City. However, the same article rather alarmingly noted that seawater desalination processes "will not influence the ecology".[63]

China's 2005 desalination capacity was just 120,000 m3 a day and western investment predictions reflected this relatively modest achievement. But over the last year China has announced plans to be desalinating 1 million m3 of seawater a day by 2010 increasing to 3 million m3 a day by 2020.[64] The market is to be supported to a level of up to 24 percent of water supplies in some currently water short coastal areas, by restricting freshwater to projects in nominated areas. There is also heavy investment, both Chinese and foreign, in China's desalination equipment manufacturing capacity and it seems likely that the nation will be a future major player in desalination, particularly in the developing world.

The China National Offshore Oil Corporation was reportedly planning to build a massive 1.4 million m3/day plant in Tangshan, northern Hebei province, partly to supply water to Beijing. [65] If such a plant were to be built it would be around three times the size of the current largest RO seawater desalination plant.

A string of news reports underlines that China's growth is putting great strain on its freshwater resources, with rivers in particular suffering from depleted flows, soaring agricultural power and urban water demands and sometimes staggering levels of contamination. Although there is some encouragement to conservation, it receives little support from the pricing structure, leaving water suppliers debt-laden and unable to upgrade infrastructure.

Leaks versus desalination in the UK

An inquiry was convened after the City of London denied planning permission for a Thames Water proposal to build a 140,000 m3/day £200 million ($US 397 million) desalination plant at Beckton on the Thames. London Mayor Ken Livingstone submitted to the inquiry that the plant would be energy intensive, would contribute to greenhouse gas emissions and, perhaps most tellingly, that around 915,000 m3/day of water a day is lost through leaks in London's water distribution system. The company argues that "reducing leakage can't close the gap between supply and demand quickly enough" and that higher costs were attached to other supply options.

The background to the controversy shows up some familiar themes, in that a large and expensive supply side infrastructure project was receiving consideration ahead of the possibility of much more concerted action on the demand side of the equation. As well as the issue of leaks from aging water mains, there were issues of inadequate water pricing and metering and patchy supplier and regulatory support for water efficiency measures.

In the longer term the indications are that climate change could mean greater variability in the water supplies available to southern England. Slow official realisation of this and a notable lack of emphasis on conservation and efficiency measures have taken the area's vital aquifers and rivers to historically low levels. In this context, the continuing frantic roll-out of housing subdivisions – including up to 160,000 new homes in the Thames Gateway by 2016 - with little planning consideration of how water requirements would be fulfilled into the future is a clear indication that southern England needs a coherent and effective plan much more than it needs a desalination plant.

The River Thames, UK © WWF-Canon / Emma Duncan

"Bottled electricity" under scrutiny in Australia

The world's driest continent – well on its way to becoming drier as a consequence of climate change – is also hosting energetic debate on the merits of large scale desalination. Perth's new desalination plant is the largest in the southern hemisphere and it is be followed by another of similar size within four years. A smaller plant has been approved for Queensland while a Sydney plant which has been on again, off again for a number of years will now be built. A large desalination plant may be tied to the world's largest uranium mine in South Australia, and consideration of desalination possibilities for the nation's second largest city of Melbourne has also started.

Commendably, some of the large scale proposals in Australia feature renewable energy use. However, in all the areas where desalination projects are proposed much potential remains for cheaper water sourcing through conservation, efficiency and recycling initiatives. All the areas are also characterised by rapid development in a context of inadequate consideration of the resource base in development planning and approvals. This extends to consideration of water availability and the natural environmental assets critical to its supply, quality and the mitigation of floods and droughts.

Sydney: On again, off again desalination

Historically huge reserves, a low priority for water management in government and a monolithic water authority has meant that Sydney defers to second-placed rival Melbourne as far as the enlightened management of water supplies is concerned. Persistent drought, thought to be linked at least in part to early effects of climate change, is increasingly challenging this complacency. Water conservation and efficiency measures have shown considerable promise, with Sydney Water reporting that its fairly unambitious programme of water savings had found enough water for around 138,000 households in the period 1999-2004 – mainly by plugging leaks in its own reticulation systems. But despite this success, the emphasis remained on large scale supply side solutions, notably a proposed $A 2 billion ($US 1.6 billion) up to 500,000 m3/day desalination facility to supply a third of the city's water requirements – a proposal initially derided by the then State premier who called desalinated water "bottled electricity". The label stuck, a fact probably regretted by the government when it approved the plant not long afterwards. However, in a further backflip just months later in early 2006, the government announced the plant was not immediately necessary, citing recent rains and the discovery of new groundwater reserves. Plant construction was to be triggered automatically when reservoir levels fell to a prescribed amount. Sydney Water Corporation meanwhile invested $A120 million ($US 100 million) to go through all the preliminary stages necessary to build and bring the desalination plant into operation within 26 months. However in early 2007, the government pre-empted the triggers in the run-up to an election and announced the go ahead to a 125,000 m3/day plant that could be rapidly scaled up to 500,000 m3/day.

According to SWC, the infrastructure and operating costs of desalinated water are much less than equivalent costs of water recycling. An independent research paper estimated that desalinated water produced in a carbon neutral manner would need to retail at almost three times the then water price[66].

Queensland: Desalination in a confused policy context

A more modest desalination plant of 125,000 m3/day was raised in the context of the future water supply strategy of south east Queensland, historically one of the fastest growing areas of Australia. The area has in recent years been plagued by water shortages, manifested in recurrent drought, historically low reservoir levels and water restrictions. The plant is to be located in one of the highest growth coastal corridors on the Gold Coast and will be operated by a local authority which in recent years has made a determined commitment to water saving and efficiency. The project, canvassed in an overall water strategy, commenced with extensive consultation and consideration of alternative sites, but as the water supply crisis rapidly worsened, State government leaders began warning of a water "armageddon". Earlier the government had sidestepped calls for increased water recycling by deferring the issue to a referendum. However in January 2007 it was suddenly announced that the referendum would be cancelled and an extensive water recycling scheme would be added as well as the desalination plant, now to be pushed through without an environmental impact study. The plan originally included mitigation for its greenhouse impacts which could include a proportion of renewable energy use [67]but it is unclear whether this commitment is to be maintained. Both the recycling and desalination plants are to be based around RO technology.

At an underlying level, Queensland has long been characterised by a confused overall approach to its water supplies and associated environmental assets. One key problem, recognised in theory in a succession of government planning studies but not addressed in practice, has been a failure to manage growth and anticipate resource and environmental constraints. The march of housing estates has been proceeding with a mainly only rhetorical consideration of such issues as water availability and the impacts on catchments - an approach sometimes derided as perpetually "planning to have a plan". In reality, as with other Australian state governments, the Queensland government's approach to least cost water provision has not lead to the most sustainable approach that was possible. Many conservationists see the choice of desalination at this stage as sign of failure to accelerate alternative water supply and demand management options over the previous ten years or more. Such measures could have prevented or certainly delayed the current crunch of growing water demand and limited available supply.

An additional issue common to a number of Australian States is that rational resource planning processes are regularly corrupted to justify poorly planned projects being thrown up from the realm of populist politics. In Queensland, the State government has committed itself to building additional dams in the face of considerable opposition, despite the most recent large dam amply fulfilling numerous predictions that it would be an uneconomic and environmentally damaging white elephant[68.] With a looming shortage of rivers in which it is politically, environmentally or economically feasible to promise a dam, there is a danger that the promise first and justify later approach might extend to large desalination plants.

Perth: The thirstiest city embraces desalination

Western Australia has had prior experience of desalination, with a small 220 m3/day plant commissioned in 1995 to supply a substantial portion of the water supply needs of Rottnest Island off the capital city of Perth. The plant, now upgraded to produce 500 m3/day of freshwater from saline groundwaters, provides 70 percent of the island's water needs. Environmental recognition and awards have flowed from the coupling of a wind turbine to the desalination plant during the recent upgrade[69.]

Perth, however, has not been noted for the same careful approach to water management as Rottnest Island. High and poorly planned growth, a permanent reduction in rainfall partially related to climate change and a past reckless resort to groundwater exploitation when reservoir levels began to fall has been the background to an acceptance that Perth's water future will be highly expensive. Perth possibly enjoys the most favorable economic environment for large scale desalination – especially when desalination proposals are lined up against fanciful schemes to find Perth's future water from distant dams in the far north of the State. The State government in 2004 approved what is the largest desalination plant in the southern Hemisphere, a 45Gl per year (123,000 m3/day) desalination facility with the cost initially estimated at $350 million[.70] The plant, which started operating in late 2006 supplies 17 percent of Perth's water supply, and will draw its water from and return brine and other wastes to environmentally sensitive Cockburn Sound. Impacts on the area are to be monitored. In linking the plant's energy consumption to a new wind turbine "farm", the government also claimed that the plant would be the world's largest to be powered by renewable energy.[71]

As this report went to press, the WA government announced a second, similarly sized desalination plant would be built by 2011, to bring total desalinated water supplies to around a third of the Perth total. The plant was chosen as an alternative to the government's initially preferred option of exploiting new groundwater reserves, which had attracted opposition on environmental grounds. The plant was also planned to take renewable energy supplies. A private water desalination plant is also being proposed to provide water to the Goldfields area of the State; if it goes ahead, this will reduce some of the pressure on water supplies to Perth.

Water conservation and efficiency measures are included in Perth's water future planning, but there are many avenues that could be exploited at much lower cost than desalination. For instance, residential developers and builders are currently encouraged rather than required to meet water and energy efficiency standards.

Can desalination help not hinder Australian water management?

A recent federal study of water supply options for Australian cities notes that there is no one simple answer to the nation's current and looming water supply issues and that the best mix of options varies greatly in cost and yield from location to location. However desalination is regarded in the study as a potentially cost effective option in many areas, ranking behind the purchase of irrigation waters from farmers, demand management, stormwater re-use and tapping into groundwater reserves. "Voluntary water conservation is often the most affordable, environmentally sensitive option available to urban water users," the study notes.

Interestingly, the study appears to rule out desalination as a major option for fast growing SE Qld on environmental grounds, largely because the location of the largest population centres would call for waste brine to be discharged into the largely enclosed waters of Moreton Bay. Otherwise, it finds that "careful attention is required to minimise impacts on the marine environment" but "there are generally technical solutions and this is largely a question of cost".

In some limited cases in Australia desalination may provide the best option from the triple bottom line perspective of sustainability. Unfortunately however, the growing financial feasibility of large scale desalination has helped support the continuation of the supply side dominated culture of water management in Australia. The question remains where to find the next large water source to meet growing water demand thus usurping the more basic question of how to best -- and most sustainably -- meet our water needs.

Beyond the current vogue for seawater desalination, there could well be a significant future for desalination related technologies in Australia in addressing land degradation and water recycling issues. The nation has significant salinity problems in groundwaters and some rivers. There are also relatively low levels of urban water recycling. Although public acceptance of recycled water is currently low, Australian cities will not forever be able to maintain a largely one way flow from dam to sea.

The risk remains that the wealthy Australian governments will continue to choose the politically easier option of new major desalination plants to meet growing water demands, before pursuing all of the potential available from implementing the less popular, but more sustainable options of greater demand management, water efficiency, and water recycling. More fundamentally, major desalination plants, like long distance water pipeline proposals, are now being used to avoid creating and implementing water and resource planning policies that acknowledge and respect the ecological constraints of catchments and regions. It remains to be seen whether desalination plants will in the long term contribute to moving towards a more sustainable water management regimes in Australia, or instead be used to prop-up existing sub-optimal (from a sustainability perspective) water management regimes that in fact need further reform.

Bottled folly

"Desalination - which the Premier, Bob Carr, once memorably dismissed as "bottled electricity" - is the most expensive and least environmentally sound solution to Sydney's water problem. The plant, once built, will supply 500 megalitres a day - a third of the city's water - but will use the equivalent of two-thirds of the output of one medium-sized coal-fired power station to do it. Those who see something of an anomaly in burning more coal to supplement water supplies which coal-induced climate change has caused to dry up can relax, Mr Carr says: the extra power will be generated by gas-fired power stations (producing fewer greenhouse emissions) or the emissions will be offset with carbon trading credits. It will, of course, cost more that way, and the vast amounts of electricity involved will have to be brought from distant power stations at further expense. This costly process should have been the Government's last resort in its search for ways to supplement Sydney's water supply. Instead, it looks like its first and only option, apart from prayers for rain.

Editorial, Sydney Morning Herald, July 12, 2005

Desalination as distraction

All of the areas where seawater desalination is rapidly assuming a more prominent water supply role had more cost effective and less potentially environmentally damaging alternatives available. This is particularly true of demand management, water conservation and water efficiency measures, where many of even the more advanced economies such as Australia do not uniformly require easily achievable water and energy efficiency standards in new buildings.

The extent to which a furore in favour of desalination is associated with unsustainable urban development, excess water intensive tourism development for arid areas, and unsustainable arid area export agriculture is also disturbing. Many of these relatively dry or drying areas have high levels of water consumption. Many of the areas where there is most intensive desalination activity also have a history of damaging or degrading natural water resources, particularly groundwater. What such societies need is a new attitude to water not a new water supply.

It is in this sense that desalination, which fits a familiar supply paradigm, caters to the edifice complex of institutions and politicians, and offers up opportunities of a new stream of contracts to the infrastructure industry, is essentially a distraction to the need to use all water wisely for the maintenance of both human societies and the natural systems on which they depend.

The World Bank, in conducting a study of desalination in Asia, the Middle East and North Africa, sounded a strong and similar note of caution about desalination.

"A key conclusion of the study is that desalination alone cannot deliver the promise of improved water supply. The ability to make the best use of desalination is subject to a series of wider water sector related conditions. In some countries weak water utilities, politically determined low water tariffs, high water losses and poor sector policies mean that desalinated water, just like any other new source of bulk water, may not be used wisely or that desalination plants are at risk of falling into disrepair. Under these conditions, there is a risk that substantial amounts of money are used inefficiently, and that desalination cannot alleviate water scarcity nor contribute to the achievement of the MDGs. It may be preferable not to engage in desalination on a large scale unless the underlying weaknesses of the water sector are seriously addressed. A programme to address these weaknesses should include a reduction of non-revenue water; appropriate cost recovery; limited use of targeted subsidies; sound investment planning; integrated water resources management; proper environmental impact assessments; and capacity building in desalination as well as in water resources management and utility management. **In any case, desalination should remain the last resort, and should only be applied after cheaper alternatives in terms of supply and demand management have carefully been considered.** *(emphasis added)*

A second conclusion is that the private sector can play a useful and important role in funding and operating desalination plants, but only if the above conditions are met. If these conditions are absent, there is a risk that excessive investments in desalination become a drain to the national budget, either directly under public financing or indirectly through implicit or explicit guarantees under private financing."[72]

Making water – a basis for sound decisions

Beyond desalination

Seawater desalination has been pushed into particular prominence as a way of resolving looming water shortages in many areas of the world. Other options for the provision of industrially produced water, such as recycling water, are consequently receiving less than their due amount of attention.

Recent developments in membrane technologies mean that the machinery and processes for making water by removing contaminants are becoming increasingly similar. In fact, as cost is closely related to the proportion of contaminants in the feed water, using similar processes to recycle wastewaters will often be economically and is invariably environmentally preferable to removing the salt from seawater.

Manufactured water is a clear water supply option for most areas and will be a necessity in some such as islands, or the extensive areas of southern and southeast Asia and other places where drinking water supplies are now laced with dangerous contaminants such as arsenic. Membrane technologies can be deployed from a scale that varies from hand held units to plants with capacities currently edging up to production volumes of 500,000 m3 of water a day.

While the sea is clearly the greatest available volume of potential feedstock for water manufacturing, proceeding straight to a desalination plant excludes viable options for sustainable water use in the same way that proceeding straight to a new dam often did in the past and unfortunately still does at times.

Making economically and environmentally sound decisions on large scale projects

The world is currently witnessing an unprecedented and dramatic growth in the number of proposals for large scale desalination proposals. **It is of concern to WWF that there currently exists no consistent, viable framework for assessing when "making water" is justified on environmental, economic or social grounds.** WWF's position on large scale desalination plants is that:

Resource planning before infrastructure planning

Immense damage has been done and large and unnecessary social and economic costs have been incurred in the past through ad-hoc development of major water infrastructure. A key antidote to a recurring pattern of resources being damaged while the water needs of human and natural communities are unevenly or poorly met is integrated water resource planning and managment at the national, catchment and more local levels. WWF believes that the environment should be well conserved as the source of water for people and nature.

It should be noted that all governments committed at the 2002 World Summit on Sustainable Development to preparing national Integrated Water Resource Management (IWRM) plans to help deliver the 2015 Millenium Development Goals. Integrated water management planning at the catchment level is now well proved as a mechanism for providing for water needs and protecting environmental assets.

As large infrastructure proposals, proposals for large scale desalination plants need to flow from or at the very least be evaluated in the context of a relevant water resource management plan. The large proportion of plants that will desalinate seawater and impact on marine areas similarly need evaluation in the context of a relevant marine resource plan.

As well as indicating where desalination may augment water supplies, such IWRM planning may well point to areas where desalination technologies can be used to reduce stress on or repair natural water systems.

Towards an assessment process for large scale desalination plants

Individual projects need to be and in many jurisdictions are assessed in relation to planning schemes for particular sites. But this is not a sufficient level of assessment to cover whether water needs have been realistically assessed, that particular proposals are the least cost way of meeting needs and that new water supplies will not promote unsustainable land and resources use.

The pioneering work of the World Commission on Dams pointed the way to an assessment process for large scale water infrastructure projects generally. WWF believes that a compatible process could and should be established for large scale desalination projects. This to ensure that any proposed plant is needed and is the best option for meeting the identified water needs after open, comprehensive and equivalent consideration of the costs and impacts of all options.

WWF considers such a model process should include:

Considering desalination and in particular seawater desalination as an option

- only after integrated water resource management plans are in place at the catchment and local levels and these demonstrate a need to augment water supplies.
- for seawater desalination, only after relevant marine protection plans are in place
- only where robust land use planning schemes that give adequate weight to environmental constraints exist and are enforced. These may include provisions to manage demand through the exclusion of thirsty developments such as irrigated agriculture or golf courses from water scarce districts.
- only after all no regrets conservation and efficiency measures have already been undertaken or allowed for in the assessment of water needs in the proposed area of supply. Implementation plans backed by adequate resourcing should exist for medium and longer term water conservation and efficiency measures.
- only where water, including agricultural water, is appropriately priced to reflect the full costs of supply. Where social reasons exist for reducing the real cost of water, the subsidies should be directed specifically to the target group, should be transparent and should not be applied to the water price.
- only where the capital expenditure devoted to desalination plants could not be more productively or cost-effectively be devoted to:
    - demand management as an alternative to additional supply
    - using related technologies to recycle water.
    - using related technologies to treat "impaired water" resulting from prior poor environmental practice
    - restoring the functioning of damaged natural water supply systems

Minimising the environmental impact of large scale desalination plants

Desalination infrastructure should proceed only where plants are sited, constructed and operated to minimise adverse environmental impacts. The major direct impacts are associated with the frequent requirement to site plants in sensitive coastal areas already subject to pressure from urbanisation, their high levels of energy demand, the design and operation of intake and outflow structures and effluent issues with concentrated brines, biocides and chemicals used in cleaning and defouling and corrosion byproducts. Where possible:

- Seawater desalination plants should not be sited in areas where intake or outlet pipes would open into or traverse sensitive marine or coastal environments.
- Intakes should be screened to the maximum possible extent with subsurface or beach wells being a preferable technology to open ocean intakes. Care needs to be exercised however that no damage is inflicted on coastal aquifers.
- "Zero spill" solutions should be considered the preferable way of treating wastes. Reducing brines to solid or minimal volume form with safe disposal options including former salt mines would minimise a major concern with desalination. In some cases, such wastes would be valuable inputs for the chemical industry. Research into more efficiently and economically concentrating wastes should be a priority.
- Where liquid disposal of concentrated brines is required this should involve adequate dilution, mixing and dispersal, should be restricted to areas of low biological sensitivity and should be subject to adequate monitoring regimes. Disposal at surface level is preferable to seabottom disposal.

Making "Bottled electricity" climate neutral

As a very energy intensive process whose product was once famously labelled "bottled electricity", desalination needs to be powered in such a way that it does not become a significant major new contributer to increasing emissions and climate change risk. Accordingly, plant promoters and approval agencies need to ensure that:

- Plants use the most energy efficient technologies
- Plants are developed in stages to take advantage of improving energy efficiency.
- With due regard to the need to site plants to protect sensitive areas, plants are sited to minimise the energy required to pump water to consumers
- Plants are powered through renewable energy, purchase green energy or use "Gold Standard" offsets for all their emissions

Coastal desalination plants particularly need to consider the implications of climate change, which is predicted to lead to sea level rises, more severe extreme coastal weather events and increased risks of saline intrusion into coastal aquifers.

Desalination and subsidies

In a long drawn out and continuing process, water is coming to be more appropriately valued in many jurisdictions and this is proving to be a powerful driver of water conservation initiatives and water use efficiency improvements. Desalinated water similarly needs to be appropriately priced in a way that is devoid of public subsidies and reflects the economic and environmental costs of production and supply.

This is clearly not the case in many if not most of the areas where desalination currently provides a significant proportion of the water supply. Where subsidies are thought necessary for social reasons, they should be in the form of transparent and direct payments to target groups rather than actions that impact on water prices. To do otherwise is to weaken incentives for water efficiency and conservation.

It should be noted that most current desalination technologies were substantially researched and developed at public expense, most significantly in the USA.

Downstream impacts

Much of the controversy surrounding desalination is less related to the process itself or the direct environmental impacts than it is to the development that will be enabled by the availability of new water supplies. In California, one key concern has been that add-on desalination is being used as a pretext to extend the life of "flow through" cooling systems used by coastal power stations which have been under regulatory pressure for their impacts on marine life and water quality.

The more general concern, apparent in all the areas studied by WWF, is that supplies of desalinated water will underpin unsustainable and environmentally damaging development. In naturally dry areas where groundwater has been depleted and contaminated supporting export horticulture, rapid real estate development and increasing the acreage of golf courses and resort pools, such concerns are easy to understand. Certainly some of the areas where desalination is being most enthusiastically proposed are also characterised by poor development controls, few or ineffective constraints on resource use and perverse subsidies that support environmentally damaging activity.

Clearly, there needs to be specific consideration as to whether the approval of large scale desalination plants will have undesirable flow-on effects. However, more durable remedies would come from pricing water correctly, removing subsidies (in particular on agricultural inputs and outputs) and establishing robust planning and development controls on resource and land use.

Further research on environmental impacts

Most of the desalination research effort is being devoted to improving desalination's technical performance. However, there is much that is not known on the cumulative environmental effects of large scale desalination, with particular attention needed to the cumulative impacts of intake structures on aquatic or marine life, the behaviour and effects of concentrated brine discharges, and the disposal or discharge effects of a considerable list of potential other pollutants including heat, corrosion byproducts and the biocides and chemicals used in regular flushing and periodic maintenance of filters.

Complicating the shortfalls in knowledge on general impacts of desalination processes are the highly site specific conditions of coastal or catchment topography, substrate and aquifer structures and currents and wave patterns that can amplify or modify impacts on aquatic, terrestrial or marine communities.

Water authorities and the growing desalination industry cannot have it both ways. They cannot assert a commitment to environmental responsibility without also committing substantially to research into potential long term cumulative impacts of an industry that is rapidly scaling up its presence in many areas of the world.

A note on measures

Jurisdictions considering desalination use a dizzying array of measures of volume. This report will use measures based on multiples of litres, as follows.

1Kl (Kilolitre) = 1000 litres = 1 cubic metre (m3)
1 Ml (Megalitre) = 1000 Kl = 1 million litres
1 Gl (Gigalitre) = 1000 Ml = 1 billion (thousand million) litres = 1 mcm (million cubic metres)

Conversions from other units of volume are

1 acre foot = 1.233 Ml= 1233 m3
1 million gallons (US) = 3785 m3

Practical Salinity Unit
Used to describe the concentration of dissolved salts in water, the UNESCO Practical Salinity Scale of 1978 (PSS78) defines salinity in terms of a conductivity ratio, so it is dimensionless. Salinity was formerly expressed in terms of parts per thousand (ppt) or by weight (parts per thousand or 0/00). That is, a salinity of 35 ppt meant 35 pounds of salt per 1,000 pounds of seawater. Open ocean salinity is generally in the range from 32 to 37.

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WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:

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Doc on Monterey Bay

A Blog by Marine Biologist and Fisheries Geneticist Carol Reeb

Menu

Marine Life

Inked In Black: The Value Of Market Squid In Monterey Bay

By Brady Latham and Carol Reeb

Market squid create one of California's most valuable fisheries. Due to its high quality as a fishery product, these squid are much sought-after by seafood traders around the world. In fact, California has become one of the world's biggest squid suppliers. A growing taste for squid in restaurants has created a demand that now exceeds supply. As a result, the value of squid is on the rise. Check out the video below on the value of market squid in Monterey Bay from the perspective of a scientist, a student, a restauranteur, and fisherman.

A Native California Species:

Several species of market squid inhabit the world's oceans. However, California's species (*Doryteuthis opalescens*) is native to the Pacific coast of North America. These squid range from Baja (Mexico) to southeastern Alaska. The biogeographic distribution of market squid is similar to Pacific salmon and steelhead trout, which are also native to California.

Market Squid Fishery Management:

Squid catch is landed at six California ports. The fishery is divided into northern and southern regions. The northern fishery is active from April – September while fishing operations in the south run from October to March.

> Monterey Bay and the Channel Islands form the centers of the northern and southern market squid fisheries in California. Today, these centers lie within two marine sanctuaries. Several Marine Protected Areas (MPAs) and Preserves have been established on traditional squid fishing grounds, as well. Commercial fishing in these areas is now limited or restricted. One benefit of MPAs and marine preserves is to create replenishment areas for market squid and other fishery species. In the case of Año Nuevo, which is an island known for its elephant seal and sea lion rookeries, restrictions help ensure adequate squid for the diets of these federally protected marine mammals.

California's Department of Fish and Wildlife (CDFW) is responsible for managing the market squid resource. Goals of the Market Squid Fishery Management Plan are:

1.) to ensure long-term sustainability and conservation of the resource, and

2.) develop a management framework that is responsive to environmental and socio-economic changes.

Market Squid Regulations:

– Seasonal catch limited to 118,000 tons (236 million pounds).

– Weekend closures (from noon Friday to noon Sunday).

– Squid monitoring (port sampling and logbooks).

– Limited entry permits (In 2012, 71 purse seiners, 34 light boats, and 41 brail vessels were permitted. Of these, 66 purse seiners and 26 brail vessels actually landed squid).

In recent years, a tremendous abundance of market squid has forced the fishing season to close early because the catch limit was met (see San Francisco Chronicle story).

Scientific Uncertainties:

Fluctuations in squid abundance are poorly understood and impossible to predict. Another problem is that scientists have no idea how big squid populations are either. Such gaps of knowledge make fishery management difficult. Nonetheless, we now know ocean temperature plays an important role in squid abundance. One day, we may be able to predict good and bad years for squid fishing by learning to forecast ocean conditions, much like we do the weather. In the meantime, much research still needs to be done.

Squid As Food:

Phil's Seafood Market, Moss Landing, CA.
Excellent seafood dishes, including Cioppino.

In restaurants, squid are commonly referred to by their Italian name, "calamari". They provide a low fat, high protein seafood that is rated by Monterey Bay Aquarium's Seafood Watch program as a GOOD ALTERNATIVE choice. One piece of fried calamari has about 1.5g of protein. According to Phil's Fish Market owner, Phil DiGirolamo, squid from Monterey Bay does not shrink in the pan and maintains a unique flavor and texture that is unlike squid imported from elsewhere. This is one reason why locally caught squid are preferred in Monterey area restaurants.

In addition to humans, many ocean species depend on squid for food. Aside from fish, birds, and marine mammals, various species of crabs, shrimp, octopi, and sea stars comprise a community of scavengers that feast on post-spawning squid. This fascinating YouTube video, Night of the Cephs, illustrates the importance of market squid to the benthic marine community.

Potential Threats to Market Squid:

1.) Climate change and its impact on ocean temperatures. Warming temperatures could be problematic for squid.

2.) Expansion of the much larger Humbolt squid from the south with warming coastal waters. Humbolt squid are voracious predators and enjoy the taste of *Doryteuthis* species.

3.) Hypoxia caused by upwelling events that draw cold, low-oxygen water from the deep sea onto the shelf where it can cause large-scale fish die-offs.

4.) Coastal pollution, especially in proximity of squid nurseries. Recent proposals to develop seawater desalination facilities along California's coast could create dense plumes of brine that have the potential to sink and settle overtop the vast white carpets of egg capsules on the seafloor, if not properly mitigated. No one knows how brine will impact developing squid embryos or the many other species comprising marine benthic communities.

Squid Facts:

- **Market Squid's life span is typically 8-9 months.**
- **A single female produces approximately 3,488 eggs.**
- **Squid fishing began in 1863 by Chinese fishermen on Monterey Bay. Torches were used to attract squid at night from small skiffs.**
- **Today, many squid fishers are the descendants of Italian fishermen. Italians introduced lampara net technology in the early 1900's.**
- **From 1916 – 1923, annual squid catch averaged less than 2 million pounds.**
- **Before 1961, the majority of squid were harvested from Monterey Bay.**
- **Prior to 1998, California's market squid fishery was an open fishery with few regulations.**

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Additional Readings:

California Wetfish Producers Association

California Dept. of Fish and Wildlife: Market Squid

Calamari Time! California oceans teeming with squid

Squid Squabble Surface in California

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5 Apr 12

Dear Ms. Jensen, State Water Board Members, and Staff,

Policies developed under California's Ocean Plan (§ 13170.2) and Enclosed Bays and Estuaries Plan (§ 13391) were specifically meant to prevent water quality degradation and protect beneficial uses of said waters for the State and its people. Current efforts to update both Plans by 2013 are commendable and extremely important. In recent years, interest in desalination as an alternative water supply for growing municipalities has rapidly gained momentum. Meanwhile, data needed to develop science-based policies specific to our State is sorely lacking. This leaves you and the Board with the difficult task of writing policies that avoids elements of assumption. While it is hoped policy amendments can balance the interests of all stakeholders, I would ask that it be precautionary in nature for now, favoring the indisputable language contained in the two Plans; specifically, that water quality degradation will be prevented and that beneficial uses will be protected. I would also ask the Board to include ways to fund the critical science necessary to fill the data gaps in order to update these two Plans in the next triennial review.

Desalination is not a cheap water supply compared to the many other alternatives of a diversified water portfolio. Energetically, the process of reverse osmosis (RO) will require significantly more electricity than diversions from local rivers or aquifers. The saltier the feedwater, the more electricity RO consumes. Since most electricity comes from fossil fuels, this leads to greenhouse gas concerns. For communities on the Central Coast or in Northern California, energy costs and CO_2 emissions for water delivery have been historically low. Only in southern California will the energy and CO_2 for desalination be comparable to current values obtained from importing water hundreds of miles overland via sophisticated networks of dams, pumps, and pipes. Board members and staff should know that each year, a quarter of the CO_2 emitted into the atmosphere is absorbed by the sea. This has been linked to the alteration of ocean water quality by the lowering of pH. Continued acidification is expected to affect plankton abundance and food webs in the future.

As a marine scientist involved in fisheries research, I consider brine discharged from desalination facilities to be the most immediate threat to marine/estuarine life. Although many have argued brine is simply salt, and the sea (or bay) is simply too big for it to have an effect, the fact is, brine is denser than its ambient source water and will therefore sink to the bottom if not properly diluted (an exception to this would be a less dense wastewater brine discharged into a saltier ocean). A density just slightly above ambient will enable a brine to sink. On the bottom, brine can roll across large areas; it can fill in depressions or accumulate in canyons and remain relatively unmixed through time. Dozens of ancient brine lakes are known to litter the seafloor around the world. These contain a limited assemblage of marine life, typically tiny crustaceans and microbes that survived the high salinities and low oxygen levels. Some brine pools are thousands of years old and may have been formed by receding seas during the last Ice Age, which then covered over once sea levels rose. With this, we know what a worse-case scenario could be if brine is not properly mitigated.

Desalination brine can contain caustic chemicals, such as those used to clean pipes and remove fouling organisms in the plant, or chlorine used to eliminate bacteria. More importantly, siting plants near any of California's "impaired" waters and drawing from them could allow pollutants present in low amounts to be concentrated to dangerous levels in the brine. If this brine is not properly diluted, it will effectively anchor a concentrated cloud of toxins to the seafloor, potentially harming benthic communities in unanticipated ways. As an example, plans to build a desalination facility on Suisun Bay (http://www.regionaldesal.com/documents.html) must anticipate the presence of pesticides, selenium, mercury, and other chemicals in the feedwater (http://www.epa.gov/region9/water/watershed/sfbay-delta/index.html#pollutant). I do not mean to specifically call this project out, but it does serve as a good case-study when considering important concerns to mitigate.

Recovery efficiencies of desalinated water projected for Suisun Bay's desalination plant range from 50% during the summer months (saltier water) up to 79% (during the wet season when water contains less salt). While the higher recovery rate greatly reduces energy cost, concentrated salts and ambient pollutants could be up to five times greater than the Bay's natural waters. It remains unknown how well native populations will tolerate an exposure of concentrated salt and pollutants, especially over the long term. During the 8 December 2011 meeting at SCCWRP, a point was made that acute brine exposure studies currently underway are not considering synergistic effects of ambient pollutants on test species. This should be addressed with research.

Brine has its greatest impact on young, developing life stages living on the seafloor. Osmoregulatory stress on rapidly growing embryos, for example, can divert energy resources away from cell growth leaving offspring weak or undeveloped. California's productive market squid fishery is one species in line of brine discharge, especially in Monterey Bay and Southern California. Squid use sandy seafloors to attach egg capsules and incubate developing embryos.

Detecting environmental impacts of brine may take many years to observe; especially if we only monitor species we have an interest in protecting. For example, Suisun Bay is home to several protected fish species. Recently, a long-term restoration project (Delta Plan) has been created to aid in their recovery. Current brine toxicity testing relies on the US EPA's approved list of species and for estuaries and that list approves the mysid shrimp, *Americamysis bahia*. Unfortunately, this species is native to the Atlantic coast and has a salinity tolerance two times higher than native mysids in Suisun Bay. Native mysids are known to be critical to the diets of young-of-year fish, including steelhead trout and green sturgeon. My concern is that thresholds of brine tolerance based on unrepresentative species could lead to the depletion of a critical food source and possibly the demise of a protected species, despite restoration efforts.
See: (http://swr.nmfs.noaa.gov/hcd/HCD_webContent/nocal/Report.pdf)

Monterey Bay and much of coastal California experience Harmful Algae Blooms (HABs or red tide) which sometimes contain powerful toxins (Caron et al. 2010. Water Research

44:385-416). I am concerned these toxins would be elevated in the brine then discharged back into the sea, especially if direct seawater intake is used. Although benthic invertebrates seem tolerant to algae toxins (at least for ambient concentrations), there remains the risk that they could make their way up the food chain, possibly contaminating seafood species and closing fisheries. Marine mammals may fall ill, as could anything else exposed to the brine. Fortunately, marine scientists are developing an HAB monitoring system in California to warn the public of blooms. Nonetheless, my concerns must be expressed here to ensure steps will be taken to prevent toxin-tainted brine from being discharged in large volumes from desalination plants.

Climate change and eutrophication of coastal waters have been linked to increasing HABS (http://www.cop.noaa.gov/stressors/extremeevents/hab/current/CC_habs.aspx). It is acknowledged that HABs are a desalination facility's Achilles heel. In the Middle East, large blooms can clog a plant and shut it down for months, sending water prices soaring. Underestimating HABs in a plant's pre-filtration design might make desalination unreliable.

Brine can restrict oxygen exchange and cause benthic communities to go hypoxic (reduced oxygen levels). Hypoxia-induced "Dead Zones" are another emerging concern for coastal oceans, especially on the west coast of North America. A continuously discharged brine spreading along the bottom could travel for miles, as has been shown in Spain with field monitoring (Fernández-Torquemada et al. 2009. Desalination and Water Treatment 5: 137–145). Benthic communities beneath this layer run the risk of hypoxia. Surprisingly, most Environmental Impact Reports (EIRs) only model brine the first few seconds after discharge. Thus these required environmental documents for permitting appear to miss the bigger picture of brine impact over time.

Along California's coast there may be areas where circulation patterns allow brine to accumulate, as has happened in some regions of the Arabian Gulf. Modeling the spread of negatively buoyant plumes on the seafloor will be complicated and complex, but multi-year simulations and analysis should be encouraged, if not mandated. Ideally, such oceanographic models could further assess site location. By having an idea of how brine behaves in receiving waters, marine biologists could then assemble a list of vulnerable species and critical habitats from which a plant designer might consider changing a particular outfall plan or relocating a pipe.

For the moment, high velocity jet discharges from pressurized pipes with a 60-90 degree upward angle is preferred in Spain and Australia. But in shallow Suisun Bay, this would not be possible. Mixing brine with wastewater was once considered a viable option. However, wastewater is 99% freshwater and its use in future recycled water projects will allow RO purification to be achieved with 1/3 the energy compared to brackish water or seawater desalting. Real-time monitoring technologies now in development promise to make wastewater a valuable, directly-potable resource in the future. Therefore wastewater dilution should probably not be considered as reliable mitigation for brine.

Finally, plant size must be scrutinized. Often EIRs base water need on past production levels averaged over years or decades when there was less incentive by the public to conserve. As water prices rise in the coming years, I suspect use per capita will drop. On the Monterey Peninsula, water use has dropped by 30% since the late 1980's despite a larger population. This is due to better conservation/efficiency attributed to WaterWise landscapes, low-flow appliances, and a response by customers to the recent, steeply tiered water rates imposed to encourage compliance under CDO-95-10 (State Order that limits water diversions from the Carmel River). In Monterey, one acre foot can serve four homes (Monterey Peninsula Water Management District, http://www.mpwmd.dst.ca.us/) while in southern California, it provides for only two. Thus I will hope that facility size, as well as the number of plants constructed in an enclosed or semi-enclosed basin (like Suisun or Monterey Bay), can be kept to a minimum until we have a better idea of how to mitigate the brine.

It has been noted several times by scientists who have published on desalination (e.g. National Academy of Sciences, 2008; Elimelech and Phillip, 2011, Science, 33:712-717) that we know little about the long term cumulative impacts of brine on the marine (or estuarine) environment. Filling gaps in the science is essential for successful desalination in the State. Fortunately, brine is easily monitored with simple instruments. Linking into California's world-class ocean observing and coastal monitoring systems will allow third party oversight as wells as the collection of missing data that could one day lead to better brine mitigation. However, funding will be required. I personally believe companies, agencies, and consumers of desalinated water must contribute to the cost of monitoring for the sake of technology advancements in the future. At the same time, incentives should be given to water agencies or industries that devise ways to better manage brine. These ways might include reuse and recovery. Brine contains valuable salts, minerals, metals, and energy (salinity gradients can be harnessed as batteries to produce electricity). Like wastewater, we might one day consider brine too valuable to simply throw away.

Sincerely,

Carol Reeb, Ph.D.

The views expressed here are not representative of Hopkins Marine Station or Stanford University.

Impacts of desalination plant discharges on the marine environment: A critical review of published studies

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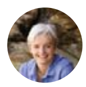

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Review

Impacts of desalination plant discharges on the marine environment: A critical review of published studies

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Desalination of seawater is an increasingly common means by which nations satisfy demand for water. Desalination has a long history in the Middle East and Mediterranean, but expanding capacities can be found in the United States, Europe and Australia. There is therefore increasing global interest in understanding the environmental impacts of desalination plants and their discharges on the marine environment. Here we review environmental, ecological and toxicological research in this arena including monitoring and assessment of water quality and ecological attributes in receiving environments. The greatest environmental and ecological impacts have occurred around older multi-stage flash (MSF) plants discharging to water bodies with little flushing. These discharge scenarios can lead to substantial increases in salinity and temperature, and the accumulation of metals, hydrocarbons and toxic anti-fouling compounds in receiving waters. Experiments in the field and laboratory clearly demonstrate the potential for acute and chronic toxicity, and small-scale alterations to community structure following exposures to environmentally realistic concentrations of desalination brines. A clear consensus across many of the reviewed articles is that discharge site selection is the primary factor that determines the extent of ecological impacts of desalination plants. Ecological monitoring studies have found variable effects ranging from no significant impacts to benthic communities, through to widespread alterations to community structure in seagrass, coral reef and soft-sediment ecosystems when discharges are released to poorly flushed environments. In most other cases environmental effects appear to be limited to within 10 s of meters of outfalls. It must be noted that a large proportion of the published work is descriptive and provides little quantitative data that we could assess independently. Many of the monitoring studies lacked sufficient detail with respect to study design and statistical analyses, making conclusive interpretation of results difficult. It is clear that greater clarity and improved methodologies are required in the assessment of the ecological impacts of desalination plants. It is imperative to employ Before–After, Control-Impact monitoring designs with adequate replication, and multiple independent reference locations to assess potential impacts adequately.

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Contents

1. Introduction

Global population growth and increasing consumption continue to place ever-increasing pressure upon natural resources. One resource under particularly intense pressure and especially vulnerable to the effects of climate change is the supply of potable domestic water. As a result many nations are turning to the desalination of seawater to complement other sources of water supply.

Recent estimates suggest that up to 25 million m^3 of desalinated water is produced daily around the world (Lattemann and Höpner, 2008). Nations in the Middle East were the first to adopt and depend upon large-scale desalination (particularly the United Arab Emirates, Kuwait and Saudi Arabia) due to the limited sources of potable water in these arid areas and the availability of cheap energy. Presently, almost half of the world's desalinated water is produced in this region (Lattemann and Höpner, 2008). Many factors are contributing to the expansion of desalination capacities in new regions of the globe. Rapid population growth, anticipated changes to precipitation patterns brought by climate change, and technological improvements in energy requirements have meant that many nations with marginal water supplies are also turning to desalination as an additional source of potable water. Expanding desalination capacities can be found in the United States, Europe, China and Australia (Lattemann and Höpner, 2008; Tulharam and Ilahee, 2007). In California alone, it has been projected that up to 20 new desalination projects with a combined capacity of 2 million m^3/d of desalinated water will be constructed by 2030 (Lattemann and Höpner, 2008). Similarly, major desalination projects are underway in multiple Australian cities including Sydney, the Gold Coast region of Queensland, Melbourne, Adelaide and Perth (Cannesson et al., 2009; Christie and Bonnelye, 2009; Port et al., 2009; Trousdale and Henderson, 2009). Thus, it is clear that desalination has become a globally important method for delivering potable water to large cities and industry.

Desalination plants extract large volumes of seawater and discharge hypersaline brine back into the marine environment. The urgent need for water in many parts of the world has meant that historically, marine environmental issues associated with desalination have been considered secondary concerns (Safrai and Zask, 2008). Despite this, it is widely suggested that desalination plants have strong potential to detrimentally impact both physicochemical and ecological attributes of receiving marine environments (Winters et al., 1979; Miri and Chouikhi, 2005; Maugin and Corsin, 2005). Considering the widespread use of desalination it is essential to review and synthesize research that has examined the environmental and ecological effects of desalination plants on marine ecosystems. The focal point for concern has been the potential impact of hypersaline discharges (hereafter referred to as 'brine') upon the salinity of seawater, and resultant effects to marine communities around discharge outlets. However, concern also exists regarding the use and release of toxic antifoulants and anti-scalants to maintain plant infrastructure (Ketsetzi et al., 2008) and possible thermal stress associated with the release of heated effluent from some systems (Bath et al., 2004; Morton et al., 1996). Whilst studies have identified several potential mechanisms by which desalination plants may impact upon marine ecosystems (Lattemann and Höpner, 2008; Sadhwani et al., 2005; Tsiourtis, 2001a) many of the published review articles and case studies cite little or no peer-reviewed literature, and present little or no empirical data to support statements regarding the environmental effects of desalination (Areiqat and Mohamed, 2005; Baalousha, 2006; Mabrook, 1994). Hence, it is unclear whether the potential impacts of desalination plants are assumed or have been determined through rigorous ecological research.

We have conducted a systematic literature review of peer-reviewed publications to critically examine evidence of environmental effects from the discharge of effluents from desalination plants. We consider the effects of plant discharges upon the physicochemical and ecological attributes of recipient marine ecosystems. This review summarises information obtained from laboratory and field-based experiments, and ecological monitoring studies.

2. Methods

We took a systematic approach to the literature review using several search terms in all possible combinations to identify scientific literature related to environmental impacts of desalination plants. Search terms were: 'desal*', 'brine', 'enviro*', 'ecol*' and 'marine'. Three databases were searched: ScienceDirect® (1994 to present, some journals also have backfile indexing), Web of Science® (with some journals indexed from, 1900 to present) and Biological Abstracts® (1969–2004). Abstracts of all the search results were read and papers that were concerned with desalination plant impacts on any aspect of the marine environment were included in the review. The reference lists of selected articles were also searched to incorporate articles not indexed in the three databases or works published prior to the range indexed in the three databases. From each article, we recorded the journal title, aspect of marine environment studied (e.g. salinity, organism abundance, diversity) and research approach utilised (e.g. monitoring, laboratory experiment, field experiment). We also recorded the capacity of the plant (in terms of plant discharge per day), the salinity and temperature of the plants effluent and any observed ecological or toxicological effects when this information was presented.

3. Results and discussion

The literature searches identified 62 research articles that were published in peer-reviewed journals and were concerned with the environmental and/or ecological effects of desalination plant discharges in receiving marine waters. Monitoring studies were the most common type of empirical research, comprising approximately one third of all articles identified. Of the remaining articles, 16% presented the results of modelling studies that were almost universally concerned with modelling brine plumes in receiving waters. Laboratory-based experiments and toxicity tests were relatively rare, comprising 8% of all research articles. Only three papers were identified that included manipulative ecological field experiments. By far the largest category was review, discussion and opinion pieces that comprised 43.5% of reviewed articles. While these types of articles were relatively common, the majority included little quantitative data and tended to discuss potential effects qualitatively or inductively.

3.1. *Physicochemical impacts of desalination plant discharges*

The vast majority of environmental research into the impacts of desalination plants has focused upon the influence of brines upon physicochemical attributes of receiving environments. In particular, research has focused on the impact of desalination discharges on salinity and temperature around outfalls, and the introduction of contaminants.

3.1.1. *Salinity*

The focus of much desalination research has been on the intensity and extent of brine plumes in receiving waters. Published research reveals variable effects of desalination plants on the salinity of receiving waters (Table 1). Observed effects range widely from plumes with elevated salinities extending over tens of meters (Gacia et al., 2007; Raventos et al., 2006; Sadhwani et al., 2005; Talavera and Ruiz, 2001), hundreds of meters (Abdul-Wahab, 2007; Chesher, 1971; Einav et al., 2002; Malfeito et al., 2005; Ruso et al., 2007), or in extreme cases, several kilometres (Fernández-Torquemeda et al., 2005) from desalination plant outfalls. The variation of these findings is likely due to a combination of the differing capacity of the plants, the diffuser designs, the hydrology of the environment (Höpner and Windelberg, 1996; Einav et al., 2002) and the sampling effort within the studies themselves (i.e. their power to detect changes which is dependent on the amount of sampling and sampling design).

In the majority of cases, however, the intensity of the plume appears to diminish rapidly and is usually no greater than 2 parts per thousand (ppt) above the background salinity within 20 m of the outlet (Table 1). Plumes that extended over hundreds of meters tended to be only slightly greater than background levels; usually less than 0.5 ppt at most (Table 1). It should be noted that most of these studies relate to desalination plants that discharge into shallow low-energy environments in the Mediterranean Sea (Table 1). As brine discharges are often denser than seawater of natural salinities, plumes tend to extend further along the seafloor than at the surface (Chesher, 1971; Cintrón et al., 1970; Gacia et al., 2007; Purnama et al., 2005). This is of biological importance and potentially contributes to greater exposure of benthic organisms to brine discharges, than pelagic and planktonic organisms. For example, brine discharges to seagrass meadows may be more apparent when porewaters are analysed, rather than overlying waters (Gacia et al., 2007) and organisms inhabiting depressions in hard and soft substrata may be differentially exposed. Seagrass have been exposed to vertically stratified salinities (exposing either the entire plant, or only the basal leaves) under laboratory conditions to simulate this brine exposure scenario (Sánchez-Lizaso et al., 2008). Results showed significant effects to seagrass survival regardless of exposure method.

Mathematical models have been employed to predict the extent and intensity of brine discharge plumes in receiving waters and in the optimisation of outfall design. In areas of prevailing currents, models suggest that those currents tend to carry brine plumes further alongshore, than offshore (Shao and Law, 2009). The consequence is that the coastal fringe is likely to be the most susceptible to deleterious effects of desalination brines. Some models suggest that increases in salinity may vary around discharges over tidal cycles, with the greatest impacts seen on incoming tides, which act to concentrate brine around outfalls (Purnama and Al-Barwani, 2006). Thus, exposures to brines are likely to be both spatially and temporally variable in

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Table 1 – Extent and intensity of brine plumes in receiving waters surrounding desalination plant discharge outlets.

Reference	Capacity (ML/d)	Discharge (ML/d)	Salinity of brine (ppt)	Location	Habitat	Plume extension and intensity
Abdul-Wahab, 2007	92.4	NR	37.3	Muscat, Oman	Soft sediments	Returned to background levels within approximately 100 m of outlet
Abdul-Wahab, 2007	191	NR	40.11	Muscat, Oman	Soft sediments	Appeared to return to background levels 980 m from outlet
Altayaran and Madany, 1992	106	288	51	Sitra Island, Bahrain	Soft sediments	Salinity of receiving water reach 51 ppt, relative to reference areas of 45 ppt, plume extended at least 160 m from discharge. Temperature also affected, discharged at 10–15° C above ambient, receiving water up to 7° C above ambient
Chesher, 1971	9.1	22	40–55	Florida, USA	Artificial hard substrata and soft sediments	0.5 ppt above background levels within 10–20 m of outlet. Nevertheless, slight elevation was maintained for 600 m within the harbour basin
Talavera and Ruiz, 2001	25	17	75.2	Canary Islands, Spain	Sub-tidal rocky reef	2 ppt above background on the seabed and 1 ppt on the surface within the 20 m of the outlet; similar to background levels at 100 m.
Einav et al., 2002	NR	NR	NR	Dhkelia, Cyprus	NR	Above background 100–200 m from outlet, occasionally as high as 60 ppt.
Fernández-Torquemeda et al., 2005	50	75	68	Alicante, Spain	Seagrass and soft sediments	0.5 ppt above ambient for up to 4 km from outlet along the seafloor
Malfeito et al., 2005	28	NR	44	Javea, Spain	Seagrass and soft sediments	Slightly above background up to 300 m from the outlet
Raventos et al., 2006	60	33	60[a]	Blanes, Spain	Seagrass and soft sediments	At background levels within 10 m of outlet. No apparent measurement or analysis of salinity
Ruso et al., 2007	50	65	68	Alicante, Spain	Soft sediments	2.6 ppt above ambient within 300 m[b] of outlet; 1 ppt within 600 m[b]; similar to background at 1300 m[b]
Safrai and Zask, 2008	274	600	42	Ashkelon, Israel	NR	Approximately 2 ppt above ambient within 400 m of outlet, <1 ppt above ambient within 4000 m of the outlet
Sadhwani et al., 2005	25	NR	75	Canary Islands, Spain	Soft sediments	75 ppt effluent diluted to 38 ppt within 20 m of outlet, no details given as to background salinity
Gacia et al., 2007	NR	2	60	Formentera, Balearic Islands, Spain	Seagrass and soft sediments	5.5 ppt above background 10 m from outlet; 2.5 ppt at 20 m; 1 ppt at 30 m; not measured any further than this

NR = not reported. [a] - g/L, [b] Inferred from figure, estimate only.

recipient systems with intensity of exposure varying over spatial scales of 10–100 s of meters, and a minimum temporal scale of hours.

3.1.2. *Temperature*

The desalination process of some plants also elevates temperature of the brine relative to background levels in receiving waters, although far fewer papers in the current review deal with the effects of desalination plants on temperature relative to salinity. Several authors have suggested that elevated temperatures in receiving waters may have played a significant role in the observed ecological effects of desalination plants (Mabrook, 1994; Miri and Chouikhi, 2005). Multi-stage flash (MSF) and other forms of thermal distillation tend to have the greatest impact on intake water temperature, and can release brines 10–15 °C warmer than oceanic intake waters (Hoepner, 1999; Lattemann and Höpner, 2008). Reverse osmosis processes are increasingly common and these tend to result in ambient temperature plumes (Dweiri and Badran, 2002).

As with studies into the effect of brines on salinity in receiving waters, findings have been variable with respect to thermal effects. For example, modelling and monitoring studies in Western Australia found a multi-purpose power and desalination plant discharge could increase the temperature of receiving waters within a 7 square kilometre area surrounding outfalls by 0.1–0.5 °C (Bath et al., 2004). Other studies have found minimal thermal impacts in the vicinity of outfalls despite the desalination process increasing the temperature of intake waters by up to 15 °C (Altayaran and Madany, 1992; Elhassadi, 2008). Typically, thermal impacts appear to be associated with MSF plants and generally dissipate quickly with temperatures diminishing in receiving waters to background levels within tens of meters of outfalls (Elhassadi, 2008; Winters et al., 1979). Again, the distribution and extent of thermal impacts is influenced by the location of the plant discharge, with brine discharges to enclosed water bodies more likely to result in measurable thermal effects than discharges to well-flushed environments.

3.1.3. Contaminants

The role of desalination plants as sources of potentially toxic contaminants is well established. In the Arabian Gulf, (an historical 'hotspot' of global desalination activities) it is estimated that between 11 and 20 million m^3 of desalinated water and brine effluent is produced every day (Hashim and Hajjaj, 2005; Lattemann and Höpner, 2008). In a synthesis of chemical discharge information from 21 plants in the Red Sea, it was estimated that 2708 kg chlorine, 36 kg copper and 9478 kg anti-scalants are released every day into the Red Sea alone through desalination activities (Hoepner and Lattemann, 2002). Similarly, monitoring of water quality surrounding a single Florida desalination plant during the late 1960s and early 1970s found up to 45 kg of copper to be discharged for each day of operation (Chesher, 1971). Copper concentrations in receiving waters were 5–10 times higher than ambient concentrations and were often present at levels exceeding toxicity thresholds for native species (Chesher, 1971).

Not surprisingly therefore, several studies describe substantial contamination of marine habitats around desalination outfalls. Waters and sediments around plant outlets may contain elevated concentrations of metals (Crockett, 1997), hydrocarbons (Saeed et al., 1999) and anti-foulants and anti-scalants used to clean reverse osmosis membranes and reduce fouling of the piping (Chesher, 1971; Miri and Chouikhi, 2005). In a review of desalination plant effluents from 28 different plants, as much as 60% exceeded the United States Environmental Protection Agency (USEPA) acute copper water quality criteria (Paquin et al., 2000). Much of the concern centres on the use of copper alloy condensers in plants, however, the authors noted that the lack of clean sampling techniques in earlier studies, and overly protective criteria, possibly led to an overestimation of water quality issues. Further support is provided by other authors who suggest that under optimal operational conditions, the likelihood of metals exceeding water quality criteria in effluents from plants using copper–nickel alloys is very low (Oldfield and Todd, 1996). Furthermore, while some contaminants such as anti-scalants and metals from plant infrastructure may be introduced to brines during the desalination process, brine components such as copper are also extracted from intake waters and concentrated in brines. Thus, at least a portion of metal load around desalination outfalls is due to extraction and concentration of naturally occurring metals in the intake waters. Regardless of source, the discharge of brines with high metal contents has the potential to impair biological communities and biomonitoring studies have found accumulation of metals in macroalgae, mussels (Romeril, 1977) and benthic sediments (Sadiq, 2002) around desalination plant outfalls.

3.2. Ecological impacts of desalination plant discharges

Our review found that a variety of approaches have been taken to determine the ecological impacts of desalination plant discharges in marine ecosystems. These include field-based monitoring, and laboratory and field experiments. The following discussion has also been summarised in Tables 2 and 3.

3.2.1. Field-based monitoring

Exposure to desalination discharges has been shown to lead to detectable ecological impacts in seagrass habitats, and to phytoplankton, invertebrate and fish communities in areas surrounding outlets. Fernández-Torquemeda et al., (2005) claim a reduction in echinoderm densities in seagrass meadows adjacent to brine discharge was attributable to desalination discharge, however details of the analytical model are not presented. Gacia et al. (2007) also found significant increases in leaf necrosis and decreased carbohydrate storage in leaf tissues in *Posidonia oceanica* meadows, which they attributed to both brine exposure and increases in nutrient availability. These impacts to seagrasses can occur following increases of only 1–2 ppt in salinity highlighting the potential sensitivity of these species to desalination brines (Sánchez-Lizaso et al., 2008). Brine discharges over soft bottom habitats may alter the structure and diversity of infaunal communities (Ruso et al., 2007, 2008). Research has found increased dominance of nematodes adjacent to brine discharges (Ruso et al., 2007), and reduced diversity and abundance of polychaetes up to 400 m from a discharge (Ruso et al., 2008). Benthic diatom communities may also be reduced in richness and abundance, as well as lower containing chlorophyll-*a* concentrations than in un-impacted areas (Crockett, 1997).

Massive losses of coral, plankton and fish in the Hurghada region of the Red Sea have been attributed to desalination discharges, although the data supporting this claim were not presented by the authors and the impacts must be considered anecdotal (Mabrook, 1994). Some research suggests that certain coral species may be relatively resilient to both sudden and prolonged increases in salinity, in the order of 10 ppt, or a 33% increase above ambient (Muthiga and Szmant, 1987). Impacts to planktonic communities may be minimised in areas of strong flow and tidal mixing. In habitats of this nature, ecological effects of brine discharges to plankton communities are generally limited to the point of discharge only (Azis et al., 2003). When discharges are released into embayments, they may have long residence times, leading to plankton die-off as a result of various factors including salinity stress, reduced dissolved oxygen levels, the production of hydrogen sulfide, or reductions in pH (Cintrón et al., 1970; Winters et al., 1979). Prolonged exposure to such conditions would presumably impair the colonisation and survival of benthic communities (Cintrón et al., 1970).

Extensive biological monitoring around a Florida desalination plant found a range of significant biological effects in receiving waters. Amongst a summary of findings, reductions in the abundance of plankton, sessile invertebrates (included serpulids, barnacles, bryozoans, sabellids, ascidians and oysters) and echinoderms were all attributed to the discharge

Table 2 – Summary of contaminants from desalination brines in marine ecosystems.

Reference	Location/ region	Matrix/species/ community	Summary of findings
Contaminant monitoring			
Hoepner and Lattemann, 2002	Red Sea (21 plants)	Discharge	Estimate that up to 2708 kg Cl, 36 kg Cu, 9478 kg anti-foulants released from desalination plants into the Red Sea each day
Crockett, 1997	McMurdo, Antarctica	Sediments	Found higher concentrations of copper, lead and zinc in sediments near a combined waste water-desalination plant outfall relative to control areas
Saeed et al., 1999	Kuwait	Seawater samples	Compared concentrations of hydrocarbons in waters around plant outlets and inlets. Found higher concentrations of many analytes around plant outlets
Chesher, 1971	Key West, Florida	Seawater samples	Copper concentrations in waters surrounding plants were five to ten times higher than background levels, and occasionally present at concentrations exceeding toxic thresholds to native organisms. Estimate that up to 45 kg of copper was discharged from the plant for each day of normal operation
Paquin et al., 2000	USA (28 plants)	Discharge	In a review of chemical data from 28 plants, up to 60% of samples exceeded water quality criteria for Cu at the time of collection. However, the authors state that a lack of clean techniques in earlier studies may have biased results, and that less conservative revised Cu criteria were not exceeded
Romeril, 1977	Jersey, England	Epibiota	Found greater accumulation of copper in algae and limpets around desalination plant compared to a reference location approximately 3 miles from the discharge
Sadiq, 2002	Ras Tanajib, Saudi Arabia	Sediments	Concentrations of Cd, Cu, Hg, Ni, P and Zn elevated in sediments within 100–250 m of outfall, concentrations decreased away from outfall out to 3 km

of desalination brines (Chesher, 1971). Many of the effects appeared to be related to the discharge of brines with excessive copper concentrations.

Some studies have not detected any effects of desalination plant discharges on seagrasses (Talavera and Ruiz, 2001) and macrobenthic organisms such as fish, crabs, echinoderms, molluscs and polychaete worms (Raventos et al., 2006). For example, Raventos et al. (2006) found no response of macrobenthic organisms to desalination discharge, in a region where the brine dissipated within 10 m of the outfall. In some cases, studies conclude that desalination plants have either substantial impacts (Mabrook, 1994), or negligible impacts (Tsiourtis, 2001b) upon the ecology of the receiving system but present no details of monitoring designs or supporting data.

As for salinity, the variation in the ecological effects observed in these studies is probably a combination of the differing intensities and frequencies of exposure to the saline plumes, the temperature of the released water, the environment in which it is being released (e.g. hydrology, temperature), the organisms inhabiting the environment and the studies themselves (i.e. the amount of sampling, appropriate sampling designs, etc.). In addition, environmental issues associated with older desalination plants have often been linked to excessive copper content of desalination brines (Chesher, 1971), an issue that is now largely avoidable with proper plant maintenance and operation (Oldfield and Todd, 1996). Few of the published studies have attempted to assess the spatial extent of the reported ecological effects through the use of nested monitoring programs, and many are vague with respect to sampling and statistical techniques applied, making conclusions difficult. For this reason, our summary of field monitoring results in Table 3 is limited to studies that have incorporated multiple reference locations into their study design. It is widely accepted that individual reference locations are insufficient as natural spatial variation may confound comparisons with the impact location (Underwood, 1994).

3.2.2. *Toxicological and laboratory-based evidence*

In addition to field-based monitoring studies, laboratory-based toxicity testing has been used to predict the effects of brines and brine constituents on aquatic organisms. These studies may take the form of single species tests (Dupavillon and Gillanders, 2009; Mandelli, 1975), multi-species screens (Iso et al., 1994), and tests on both lethal and sub-lethal endpoints (Iso et al., 1994; Mandelli, 1975).

Much of the experimental research has focused upon the effects of brine upon seagrass (*P. oceanica*) and associated fauna. Laboratory experiments have observed reduced growth, greater occurrence of necrotic lesions and premature senescence in seagrasses at salinities of approximately 39 ppt, which represents only a minor increase above ambient salinity in the study region (Sánchez-Lizaso et al., 2008). Salinities of 40–45 ppt appear to cause significant increases in the mortality of exposed plants, epifaunal mysids and echinoderms (Sánchez-Lizaso et al., 2008). Chesher (1971) exposed echinoderms, seagrass (*Thalassia testudinum*), and ascidians (*Ascidia nigra*) to diluted brines in laboratory experiments for 24–96 h. Ascidians were the most sensitive with 50% mortality following 96-h exposures to 5.8% brine dilutions. Echinoids showed similar levels of mortality across 96 h in 8.5% brine dilutions. Seagrass photosynthesis was reduced by 50% following 24-h exposures to 12% brine dilutions (Chesher, 1971). The results of these studies contrast somewhat with experiments conducted on seagrasses from naturally hypersaline environments. Growth and leaf production of seagrasses collected from Shark Bay, Western Australia (some sections of which may have salinities as high as 70 ppt), were greatest at salinities of 42.5 ppt (Walker and McComb, 1990). Senescence and mortality occurred at salinities between 50 and 65 ppt (Walker and McComb, 1990). Thus, it is not possible to provide a global salinity value that is protective of seagrass communities. However, laboratory research suggests that in the Mediterranean desalination brines influence salinity

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Table 3 – The ecological and toxicological effects of desalination brines in marine ecosystems

Reference	Location/ region	Matrix/species/community	Summary of findings
Biological monitoring[a]			
Fernández-Torquemeda et al., 2005	Alicante, Spain	Seagrass (*Posidonia oceanica*) and epifauna	Echinoderms disappeared from the impact location following commissioning of plant, and one of the controls also exposed to a lesser extent. Salinity adjacent to the outfall corresponded to that which was toxic to *Posidonia oceanica* in Sánchez-Lizaso et al., 2008, shoot division appeared lower at the exposed site
Chesher, 1971	Key West, Florida	Plankton, echinoids, ascidians and seagrass	Found reduced abundance of plankton in water surrounding discharge, as well as reduced abundances of hard substrate epifauna (serpulids, barnacles, bryozoans, sabellids, ascidians, and oysters) and echinoderms in exposed areas. The majority of effects were attributed to the copper content of the brine
Gacia et al., 2007	Formentera, Spain	Seagrass (*Posidonia oceanica*)	Found increased leaf necrosis, greater epiphyte cover and decreased carbohydrate storage in seagrass tissues in meadows exposed to brines for more than 6 years, relative to control locations
Crockett, 1997	McMurdo, Antarctica	Sea ice chlorophyll	Sea ice samples taken from vicinity of a mixed brine/waste water outfall contained lower chlorophyll-*a* concentrations than sea ice samples from control locations
Ruso et al., 2007	Alicante, Spain	Sediment infauna	Infaunal communities close to a desalination plant outfall were dominated by nematodes (up to 98%). Polychaetes, molluscs and crustaceans became more abundant in infaunal communities with increasing distance from the discharge
Ruso et al. 2008	Alicante, Spain	Sediment infauna	Monitoring of transects adjacent to a discharge and 400 m north and south of the discharge found reduced abundance and diversity of polychaete assemblages directly adjacent to outfall. Polychaete families showed variable sensitivities with Ampharetidae being the most sensitive, and Paraonidae the least sensitive
Raventos et al., 2006	Blanes, Spain	Sediment infauna	Monitoring found no effects of brine discharge on community structure or on the abundance of fish and invertebrates in sediment habitats
Sánchez-Lizaso et al., 2008	Alicante, Spain	Seagrass (*Posidonia oceanica*)	Seagrass meadows adjacent to plant discharge experience 1–2 ppt increases in ambient salinity, as well as increased nutrients. Exposed meadows had increased necrotic marks and lower epifaunal abundances (see also laboratory and field experiments)
Laboratory experiments			
Dupavillon and Gillanders, 2009	Spencer Gulf, SA	Cuttlefish (*Sepia apama*)	Exposed cuttlefish embryos until hatch date to a range of salinities, and a control of 39 ppt. Size and weight of hatchlings was reduced at salinities above 42 ppt. Fewer survived to term at 45 ppt, and survivors showed reduced ink production and mobility. No individuals survived to term at salinities greater than 50 ppt
Chesher, 1971	Key West, Florida	Echinoids, ascidians and seagrass	Organisms were exposed to dilutions of brines for 24–96 h. Ascidians were the most sensitive, with 50% mortality on exposure to 5.8% effluent. Echinoids showed reduced survival on exposure to 8.5% dilutions. Seagrass photosynthesis was inhibited following exposure to 12% brines for 24 h
Mandelli, 1975	Texas, US	Oyster (*Crassostrea virginica*)	Conducted 60-d exposures of juvenile and adult oysters to brines with salinities of 45–55 ppt. Survival and reproduction were affected, with toxic effects attributed primarily to the copper content of brine. Pathogenic fungus infection also increased on exposure to brines
Iso et al., 1994	NA	Fish (*Pagrus major*, *Pleuronectes yokohamae*) and clam (*Tapes philippinarum*)	Laboratory exposures to a range of salinities found no effects at salinities below 50 ppt. Juvenile *Pagrus major* exposed to salinities of 70 ppt died within 1 h, with some mortality at 50 ppt. Larval *Pleuronectes yokohamae* died at salinities of 55 ppt after approximately 6-d of exposure. Egg hatching was delayed at 60 ppt and completely inhibited at 70 ppt. Mortality of clams was noted at 60 ppt following 48-h exposures. Fish appeared to avoid all waters tested above control salinities
Latorre, 2005	Spain	Seagrass (*Posidonia oceanica*)	Growth of seagrass in the laboratory was significantly lower on exposure to salinities of 43 ppt (50% lower) and 40 ppt (14% lower) compared to control salinities of 38 ppt
Sánchez-Lizaso et al., 2008	Alicante, Spain	Seagrass (*Posidonia oceanica*)	Fifteen-day laboratory exposures to a range of salinities showed significant sub-lethal effects of salinities 1–2 ppt above ambient upon seagrass growth and survival (see also monitoring and field experimental results)

(*continued on next page*)

Table 3 (*continued*)

Reference	Location/ region	Matrix/species/community	Summary of findings
Walker and McComb, 1990	Shark Bay, WA	Seagrass (*Posidonia australis*)	Collected seagrass from a naturally hypersaline environment (Shark Bay, Western Australia) where salinity may reach 70 ppt. In laboratory exposures, seagrass had the greatest growth and production at 42.5 ppt, with increasing mortality and senescence at salinities of 50–65 ppt
Field experiments			
Chesher, 1971	Key West, Florida	Hard substrate epifauna	Echinoderms, ascidians, gorgonian corals, and stone crabs were transplanted to sites receiving effluents. Echinoderms were the most sensitive, dying within 2–3 d exposure to low concentrations of brines. Survival improved when copper emissions were reduced following plant maintenance
Latorre, 2005	Spain	Seagrass (*Posidonia oceanica*)	Small-scale simulations of brine discharge were conducted in the microcosms and in experimental field plots. Details of the methodology are not presented, by salinities of 50 ppt resulted in complete mortality of seagrass in 15-d. Salinities of 45 ppt lead to approximately 50% mortality
Sánchez-Lizaso et al., 2008	Alicante, Spain	Seagrass (*Posidonia oceanica*)	Seagrass were exposed to brines in the field for a period of three months. Exposures raised natural salinities of 37.7 ppt to 38.4–39.2 ppt in experimental plots. Exposed seagrass experienced poorer survivorship, and surviving plants had reduced shoot and leaf abundance

a Biological monitoring studies are limited to studies incorporating multiple reference locations.

sufficiently to impact upon the health and survival of seagrasses and associated invertebrate communities (Sánchez-Lizaso et al., 2008).

Salinities of 55, 60 and 70 ppt have been found to be acutely toxic to juvenile sea bream, clams and larval flounder, respectively (Iso et al., 1994). Behavioural avoidance was noted at salinities of 45 ppt (Iso et al., 1994). In 60-d exposures, desalination brines reduced the survival and impaired reproduction in the oyster *Crassostrea virginica* (Mandelli, 1975). These toxicological effects were primarily attributed to dissolved copper present in the desalination effluent. In addition to direct toxicological effects, the altered physicochemical characteristics of the brine appeared to enhance pathogenic fungus infection rates in the exposed oysters (Mandelli, 1975).

Recent experiments have shown desalination brines to be acutely toxic to developing cuttlefish embryos, attributable to both increased salinities, and trace metal concentrations in brines (Dupavillon and Gillanders, 2009). In laboratory exposures, fewer eggs of the giant Australian cuttlefish *Sepia apama* developed to term when exposed to brine effluent with salinities greater than 45 ppt. Surviving individuals at these concentrations displayed behavioural effects such as slow response to stimulation and reduced ink-jet defence responses (Dupavillon and Gillanders, 2009). In brines exceeding 45 ppt, mortality of exposed eggs was absolute (Dupavillon and Gillanders, 2009).

3.2.3. *Field-based experimentation*

Manipulative ecological experiments in the field are important complements to ecological studies. Manipulative experiments assist in establishing a causal relationship between the discharge of brines and observed ecological effects. However, only three studies utilised manipulative field experiments in the current review. In novel experiments, brine from a pilot desalination plant was pumped to experimental seagrass plots in the field for a period of three months (Latorre, 2005; Sánchez-Lizaso et al., 2008). During these exposures, salinities were elevated from control salinities of approximately 37.7 ppt, to 38.4–39.2 ppt. These slight but long-term (3 months) increases in salinity resulted in reduced survivorship of seagrass, and exposed patches showed poorer vitality as measured by shoot abundance, length and biomass, and presence of necrotic lesions. Monitoring of meadows adjacent to plant outfalls also found reduced shoot density, greater abundance of epiphytes and reduced abundance of epifauna (Latorre, 2005; Sánchez-Lizaso et al., 2008).

Additionally, Chesher (1971) describes the results of *in situ* bioassays whereby echinoderms ascidians, gorgonian corals and stone crabs were transplanted to sites and caged in areas receiving brine inputs. Echinoderms showed the greatest sensitivity and died within days of exposure to as little as 3% brines in seawater, but survival increased rapidly when corroded copper–nickel trays were replaced in the desalination plant (Chesher, 1971). For this reason, impaired survival was attributed to the copper content of the desalination brine.

3.3. *Impact minimisation*

Desalination technologies have evolved rapidly in recent decades. In a 1991 review, it was found that over 65% of desalination plants relied upon thermal distillation processes referred to as multi-stage flash (MSF), a process which yields high temperature brines, and greater atmospheric pollution (Al-Mutaz, 1991; Morton et al., 1996). Historically, MSF plants have been popular in the Middle East where rich fossil fuel deposits have meant cheap energy is available (Tulharam and Ilahee, 2007). In nations such as the United States and Australia, these methods are rapidly being replaced by membrane based methods of desalination such as reverse osmosis (RO) plants, which tend to have lesser thermal impacts, but produce saltier brines (Dweiri and Badran, 2002; Tulharam and Ilahee, 2007). Developing pressure exchange technologies may assist in reducing the salt content of RO brines (Campbell and Jones, 2005). By reducing recovery rates

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(i.e. reducing the amount of freshwater extracted from a given volume of seawater), RO plants may improve energy efficiency, produce less salty brines, and reduce the need for pretreatment of intake waters with chemicals (Campbell and Jones, 2005).

One mechanism to reduce potential environmental effects of brine is to dilute brine with power plant cooling waters (Einav and Lokiec, 2003). In many cases these plants are co-located and modelling suggests this would greatly limit the extent and magnitude of brine plumes in receiving waters (Einav and Lokiec, 2003). Similarly, brines may be diluted with natural seawater or municipal waste waters to reduce salinity prior to discharge (Baalousha, 2006; Malfeito et al., 2005). In addition, there is a current focus of research on the development of effective anti-scalants with no biological effects (Ketsetzi et al., 2008; Mavredaki et al., 2007). This may assist in the production of less toxic brines in the future. It has also been suggested that desalination of groundwater is a more environmentally friendly alternative to seawater desalination, although the availability of appropriate groundwater resources will likely be a limiting factor in many areas (Muñoz and Fernández-Alba, 2008). Energy costs are reduced and discharge brines are less salty than those produced following seawater desalination (Muñoz and Fernández-Alba, 2008), however, desalination of groundwater with low levels of salinity may result in brines with lower salinity than marine waters, thereby trading an issue of hypersaline brines for one of hyposaline brines if marine environments are to be the recipient of discharges.

Jetties have been constructed adjacent to desalination plant discharges, to minimise the spread of brine plumes and encourage more rapid mixing by creating offshore currents (Altayaran and Madany, 1992). This has been done not only to limit the intrusion of brines into seawater intake areas, but also to minimise areas of ecological impacts, however these structures appear to have limited success in either of these applications (Altayaran and Madany, 1992).

A clear consensus amongst many articles is that discharge site selection is perhaps the primary factor that determines the extent of ecological impacts of desalination plants (Lattemann and Höpner, 2008; Maugin and Corsin, 2005; Tsiourtis, 2008). Major marine habitat types have been ranked in order of predicted sensitivity to desalination brines (Höpner and Windelberg, 1996). Turbulent coastal environments with continuous flushing are predicted to be less susceptible to detrimental impacts of desalination brines than lower-energy systems, and habitats with strong tidal influence (Höpner and Windelberg, 1996). These predictions do not appear to have been drawn from empirical research, but rather observations and assumptions pertaining to physical characteristics of each of these types of environments. Whilst it does seem logical that well-flushed environments may experience reduced intensity and duration of exposure to effluents of any type, there is a strong possibility that the ecological impacts of desalination plants will resist prediction along such simplistic lines. Furthermore, areas known to support important biological resources should be avoided. The presence of rare, valuable or unique habitat and biological resources within the vicinity of desalination plant discharges should be a primary consideration in discharge site selection as a means of minimizing potential impacts to marine ecosystems (Dupavillon and Gillanders, 2009; Lattemann and Höpner, 2008).

Modelling approaches have also been used to improve the design of discharges such that impacts on salinity are minimised. Models suggest that the worst discharge design, from the perspective of dilution of brines, is an intertidal, or surface discharge as plumes tend to extend further and dilute less rapidly (Alameddine and El-Fadel, 2007; Bleninger and Jirka, 2008). Similarly, semi-enclosed seas, such as the Arabian Gulf, or Red Sea are more susceptible to significant increases in salinity around outfalls due to the limited flushing these environments experience (Cintrón et al., 1970; Purnama et al., 2005). The spatial extent of brine plumes and coastal erosion due to outfalls can be minimised by building discharges further offshore (Al-Barwani and Purnama, 2007, 2008; Purnama et al., 2003; Shao and Law, 2009). It has historically been recommended that sub-surface discharges release a 'jet' of brine at an angle of approximately 60° to the seafloor, and this has become the design standard for brine discharges (Roberts et al., 1997). However, more recent models suggest a shallower discharge angle of 30–45° may enhance mixing and offshore transport of desalination brines in coastal waters with moderate-to-steep bottom slopes (Bleninger and Jirka, 2008; Jirka, 2008; Maugin and Corsin, 2005). Thus there is broad agreement amongst modelling studies that sub-tidal, offshore discharge in an area of persistent turbulent flow is the optimal design to minimise the spatial extent and intensity of brine plumes.

4. Conclusion

4.1. *Monitoring ecological impacts of desalination plants – state of the art*

From a review of the literature it is clear that there is a widespread belief and recognition that desalination plants pose a potentially serious threat to marine ecosystems. The evidence for salinity, thermal, and contaminant impacts of desalination brines upon receiving water quality is relatively clear, however, when brines are released to well-flushed environments impacts tend to be on a small-scale (10 s of meters). Laboratory-based experiments, toxicological investigations and manipulative field experiments clearly demonstrate the potential for brines and their constituents to illicit adverse impacts on aquatic organisms when present at sufficient concentrations. In some cases substantial toxicological effects of desalination brines have been detected on marine vertebrates and invertebrates, at dilutions likely to be encountered in the vicinity of desalination outfalls. Thus, our review of the literature does show that desalination plants may adversely impact the ecology of marine ecosystems. However, while some earlier studies found broad-scale impacts upon the ecology of receiving environments, recent research stresses that appropriate discharge site selection, modelling of ocean currents, and proper plant maintenance and operation will minimise the spatial extent of the ecological effects of desalination plant discharges.

The one area where evidence is clearly lacking is in field-based ecological monitoring. Unfortunately, many of the

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published ecological monitoring programs do not appear to be scientifically defensible assessments of impacts. Thus, there is a general lack of empirical evidence supporting conclusions regarding the effects of desalination brines in receiving systems, a fact that is recognised in almost all regions that operate large plants (Baalousha, 2006). The only possible exception to this is in seagrass habitats, where biological monitoring studies have been combined with laboratory and field experiments to assess the effects of brines on seagrass ecosystems (Sánchez-Lizaso et al., 2008). Furthermore, professional experience suggests much of the research into ecological and environmental effects of desalination plants may be present in the grey literature (i.e. unpublished technical reports produced by consultants and government bodies). This literature is notoriously difficult to access for the purpose of literature review. It is essential that scientists involved in such research be supported and encouraged to publish their results in peer-reviewed journals to further advance knowledge in this area. Well-designed monitoring programs can assess the spatial extent of impacts resulting from desalination discharges, and are required to further feed into future decisions regarding site selection criteria for discharges.

It is worth highlighting that many published manuscripts purport to describe or review ecological impacts of desalination plants, but cite little or no peer-reviewed literature (Areiqat and Mohamed, 2005; Baalousha, 2006; Elhassadi, 2008; Miri and Chouikhi, 2005), provide little or no details of methodologies and statistical analyses (Azis et al., 2003; Elhassadi, 2008; Latorre, 2005; Mabrook, 1994), and, occasionally, present purely qualitative evidence (Mabrook, 1994). Environmental research must move from qualitative to quantitative approaches, following robust experimental designs as used to assess ecological impacts in other areas of marine research (Underwood, 1994). With expanding desalination capacities occurring in many regions around the world there is a clear need to monitor their impacts upon marine ecosystems using sound and defensible scientific approaches.

In conclusion, we can recommend the following key areas where future research would be valuable.

1. *Use of manipulative field experimentation to examine the effects of desalination brines under field conditions.* As discussed, only three studies were identified in this review that conducted manipulative experiments under field conditions. However, each of these studies was able to provide observations of impacts to multiple species simultaneously, demonstrate that small shifts in salinity (1–2 ppt) could have substantial consequences for exposed communities, and provide insights into the constituents of brines that were responsible for observed effects (Chesher, 1971; Latorre, 2005; Sánchez-Lizaso et al., 2008). Field experiments of this nature may be challenging to conduct, but clearly the information provided is extremely valuable. These studies could simulate effluent release in a range of flow conditions to examine impacts at a range of exposure intensities.
2. *Before–After Control-Impact (BACI) monitoring programs utilizing multiple reference locations and repeated sampling before and after plant operation.* Ecological monitoring programs that examine human effects in marine ecosystems should include multiple reference locations and replicated sampling before and after the activity of concern takes place (Underwood, 1994). In addition to those studies reviewed here, BACI monitoring studies that incorporate multiple reference locations have been implemented to detect the potential ecological effects of desalination plants in Australia, although data are yet to be published in peer-reviewed journals (Cannesson et al., 2009; Port et al., 2009). Without the use of appropriate reference locations and baseline estimates of ecological condition it is extremely difficult to demonstrate that an effect has or has not taken place, which is problematic for both operators and regulators. Generally, these designs will require sampling of at least five reference locations on at least three times prior to and during the operation of the plant (annually where possible to avoid confounding by seasonal changes). Post-operation studies (i.e. those with no before-operation data, also referred to as After, Control-Impact studies) can be performed, but they inherently have lower confidence attached to them as any differences between reference and potentially impacted locations may have existed prior to the operation of the plant (Glasby, 1997). Nevertheless, in situations where pre-construction data is not available, a study including multiple sampling times and numerous independent reference locations should provide a reasonable assessment of the effects of an existing plant. A range of statistical models and philosophical approaches to the analysis of these types of studies have been suggested, and these should be reviewed as part of the design process of any new ecological monitoring program (Downes et al., 2008; Glasby, 1997; Stewart-Oaten and Bence, 2002; Underwood, 1994).
3. *Whole of effluent testing and ecological monitoring to examine interactions, synergistic and additive effects of a range of climatic conditions and desalination brines.* Different climatic conditions may have additive or synergistic effects upon the responses of marine communities to desalination brines. Toxicity testing could be conducted under a range of environmental conditions (e.g. temperatures) using local organisms relevant to the development location to address these interactions. Ecological monitoring studies could also be designed to assess the potential for different responses of marine communities to desalination brines between summer and winter seasons.
4. *Specific tests of commonly used anti-scalants used in desalination plants.* There is a dearth of basic toxicological information in the published literature pertaining to commonly used anti-scalants that are currently included in brine effluent. Studies that optimise the use of such anti-scalants in order to minimise their inclusion in brine are required.
5. *Publishing studies in the scientific literature.* Experience suggests much of the research associated with the effects of desalination plants has been published only in the grey literature. It is important that these studies be published in peer-reviewed journals to further shape the design, location, and management of desalination plants to minimise or eliminate any potential impacts.

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STATE WATER RESOURCES CONTROL BOARD
RESOLUTION 2015-0033

AMENDMENT TO THE STATEWIDE WATER QUALITY CONTROL PLAN FOR THE OCEAN WATERS OF CALIFORNIA ADDRESSING DESALINATION FACILITY INTAKES, BRINE DISCHARGES, AND TO INCORPORATE OTHER NONSUBSTANTIVE CHANGES

WHEREAS:

1. The State Water Resources Control Board (State Water Board) adopted the California Ocean Plan (Ocean Plan) in 1972 and revised it in 1978, 1983, 1988, 1990, 1997, 2001, 2005, 2009, and 2012.

2. California Water Code section 13142.5, subdivision (b) (hereafter Water Code section 13142.5(b)), adopted as part of the California Coastal Act of 1976, requires that any "new or expanded coastal power plant or other industrial installation using seawater for cooling, heating or industrial processing" must utilize "the best available site, design, technology and mitigation measures feasible . . . to minimize the intake and mortality of all forms of marine life."

3. The operation and construction of desalination facilities can lead to marine life mortality and harm to aquatic life beneficial uses. The withdrawal of seawater for the purpose of desalination can result in the impingement and entrainment of marine life. If improperly discharged by desalination facilities, brine may accumulate on the sea floor, adversely affecting bottom-dwelling marine organisms. The State Water Board recognizes the importance of protecting of all forms of marine life.

4. The Water Boards currently regulate brine discharges from desalination facilities through Waste Discharge Requirements (WDR) and National Pollution Discharge Elimination System (NPDES) permits. In addition, the Water Code section 13142.5(b) requirements applying to seawater intakes have been implemented by regional water quality control boards through provisions included in WDRs and NPDES permits on a case-by-case basis. Currently, the Ocean Plan does not include provisions to protect aquatic life from impacts associated with seawater intakes at locations that are not State Water Quality Protection Areas. Additionally, the Ocean Plan lacks an objective or receiving water limitation for elevated salinity levels in ocean waters.

5. On March 15, 2011, the State Water Board adopted the Ocean Plan Triennial Review Work Plan (2011-2013) by Resolution 2011-0013 and directed State Water Board staff to review high priority issues identified in the work plan, including desalination facilities and their associated brine disposal, and to make recommendations for any necessary changes to the Ocean Plan.

6. To address desalination facility seawater intakes, the State Water Board proposes an amendment to the Ocean Plan, interpreting and applying Water Code section 13142.5(b) in establishing a consistent statewide analytic framework for the best available site, design, technology, and mitigation measures feasible in order to minimize intake and mortality of all forms of marine life. The Desalination Amendment will also establish a receiving water limitation for brine discharges from desalination facilities, with the purpose of protecting beneficial uses. The State Water Board encourages owners and operators of desalination facilities to design and operate facilities sustainably whenever possible.

7. When making Water Code section 13142.5(b) determinations, the State Water Board intends for the regional water boards to provide public trust protections, where feasible, when considering whether to approve or not approve a desalination facility. The Water Boards should exercise their public trust responsibilities to ensure environmental protection for the benefit of present and future generations.

8. The State Water Board encourages the development of new and underutilized water resources, including improved conservation and water use efficiency, conjunctive water management (i.e., coordinated management of surface and groundwater), recycled water, groundwater remediation, and brackish and seawater desalination. The State Water Board encourages projects with multiple benefits that can help simultaneously improve the environment, flood management, and water supply, such as storm water capture. Seawater desalination is just one of several alternative water supply options that should be considered when developing reliable water supplies. To be sustainable, seawater desalination and other new and underutilized water resources must balance the need to provide for public health and safety, to protect the environment, and to support a stable economy. The State Water Board encourages local and regional agencies to take a watershed approach to water management.

9. The State Water Board commissioned expert review panels and scientific studies to provide information to support the development of the proposed Desalination Amendment.

   a. The State Water Board contracted with the Southern California Coastal Water Research Project to commission an expert review panel on the impacts and effects of brine discharges. On July 5, 2011, a public meeting was held in Sacramento to solicit input regarding panel members and key desalination issues. The panel released a draft report and solicited input from the public during a public meeting on December 8-9, 2011. The panel submitted the final report with their findings and recommendations to the State Water Board in February 2012.

   b. The State Water Board contracted with Moss Landing Marine Laboratory to commission an expert review panel on minimizing and mitigating intake impacts from power plants and desalination facilities. During a public meeting on March 1, 2012, the panel presented their recommendations, and the public asked questions and provided comments on the panel's draft report. The panel submitted the final report with their findings and recommendations on March 14, 2012.

   c. The State Water Board commissioned a salinity toxicity study through the Marine Pollution Studies Laboratory at Granite Canyon. The study determined the tolerance of seven Ocean Plan test species to various concentrations of hyper-saline brine. The study's results were described in the final report that was submitted in July 2012.

   d. The State Water Board contracted with Moss Landing Marine Laboratory to reconvene the expert review panel to address potential effects of discharge diffusers on marine life and to provide an explanation of the mitigation "fee" approach for entrainment impacts caused by surface intakes at desalination facilities. These were issues raised at the January 30, 2013 stakeholder meeting at Moss Landing Marine Laboratory. The panel submitted the final report with their findings and recommendations on October 9, 2013.

10. 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 an interagency working group comprised of staff members from affected regional water boards and state and federal agencies involved with regulating and permitting desalination facilities in California. The interagency working group met seven times between 2012 and 2015 to review and comment on the proposed Desalination Amendment.

11. State Water Board staff held public scoping meetings, pursuant to the California Environmental Quality Act (CEQA) (Pub. Resources Code section 21000 et seq.), on June 26, 2007 in San Francisco and on March 30, 2012 in Sacramento.

12. The adoption or amendment of a water quality control plan is a regulatory program that has been certified by the State's Secretary for Natural Resources as exempt from the CEQA requirements to prepare an Environmental Impact Report (EIR) or Negative Declaration. (Cal. Code of Regs., tit. 14, sec. 15251, subd. (g)). Accordingly, the State Water Board has prepared Substitute Environmental Documentation (SED) in lieu of an EIR or Negative Declaration.

13. The State Water Board circulated the draft Desalination Amendment and supporting draft Staff Report, including the draft SED dated July 3, 2014, for public comment on July 3, 2014. The deadline for submission of written comments was 12:00 noon on August 19, 2014.

14. The State Water Board held a public workshop on August 6, 2014 in Sacramento to provide information and to answer questions from the public on the proposed Desalination Amendment and the draft Staff Report, including the draft SED.

15. 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.

16. In developing, considering, and adopting the proposed Desalination Amendment, the State Water Board complied with procedural requirements contained in the State Water Board's regulations for implementing the CEQA (23 Cal. Code Regs. § 3720-3780).

17. Thirty written public comment letters on the revised Desalination Amendment and revised Staff Report, including the revised SED 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.

18. 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 Amendment and changes to the proposed final Staff Report, including the proposed final SED, was April 9, 2015 at noon.

19. 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.

20. Seventeen written public comment letters on the revised Desalination Amendment and revised Staff Report, including the revised SED, were timely submitted, and the State Water Board provided written responses to those comments on April 24, 2015.

21. An initial change sheet was circulated on May 1, 2015. This Change Sheet #1 included proposed changes to several sections of the April 24, 2015 draft Desalination Amendment. A draft final Desalination Amendment showing all changes since March 20, 2015, including changes in Change Sheet #1, was also circulated on May 1, 2015. A second change sheet was circulated on May 4, 2015. The second change sheet, Change Sheet #2, included additional changes for two sections that were proposed to be revised in Change Sheet #1. The two sections in Change Sheet #2 replaced the corresponding sections in Change Sheet #1. A draft final Desalination Amendment reflected all changes since March 20, 2015, including the revisions from Change Sheet #1 and Change Sheet #2, and was circulated on May 5, 2015. The May 5, 2015 draft final Desalination Amendment included no new changes, but was provided to reflect all changes after March 20, 2015 in one document.

22. The proposed Desalination Amendment and final Staff Report, including the final SED, satisfy the substantive requirements contained in the State Water Board's regulations for implementing the CEQA (23 Cal. Code Regs. § 3777 and 14 Cal Code of Regs. § 15250, 15251(g) and 15252).

    a. The final Staff Report, including the final SED, contains a description of the project, a completed environmental checklist, and an environmental analysis of any impacts associated with the project; it identifies reasonably foreseeable methods of compliance and analyzes potentially significant adverse environmental impacts associated with methods of compliance and mitigation, where applicable.

    b. The final SED consists of the draft Staff Report, including appendices, the proposed final Staff Report, and written comments and responses to comments on the draft Staff Report and the proposed Desalination Amendment.

23. The final Staff Report, including the final SED identifies a number of alternatives to adoption of the proposed Desalination Amendment, which included a no project alternative and various other alternative provisions governing requirements for seawater intakes and brine discharges. The State Water Board finds that these alternatives would not meet all of the project objectives identified for the Desalination Amendment, would unnecessarily restrict locations where desalination facilities may be built, would result in unacceptable levels of intake and mortality of marine life, or may not otherwise be adequately protective of marine life.

24. In accordance with California Code of Regulations, title 23, section 3777, subdivision (b)(4), the State Water Board in the final Staff Report, including the final SED has evaluated the potential environmental impacts of reasonably foreseeable methods of compliance with the proposed Desalination Amendment. In addition, the State Water Board has evaluated potential environmental impacts associated with the overall construction and operation of desalination facilities in general. Although many of the potentially significant impacts from desalination facilities in general would likely occur in the absence of adoption of the Desalination Amendment, they are evaluated in the final Staff Report, including the final SED, for the purposes of disclosure and to fully inform decision-making. The potentially significant impacts from desalination facilities in general are uncertain and site-specific in nature, and are more appropriately addressed in a project-specific CEQA analysis.

25. The State Water Board has identified potentially significant indirect impacts to aesthetics resulting from reasonably foreseeable methods of compliance with the proposed Desalination Amendment. These impacts include visual impacts to scenic vistas from construction activities related to installation of intake and outfall structures, as well as permanent infrastructure needed to move source water to the plant and to transfer waste from the facility to the outfall. The State Water Board has identified potential mitigation measures available for these methods of compliance that may reduce or eliminate those aesthetic impacts. These measures include limitations on the time of year when construction occurs and ensuring that infrastructure is installed underground or outside areas where public and recreational uses occur. However, for any specific site, it is unknown what specific mitigation measures are available or the extent to which such measures are capable of reducing impacts to a level that is less than significant, nor are these measures within the authority of the State Water Board. Pursuant to title 14, California Code of Regulations section 15091, subdivision (a)(2), the State Water Board finds that such changes or alterations are within the responsibility and jurisdiction of another public agency and are not within the authority of the State Water Board. Such changes would be adopted by other public agencies or can and should be adopted by such other agencies. Therefore, such impacts to aesthetics may be significant and unavoidable.

26. The State Water Board has identified potentially significant indirect impacts to air quality resulting from reasonably foreseeable methods of compliance with the proposed Desalination Amendment. These impacts include short-term air emissions associated with the construction activities related to installation of intake and outfall structures. Air quality- related impacts include short-term air emissions that may conflict with or obstruct implementation of an applicable air quality plan or may otherwise violate applicable air quality standards. The State Water Board has identified potential mitigation measures available for these methods of compliance that may reduce or eliminate those air quality impacts. These measures include use of low-emission equipment and practices, and use of appropriate management practices during surface disturbance activities. However, because the State Water Board does not have authority to require these measures, there is uncertainty in the degree of mitigation implemented to reduce potentially significant impacts. Pursuant to title 14, California Code of Regulations section 15091, subdivision (a)(2), the State Water Board finds that such changes or alterations are within the responsibility and jurisdiction of another public agency and are not within the authority of the State Water Board. Such changes would be adopted by such other agencies or can and should be adopted by such other agencies. Therefore, such impacts to air quality may be significant and unavoidable.

27. The State Water Board has identified potentially significant indirect impacts to biological resources resulting from reasonably foreseeable methods of compliance with the proposed Desalination Amendment. These impacts from construction activities include: impacts related to the installation of intake and outfall structures, including potential loss or modification of sensitive habitat, conversion of riparian or wetland habitat supporting a variety of resident and migratory species, disturbance or interference with fish migration patterns, adverse impacts to migratory bird nesting and feeding habitat, and disturbance of marine and onshore habitat through generation of noise and vibration. The State Water Board has identified potential mitigation measures available for these methods of compliance that may reduce or eliminate those impacts. These measures include: construction surveys, relocation of impacted species, consultation with appropriate agencies identify seasonal work windows, avoidance technology and required monitoring, and obtaining appropriate permits. However, for any specific site, it is unknown what specific mitigation measures are available or the extent to which such measures are capable of reducing impacts to a level that is less than significant, nor are

these measures within the authority of the State Water Board. Pursuant to title 14, California Code of Regulations section 15091, subdivision (a)(2), the State Water Board finds that such changes or alterations are within the responsibility and jurisdiction of another public agency and are not within the authority of the State Water Board. Such changes would be adopted by such other agencies or can and should be adopted by such other agencies. Therefore, such impacts to biological resources may be significant and unavoidable.

28. The State Water Board has identified potentially significant indirect impacts from greenhouse gas emissions resulting from reasonably foreseeable methods of compliance with the proposed Desalination Amendment. These impacts resulting from construction activities related to installation of intake and outfall structures include exhaust emissions from equipment that may exceed local thresholds of significance. The State Water Board has identified potential mitigation measures available for these methods of compliance that may reduce or eliminate those impacts. These measures include use of low-emission equipment and practices and use of appropriate management practices. However, because the State Water Board does not have authority to require these measures, there is uncertainty in the degree of mitigation implemented to reduce potentially significant impacts. Pursuant to title 14, California Code of Regulations section 15091, subdivision (a)(2), the State Water Board finds that such changes or alterations are within the responsibility and jurisdiction of another public agency and are not within the authority of the State Water Board. Such changes would be adopted by such other agencies or can and should be adopted by such other agencies. Therefore, such impacts from greenhouse gas emissions may be significant and unavoidable.

29. The State Water Board has identified potentially significant impacts to hydrology and water quality resulting from reasonably foreseeable methods of compliance with the proposed Desalination Amendment. These impacts include the potential for operation of subsurface wells to cause or exacerbate saltwater intrusion into freshwater aquifers or alter groundwater flow to freshwater aquifers and wells. Pursuant to express terms of the Desalination Amendment, the feasibility determination for subsurface intakes will entail analysis of issues that include hydrogeology. As a result, a proposed facility that with apparent potential to result in such impacts is unlikely to be approved. However, due to the site-specific nature of this determination, the potential for such impacts is uncertain and is appropriately addressed more extensively in a project-specific CEQA analysis. Regardless, the State Water Board has identified potential mitigation measures available for these methods of compliance that may reduce or eliminate those impacts in the event that these impacts nonetheless occur. These measures include reducing pumping rate or potentially relocating wells. However, because the State Water Board does not have authority to require these measures, there is uncertainty in the degree of mitigation implemented to reduce potentially significant impacts. Pursuant to title 14, California Code of Regulations section 15091, subdivision (a)(2), the State Water Board finds that such changes or alterations are within the responsibility and jurisdiction of another public agency and are not within the authority of the State Water Board. Such changes would be adopted by such other agencies or can and should be adopted or undertaken by such other agencies. Therefore, such impacts to hydrology and water quality may be significant and unavoidable.

30. The State Water Board has duly considered the final Staff Report, including the final SED, which identifies potentially significant and unavoidable impacts resulting from adoption and implementation of the Desalination Amendment. Consistent with Public Resources Code section 21081, subdivision (b), specific overriding economic, legal, social, technological or other benefits outweigh the potentially unavoidable adverse

environmental impacts. The State Water Board makes this statement of overriding considerations concerning the Desalination Amendment to explain why the benefits override and outweigh any potentially unavoidable impacts. These benefits include ensuring continued availability of an important alternative source of potable water while providing consistency to regional water boards in permitting desalination facilities. Desalination may provide a reliable alternative source of water as a supplement to more traditional supplies to reduce uncertainty in times of drought. The Desalination Amendment provides a statewide, coordinated and consistent approach to consideration of new or expanded desalination facilities while protecting beneficial uses and minimizing intake and mortality of all forms of marine life. The State Water Board finds that potentially significant, unavoidable environmental impacts that may directly or indirectly result from adoption of the Desalination Amendment are acceptable in light of the benefits set forth above, and that each of the benefits constitute an overriding benefit warranting approval of the Desalination Amendment, independent of the other benefits, despite each and every potentially unavoidable impact.

31. Pursuant to Health and Safety Code section 57004, the proposed Desalination Amendment and draft Staff Report, including the draft SED, were subject to external scientific peer review through an interagency agreement with the University of California. Peer review was solicited on June 18, 2014 and was completed on September 17, 2014. State Water Board staff revised the proposed Desalination Amendment and draft Staff Report, including the draft SED, in response to comments provided by the peer reviewers or provided written responses that explained the basis for not incorporating other proposed changes.

32. New Ocean Plan section III.M.2(e)(1)(a) specifies a mitigation assessment methodology developed based on the current state of science. As mitigation methodology evolves, the State Water Board may propose further amendments to this plan to authorize alternative mitigation assessment methods that assess intake and mortality of all forms of marine life and can be used to determine the number of mitigation acres needed to fully mitigate the impacts.

33. The plan amendment recognizes that, at this time, the commingling with wastewater is the preferred brine discharge technology for dealing with brine discharges. The State Water Board has adopted a state policy for water quality control that promotes the development and use of recycled water. Generally, once wastewater is sufficiently treated and can be distributed locally, then the plan amendment recognizes that the commingling of treated wastewater with the brine discharge will no longer be the preferred brine discharge technology.

34. The Desalination Amendment to the Ocean Plan does not become effective until approved by the Office of Administrative Law (OAL) and the State Water Board has paid the applicable fee established by the Department of Fish and Wildlife for an environmental document adopted pursuant to a certified regulatory program as required by the CEQA, section 21089(b).

THEREFORE BE IT RESOLVED THAT THE STATE WATER BOARD:

1. Adopts the Desalination Amendment to the Ocean Plan.

2. Approves the final Staff Report, including the final SED.

3. Directs State Water Board staff to propose and pursue a Memorandum of Agreement with the California Coastal Commission, California Department of Fish and Wildlife, and the State Lands Commission to promote interagency collaboration for siting, design, mitigation, and permitting of desalination facilities.

4. Authorizes the Executive Director or designee to submit the Desalination Amendment to OAL for review and approval.

5. Directs the Executive Director or designee to make minor, non-substantive modifications to the language of the Desalination Amendment, if during the OAL approval process, OAL determines that such changes are needed for clarity or consistency, and to inform the State Water Board of any such changes.

6. Directs State Water Board staff, upon approval by OAL, to file a Notice of Decision with the Secretary for Natural Resources and transmit payment of the applicable fee as may be required to the Department of Fish and Wildlife pursuant to Fish and Game Code section 711.4.

CERTIFICATION

The undersigned Clerk to the Board does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on May 6, 2015.

AYE: Chair Felicia Marcus
Vice Chair Frances Spivy-Weber
Board Member Tam M. Doduc
Board Member Steven Moore
Board Member Dorene D'Adamo

NAY: None

ABSENT: None

ABSTAIN: None

Jeanine Townsend

Jeanine Townsend
Clerk to the Board

Ecological Rights Foundation (ERF), the Center for Biological Diversity (CDB), and Our Children's Earth Foundation (OCEF) - Attachments

Marine and Coastal Impacts of Ocean Desalination in California

Prepared by Water in the West, Center for Ocean Solutions, Monterey Bay Aquarium, The Nature Conservancy

May 2016

Stanford Woods Institute for the Environment

Water in the West

Center for Ocean Solutions

Monterey Bay Aquarium

The Nature Conservancy

May 2016

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Acknowledgments

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About Water in the West

Water in the West is a partnership of the faculty, staff and students of the Stanford Woods Institute for the Environment and the Bill Lane Center for the American West. The mission of Water in the West is to design, articulate and advance sustainable water management for the people and environment of the American West. Linking ideas to action, we accomplish our mission by engaging in cutting-edge research, creative problem solving, active collaboration with decision-makers and opinion leaders, effective public communications and hands-on education of students. To learn more, please visit: waterinthewest.stanford.edu.

About Center for Ocean Solutions

The Center for Ocean Solutions works to solve the major problems facing the ocean and prepares leaders to take on these challenges. We value and steward linkages between the ocean, health and climate resulting in thriving marine ecosystems and vibrant coastal communities. The Center for Ocean Solutions is a partnership of Stanford University (through the Stanford Woods Institute for the Environment and Hopkins Marine Station), the Monterey Bay Aquarium, and the Monterey Bay Aquarium Research Institute. To learn more, please visit centerforoceansolutions.org.

About Monterey Bay Aquarium

The mission of the nonprofit Monterey Bay Aquarium is to inspire conservation of the ocean. Today, more than 30 years after opening, the Aquarium is a showcase for the habitats and sea life of one of the world's richest marine regions. More than 35,000 creatures representing over 550 species fill nearly 200 exhibits in all. The Aquarium is not only a window to the wonders of the ocean for 2 million visitors per year, but it is also a leader in ocean conservation and education. To learn more, please visit montereybayaquarium.org.

About The Nature Conservancy

The Nature Conservancy is a global, non-profit organization dedicated to the conservation of the lands and waters upon which all life depends. Our vision is a world where the diversity of life thrives, and people act to conserve nature for its own sake and it's ability to fulfill our needs and enrich our lives. We achieve our mission and vision by working collaboratively to develop field-leading science, demonstrate solutions at place and advocate for policies that enable conservation at scale. To learn more, please visit nature.org.

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INTRODUCTION

Like many areas of the world, California is facing an increasing challenge to maintain a water supply that meets the needs of its growing population and addresses the uncertainties of a changing climate (Brozovic et al., 2007; Cayan et al., 2010; Viviroli et al., 2011; CDWR, 2013; Grantham and Viers, 2014; Diffenbaugh et al., 2015). Currently in its fourth year of drought, California is investigating a variety of alternative sources for water—each of which has its own environmental, economic and social considerations. Ocean desalination, currently a small piece of California's overall water supply, has received rekindled interest as a potential alternative in large part due to a seemingly "drought-proof" supply of seawater on the state's doorstep. However, many desalination proposals have been controversial, and many community leaders, policymakers and advocates have questioned the relative value of ocean desalination as compared to potentially cheaper and more efficient alternatives, such as water conservation. In addition, as with all developed sources of water, the process of desalination could impact the environment. If poorly sited and designed, ocean desalination can have major undesirable impacts on marine ecosystems, nearshore habitats and coastal communities. Moreover, regardless of how well they are designed, all desalination facilities currently consume a great deal of energy and have the potential to increase greenhouse gas emissions.

In January 2016, the Stanford Woods Institute for the Environment, through its Water in the West Program and the Center for Ocean Solutions, collaborated with the Nature Conservancy and the Monterey Bay Aquarium to organize and facilitate an "uncommon dialogue" on the coastal and marine impacts of ocean desalination among leading experts from nongovernmental organizations, private industry, government agencies and academia. The dialogue had two primary objectives: 1) to promote information exchange and open discussion regarding the best available science, technology and policy related to marine and coastal impacts of desalination projects in California and beyond; and 2) to identify key issues and knowledge gaps for future research and policy development with respect to marine and coastal impacts of ocean desalination in California. To accomplish these objectives, the dialogue was split into four sessions: (1) Scope of Desalination and Current Regulatory Framework in California, (2) Seawater Intakes, (3) Brine Disposal, and (4) Facility Siting and Community Impacts. This report synthesizes and summarizes the proceedings and conclusions of that dialogue.

SUMMARIES OF SESSIONS

1) Scope of Desalination and Current Regulatory Framework in California

Issue Statement

California's major population centers are located away from areas of high precipitation levels in the Sierra Nevada Mountains and the coastal northwest (Figure 1A). To address this mismatch in supply and demand, the state has an elaborate (and now considerably stressed) combination of federal, state, and local infrastructure to store water and to convey it from Northern California, the Sierra Nevada and the Colorado River to agricultural users in the Central Valley and to the population centers of Central and Southern California, most of which are found near or along the coast (Figure 1B). The current drought, restrictions on historical sources of freshwater and uncertainty stemming from a changing climate are among the factors driving a search for new sources of water for human use—including ocean desalination for coastal populations.

Figure 1A. Average annual precipitation in California (in inches) between 1961 and 1990.

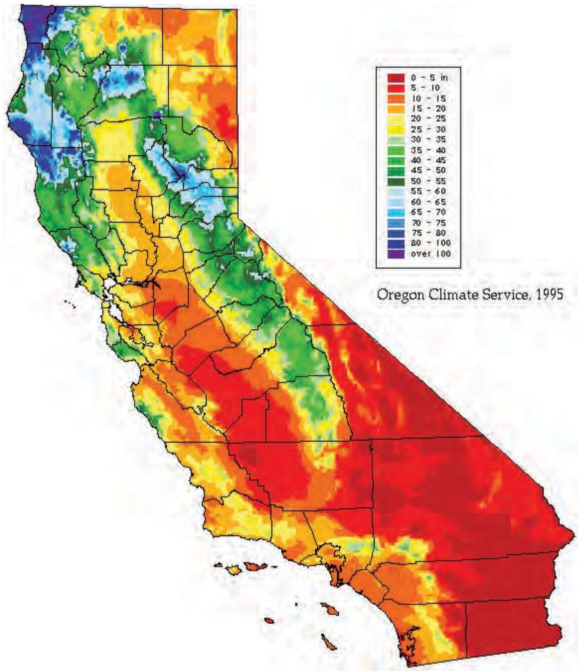
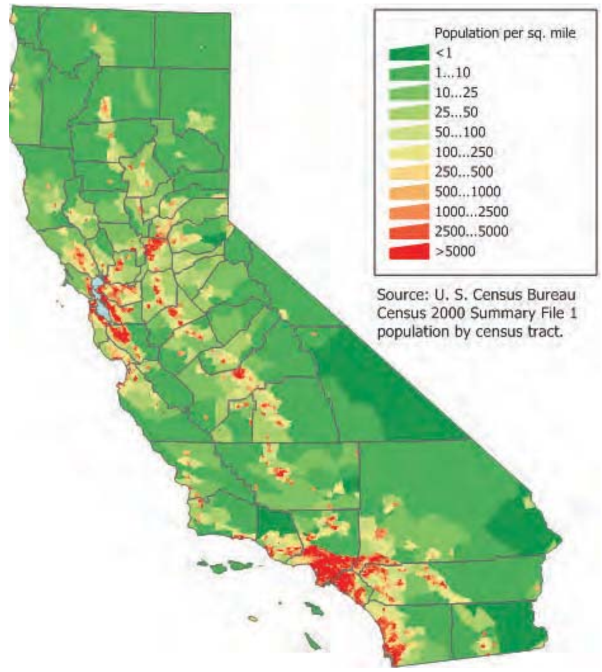


Figure 1B: Population density in California from the 2000 US Census.



As the interest in desalination projects increases, the role of review of the relative costs, benefits and environmental impacts of ocean desalination becomes more important. The State Water Resources Control Board recently developed a new and promising regulatory framework for ocean desalination in the form of an amendment to its Water Quality Control Plan for the Ocean Waters of California (Ocean Plan). The new policy covers siting, design, best technologies for intakes and discharges, and appropriate mitigation measures. However, there are further policy development opportunities. Work can be done on incentivizing the most sustainable categories of desalination (including with respect to facility siting and energy use), further inform permitting with better science and data, and support true demand driven projects.

Findings

- The role of ocean desalination will be minor in the context of California's overall water budget, although it may be very important in some local areas.
- Ocean desalination will not, in the foreseeable future, significantly reduce stress on freshwater resources—particularly freshwater ecosystems. Even the highest total projected production of potable water from ocean desalination in California is so low that it will not meaningfully reduce stress on freshwater systems, such as, for example, exports from the Bay Delta system (Water Plan, 2013). In addition, it is not clear the extent to which planned desalination facilities will provide the regions with supplemental supply and therefore work to reduce or replace existing demands on groundwater and surface water sources.
- It is possible for desalination to reduce stress on other water sources. For example, on the Monterey Peninsula, desalination will serve to replace withdrawals from the Carmel River, reducing stress on that ecosystem. Based on the discussion, this situation is ideal, but also unique. It would be worth evaluating whether other similar opportunities exist in California.
- Communities should compare all costs and benefits (social, environmental and economic) of desalination with the true costs and benefits of other water supply sources. Researchers have an important role to play in developing methodologies to allow for the quantification and comparison of all the costs of various potential sources of water supply, from withdrawal to disposal.

- Characteristics of what could be deemed a "sustainable desalination" facility are becoming more apparent, including projects that (1) are based on community demand in coastal areas; (2) use subsurface intakes that do not adversely affect marine life and do not affect inland water sources; (3) draw energy from renewable sources; (4) use brackish water sources, which require less energy to extract salt and can be disposed of at ocean salinities; and (5) are sized and sited to reduce local community impacts and to allow for the use of subsurface intakes. An important area of future work is assessing the success of the new California desalination policy in incentivizing such projects, and whether additional policies are needed.

2) Seawater Intakes

Issue Statement

The new California desalination policy explicitly favors subsurface intakes. These intakes greatly reduce entrainment impacts but have other potential downsides. Depending on context and perspective, such downsides may include initial construction costs, size limitations, potential impacts on freshwater aquifers, and a larger terrestrial footprint for wells and pumping stations. Subsurface intakes will not work everywhere. Not all facilities will have land available for pumping stations and wells. Larger facilities will likely use screened open-water intakes, for which the California policy requires after-the-fact mitigation for any impacts of entrainment mortality. California, other coastal states and the federal government have decades of experience monitoring and regulating ocean intakes for power plants. In recent years, this data has led to stricter rules for power plant intakes, including a prohibition on once through cooling for new plants. Additional monitoring, research and other work may be needed to assess entrainment impacts and develop more effective mitigation strategies for ocean desalination intakes.

Findings

- California has access to many years of expertise and data related to open ocean water intakes related to power plants. Further study of this data, as well as monitoring of new desalination facilities, is needed to assess and mitigate impacts resulting from desalination if technology other than subsurface is used.
- The primary adverse effect of screened open ocean intakes is mortality of larval fish, fish eggs and other types of plankton. This mortality can be assessed, but prediction of the overall impact from such mortality using traditional models is hindered by the paucity of information on typical survivorship to maturity for most species. As a result, the overall impact of intake mortality on the marine ecosystem cannot always be quantified reliably.
- As a result of this difficulty in quantifying the impact of open water intakes, California policy has relied on the Empirical Transport Model (ETM)/Area of Production Foregone (APF) approach. This approach estimates the habitat needed to compensate for entrainment impacts and requires mitigation of that quantity of habitat.
- This mitigation requirement applies only to open water intakes. The effect of the policy is to favor underground (either under the beach or below the seabed) intakes, which are primarily appropriate for smaller facilities (due to increased land requirements and pumping costs for below ground intakes). Despite this approach, some proposed facilities intend to use open ocean intakes to allow for greater volumes of water.
- Focusing on selecting sites where subsurface intakes would be feasible has the potential to reduce the entrainment impacts of open water intakes.

3) Brine Disposal

Issue Statement

California has much less experience regulating and monitoring coastal impacts from brine disposal than it does for ocean water intakes; however, other areas of the world have been developing and researching technologies relevant to brine disposal for decades. California's new policy focuses on water quality near the discharge point, and the preferred technologies identified in the new state desalination policy (either combining a desalination discharge with an existing wastewater treatment facility discharge or using multiport diffusers) should be able to meet the standard in the new regulations. The specific standard is that increases in salinity 100 meters from the discharge point can be no more than 2.0 parts per thousand (ppt). The consensus is that this standard is both achievable and adequate to protect marine life in general. However, there is still concern about whether it is adequate at all locations and whether it protects from all potential site-specific adverse effects of brine disposal. The accumulation of higher salinity water in seabed depressions and mortality in the discharge plume were among site-specific concerns raised at the workshop. While the technology for releasing brine effluent into the water column advances, there is a need to better understand the impacts through research and monitoring. Additionally, the impacts from brine disposal could be alleviated significantly through siting facilities in nonsensitive areas of the California coast.

Findings

- The current best practices for mitigating the effects of brine discharge into the ocean are the use of multiport diffusers or combining a brine discharge with another existing discharge when the combined discharge would have fewer overall effects than two separate discharges. The best science indicates that these approaches, deployed appropriately for each site, can meet requirements of California state policy (limit of a 2.0 ppt increase in salinity outside of 100-meter mixing zone).
- More work is needed to understand the long-term impacts of discharges meeting the above standard on ecosystems at specific sites. For example, larval mortality in the 100-meter mixing zone where elevated salinities are permitted and long-term accumulation of higher salinity water in depressions on the ocean floor are areas that both merit focused monitoring and more study.
- There is a great deal of data related to brine impacts from desalination facilities around the world, including those using technologies contemplated for California. California should assess the existing analyses of these data and conduct any additional work that might provide information relevant to how to deploy and monitor these technologies in the state. The state needs to ensure that monitoring at existing and new facilities in California is appropriately designed to capture potential site-specific impacts.

4) Facility Siting and Community Impacts

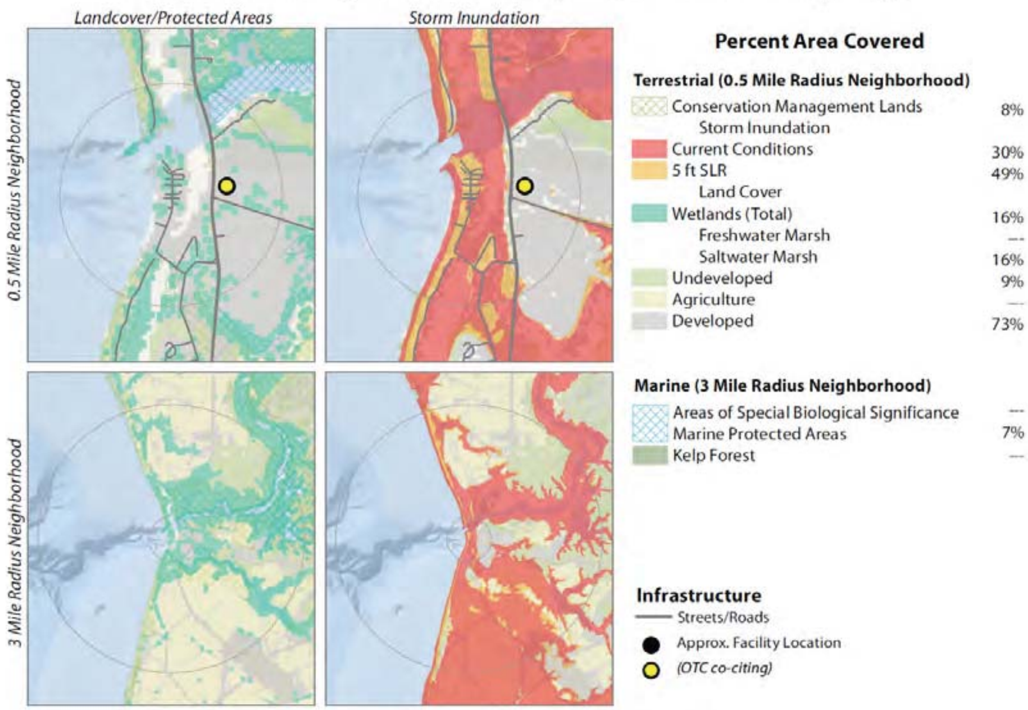
Issue Statement

To date, siting and design specifications for proposed desalination facilities have primarily been based on opportunistic considerations, such as proximity to demand and to existing intake and discharge infrastructure. However, a comprehensive spatial siting framework could help inform decisions that optimize both meeting water demand and reducing environmental impacts. By elucidating high value coastal areas, such as wetland habitats, kelp forests or marine bathymetric features, a geodatabase could identify avoidance areas to prevent ecosystem impacts (Figure 2). A full suite of ecological coastal and marine attributes could be mapped, as well as coastal and marine protection status (for example, Figure 2), to inform an impact avoidance and mitigation strategy that would minimize site-specific concerns related to intakes and discharges. Other key issues, including vulnerability to rising sea levels, demonstrated local need, uncertainty about the reliability of an area's existing water sources, beneficial existing infrastructure and community concerns, could further identify locations more suited to or in need of desalination. For example, a desalination facility may be appropriate where water supply needs cannot be met through other means (for example, efficiency measures or water recycling), particularly if it has been determined that impacts to sensitive ecosystems would be minimal. Ideally, local communities—in collaboration with statewide agencies—can take the lead in identifying their water supply needs and the appropriate means to address them.

Figure 2: Central Coast Regional Water Project (10 – 25 MGD Capacity)

Examples of criteria to be mapped to inform locations where facilities would meet supply needs while minimizing impacts to marine and coastal environments. Zones of influence may vary from local footprint impacts to coastal areas of concern to larger zones of influence when considering marine species entrainment. The full suite of information needed to guide siting decisions is not represented here. Example maps courtesy of the Nature Conservancy and the Center for Integrated Spatial Research.

Desalination co-sited with Moss Landing Power Plant (10-25 MGD Capacity)



Findings

- The Nature Conservancy presented a spatial analysis framework to inform a mitigation hierarchy and potential guide for decision making. The full suite of environmental, political, infrastructure and social attributes to be included in such an analysis framework merits further research and effort. In addition, state agencies and localities need to evaluate potential policy and permitting approaches for integrating such a framework into existing decision making.
- A more thorough spatial analytic approach that integrates evaluation of sensitive ecosystems and human concerns could help minimize impacts to marine and coastal environments. Such an approach could also help reduce the chances of site-specific impacts that are not considered by the generally applicable permitting approach.
- While sometimes cited as a co-benefit, co-location of desalination intakes with existing power plant intakes will likely not be an effective strategy for the long term. Open ocean intakes are no longer allowed for new power plants, and existing power plants with that technology along California's coast will likely be retired or retrofitted in coming years. Co-location opportunities with such facilities are declining, but are also controversial because of perpetuating or compounding existing impacts to the ocean from intakes.
- An integrated spatial analysis of the California coast has the potential to identify locations where desalination facilities would have the lowest impacts to marine and coastal environments; combined with favoring smaller projects that are demand-driven, use subsurface intakes and are powered by renewable power, this integrated approach could potentially guide the siting of sustainable ocean desalination for California.

SUMMARY

Throughout the course of the dialogue, participants raised and clarified a variety of existing scientific and policy-related knowledge gaps. As a collective group, the participants agreed that ocean desalination could potentially contribute to the state's water portfolio; however the extent to which it should and will do so remains uncertain. This uncertainty highlights several clear opportunities to fill knowledge gaps in a way that better informs decision-makers and the general public about the true costs and benefits of desalination in relation to using other sources of water. To highlight these opportunities and begin to chart a course of action, the dialogue concluded with a discussion around potential areas of further focus.

Summary Findings

Through exploration of the session topics and extensive open discussion, a general (but not necessarily unanimous) consensus of the group formed around a few findings:

- While desalination may prove critical for a few coastal communities, it is unlikely to be a major part of California's water supply portfolio due to its high cost of operation, the availability of other sources of water (such as recycled wastewater), its high energy use and the resulting high levels of greenhouse gas emissions, and siting difficulties given the fragility and importance of California's coastal ecosystems.
- Given the relatively small potential footprint of ocean desalination, it is not likely to play a meaningful role in reducing the stress on freshwater ecosystems caused by diversions for water supply.
- Using an integrated spatial approach to identify marine and coastal areas of high ecological and natural value, as well as areas that have local need and existing beneficial infrastructure, could effectively complement California's new desalination policies and help guide sustainable desalination development for California.
- Future work is needed to further define the elements of sustainable desalination projects and develop policies to incentivize adoption of those elements. Elements of sustainable desalination identified at the conference included projects that are smaller; that provide supply to meet a specific, clear local demand; that are located away from sensitive and valuable marine areas; and that are powered by renewable energy sources.
- California's new ocean desalination policy has taken important steps to reduce the environmental effects of both ocean water intakes and brine disposal, yet a need remains for further study in minimizing impacts in a site-specific context and in advancing technologies, particular technologies for surveying and monitoring such site-specific impacts. Better evaluation of data from facilities around the world and better monitoring of facilities built in California were both identified as important avenues for research.
- In making decisions about water supply, water managers may not have access to good information about the true costs of water from different sources, including financial costs, environmental impacts, impacts on the source community (if the water is imported) and potential economic impacts on the state as a whole. A rigorous examination of the full costs, benefits and trade-offs of desalination in the context of the full costs and sustainability of current water supply solutions would improve decisions about desalination and water supply more generally and the public's understanding of the trade-offs involved in those decisions.

IDENTIFIED FUTURE WORK

Inform and Engage the Public: The costs, benefits and limitations of desalination are not well understood by the California public. Misinformation and sweeping generalizations may lead the public to overestimate the potential usefulness of desalination as a drought response tool, to underestimate its true short- and long-term costs, or to fail to recognize when it is truly needed and appropriate. The sponsors of this uncommon dialogue could further public understanding of issues related to desalination in a variety of ways that would help improve the collective understanding of water supply issues in the state, desalination generally, its costs and benefits and in what contexts it is most appropriate. The sponsors of this uncommon dialogue will work to put on a public conference (potentially at the Monterey Bay Aquarium) that will explore the issues raised in the report for a broader audience.

Provide a Sound Basis for Comparing the Costs and Benefits of Desalination to Other Sources of Water: An underlying problem in water management is the difficulty in assessing the true cost of water, including not only infrastructure, energy and other direct costs, but also environmental costs, impacts on other water users and other externalities. Developing better metrics for analyzing the true cost and sustainability of various water sources is critical to making better water management decisions, including choices about alternative water supply sources such as desalination.

Engage the Research Community: A larger, internationally focused conference on the broader impacts of desalination, hosted by, for example, the Monterey Bay Aquarium or other entities, would broaden the perspective of lessons from other nations as they address similar water supply issues through desalination technologies.

Clarify the Design, Siting, Operation and Water Supply Specifications of Sustainable Desalination: A variety of factors affect the overall environmental impact of desalination – size, energy consumption, the relevant water demand, the facility location, and the intake and discharge factors discussed in this report. Decisions about building and permitting desalination facilities, as well as public understanding, could benefit from a more integrated approach to these issues and a vision for what constitutes sustainable desalination, what was referred to by some conference participants as "desalination done right." Research areas include evaluating a framework for sustainable desalination, including true water needs, other potential water sources, best methods of water distribution, social and economic implications, greenhouse gas emissions and other factors, and then developing policies or other tools would promote that vision.

Define Attributes for Appropriate Siting: Previous siting for desalination facilities has been opportunistic and driven mainly by short-term economic interests. A spatial planning tool that includes a series of key ecological and community-based planning considerations (for example, coastal development type, value and status of marine ecosystem and proximity to high value areas) could aid water infrastructure planners, regulators and other decision-makers in making smart siting and planning decisions for future ocean desalination projects, and could complement California's new permitting policy. Developing a consensus around key factors to include in such a tool, and developing the tool itself, is an area ripe for future research and development. For example, the most prevalent impacts to coastal ecosystems from intakes and discharges may be reduced or alleviated by siting facilities in areas that are less environmentally sensitive.

Better Define Processes and Requirements for Public and Private Projects: The conference included discussion of at least two discernible categories of projects: public projects sponsored by water utilities and tailored to current and anticipated local demand, and private projects sponsored by for-profit companies in anticipation of future demand. Analysis of differences between public projects and private projects would provide clarity on the distinct processes and requirements in place for larger projects sponsored by private developers and smaller, more targeted public water supply projects. Although this distinction and its implications were discussed in the dialogue, the problem statement and its relevant considerations were not well defined. Future research could include analysis of the role that different projects might play in California under different policy scenarios, or how different economic drivers and regulatory regimes might affect key aspects of desalination projects and other issues.

Require and Conduct Sufficient Long-Term Monitoring of Impacts: California is unique, and its complex shoreline is diverse in terms of form, function and processes. Comprehensive monitoring should be required and conducted to understand the relatively novel impacts of desalination along California's complex shore. In particular, long-term monitoring of the point source and cumulative impacts of brine disposal is warranted. Similarly, the long-term implications of subsurface intakes should be monitored, including initial disturbance to place the infrastructure, any disturbance associated with maintenance, and any accumulated long-term impacts associated with the technique.

Advance Technological Research: Advancing knowledge about relationships between intake mortality and ecosystem health would be beneficial. Similarly, innovative technologies for monitoring the effects of brine outflows that include remote sensing and autonomous underwater vehicles would provide more data and a means to decrease impact on coastal ecosystems.

APPENDIX A: WORKSHOP AGENDA

Uncommon Dialogue: Marine and Coastal Impacts of Desalination in California

January 14-15, 2016
Harborview Conference Room
99 Pacific St., Suite 100A, Monterey, CA

Workshop Description

Dialogue Goals and Objectives:

1. Exchange information and promote an open discussion regarding best available science, technology, and policy on marine and coastal impacts of desalination projects in California and elsewhere.
2. Identify key issues and knowledge gaps for both research and policy development with respect to marine and coastal impacts of desalination in California and elsewhere.

Possible Dialogue Outputs:

1. Report or white paper for the research and NGO communities highlighting key issues and recommendations for further work.
2. One or more policy briefs targeted directly at key decision-makers working on desalination issues in California.
3. Building relationships between the conference sponsors (Stanford, Monterey Bay Aquarium, The Nature Conservancy) and policy-makers and researchers to help move forward on effective work related to marine and coastal impacts of desalination.

Meeting Details:

When: January 14-15, 2016 (1.5 days)
Where: Monterey Bay Aquarium Heritage Harbor Conference Room
Hotel: InterContinental – The Clement Monterey, 750 Cannery Row

Attendees:

The workshop will be attended by a selected group of approximately 35 representatives of NGOs, government agencies, and research institutions focused on marine and coastal environments and water management, primarily in California.

Conference Hosts and Sponsors:

- Stanford University Woods Institute for the Environment: Water in the West and Center for Ocean Solutions
- Monterey Bay Aquarium
- The Nature Conservancy

AGENDA

Thursday, January 14

9:00 – 9:30 **Light Breakfast**

9:30 – 10:00 **Welcome & Introductions**

10:00 – 12:00 **Session I: Potential scope of ocean desalination in California and current regulatory context**

Panel Speakers

Newsha Ajami, Water in the West
Topic: Overview of potential extent of ocean desalination in California, including currently planned or proposed facilities, potential quantities of water, and potential role in California's water supply portfolio.

Tom Luster, California Coastal Commission
Topic: Overview of state policies and regulations with respect to ocean desalination facilities.

Moderated Discussion (Ashley Erickson, Center for Ocean Solutions)

Potential Topics for Discussion:

- Projected water resources outlook for California and the potential role of ocean desalination in the state's water supply portfolio.
- Likely locations of future facilities.
- Role of desalination in the context of other "new" sources of water, including conservation and reclamation.
- Desalination's potential to displace water demand from stressed surface and ground waters.
- How current policies and agency resources will address the challenges of the pace of desalination development in California.

12:00 – 1:00 **Lunch**

1:00 – 2:45 **Session II: Sea water intakes**

Panel Speaker

Peter Raimondi, University of California at Santa Cruz
Topic: Overview of impacts of ocean intakes on the marine environment, mitigation strategies, and implications of the new California policy regarding ocean intakes.

Moderated Discussion (Letise LaFeir, Monterey Bay Aquarium)

Potential Topics for Discussion:

- Comparison of seawater intake approaches.
- Adequacy of existing data, studies, and other information for understanding intake impacts and how best to mitigate them.
- Experience in California with marine impacts of ocean water intakes, including desalination facilities and power plants.
- California policies and regulations, including compensatory mitigation frameworks and assessment of gaps.
- How intake issues, including relevant California policy, affect siting possibilities and decisions.

2:45 – 3:00 **Break**

3:00 – 5:00 **Session III: Siting issues and community impacts**

Panel Speakers

Walter Heady, The Nature Conservancy
Topic: Overview of spatial considerations for desalination development in California including marine and coastal habitats, vulnerability to sea level rise, and other environmental and infrastructure considerations.

Jason Burnett, Mayor, Carmel-by-the-Sea
Topic: Community perspective on desalination approval and siting decisions, including overview of process for proposed desalination facility on the Monterey Peninsula.

Moderated Discussion (Lily Verdone, The Nature Conservancy)

Potential Topics for Discussion:

- Lessons learned from the approval and siting process for desalination plants in California to date.
- The interrelationship between once through cooling power plants and desalination plants, and the potential need to move away from colocation under new California policy regarding intakes.
- Climate impacts of desalination, and impacts of climate change (ocean level rise) on siting decisions.
- The impacts and benefits of desalination facilities for coastal communities.
- The community dynamics related to the need for desalination and the facility approval process.

5:30 – 6:30 **Reception at The InterContinental Hotel – The Clement Monterey**

6:30 – 7:30 **Dinner**

Friday, January 15

8:00 – 9:00 **Breakfast**

9:00 – 10:30 **Session IV: Brine disposal**

Panel Speaker

Phillip Roberts, Georgia Institute of Technology
Topic: Overview of potential marine impacts of brine disposal, state of knowledge about those impacts, and existing technology for brine disposal.

Moderated Discussion (Jeff Koseff, Stanford Woods Institute for the Environment)

Potential Topics for Discussion:

- Adequacy of existing data, studies, and other information for understanding brine impacts and how to best mitigate them.
- Assessment of technologies and methods for mitigation of brine disposal effects.
- How potential impacts may vary in different coastal environments in California.
- California policies and regulations, including assessment of gaps.

10:30 – 10:45 **Break**

10:45 – 12:00 **Session V: Wrap up – Leon Szeptycki, Water in the West**

12:00 – 1:00 **Lunch**

APPENDIX B: PARTICIPANT LIST

Newsha Ajami, Water in the West (Organizing Committee)
Matt Armsby, Resources Legacy Fund
Steven Bay, Southern California Coastal Water Research Project
John Bohn, DeepWater Desal, LLC
Kristi Boosman, Center for Ocean Solutions (Note Taker)
Jason Burnett, Carmel-by-the-Sea, CA
Meg Caldwell, David and Lucile Packard Foundation
Heather Cooley, Pacific Institute
Larry Crowder, Stanford University
Ashley Erickson, Center for Ocean Solutions (Organizing Committee)
Karen Grimmer, Monterey Bay National Marine Sanctuary
Eric Hartge, Center for Oceans Solutions (Organizing Committee)
Walter Heady, The Nature Conservancy (Organizing Committee)
Tim Hogan, Alden Research Laboratory
Charlie Hogg, Stanford University
Susan Jordan, California Coastal Protection Network
Jeffrey Koseff, Stanford Woods Institute for the Environment (Organizing Committee)
Manish Kumar, Penn State University
Letise LaFeir, Monterey Bay Aquarium (Organizing Committee)
Minh Le, Executive Office of the President
Tom Luster, California Coastal Commission
Robert MacLean, California American Water
Sandi Matsumoto, The Nature Conservancy
Barbara Meister, Monterey Bay Aquarium (Organizing Committee)
Molly Melius, Stanford University
Sarah Newkirk, The Nature Conservancy
Joe Phelan, Tenera
Pete Raimondi, University of Santa Cruz
Carol Reeb, Hopkins Marine Station, Stanford University
Philip Roberts, Georgia Institute of Technology
Athena Serapio, Water in the West (Event Coordinator)
Deborah Sivas, Stanford University
Margaret Spring, Monterey Bay Aquarium
Leon Szeptycki, Water in the West (Organizing Committee)
Lily Verdone, The Nature Conservancy (Organizing Committee)
Kristen Weiss, Center for Ocean Solutions (Note Taker)
Paige Welsh, Center for Ocean Solutions (Note Taker)
Vicky Whitney, State Water Resources Control Board
Eric Zigas, Environmental Science Associates

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Ecological Rights Foundation (ERF), the Center for Biological Diversity (CDB), and Our Children's Earth Foundation (OCEF) - Attachments

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Stanford Woods Institute for the Environment | Water in the West | Center for Ocean Solutions | Monterey Bay Aquarium | The Nature Conservancy

MONTEREY PENINSULA WATER MANAGEMENT DISTRICT

MPWMD REGULATION XV

2016 MONTEREY PENINSULA

WATER CONSERVATION

AND

RATIONING PLAN

(MPWMD Rules 160-167)

Ordinance No. 169 - adopted February 17, 2016

5 Harris Court, Building G, Monterey, CA 93940 • P.O. Box 85, Monterey, CA 93942-0085
831-658-5601 • Fax 831-644-9558 • www.mpwmd.net • www.montereywaterinfo.org

Contents

<u>Regulatory Production Targets And Physical Storage Target (MPWMD Rule 160)</u>

The monthly distribution of water production from sources within the Monterey Peninsula Water Resource System (MPWRS), as shown in Tables XV-1, XV-2, and XV-3 shall be approved by the Board of Directors as part of the Quarterly Water Supply Strategy and Budget process. The Board shall hold public hearings during the Board's regular meetings in September, December, March, and June, at which time the Board may modify Tables XV-1, XV-2, and XV-3 by Resolution.

The Physical Storage Target, as shown in Table XV-4 shall be approved as of May 1 each year by the Board of Directors. The Board shall hold a public hearing during the Board's regular meeting in May, at which time the Board may modify Table XV-4 by Resolution.

Table XV-1
Regulatory Water Production Targets
For All California American Water Systems
With Sources from Within the Monterey Peninsula Water Resource System
(All Values in Acre-Feet)
Adopted September 21, 2015

Month	Monthly Target	Year-to-Date at Month-End Target
October	1,076	1,076
November	904	1,980
December	796	2,776
January	797	3,573
February	748	4,321
March	850	5,171
April	914	6,085
May	1,112	7,197
June	1,157	8,354
July	1,258	9,612
August	1,239	10,851
September	1,151	12,002
TOTAL	12,002	---

Notes:
Monthly and year-to-date at month-end production targets are based on the annual production limit specified for the California American Water (Cal-Am) systems for Water Year (WY) 2016 from Carmel River sources per State Water Resources Control Board Order WR 2009-0060 (9,703 acre-feet) and adjusted annual production limits specified for the Cal-Am satellite systems from its Coastal Subarea sources (2,251 acre-feet) and Laguna Seca Subarea sources (48 acre-feet) of the Seaside Groundwater Basin per the Seaside Basin adjudication decision. These values do not include consideration of any carryover credit in the Seaside Basin for WY 2016. This combined total (12,002 acre-feet) was distributed monthly based on Cal-Am's reported monthly average production for its main and satellite systems during the WY 2006 through 2013 period.

Table XV-2
Regulatory Water Production Targets for California American Water Satellite Systems Not Within the Monterey Peninsula Water Resource System (All Values in Acre-Feet)

Adopted September 21, 2015

Month	Monthly Target	Year-to-Date at Month-End Target
October	5	5
November	3	8
December	3	11
January	3	14
February	2	16
March	3	19
April	3	22
May	5	27
June	5	32
July	6	38
August	5	43
September	5	48
TOTAL	48	---

Notes:
Monthly and year-to-date at month-end production targets are based on the adjusted annual production limit specified for the California American Water (Cal-Am) satellite systems for Water Year 2016 from its sources in the Laguna Seca Subarea of the Seaside Groundwater Basin per the Seaside Basin adjudication decision. This Laguna Seca Subarea total (48 acre-feet) was distributed monthly based on Cal-Am's reported monthly average production for its satellite systems during the WY 2006 through 2013 period.

Table XV-3
Regulatory Water Production Limits
For California American Water Systems from Carmel River Sources
Within the Monterey Peninsula Water Resource System
(All Values in Acre-Feet)
Adopted September 21, 2015

Month	Monthly Target	Year-to-Date at Month-End Target
October	869	869
November	730	1,599
December	644	2,244
January	645	2,889
February	605	3,494
March	687	4,181
April	740	4,920
May	899	5,820
June	934	6,754
July	1,017	7,771
August	1,002	8,773
September	930	9,703
TOTAL	9,703	---

Notes:
Monthly and year-to-date at month-end production targets are based on the annual production limit specified for California American Water (Cal-Am) for Water Year (WY) 2016 from its Carmel River system sources per State Water Resources Control Board Order WR 2009-0060 (9,703 acre-feet). This amount was distributed monthly based on Cal-Am's reported monthly average production for its Main system sources during the WY 2006 through 2013 period. These values incorporate consideration of the triennial reductions specified for the Cal-Am systems in the Seaside Basin adjudication decision, in setting the monthly maximum production targets from each

Table XV – 4
Physical Storage Target
for the Monterey Peninsula Water Resource System
for the Remainder of WY 2015 and all WY 2016
(All Values in Acre-Feet)
Adopted May18, 2015

Producer	May-September Demand	Carryover Storage Needs for Next Water Year Demand	Total Storage Required on May 1
Cal-Am	7,071	12,123	19,194
Non Cal-Am	1,946	3,046	4,992
Total	9,017	15,169	24,186
			Total Storage Available on May 1
			30,990 [5]

Notes:
1. The May-September period refers to the remainder of the current water year.

2. Carryover storage refers to the volume of usable surface and Groundwater that is in storage at the end of the current Water Year and is projected to be available for use at the beginning of the following Water Year.

3. Total storage required refers to the combination of demand remaining from May 1 to the end of the current Water Year and carryover storage for the next water year that is required to avoid imposing various levels of water Rationing. The values in bold type represent the storage triggers that would be used for the system in Water Year 2015. The values are based on the production limits for California American Water (Cal-Am) from Carmel River sources (9,945 Acre-Feet in WY 2015 and 9,824 Acre-Feet in WY 2016) set by State Water Resources Control Board Order WR 2009-0060, the production limit for Cal-Am from the Seaside Groundwater Basin (2,299 Acre-Feet in WY 2015 and in WY 2016) set by the Court in its March 27, 2006 Seaside Basin Adjudication Decision, and the production limit specified for non Cal-Am Users from the Monterey Peninsula Water Resource System set in the District's Water Allocation Program (Ordinance No. 87.)

4. The Rationing triggers are based on physical water availability and do not account for legal or environmental constraints on diversions from the Carmel River system

5. May 1, 2015 System Storage = 30,990 Acre-Feet (26,220 Acre-Feet Carmel Valley Alluvial Aquifer; 3,100 Acre-Feet Seaside Groundwater Basin; 1,670 Acre-Feet Los Padres Reservoir); this is 97 percent of average and 82 percent of System Capacity (37,505 AF).

General Provisions (MPWMD Rule 161)

A. All Water Users within the Monterey Peninsula Water Management District shall comply with the District's Water Waste Prohibitions of Rule 162 and with the requirements of MPWMD Regulation XIV, Water Conservation.

B. California American Water shall amend its Urban Water Management Plan and its Rule 14.1.1 (Standard Practice U-40-W), Water Shortage Contingency Plan - Monterey County District, to conform to this Regulation. A copy of Rule 14.1.1 shall be filed with the California Public Utilities Commission (CPUC) and the District within thirty (30) days of the effective date of this Regulation and any amendment thereto.

C. Water Distribution Systems regulated by the CPUC shall amend their Rule 14.1 to conform to this Regulation. A copy of Rule 14.1 shall be filed with the California Public Utilities Commission (CPUC) and the District within thirty (30) days of the effective date of this Regulation and any amendment thereto.

D. At least ten (10) days prior to a first reading of amendments to Regulation XV, a copy of the proposed changes shall be provided to the CPUC Office of Ratepayer Advocates (ORA).

E. California American Water shall provide the District with monthly consumption reports by customer classification and jurisdiction in a format approved by the District. A Water Year summary report shall be provided by December 1 of the next Water Year. Monthly reports shall be provided within fifteen (15) days of the close of the preceding month.

F. Each Water Distribution System Operator shall provide individual consumption data pertaining to any Water User of that Water Distribution System upon written request of the General Manager. Data shall be in the form and manner specified by the General Manager and may be subject to a non-disclosure agreement with the Water Distribution System Owner/Operator. Each failure to respond in full to such written request by the date specified therein shall result in a penalty to the Water Distribution System of five-hundred dollars ($500) per day for each day or portion thereof that the response is delayed.

G. The General Manager shall retain and use any data received under this provision for the sole purposes of testing, administering, evaluating or enforcing water Rationing, Water Waste, or other provisions of the Rules and Regulations.

H. California American Water shall maintain Non-Revenue Water in its Water District Systems at or below seven (7) percent. Average losses of more than seven (7) percent during the most recent twelve-month period shall be considered Water Waste.

I. Each Water Distribution System Operator shall provide written notice of any adjustment to a Water Conservation or Rationing Stage to every customer via first class mail at least thirty (30) days before any change in Stage is imposed.

J. At all times during Stages 2 through 4 each affected Water Distribution System shall send monthly conservation reminders.

K. During a Water Supply Emergency, or at the direction of the Board of Directors, each Owner or Operator or Extractor of a private water Well, Water Distribution System, or other Water-Gathering Facility shall comply with the provisions of this Regulation, as they relate to such Well, Water Distribution System, or other Water-Gathering Facility.

Stage 1 Water Conservation: Prohibition on Water Waste (MPWMD Rule l62)

A. Trigger. Stage 1 shall remain in effect at all times and shall apply to all Water Users subject to modification by the Board.

B. Water Waste Prohibitions. Water Waste shall mean the indiscriminate, unreasonable, or excessive running or dissipation of water. Water Waste shall include, but not be limited, to the following:

1. Waste caused by correctable leaks, breaks or malfunctions. All leaks, breaks, or other malfunctions in a Water User's plumbing or distribution system must be repaired within 72 hours of notification that a leak exists. Exceptions may be granted by the General Manager for corrections, which are not feasible or practical;

2. Indiscriminate or excessive water use which allows excess to run to waste;

3. Washing driveways, patios, parking lots, tennis courts, or other hard surfaced areas with Potable water, except in cases where health or safety are at risk and the surface is cleaned with a Water Broom or other water efficient device or method. Water should be used only when traditional brooms are not able to clean the surface in a satisfactory manner;

4. Power or pressure washing buildings and structures with Potable water, except when preparing surfaces for paint or other necessary treatments or when abating a health or safety hazard;

5. Irrigation between 9 a.m. and 5 p.m. on any day, and irrigation on any day other than Saturdays and Wednesdays, except for irrigation overseen by a professional gardener or landscaper who is available on Site and that is not exceeding a maximum two watering days per week. This prohibition applies to hand watering with a hose, and irrigation systems whether spray, drip, or managed by a Smart Controller. Limited hand watering of plants or bushes with a small container or a bucket is permitted on any day at any time. Subsurface Graywater Irrigation Systems may also be operated at any time. An exemption may be given to a Non-Residential establishment whose business requires water in the course of its business practice (e.g. golf courses, nurseries, recreational space, among others)

with notification by the business owner to the District, and subject to the approval of the General Manager;

6. Hand watering by a hose, during permitted hours, without a quick acting Positive Action Shut-Off Nozzle;

7. Irrigating during rainfall and for 48 hours after Measurable Precipitation;

8. Use of water for irrigation or outdoor purposes in a manner inconsistent with California's Model Water Efficient Landscape Ordinance (Code of Regulations, Title 23, Water, Division 2, Department of Water Resources, Chapter 2.7, and any successor regulations) where applicable, or in a manner inconsistent with local regulations;

9. Operation of fountains, ponds, lakes or other ornamental use of Potable water without recycling, and except to the extent needed to sustain aquatic life, provided such animals are of significant value and have been actively managed;

10. Individual private washing of cars with a hose except with the use of a Positive Action Shut-Off Nozzle;

11. Washing commercial aircraft, cars, buses, boats, trailers or other commercial vehicles with Potable water, except at water efficient commercial or fleet vehicle or boat washing facilities where equipment is properly maintained to avoid wasteful use;

12. In-Bay or Conveyor Car Washes permitted and constructed prior to January 1, 2014, that do not recycle and reuse at least 50 percent of the wash and rinse water. In-Bay or Conveyor Car Washes that were permitted and constructed after January 1, 2014, that do not either (1) use and maintain a water recycling system that recycles and reuses at least 60 percent of the wash and rinse water; or (2) use recycled water provided by a water supplier for at least 60 percent of its wash and rinse water;

13. Charity car washes;

14. Use of Potable water for street cleaning;

15. Failure to meet MPWMD Regulation XIV water efficiency standards for an existing Non-Residential User after having been given a reasonable amount of time to comply;

16. Serving drinking water to any customer unless expressly requested, by a restaurant, hotel, café, cafeteria or other pubic place where food is sold, served or offered for sale;

17. Visitor-Serving Facilities that fail to adopt and promote towel and linen reuse programs and provide written notice in the rooms, whereby towels and linens are changed every three days or as requested by action of the guest;

18. Washing of livestock with a hose except with the use of a Positive Action Shut-Off Nozzle;

19. Transportation of water from the Monterey Peninsula Water Resource System without prior written authorization from the MPWMD;

20. Delivery, receipt, and/or use of water from an unpermitted Mobile Water Distribution System;

21. Unreasonable or excessive use of Potable water for dust control or earth compaction without prior written approval of the General Manager where Sub-potable water or other alternatives are available or satisfactory;

22. Use of unmetered fire hydrant water by individuals other than for fire suppression or utility system maintenance purposes, except upon prior approval of the General Manager;

23. Water use in excess of a Water Ration;

24. Non-compliance with Regulations XIV and XV;

C. The following activities shall not be cited as Water Waste:

1. Flow resulting from firefighting or essential inspection of fire hydrants;

2. Water applied to abate spills of flammable or otherwise hazardous materials, where water application is the appropriate methodology;

3. Water applied to prevent or abate health, safety, or accident hazards when alternate methods are not available;

4. Storm run-off;

5. Flow from fire training activities during Stage 1 Water Conservation through Stage 3 Water Conservation;

6. Reasonable quantities of water applied as dust control as required by the Monterey Bay Unified Air Pollution Control District, except when prohibited;

7. When a Mobile Water Distribution System Permit is not obtained by a State licensed Potable water handler by reason of an emergency or health related situation, authorization for the Mobile Water Distribution System Permit shall be sought from the District by submittal of a complete application compliant with Rule 21, within five working days following commencement of the emergency or health related event.

D. Prohibitions against Water Waste and Non-Essential Water Use shall be enforced by the District and its designated agents, unless indicated otherwise. All notices and assessments of Water Waste and/or excess water use charges made by a Water Distribution System Operator shall be reported to the District within thirty (30) days.

E. Each occurrence of Water Waste or Non-Essential Water Use that continues after the Water User has had reasonable notice to cease and desist that type of water use shall constitute a Flagrant Violation.

F. Repeated occurrences of Water Waste or Non-Essential Water Use, which continue or occur after the Water User has had a reasonable notice to cease and desist that type of water use, or which continues or occurs after the Water User has had a reasonable opportunity to cure any defect causing that type of water use, shall provide cause for the placement of a Flow Restrictor with a maximum flow rate of six (6) CCF/month within the water line or Water Meter. Exemptions to the installation of a Flow Restrictor as a means to enforce the Water Ration shall occur when there are provable risks to the health, safety and/or welfare of the Water User. An exemption shall be made for Master Meters serving three or more Multi-Family Households or Master Meters serving both

Residential and Non-Residential Users by substituting an excess water use charge equivalent to the appropriate Water Meter size, Rationing stage, and 4th offense amount times the number of Dwelling Units located on the Water Meter during each month in which a violation of the Water Ration occurs. The Responsible Party shall be liable for payment of all excess water use charges.

G. Water Waste Fines shall be assessed as shown in Table XV-5. Table XV-5 may be amended by Resolution of the Board. Amendments to this table shall be concurrently made to the Fees and Charges Table found in Rule 60.

Table XV-5 Water Waste Fines	
First offense	No fee: Written notice and opportunity to correct the situation
Fine for first Flagrant Violation	$100*
Fine for second Flagrant Violation within two (2) months	$250*
Fine for third and subsequent Flagrant Violations within twelve (12) months	$500*
Fine for Administrative Compliance Order or Cease & Desist Order	Up to $2,500 per day* for each ongoing violation, except that the total administrative penalty shall not exceed one hundred thousand dollars ($100,000.00) exclusive of administrative costs, interest and restitution for compliance re-inspections, for any related series of violations
Late payment charges	Half of one percent of the amount owed per month
*Fines triple for customers using over 500,000 gallons/year	

H. In addition to Water Waste fines and fees described in this Rule 162, enforcement of all District Rules and Regulations is subject to District Regulation XI and may include an Administrative Compliance Order, a Cease & Desist Order, or other remedy available to the District under its Regulation XI.

Stage 2 Water Conservation: Voluntary Reduction in Use (MPWMD Rule 163)

A. Trigger.

1. Physical Shortage Trigger (California American Water Company Distribution Systems): Stage 2 shall take effect for all California American Water Company Water Distribution Systems that rely, in whole or in part, on production or production offsets from the Carmel River System or the Seaside Coastal Subareas, on June 1 or such earlier date as may be set by the Board following the District's May Board meeting if Total Storage Available in Table XV-4 is below the Total Storage Required, but at least 95 percent of Total Storage Required. The amount of voluntary reduction shall equal the percentage shortfall in Total Storage Required.

2. Physical Shortage Trigger (Non-California American Water Company Distribution Systems): Stage 2 shall take effect for any Water Distribution System, other than California American Water Company's Water Distribution Systems, that relies in whole or in part on production or production offsets from the Carmel River System or the Seaside Coastal Subareas on June 1 or such earlier date as may be set by the Board following the District's May Board meeting if Total Storage Available in Table XV-4 is below the Total Storage Required. The amount of voluntary reduction shall equal the percentage shortfall in Total Storage Required.

3. Regulatory Trigger – Production Targets: Stage 2 shall take effect on the California American Water Company Water Distribution System when the most recent 12 month California American Water production from the MPWRS is greater than the then-current annual production target as determined in Table XV-1 but no greater than 105 percent of the annual production target. The amount of voluntary reduction shall equal the percentage overage of the annual production.

4. Regulatory Trigger – Regulatory Order: Stage 2 shall take effect in any Water Distribution System when that system is directed to reduce use by a governmental or regulatory agency. The amount of voluntary reduction shall equal the percentage directed by that governmental or regulatory agency relative to a base year determined by the governmental or regulatory agency.

5. Emergency Trigger: Stage 2 shall take effect for any Water Distribution System,

private Well, or Water User when the Board finds that a Water Supply Emergency exists for a Water Distribution System. Stage 2 shall take effect upon adoption of a Resolution of the District Board of Directors, or a declaration of a Water Supply Emergency by the Water Distribution System Operator or a State or County entity, due to a catastrophic event. In that Resolution or declaration, there shall be a finding of an immediate need to reduce production and shall name the Water Distribution System(s) affected. The amount of voluntary reduction shall be determined by the Board, the Water Distribution System Operator, or the State or County entity.

B. The Water Distribution System Owner or Operator shall provide notice of the amount of voluntary reduction requested to affected Water Users pursuant to Rule 161. Additional noticing and public outreach may be provided by the District at the direction of its Board of Directors.

C. The District and its agents shall increase enforcement activities related to Water Waste prohibitions.

D. Stage 1 shall remain in effect.

E. Sunset.

1. Without further action of the Board of Directors, Stage 2, when implemented pursuant to Rule 163-A-1 and Rule 163-A-2, shall sunset and water use restrictions shall revert to Stage 1 when remaining Total Storage Available computed consistent with Table XV-4 is greater than remaining Total Storage Required for two (2) consecutive months.

2. Without further action of the Board of Directors, Stage 2, when implemented pursuant to Rule 163-A-3, shall sunset for the California American Water Company and water use restrictions shall revert to Stage 1 when that Water Distribution System's 12 month total production has been less than or equal to its then-current annual production target for two (2) consecutive months.

3. Without further action of the Board of Directors, Stage 2, when implemented pursuant to Rule 163-A-4, shall sunset for that Water Distribution System(s) and water use restrictions shall revert to Stage 1 when the governmental or regulatory agency rescinds the request.

4. Stage 2, when implemented pursuant to Rule 163-A-5, shall sunset and water use restrictions shall revert to Stage 1 when the Board finds that a Water Supply Emergency no longer exists.

Stage 3 Water Conservation: Conservation Rates (MPWMD Rule 164)

A. Trigger.

1. Stage 2 Deemed Unsuccessful: Stage 3 shall take effect for all California American Water Company Water Distribution Systems if Stage 2 has been implemented pursuant to Rule 162-A-1 or Rule 162-A-3 and has failed to sunset after a period of six (6) months.

2. Physical Shortage Trigger: Stage 3 shall take effect for all California American Water Company Water Distribution Systems, on June 1, or such earlier date as may be set by the Board following the District's May Board meeting, if Total Storage Available in Table XV-4 is below 95% of Total Storage Required.

3. Regulatory Trigger – Production Targets: Stage 3 shall take effect for all California American Water Company Water Distribution Systems when the most recent 12 month California American Water production from the MPWRS is greater than 105 percent of the then-current annual production target as determined in Table XV-1 and Stage 2 has not been implemented.

4. Regulatory Trigger – Regulatory Order: Stage 3 shall take effect for all California American Water Company Water Distribution Systems when directed by a governmental or regulatory agency to implement Stage 3.

5. Emergency Trigger: Stage 3 shall take affect for all California American Water Company Water Distribution Systems when the Board finds that a Water Supply Emergency exists and upon adoption of a Resolution of the Board of Directors, or a declaration of a Water Supply Emergency by California American Water, or by a State or County entity due to a catastrophic event. In that Resolution or declaration, there shall be a finding of an immediate need to reduce production through the imposition of Stage 3 Conservation Rates.

B. Stages 1 and 2 shall remain in effect.

C. If Stage 2 has not already been implemented, Stage 2 shall be triggered simultaneously with Stage 3.

D. Thirty days prior to implementation of Stage 3, California American Water shall file to implement Level 1 Conservation Rates within its Main California American Water Company Water Distribution System, the Bishop Water Distribution System, Hidden Hills System, and Ryan Ranch Water Distribution System and shall provide notification to its customers that such rates shall be implemented after thirty (30) days. Prior to an increase to Level 2 Conservation Rates, California American Water shall provide notification to its customers that such rates shall be implemented after thirty (30) days.

1. Level 1 Conservation Rates comprised of a 25 percent surcharge shall be implemented on the then existing rates for a minimum of three (3) months. The surcharge shall not apply to Tier 1 Residential customers.

2. Level 2 Conservation Rates comprised of a 40 percent surcharge shall be implemented on the then existing rates (without the 25 percent Level 1 surcharge) if after the imposition of Level 1 Conservation Rates for three (3) months, the monthly production in the California American Water System exceeds the monthly production target for the previous two (2) consecutive months. The surcharge shall not apply to Tier 1 Residential customers.

E. Sunset.

1. Without further action of the Board of Directors, Stage 3, when implemented pursuant to Rule 164-A-2, shall sunset and water use restrictions shall revert to Stage 1 when remaining Total Storage Available computed consistent with Table XV-4 is greater than remaining Total Storage Required for two (2) consecutive months.

2. Without further action of the Board of Directors, Stage 3, when implemented pursuant to Rule 164-A-3, shall sunset and water use restrictions shall revert to Stage 1 when the 12 month total production has been less than or equal to its then-current annual production target for two (2) consecutive months.

3. Without further action of the Board of Directors, Stage 3, when implemented pursuant to Rule 164-A-4, shall sunset and water use restrictions shall revert to Stage 1 when the governmental or regulatory agency rescinds the request.

4. Stage 3, when implemented pursuant to Rule 164-A-5, shall sunset and water use restrictions shall revert to Stage 1 when the Board finds that a Water Supply Emergency no longer exists and Rules 164-A-2 and 164-A-3 do not apply.

Stage 4: Water Rationing (MPWMD Rule 165)

A. Trigger.

1. Stage 3 Deemed Unsuccessful (California American Water Company Distribution Systems): Stage 4 shall take effect for all California American Water Company Water Distribution Systems if Stage 3 has been implemented and has failed to sunset after a period of 8 months.

2. Physical Shortage Trigger. Stage 3 Deemed Unsuccessful for California American Water Company Distribution Systems and Stage 2 Deemed Unsuccessful for Non-California American Water Systems: Stage 4 shall take effect for any Water Distribution System that relies, in whole or in part, on production or production offsets from the Carmel River System or the Seaside Coastal Subareas if Stage 2 (Non-California American Water Company Water Distribution Systems, private Wells, or Water Users) and Stage 3 (California American Water Company Distribution Systems) have been implemented and have failed to sunset after a period of eight (8) months.

3. Regulatory Trigger: Stage 4 shall take effect in any Water Distribution System when that system is directed by a governmental or regulatory agency to enact Stage 4.

4. Emergency Trigger: Stage 4 shall take effect for any Water Distribution System, private Well, or Water User when the Board finds that a Water Supply Emergency exists and upon adoption of a Resolution of the Board of Directors, or a declaration of a Water Supply Emergency by the Company, or a State or County entity, due to a catastrophic event. In that Resolution or declaration, there shall be a finding of an immediate need to reduce production through the imposition of Stage 4 Water Rationing.

5. Stage 4 shall not be triggered if the General Manager determines upon credible evidence that the production targets associated with a final Cease and Desist Order are likely to be met by adhering to the requirements of a lesser Stage. The General Manager shall record this determination and any amendment thereto, by memorandum which may be appealed to the Board in accord with Regulation VII, Appeals.

6. Delay of Stage Implementation. The Board may delay implementation of Stage 4 Water Rationing for any Water Distribution System to ensure adequate operation of the program. Delays authorized by the Board shall not exceed sixty (60) days.

B. Amount of Reduction.

1. The amount of mandatory reduction shall equal the shortfall in Total Storage Available as compared to the Total Storage Required; or

2. The amount of mandatory reduction shall equal the overage of the last 12 months actual production as compared to the then-current annual production target; or

3. The amount of mandatory reduction shall equal some other amount as reflected in a governmental or regulatory order.

C. Stages 1, 2, and 3 (if applicable) shall remain in effect.

D. Additional Prohibitions.

1. The Board shall consider prohibiting all or specific Non-Essential Water Uses. The Board may enact such prohibitions by Resolution.

2. California American Water shall maintain Non-Revenue Water at or below seven (7) percent.

3. Moratorium. Upon implementation of Stage 4, the Board shall declare a moratorium on accepting Water Permit applications within the affected Water Distribution System other than those applications that rely upon a Water Credit, Water Use Credit, or Water Use Permit. The Board may amend the moratorium to include the use of Water Credits and/or Water Use Credits if warranted. All pending Water Permits not issued within 120 days of declaration shall be suspended. Water Use Permits shall be exempt from any moratorium on Water Permits.

4. No New Potable Water Service: Upon declaration of Stage 4 Water Rationing, no new Potable water service will be provided, no new temporary Water Meters or permanent Water Meters will be provided, and no statements of immediate ability to serve or provide Potable water service (e.g. will-serve letters, certificates, or

letters of availability) will be issued by the Water Distribution System Operator, except under the following circumstances:

a. The project is necessary to protect the public health, safety, or welfare;

b. The setting of meters in the California American Water Company Water Distribution System shall not be terminated or diminished by reason of any water emergency, water moratorium or other curtailment on the setting of meters for holders of Water Use Permits.

c. This provision does not preclude the resetting or turn-on of Water Meters to provide continuation of water service or the restoration of service that has been interrupted for a period of one year or less.

5. No New Annexations: Upon the declaration of a Stage 4, California American Water Company will suspend annexations to its Service Area. This subsection does not apply to boundary corrections and annexations that will not result in any increased use of water, or annexations required by a regulatory agency.

6. Customers utilizing portable Water Meters or hydrant Water Meters or using hydrants to fill water tanks without the use of a Water Meter, shall be required to cease use of the water, except upon prior approval of the General Manager. Portable Water Meters shall be returned to the Water Distribution System at least thirty (30) days before the implementation of Stage 4.

7. Draining and refilling of swimming pools or spas except (a) to prevent or correct structural damage or to comply with public health regulations, or (b) upon prior approval of the General Manager.

8. Restriction on Watering or Irrigating: Watering or irrigating of Lawn, landscape or other vegetated area with Potable water will be subject to restriction at the direction of the District. This restriction does not apply to the following categories of use, or where the District has determined that recycled Sub-potable water is available and may be applied to the use:

a. Businesses dependent on watering or irrigating in the course of business such as agriculture, nursery, and similar uses;

b. Maintenance of existing Landscaping necessary for fire protection;

c. Maintenance of existing Landscaping for soil erosion control;

d. Maintenance of plant materials identified to be rare or essential to the well-being of protected species;

e. Maintenance of Landscaping within active Public parks and playing fields, Day Care Centers and school grounds, provided that such irrigation does not exceed one (1) day per week;

f. Actively irrigated environmental mitigation projects.

E. Residential Rations.

1. Upon adoption of a Resolution by the Board for a specific reduction in Residential water use, daily Household Water Rations shall be set at a level to achieve the necessary reduction. In no case shall daily Household Water Rations be less than 90 gallons per Household. This shall be known as the Minimum Daily Water Ration.

   Where two or more Households are served by a Master Meter, it shall be the responsibility of the Water Users to divide the Water Rations among the Water Users.

2. Additional Water Rations for Large Households:

   Where four or more Permanent Residents occupy a single Household served by one Water Meter, the Minimum Daily Water Ration may be increased by the amounts listed below:

Number of Permanent Residents	Residential Household Gallons per Day
Fourth Permanent Resident	30
Fifth Permanent Resident	25
Sixth Permanent Resident	20
Seven or More Permanent Residents (Per Additional Resident)	15

3. Procedure for Obtaining Additional Water Rations for Large Households:

   a. The Applicant shall complete a Residency Affidavit (obtained from the District) that requests the name, age and verification of full-time Permanent Residents for each resident in the Household for which the additional Water Ration is requested. The information on the application shall be presented under penalty of perjury. The additional Water Ration request shall be submitted to the General Manager, who will approve or disapprove the request within 10 business days of submission of a completed application.

   b. If the application is disapproved, the General Manager will explain in writing the reason for the disapproval, and if the Applicant is not satisfied with the decision of the General Manager, the Applicant may appeal the General Manager's decision to the Board of Directors.

4. Procedure for Obtaining Additional Water Rations Where Two or More Households are Served by a Master Meter:

   a. The Applicant must fill out the required form that lists the number of Residences served by the Master Meter and submit a use permit issued by the Jurisdiction for the Multi-Residential Dwelling Units served by the Master Meter. The District shall retain the right to require Residency Affidavits to determine the appropriate Water Rations. The additional Water Ration request shall be submitted to the General Manager, who will approve or disapprove the request within 10 business days of submission of a completed application. The Application shall be submitted under penalty of perjury.

b. If the application is disapproved, the General Manager will explain in writing the reason for the disapproval, and if the Applicant is not satisfied with the decision of the General Manager, the Applicant may appeal the General Manager's decision to the Board of Directors.

5. Additional Water Ration for Special Needs. Where more water than allowed in Sections 3 or 4 above is necessary to preserve the health or safety of a Household, the General Manager may increase the Water Ration during the period of need according to the needs of the Applicant.

   a. The Applicant or his or her representative may file a request for an additional Water Ration and shall state to the General Manager: (1) the amount of the requested additional Water Ration, and (2) a general statement in support of the need. Where appropriate, Applicant shall provide a letter from a medical doctor stating the need for additional water usage and projected amount and duration of that need, if possible, or other appropriate justification for the special need.

   b. Additional Water Rations shall require the replacement of inefficient water fixtures to comply with Rule 142-E, Residential and Non-Residential Change of Ownership, Change of Use, and Expansion of Use Water Efficiency Standards.

   c. Additional Water Rations shall require the Connection have a working Pressure Regulating Valve that maintains water pressure at a maximum of 60 psi.

   d. If the General Manager does not approve an additional Water Ration, the Applicant may appeal to the Board. An appeal from the General Manager's decision must contain all of the following: (a) a copy of the original application; (b) a copy of the written explanation of the General Manager's decision; and (c) a written explanation of why the Applicant believes the decision should be changed.

6. Misrepresentation. Any Water User intentionally over-reporting the number of Permanent Residents in a Household may be charged with a misdemeanor punishable as an infraction as provided by Section 256 of the Monterey Peninsula Water Management District Law, Statutes of 1981, Chapter 986, as well as fines

and penalties set forth in this Regulation. During this Stage 4, whenever there is a change in the number of Permanent Residents, the Water User shall notify the District.

F. Non-Residential Water Rations.

1. If Residential Water Rationing does not achieve measurable results as expected after a period of six (6) months, upon adoption of a Resolution by the Board for a specific reduction in Non-Residential water use, Non-Residential Water Rations shall be implemented at a level to achieve the necessary reduction in use.

2. Non-Residential Water Rations shall be determined by selection by the District of a previous year for which Stages 2, 3, or 4 Conservation or Rationing was not in place and then reducing each month's water use by a percentage determined by the District to achieve the Non-Residential reduction in use. Where a previous year history is deemed to be unavailable or inappropriate by the District, a Non-Residential Water Ration shall be established by the District based on type of Non-Residential water use, building design, and water fixtures.

3. Exemptions: In the Resolution to implement a level of Non-Residential Rationing, the Board shall include an exemption for compliance with District Rule 143 and an exemption for a Non-Residential establishment whose business requires water in the course of its business practice (e.g. laundromats, nurseries, among others.)

4. An Applicant or his or her representative may file a request for an additional Water Ration. The Applicant shall state in a letter to the General Manager: (1) the amount of the requested additional Water Ration, and (2) a general statement in support of the need.

5. Additional Water Rations shall require the Connection have a working Pressure Regulating Valve that maintains water pressure at a maximum of 60 psi.

6. If the request for additional Water Ration is disapproved, the General Manager will explain in writing the reason for the disapproval, and if the Applicant is not satisfied with the decision of the Board, the Applicant may appeal to the Board of Directors for a hearing.

G. Irrigation required by the Mitigation Program adopted when the Water Allocation

Program Environmental Impact Report was adopted in 1990, and as required by SWRCB Order No. WR 95-10, shall not be subject to reductions in use. Required irrigation of the Riparian Corridor shall be identified and reported by California American Water separately from other non-revenue water.

H. CAWD/PBCSD Wastewater Reclamation Project Recycled Water Users. Recycled Water Irrigation Areas receiving water from the CAWD/PBCSD Wastewater Reclamation Project shall be subject to Stage 4 for Potable water used during an Interruption or emergency, in accordance with contractual Agreements between the District and the respective Owners of the Recycled Water Irrigation Areas.

1. The Owners of the Recycled Water Irrigation Areas shall have the respective irrigation requirements thereof satisfied to the same degree as any non-Project Golf Course or open space which derives its Source of Supply from the California American Water system. The irrigation requirements of the Recycled Water Irrigation Areas will be determined based on the most-recent non-Rationed four-year average irrigation water demand, including both Recycled Water and Potable water, for each respective Recycled Water Irrigation Area.

2. Each Recycled Water Irrigation Area shall be entitled to receive the average irrigation requirement determined above, reduced by the percentage reduction required by the current stage of Water Rationing. If the quantity of Recycled Water that is available is less than the quantity of water that the Recycled Water Irrigation Area is entitled to, Potable water shall be provided to make up the difference and satisfy the irrigation requirements of the Recycled Water Irrigation Areas to the same degree that the irrigation requirements of non-Project Golf Course and open space Users are being satisfied. The preceding sentence shall not apply to the extent that the irrigation requirements of any Recycled Water Irrigation Area are met with water legally available to Buyer from any source other than the Carmel River System or the Seaside Groundwater Basin, including percolating Groundwater underlying Buyer's Property, to make up any such difference.

3. When Recycled Water (as defined in Rule 23.5) is available in sufficient quantities to satisfy the irrigation requirements of the Recycled Water Irrigation Areas, such irrigation shall not be subject to Stage 4, and neither Potable water nor any water described in the preceding sentence (whether or not it is Potable) shall be used for irrigation of the Recycled Water Irrigation Areas except to the

extent allowed in the circumstances described in the next two sentences.

4. If there is an Interruption in Recycled Water deliveries to any Recycled Water Irrigation Area (as the capitalized terms are defined in Rule 23.5), the temporary use of Potable water for irrigating each such Recycled Water Irrigation Area is authorized in the manner described in Rule 23.5, Subsection F.

5. If the District has adopted an ordinance in response to any emergency caused by drought, or other threatened or existing water shortage pursuant to section 332 of the Monterey Peninsula Water Management Law, said ordinance shall prevail over contrary provisions of this Rule. Notwithstanding the preceding sentence, Potable water shall be made available for irrigating tees and greens of the Recycled Water Irrigation Areas in sufficient quantities to maintain them in good health and condition during an Interruption, without any limitation on the duration.

6. The District shall have no obligation to furnish Potable water for irrigation of the Recycled Water Irrigation Areas except in the circumstances set forth above.

7. If (1) an emergency or major disaster is declared by the President of the United States, or (2) a "state of war emergency," "state of emergency," or "local emergency," as those terms are respectively defined in Government Code section 8558, has been duly proclaimed pursuant to the California Emergency Services Act, with respect to all or any portion of the territory of MPWMD, the provisions of this section shall yield as necessary to respond to the conditions giving rise to the declaration or proclamation.

I. Sunset.

1. Without further action of the Board of Directors, Stage 4, when implemented due to non-compliance with regulatory targets, shall sunset for all California American Water Company Water Distribution Systems and water use restrictions shall revert to Stage 1 when the 12 month total production has been less than or equal to its then-current annual production target for two (2) consecutive months.

2. Physical Shortage Trigger: Without further action of the Board of Directors, Stage 4 shall sunset and water use restrictions shall revert to Stage 1 when remaining Total Storage Available computed consistent with Table XV-4 is greater than remaining Total Storage Required for two (2) consecutive months.

3. Regulatory Trigger: Without further action of the Board of Directors, Stage 4 shall sunset for that Water Distribution System(s) and water use restrictions shall revert to Stage 1 when the governmental or regulatory agency rescinds the request.

4. Emergency Trigger: Stage 4 shall sunset and water use restrictions shall revert to Stage 1 when the Board finds that a Water Supply Emergency no longer exists.

5. Restoration of Lower Stage. A Resolution causing the sunset of one or more provisions of Stage 4 may also activate any lower Stage as may be warranted for good cause by circumstances affecting a particular Water Distribution System, private Well, or Water User.

Water Rationing Exemptions and Variances (MPWMD Rule 166)

A. Special Needs Exemptions. The following needs shall be given additional Rations:

1. Medical and/or sanitation needs certified by a doctor;

2. Hospital and/or health care facilities that have achieved all BMPs for those uses;

3. Riparian irrigation using water efficient irrigation technology when required as a condition of a River Works Permit issued by the District;

4. Non-Residential Users that can demonstrate compliance with all District regulations appropriate for the type of use and where there is minimal exterior water use on the Water Meter or water supply serving the use.

B. Hardship Variances. The following shall be given consideration of additional Rations to meet extraordinary needs:

1. Health and safety situations on a case-by-case basis;

2. Drinking water for large livestock;

3. Commercial laundromats with signs advising full loads only;

4. Business in a home on a case-by-case basis;

5. Emergency, extreme, or unusual situations on a case-by-case basis.

C. No Exemption or Variance. The following categories of water use shall not qualify for an additional Ration:

1. Short-Term Residential Housing as defined in Rule 11 (Definitions);

2. Guests and short-term visitors;

3. Irrigation, other than variances allowed for required riparian irrigation or safety;

4. Filling pools, spas, ponds, fountains, etc;

5. Leaks that are not repaired within 72 hours of notice.

D. Mandatory Conditions of Approval. Prior to approving any variance, the Site must be in compliance with all applicable District Rules and Regulations and the water conservation standards. Verification by District inspection may be conducted prior to granting a variance.

Definitions Used in the 2016 Monterey Peninsula Water Conservation and Rationing Plan (MPWMD Rule 167)

Acre-Foot – "Acre-Foot" shall mean an amount of water equal to 325,851 gallons.

Administrative Compliance Order – "Administrative Compliance Order" shall mean a written order issued by the General Manager directing any Person responsible for serious, continuing or recurring violations to take affirmative action to remedy consequences of those violations. Administrative Compliance Orders are in addition to all other legal remedies, criminal or civil, which may be pursued by the Water Management District. An Administrative Compliance Order may be issued in conjunction with a Cease & Desist Order.

Applicant – "Applicant" shall mean the Person or Persons responsible for completing the requirements of an application.

Best Management Practices (BMPs) – "Best Management Practices" shall mean a conservation measure or series of measures that is useful, proven, cost-effective, and generally accepted among conservation experts to reduce water consumption and protect water quality.

Bishop Water Distribution System – "Bishop Water Distribution System" or "Bishop" shall mean the California American Water subsystem as described in the purchase agreement between Bishop Water Company and California American Water dated September 1, 1996.

California American Water Company Water Distribution System – "California American Water Company Water Distribution System" shall mean all California American Water Company Water Distribution Systems that rely, in whole or in part, on production or production offsets from the Carmel River System or the Seaside Coastal Subareas.

Carmel River System – "Carmel River System" shall mean water from the Carmel River and underlying alluvial aquifer.

CAWD/PBCSD Wastewater Reclamation Project Recycled Water Users – "CAWD/PBCSD Wastewater Reclamation Project Water Users" shall mean those Users of the wastewater reclamation project undertaken by the Carmel Area Wastewater District and the Pebble Beach Community Services District that supplies Reclaimed Water to the Golf Courses and certain open space areas within Pebble Beach.

Cease & Desist Order – "Cease & Desist Order" shall mean an order issued by the General Manager prohibiting a Person from continuing a particular course of conduct. Cease & Desist Orders are in addition to all other legal remedies, criminal or civil, which may be pursued by the Water Management District. A Cease & Desist Order may be issued in conjunction with an Administrative Compliance Order.

CCF– "CCF" (or one-hundred cubic feet) is equivalent to 748 gallons.

Conservation Rates – "Conservation Rates" shall mean the increase in the water rates for California American Water customers at levels of either 25 percent (Level 1 Conservation Rates) or 40 percent (Level 2 Conservation Rates). Conservation Rates do not apply to Residential Tier 1 water use.

Conveyor Car Wash – "Conveyor Car Wash" shall mean a commercial car wash where the vehicle moves on a conveyor belt during the wash and the driver of the vehicle can remain in, or wait outside of, the vehicle.

District – See Monterey Peninsula Water Management District.

Dwelling Unit – "Dwelling Unit" shall mean single or multiple residences suitable for single household occupancy but shall not refer to non-permanent student or transient housing, the occupancy of which is projected to average 24 months or less.

Extractor – "Extractor" shall means a user, or consumer of water delivered by a water Well or Water-Gathering Facility, which is not a part of any Water Distribution System.

Flagrant Violation – "Flagrant Violation" shall mean any willful or wanton disregard of the Rules and Regulations of the District which results in unreasonable waste, contamination, or pollution of District waters by any Extractor, User, or by the Owner or Operator of a Well, Water-Gathering Facility or Water Distribution System.

Flow Restrictor – "Flow Restrictor" shall mean a device placed into the Water Distribution System by the distribution system Operator, or put into the output of a private Well, that restricts the volume of flow to the User.

Graywater Irrigation System – "Graywater Irrigation System" shall mean an onsite wastewater treatment system designed to collect Graywater and transport it out of the structure for distribution in an Irrigation System.

Hidden Hills System – "Hidden Hills System" shall mean the California American Water subsystem as described in the purchase agreement between Carmel Valley Mutual Water Company and California American Water recorded July 8, 1994, Document #49389, Reel 3125, Page 696.

Household – "Household" shall mean all the people who occupy a housing unit. A housing unit is a house, an apartment, a mobile home, a group of rooms, or a single room occupied (or if vacant, intended for occupancy) as separate living quarters. Separate living quarters are those in which the occupants live separately from any other people in the building and that have direct access from the outside of the building or through a common hall.

In-Bay Car Wash – "In-Bay Car Wash" shall mean a commercial car wash where the driver pulls into bay, parks the car, and the vehicle remains stationary while either a machine moves over the vehicle to clean it or one or more employees of the car wash clean the vehicle, instead of the vehicle moving through a tunnel.

Interruption – "Interruption" shall mean an interruption for longer than 12 hours in the supply of Recycled Water to a Recycled Water Irrigation Area.

Laguna Seca Subarea – "Laguna Seca Subarea" shall mean one of the subdivisions of the Southern Seaside Subbasin. Its boundary is shown on a map maintained at the offices of the Water Management District, as that map may be amended from time to time.

Landscaping – "Landscaping" shall mean the arrangement of plants and other materials that may result in outdoor water use.

Lawn – "Lawn" shall mean an area of land planted with live, healthy grass which is regularly maintained, irrigated and groomed at a low, even height.

Main California American Water System – "Main California American Water System" shall mean the California American Water's Water Distribution System that derives its Source of Supply from the Carmel River System and the Seaside Coastal Subareas of the Seaside Groundwater Basin.

Master Meter – "Master Meter" shall mean a single Water Meter that supplies water to more than one Water User.

Measurable Precipitation – "Measureable Precipitation" shall mean rainfall of 0.1 inch or more.

Minimum Daily Water Ration – "Minimum Daily Water Ration" shall mean a minimum Water Ration of 90 gallons per day per Household.

Mobile Water Distribution System – "Mobile Water Distribution System" shall mean any Potable or Sub-potable Water delivery that originates at a location apart from the Site of use and that is delivered via a truck or other movable container. This definition includes, but is not limited to, trucked water. This definition shall not apply to deliveries of water by commercial companies in volumes less than or equal to 55 gallons per container.

Model Water Efficient Landscape Ordinance – "Model Water Efficient Landscape Ordinance" shall mean the ordinance found at California Code of Regulations, Title 23. Waters, Division 2. Department of Water Resources, Chapter 2.7.

Monterey Peninsula Water Management District (District) – "Monterey Peninsula Water Management District" ("District") is a public agency created by the California State Legislature in 1977 and approved by the voters on June 6, 1978. The enabling legislation is found at West's California Water Code, Appendix Chapters 118-1 to 118-901.

Monterey Peninsula Water Resource System (MPWRS) – "Monterey Peninsula Water Resource System" ("MPWRS") shall mean the surface water in the Carmel River and its tributaries, Groundwater in the Carmel Valley Alluvial Aquifer which underlies the Carmel River, and Groundwater in the Seaside Groundwater Basin.

MPWMD– See Monterey Peninsula Water Management District.

Multi-Family Household – "Multi-Family Household" shall mean a Household where two or more Dwelling Units receive water from a Master Meter.

Non-Essential Water Use – "Non-Essential Water Use" shall mean uses of water that are acceptable during times of normal water availability, as long as proper procedures to maximize efficiency are followed. However, when water is in short supply, Non-Essential Water Uses must be curtailed to preserve limited water resources for essential uses. Non-Essential Water Uses do not have health or safety impacts, are not required by regulation, and are not required to meet the core functions of a Non-Residential use.

Non-Residential – "Non-Residential" shall mean water uses not associated with Residential use. These uses include Commercial, Industrial, Public Authority, Golf Course, Other Use, Non-Revenue Metered Use, and Reclaimed Water.

Non-Revenue Water – "Non-Revenue Water" shall mean those components of system input volume that are not billed and produce no revenue; equal to unbilled authorized consumption, plus apparent losses, plus real losses.

Open Space – "Open Space" shall mean public land area left in an un-built state as defined in the California Government Code, Section 65560. Open Space includes plazas, parks, and cemeteries.

Owner or Operator – "Owner or Operator" shall mean the Person to whom a Water Gathering Facility is assessed by the County Assessor, or, if not separately assessed, the Person who owns the land upon which a Water-Gathering Facility is located.

Permanent Resident – "Permanent Resident" shall mean a Person who resides continuously in a Dwelling Unit for more than 30 days or a resident that can submit such other evidence to clearly and convincingly demonstrate permanent residency.

Positive Action Shut-Off Nozzle – "Positive Action Shut-Off Nozzle" shall mean a device that completely shuts off the flow of water from a hose when released.

Potable – "Potable" shall mean water that is suitable for drinking.

Pressure Regulating Device – "Pressure Regulating Device" shall mean a water pressure reducing device installed in the water line after the water meter that automatically reduces the pressure from the water supply main to a lower pressure.

Production Limit – "Production Limit" shall mean the maximum production permitted for a Water Distribution System.

Reclaimed Water – "Reclaimed Water" shall mean wastewater that has been treated to the tertiary level, including disinfection. Reclaimed Water is a form of Recycled Water.

Recycled Water – "Recycled Water" shall mean water that originates from a Sub-potable Source of Supply such as wastewater treated to the tertiary level.

Recycled Water Irrigation Areas – "Recycled Water Irrigation Areas" shall mean the golf courses and other vegetated areas located within the Del Monte Forest that are being irrigated with Recycled Water.

Residency Affidavit – "Residency Affidavit" shall mean a document attesting to the number of Permanent Residents in a Household.

Residential – "Residential" shall mean water used for household purposes, including water used on the premises for irrigating lawns, gardens and shrubbery, washing vehicles, and other similar and customary purposes pertaining to Single-Family and Multi-Family Dwellings.

Responsible Party – "Responsible Party" shall mean the Person or Persons who assume through the District Permit process legal responsibility for the proper performance of the requirements of a Permit holder as defined in the Rules and Regulations and/or in conditions attached to a Permit. "Responsible Party," when used in the context of the 2016 Monterey Peninsula Water Conservation and Rationing Plan, shall mean the Person who is responsible for paying the water bill. When a property is served by a private Well or a small Water Distribution System, the "Responsible Party" shall be the Water Users of the Well and the small distribution system Operator.

Riparian Corridor – "Riparian Corridor" shall mean all that area which comprises the Riverbed and riverbanks of the Carmel River which lies within the boundaries of the Carmel River Management Zone (Zone No. 3), and all those areas which lie within 25 lineal feet of the Riverbank Assessment Line, excepting however, all lands which lie outside of the Zone No. 3 boundary, and exempting lawns, Landscaping and cultivated areas as shown on the spring 1983 aerial photographs taken by California-American Water pursuant to the agreement with the District in accord with MPWMD Rule 123 A.

Ryan Ranch Water Distribution System – "Ryan Ranch Water Distribution System" or "Ryan Ranch" shall mean the California American Water subsystem as described in the purchase agreement between Neuville Co. N.V. (a Delaware Corporation) and California American Water dated April 30, 1990.

Seaside Basin Adjudication Decision – "Seaside Basin Adjudication Decision" or "Seaside Decision" shall mean the March 27, 2006 court adjudication, as amended, determining water rights in the Seaside Groundwater Basin that restrict California American Water production from the Coastal Subareas and Laguna Seca Subarea of the basin.

Seaside Groundwater Basin – "Seaside Groundwater Basin" shall mean the set of geologic formations that stores, transmits, and yields water in the Seaside area, comprising of the Northern Seaside Subbasin and the Southern Seaside Subbasin. The Seaside Groundwater Basin also includes those areas known as the Northern Coastal Subarea, the Northern Inland Subarea, the Southern Coastal Subarea and the Laguna Seca Subarea.

Short-Term Residential Housing – "Short Term Residential Housing" shall mean one or more Residential Dwelling Units on a property that are occupied by visitors, are operated as a business and for which a fee is charged to occupy the premises.

Single Residential Household – "Single Residential Household" shall mean a Household that receives its water supply through a Water Meter that is not shared with other Households.

Site – "Site" shall mean any unit of land which qualifies as a Parcel or lot under the Subdivision Map Act, and shall include all units of land: (1) which are contiguous to any other Parcel (or are separated only by a road or easement); and (2) which have identical owners; and (3) which have an identical present use. The term "Site" shall be given the same meaning as the term "Parcel."

Smart Controller – "Smart Controller" shall mean a weather-based device (typically a "timer") that automatically controls an outdoor Irrigation System. Smart Controllers use weather, site or soil moisture data as a basis for determining an appropriate watering schedule. Smart Controllers (commonly referred to as ET controllers, weather-based irrigation controllers, smart sprinkler controllers, and water smart controllers) are a new generation of irrigation controllers that utilize prevailing weather conditions, current and historic Evapotranspiration, soil moisture levels, and other relevant factors to adapt water applications to meet the actual needs of the plants.

Source of Supply – "Source of Supply" shall mean the Groundwater, surface water, Reclaimed Water sources, or any other water resource where a Person, Owner or Operator gains access by a Water-Gathering Facility.

Sub-potable Water – "Sub-potable Water" shall mean water which is not fit for human consumption without treatment and shall include Reclaimed Water as that term is used in the Water Reclamation Law, and particularly in Section 13550 of the Water Code.

Total Storage Available – "Total Storage Available" shall mean the usable water as measured by the District on May 1 in any year that is contained in the Carmel Valley Alluvial

Aquifer plus usable water in the Seaside Groundwater Basin and the usable water in the Los Padres Reservoir.

Total Storage Required – "Total Storage Required" shall mean the combination of demand remaining from May 1 to September 30 and carryover storage for the next Water Year that is required to meet the following Water Year production limit for California American Water from Carmel River sources set by State Water Resources Control Board Order WR 2009-0060, plus the production limit for California American Water from the Seaside Groundwater Basin set by the Court in its March 27, 2006 Seaside Basin Adjudication Decision and the production limit specified for non-California American Water Users from the Monterey Peninsula Water Resource System set in the District's Water Allocation Program.

User – "User" shall mean a customer or consumer of water delivered by a Water Distribution System. User does not include any Owner or Operator of a Water Distribution System. Each residence, commercial enterprise, or industrial enterprise shall be deemed a separate and distinct User.

Visitor-Serving Facility – "Visitor-Serving Facility" shall include all hotels, motels, restaurants, convention/meeting facilities, and service stations within the Monterey Peninsula Water Management District. Other facilities may be designated as a Visitor- Serving Facility by the General Manager upon finding that such facility exists primarily for the use of tourists and the traveling public. Short term rentals of private property are not included under this definition.

Water Broom – "Water Broom" shall mean a water efficient broom-like cleaning device that uses a combination of water and air to clean hard surfaces with no runoff.

Water Credit – "Water Credit" shall mean a record allowing reuse of a specific quantity of water upon a specific Site. A Water Credit differs from a Water Use Credit in that it is not characterized by a Permanent Abandonment of Use, but may be the result of a temporary cessation of use.

Water Distribution System – "Water Distribution System" shall mean all works within the District used for the collection, storage, transmission or distribution of water from the Source of Supply to the Connection of a system providing water service to any Connection including all Water-Gathering Facilities and Water-Measuring Devices. In systems where there is a Water Meter at the point of Connection, the term "Water

Distribution System" shall not refer to the User's piping; in systems where there is no Water Meter at the point of Connection, the term "Water Distribution System" shall refer to the User's piping.

Water Distribution System Operator – "Water Distribution System Operator" shall mean the Person or Persons who assume through the District Permit process legal responsibility for the proper performance of the requirements of a Water Distribution System Permit holder as defined in the Rules and Regulations and/or in conditions attached to a Permit.

Water-Gathering Facility – "Water-Gathering Facility" shall mean any device or method, mechanical or otherwise, for the production of water from dams, Groundwater, surface water, water courses, Reclaimed Water sources, or any other Source of Supply within the Monterey Peninsula Water Management District or a zone thereof. Water-Gathering Facilities shall include any water-production facility as defined in the Monterey Peninsula Water Management District Law. This definition shall not apply to On-Site Cisterns that serve an existing single-Connection Residential situations where rainwater is captured for On-Site Landscape irrigation use.

Water Ration – "Water Ration" shall mean a specific amount of water available to each Water User during Stage 4 Water Rationing.

Water Supply Emergency – "Water Supply Emergency" shall mean a declaration pursuant to Regulation XV, The 2016 Monterey Peninsula Water Conservation and Rationing Plan, that a water shortage emergency condition prevails within one or more Water Distribution Systems.

Water Use Credit – "Water Use Credit" shall mean a limited entitlement by a Person to use a specific quantity of water upon a specific Site. Water Use Credits shall be limited by time, and by other conditions as set forth in the District's Rules and Regulations.

Water User – "Water User" shall mean Users of water for domestic or other uses from any Water Distribution System or private Well.

Water Waste – "Water Waste" shall mean the indiscriminate, unreasonable, or excessive running or dissipation of water as defined in Rule 162.

Water Year – "Water Year" shall mean the period from October 1 of one year to September 30 of the succeeding year.

Well – "Well" shall mean any device or method, mechanical or otherwise, for the production of water from Groundwater supplies within the District excluding seepage pits and natural springs.

Water Meter – "Water Meter" shall mean any measuring device intended to measure water usage. The term "Water Meter" shall have the same meaning as the term "Water Measuring Device."

Ecological Rights Foundation (ERF), the Center for Biological Diversity (CDB), and Our Children's Earth Foundation (OCEF) - Attachments

Tom Moore: Slant wells a threat to water supply

The CEMEX plant in Marina. (Vern Fisher - Monterey Herald)

By Tom Moore, Guest commentary

POSTED: 06/18/16, 4:06 PM PDT | UPDATED: ON 06/18/2016 0 COMMENTS

A couple of months ago at a meeting of the Board of Directors of Marina Coast Water District, I was picked to testify before the California Public Utilities Commission (CPUC) regarding Marina Coast's policy positions related to Cal Am's proposed desalination project.

The purpose of my testimony was to defend the long-term interests of Marina Coast's customers. While you're welcome to read the testimony and cross-examination transcript online, here, in a nutshell, are the main points:

• Marina Coast does not object to Cal Am building a desalination plant to meet the real needs of its Monterey Peninsula Service area.

• However, Marina Coast strongly objects to Cal Am taking 27,000 acre-feet per year (AFY) of source water (or more) for desalination from a location that's 1,800 feet from Marina Coast's existing mothballed desal plant and barely 1.6 miles from one of Marina Coast's major groundwater wells. In contrast, Marina Coast pumped less than 3,300 acre-feet of groundwater in 2015 to serve its central Marina and Ord community customers.

• Cal Am has no legal right to take groundwater from this area of the Salinas Valley groundwater basin and has no legal means to acquire such rights. (Worse yet, last January this area of the basin was designated by the state as a critically overdrafted sub-basin.)

• The CPUC must use the latest demand numbers from the Cal Am service area to calculate the size of the proposed desalination plant rather than allowing Cal Am to use inflated demand figures.

Cal Am admits that slant wells on the CEMEX property will pump good groundwater from

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the groundwater basin. They claim it will be only a tiny amount, but Marina Coast's hydrogeologist says it will be a much larger amount than Cal Am predicts and that the pumping will harm the groundwater aquifers that Marina Coast relies on for its water supply.

Cal Am claims it will mitigate its CEMEX pumping by selling some "return water" from its desalination plant to Castroville. However, this is nearly five miles away from the CEMEX property and on the other side of the Salinas River. How will slightly decreasing the groundwater pumping in Castroville while massively increasing the pumping near Marina's wells prevent harm to the groundwater aquifer that Marina Coast relies on?

In the recent past, Marina Coast has proactively shifted wells and pumping further inland to help create and preserve a barrier of fresh water between the ocean and MCWD's wells. Cal Am's proposed slant wells threaten to pull water from that protective barrier, putting the source of supply for MCWD's customers at significant risk.

Marina Coast serves nearly 33,000 people in the Ord community and Marina. This includes all of CSU Monterey Bay, the Army's Presidio of Monterey Annex, the East Garrison development and more than half of the city of Seaside. The water needs of these customers are every bit as important as the water needs of Cal Am's customers.

The Marina Coast Water District has an obligation to protect the interests of its customers and to provide high-quality water at the most reasonable possible price. Therefore, we must defend our access to and protect our groundwater. Ten Cal Am slant wells pumping from the CEMEX property represents just too serious a threat to our critical water supply and must be stopped.

Tom Moore is vice president of the Marina Coast Water District board of directors.

SPCA for Monterey County empties its shelter in free adoption event

MORE VIDEOS:

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WATEREUSE ASSOCIATION

Sustainable Solutions for a Thirsty Planet®

Overview of Desalination Plant Intake Alternatives

White Paper

June 2011

The WateReuse Desalination Committee's White Papers are living documents. The intent of the Committee is to enhance the content of the papers periodically as new and pertinent information on the topics becomes available. Members of the desalination stakeholder community are encouraged to submit their constructive comments to white-papers@watereuse.org and share their experience and/or case studies for consideration for inclusion in the next issuance of the white papers.

WATEREUSE ASSOCIATION
DESALINATION COMMITTEE

Overview of Desalination Plant Intake Alternatives

White Paper

INTRODUCTION

Over 75 % of the US population lives along the coast. Currently, many of our coastal communities are supplied by inland fresh water resources or low-salinity coastal aquifers. Because of the limited availability of these resources and their intensive use over the years, traditional sources of water supply are nearing depletion in many parts of the country, and reliance solely on such resources is no longer sustainable in the long run. Along with enhanced water reuse and conservation, seawater and brackish desalination provides a viable alternative for securing reliable and drought-proof water supplies for coastal communities.

The purpose of desalination plant intakes is to collect source seawater of adequate quantity and quality in a reliable and sustainable fashion so as to produce desalinated water cost-effectively and with minimal impact on the environment. Currently, there are two categories of widely used desalination plant source water collection facilities: open intakes and subsurface intakes (wells and infiltration galleries). Open intakes collect seawater directly from the ocean via on-shore or off-shore inlet structure and pipeline interconnecting this structure to the desalination plant. Subsurface intakes, such as vertical beach wells, horizontal wells, slant wells and infiltration galleries, tap into the saline or brackish coastal aquifer and/or the off-shore aquifer under the ocean floor.

This white paper presents an overview of alternative open-ocean and subsurface intake technologies for seawater desalination plants. While subsurface intakes (beach wells, infiltration galleries, slant wells, etc.) are often favored by the environmental community because of their potentially lower impingement and entrainment impacts on aquatic life, they have found limited application to date, especially in medium- and large-scale desalination projects. The white paper describes the main challenges associated with the use of subsurface intakes and discusses the key factors that determine their feasibility for the site specific conditions of a given desalination project.

Potential impingement and entrainment (I&E) impacts associated with the operation of open ocean intakes for seawater desalination plants are discussed in a separate WateReuse Association white paper entitled "Desalination Plant Intakes – Impingement and Entrainment Impacts and Solutions."

SUBSURFACE INTAKES

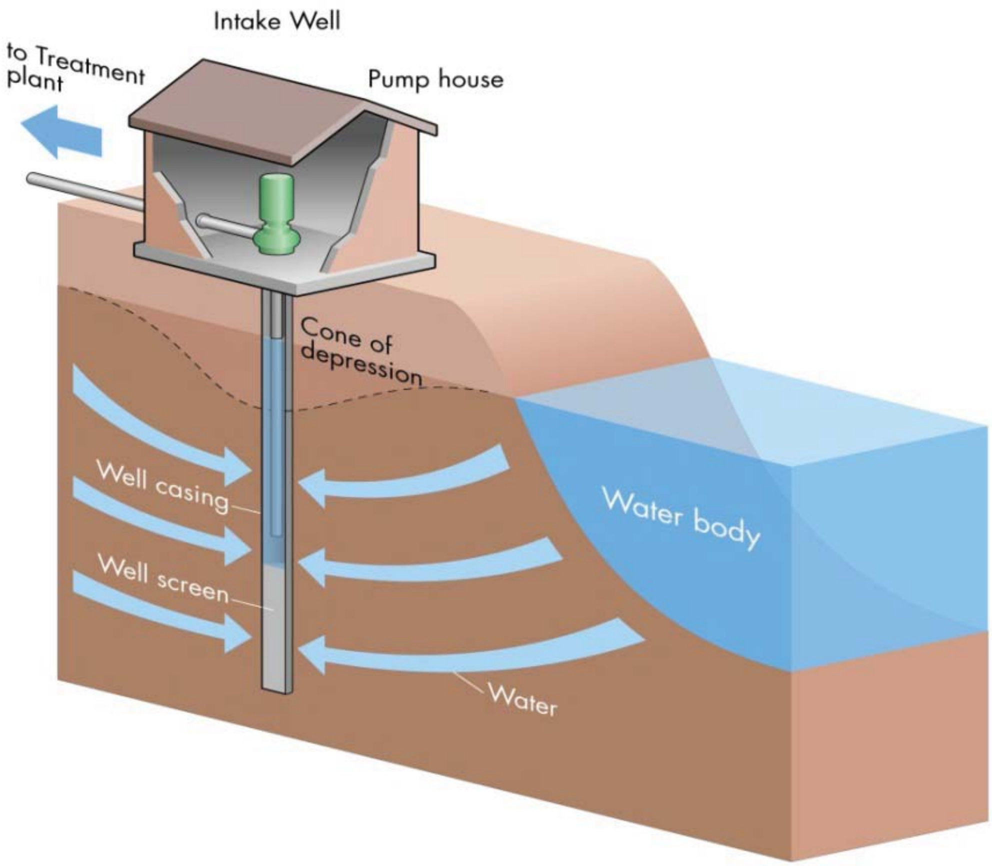
Seawater collected by subsurface intakes is naturally pretreated via slow filtration through the typically sandy ocean floor. As such, the collected flow usually contains low levels of solids, slit, oil & grease, natural organic contaminants, and aquatic organisms. When subsurface intakes collect water from an on-shore coastal aquifer, this water is often of lower salinity than ambient seawater.

If a subsurface intake collects source water from an alluvial aquifer, however, such water could have very low oxygen concentration and could contain high level of manganese, iron, hydrogen sulfide, and other contaminants that can have an adverse impact on desalination plant reverse osmosis (RO) membrane performance, water production costs, and discharge water quality.

Vertical beach wells (Figure 1) have typically found an application for supplying source water to relatively small seawater desalination plants of capacity of 1 MGD or less. Horizontal wells are more suitable for larger seawater desalination plants and are applied in two configurations: radial Ranney-type collector wells (Figure 2) and horizontal wells with directionally drilled (HDD) collectors (Figure 3). These types of wells have already found full-scale applications worldwide.

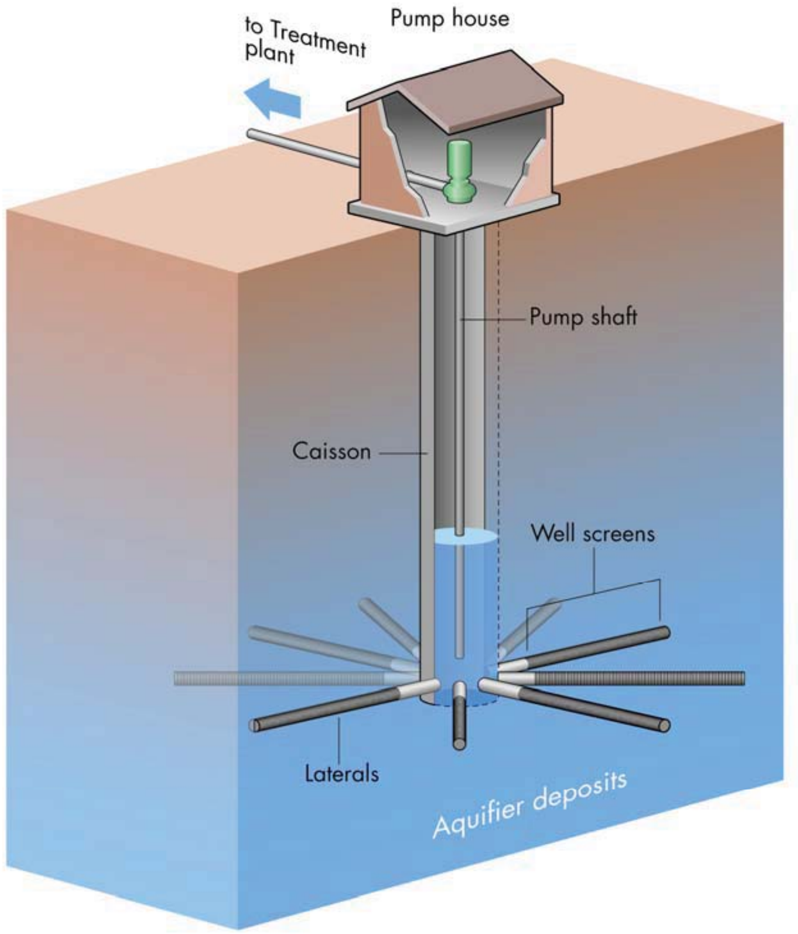
Slant wells are innovative subsurface intakes, which use vertical well drilling technology to install inclined source water collectors under the ocean floor (Figure 4). Such intakes are currently tested by the Municipal Water District of Orange County (MWDOC) at a pilot facility located in Dana Point, California.

Subsurface infiltration gallery intake systems (also known as under-ocean floor seawater intakes or seabed infiltration systems) consist of a series of man-made submerged slow sand media filtration beds located at the bottom of the ocean in the near-shore surf zone (Figure 5). As such, seabed filter beds are sized and configured using the same design criteria as slow sand filters. Currently, such intake system is undergoing long-term testing by the Long Beach Water Department in California.



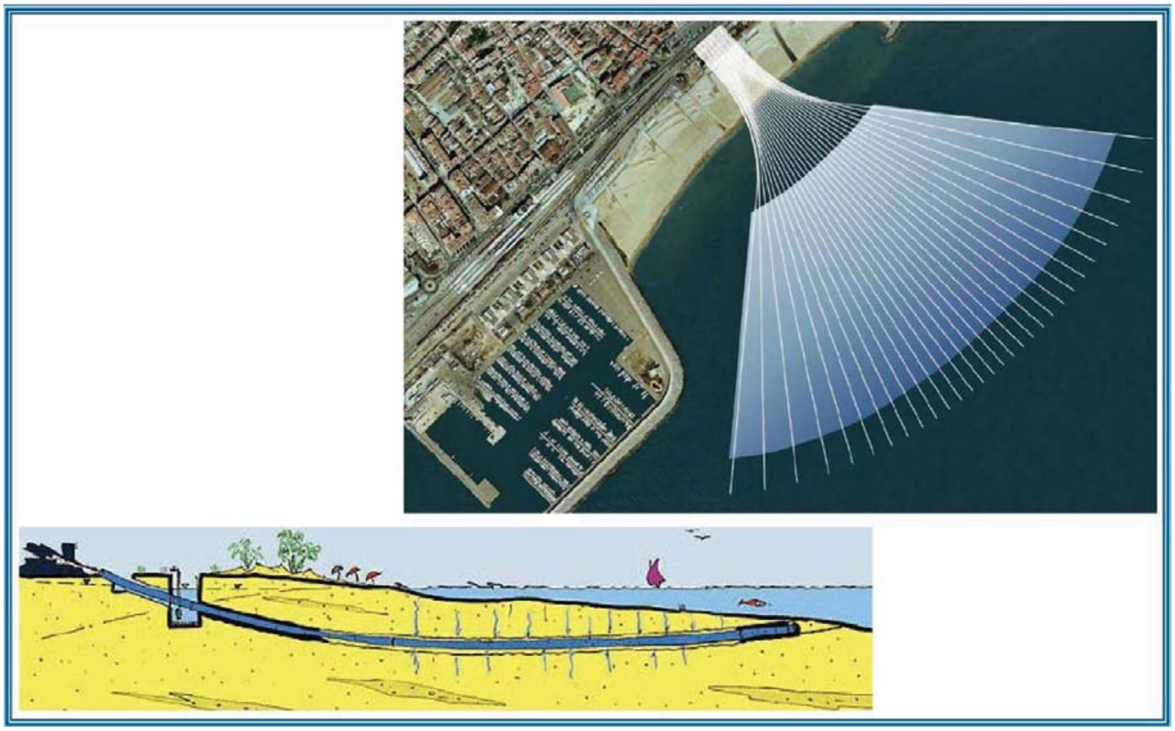
Source: Water Globe Consulting

Figure 1 – Vertical Beach Well



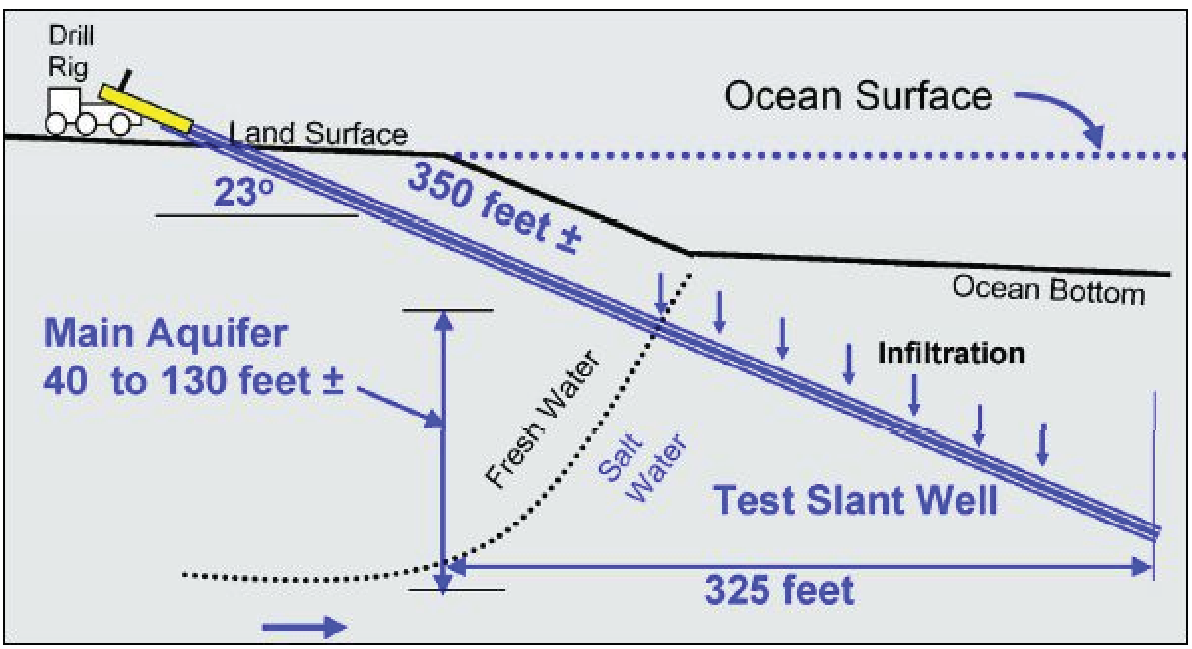
Source: Water Globe Consulting

Figure 2 - Horizontal (Radial) Intake Well



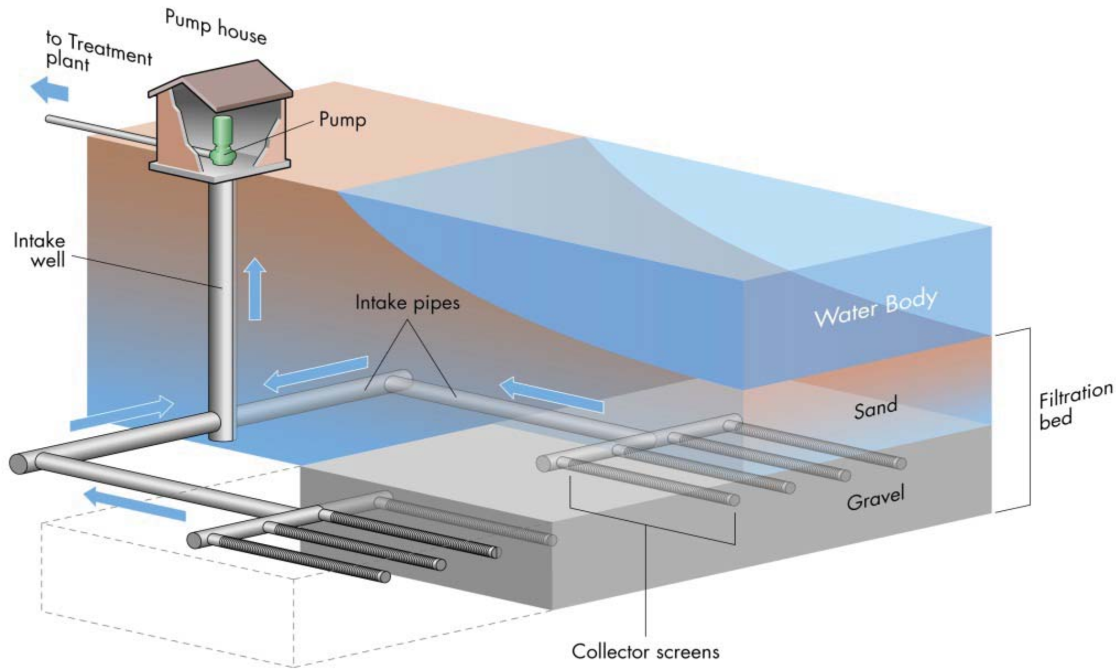
Source: Catalana de Perforacions

Figure 3 – HDD Intake



Source: MWDOC

Figure 4 – Slant Well



Source: Water Globe Consulting

Figure 5 – Infiltration (Seabed) Gallery

Subsurface Well Source Water Quality

While it is typically stipulated that subsurface intakes yield better seawater water quality than open ocean intakes, this assumption only holds true for very site specific conditions: usually when subsurface intakes are located in well flushed ocean bottom or shorelines which are away from surface fresh water influence and are collecting seawater from a coastal aquifer of uniformly porous structure, such as limestone. There are numerous small seawater desalination plants located in the Caribbean and several medium-size plants in Malta which have such subsurface intakes and which require only minimal pretreatment (typically bag filters and/or sand strainers) ahead of the reverse osmosis membrane separation system. However, the majority of the existing seawater desalination plants worldwide using subsurface intakes require an additional filtration pretreatment step prior to membrane salt separation.

At present, the largest seawater desalination plant in the world using infiltration gallery type of subsurface intake is located in Fukuoka, Japan. The plant has capacity of 13.2 MGD, and has been in operation since 2006. This plant pretreats the source seawater collected by the infiltration gallery using ultrafiltration (UF) membranes because its water quality is not adequate for direct application to the RO membranes.

The 34 MGD San Pedro Del Pinatar (Cartagena) plant in Spain is the largest seawater desalination plant in the world today which uses subsurface intakes (HDD wells). While the HDD wells have performed adequately for the initial 17 MGD project phase, site specific hydrogeological constraints have limited their use for the plant expansion to 34 MGD, and a new 17 MGD open water intake system was constructed instead[1]. The source water collected by the plant HDD well intake system also has to be pretreated by granular media filtration in order to make it suitable for seawater desalination by reverse osmosis.

Existing experience with the use of beach wells for seawater desalination in California to date, and at the largest beach-well seawater desalination plant on the Pacific coast in Salina Cruz, Mexico indicate that some desalination plants using subsurface intakes may face a costly challenge – high concentrations of manganese and/or iron in the intake water. Unless removed ahead of the seawater reverse osmosis (SWRO) membrane system, iron and manganese may quickly foul the 5 micron cartridge filters and reverse osmosis membranes, thereby rendering the desalination plant inoperable. The treatment of beach well water which naturally contains high concentrations of iron and/or manganese requires chemical conditioning and installation of conservatively designed "green sand" pretreatment filters or UF membrane pretreatment system ahead of the SWRO membranes. This costly pretreatment requirement may significantly reduce the potential cost benefits of the use of beach wells as compared with an open seawater intake. Open seawater intakes typically do not have iron and manganese source water quality related problems.

An example of a beach well desalination plant which faced an elevated source water iron challenges is the 1.2 MGD Morro Bay SWRO facility in California. The plant source water is supplied by five beach wells with a production capacity of 0.3 to 0.5 MGD each. The beach well intake water has iron concentration of 5 to 17 mg/L. For comparison, open intake seawater typically has several orders of magnitude lower iron concentration. The Morro Bay facility was originally designed without pretreatment filters, which resulted in plugging of the RO cartridge filters within half-an-hour of starting operations during an attempt to run the plant in 1996. The high-iron concentration problem was resolved by the installation of pretreatment filter designed for a loading rate of 2.5 gpm/ft^2. For comparison, a typical open-intake desalination plant is designed for pretreatment loading rates of 4.0 to 5.0 gpm/ft^2 – and, therefore would require less pretreatment filtration capacity.

Usually open ocean intakes are considered a less viable source of water for desalination plants in areas located in close proximity to wastewater discharges or industrial and port activities. Open intake seawater is typically free of endocrine-disruptor or carcinogenic type of compounds such as: Methyl Tertiary Butyl Ether (MTBE); N-nitrosodimethylamine (NDMA); and 1,4-dioxane.

[1] California Coastal Commission CDP application E-06-013 November 15, 2007, hearing transcript pages 170-171.

Beach well water, however, may contain difficult to treat compounds especially when the intake is under influence of contaminated groundwater or surface water runoff. If a saline coastal aquifer used as a desalination plant source water is connected to a fresh/brackish groundwater aquifer contaminated with pollutants (such as fuel oil contaminants, endocrine disruptors, heavy metals, arsenic from a nearby cemetery, etc.) then the desalination plant may need to be provided with additional treatment and/or disposal facilities, which would erode the benefits of well intake use. Potential sources of pollution of the on-shore coastal aquifers include existing landfills, septic tank leachate fields, and industrial & military installations. The compounds of concern could be treated by a number of available technologies, including activated carbon filtration, ultraviolet irradiation, hydrogen peroxide oxidation, ozonation, etc. However, because these treatment systems will need to be constructed in addition to the RO system, the overall desalinated water production cost will increase measurably.

Example of such challenge is the Morro Bay desalination plant, where beach well intake water was contaminated by MTBE, a gasoline additive, caused by contamination from an underground gasoline tank spill. Similar problems were observed at the Santa Catalina Island (California) 0.132 MGD seawater desalination plant that uses beach well intakes.

Site Feasibility Considerations

The feasibility of using subsurface intakes is very dependent on the availability of suitable surface and hydrogeological site conditions. The most favorable hydrogeological condition for constructing subsurface intakes is highly permeable geological formation (sand, limestone, gravel) with hydraulic conductivity which exceeds 1,000 gallons/day/ft^2 and depth of at least 45 feet[2]. The consistency of the hydrogeological conditions along the portion of the shoreline that will be used to develop a subsurface intake is also of critical importance for the feasibility of subsurface intakes. Such favorable aquifer conditions are not always readily available and are especially difficult to find for large desalination projects because of the random nature of the size and consistency of the coastal geological formations. Often the on-shore hydrogeological conditions do not extend significantly off-shore due to beach erosion and deposition of poorly consolidated marine sediments.

One important consideration for well intake feasibility is to establish whether there is a clear separation between the coastal aquifer that will be used for seawater plant supply and the under- and/or overlaying fresh water aquifers, especially if they are already used for potable water supply. Removal of large volumes of water from an on-shore coastal aquifer hydraulically connected to a freshwater aquifer may result in lowering the water levels in the exiting fresh water supply wells in the area and, thereby, reducing their production capacity.

[2] AWWA (2007), Manual of Water Supply Practices, M46, Reverse Osmosis and Nanofiltration, Second Edition.

Special attention has to be given to seawater intake well sites in the vicinity of existing coastal wetlands. The operation of large intake wells located adjacent to coastal wetlands may result in a substantial drawdown of the groundwater table and could ultimately drain or irreversibly impair the wetlands and cause significant environmental damage. Year-round study of the interaction between the coastal aquifer and the nearby wetlands is warranted.

Similarly, beaches contiguous to shallow bays that contain significant amount of mud and alluvial deposits may have limited natural flushing and are not considered favorably for the use of subsurface intakes. High content of fine solids in the bay seawater in combination with low frequency of bay flushing and low transmissivity of the beach deposits may render shallow bay beaches less desirable or unsuitable for construction of desalination plant beach well intakes.

It should be pointed out that both beach wells and open intakes use the same seawater as a source to produce drinking water. If the intake area is not well flushed and the naturally occurring wave movement is inadequate to transport the solids away from the beach well collection area at a rate higher than the rate of solids deposition, then these solids will begin to accumulate on the ocean floor and will ultimately reduce the well capacity and source water quality.

In desalination plants with open intakes, the solids contained in the source seawater are removed in the desalination plant's pretreatment filtration system in a closely monitored and controlled manner. When subsurface intakes are used, the same amount of solids is retained on the ocean floor in the area of the well source water collection, while the filtered water is slowly conveyed through the ocean floor sediments until it reaches the well collectors. The wave action near the ocean floor is the main force that allows the solids separated from the beach well source water to be dissipated in the ocean.

Potential Beach Erosion Impacts

If the intake site is exposed to accelerated beach erosion, such erosion could compromise well performance as a pretreatment filtration device. In order for wells to provide adequate pretreatment, the well collectors will need to have a minimum sustainable ocean bottom sediment layer through which natural filtration is accomplished. As beach erosion may reduce or completely remove the filtration layer over time, long-term well performance may be difficult to predict and rely upon for consistent source seawater pretreatment.

As seen on Figure 6 depicting a 3.8 MGD horizontal beach well for seawater desalination plant located in Salina Cruz, Mexico, beach erosion after only a few years of operation may result in a loss of structural support on the ocean side of the wells and associated service buildings, which in turn could cause the wells to tilt towards the ocean, and ultimately could compromise well structural integrity and performance. Unless controlled by special protection or revetment measures, further tilt of the well structure may result in damage of the well collectors and render the wells inoperable or unpredictably impact their performance.

Therefore, beach erosion may shorten significantly the useful life of the intake wells and increase the overall life-cycle water cost if the well location is not selected appropriately, or the well design does not take into account for this impact on well performance and integrity. Due to its significant impact on the intake system operation and costs, potential for beach erosion in the vicinity of the targeted intake well location has to be thoroughly evaluated and investigated. If the selected beach site has a high potential for erosion, then the beach wells have to be provided with anti-erosion measures.

Source: Water Globe Consulting

Figure 6 – Desalination Plant Intake Beach Well Erosion

Useful Life

Inevitably, some of the solid particles contained in the source seawater may propagate into the natural filtration layer above the beach well's lateral collectors and over time these particles may plug the filtration layer pores and ultimately reduce the intake well productivity or render the wells inoperable. Usually, this process of reduction of well capacity spans over 10 to 20 years. However, particle penetration processes can occur at a much faster rate (six to nine months) if the aquifer contains porous formations which cannot be naturally flushed. In this case, practically nothing can be done to recover well capacity; typically under-performing wells are abandoned, and additional wells are constructed to address such conditions.

Usually, the useful life of a well-designed and operated seawater desalination plant is 25 to 30 years. Because intake wells may often have a shorter useful life span than that of the desalination plant, two sets of intake wells could potentially need to be constructed over the useful life of the desalination plant. The need for replacement of some or all of the original intake wells after the first 10 to 20 years of the desalination plant operation would magnify the shoreline impacts of the beach wells and would increase the overall water production cost. Therefore, the potential difference between the useful life of beach wells and open intakes has to be reflected in the life-cycle cost comparison associated with the selection of the most viable type of desalination plant intake.

Operation and Maintenance Considerations

Depending on their type, subsurface intakes may require significant maintenance efforts over their useful lifespan. For example, infiltration galleries operate as slow-sand filters and retain the majority of the particles contained in the source seawater on the surface of the filter bed. While a portion of this layer is removed periodically be the tidal movement of the ocean water, over time the layer of fine particles retained from the filtered source water would accumulate in the upper portion of the bed and would have to be removed offsite by dredging or replacement of the filter bed media in order to maintain intake capacity. Depending on the intake size, periodic dredging of the filtration bed or replacement of the upper portion of the intake filtration media would involve significant cost and time expenditures, and would preclude the use of the seashore in the vicinity of the intake for other activities such as recreation, fishing, boat traffic, etc.

Environmental Impacts Associated with Construction of Infiltration Galleries

It should be noted that infiltration gallery filter beds are sized and configured using the same design criteria as slow sand filters. The design surface loading rate of the filter media is typically between 0.05 to 0.10 gpm/ft^2. For example, for a 10 MGD desalination plant operating at 50 % recovery, the source seawater collected by the intake would have to be at least 20 MGD (13,880 gpm). At a loading rate of 0.075 gpm/ft^2, the active filtration bed area would need to be 185,100 ft^2 (4.3 acres). This would mean that 4.3 acres of the ocean bottom sediments would need to be excavated to a depth of 6 to 8 feet, and would have to be disposed of offsite to a landfill in order to construct the plant intake. The environmental impact of such excavation is significant, because it would involve the destruction of 4.3 acres of bottom marine habitat during the period of intake construction. The actual environmental impact will be higher because infiltration gallery intake construction will also include the installation of intake piping connecting the infiltration gallery to the desalination plant as well as periodic removal of the surface layer of the infiltration gallery filter bed to recover intake capacity.

Discharge Issues

Beach well water typically has a very low dissolved oxygen (DO) concentration. The DO concentration of this water is usually less than 2 mg/l, and it often varies between 0.0 and 1.5

mg/L. The SWRO treatment process does not add appreciable amounts of DO to the intake water. Therefore, the SWRO system product water and concentrate have the same or lower DO concentration. Low DO concentration of the product water will require either product water re-aeration or will result in significant use of chlorine.

If the low DO concentrate from a well intake desalination plant is to be discharged to an open water body, this discharge will not be in compliance with the United States Environmental Protection Agency (US EPA) daily average and minimum DO concentration discharge requirements of 4 mg/L and 5 mg/L, respectively. Because large desalination plants which use intake wells would discharge a significant volume of low-DO concentrate, this discharge could cause oxygen depletion and stress to aquatic life in the vicinity of the discharge. Therefore, this beach well desalination plant concentrate has to be re-aerated before surface water discharge.

For a large desalination plant, the amount of air and energy to increase the DO concentration of the discharge from 1 mg/L to 4 mg/L is significant and would have a measurable effect on the potable water production costs. Discharge of this low DO concentrate to a wastewater treatment plant outfall would also result in a significant additional power use to aerate this concentrate prior to discharge. For comparison, concentrate from SWRO plants with open intakes have DO concentration of 5 to 8 mg/L, which is adequate for disposal to the ocean, without re-aeration. If disposed to a wastewater treatment plant outfall, this concentrate will actually help in terms of the DO of the discharge blend, taking into consideration that wastewater plant effluent usually has lower DO level.

Potential Visual Impacts

If large horizontal intake wells are constructed as above-ground concrete structures, then they will have a visual and aesthetic impact on the shore line on which they are located (see Figure 7). For relatively small-size beach wells, the caisson/vertical well collector can be built water-tight and located below grade to minimize visual impact. However, the size and servicing of the well pumps, piping, electrical, instrumentation and other auxiliary equipment of large-capacity wells usually dictates the location of their pump house to be above grade. In addition, the construction of below-grade wells would require the use of submersible intake pumps, which for large-size applications are not advisable due to their overall lower energy efficiency. Typically, large-size wells use vertical turbine intake pumps rather than submersible pumps to minimize power use and simplify maintenance. Although the above-grade pump house could be designed in virtually any architectural motif, this facility and its service roads with controlled access/fencing provisions would change the visual landscape of the seashore.

Source: Water Globe Consulting

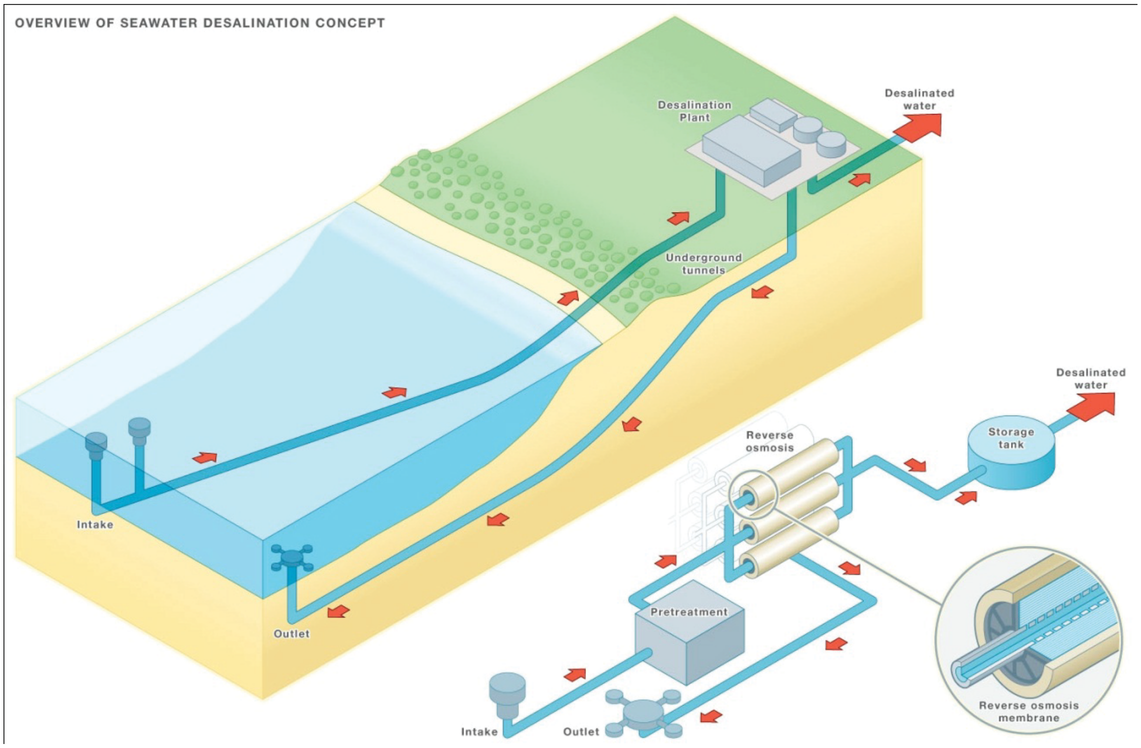
Figure 7 – 3.8 MGD Intake Beach Well of Large Seawater Desalination Plant

Taking into consideration that the desalination plant source water has to be protected from acts of vandalism and terrorism, the individual beach wells may need to be fenced-off or otherwise protected from unauthorized access. The tall fenced-off beach well concrete structures would have a limited visual and aesthetic appeal. Since beaches are visually sensitive areas, the installation of large beach wells may affect the recreational and tourism use and value of the seashore, and may change the beach appearance and character.

For comparison, open coastal intakes are typically lower-profile structures that may blend better with the coastal environment and its surroundings. If the desalination plant is collocated with an existing power plant, construction of new on-shore structures or facilities is typically not required and is more favorable in terms of additional negative visual and aesthetic impact on the coastal environment and landscape.

OPEN OCEAN INTAKES

Open intakes typically include the following key components: inlet structure (forebay) with coarse bar screens; source water conveyance pipeline or channel connecting the inlet structure to an onshore concrete screen chamber; and mechanical fine screens in the chamber. Depending on the location of the inlet structure, the intakes could be on-shore or off-shore type. Off-shore intakes with vertical inlet structures are the most commonly used for seawater desalination projects. The off-shore inlet structure is usually a vertical concrete or steel well (vault) or pipe located at or above the ocean floor and submerged below the water surface (see Figure 8).

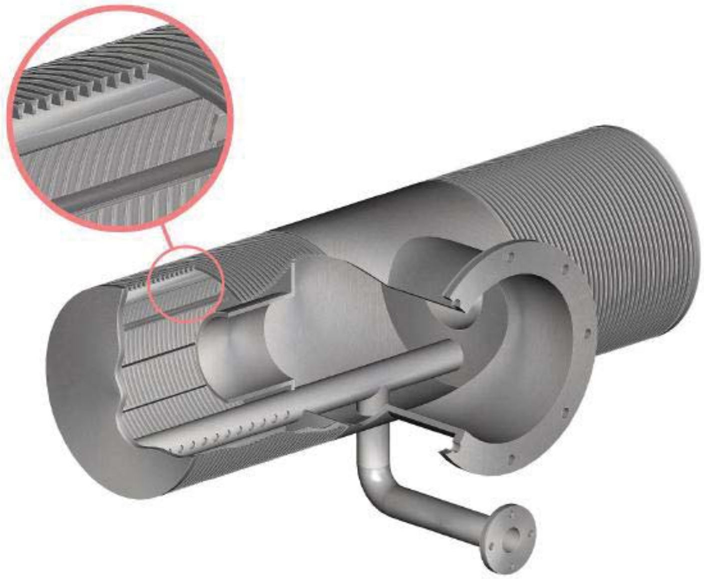


Source: Sydney Water

Figure 8 – Desalination Plant with Off-Shore Intake

The open intake inlet system may include passive wedge-wire screens (see Figure 9). The use of such screens eliminates the need for coarse and fine screens on shore. Wedge-wire screens are cylindrical metal screens with trapezoidal-shaped "wedgewire" slots with openings of 0.5 to 10 mm. They combine very low flow-through velocities, small slot size, and naturally occurring high screen surface sweeping velocities to minimize impingement and entrainment. These screens are designed to be placed in a water body where significant prevailing ambient cross flow current velocities (≥ 1 fps) exist. This high cross-flow velocity allows organisms that would otherwise be impinged on the wedge-wire intake, to be carried away with the flow.

An integral part of a typical wedge-wire screen system is an air burst back-flush system, which directs a charge of compressed air to each screen unit to blow-off debris back into the water body, where they are carried away from the screen unit by the ambient cross-flow currents.

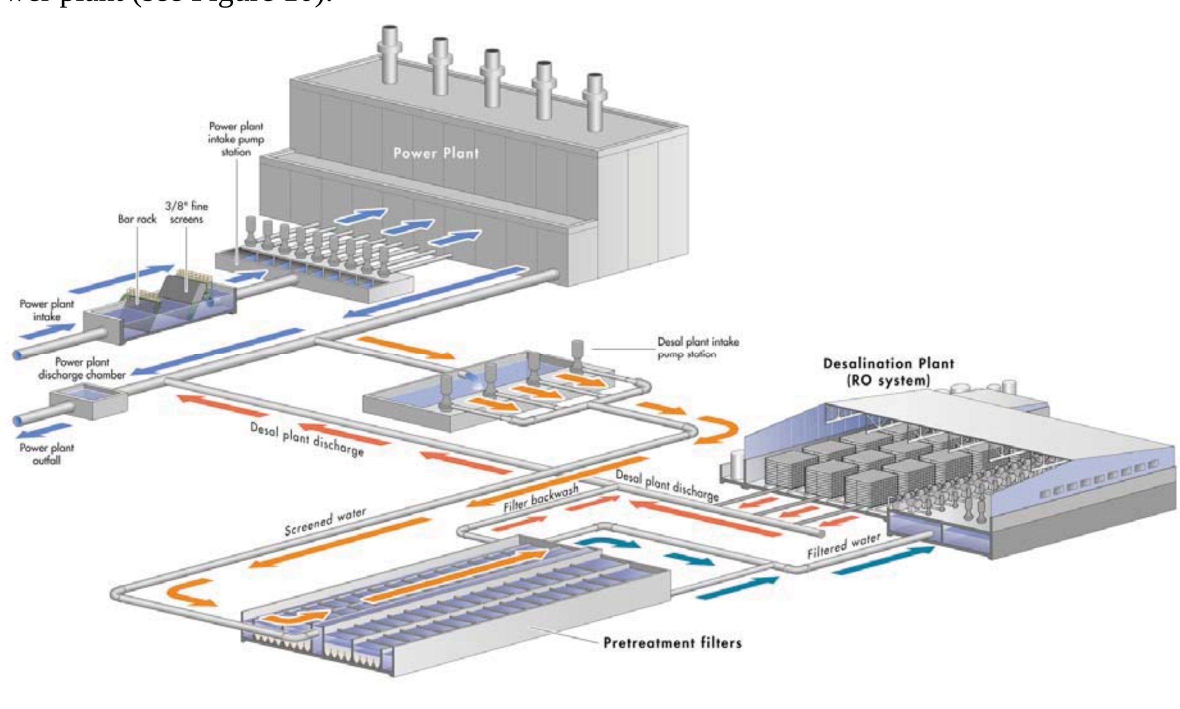


Source: Acciona Agua

Figure 9 – Wedgewire Screen

Collocated Intakes

This is a type of open intake for desalination plants co-sited (collocated) with existing power generation stations using seawater for once-through cooling purposes. Intake and/or discharge of collocated desalination plants are typically directly connected to the discharge outfall of a coastal power plant (see Figure 10).



Source: Water Globe Consulting

Figure 10 – Collocated Desalination Plant

In once-through cooled power plants, seawater enters the power plant intake facilities and, after screening, is pumped through the power plant condensers to cool the steam turbines, thereby removing the waste heat produced during the electricity generation process. The cooling water discharged from the condensers is typically 5 to 15 ^{0}F warmer than the source ocean water. The desalination plant uses a portion of this post-condenser cooling water to produce drinking water. This warmer cooling water is less viscous than the ambient ocean water, which reduces the energy needed for desalination by membrane separation. The main reason for the increased interest in collocated desalination plants over the past decade is the fact that they avoid the need to permit and construct new desalination plant intakes and outfalls, while also improving on the desalination plant membrane performance due to the readily available warmer water.

CONSIDERATIONS FOR SELECTION OF INTAKE TYPE

At present, open-ocean intakes are the most widely used type of intake technology worldwide, because they can be installed in practically any location and built in any size. While open intakes are suitable for all sizes of desalination plants, their cost effectiveness depends on a number of location-related factors such as: plant size; depth and geology of the ocean floor; impact of sources of water quality contamination on their performance (i.e., wastewater and storm water outfalls; ship channel traffic; and large industrial port activities); and ease of installation.

Mainly due to the fact that favorable hydrogeological conditions for subsurface intakes are often impossible to find in the vicinity of the desalination plant site, the application of this type of intake technology to date has been limited to plants of relatively small capacity. In addition, densely populated coastal areas, where large desalination plants are needed, have very limited land availability for installation of numerous beach wells, which often is an important factor and potentially a fatal flaw in certain coastal communities.

Both open and subsurface intakes offer different advantages and usually have different disadvantages in terms of capital, operation, & maintenance costs; construction complexity; environmental impacts; operational considerations; and subsequent source water pretreatment and concentrate disposal needs. Therefore, the selection of the most suitable intake system for the site-specific conditions of a given desalination project should be completed based on life-cycle cost-benefit analysis and environmental impact assessment including all key project components - intake, pretreatment, membrane salt separation, and concentrate disposal.

Intake selection should be based on reasonable balance between the cost expenditures and environmental impacts associated with production of desalinated water. Project proponents should not be burdened with the use of the most costly intake alternative if the environmental impacts associated with the construction and operation of a less expensive type of intake are minimal and can be reasonably mitigated.

While thorough feasibility evaluation of intake alternatives is warranted, this evaluation should be initiated with pre-screening for fatal flaws based on site specific studies for the selected intake location. If the pre-screening shows that certain intake alternatives have one or more fatal flaws that preclude their use, such intake systems should be removed from the evaluation process because their detailed feasibility assessment will be unproductive and would only cause unwarranted project delays and expenditures.

While the desalination project proponent has the burden to complete feasibility evaluation of alternative intakes for a given project, the permitting agencies involved with project review should facilitate the engineering and environmental studies needed to establish their viability. For example, if subsurface intake appears to be possible for a given project, permitting agencies should provide the necessary allowance for test well drilling and installation while not creating hurdles that make the intake feasibility investigations overly complicated.

CONCLUDING REMARKS

At present, open intakes are by far the most widely used type of source water collection facilities worldwide because they are suitable for all sizes of desalination plants; they are more predictable and reliable in terms of productivity and performance; they are easier and more cost-effective to operate and maintain; and they usually offer better economy of scale for desalination systems of capacity greater than 5 million gallons per day (MGD).

The feasibility of subsurface intakes is very site specific and highly dependent on the project size; the coastal aquifer geology (aquifer soils, depth, transmissivity, water quality, capacity, etc.); the intensity of the natural beach erosion in the vicinity of the intake site; and on many other environmental and socio-economic factors discussed in the previous sections of this white paper.

Both open ocean intakes and wells may have advantages and pose environmental and socio-economic challenges for the site-specific conditions of a given desalination project. Therefore, the selection of most viable intake alternative should be based on balanced life-cycle cost-benefit analysis and environmental assessment.

Brown Pelican
Figures

Table 1. The number of California Brown Pelicans observed at roosts in the Monterey Bay National Marine Sanctuary during aerial surveys completed in the fall of 1998, 1999, and 2000 ([15]Strong and Jaques 2001). The highest and lowest numbers observed at each roost are shown. Roosts are listed from North to South. Names in italics identify sites that were listed as important roosts by Briggs and colleagues in 1983.

Roost	1998-2000
Rodeo Lagoon	0-277
Bird Rock, Pt. Bonita	325-1262
Seal Rocks, San Francisco	13-1003
Mussel Rock	0-40
Devil's Slide/Pt. San Pedro	177-602
Pillar Point Harbor	460-787
Seal and Eel Rocks, San Mateo Co.	64-218
Pigeon Pt/Martin's Creek Rock	17-93
Gazos Creek	12-77
Año Nuevo Island	1388-5229
Año Nuevo Mainland	38-1438
Greyhound Rock	0-233
Wilder State Beach	3-115
Santa Cruz Point Rocks	38-280
Santa Cruz Wharf	0-96
Black Point	0-198
Cement Ship Pier	55-79
Pajaro River mouth	23-695
Moss Landing Wildlife Management Area	449-1189
Elkhorn Slough NERR	449-1189
Moss Landing Harbor	0-42
Salinas River mouth	165-1086
Monterey Harbor & Jetty	95-235
Point Piños & Hopkins Rock	20-67
Bird and Seal Rocks	74-266
Pescadero Rock	172-348
Carmel River	0-160
Point Lobos Rocks (including Bird Island)	461-2519
Plaskett Rocks	58-203
Cape San Martin Rock	50-787
La Cruz Rock	68-103
Point Piedras Blancas	84-377
Rocks S of Pt. Piedras Blancas	114-275

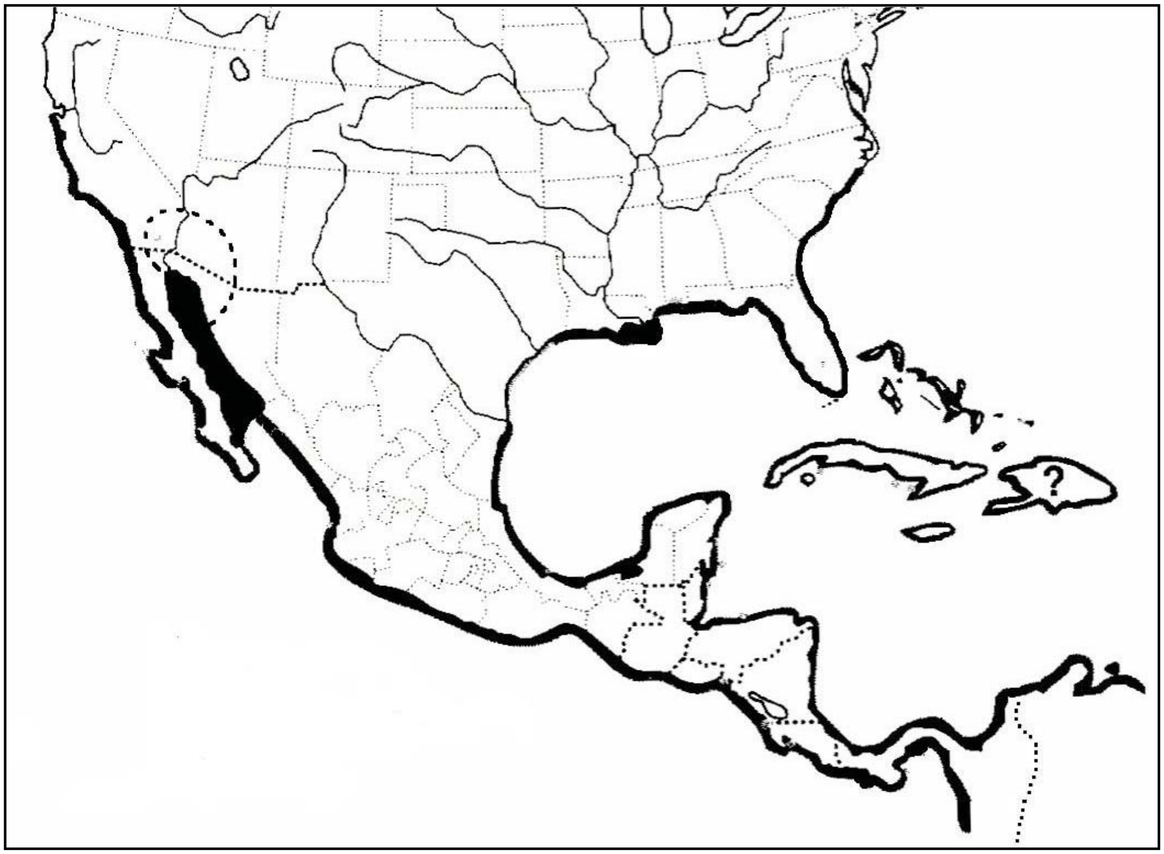


Figure 1. Distribution of the Brown Pelican in North and Central America and the western Caribbean. The dashed lines indicate the limits of post-breeding dispersal. This species also is a resident in the eastern Caribbean, along the coast of Ecuador, and in the Galápagos Islands. [modified from [12]Shields 2002].

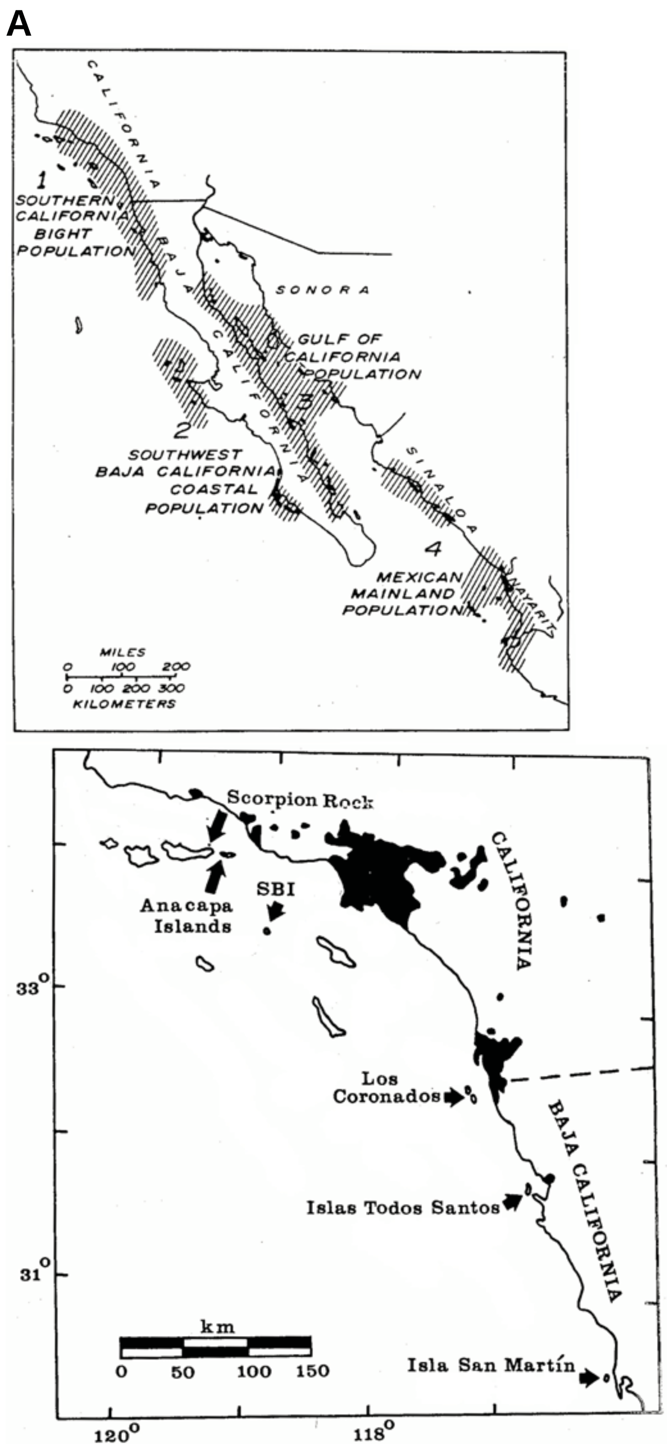


Figure 2. Map showing (A) the breeding populations and range of the California Brown Pelican and (B) the Southern California Bight region indicating the location of past and present California Brown Pelican nesting colonies (SBI = Santa Barbara Island) [reprinted with permission from [1]Gress and Anderson 1983].

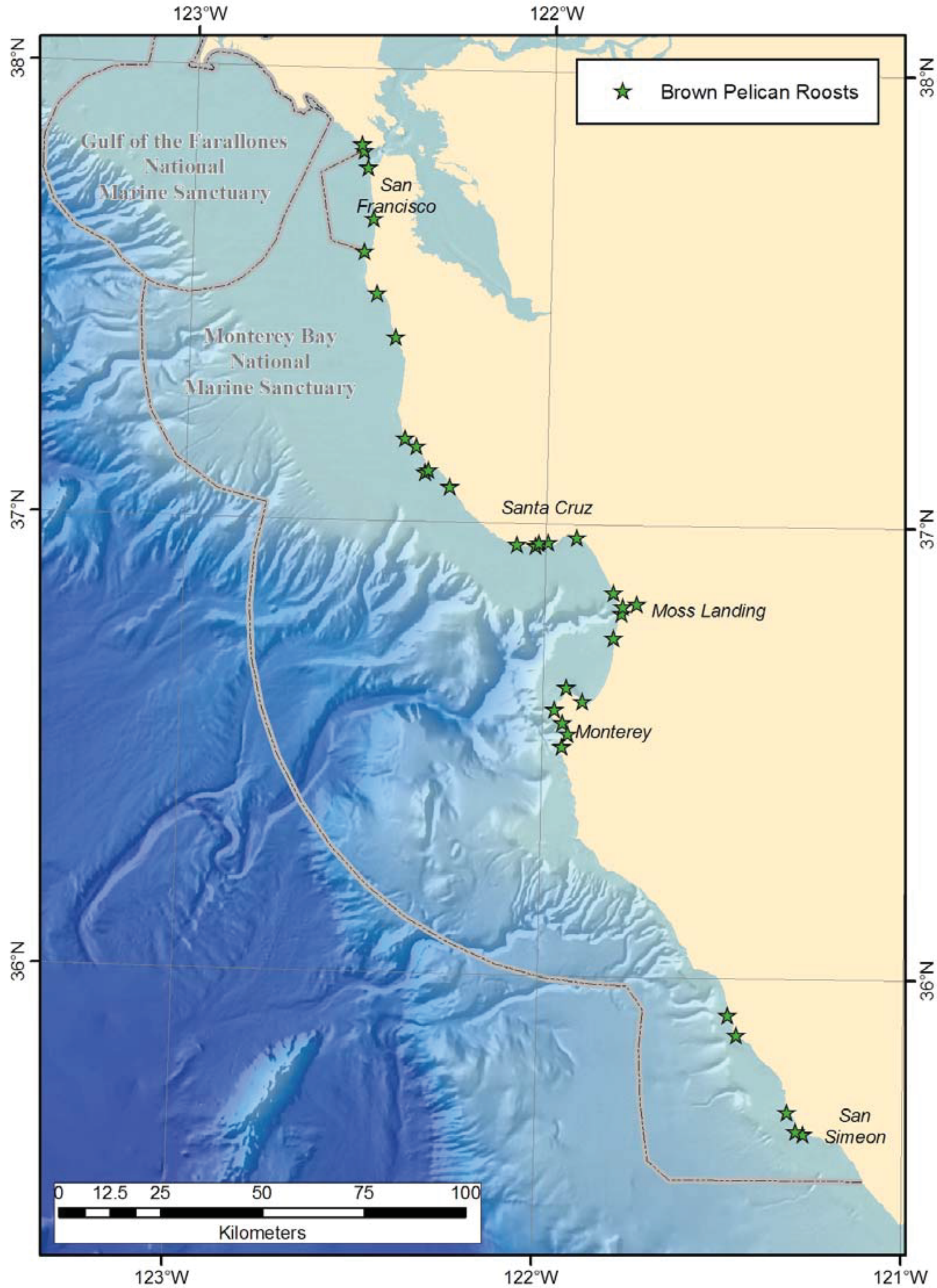


Figure 3. California Brown Pelican roost observed in the Monterey Bay National Marine Sanctuary during aerial surveys completed in the fall of 1998, 1999, and 2000 ([15]Strong and Jaques 2001).

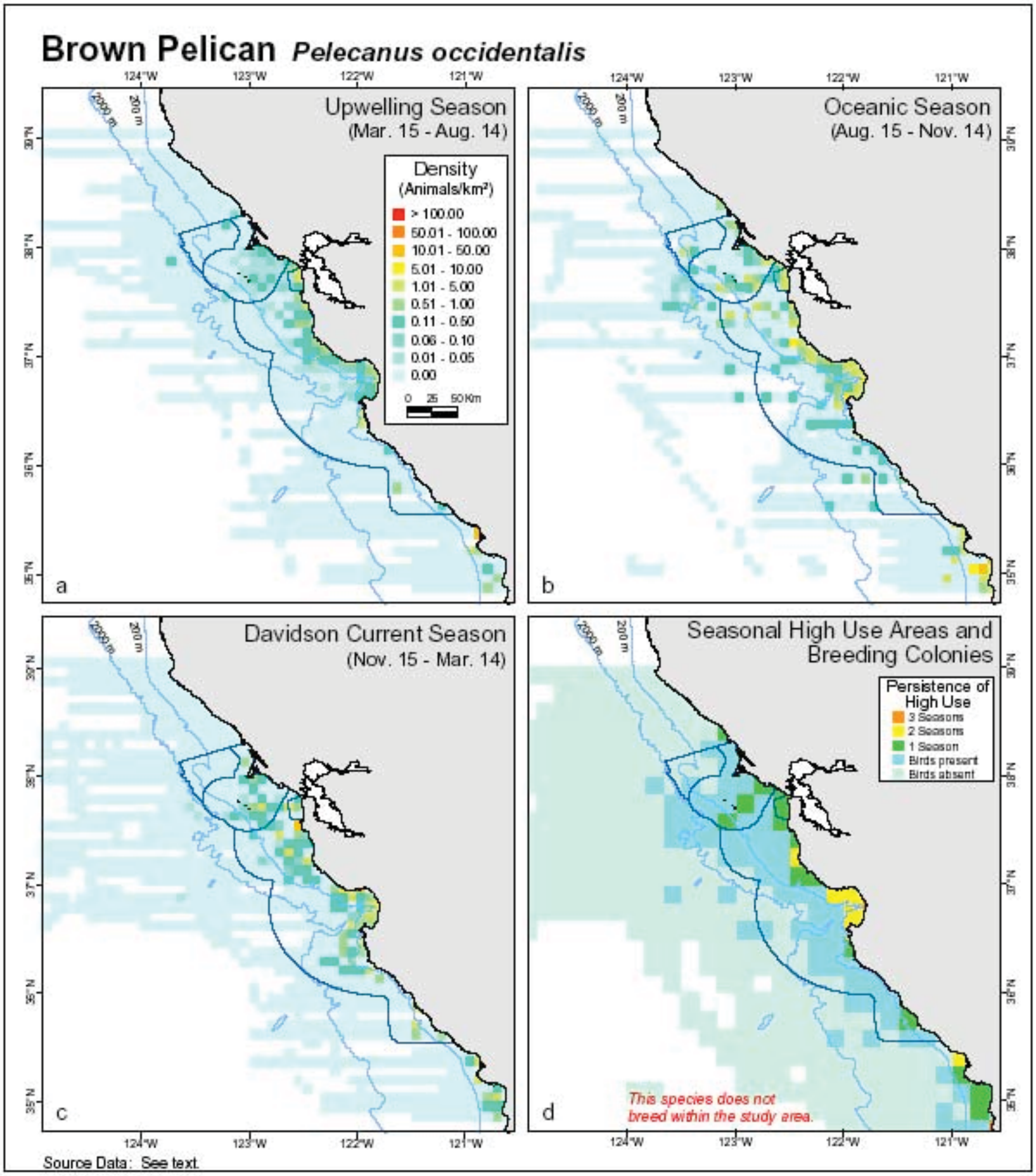


Figure 4. These maps shows the density of the California Brown Pelican (*Pelecanus occidentalis californicus*) in the Monterey Bay, Gulf of the Farallones and Cordell Bank National Marine Sanctuaries during three seasons: Upwelling season (March 15 - August 14); Oceanic season (August 15 - November 14); and Davidson Current season (November 15 - March 14). These data are provided by the California Biogeographic Assessment prepared for the Monterey Bay National Marine Sanctuary's Management Plan.

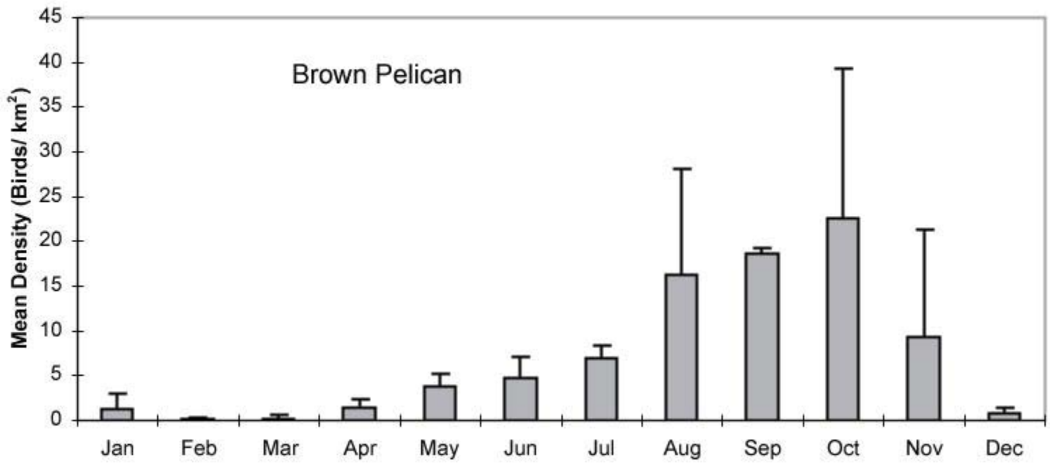


Figure 5. Mean monthly density of California Brown Pelicans occurring in Monterey Bay based on 34 surveys from 1999-2001 (reprined with permission from [19]Henkel 2004)

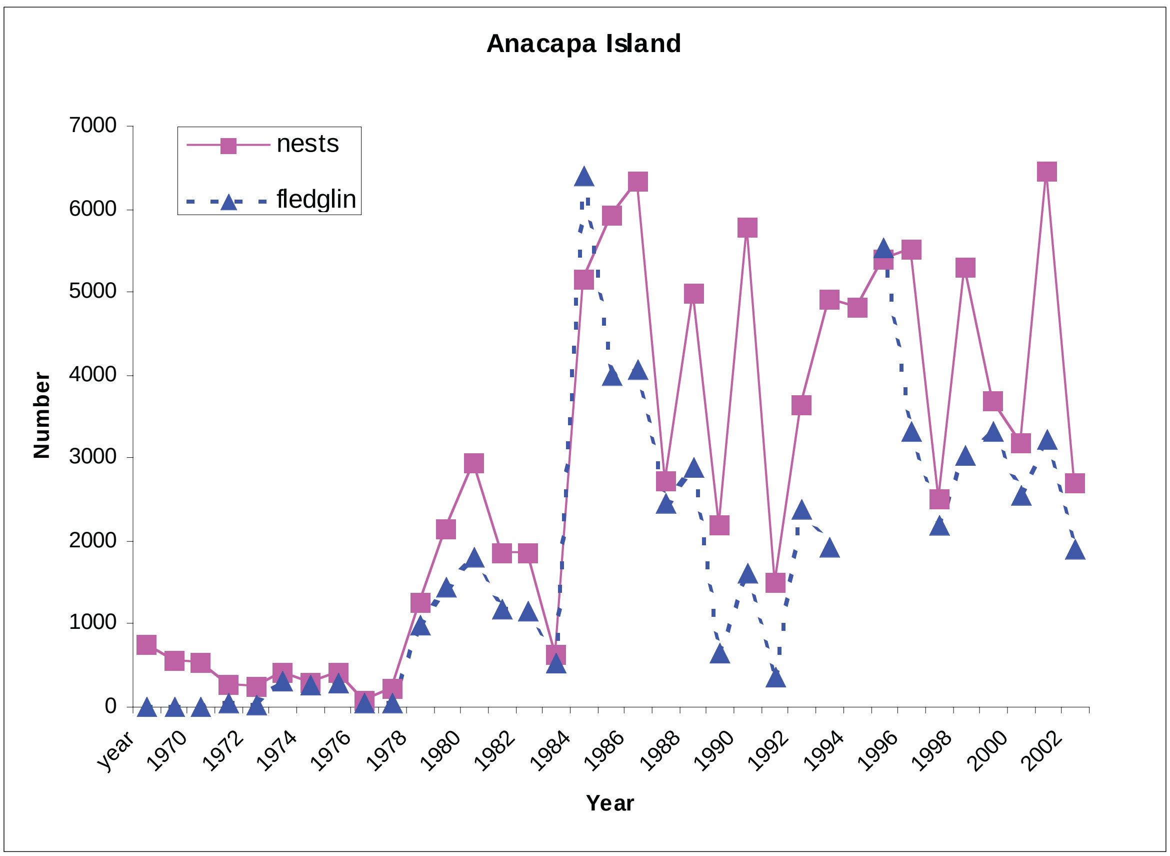


Figure 6. Temporal trends in the number of nesting attempts and the number of fledglings produced by California Brown Pelicans on West Anacapa Island and Scorpion Rock (reprinted with permission from [50]Gress and Harvey 2003).

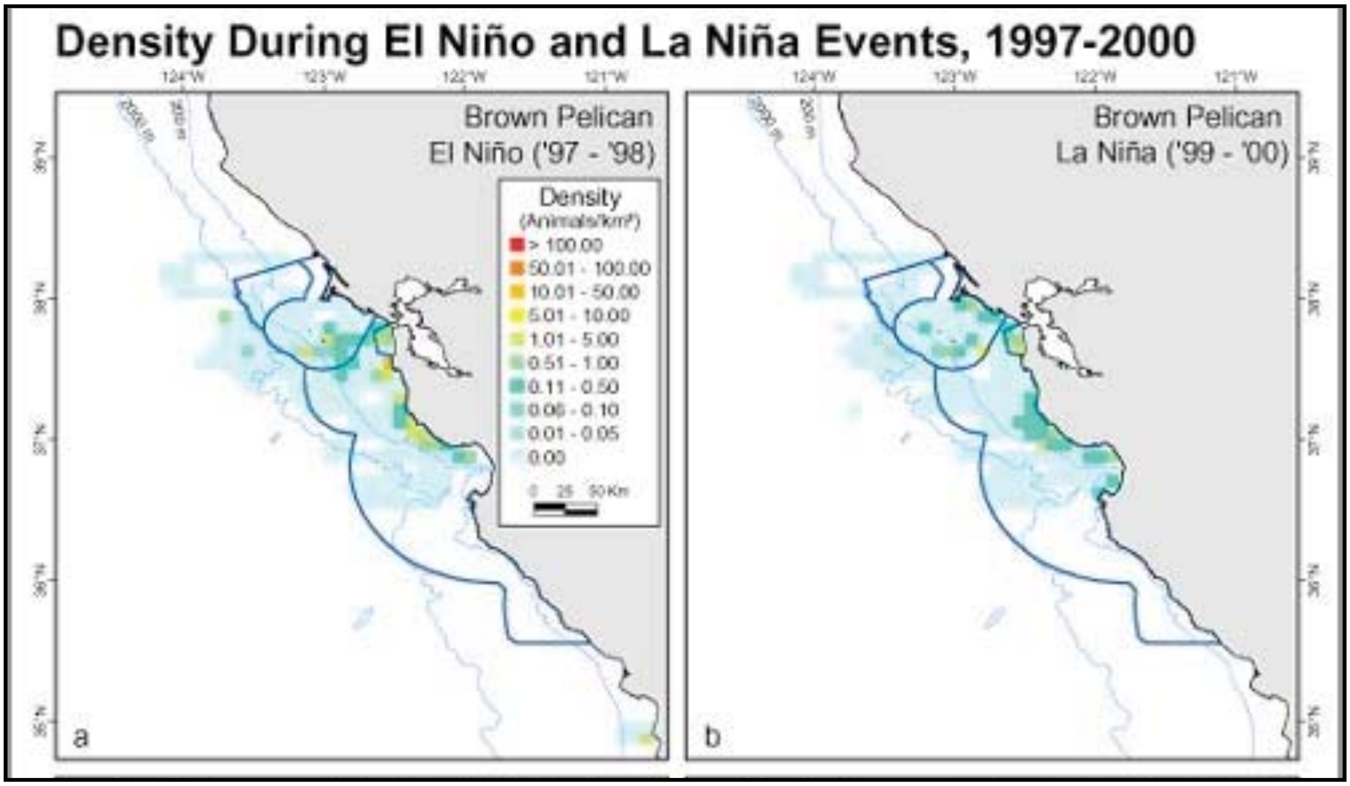


Figure 7. These maps show the density of the California Brown Pelican in the Monterey Bay, Gulf of the Farallones, and Cordell Bank National Marine Sanctuaries during El Niño and La Niña events. Densities are much higher in central California during warm-water periods (El Niño). Data provided by the California Biogeographic Assessment prepared for the Monterey Bay National Marine Sanctuary's Management Plan.

The People's Moss Landing Water Desal Project

Draft Process Design Report

February 27, 2015

Prepared by:

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Table of Contents

Executive Summary

The People's Moss Landing Water Desalination Project (PMLD) is a proposed desalination plant in Moss Landing that will produce 13,404 acre-feet per year (AFY) of potable water. The overall purpose of the PMLD is to rehabilitate existing facilities at the Moss Landing Green Commercial Park to develop a desalination project in order to provide potable water to the North Monterey County area and to the Monterey Peninsula. This project proposes to provide 3,652 AFY of "new water" to customers in North Monterey County and 9,752 AFY to the Monterey Peninsula. This capacity was selected based on historical water use, expected future planned demands and additional water supply needs.

The proposed desalination plant would be located at the Moss Landing Business Park, which is the location of the former Kaiser Refractories Magnesium Extraction and Brick Production Plant that ceased production in February 1999. One of the biggest advantages of the site is having significant infrastructure in place. The site is considered to be ideal for a desalination plant since it has access to a major roadway for deliveries, is adjacent to a power plant and high voltage grid and is an industrial zoned property. Approximately 16 to 18 acres of the 186 acre site is required for locating the desal plant.

Three different sources with some variation in seawater quality were considered. Due to this variation and the impact on the process equipment sizing and selection, three alternatives were evaluated:

Alternative A: Intake is from the harbor at the location of the existing intake pump station

Alternative B: Intake is from the open sea in the bay

Alternative C: Intake is from subsurface system

The purpose of this report is to address water quality issues, evaluate the various alternatives and provide calculations, sizing and equipment layouts for these alternatives. The report also provides estimates for Capital and Operation/Maintenance costs as well as power, chemical, by-products handling and staffing requirements.

Conservative assumptions were made establishing the design seawater quality based on the available historical seawater quality data. The final product water goal was set to not only meet, but also surpass the drinking water standards set by the United States Environmental Protection Agency (USEPA), the California drinking water quality requirements as well as California Title 22 recommendations.

For each alternative, detailed calculations were performed and process selections were made. Conservative loading and sizing rates were utilized for all equipment for purposes of sizing to meet industry standards and guidelines.

Based on the technical, environmental, water quality and economical considerations discussed in this report, Alternative A (Harbor Intake) is not recommended for implementation. From the 2014 hydro-geological feasibility study conducted by by CapRock Geology Inc., it appears that Alternative C (Subsurface Intake) is not a reasonably feasible option. Therefore, the Project Team is planning to proceed and implement Alternative B (Open Bay Intake).

The total estimated cost of producing the 13,404 AFY at the proposed facility (without distribution system) ranges from $1500 to $ 1600 per Acre Feet.

The cost for the delivery system (pipelines and tanks) for 9,752 AFY from project site to CalAm's terminal in Seaside and delivery of 3,652 AFY to customers in North Monterey County would be approximately an additional $400 per Acre Feet. Although the delivery system for North County is still under development, including the number of pipelines required and their routes, preliminary costs of pipelines and terminal storage tanks are included in these estimates.

1.0 Introduction

This section of the report will give a summary of the purpose of this report and project background.

1.1 Report Purpose and Scope

This report will establish the design criteria for the site, intake, outfall and all major plant components. The level of design included in this document is about 20%. Preliminary process design and equipment sizing and layouts have been prepared based on this level of design.

Included in this report are the following:

- Process Flow Diagrams (PFDs)
- Preliminary equipment layouts
- Preliminary major equipment selection
- Verification of infrastructure capacity
- Power and chemical usage estimates
- Office space requirements
- Staffing needs
- Capital and operation/maintenance cost estimates

1.2 Project Description and Background

The People's Moss Landing Water Desalination Project (PMLD) is a proposed desalination plant in Moss Landing that will produce 13,404 acre-feet per year (AFY) of potable water. The overall purpose of the PMLD is to rehabilitate existing facilities at the Moss Landing Green Commercial Park to develop a desalination project in order to provide potable water to the North Monterey County area and to the Monterey Peninsula. This project proposes to provide 3,652 AFY of "new water" to customers in North Monterey County and 9,752 AFY to the Monterey Peninsula. This capacity was selected based on historical water use, expected future planned demands and additional water supply needs.

The proposed desalination plant would be located at the Moss Landing Business Park southeast of the intersection of Dolan Road and Highway 1, and across Dolan Road from the Moss Landing Power Plant facility. The Moss Landing Business Park is the location of the former Kaiser Refractories Magnesium Extraction and Brick Production Plant that ceased production in February 1999. Figure 1 (in Appendix) shows the overall location of the existing site and the proposed desalination plant in the shaded area.

To the extent possible, the proposed desalination plant will incorporate existing infrastructures and service facilities located at the Moss Landing Business Park including some of the tanks, structures and pipelines.

1.3 Desalination Plant Capacity

The proposed desalination plant's net production capacity will be 11.97 Million Gallons per Day (MGD), which is equivalent to 13,404 acre-feet per year (AFY). Actual product water from the plant is slightly more (12.05 MGD) to accommodate internal water uses such as process wash water needs, process analyzers flows, bathrooms, sinks and other miscellaneous uses.

This capacity was selected based on historical water use, expected future planned demands and additional water supply needs. For the basis and calculations of the plant capacity, refer to the project Environmental Impact Report (EIR).

2.0 Water Quality Considerations

In addition to the plant capacity, water quality of the source water and expected water quality of the final product water in a desalination plant will have the most significant impact on the process equipment efficiency, selection and sizes. These water qualities will also dictate the volume and quality of the outfall and by-products.

For the purposes of this report, three different sources, with some variation in seawater quality are considered.
Due to this variation and the impact on the process equipment sizing and selection, three alternatives are being evaluated.

- **Alternative A:** Intake is from the harbor at the location of the existing intake pump station
- **Alternative B:** Intake is from the open sea in the bay
- **Alternative C:** Intake is from subsurface system

Refer to Figure 1 for location of the desal plant and intake alternatives.

2.1 Seawater Quality

Significant water quality data for the bay and the harbor is available from previously published studies and reports, which is summarized and is being utilized as the Design Seawater Quality Basis. A comprehensive report by Marine Pollution Studies Laboratory and Moss Landing Marine Laboratories (Surface Water Ambient Monitoring Program, 2007) provided the major water quality data needed for this report.

Table 2.1 is a summary of the available water quality data. Conservative assumptions were made in order to establish the design seawater quality used for the three alternatives, as shown in the right three columns of this table.

Additional data collection and proof pilot studies are planned for confirmation of the basis of design during the next engineering and design phase.

Table 2.1 : Seawater Intake Design Water Quality									
							Conservative Design Value Used After Balancing Ions		
		From Previous Reports and literature			Surface Water Ambient Monitoring Program Report (Stations 14 and 30)		Alternative A	Alternative B	Alternative C
Parameter	Unit	Minimum	Maximum	Average Value	Minimum	Maximum	Design Value	Design Value	Design Value
Ammonia	mg/L				0	0.12	0.12	0.12	0.12
Potassium	mg/L						390	390	390
Sodium	mg/L						10760	10760	10760
Magnesium	mg/L						1400	1400	1400
Calcium	mg/L						500	500	500
Strontium	mg/L						13	13	13
Barium	mg/L						0.1	0.1	0.1
Bicarbonate	mg/L			143			145	145	145
Nitrate	mg/L				0	0.015	0.1	0.015	0.015
Chloride	mg/L	16900	20800	19400			19822	19822	19822
Sulfate	mg/L			2700			2700	2700	2700
Boron	mg/L	3.6	5	4.5			5	5	5
Total Dissolved Solids (TDS)	mg/L	32500	34500	33200	33200	34200	35800	35800	35800
pH	Units	7.3	8.1	7.6	8	8.5	8	8	8
Turbidity	NTU	5	40	26			50	10	5
Total Suspended Solids (TSS)	mg/L	5	45	26	15	55	60	10	5
Chlorophyll a	ug/L				0.2	4.2	5	2	1
Total Organic Carbon (TOC)	mg/L				0.2	3	5	2	2
Temperature	°C	10	15	12	12	17	7-17	5-17	5-17
Potential for Agricultural Contaminants							High	Low	Very Low
Potential for Petroleum Contaminants							High	Low	Very Low
Potential for Synthetic Organic Chemicals (SOCs)							High	Low	Very Low
Potential for Volatile Organic Chemicals (VOCs)							High	Low	Very Low

2.2 Product Water Quality

The product water from the proposed desal plant will be post treated, disinfected, re-mineralized and conditioned to meet and surpass the regulatory requirements of the US-EPA Drinking Water Regulations, Safe Drinking Water Act and the California Title 22 Code requirements and recommendations (July 1, 2013) as shown in Table 2.2.

The project team also reviewed the 2012 existing water quality report on the California American Water Company (CalAm) website and has set a goal to produce a lower hardness and dissolved solids from the proposed plant finished water. Hard water contributes to an inefficient and costly operation of water-using appliances such as boilers, water heaters and heat exchangers. Heated hard water forms a scale of calcium and magnesium minerals that can contribute to an inefficient operation or premature failure of such appliances. Pipes can become clogged with scale buildup, which reduces water flow, causing more power consumption and ultimately may require pipe repair or replacement. Hard water also interferes with almost every cleaning task in households and Laundromats. The hardness in water affects the amount of soap and detergent necessary for cleaning.

A hardness target of 100 mg/L was established for this report, which is well below the current CalAm's 2012-reported finished water hardness of 183 mg/L (average) to 310 mg/L (high) values.

We also considered the Monterey Peninsula Regional Water Authority Consultant's recommendations (Final Report, Jan 2013) by Separation Processes, Inc. (SPI) in establishing the design product water quality.

The Total Dissolved Solids (TDS) of less than 380 mg/L was established for the purposes of equipment selection and sizing in this report, which surpasses California Title 22 requirement (<1000 mg/L), California Title 22 recommendations (<500 mg/L) and meets SPI's recommendation (<380 mg/L).

Table 2.2 is a summary of the proposed product water quality goals set for the PMLD product water and provides a comparison to the above-referenced water quality parameters.

Table 2.2: Finished Water Design Water Quality		California American Water (2012 Water Quality Report)			California Title 22 Regulations (MCL or SMCL)	California Title 22 Regulations (Recommended)	Recommended by Monterey Peninsula Regional Water Authority (Final Report, Jan 2013) Separation Processes, Inc.	Design Product Water Quality Goal
Parameter	**Unit**	Low	High	Average				**After Post Treatment**
Gross Alpha Prticles Radio-Activity	pCi/L	0.1	0.4	0.3	15			**ND**
Combined Radium	pCi/L	ND	3	1.7	5			**ND**
Uranium	pCi/L	0.1	0.4	0.3	20			**ND**
Radon	pCi/L	163	638	322				**ND**
Arsenic	ug/L	ND	8	1.2	10			**ND**
Nitrate (As NO3)	mg/L	ND	26.9	10.1	45			**<10**
Selenium	ug/L	ND	7	3	50			**<1**
Total Trihalomethanes (TTHM)	ug/L	3.9	61.2	29.3	80			**<40**
Haloacetic Acids (HAAs)	ug/L	1.3	28.7	14.4	60			**<30**
Sulfate	mg/L	60	80	69	500	250		**<50**
Total Dissolved Solids (TDS)	mg/L	136	618	417	1000	500	380	**<380**
Chloride	mg/L	32	136	84	500	250	60	**<100**
Boron	mg/L	ND	1.1	0.23			0.5	**0.5-1.0**
Calcium	mg/L	17	86	48			40 as CaCO3	**40**
Alkalinity	mg/L	48	242	151			40 as CaCO3	**40**
pH	Unit	6.2	8.4	7.3			>8	**8**
Magnesium	mg/L	ND	25	15				
Sodium	mg/L	48	91	70				**<100**
Total Hardness	mg/L	42	310	183				**<100**
Sodium Adsorpbtion Ratio (SAR)	Unit							**<5**
LSI	Unit							**>0**

2.3 Outfall Water Quality

The quality and quantity of outfall is a function of the treatment system and the plant recovery. Refer to section 3.19 for discussion of the outfall water quality and characteristics.

3.0 Treatment Process Description

The design team has evaluated all available data, water quality goals and previous studies and is considering the following major process units for this conceptual design. Conservative approach is utilized in sizing unit processes. Also as shown, redundant units are being proposed for a reliable and dependable system with minimum need for shutdowns. The unit process sizing and loading rates will be refined as additional water quality and pilot test data is made available and as the design progresses.

As discussed, for the purposes of this report, three different sources with some variation in seawater quality are considered. Due to this variation and the impact on process equipment sizing and selection, three alternatives are being evaluated.

- **Alternative A:** Intake is from the harbor at the existing intake pump station location
- **Alternative B:** Intake is from the open sea in the bay at the location of the existing abandoned intake
- **Alternative C:** Intake is from subsurface system

Conceptual sizes and layouts are also included in this section for the following major process units. Some unit processes listed below are not used in certain alternatives as discussed in the relevant sections.

- Intake System and Screens
- Elector-chlorination Unit
- Coagulation
- Contact basins
- Flocculation
- Dissolved Air Floatation
- Two Stage Media Filtration
- Ultrafiltration (for Alternative A only)
- Cartridge Filtration
- First Pass Reverse Osmosis (RO) Desalination
- Energy Recovery System on first pass RO
- Partial Second Pass RO
- Calcite Remineralization with pH adjustment
- Disinfection
- Packed Tower Aeration (for Alternative A only)
- On site water storage tank
- Distribution Pumping and pipeline
- Backwash treatment
- Solids and Residual handling
- Concentrate blending system
- Auxiliary equipment such as Clean In Place for membrane systems

Preliminary Process Flow Diagrams (PFDs) are shown in Figures 3 through 11 for all major equipment with major pipe sizes for the three alternatives. Although extreme, worst-case values have been considered in equipment selection, these PFDs represent average seawater quality and temperatures.

3.1 Intake Options

The water source for a Seawater Reverse Osmosis (SWRO) facility has a direct impact on the level of pretreatment required, plant efficiency, the achievable treated water quality, and often the degree of subsequent operational issues, which may be encountered. Most of the world's experience with seawater intakes is a result of their use in the electric power generation industry, where seawater is commonly used for cooling purposes in large condensers. Thermal desalination processes have intake water quality requirements, which are virtually identical to power plant condensers. Membrane SWRO systems, however, benefit greatly from a finer level of screening and pretreatment than is typically used in power plants.

In general, seawater intakes can be broadly categorized as open intakes, where water is collected above the seabed, and subsurface intakes, where water is collected via beach wells, infiltration galleries, or from other locations beneath the seabed. The most appropriate location and type of the intake can only be determined after a thorough site assessment and careful consideration of the environmental and permitting impacts, commercial impacts and technical feasibility.

A reliable intake design will not only protect downstream equipment and reduce environmental impacts on marine life, but also will improve the performance and reduce the operating cost of the treatment facility.

For large plants, surface intakes are most common due to limited ability of subsurface intakes to deliver sufficient volumes of seawater. Risks associated with poor water quality are highest with surface intakes. Therefore, care must be given to ensure adequate intake depths and screening are maintained.

For a conceptual plan of the three intake options, refer to Figure 14.

Alternative A: Existing Harbor Intake

The existing surface intake pump station in the harbor was originally constructed in the 1940s to serve the Kaiser Refractories Plant and was upgraded in 1968. The existing intake system currently consists of nine pumps, which are housed in a building and supported on a concrete structure. The system was used to provide up to 60 MGD of seawater for the purpose of removing calcium and magnesium as part of the magnesia production.

If this alternative is selected, this structure will be rehabilitated and modified by dredging the harbor and installing walls around the existing platform (to form a wet well) and installing passive screens as described in the following sections and as shown in Figure 14. All existing pumps and motors will be removed and replaced with the numbers and sizes shown. A new pump and control building will be constructed. The new structure will house the screen air burst and Electro-Chlorination Unit (ECU), as described in the following sections. Use of a cofferdam will be necessary for a majority of the underwater construction. Boats and marine activities in the harbor will be significantly impacted with this alternative, both during construction as well as long term.

Alternative B: Open Bay Intake

This intake option will be at the Bay Shore near location of the abandoned intake (near old pier) as shown in Figure 1. The old intake structure will be extended down and rehabilitated with a new pipe extended to the bay with new passive screens as shown in Figure 14. The intake structure will have a building on top to house the electrical gear and the screen air burst and Electro-Chlorination Unit (ECU), as described in the following sections.

For this alternative, dispersion and mixing models are planned to confirm the assumption that the PMLD concentrate will have no adverse impact on the quality of the intake for the PMLD plant. Based on our research of other desal plants, same arrangements (intake and outfall near each other) have been successfully used without any water quality issues, as long as proper diffusers and dispersion are implemented. An example is the Victorian

Desal plant in Australia, with a capacity of 117 MGD, which has been successfully operated without any water quality issues since December 2012. This plant uses a combined tunnel alignment for intake and outfall pipes, with intake and outfall ends within 984' of each other in the ocean and separated 165' horizontally.

Alternative C: Subsurface Intake

Subsurface intake systems considered for the project are the most common subsurface type intake systems with proven technology and include: beach wells, slant wells, vertical wells, infiltration galleries, Ranney Collectors and seabed filtration systems. Despite variation in type of subsurface intake, the common advantages of a subsurface system are better water quality with less environmental impacts on marine life (impingement and /or entrainment).

The limiting factor for any subsurface system is the ability to achieve sufficient yield. In order to produce the required 12 MGD (13,440 AFY) of Product Water for this proposed project, the intake facility needs to produce approximately 29-33 MGD of Source Water. Due to space constraints at the existing Moss Landing Commercial Park, there are only two realistic locations that are being considered for subsurface intake. The first is a Harbor Location – the 1500 feet long portion of PMLD west of Highway 1, including the area of the existing PMLD intake, adjacent to and/or within the Moss Landing Harbor. The second location is the Bay Location adjacent to Monterey Bay. There is an existing abandoned intake system located on the spit near the former Moss Landing Marine Labs (MLML) pier within the PMLD property.

In 2014, CapRock Geology, Inc. performed a feasibility study of various alternative intake sources for the proposed project at both the Harbor Location and the Bay Location. The feasibility study reports on the potential for developing desalination feed water facilities for the plant in the shallow (<60 feet) Sand Dune Aquifer water bearing zones that are hydraulically connected to the harbor and/or bay as well as a deeper water bearing zone (100-140 feet).

1) Subsurface Wells on MLCP Property: Based on CapRock's field observations during drilling of the two exploratory wells, the shallow sand dune zone (0-60 feet) does not produce enough source water to support the project. With respect to the deeper zone (100-140 feet), CapRock noted that a recent CalAm study conducted on the property concluded that individual sand lenses, as well as sand and gravel lenses, were neither vertically or aerially extensive in the Moss Landing area and were deemed ill-suited to producing the quantities of feed water needed for a desalination plant.

2) Subsurface Wells at Moss Landing Marine Lab / Beach: CapRock noted that results from the MLML Test Well "suggest geologic conditions that are unfavorable for a subsurface desalination intake requiring in excess of 2MGD." In addition, CapRock noted that there is space for one Horizontal Beach Ranney Collector Well adjacent to Monterey Bay on the existing MLCP abandoned intake caisson footprint on MLML property. The project requires 29-33 MGD of Source Water to produce 12 MGD of Product Water. An existing individual collector is estimated to supply between 0.5-5 MGD – and thus the project would require between 7 and 65 collectors and between 2500 feet and 4.5 miles of beachfront for installation of the collectors. CapRock further noted that "backup collectors (in case one collector goes offline) might be required, which would necessitate additional beachfront footage. The oceanfront site is subject to potentially significant tsunamis and beach erosion related to global sea level rise. In addition, shallow pumping of large quantities of groundwater could cause subsidence. For these and the other reasons specified in this section, the MLML Shore Lab is not a feasible site for feed water intake."

3) Harbor Location: Data collected to date indicate that even if sufficient quantity of water is available, the water quality of the subsurface water at the Harbor would not be sufficient due to previous contamination issues associated with the legacy operations of both the Moss Landing National Refractory and/or the Moss Landing Power Plant;

4) Current studies indicate that drawing subsurface water at the Harbor location and/or the Bay location would likely interfere with the 180 and/or the 400-foot aquifers and could cause seawater intrusion, adverse impacts to existing water rights, and therefore would be technically and/or politically infeasible.

For these reasons, CapRock's study concludes that a subsurface intake does not appear to be a reasonably feasible option and a viable alternative for this proposed project.

Co-Locating Intake Option:

An option that was considered by a previous study is co-locating the desalination plant intake with the adjacent power plant cooling water. Refer to the Conceptual Design Report, Poseidon Resources Corporation, March 2006.

General advantages of co-locating at power plants include:

- Capital cost savings, due to the reduction of intake and outfall infrastructures
- If seawater is taken downstream of power plant condensers, there is potential savings in power consumption due to greater permeability of SWRO membranes at warmer temperature, but likely will be offset by power and chemical consumption of additional pretreatment equipment
- Potential ease of Permitting

General disadvantages of co-locating at power plants include:

- Environmental considerations still need to be addressed and existing power plant seawater intake permit may be compromised due to changes in use and discharge water quality
- Many commercial issues must be addressed with the power plant owner, including liability, seawater availability, costs, addition and/or removal of infrastructure at the power plant site, and dependency and risks associated with the power plant operations
- If seawater is taken downstream of the condensers, there is a risk of increased SWRO bio-fouling due to warmer seawater temperatures
- Cleaning and maintenance schemes used at the power plant may increase risk of spike events (e.g. increased chlorine loading, shards from mussels and other organisms sloughed from the intake) that could potentially damage or overload the desal plant pretreatment system
- Continuous chlorination as practiced by most power plants is not ideal for SWRO plants

Due to the above considerations and uncertainty of the long-term future of the adjacent power plant's intake and cooling system, the Co-Locating option is not evaluated in this report and an independent intake system is proposed.

3.2 Intake Screens

Alternatives A and B would require passive screens at the intake. In order to minimize the adverse impacts to aquatic organisms (by impingement and entrainment). The intake design will meet the recommendations of the EPA 316b Rule. In addition, the California Water Board (2014) has been carefully considering the velocity at which seawater is withdrawn and is recommending that 0.5 ft/sec (0.15 meters/sec) is appropriate to preclude most impingement of fish. They also found that 0.5 mm slot-sized fine mesh protects larvae and eggs. This report uses the EPA 316b Rule and the California Water Board guideline for sizing the screens.

The intake screens will be provided with an automatic air-burst system to keep the screens clean. The air-burst system is estimated to operate 10-12 times per day for Alternative A, while with alternative B, it would operate 3-5 times per day.

For Alternative A, the existing intake structure perimeter walls will be extended to the bottom of the harbor, to form a wet well, using cofferdams and passive screens installed on the wall of the structure. The harbor needs to be dredged to the original bottom (Elevation -15.0) to remove organic matter and deposits and provide a true open intake system. It is estimated that about 10' of the bottom sediments and deposits have to be dredged. Dredging needs to continue every few years and as needed to maintain the bottom level.

Alternative C does not require additional screening; since regardless of the subsurface type, screens are incorporated in the collector system.

Table 3.2 presents conceptual design of the screens for the applicable alternatives.

Table 3.2 Intake Screens

	Units	Alternative A	Alternative B	Alternative C[1]
Total Number of Screens	EA	3	3	N/A
Number of Screens in Service	EA	2	2	-
Screen Size	Inch	48	42	-
Capacity, each	gpm	12,000	10,400	-
Screen Opening Size	mm	0.5	0.5	-
Velocity Through Screen Slots	ft/sec	< 0.5	< 0.5	-

[1] None required for Alternative C, part of subsurface screen system.

3.3 Electro-Chlorination Unit

In order to minimize bio-growth in the piping and downstream unit processes, occasional chlorination of incoming seawater will be necessary. Instead of purchasing and transporting gas or liquid chlorine, many SWRO facilities use Electro-Chlorination Units (ECU) to generate chlorine on site. This approach is much safer and more environmentally friendly. ECU is an electrolysis process where chloride from seawater is converted into a sodium hypochlorite solution. Salt is composed of sodium and chloride, so when a direct current passes through titanium electrodes to the electrolyte, the chlorides disassociate to form chlorine.

Capacities of the ECU systems for the three alternatives are shown in Table 3.3. For all alternatives, the ECU will have two completely separate sub-units, each rated for 50% maximum dosage.

Any chlorine must be neutralized prior to SWRO membranes, since these membrane elements are not chlorine tolerant. Sodium Meta-Bisulfite (SMBS) will be dosed at the outlet of cartridge filters in the desal plant (when chlorine is added to the intake) to neutralize any chlorine residual and protect SWRO membranes from chlorine damage.

Table 3.3 Electro-Chlorination Units (ECU)

	Units	Alternative A	Alternative B	Alternative C
Number	EA	1	1	1
Capacity, each	Pounds/hr	50	30	25

3.4 Intake Water Pipe

For Alternative A based on maximum expected flow rates, as shown in Table 3.4, one of the existing 36-inch pipes is adequate for transfer of the seawater to the desalination facility, with a velocity of 6.5 to 7.3 feet per second.

For Alternatives B and C (Bay location), a 32-inch pipes is planned generally within the existing abandoned 36-inch intake pipe. It is assumed that majority of the new pipes can be slip-lined within the existing pipes. For sections that the old pipes may have been removed (such as the segment adjacent to the bridge), Horizontal Directional Drilling (HDD) method will be used. Cost estimates reflect open cut access points, all new flexible pipes and HDD method where necessary. The new pipes will be pressure class pipe (80 psi rating) so the existing pipes are only used as a conduit and are not relied upon for internal pressures.

Table 3.4 Raw Water Pipes

	Units	Alternative A	Alternative B	Alternative C
Number	EA	1	1	1
Size, each	Inch	36	32	32
Velocity	ft/sec	7.3	10.0	10.0
Length	Feet	1,800	2,200	2,200

3.5 Pretreatment

The optimum RO pretreatment depends on raw water composition, seasonal and historical water quality changes and the RO system design and operational parameters. The primary objective of pretreatment for any membrane system is to make the feed water compatible with the membrane, which involves a total system approach for continuous, consistent and reliable operation.

Fouling is a major issue in RO applications with surface water sources and inadequate pretreatment. Fouling refers to entrapment of particulates, such as silt, clay, suspended solids, biological slime, algae, silica, iron flocs and other matters on the surface, or even worst, within the membrane pores. Depending on the operating conditions and water chemistry, some metals such as soluble iron and manganese oxidize once they are within the membrane system and can precipitate in the RO system. Similarly, microbes and bacteria can grow and spread throughout an entire RO system. Microbiological and organic fouling are perhaps the most common types of foulants and more difficult to control in surface water applications and thus have been the primary cause of failures in some systems with inadequate SWRO pretreatment.

Inadequate SWRO pretreatment can cause the following types of issues to occur, individually or in combination with one another:

- Particulate fouling
- Bio-fouling
- Organic fouling
- Colloidal fouling
- Increase in net driving pressure, and therefore higher energy costs
- Reduction in normalized permeate flow
- Degradation of treated water quality
- Increase in pressure drop across membranes, resulting in increased power consumption,

- Increase in membrane cleaning frequency
- Reduction of membrane life, as a consequence of increased cleaning
- Reduction of permeability, and therefore lower production
- Increase in plant downtime and shutdowns

Scaling refers to precipitation and deposition of sparingly soluble salts such as Calcium Sulfate, Barium Sulfate, Calcium Carbonates, Silica, Calcium Fluoride and any other super saturated salt on the immediate surfaces of the membrane. Once a crystal of scale forms within the membrane element, it acts as a nucleation site for additional scales to form and the rate of scale formation increases exponentially. Many custom formulated Scale Inhibitors will significantly reduce the scaling potential if properly chosen and adequately fed to the RO feed water. Scaling is not a major concern for the PMLD project due to the chemistry of the seawater. However, provisions have been made in the RO design for adjusting the feed water chemistry and applying a small dosage of food grade anti-foulant chemical.

In addition to minimizing scaling and fouling, optimum pretreatment is required to increase the efficiency and life expectancy of the SWRO membrane elements.

Pretreatment is generally considered to be sufficient when the SWRO cleaning is limited to 10-12 times per year or less, membrane elements last at least 4-6 years and the productivity and salt rejection are maintained within the expected ranges.

A number of technologies and process units, which offer the ability to remove the naturally occurring materials that cause fouling, are available for seawater pretreatment. The predominant technologies include:

- Fine Screening
- Coagulation/Flocculation
- Sedimentation
- Dissolved Air Flotation (DAF)
- Chlorination/Dechlorination
- Media Filtration
- Membrane Filtration, such as ultrafiltration (UF)
- Cartridge filters

Since the source waters of the three alternatives have different degrees of fouling potentials and contaminants, each alternative was evaluated for the optimum pretreatment, as discussed in the next few sections. Alternative A, with the highest degree of organics, algae, suspended solids, surface run off contaminants and other potential foulants has a higher degree of pretreatment than other two alternatives.

The physical size of the pretreatment unit processes also varies between alternatives, as shown in Figure 12.

3.6 Contact Tanks

Two existing tanks, as shown in Figure 2, will be rehabilitated and used as contact tanks. These contact tanks will be multi-purpose:

- To provide some degree of equalization of the seawater
- To provide adequate detention time for coagulation chemicals to react with the raw water, typically 20-30 minutes for cold waters
- To provide settling of large particulates and solids which pass through the intake screens

Plate settlers will be installed in the tanks after rehabilitation, to enhance sedimentation and settling.

Coagulant dosing systems is used upstream of the contact tanks to inject chemicals such as Ferric Sulfate or Ferric Chloride into seawater, in order to aid coagulation process and to improve the efficiency of downstream treatment processes such as DAF and Media filtration systems. Provisions will also be made to lower the pH of the seawater for optimum coagulation, when needed. The planned pilot study will determine the optimum coagulation process to be implemented in design.

These tanks have hopper bottoms for solid collection. A mechanical rotating sludge collector will be installed in each tank to remove deposited solids as needed based on a timer control.

All handrails, stairs, piping and valves for both tanks will be replaced.

Table 3.6 Contact Tanks

	Units	Alternative A	Alternative B	Alternative C
Number [1]	EA	2	2	2
Volume, each	Gallons	1,800,000	1,800,000	1,800,000
Detention Time with 1 Out of Service [2]	Minutes	78	86	88

[1] Existing tanks will be rehabilitated and plate settlers will be installed

[2] Additional detention time is available in raw water piping

3.7 Flocculation

Flocculation is the agglomeration of small particles and colloids to form larger settleable and filterable particles (flocs), for removal in subsequent treatment processes. During flocculation, gentle mixing accelerates the rate of particle collision, and the destabilized particles are further aggregated and enmeshed into larger precipitates.

Optimum mixing intensity requires gentle (low-shear) mixing equipment to enhance contact of destabilized particles (typically 20-25 minutes) and to build floc particles of optimum size, density and strength. Optimum floc is usually formed under conditions of gradually reducing energy (tapered flocculation), as achieved in multiple stages, each with variable speed mixers.

A two stage tapered energy flocculation is proposed, as shown in Figure 12, with variable mixer drives which will be automatically adjusted based on seawater temperatures and water quality.

Table 3.7 Flocculation

	Units	Alternative A	Alternative B	Alternative C
Number of Stages	-	2	2	2
Number Per Stage	EA	16	12	12
Number in Service for Sizing	EA	14	10	10
Volume, each Per Stage	Gallons	41,000	41,000	41,000
Detention Time with 2 Out of Service [2]	Minutes	25	20	20

[1] Two stage tapered energy

[2] Each stage

3.8 Dissolved Air Flotation

Dissolved air flotation (DAF) is a water treatment process that is used for removing light weight organics, algae, oil and difficult to settle particulates. DAF is particularly effective when the suspended solids are neutrally or positively buoyant, typical of many surface waters. DAF has been used extensively in seawater desalination facilities to minimize the impacts of harmful algal blooms and other organic matter. Excessive algae dramatically increases suspended solids concentrations in seawater supplies, fouling downstream filters and necessitating rapid backwash cycles or even causing systems to fail. In some cases in the Middle East, desalination systems without DAF had to be taken offline for months while algal blooms persisted.

Removal in DAF is achieved by dissolving air in the water under pressure and then releasing the air at atmospheric pressure in a flotation tank. A portion of the clarified effluent water leaving the DAF tank is pumped to a small pressure vessel (saturator) into which compressed air is also introduced. This results in saturating the pressurized effluent water with air. The tiny bubbles adhere to the suspended matter, causing the suspended matter to float to the surface and form a froth layer, which is then removed by a skimmer.

For the PMLD project, a 10% recycle rate is used. Other DAF design parameters are shown in Table 3.8.

As shown, a lower loading rate is used for Alternative A for the expected lower quality raw water.

A typical schematic of DAF (Xylem's system) is shown below. Figure 12 shows a conceptual layout of the DAF units for the PMLD project.

<u>**SCHEMATIC OF A DAF UNIT WITH TWO STAGE FLOCCULATION**</u>

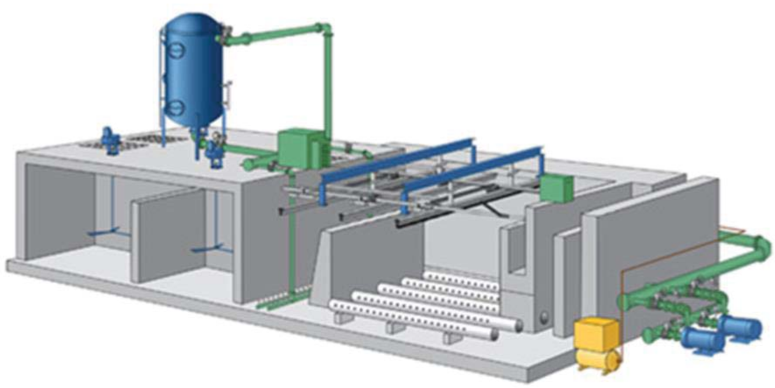


Table 3.8 Dissolved Air Floatation

	Units	Alternative A	Alternative B	Alternative C
Total Number	EA	8	6	6
Number in Service for Sizing	EA	6	4	4
Dimensions, each	Feet	36'x36'	36'x36'	36'x36'
Loading Rate with 2 Out of Service	gpm/SF	2.9	4.0	4.0
Recycle Rate	%	10	10	10

3.9 Media Filtration

In a media filtration, water travels through layers of sand/gravel/anthracite, ranging from fine to coarse grades, in a process known as straining or sieving. Thus, suspended solids are removed from the source water. Two stage media filtration results in a higher degree of clarity of the filtered water because more turbidity particles are trapped throughout the bed. Media Filtration consisting of anthracite-sand multimedia has been successfully utilized in many SWRO plants worldwide with relatively clean ocean waters, referred to as Dual Media Filtration (DMF).

In order to have very low (non-detect) particulates and a Silt Density Index (SDI) of less than 3, which is the goal of this project, two stage media filtration would be required. SDI is a field test, which gives a more accurate determination of pretreatment quality for desalination systems than turbidity measurements. SWRO membrane manufacturers require a maximum SDI of 4, ideally less than 3. With SDI values greater than 5, some SWRO membrane manufacturers will terminate their performance guarantees.

After the water is treated by the first stage filters, it is filtered again through the second stage. This stage of media filtration further reduces the amount of particulates, bacteria, turbidity, and organic levels in the filtered water and acts as a polishing filter. Table 3.9 shows the first and second stage media filtration parameters.

Lower rates are used for Alternative A due to expected lower grade water quality.

Figure 12 shows a conceptual layout of the DMF units for the PMLD project.

Table 3.9 First and Second Stage Media Filtration

		First Stage			Second Stage		
	Units	Alternative A	Alternative B	Alternative C	Alternative A	Alternative B	Alternative C
Total Number	EA	8	6	6	8	6	6
Number in Service for Sizing	EA	6	5	5	6	5	5
Dimensions, each	Feet	18'x56'	18'x56'	18'x56'	18'x56'	18'x56'	18'x56'
Loading Rate with 2 Out of Service	gpm/SF	3.7	4.0	4.0	3.7	4.0	4.0
Wash Water Percent	%	5	4	3	5	3	2

3.10 Ultrafiltration

Ultrafiltration (UF) is becoming increasingly popular in Integrated Membrane Systems (IMS) due to its superior filtrate quality and ability to cope with challenging waters. UF is the most reliable and most consistent form of pretreatment. It produces high grade RO feed water, which is independent of feed water quality, yet more tolerant to feed water changes.

SWRO systems with source waters, which are more biologically active and have the potential for algae blooms and/or the potential for surface or suspended solids from the ocean floor stirred up during storms, would greatly benefit from UF. Due to the concerns with the source water associated with Alternative A, a UF system is proposed downstream of the media filtration for better protection of the SWRO system.

Typical UF flux rates as sole pretreatment range from 25-50 Gallons per square Feet of membranes per Day (GFD). Since the UF system at PMLD facility will be pretreated with two stage media filtration, a higher flux rate (but still conservative) is used as shown in Table 3.10.

Table 3.10 Ultrafiltration

	Units	Alternative A[1]	Alternative B	Alternative C
Total Number	EA	18	N/A	N/A
Number in Service for Sizing	EA	15	-	-
Flux Rate with 2 Out of Service	GFD	50	-	-
Recovery	%	94	-	-

[1] Only required for Alternative A

3.11 Cartridge Filters

For most municipal RO systems, cartridge filters (typically 5 microns) should be considered, even for the optimized pretreated waters. The reason is that sometimes foulants / scalants are not in the source water but are coming from other sources. Examples are: cement lining and corrosion of steel and ductile iron raw water piping, colloidal sulfur from oxidation of Hydrogen sulfide and pretreatment failure or upset. In these occasional, but not unusual cases, the cartridge filter will act as an "insurance policy" for protecting the "asset," the SWRO membranes. Therefore, cartridge filters should not be viewed as a "pretreatment" but as a last defense for protecting SWRO elements.

For the purpose of this report, 5 micron cartridge filters in horizontal special alloy stainless steel housings are used. A conservative loading rate of 3.5 gallons per minute (gpm) per 10-inch equivalent elements is used for this report. After several months of operation, if there is no indication of particulate pass through in the pretreated water, cartridge filters with a larger nominal size of 10 micron could be utilized.

Table 3.11 shows the proposed cartridge filters for the three alternatives.

<u>**PICTURE OF TYPICAL CARTRIDGE FILTER HOUSINGS**</u>

Table 3.11 Cartridge Filters

	Units	Alternative A	Alternative B	Alternative C
Total Number	EA	7	7	7
Number in Service for Sizing	EA	6	6	6
Loading Rate with 1 Out of Service	gpm/10"	3.5	3.5	3.5
Cartridge Filter Rating [1]	micron	5	5	5

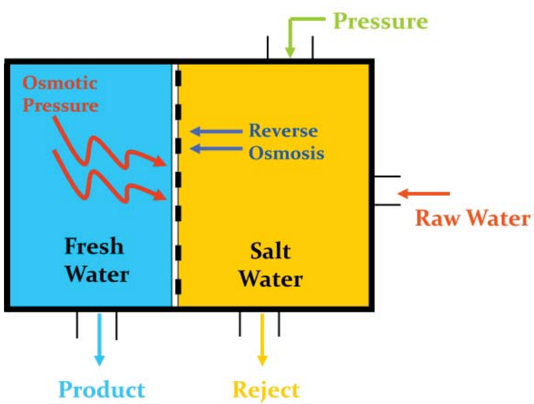
[1] After several months of successful operation, they may be replaced with 10 micron.

3.12 Desalination

3.12.1 First Pass RO

Reverse osmosis (RO) is a physical separation process in which properly pretreated source water is delivered at moderate pressures against a semipermeable membrane. The membrane rejects most solute ions and dissolved compounds, while allowing water of very low mineral content to pass through. The process produces a concentrated reject stream in addition to the purified permeate (i.e. product water).

PRINCIPLE OF REVERSE OSMOSIS (RO)



In an RO system, a higher concentration solution on one side of a semi-permeable membrane is subjected to pressure, exceeding natural Osmotic pressure of the feed water, causing freshwater to diffuse through the membrane, leaving behind a more concentrated solution containing a majority of the dissolved minerals and other contaminants. This process explains the origin of the name, "Reversing the Osmotic Pressure". The major energy requirement for reverse osmosis is to pressurize the source, or "feed" water. Because the feed water has to pass through very narrow passages in the membrane module, any suspended solids and particulates must be removed during the initial treatment phase (pretreatment).

Recovery in an RO system is defined as the percent of product (Permeate) over the feed water multiplied by 100. The higher the recovery rate, the less by-product (Concentrate) is produced, but with a higher potential for fouling and scaling. A conservative recovery rate of 45% is used for the purposes of this report.

Since the concentrate stream of the SWRO still has significant residual pressure, Energy Recovery

Devices (ERD) will be installed on each SWRO train to recover this energy by reducing the SWRO feed pump pressure. For the purposes of this design report, pressure exchanger type ERD (which are the most efficient available recovery devices) are utilized. SWRO pumps were selected based on coldest expected temperature and a 15% contingency/ fouling factor.

Table 3.12.1 summarizes the conceptual design of the SWRO system for PMLD facility.

Conceptual layout of first pass SWRO with cartridge filters for PMLD project is shown in Figure 13.

PICTURE OF A SWRO PLANT

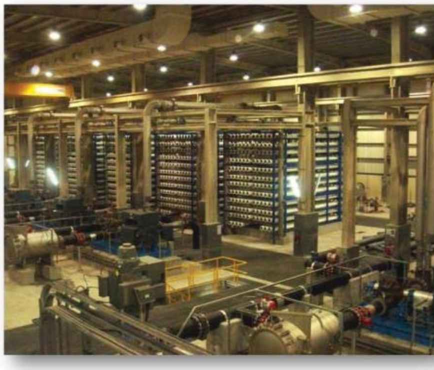


Table 3.12.1 First Pass Seawater RO

	Units	Alternative A	Alternative B	Alternative C
Total Number of Skids	EA	7	7	7
Number in Service for Sizing	EA	6	6	6
Flux Rate with 1 Out of Service	GFD	8.0	8.0	8.0
Number of Pressure Vessels Per Skid [1]	EA	96	96	96
Number of Elements Per Pressure Vessel	EA	7	7	7
Recovery	%	45	45	45
Membrane Feed Pressure [2]	psi	700-780	700-780	700-780

[1] Space on skid for 108 PVs, or 12% expansion

[2] Varies with seawater temperature

3.12.2 Second Pass RO

The first pass of SWRO results in permeate with a TDS concentration of 200-300mg/L depending on the seawater temperature. In order to meet and surpass the design water quality requirements established for this project as discussed in Section 2.2, the Boron level should be between 0.5mg/L and 1.0mg/L and TDS less than 300mg/L (allowance for additional TDS from post treatment). Computer projections indicate a partial second pass with brackish water RO (BWRO) elements will provide the optimum blend water quality.

As a minimum, 30% of product water needs to come from the second pass. For this report, a conservative 1.4 pass (i.e. 40% from second pass) is used.

Since the second pass feed is the permeate from the first pass RO, there is no concerns with fouling and scaling. Therefore, a higher recovery rate (90-95% can be used in the second pass. A conservative recovery of 90% is used for the PMLD project.

Table 3.12.2 summarizes the conceptual design of the BWRO system for PMLD facility.

PICTURE OF A BWRO PLANT (AS A SECOND PASS)

Table 3.12.2 Second Pass Brackish Water RO

	Units	Alternative A	Alternative B	Alternative C
Percent of Plant Production from Second Pass	%	40	40	40
Total Number of Skids	EA	5	5	5
Number in Service for Sizing	EA	4	4	4
Flux Rate with 1 Out of Service	GFD	16	16	16
Number of Pressure Vessels Per Skid [1]	EA	27	27	27
Number of Elements Per Pressure Vessel	EA	7	7	7
Stages [2]	EA	2	2	2
Recovery	%	90	90	90
Membrane Feed Pressure [3]	psi	240-390	240-390	240-390

[1] Space on skid for 30 PVs, or 11% expansion

[2] Array: 2:1

[3] Varies with seawater temperature

Figure 13 shows conceptual design of the two pass RO system as well as post treatment and auxiliary equipment.

3.13 Remineralization

Based on the quality of the permeate produced from the partial double pass RO system and the product water quality goals set in Section 2.2, Calcium (Ca) must be added to the product water and pH should be adjusted for a LSI greater than zero. The goal is to have calcium greater than 40mg/L as $CaCO_3$ and HCO_3 greater than 40mg/L as $CaCO_3$, as indicated in Section 2.2.

Based on experience with other desalination plants, we have utilized an up-flow limestone contactors polishing with Lime and Caustic. This approach, although has a higher Capital cost, will result in a much more reliable post treatment, consistent water quality and lower turbidity in the finished water.

Another proven, but relatively new method is to not post treat all product water, but only 30-50% and then blend it, allowing for better mixing and control, which is selected method for PMLD.

Typically, the limestone up-flow rate is 3-4 gpm per square feet to minimize media escape. The conceptual design for PMLD consists of 50% of the blended permeate being acidified, then fed to an up-flow limestone bed, which is then blended with the rest of the product, and lime is added to the bypass line. Fine tuning of pH level will be achieved with a small dose of Caustic.

Remineralization conceptual design parameters and layouts are shown in Table 3.13 and Figure 13.

Table 3.13 Calcite Remineralization

	Units	Alternative A	Alternative B	Alternative C
Percent of Product Through Calcite System	%	50	50	50
Total Number of Calcite Beds	EA	7	7	7
Number in Service for Sizing	EA	6	6	6
Dimensions, each	Feet	12'x46'	12'x46'	12'x46'
Loading Rate with 1 Out of Service	gpm/SF	3	3	3
Wash Water Percent After Recovery	%	1	1	1

3.14 Packed Tower Aeration

As discussed in Section 2.1, Alternative A has a high potential for having trace amounts of Volatile Organic Chemicals (VOCs) and Synthetic Organic Chemicals (SOCs) due to surface run offs and current boat activities. Packed towers with air stripping columns are widely used for the treatment and removal of such contaminants.

The process consists of counter-current flow of water and air through a packing material. The packing material provides a high surface area for the transfer of volatile contaminants from the liquid to the gaseous phase. As the water flows down the packed bed, air ascends, essentially "stripping" the contaminants and letting clean water to be collected in the bottom of the towers.

For Alternative A, re-pumping of the product water would be required as shown on Figure 5.

If Alternative A is selected, a portion of post treatment chlorine will be added upstream of the packed tower to prevent bio growth and to keep the tower media sanitized.

The conceptual design of the packed tower aeration is shown in Table 3.14.

Table 3.14 Packed Tower Aeration				
	Units	Alternative A[2]	Alternative B	Alternative C
Type [1]		-	N/A	N/A
Total Number of Towers	EA	4	-	-
Number in Service	EA	3	-	-

[1] Forced draft

[2] Only required for Alternative A

3.15 Disinfection

In post disinfection, chlorine is needed for distribution system protection. On site generation may be considered depending on the bulk chemical costs. The disinfection will meet and surpass the regulatory requirements of the Safe Drinking Water Act and the California Title 22 Code and US Environmental Protection Agency guidelines. Depending on the final pipeline and termination point (such as intermediate chlorine boost stations) Chloramines may be more effective than Chlorination.

3.16 On-Site Finished Water Storage

A 4 million gallon ground storage tank is proposed to be built on site, as shown in Figure 2. The proposed tank will be a pre-stressed concrete tank with dome top and internal columns. For better mixing inside the tank, internal baffles and nozzles on inlet piping are considered.

Table 3.16 On-Site Finished Water Storage				
	Units	Alternative A	Alternative B	Alternative C
Number of Onsite Storage Tanks	EA	1	1	1
Size of Onsite Tank	MG	4	4	4
Diameter	FT	180	180	180
Side Water Depth	FT	22	22	22

3.17 Finished Water Pumping

This on site pump station will pump the product water from the on-site tank to the off-site tanks. The pump station will potentially have two different sets of pump systems, one for the peninsula and one set for the North County.

For the Peninsula distribution and for the purpose of conceptual sizing of this pump station, it is assumed that the pipeline termination will be approximately at elevation 35' above MSL, and the pipeline is 17.5 miles long. Based on the estimated pressure losses due to fittings and pipe losses, a pressure of approximately 100 psi is needed at the desal plant.

The delivery system for North County is still under evaluation, including the number of pipelines required and their required routes. However, preliminary estimates are included for sizing and cost estimates in this report.

Table 3.17 Finished Water Pump Station

	Units	Alternative A	Alternative B	Alternative C
Total Number of Pumps	EA	6	6	6
Number in Service for Sizing	EA	4	4	4
Pressure	psi	80	80	80

3.18 Finished Water Distribution Pipeline and Terminal Tanks

For all alternatives terminal storage tanks are included in the estimates with adequate size for approximately 24 hours of water storage. Transmission mains are assumed to be Ductile Iron Pipe (DIP) class 300 minimum. All major road crossings and sensitive area crossings such as streams and wetlands are assumed to be installed with trenchless technologies such as jack/bore in a casing.

For the Peninsula distribution, the following are included in the cost estimates:

- 92,400' of 24" water main
- 10 MG storage tank

For the North county distribution, the following are included in the cost estimates:

- 52,800' of 12" water main
- 79,200' of 10" water main
- 26,400' of 8" water main
- Three terminal tanks (0.8MG, 1MG and 2MG)

3.19 Byproducts and Residual Management

The following is a summary of the types and estimated quantities of byproducts and residuals produced at the proposed facility for the three alternatives:

Type 1: Concentrate from the RO system. This stream will essentially have all salts and ions present in the source water but at higher concentration. At the conservative proposed SWRO recovery rate of 45%, the concentration of salts and ions will be 1.8 times that of the seawater. At this recovery rate for all alternatives, the concentrate will contain TDS in the range of 63,000 to 64,000 mg/L depending on the alternative and the seawater temperature. Due to the TDS content, there are no economically feasible reuse opportunities with the SWRO concentrate. The second pass BWRO concentrate will have a TDS of 2,000 mg/L, which is substantially lower than the seawater and therefore will be completely recycled to the feed of the SWRO system as shown in Figures 4, 7 and 10.

Type 2: The backwash water from the Media Filters and UF will be transferred to the backwash collection tanks and pumped to the backwash treatment system consisting of sludge tank and centrifuges. The sludge is collected and sent to sludge treatment facility, while the clear supernatant is mixed with the concentrate and sent to the outfall.

Type 3: Similarly, recovered clean backwash from post treatment will be mixed in the outfall blend tank and sent to outfall. A possible re-use of the stream for spray irrigation, wash water, etc. will be investigated during design.

Table 3.19.1 is a summary and expected quality of the combined outfall. Total Suspended Solids (TSS) and other discharge parameters will meet the future effluent permit requirements. For the purposes of this report, it is assumed that the combined outfall concentrations (with the exception of salts) will be processed to be the same or less than ambient seawater quality after dispersion.

Table 3.19.1 Outfall Water Quality and Quantity

	Alternative A			Alternative B			Alternative C			To
	Flow (MGD)	TDS (mg/L)	TSS (mg/L)	Flow (MGD)	TDS (mg/L)	TSS (mg/L)	Flow (MGD)	TDS (mg/L)	TSS (mg/L)	
Concentrate from RO	15.46	65,000		15.46	65,000		15.46	65,000		Outfall
Recovered and Treated Backwash from Media Filtration	4.78	35,800		1.98	35,800		1.39	35,800		Outfall
Recovered and Treated Backwash from Ultrafiltration	1.76	35,800		-	-	-	-	-	-	Outfall
Recovered and Treated Backwash from Post Treatment	0.06	400		0.06	400		0.06	400		Outfall
Combined Total	**22.05**	**56,200**		**17.5**	**61,500**		**16.91**	**62,300**		

Type 4: All three types of membranes used in PMLD require occasional cleaning, called Clean In Place (CIP). The waste from CIP cannot be recycled, nor can it be sent directly to the sewer due to its basic or acidic nature. Therefore, neutralization systems will be included in the membrane facility with neutralization tank placed under the building floor. The appropriate chemical, typically either sodium bisulfite acid or sodium hydroxide, neutralizes the cleaning chemicals so that the waste can be properly sent to the sanitary sewer. Vertical chemical resistant pumps will serve for mixing the chemicals as well as pumping the neutralized content of the tank gradually to the sewer system.

The CIP events are planned and will be scattered throughout a week or month to reduce peak waste flows.

Type 5: Miscellaneous drains from analyzers, wash-downs, sample panels, etc. will be connected to sanitary sewer system.

Type 6: Bathroom, showers and other building plumbing wastes will be connected to sanitary sewer system.

Table 3.19.2 shows the estimated peak volumes and continuous flows to the sanitary system. A sewage pump station with adequate equalization wet well will be included to pump the sewer to the existing sanitary sewer adjacent to the PMLD site.

This estimated equalized flow was discussed with the Castroville Sanitation District (CSD), who will be taking over the Moss Landing area, and they indicated this volume of discharge can be sent to the gravity sewer at the intersection of Dolan and Highway 1 sewer system manhole.

Table 3.19.2 Other Residuals

	Total Volume Per Event, all Skids (Gallons)	Frequency	Continuous Flow (gallons per day)	Comment	To
SWRO CIP Cleaning	300,000	Once per Month	50,000	Neutralized	Sanitary Sewer
BWRO CIP Cleaning	80,000	Once every two months	20,000	Neutralized	Sanitary Sewer
UF CIP Cleaning (Alternative A only)	225,000	Once every two months	15,000	Neutralized	Sanitary Sewer
Floor Drains, Analyzers, and Wash Waters	-	Continuous	3,000	-	Sanitary Sewer
Sanitary Sewer from Buildings and Offices	-	Continuous	1,500	-	Sanitary Sewer
Total			**90,000**		

All process solid wastes will be combined and sent to the sludge tanks and sludge treatment facility. The sludge treatment will consist of sludge conditioning, centrifuges, thickeners, belt presses and chemical treatment for production of 30-35% solid content sludge, which will be sent off site by dump trucks.

Table 3.19.3 shows estimated volume of sludge to be hauled off-site for each alternative.

Table 3.19.3 Estimated Sludge Production

	Units	Alternative A	Alternative B	Alternative C
Dry Sludge Volume (30% Solids)	Gal/Day	5,525	831	407
Weight of Dry Sludge	Pounds/Day	55,250	8,310	4,070
Weight of Dry Sludge	Tons/Day	27.6	4.2	2.0
Number of Hauling Trucks per Week	Number	20	3	< 2

4.0 Building and Site Considerations

4.1 Existing Site

The proposed desalination plant would be located at the Moss Landing Business Park, which is the location of the former Kaiser Refractories Magnesium Extraction and Brick Production Plant that ceased production in February 1999.

Figure 1 shows the overall location of the existing site and the proposed desalination plant in the shaded area. Approximately 16 out of 186 acre site is needed for the desal plant.

Figure 2 shows the proposed desal related facilities south of existing buildings and tanks on site.

The site is ideal for a desalination plant since it has access to a major road for deliveries, is adjacent to a power plant and high voltage grid and is an industrial zoned property.

The site layout focuses on locating permanent structures away from environmentally sensitive areas of the site, such as wetlands and flood plains.

Portions of the proposed structures are located on the deposits from the old Kaiser production plant. A comprehensive geotechnical engineering investigation is budgeted for conducting soil borings and testing to provide recommendations for foundation supports and soil excavation/backfill.

4.2 Existing Infrastructure

The site has significant important infrastructures; some are planned for re-use and utilization with some rehabilitation and upgrades. Examples are:

- Existing Intake structure in the harbor (for Alternative A)
- Twin Intake pipes (for Alternative A)
- Existing outfall for concentrate and treated backwash water discharge (for all Alternatives)
- Portions of the existing intake pipe from the pier to the plant (for Alternatives B and C)
- Several existing tanks
- Existing tunnels and casings under Highway 1

A study was conducted (John Miller, August 2012) on the condition of the existing pipelines, outfall and major tanks on the site. The study generally found the major structures to be structurally adequate and recommended various improvements and rehabilitation such as removal of defective concrete, replacement of affected rebar, and application of epoxy grout and lining to rehabilitate the tanks.

The outfall pipe was videotaped and found to be generally in good condition with some rehabilitation needs. A more detailed investigation will be conducted during design of tanks, buildings and infrastructure to be used in the proposed desal plant. This report has assumed that due to age of the outfall, a new 30" pipe will be inserted into the existing 51" outfall. Similarly, it is assumed that the existing intake from the Bay near the old pier will be used as a conduit for sliplining the new pressure pipe as new intake pipe for Alternatives B and C with limited open excavation and directional drilling under sensitive areas.

This report includes estimated costs for such repairs and an allowance for a higher degree of rehabilitation if required.

4.3 Access and Security

The primary plant access will be from Dolan Road in the vicinity of the existing entrance. The entire desal plant site will be fenced and separated from other current or proposed activities on site as shown in Figure 2. Automated motorized gates with cameras at entrances and other strategically located areas will be installed with split screen monitors in the plant control room for security and safety.

In terms of security of the water system, all final product water systems will be secured by removable access ladders and locks on access hatches. Similarly, the intake pump station will have fencing and security cameras.

4.4 Offices and Process Spaces

Table 4.4 is a summary of the office space requirements. The control room, laboratory and offices are planned to be located in the desal building. The Desal Process Building will also house bulk desal chemicals and have space for parts and storage.

Coagulants and other bulk chemicals will be housed in a building adjacent to the existing contact tanks as shown in Figure 2. All chemicals will be contained in full containment structures and any spill will be completely contained within the building.

For optimum efficiency, the Desal Process Building will also house the central electrical room for shortest distance to the major power users such as SWRO pumps.

Proper safety equipment and emergency eyewash/shower stations will be provided at all chemical storage/feed facilities, meeting code requirements.

Fire extinguishers and fire sprinklers will be installed in the buildings where necessary in order to meet local code requirements.

Table 4.4 Office Space Requirements

Space	Estimated area (SF)
5 Offices	650
Control Room	400
Conference Room	400
Laboratory	350
Records and Archives Room	300
Bathrooms/ Shower	400
Parts Storage and Workshop	1000
Total	**3,500**

4.5 Emergency Power

An independent secondary power supply or emergency stand-by generators will be required to operate the entire facility during power shortages. The emergency generator can run on diesel fuel or natural gas (preferred, if available). The availability of an independent secondary source is being investigated. For the purposes of this report, emergency stand-by generators are included in the cost estimates.

All major plant controls, critical instruments and automation devices will have Uninterruptable Power Supply (UPS) and battery backups.

4.6 Construction Methods

A previous study found the major existing structures to be structurally adequate and recommended various improvements and rehabilitations such as removal of defective concrete, replacement of affected rebar, and application of epoxy grout and lining to rehabilitate the tanks. The recommendations of this study, along with more detailed investigation will be utilized to rehabilitate tanks, which are proposed to be re-used.

The outfall pipe was videotaped and found to be generally in good condition with some rehabilitation needs. A more detailed investigation will be conducted during design to insert the new 36-inch outfall pressure pipe in the existing 51-inch pipe. Similarly a new 32-inch pipe is proposed to be inserted in the existing 36-iinch intake pipe, using Horizontal Directional Drilling (HDD) method, or if needed, Pipe Bursting (PB) method. Both methods are trenchless and will have minimum impact on the environment. However, both methods require access to the pipe, especially near bends, fittings and valves. Several access points exist on these pipelines. These access points and other new access points may need to be constructed for utilizing these technologies. During detail design, every attempt will be made to minimize site disturbances by strategically locating these access points, especially in sensitive areas. Based on review of the pipe plan and profiles and dedicated right-of-ways, it is believed that both outfall and intake can be built in the existing right-of-ways, with limited temporary access and construction easements.

The pipeline from the PMLD property to the bay crosses a portion of Harbor District property and is covered by an easement over that property. The parties are currently negotiating an extension of the easement term for purposes of this project.

The construction of desal facilities will be similar to any industrial construction and will follow industry practices and local codes. Every attempt will be made to minimize construction noise (especially after hours) and project specific plans will be provided to local authorities for approval for soil, sediment and erosion control, storm water management and dust control.

Facility design will also include provisions for controlling vibration and noise from desal equipment. The buildings will have sound attenuation. Heavy equipment and large high pressure pipes will be provided with vibration isolation to minimize noise and vibration transmitted to outside buildings.

5.0 Power and Chemical Usage Estimates

5.1 Power Estimates

Detailed power calculations were prepared for each alternative assuming average water temperatures. A summary of power estimates are presented in Table 5.1. These estimates include power for intake pumps, pretreatment, desal, finished water pumping, all other process equipment, as well as estimates for building lighting, exterior lighting, HVAC, ventilation and miscellaneous uses. The estimates also include a 10% contingency. More refined estimates will be provided as the design progresses.

Table 5.1 Power Estimates for Entire Facilities

Process Description	Units	Alternative A	Alternative B	Alternative C
Intake Pumps and Systems	KW	578	608	518
Pretreatment	KW	1610	1030	1029
First Pass SWRO	KW	3919	3924	3918
Second Pass BWRO	KW	722	721	727
Post Treatment Systems	KW	410	225	221
Solids Handling	KW	40	18	9
Finished Water Pumping	KW	472	472	472
Buildings, Lighting and HVAC	KW	574	541	541
Other Miscellaneous	KW	123	41	41
Total Power Estimate	**MW**	**8.4**	**7.6**	**7.5**
KWH/1000 Gallons of Finished Water	**kWh/kGal**	**16.9**	**15.2**	**15.0**

5.2 Chemical Use Estimates

Detailed chemical use estimates were prepared for each alternative and summarized in Table 5.2. The estimates include a 10% contingency and are based on active chemicals. More refined estimates will be provided as the design progresses.

Table 5.2 Chemical Use Estimates

	Alternative A			Alternative B			Alternative C		
Chemicals	mg/L	Flow (MGD)	lb/day	mg/L	Flow (MGD)	lb/day	mg/L	Flow (MGD)	lb/day
Coagulant (Ferric Chloride or Ferric sulfate)	30	33	8,294	20	30	4,987	10	29	2,443
Flocculant/Polymer/filter Aid	3	33	829	2	30	499	2	29	489
Sulfuric Acid	20	33	5,529	15	30	3,740	10	29	2,443
Antifoulant	3	28	703	2	28	469	2	28	469
Lime	20	6	1,004	20	6	1,004	20	6	1,004
Caustic	10	12	1,005	10	12	1,005	10	12	1,005
CO2	5	6	251	5	6	251	5	6	251
Hypochlorite	6	12	603	4	12	402	3	12	301
Ammonia	3	12	301	3	12	301	3	12	301
Sodium Metabisulfite	3	12	300	3	12	300	3	12	300
Total lb/day (All Chemicals)	**18,821**			**12,959**			**9,006**		

6.0 Staffing Requirements

The proposed facility will be fully automated with a central control system with Programmable Logic Controller (PLC) as well as multiple remote PLCs and controllers at each group of controlled equipment. This level of automation is necessary for proper control and optimization of various process units. The facility control will also include various levels of alarms containing outside calling Remote Telemetry Unit (RTU) for safety, water quality and process reliability reasons.

However, despite this level of automation, any plant of this size and complexity must have full time licensed operators at all times during facility operation. In addition, the State of California has mandatory minimum requirements for staffing water treatment facilities.

Based on our experience with other similar desalination plants and complexity of the proposed PMLD facility, we have prepared Table 6.1 for the staffing requirements. This level of staffing and operator licensing requirements meets and exceeds the minimum state requirements.

Each of the off-duty staff will be "on call" to be able to respond to emergencies.

Table 6.1 Staffing Needs

Position	First Shift	Second Shift	Third Shift
Plant Manager	1	-	-
Assistant Plant Manager	1	-	-
Operators	4	2	2
Laboratory Technician	1	-	-
Electrical Technician	1	-	-
Instrument Technician	1	1	-
Maintenance Mechanic	1	1	1
Administrative Assistant	1	-	-
Total Number of Staff	**18**		

7.0 Cost Estimates

7.1 Construction Costs

Costs are based on our experience from other similar projects, price index methods and other industry guidelines. It should be noted that due to the preliminary nature of the estimates, they should be used only for planning purposes. More accurate and detailed cost estimates will be provided as the design progresses. Since we have no control over the cost of labor, materials, or equipment, the contractor's methods of determining prices, or over competitive bidding and market conditions, our opinion of probable cost is on the basis of our experience and qualifications and represents our best judgment as a design professional familiar with the construction industry. All costs were estimated for the first quarter of 2015.

7.2 Indirect Costs

There are three variables that have significant impacts on the cost of water per acre foot: land cost, energy cost, and the interest rate to be paid on bond financing. The cost analysis includes the following assumptions:

Land Cost: Moss Landing Commercial Park owns the land upon which the desalination plant is located, as well as the infrastructure and easements for the intake and outfall pipelines. It is anticipated that the desalination plant, when constructed, will be owned and operated by a public entity. If that public entity wishes to own (rather than lease) the land and easements, it will need to purchase the land and easements following appraisal. This cost analysis assumes an estimated purchase price of $20 million, which includes the already-existing intake and outfall pipes running from the project site, under the harbor, and out to the bay. To allow for future comparison, every $1 million that the purchase price decreases or increases will affect the cost of water production by $5 per acre foot.

Energy Cost: The cost of energy has the largest impact on the annual operating and maintenance costs of the desalination plant. This cost analysis assumes that the project will pay $0.12 per kw/hr for energy. MLCP believes that the public entity owning the project will be able to negotiate a more favorable energy rate with Dynegy (the owner of the adjacent power plant). Nonetheless, a recent cost analysis of a competing desalination project used a $0.12 per kw/hr energy assumption, so that rate has been used in this analysis for an "apples to apples" comparison. To allow for future comparison, every $ 1 cent per KWH decrease in energy costs will decrease the cost of water production by $50 per acre foot.

Bond Financing: The project will likely be financed through municipal bonds, and this cost analysis assumes that the bond interest rate will be 4.3%. Although MLCP believes that a lower interest rate may be obtainable, a recent cost analysis of a competing desalination project used 4.3% bond financing in its analysis, so that rate has been used in this analysis for an "apples to apples" comparison. To allow for future comparison, every 1% decrease in the bond interest rate will decrease the cost of water production by $80 per acre foot.

Other indirect costs are based on a percentage of the direct costs and include the following:

- Engineering, design and construction management assumed to be 10% of construction cost
- Contractor's mobilization, bond and insurance: 5%
- Contractor's overhead and profit: 15%
- Contingencies: 20%

7.3 Operation and Maintenance Costs

The operations and maintenance costs are based on the following factors:

Membrane Replacement – SWRO membrane replacement rate of 20% per year

Membrane Replacement – BWRO membrane replacement rate of 17 % per year

Membrane Replacement – UF membrane replacement rate of 13 % per year

Cartridge Filters Replacement – Every month

7.4 Water Production Cost

The following factors were used in estimating the total water production cost:

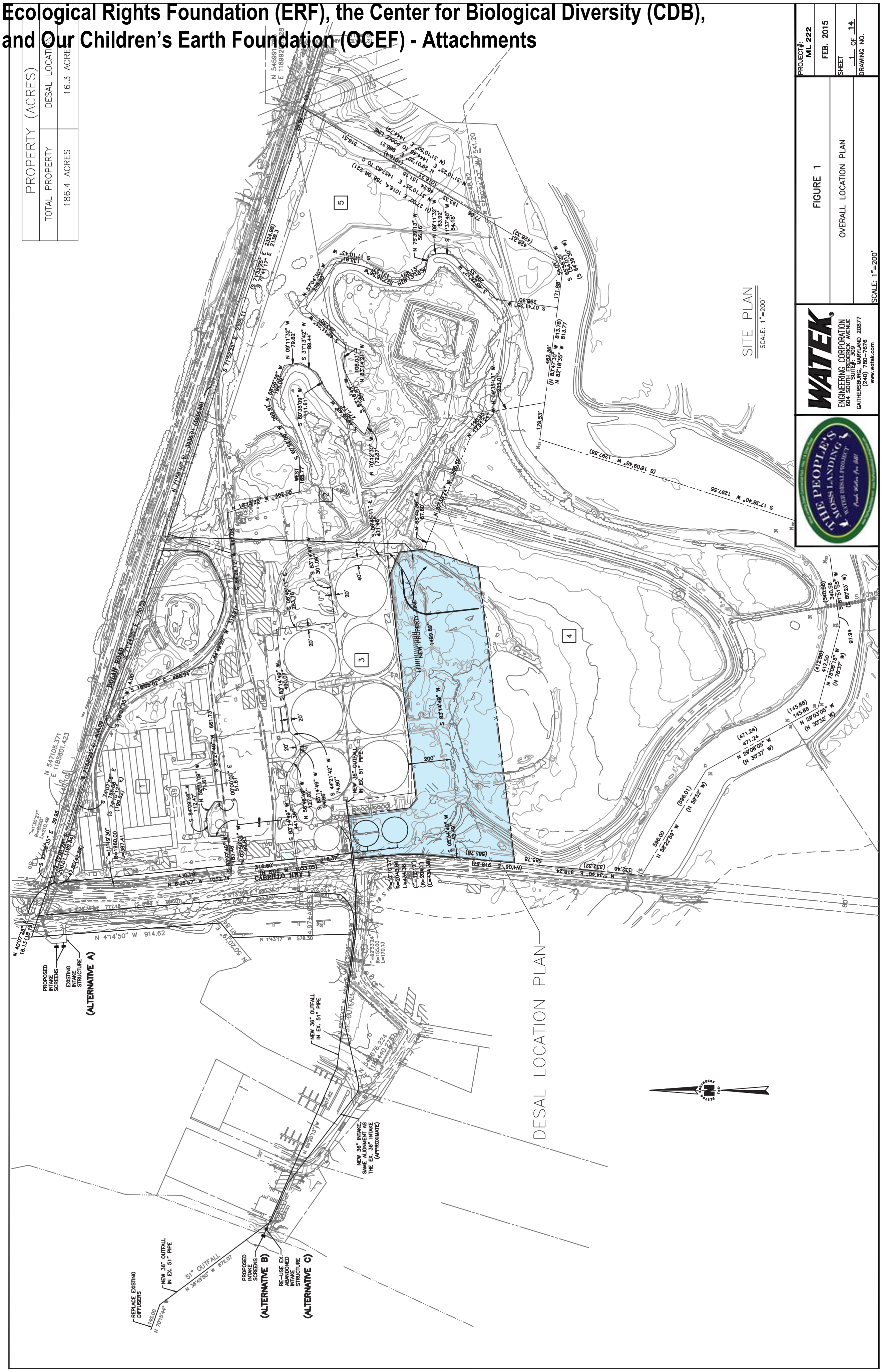
- Life Cycle Period: 30 years
- Salvage Value: None

As shown in Table 7.1, the total estimated cost of producing the 13,404 AFY at the proposed facility (without distribution system) ranges from $1500 to $ 1600 per Acre Feet.

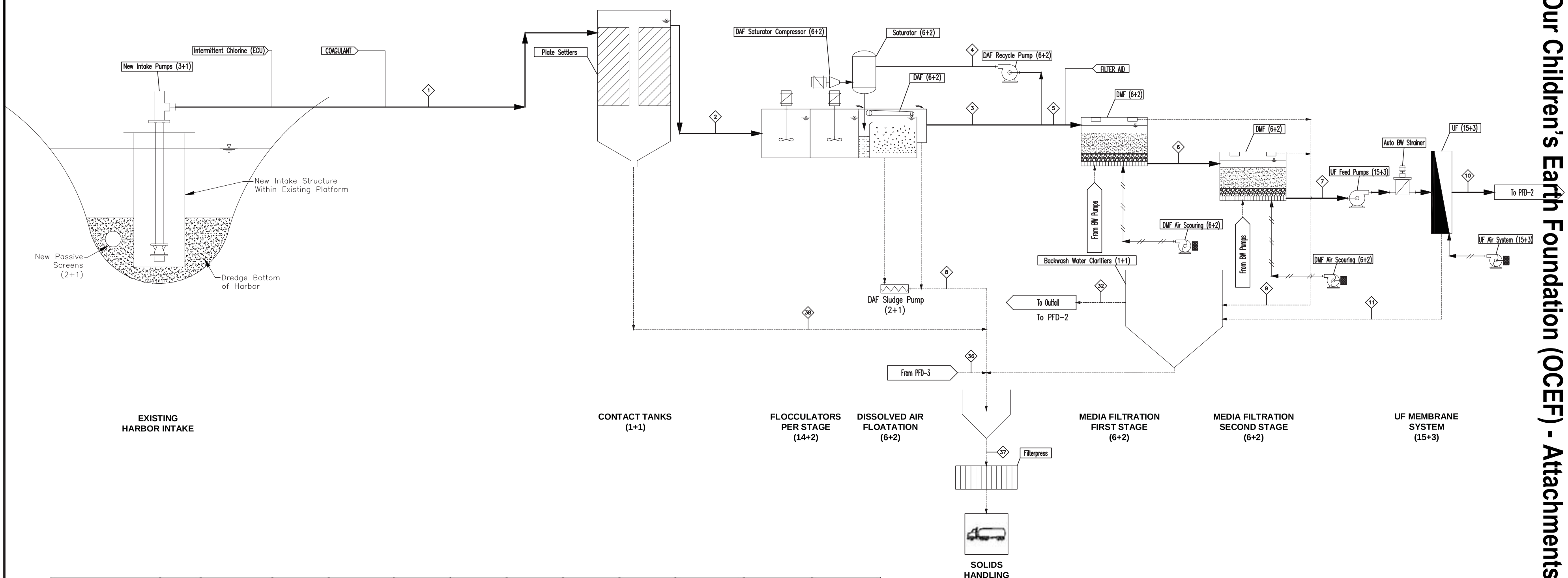
The cost for the delivery system (pipelines and tanks) for 9,752 AFY from project site to CalAm's terminal in Seaside and delivery of 3,652 AFY to customers in North Monterey County would be approximately an additional $400 per Acre Feet. Although the delivery system for North County is still under development, including the number of pipelines required and their routes, preliminary costs of pipelines and terminal storage tanks are included in these estimates.

TABLE 7.1: WATER COST FOR DESAL FACILITY WITHOUT DISTRIBUTION SYSTEM			
	ALT A	ALT B	ALT C
Description			
A: Direct Facility Construction Costs (Including O&P markups & contingency)			
Site and Civil	$1,371,600	$1,227,600	$1,227,600
Structural Concrete and Buildings	$34,007,040	$28,376,640	$26,850,240
Electrical	$16,236,000	$14,616,000	$14,184,000
Process Equipment and piping	$85,880,818	$60,512,338	$64,241,938
Mechanical HVAC	$554,400	$468,000	$468,000
Instrumentation and Controls	$3,931,200	$3,542,400	$3,542,400
Furnishings, supplies and casework	$172,800	$172,800	$172,800
TOTAL DIRECT FACILITY CONSTRUCTION COSTS	**$142,153,858**	**$108,915,778**	**$110,686,978**
Amortized/Annual	**$8,522,822**	**$6,530,036**	**$6,636,228**
Water Cost for this portion ($/AF)	**$636**	**$487**	**$495**
B: Facility Indirect Costs			
Cost of facilities land, easements and existing Infrastructure	$20,000,000	$20,000,000	$20,000,000
Engineering and Construction Management @ 10 % of construction cost	$14,215,386	$10,891,578	$11,068,698
Permitting, Pilot Tests and Mixing Studies	$1,200,000	$1,000,000	$500,000
Commissioning, Testing and training for facilities	$400,000	$350,000	$350,000
TOTAL INDIRECT FACILITY COSTS	**$35,815,386**	**$32,241,578**	**$31,918,698**
Amortized/Annual	**$2,147,308**	**$1,933,041**	**$1,913,683**
Water Cost for this portion ($/AF)	**$160**	**$144**	**$143**
C: Facility O&M Costs			
Power for intake, outfall and desal facility	$8,384,970	$7,471,312	$7,362,426
Chemicals	$2,123,149	$1,398,111	$1,020,889
Labor for facilities	$2,710,000	$2,710,000	$2,710,000
Replacements & Consumables	$1,400,910	$1,073,710	$1,052,210
By-product Handling	$753,180	$140,310	$84,100
General services	$100,000	$90,000	$70,000
TOTAL FACILITY ANNUAL O&M COST	**$15,472,209**	**$12,883,443**	**$12,299,625**
Water Cost for this portion ($/AF)	**$1,154**	**$961**	**$918**
D: Total Water Cost Analysis			
Total Annual Cost including Capital Recovery	$26,142,339	$21,346,520	$20,849,536
Water Cost per 1000 Gallons	**$5.98**	**$4.89**	**$4.77**
Water Cost per AF	**$1,950**	**$1,593**	**$1,555**
E: Assumptions			
Power Cost delivered to site, per KWH	$0.12		
Life Cycle Years/Amortization	30		
Amortization/ Interest Rate, %	4.3%		
Engineering and Construction Management, % of construction cost	10.0%		
Estimates are for year 2015	2,015		
North County Demand, AFY	3,652		
Peninsula Demand, AFY	9,752		
Total Demand, AFY	13,404		
Total Demand, MGD	11.97		
Cost of Land and Easements from MLCP	$20,000,000		
Savage Value	$0		

Ecological Rights Foundation (ERF), the Center for Biological Diversity (CDB), and Our Children's Earth Foundation (OCEF) - Attachments



Ecological Rights Foundation (ERF), the Center for Biological Diversity (CDB), and Our Children's Earth Foundation (OCEF) - Attachments



PFD LINE NUMBER		1	2	3	4	5	6	7	8	9	10	11
DESCRIPTION	UNITS	COMMON SEAWATER	SETTLED WATER	DAF EFFLUENT	DAF RECIRCULATION	FIRST STAGE DMF FEED	SECOND STAGE DMF FEED	DMF FILTERED WATER/UF FEED	DAF WASTE	DMF BACKWASH	UF FILTRATE	UF BACKWASH
FLOW	gpm	23,024	23,024	24,820	2,256	22,564	21,435	20,364	460	2,200	19,142	1,222
FLOW	MGD	33.15	33.15	35.74	3.25	32.49	30.87	29.32	0.66	3.17	27.56	1.76
FLOW	AFY	37,136	37,136	40,032	3,639	36,393	34,573	32,845	743	3,548	30,874	1,971
PIPE DIAMETER	Inches	36.0	36	40				48			42	
VELOCITY	FPS	7.3	7.3	6.3				3.6			4.4	
TDS	mg/L	35,800										35,800

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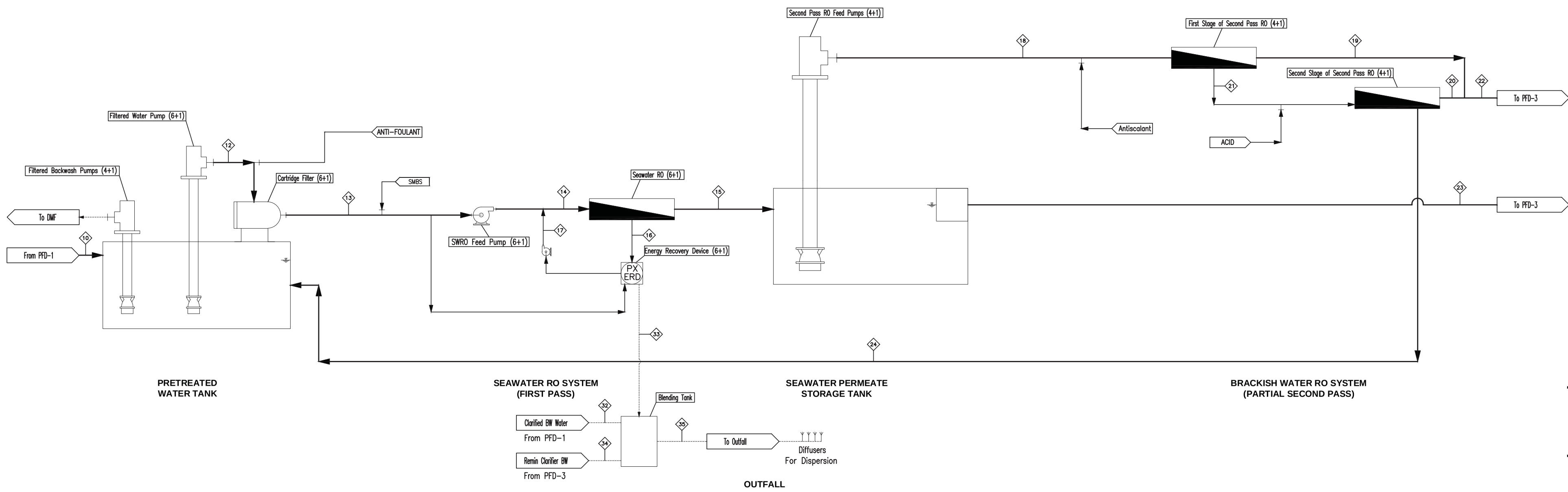
FIGURE 3
PROCESS FLOW DIAGRAM – 1
ALTERNATIVE A (HARBOR INTAKE)

PROJECT#: ML 222
FEB. 2015
SHEET 3 OF 14
DRAWING NO. PFD-1A



PFD LINE NUMBER		12	13	14	15	16	17	18	19	20	21	22	23	24
DESCRIPTION	UNITS	TOTAL FILTERED WATER PUMPS DISCHARGE	TOTAL CARTRIDGE FILTER DISCHARGE	TOTAL FIRST PASS SWRO MEMBRANE FEED	TOTAL SWRO PERMEATE	TOTAL SWRO CONCENTRATE	PX ERD BOOSTER CIRCULATION	TOTAL BWRO FEED PUMP	TOTAL BWRO FIRST STAGE PERMEATE	TOTAL BWRO SECOND STAGE PERMEATE	TOTAL BWRO INTERSTAGE	TOTAL SECOND PASS PERMEATE	TOTAL FIRST PASS SWRO PERMEATE TO BLEND	TOTAL SECOND PASS BWRO CONCENTRATE TO RECYCLE
FLOW	gpm	19,516	19,516	19,516	8,782	10,734	10,734	3,737	2,327	1,037	1,426	3,363	5,045	374
FLOW	MGD	28.10	28.10	28.10	12.65	15.46	15.46	5.38	3.35	1.49	2.05	4.84	7.26	0.54
FLOW	AFY	31,477	31,477	31,477	14,165	17,312	17,312	6,027	3,753	1,672	2,299	5,425	8,137	603
PIPE DIAMETER (ID)	Inches				30	36						20	24	
VELOCITY	FPS				4.0	3.4						3.4	3.6	
TDS	mg/L			36,500	300		37,100					10	300	2,000

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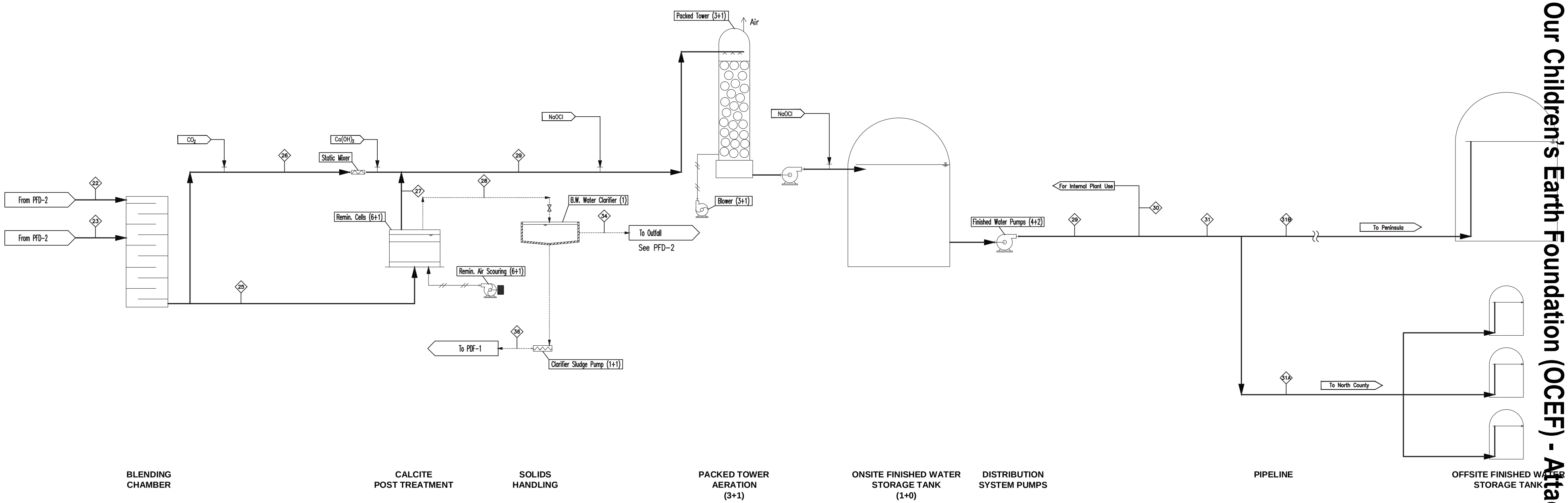
FIGURE 4
PROCESS FLOW DIAGRAM – 2
ALTERNATIVE A (HARBOR INTAKE)

PROJECT#: ML 222
FEB. 2015
SHEET 4 OF 14
DRAWING NO. PFD-2A



PFD LINE NUMBER		25	26	27	28	29	30	31	31A	31B	32	33	34	35
DESCRIPTION	UNITS	TOTAL CALCITE FEED	TOTAL CALCITE BYPASS	POST TREATED PRODUCT FROM CALCITE	CACITE WASHWATER	TOTAL PLANT PRODUCTION	WATER FOR INTERNAL PLANT USES	FINISHED WATER TO DISTRIBUTION	PRODUCT WATER TO NORTH COUNTY	PRODUCT WATER TO PENINSULA	CLARIFIED BACKWASH	FIRST PASS RO CONCENTRATE	REMIN CLARIFIER SUPERNATANT	OUTFALL
FLOW	gpm	4,225	4,183	4,183	42	8,366	56	8,311	2,264	6,046	3,319	10,734	41	15,315
FLOW	MGD	6.08	6.02	6.02	0.06	12.05	0.08	11.97	3.26	8.71	4.78	15.46	0.06	22.05
FLOW	AFY	6,815	6,747	6,747	68	13,494	90	13,404	3,652	9,752	5,353	17,312	66	24,702
PIPE DIAMETER (ID)	Inches		20			36		36	16	24		36		30.6
VELOCITY	FPS		4.3			2.6		2.6	3.6	4.3		3.4		6.7
TDS	mg/L	160	160	340		300	300	300	300	300	35,800	65,000	400	56,170

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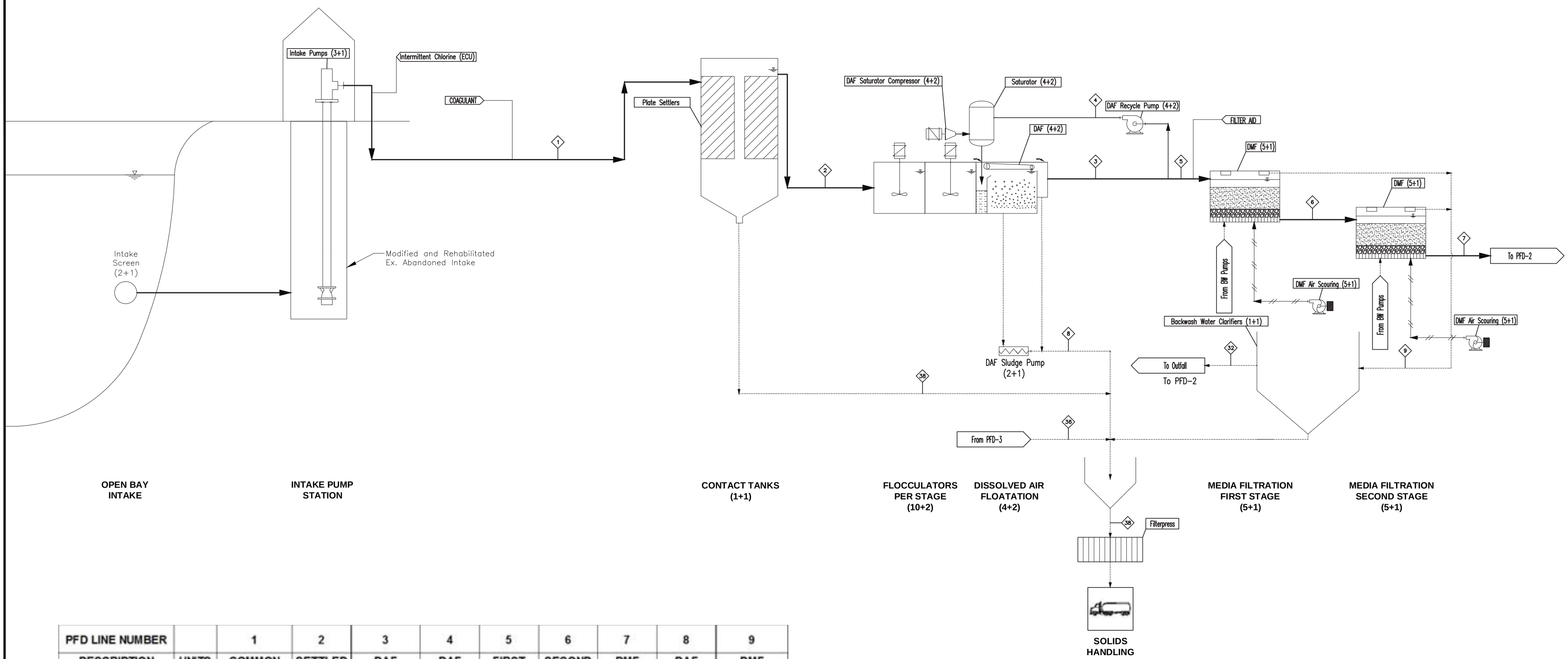
FIGURE 5

PROCESS FLOW DIAGRAM - 3

ALTERNATIVE A (HARBOR INTAKE)

PROJECT#: ML 222
FEB. 2015
SHEET 5 OF 14
DRAWING NO. PFD-3A



PFD LINE NUMBER		1	2	3	4	5	6	7	8	9
DESCRIPTION	UNITS	COMMON SEAWATER	SETTLED WATER	DAF EFFLUENT	DAF RECIRCULATION	FIRST STAGE DMF FEED	SECOND STAGE DMF FEED	DMF FILTERED WATER	DAF WASTE	DMF BACKWASH
FLOW	gpm	20,764	20,764	22,612	2,056	20,556	19,734	19,142	208	1,414
FLOW	MGD	29.90	29.90	32.56	2.96	29.60	28.42	27.56	0.30	2.04
FLOW	AFY	33,490	33,490	36,471	3,316	33,155	31,829	30,874	335	2,281
PIPE DIAMETER	Inches	28.7	36	40				48		
VELOCITY	FPS	10.3	6.5	5.8				3.4		
TDS	mg/L	35,800								

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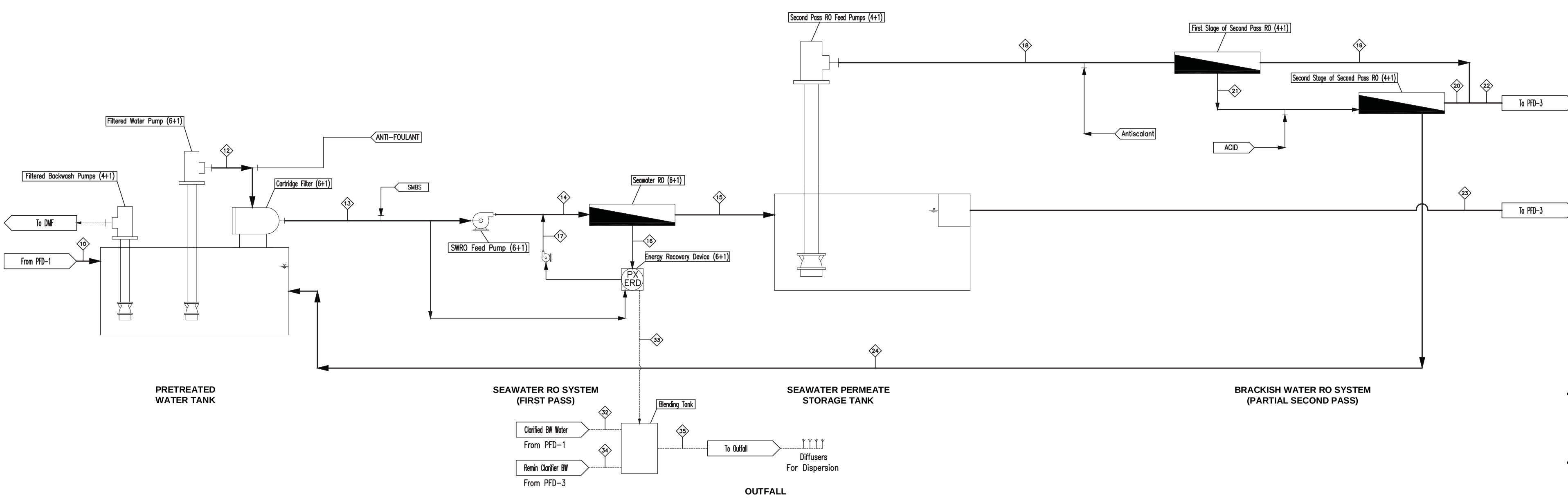
FIGURE 6

PROCESS FLOW DIAGRAM - 1

ALTERNATIVE B (OPEN BAY INTAKE)

PROJECT#: ML 222
FEB. 2015
SHEET 6 OF 14
DRAWING NO. PFD-1B



PFD LINE NUMBER		10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DESCRIPTION	UNITS	TOTAL PRETREATED WATER	NOT USED	TOTAL FILTERED WATER PUMPS DISCHARGE	TOTAL CARTRIDGE FILTER DISCHARGE	TOTAL FIRST PASS SWRO MEMBRANE FEED	TOTAL SWRO PERMEATE	TOTAL SWRO CONCENTRATE	PX ERD BOOSTER CIRCULATION	TOTAL BWRO FEED PUMP	TOTAL BWRO FIRST STAGE PERMEATE	TOTAL BWRO SECOND STAGE PERMEATE	TOTAL BWRO INTERSTAGE	TOTAL SECOND PASS PERMEATE	TOTAL FIRST PASS SWRO PERMEATE TO BLEND	TOTAL SECOND PASS BWRO CONCENTRATE TO RECYCLE
FLOW	gpm	19,142		19,516	19,516	19,516	8,782	10,734	10,734	3,737	2,327	1,037	1,426	3,363	5,045	374
FLOW	MGD	27.56		28.10	28.10	28.10	12.65	15.46	15.46	5.38	3.35	1.49	2.05	4.84	7.26	0.54
FLOW	AFY	30,874		31,477	31,477	31,477	14,165	17,312	17,312	6,027	3,753	1,672	2,299	5,425	8,137	603
PIPE DIAMETER (ID)	Inches	42					30	36						20	24	
VELOCITY	FPS	4.4					4.0	3.4						3.4	3.6	
TDS	mg/L					36,500	300		37,100					10	300	2,000

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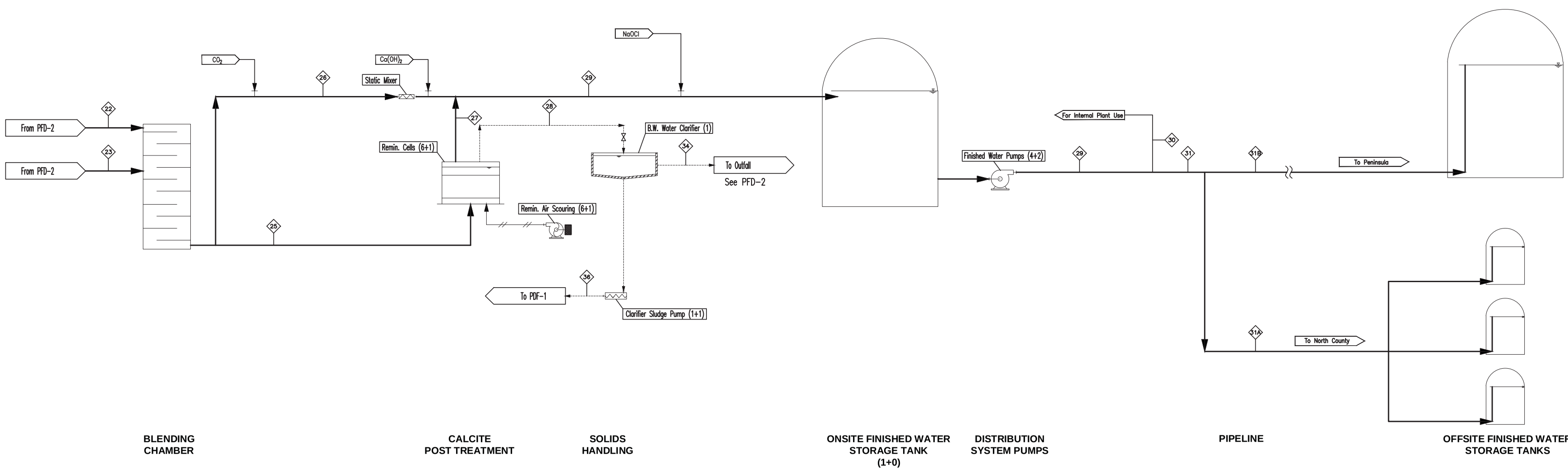
FIGURE 7

PROCESS FLOW DIAGRAM – 2

ALTERNATIVE B (OPEN BAY INTAKE)

PROJECT#: ML 222
FEB. 2015
SHEET 7 OF 14
DRAWING NO. PFD-2B



PFD LINE NUMBER		25	26	27	28	29	30	31	31A	31B	32	33	34	35
DESCRIPTION	UNITS	TOTAL CALCITE FEED	TOTAL CALCITE BYPASS	POST TREATED PRODUCT FROM CALCITE	CACITE WASHWATER	TOTAL PLANT PRODUCTION	WATER FOR INTERNAL PLANT USES	FINISHED WATER TO DISTRIBUTION	PRODUCT WATER TO NORTH COUNTY	PRODUCT WATER TO PENINSULA	CLARIFIED BACKWASH	FIRST PASS RO CONCENTRATE	REMIN CLARIFIER SUPERNATANT	OUTFALL
FLOW	gpm	4,225	4,183	4,183	42	8,366	56	8,311	2,264	6,046	1,372	10,734	41	12,146
FLOW	MGD	6.08	6.02	6.02	0.06	12.05	0.08	11.97	3.26	8.71	1.98	15.46	0.06	17.49
FLOW	AFY	6,815	6,747	6,747	68	13,494	90	13,404	3,652	9,752	2,213	17,312	66	19,591
PIPE DIAMETER (ID)	Inches		20			36		36	16	24		36		30.6
VELOCITY	FPS		4.3			2.6		2.6	3.6	4.3		3.4		5.3
TDS	mg/L	160	160	340		300	300	300	300	300	35,800	65,000	400	61,484

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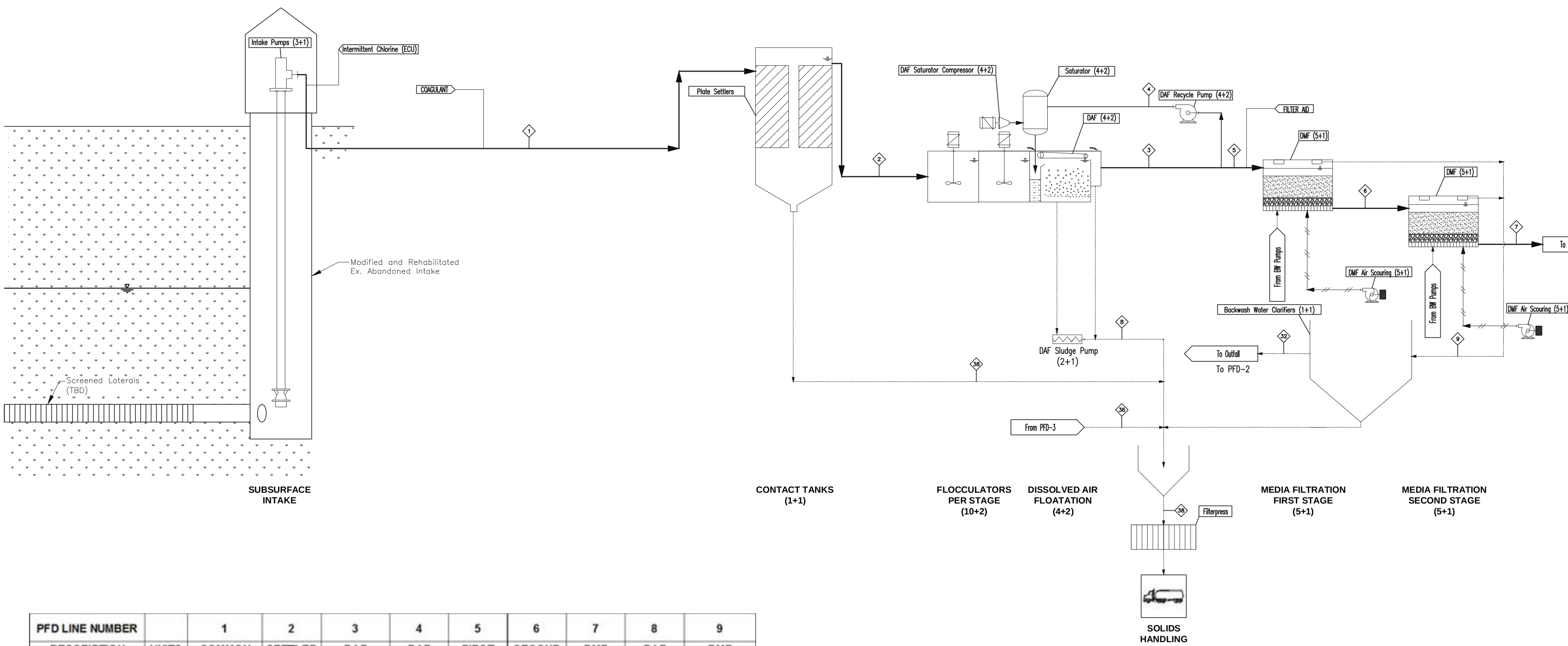
FIGURE 8

PROCESS FLOW DIAGRAM – 3

ALTERNATIVE B (OPEN BAY INTAKE)

PROJECT#: ML 222
FEB. 2015
SHEET 8 OF 14
DRAWING NO. PFD-3B



PFD LINE NUMBER		1	2	3	4	5	6	7	8	9
DESCRIPTION	UNITS	COMMON SEAWATER	SETTLED WATER	DAF EFFLUENT	DAF RECIRCU LATION	FIRST STAGE DMF FEED	SECOND STAGE DMF FEED	DMF FILTERED WATER	DAF WASTE	DMF BACKWASH
FLOW	gpm	20,341	20,341	22,151	2,014	20,138	19,534	19,143	203	995
FLOW	MGD	29.29	29.29	31.90	2.90	29.00	28.13	27.57	0.29	1.43
FLOW	AFY	32,808	32,808	35,728	3,248	32,480	31,506	30,876	328	1,605
PIPE DIAMETER	Inches	28.7	36	40				48		
VELOCITY	FPS	10.1	6.4	5.7				3.4		
TDS	mg/L	35,800								

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FIGURE 9

PROCESS FLOW DIAGRAM – 1

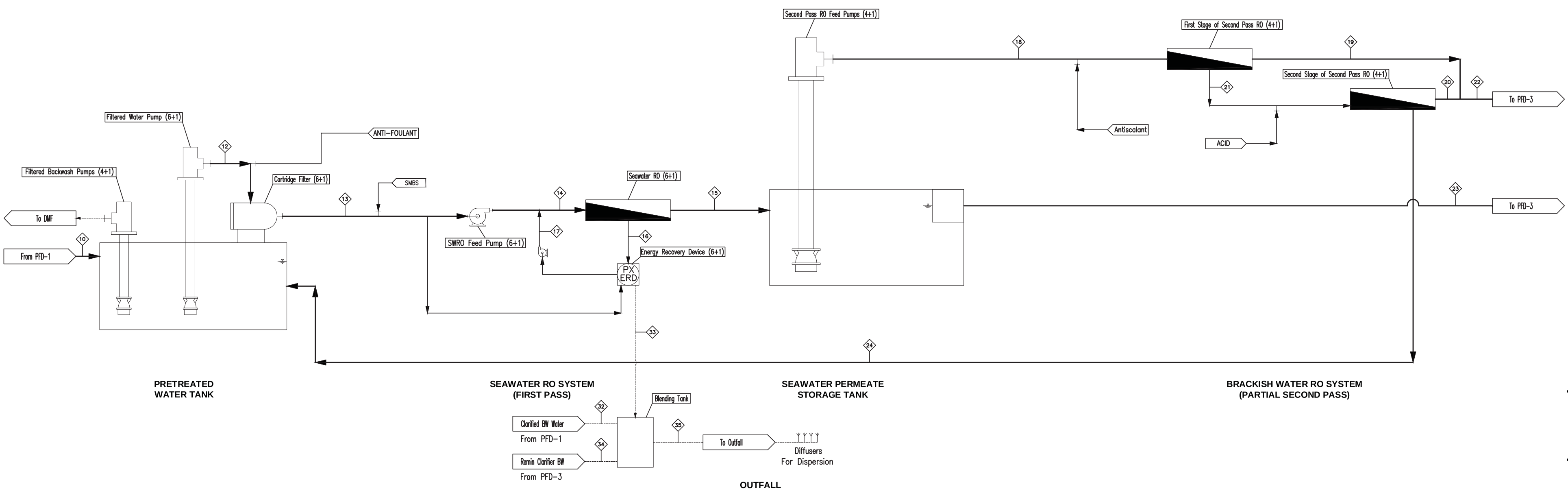
ALTERNATIVE C (SUBSURFACE INTAKE)

PROJECT#: ML 222

FEB. 2015

SHEET 9 OF 14

DRAWING NO. PFD-1C



PFD LINE NUMBER		10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DESCRIPTION	UNITS	TOTAL PRETREATED WATER	NOT USED	TOTAL FILTERED WATER PUMPS DISCHARGE	TOTAL CARTRIDGE FILTER DISCHARGE	TOTAL FIRST PASS SWRO MEMBRANE FEED	TOTAL SWRO PERMEATE	TOTAL SWRO CONCENTRATE	PX ERD BOOSTER CIRCULATION	TOTAL BWRO FEED PUMP	TOTAL BWRO FIRST STAGE PERMEATE	TOTAL BWRO SECOND STAGE PERMEATE	TOTAL BWRO INTERSTAGE	TOTAL SECOND PASS PERMEATE	TOTAL FIRST PASS SWRO PERMEATE TO BLEND	TOTAL SECOND PASS BWRO CONCENTRATE TO RECYCLE
FLOW	gpm	19,143		19,517	19,517	19,517	8,782	10,734	10,734	3,737	2,327	1,037	1,426	3,364	5,045	374
FLOW	MGD	27.57		28.10	28.10	28.10	12.65	15.46	15.46	5.38	3.35	1.49	2.05	4.84	7.27	0.54
FLOW	AFY	30,876		31,478	31,478	31,478	14,165	17,313	17,313	6,028	3,753	1,672	2,300	5,425	8,137	603
PIPE DIAMETER (ID)	Inches	42					30	36						20	24	
VELOCITY	FPS	4.4					4.0	3.4						3.4	3.6	
TDS	mg/L					36,500	300		37,100					10	300	2,000

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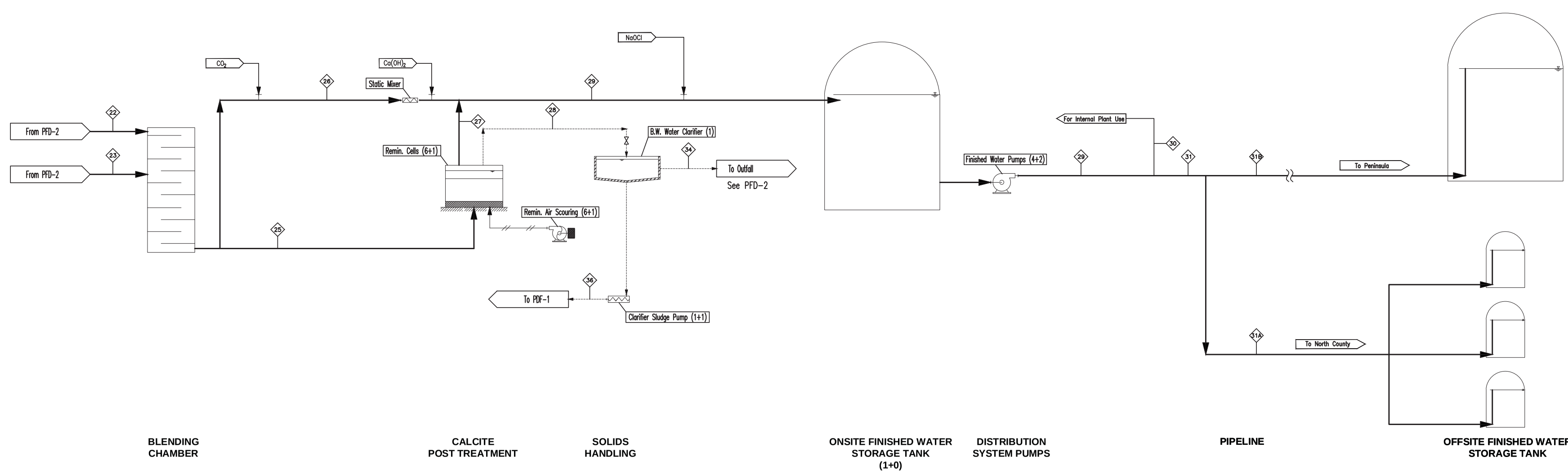
FIGURE 10

PROCESS FLOW DIAGRAM - 2

ALTERNATIVE C (SUBSURFACE INTAKE)

PROJECT#: ML 222
FEB. 2015
SHEET 10 OF 14
DRAWING NO. PFD-2C



PFD LINE NUMBER		25	26	27	28	29	30	31	31A	31B	32	33	34	35
DESCRIPTION	UNITS	TOTAL CALCITE FEED	TOTAL CALCITE BYPASS	POST TREATED PRODUCT FROM CALCITE	CACITE WASHWATER	TOTAL PLANT PRODUCTION	WATER FOR INTERNAL PLANT USES	FINISHED WATER TO DISTRIBUTION	PRODUCT WATER TO NORTH COUNTY	PRODUCT WATER TO PENINSULA	CLARIFIED BACKWASH	FIRST PASS RO CONCENTRATE	REMIN CLARIFIER SUPERNATANT	OUTFALL
FLOW	gpm	4,226	4,183	4,183	42	8,367	56	8,311	2,264	6,046	965	10,734	41	11,740
FLOW	MGD	6.08	6.02	6.02	0.06	12.05	0.08	11.97	3.26	8.71	1.39	15.46	0.06	16.91
FLOW	AFY	6,815	6,747	6,747	68	13,494	90	13,404	3,652	9,752	1,556	17,313	66	18,936
PIPE DIAMETER (ID)	Inches		20			36		36	16	24		36		30.6
VELOCITY	FPS		4.3			2.6		2.6	3.6	4.3		3.4		5.1
TDS	mg/L	160	160	340		300	300	300	300	300	35,800	65,000	400	62,374

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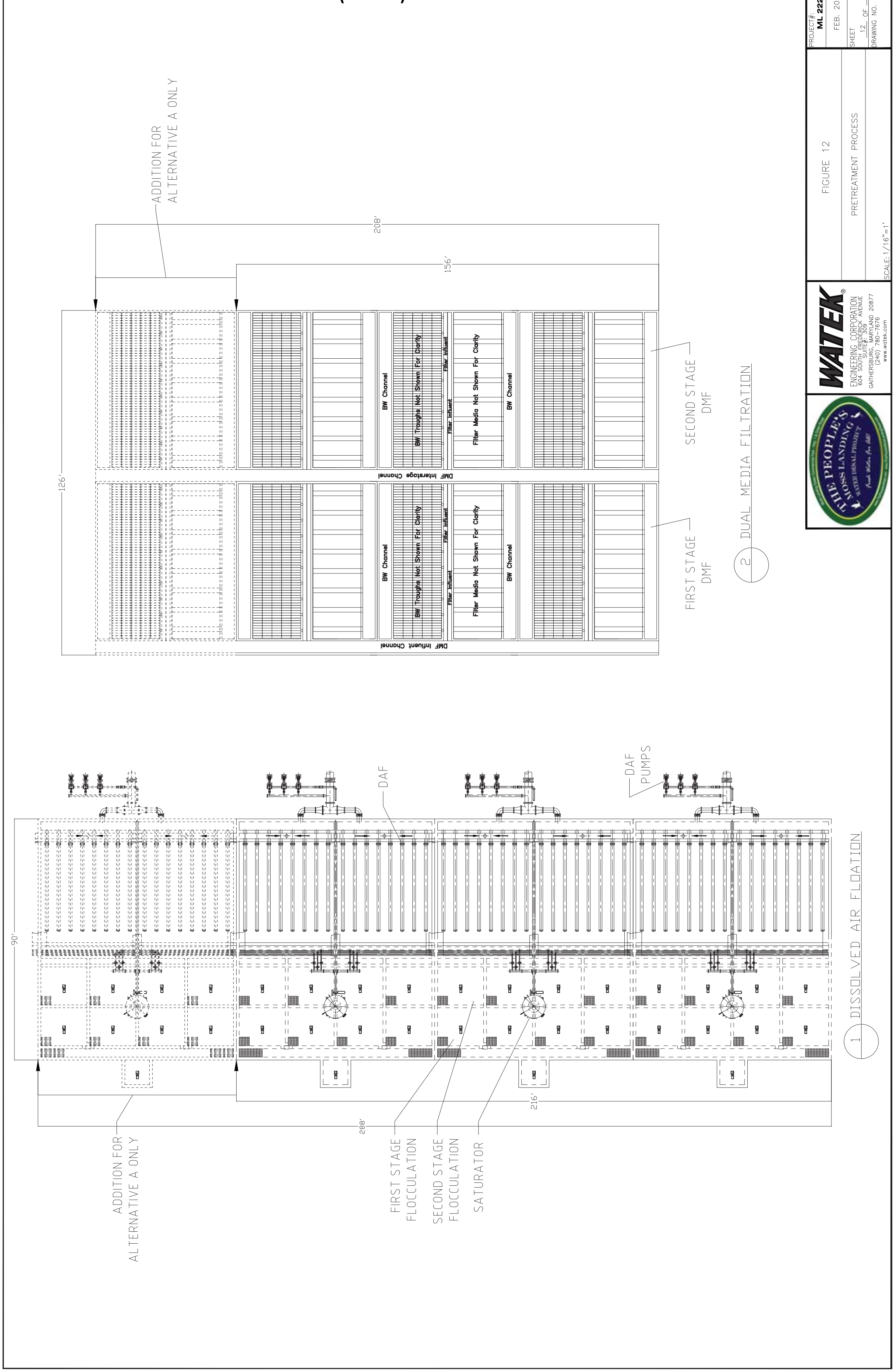
FIGURE 11
PROCESS FLOW DIAGRAM – 3
ALTERNATIVE C (SUBSURFACE INTAKE)

PROJECT#: ML 222
FEB. 2015
SHEET 11 OF 14
DRAWING NO. PFD-3C


PROJECT#: ML 222
FEB. 2015
SHEET 12 OF 14
DRAWING NO.
FIGURE 12
PRETREATMENT PROCESS
SCALE: 1/16"=1'
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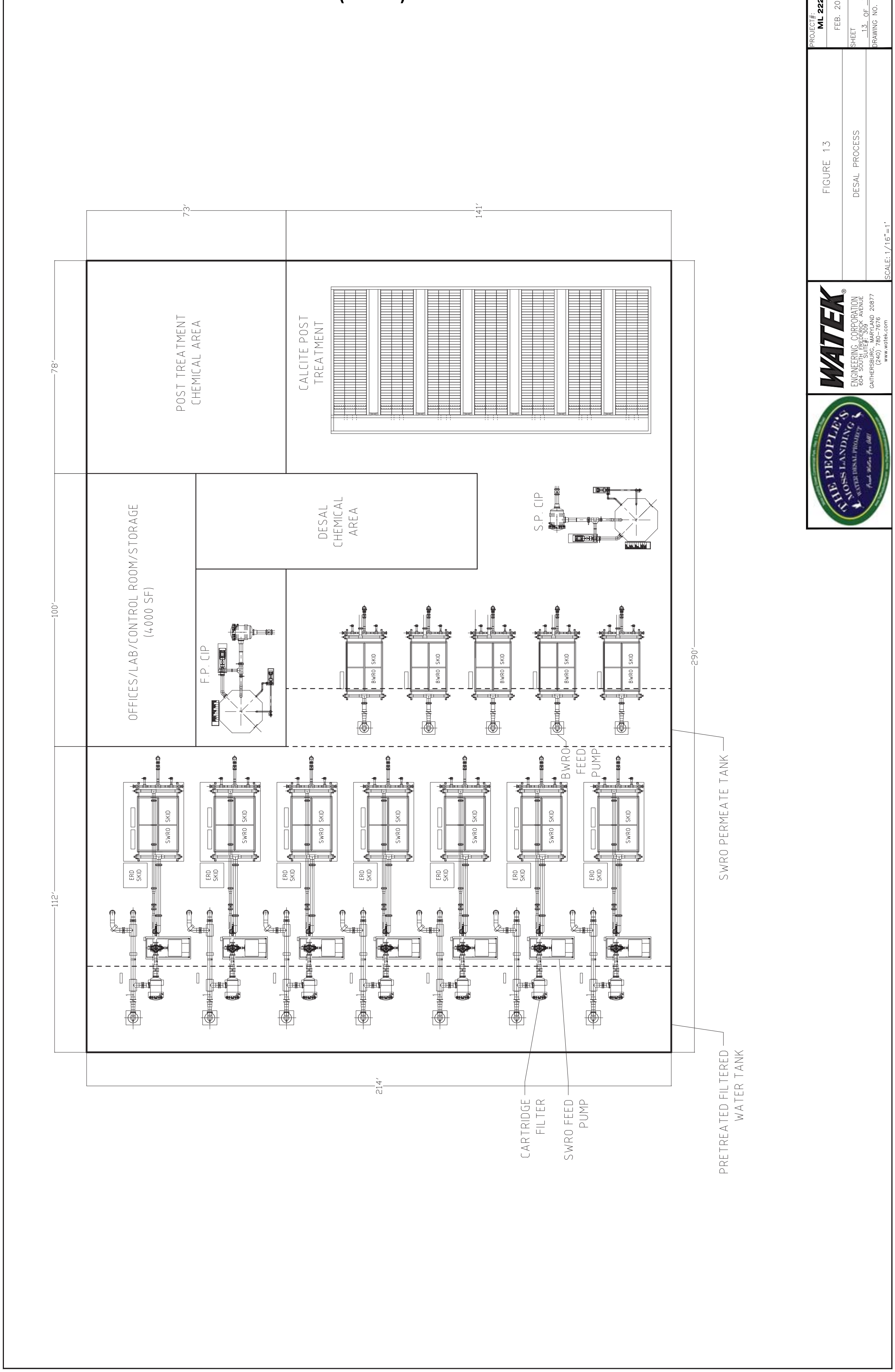
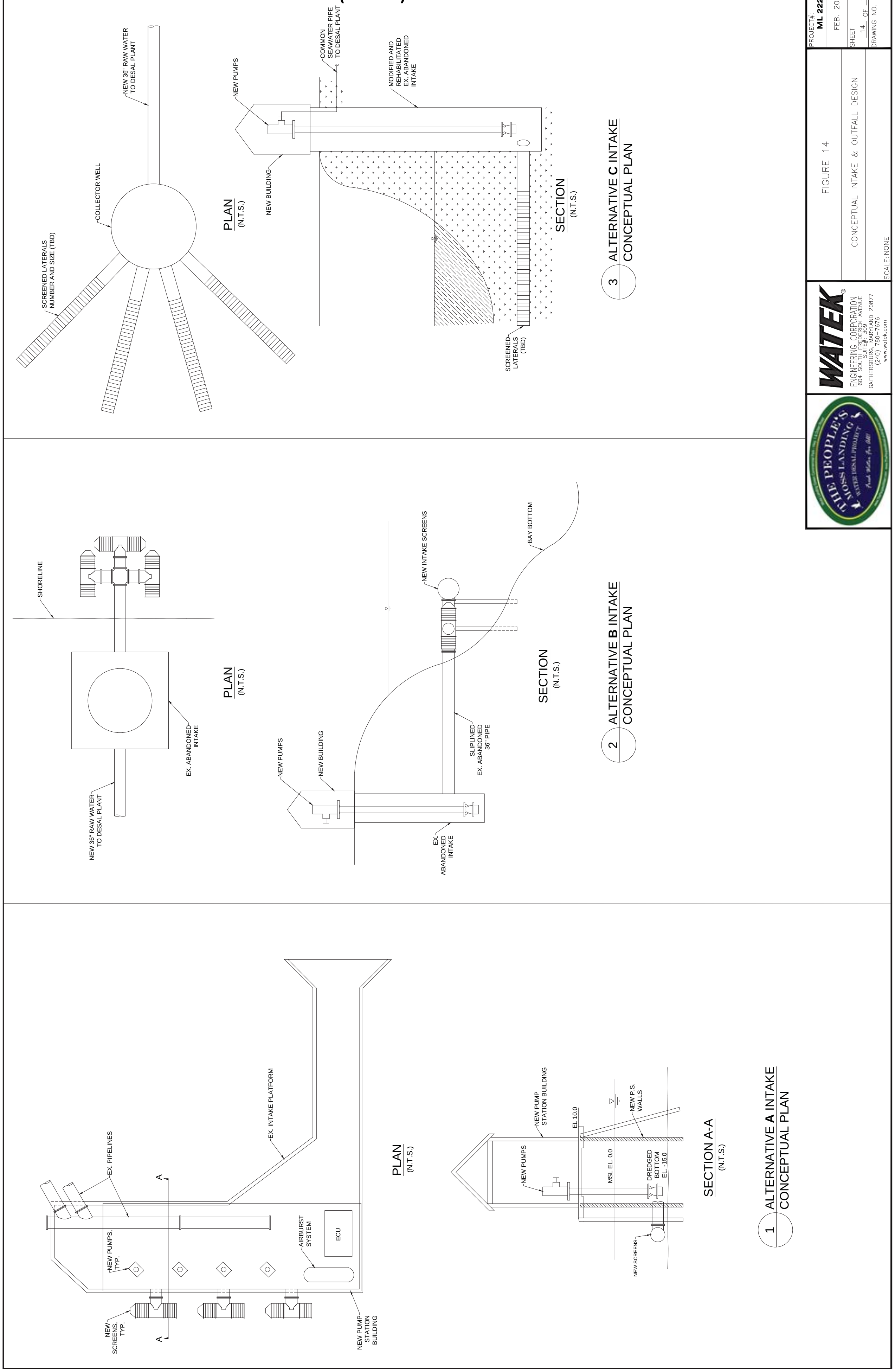
156'
126'
BW Channel
BW Troughs Not Shown For Clarity
Filter Influent
Filter Media Not Shown For Clarity
DMF Interstage Channel
DMF Influent Channel
SECOND STAGE DMF
FIRST STAGE DMF
2 DUAL MEDIA FILTRATION
DAF
DAF PUMPS
90'
216'
288'
FIRST STAGE FLOCCULATION
SECOND STAGE FLOCCULATION
SATURATOR
1 DISSOLVED AIR FLOATION

Ecological Rights Foundation (ERF), the Center for Biological Diversity (CDB), and Our Children's Earth Foundation (OCEF) - Attachments



Ecological Rights Foundation (ERF), the Center for Biological Diversity (CDB), and Our Children's Earth Foundation (OCEF) - Attachments



Management of Brine Discharges to Coastal Waters

Recommendations of a Science Advisory Panel

Panel Members

Scott Jenkins, Jeffrey Paduan, Philip Roberts (Chair), Daniel Schlenk, and Judith Weis

submitted at the request of the

California Water Resources Control Board

by the

Southern California Coastal Water Research Project

Costa Mesa, CA

Technical Report 694

March 2012

Ecological Rights Foundation (ERF), the Center for Biological Diversity (CDB), and Our Children's Earth Foundation (OCEF) - Attachments

DISCLAIMER

This document represents a technical review and recommendations of an expert panel regarding brine discharges to coastal waters. The report is intended to describe status of knowledge, identify methods, an propose a revised framework for regulation and monitoring. The recommendations contained in the report represent the opinions of the Panel and are not a statement of Water Board policy.

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

A panel of five experts in diverse fields related to brine disposal in the ocean was convened to advise the State Water Resources Control Board on best practices for brine disposal in support of the development of an amendment to the Ocean Plan. The brine concentrates can result from desalination of brackish groundwater, recycling domestic wastewater, and especially desalination of seawater. The potential of seawater desalination to provide potable water in the state is growing rapidly, with many plants currently proposed or in the planning stage. The state presently has no regulations on brine discharges and each plant is considered on a case-by-case basis.

The panel reviewed extensive material, including peer-reviewed journal articles, articles in the gray literature, NPDES permits that have been issued, various regulations from around the world, and results of monitoring studies, and heard presentations about experience with operating discharges.

From these reviews it is apparent that concentrate can be disposed of with minimal environmental effects if properly executed. Desirable methods of discharge include co-disposal with heated cooling water from power plants or domestic wastewater, or from a multiport diffuser if "pure" brine is released. Discharges with rapid initial dilution into areas of good flushing result in impacts that extend only a few tens of meters from the discharge. Conversely, poorly implemented disposal schemes with low initial dilution in poorly flushed areas can cause widespread alterations of community structure in seagrass, coral reef, and soft-sediment systems.

Extensive literature on the toxic effects of concentrates were reviewed. The effects (or lack thereof) of desalination concentrate vary widely, depending on the organism, site, the biotic community at the site, the nature of the concentrate, and to what degree it is dispersed. It appears that benthic infaunal communities and sea grasses are the most sensitive; some communities seem to be tolerant of effects of up to 10 psu increases, while others are affected by increases of only 2-3 psu. None of the studies reviewed indicated any impacts of elevated salinity levels less than 2-3 psu. It should be noted, however, that very few peer-reviewed studies have evaluated sublethal effects of desalination discharges either in the laboratory or in the field. It should also be noted that few studies have evaluated "worst-case" embayment scenarios and chronic impacts on demersal vertebrates, particularly those which have significant life history behaviors (i.e., reproduction, migration) driven by salinity variations. For example, embayments with limited flushing may have thresholds lower in anadromous fish such as salmonids or estuarine demersal flatfish, which undergo saltwater acclimation and significant endocrine alterations. Additional and long-term studies are needed on sublethal endpoints such as reproduction and on different types of concentrates and mixtures with antiscalants and other chemicals associated with RO.

We also reviewed regulations and standards that have been applied around the world. These range from salinity increments within 1 ppt, 5%, or absolute levels such as 40 ppt. These limits typically apply at the boundary of a mixing zone whose dimensions are of order 50 to 300 m around the discharge.

Because discharges can be designed to result in rapid initial dilution around the discharge, we recommend that they be regulated by a mixing zone approach wherein the water quality regulations are met at the mixing zone boundary. The mixing zone should encompass the near field processes, defined as those influenced hydrodynamically by the discharge itself. These processes typically

occur within a few tens of meters from the discharge, therefore we conservatively recommend that the mixing zone extend 100 m from the discharge structure in all directions and over the whole water column.

Based on the studies of effects of brine discharges we recommend an incremental salinity limit at the mixing zone boundary of no more than 5% of that occurring naturally in the waters around the discharge. Expressing the limit as a percentage increase allows for natural variability in the background waters. For most California open coastal waters this increment will be about 1.7 ppt; for a typical seawater desalination plant where the brine is concentrated by a factor of roughly two times, this corresponds to a dilution of about 20:1, which should be readily achievable. The dilution is the combination of in-pipe dilution in the case of co-discharges, and near field mixing. In addition to the salinity requirement, the discharge should meet toxicity and other requirements in the Ocean Plan at the edge of the mixing zone.

Co-discharges with power plant cooling water or domestic effluent can be positively buoyant, i.e. less dense than the receiving water. In that case, the regulatory framework of the Ocean Plan should be sufficient for protection of beneficial uses. Near field models should be re-run, however, to account for the increase in effluent density and flow rates on plume behavior.

The preferred methods of discharge are from a multiport diffuser for "raw" effluents, or co-disposal with power plant cooling water or domestic wastewater that results in significant in-pipe dilution. These discharges can be either a shoreline surface discharge (if positively buoyant) or through an existing multiport diffuser. Shoreline discharge of raw effluent is discouraged due to slow near field mixing and potentially high exposures of benthic organisms to elevated salinity.

In computing near field dilutions of negatively buoyant discharges from diffusers, conservative assumptions should be applied: that ocean currents do not increase dilution, and the seabed is flat and horizontal. To account for possible reductions in dilution in areas of poor flushing, estimates of overall flushing of the discharge site should be made to ensure that the dilution requirement at the edge of the mixing zone is still met.

No specific mathematical models are endorsed, but it is recommended that calculations be made using either tested semi-empirical equations available in the literature or by integral mathematical models based on entrainment assumptions. Mathematical models should be validated, and attention should be made to special conditions that occur with typical negatively buoyant discharges such as reduction in dilution due to Coanda effects and jet merging in the case of multiport diffusers.

Because of uncertainties in plume modeling and predicting the biological effects of the discharges, a field monitoring program should be used. Monitoring should include pre-discharge conditions and continue after discharge has begun to evaluate changes in the ecosystem. We recommend that the receiving water monitoring programs be based on Before-After Control-Impact (BACI) monitoring that includes multiple reference locations, samples at various distances from the discharge, and repeated sampling over time. The effluent should also be monitored for specified physical and chemical parameters.

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1. INTRODUCTION

Interest in desalination is high in California, where increasing populations and limitations to existing water supplies have spurred development of alternative sources derived from seawater desalination and reclamation of wastewater and groundwater. A few seawater desalination facilities are currently in operation in California (Table 1-1), but proposals for over 20 additional coastal facilities are under consideration (Cooley et al. 2006) with a potential total capacity approaching 500 mgd in 2030 (Bleninger and Jirka 2010). These include plants in Carlsbad, Camp Pendleton, Huntington Beach, Dana Point, Long Beach, El Segundo, Playa Del Rey, Oceano, Cambria, Marina, Sand City, Ocean View Plaza, Santa Cruz, Moss Landing, Montara, San Rafael, East Bay, and Crockett, with the largest of these proposed plants located in Southern California. The development and operation of these additional facilities will greatly increase the amount of desalination capacity and associated concentrate production in California.

Table 1-1. Desalination facilities located along the California coast (adapted from Cooley et al. 2006).

			Maximum capacity	
Operator/Location	Purpose	Ownership	MGD	Status
Chevron/Gaviota	Industrial processing	Private	0.4	Active
City of Morro Bay	Municipal/domestic	Public	0.6	Intermittent use
City of Santa Barbara	Municipal/domestic	Public	2.8	Decommissioned
Duke Energy/Morro Bay	Industrial processing	Private	0.4	Not known
Duke Energy/Moss Landing	Industrial processing	Private	0.5	Active
Marina Coast Water District	Municipal/domestic	Public	0.3	Temporarily idle
Monterey Bay Aquarium	Aquarium visitor use	Non-profit	0.04	Active
PG&E/Diablo Canyon	Industrial processing	Private	0.6	Not known
Santa Catalina Island	Municipal/domestic	Public	0.1	Inactive
U.S. Navy/Nicholas Island	Municipal/domestic	Government	0.02	Not known
Oil and gas companies	Platform uses	Private	0.002-0.03	Active

Various technologies are utilized to remove salts and other contaminants from water, depending of the characteristics of the source water. The most widely used method is reverse osmosis (RO), where dissolved constituents are removed by passing the water through a membrane under high pressure. In addition to the potable water, reverse osmosis produces a waste stream (concentrate) that contains elevated concentrations of salts (typically double in the case of seawater) and other dissolved constituents. At present, seawater desalination represents a minor portion of the desalination activity within California;most capacity is utilized for the treatment of brackish groundwater or wastewater (Figure 1-1).

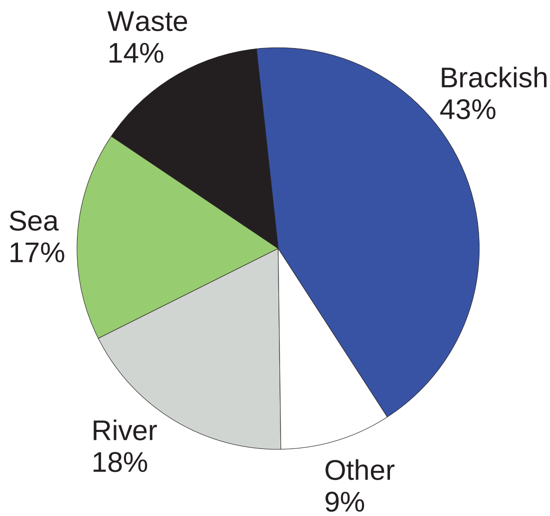

Figure 1-1. California desalination capacity by source water, January 2005 (adapted from Cooley et al. 2006).

The concentrate from desalination (often referred to as brine) varies in composition and volume depending upon the nature of the source water. This concentrate is continuously produced and must be disposed of in a manner that results in minimal environmental impact. In some cases this concentrate is discharged into coastal waters, either through a dedicated outfall or as part of a larger effluent stream from wastewater treatment or power generating facilities. The elevated salinity of the concentrate can cause it to behave differently than traditional wastewater, stormwater and cooling water plumes. When the effluent density exceeds that of the ambient seawater, the plume could settle on the ocean floor and spread as a density current, resulting in increased exposure to bottom-dwelling marine life. The elevated concentration of salts and other constituents in these discharges may result in adverse impacts to sensitive components of the ecosystem.

The regulation of discharges and protection of water quality in California is based on federal and state laws (Section 7 and Appendix A). Discharges to coastal waters must comply with water quality objectives in the California Ocean Plan, as well as regional water quality control plans. Currently, the Water Boards regulate brine discharges from these types of facilities through the issuance of National Pollutant Discharge Elimination System (NPDES) permits that contain conditions protective of aquatic life. However, the Ocean Plan does not yet have an objective for elevated salinity levels in the ocean, nor does it describe how brine discharges are to be regulated and controlled, leading to permitting uncertainty. The Ocean Plan also does not address possible impacts to marine life from intakes for desalination facilities. It is currently left to the Regional Water Boards' discretion to decide what constitutes the "best available site, design, technology, and mitigation measures feasible" for a proposed desalination facility when issuing NPDES permits for plants within their jurisdiction. However, the issues are complex and require significant staff resources and expertise to evaluate the most appropriate technology-based solution. Absent a statewide policy, permits for new desalination plants are likely to be delayed and challenged repeatedly by industrial and citizen petitioners. The planned amendment to the Ocean Plan would provide statewide consistency in controlling impacts from desalination plant intakes. In this report, we address only issues related to discharges, not intakes.

State Water Board staff are presently developing an amendment to the Ocean Plan that would address issues associated with the disposal of brine from desalination facilities and other sources. Desalination facilities and brine disposal was discussed as Issue No. 4 in the 2011-2013 Triennial Review Workplan. The issue has been identified as very high priority for the State Water Board to address. The planned amendment to address potential impacts to aquatic life from the intakes and brine discharges from desalination facilities is scheduled to be adopted by the end of 2012 and would be implemented through individual NPDES permits.

Particular questions need to be addressed in support of the Ocean Plan amendment development, including:

- How can the effects of these discharges be minimized through proper disposal strategies?
- What models should be applied in order to predict how these plumes will behave?
- What cumulative effects are there from multiple sources?
- What are appropriate monitoring strategies for these discharges?

The Southern California Coastal Water Research Project (SCCWRP) was selected by the Water Board to convene an expert panel and develop recommendations in support of the Ocean Plan amendment. This process was coordinated and facilitated by Mr. Steve Bay (SCCWRP). A panel of experts was convened in 2011 to advise water board staff regarding the above questions. Members of the panel represented expertise in physical oceanography, modeling, ecology, and toxicology (Appendix B). The panel met and received stakeholder input during 2011 and 2012 in order to assess available information, identify data gaps, and develop recommendations for the Water Board.

This document describes the recommendations of the panel and is organized into several sections. Sections 2 through 4 provide background information on key aspects of the regulation, characteristics, and biological effects of concentrate discharges. Section 5 describes important features of different types of environments that affect the fate and effects of concentrate discharges. Subsequent sections describe the Panel's recommendations regarding the design of concentrate discharges (Section 6), revisions to the regulatory process (Section 7), plume modeling (Section 8), and monitoring (Section 9). Section 10 includes a summary of the Panel's recommendations. This report also includes several appendices, which provide additional background and technical information to support the recommendations.

A diverse collection of information was reviewed by the Panel to prepare this report, ranging from peer-reviewed scientific papers to technical memoranda concerning specific facilities. These sources often used different terms to describe similar discharge parameters and factors, such as salinity. An attempt has been made to standardize several of these terms in this report in order to minimize confusion. The terms "concentrate" and "brine" are used interchangeably when referring to the reject stream from a RO facility, regardless of the source water type. The literature and regulations use various units to describe the salinity of concentrate discharges, usually ppt (parts per thousand) or psu (practical salinity units). In this report we use both units, depending on their use in the original source, but it is noted that salinity in ppt and psu are essentially interchangeable in the context of this report.

2. REGULATORY CRITERIA

This section summarizes regulations for receiving water salinity impacts resulting from dedicated brine discharges, i.e. discharges that are not comingled with other effluent such as municipal wastewater or power plant cooling water. For these discharges, the main water quality concern is elevated salinity in the receiving waters and secondarily the discharge of various chemicals used in the treatment process. The Panel recommends that regulations for salinity be promulgated as applying at the end of a regulatory mixing zone. The mixing zone will generally encompass the near field in which rapid mixing of the concentrate and reduction in salinity occurs. The concepts of mixing zones and near field are discussed in more detail in Appendix D. The recommended salinity limits and mixing zone definitions for California discharges are presented in Sections 4 and 7.

2.1 Existing Regulatory Criteria for Salinity

A few recommendations for regulatory criteria have been proposed based on field and experimental studies of Mediterranean sea grasses, which are highly sensitive to elevated salinity (see Section 4). Sánchez-Lizaso et al. (2008) recommend salinity be less than 38.5 psu for 25% of the time and less than 40 psu (an increment of about 2 psu) for 5% of the time. And Palomar and Losada (2011) quote a Spanish Ministry of the Environment recommendation that the salinity increment be less than 2 psu for 5% of observations. An increment of 2 psu corresponds to an elevation of about 5% over background levels.

There are few actual regulations, standards, or guidelines for brine discharges around the world. Some that have been established and their compliance points for various desalination plants are summarized in Table 2-1. There is substantial variation in the specifics of the regulations, but almost all share two key elements: a salinity limit and a point of compliance expressed as a distance from the discharge. The salinity limit is usually stated as an increment of no more than 1to 4 ppt relative to ambient. However, limits are also less frequently expressed as an absolute salinity or a minimum level of dilution. The point of compliance for the salinity limit is the boundary of the mixing zone, which is usually specified in terms of a fixed distance from the discharge that ranges from 50 to 300 m.

Table 2-1. Regulations and salinity limits for selected desalination brine discharges.

Region/Authority	Salinity Limit	Compliance Point (relative to discharge)	Source
US EPA	Increment ≤ 4 ppt		
Carlsbad, CA	Absolute ≤ 40 ppt	1,000 ft	San Diego Regional Water Quality Control Board 2006
Huntington Beach, CA	Absolute ≤ 40 ppt salinity (expressed as discharge dilution ratio of 7.5:1)	1,000 ft	Santa Ana Regional Water Quality Control Board 2012
Western Australia guidelines	Increment < 5%		
Oakajee Port, Western Australia	Increment ≤ 1 ppt		The Waters of Victoria State Environment Protection Policy
Perth, Australia/Western Australia EPA	Increment ≤ 1.2 ppt at 50 m and ≤ 0.8 ppt at 1,000m	50 m and 1,000 m	Wec, 2002
Sydney, Australia	Increment ≤ 1 ppt	50-75 m	ANZECC (2000);
Gold Coast, Australia	Increment ≤ 2 ppt	120 m	GCD Alliance (2006).
Okinawa, Japan	Increment ≤ 1 ppt	Mixing zone boundary	Okinawa Bureau for Enterprises
Abu Dhabi	Increment ≤ 5%	Mixing zone boundary	Kastner (2008)
Oman	Increment ≤ 2 ppt	300 m	Sultanate of Oman (2005)

3. CHARACTERISTICS OF DESALINATION BRINE AND OTHER CONCENTRATE DISCHARGES

The concentrate produced by the reverse osmosis (RO) process contains multiple chemical constituents in addition to natural seawater components, and the amounts and types of these constituents vary as a function of the source water treated. All RO concentrates contain chemical additives necessary to maintain the treatment system. In addition, RO treatment of wastewater and groundwater will concentrate contaminants and other constituents, which may influence the toxic potential of the concentrate when discharged into the environment. Discharge regulations, monitoring, and future research should take into account differences in the chemical composition of different concentrate types.

3.1 Chemical Additives

Reverse osmosis (RO) membrane systems are widely used for the desalination of water and wastewater. The process itself is relatively simple and involves applying pressure to membranes that are essentially permeable only to water. The membranes reject more than 99.5 % of dissolved salts and suspended contaminants in the feedwater, producing a reject waste stream (concentrate) containing a 2 to 7 fold increased concentration of dissolved and suspended constituents. This can lead to fouling of the membrane and membrane element feed channels by scales, gel-like deposits of coagulated colloidal particles, and biofilms. To control this, various chemicals are continuously added to the system, depending on the feedwater characteristics. In addition, periodic cleaning and flushing of the membranes occurs, which can also alter the composition of the concentrate. Thus, concentrates are complex mixtures of many chemicals. While most studies focus on salinity as the primary cause of biological effects, many chemicals are used in the desalination process (e.g. antiscalants, biocides, etc.), some of which can be toxic.

There is uncertainty regarding the nature and concentrations of chemical additives in RO concentrate, partly because chemical formulations are often proprietary and the concentrations used vary among applications and water types. Antiscalants are aqueous solutions of blended active ingredients chosen from the families of phosphonates, and anionic organic polymers consisting of homopolymers, co-polymers and terpolymers of acrylic, maleic, and related monomers. The total active ingredients in antiscalant products vary from 1 to 40% by weight, the balance being water. Antiscalants typically used in all RO plants that treat groundwater or wastewater are dosed continuously into RO feedwaters at an average dosage of about 3 mg/L, resulting in a concentration of about 5 mg/L of active ingredients in the concentrate. Concentrated sulfuric acid is also frequently added during treatment of wastewater or groundwater. Antiscalants are typically not used in seawater desalination, although other chemicals such as chlorine are added to reduce biofouling or colloidal fouling.

The continuous use of chemical additives can result in relatively large mass loadings of chemicals in concentrate discharges (Höepner and Lattemann 2002). Additional chemical constituents in the discharge result from the concentration of materials occurring in the feedwater. Regardless of source, the discharge of concentrates with high chemical levels has the potential to impair biological communities. Monitoring of water quality around a single Florida desalination plant during the late 1960s found up to 45 kg copper discharged daily (Chesher 1971). Copper concentrations in receiving waters were often at levels above toxicity thresholds for native species (Chesher 1971).

3.2 Concentrate Types

RO treatment of wastewater or groundwater produces concentrates likely to differ in chemical composition from those produced from seawater, due to differences in the composition of the feedwater (Table 3-1). The toxicity of concentrates from groundwater or wastewater treatment should be evaluated separately from seawater concentrates. First, the ionic composition of concentrates from seawater desalination differs significantly from those derived from other feedwater types with the latter being primarily sulfate-dominated and in some cases less toxic than seawater concentrates (Schlenk et al. 2003, Lavado et al. 2012). For example, sulfate is highly regulated biologically and tends to be rapidly converted to molecular forms of sulfur that scavenge metals as well as protect against toxicity resulting from metals (i.e., oxidative stress). Second, the wastewater that is used for recycling and reverse osmosis treatment is typically secondary or tertiary-treated wastewater derived from municipal sewage treatment facilities (Grissop 2009). Consequently, this concentrate may contain excreted hormones, pharmaceuticals or personal care products. There have been few published studies that have evaluated the concentrations of pharmaceuticals and emerging contaminants within the RO concentrate. A concentration factor for pharmaceutical agents typically ranges from 3 to 4-fold (Snyder et al. 2006). While the concentrate is likely diluted upon blending with either wastewater or thermal (i.e., cooling) effluent, no studies have examined the fate of the compounds after blending with effluent, undergoing disinfection and then discharge. Given the possibility that many of these agents target sublethal biological endpoints, it is likely that effects of this effluent may have chronic impacts in addition to the short-term effects typically measured in effluent toxicity evaluations.

Table 3.1. General characteristics of concentrate from different sources. The values shown represent estimated concentrate concentrations for seawater and wastewater (estimated value= source water*100/reject rate). Actual values are shown for groundwater concentrate. Reject rates = 50% for seawater and 15% for wastewater.

Constituent	Seawater [a]				Wastewater [b]				Groundwater [c]			
	N	Min	Med	Max	N	Min	Med	Max	N	Min	Med	Max
TDS (mg/L)	9963	66400[d]	67200[d]	68200[d]	NA	NA	NA	NA	13	25	6320	70000
TOC (mg/L)	NA	NA	NA	NA	239	55	127	724	3	3.4	3.4	4.6
Ammonia-Nitrogen (mg/L)	72	0	0.02	0.46	480	153	207	294	3	0.2	0.21	1.15
Nitrate-Nitrogen (mg/L)	57	0	0.09	2.0	145	0.1	0.7	15	6	0.2	2.65	19.8
Phosphate (mg/L)	65	0.00	0.07	3.1	124	2	12	44	2	0.1	0.1	0.1
Sulfate (mg/L)	-	-	5480	-	136	1087	1630	1967	6	9	710	3400
Arsenic (mg/L)	12	2.46	2.9	3.84	458	0.01	11	45	5	0	0.01	5.1
Bromide (mg/L)	-	-	130	-	NA	NA	NA	NA	2	10	10.4	10.4
Barium (mg/L)	-	-	0.1	-	108	147	240	335	5	0.2	0.39	0.735
Calcium (mg/L)	-	-	820	-	NA	NA	NA	NA	7	53	734	960
Iron (mg/L)	-	-	<0.04	-	148	3	28133	49067	3	20	69	100
Magnesium (mg/L)	-	-	<0.02	-	NA	NA	NA	NA	3	46	63	230
Silica (mg/L)	72	0	0.29	0.93	NA	NA	NA	NA	5	54	100	160
Sodium (mg/L)	-	-	21800	-	4	2053	2357	2613	5	160	210	960

a= Seawater minimum, median and maximum values were calculated from measurements of selected California areas, except where noted. Data obtained from the Bight 2008 Offshore Water Quality Study as part of the Bight 2008 Regional Monitoring Program. Values for seawater sulfate, bromide, barium, calcium, iron, magnesium and sodium represent standard values from Millero et al., 2008.

b= Wastewater minimum, median and maximum values were calculated from measurements of large POTWs as part of SCCWRP Mass Emissions Monitoring Program and from

c= Groundwater minimum, median and maximum values were calculated from measurements of southern California facilities. Data obtained from the Groundwater Desalter and Groundwater Cleanup Treatment Plant Capacity and Discharge Data taken from the USBR Survey on Groundwater Desalters. Data quality reports provided by the South Coast Water District and the City of San Juan Capistrano.

d= Seawater values estimated from salinity measurements as mg/kg.

4. ENVIRONMENTAL IMPACTS OF SEAWATER BRINE DISCHARGE

Peer-reviewed studies on the effects of elevated salinity or brine discharge were reviewed by the Panel. From these studies, it is clear that the effects (or lack thereof) of desalination concentrate vary widely, depending on the organism, site, the biotic community at the site, the nature of the concentrate, and to what degree it is diluted and dispersed. Overall, it would appear that benthic infaunal communities and sea grasses are the most sensitive to the acute effects of concentrate discharge; some communities seem to be tolerant of effects of up to 10 psu increases, while others are affected by increases of only 2-3 psu. However, few studies have evaluated discharges to embayments, where less dispersion of the discharge may occur, and the chronic impacts on demersal vertebrates, particularly those which have significant life history behaviors (i.e., reproduction, migration) driven by salinity variations.

4.1 Biological Impacts

As described previously, effluents from desalination are not merely concentrated salts, but include a variety of chemicals that come from the reverse osmosis process, such as antiscalants and antifoulants, including chlorine and other disinfection by-products that may be toxic, as well as chemicals present in the intake water. Discharge of this mixture into the environment may have adverse effects on marine biota. Ways in which such effects can be measured include 1) laboratory tests (bioassays) of various concentrations of the effluent on different species and 2) field studies focusing on changes in the community of organisms in the receiving environment.

Laboratory and field studies have been conducted throughout the world to better characterize the risks that concentrates pose to the marine environment. Most studies that have evaluated the biological effects of elevated salinity have used concentrate predominately derived from desalination of seawater or concentrated hypertonic solutions from pre-mixed salts.

With regard to laboratory studies, Whole Effluent Toxicity Testing (WET) has primarily been used to evaluate the impacts of desalination concentrates on biota. However, most studies have focused on mortality as an endpoint. This is, of course, the most extreme effect, and the absence of death in exposed organisms does not mean that they are not seriously impaired. There is a great need to learn about sublethal effects, but there have been very few studies that examined effects of long-term exposure on sublethal parameters, such as behavior and reproduction. While the methodology for WET assessments is standardized and evaluates the complete discharge mixture from desalination, reproduction is rarely evaluated as an endpoint. Given the interactions of osmoregulatory alterations with endocrine and reproduction hormone responses, particularly in vertebrates (Avella et al. 1991, Ayson et al. 1994, McCormick 1995), this endpoint may provide more conservatism in discharge areas with little dilution (i.e., embayments).

Wide variations in study design complicate the synthesis of published effects studies. Organisms tested ranged from benthic arthropods, to echinoderms, algae, sea grasses, and mollusks (see Roberts et al. 2010a for review and table in Appendix C). Different studies evaluated different endpoints after exposing organisms for varying periods of time. Furthermore, some studies provide the absolute salinity, while others report the increase over ambient (which varies from site to site), and others refer to the percent dilution of an effluent, so it is not possible to standardize the exposures.

In this section, we review the literature on environmental effects of elevated salinities, through both laboratory and field studies.

Organisms Evaluated in Laboratory Studies:

Mollusks:

A 3 ppt salinity increase reduced size and weight of cuttlefish (*Sepia apama*) embryos, and a 6 ppt increase reduced survival (Dupavillon and Gillanders 2009). Surviving individuals at these concentrations displayed abnormal behaviors such as slow response to stimulation and reduced ink-jet defense responses.

Oyster (*Crassostrea virginica*) survival and reproduction was impaired by 60 day exposure to a 45-55 ppt concentrate, but toxicity was thought to be caused by excessive copper concentrations (Mandelli 1975). In addition to toxicological effects, the altered physicochemical characteristics of the brine appeared to enhance pathogenic fungus infection rates in the exposed oysters. Iso et al. (1994) evaluated the impact of a hypertonic solution on the survival of Japanese clams. Generally, no effects were observed below a 19 ppt increase over control salinity, but survival is the most drastic possible response, and this study did not use whole effluent.

Fish

Iso et al. (1994) evaluated the impact of a hypertonic solution (not whole effluent) on the survival and behavior of sea bream and the survival of flounder embryos and larvae. Generally, no effects were observed below a 19 psu increase over control salinity.

Echinoderms

Effects on echinoids (sea urchins) were observed at 8.5% dilutions of a concentrate from Florida (Chesher 1971). Toxicity was thought to be related to copper concentrations.

Chordates

Effects on ascidians (tunicates) were observed at 5.8% dilutions of a concentrate from Florida (Chesher 1971). Toxicity was thought to be related to copper concentrations.

Sea Grasses

Much experimental research has focused upon the effects of brine upon seagrass (*P. oceanica*) and associated fauna. Laboratory experiments have observed reduced growth, greater occurrence of necrotic lesions and premature senescence in seagrasses at salinities of approximately 39 ppt, which represents only a minor increase above ambient salinity in the study region (Sánchez-Lizaso et al. 2008). Effects on seagrass were observed at 12% dilutions of a concentrate from Florida (Chesher 1971). Toxicity was thought to be related to copper concentrations. Growth of seagrass was impaired 50% following a 15 d exposure to a 5 ppt increase in salinity (Latorre 2005).

California Biota

Data on the effects of elevated salinity and concentrate discharges on California biota are extremely limited, often not peer-reviewed, not readily available, or have flaws in the study design. Only one published study has documented impacts of a concentrate discharge on marine biota of California in the laboratory (Voutchkov 2006). Laboratory studies were conducted on 18 different species encompassing algae, invertebrates and fishes. In contrast to WET, the selection of species included biota from the site of discharge. Salinities ranged from 33.5 (control) to 40 ppt and the duration of exposure was 19 days with survival as the only measure of biological effect reported in the reference. While the author stated growth and fertilization of sea urchins held for 5.5 months were unchanged, it was apparent that the study suffered serious flaws due to a lack of replication and very low individual numbers, which effectively prevent any statistical analysis of results. Overall, the author concluded that no effects were apparent in any of the treatment groups and reported an unreferenced citation that a chronic red abalone threshold derived from WET was 40 ppt. While this author proposed a 10 ppt increase of total dissolved solids as a threshold using WET methods (with lethality as the endpoint), from the other studies reviewed here, it is apparent that a 2-3 ppt increase can produce significant deleterious effects in sea grasses and mollusks.

Benthic Communities

Depending on how it is discharged, as concentrate from desalination plants is more saline than the receiving water, it may settle on the bottom, with potential deleterious effects to the benthic community. Some field studies of desalination concentrates at various sites found adverse effects on benthic biota, while other studies found none. Differences in effects or lack thereof are due to differences in ecosystems and varying concentrate characteristics.

Diatom Communities

Benthic diatom communities were reduced in richness and abundance, and had lower chlorophyll-a in areas receiving desalination concentrate, even though salinity measurements were not different at outfall and reference locations (Crockett 1997).

Sea Grass Communities

Perez Talavera and Quesada Ruiz (2001) found that the discharge from a Canary Island desalination plant was associated with the disappearance of the sea grass, *Cympodocea nodosa,* in areas near the outfall; farther away, the grass was present but in poor condition, but at even farther distances it was in good condition. They found that although the initial dilution was high, a 2 ppt increase of bottom salinity remained over a large area on the bottom, accounting for the effects on the plants. A 1 ppt increase was observed on the surface. Gacia et al. (2007) studied seagrass (*Posidonia oceania*) meadows exposed to concentrate from a reverse osmosis plant, which contained nitrogen from the groundwater source of the intake water. The salinity was 5 ppt above background 10 m from the outlet. Respective increases of 2.5 ppt and 1 ppt were observed at 20 m and 30 m from the outlet. Sea urchins and sea cucumbers, present at the reference sites, were absent from transects that were impacted by the concentrate. These species are highly sensitive to elevated salinity. The sea grass itself showed reduced growth and necrotic tissue, but there was no extensive decline of the meadow. Effects on seagrass meadows may be more apparent when organisms inhabiting depressions in substrata, where pore waters are more saline are studied, since they may be differentially exposed.

In field experiments, discharge from a pilot desalination plant was pumped to experimental seagrass plots for three months (Latorre 2005, Sánchez-Lizaso et al. 2008), elevating salinities from about 37.7 psu, to a range of 38.4 to39.2 psu. These slight, increases in salinity resulted in reduced survival of seagrass, reduced shoot abundance, length and biomass, and presence of necrotic lesions. Monitoring of meadows adjacent to plant outfalls also revealed reduced shoot density, greater abundance of epiphytes, and reduced abundance of epifauna (Latorre 2005, Sánchez-Lizaso et al. 2008). That impacts to seagrasses can occur following increases of only 1 to 2 ppt in salinity highlights the potential sensitivity of these species to desalination brines

Soft Bottom Benthic Infauna

Del Pilar Ruso et al. (2007) found major impacts on benthic communities following the opening of a seawater reverse osmosis plant in Alicante, Spain. The discharge had low initial dilution, and the salinity near the discharge was over 39 psu, and farther away was 37.9. Before the discharge began, the benthic infaunal community was studied along three transects perpendicular to the coast, and was dominated by polychaetes, nematodes, and bivalves. Over time, following the opening of the plant, the diversity and abundance of polychaetes decreased at distances of up to 400 m from the discharge, and the community became dominated by nematodes alone, with the degree of dominance increasing over the two-year time period of the study. This study demonstrates the importance of baseline studies before a plant goes into operation.

Meiofauna

Riera et al. (2011) assessed whether proximity to a brine discharge point in the Canary Islands altered patterns in the abundance and assemblage structure of subtidal, soft-bottom, meiofauna. Samples were collected twice (May 2008 and January 2009) at 0, 15 and 30 m away from the brine discharge point, corresponding to a change in salinity from 45 to 36 psu. Proximity to the brine discharge point affected overall meiofaunal abundance: lowest abundances were observed at 0 m (mean of 64.55 individuals per 10 cm^2) than at 15 (average of 210.49 individuals) and 30 m (average of 361.88 individuals) away from the discharge point. This was particularly notable for the dominant meiofauna: nematodes and copepods. The community structure also differed with varying proximity to the brine discharge point. Multivariate techniques identified changes in salinity as a relevant driver of patterns in community structure, but a shift in particle size composition between the sampling dates also contributed to differences in abundance and assemblage structure with proximity to the discharge point. Hence, meiofauna are suitable for monitoring impacts of hypersaline effluents as long as potential confounding factors, (e.g., changes in particle size composition) are accounted for.

Coral Communities:

In contrast to previous reports of benthic effects, an intensive field study in Antigua found that elevated salinity (sometimes over 40) was present down slope from the brine discharge, but no significant changes were seen in the biotic community including seagrasses, hard and soft corals, algae, other invertebrates, and fishes (Blake et al. 1996, Hammond et al. 1998, cited in NRC 2008). Coral heads exposed to a salinity elevation of 4.5 psu showed no adverse effects after six months. The elevated salinity was distributed well past the 10 m study area, mainly down slope. Unfortunately, although this study did have baseline data, it did not continue after six months, and no reference sites were monitored. The investigators did perform settling plate studies, and seasonal differences were attributed to reproductive seasons rather than to elevated salinity. However, they did not perform settling plate studies before the discharge commenced, so it is not known if the discharge prevented any species from settling. This study was not published in the refereed scientific literature. In contrast, massive losses of coral, plankton and fish in the Hurghada region of the Red Sea have been attributed to desalination discharges, although the data supporting this claim were not presented by the authors and the impacts must be considered anecdotal (Mabrook 1994).

Raventos et al. (2006) found no significant impacts of discharges from a small seawater desalination plant in the northwest Mediterranean, using visual census techniques 12 times before and 12 times after the plant began operating. Levels of salinity were equivalent to background within 10 m of the outlet. The lack of effects was attributed to high natural variability and to rapid dilution of the concentrate upon leaving the discharge pipe, which had a diffuser with 43 ports to facilitate rapid dilution. The use of visual census precludes an analysis of benthic infauna, which may have been affected.

4.2 Overall Summary of Effects:

Roberts et al. (2010a) reviewed previous work on the environmental impacts of discharge from desalination plants. Experiments in the field and laboratory demonstrated the potential for acute and chronic toxicity, and small-scale alterations to community structure after exposures to concentrations of concentrate likely to be present near the discharge site. It was clear from the reviewed articles that the method of discharge and site selection are the main factors determining the extent of ecological impacts. Ecological monitoring studies have found variable effects ranging from no significant benthic impacts to widespread alterations of community structure in seagrass, coral reef, and soft-sediment systems when discharges are released in poorly flushed areas. In most other cases, environmental effects appeared to be limited to within 10s of meters of outfalls. The greatest impacts in the field have occurred around older multi-stage flash (MSF) plants discharging to water bodies with little flushing, a discharge scenario not relevant in California. Such sites show substantial increases in salinity and temperature, along with accumulation of metals, hydrocarbons, and anti-fouling compounds in receiving waters. Environmental issues associated with older desalination plants have often been linked to excessive copper content of the concentrate (Chesher 1971), an issue that is now largely avoidable.

Roberts et al. noted that a large proportion of the published work is descriptive and provides little quantitative data that can be assessed independently. Many monitoring studies lacked sufficient details of study design and statistical analyses, making interpretation of results difficult. They concluded that greater clarity and improved methodologies are required in the assessment of the ecological impacts of desalination plants, that it is necessary to employ Before–After, Control-Impact (BACI) monitoring designs with adequate replication, and that multiple independent reference locations are needed to assess potential impacts adequately. Such studies using robust experimental designs are currently underway in Australia (e.g., Perth and Sydney desalination plants) and are expected to substantially add to our understanding of field effects of desalination concentrate discharge. Detailed results from these studies are not yet available for review.

4.3 Recommendations

Based on published studies, a salinity increment of less than about 2 to3 psu would seem to be protective of local ecosystems. However, as we have noted, there is a surprising paucity of studies focused on sublethal impacts, including effects on biota in California waters. In addition, this value does not include site specific aspects of water quality or bathymetry which could substantially affect threshold determinations. For example, in embayments with limited flushing, thresholds may be lower in anadromous fish such as salmonids or estuarine demersal flatfish, which undergo saltwater acclimation and significant endocrine alterations.

Additional and long-term studies are needed specifically on sublethal endpoints such as reproduction, endocrine disruption, development, and behavior, and on additional taxa including benthic invertebrates and fish (i.e., demersal flatfish). Studies are also needed on different types of concentrates and mixtures with antiscalants and other chemicals associated with RO. Such studies are strongly encouraged, and their results may warrant more conservative levels.

Studies are also needed to evaluate the potential impact of concentrate discharge into estuarine waterways that have hydrodynamic issues which may limit discharge dilution and dispersion. For example, the combination of freshwater removal and climate change-induced hypersalinization combined with significant concentrate discharge into embayments such as the San Francisco Bay Delta may substantially alter species that utilize salinity gradients for critical life history segments (i.e., salmonids; delta smelt). It is likely WET would greatly underestimate the impacts of these combined stressors.

5. DISCHARGE SITE SCENARIOS

This section discusses the key features of the discharge site that can influence the fate and ecological risk of concentrate discharges. The geomorphic, depth, and habitat characteristics of the discharge site are important factors to consider, as well as variability in salinity, temperature, and waves. These factors should be considered in determining the suitability of a site for discharge and in developing effluent limits and monitoring requirements. Receiving water salinity can vary naturally by as much as 8% to 71%, depending on location along the California Coast. A statewide water quality objective for salinity should not be expressed only as an absolute salinity value, as such an objective would likely not be appropriate for all discharge scenarios. Discharge sites with high ambient mixing and advection (typical of exposed, open-ocean, collision-coastlines) are preferred, due to their greater ability to dilute and disperse the discharge. Discharge sites with bathymetric depressions (hollows) or barriers (offshore rocky outcrops) should be avoided with negatively buoyant discharges. Such sites have an increased potential for accumulation resulting in degraded water quality in the near-bottom. Discharge sites in estuarine embayments present greater potential ecological risk from concentrate discharge, due to accelerated flocculation of the sediment in the receiving water or reduced dispersion of the plume.

5.1 Key Site Characteristics

The dilution, dispersion, and biological impacts of a concentrate discharge are determined by the interaction of multiple factors specific to the site and discharge. From a plume modeling perspective, there are three types of factors to be considered: 1) effluent characteristics and type and mode of discharge, 2) boundary conditions that represent the topography and other physical and biological characteristics of the receiving environment (i.e., the far field), and 3) forcing functions such as tides, waves, and currents. All of these factors interact on a site-specific basis and should be considered when assessing the ecological risk of the discharge (Figure 5-1). The Panel recommends that these factors and their interaction, which constitute the discharge site scenario, be considered in evaluating the impacts of concentrate discharges and establishing permit conditions.

Effluent Type

As discussed in Section 3, the physical and chemical composition of the concentrate can vary greatly, depending on the characteristics of the feedwater and additives. The type of concentrate considered in this report includes brine from ocean desalination facilities, as well as concentrates from treated municipal wastewater or brackish water. Each of these effluent types are likely to vary in salinity and the concentration of potentially toxic constituents from chemical additives or wastewater contaminants. These characteristics, in addition to the volume discharged and temperature, will influence the initial dilution of the discharge, its interaction with other constituents in a combined discharge, and the overall toxic potential to marine life.

Discharge Mode

The mode of discharge controls the physical properties of the discharge plume, the most significant of which is the net buoyancy of the plume. There are three principal discharge modes to be considered: 1) positively buoyant combined discharges that blend concentrate with thermal or wastewater effluents using existing infrastructure, 2) negatively buoyant discharge using dedicated brine discharge infrastructure, and 3) sometimes or weakly-negatively buoyant combined discharge when brine is the predominant effluent constituent. Each of these discharge modes will interact differently with the receiving environment, producing different near field different characteristics and dimensions in both the near and far fields. Discharge modes are discussed further in Section 6.

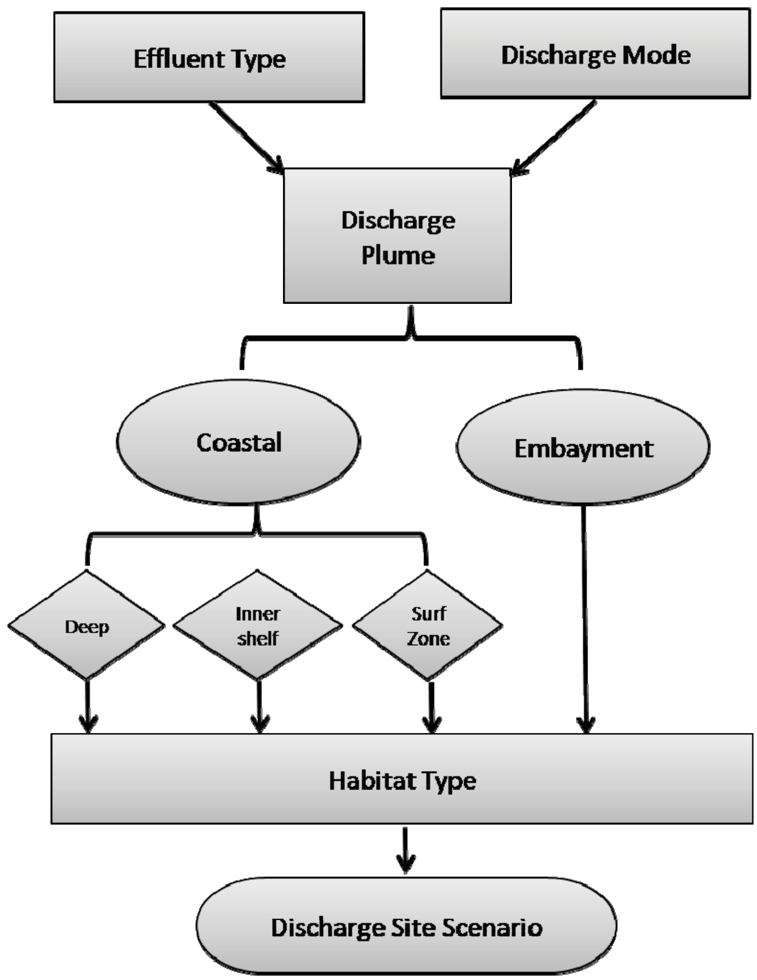

Figure 5.1. Factors influencing discharge site scenarios.

Receiving Environment

The physical boundaries, oceanography, and geomorphology of the receiving environment affect the fate of the plume and also determine the nature of the biological communities potentially affected by the discharge. Key boundary conditions that should be considered include coastal type, bathymetry and coastal structures, sediment properties, and water mass properties (salinity and temperature). The coastal type includes collision coasts, which are exposed open coastlines that are accompanied by either sandy or rocky intertidal and subtidal habitats. The geomorphology of both the sandy and rocky collision coastal types creates high-energy coastal environments with vigorous ambient mixing and advection that contributes to rapid dilution that limits dispersion and accelerates extinction of brine discharge plumes.

Concentrate releases into the open ocean will be influenced by different currents as a function of the depth (i.e., location) of the discharge. The three primary circulation regimes that can be expected in the coastal setting are shown in Figure 5-1: 1) surf zone, 2) inner shelf, and 3) deep waters. These regimes are distinguished by the different processes that dominate their currents. The surf zone is that shallow water province at the shoreline in which currents are dominated by the effects of breaking waves. The inner shelf is that region from the surf zone to the offshore location where incident waves begin to refract and shoal and where surface and bottom boundary layers (also known as Ekman layers) first intersect. Finally, the deep water is the offshore region for which surface and bottom boundary layers exist but the bulk of the flow is dominated by the geostrophic acceleration balance between horizontal pressure gradients and the effect of Earth's rotation (i.e., the Coriolis acceleration). The exact depths that determine the boundaries between the three offshore regimes vary from place to place and, at one location, in time. The boundary between the surf zone and the inner shelf is around 10 m and between the inner shelf and the deep water is around 30 m.

Tidally influenced bays and estuaries represent another important coastal type in California. This coastal type has three subsets: 1) estuarine embayments at the mouth of a major coastal river/watershed (eg. San Francisco Bay), 2) marine embayments that no longer have significant fresh water input, due usually to river diversion/navigation projects (e.g., San Diego Bay), and 3) man-made embayments (e.g., Los Alamitos Bay). All types of embayments in California are low energy depositional environments. The predominant mixing and advection processes in these environments are tidally driven, although the interaction of river flow with the tidal transport produces salt wedge stratification and flocculation dynamics that can have a controlling influence on concentrate dilution and dispersion.

Geomorphology also influences the resident biological communities of a particular coastal environment. Open coasts with sandy environments support soft-bottom habitat species (particularly benthic macroinvertebrates), while rocky coasts provide substrate for kelp-based marine communities. Rocky coasts support tide pool environments, and kelp beds and sea grasses in the offshore environments, both of which are often protected in California as designated Areas of Special Biological Significance (ASBS). The dispersion of concentrate discharges near any ASBS should be avoided as discharges into ASBS of any kind are prohibited by State law. Estuarine embayments are generally complex and highly productive ecosystems, likely to have tidal marshes in the intertidal zone, which is another sensitive habitat type protected under the Clean Water Act. The subtidal areas of embayments are generally nurseries for a variety of juvenile fish species and are considered to be sensitive habitats under the California Coastal Act.

Forcing Functions

Forcing functions affect the strength of ocean mixing, ventilation and available dilution volume in shallow water, including: waves, currents, ocean water levels (tides and sea level anomalies), and winds. Movement of material in inner shelf and surf zone, including the average and low-frequency movements, is controlled by the waves approaching the beach and the shape of the bottom. Waves striking the beach at an oblique angle drive mean currents up or down the beach (cross-shore currents) and parallel to the beach (long-shore currents) as a function of the incidence angle. When waves approach the beach straight on, local rip currents are more common, which are associated with complex circulation cells that control the amount of mixing with waters outside the surf zone.

Hence, any assessment or monitoring of a shoreline (i.e., surf zone) discharge must include local wave statistics and bathymetry data. Appropriate theory, models, and data for the assessment of dispersion in the surf zone can be seen in a number of textbooks on coastal processes and sedimentation, including the ones by Dean and Dalyrmple (2002) and Arnott (2010).

Of the three current regimes, the inner shelf has received the least amount of study. By definition, it is a transition region between the surf zone and deep waters. In recent years it has been recognized that the inner shelf is a critical region with regard to cross-shore exchange of material and better characterization of inner shelf dynamics has been shown. A good review of the important dynamics in the inner shelf is given by Lentz and Fewings (2012).

The deep water currents outside the inner shelf are a combination of flow driven by local winds and geostrophic currents. Accurate modeling of velocity statistics for a given location can be difficult because, in all cases, flow is highly dependent on the conditions at the boundary of any local model. (For a review of numerical ocean circulation models see Miller 2007). Direct measurements in the region may be adequate to describe the velocity variability if the data records are appropriately long. Care must be taken, however, to focus model results and observations on the local bottom currents when assessing the fate of concentrate in a negatively buoyant plume. In particular, deep water bottom currents will include the effects of the frictional bottom Ekman (boundary) layer (see: Csanady 1982 and Cushman-Roisin and Beckers 2011).

5.2 Discharge and Site Variability

None of the initial conditions, forcing functions or the boundary conditions of the far-field are constants over time, and consequently the dilution and dispersion of concentrate discharge can have considerable variability, which complicates the determination of "natural" conditions and prediction of discharge dispersion. There may be short-term or seasonal changes in RO operations resulting in variations in the concentrate discharge rates, salinities and temperatures. On the other hand, the temporal variation in boundary conditions and forcing functions of the far field receiving water can vary over a vast range of time scales that are related to geophysical, atmospheric, and climatic processes, including: diurnal variations related to tides, solar heating and coastal winds, monthly variations related to tidal spring/neap cycles, semi-annual variability related to summer/winter equilibrium transitions, and longer term variability related to climate (e.g., El Nino/Southern Oscillation (ENSO)). Variations in salinity, climate, and bathymetry are discussed here to illustrate some of the most important factors. Additional discussion of variability is included in Appendix E.

Salinity

Ocean salinity variation exerts a modulating effect on the impact of sea salts discharged from a desalination plant. The RO process produces a concentrated sea water reject (brine) that is a fixed multiple of the instantaneous source-water salinity (generally 1.8 to 2 times ambient). However, the ambient ocean salinity has considerably different degrees of variability throughout California.

Figure 5-2 shows the variation in daily mean salinity in the coastal waters off Huntington Beach in Southern California from 1980 until mid-2000. These data indicate ocean salinity varies naturally by 10% between summer maximums and winter minimums, with a long term average value of 33.53 parts per thousand (ppt). Maximum salinity was 34.34 ppt during the 1998 summer El Nino when southerly winds transported high salinity water from southern Baja up into the Southern California Bight. Minimum salinity was about 31.02 ppt during the 1993 winter floods.

Ocean salinity can be much more variable in other regions, such as is shown for Northern California in Figure 5-3. Here, long term variability about the mean is 71.7 %, with a long term average value of 33.39 ppt. Maximum salinity was 35.6 ppt during the 1998 summer El Nino when southerly winds transported high salinity water from southern waters. Minimum salinity was about 13.6 ppt during the 1993 winter floods. Considerably greater salinity depression occurs in the coastal waters of Northern California because the climate is wetter and the rivers discharge proportionally greater volumes of fresh water during floods (Inman and Jenkins 1999).

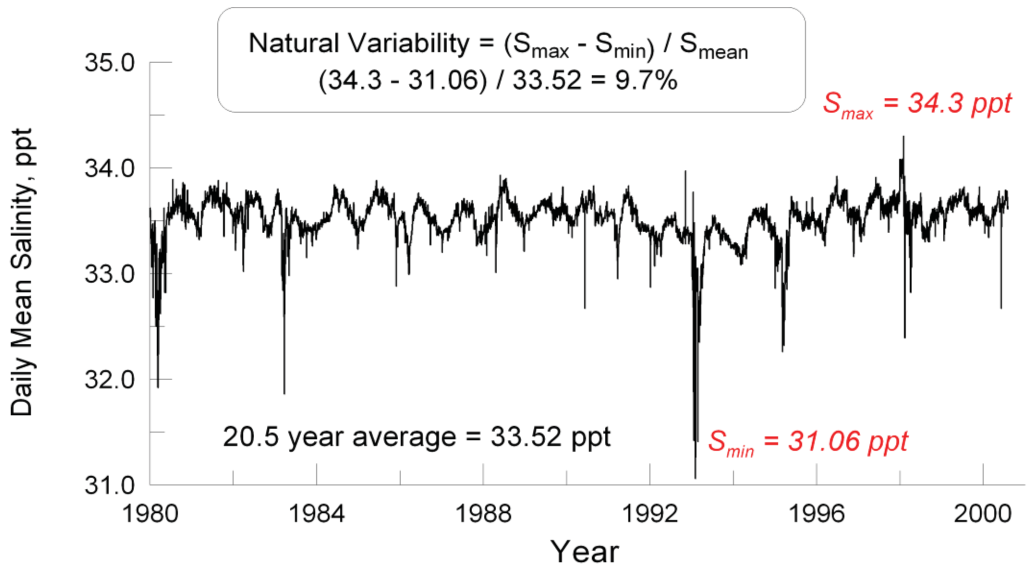

Figure 5-2. Long-term salinity variation typical of the Southern California Bight. Data from NPDES monitoring reports for AES and OCSD outfalls in Huntington Beach.

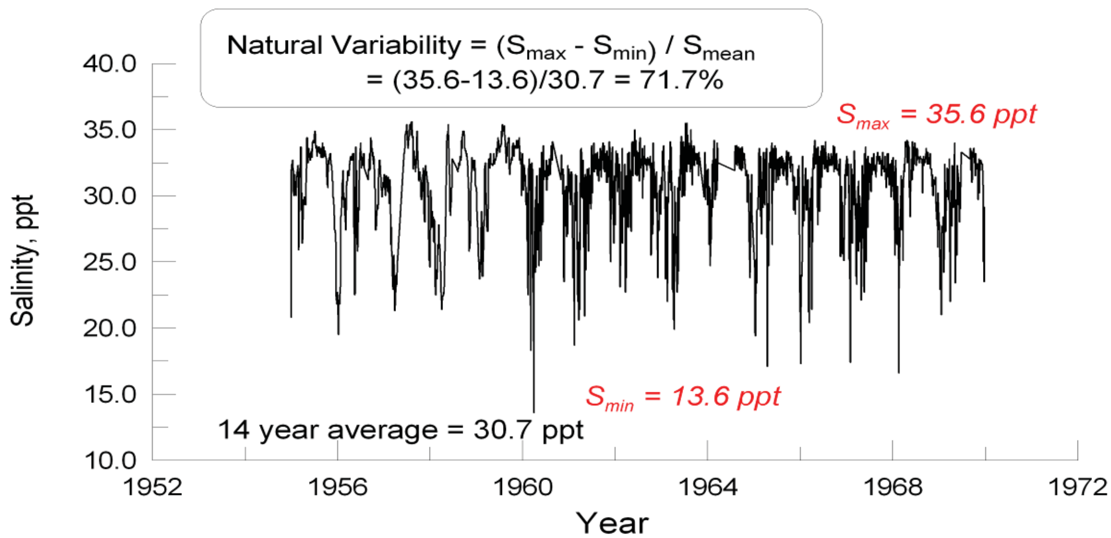

Figure 5-3. Long-term salinity variation typical of Northern California. Data for Crescent City.

Because receiving water salinity can vary naturally over the long term by as much as 71%, along the California Coast, a water quality objective for salinity should not be a fixed limit in terms of absolute salinity units. Rather, a water quality objective should be stated in terms of some relative measure of deviation from natural background, such as % deviation from background or a minimum initial dilution producing equivalent results.

Ocean climate

The plume dilution and dispersion processes in the far field are influenced by ocean temperature, salinity and the wave climate. These features vary as a result of seasonal weather cycles and can also be severely modified by global ocean climate events, such as the Pacific Decadal Oscillation (Inman and Jenkins 2004).

The effect of climate on plume dispersion is illustrated using the proposed Santa Cruz Seawater Desalination Project (SCSDP) in Monterey Bay as an example. This example assumes brine from the proposed SCSDP would be blended with treated wastewater and the combined effluent would be discharged through the existing ocean outfall one mile (1.6 km) offshore in about 110 feet (30.5 m) of water at an initial dilution of 139:1 (NPDES Permit No. CA0048194, 2005).

There are three well known hydrographic climate periods of Monterey Bay circulation, namely: 1) the wind-induced *upwelling period*, 2) the *oceanic period* dominated by *relaxation states*, and 3) the *Davidson Current period*. During upwelling, a front typically forms across the mouth of Monterey Bay with a cyclonic gyre inshore of the front inside the Bay (the Monterey Bay Gyre); and an anti-cyclonic eddy offshore of the upwelling front that is influenced by the California Current meander system, (Paduan and Cook 1997, Ramp, et al. 2009, Tseng et al. 2009). The Monterey Bay Gyre (Tseng et al. 2003) produces westward flow in the neighborhood of Santa Cruz , causing the net drift of the discharge plume to spread along shore toward the west (Figure 5-4a). Circulation patterns change and become more variable when upwelling subsides during the relaxation state. The transport of the discharge plume under this condition is less consistent, but is expected to have a slight eastward trajectory bringing the plume closer to shore (Figure 5-4b). The influence of the Davidson Current and other circulation patterns during the Davidson Current Period are very weak at the nearshore location of the SCSDP. Consequently, there is very little net mean motion in any direction from the Davidson Current circulation pattern and dispersion of the discharge plume is governed by balanced east-west tidal oscillations (Figure 5-4c).

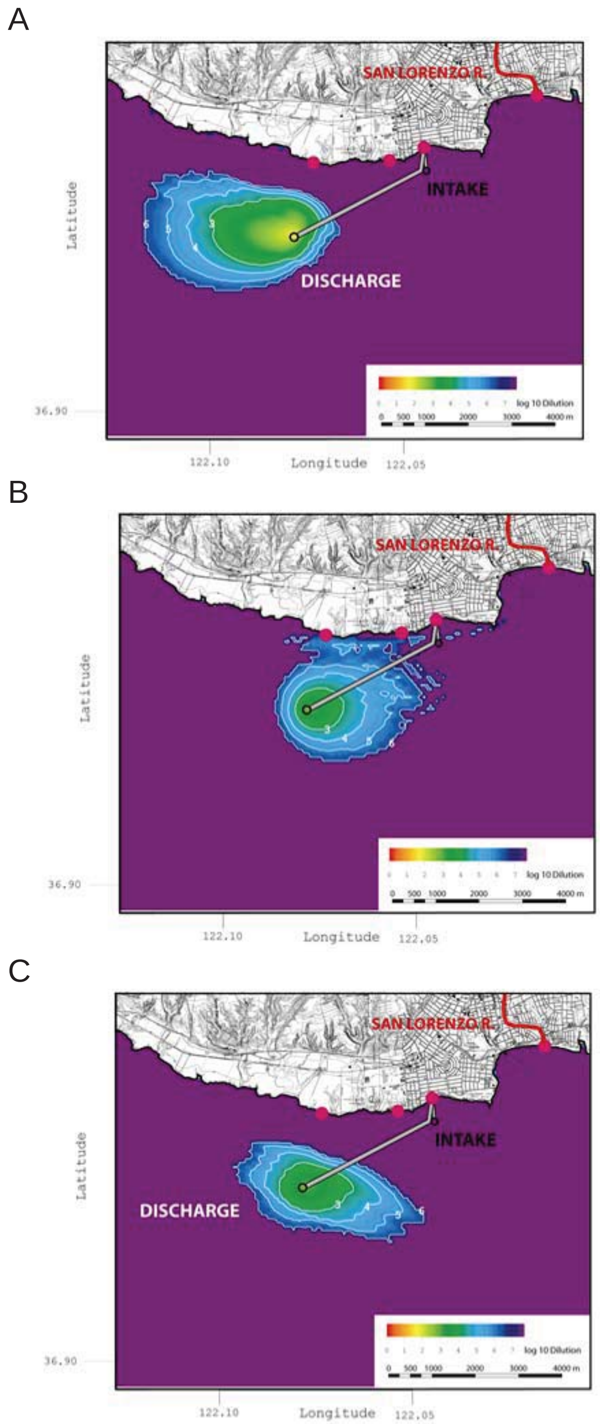

Figure 5-4. Example of effect of ocean climate on plume dispersion. Simulations based on proposed discharge off the coast of Santa Cruz, CA (from Jenkins and Wasyl, 2009).

5.3 Bathymetry and Gravity Currents

The dynamics of negatively buoyant plumes are fundamentally different that those of positively buoyant plumes. The fate of positively buoyant plumes is primarily controlled by background currents, density stratification, and wave or wind-induced mixing. They will either reach the water surface or be trapped by ambient stratification. Negatively buoyant plumes, on the other hand, will generate density (i.e., gravity) currents along the seabed by virtue of their density anomaly compared with the ambient bottom waters. The magnitude of these density currents will depend on the magnitude of the density anomaly and the bottom slope (Simpson 1997). Most of the coastline of California has favorable bottom gradients for offshore dispersion of dense plumes, because the narrow continental shelf geomorphology provides steep shelf and nearshore bathymetry. Therefore, residual high density waters at the edge of the near field in the case of negatively buoyant plumes will move away from the zone (and shoreline) under the influence of background bottom currents and self-induced density currents.

There may be environmental concerns with respect to density currents, however. The presence of rocky outcrops and reefs offshore from the discharge site may block the offshore dispersion of brine by gravity. Therefore, discharge sites with bathymetric barriers (offshore rocky reefs and outcrops) should be avoided with negatively buoyant discharges. Depending on the mixing rates with ambient waters outside of the density layer, the dissolved oxygen (DO) supply to the density layer may not meet the net oxygen demand of the benthic fauna within the layer. In this case, DO will decrease over time and, if the layer persists long enough, hypoxia or anoxia within the bottom layer can produce lethal effects in the far field well away from the discharge. This is unlikely to occur with a well-designed discharge, however.

Many factors control the development of hypoxia or anoxia, including the stratification between the ambient waters and the density layer, the thickness of the layer, the water depth, the slope of the bottom, the strength of the wind, the vertical velocity shear across the layer, and the height of the surface waves. The general situation and many of these factors are addressed in the excellent study by Hodges et al. (2011) using observations from a natural proxy to an anthropogenic negatively buoyant discharge created when high-salinity, dense waters flow out from Oso Bay into the larger Corpus Christi Bay along the Texas Gulf Coast. The potential for such a situation occurring in California can be minimized by avoiding shoreline discharges of dense undiluted concentrate.

Other far field bathymetric features to be avoided for the siting of a negatively buoyant brine discharge are bathymetric depressions (hollows). These are not generally features found along the exposed open coast of California, but can be common in embayments, either from natural shoaling effects or from man-induced activities such as the dredging of navigation channels and berthing areas. When such features are located in embayments with low mixing, a bathymetric depression can fill with brine and displace the lighter ambient seawater from the depression. This situation can result in stratification and stagnation of the bottom layer, leading to hypoxia and increased exposure of the benthos to the plume contaminants. Sites with topographic depressions should be avoided as locations for negatively buoyant discharges.

6. DISPOSAL STRATEGIES AND NEAR FIELD EFFECTS

The Panel reviewed the discharge technologies either in use, or likely to be used, in California with respect to their ability to achieve the level of dilution needed to minimize ecological risk. For a direct discharge of brine, the use of a diffuser is preferred. For flows typical of major desalination plants, a multiport diffuser will probably be required that results in high dilutions and rapid reductions of salinity in the near field. The diffuser should be designed so that the jets do not impact the water surface and the effects of jet merging should be carefully modeled (see later discussion of modeling techniques). For co-discharges with power plant cooling water, existing shoreline surface discharges, multiport diffusers, or single-port risers can probably be used. In most cases, however, near field dilution alone may not suffice to meet water quality standards and in-pipe dilution will also be needed. If the discharge is negatively buoyant, the dilution from horizontal nozzles must be carefully evaluated to ensure adequate initial dilution. Small amounts of concentrate can probably be discharged through existing municipal wastewater outfall diffusers. However, the dilution must be reevaluated to account for the change in effluent density and flow rates, and carefully evaluated if negatively buoyant.

6.1 Introduction

It is important to understand the distinctions between near field, mixing zones, and other related terms that are often associated with wastewater discharges. These are discussed further in Appendix D. The near field is a hydrodynamic, or physical, concept. It is the region where mixing of the effluent is influenced and affected by discharge parameters. The physical processes are primarily entrainment caused by shear between the buoyant jet (either positively or negatively buoyant), an internal hydraulic jump where the plume impacts a boundary (e.g., sea floor) or water surface and transitions to horizontal flow, and entrainment in the horizontally spreading layer. The near field ends where the self-induced turbulence collapses under the influence of the induced density stratification. The layer then spreads as a density current of some finite thickness. Ultimately, ambient diffusion due to oceanic turbulence is responsible for most mixing and dilution; this region is known as the far field. The rate of mixing and dilution in the far field is much slower than in the near field. A mixing zone is a regulatory concept that will generally encompass most, or all, of the near field.

The near field characteristics of negatively buoyant discharges are primarily determined by the orientation of the discharge port or nozzle to the horizontal, the jet exit velocity, and the density difference between the effluent and receiving water. Flowing currents will generally increase the dilution in the near field. For larger discharges a multiport diffuser consisting of many nozzles will be needed. In that case, an additional parameter is the port spacing and orientation of the diffuser axis to the prevailing currents.

6.2 Disposal Alternatives

Examples of common concentrate discharge scenarios are shown in Figure 6-1 (after Bleninger and Jirka 2010). Concentrates can be disposed of in several ways. They can be discharged as a surface stream at the shoreline, co-mixed (and pre-diluted) with other effluent such as municipal wastewater or power plant cooling water, or directly into the ocean as a "pure" brine stream.

For shoreline surface discharges (Figures 6-1a and b), the near field results primarily from entrainment into the surface layer (for a positively buoyant flow), or the bottom density current (for a negatively buoyant flow). This entrainment is dependent on the source velocity, as entrainment due to the spreading density currents is quite slow. Also, the density stratification reduces vertical mixing in the far field. Because of these effects, near field dilution is quite small, of order 5 times or less.

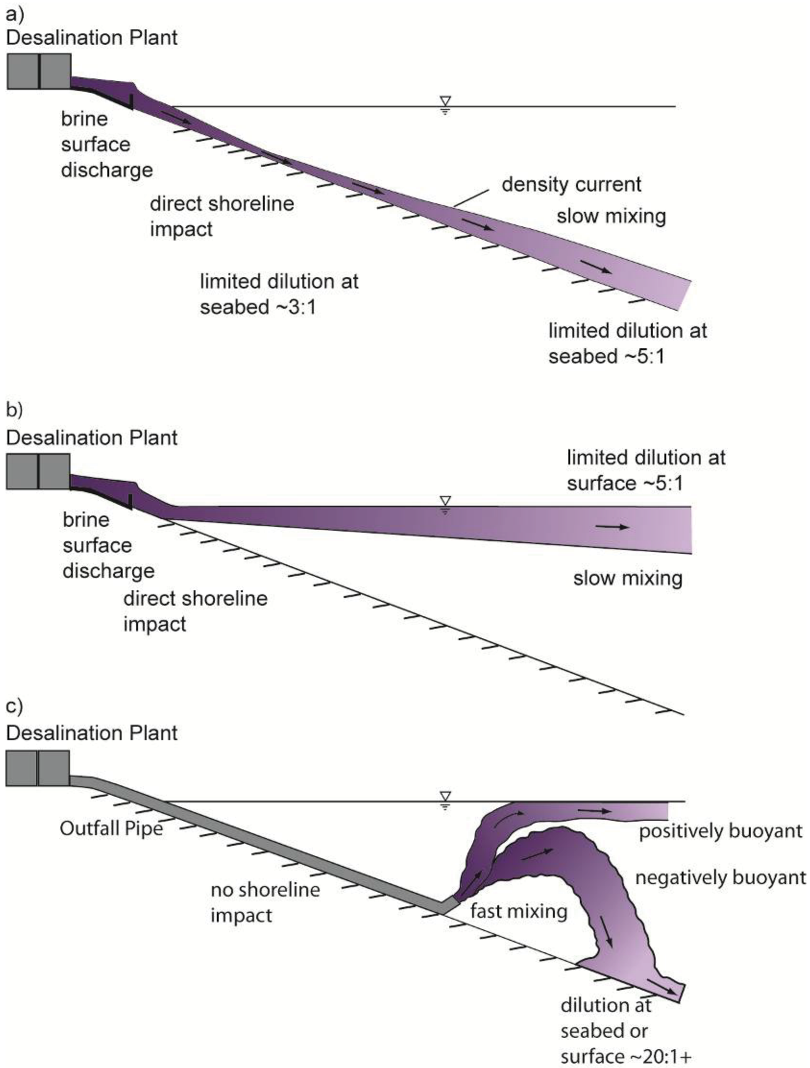

Figure 6-1. Mixing characteristics and substance distributions for various brine discharge configurations and effluents (after Bleninger and Jirka 2010). ***a*) RO plant (dense effluent) shoreline discharge via channel or weir, *b*) Thermal plant (dense effluent mixed with buoyant cooling water) shoreline discharge via channel or weir, *c*) submerged discharge (dense effluent) via pipeline and nozzle or diffuser.**

Shoreline discharge of raw (negatively buoyant) concentrate (Figure 6-1a) will result in a density current that runs down the bottom slope. Because the resulting density stratification inhibits vertical mixing, dilution is relatively small and benthic organisms could be exposed to relatively high salinities. Shoreline disposal of pure concentrate by this means in California is discouraged.

Co-discharge is another disposal strategy that involves diluting the concentrate to below potentially toxic levels prior to discharge into the receiving water body. This strategy involves blending brine with an existing effluent stream to achieve what is referred to as *in-the-pipe dilution* or *in-plant dilution*. Co-discharge is permitted by California water quality regulations and is currently used by several facilities. Shoreline discharges are practical if co-discharged with a much larger flow for pre-dilution, such as power plant cooling water. In this case, the effluent is likely to be positively buoyant because of the elevated temperature of the cooling water (Figure 6-1b).

There are two common means for achieving in-plant dilution: 1) co-locating the desalination plant with a wastewater plant, in which the dilution water is generally of very low salinity; or 2) co-locating the desalination plant with a power plant where the dilution water is cooling water taken from the receiving water body, typically the ocean. Dilution with wastewater produces a discharge salinity lower than ambient seawater, even at relatively low wastewater discharge rates because the treated effluent is fresh water. This is a means of reducing or eliminating hypersalinity impacts on marine life from brine discharge (Jenkins and Wasyl, 2005).

Concentrates that are blended with other effluents are typically discharged though existing ocean outfalls and diffusers (Figure 6-1c). Discharge through an existing outfall and diffuser will generally be at "low" pressure, i.e. the jet exit velocity is relatively low and the jet momentum flux will be quite small. For thermal discharges from power plants this would be either through a multiport diffuser (such as San Onofre) or a large single riser (such as Huntington Beach). In the former case, and for a municipal wastewater diffuser, the nozzles are generally horizontal. If the effluent is positively buoyant as a result of the elevated effluent temperature, the jets will ascend towards the surface. If the ambient stratification is strong enough the plumes will be trapped below the water surface, if not the plumes will reach the water surface. The near field is primarily the rising plume region and has dispersion characteristics similar to other buoyant plumes currently addressed in the Ocean Plan. Because multiport diffusers for positively buoyant effluents are predominantly horizontal, they may not be suitable for a negatively buoyant discharge and will have to be carefully evaluated. A possible solution is to open more ports on the diffuser and fit the ports with variable-area check valves which give higher velocity at low flow rates. Again, the dilution must be carefully modeled and evaluated.

For co-discharge though a single large vertical riser (such as used for some power plants) the exit dimensions may be very large, such as a square opening 25 ft on side, which is comparable to the local water depth. In that case, the initial dilution can be quite small and mixing in the spreading layer should be incorporated into the near field. These types of discharges should include in-pipe dilution of the brine with larger flows of seawater in order to achieve adequate dilution of the brine within the mixing zone.

The use of seawater to achieve in-plant dilution requires a much larger volume, relative to municipal wastewater effluent, to achieve a comparable level of reduction in the salinity of the brine discharge. The intake of seawater used for in-plant dilution (e.g., as power plant cooling water) causes additional mortality to marine organisms through velocity shear and turbulence in the confined flows through pumps and impellors of the (older design) once-through sea water circulation systems (Marcy et al. 1978, Bamber and Seaby 2004). However, recent work on hydro-electric turbines by Cada (2001) and Cada et al. (2006) has shown pump-induced turbulence mortality can be reduced by employing low speed impellors after the *Kaplan* turbine and Archimedes screw pump that reduce the shear stresses on entrained organisms to levels they can tolerate. Low-stress water wheel technologies are also being considered as alternatives to seawater circulation pumps of legacy power plants to reduce impacts on marine life. The practicality of these technologies for the applications considered here remains to be demonstrated, however.

The final case is direct discharge of negatively buoyant brine concentrate by means of high velocity jets inclined upwards. This could be either a single jet for a small discharge or a multiport diffuser for larger discharges. Multiport diffusers are used for the Perth and Sydney (Australia) desalination plants. The high jet velocities result in entrainment of ambient seawater into the jets and rapid dilution and reduction of salinity. The processes are illustrated in Figure 6-2. Dilutions exceeding 30:1 can be readily accomplished by such a diffuser.

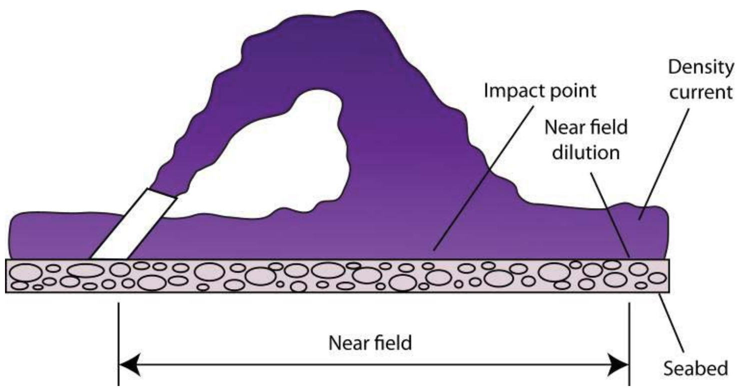

Figure 6-2. Schematic depiction of brine discharge as inclined jet.

A multiport diffuser with multiport "rosette" risers is shown in Figure 6-3. In this example, the rosettes each consist of four nozzles. Other diffusers may have the nozzles distributed uniformly along one or both sides of the diffuser.

Figure 6-3. A rosette multiport brine diffuser.

In turbulent environments, physical damage can occur to delicate eggs and larvae. The effect of turbulence on larval mortality was studied in the field by Jessopp (2007), who found that even turbulent tidal flows produce significantly increased mortality to thin-shelled veligers of gastropods and bivalves. While there is presently no known published evidence of mortality to marine species for diffuser jets, the cause and effect relations demonstrated by prior studies certainly raises that possibility. Threshold shear stress tolerances of marine organisms to diffuser discharges could be established by combining data from laboratory tests, computational fluid dynamics modeling, and field studies of diffuser systems.

7. CONCEPTUAL FRAMEWORK FOR REGULATION AND MONITORING

The Panel developed a revised regulatory framework that accommodates the varying concentrate types and discharge scenarios. The current regulatory framework is appropriate for concentrate-containing discharges that are buoyant relative to the receiving water. However, the initial dilution of the discharge and mixing zone should be reevaluated and the permit conditions modified accordingly. The initial dilution and dispersion of discharges that are negatively buoyant should be assessed using models appropriate for the discharge and receiving environment. A monitoring program consisting of both laboratory and field measurements is needed to confirm model-based predictions regarding plume dilution, fate, and effects.

7.1 Existing Regulatory Approach

Currently, there are no water quality objectives in the Ocean Plan that apply specifically to concentrate discharges from seawater desalination plants, wastewater reclamation plants, or groundwater desalting facilities. Operating seawater desalination plants discharge either directly to nearshore waters or blend the concentrate with higher volume seawater discharges. Regional Water Quality Control Boards have established permit requirements on a site-specific basis, and have applied variable effluent limits.

Concentrate discharges from wastewater and groundwater treatment facilities are not usually discharged directly into coastal waters, but rather are discharged into the influent stream of wastewater treatment systems or combined with treated wastewater effluent prior to discharge. In such cases, no special effluent limits are assigned to the concentrate discharge by the regulatory agencies; the final combined discharge must meet the water quality objectives for toxicity and chemical characteristics specified in the Ocean Plan at the boundary of the zone of initial dilution (ZID) or mixing zone. Examples of this situation are found in the NPDES permit for the Monterey Regional Water Pollution Control Agency, which receives concentrate from groundwater desalination and treatment systems, and also for the Oceanside Ocean Outfall NPDES permit, where groundwater desalination concentrate is comingled with treated wastewater effluent from several other facilities prior to ocean discharge. However, variations from the application of discharge limits have occurred. For example, concentrate from the South Coast Water District's groundwater recovery facility is currently required in their permit to meet certain Ocean Plan objectives prior to its blending with other effluents before discharge through the San Juan Creek Ocean Outfall.

7.2 Revised Regulatory Framework

New or revised permits involving concentrate discharge will need to consider a number of environmental factors that may influence the behavior and impacts of the plume. The first level determination that should be addressed is whether the discharge plume will be always positively buoyant, always negatively buoyant, or possibly positively or negatively buoyant under the range of operating conditions. The type of optimal discharge and the amount and extent of the initial dilution will depend on which situation applies. Regulations and precedent exist for the first case in which the plume is always positively buoyant. This report is focused on the second case in which the plume is always negatively buoyant. The third case in which the plume may be either positively or negatively buoyant depending on the particular operating parameters is, obviously, more complex. It is recommended that this case be evaluated and monitored for impact based on the requirements and expectations for both positively and negatively buoyant plumes.

The regulation of any new or modified discharge will follow one of the two main pathways diagrammed in Figure 7-1 as a function of its buoyancy relative to ambient receiving waters. In the case of plumes that remain positively buoyant even following the introduction of a brine component, the evaluation of the discharge will follow the existing regulatory framework for ocean discharges. The exception to this statement is the need for modified discharges to undertake a new determination of their zone of initial dilution based on the modified discharge parameters. This revision may require adjustments in the monitoring program specified by the initial permit. However, the engineering and environmental assessment guidelines for this case are covered by the existing regulatory framework.

In the case of a negatively buoyant plume, the regulation and monitoring of a new or revised discharge should follow the alternative pathway outlined in Figure 7-1 and discussed throughout this report. Both best-case engineering practices and the methods of environmental impact assessment will vary depending upon the location of the discharge - within an embayment or into the open ocean - and, in the open ocean scenario, depending upon the depth of the discharge. In all cases, the goal of the assessment is to understand both the initial and long-term fate of the concentrate discharged into the environment. The initial dilution and the expected footprint of the zone of initial dilution can be estimated using mixing models as described elsewhere in this report. Furthermore, the ultimate fate of the concentrate materials will depend on the background circulation, the local topography, and, possibly, flocculation effects. It is these processes that the revised regulatory framework recommended here is intended to address.

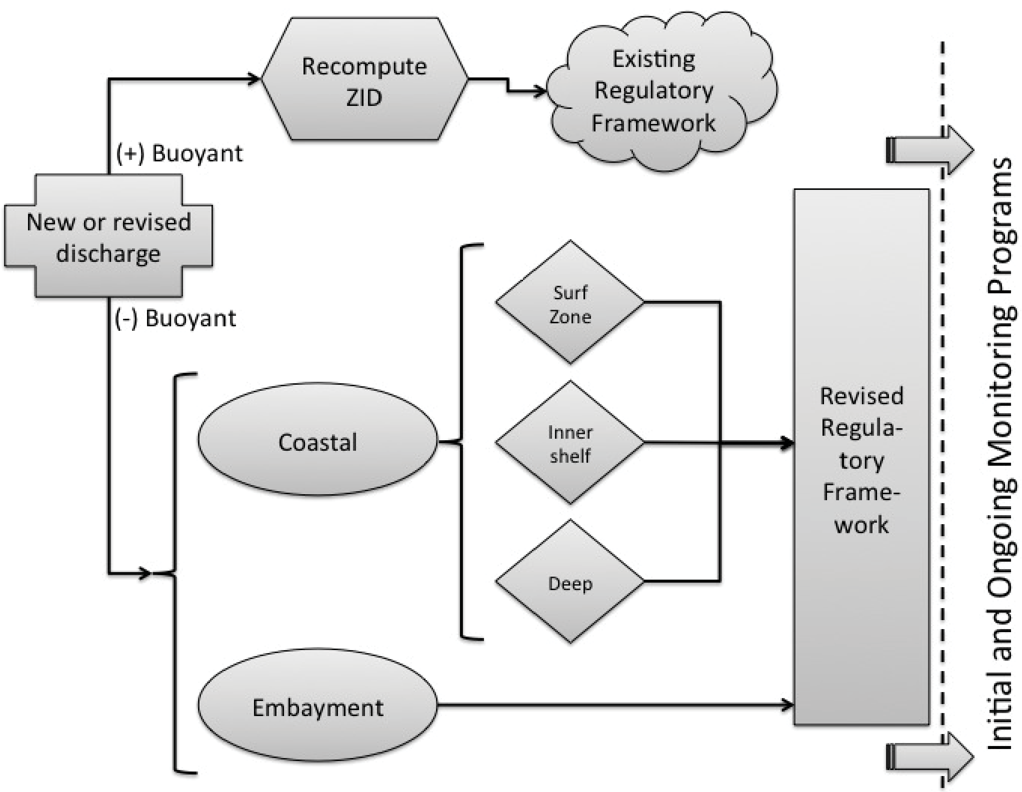

Figure 7-1. Proposed regulatory approach.

The revised regulatory framework should include three major elements (Figure 7-2). The first element consists of determining the near field characteristics of the discharge, which are used to evaluate the effectiveness of the discharge for minimizing ecological impacts. Plume models are applied to the discharge characteristics, the mixing characteristics of the site, and the proposed discharge technology to determine the initial dilution and verify that receiving water objectives will be met at the edge of the mixing zone.

The second element of the recommended framework is specification of the water quality conditions to be met at the mixing zone boundary (Figure 7-2). Establishment of these limits is expected to follow the existing regulatory guidelines. In addition, for dense discharges it will be necessary to establish effluent limits for additional constituents, e.g., salinity. A salinity objective of no more than a 5 % increase relative to background is recommended.

The final element of the regulatory framework consists of a monitoring program designed in consideration of the site-specific discharge scenario. The monitoring program should contain both laboratory and field components, be designed to have adequate statistical power, and include both biological and chemical parameters relevant to the discharge. The mixing zone is a defined region around the discharge that should be equal or larger than the near field (Figure 7-3). Monitoring locations should include locations within, at the edge of, and outside of the mixing zone.

The actual dimensions of the mixing zone will continuously vary as a function of discharge and environmental characteristics, and can be estimated using modeling approaches (see Section 8). For practical purposes and most discharge situations, a fixed mixing zone extending 100 m from the discharge point is suggested for compliance monitoring. Such a zone will encompass the near field of well-designed discharges. Dense plume discharges may require monitoring of the sediments inside the regulatory mixing zone over time to address potential build-up of hazardous chemicals in the vicinity of the discharge due to flocculation followed by rapid sedimentation. Other constituents may require monitoring far outside the regulatory mixing zone, such as dissolved oxygen (DO), in order to address long-term or cumulative effects.

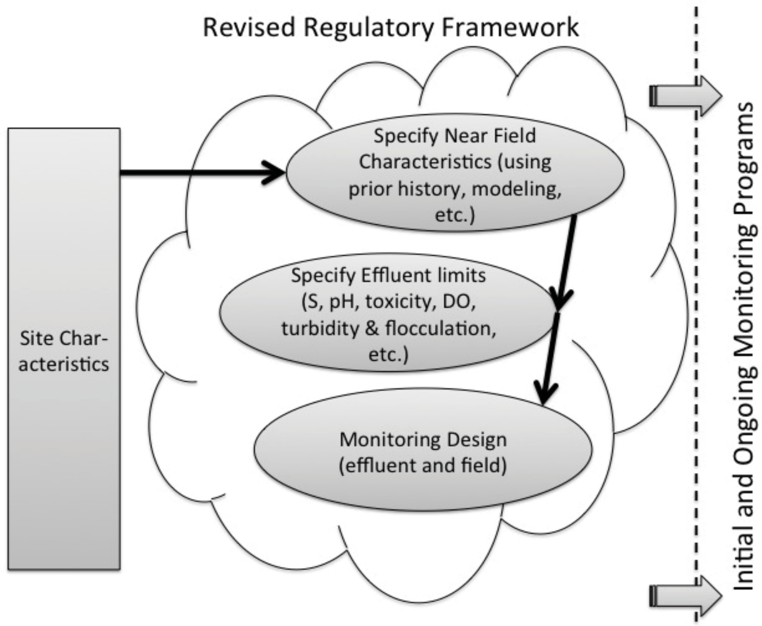

Figure 7-2. The three major elements of the expanded regulatory framework with respect to dense plumes.

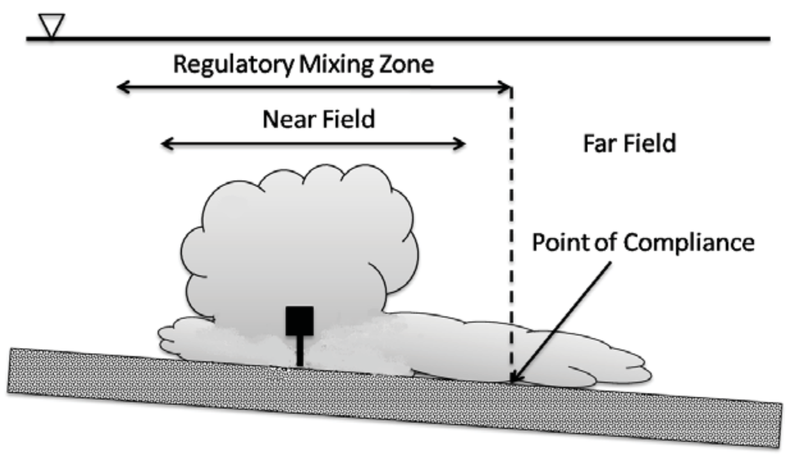

Figure 7-3. Relationship of regulatory boundaries to plume features.

7.3 The Various Discharge Site Scenarios

Depending upon the design of a given discharge, the concentrate may be released into very different oceanographic regimes and habitats (Section 5). The processes that drive the currents vary fundamentally across the different regimes, which means that models used and data required to predict or monitor the fate of the plume also vary widely. Any assessment or monitoring program should identify the dominant circulation processes associated with the discharge site scenario and choose appropriate models and data sources.

The contrasting situation of discharge into an embayment versus the open ocean is a clear first-cut distinction. Coastal open ocean discharges provide the best opportunity for plume dispersion and are preferable to embayments as sites for concentrate discharges. In most cases, discharge into an embayment is expected to restrict the long-term dispersion of the concentrate compared with a similar discharge into the open ocean. It will be critical to determine the residence time of water within the embayment, particularly for bottom water. Cases where bottom waters in an enclosed bay have little or no exchange with the ocean have long residence times (i.e., measured in weeks or months) and represent very poor choices for receiving water with respect to negatively buoyant plumes. Other cases exist, however, in which the residence time of bottom waters in an enclosed bay are very short (i.e., measured in hours or days). This can occur, for example, in enclosed bays with a strong tidal connection to the ocean. If the tidal prism is large relative to the volume of the bay then bay waters are mixed quite extensively with ocean water. If concentrate were discharged into the strong tidal flow, then its long-term dispersion would be relatively high.

7.4 Monitoring Concentrate Dispersion

Monitoring programs represent an important aspect of the recommended permitting process for negatively buoyant discharges. Modeling and background observations conducted prior to commissioning can and should be used to predict plume behavior but monitoring after commissioning is essential to validate those predictions. Monitoring should be used to confirm predictions about the near field. i.e., its size and near field dilutions. This includes physical properties and brine constituent concentrations. Monitoring should also be used to confirm predictions about far field effects, including potential hypoxia generation resulting from bottom trapped density layers as described in this section.

Monitoring should be short term and long term. Because the near field dilution modeling and the far field distribution modeling is complex and site specific, the initial monitoring should be much more comprehensive in both time and space. Critical diurnal variations, such as oceanographic tides, atmospheric sea breezes, and discharge cycling should be resolved during the initial monitoring phase. Similarly, spatial sampling grids must be dense enough within the near field to confirm predictions about the zone of initial dilution and they must extend far enough into the far field to validate predictions about the movement and breakdown of any bottom-trapped density layers. In addition, local two-dimensional bathymetry data must be incorporated into the sampling design so that all observations are placed into the proper context in terms of sloping versus flat bottoms and any local depressions.

The types of observations taken during the various monitoring phases will also be site dependent. Various chemical constituents known to exist in the initial concentrate at levels exceeding environmental standards must be shown to have been reduced to acceptable levels at the edge of the regulatory mixing zone. In terms of far field effects, sampling with commonly available conductivity, temperature, and depth plus dissolved oxygen (CTD+O2) sensor suites, as was illustrated in the study of Hodges et al. (2011), is a good alternative. In addition to the relationship of the sampling grid to the local topography, it will be essential to collect observations that extend very close (i.e., within centimeters) of the sea bottom to identify and track potential thin layers along the bottom.

8. DISCHARGE MODELING AND ASSESSMENT

The Panel reviewed the key issues involved with modeling the dilution and fate of negatively buoyant discharges. Different modeling approaches are needed to assess plume fate at the three scales of importance to receiving water impacts: near field, far field, and overall flushing. Near field modeling may involve physical or numeric approaches. For numeric modeling, the use of entrainment models is recommended. Several entrainment models are available for use with dense plumes. Different models and more extensive data are needed to assess far field plume fate. Both near field and far field model results must be coupled to predict overall plume behavior. The use of mass-balance box models is recommended for assessing the long-term buildup of contaminants in the vicinity of the discharge.

8.1 General Considerations

The fate and transport of concentrate discharged into the ocean depend on processes that operate over a very wide range of length and time scales. Shortly after discharge, turbulent entrainment dominates, the plumes may then impact the sea bed if negatively buoyant, or rise and be trapped by ambient stratification or impact the water surface if positively buoyant. After reaching their terminal levels, the flows becomes primarily horizontal, may undergo an internal hydraulic jump, and entrain further seawater, but eventually the turbulence collapses under its own induced density stratification. All these processes are commonly referred to as near field processes, i.e. determined by the discharge itself under parameters under the control of the outfall designer. Beyond the near field, the plume drifts with the ocean currents and is diffused by oceanic turbulence; this region is referred to as the far field. The rate of mixing in the near field is generally much greater than in the far field. In addition, there may be a region of lateral spreading as dynamical density current. This is sometimes referred to as a mid-field.

Near field processes typically operate on time scales of minutes and over length scales of tens of meters. Far field processes operate under time scales of hours to days and length scales of tens of meters to kilometers. Finally, large scale ocean currents and other processes such as upwelling determine the long-time flushing of contaminants and build-up of background levels over time scales of weeks to months.

Mixing in the near field is very rapid and high dilutions are readily obtained that rapidly reduce contaminant levels. Because of this, regulatory agencies allow a small mixing zone and water quality regulations are met at the mixing zone boundaries. The distinctions between near and far field and mixing zones are discussed in more detail in Appendix D.

The modeling challenges are to predict water quality at the mixing zone boundaries to ensure that water quality regulations are met and to assess the longer term fate of the effluent. Because of the very wide range of length scales involved it is generally not feasible to capture all of them in one model. Instead, separate models are employed for each phase and the models are coupled. In this section, we discuss some of the essential issues involved in modeling. First we discuss near field models, then far field models, and finally a simple box model to assess overall flushing. For a more detailed discussion, see Appendix F.

8.2 Discharge Configurations

Depending on the discharge area characteristics and the dilution needed for regulatory compliance, various concentrate disposal modes are possible, including co-discharge with power plant cooling water or municipal wastewater, and direct discharge. Depending on the flows and densities, effluents from co-disposal may be positively or negatively buoyant. Here we mainly consider negatively buoyant discharges, as modeling positively buoyant discharges are covered extensively in other publications and are accommodated by the current Ocean Plan.

Shoreline surface discharges of negatively buoyant effluent (Figure 6-1a) will result in a density current that runs down the bottom slope. Because the resulting density stratification inhibits vertical mixing, dilution is relatively small and benthic organisms will be exposed to relatively high salinities. This mode of disposal is therefore not recommended and shoreline disposal of pure brine by this means in California seems unlikely.

Shoreline surface discharges are sometimes employed with co-disposal of power plant cooling water. In that case, the mixed effluent is probably positively buoyant and forms a surface jet (Figure 6-1b). Near field mixing is also quite slow for this case.

In the absence of a co-located facility, offshore submerged diffuser systems are used to maximize brine dilution, Figure 6-1c.

8.3 Characteristics of Negatively Buoyant Diffuser Discharges

In order to effect high dilution of negatively buoyant effluent it will be necessary to discharge it as high velocity jets through a diffuser (Figure 6-2). These diffuser systems effect rapid mixing and dilution by entrainment into the jet. Because the jet is dense, it falls back to the seabed where it then spreads as a density current. The highest seabed salinity occurs where the centerline of the jet impacts the seabed. Additional dilution occurs beyond this point before the flow collapses under the influence of the induced density stratification. The point where this collapse occurs is the end of the near field, and the dilution at this point is the near field dilution. The processes in the near field operate over small scales: distances of order tens of meters and times of order minutes.

Figure 6-2 shows details of the different flow regions: the ascending jet phase, terminal rise height, descending jet phase, seabed impaction and transition to horizontal flow, mixing in the density current, and finally into the far field. For multiport diffusers, such as the one shown in Figure 6-3, merging of the individual jets and the concomitant reduction in dilution must also be considered. The degree of dilution depends on the exit velocity and jet diameter, the effluent and receiving water densities, and ambient currents. It can be estimated in stagnant environments by semi-empirical equations as discussed below.

The far field is located farther away from the discharge point, where the brine becomes a gravity current that flows down the seabed slope or horizontally in the case of a flat seabed. Mixing depends primarily on ambient (oceanic) turbulence and is affected by currents, breaking waves, etc. The difference in density between the spreading layer and receiving waters results in a density stratification that reduces vertical mixing. Because of these effects, the rate of mixing is much slower than in the near field. Flow and mixing characteristics are dominated by larger scales: distances of order hundreds of meters to kilometers, and times of order hours.

8.4 Near Field Modeling

Introduction

Modeling positively buoyant discharges from submerged diffusers has been discussed in many publications, for example, Roberts et al. (2011) and Davis (1999). The near fields are usually simulated by entrainment-type models. Examples of models that are widely used include CORMIX (CorJet) module, UM3 module of Visual Plumes, VisJet, and NRFIELD. Shoreline surface buoyant discharges are also often modeled by entrainment models. Well known models include Cormix2 and PDS, a component of Visual Plumes. For a review of surface buoyant jet modeling, see Jirka (2007ab) and Davis (1999). Because positively buoyant discharges are extensively covered in the above publications and elsewhere, we do not consider them further here.

There are three main techniques for predicting the near fields of negatively buoyant concentrate discharges: 1) Physical modeling using scaled laboratory models, 2) Semi-empirical equations, and 3) Numerical modeling.

If mathematical models are used it is recommended that entrainment-type models are used. They should be verified, however, as the jets do not always correspond to the symmetrical Gaussian distributions assumed in these models nor do they account for Coanda effects that result in reduced entrainment and dilution as discussed further in Appendix F.

Physical Modeling

Physical modeling consists of laboratory experiments using scale models that simulate the particular case being tested at a smaller scale. Tests can be carried out on any effluent, discharge configuration, and ambient conditions. For discussions of physical modeling, see Ettema et al. (2000) and Appendix F.

Physical modeling is particularly useful where mathematical models are not verified or uncertain, such as merging multiple jets, discharges from multiport rosettes (for example, Figure 6-3), or the effects of ambient currents. Their disadvantages are that they may be relatively expensive and it is less easy to simulate a wide variety of alternatives. Examples of physical modeling of concentrate diffusers are given in Miller and Tarrade (2010), Tarrade et al. (2010), and Miller (2011).

Semi-Empirical Equations

Semi-empirical equations (see Appendix F, Section 3.2) have been obtained from experimental studies of dense jets with the common design of a 60° orientation that are widely used for diffuser design with single (or non-merging) jets. These equations have been widely used in brine diffuser designs and validated in various field studies.

Numerical modeling

Numerical (computer) modeling is now often employed for near field predictions. They are used particularly for complex cases, such as merging jets, effects of currents, or effects of bottom slopes.

Near field predictions are usually made by entrainment models or computational fluid dynamics models (CFD). However, as will be discussed, present numerical models cannot accurately simulate all flow features, especially the effects of currents and jet merging.

Entrainment Models

Entrainment models are the most common tool for engineering analyses of jet and plume-type flows such as brine discharges. The concept is illustrated in Figure F-2. The rising plume entrains external fluid that then mixes with and dilutes the plume fluid. The entrainment hypothesis is that fluid is entrained into the plume at a rate proportional to the local centerline velocity. Because the conservation equations are integrated over the jet cross-sections, entrainment models are also known as integral models.

Although entrainment models can be used for predicting dense jets, they are subject to a number of limitations. Experiments in stationary and flowing currents reveal complex flows in which different phenomena can occur and predominate at different locations in the same jet and at different current speeds. These include shear-induced entrainment modified by a crossflow, buoyancy effects, a sharp radius of curvature near the top, bottom impingement, turbulence collapse, gravitational spreading, and bifurcation, among others. Tracer cross sections do not show axial or self-symmetry, either within the same flow at one current speed, or between flows at different current speeds. Fluid can detrain from the plume. These factors probably lead to the common refrain that entrainment models can predict trajectories (with suitable choice of entrainment coefficients), but significantly underestimate dilutions.

Merging jets from multiport diffusers result in further complications. In particular, the jets entrain, or attract, each other, sometimes called the Coanda effect. If the jets are too close together, the supply of entraining water is restricted resulting in reduced dilution. In general, entrainment models cannot predict the Coanda effect, which reduces jet rise height and dilution. For these cases, physical modeling will be more reliable.

Some common models that have been are widely used for predicting jet and plume-type flows, including dense brine discharges are Cormix, Visual Plumes (UM3), and VisJet. For a recent extensive discussion and comparison of these models for simulating dense jets in stationary environments, see Palomar et al. (2012ab).

Computational fluid dynamics models

Computational fluid dynamics (CFD) modeling is being increasingly applied to a wide variety of turbulent flows in nature and engineering. In CFD computations, the equations of continuity and momentum are solved numerically with some turbulence closure assumptions. There are several major CFD techniques; for a review, see Sotiropoulos (2005) and further discussion in Appendix F.

There have not been many applications of CFD to jet and plume-type flows such as dense jets. This is because of the geometrical complexity of realistic multiport diffusers, the large difference between port sizes and the characteristic length scales of the receiving waters, buoyancy effects, plume merging, flowing current effects, and surface and bottom interactions. CFD models of brine discharges have been reported by Muller et al (2011) and Seil and Zhang (2010).

Although promising, the complexity of CFD models and the effort required to set them up and run and long computation times suggests that entrainment models will continue to be used for many years.

8.5 Far Field Modeling

Far field hydrodynamic models are being increasingly used to predict the fate and transport of coastal discharges in the far field. Most models have been two-dimensional (depth-averaged) and this may be adequate for fairly shallow (unstratified) waters. But in deeper waters, three-dimensional models are needed. The models should be combined with field studies to ensure reliable results.

In contrast to near field models, far field hydrodynamic models require extensive data. Boundary conditions in open coastal waters must be specified, requiring detailed information on the variations of currents and water level, stratification, and other parameters and their temporal variations. Due to computational restrictions, it is usually not practical to model an area large enough that the area of interest is independent of these boundary conditions. Therefore, a common approach is to model a large area with a coarse grid and to embed a finer-scale model within it. The grid size of the smaller model is small enough to resolve scales of interest to outfall dispersion. The fine-grid model derives its boundary conditions from the larger model and is said to be nested within it. Frequently used models include Delft3D from Deltares, Mike3 from DHI, ROMS, Elcom, and many others.

8.6 Model Coupling

The separate near and far field models must be coupled to predict overall plume behavior. The problem is illustrated in Figure 8-1.

Entrainment induces a current whose magnitude is typically a few cm/s and decreases with distance from the diffuser. Therefore, typical outfalls do not significantly affect coastal circulation patterns (this may not be true for large cooling water discharges from power plants). The coupling is therefore usually considered to be one way, i.e. local currents affect the discharge, but not vice versa.

The main question is how and where to introduce the effluent flow and its pollutant mass into the far field model. This can be accomplished (see Appendix F) by making the contaminant fluxes computed at the end of the near field be mass input fluxes to the appropriate grid cells of the far field model. The height of the input cells may vary with varying current speeds; for a dense discharge they will be the cells closest to the seabed.

Suitable coupling between the near and far field models is essential for reliable prediction of impacts. If near field dilution is not accounted for, predicted far field dilutions will be much too low, leading to considerable overestimates of environmental impacts. The concern that biologically thin density layers may persist along the bottom for time periods long enough to create hypoxic conditions represents a unique aspect of the dense plume problem that could be addressed in this way given accurate stratification data near the bottom and accurate bathymetry.

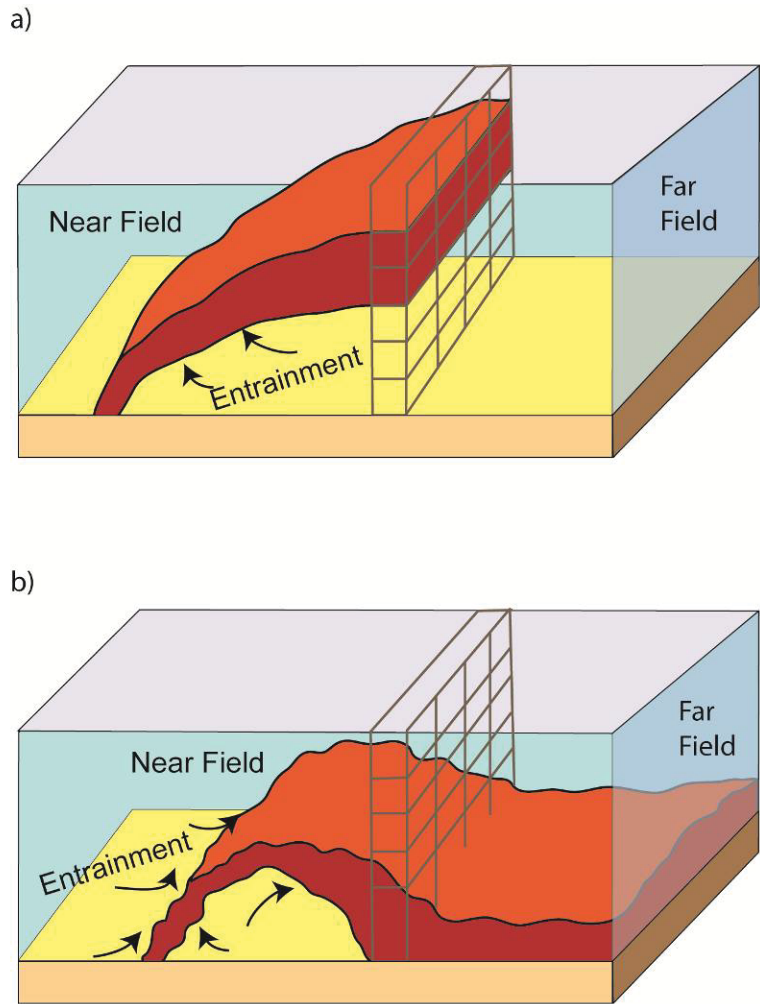

Figure 8-1 Model coupling (after Bleninger 2006). a: positively buoyant discharge, b: negatively buoyant discharge.

8.7 Box Models

Mass-balance box models (Figure 8-2) are a useful, but simple, way to assess the long-term buildup of contaminants in the vicinity of the discharge, or coastal "flushing" which occurs on long time scales. The "background" mean concentration field in the vicinity of the diffuser is governed primarily by flushing due to the mean drift, horizontal diffusion (and, for non-conservative substances, chemical and biological decay). It can reduce the near field dilution due to re-entrainment of previously discharged effluent and should be accounted for in near field dilution predictions.

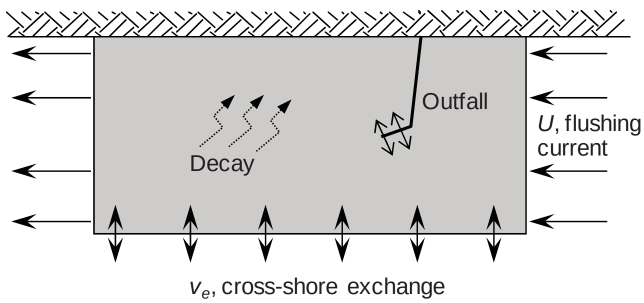

Figure 8-2 Box model for estimating long-term buildup of contaminants (after Csanady 1983).

Tidal currents distribute the effluent over an area, or "box" whose dimensions are approximately equal to the tidal amplitude. Long-term average current speeds are usually much slower than instantaneous values. Long-term average dilutions due to mean flushing currents, cross-shelf diffusion (and decay processes for non-conservative constituents) can be obtained by mass conservation using equations suggested in Appendix F. These methods give only approximate order of magnitude calculations, but they are very useful for screening and estimating long-term impacts. They can be applied to other substances such as toxic materials to estimate their potential for accumulation.

9. DISCHARGE MONITORING STRATEGIES

Concentrate discharge sites can vary in terms of physical structure, hydrology, and biological communities Consequently, any monitoring strategy should be site-specific and a "one-size-fits-all" approach will not be effective. A monitoring strategy should be based upon what the State of California wishes to protect and its policies, and should be revisited in 3-5 year increments. Monitoring of physical and chemical parameters of the influent, effluent and receiving water are required. Methods should be conducted with standard Quality Assurance/Quality Control guidelines as required under typical NPDES permitting guidelines. Monitoring should include laboratory analyses of influent and effluent as well as field components for effluent and receiving water.

9.1 Influent

Incoming water to the desalination facility should be monitored as in any other treatment facility, for the purposes of informing plant operation and maintenance decisions. Constituents would include pH, total residual chlorine, salinity, temperature, ammonia-nitrogen, suspended solids, and priority metals and other contaminants of local concern. Measures of harmful algae may also be needed if blooms are apparent at the time of sampling.

9.2 Effluent

Periodic chemical and toxicological effluent testing should be done in accordance with NPDES testing parameters, with site-specific caveats mentioned below (i.e. site-specific species etc.). In addition to standard toxicity endpoints of embryonic development, survival and growth, reproduction endpoints (particularly in vertebrates) should be added if discharge occurs within embayments where extensive dilution does not occur.

WET testing is currently used to evaluate biological impacts of discharges for NPDES permitting. This approach has provided consistency as well as standardization, and the use of biological testing provides a means to evaluate the impact of chemical and physical mixtures at the site of discharge. However, the species that are used in WET are in some cases not relevant to the sites and primarily depend upon short-term effects on survival, and in some cases growth. Consequently, care should be given with regard to species and endpoint selection. We strongly recommend the inclusion of sublethal endpoints, especially reproduction. Reproduction should be evaluated especially if the concentrate is derived from wastewater recycling, which would likely contain concentrated micropollutants and constituents of emerging concern that have undergone disinfection (typically with chlorine) and treatment with descalants. Site specific thresholds for biologic effects need to be determined for each concentrate and each discharge site. Until the impacts of these constituents and degradates have been clearly shown to not impair biota, monitoring should be employed.

From a constituent perspective, the panel has already discussed the unique aspects of concentrates with regard to potential hazardous compounds (i.e. metals, excess solutes). It is probably not necessary to include the standard list of "priority pollutants" that are normally evaluated unless the concentrate is blended with WWTP discharge or discharge in which those constituents occur. Contaminants of emerging concern should only be evaluated if concentrate from municipal wastewater or contaminated groundwater is discharged. Chlorine residuals, ammonia-nitrogen, antiscalants and other chemicals used in the reverse osmosis process should also be measured (if methods for chemical analysis exist). The same characteristics monitored for influent: pH, salinity, temperature, and suspended solids should also be included on a standard list for monitoring. The effluent should also be measured for all constituents for which effluent limits are established in the permit.

WET tests should emphasize benthic species and/or species most relevant to the site. At any of these site scenarios, the benthic habitat is of primary concern for effluents that are denser than seawater and sink to the bottom. Benthic habitats may be soft bottomed (sand or mud) or may be a hard substrate. Each substrate has unique biota that may be affected. Laboratory tests should focus on those unique species. For example, an abalone test would likely be a better species if the discharge was expected to contact hard substrate and a sand dollar test would be appropriate for sand/mud. Since field studies have indicated algal impacts at 1-2 ppt salinity increases, testing a site-specific algal species is also recommended.

9.3 Receiving Water

An important conclusion of the review by Roberts et al. (2010a) is that many published ecological monitoring programs do not appear to be scientifically defensible assessments of the impacts of concentrates. Thus, there is a general lack of empirical evidence supporting conclusions on effects of desalination concentrates in receiving systems, a fact that is recognized in almost all regions that operate large plants. Much of the research into the environmental effects of desalination plants is in the grey literature (i.e. unpublished technical reports produced by consultants and government bodies).

We recommend receiving water monitoring programs include two major design elements:

- Use of field experimentation, such as settling plates, to examine the effects of desalination concentrates under field conditions.
- Before-After Control-Impact (BACI) monitoring design that includes multiple reference locations, samples at various distances from the discharge, and repeated sampling before and after plant operation.

For California, an ecosystem monitoring program should be set up to assess potential impacts of any proposed project that would discharge concentrate. Monitoring of physical factors in the water such as salinity, pH, DO, turbidity, and high resolution near field bathymetry should be conducted concurrently with biological monitoring. Similar monitoring data has been used by Perth Australia to manage operations of the Cockburn desalination plant in order to reduce risk of hypoxia.

Limited sediment chemistry monitoring should be conducted to assess flocculation and deposition of effluent chemical components, especially with negatively buoyant plumes. Measurements in the near field are needed to assess whether effluent limits are sufficient to prevent accumulation of harmful constituents. Particular concern should be taken when concentrate is combined with effluent from sewage treatment plants, since they may contain toxic materials (e.g. metals, industrial contaminants, pharmaceuticals). These can accumulate in benthic animals, which could be a route of trophic transfer to fishes and other larger organisms. In addition, sewage treatment plants often chlorinate their effluent, and the chlorine may combine with organic materials to produce trihalomethanes and other organochlorine compounds that are toxic, bioaccumulative, and persistent. The high salinity of the concentrate may cause flocculation, and promote the movement of the toxicants towards the bottom, where they accumulate in biota. Under these circumstances it would be important to monitor the potential accumulation of these toxicants in the benthic biota.

In hard bottom environments, environmental monitoring should include the use of settling plates. These plates can give an early indication of possible effects on the recruitment of sessile organisms long before changes can be detected in the resident assemblage. The plates are placed in the water for a period of time and then removed for quantification of the abundance of the various species that have settled on them. Settling plates should be deployed at various seasons of the year, since different species have different reproductive seasons. It is most useful to deploy settling plates initially before construction of the plant, to determine which species normally settle during different times of the year. This baseline data can later be compared with results after operation of the plant has begun.

For both hard and soft bottoms, the resident benthic community should be assessed at sites along transects radiating out in different directions from the discharge. The same sites should be used for the physical/chemical measurements. The sites chosen for sampling along the transects should include both near field and far field sites. Standard techniques for community analysis should be used to quantify the abundance of various species and species richness, and to calculate a diversity index (e.g. Shannon-Wiener) from replicate samples. These data can be analyzed by parametric and multivariate statistics to gain greater insights. On hard substrates, the percent cover is another metric of interest.

The data should be used to calculate an index of biological condition. There are many such indices developed for different ecosystems and regions, and several are available for use in California. Benthic indices evaluate the ecological condition of a sample by calculating scores based on various community attributes (metrics) and comparing them to reference values expected under non-degraded conditions in similar habitats. The expected values may be different during different seasons of the year. Multiple types of metrics may be used in benthic indices, including: abundance, species diversity (richness), diversity index, and abundance/biomass of pollution-tolerant or pollution sensitive taxa. Other metrics that may be used in soft bottom environments include percent abundance of carnivores and omnivores, percent abundance of deep-deposit feeders, percent biomass and percent number of taxa found >5cm below the sediment-water interface. Benthic indices synthesize this complexity into an overall score that can be used to evaluate the overall ecological condition of a site.

All of these analyses require scientists who can identify the various organisms resident in the soft and hard bottom environments subject to the effluent. It is important that multiple reference sites be identified that are similar in nature (same benthic fauna) to the site of the future discharge..

The frequency of field monitoring is an important design element. Site-specific factors such as the size of the discharge, potential for impacts, and uncertainty in data used to derive effluent limits should be considered. For example, the Huntington Beach desalination plant permit specifies that the field monitoring frequency shall be quarterly for the 1st and 5th year of the permit and semiannually during the 2nd, 3rd and fourth year of the permit.

For monitoring to be most useful, the benthic community should be characterized and monitored at multiple phases of plant development: 1) before construction of the plant, 2) after construction but before the plant is discharging concentrate, and 3) after the plant is in operation. This will establish the baseline conditions, demonstrate before/after effects, and separate out effects of plant construction from effects of the discharge itself. Knowledge of baseline conditions will also provide guidance for the selection of appropriate reference sites for ongoing monitoring.

A power analysis study should be performed to assess the statistical power of the monitoring (e.g. how much of a change in abundance or species richness would be needed in order for the data to be statistically significant, given the natural variation found in the benthic environment). Development of the monitoring program for the Sydney Australia desalination project provides an example of this process. The process used for developing monitoring programs in Australia should be considered as a template for the design of brine discharge monitoring programs in California.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1 Environmental Impacts of Discharges

- Based on existing information, a salinity increase of no more than 2 to 3 ppt in the receiving waters around the discharge appears to be protective of marine biota.
- When concentrate is blended with municipal wastewater, chemical/physical interactions of the concentrate with municipal wastewater constituents may produce toxic effects that cannot be detected using traditional WET test methods.
- A monitoring program of both the effluent and the receiving environment should be required for all discharges having potential for environmental impacts. Laboratory toxicity testing of effluent using local species and sublethal endpoints should be included. Field monitoring should include analysis of benthic community condition and employ a study design having adequate statistical power to detect changes of concern.

10.2 Discharge Strategies

- Different discharge strategies can be used, depending on site-specific considerations. There is no single discharge strategy that is optimum for all types of anticipated scenarios.
- Multiport diffusers provide the highest dilution of dense discharges. This technology is preferred when developing a new discharge containing only brine.
- Discharge sites with high ambient mixing and advection are preferable.
- Discharge sites with nearby bathymetric depressions or barriers should be avoided with negatively buoyant discharges.
- Blending or co-location with existing discharges can be effective in achieving high dilution of the discharge.
- Use of augmented seawater intake to achieve high dilution can be effective, but may result in adverse impacts due to impingement or entrainment. Clarification of whether this discharge strategy is permissible is needed in the revised regulatory framework.

10.3 Regulatory Approach

- For a blended concentrate discharge that results in a positively buoyant plume, the current process for establishing effluent limits and monitoring (i.e. the regulatory framework) is adequate.
- For negatively buoyant plumes, such as those arising from dedicated seawater desalination brine discharges, a revised regulatory framework is needed. This framework should include a revised definition of the regulatory mixing zone and a field monitoring component.
- The regulatory mixing zone should include the near field.

- Water quality objectives must be met at the edge of a regulatory mixing zone that extends vertically through the water column up to 100 m from the discharge structure in all directions.
- In addition to toxicity and other limits contained in the Ocean Plan, excess salinity at the mixing zone boundary should not exceed 5% (or an absolute increment of no more than 2 psu, whichever is less) of that occurring naturally in the receiving waters. This reduction can be achieved through a combination of in-pipe dilution and near field hydrodynamic mixing that results in an overall dilution not less than 20:1.

10.4 Discharge Modeling and Dilution Calculation

- Deterministic process-based models should be used for describing near field plume dynamics. The models must be calibrated and verified.
- Near field dilution calculations should be made using either tested semi-empirical equations available in the literature or by integral mathematical models based on entrainment assumptions. Physical modeling may be needed for complex diffuser geometries.
- In computing near field dilutions of dense discharges, conservative assumptions must be made: that ocean currents do not increase dilution, and the seabed is horizontal. The possible reduction of near field dilution due to reentrainment caused by limited overall flushing must also be accounted for.
- Discharges near areas of special biological significance should be avoided.

10.5 Data Gaps and Research Needs

- Additional research is needed on the sublethal and chronic effects of elevated salinity to sensitive life stages and locally relevant species. Emphasis should be given to effects on benthic species likely to be exposed from negatively buoyant plumes.
- Insufficient toxicology data are available to evaluate the potential ecological risk of RO chemical additives and interactions between brine and municipal wastewater constituents. Especially lacking are studies of reproductive and behavioral effects that evaluate the final effluent mixture discharged to the environment.
- Studies are needed to investigate the impacts of turbulence from high velocity diffusers on plankton. Threshold tolerances of marine organisms to free-stream turbulent shear could be established by combining data from laboratory tests, computational fluid dynamics modeling, and field studies of diffuser systems using methods previously applied to hydro-electric turbines.

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APPENDIX A. WATER QUALITY REGULATION IN CALIFORNIA

Applicable State and Federal Water Quality Law

In 1972, Congress enacted the federal Clean Water Act (CWA) to restore and maintain the chemical, physical, and biological integrity of the Nation's waters[1]. Under the CWA, the states are primarily responsible for the adoption and periodic review of water quality standards for all waters within their boundaries.

The California Porter-Cologne Water Quality Control Act[2] (Porter-Cologne) of 1969 is the primary water quality law in California. The State Legislature, in adopting Porter-Cologne, directed that California's waters "shall be regulated to attain the highest water quality which is reasonable". Porter-Cologne addresses two primary functions: water quality control planning and waste discharge regulation. Porter-Cologne is administered regionally, within a framework of statewide coordination and policy.

Porter-Cologne authorizes the State Water Resources Control Board (State Water Board) to adopt statewide water quality control plans and directs each of the nine Regional Water Quality Control Boards (Regional Water Boards) to adopt water quality control plans that provide the basis for protecting water quality in each Region[3]. When the State Water Board adopts a water quality control plan, the state plan supersedes regional plans for the same waters, to the extent of any conflict[4]. All water quality control plans must list "beneficial uses" of waters which need to be protected; establish "water quality objectives" necessary to achieve protection for those beneficial uses; identify areas where discharges are prohibited, and set forth a program of implementation to ensure that water quality objectives are met. The program of implementation describes the actions necessary to achieve objectives, includes a time schedule for these actions to be taken, and describes the monitoring to be performed to determine compliance with the objectives[5].

Both statewide and regional plans are subject to review every three years, which may lead to periodic updates[6]. Triennial reviews are comprehensive and include a public hearing to identify issues to be addressed. The State or Regional Water Board evaluates all available information at the hearing to determine whether revisions to the plans are needed and the nature of any necessary revisions.

Amendments to a statewide or regional plan are initiated by the appropriate Water Board, and follow state and federal requirements for public participation and for environmental and economic consideration. Regulatory provisions of amendments must further be approved by the State Office of Administrative Law (OAL). Any amendments to surface water quality standards must also be approved by the U.S. Environmental Protection Agency (USEPA) in order to be effective.

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[1] See 33 United States Code (U.S.C.) §1251 et seq.
[2] See Wat. Code, §13000 et seq.
[3] See Wat. Code, §13240.
[4] See Wat.Code § 13170.
[5] See Wat.Code § 13242.
[6] See CWA §303(c)(1).

Under Porter-Cologne, the Water Boards regulate waste discharges that could affect water quality through waste discharge requirements, waivers or prohibitions[7]. In addition, the Water Boards are authorized to issue federal National Pollution Discharge Elimination System (NPDES) permits to point source dischargers of pollutants to navigable waters. Issued NPDES permits must implement all applicable state and federal standards, whether numeric or narrative. Permits contain technology-based effluent limitations (reflecting the pollution reduction that is achievable through technology) and any more stringent limitations necessary to meet water quality standards. NPDES permits are usually renewed (and expire) on a five-year schedule. Regional Water Boards are generally responsible for issuing the NPDES permits, which include self-monitoring and reporting programs. Consideration of the terms and conditions of NPDES permit requirements must occur at a public hearing. Regional Water Board staff also conducts periodic inspections of each permitted discharge to monitor permit compliance.

The California Ocean Plan

Porter-Cologne specifically requires the State Water Board to formulate and adopt the California Ocean Plan[8] to protect the State's ocean waters. The Ocean Plan designates ocean waters for a variety of beneficial uses, including rare and endangered species, marine habitat, fish spawning and migration and other uses (including industrial water supply), and establishes water quality objectives to protect those beneficial uses. The Ocean Plan provides the basis for regulation of wastes discharged into California's coastal waters. The State Water Board, in conjunction with the six coastal Regional Water Boards, implements and interprets the Ocean Plan. Coastal Regional Water Boards consist of the North Coast, San Francisco Bay, Central Coast, Los Angeles, Santa Ana and San Diego Regions.

The State Water Board first adopted the Ocean Plan in 1972, and has since periodically revised the Plan. The Ocean Plan was last updated in 2009[9].

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[7] See Wat. Code, §§13263, 13377.

8 See Wat. Code, §13160 et seq.

[9] See http://www.waterboards.ca.gov/water_issues/programs/ocean/docs/2009_cop_adoptedeffective_usepa.pdf

APPENDIX B. PANEL MEMBER BACKGROUND

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Scott A. Jenkins received his B.S. in Chemistry and Physics from Yale University in 1972 and his Ph.D. in Physical Oceanography from Scripps Institution of Oceanography in 1980. He has been a researcher in nearshore physical oceanography and coastal engineering for 30 years, with experience in field measurements, experimental design, and theoretical modeling. He has worked on a broad range of problems related to coastal processes, including: estuarine and littoral transport; beach and shoreline erosion; scour and burial of structures on the seafloor; hydrodynamic and hydraulic modeling of estuarine and nearshore circulation involving point and non-point source pollution; wastewater and thermal effluent discharges from engineered outfalls; and brine discharged from co-located desalination plants.

Dr. Jenkins has performed hydrodynamic modeling for desalination projects by the cities of Carlsbad, Huntington Beach, Long Beach, and Santa Cruz, CA; the Los Angeles Department of Water and Power; the West Basin Municipal Water District; and the San Diego County Water Authority. Dr. Jenkins is an author of over 60 scientific papers on coastal processes, numerical hydrodynamic modeling, sediment transport, sedimentation control, and underwater glider technologies. He has given scientific presentations on brine dilution and source water modeling before the National Research Council and their Committee on Advancing Desalination Technology and before the Workshop on Environmental Issues with Desalination in California hosted by the University of California at Santa Cruz. He has also been an invited speaker at a number of national conferences on desalination, including those hosted by the Multi-State Salinity Coalition, the American Membrane Technology Association, the South Central Membrane Association, and the Association of California Water Agencies.

Dr. Jenkins holds four United States patents for coastal flow control devices. He received the 1985 Inventor of the Year Award from the Patent Law Association and was co-recipient of the 1988 Best Special Project Award from the American Council of Consulting Engineers. He was recently inducted into the Who's Who in America 64th and 65th editions (2010, 2111).

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Jeffrey D. Paduan received his B.S. in Engineering from the University of Michigan in 1982 and his Ph.D. in physical oceanography from Oregon State University in 1987. His background involves study of upper ocean currents and air-sea interaction. As a research scientist at Scripps Institution of Oceanography, his investigations focused on larger-scale current structures as measured by satellite-tracked surface drifters. In 1991, he joined the faculty of the Department of Oceanography at the Naval Postgraduate School (NPS) where his research has focused on the application of high frequency (HF) radar systems in coastal oceanography. In 1997, he co-edited a special issue of the Oceanography Society's journal (Oceanography, Vol. 10, #2) devoted to this topic. In 1999, as keynote speaker, Dr. Paduan presented an overview of this research area at the IEEE 6th Working Conference on Current Measurement Technology. In 2001, he co-founded the International Radiowave Oceanography Workshop (ROW; http://radiowaveoceanogrphy.org), which continues to be an important focal point for this growing branch of marine science.

Dr. Paduan has been principal investigator for a series of projects around Monterey Bay that have brought together observations, modeling, and data assimilation of circulation and ecosystem responses; these projects include: the ICON project, which was a Monterey Bay area component of the National Ocean Partnership Program; the NOAA/COTS Center for Integrated Marine Technology program based at UC Santa Cruz (CIMT); and the state-funded Coastal Ocean Currents Monitoring Program (COCMP). He has also designed and conducted a series of environmental assessments to characterize the thermal plumes produced by the Moss Landing and Morro Bay power plants. In addition, Dr. Paduan has co-authored 49 publications and numerous technical reports related to the physics of the upper ocean.

Dr. Paduan is a member of the American Geophysical Union, the Oceanography Society, and the American Meteorological Society (AMS). He has served on the AMS committee for Meteorology and Oceanography of the Coastal Zone, on the steering committee for the Ocean.US community workshop on ocean observing systems, and as chair of the Ocean.US steering committee for the national Surface Current Mapping Initiative. Dr. Paduan has also served as President of the Monterey Bay Crescent Ocean Research Consortium, a member of the Monterey Bay National Marine Sanctuary's Integrated Monitoring Network science steering committee, and a member of the Science Advisory Team for California's Ocean Protection Council.

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Philip J.W. Roberts received his B.S. in Mechanical Engineering from Imperial College of Science and Technology University, London in 1968 and his Ph.D. in Environmental Engineering Science from California Institute of Technology in 1977. Dr. Roberts' research interests focus on environmental fluid mechanics, particularly in terms of application to the engineering design of water intakes and ocean outfalls for disposal of wastewaters and desalination brine, and density-stratified flows in lakes, estuaries, and coastal waters. His research includes investigation of mixing and dynamics of natural water bodies, mathematical modeling of water quality, field studies, and laboratory studies of turbulent mixing.

Dr. Roberts is an authority on the fluid mechanics of outfall diffuser mixing and the development and application of mathematical models of wastewater fate and transport. He is an author of 49 scientific articles and 7 books related to this subject. He has extensive international experience in marine wastewater disposal including the design of ocean outfalls, review of disposal schemes, numerical modeling, and the design and analysis of oceanographic field study programs. In addition, he has lectured widely on outfall design and is presently Co-Chairman of the IAHR/IWA Committee on Marine Outfall Systems.

Dr. Roberts' mathematical models and methods have been adopted by the U.S. EPA and are widely used around the world. He is a regular lecturer at workshops for the U.S. EPA on mixing zone analyses and on the use of mathematical models and outfall design for the Pan American Health Organization. He has developed innovative experimental techniques for research on diffuser mixing processes using three-dimensional laser-induced fluorescence and has published extensively in this area. For this research he was awarded the Collingwood Prize of ASCE in 1980 and was UPS Foundation Visiting Professor at Stanford University in 1993-94. Dr. Roberts is presently one of only two Distinguished Scholars in the National Ocean and Atmospheric Administration (NOAA) Oceans and Human Health Initiative (OHHI) in which he is conducting research on the hydrodynamic aspects of bacterial and pathogen transport in coastal waters.

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Daniel Schlenk received his B.S. in Toxicology from Northeast Louisiana University, Monroe in 1984 and his Ph.D. in Biochemical Toxicology from Oregon State University in 1989. From 1989 to 1991 his studies were supported by a National Institute of Environmental Health Science postdoctoral fellowship at Duke University. He was a visiting Scholar in the Department of Biochemistry at the Chinese University of Hong Kong, in 1995, 1998, and 1999; a visiting scholar at the Instituto Del Mar - Venice, Italy, in 1999; a visiting scientist at the CSIRO Lucas Heights Laboratory - Sydney, Australia, in 2003; and a Distinguished Fellow of the State Key Laboratory for Marine Environmental Science in Xiamen University of China. His initial studies focused on the impacts on pesticides within estuarine systems. Today, the overall focus of Dr. Schlenk's laboratory is to evaluate mechanisms of action of chemicals in aquatic and marine organisms.

Dr. Schlenk's professional interests include impacts of hypersaline acclimation on the biotransformation and toxicity of xenobiotic chemicals in anadromous and catadromous fish. He is an author of more than 175 scientific publications related to this subject. His research in California has focused on the impacts of hypersaline acclimation on organophosphate insecticides and organoselenide compounds that are biomagnified in hypersaline waterways, such as the Salton Sea and the Central Valley. Current studies are underway to evaluate the impacts of climate change on hypersaline conditions in San Francisco Bay and the role it may have in enhancing or diminishing the toxicity of current-use pesticides, such as pyrethroids. It is his goal to understand the modes of action of these compounds, alone and in mixtures, to determine the interactive roles each may have in endocrine disruption.

Since 2007, Dr. Schlenk has served as a permanent member of the USEPA FIFRA Science Advisory Panel and will serve as chair during 2012. In addition, he was elected as a Fellow of the American Association for the Advancement of Science (AAAS) in 2009, and he served as a member of the Board of Directors for the North American Society of Environmental Toxicology and Chemistry from 2003 to 2006. He was the co-Editor-in Chief of *Aquatic Toxicology* from 2005 to 2011, and now serves on the editorial board for this journal and the editorial boards for *Toxicological Sciences*, *The Asian Journal of Ecotoxicology*, and *Marine Environmental Research*. He has also participated in proposal review panels for the USEPA, NOAA, and the National Institute of Environmental Health Sciences.

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Judith S. Weis received her B.A. in Zoology from Cornell University in 1962 and her Ph.D. in Biology from New York University in 1967. Much of her research has been focused on estuaries in the NY/NJ Harbor area, but she has also done research also in Indonesia and Madagascar.

Dr. Weis is interested in stresses in estuaries (including pollution, invasive species, and parasites), and their effects on organisms, populations and communities. Her research focuses mostly on estuarine ecology, and she has published over 200 refereed scientific papers, as well as a book on salt marshes ("Salt Marshes: A Natural and Unnatural History") in 2009 and a book on fish ("Do Fish Sleep?") published in 2011. She served for two years as a Program Director at the National Science Foundation and has been a visiting scientist with the US Environmental Protection Agency.

Dr. Weis is a Fellow of the American Association for the Advancement of Science (AAAS), was a Congressional Science Fellow with the U.S. Senate Environment and Public Works Committee, and was a Fulbright Senior Specialist in Indonesia in 2006. She serves on the editorial board for BioScience, and is one of the editors of the on-line Encyclopedia of Earth. She has also served on numerous advisory committees for USEPA, NOAA and the National Research Council and is currently chair of the Science Advisory Board of the NJ Department of Environmental Protection. She was the Chair of the Biology Section of AAAS, served on the boards of the Society of Environmental Toxicology and Chemistry (SETAC), the Association for Women in Science (AWIS), and the American Institute of Biological Sciences (AIBS), of which she was the President in 2001.

APPENDIX C. STUDIES OF BRINE IMPACTS IN MARINE SYSTEMS

Table C-1. Biological impacts of concentrate discharges. Table modified from Roberts et al., 2010a.

Species	Study Type	Condition/ Location	Observed Biological Effects	Reference
Seagrass				
Posidonia oceanica	Lab exposure	15-d exposure to 38-43 ppt	Decreased growth after exposure to salinities ≥ 40 ppt; 50% mortality at 45 ppt	Latorre 2005
Posidonia oceanica	Lab exposure	15-d exposure to 23-57 psu	Reduction of vitality and mortality at salinities ≥ 39.1, at 45 psu 50% of plants died	Sánchez-Lisazo et al. 2008
Cympodocea nodosa	Field study	Barranco del Toro Beach, Canary Islands	Decreased presence near outfall discharges. Farther away from the outfall discharge the seagrass improved condition	Perez and Ruiz 2001
Caulerpa prolifera	Field study	Barranco del Toro Beach, Canary Islands	Decreased presence near outfall discharges. Farther away from the outfall discharge the seagrass condition improved	Perez and Ruiz 2001
Posidonia oceanica	Field study	Formentera, Spain	Increased leaf necrosis and decreased carbohydrate storage near discharge site, relative to control locations	Gacia et al. 2007
Posidonia oceanica	Field study	Key West, Florida	Seagrass photosynthesis inhibited after exposure to 12% brines for 24 h	Chesher 1971
Posidonia oceanica	Field study	Shark Bay, WA	Increased mortality and senescence at salinities of 50-65 ppt	Walker and McComb 1990
Posidonia oceanica	Field study	Alicante, Spain	Exposed to brines in the field for 3 months. Exposures raised salinity to 38.4-39.2 ppt in experimental plots and caused mortality, surviving plants had reduced shoot and leaf abundance	Sánchez-Lizaso et al. 2008
Posidonia oceanica	Field study	Balearic Islands, Spain	Reduced growth and presence of necrotic tissue in seagrass from transects impacted by brine, but there was no extensive meadow decline	Gacia et al. 2007
Plankton				
	Field study	Key West, Florida	Reduced abundance in water surrounding brine discharge area. Majority of effects attributed copper levels in brine	Chesher 1971

Table 1. Continued.

Species	Study Type	Condition/ Location	Observed Biological Effects	Reference
Ascidians				
	Lab exposure	Key West, Florida	Relatively more sensitive than other invertebrates exposed in the study, 50% mortality after exposure to 5.8% effluent	Chesher 1971
	Field study	Key West, Florida	Reduced abundances in areas surrounding brine discharges. Majority of effects attributed to copper levels in brine	Chesher 1971
Mysids				
Leptomysis posidoniae	Lab exposure	15 d exposure to 23-57 psu	Mortality observed at salinities > 40 psu and it was temperature dependent	Sánchez-Lisazo et al. 2008
Echinoderms				
Paracentrotus lividus	Lab exposure	15 d exposure to 23-57 psu	Mortality observed at salinities > 40 psu and it was temperature dependent	Sánchez-Lisazo et al. 2008
	Field study	Alicante, Spain	Disappeared from meadow in front of desalination plant, lower vitality observed in seagrass in the same area	Fernandez-Torquemeda et al. 2005
	Field study	Key West, Florida	Reduced abundances in areas surrounding the effluent discharge area. Majority of effects attributed to copper levels in brine	Chesher 1971
	Lab exposure	Key West, Florida	Reduced survival after exposure to 8.5% dilutions	Chesher 1971
	Field study	Key West, Florida	Died within 2-3 d of exposure, survival improved when copper emissions were reduced following plant maintenance	Chesher 1971
Paracentrotus lividus	Field study	Balearic Islands, Spain	Sea urchins and sea cucumbers absent from transects impacted by brine	Gacia et al. 2007
Mollusks				
Sepia apama (squid embryos)	Lab exposure	99-d exposure to 39-55 ppt	Total mortality observed after exposure to 50 ppt. Egg hatching decreased at 45 ppt. Reduced growth after exposure to 45 ppt	Dupavillon and Gillanders 2009
Crassostrea virginica (juveniles and adults)	Lab exposure	60-d exposure to 45-55 psu	Brines contained high Cu concentrations. Effects in juveniles and adults observed at Cu levels between 19 -43 ug/L. Effects included, reduced reproduction and increased fungal infections	Mandelli 1975
Tapes philippinarum (clams)	Lab exposure	0.5-72 h exposure to 31-100 ppt	Mortality found at 60 ppt after 48 h, sluggish behavior observed after 24 h at 60 and 70 ppt	Iso et al. 1994

Table 1. Continued.

Species	Study Type	Condition/ Location	Observed Biological Effects	Reference
Fish				
Pagrus major (juveniles)	Lab exposure	0.5-72 h exposure to 31-100 ppt	Mortality observed at 50 ppt after 24 h, body coloration changed at this salinity after 0.5 h of exposure	Iso et al. 1994
Pleuronectes yokohumae (eggs/ larvae)	Lab exposure	0.5-144 h exposure to 31-100 ppt	Larvae mortality at 55 ppt after 140 h of exposure; egg hatchability was delayed at concentrations ≥ 50 ppt after 73 h	Iso et al. 1994
Benthic Communities				
	Field study	Alicante, Spain	Communities close to outfall discharges were dominated by nematodes (up to 98%); polychaetes, mollusks and crustaceans more abundant with increasing distance from discharge	Del Pilar Ruso et al. 2007
	Field study	Alicante, Spain	Reduced polychaete abundance and diversity adjacent to outfall. Ampharetidae and Paraonidae were the most and least sensitive families (respectively)	Del Pilar Ruso et al. 2008
	Field study	Antartica	A study of diatom communities found reduced richness and abundance in areas receiving brine, even though salinity measurements were not different at outfall and reference locations D46	Crockett 1997
	Field study	Grand Canaria, Canary Islands	A study of meiofauna communities found lower abundance of copepods and nematodes near outfall discharge, abundances increased away from the discharge point. A shift in particle size also contributed to the changes in abundance	Riera et al. 2011
	Field study	Tampa, Florida	No changes in the abundance of the benthic community including sea grasses, algae, hard and soft corals, and other invertebrates despite salinity increases of up 40 times higher than baseline data	Blake et al. 1996
	Field study	Hurghada, Egypt	Many fish species declined and even disappeared, as well as many planktonic organisms and corals, near the area around the plant	Mabrook 1994
	Field study	Blanes, Spain	No significant impact found by discharges after visual census. Lack of effects attributed to high natural variability and to rapid dilution	Raventos et al. 2006

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APPENDIX D. MIXING ZONES

Central to understanding the environmental impacts of an ocean discharge and how they are regulated is the concept of a mixing zone. The mixing zone is a region of non-compliance and limited water use around the diffuser. Water quality criteria must be met at the edge of the mixing zone. Within this zone the discharge undergoes energetic mixing that rapidly reduces the concentrations of most contaminants to safe levels. The mixing is caused by the turbulence generated by the high velocity of the jets issuing from the diffuser ports and by the effluent buoyancy (positive or negative) that causes it to rise or sink through the water column. These mechanisms entrain substantial quantities of ocean water that readily dilutes the effluent within a few minutes after discharge and within a few hundred meters from the diffuser.

This rapid and very substantial contaminant reduction is recognized by the concept of a regulatory mixing zone. For example, the US EPA regulations for toxics (USEPA 1991), defines a mixing zone as:

"*An area where an effluent discharge undergoes initial dilution and is extended to cover the secondary mixing in the ambient water body. A mixing zone is an allocated impact zone where water quality criteria can be exceeded as long as acutely toxic conditions are prevented.*" (Water quality criteria must be met at the edge of a mixing zone.)

Thus, water quality requirements are specified at the edge of the mixing zone rather than by end-of-pipe requirements for conventional and toxic discharges.

There is much terminology associated with wastewater mixing processes and the regulations that cover them. Unfortunately, there do not appear to be universal definitions of these terms and they are often used interchangeably and imprecisely. As summarized in Table D-1, they include zone of initial dilution, regulatory and hydrodynamic mixing zones, and near and far field mixing. This report will use the definitions given in Table D-1.

Table D-1. Outfall mixing and mixing zone terminology

Term	Definition	Comments
Mixing zone	A limited area where rapid mixing takes place and where numeric water quality criteria can be exceeded but acutely toxic conditions must be prevented. Specified dilution factors and water quality requirements must be met at the edge of the mixing zone	
Allocated impact zone (AIZ)	Same as a mixing zone	
Regulatory mixing zone	As defined by the appropriate regulatory authority	Can be a length, an area, or a volume of the water body
Legal mixing zone (LMZ)	Same as a regulatory mixing zone	
Near field	Region where mixing is caused by turbulence and other processes generated by the discharge itself	Near field processes are intimately linked to the discharge parameters and are under the control of the designer. For further discussion, see Doneker and Jirka (1999), Roberts (1999), and Roberts et al. (2010).
Hydrodynamic mixing zone	Same as near field	Near field and hydrodynamic mixing zone are synonymous with these definitions
Far field	Region where mixing is due to ambient oceanic turbulence	Far field processes are not under control of the designer
Toxic dilution zone (TDZ)	A more restrictive mixing zone within the usual mixing zone	
Initial dilution		A general term for the rapid dilution that occurs near the diffuser
Zone of initial dilution (ZID)	A region extending over the water column and extending up to one water depth around the diffuser.	A regulatory mixing zone, as defined in the U.S. EPA's 301(h) regulations (USEPA 1994)

The mixing zone may not correspond to actual physical mixing processes. It may fully encompass the near field and extend some distance into the far field, or it may not even fully contain the near field. Mixing zones can be defined as lengths, areas, or water volumes. An example is contained in the guidelines for the US National Pollutant Discharge Elimination System (NPDES) permits for the discharge of pollutants from a point source into the oceans at 40 CFR 125.121(c) U.S. Federal Water Quality that defines a mixing zone for federal waters as:

"*…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 California Ocean Plan (discussed below) defines initial dilution (which is therefore a regulatory mixing zone) as:

"*…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.*"

Clearly, application of these regulations require much judgment, such as which oceanographic conditions, currents, density stratification, flow rates, and averaging times are used. These must be carefully chosen and explicitly specified in the outfall design documentation.

Mixing zone water quality standards are usually limited to parameters for acute toxicity protection (sometimes determined by bioassays) and to minimize visual impacts. They are not usually applied to BOD, dissolved oxygen, or nutrients. Bacterial standards are also not normally imposed within or at the boundary of mixing zones unless the diffuser is located near areas of shellfish harvesting or recreational uses.

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APPENDIX E: DISCHARGE SITE CONSIDERATIONS

E.1 General Boundary Conditions and Forcing Functions of *Collision Coasts*

Collision coastal environments are the predominant geomorphic coastal environment in California. These are exposed, open-coastlines that are intrinsically erosional, with steep coastal topography and narrow continental shelves formed by the collision of oceanic techtonic plates with continental plates (Figure E-1). The natural boundaries of these coastal environments are referred to as *littoral cells*, of which there are two general categories based on the amount of sediment cover over the bed rock. *Sandy littoral cells* have abundant sediment cover because they are nourished by coastal streams and rivers, with sandy beaches and moderately sloping shelves, and are bounded in the longshore direction by headlands and submarine canyons. The other collision coastal type is referred to as *rocky littoral cells*. These are nourished by sea-bluff erosion that form pocket beaches, accompanied by tide-pools, rocky reefs, steeply-sloping shelves with limited sediment cover, and are bounded in the longshore direction by headlands, bluffs and rocky out-crops. The geomorphology of both the sandy and rocky collision coastal types creates high-energy coastal environments with vigorous ambient mixing and advection that contributes to rapid dilution and limited dispersion of brine discharge. The high energy in these collision coastal environments in California arises from shoaling ocean waves produced by North Pacific frontal cyclones and Southern Hemisphere storms, wave and wind driven currents and weakly damped tidal currents and internal waves exhibiting numerous high amplitude harmonics arising from trapped oscillations over the shelf bathymetry.

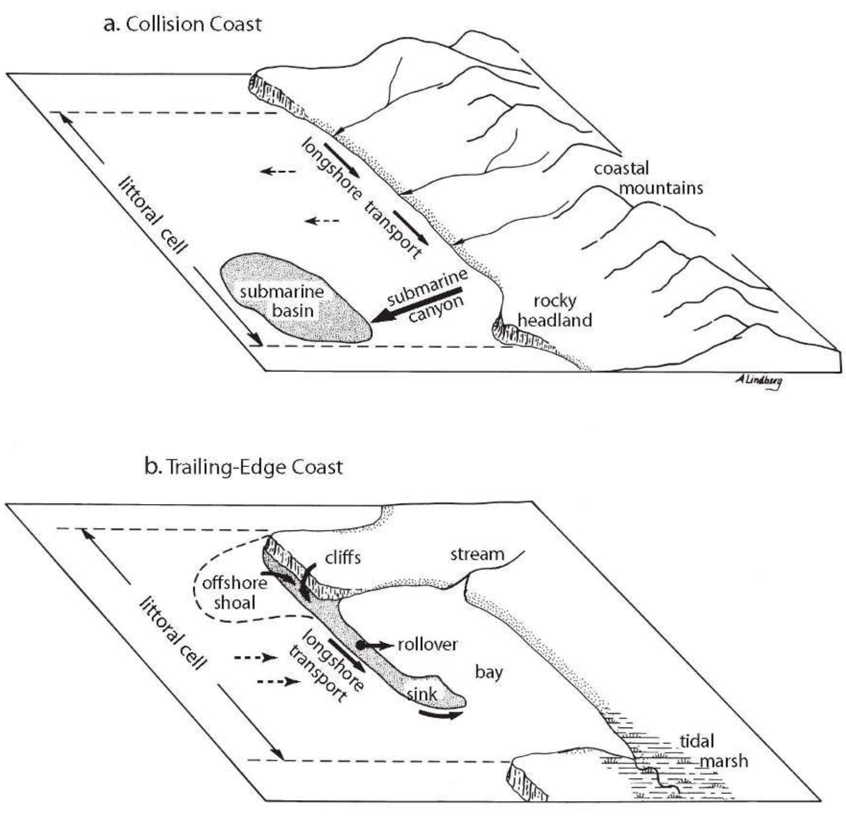

Figure E-1. Geomorphic coastal types.

E.2 Boundary Conditions related to *Far-field Bathymetry, Coastal Structures and Earth-Works*:

Bathymetry exerts a controlling influence on all of the coastal processes that affect dispersion and dilution. The bathymetry consists of two parts: 1) a stationary component in the offshore where depths are roughly invariant over time; and 2) a non-stationary component in the nearshore where depth variations do occur over time. The stationary bathymetry generally prevails at depths that exceed closure depth which is the depth at which net on/offshore sediment transport vanishes. Closure depth is typically -12 m to -15 m MSL for most California wave climate, [Inman et al. 1993]. The stationary bathymetry is typically derived from the National Ocean Survey (NOS) digital database. For the non-stationary bathymetry data inshore of closure depth (less than -15 m MSL) nearshore and beach survey data is typically used, generally provided by the US Army Corps of Engineers.

Because most of the coastline of California is a collision coast it generally has favorable bottom gradients for offshore dispersion of brine discharge, because the narrow continental shelf geomorphology provides steep shelf and nearshore bathymetry. The case of Huntington Beach is a sandy littoral cell, but if it were re-located about 5 miles to the south along the Newport Coast, then the discharge would reside in a rocky littoral cell. Because of the thin sediment cover along the Newport Coast, there are numerous rocky outcrops and reefs offshore, that would present barriers that block the offshore dispersion of brine by gravity. Therefore, discharge sites with bathymetric barriers (offshore rocky reefs and outcrops) should be avoided with negatively buoyant discharges.

Another far-field bathymetric feature to be avoided for negatively buoyant brine discharge are closed form hollow and depressions. These are not generally features found along the exposed open coast of California, (again due to the steep gradient geomorphology of a collision coast), but can be common in embayments, either from natural shoaling effects or from man-induced activities such as the dredging of navigation channels and berthing area. Figure E-2 shows a series of dredged channels and berthing areas in San Diego Bay that create closed depressions significantly deeper than the surrounding native bathymetry. Despite a resonant tidal system with 1-2 knot tidal currents in San Diego Bay, there is very little net transport after multiple tide cycles of a negatively buoyant test particle that serves as a proxy for negatively buoyant brine. In cases where there is little net transport of the brine discharge, a bathymetric depression will fill with brine and displace the lighter ambient seawater from the depression. Such accumulation of brine might lead to increased exposure of benthic organisms to elevated salinity or reduce oxygen exchange with the sediment. The potential for accumulation in local depressions should be considered in the environmental analyses and design.

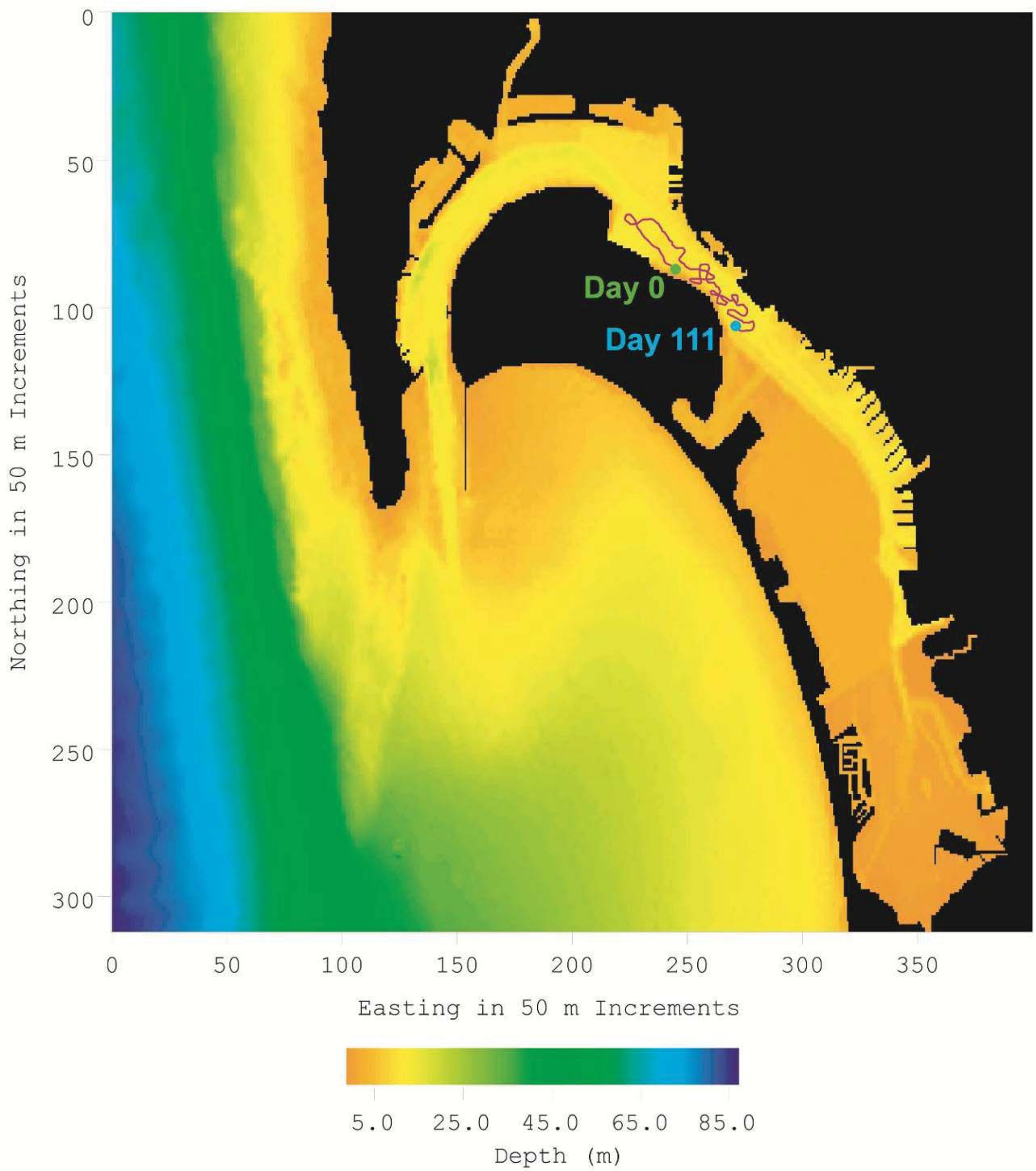

Figure E-2. Bathymetric depressions in San Diego Bay associated with dredged channels and berthing areas for deep-draft ships. Depth gradients indicated by the color bar scale. Transport trajectories of a negatively buoyant particle ($\rho_{brine} = 1.05 g/cm^3$) over 11 days of tidal exchange shown in red.

Bathymetry also exerts a strong influence on the boundaries of littoral cells and on the spatial variability of forcing functions, particularly waves. Figure E-3 shows how bathymetry has partitioned the Southern California Bight into a discrete set of littoral cells and how the bathymetry within those cells and the offshore islands (Channel Islands) has produced distinct refraction and diffraction patterns in the incident wave field throughout the Southern California Bight. (Figure E-3 uses the back refraction calculations of the CDIP data from the San Clemente array after Jenkins and Wasyl 2005). Wave heights are contoured in meters according to the color bar scale and represent 6 hour averages, not an instantaneous snapshot of the sea surface elevation. Note how the sheltering effects of Catalina and San Clemente Islands have induced variations in wave height throughout the Southern California Bight. Diffraction around these channel islands, and refraction over the inner shelf bathymetry concentrates the incident wave energy in certain regions of referred to as "bright spots.", (indicated by red colors in Figure E-3), while it dilutes wave energy in other areas referred to as "shadows" (indicated by blue colors in Figure E-3). The increased wave heights in the bright spots increase the mixing and turbulence generated over the seabed boundary layer, and induces bottom boundary currents (referred to as bottom wind). In addition, bright spots excite vigorous oscillatory wakes around intake and discharge riser structures in the nearfield (Section 6). These effects increase the mixing and dilution rates of the heavy brine that disperse rapidly along the seabed within a bright spots. Conversely, the dark areas in Figure E-3 where wave heights have been diminished (shadows), represent areas of reduced mixing and retarded dilution rates.

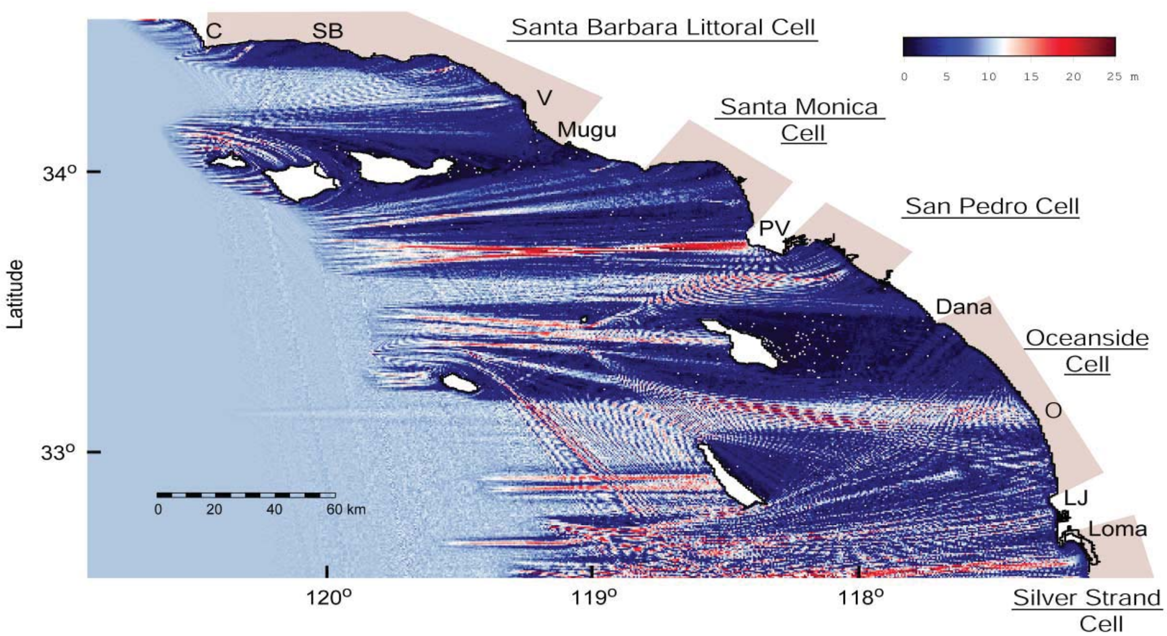

Figure E-3. Wave refraction and diffraction patterns in the Littoral Cells of the Southern California Bight. Sandy Littoral Cells include: Santa Barbara,Santa Monica Oceanside and Siverstrand Littoral Cells. Rocky Littoral Cells are Pacific Palisades Littoral Cell (between Pt Mugu and Santa Monica), and San Pedro Littoral Cell. Also shown are back-refraction pattern of waves measured by San Clemente CDIP station during the storm of 17 January 1988 with 10m high waves at 17 second period approaching the Southern California Bight from 270^0 , (from Jenkins and Wasyl, 2005).

Another aspect of bathymetric influence on wave forcing is in the generation of wave induced currents. In many of the littoral cells in Figure E-3, waves approaching from the west shoal at an angle to the coastline, giving rise to a component of the wave radiation stress directed parallel to the shoreline. In the Santa Barbara littoral, the incident wave radiation stress is directed shore parallel from west to east, giving rise to a general longshore current that flows towards the east. In the Santa Monica, San Pedro, and Oceanside littoral cells, the incident wave radiation stress is directed shore parallel from north to south, giving rise to a general longshore current that flows towards the south. These broad scale longshore currents that persist over entire littoral cells are referred to as *littoral drift*. In addition, there a locally intensified wave driven currents that flow away from bright spots and towards shadows, referred to as *divergence of drift*. When two bright spots are separated by a shadow, the opposing divergence of drift currents flowing into the shadow give rise to a seaward flowing current termed a *rip current*. These wave induced currents are often locally intensified near coastal structures as shown in the far-field hydrodynamic simulation at Oceanside Harbor in Figure E-4. Here the harbor has created a seaward bulge in the bathymetric depth contours, that focuses shoaling waves in a bright spot similar to a point break in surfing. The Oceanside Harbor breakwater also intercepts the littoral drift and deflects it seaward forming a rip current. The rip current converges with the general southward drift causing divergence of drift that locally intensifies the southward drift in the waters seaward of the harbor. As the intensified southward drift flows past the harbor, a "backwater eddy" is formed along the down-drift reach of coastline. These bathymetric and structurally induced effects on local waves and currents create an idea brine disposal site where both mixing and advection of brine discharge can be maximized. An example of this can be seen in the farfield brine dilution ratios calculated in Figure E-5 on the seabed for a potential desalination project sited at a similar harbor setting at Redondo Beach CA.

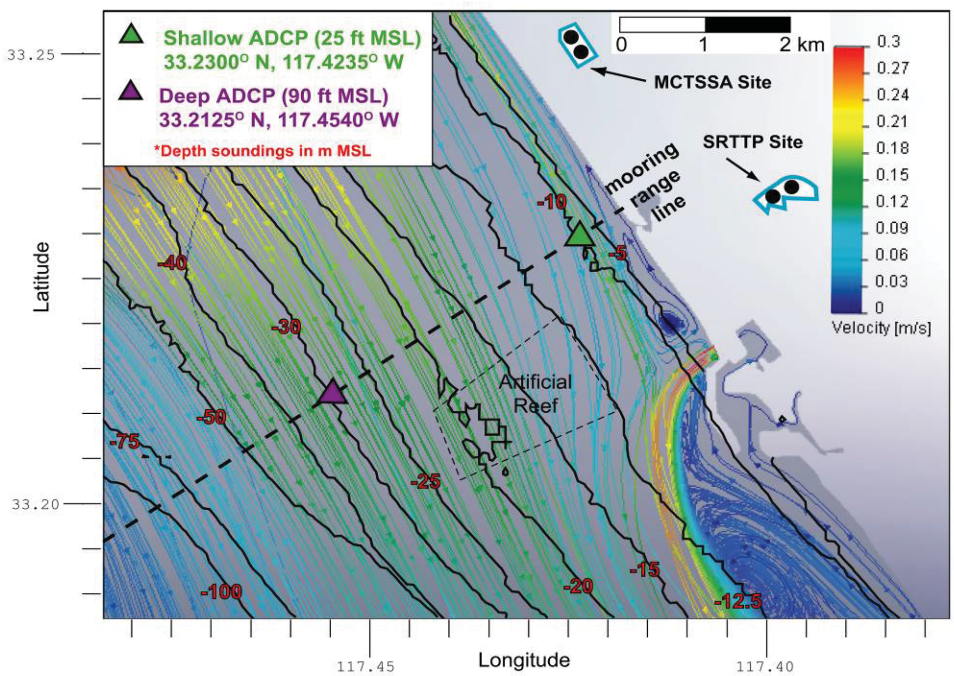

Figure E-4: Wave-induced longshore currents and rip currents, superimposed on ebb-tide at Oceanside Harbor, CA. (from Jenkins, 2011).

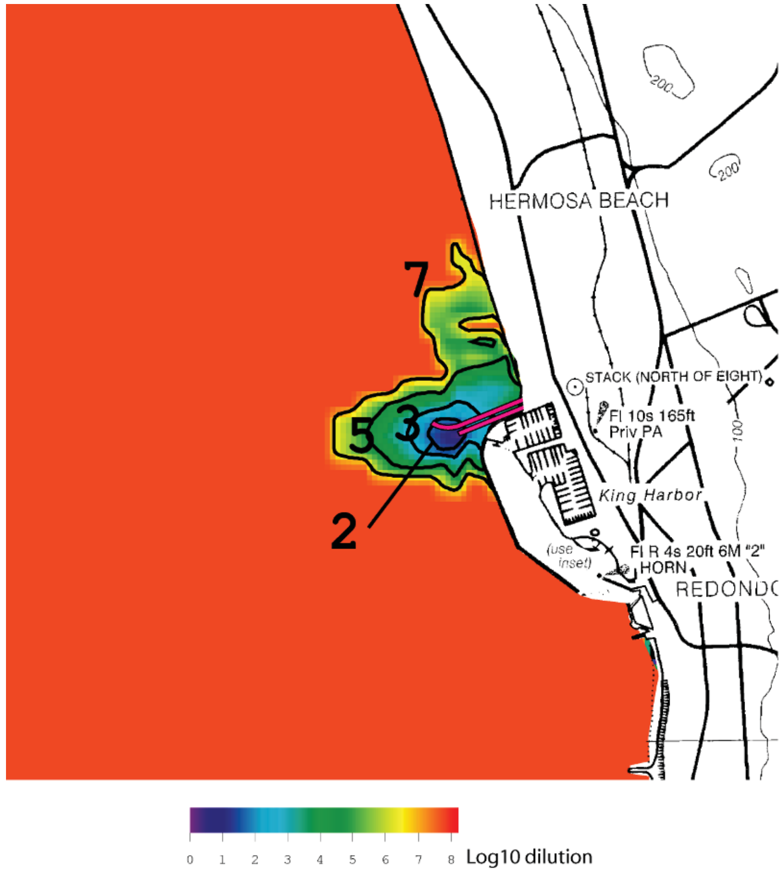

Figure E-5. Dilution of brine on the seabed as a result of mixing and advection intensification at the Redondo Beach King Harbor, after West Basin Desalination Demonstration Facility, 2010.

Here, brine discharge from a legacy power plant discharge riser located very close to shore, is deflected seaward by the Redondo Beach King Harbor jetty system intercepting the littoral drift. The result is seaward dispersion of the brine and very rapid dilution, with minimum dilution at the beach reaching at least 10,000 to 1, increasing rapidly to 10^{6}- 10^{7} to 1 as one proceeds up-coast to the northwest away from the harbor. This example illustrates that discharge sites with high ambient mixing and advection (typical of exposed, open-ocean, collision-coastlines) are preferable, particularly when siting near coastal structures will give rise to intensification of ambient mixing and advection.

E.3 Climate effects on Wind and Wave Forcing Functions

The advective and diffusive fluxes of the far-field brine dilution and dispersion processes in the nearshore are influenced by ocean temperature, salinity and the wave climate. Upon occasion, the typical seasonal weather cycles are abruptly and severely modified on a global scale. These intense global modifications are signaled by anomalies in the pressure fields between the tropical eastern Pacific Ocean and Australia/Malaysia known as the ***Southern Oscillation***. The intensity of the oscillation is often measured in terms of the ***Southern Oscillation Index (SOI)***, defined as the monthly mean sea level pressure anomaly in mb normalized by the standard deviation of the monthly means for the period 1951-1980 at Tahiti minus that at Darwin, Australia. The Southern Oscillation is in turn, modulated over multi-decadal periods by the ***Pacific Decadal Oscillation***, which results in alternating decades of strong and weak El Niño

The potential impact of variations in ocean temperature, salinity and waves can be evaluated by examining conservative or worst case scenarios. The worst case can be described by searching long-term records for historical events relevant to the discharge site that match criteria for worst-case. The criteria for worst case are based on the simultaneous occurrence of the high salinity and temperature in the receiving water during periods of low mixing and advection in the local ocean environment. The low mixing/ advection conditions arise during periods of benign weather when waves are small and winds and waves are close to stagnation. The environmental conditions are combined with worst case operating scenarios that give lowest in-the-pipe dilution of discharge constituents from a desalination facility. Table E-1 gives an example of the worst case criteria applied to each controlling variable in the computer search of the historic record for a discharge site in Huntington Beach, CA.

Table E-1. Search criteria for worst case scenario.

Variable	Search Criteria	Ecological Significance
Co-located Plant Flow Rates	Minimize	Lower flow rate results in less initial dilution in the pipe of the constituents from desalination
Ocean Salinity	Maximize	Higher salinity leads to higher initial concentrations of sea salts and backwash constituents from desalination
Ocean Temperature	Maximize	Higher ocean temperature leads to higher density contrast between receiving water and discharge
Ocean Water Levels	Minimize	Lower water levels result in less dilution volume in the nearshore and consequently lower dilution rates
Waves	Minimize	Smaller waves result in less mixing in bottom boundary layer of shoaling zone, weaker oscillatory vortices shed from discharge riser, weaker wave-induced currents, and consequently less near-bottom dilution
Currents	Minimize	Weaker currents result in less advection and less offshore dilution
Winds	Minimize	Weaker winds result in less surface mixing and less dilution in both the inshore and offshore

For the Huntington Beach example, minimum ocean mixing levels were obtained Figure E-6 from a computer search of 24 year long records of winds, waves and currents. However, the highest ocean salinity during the event day when minimal mixing conditions prevailed was 33.49 ppt, not the salinity maximum of 34.3 ppt identified in Figure 5.2. This is due to the fact that salinity maximums are mutually exclusive with mixing minimums. Salinity maximums are caused by vigorous southerly winds that create a well-mixed coastal ocean while pushing high salinity water masses along the California coast. A series of sensitivity analyses determined the salinity maximum might increase the concentration of brine discharge by 2%, but that this effect is offset by a reduction in far-field dilution caused by the effects of retarded mixing during low energy conditions. In fact the dilution rates for the mixing minimum are 99% smaller than the dilution rates during the salinity maximum. Therefore, minimal ocean mixing conditions became the dominant set of environmental variables in defining the worst case scenario. Accordingly worst case dilution modeling is based on the set of worst-case forcing parameters annotated in the example in Figure E-6.

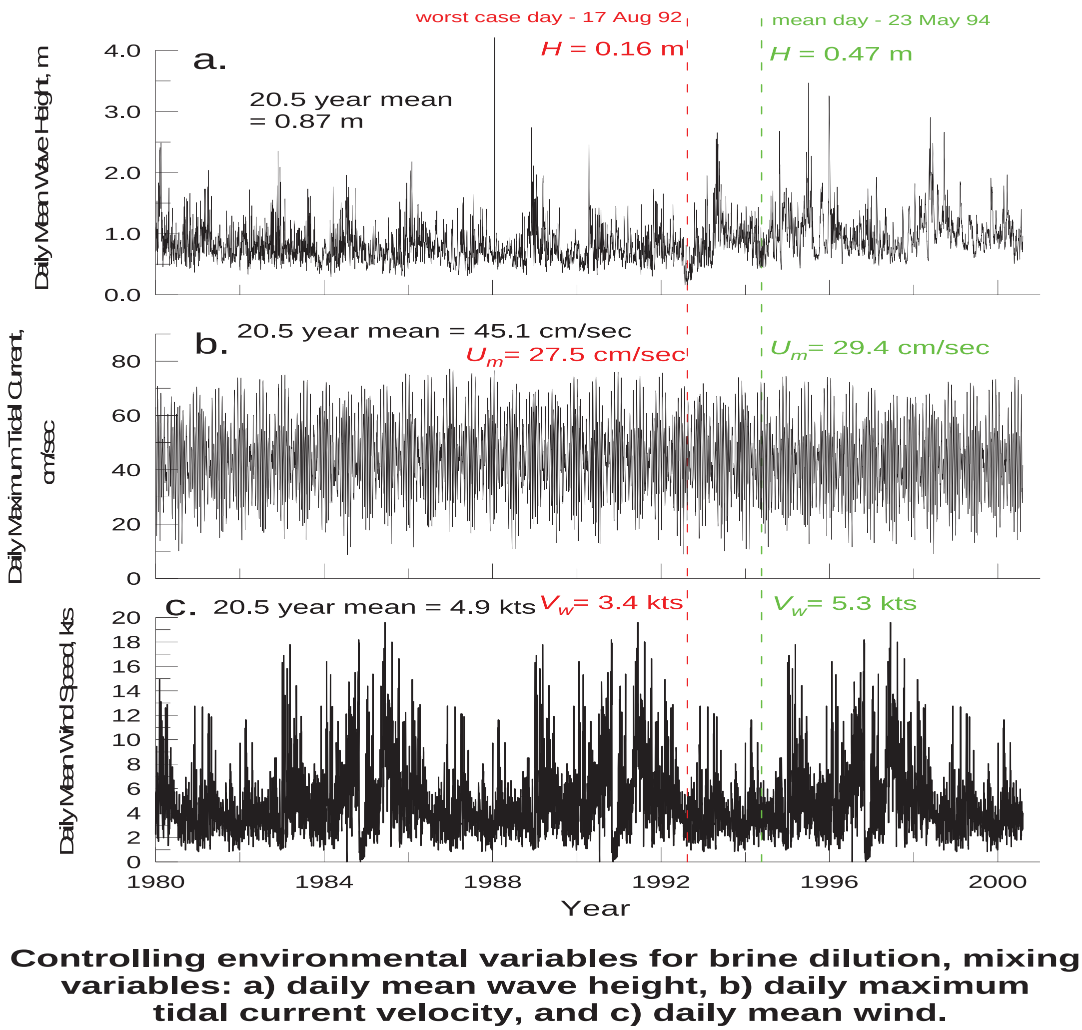

Figure E-6. Minimal ocean mixing conditions for worst case discharge scenarios from forcing function climate minimums. (from Huntington Beach Desalination Project, SEIR, 2010).

E.4 Salt Wedge Sediment Dynamics Effects on *Boundary Conditions and Forcing Functions for Estuarine Embayments*

Estuarine embayments generally present very tricky site discharge scenarios. To illustrate the hydrodynamic and sediment dynamic issues related to discharging brine in these types of environments, the details of the Sacramento Delta section of the San Francisco Bay estuary are examined. The source water for this example is obtained from a channel that branches off the Suisun Bay (Figure E-7). The source water flow from Suisan Bay is due primarily to tidal exchange and Suisun Bay is also the receiving water for the brine discharge. Circulation in Suisan Bay is a complex salt wedge system driven by tidal exchange between Suisun Bay and San Pablo Bay and discharge from the Sacramento River. Therefore both the source water and receiving water would be brackish and sediment-laden and these characteristics will very daily in response to the spring-neap tidal variability, and seasonally with variation in the Sacramento River discharge.

Figure E-7 presents a composite of a Google Earth image of this site with a brine plume simulation overlaid. The plume simulation is based on jet dynamics, sedimentation, scour and burial after Jenkins et al (1992; 2007) and on algorithms for flocculation and shear stress dynamics after Aijaz and Jenkins (1993; 1994). The simulation uses salinity and flow rates of the Sacramento River based on the USGS gage station #11455420. The simulation in Figure E-7 illustrates the potential for the high salinity brine to induce flocculation of the sediment load of the Sacramento River in the neighborhood of the discharge, causing local increases in sediment deposition rates in the navigation channel of the Sacramento River and over adjoining mud flats along the river banks. Both of these alterations in the depositional features of the receiving water have potentially adverse environmental impacts, since increased sediment deposition in the navigation channel would interfere with ship traffic and increase dredging requirements along with those related impacts; while increased deposition in the mudflats would impact existing intertidal wetland habitat.

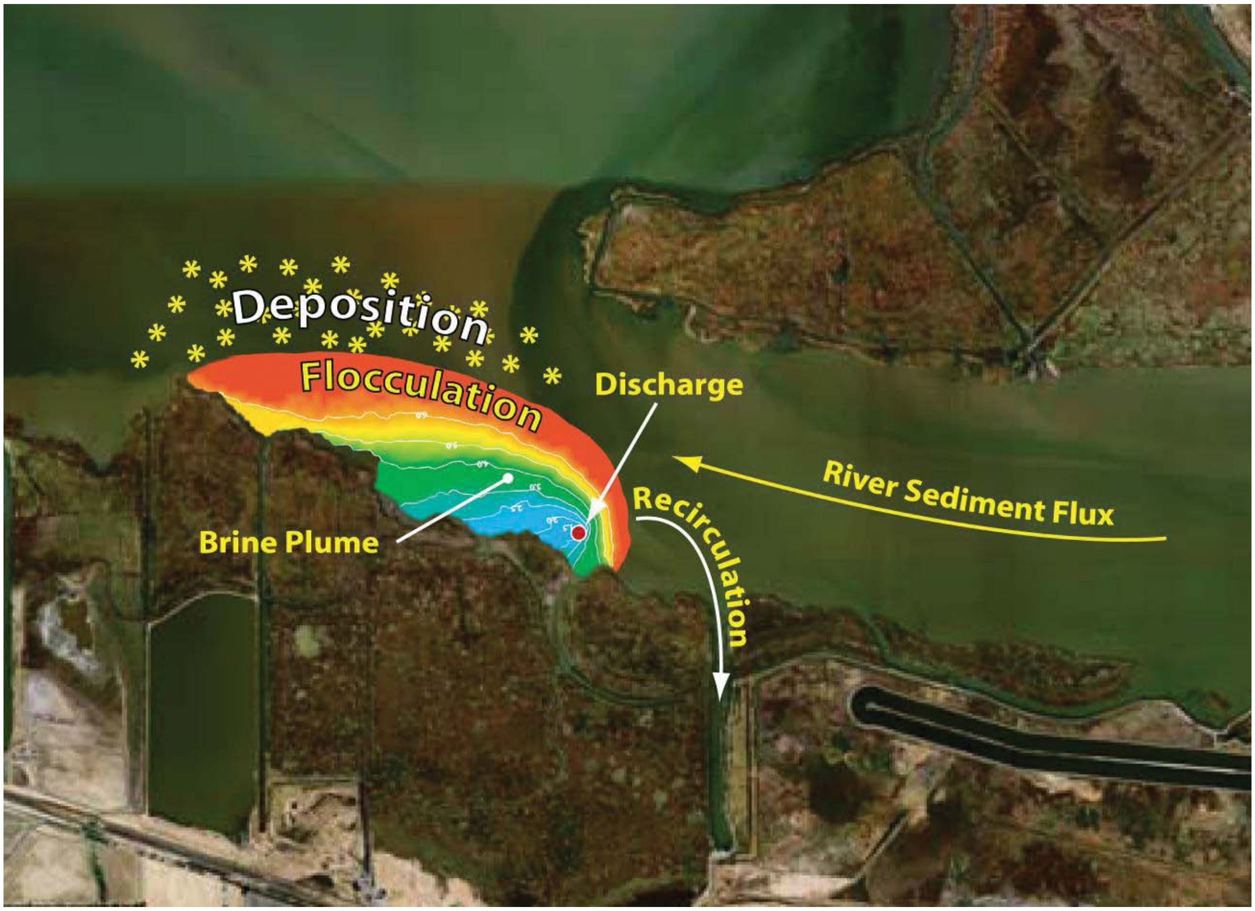

Figure E-7. Simulated brine discharge plume in the lower Sacramento River Delta. Flocculation convergence zone indicated in red, deposition zone indicated as yellow stars.

References:

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APPENDIX F: MATHEMATICAL MODELING

1. Introduction

The effluent may be negatively or positively buoyant as it enters the ocean, depending on whether the discharge is raw concentrate, or blended with power plant cooling water or domestic wastewater. Modeling positively buoyant submerged and shoreline discharges has been discussed in many publications so we do not consider them further here.

Shoreline negatively buoyant discharges (Figure 6-1a) will result in a density current that flows down the bottom slope. Because the resulting density stratification inhibits vertical mixing, dilution is relatively small and benthic organisms will be exposed to relatively high salinities. Shoreline disposal of pure concentrate by this means is therefore discouraged and is not considered further here.

The hydrodynamic mixing regions of wastewater discharges are usually considered in two phases: The near field and the far field. The distinctions are discussed in more detail in Appendix D, but briefly in the near field mixing and dilution is rapid and results from processes induced by the discharge itself, such as turbulent entrainment, whereas in the far field mixing is due to natural oceanic turbulence. Some authors include a mid-field characterized by dynamical spreading as a density current.

Near field processes operate over fairly small scales: distances of order tens of meters and times of order minutes. The far field is dominated by larger scales: distances of order hundreds of meters to kilometers and times of order hours to days. The rate of mixing in the far field is much slower than in the near field.

Because of the wide range in length and time scales, it is generally not possible to capture them all in one model, so separate near and far field models are usually employed. The far field models are probably two or three dimensional hydrodynamic models of the coastal waters. The two models must be coupled to predict the overall brine dispersion, with the output from the near field model becoming the input to the far field model.

In this Appendix we consider modeling of negatively buoyant discharges from diffusers. We first discuss some overall concepts, then near field models, then far field models. Coupling the two models together is then discussed. Finally, we discuss simple mass-balance box models which are useful tools to assess flushing and potential background build-up of contaminants. Much of the material in this Appendix is adapted from Roberts et al (2010b).

2. Characteristics of Negatively Buoyant Discharges

In order to effect high dilution of negatively buoyant effluent it will be necessary to discharge it as high velocity jets through a diffuser that effects rapid mixing by entrainment (Figure F-1). Because the jets are dense, they reach a terminal rise height and then fall back to the seabed where they spread as a density current. The highest salinity on the seabed occurs where the centerline of the jet impacts the seabed. The dilution at this point is labeled S_i (for impact point dilution) on Figure F-1. Additional dilution occurs beyond the impact point before the flow collapses under the influence of the induced density stratification. The point where this collapse occurs is the end of the near field, and the dilution at this point is the near field dilution. The length of the near field is denoted by x_n in Figure F-1 and the near field dilution is S_n. Typically, near field dilutions are of order 60% higher than impact dilutions (Roberts et al, 1997). The length of the near field is of order a few tens of meters.

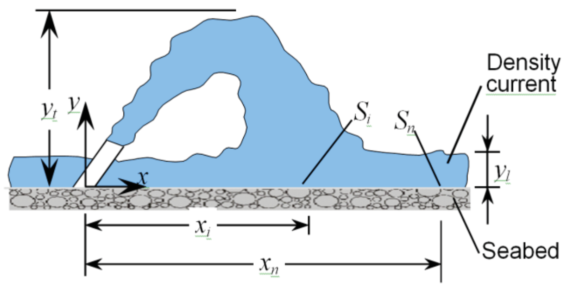

Figure F-1. Schematic depiction of brine discharge as inclined jet

For multiport diffusers, such as the one shown in Figure 6-3, merging of the individual jets and the concomitant reduction in dilution must also be considered.

Figure F-1 shows details of the different flow regions: the ascending jet phase, terminal rise height, descending jet phase, seabed impaction and transition to horizontal flow, mixing in the density current, and finally the far field.

3. Near Field Modeling

There are three main techniques for predicting the near fields of brine discharges: 1) Physical modeling using scaled laboratory models, 3) Semi-empirical equations, and 3) Numerical modeling.

3.1 Physical modeling

Physical modeling is employed primarily for predicting near field behavior. It consists of laboratory experiments using scale models that simulate the particular case being tested at a smaller scale. Tests can be carried out on any effluent, discharge configuration, and ambient conditions. For discussions of physical modeling, see Ettema et al. (2000).

The model and the prototype maintain the relative proportions (the scale factor) and are scaled in terms of both geometry and forces. In order to guarantee the correspondence between the model and the prototype behavior, the model must satisfy:

1. **Geometric similarity** where the ratio of all corresponding dimensions in the model and prototype are equal. This is commonly referred to as an undistorted model.

2. **Dynamic similarity** where the ratios of all forces in the model and prototype are the same. The main forces are inertia, gravity, and viscous forces, and their ratios are generally expressed in terms of dimensionless numbers. The ratio between inertia and viscous forces is determined by the Reynolds number. If its value is sufficiently high, as will always be the practical case, the flow is fully turbulent and viscous forces can be neglected. The brine behavior then depends

mainly on the ratio of inertial to buoyancy forces, which is expressed by the densimetric Froude number.

3. **Kinematic similarity** is equality of ratios of speeds and velocities at similar points. But if conditions 1 and 2 above are satisfied, kinematic similitude automatically follows.

Physical modeling is particularly useful where mathematical models are not verified or uncertain, such as merging multiple jets, discharges from multiport rosettes (for example, Figure 6-3), or the effects of ambient currents. Their disadvantages are that they may be relatively expensive and it is less easy to simulate a wide variety of alternatives. Examples of physical modeling of concentrate diffusers are given in Miller and Tarrade (2010), Tarrade et al. (2010), and Miller (2011).

3.2 Semi-Empirical Equations

Experimental studies of dense jets with the common design of a 60° orientation has resulted in semi-empirical equations that are widely used for diffuser design with single (or non-merging) jets. For example, in stationary environments, (Pincince and List, Roberts and Toms and others):

$$\frac{S_i}{F} = 1.6; \qquad \frac{S_n}{F} = 2.6; \qquad \frac{y_t}{dF} = 2.2; \qquad \frac{x_n}{dF} = 9.0 \tag{1}$$

Where (Figure F-1) S_i is the impact dilution, S_n the near field dilution, y_t is the terminal rise height, d the nozzle diameter, x_n the length of the near field, and F is the densimetric Froude number defined as:

$$F = \frac{u}{\sqrt{g_o' d}} \tag{2}$$

where $g_o' = g(\rho_o - \rho_a)/\rho_a$ is the initial value of the modified acceleration due to gravity, and g is the acceleration due to gravity, ρ_o is the effluent density ρ_a the receiving fluid density d the nozzle diameter and u the jet exit velocity. The values of the constants in Eq. 1 are taken from Roberts et al. (1997) and have been widely used in brine diffuser designs.

3.3 Numerical Modeling

The equations (1) will often suffice for estimating the major flow characteristics of non-merging 60° inclined jets into stationary environments. For other cases, for example other orientations, merging jets, effects of currents, or effects of bottom slopes, numerical models are now frequently employed.

Near field predictions are usually made by entrainment models or computational fluid dynamics models (CFD). However, as will be discussed, present numerical models cannot accurately simulate all flow features within a single model configuration, especially the effects of currents and jet merging.

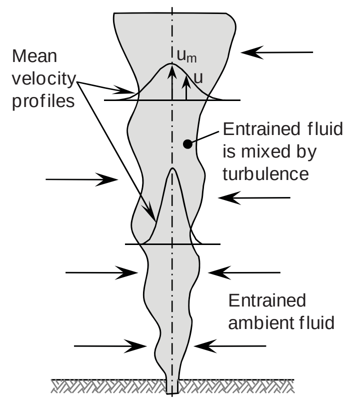

Figure F-2. Schematic view of the exit velocity along the axis of a turbulent plume and the direction of entrainment of ambient fluid into the plume.

3.3.1 Entrainment Models

Entrainment models are the most common tool for engineering analyses of jet and plume-type flows such as brine discharges.

The entrainment hypothesis was first suggested by Morton et al. (1956) and has since been applied to a variety of engineering and natural flows, as reviewed in Turner (1986). It is particularly relevant here as it has found great utility for predicting the jet and plume-type flows typical of ocean discharges. Below we summarize the essential features and limitations of these models; for details, the original references should be consulted, and for recent extensive reviews of entrainment models, see Jirka (2004, 2006), and Roberts et al (2011).

The concept of entrainment, as applied to a simple round rising plume in a stationary environment, is shown in Figure F-2.

The rising plume entrains external fluid that then mixes with and dilutes the plume fluid. The entrainment hypothesis (Fischer et al. 1979) states that fluid is entrained at the plume radius b with a velocity u_e that is proportional to the mean centerline velocity, u_m:

$$u_e = \alpha u_m \tag{3}$$

where α is the entrainment coefficient (whose value is different for jets and plumes). The rate of change of volume flux Q in the plume with distance s is then given by:

$$\frac{dQ}{ds} = 2\pi\alpha b u_m \tag{4}$$

Eqs. 3 and 4 are the essence of the entrainment hypothesis, and form the basis for most entrainment models.

Although entrainment models can be used for predicting dense jets, they are subject to a number of limitations and should be used with some caution.

Integral models assume incorporation of external fluid into the jet by entrainment and the profiles of velocity and tracer concentration to be self-similar and axially symmetric. Experimental jets often violate these assumptions, however, leading to unreliable predictions. For example, Pincince and List (1973) concluded that, although jet trajectories were reasonably predicted, dilutions were considerably underestimated. Anderson et al. (1973) concluded that the models can only predict trends, rather than exact dilutions and trajectories.

The vertical asymmetry in the tracer profiles, whereby the peak concentration is closer to the top, has been observed in many previous studies of dense jets in crossflows and inclined jets in stationary environments. Lane-Serff et al (1993) point out that the top half of the jet is gravitationally stable, with density decreasing upwards, but the bottom half is unstable, with heavier fluid above lighter fluid. This leads to the upper plume edge being sharp and well-defined, but in the lower half fluid can detrain from the jet so the lower boundary is poorly defined. Lindberg (1994) also noted in his experiments with crossflows that low momentum fluid almost immediately descended after leaving the nozzle and this continued through the jet trajectory, and Kikkert et al (2007) observed it in stationary inclined jets. This gravitational instability also leads to enhanced mixing within the jet and also between the jet and the environment.

Integral models usually do not include the additional mixing that occurs in the near field beyond the jet impact point. For inclined jets in stationary environments, Roberts, et al. (1997) find the increase in dilution between the impact point and the end of the near field to be around 60%.

At low current speeds the bottom layer forms an upstream wedge that is expelled at higher speeds. The length of the arrested wedge depends on hydrodynamic drag at the head and interfacial friction over the length of the wedge.

Merging jets from multiport diffusers result in further complications. In particular, the jets entrain, or attract, each other, sometimes called the Coanda effect. If the jets are too close together, the supply of entraining water is restricted resulting in reduced dilution. In general, entrainment models cannot predict the Coanda effect, which reduces jet rise height and dilution. For these cases, physical modeling will be more reliable.

Some common models that have been are widely used for predicting jet and plume-type flows, including dense brine discharges are Cormix, Visual Plumes (UM3), and VisJet. For a recent extensive discussion and comparison of these models for simulating dense jets in stationary environments, see Palomar et al. (2012ab).

3.3.2 CFD

Computational fluid dynamics (CFD) modeling is being increasingly applied to a wide variety of turbulent flows in nature and engineering. There are several major CFD techniques; for a review, see Sotiropoulos (2005).

One method is direct numerical simulation (DNS). The unsteady, three-dimensional Navier-Stokes equations are solved over scales small enough to resolve the entire spectrum of turbulence. In principle, DNS could model turbulent flows with virtually no modeling uncertainties but because it requires extensive computational resources it has been mainly applied to relatively simple, low Reynolds number flows. DNS is therefore not yet a practical modeling tool for simulating engineering-relevant flows.

A more realistic approach is Large Eddy Simulation (LES). The spatially filtered unsteady Navier-Stokes equations are solved to resolve motions larger than the grid size, and smaller-scale motions are modeled with a sub-grid model. For high Reynolds number flows of practical engineering interest, however, very high grid resolutions and supercomputers are still required.

The most common CFD models are Reynolds-decomposition models. Flow quantities are decomposed into time-averaged and fluctuating values and the Navier-Stokes equations are then time averaged, producing Reynolds-averaged Navier-Stokes (RANS) equations. Assumptions are made about the new terms that arise from this averaging. Probably the most common is the k-ε model that assumes an empirical relationship between turbulent kinetic energy, k, and the rate of energy dissipation, ε.

There have not been many applications of CFD to jet and plume-type flows. Hwang and Chiang (1995) and Hwang et al. (1995) simulated the initial mixing of a vertical buoyant jet in a density-stratified crossflow. They employed a RANS model with a buoyancy modified k-ε model. Blumberg et al. (1996) and Zhang and Adams (1999) used far-field CFD circulation models to calculate near field dilutions of wastewater outfalls. Law et al. (2002) used a revised buoyancy-extended k-ε turbulence closure to investigate the dilution of a merging wastewater plume from a submerged diffuser with 8-port rosette-shaped risers in an oblique current. Davis et al. (2004) used the commercial codes ANSYS and FLUENT to simulate several case studies of effluent discharges into flowing water, including a line diffuser, a deep ocean discharge, and a shallow river discharge. They concluded that CFD models are becoming a viable alternative for diffuser discharges with complex configurations.

The paucity of CFD applications to near field mixing is because of the major challenges that they face. These arise from the geometrical complexity of realistic multiport diffusers, the large difference between port sizes and the other characteristic length scales, buoyancy effects, plume merging, flowing current effects, and surface and bottom interactions. To overcome these difficulties, Tang et al. (2008) applied a three-dimensional RANS model using a domain decomposition method with embedded grids to model diffusers.

Although promising, the complexity of CFD models, the effort required to set them up, and long run times suggests that entrainment and length-scale models will continue to be used for many years.

CFD models of brine discharges have been reported by Muller et al (2011) and Seil and Zhang (2010).

4. Far Field Modeling

Hydrodynamic models of coastal circulation are being increasingly used to predict the fate and transport of coastal discharges in the far field and potential build-up of salinity in the vicinity of the discharge. For further discussion of far field hydrodynamics models see Roberts et al. (2010b).

Most models have been two-dimensional (depth-averaged) which is probably adequate for fairly shallow unstratified waters. But in deeper waters, especially if there are wind-shear effects, baroclinic processes, and density stratification, three-dimensional models are needed. In contrast to near field models, far field hydrodynamic models require extensive data input. These include currents, bathymetry, winds, density stratification, tides, and their spatial and temporal variability. The models are either finite element, finite difference, or finite volume, of which finite difference is the most common. The models should be combined with field studies to ensure reliable results.

Ocean circulation models can be combined with mass transport models to predict contaminant transport. Examples are bacteriological pollution in nearshore areas due to storm water runoff (Carnelos 2003) and marine outfalls during different flow conditions such as flood and ebb tides (Liu et al. 2007). Hydrodynamic models have also been used to predict near field plume behavior (Blumberg et al. 1996; Zhang 1995).

Some commonly used ocean circulation models are Delft3D, POM, ECOM, ROMS, Mike3, Telemac, and Elcom. These models are applicable to oceans, coastal waters, lakes, rivers, and estuaries. Some are commercial and some are open source (free).

Most models assume incompressibility and are hydrostatic and Boussinesq, so that density variations are neglected except where they are multiplied by gravity in the buoyancy force terms. The basic equations are based on continuity, momentum, and thermodynamics including temperature and salinity, and an equation of state.

Three-dimensional models are probably needed for waters deeper than about 30 m or so that are stratified. This is because the currents can be strongly sheared, not only flowing at different speeds over depth but in different directions also; two-dimensional models would not capture this variability. But for reliable results, three-dimensional models require extensive data on currents and density at the boundaries and intensive efforts to set up and verify. For these reasons they are not commonly used for smaller outfall projects, but may be part of larger ones.

Due to computational restrictions, it is usually not practical to model an area large enough that the area of interest is independent of the boundary conditions. Therefore, a common approach is to model a large area with a coarse grid and to embed a finer-scale model within it. The grid size of the smaller model is small enough to resolve scales of interest to outfall dispersion. The fine-grid model derives its boundary conditions from the larger model and is said to be nested within it.

5. Model Coupling

Coupling the near and far field models involves transfer of flow quantities, such as volume, momentum, and pollutant mass between them, possibly in both directions. This is illustrated in Figure F-3.

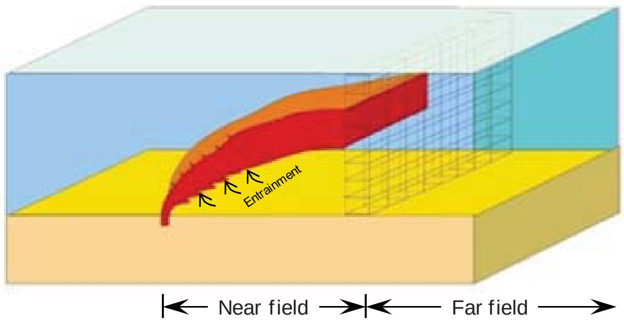

Figure F-3 Model coupling (after Bleninger 2006)

The near field dynamics are characterized by entrainment and small-scale turbulence. The jets entrain fluid that induces a current around the diffuser. This will usually be a few cm/s and its magnitude decreases with distance from the diffuser so it will generally be negligible compared to ambient currents. Therefore, typical outfalls do not significantly affect coastal circulation patterns (this may not be true for large cooling water discharges from power plants). The coupling is therefore usually considered to be one way, i.e. local currents affect the discharge, but not vice versa.

Bleninger (2006) describes an approach in which output from the near field model CORMIX is linked to a far field hydrodynamic model, Delft3D. Bleninger assumes passive, i.e. one-way, coupling. The source is introduced into the far field grid cells as a volume flux that is equal to the source volume flux multiplied by the near field dilution with a contaminant concentration equal to the source concentration divided by the near field dilution. Although this preserves the contaminant mass flux, it does not satisfy volume continuity as the entrained flow is not removed from any cells. As discussed above this is usually a good assumption for marine wastewater outfalls.

Other examples include Chin and Roberts (1985) who coupled a near field model with a far field particle tracking model. Zhang (1995) discusses different means of introducing the effluent into the far field grid. Connolly et al. (1999) used a hybrid modeling approach to predict bacterial impacts from outfalls in Mamala Bay, Hawaii. They used ECOM to simulate advective and dispersive processes in the bay. The predicted near field characteristics were directly inputted into grid cells at the predicted plume rise height following the methodology of Zhang and Adams (1999).

Dynamic, i.e. two-way, linkage between the near and intermediate fields was addressed by Choi and Lee (2007). They applied a distributed entrainment sink approach (DESA) to model the intermediate field by coupling a 3D far field model with a Lagrangian near field model (JETLAG). The action of the plume on the surrounding flow is modeled by a distribution of sinks along the jet trajectory. This establishes a two-way dynamic link at grid cell level between the near and far field models.

Suitable coupling between the near and far field models is essential for reliable prediction of impacts. If near field dilution is not accounted for, predicted far field dilutions will be much too low, leading to considerable overestimates of environmental impacts.

6. Box Models

The "background" mean concentration field near the diffuser is governed primarily by flushing due to the mean drift, horizontal diffusion (and, for non-conservative substances, chemical and biological decay). One approach to predicting the physical dilution caused by these processes is to estimate it from a solution to the two-dimensional diffusion equation (Csanady 1983a; Koh 1988). Another is a mass-balance box model (Csanady, 1983b), which is a useful and simple way to assess coastal "flushing" and the relative orders of magnitude of the various processes. The box model is shown in Figure F-4.

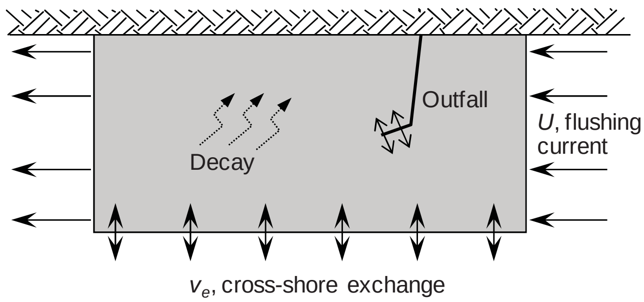

Figure F-4 Box model for estimating long-term buildup of contaminants (after Csanady 1983b)

Tidal currents distribute the effluent over an area, or "box" whose dimensions are approximately equal to the tidal amplitude. These dimensions are approximately $X = u_t T/2$ and $Y = v_t T/2$, in the alongshore and cross-shore directions, respectively, where u_t and v_t are the amplitudes of the tidal currents, and T is the tidal period. Csanady (1983b) calls this area the "extended source region."

Long-term average current speeds are usually much slower than instantaneous values. They lead to an average dilution equal to UhY/Q, where Q is the effluent flowrate, h the average depth of the plume over the extended area, and U the long-term average "flushing velocity."

This can be extended to include the other processes by applying a mass balance to the box. This yields a "long-term average dilution" S_p:

$$S_p = \frac{UhY}{Q} + \frac{v_e hX}{Q} + \frac{khXY}{Q} \tag{8}$$

The first term on the right is the dilution due to flushing by the mean current. The second is dilution due to cross-shore mixing which is parameterized by v_e, a mass transfer "diffusion velocity," that can be assumed equal to the standard deviation of the cross-shore tidal fluctuations (probably an underestimate). The third term is "dilution" due to chemical or biological decay, where k is a first-order decay rate. The total effective dilution is the sum of these individual dilutions.

Consider a typical problem. Suppose we have a discharge $Q = 4\ m^3/s$ into a tidal current whose alongshore amplitude is $u_t = 0.25$ m/s, and cross-shore amplitude is $v_t = 0.08$ m/s, and cross-shore rms velocity is $v_e = 0.04$ m/s. Suppose the average current speed (the flushing velocity) is $U = 0.06$ m/s. For a semi-diurnal tide, the period T is about 12 hours. Suppose further that the average depth (thickness) of the wastefield is 4 m.

Then the extended source area (size of the box in Figure F-4) is:

$$X = u_T T / 2 = 0.25 \times 12 \times 3600 / 2 \approx 5{,}400 \text{ m} \approx 5.4 \text{ km} \quad \text{and}$$

$$Y = v_T T / 2 = 0.08 \times 12 \times 3600 / 2 \approx 1{,}700 \text{ m} \approx 1.7 \text{ km}$$

and the dilutions for a conservative substance are:

$$\text{Due to the mean current:} \quad \frac{UhY}{Q} = \frac{0.06 \times 4 \times 1700}{4} \approx 100$$

$$\text{Due to cross-shore exchange:} \quad \frac{v_e hX}{Q} = \frac{0.04 \times 4 \times 5400}{4} \approx 220$$

The total effective dilution, the sum of these dilutions, is about 320.

These are obviously only approximate order of magnitude calculations, but they are very useful for estimating long-term impacts. They can be applied to other substances such as toxic materials to estimate their potential accumulation.

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MEMORANDUM

FILE NO.: 2037.29635

RE: Pebble Beach Water Entitlement

DATE: March 14, 2017

PREPARED BY: Thomas H. Jamison, Esq.

In 1989, the Monterey Peninsula Water Management District ("MPWMD") granted to Pebble Beach Company ("PBC") a Water Entitlement (the "Pebble Beach water entitlement") of 365 acre feet annually ("AFA") of potable water. The Pebble Beach water entitlement is described as "an irrevocable, divisible binding entitlement to potable water, as a vested property right and interest, in and for the Benefitted Properties, for use on and by the Benefitted Properties."[1] The Pebble Beach water entitlement was granted to PBC in exchange for PBC's financial guarantee of (a) principal and interest on $34 million in long-term bonds issued by MPWMD to pay the costs of construction and (b) any future financial operating shortfalls of the Carmel Area Wastewater District ("CAWD") - Pebble Beach Community Services District ("PBCSD") Wastewater Reclamation Project (the "Recycled Water Project"). The Recycled Water Project was completed and began operation in 1994, and initially met about 70% of the irrigation requirements of the eight golf courses and certain other recreational open spaces in the Del Monte Forest.

The "Benefitted Properties" on which the Pebble Beach water entitlement could be used were initially limited to PBC properties in Del Monte Forest. In 2004, MPWMD and PBC entered into a further agreement[2] which allowed PBC to sell up to 175 AFA of its Pebble Beach water entitlement to other landowners in Del Monte Forest for residential use on their land.[3] This right was granted in exchange for PBC's commitment to fund an additional $33 million cost of improvements to the Recycled Water Project. These improvements were needed to upgrade the quality and quantity of the recycled water so that the Recycled Water Project could meet

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[1] Wastewater Reclamation Project Fiscal Sponsorship Agreement between the Monterey Peninsula Water Management District and Pebble Beach Company dated as of October 3, 1989 (the "Fiscal Sponsorship Agreement").

[2] Supplemental Financing Agreement between the Monterey Peninsula Water Management District and Pebble Beach Company dated as of December 15, 2004 (the "Supplemental Financing Agreement").

[3] All of the land in Del Monte Forest was added as "Benefitted Properties".

100% of the irrigation requirements of the golf courses and other recreational open spaces in the Del Monte Forest.

The Pebble Beach water entitlement has been regarded and treated as "a vested property right and interest" by MPWMD and PBC; indeed, a major purpose and intent of the Fiscal Sponsorship Agreement was to make the Pebble Beach water entitlement as secure as possible as a "vested property right."[4] The Pebble Beach water entitlement granted to PBC the right to hook up to the California American Water ("Cal-Am") system simply upon submission of construction plans and payment of the required connection fees. At that time (1989), there had been no concerted challenge to Cal-Am's water rights in the Carmel River; and MPWMD did not apply to the California State Water Resources Control Board ("SWRCB") for any appropriative water rights permit for the Pebble Beach water entitlement.

In 1995, however, in response to a petition filed by the local Sierra Club and others, SWRCB found that Cal-Am only owned water rights in the Carmel River of 3,376 AFY, that its diversions in excess of this amount were illegal, and that such illegal diversions were causing harm to the Carmel River. (SWRCB Order WR 95-10). As a consequence, SWRCB ordered Cal-Am to reduce its diversions by 20%, from 13,542 AFA to a maximum of 11,285 AFA, and to take other actions to find alternate sources of water to replace, and thus terminate, its illegal diversions above 3,376 AFA.

In response to the SWRCB action, PBC arranged to meet with SWRCB staff to make sure the Pebble Beach water entitlement would continue to be respected and served under Order 95-10.[5] In a 1998 letter from the SWRCB Chief, Division of Water Rights, SWRCB stated that on account of the savings of the Recycled Water Project, "380 afa is available to serve these [Del Monte Forest] projects" and that SWRCB would "use its enforcement discretion to not penalize Cal-Am for excess diversions from the Carmel River as long as their diversions do not exceed 11,285 afa plus the quantity of potable water provided to Pebble Beach Company and other

[4] In this vein, MPWMD filed and obtained a final judgment in a Validation Action to validate, as a legal exercise of its authority, its actions in entering into the Fiscal Sponsorship Agreement (Judgment of Validation Pursuant to Code of Civil Procedure Sections 860-870, and Default, entered July 12, 1990, in Monterey County Superior Court Case No. M2159) (the "Validation Judgment").

[5] Footnote 2 in Order 95-10 recited that PBC had received the Pebble Beach water entitlement based on issuance of an appropriative right permit to MPWMD for the Pebble Beach water entitlement, implying that the Pebble Beach water entitlement was supported by a water right that was not affected by Order 95-10. However, MPWMD had not obtained an appropriative right permit for the Pebble Beach water entitlement.

sponsors under this entitlement."[6] This commitment was reiterated in further letters from SWRCB officials in 1998, 2001, and 2004.

In 2008, SWRCB staff commenced proceedings against Cal-Am based on Cal-Am's alleged failure to comply with Order 95-10's mandate to implement actions to reduce its illegal diversions from the Carmel River – specifically, Cal-Am's failure to pursue, aggressively enough in staff's opinion, a new water supply project to replace such illegal diversions.

SWRCB Cease and Desist Order No. WR 2009-0060 (the "CDO") ultimately adopted by the SWRCB ordered Cal-Am to reduce its diversions from the Carmel River to 10,978 AFA immediately, and to implement further specified reductions each year thereafter through December 31, 2016, at which time Cal-Am was ordered to terminate any further illegal diversions (as noted above, Cal-Am has the right to 3,376 AFA of legal diversions, and these were unaffected by the CDO). THE SWRCB also immediately prohibited Cal-Am from diverting water from the Carmel River "for new service connections or for any increased use of water at existing service addresses resulting from a change in zoning or use" – in essence, imposing a moratorium on any new connections or increased water use for new uses in the Cal-Am service area until a new water supply project was implemented.[7]

There were certain exceptions to this "moratorium," and the Pebble Beach water entitlement was one. The CDO recited the background and history of the Pebble Beach water entitlement, in particular the success of the Recycled Water Project in conserving potable water and PBC's role in assuring the financing of its costs, and concluded that SWRCB "should not prohibit any increased diversions from the river by Cal-Am for deliveries made under PBC's entitlement from MPWMD" during the period before the expected new water supply project came on line.[8] To implement this exception, the CDO stated: "Increased diversions from the river by Cal-Am to satisfy PBC entitlements from MPWMD shall be added to the adjusted base,

[6] The letter further stated that the enforcement discretion would continue to be exercised as long as the Recycled Water Project produced more reclaimed water than potable water used under the Pebble Beach water entitlement, and the reclaimed water was used in the Cal-Am service area. This condition has always been met by the Recycled Water Project.

[7] Lawsuits challenging the validity of Order 2009-0060 have been filed by Cal-Am, MPWMD, and certain other parties. PBC is named as a Real Party in Interest in the suit filed by MPWMD. The cases have been consolidated and are pending in the Santa Clara County Superior Court. Settlement discussions in the cases are ongoing.

[8] The CDO does state, however, that "any water users who receive water under the PBC entitlement should not be exempted from any conservation program or other effort to reduce Cal-Am's unauthorized diversions."

and are not subjected to section 2 of this order [the moratorium]. Water diverted from the river by Cal-Am for PBC entitlements can only be served to properties that have received a PBC entitlement from MPWMD and which are located in the Cal-Am service area. After December 31, 2016, Cal-Am shall not illegally divert water from the river to supply the holders of PBC entitlements." This language applied only to new connections to supply the Pebble Beach water entitlement after January 1, 2017. Owners of the Pebble Beach water entitlement who have hooked up and are using water prior to that date can continue to use water in the same manner as other existing Cal-Am customers who are already connected to the system.

To implement the terms of the CDO regarding the moratorium, Cal-Am filed an application with the PUC to impose a moratorium along the lines set forth in the SWRCB Order. The PUC rendered its decision in 2011. Cal-Am and various other participants raised the same issue they had raised in the lawsuit; i.e., while SWRCB has authority to limit Cal-Am's Carmel River diversions, it does not have jurisdiction to order a moratorium on service connections. The PUC, however, decided that "pending the outcome of those court cases, we take the position that an order of a sister agency carries a presumption of validity." As a result, the PUC ordered Cal-Am to recognize that SWRCB moratorium and incorporate it into its tariff schedules as a special condition. The Pebble Beach water entitlement exception was discussed and recognized in the decision, and made a part of the Order, as follows: "This special condition does not authorize California-American Water Company to deny service to … the area served by the Carmel Area Wastewater District [sic] Water Entitlement pursuant to Monterey Peninsula Water Management District Ordinances 39 and 109 and Rule 23.5, prior to January 1, 2017."

On July 19, 2016, upon the application of Cal-Am, MPWMD, PBC and others, SWRCB issued a modified CDO to extend the date for Cal-Am to complete a water supply project to December 31, 2021 and correspondingly extend to December 31, 2021 the date after which Cal-Am could supply the Pebble Beach water entitlements only from legal sources (Order WR 2016-0016).

The present status of the Pebble Beach water entitlement is as follows. The Pebble Beach water entitlement has been recognized by SWRCB (and by incorporation the PUC and Cal-Am) as a valid contractual right with MPWMD to water service. This right includes water service by Cal-Am. Cal-Am may provide new water connections to serve the Pebble Beach water entitlement from any source, including illegal diversions from the Carmel River, through December 31, 2021. After that date, Cal-Am can continue to serve the Pebble Beach water entitlement from any source, except that it cannot serve the Pebble Beach water entitlement from illegal diversions from the Carmel River. The PUC moratorium is to expire when there is concurrence by SWRCB that "a permanent supply of water is ready to serve as a replacement for the unlawful diversions of Carmel River water."

The following conclusions may be drawn from the foregoing discussion.

First, the Pebble Beach water entitlement remains valid without regard to whether a water supply project is completed by December 31, 2021, or indeed ever completed. It is not extinguished after December 31, 2021 by virtue of the SWRCB CDO; the only effect of the CDO is that the Pebble Beach water entitlement cannot be served with illegal Cal-Am diversions from the Carmel River after December 31, 2021. The Pebble Beach water entitlement can still be served thereafter from legal Cal-Am diversions from the Carmel River and from any other Cal-Am source.[9] Second, holders of the Pebble Beach water entitlement who have hooked up and are using water prior to December 31, 2021, can continue to use water in the same manner as other existing Cal-Am customers. Neither the CDO nor the PUC moratorium contains any language that would cause existing users of the Pebble Beach water entitlement to somehow be divested of their water use and cut-off from further Cal-Am service.[10]

Second, the Pebble Beach water entitlement holders are not subject to a moratorium. Any such action would be contrary to the Fiscal Sponsorship Agreement, the Supplemental Financing Agreement, the Ancillary Project Costs Agreement, and the MPWMD Rules adopted to implement the Recycled Water Project and the Pebble Beach water entitlement. All of these agreements contain covenants in some form that MPWMD and Cal-Am are to supply water to serve the Pebble Beach water entitlement without regard to source; and in the event water is not

[9] This is made clear in the SWRCB Order Denying Reconsideration issued in January 2010 on the CDO: "Order WR 2009-0060 does not contain language extinguishing the entitlements. The order leaves the entitlements in place; however, the entitlements must be served in a manner consistent with the water rights held by Cal-Am. When Cal-Am develops a new source of water that makes water available for new connections consistent with Order WR 2009-0060, the entitlements will apply to that new supply. We conclude, therefore, that Order WR 2009-0060 does not deprive petitioner of the water entitlements received from MPWMD."

[10] Such users would, as would all other users in the Cal-Am system, be subject to generally applicable conservation requirements for the Cal-Am system, including cutbacks in water use if adopted. This is explicit in the CDO, but it is required in any event under MPWMD rules applicable to Pebble Beach water entitlement users.

available through normal channels, water must be found elsewhere to serve the Pebble Beach water entitlement. The Fiscal Sponsorship Agreement recites that the "Water Entitlement evidenced by each Water Use Permit … shall not be terminated or diminished by reason of any water emergency, water moratorium or other curtailment on the setting of meters for the Cal-Am water system, and … shall not be subject to diminishment or revocation except as provided [in circumstances not applicable here]."[11] The Fiscal Sponsorship Agreement further states that in the event MPWMD "breaches any of its representations and warranties or covenants in this Agreement with respect to the Water Entitlement or the Water Permits: (a) in the event that, after such breach, an owner of a Benefitted Property is entitled to less potable water for use on such Benefitted Property than is contemplated by this Agreement or ceases to be entitled to a Water Use Permit for such Benefitted Property, as and to the extent contemplated by this Agreement, WMD shall utilize its regulatory powers to the fullest extent to immediately ensure that the owner of such Benefitted Property is entitled to receive, and does receive, potable water at such times, in such quantities and pursuant to such terms and conditions as are substantially equivalent to its rights with respect to potable water specified in this Agreement" and that "because the damages which such owner would suffer as a result of such breach would be irreparable and are difficult to quantify, such owner shall be entitled to specific enforcement."[12]

As for Cal-Am, the Ancillary Project Costs Agreements states:

> "4.1 Service to Properties. Cal-Am shall serve (a) the Benefitted Properties, and each property which succeeds to the interest of a Benefitted Property, in part or in whole, under the Water Use Permit issued with respect to such property (collectively, the "Successor Properties"), in accordance with the terms of the Water Use Permits issued with respect thereto, to the extent requested, from time to time, by the owners of such properties, with an aggregate of 380 acre feet of Water each year, and (b) each of the Benefitted Properties and the Successor Properties with the amount of Water that the owner of such property requests, from time to time, up to the maximum amount which such property is entitled to use

[11] Fiscal Sponsorship Agreement, section 4.4 (emphasis added). Supplemental Financing Agreement, section 4.3(8) contains nearly identical language. MPWMD Rule 23.5.A.8 contains substantially the same language. The exceptions are (a) PBC's failure to pay the Financial Commitment, and (b) failure to use all 380 AF of the Pebble Beach water entitlement by Jan. 1, 2075, and then only as to that portion not used.

> pursuant to this Agreement. Each Water Use Permit shall entitle the owner of a Benefitted Property or Successor Property to full water service by Cal-Am with respect to such property, including, without limitation, the installation of water meters as necessary, in accordance with the terms of such Water Use Permit. Cal-Am shall at all times reserve, and have the capability of providing, an amount of Water sufficient to meet its service obligations to all of such properties, and shall not serve or commit service of Water to other persons or entities which would, at any time, have the effect of impairing such capability. Cal-Am acknowledges the existence of, and agrees to honor, the Water Entitlement and each Water Use Permit according to the terms thereof. Cal-Am's obligations under the foregoing provisions of this Section 4.1 shall be subject to Section 11.17 hereof and the rules and orders of the PUC, the WMD and other governmental agencies having jurisdiction over Cal-Am. No limitations on the rights of any holder of any Water Entitlement hereunder shall affect or limit the rights of such holder to receive Water, and other related services from Cal-Am to which it may be entitled, from time to time, under applicable law on the same basis on which Cal-Am provides Water and such other services to its other customers."[13]

The foregoing quoted provisions of these agreements embody an unqualified obligation on the part of MPWMD, and Cal-Am as well, (1) to identify and supply water from Cal-Am legal sources after December 31, 2021, and (2) if Cal-Am is unable to do so, for MPWMD to identify and supply water from a source independent of Cal-Am's water rights, whether from MPWMD's own water rights or some external source. This obligation is exactly what PBC bargained for in accepting the Pebble Beach water entitlement in exchange for its commitment to assure payment of the nearly $67 million costs of the Recycled Water Project: an unquestioned, unqualified right to water service no matter what.

If the MPWSP (or any alternate water supply project) is not online by December 31, 2021, MPWMD and Cal-Am still have the obligation to serve the Pebble Beach water entitlement from their lawful water rights, either existing or future. How they determine to serve

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[12] Fiscal Sponsorship Agreement, Section 9.2 (emphasis added). The Supplemental Financing Agreement contains nearly identical language in section 6.2(a).
[13] Wastewater Reclamation Project Ancillary Project Costs Agreement between California American Water Company and Pebble Beach Company dated as of August 1, 1990, section 4.1, (emphasis added).

the Pebble Beach water entitlement will be in their discretion. As such, however, the Pebble Beach water entitlements clearly represent a component of the "Existing Demand" of Cal-Am.

EXHIBIT A

-ONFORMED COF..
OF ORIGINAL FILED
Los Angeles Superior Court

JUL 2 4 2007

ohn A. Clarke, Executive Officer/Clerk

By I. Flores, Deputy

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SUPERIOR COURT OF THE STATE OF CALIFORNIA

FOR THE COUNTY OF LOS ANGELES

CALIFORNIA WATER SERVICE COMPANY, et al., Plaintiff, v. CITY OF COMPTON, et al., Defendants.	Case No.: C 506 806 **JOINT STIPULATION AND [redacted] ORDER RE OPERATION OF GOLDSWORTHY DESALTER** Dept: 49 Honorable Judge Conrad Aragon

The following stipulation and proposed order are submitted by the Water Replenishment District of Southern California ("WRD") and the Department of Water Resources of the Resources Agency of the State of California, acting as Watermaster in the above-entitled action.

EXB

I. INTRODUCTION AND BACKGROUND

On March 21, 1980, an amended Judgment governing the West Coast Groundwater Basin ("Basin") was entered ("Amended Judgment"). Pursuant to that Amended Judgment, the Department of Water Resources serves as the Watermaster. The City of Torrance ("Torrance") is a party to the Amended Judgment with an adjudicated water right. WRD is not a party to the Judgment but has intervened in an Action relating to the operation of the Goldsworthy Desalter.

Upon Motion of WRD to this Court, on August 30, 2001, this Court entered an Order ("the "original Order") in connection with the operation of the project located in Torrance and commonly referred to as the "Goldsworthy Desalter" ("the "Desalter"). The Original Order allowed WRD to extract "saline groundwater" [defined as groundwater containing chlorides in excess of 1,000 parts per million ("ppm")] without first obtaining an adjudicated water right and without the extraction being debited against the adjudicated water rights of any party to the Amended Judgment as long as certain conditions were met. The Original Order was amended twice, once on June 24, 2002 and again on November 9, 2006. Copies of the three prior Orders governing operation of the Desalter are attached hereto as Exhibit A.

On November 9, 2006, the Court set a hearing for April 23, 2007 at which time the court sought to address the future operation of the Desalter and to determine whether the exemption from having to obtain an adjudicated water right granted pursuant to Paragraph 2 of the original Order shall no longer be effective. Among other things, the water being extracted from the Desalter well contained chlorides below the 1,000 ppm.

In its Status Brief for the April 23, 2007 hearing, WRD filed with the Court a contract services Agreement between WRD and Torrance ("Agreement"). Pursuant to that Agreement, Torrance is required to use a portion of its annual pumping rights to extract water from the Basin in an amount corresponding to the amount of groundwater extracted by WRD at the Desalter well on behalf of Torrance. Because the Agreement contemplates the

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extraction of groundwater pursuant to Torrance's adjudicated water rights in the Judgment, WRD asked the court to hold that the "Exemption" as set forth in the three court orders is no longer effective, and is therefore void.

The Watermaster, in its Response, agreed in principle with the general proposed solution as evidenced by the Agreement but identified certain flaws or omissions in the Agreement. Specifically, Watermaster argued that 1) the Agreement did not clearly require that any right to operate the well and extract water is conditioned upon the use of the Torrance's water rights without any regard to whether the water is above or below 1000 ppm; 2) The Agreement did not provide that if Torrance's water rights become unavailable, then production will be in violation of the Amended Judgment and will automatically cease; 3) The Agreement did not clarify that utilization of Torrance's water rights is not conditioned upon the levels of salinity of the water or the treatment of the water.

A status conference hearing was held in this matter on April 23, 2007 to consider whether the Exemption was no longer effective and therefore void. In addition, the court considered the Agreement as it related to the future operation of the Desalter. In addition to the issues raised by the Watermaster, the court asked for additional clarification with respect to the Agreement, specifically "whether or not the proposal by the District results in a substantive change in the Judgment or is otherwise prohibited by the Judgment or otherwise prejudices a party with Adjudicated Water Rights." (Transcript, p. 3 attached hereto as Exhibit B.)

After the April 23, 2007 hearing, the Court issued a minute order and signed an Order re Goldsworthy Desalter, copies of which are attached hereto as Exhibit C. The Court held that the Orders issued on August 30, 2001, June 24, 2002 and November 9, 2006 are no longer effective. The Court further ordered that any and all Exemptions for the Desalter are rescinded and void as of April 23, 2007. In addition, the court ordered that effective immediately; Torrance will utilize its annual adjudicated water rights (in the West Coast Basin Amended Judgment) for any and all extractions from the Desalter well. The Court

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ordered that "if at any time the City of Torrance fails to utilize its annual adjudicated water rights for extractions from the Goldsworthy Desalter, the Goldsworthy Desalter will immediately cease operating." A follow-up hearing was set for June 28, 2007 to consider approval of the Amended Agreement. In its Minute Order, the Court ordered WRD to file a revised Agreement no later than five court days before the hearing and ordered the parties to meet and confer to discuss and address the Court's concerns prior to the June 28th 2007 hearing.

To address the Court's concerns, this joint Stipulation and Order is submitted by the Watermaster and WRD in an effort to further clarify the nature of the proposed agreement. Specifically, this joint Stipulation and Order clarifies that: 1) the revised Agreement does not prejudice any parties to the Amended Judgment; 2) the revised Agreement is not being construed as a lease of water rights to a non-party; and 3) the revised Agreement must provide, as it presently does, that Torrance must utilize its adjudicated water rights for any and all extractions from the well associated with the Desalter, and if there is no Agreement, or the extractions exceed the amount allowed under this Agreement, the extractions must immediately cease.

In addition, the Watermaster and WRD stipulate and agree that the solution for this situation is unique and the Court does not determine that this situation or solution serves as a precedent in any way.

II. FACTUAL BACKGROUND

The purpose of the Amended Judgment was to adjudicate the rights of various parties to pump groundwater and to enjoin any groundwater production that is in excess of those adjudicated rights. The Amended Judgment does not address the quality of the groundwater that must be extracted and does not consider the chloride concentration of the groundwater extracted.

Because the Amended Judgment does not consider the chloride concentration of the groundwater extracted and because WRD was not a party to the Amended Judgment,

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this Court issued the Original Order authorizing WRD to intervene in a Motion regarding the operation of the Desalter in 2001.

One of the key terms of the 2001 Original Order was that WRD could operate the Desalter without an adjudicated water right, but the chloride concentration of the groundwater extracted must exceed 1,000 parts per million ("ppm"). If the chloride concentrations drop below the 1,000 threshold, WRD was required to commence a stakeholder process and, if certain conditions set forth in the Original Order were met, to shut down the Desalter or obtain an adjudicated water right. The concentrations of chloride have not consistently met the 1,000 ppm threshold specified in the Exemption. In order to prevent the shut down of the Desalter, WRD requested this court amend the 2001 Order on two occasions, once on June 24, 2002 and again on November 9, 2006.

The purpose of both amendments was to provide WRD with time to develop a solution for the Desalter that would allow it to continue to operate. To accomplish this task, WRD entered into an agreement with Torrance which provides that Torrance's adjudicated water rights under the Amended Judgment will be used to extract groundwater from the Desalter well. A copy of the originally proposed Agreement is attached as Exhibit D.

III. THE TORRANCE/WRD AGREEMENT

WRD summarizes the Agreement as follows: The Agreement is a contract services agreement between WRD and Torrance by which Torrance retains WRD as a contractor to provide Torrance with a fully treated potable water supply that meets all water quality standards for use as a domestic water supply. WRD provides these services by using the Desalter to treat up to 2,990 acre-feet of groundwater extracted from the Basin by Torrance. Under the terms of the Agreement, Torrance is required to use a portion of its annual pumping rights to extract groundwater from the Basin. WRD will then treat that same groundwater using the Desalter's treatment facilities. The Agreement requires Torrance to debit its annual allowable water extractions from the Basin in an amount directly corresponding to the amount of groundwater extracted by WRD.

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Because Torrance's annual allowable extractions will be reduced in proportion to the groundwater extracted, no party to the Amended Judgment will be unduly prejudiced by the Agreement; as long as the terms of the Agreement require that all extractions are reported to the Watermaster under Torrance's adjudicated water rights.

IV. PROGRESS SINCE THE APRIL 23, 2007 HEARING

At the last hearing on April 23, 2007, this Court issued a ruling that the Desalter can continue extracting groundwater, although pursuant to Torrance's rights, rather than pursuant to the Exemption. Since that date, WRD represents to this Court that the Desalter has been operating solely pursuant to Torrance's adjudicated rights. The Watermaster and WRD have worked together diligently in order to revise the Agreement and prepare this Joint Stipulation to accommodate both this Court's and the Watermaster's concerns. A copy of the revised Agreement is attached as Exhibit E.

An earlier revised version of the Agreement was presented to the Desalter Working Group on April 30, 2007 and May 23, 2007 and was presented to and approved by WRD's Groundwater Quality Committee on May 24, 2007. The revised Agreement was discussed at the Desalter Working Group on June 6, 2007, at which time the Desalter Working Group agreed to the final revised Agreement in concept (a final draft not being available) and recommended approval by WRD's Board of Directors. The final revised Agreement was then approved by WRD's Board of Directors on June 15, 2007 and by Torrance's City Council on June 19, 2007.

This revised Agreement clarifies the following issues: (1) that the Desalter will immediately shut down if, for whatever reason, Torrance's adjudicated water rights are no longer available. This does not preclude WRD attempting to first secure other water rights with approval of the Watermaster and the Court or attempting to secure an entirely new exemption from the court pursuant to the law and motion process set forth in the Judgment; (2) if WRD seeks to operate the Desalter in the future pursuant to an exemption, it must first secure Watermaster and court approval; and (3) that the agreement is not to be construed so

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that WRD has a leasehold interest or any other property interest in Torrance's adjudicated groundwater pumping rights in the West Coast Basin.

DATED: June 21, 2007

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DATED: June 19th, 2007

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[redacted] ORDER

Having reviewed the revised Agreement and the Stipulation set forth above, the Court hereby incorporates its Minute order dated April 23, 2007 and Order Re Goldsworthy Desalter dated April 23, 2007 and issues the following revised order:

1. The Orders issued on August 30, 2001, June 24, 2002 and November 9, 2006 are hereby rescinded and are no longer effective. Any and all Exemptions for the Goldsworthy Desalter Project are void as of April 23, 2007.

2. Effective as of April 23, 2007, Torrance will utilize its annual adjudicated water rights as set forth in the Amended Judgment for any and all extractions from the Goldsworthy Desalter Project well. If at any time Torrance fails to utilize its annual

adjudicated water rights for extractions from the Goldsworthy Desalter, the Goldsworthy Desalter will immediately cease operating.

3. The revised Agreement between Torrance and WRD addresses the concerns raised by the Court and the Watermaster.

4. Nothing in this Order or in the Stipulation or revised Agreement constitutes a precedent for any other project in the West Coast Basin nor does the Court make any findings or determinations that this solution serves as a precedent for any other project in the West Coast Basin.

DATED: JUL 24 2007

HONORABLE CONRAD ARAGON
Judge of the Superior Court

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EXHIBIT B

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SUPERIOR COURT OF THE STATE OF CALIFORNIA

FOR THE COUNTY OF LOS ANGELES

CALIFORNIA WATER SERVICE COMPANY, et al.,

Plaintiff,

vs.

CITY OF COMPTON, et al.,

Defendant.

Case No. C 506 806
[Related to Case No. C 786656]

Assigned for All Purposes to the Honorable Kenneth R. Freeman (Dept. 310)

AMENDED JUDGMENT

Action Filed: 7/21/1945

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(continued)

EXHIBIT B

NONCONSUMPTIVE USE

1. Nonconsumptive Water Use Right:

ORDER APPROVING INTERVENTION AFTER JUDGMENT OF HUGHES AIRCRAFT COMPANY, AS A PARTY DEFENDANT, AND AMENDING AMENDED JUDGMENT HEREIN

(Filed September 24, 1981)

The Petition of Defendant, Dominguez Water Corporation, for the order set forth below duly and regularly came on for hearing on September 24, 1981. Helm, Budinger & Lemieux and Ralph B. Helm, appeared as attorneys for said defendant and proof being made to the satisfaction of the court, and good cause appearing:

IT IS ORDERED that Hughes Aircraft Company be, and it is, hereby, made a party defendant herein, bound and entitled to the burdens and benefits of the Judgment herein.

IT IS FURTHER ORDERED that the Amended Judgment herein be further amended in the following particulars:

That there be added to the Amended Judgment herein, Paragraph III-A to read as follows:

"III-A

"There is hereby established a 'nonconsumptive water use right' in the Basin which is subordinate to the adjudicated rights set forth in Paragraph III hereof and which right is exercisable only on the hereinafter specifically defined lands and cannot be separately conveyed or transferred apart therefrom.

"Such right is exercisable without quantitative limit so long as Watermaster reasonably determines at the end of each fiscal year that the water produced from the Basin under such right is used in a closed system so that essentially all such produced water is returned without quality impairment, to the aquifer of the Basin from which the same was produced.

"Annually, during the first two weeks of June in each calendar year, such nonconsumptive water right producer shall submit to Watermaster a verified statement as to the amount and nature of the then current uses of said nonconsumptive right for the next ensuing fiscal year, whereupon Watermaster shall either affirm the nonconsumptive nature of such use or petition the Court for instructions or an injunction prohibiting the exercise of such nonconsumptive right by said nonconsumptive right producer.

"HUGHES AIRCRAFT COMPANY is the owner of a non-consumptive water right use in the Basin.

"A nonconsumptive water right owner shall, at such party's own expense, install and at all times maintain in good working order, mechanical measuring devices, approved by Watermaster, and keep records of water production and water returned to the Basin, as required by the Watermaster, through the use of such devices. The Watermaster may require such nonconsumptive use right party, at such party's own expense, to measure and record not more often than once a month, the elevation of the static water level of his well.

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"Any nonconsumptive production of a party herein shall be considered in the total adjudicated rights of all parties herein for the purpose of sharing Watermaster's fees as parties' costs.

"Payment of his proportionate share of Watermaster fees, whether or not subject to adjustment by the Court as provided in Paragraph XII of the Judgment herein, shall be made by each such party, on or prior to the beginning of the fiscal year to which such final budget and statement of assessed cost is applicable. If such payment by any party is not made on or before said date, the Watermaster shall add a penalty of 5 percent thereof to such party's statement. Payment required of any party hereunder may be enforced by execution issued out of the Court, or as may be provided by any order hereinafter made by the Court, or by other proceedings by the Watermaster or by any party hereto on the Watermaster's behalf.

"Each nonconsumptive water right owner, its officers, agents, employees, successors and assigns, IS ENJOINED AND RESTRAINED from materially changing said nonconsumptive use at any time without first notifying Watermaster of the intended change of use, in which event Watermaster shall promptly petition the Court for instructions concerning the future exercise of such nonconsumptive use right.

"Defendant owner of said nonconsumptive right shall comply with and be subject to the rules and regulations of Watermaster and within 60 days of the entry of this Order, confirm with the Watermaster that the meters now installed on its existing wells satisfactorily measure its water production and return to the Basin. If such meters are not approved by Watermaster, Defendant owner shall have meters of the type designated by Watermaster installed within 60 days of Watermaster's said determination.

"The property upon which said nonconsumptive use wells are located is situated in the County of Los Angeles, State of California and is described as follows:

Parcel 1:

The surface and that portion of the subsurface lying above a plane 500 feet in depth, measured vertically from the surface, as said surface existed on January 27, 1959 of that portion of that certain parcel of land in the Rancho Los Palos Verdes, in the city of Torrance, county of Los Angeles, state of California, allotted to Orin S. Weston by decree of distribution in the estate of B. S. Weston, recorded in book 2838 page 230 of Deeds, in the office of that certain tract of land marked "B.S. Weston 1898.4 Acres" on a map of partition of part of the Rancho Los Palos Verdes, filed in Case No. 11575, of the Superior Court of said county, a copy of which map is filed in book 1 page 3, of Record of Surveys, in said office of the county recorder, described as follows:

Beginning at the southwest corner of that certain parcel of land conveyed to Standard Oil Company by deed dated December 18, 1925, recorded in book 5494 page 188 of Official Records of said Los Angeles County; thence South 62° 50' 50" East along the southerly boundary line of said land conveyed to Standard Oil Company 2141.41 feet, to the southeasterly corner of the land described in the deed to Pacific Semiconductors, Inc., a Delaware corporation, recorded January 3, 1963, as Instrument No. 2182, in book D 1872 page 433, Official Records, and the true point of beginning of this description; thence northerly, parallel with the westerly boundary line of said B.S. Weston Allotment to a point in the southwesterly boundary line of Lomita Boulevard, formerly known as Wilmington and Salt Works Road, as described in deeds to the County of Los Angeles, recorded in book 1135 page 101 of Deeds, and in book 754 page 171 of Deeds, records of said Los Angeles County; thence southwesterly along the southwesterly boundary line of Lomita Boulevard 422.81 feet; thence southerly parallel with the westerly boundary line of said B.S. Weston allotment to a point in the southerly line of said land conveyed to Standard Oil Company; thence North 62° 50' 50" West along said southerly line 422.81 feet to the true point of beginning.

EXCEPT all oil gas, asphaltum and other hydrocarbon substances and other minerals in or under said land or that may be produced there from, but with no right of. en try upon or through the surface of or that portion of the subsurface lying 500 feet vertically in depth below the surface thereof, as reserved by H. J. Early and Daisy Lee Early, his wife, in deed recorded April 16, 1963.

Parcel 2:

The surface and that portion of the subsurface lying above a plane 500 feet in depth, measured vertically from the surface, as said surface existed on January 27, 1959 of that portion of that certain parcel of land in the Rancho Los Palos Verdes, in the city of Torrance , county of Los Angeles, state of California, allotted to Orin S. Weston by decree of distribution in the estate of B.S. Weston, recorded in book 2838 page 230 of Deeds, in the office of the county recorder of said county, and being the part of that certain tract of land marked "B.S. Weston 1898.4 Acres" on a map of partition of part of the Rancho Los Palos Verdes filed in Case No. 11575, of the Superior Court of said county, a copy of which map is filed in book 1 page 3, of Record of Surveys, in said office of the county recorder, described as follows:

Beginning at the southwest corner of that certain parcel of land conveyed to Standard Oil Company by deed dated December 18, 1925, recorded in book 5494 page 188 of Official Records of said Los Angeles County; thence South 62°SO'SO" East along the southerly boundary line of said land conveyed to Standard Oil Company 1718.60 feet, to the southeasterly corner of the land described in the deed to Pacific Semiconductors, Inc., a Delaware corporation, recorded May 1, 1961, as Instrument No. 1723, in book D 1206 page 131, Official Records, and the true point of beginning of this description; thence northerly, parallel with the westerly boundary line of said B.S. Weston Allotment to a point in the southwesterly boundary line of Lomita Boulevard, formerly known as Wilmington and Salt Works Road, as •described in deeds to the county of Los Angeles, recorded in book 1135 page 101 of Deeds and in book 754 page 171 of Deeds, records of said Los Angeles county; thence southeasterly along the southwesterly boundary line of Lomita Boulevard 422.81 feet; thence southeasterly parallel with the westerly boundary line of said B.S. Weston allotment to a point in the southerly line of said land conveyed to Standard Oil Company; thence North 62° 50' 50" West along said southerly line, 422.81 feet to the true point of beginning.

EXCEPT all oil, gas, asphaltum and other hydrocarbon substances and other minerals in or under said land or that may be produced therefrom, but with no right of entry upon or through the surface of or that portion of the subsurface lying 500 feet vertically in depth below the surface thereof.

Dated: September 24, 1981 [Signature]

Judge

2. <u>Nonconsumptive Use Practices</u>:

ORDER AMENDING JUDGMENT

(Filed with County Clerk on March 8, 1989)

GOOD CAUSE APPEARING upon the duly-noticed Motion of West Basin Municipal Water District:

IT IS HEREBY ORDERED THAT THE JUDGMENT HEREIN BE AMENDED AS FOLLOWS:

"NON-CONSUMPTIVE PRACTICES

1. Any party herein may petition the Watermaster for a non-consumptive water use permit as part of a project to recover old refined oil or other pollutants that has leaked into the

underground aquifers of the Basin. If the petition is granted as set forth in this part, the petitioner may extract the groundwater covered by the petition without the production counting against the petitioner's production rights.

2. If the Watermaster determines that there is a problem of groundwater contamination which the proposed project will remedy or ameliorate, an operator may make extractions of groundwater to remedy or ameliorate that problem if the water is not applied to beneficial surface use, its extractions are made in compliance with terms and conditions established by the Watermaster, and the Watermaster has determined either of the following:

(a) The groundwater to be extracted is unusable and cannot be economically blended for use with other water.

(b) The proposed program involves extraction of usable water in the same quantity as will be returned to the underground without degradation of quality.

3. The Watermaster may provide those terms and conditions the Watermaster deems appropriate, including, but not limited to, restrictions on the quantity of extractions to be so exempted, limitations on time, periodic reviews, requirement of submission of test results from a Watermaster-approved laboratory, and any other relevant terms or conditions.

4 The Watermaster shall conduct a public hearing on the petition and all parties herein and their representatives shall have an opportunity to be heard concerning the same.

5. The Watermaster shall, in its discretion, grant or deny the petition and fix a reasonable annual administrative fee to be paid to the Watermaster by the permittee. Within fifteen (15) days after the rendition of its decision, the Watermaster shall give written notice thereof to the designees of all parties herein.

6. After a noticed, public hearing, the Watermaster may, on the motion of any party herein or on its own motion, interrupt or stop a project for non-compliance with the terms of its permit or rescind or modify the terms of a permit to protect the integrity of the Basin of the Judgment herein. An order to interrupt or stop a project or to rescind or modify the terms of a permit shall apply to groundwater extractions occurring more than 10 days after the date of the order. The permit holder and the designees of all parties herein shall be given two weeks written

notice of any hearing to consider interrupting or stopping a permitted project or the rescission or modification of the terms of a permit. Notice will be deemed given when mailed by first-class mail or when personally delivered.

7. The Watermaster's decision to grant, deny, modify or revoke a permit or to interrupt or stop a permitted project may be appealed to this court within thirty (30) days of the notice thereof and upon thirty (30) days notice to the designees of all parties herein.

8. The Watermaster shall monitor and periodically inspect the project for compliance with the terms and conditions of the permit hereunder.

9. No party shall recover costs from any other party herein."

IT IS FURTHER ORDERED that the amendment to the judgment approved by the court on March 22, 1984 ("former amendment") is hereby repealed, provided, all permits issued by the Watermaster under the former amendment shall be deemed under the instant amendment.

Dated: March 8, 1989 [Signature]
Judge

BROWNSTEIN HYATT FARBER SCHRECK, LLP
21 East Carrillo Street
Santa Barbara, CA 93101-2706

EXHIBIT C

TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

TECHNICAL MEMORANDUM

Date: February 23, 2017

To: Nancy Isakson

From: Timothy Durbin, PE

Subject: Monterey Peninsula Water Supply Project DEIR

I have reviewed the groundwater impacts analysis contained in the January 2007 Draft Environmental Impact Report/Environmental Impact Statement ("DEIR") for the CalAm Monterey Peninsula Water Supply Project. I also have participated in review of the groundwater impacts analysis computer modeling through my participation in the Hydrogeological Working Group created pursuant to the large settlement agreement. Based on that review and evaluation, I conclude that the DEIR's groundwater impacts analysis supports the need to approve and implement the proposed Return Water Settlement Agreement ("RWSA"). Implementing the RWSA will help to ensure that operation of slant wells to produce source water for the MPWSP desalination process will not substantially deplete groundwater resources within the Salinas River Groundwater Basin and would help prevent the source water production from making a contribution to ongoing depletion of the groundwater resources within the Salinas River Groundwater Basin ("SRGB").

The operation of the slant wells will impact the water-budget balance and groundwater levels within the SRGB. However, those impacts will be ameliorated by the return-water provisions described in the RWSA. Correspondingly, the return-water element of the Project is important to maintaining the essential without-project conditions within the coastal portion of the SRGB.

The region near the Project slant wells has nearly balanced inflows and outflows. The inflows are local recharge and seawater inflow from Monterey Bay, and the outflows include local pumping and inland-directed underflow toward Salinas. The operation of the Project slant wells will change that balance. The incremental effects are increased seawater inflow, increased local pumping corresponding to the Project pumping, and decreased inland underflow. These would be the results without Project return water. The return water under the RWSA would cause oppositely directed incremental effects. Those effects are decreased seawater inflow and increased underflow. Furthermore, the return-water quantity specified within the RWSA is such that (1) net increase in seawater inflow is subsequently removed by the Project pumping and (2) the net change in underflow is zero. Correspondingly, the Project with return water has net zero water-budget impact.

Pumping from the Project slant wells will cause groundwater-level declines as described in the DEIS. However, the return water under the RWSA will cause groundwater-level increases. The effect of the return water is to reduce the groundwater-level impacts of the Project pumping. Without return water, groundwater-level declines occur in the dune sand 180-foot and 400-foot aquifers. With return water, groundwater-level increases occur in the dune sand, 180-foot, and 400-foot aquifer. Geographically averaged, groundwater levels are higher with return water than they would be if the proposed Project is implemented without the return water. Correspondingly, the Project with return water has a net zero water-level impact.

TIMOTHY J. DURBIN, INC.
CONSULTING HYDROLOGISTS

Timothy Durbin, P.E.

Experience

Tim Durbin has over 40 years of engineering experience and directs projects relating to groundwater and surface-water hydrology. Areas of expertise include design of multidisciplinary investigations, design of large-scale programs for the collection and interpretation of hydrologic data, and application of mathematical modeling to the analysis of problems in groundwater and surface-water hydrology. Tim Durbin's early professional career was with the U. S. Geological Survey, first as a research hydrologist, later as director of that agency's water-resource activities successively in Nevada and California.

Timothy J. Durbin, Inc. Carmichael, California, President (1999-present)[1]

Directs projects related to groundwater hydrology, surface-water hydrology, and water-resource management. Examples of such projects include:

San Diego County Groundwater, California. Analyzing the occurrence and availability of groundwater in southwestern San Diego County and northwestern Baja California. The work has involved characterizing the hydrogeologic setting, including the coastal sedimentary deposits and the inland crystalline rocks. The work has involved define the extent and thickness of water-bearing sediments and rocks, and it has include estimating recharge to water-bearing units underlying urban, agricultural, and natural areas. The study area includes the watershed areas tributary to the ocean from the San Diego River to the Tijuana River, including the portion of the Tijuana River watershed within Mexico. *City of San Diego*.

Eastern Yolo County Groundwater, California. Developing a plan for the optimal management of groundwater and surface-water resources within eastern Yolo County. The objective is to maximize the utilization of groundwater and surface water subject to constraints regarding groundwater levels, land subsidence, groundwater quality, streamflow depletions, surface-water rights, and facility capacities. A groundwater model has been developed for the study area, which will be used to allocate surface-water usage and to locate groundwater pumping to meet management objectives while satisfying the constraints.

Carbonate Aquifer System, Eastern Nevada. Analyzed the water-related impacts of groundwater development within the regional Carbonate Aquifer System that underlies central and eastern Nevada. The Southern Nevada Water Authority, which delivers water to Las Vegas and neighboring communities, is considering a project to import of groundwater from the Carbonate Aquifer. The analysis is focused on the possible impacts of the project on springs and phreatophytes. The work includes developing a groundwater model of the Carbonate Aquifer System. The model extends over an area covering 20,000 square miles. The work was done in support of hearings before the Nevada State Engineer on water-right applications by the Authority. *Southern Nevada Water Authority, Las Vegas, Nevada and subsequently U. S. Department of the Interior.*

Antelope Valley Groundwater Basin, California. The Antelope Valley groundwater basin is being adjudicated to address the overdraft within the basin. The groundwater basin underlies Palmdale, Lancaster, and Edwards AFB in northeastern Los Angeles County and southern Kern County. The work involved developing criteria for defining the geographic extent of the groundwater basin and estimating the natural recharge within adjudicated area. Work was done in support of litigation related to the adjudication. *City of Los Angeles, California.*

[1] Some of this work was done while associated with West Yost Associates, Davis, Calif.

Seaside Groundwater Basin, California. The Seaside groundwater basin was adjudicated to balance the threat of seawater intrusion against the need for groundwater production to supply water to communities overlying the basin and within the Monterey Peninsula area. Developed a groundwater model to assess the relation between groundwater production and seawater intrusion. Work was done in support of litigation related to the adjudication. *California American Water, Monterey, California*.

Heavenly Valley, California. Analyzed the hydrologic impacts of the proposed use of groundwater for snow-making within the Heavenly Valley ski resort. The proposal was to pump groundwater from an alpine valley within which the groundwater and surface-water system were hydrologically connected. The analysis involved collecting field data, constructing a linked groundwater/surface-water model, and using the model to predict the impact of the proposed pumping on both groundwater levels and streamflow. Work was done in support of a permit to pump additional groundwater for snow-making. *Vail Resorts, South Lake Tahoe, California.*

North Platte River, Wyoming and Nebraska. Analyzed the impacts of water-resource development and reservoir operations on water supply, streamflows, regional economics, and wildlife resources within the North Platte River Basin, Nebraska and Wyoming. Designed and directed a multi-disciplinary investigation involving agricultural engineers, groundwater hydrologists, surface-water hydrologists, agricultural economists, and environmental scientists in six different consulting firms. Work was done in support of litigation before the U.S. Supreme Court between the states of Nebraska and Wyoming. *Attorney General, Lincoln, Nebraska.*

Santa Monica Groundwater Basin, California. Analyzed the occurrence of MTBE in the Santa Monica groundwater basin, California. MTBE contamination from multiple sites has resulted in abandonment of public-supply wells. An analysis of the sources and fate of MTBE within the Santa Monica groundwater basin is being conducted. Work was done within the context of State and Federal regulatory proceedings and litigation. *ConocoPhillips, Houston, Texas.*

Special Master, California. Assigned as Special Master in a technical dispute between City of San Bernardino, California and the Regional Water Quality Control Board. The issue is the cause of a wastewater discharge to the Santa Ana River. The work was being done within the context of a State regulatory proceeding. *Regional Water Quality Control Board, Santa Ana, California.*

Hydrologic Consultants, Inc., Sacramento, California, President (1988-1999)[2]

Directed projects related to groundwater hydrology, surface-water hydrology, and water-resources management. Examples of such projects include:

Modesto and Turlock Groundwater Basins, California. Developed groundwater models for the Modesto and Turlock groundwater basins to facilitate basin management. The first model covered both the Modesto and Turlock basins. It was developed to support participation in Federal Energy Regulatory Commission (FERC) proceeding on Don Pedro Reservoir by the Modesto Irrigation District (MID) and Turlock Irrigation District (TID). The second model was developed for the Turlock basin. It was developed to facilitate decision making by TID and other local entities on groundwater planning and management. The third model was developed for the Modesto basin to support preparation of an EIR on a large residential and commercial development within the northwestern part of the basin. The model simulated both groundwater flow and salinity.

Lake Tahoe, California and Nevada. Analyzed the impacts of urban development on the water quality of Lake Tahoe, California. Work involved the analysis of sediment and nutrient transport in streams tributary to the lake and nutrient cycling within the lake. Work was done for litigation.

Streamflow Temperature, California. Analyzed streamflow temperature within the Owens River, Owens Valley, California. Work was done to evaluate the hydrologic feasibility of reestablishing a fishery within the Owens River.

Groundwater Salinity, California. Analyzed the source and management of surface-water and groundwater salinity within the Lompoc groundwater basin. Work involved developing groundwater and

[2] Some this work was done while associated with Bookman Edmonston Engineers, Sacramento, Calif.

surface-water models of the Santa Ynez River basin, including salinity models. Work was done in support of litigation.

Agricultural Drainage, California. Analyzed the causes and management of drainage water discharges from the Firebaugh and Central California Water District to natural watercourses and the San Joaquin River. Work was done in support of litigation.

FERC Re-licensing, California. Developed a model for the optimal use of ground water and surface water within the Turlock and Modesto Irrigation Districts for the benefit of water supply and environmental resources. Work was done in support of the FERC re-licensing of New Don Pedro Reservoir.

Seawater Intrusion, California. Analyzed seawater intrusion in the Salinas Valley. Analyzed the impacts of groundwater pumping on seawater intrusion. Analyzed the impacts of reservoir operations on streamflow recharge and seawater intrusion. Work was done in support of litigation.

Petroleum Contamination, California. Analyzed the source of soil and groundwater contamination by petroleum hydrocarbons at Santa Barbara, California. Work was done in support of litigation. Analyzed the source of soil and groundwater contamination by petroleum hydrocarbons at Oxnard, California. Work was done in support of litigation.

San Bernardino Groundwater Basin, California. Analyzed the occurrence of high groundwater levels in the San Bernardino Valley, California using surface-water and groundwater models. High groundwater levels resulted from excess artificial recharge and other factors. Work was done in support of litigation.

Arkansas River, Colorado and Kansas. Analyzed the effects of groundwater pumping and other factors in the depletion of streamflow in the Arkansas River at the Colorado-Kansas state line using surface-water, groundwater, and institutional models. Work was done in support of litigation in the U.S. Supreme Court between the states of Kansas and Colorado.

Geothermal Development, California. Analyzed the effects of geothermal development on thermal-spring discharges in the Mammoth Lakes area, California using groundwater and heat-transport models. Work was done in support of litigation.

S.S. Papadopulos & Associates, Inc., Davis, California, Vice President (1983-1988)

Directed and conducted investigations of numerous aspects of groundwater hydrology. Examples of such projects include:

Love Canal, New York. Analyzed the migration of groundwater contaminants at the Love Canal hazardous waste site in Niagara Falls, New York using a groundwater model. The Love Canal site is a Superfund Site. Work was done in support of litigation.

Groundwater Contamination, New Jersey. Analyzed the migration of groundwater contaminants at the Lone Pine landfill near Freehold, New Jersey. The Lone Pine landfill is a Superfund site. Work was done as part of a remedial investigation.

Modeling Code. Developed a computer program for the simulation of soil-water movement within and near a land-disposal facility. Work was done for the U.S. Environmental Protection Agency in support of the preparation regulations relating to the design of cover, liner, and leak-detection systems for land-disposal facilities.

Sediment Transport, California. Analyzed the impacts of urban development on flooding and sediment transport for streams in Orange County, California. Work supported the permitting of a large residential and commercial development project.

U.S. Geological Survey, Water Resources Division, California District, District Chief (1980-1983)

Managed California District (350 persons in 14 offices) with annual budget of $25 million (in 1995 dollars) for hydrologic investigations. Responsible for developing plans for hydrologic investigations and ensuring plans were implemented. Provided organizational and technical input to development of large scale, multi-agency investigations. Examples of such projects include:

Agricultural Drainage, California. Investigation of water quality related to agricultural drainage from the west side of San Joaquin Valley, California.

San Francisco Bay, California. Investigation of hydrodynamics of San Francisco Bay and Sacramento-San Joaquin, California Delta hydrologic systems.

Groundwater Exports, California. Investigation of the effects of exporting water from Owens Valley groundwater basin, California, including both hydrologic and biological impacts.

Central Valley Groundwater, California. Assessment of the groundwater resources of the Central Valley, California. Work was part of the Central Valley Regional Aquifer System Analysis (RASA).

Modeling Code. Development of numerical finite element codes (now used within the U.S. Geological Survey) for simulation of two- and three-dimensional groundwater flow and solute transport.

U.S. Geological Survey, Water Resources Division, Nevada District, District Chief (1977-1980)

Managed Nevada District (80 persons in three offices) with annual budget of $10 million (in 1995 dollars) for hydrologic investigations. Projects included:

Truckee River, Nevada. Design and organization of Truckee-Carson River Quality Assessment and Great Basin Regional Aquifer System Analysis (RASA).

Groundwater Management, Nevada. Development of groundwater and solute transport models for Washoe Valley, Galena Creek, Eagle Valley, and Carson Valley groundwater basins in Nevada.

Geothermal Development, Nevada. Design and organization of regional geothermal investigations of areas throughout Nevada including Dixie Valley, Ruby Valley, Black Rock Desert, and Carson Desert.

U.S. Geological Survey, Water Resources Division, California District. Hydrologist (1972-1977)

Served as Project Chief for numerous groundwater projects involving hydrogeologic and geophysical investigations and groundwater modeling. Conducted research in development of finite-element models for simulation of groundwater flow and mass transport. Applied results of research to solution of management problems and provided assistance to hydrologists within USGS and other public agencies in use of these models.

Registration, Education, and Affiliations

Professional Registration

Professional Civil Engineer, 1972
California License No. 20651

Education

Master of Science, Civil Engineering, Stanford University, California 1971
Bachelor of Science, Civil Engineering, Stanford University, California 1967

Professional Affiliations

American Society of Civil Engineers
American Geophysical Union
International Association of Hydrogeologists
National Groundwater Association

Publications

Papers

Durbin, T.J., 1974, Digital simulation of the effects of urbanization on runoff in the upper Santa Ana Valley, California: U.S. Geological Survey Water-Resources Investigations 41-73, 44 p.

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Kapple, G.W., Mitten, H.T., Durbin, T.J., and Johnson, M.J., 1984, Analysis of Carmel Valley alluvial ground-water basin, California, using digital flow model techniques: U.S. Geological Survey Water-Resources Investigation 83-4280, 45 p.

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Martin, P., and Durbin, T.J., 1990, Identification of net-flux rates for ground-water models: U.S. Geological Survey Water-Supply Paper, 2340, pp. 119-130.

Hromadka, T.V., and Durbin, T.J., 1986, Two-dimensional dam-break analysis for Orange County Reservoir: Water Resources Bulletin, v. 22, n. 2, p. 249-256.

Hromadka, T.V., and Durbin, T.J., 1986, Modeling steady-state advective transport by the CVBEM: Engineering Analysis, v. 3, n. 1, p. 9-15.

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Avon, L., and Durbin, T.J., 1994, Evaluation of the Maxey-Eakin method for estimating recharge to ground-water basins in Nevada: Water Resources Bulletin, v. 30, n. 1, pp. 99-112.

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Hromadka, T. V., Durbin, T.J., 2000, Estimating changes in sediment transport trends due to catchment changes: in Proceedings of Floodplain Management Association Conference on Non-Structural Solutions to Floodplain Management, San Diego, Calif.

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Hromadka, T.V., McCuen, R.H., Devries, J.J., and Durbin, T.J., 1993, Computer methods in environmental and water resources engineering: Lighthouse Publications, Mission Viejo (California), 590 p.

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Attorneys for Plaintiff WRAMP

SUPERIOR COURT OF CALIFORNIA

COUNTY OF MONTEREY

WATER RATEPAYERS ASSOCIATION OF THE MONTEREY PENINSULA, Petitioner, vs. COUNTY OF MONTEREY, MONTEREY COUNTY BOARD OF SUPERVISORS, MONTEREY COUNTY WATER RESOURCES AGENCY, CALIFORNIA COASTAL COMMISSION, CALIFORNIA COASTAL COMMISSION BOARD OF COMMISSIONERS, Respondents, CALIFORNIA AMERICAN WATER COMPANY, Real Party in Interest	**Case No.: 16CV001983** **FIRST AMENDED PETITION FOR WRIT OF MANDATE**

Petitioner hereby alleges as follows:

PARTIES

1. Petitioner Water Ratepayers Association of the Monterey Peninsula ("WRAMP") is a water ratepayers' advocacy group located in the County of Monterey. WRAMP's mission is to advocate in behalf of local Cal Am ratepayers for an adequate and affordable water supply by all reasonable means. WRAMP is bringing this lawsuit on behalf of and in the name of the State of California.

2. Respondent COUNTY OF MONTEREY ("COUNTY") is a political subdivision of the State of California, and Defendant MONTEREY COUNTY BOARD OF SUPERVISORS ("BOS") is the County's governing body. Respondent MONTEREY COUNTY WATER RESOURCES AGENCY ("MCWRA") is a political subdivision of the State of California and is overseen by a nine member Board of Directors, who are appointed by the BOS.

3. Respondent CALIFORNIA COASTAL COMMISSION ("CCC") is an agency of the State of California, and Defendant CALIFORNIA COASTAL COMMISSION BOARD OF COMMISSIONERS ("CCC COMMISSIONERS") is the CCC's governing body.

4. Real Party in Interest California American Water Company ("Cal-Am") is a subsidiary of American Water Works Company, Inc. Cal-Am is licensed to do business within the State of California and has its principal place of business in California. Cal-Am is a massive, multi-million dollar for-profit corporation with a lack of water rights and a record of a 20 year long, chronic and illegal diversion of water from the Carmel River. Cal-Am has made, and continues to make, tens of millions of dollars every year selling water to which it has no legal water rights or entitlements (See SWRCB Order 95-10).

JURISDICTION AND VENUE

5. This Court has jurisdiction over the subject matter of the Petitioner's claims because many of the transactions and events complained of herein occurred in this jurisdictional area and the project at issue in this lawsuit is located in Monterey County.

6. Venue is proper in this Court because the project at issue in this Complaint is located in the County of Monterey and many of the events alleged herein occurred within the County of Monterey, all Defendants conduct operations within the County of Monterey; and most witnesses either work or live within the County of Monterey.

BENEFICIAL INTEREST

A. Cease and Desist Order and Water Rationing

7. WRAMP is a ratepayer advocacy group comprised of Cal-Am ratepayers living

on the Monterey Peninsula. WRAMP and its members will all be specifically affected by the "Cease and Desist Order" ("CDO") of the State Water Resources Control Board ("SWRCB") against Cal-Am. The CDO was first imposed in 1995 by the State Board's Order WR 95-10. Among other matters, the order found that Cal-Am was diverting about 10,730 acre feet per year (afy) of water from the Carmel River without a valid basis of right and directed that Cal-Am should diligently implement actions to terminate its unlawful diversion.

8. In 2009, the State Board concluded that Cal-Am continued to illegally divert about 7,150 afy from the river without a valid basis of right. In Order WR 2009-0060, the SWRCB ruled that "Cal-Am shall diligently implement actions to terminate its unlawful diversions from the Carmel River and shall terminate all unlawful diversions from the river no later than December 31, 2016." The SWRCB also imposed a series of annual cut-backs.

9. At this point, despite the cut-backs and conservation efforts, Cal-Am has continued its illegal diversions from the Carmel River in order to meet the water demands of the Monterey Peninsula. Further, demand for water far exceeds supply and viable alternatives are still in the planning stages and have not been constructed. As noted above, the State Board's CDO requires Cal Am to stop most of its pumping from the Carmel River by January 1st, 2017. This is often referred to as the CDO "cliff." It is broadly recognized that the community would face severe water rationing if the community members were required to meet the CDO "cliff" without new water supply projects. WRAMP and its members, insofar as they reside in Cal-Am's service area, are beneficially interested in (i) Cal-Am's efforts to construct a viable alternative to the Carmel River diversion, and (ii) avoiding the water rationing that would occur if Cal-Am does not meet the January 1, 2017, CDO date set by the SWRCB.

B. <u>Ratepayer Reimbursement of Cal-Am Pre-Construction Costs</u>

10. In D.03-09-022, the CPUC authorized Cal-Am to track preconstruction costs related to a long-term water supply project in a memorandum account. In D.06-12-040, the Commission authorized California American Water to recover from ratepayers via Surcharge 1 the long-term water supply project costs that it was tracking in that memorandum account. The Commission also approved the Special Request 2 Surcharge ("Surcharge 2"), which could fund

the implementation of a water supply solution on a pay-as-you-go basis, but delayed implementation of Surcharge 2 until the issuance of a Certificate of Public Convenience and Necessity ("CPCN") for a long-term water supply project. In D.11-09-039, the Commission authorized California American Water to increase Surcharge 1 to 15%.

11. In a Settlement Agreement dated July 31, 2013, Cal-Am agreed to reduce the amount of Surcharge 2 from its proposed level of approximately $103 million to $71.5 million. In addition, the first $35 million of funds collected under Surcharge 2 will be applied to the lower risk pipeline components of the MPWSP. The remaining $36.5 million to be applied to the desalination facilities would only be collected after permits to construct the facility have been obtained.

12. Cal-Am is currently collecting the Surcharge 1 funds, which are being used by Cal-Am to fund MPWSP development costs until the CPUC approves the new project. (Surcharge 2 has not yet been funded.) WRAMP and its Cal-Am ratepayer members are beneficially interested in (i) ensuring that the Surcharge 1 and Surcharge 2 Funds are used efficiently; (ii) ensuring that the Surcharge 1 Funds are used for development costs that are lawful; and (iii) obtaining a ruling from this Court, before the Surcharge 1 Funds are dissipated (and before more Surcharge 2 Funds are collected), as to whether or not the predevelopment activities of Cal-Am are lawful.

C. <u>Compelling of Public Duties / Questions of Public Right</u>

13. All members of WRAMP are Monterey County and California state taxpayers, whose goal in bringing this lawsuit is to compel the performance of public duties which the law specifically requires. Finally, the questions raised herein are questions of public right and the object of the mandamus is to procure the enforcement of a public duty. WRAMP and its members are interested as citizens in having the laws executed and the duty in question enforced.

FACTS

I. GENERAL BACKGROUND

14. In 2004, California American Water Company filed Application A.04-09-019 seeking a Certificate of Public Convenience and Necessity from the California Public Utilities Commission. The Coastal Water Project ("CWP") was intended to replace existing Carmel River water supplies for the Cal-Am Monterey District service area that are constrained by the SWRCB decisions. In general, the previously proposed CWP involved the production of desalinated water supplies, increased yield from the Seaside Groundwater Basin ASR system, and additional storage and conveyance systems to move the replacement supplies to the existing Cal-Am distribution system.

15. On January 30, 2009, the CPUC published a Draft Environmental Impact Report (EIR) analyzing the environmental impacts of the CWP proposed project (also referred to as the Moss Landing Project), as well as the environmental impacts of two project alternatives-the North Marina Project and the Regional Project. The CPUC published the Coastal Water Project Final EIR (SCH No. 2006101004) in October 2009 and certified the EIR in December 2009 (Decision D.09-12-017). A year later, in Decision D.10-12-016, the CPUC approved implementation of the Regional Project alternative.

16. Subsequent to approval of the Regional Project, Cal-Am withdrew its support for the Regional Project in January 2012. As a result, on April 23, 2012, Cal-Am filed an application with the CPUC for a reconfigured Monterey Peninsula Water Supply Project (the "MPWSP") (A.12-04-019), seeking a Certificate of Public Convenience and Necessity (CPCN) to construct, own, and operate a desalination facility for water supply on the Monterey Peninsula. The MPWSP application to the CPUC proposed a subsurface intake feedwater system consisting of slant wells located at the CEMEX sand mining property in Marina, CA.

17. The Salinas Valley groundwater basin has been identified as being in overdraft by the California Department of Water Resources, the CCC, and the Monterey County Water Resources Agency (MCWRA) for over 60 years. The sole source of recharge to the aquifer is rainfall and water percolated into the Salinas River from water supply projects paid for,

pursuant to Proposition 218 requirements and provisions of the California Constitution, by overlying land owners (assesses) within the basin, including the Ag Land Trust. The overlying water rights holders have paid tens of millions of dollars to protect and restore their groundwater supplies. Cal-Am has not paid anything to protect and preserve the aquifers, and has acquired no groundwater rights in the basin or from those projects.

18. The overdraft was initially identified in Monterey County studies of the basin in the 1960's and 1970's, and has been repeatedly identified by more recent MCWRA hydrologic and hydro-geologic studies (U.S. ARCORPS, 1980; Anderson-Nichols. 1980-81; Fuqro, 1995; Montgomery-Watson, 1998). The universally identified remedy for seawater intrusion specified in these studies is the reduction of well pumping near the coast. Further, the overdraft in the North County aquifers has been publicly acknowledged for decades by both the Monterey County Board of Supervisors and the CCC in the certified "North County Land Use Plan (Coastal)" (1982), the Monterey County General Plan (1984 and 2010) and the North County Area Plan (1984).

19. Land owners within the basin have spent millions of dollars over the last sixty years to build water projects to reverse and remedy the overdraft and recharge the aquifers. Cal-Am has not spent anything to protect the groundwater resources of the Salinas Valley.

20. Wells and pumps belonging to the Ag Land Trust, on the Trust's ranch adjacent to the location of Cal-Am's proposed well field, are maintained and fully operational. The Trust's largest well is located west of Highway 1 and within the "cone of depression" area of Cal-Am's proposed "taking" of the groundwater. Its water is being taken and contaminated by Cal-Am's actions that are endorsed by CCC staff and County staff.

21. The Trust relies on its groundwater and overlying groundwater rights to operate and provide back-up supplies for the Trust's extensive agricultural activities. The Trust's property was purchased with federal grant funds and the U.S. Department of Agriculture, which has a reversionary interest in the Trust's prime farmland and the Trust's water rights and supplies that underlie the Trust's farm.

22. Cal-Am constructed a test slant well and pilot program (including the slant well, a

submersible well pump, a wellhead vault, and related facilities). The test slant well was screened at depths corresponding to both the Dune Sand Aquifer and the underlying 180-Foot-Equivalent Aquifer of the Salinas Valley Groundwater Basin. This slant test well has been intermittently operational since April 2015. When operational, the test well has extracted approximately 2,000 gallons per minute from the Dune Sand Aquifer and the 180-foot-Equivalent Aquifer of the Salinas Valley Groundwater Basin. The entirety of that water is being discharged into the Pacific Ocean.

23. Cal-Am's assertions that it intends to pump seawater from the proposed "test well" is untrue. Cal-Am has conducted water quality sampling that already shows that its proposed extended pumping of that test well will intentionally and significantly draw water from "fresh" potable aquifers (180 ft. and 400 ft.) that underlie the Ag Land Trust property and the property of other local landowners, and aggravate seawater intrusion below the Ag Land Trust property and the property of other local landowners.

24. Cal-Am wants to be a junior water appropriator without overlying or senior groundwater rights. Cal-Am has no groundwater rights and cannot acquire any. Cal-Am has conducted water quality sampling that already shows that its proposed extended pumping of the test well has drawn and will continue to intentionally and significantly draw water from "fresh" potable aquifers without a claim of right. Specifically, as shown in the most MPWSP Test Slant Well Long Term Pumping Monitoring Report No. 74 (attached hereto as Exhibit A and incorporated herein by reference), the TDS in the nearby monitoring wells have increased from 25,400 mg/L to a high of 31,700 mg/L – a 25% increase in groundwater salinity. (Ex. A, Table 2.)

25. The test well also has a number of monitoring wells that monitor changes in groundwater elevation, total dissolves solids, and conductivity. Several of these wells are located in unincorporated Monterey County (covered by the North Monterey County Land Use Plan) and show changes to the Salinas Valley Groundwater Basin as a result of Cal-Am's pumping.

26. Further, the test well has and will result in a huge cone of depression in the area

surrounding the test well, and the excessive duration (2 years) of Cal-Am's intended pumping, has resulted and will result in the contamination of surrounding wells (including wells owned by the Ag Land Trust) and the unlawful "taking" of potable groundwater from beneath the adjacent properties. The drop in local groundwater levels during periods of pumping is shown in the Long Term Pumping Monitoring Report Figure 2-1 through 2-12.

27. Finally, MCWRA holds no overlying groundwater rights in the overdrafted Salinas Valley groundwater basin and thus cannot grant any such rights to Cal-Am.

II. VIOLATIONS OF MANDATORY NORTH MONTERY COUNTY LAND USE PLAN (COASTAL) REQUIREMENTS

A. Applicable Provisions of the Coastal Plan

28. The "test well" directly violates the following policies / mandates of the certified North Monterey County Land Use Plan (Coastal) that Monterey County and the Coastal Commission are required to uphold and enforce:

- NMCLUP 2.5.1 Key Policy: The water quality of the North County groundwater aquifers shall be protected, and new development shall be controlled to a level that can be served by identifiable, available, long term-water supplies. The estuaries and wetlands of North County shall be protected from excessive sedimentation resulting from land use and development practices in the watershed areas.

- NMCLUP 2.5.3 Specific Policies:

  - The County's Policy shall be to protect groundwater supplies for coastal priority agricultural uses with emphasis on agricultural lands located in areas designated in the plan for exclusive agricultural use.

  - The County's long-term policy shall be to limit groundwater use to the safe-yield level. The first phase of new development shall be limited to a level not exceeding 50% of the remaining buildout as specified in the LUP. This maximum may be further reduced by the County if such reductions appear necessary based on new information or if required in order to protect agricultural water supplies. Additional development beyond the first phase shall be permitted only after safe-yields have been established or other water supplies are determined to be available by an approved NMCLUP amendment. Any amendment request shall be based upon definitive water studies, and shall include appropriate water management programs.

- The County shall regulate construction of new wells or intensification of use of existing water supplies by permit. Applications shall be regulated to prevent adverse individual and cumulative impacts upon groundwater resources.

29. Cal-Am's illegal pumping and then its "wasting/dumping" of the potable groundwater resources will result in significant individual and cumulative adverse impacts, immitigable permanent damage, a continuing nuisance, and irreversible seawater intrusion into the potable groundwater resources and aquifers of the Salinas Valley Groundwater Basin. Further, it will cause irreparable damage to the adjacent protected prime coastal farmlands in violation of the certified Land Use Plan (Coastal).

B. Harm to the Groundwater Supply

30. The harm to the North Monterey County groundwater supply is evidenced by Cal-Am's violation of three separate laws. First, Cal-Am's actions violate the new mandates of Governor Brown's groundwater legislation that specifically identifies (and prohibits) "significant and unreasonable seawater Intrusion" as an "Undesirable Result" that must be avoided in the management of potable groundwater basins, and specifically in the Salinas Valley. (See AB 1739 (Dickinson); SB1168 (Pavley); and SB1319 (Pavley) signed by Governor Brown in October, 2014).

31. Second, Cal-Am, through its test well, intends to intentionally contaminate a potable groundwater supply in violation of multiple state regulations and water quality laws. The California Regional Water Quality Control Board – Central Coast (CCRWQCB) is tasked with the adoption and enforcement of the Water Quality Control Plan for the Central Coastal Basin. The Plan was adopted in June 2011 and references the SWRCB Non-Degradation Policy adopted in 1968 which is required to be enforced by the CCRWQCB: "wherever the existing quality of water is better than the quality of water established herein as objectives, such existing quality shall be maintained unless otherwise provided by the provisions of the State Water Resources Control Board Resolution No. 68-16, Statement of Policy with Respect to

Maintaining High Quality of Waters in California, including any revisions thereto."

32. Third, Cal-Am's test well, and its removal of groundwater from the basin (and discharging that groundwater into the Pacific Ocean) violates several aspects of California groundwater rights law:

- In an overdrafted percolated groundwater basin, there is no groundwater available for junior appropriators to take outside of the basin. (*Katz v. Walkinshaw* (1902) 141 Cal. 116). This is the situation in the over-drafted Salinas Valley percolated groundwater basin, there is no "new" groundwater underlying the over-drafted Salinas aquifers. Cal-Am is a junior appropriator that has no rights to groundwater in the Salinas Valley, and it can't get any.

- The "Doctrine of Correlative Overlying Water Rights," as created and interpreted by the California Supreme Court in *Walkinshaw*, and as reiterated for the last 110 years (most recently in *City of Barstow v. Mojave* (2000) 23 Cal.4th 1224, prohibits any land owner in an over-drafted percolated groundwater basin from pumping more than that land owner's correlative share of groundwater from the aquifer as against all other overlying water rights holders and senior appropriators. CEMEX (the landowner where Cal-Am's wells are located) is only allowed to pump a fixed (correlative) amount of water for beneficial uses solely on its' property.

- Finally, Cal-Am has not used and has indicated that it intends to not use, but has "dumped" and intends to "dump" the water it pumps from its "test well," including the Trust's potable water, back into the ocean, thereby constituting a prohibited "waste of water" and a direct violation of Article X, Sec.2 of the Constitution of California and the "Doctrine of Reasonable Use." (*Peabody v. Vallejo* (1935) 2 Cal.2d 351-371.)

C. **Duty to Enforce**

33. The California Coastal Commission and the County of Monterey are legally required, duty bound, and obligated to enforce the non-discretionary mandates encompassed by and included in the state certified local coastal plans, including the NMCLUP.

34. The legal obligations to enforce the non-discretionary mandates in this state certified local coastal plan, which was unanimously certified and adopted on March 1, 1982 by the California Coastal Commission and adopted by the Monterey County Board of Supervisors in June of 1982, may not be ignored or waived by either the staffs or the voting officials of those two governmental entities.

35. The 1982 certified land use plan for North Monterey County is an adopted and enforceable California state coastal plan (certified Land Use Plan (Coastal)) as provided for by the State Legislature in the California Public Resources Code and the California Coastal Act. All State agencies, including the Coastal Commission, have a duty and are mandated at all times both to enforce the state certified requirements in the North County NMCLUP policies, and to jealously protect the recognized groundwater resources of the Monterey County Coastal Zone, and particularly to preserve protected and statutorily protected coastal agricultural resources.

36. It is mandatory that certified local coastal plans, requiring protection and preservation of identified, recognized, and protected coastal natural resources, are required to be enforced by both the County and the Coastal Commission, even if the threat of damage or loss to protected groundwater resources, or the violation of the mandated protective policies in the certified NMCLUP, result from activities that are outside, but immediately proximate, to the jurisdictional coastal area of the NMCLUP.

37. Finally, the Monterey County Department of Environmental Health issued a well permit for the Test Well, which was required before the Test Well could begin operations. Upon information and belief, the Department of Health, in issuing the permit, was acting as a contracting agency for the City of Marina. Nonetheless, upon information and belief, the Department of Environmental Health, as a subdivision of the County of Monterey, was required to comply with the NMCLUP in issuing those permits.

38. Enforcement of the NMCLUP is addressed in section 7.2.8 of the NMCLUP, which provides that the County (i) shall refer possible violations to the County Planning Department for investigation; and (ii) shall refer violations to the County Counsel's office or District Attorney's office, as appropriate. While the normal remedy is a misdemeanor prosecution, the County can also enjoin misuse, or impose civil penalties, where appropriate.

D. <u>CPUC and MBNMS Involvement</u>

39. As noted above, Cal-Am filed an application with the CPUC for a reconfigured Monterey Peninsula Water Supply Project (the "MPWSP") (A.12-04-019), seeking a CPCN to

construct, own, and operate a desalination facility for water supply on the Monterey Peninsula. That project is currently undergoing environmental review pursuant to CEQA, and the CPUC is the CEQA lead agency. The Monterey Bay National Marine Sanctuary is the NEPA lead agency for federal review. The draft Combined DEIR/DEIS is scheduled to be issued on December 21, 2016.

40. This lawsuit does not implicate, and will not frustrate or hinder, any general supervisory or regulatory policies of the CPUC. First, the CPUC is not the state expert on water issues – that function belon

41. gs to the State Water Resources Control Board ("SWRCB"). This includes issues relating to the legal feasibility of the MPWSP, given the water rights issues involved. Further, it is the SWRCB, and not the CPUC, that has jurisdiction over groundwater issues and basin degradation. Significantly, it is the SWRCB's Ocean Plan, rather than any supervisory or regulatory policy of the CPUC, that will govern permitting and legal challenges. Finally, this Petition challenges Cal-Am specific activity and not regulatory or supervisory policies.

42. Second, this lawsuit concerns issues relating to basin degradation and illegal water exportation and seeks mitigation of those issues. There are no regulations of the CPUC that would *preclude* or *hinder* mitigation, and accordingly, such mitigation would not interfere with the CPUC's function.

43. Third, there has been no indication that the CPUC has been actively seeking to regulate in the area of basin degradation and water exportation from the SVGB. Nor has there been a finding that the basin degradation and water exportation could not be mitigated without violating a CPUC regulation. As such, exclusive CPUC jurisdiction is inappropriate. *See Wilson v. Southern California Edison Co.* (2015) 234 Cal.App.4th 123, 151.

44. Fourth, the relief sought in this Petition will not have the effect of reversing, correcting, or annulling any decision or order of the CPUC.

FIRST CAUSE OF ACTION AGAINST CALIFORNIA COASTAL COMMISSION, CCC COMMISSIONERS, COUNTY OF MONTEREY, AND BOS

Violation of the Land Use Plan (Coastal)

45. Petitioner hereby incorporates by reference paragraphs 1 through 43 as if fully set forth herein.

46. The California Coastal Commission and the County of Monterey are legally required, duty bound, and obligated to enforce the non-discretionary mandates encompassed by and included in the state certified NMCLUP.

47. Cal-Am's slant test well is in violation of Key Policy 2.5.1 of the NMCLUP and the Specific Policies of section 2.5.3 of the NMCLUP, as detailed above. Cal-Am's pumping from the slant test well is also in violation of state water laws and is causing harm to groundwater supplies. Finally, Cal-Am's pumping is in violation of the Monterey County Water Resources Agency Act.

48. On May 19, 2016, Petitioner wrote to the County and CCC and demanded that each entity enforce the NMCLUP concerning Cal-Am's slant test well, for the reasons listed above. During the week of June 20, 2016, the CCC and County each responded that it would not enforce the terms of the NMCLUP. The CCC's and County's failure to enforce the terms of the NMCLUP are in direct conflict with state law. This Court's intervention is therefore required to remedy the CCC's and County's action in this regard. Accordingly, the Court should issue a writ of mandate directing the CCC and County to enforce the NMCLUP (Coastal) as required by State law, including if appropriate by issuing a cease-and-desist order to Cal-Am.

SECOND CAUSE OF ACTION

(Withdrawn)

THIRD CAUSE OF ACTION (AGAINST MCWRA)

Violation of Agency Act

49. Petitioner hereby incorporates by reference paragraphs 1 through 47 as if fully set forth herein.

50. MCWRA is organized and existing under the Monterey County Water Resources Agency Act, Water Code Appendix Chapter 52 ("Agency Act"), and its territory consists of "all of the territory of the county lying within the exterior boundaries of the county." (Agency Act Section 52-4). The Agency Act provides in relevant part:

> The Legislature finds and determines that the agency is developing a project which will establish a substantial balance between extractions and recharge within the Salinas River Groundwater Basin. *For the purpose of preserving that balance, no groundwater from that basin may be exported for any use outside the basin*, except that use of water from the basin on any part of Fort Ord shall not be deemed such an export. *If any export of water from the basin is attempted, the agency may obtain from the superior court, and the court shall grant, injunctive relief prohibiting that exportation of groundwater.*" (Agency Act § 52-21; emphasis added)

51. Cal-Am's Project includes a desalination plant that will provide a potable water supply for Cal-Am's Monterey Peninsula service area. Rather than using an open-ocean intake that would produce only seawater as source water for the desalination plant, the Project desalination plant will produce its source water from subterranean slant wells drilled adjacent to the ocean. The location of the wells overlies the western portion of the Salinas Valley Groundwater Basin ("SVGB") (identified in the Return Water Agreement as the Salinas River Groundwater Basin). (Return Water Agreement, attached as Ex. B and incorporated herein by reference.)

52. Interestingly, Cal-Am initially planned to draw its source water via slant wells from under the seafloor because the company lacked water rights to draw water from the SVGB. This earlier planned action was supposed to avoid violation of the state Agency Act – the assumption being that the water was not going to be drawn from the SVGB despite the well-known fact (McMillian, 2006) that the basin extends miles out to sea. Cal-Am has since reconfigured its intake structure and moved the slant wells further inland. (*See* Change in

project description in CPUC A.12-04-019, Service of Amended Application dated March 14, 2016, attached hereto as Exhibit C and incorporated herein by reference.) Cal Am now proposes to obtain the project's source water from aquifers that are a part of the Salinas Valley Groundwater Basin. That proposed action is in direct violation of the state Agency Act, which prohibits the exportation of groundwater from the Salinas Valley.

53. Recognizing that the groundwater it now plans to use for source water comes from the SVGB, Cal Am is proposing to satisfy the Agency Act through the Return Water Agreement, whereby Cal-Am would return to the SVBG sufficient potable water claimed to be equal to the potable percentage of the groundwater it extracted. Cal-Am's thinking can be summarized as follows:

- The SVGB groundwater in the area of the slant wells is "brackish," meaning it contains a level of salts and other dissolved solids ("Total Dissolved Solids" or "TDS") that exceeds the levels found in drinking water. According to Cal-Am, this means that the SVGB groundwater is a combination of seawater (not subject to the Agency Act, according to Cal-Am) and freshwater (subject to the Agency Act, according to Cal-Am).
- Pacific Ocean seawater along the U.S. West Coast has a TDS concentration of 33,500 mg/L of which approximately 75% is sodium chloride.
- By comparing the TDS in the slant well source water against the TDS in seawater, Cal-Am contends that it can calculate the ratio of freshwater to seawater in the groundwater
- Cal-Am further contends that, after thus calculating the percentage of freshwater, it is ***only*** this volume of water that is subject to the Agency Act prohibition on exportation

54. In short, Cal-Am is planning now to satisfy the Agency Act by returning a fraction of the potable water it filters from source water to the SVGB while exporting a much larger fraction to the Monterey Peninsula, the two fractions putatively corresponding to the fractions of basin-water and seawater in the source water, respectively. One tacit premise of this plan is that basin water consists only of potable water, a fraction of which is all that needs to be returned to the SVGB to satisfy the Agency Act. That promise is untrue. Basin water consists of not only potable but also non-potable components, possibly including salt, which need to be

subject to filtration, including desalination if necessary, to produce potable water. If the premise were true, desalination would be unnecessary.

55. Moreover, according to hydrologist Curtis J. Hopkins in his 26 May 2016 Memo re: North Marina Area Groundwater Data and Conditions (attached hereto as Exhibit D and incorporated herein by reference), the water found in the test wells is characteristic of freshwater and not seawater: "while the freshwater in this area contains salts and nutrients that are derived from overlying land uses ... , the chemical character is not sodium chloride, which is indicative of seawater intrusion ... [T]he chemical character of groundwater in these new [monitoring] wells is predominantly calcium chloride and calcium bicarbonate." (Ex. D, p. 7.)

56. What is more, the attempt to redefine groundwater as "potable water under the ground" was foreclosed by CPUC ALJ Weatherford when he ruled that a desalination facility is not an independent "water source":

> In addition, Marina Coast assumes that the desalination plant is a "water source," and based on that assumption, Marina Coast argues that the desalination plant falls outside of the Commission's purview. (Marina Coast Reply Brief at 1-2.) Marina Coast's assumption is incorrect. While the proposed desalination plant may produce fresh water, it is not the source or supply of water – the source of water would be the ocean (or possibly groundwater). Treatment of surface water or groundwater does not make the treatment plant the "source" of that water. Likewise here, treatment of seawater (including desalination) does not make the treatment plant the source of the water. (Excerpt from p. 15 of D.12-10-030 (31 October 2012.)

49. To remove any doubt, consider the following.: Return water is a tiny fraction of groundwater extracted and exported from the Salinas Valley whose return to the valley the Return Water Agreement claims will comply with the state Agency Act's prohibition of the exportation of groundwater from the valley (Fort Ord excepted), the rationale being that the tiny fraction (currently about nine percent) is the total amount of potable water existing in the extracted and exported groundwater. That rationale is patently false. The fraction computed is not a fraction of *water*. It is a fraction of *total dissolved solids* ("TDS"), equal to the ratio to the amount of TDS in a liter of seawater of the difference between that amount and the amount of TDS in a liter of groundwater. On the false assumption that the remaining fraction of the groundwater is solely TDS, that ratio is supposed to represent the fraction of the groundwater

that is pure or potable. In fact, 96.5 percent of seawater is pure water (H_2O), 96.8 percent being the corresponding percentage for the groundwater currently at the proposed MPWSP well site. The 0.3 percent pure-water difference represents the nine percent difference in TDS between local groundwater and seawater (0.3 is about nine percent of the 3.5 percent seawater TDS). What does that mean? It means that application of the return-water doctrine would return to the Salinas Valley only 0.31 percent of the pure water (0.3/96.8) extracted and exported from the valley, a return obviously as illegal as it is illogical.

50. Finally, since April 2015, when operational, the test well has extracted approximately 2,000 gallons per minute from the Dune Sand Aquifer and the 180-foot-Equivalent Aquifer of the Salinas Valley Groundwater Basin. The entirety of that water is being discharged into the Pacific Ocean. By definition, this is groundwater that is exported outside of the SVGB. No effort has been made by the MCWRA to prohibit Cal-Am from currently exporting this SVGB groundwater into the Pacific Ocean.

51. On May 19, 2016, Petitioner wrote to the County and demanded that it enforce the provisions of the Agency Act listed above. During the week of June 20, 2016, the County (on behalf of itself and the MCWRA) responded that it would not enforce the terms of the Agency Act. The MCWRA's failure to enforce the terms of the Agency Act is in direct conflict with state law. This Court's intervention is therefore required to remedy the MCWRA's action in this regard. Accordingly, the Court should issue a writ of mandate directing the MCWRA to enforce the Agency Act as required by State law, including if appropriate by issuing a cease-and-desist order to Cal-Am.

WHEREFORE, Petitioner prays for judgment as follows:

1. On the First Cause of Action: for Alternative and Peremptory Writs of Mandate ordering Respondents to enforce the NMCLUP (Coastal) as required by State law, including if appropriate by issuing a cease-and-desist order to Cal-Am.
2. On the Third Cause of Action: for Alternative and Peremptory Writs of Mandate ordering Respondent MCWRA to enforce the Agency Act as required by State law, including if appropriate by issuing a cease-and-desist order to Cal-Am.
3. For costs of suit;

5. For an award of attorney's fees; and

6. For such other and further relief as the court deems proper.

Dated: November 14, 2016

L+G, LLP

By: David W. Balch

Attorney for Petitioner

VERIFICATION

I, RON WEITZMAN, declare:

I am the President of WRAMP, the Petitioner in this action. I am authorized to make this declaration on behalf of WRAMP. I make this declaration of my own knowledge, and if called to testify thereto, I could and would competently testify.

I have read the foregoing First Amended Petition for Writ of Mandamus and know the contents thereof. The contents therein are true of my own knowledge, except as to those matters that are alleged on information and belief, and as to those matters I believe them to be true. I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct. Executed this 14 day of November, in CARMEL, California.

Ron Weitzman

PROOF OF SERVICE

I am employed in the County of Monterey, State of California. I am over the age of eighteen years and not a party to the within action. My business address is L+G, LLP, 318 Cayuga Street, Salinas, CA 93901.

On the date set forth below, I caused the following document(s) entitled:

FIRST AMENDED PETITION FOR WRIT OF MANDATE

to be served on the party(ies) or its (their) attorney(s) of record in this action listed below by the following means:

X	**BY MAIL**. By placing each envelope (with postage affixed thereto) in the U.S. Mail at the law offices of L+G, LLP, 318 Cayuga Street, Salinas, CA 93901, addressed as shown on the attached sheet. I am readily familiar with this firm's practice for collection and processing of correspondence for mailing with the U.S. Postal Service, and in the ordinary course of business, correspondence would be deposited with the U.S. Postal Service the same day it was placed for collection and processing.
	BY HAND-DELIVERY. By causing a true copy thereof, enclosed in a sealed envelope, to be delivered by hand to the persons shown below.
	BY FACSIMILE TRANSMISSION. By transmitting a true copy thereof by facsimile transmission from facsimile number (831) 754-2011 to the interested party(ies) or their attorney(s) of record to said action at the facsimile number(s) shown below.
X	**BY ELECTRONIC MAIL.** By transmitting a true copy thereof by electronic mail from e-mail address michelle@lg-attorneys.com to the interested party(ies) or their attorney(s) of record to said action at the electronic mail address(es) shown below

SEE ATTACHED SERVICE LIST

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed on November 14, 2016 at Salinas, CA.

MICHELLE BARTY-BILLECI

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EXHIBIT A

MONTEREY PENINSULA WATER SUPPLY PROJECT

Test Slant Well Long Term Pumping Monitoring Report No. 79

26-October-16 - 2-November-16

Coastal Development Permit #A-3-MRA-14-0050 and Amendment No. A-3-MRA-14-0050-A1

November 8, 2016

PREPARED FOR:
California American Water

CALIFORNIA AMERICAN WATER

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THIS REPORT HAS BEEN PREPARED BY OR UNDER THE DIRECTION OF THE FOLLOWING DESIGN PROFESSIONAL LICENSED BY THE STATE OF CALIFORNIA AND BASED ON THE MOST RECENT AVAILABLE INFORMATION.

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B Groundwater Level and Salinity Instrument Data for the Period 26-October-16 through 2-November-16

Note: As they become available additional Appendices, each to include weekly instrument data, will be posted to:

www.watersupplyproject.org

MONTEREY PENINSULA
WATER SUPPLY PROJECT

TEST SLANT WELL LONG TERM PUMPING MONITORING REPORT NO. 79
26-OCTOBER-16 - 2-NOVEMBER-16

1.0 GENERAL

1.1 Purpose and Scope

Coastal Development Permit #A-3-MRA-14-0050 dated 8-Dec-14 granted California American Water Company (CalAm) permission for development consisting of: Construction, operation and decommissioning of a test slant well at the CEMEX sand mining facility in the City of Marina and beneath Monterey Bay in the County of Monterey. Special condition 11, "Protection of Nearby Wells", of that permit requires groundwater monitoring of a minimum of four wells on the CEMEX site within 2,000 ft of the test well and one or more offsite wells to record water and salinity levels (see Appendix A-1).

1.2 Monitoring Well Construction

During the period from December 2014 to March 2015, four monitoring well clusters were constructed (MW-1, MW-3, MW-4, and MW-5) with each cluster consisting of three monitoring wells completed at different depth intervals. In addition, four monitoring well clusters (MW-6, MW-8, MW-9, and MW-7) were completed on 5-Apr-15, 29-May-15, 30-Jun-15, and 9-Aug-15. An additional cluster had been planned for construction (MW-10), however, due to inaccessibility the proposed cluster has been removed from the proposed monitoring network. The naming convention for the monitoring wells in each cluster is as follows: MW-1S, MW-1M and MW-1D refer to shallow, middle and deep monitoring zones, respectively, for monitoring well cluster MW-1. In addition, there are several existing wells which are being monitored or are planned to be monitored for water level and salinity: one well at the Monterey Regional Water Pollution Control Agency Plant (MRWPCA Well 1); and one existing well on the CEMEX property (CEMEX North Well). In addition to the already constructed, planned and existing groundwater monitoring wells, a stilling well installed at the north end of CEMEX's dredge pond (CP-1) is also being monitored. The transducer installed in the dredge pond was buried in sand due to winter storms surges in December 2015. Upon CEMEX's request a replacement stilling well and transducer were installed in the dredge pond in July 2016. Data will be included in Figures 2-10 and 3-10 as soon as survey elevations become available.

Table 1 summarizes general technical details of the monitoring wells and Figure 1-1 shows the monitoring well locations.

1.3 Baseline Water Level and Water Quality Weekly Monitoring Reports

Weekly reports containing baseline water levels and water quality data have been uploaded to the CalAm project website. A total of seven weekly reports were uploaded providing baseline data for the period: February 19, 2015 through April 22, 2015. Monitoring Reports No. 1 through No. 7 provide baseline data collected prior to initiation of the long-term pumping test.

1.4 Test Slant Well Baseline Water Level and Quality Data

A report entitled "TECHNICAL MEMORANDUM - Monterey Peninsula Water Supply Project Baseline Water and Total Dissolved Solids Levels Test Slant Well Area" was prepared on April 20, 2015 and submitted to the Hydrogeologic Working Group (HWG) for review and concurrence. The report provided observations of the trends in water levels and water quality from the data provided weekly in the monitoring reports and included recommendations for a methodology to evaluate changes in water level and water quality trends at MW-4 series in order to comply with the conditions of Coastal Development Permit #A-3-MRA-14-0050. The report is available at: www.watersupplyproject.org

1.5 Test Slant Well Long Term Pumping Test Monitoring Reports

This report is part of the second set of weekly monitoring reports required by Coastal Development Permit #A-3-MRA-14-0050 for the Test Slant Well project, providing water level and water quality data from the project monitoring wells. Figure 1-1 shows the location of the monitoring wells. The long-term pumping test of the Test Slant Well commenced on April 22, 2015.

On June 5, 2015, the Test Slant Well was voluntarily shut off so that the HWG could evaluate regional trends in water levels and salinity. During the shut off period, the California Coastal Commission allowed for weekly maintenance pumping of 6-hours per week to maintain the Test Slant Well (TSW) in an operational condition. Long term pumping of the Test Slant Well resumed on October 27, 2015 under Coastal Development Permit Amendment No. A-3-MRA-14-0050-A1 dated 13-Oct-15 (Appendix A-2). This report summarizes monitoring performed for the period 26-October-16 through 2-November-16 and is presented with data collected since the start of the long term pumping test. Each subsequent weekly report will provide an additional seven days of data.

On January 19, 2016 at 11:10 am, the Test Slant Well unexpectedly stopped pumping due to a Pacific Gas & Electric Company (PG&E) low voltage issue in the immediate area. The outage was later resolved and the Test Slant Well was turned on approximately 22 hours later on January 20, 2016 at 8:51 am. The pump unexpectedly turned off again due to PG&E power interruptions on January 22, 2016 at 11:53 pm for 35 hours, January 30, 2016 at 2:50 am for 8 hours, January 31, 2016 at 3:29 pm for 20 hours, and February 12, 2016 at 2:43 am for 8 hours. The pump was turned off for 29 hours on March 1, 2016 for discharge line repairs. On March 4, 2016 at 10:10 am the pump was again turned off for discharge line repairs. Pumping resumed on May 2, 2016 at 1:22 pm. On May 17, 2016 at 11:59 pm and May 25, 2016 at 1:28 pm the pump turned off due to PG&E power interruptions and pumping resumed 15 hours and 4 hours later, respectively. Power interruptions also occurred on June 3, 2016 at 7:45 am, July 8, 2016 at 6:12 am, and July 14, 2016 at 10:21 am, where the well was off for approximately 1 hour each day. The pump was off for 80 hours beginning on August 13, 2016 at 11:32 am and for 46 hours on October 3, 2016 at 7:55 pm due to PG&E power interruptions.

1.6 Test Slant Well Water Quality

Groundwater quality samples were collected from the Test Slant Well on April 8, 2015, prior to initiation of the long term pumping operations, on April 29, 2015, weekly during the Month of May and on June 3, 2015. A summary of the water quality laboratory results from the Test Slant Well are included in Table 2. Since October 27, 2015, water quality data has been collected weekly on average while the well is in operation and is presented in Table 2.

1.7 Format of Report

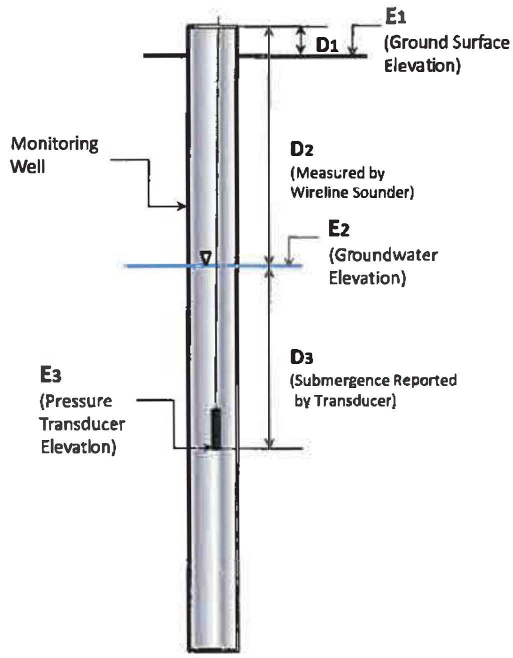
All downloaded pressure transducer data as well as specific conductivity (EC) during the monitoring period are included in Appendix B. Appendix B data is cumulative and only the appended data will be printed in each weekly monitoring report. Figures 2-1 to 2-8 show graphical plots of groundwater elevations for the eight monitoring well clusters (MW-1, MW-3, MW-4, MW-5, MW-6, MW-7, MW-8, and MW-9). Figure 2-9 shows groundwater elevations for existing well MRWPCA Well 1. Monitoring of MRWPCA Well 1 ceased due to the pressure transducer failing and the decision to not replace it due to an abundance of well motor lubricant oil in the well. Figures 3-1 through 3-8 show corresponding graphical plots of the specific conductivity for the above-mentioned wells. Figure 2-10 and 3-10 are water levels and specific conductivity for the CEMEX dredge pond, respectively. The dredge pond was breached by the ocean on October 28, 2015 allowing only six more weeks of data before the transducer could not be found. Figure 2-11 and 3-11 are plots of water level elevation and specific conductivity for the CEMEX North Well and Figures 2-12 and 3-12 are water levels and specific conductivity, respectively, for the Test Slant Well.

CEMEX's North Well collapsed on November 13, 2015. Monitoring of the North Well continued after the collapse for 15 weeks to evaluate whether water levels would equilibrate. Consistent shallow groundwater measurements indicate that the well screen is blocked and water levels in the well are no longer representative of the aquifer conditions. Therefore, water level measurements will no longer be collected in the CEMEX North Well.

In compliance with CDP #A-3-MRA-14-0050, the Test Slant Well Long Term Pumping Monitoring Report No. 79 (this report), is the seventy-ninth of the weekly long-term pumping monitoring reports and follows the weekly baseline monitoring reports, the last of which ended on 22-Apr-15 (Baseline Monitoring Report No. 7[1]).

2.0 CONVERSION OF TRANSDUCER PRESSURE MEASUREMENTS TO GROUNDWATER ELEVATIONS

Pressure transducer readings were converted to groundwater elevation values (expressed as ft NAVD88) using the setting depth of the pressure transducer and the ground surface elevation at the monitoring well site (see inset). After initially setting a pressure transducer in the well, and after each time a transducer is removed from a well, the transducer setting depth is determined using an electrical wire line sounder (Solinst , Model 101) to establish the depth to water in the well. The transducer elevation is then determined as follows:



$$Transducer\ Elevation\ (E3) = E1 + D1 - D2 - D3$$

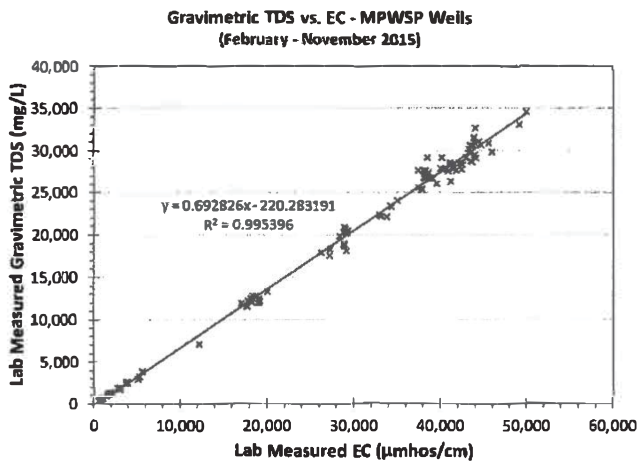
Once the transducer elevation has been established, groundwater elevations in ft NAVD88 are calculated from transducer submergence readings (*D3*) (psi converted to ft) and depth to water measurements (*D2*) as follows:

$$Groundwater\ Elevation\ (E2) = E3 + D3$$

[1] Note: The last of the baseline monitoring reports (Monitoring Report No. 7) covered a five day period (17-22 Apr-15 as the long-term pumping began on 22-Apr-15).

MW-1, MW-3, MW-4, MW-5, Dredge Pond, and Test Slant Well reference point elevations (RP) were surveyed on 26-Mar-15. MW-6, MW-7, MW-8, MW-9, and CEMEX North Well RPs were surveyed on 1-Oct-15 and are summarized in Table 1. All elevations are in ft NAVD88 including RP and ground surface elevations. CEMEX South Well, and MRWPCA's Well No. 1 and Well No. 2 ground surface elevations were estimated using Google Earth (see Table 1).

3.0 ESTIMATING TOTAL DISSOLVED SOLIDS FROM ELECTRICAL CONDUCTIVITY (EC) MEASUREMENTS



Estimation of TDS from EC utilizes a conversion factor that is specific to a given water chemistry. Based on the normalized EC value (corrected to 25° C), an EC conversion factor may be used to estimate TDS from the product of the temperature-corrected EC value and the TDS:EC correction factor. The factor is calculated by dividing the laboratory measured EC by the laboratory measured TDS using the gravimetric calculated TDS. Accuracy of the TDS:EC conversion factor is improved through collection of on-going direct measurements of TDS in groundwater samples using laboratory gravimetric methods. A plot of well specific laboratory measured EC versus TDS from 133 sampling events (from the Test Slant Well and network monitoring wells) collected between February and November 2015 shows a linear relationship (see inset). The equation of which may be used as a general estimate of TDS from measured EC.

3.1 Additional Monitoring Methods

The baseline water level and water quality data indicated that the water quality in the aquifers at MW-3 and MW-4 series show vertical stratification. Therefore, direct correlation between laboratory samples collected by pumping the monitoring wells and conductivity data cannot be made since the pumped samples represent a mixing of waters from the entire screen interval and the transducer records conductivity from a single depth.

To evaluate conductivity data in the MW-4 series, regular groundwater samples are being collected by pumping and compared to previous samples collected by pumping. During the long term test, weekly samples have been collected at the Test Slant Well and MW-4 through May 27, 2015, while the remaining monitoring wells were sampled monthly. Monthly water quality samples from all well sites were then collected through July 29, 2015. Following restart of the TSW pump, sample collection from the TSW has resumed. Results of the TSW analyses can be found in Table 2.

Data collected from transducers will continue to be plotted. Where no transducers were present, specific conductivity data was collected using a hand-held electrical conductance meter (MW-5 & MW-6). MW-3 series and MW-4 series are the closest inland wells from the Test Slant Well (see Figure 1-1) and show a vertical stratification of water quality.

FIGURES

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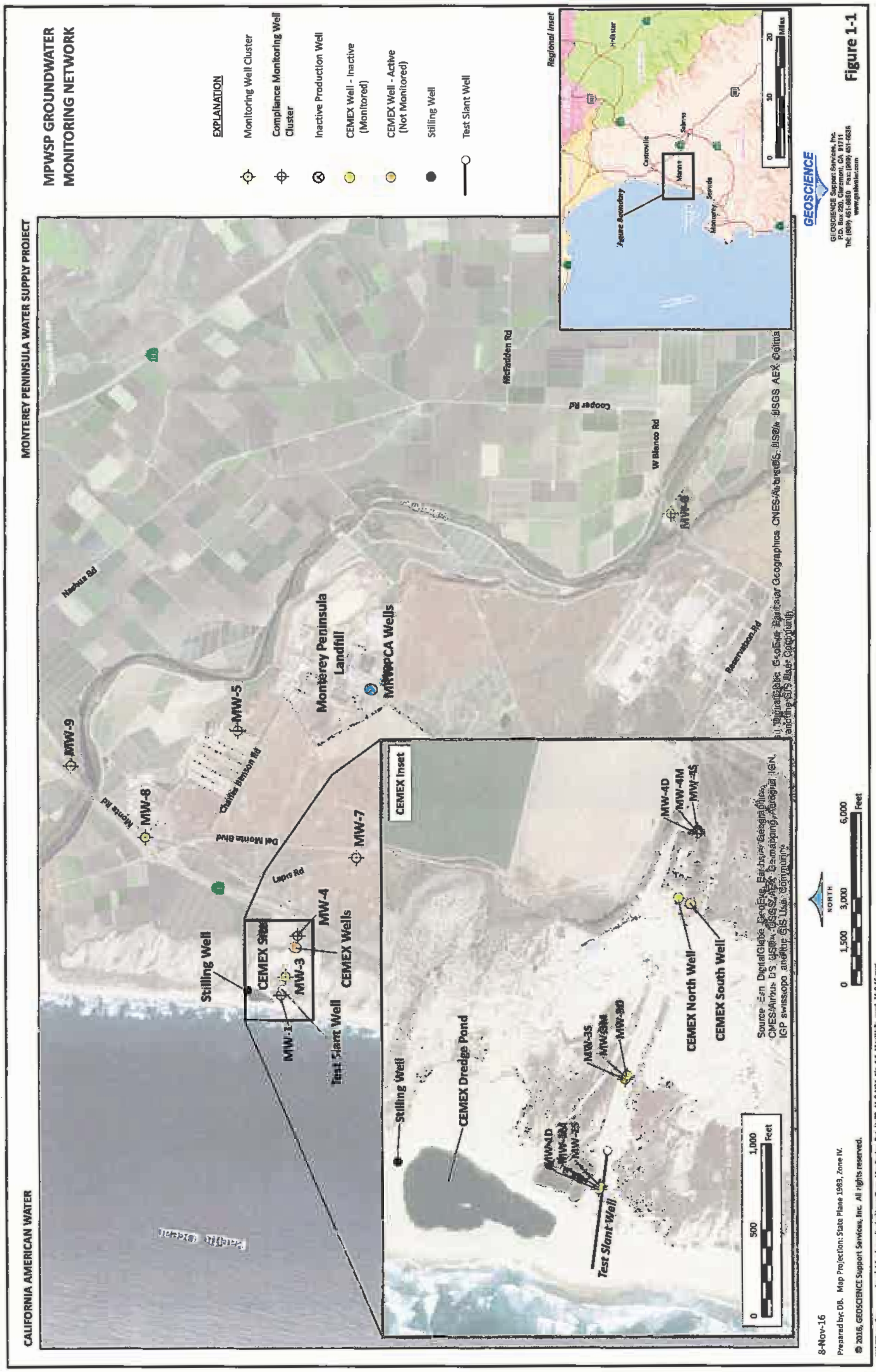

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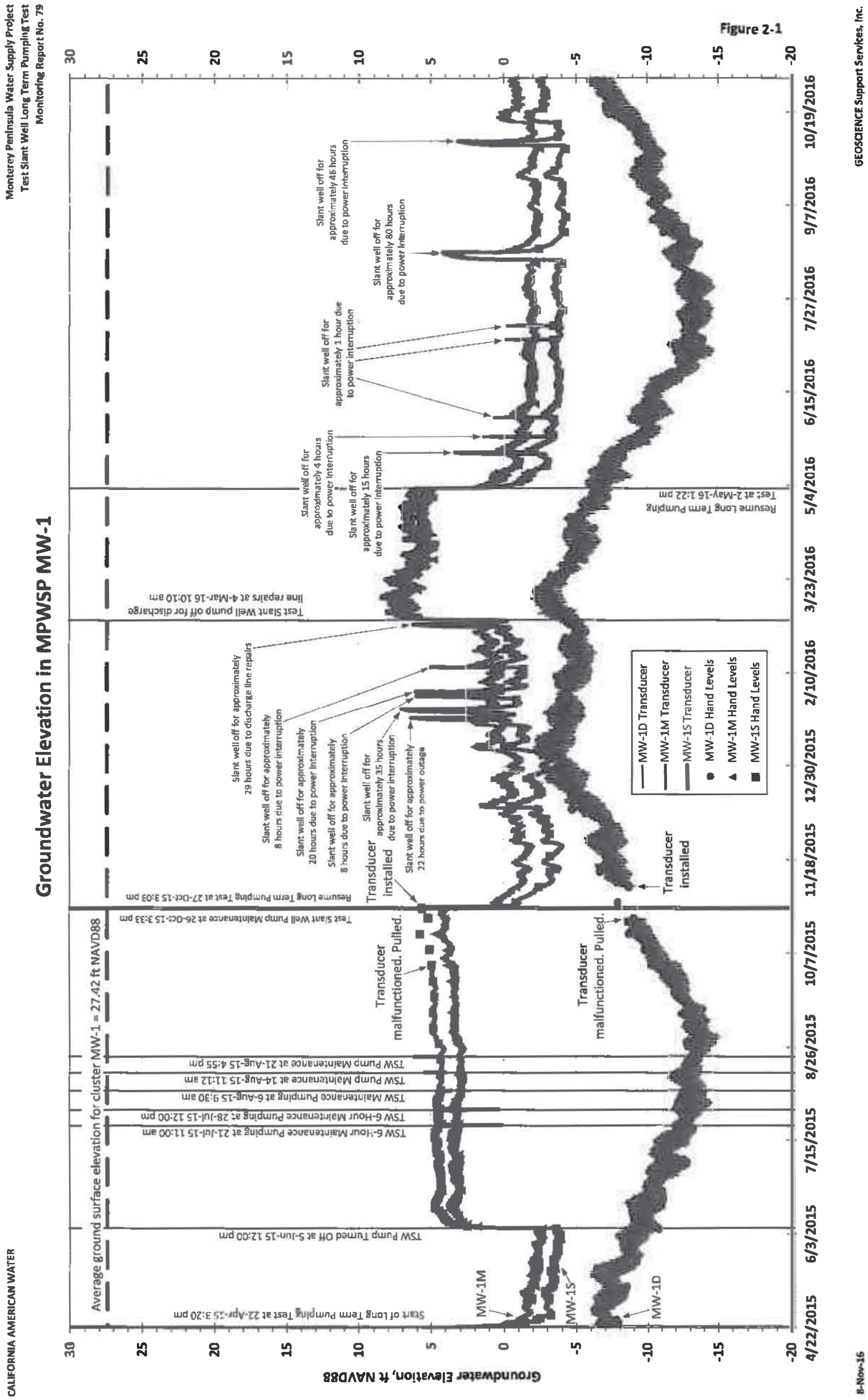

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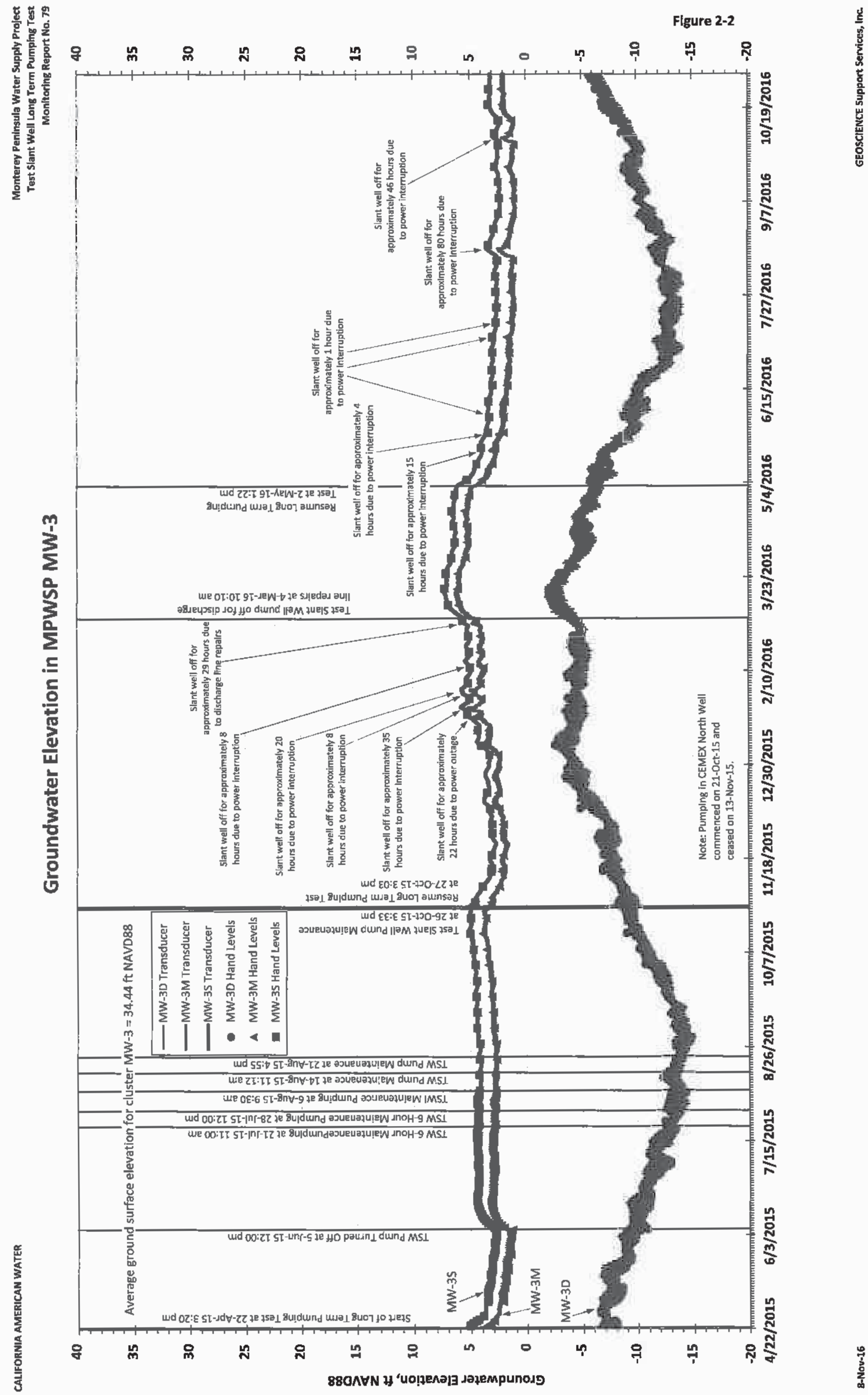

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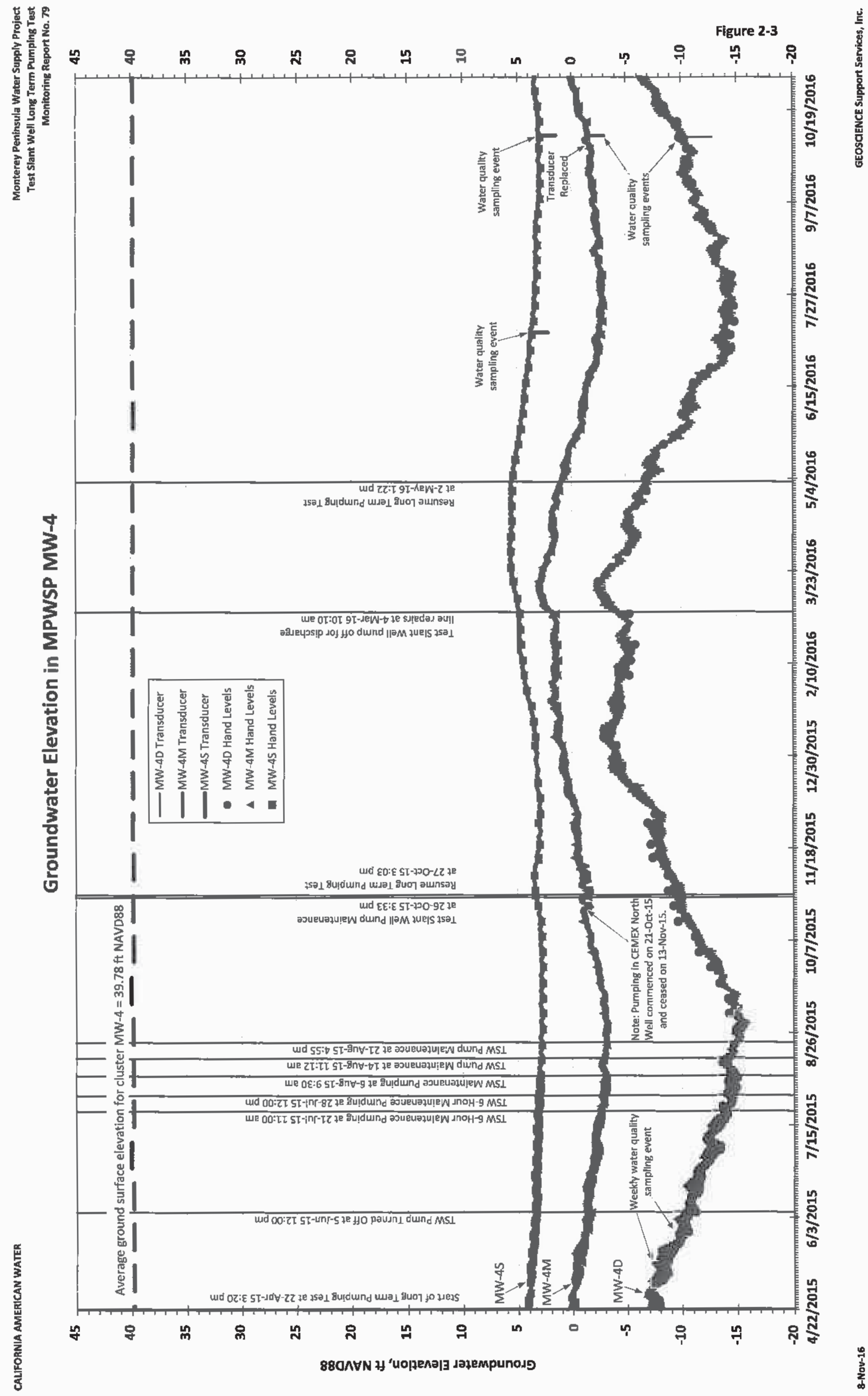

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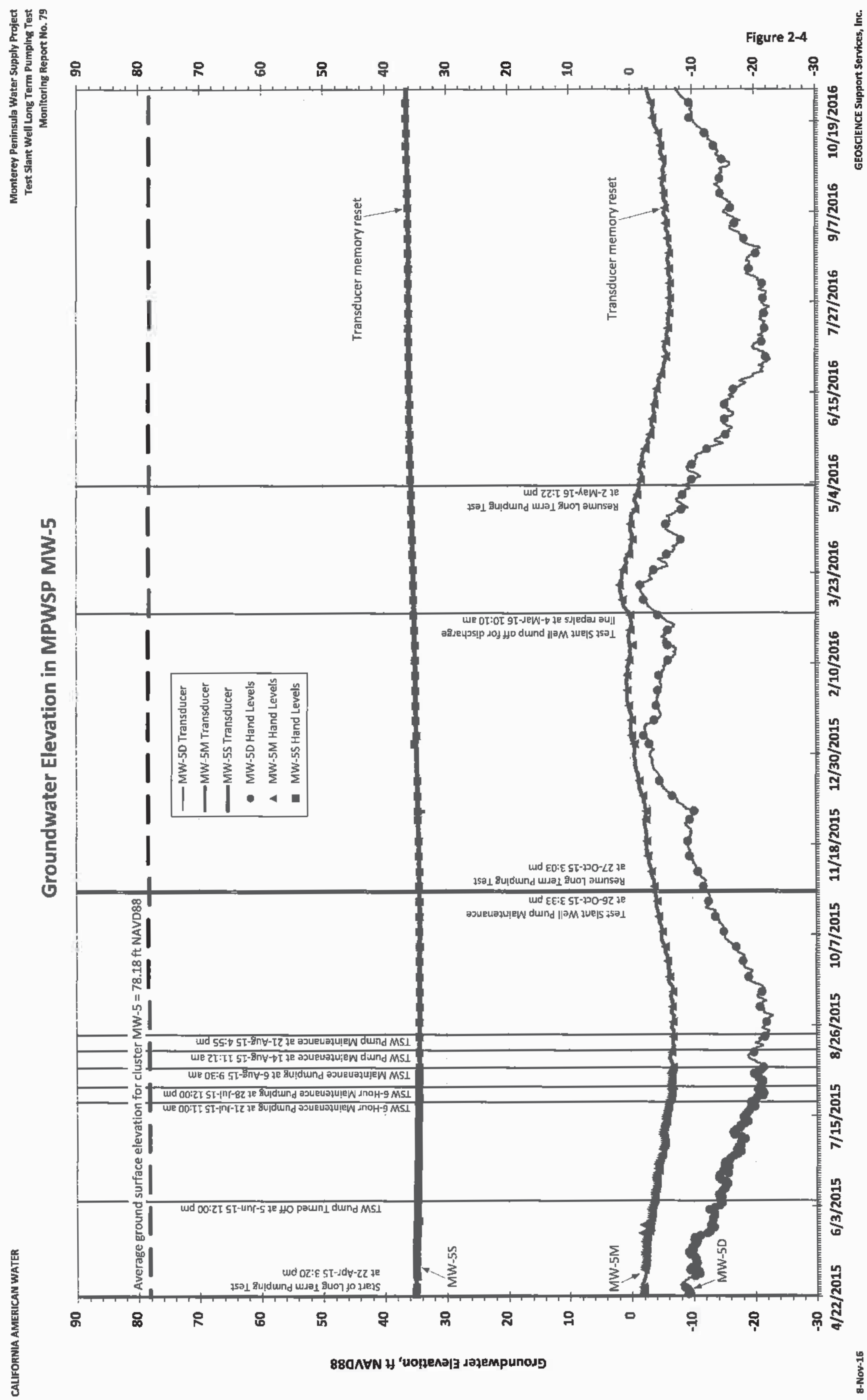

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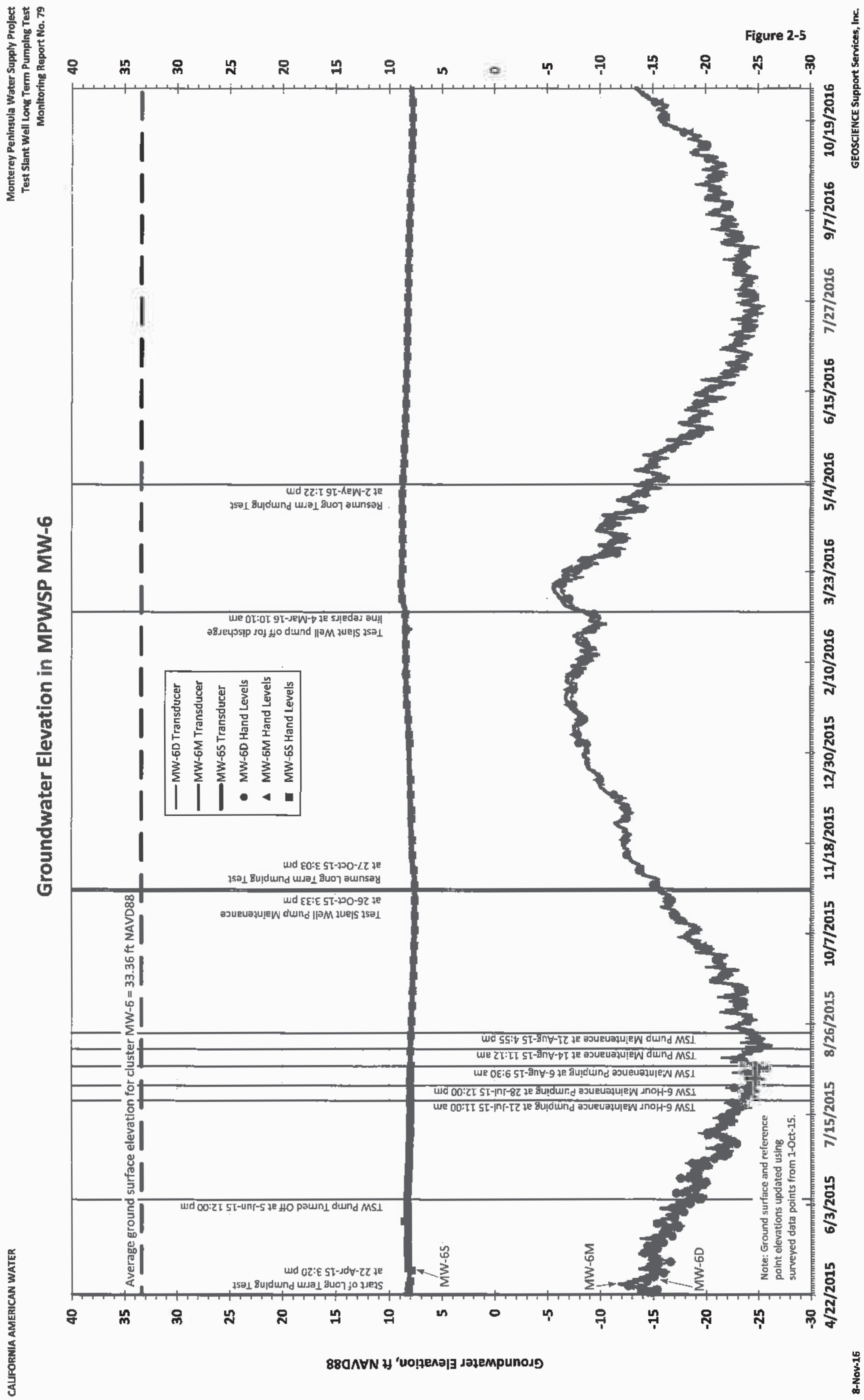

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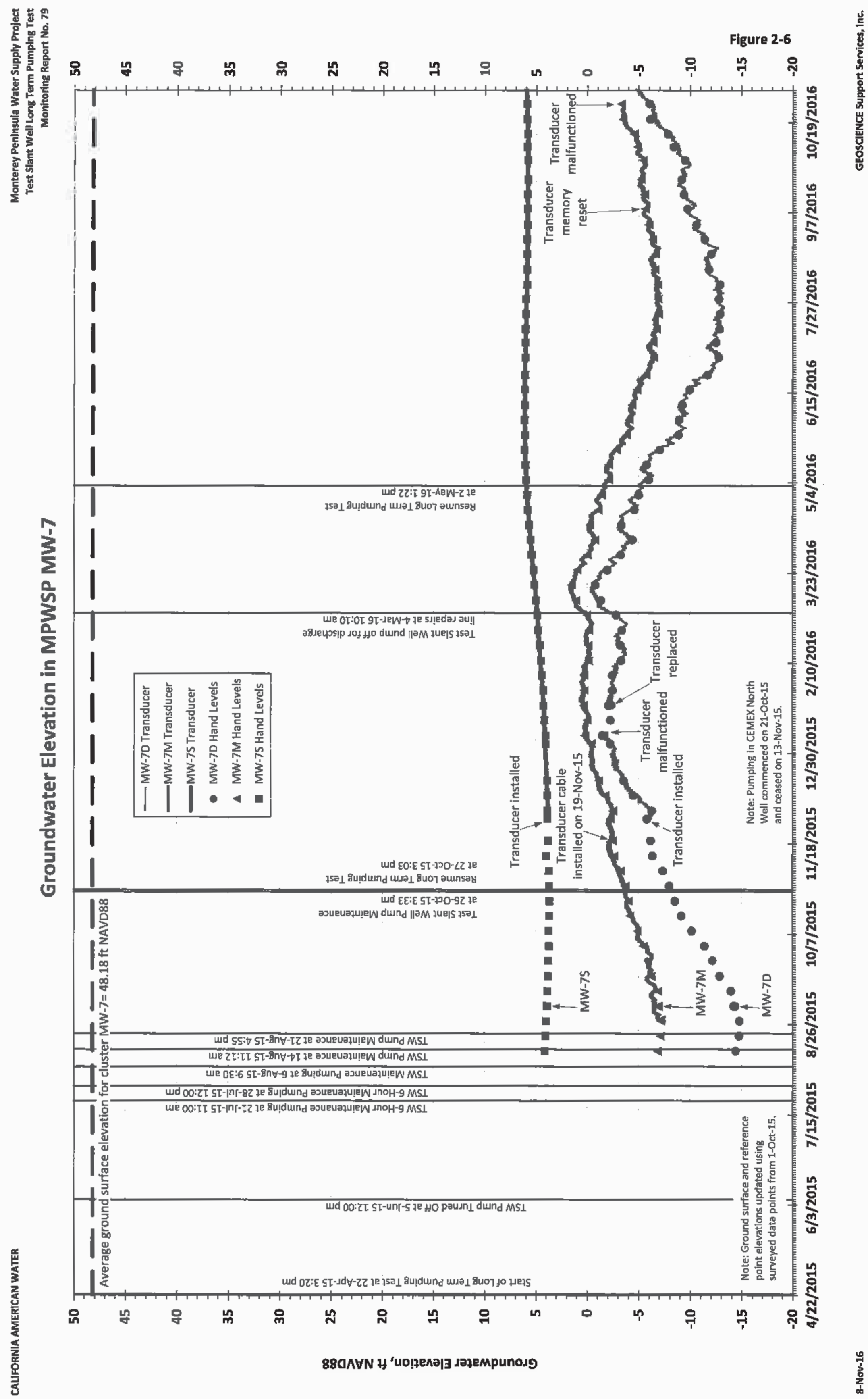

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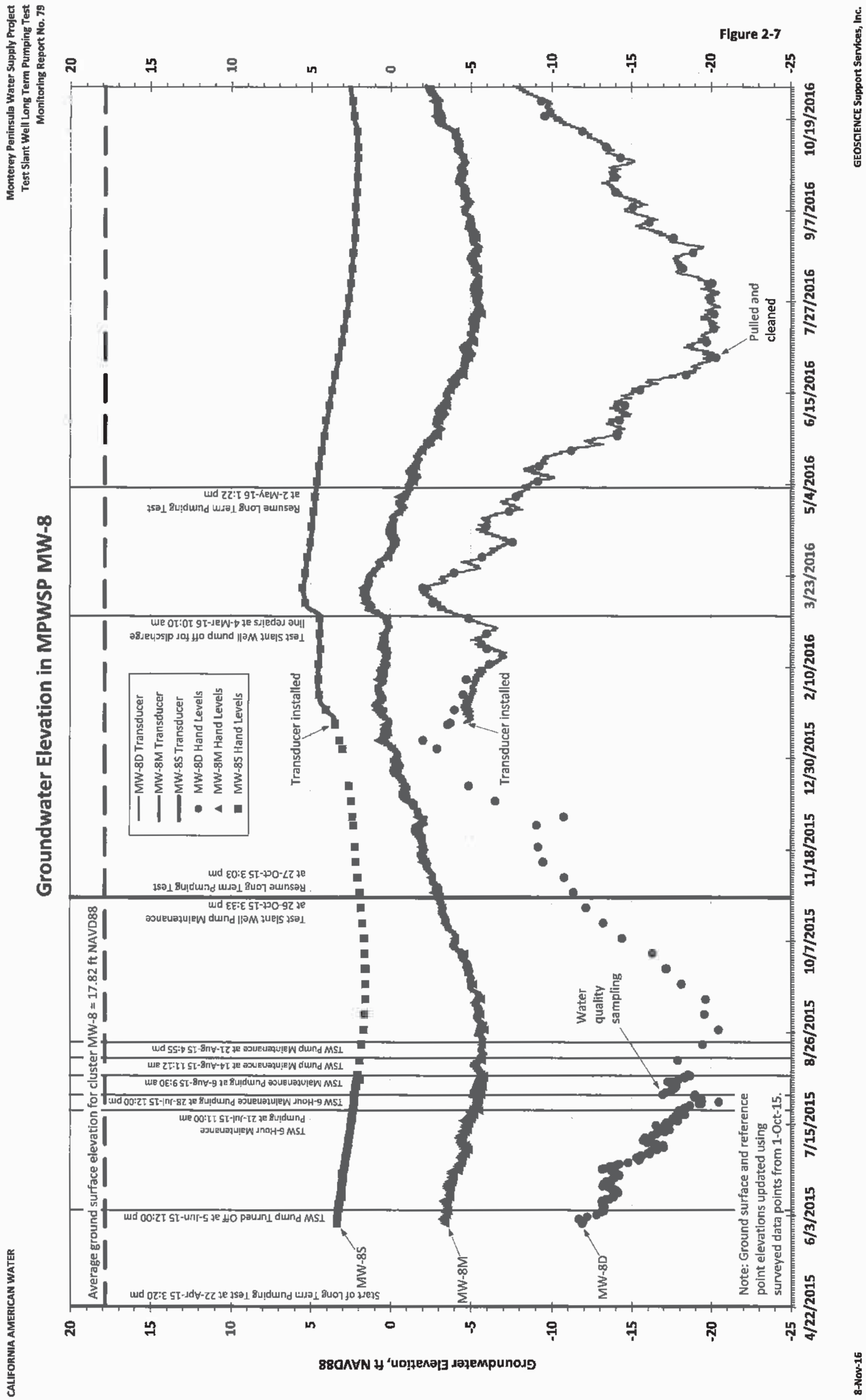

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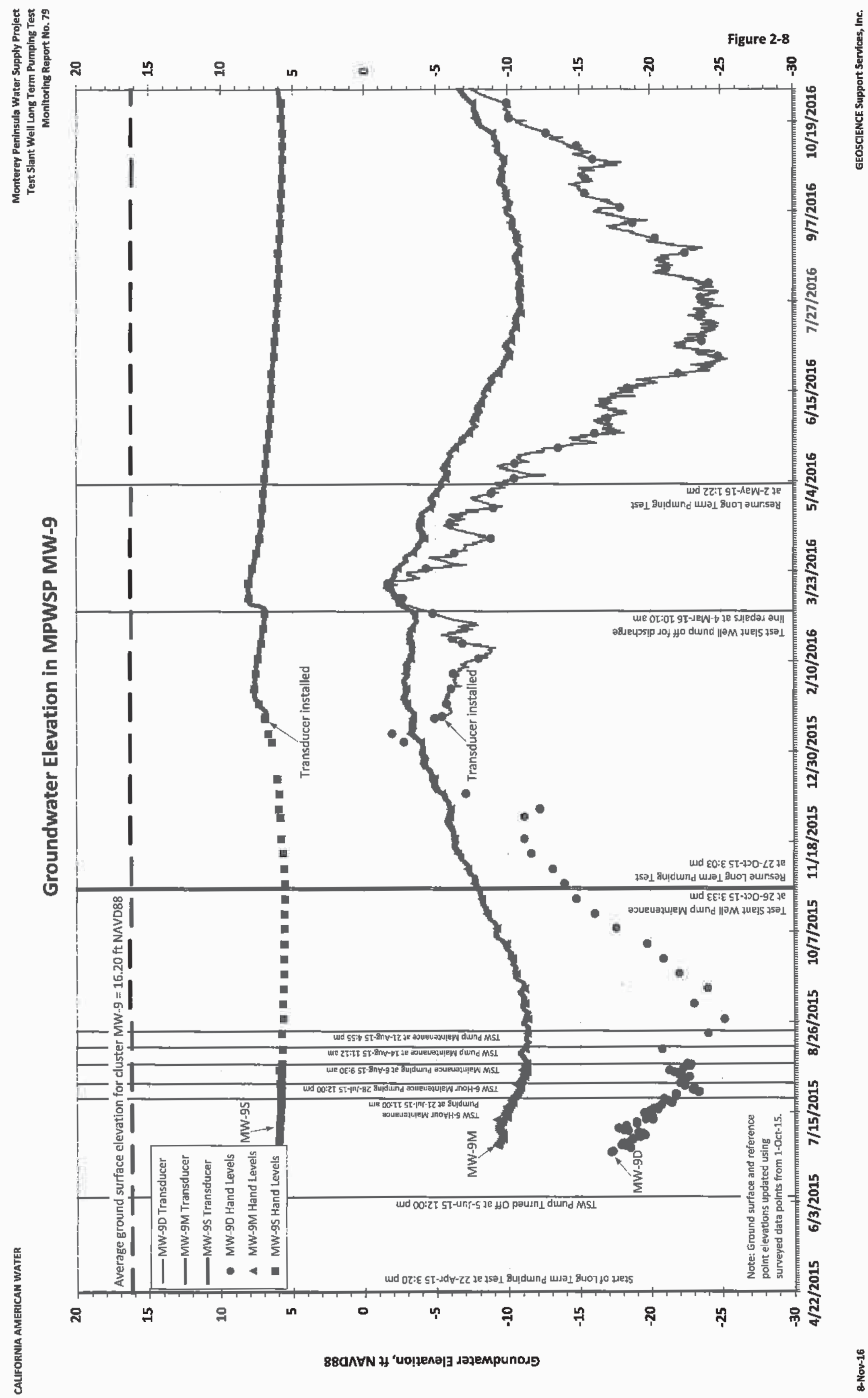

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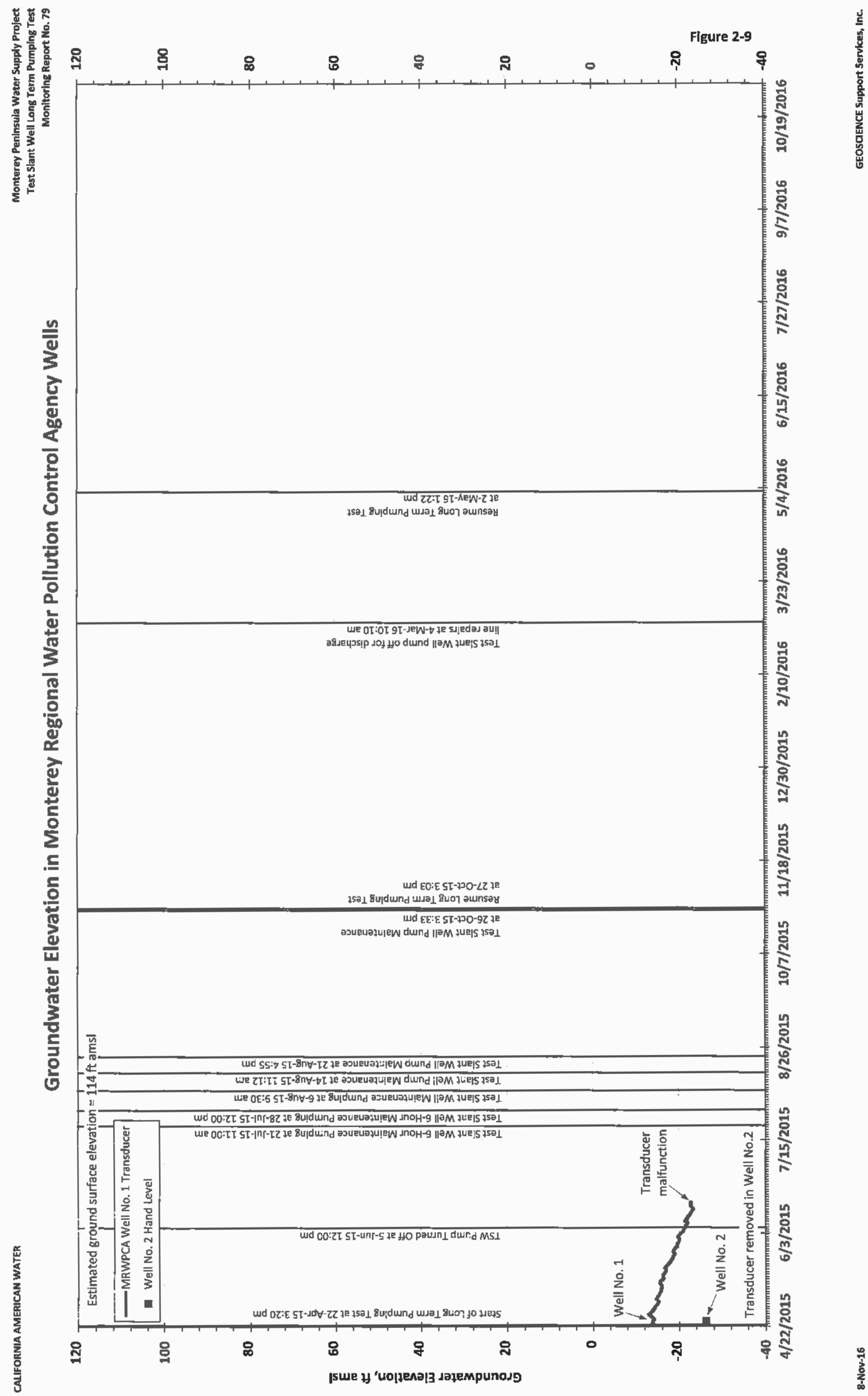

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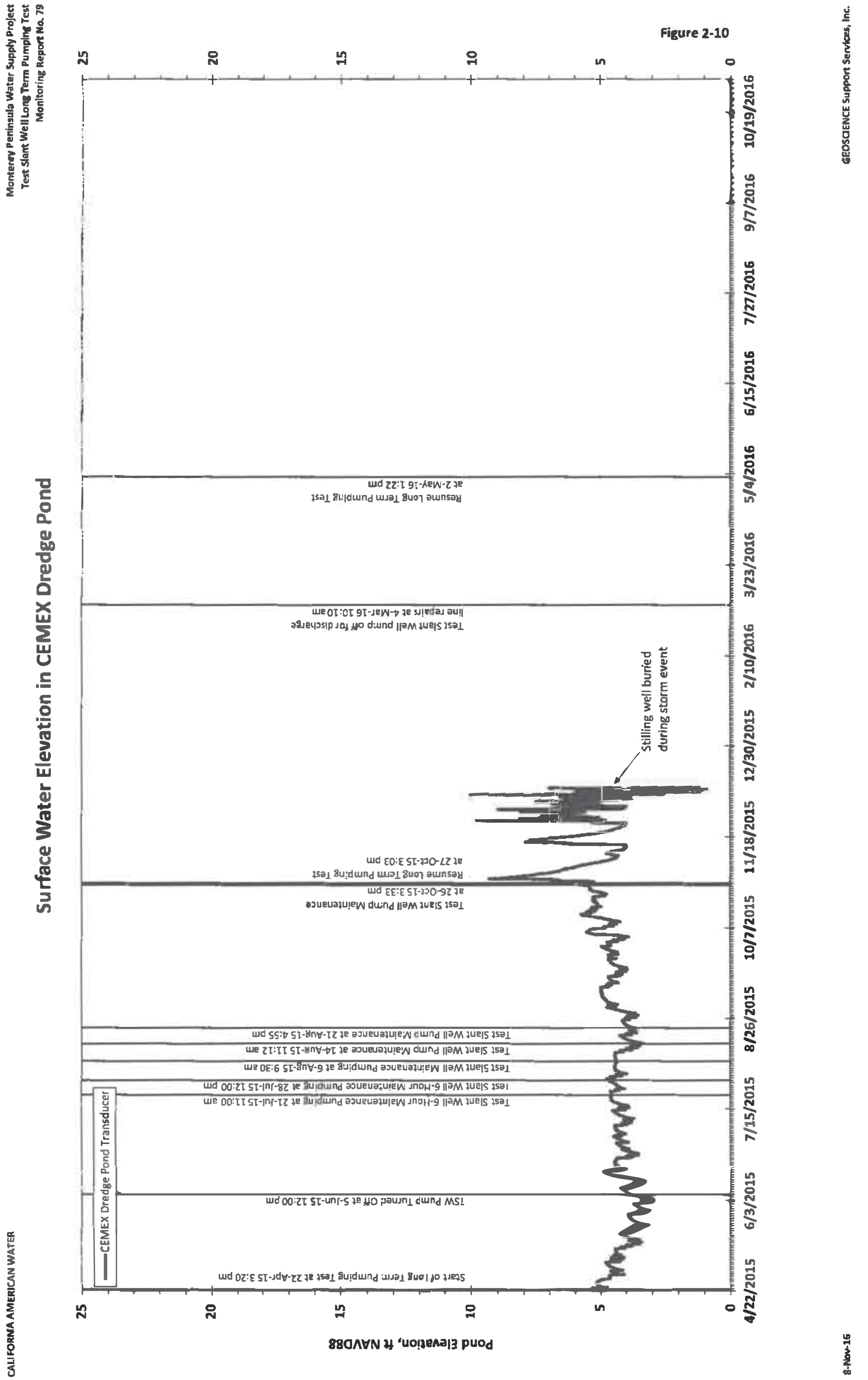

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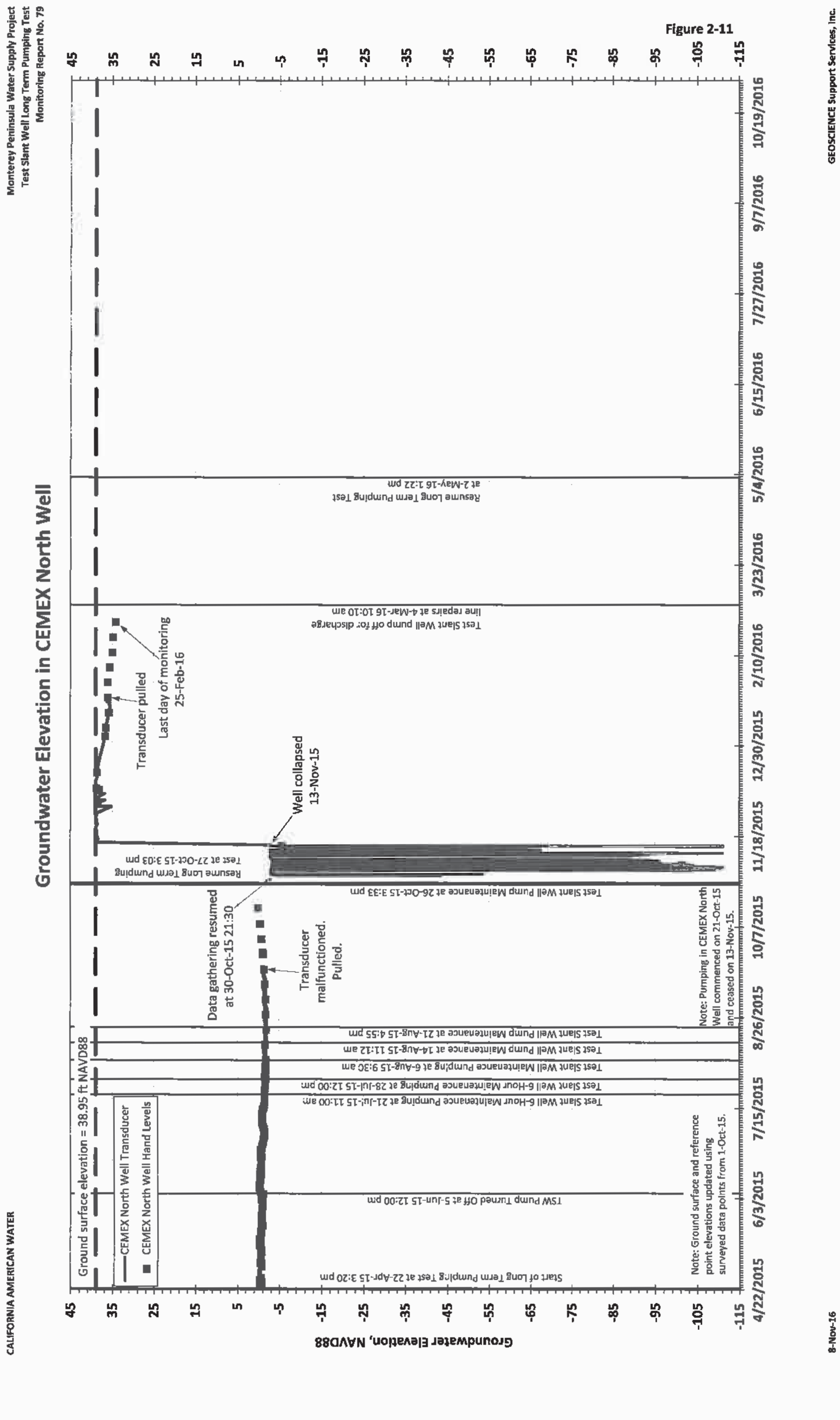

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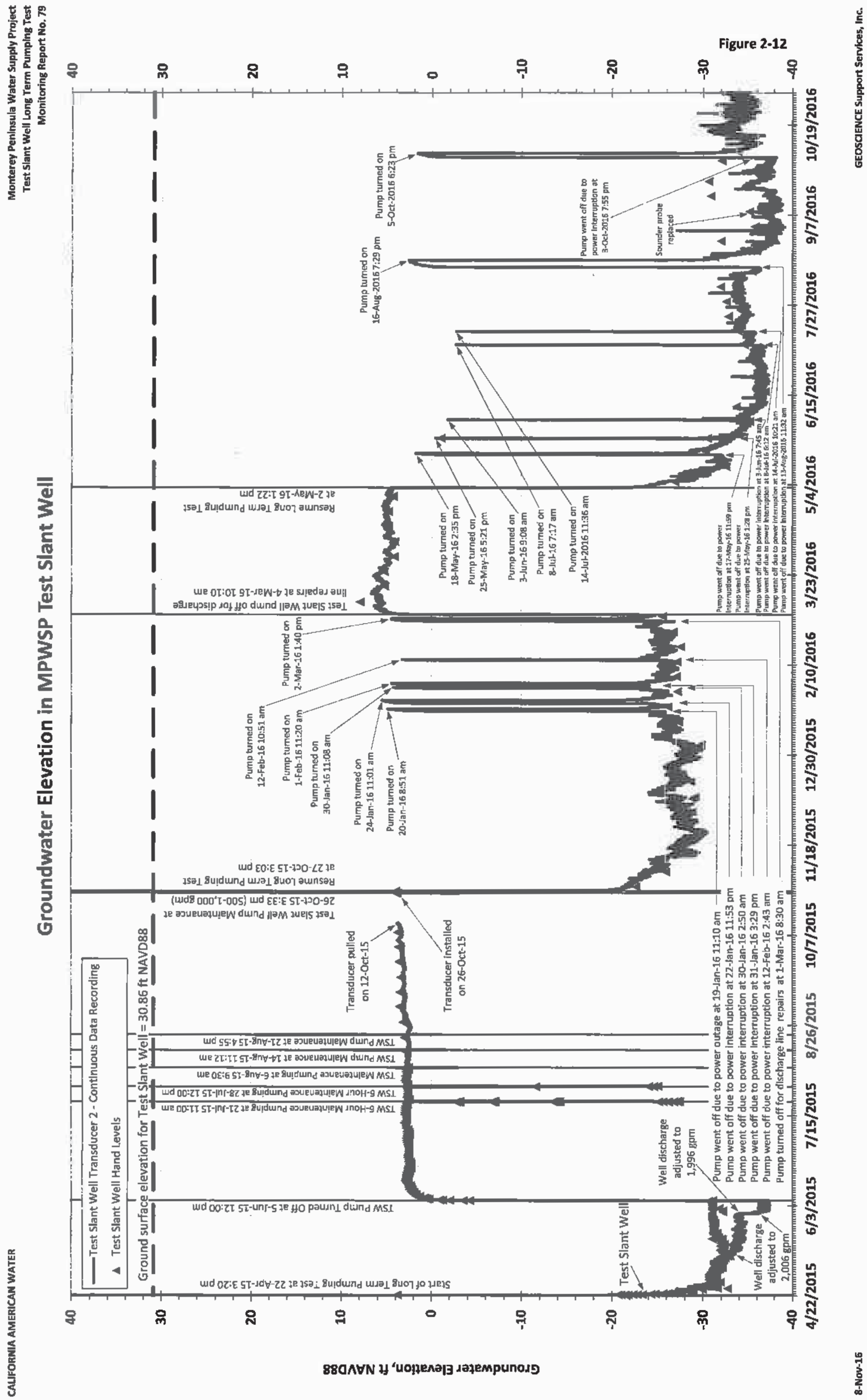

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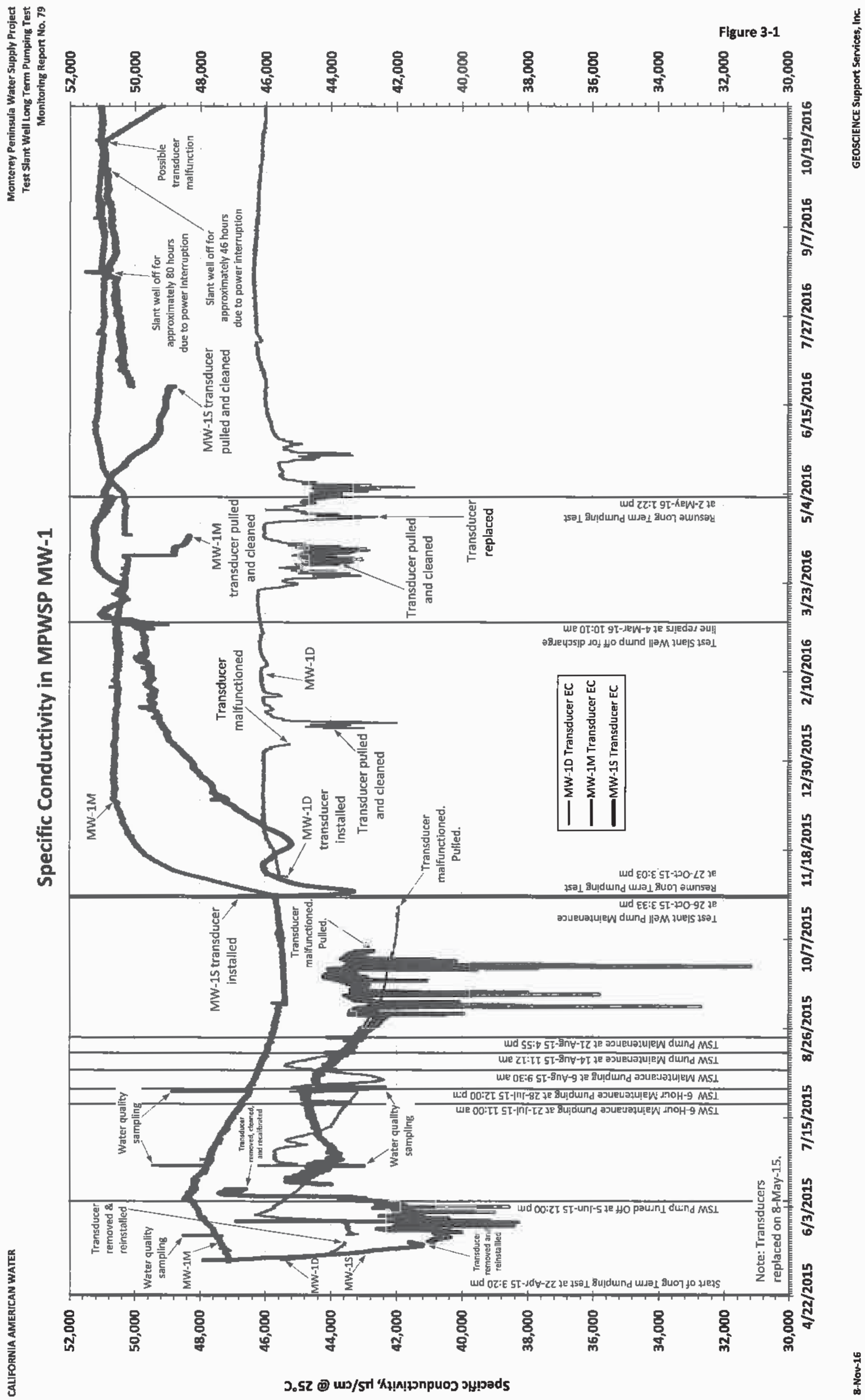

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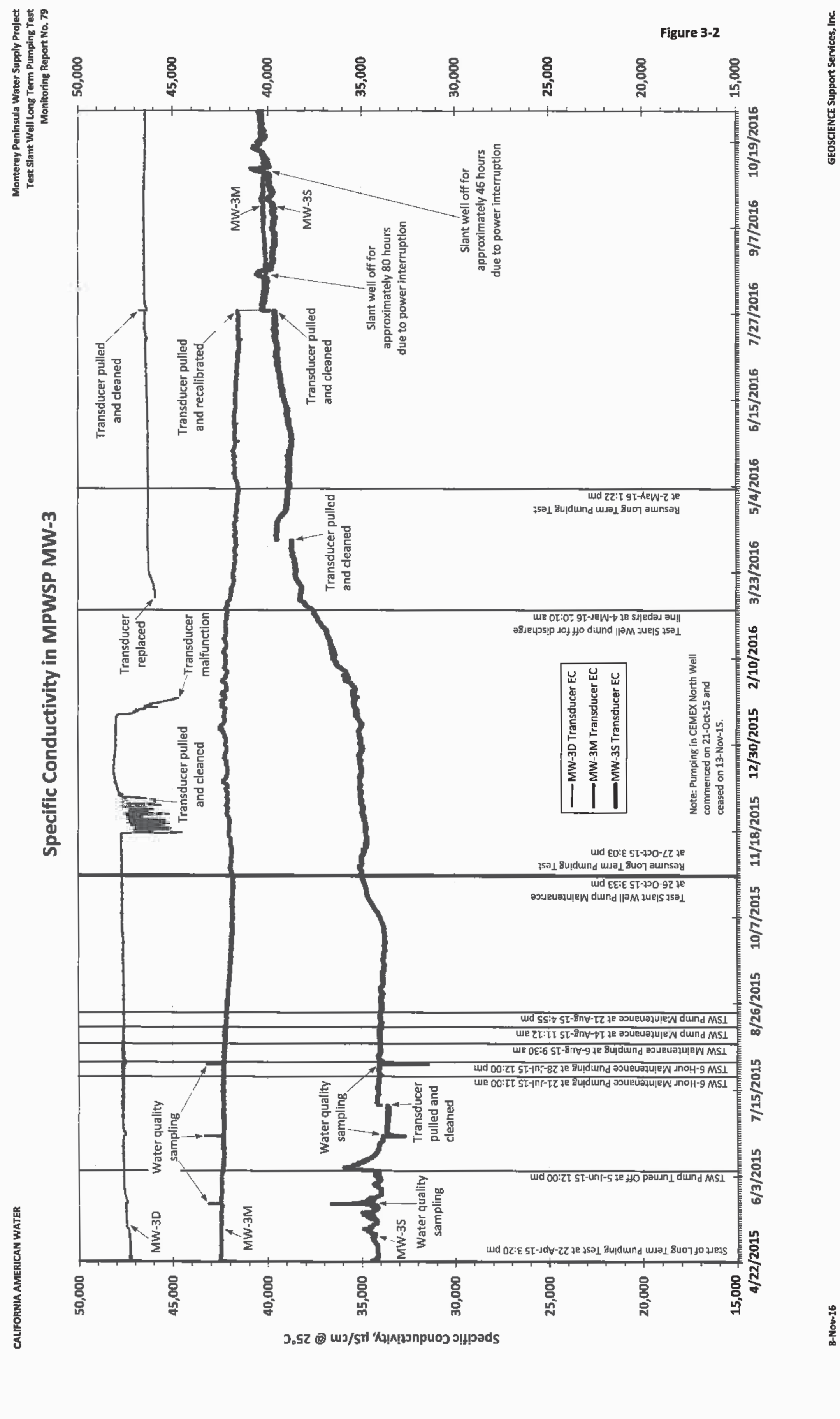

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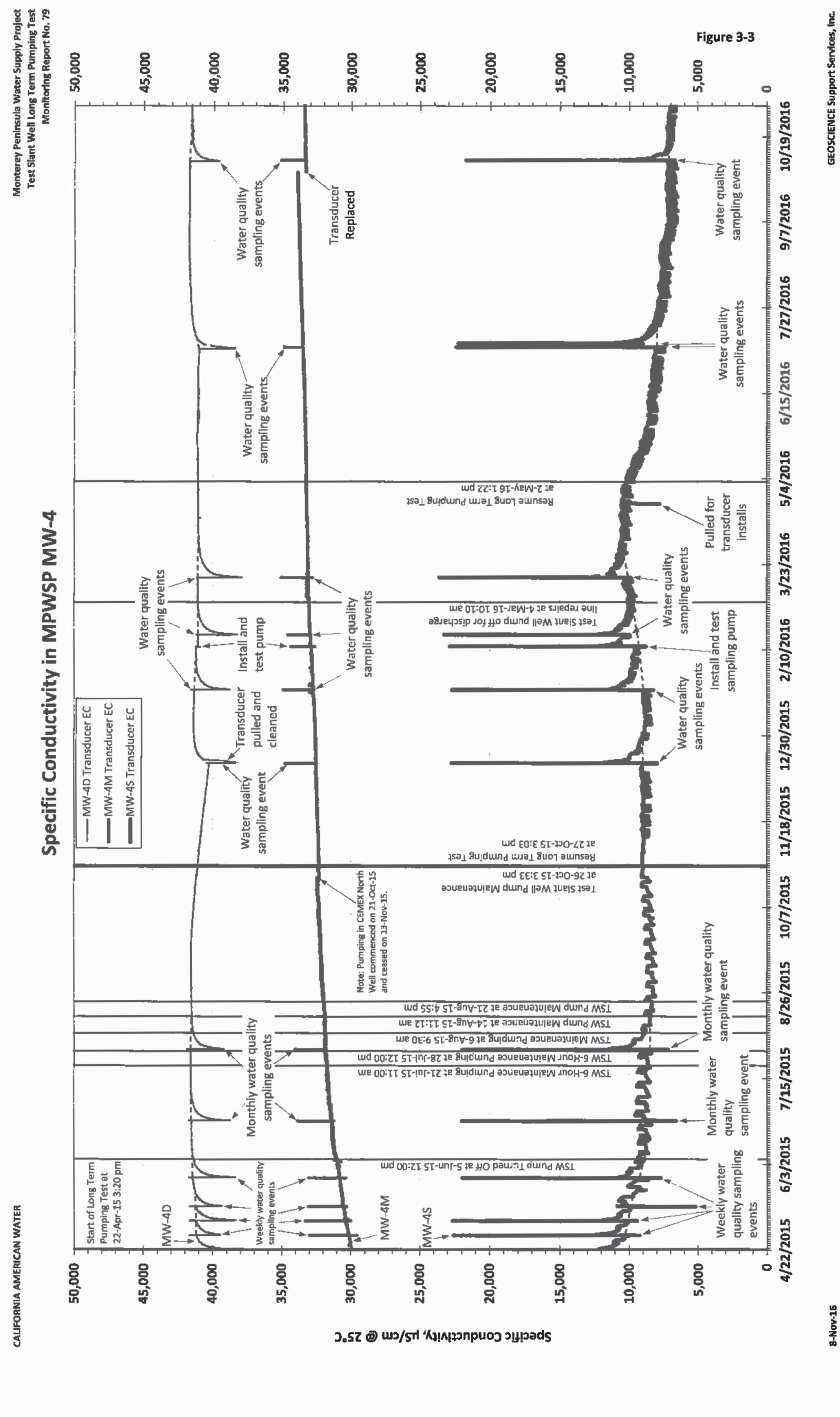

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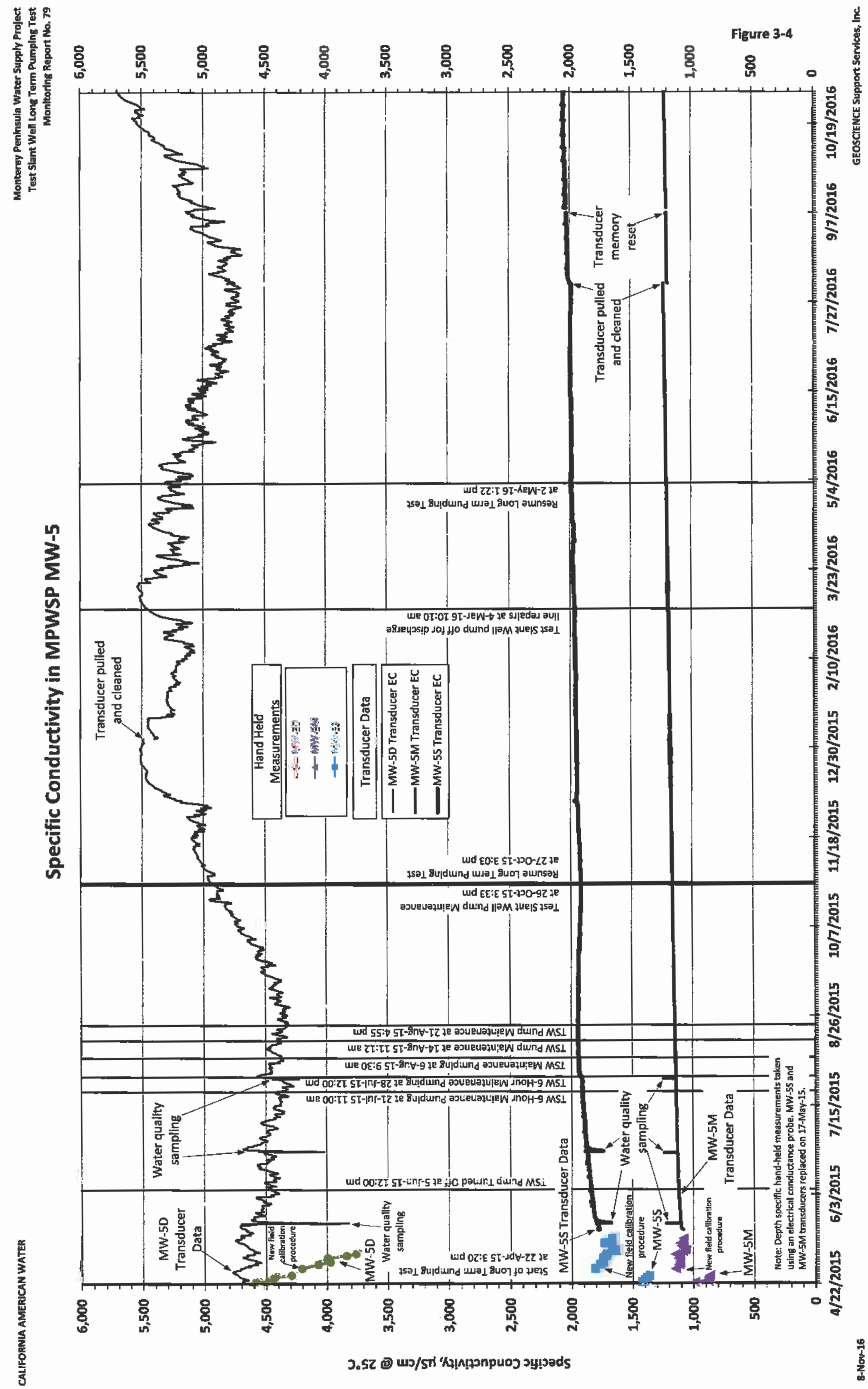

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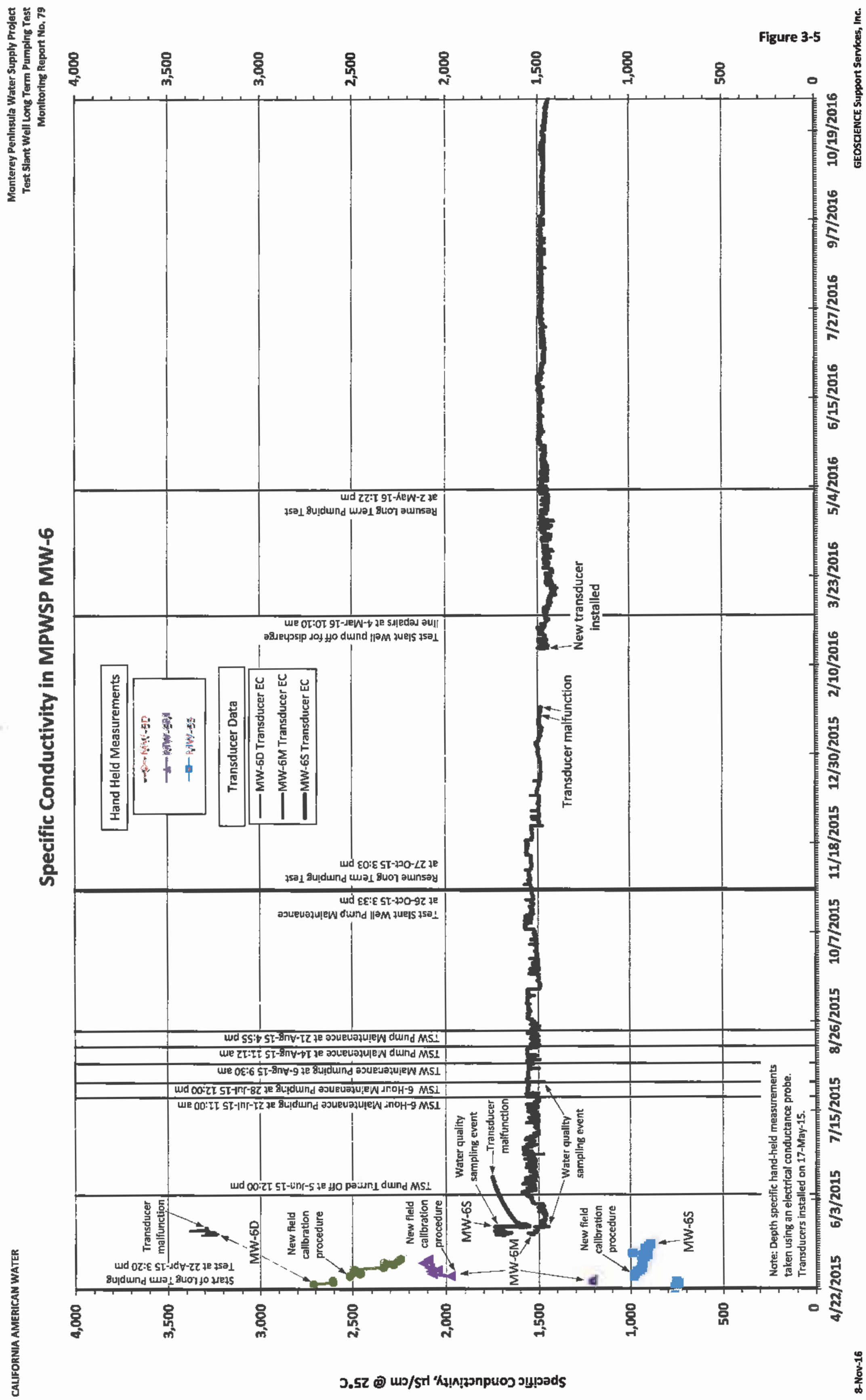

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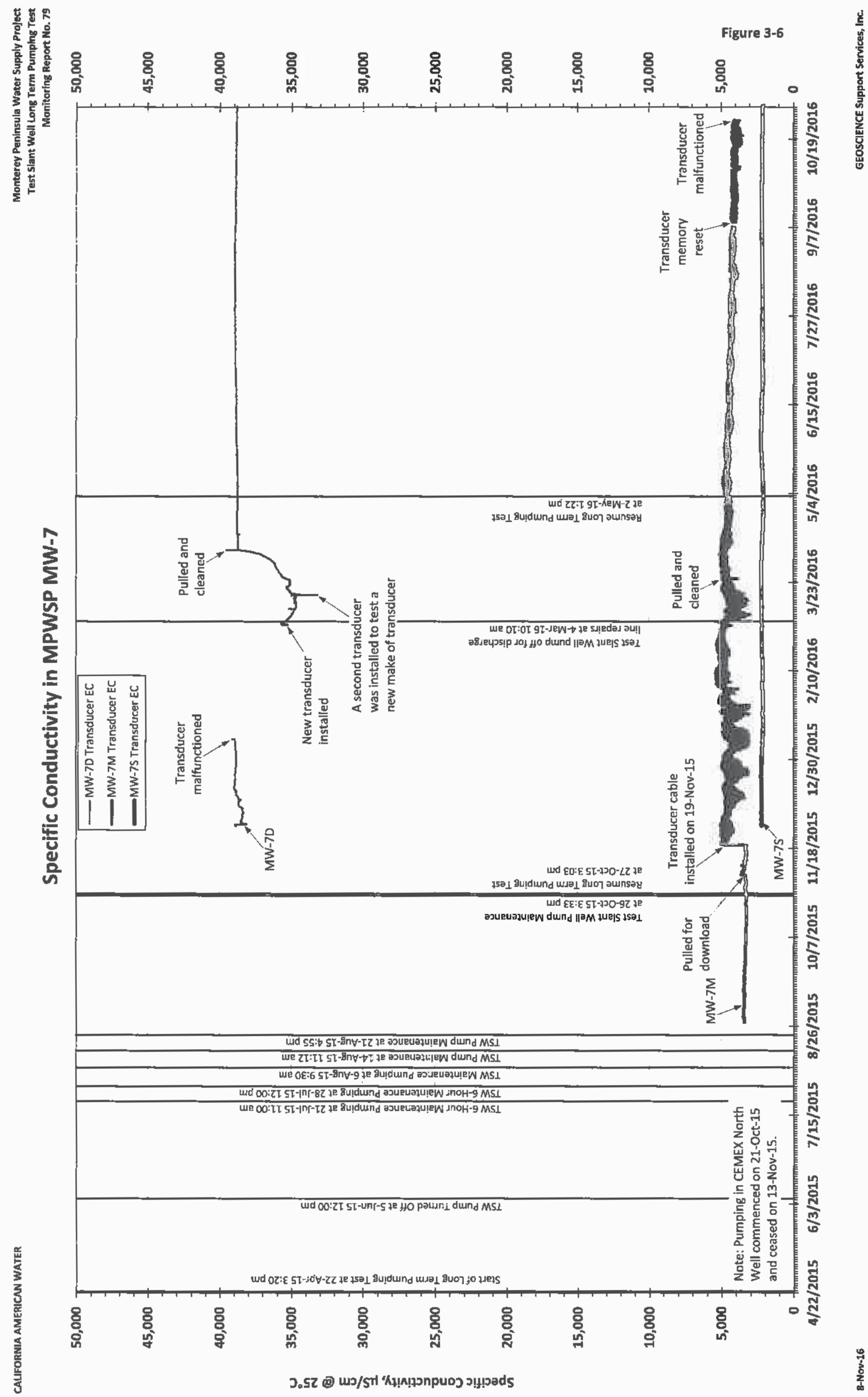

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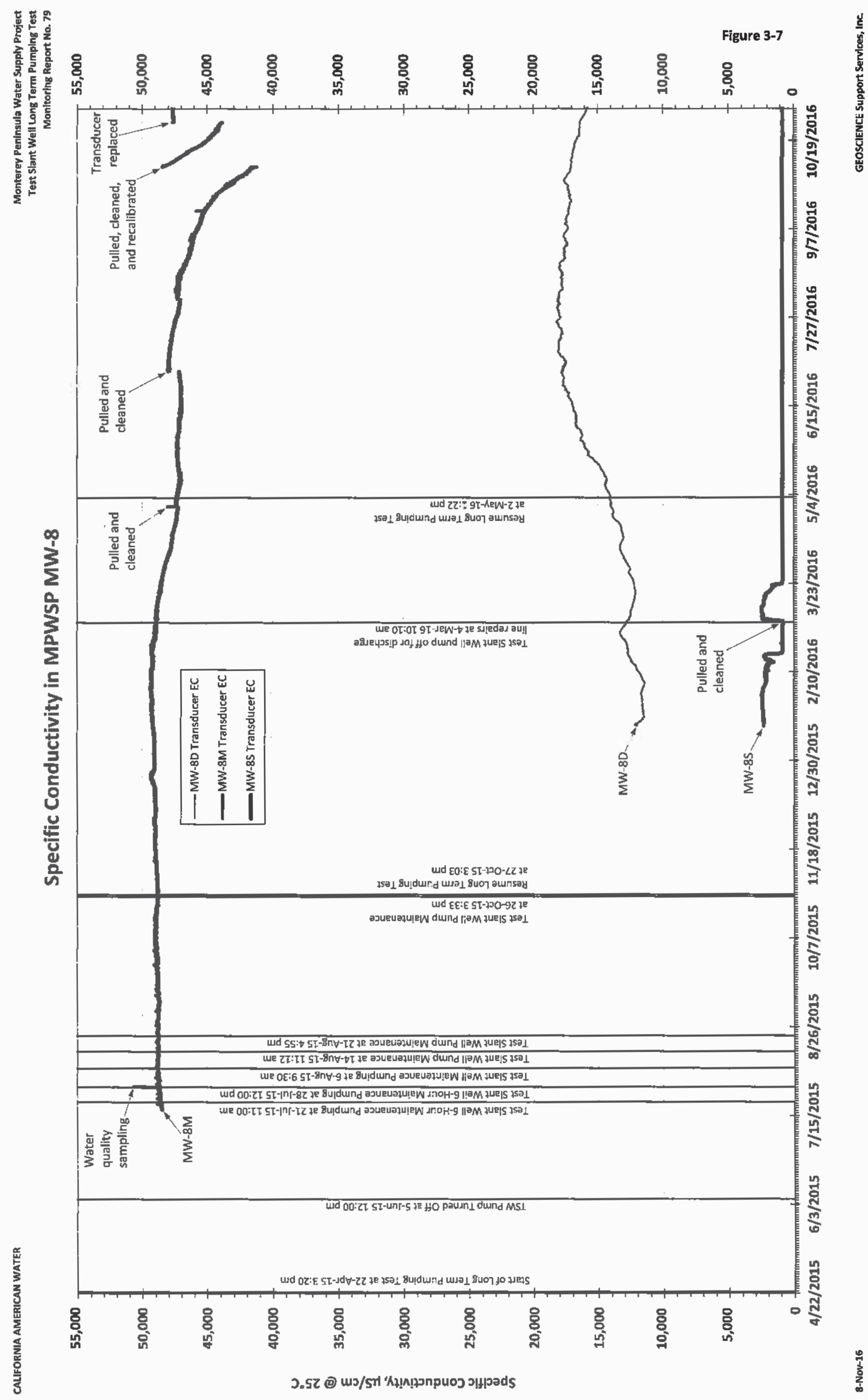

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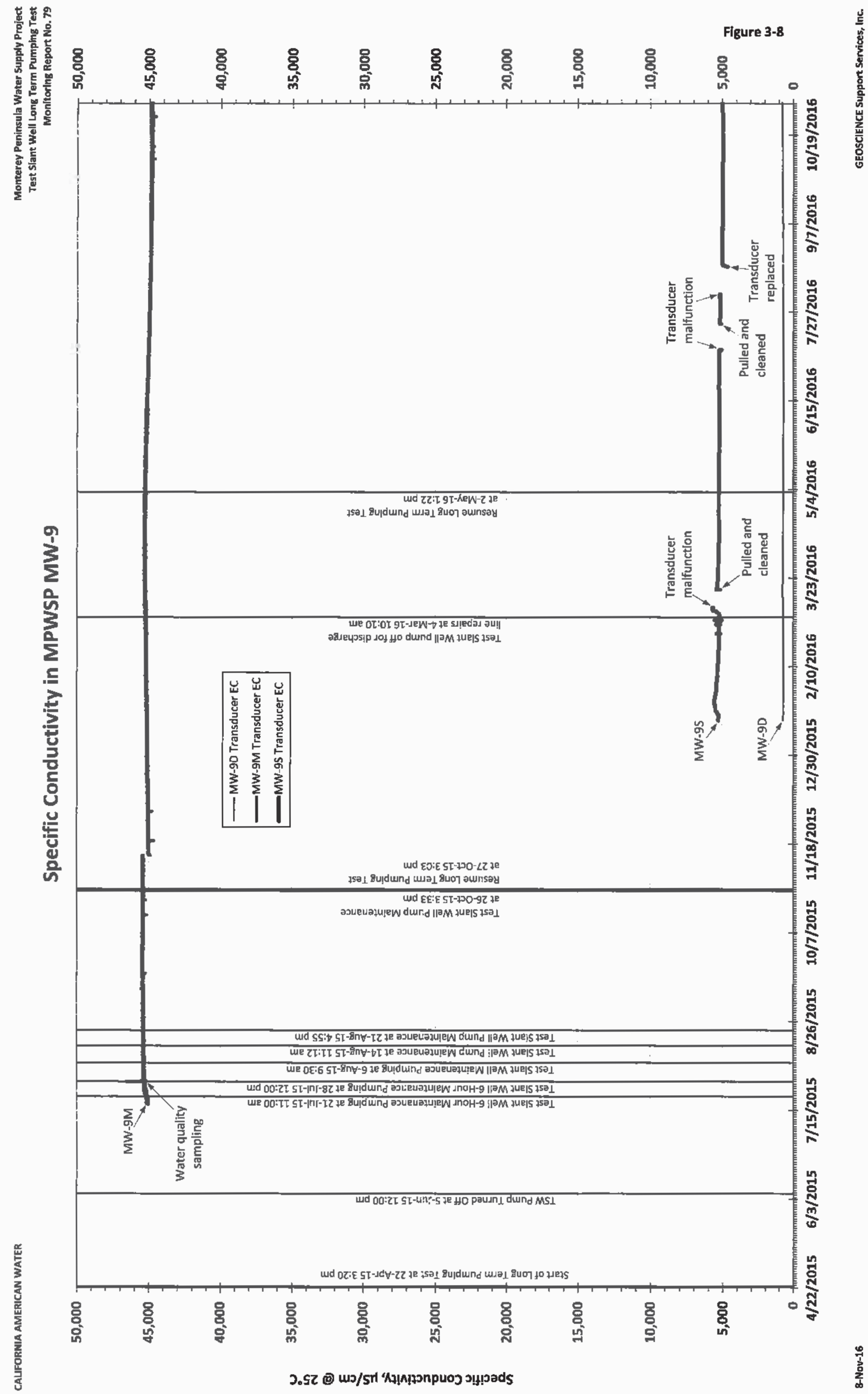

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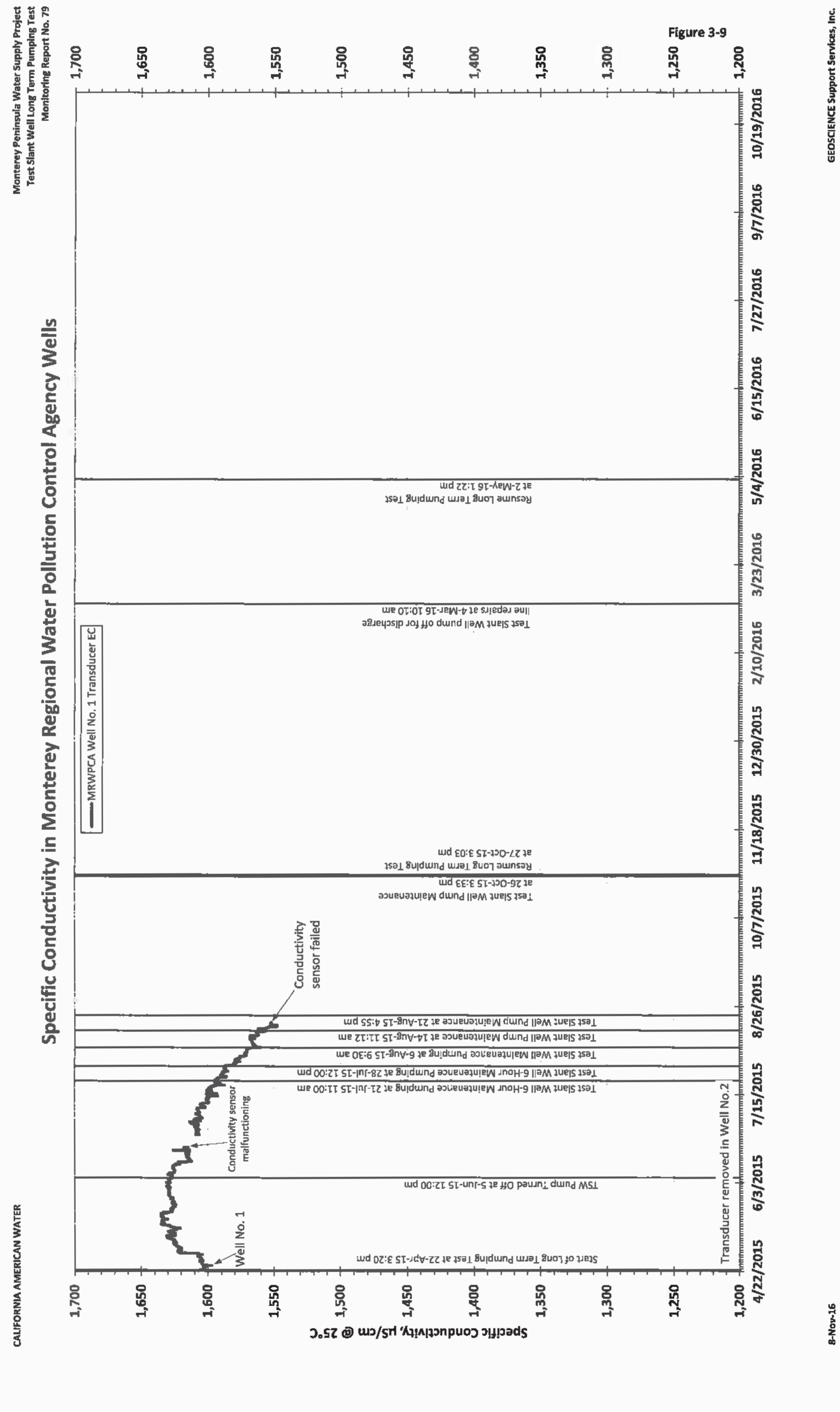

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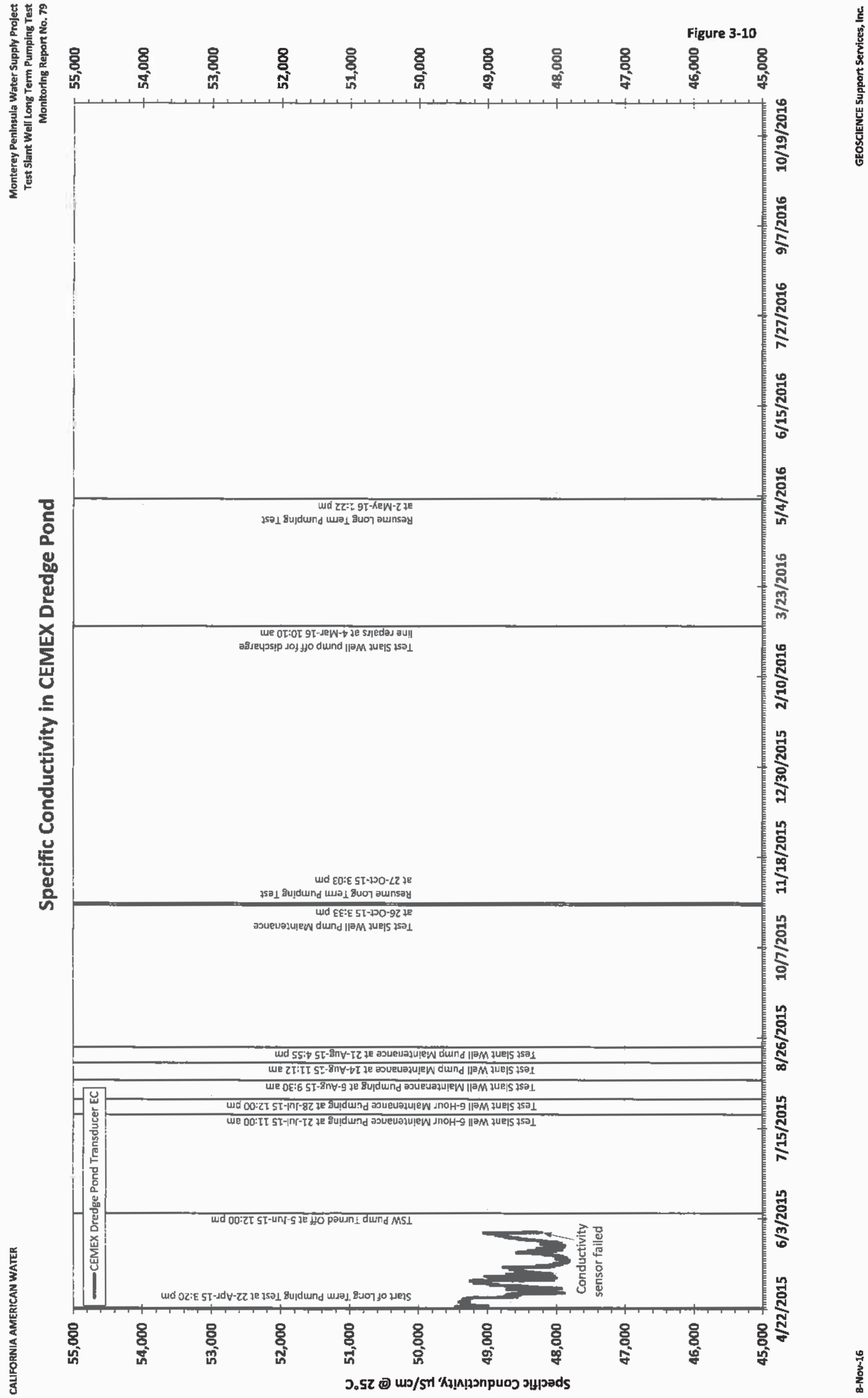

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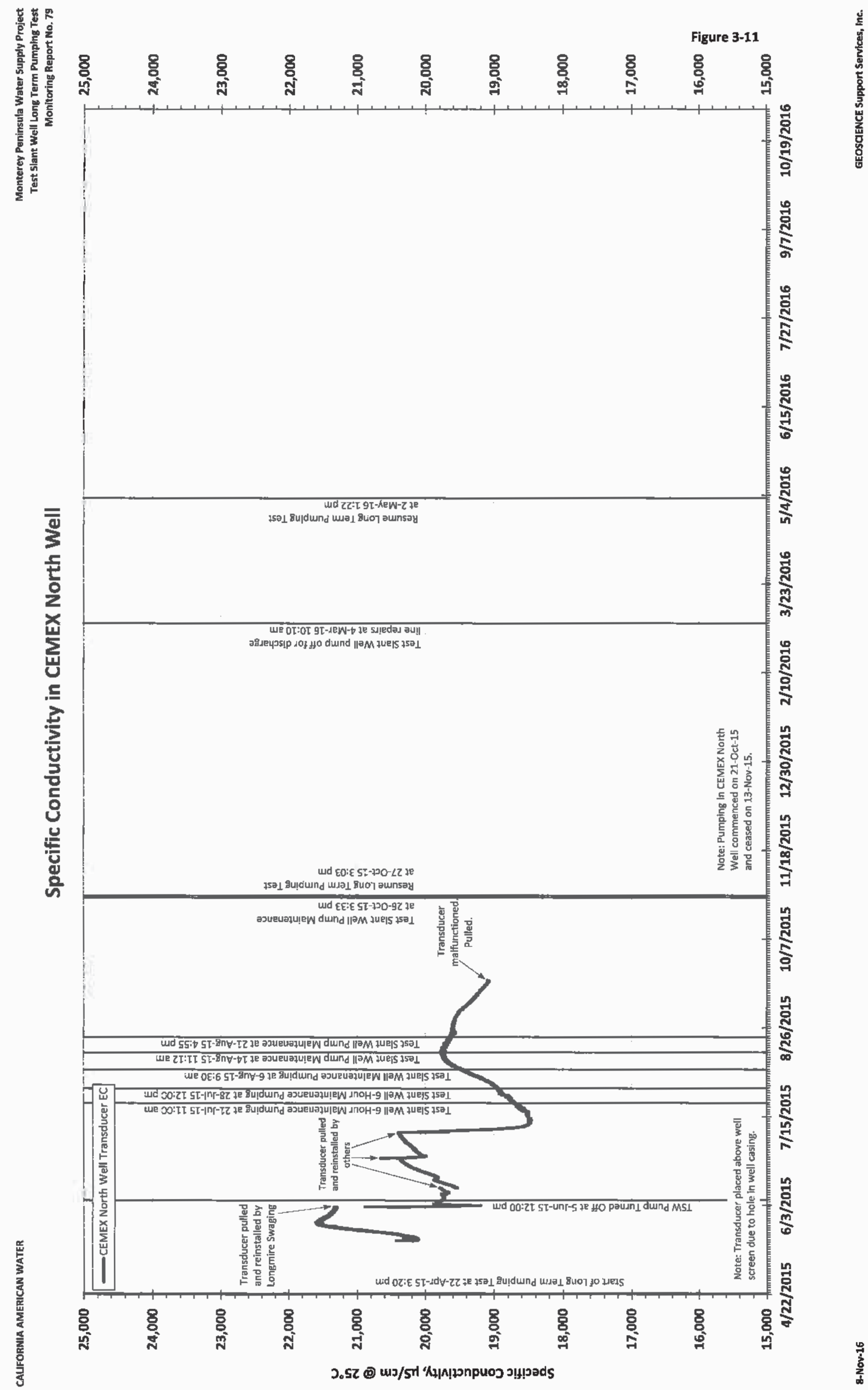

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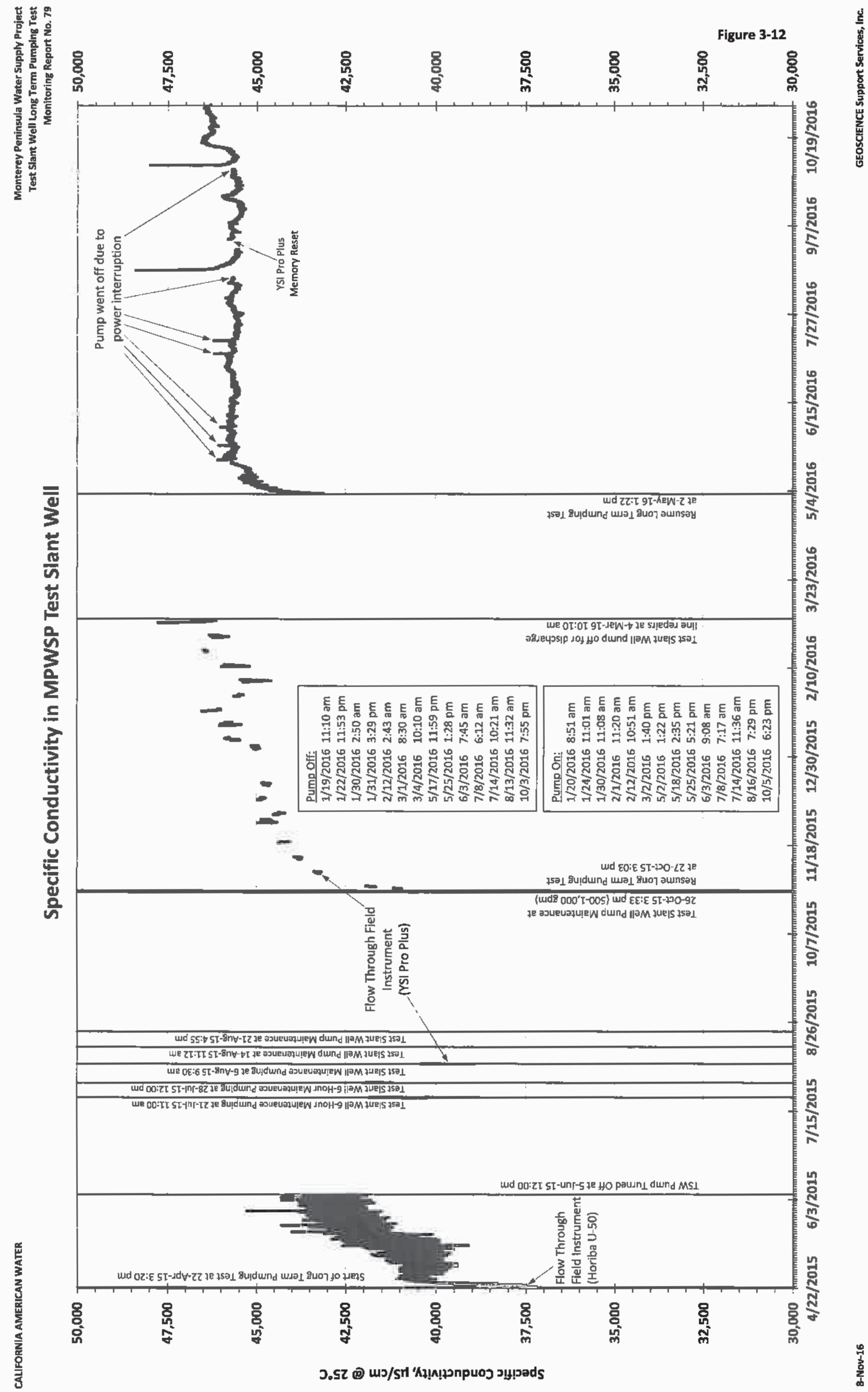

TABLES

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Table 1: Well Information Table

Well Name	Owner	Reference Point (RP)	State Plane Coordinates Northing	Easting	RP Elevation ft NAVD88	RP Height (ft above GS)	Distance of RP from Slant Well Head (ft)	Top of Screen Interval (ft below GS)	Bottom of Screen Interval (ft below GS)	Transducer Installed Depth (ft below RP)	Survey Date	Data Logging Start Date	Data Collected
MW-1S	MW-1	Top of ABS Transducer Mount	2,154,745 35	5,739,355 87	30 51 [1]	2 65 [1]	211	55	95	76	26-Mar-15	19-Feb-15	Level, Conductivity
MW 1M	MW-1	Top of ABS Transducer Mount	2,154 751 93	5 739,347 94	29 86	2 46	220	115	225	167	26-Mar-15	19-Feb-15	Level, Conductivity
MW 1D	MW-1	Top of ABS Transducer Mount	2,154 753 60	5 739 337 98	29 68 [1]	2 65 [1]	230	277	327	309	26-Mar-15	19-Feb-15	Level Conductivity
MW-3S	MW 3	Top of ABS Transducer Mount	2,154,599 85	5,739 977 02	37 16	2 66	428	50	90	76	26 Mar-15	1-Mar 15	Level, Conductivity
MW-3M	MW-3	Top of ABS Transducer Mount	2,154 592 96	5 739 988 54	37 35	2 73	441	105	215	182	26-Mar-15	1-Mar 15	Level, Conductivity
MW-3D	MW-3	Top of ABS Transducer Mount	2 154 589 81	5 739 998 68	36 93	2 74	451	295	350	321	26-Mar-15	4-Mar-15	Level Conductivity
MW-4S	MW-4	Top of ABS Transducer Mount	2,154 170 90	5,741 427 62	41 96	2 26	1,940	60	100	66	26-Mar 15	9 Mar-15	Level, Conductivity
MW-4M	MW-4	Top of ABS Transducer Mount	2,154 172 79	5,741 416 78	41 92	2 15	1 929	130	260	208	26-Mar-15	9-Mar-15	Level, Conductivity
MW-4D	MW-4	Top of ABS Transducer Mount	2,154,174 30	5,741 406 09	41 85	2 15	1,918	290	330	317	26-Mar-15	20-Feb-15	Level, Conductivity
MW-5S	MW 5	Top of ABS Transducer Mount	2 156,239 19	5,748,566 36	80.25 [1]	2 20 [1]	9 135	43	83	71	26-Mar-15	10-Mar 15	Level, Conductivity
MW-5M	MW-5	Top of ABS Transducer Mount	2,156 230 58	5,748,564 26	80 48 [1]	2 31 [1]	9,131	100	310	171	26-Mar-15	10-Mar-15	Level, Conductivity
MW-5D	MW 5	Top of ABS Transducer Mount	2 156 220 77	5,748 560 95	80 06	1 97	9,126	395	435	417	26-Mar-15	19 Feb-15	Level, Conductivity
MW-6S	MW-6	Top of ABS Transducer Mount	2,141 142 97	5,756,164 01	35 89	2 45	21,436	30	60	61	1-Oct-15	22 Apr 15	Level, Conductivity
MW-6M	MW-6	Top of ABS Transducer Mount	2 141 138 40	5 756 154 35	35 68	2 44 [1]	21,431	150	210	184	1-Oct-15	22-Apr-15	Level Conductivity
MW-6D	MW 6	Top of ABS Transducer Mount	2,141 133 06	5 756,144 99	35 82	2 42 [1]	21 427	255	325	201	1 Oct-15	22-Apr-15	Level Conductivity
MW-7S	MW-7	Top of ABS Transducer Mount	2 152 099 25	5,744,145 10	50 64	2 06	5,274	60	80	72	1-Oct 15	13-Aug-15	Level, Conductivity
MW-7M	MW-7	Top of ABS Transducer Mount	2 152,110 46	5 744,146 08	50 29	2 09	5 266	130	220	187	1-Oct-15	13-Aug-15	Level Conductivity
MW-7D	MW 7	Top of ABS Transducer Mount	2,152,120 50	5 744,144 38	50 24	2 14	5,260	295	345	322	1 Oct 15	13-Aug 15	Level Conductivity
MW-8S	MW-8	Top of ABS Transducer Mount	2 159 440 33	5.744.871 52	19.96	2 14 [2]	7,116	40	80	61	1-Oct-15	30-May-15	Level, Conductivity
MW-8M	MW-8	Top of ABS Transducer Mount	2,159,430 86	5,744 866 05	19 99	2 17 [2]	7 106	125	215	181	1 Oct-15	30 May 15	Level Conductivity
MW-8D	MW-8	Top of ABS Transducer Mount	2 159 421 17	5 744,861 04	20 06	2 10 [3]	7 096	300	350	326	1 Oct-15	30-May-15	Level Conductivity
MW-9S	MW-9	Top of ABS Transducer Mount	2,162 010 77	5,747,345 03	18 12	2 16 [3]	10 677	30	110	71	1 Oct-15	1-Jul-15	Level, Conductivity
MW 9M	MW-9	Top of ABS Transducer Mount	2,162 016 58	5 747,353 64	18 32	2 13 [3]	10 687	145	225	182	1 Oct-15	29-Jun-15	Level, Conductivity
MW-9D	MW-9	Top of ABS Transducer Mount	2 162 022 89	5,747,362 25	18 32	2 15 [3]	10,697	353	393	377	1-Oct-15	26-Jun-15	Level, Conductivity
Well No 1[4]	MRWPCA	Well Cover	2,151 622 14	5,750 015 59	114 ft amsl (GS)	1 60	10 898	260	340	299		19-Feb-15	Level, Conductivity
Well No 2[4]	MRWPCA	Well Cover	2,151,550 48	5 749 987 41	115 ft amsl (GS)	1 65	10,892	260	340	319		19-Feb-15	Level Conductivity
CEMEX Dredge Pond	CEMEX	Top of ABS Transducer Mount	2,155 913 41	5,739 497 26	14 14	8 97	1 21[illegible]			-	26-Mar-15	8-Mar-15	Level, Conductivity
Test Slant Well	CEMEX	Near Ground Surface	2 154 702 56	5.739 561 92	30 86	0	0	46**	221**	705MD	26 Mar-15	1-Apr 15	Level Conductivity
CEMEX North Well	CEMEX	Well Cover	2 154,264 48	5,740 032 07	39 20	0 25	1 529	244	481	150	1-Oct 15	1 Apr 15	Level Conductivity
CEMEX South Well[4]	CEMEX	Ground Surface	2,154 212 30	5 740 996 57	31 ft amsl (GS)	0	1 518	400	506				

Horizontal Datum: NAD83 State Plane Zone 4
Vertical Datum: NAVD88
* RP height above pond water level 5.22 ft NAVD88 (8-11 am 26-Mar-15)
** Top of 18 in. screen = 140 ft x Sin(19) = 46 ft TVD, Bottom of 14 in. screen = 710 x Sin(19) = 231 ft TVD

[1] RP/elevation change on May 17, 2015 - New caps
[2] RP/elevation change on July 17, 2015 - New caps
[3] RP/elevation change on September 24, 2015 - New caps
[4] Estimated - not surveyed.

MD: Measured Depth - lineal feet along the angle of the slant well
GS: Ground Surface - approximate ground surface elevation based on Google Earth

Table 2: Summary of Test Slant Well Laboratory Water Quality Results

		Sample Collection Date:	8-Apr-15	29-Apr-15	6-May-15	13-May-15	20-May-15	27-May-15	3-Jun-15	28-Oct-15	12-Nov-15	19-Nov-15
Constituent	Method	Units	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Alkalinity, Total (as CaCO3)	SM2320B	mg/L	117	-	121	120	121	118	124	-	-	117
Aluminum, Total	EPA 200.8	µg/L	ND	-	70	ND	ND	321	ND	-	-	ND
Ammonia-N, Dissolved	SM4500NH3 D	mg/L	ND	-	ND	ND	ND	ND	ND	ND	-	ND
Arsenic, Total [1]	EPA 200.8	µg/L	33	-	31	31	38	38	37	-	-	38
Arsenic, Total	EPA 1640	µg/L	-	-	-	-	-	-	-	-	-	-
Barium, Dissolved	EPA 200.8	µg/L	95	-	106	106	100	110	87	-	-	88
Bicarbonate (as HCO3-)	SM2320B	mg/L	143	-	148	146	148	144	151	-	-	143
Boron, Dissolved	EPA 200.7	mg/L	2.6	-	2.51	3.10	2.88	2.71	2.86	-	-	3.37
Bromide, Dissolved	EPA 300.0	mg/L	37.0	-	45	45	48.7	48	47.4	-	-	53.6
Calcium	EPA 200.7	mg/L	349	-	621	606	607	587	598	-	-	541
Calcium, Dissolved	EPA 200.7	mg/L	371	-	581	660	595	584	583	-	-	551
Carbamates by HPLC (EPA 531)	EPA 531	µg/L	ND	-	-	-	-	-	-	-	-	-
Carbonate as CaCO3	SM2320B	mg/L	ND	-	ND	ND	ND	ND	ND	-	-	ND
Chloride, Dissolved	EPA 300.0	mg/L	13,830	-	14,476	14,344	15,724	15,721	15,869	-	-	14,186
Chlorinated Pesticides and PCB (EPA 5	EPA 508	µg/L	ND	-	-	-	-	-	-	-	-	-
Color, Apparent (Unfiltered)	SM2120B	Color Units	4	-	4	ND	ND	ND	ND	6	-	4
Copper	EPA 200.7	µg/L	-	-	-	-	-	ND	ND	-	-	ND
Copper, Total	EPA 200.8	µg/L	44	-	75	74	40	-	-	-	-	-
DBCP & EDB	EPA 504.1	µg/L	ND	-	-	-	-	-	-	-	-	-
Dioxin	EPA 1613	pg/L	ND	-	-	-	-	-	-	-	-	-
Diquat (EPA 549)	EPA 549	µg/L	ND	-	-	-	-	-	-	-	-	-
Dissolved Anions	Calculation	Meq/L	431.33	-	453.50	451.38	491.70	491.97	496.41	-	-	447.47
Total Anions	Calculation	Meq/L	431.33	-	453.50	451.38	491.70	491.97	496.41	-	-	447.47
Dissolved Cations	Calculation	Meq/L	455.09	-	435.45	479.03	508.91	458.32	460.38	-	-	494.88
Total Cations	Calculation	Meq/L	430.99	-	477.91	445.16	524.66	458.67	465.32	-	-	483.86
Fluoride, Dissolved	EPA 300.0	mg/L	0.2	-	0.7	ND	ND	0.7	ND	-	-	0.8
Hardness (as CaCO3)	SM2340B/Calc	mg/L	4,751	-	5,879	5,796	6,066	5,748	5,924	-	-	5,798
Hydroxide	SM2320B	mg/L	ND	-	ND	ND	ND	ND	ND	-	-	ND
Iodide	EPA 9056M	µg/L	ND	-	ND	ND	ND	ND	ND	-	-	ND
Iron	EPA 200.7	µg/L	69	-	99	ND	ND	ND	ND	-	-	ND
Iron, Dissolved	EPA 200.7	µg/L	65	-	ND	ND	ND	ND	ND	-	-	ND
Kjehidahl Nitrogen, Dissolved	SM4500-NH3 B,C,E	mg/L	ND	-	ND	ND	ND	ND	ND	-	-	ND
Lithium	EPA 200.8	µg/L	152	-	169	144	165	250	212	-	-	106
Magnesium	EPA 200.7	mg/L	942	-	1,050	1,040	1,100	1,040	1,080	-	-	1,080
Magnesium, Dissolved	EPA 200.7	mg/L	989	-	970	1,110	1,080	1,040	1,060	-	-	1,110
Manganese, Dissolved	EPA 200.7	µg/L	26	-	ND	ND	ND	ND	ND	-	-	ND
Manganese, Total	EPA 200.7	µg/L	26	-	ND	ND	ND	ND	ND	-	-	ND
MBAS (Surfactants)	SM5540C	mg/L	ND	-	ND	ND	ND	ND	ND	-	-	ND
Nitrate as NO3	EPA 300.0	mg/L	5	-	7	8	ND	6	8	-	-	6
Nitrate+Nitrite as N	EPA 300.0	mg/L	1.0	-	1.9	1.8	1.8	1.8	1.7	-	-	1.4
Nitrite as NO2-N, Dissolved	EPA 300.0	mg/L	ND	-	0.2	ND	ND	0.3	ND	-	-	ND
Odor Threshold at 60 C	SM2150B	TON	2	-	1	1	1	1	1	-	-	2
o-Phosphate-P	Hach 8048	mg/L	0.10	-	0.12	0.13	0.12	0.11	0.13	-	-	0.14
pH (Field Test)	SM4500-H+B	pH	7.03	6.86	6.84	6.85	6.94	6.91	6.94	7.01	7.05	7.04
pH (Laboratory)	SM4500-H+B	pH (H)	7.2	-	7.4	7.4	7.4	7.4	7.4	7.2	-	7.1
Phenoxy Acid Herbicides (515.3)	EPA 515.3	µg/L	ND	-	-	-	-	-	-	-	-	-
Phosphorus, Dissolved Total	HACH 8190	mg/L	0.09	-	0.10	0.13	0.13	0.07	0.14	-	-	0.10
Potassium	EPA 200.7	mg/L	203	-	212	209	231	220	226	-	-	256
Potassium, Dissolved	EPA 200.7	mg/L	213	-	185	230	227	219	220	-	-	263
QC Ratio TDS/SEC	Calculation	-	0.67	0.66	0.64	0.66	0.67	0.67	0.68	0.67	0.67	0.68
Reg. Org. Compounds (EPA 525)	EPA 525	µg/L	ND	-	-	-	-	-	-	-	-	-
Salinity	SM2520B	psu	-	-	-	-	-	-	-	-	-	-
Silica as SiO2, Dissolved	EPA 200.7	mg/L	20	-	16	22	19	17	20	-	-	19
Sodium	EPA 200.7	mg/L	7,606	-	8,163	7,448	9,148	7,774	7,835	-	-	8,309
Sodium, Dissolved	EPA 200.7	mg/L	8,040	-	7,400	8,020	8,840	7,770	7,780	-	-	8,490
Specific Conductance (E.C)	SM2510B	µmhos/cm	37,860	39,500	41,110	41,800	42,100	42,410	42,950	41,400	43,940	43,730
Specific Conductance (E.C) (Field)	SM2510B	µmhos/cm	38,097	40,100	40,600	42,400	41,900	42,400	43,300	40,915	43,940	44,222
Strontium, Dissolved	EPA 200.8	µg/L	7,440	-	7,820	8,008	8,349	7,734	7,900	-	-	7,670
Sulfate, Dissolved	EPA 300.0	mg/L	1,840	-	2,018	2,096	2,160	2,181	2,188	-	-	1,973
Temperature (Field)	SM2550	°C	17.20	16.79	16.71	16.86	16.63	16.35	16.68	18.4	17.1	17.1
Total Diss. Solids	SM2540C	mg/L	25,400	26,000	26,300	27,600	28,400	28,500	29,100	27,700	29,400	29,800
Turbidity	EPA 180.1	NTU	0.40	-	0.30	0.30	0.25	0.25	0.15	0.5	-	0.30
Turbidity (Field)	EPA 180.1	NTU	0.74	0.84	0.69	0.76	0.30	0.29	0.353	0.59	0.98	0.61
Volatile Org. Compounds (524)	EPA 524	µg/L	ND	-	-	-	-	-	-	-	-	-
Zinc	EPA 200.7	µg/L	-	-	-	-	-	142	ND	-	-	ND
Zinc, Total	EPA 200.8	µg/L	ND	-	158	ND	209	-	-	-	-	-
PCBs, Total	EPA 508	µg/L	ND	-	-	-	-	-	-	-	-	-
Total PCB	EPA 1668C	pg/L	-	-	7.68	-	ND	12.2	0.766	-	-	-

Notes:

°C = Degrees Celsius
CU = Color Units
Meq/L = Milliequivalents per Liter
mg/L = Milligrams per Liter
NTU = Nephelometric Turbidity Units
pg/L = Picograms per Liter
TON = Threshold Odor Number
µg/L = Micorgrams per Liter
µmhos/cm = Micromhos per Centimeter

ND = NOT DETECTED at or above the Reporting Limit (RL) or Practical Quantitation Limit (PQL). See laboratory water quality reports for RL and PQL values.

[1] Using EPA Method 200.8, Arsenic values are overstated due to matrix interference caused by high chloride levels. The overstated values are in laboratory reports through February 11, 2016. Going forward, EPA Method 1640 will be used for Arsenic analysis only.

Water Ratepayers Association of the Monterey Peninsula (WRAMP) Exhibits

Table 2: Summary of Test Slant Well Laboratory Water Quality Results

		Sample Collection Date:	30-Nov-15	3-Dec-15	10-Dec-15	17-Dec-15	4-Jan-16	14-Jan-16	21-Jan-16	28-Jan-16	4-Feb-16	11-Feb-16
Constituent	Method	Units	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Alkalinity, Total (as CaCO3)	SM2320B	mg/L	114	111	113	112	111	110	111	110	109	110
Aluminum, Total	EPA 200.8	µg/L	ND	ND	53	ND	ND	ND	ND	ND	ND	ND
Ammonia-N, Dissolved	SM4500NH3 D	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic, Total [1]	EPA 200.8	µg/L	45	42	42	40	47	ND	48	50	46	42
Arsenic, Total	EPA 1640	µg/L	-	-	-	-	-	-	-	-	-	0.39
Barium, Dissolved	EPA 200.8	µg/L	81	88	82	78	78	74	82	74	69	ND
Bicarbonate (as HCO3-)	SM2320B	mg/L	139	135	138	137	135	134	135	134	133	134
Boron, Dissolved	EPA 200.7	mg/L	3.38	3.16	3.14	3.97	3.21	3.71	3.48	3.35	3.33	3.41
Bromide, Dissolved	EPA 300.0	mg/L	53	52.6	50.2	50.2	50.0	52.4	48.2	51.3	50.1	51.8
Calcium	EPA 200.7	mg/L	582	538	511	657	515	531	493	523	522	523
Calcium, Dissolved	EPA 200.7	mg/L	577	532	518	686	511	537	532	523	526	533
Carbamates by HPLC (EPA 531)	EPA 531	µg/L	ND	-	-	-	-	-	-	ND	-	-
Carbonate as CaCO3	SM2320B	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloride, Dissolved	EPA 300.0	mg/L	16,111	16,383	16,257	16,579	16,510	16,972	15,685	16,798	17,195	16,980
Chlorinated Pesticides and PCB (EPA 5	EPA 508	µg/L	ND	-	-	-	-	-	-	ND	-	-
Color, Apparent (Unfiltered)	SM2120B	Color Units	7	4	ND	ND	3	5	ND	ND	ND	5
Copper	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper, Total	EPA 200.8	µg/L	-	-	-	-	-	-	-	-	-	-
DBCP & EDB	EPA 504.1	µg/L	ND	-	-	-	-	-	-	ND	-	-
Dioxin	EPA 1613	pg/L	ND	-	-	-	-	-	-	ND	-	-
Diquat (EPA 549)	EPA 549	µg/L	ND	-	-	-	-	-	-	ND	-	-
Dissolved Anions	Calculation	Meq/L	503.06	503.06	507.53	516.55	514.28	529.53	493.46	524.48	535.83	529.87
Total Anions	Calculation	Meq/L	503.06	510.47	507.53	516.55	514.28	529.53	493.46	524.48	535.83	529.87
Dissolved Cations	Calculation	Meq/L	526.37	498.07	506.84	484.86	457.70	533.96	514.92	523.20	521.97	537.19
Total Cations	Calculation	Meq/L	544.39	500.67	500.01	510.72	466.00	526.46	484.44	516.68	524.71	526.05
Fluoride, Dissolved	EPA 300.0	mg/L	0.8	0.8	ND	ND	ND	ND	ND	ND	ND	ND
Hardness (as CaCO3)	SM2340B/Calc	mg/L	6,383	5,890	5,756	6,710	5,651	5,938	5,909	5,918	5,940	5,972
Hydroxide	SM2320B	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iodide	EPA 9056M	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	EPA 200.7	µg/L	ND	ND	ND	96	ND	ND	ND	ND	ND	ND
Iron, Dissolved	EPA 200.7	µg/L	ND	ND	ND	126	ND	ND	ND	ND	ND	ND
Kjehldahl Nitrogen, Dissolved	SM4500-NH3 B,C,E	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lithium	EPA 200.8	µg/L	135	131	142	149	133	160	129	128	117	170
Magnesium	EPA 200.7	mg/L	1,200	1,100	1,090	1,230	1,060	1,120	1,140	1,120	1,130	1,130
Magnesium, Dissolved	EPA 200.7	mg/L	1,170	1,090	1,100	1,310	1,050	1,150	1,190	1,130	1,130	1,150
Manganese, Dissolved	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese, Total	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MBAS (Surfactants)	SM5540C	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate as NO3	EPA 300.0	mg/L	6	6	2	9	8	8	8	8	8	8
Nitrate+Nitrite as N	EPA 300.0	mg/L	1.4	1.3	2.0	2.0	1.9	1.9	1.8	1.8	1.8	1.8
Nitrite as NO2-N, Dissolved	EPA 300.0	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Odor Threshold at 60 C	SM2150B	TON	2	2	3	1	2	2	1	1	2	1
o-Phosphate-P	Hach 8048	mg/L	0.15	0.15	0.14	0.13	0.13	0.12	0.11	0.12	0.12	0.13
pH (Field Test)	SM4500-H+B	pH	7.06	8.14	7.10	7.08	7.11	7.07	7.08	7.06	7.04	7.05
pH (Laboratory)	SM4500-H+B	pH (H)	7.1	7.1	7.1	7.1	7.1	7.3	7.2	7.2	7.1	7.2
Phenoxy Acid Herbicides (515.3)	EPA 515.3	µg/L	ND	-	-	-	-	-	-	ND	-	-
Phosphorus, Dissolved Total	HACH 8190	mg/L	0.14	0.13	0.13	0.13	0.10	0.10	0.10	0.11	0.09	0.10
Potassium	EPA 200.7	mg/L	284	268	266	293	256	275	271	267	270	268
Potassium, Dissolved	EPA 200.7	mg/L	281	268.0	266	308	254	278	282	272	269	276
QC Ratio TDS/SEC	Calculation	-	0.68	0.69	0.68	0.67	0.66	0.69	0.67	0.67	0.67	0.69
Reg. Org. Compounds (EPA 525)	EPA 525	µg/L	ND	-	-	-	-	-	-	ND	-	-
Salinity	SM2520B	psu	-	-	-	-	-	-	-	-	-	-
Silica as SiO2, Dissolved	EPA 200.7	mg/L	18	16	16	20	16	20	17	15	14	14
Sodium	EPA 200.7	mg/L	9,410	8,654	8,691	8,488	7,966	9,213	8,255	9,002	9,167	9,198
Sodium, Dissolved	EPA 200.7	mg/L	9,060	8,620	8,820	7,700	7,800	9,320	8,810	9,130	9,100	9,400
Specific Conductance (E.C)	SM2510B	µmhos/cm	44,110	44,470	44,380	44,870	45,370	45,720	46,900	45,720	45,790	45,650
Specific Conductance (E.C) (Field)	SM2510B	µmhos/cm	44,835	44,246	44,834	44,649	45,090	45,937	46,026	45,487	45,392	45,697
Strontium, Dissolved	EPA 200.8	µg/L	7,767	7,668	7,444	7,194	7,306	7,800	7,481	7,503	5,865	5,796
Sulfate, Dissolved	EPA 300.0	mg/L	2,187	2,177	2,204	2,202	2,188	2,294	2,307	2,288	2,297	2,300
Temperature (Field)	SM2550	°C	16.3	16.9	16.9	16.7	15.6	15.2	15.5	15.3	15.5	15.9
Total Diss. Solids	SM2540C	mg/L	29,800	30,900	30,200	30,200	30,100	31,700	31,400	30,600	30,500	31,400
Turbidity	EPA 180.1	NTU	0.30	0.15	0.40	0.25	0.30	0.35	0.30	0.10	0.15	0.25
Turbidity (Field)	EPA 180.1	NTU	1.15	0.64	0.67	0.36	0.31	0.37	0.09	0.11	0.64	0.35
Volatile Org. Compounds (524)	EPA 524	µg/L	ND	-	-	-	-	-	-	ND	-	-
Zinc	EPA 200.7	µg/L	ND	ND	204	ND	ND	ND	ND	ND	ND	ND
Zinc, Total	EPA 200.8	µg/L	-	-	-	-	-	-	-	-	-	-
PCBs, Total	EPA 508	µg/L	ND	-	-	-	-	-	-	ND	-	-
Total PCB	EPA 1668C	pg/L	25.8	-	-	-	-	-	-	7.73	-	-

Notes:

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[1] Using EPA Method 200.8, Arsenic values are overstated due to matrix interference caused by high chloride levels. The overstated values are in laboratory reports through February 11, 2016. Going forward, EPA Method 1640 will be used for Arsenic analysis only.

Table 2: Summary of Test Slant Well Laboratory Water Quality Results

		Sample Collection Date:	18-Feb-16	25-Feb-16	3-Mar-16	3-May-16	12-May-16	19-May-16	26-May-16	2-Jun-16	9-Jun-16	16-Jun-16
Constituent	Method	Units	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Alkalinity, Total (as CaCO3)	SM2320B	mg/L	110	110	110	108	110	114	112	111	110	112
Aluminum, Total	EPA 200.8	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia-N, Dissolved	SM4500NH3 D	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic, Total [1]	EPA 200.8	µg/L	-	-	-	-	-	-	-	-	-	-
Arsenic, Total	EPA 1640	µg/L	0.28	0.30	0.28	0.32	0.26	0.24	0.29	0.28	0.27	0.30
Barium, Dissolved	EPA 200.8	µg/L	ND	71	75	ND	ND	74	ND	ND	62	ND
Bicarbonate (as HCO3-)	SM2320B	mg/L	134	134	134	132	134	139	137	135	134	137
Boron, Dissolved	EPA 200.7	mg/L	3.19	3.31	3.43	3.62	3.30	3.54	3.11	3.18	3.47	3.38
Bromide, Dissolved	EPA 300.0	mg/L	52.6	52.6	52.3	50.3	43.2	59.4	59.6	50.5	40.1	35.4
Calcium	EPA 200.7	mg/L	497	510	493	458	489	542	430	469	506	498
Calcium, Dissolved	EPA 200.7	mg/L	503	510	502	456	496	528	396	479	506	499
Carbamates by HPLC (EPA 531)	EPA 531	µg/L	-	-	-	-	-	-	-	-	-	-
Carbonate as CaCO3	SM2320B	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloride, Dissolved	EPA 300.0	mg/L	17,243	17,186	17,337	15,946	15,872	16,965	16,326	16,326	16,807	16,547
Chlorinated Pesticides and PCB (EPA 5	EPA 508	µg/L	-	-	-	-	-	-	-	-	-	-
Color, Apparent (Unfiltered)	SM2120B	Color Units	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper, Total	EPA 200.8	µg/L	-	-	-	-	-	-	-	-	-	-
DBCP & EDB	EPA 504.1	µg/L	-	-	-	-	-	-	-	-	-	-
Dioxin	EPA 1613	pg/L	-	-	-	-	-	-	-	-	-	-
Diquat (EPA 549)	EPA 549	µg/L	-	-	-	-	-	-	-	-	-	-
Dissolved Anions	Calculation	Meq/L	538.01	536.27	541.32	499.99	499.14	530.65	509.47	510.34	528.27	520.48
Total Anions	Calculation	Meq/L	538.01	536.27	541.32	499.99	499.14	530.65	509.47	510.34	528.27	520.48
Dissolved Cations	Calculation	Meq/L	522.84	541.86	557.28	520.85	514.63	529.51	491.98	515.26	496.63	479.25
Total Cations	Calculation	Meq/L	520.40	544.60	540.75	516.58	507.73	540.16	497.14	507.81	493.75	481.32
Fluoride, Dissolved	EPA 300.0	mg/L	ND	ND	1.1	1.0	ND	ND	ND	ND	ND	ND
Hardness (as CaCO3)	SM2340B/Calc	mg/L	5,870	6,112	5,901	5,739	5,776	6,316	5,492	5,656	5,822	5,732
Hydroxide	SM2320B	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iodide	EPA 9056M	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron, Dissolved	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Kjehldahl Nitrogen, Dissolved	SM4500-NH3 B,C,E	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lithium	EPA 200.8	µg/L	154	164	166	153	149	145	164	159	177	132
Magnesium	EPA 200.7	mg/L	1,120	1,180	1,130	1,120	1,110	1,200	1,070	1,090	1,110	1,090
Magnesium, Dissolved	EPA 200.7	mg/L	1,120	1,170	1,180	1,120	1,120	1,180	1,040	1,100	1,110	1,090
Manganese, Dissolved	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese, Total	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MBAS (Surfactants)	SM5540C	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate as NO3	EPA 300.0	mg/L	8	8	8	6	6	3	ND	ND	1	ND
Nitrate+Nitrite as N	EPA 300.0	mg/L	1.8	1.8	1.8	1.4	1.3	0.7	ND	ND	0.2	ND
Nitrite as NO2-N, Dissolved	EPA 300.0	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Odor Threshold at 60 C	SM2150B	TON	1	1	1	1	1	1	1	1	1	1
o-Phosphate-P	Hach 8048	mg/L	0.11	0.12	0.11	0.11	0.12	0.12	0.12	0.11	0.11	0.11
pH (Field Test)	SM4500-H+B	pH	7.11	7.12	7.14	7.25	7.10	7.07	7.16	7.04	7.17	7.07
pH (Laboratory)	SM4500-H+B	pH (H)	7.3	6.8	7.3	7.3	7.2	7.2	7.2	7.3	7.3	7.4
Phenoxy Acid Herbicides (515.3)	EPA 515.3	µg/L	-	-	-	-	-	-	-	-	-	-
Phosphorus, Dissolved Total	HACH 8190	mg/L	0.11	0.10	0.10	0.13	0.11	0.10	0.12	0.11	0.09	0.09
Potassium	EPA 200.7	mg/L	261	271	273	310	276	287	257	258	264	261
Potassium, Dissolved	EPA 200.7	mg/L	261	271	280	309	277	280	252	263	266	260
QC Ratio TDS/SEC	Calculation	-	0.67	0.67	0.69	0.68	0.68	0.70	0.70	0.68	0.69	0.68
Reg. Org. Compounds (EPA 525)	EPA 525	µg/L	-	-	-	-	-	-	-	-	-	-
Salinity	SM2520B	psu	-	-	-	28.8	29.1	29.4	29.6	29.7	29.7	29.3
Silica as SiO2, Dissolved	EPA 200.7	mg/L	12	12	14	ND	13	10	12	13	17	16
Sodium	EPA 200.7	mg/L	9,121	9,543	9,401	9,049	8,849	9,357	8,760	8,922	8,515	8,278
Sodium, Dissolved	EPA 200.7	mg/L	9,170	9,480	9,680	9,150	8,980	9,170	8,740	9,060	8,580	8,230
Specific Conductance (E.C)	SM2510B	µmhos/cm	45,560	46,190	46,380	44,530	45,030	45,430	45,730	45,880	45,800	45,340
Specific Conductance (E.C) (Field)	SM2510B	µmhos/cm	46,403	46,259	46,381	44,112	45,258	45,810	45,693	45,759	45,762	45,685
Strontium, Dissolved	EPA 200.8	µg/L	7,671	7,823	7,910	7,601	7,910	7,976	7,515	7,735	7,600	7,377
Sulfate, Dissolved	EPA 300.0	mg/L	2,334	2,328	2,366	2,270	2,332	2,353	2,206	2,254	2,470	2,450
Temperature (Field)	SM2550	°C	15.1	15.0	15.0	15.1	15.4	15.5	15.4	15.6	15.8	15.9
Total Diss. Solids	SM2540C	mg/L	30,700	30,800	31,800	30,200	30,800	31,900	32,200	31,300	31,600	30,900
Turbidity	EPA 180.1	NTU	0.10	0.10	0.30	1.6	0.35	0.30	0.35	0.20	0.25	0.25
Turbidity (Field)	EPA 180.1	NTU	0.33	0.15	0.08	0.29	0.37	0.10	0.30	0.12	0.19	0.31
Volatile Org. Compounds (524)	EPA 524	µg/L	-	-	-	-	-	-	-	-	-	-
Zinc	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc, Total	EPA 200.8	µg/L	-	-	-	-	-	-	-	-	-	-
PCBs, Total	EPA 508	µg/L	-	-	-	-	-	-	-	-	-	-
Total PCB	EPA 1668C	pg/L	-	-	-	-	-	-	-	-	-	-

Notes:

°C = Degrees Celsius
CU = Color Units
Meq/L = Milliequivalents per Liter
mg/L = Milligrams per Liter
NTU = Nephelometric Turbidity Units
pg/L = Picograms per Liter
TON = Threshold Odor Number
µg/L = Micorgrams per Liter
µmhos/cm = Micromhos per Centimeter

ND = NOT DETECTED at or above the Reporting Limit (RL) or Practical Quantitation Limit (PQL). See laboratory water quality reports for RL and PQL values.

[1] Using EPA Method 200.8, Arsenic values are overstated due to matrix interference caused by high chloride levels. The overstated values are in laboratory reports through February 11, 2016. Going forward, EPA Method 1640 will be used for Arsenic analysis only.

Table 2: Summary of Test Slant Well Laboratory Water Quality Results

		Sample Collection Date:	23-Jun-16	30-Jun-16	7-Jul-16	15-Jul-16	21-Jul-16	28-Jul-16	4-Aug-16	10-Aug-16	18-Aug-16	25-Aug-16
Constituent	Method	Units	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Alkalinity, Total (as CaCO3)	SM2320B	mg/L	113	114	113	114	113	114	115	114	113	116
Aluminum, Total	EPA 200.8	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia-N, Dissolved	SM4500NH3 D	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic, Total [1]	EPA 200.8	µg/L	-	-	-	-	-	-	-	-	-	-
Arsenic, Total	EPA 1640	µg/L	0.33	0.30	0.27	0.27	0.28	0.18	0.27	0.23	0.22	0.24
Barium, Dissolved	EPA 200.8	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bicarbonate (as HCO3-)	SM2320B	mg/L	138	139	138	139	138	139	140	139	138	142
Boron, Dissolved	EPA 200.7	mg/L	3.46	3.58	3.21	3.18	3.53	3.40	3.54	3.18	3.61	3.37
Bromide, Dissolved	EPA 300.0	mg/L	37.3	40.2	50.8	39.8	44.6	52.9	31.2	27.8	31.3	48.9
Calcium	EPA 200.7	mg/L	489	510	482	471	559	495	486	520	505	490
Calcium, Dissolved	EPA 200.7	mg/L	494	515	467	481	531	493	506	504	510	470
Carbamates by HPLC (EPA 531)	EPA 531	µg/L	-	-	-	-	-	-	-	-	-	-
Carbonate as CaCO3	SM2320B	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloride, Dissolved	EPA 300.0	mg/L	17,230	17,425	17,982	16,795	17,100	18,028	18,231	18,374	17,490	17,636
Chlorinated Pesticides and PCB (EPA 5	EPA 508	µg/L	-	-	-	-	-	-	-	-	-	-
Color, Apparent (Unfiltered)	SM2120B	Color Units	ND	ND	ND	ND	3	ND	ND	ND	ND	ND
Copper	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper, Total	EPA 200.8	µg/L	-	-	-	-	-	-	-	-	-	-
DBCP & EDB	EPA 504.1	µg/L	-	-	-	-	-	-	-	-	-	-
Dioxin	EPA 1613	pg/L	-	-	-	-	-	-	-	-	-	-
Diquat (EPA 549)	EPA 549	µg/L	-	-	-	-	-	-	-	-	-	-
Dissolved Anions	Calculation	Meq/L	536.91	541.24	558.08	524.21	532.46	563.12	564.83	568.56	545.43	546.73
Total Anions	Calculation	Meq/L	536.91	541.24	558.08	524.21	532.46	563.12	564.83	568.56	545.43	546.73
Dissolved Cations	Calculation	Meq/L	505.36	544.69	514.15	518.34	556.30	517.87	529.65	512.33	531.64	494.71
Total Cations	Calculation	Meq/L	495.32	523.17	511.63	499.31	583.22	514.08	509.12	523.03	528.35	527.38
Fluoride, Dissolved	EPA 300.0	mg/L	ND	1.2	ND	1	1.1	0.5	1.2	1.1	1.3	ND
Hardness (as CaCO3)	SM2340B/Calc	mg/L	5,907	6,009	5,799	5,611	6,531	5,918	5,785	6,038	6,310	5,671
Hydroxide	SM2320B	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iodide	EPA 9056M	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron, Dissolved	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Kjehldahl Nitrogen, Dissolved	SM4500-NH3 B,C,E	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lithium	EPA 200.8	µg/L	145	162	128	142	150	135	145	142	152	162
Magnesium	EPA 200.7	mg/L	1,140	1,150	1,120	1,080	1,250	1,140	1,110	1,150	1,230	1,080
Magnesium, Dissolved	EPA 200.7	mg/L	1,150	1,160	1,100	1,090	1,200	1,140	1,160	1,150	1,200	1,010
Manganese, Dissolved	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese, Total	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MBAS (Surfactants)	SM5540C	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate as NO3	EPA 300.0	mg/L	3	3	3	3	3	4	3	3	3	2
Nitrate+Nitrite as N	EPA 300.0	mg/L	0.7	0.7	0.7	0.7	0.7	0.8	0.6	0.6	0.6	0.4
Nitrite as NO2-N, Dissolved	EPA 300.0	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Odor Threshold at 60 C	SM2150B	TON	1	1	1	1	1	1	1	1	1	1
o-Phosphate-P	Hach 8048	mg/L	0.11	0.11	0.10	0.11	0.10	0.10	0.10	0.11	0.11	0.10
pH (Field Test)	SM4500-H+B	pH	7.17	7.11	7.14	7.65	7.10	7.10	7.15	7.15	7.08	7.05
pH (Laboratory)	SM4500-H+B	pH (H)	7.3	7.2	7.3	7.2	7.2	7.3	7.2	7.2	7.2	7.3
Phenoxy Acid Herbicides (515.3)	EPA 515.3	µg/L	-	-	-	-	-	-	-	-	-	-
Phosphorus, Dissolved Total	HACH 8190	mg/L	0.10	0.09	0.09	0.09	0.05	0.14	0.09	0.11	0.10	0.10
Potassium	EPA 200.7	mg/L	262	276	262	279	317	273	285	285	306	285
Potassium, Dissolved	EPA 200.7	mg/L	264	282.9	260.2	276	305	277.1	291	279	300	277
QC Ratio TDS/SEC	Calculation	-	0.69	0.65	0.68	0.66	0.68	0.69	0.69	0.68	0.67	0.67
Reg. Org. Compounds (EPA 525)	EPA 525	µg/L	-	-	-	-	-	-	-	-	-	-
Salinity	SM2520B	psu	29.3	29.4	29.7	29.3	29.1	29.1	28.6	29.4	29.8	29.2
Silica as SiO2, Dissolved	EPA 200.7	mg/L	10	16	14	12	14	9.0	12	14	12	11
Sodium	EPA 200.7	mg/L	8,515	9,104	8,936	8,731	10,215	8,933	8,879	9,084	9,060	9,351
Sodium, Dissolved	EPA 200.7	mg/L	8,720	9,570	9,050	9,140	9,730	9,020	9,230	8,860	9,190	8,760
Specific Conductance (E.C)	SM2510B	µmhos/cm	45,330	45,380	45,800	45,240	45,000	45,070	44,370	45,360	46,050	45,200
Specific Conductance (E.C) (Field)	SM2510B	µmhos/cm	45,663	45,769	45,763	45,620	45,544	45,613	45,770	45,632	46,081	45,509
Strontium, Dissolved	EPA 200.8	µg/L	7,438	7,460	7,791	7,147	7,366	7,164	7,552	7,884	7,620	7,785
Sulfate, Dissolved	EPA 300.0	mg/L	2,309	2,250	2,299	2,286	2,267	2,476	2,296	2,282	2,370	2,221
Temperature (Field)	SM2550	°C	15.9	15.8	15.9	15.9	16.2	16.1	15.9	16.0	15.9	15.9
Total Diss. Solids	SM2540C	mg/L	31,300	29,700	31,000	29,800	30,700	30,900	30,800	30,800	30,800	30,200
Turbidity	EPA 180.1	NTU	0.15	0.30	0.20	.10	0.30	0.25	0.40	0.10	0.30	0.05
Turbidity (Field)	EPA 180.1	NTU	0.34	0.26	0.21	0.16	0.17	0.33	0.27	0.14	0.12	0.24
Volatile Org. Compounds (524)	EPA 524	µg/L	-	-	-	-	-	-	-	-	-	-
Zinc	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc, Total	EPA 200.8	µg/L	-	-	-	-	-	-	-	-	-	-
PCBs, Total	EPA 508	µg/L	-	-	-	-	-	-	-	-	-	-
Total PCB	EPA 1668C	pg/L	-	-	-	-	-	-	-	-	-	-

Notes:

°C = Degrees Celsius
CU = Color Units
Meq/L = Milliequivalents per Liter
mg/L = Milligrams per Liter
NTU = Nephelometric Turbidity Units
pg/L = Picograms per Liter
TON = Threshold Odor Number
µg/L = Micorgrams per Liter
µmhos/cm = Micromhos per Centimeter

ND = NOT DETECTED at or above the Reporting Limit (RL) or Practical Quantitation Limit (PQL). See laboratory water quality reports for RL and PQL values.

[1] Using EPA Method 200.8, Arsenic values are overstated due to matrix interference caused by high chloride levels. The overstated values are in laboratory reports through February 11, 2016. Going forward, EPA Method 1640 will be used for Arsenic analysis only.

Water Ratepayers Association of the Monterey Peninsula (WRAMP) Exhibits

Table 2: Summary of Test Slant Well Laboratory Water Quality Results

		Sample Collection Date:	1-Sep-16	8-Sep-16	15-Sep-16	22-Sep-16	30-Sep-16	7-Oct-16	13-Oct-16
Constituent	Method	Units	Result	Result	Result	Result	Result	Result	Result
Alkalinity, Total (as CaCO3)	SM2320B	mg/L	116	117	116	115	117	115	113
Aluminum, Total	EPA 200.8	µg/L	ND	ND	ND	ND	ND	ND	ND
Ammonia-N, Dissolved	SM4500NH3 D	mg/L	ND	ND	ND	ND	ND	ND	ND
Arsenic, Total [1]	EPA 200.8	µg/L	-	-	-	-	-	-	-
Arsenic, Total	EPA 1640	µg/L	0.27	0.23	0.22	0.22	0.22	0.21	PENDING
Barium, Dissolved	EPA 200.8	µg/L	ND	ND	ND	ND	ND	ND	ND
Bicarbonate (as HCO3-)	SM2320B	mg/L	142	143	142	140	143	140	138
Boron, Dissolved	EPA 200.7	mg/L	3.20	3.23	3.20	3.17	3.41	3.36	3.40
Bromide, Dissolved	EPA 300.0	mg/L	56.4	51.8	47.2	54.0	50	50.0	50.4
Calcium	EPA 200.7	mg/L	461	461	460	494	492	508	510
Calcium, Dissolved	EPA 200.7	mg/L	467	457	454	488	495	458	473
Carbamates by HPLC (EPA 531)	EPA 531	µg/L	-	-	-	-	-	-	-
Carbonate as CaCO3	SM2320B	mg/L	ND	ND	ND	ND	ND	ND	ND
Chloride, Dissolved	EPA 300.0	mg/L	16,683	16,820	15,643	16,179	16,705	16,568	16,897
Chlorinated Pesticides and PCB (EPA 5	EPA 508	µg/L	-	-	-	-	-	-	-
Color, Apparent (Unfiltered)	SM2120B	Color Units	ND	ND	ND	ND	ND	ND	ND
Copper	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND
Copper, Total	EPA 200.8	µg/L	-	-	-	-	-	-	-
DBCP & EDB	EPA 504.1	µg/L	-	-	-	-	-	-	-
Dioxin	EPA 1613	pg/L	-	-	-	-	-	-	-
Diquat (EPA 549)	EPA 549	µg/L	-	-	-	-	-	-	-
Dissolved Anions	Calculation	Meq/L	521.27	526.22	493.31	508.70	523.28	519.14	532.46
Total Anions	Calculation	Meq/L	521.27	526.22	493.31	508.70	523.28	519.14	532.46
Dissolved Cations	Calculation	Meq/L	501.83	487.61	466.60	537.27	528.58	521.64	545.47
Total Cations	Calculation	Meq/L	512.46	489.96	483.65	530.53	543.94	537.38	544.72
Fluoride, Dissolved	EPA 300.0	mg/L	0.8	1.1	0.9	1.0	0.9	1.1	0.9
Hardness (as CaCO3)	SM2340B/Calc	mg/L	5,286	5,619	5,534	5,924	5,874	5,918	5,964
Hydroxide	SM2320B	mg/L	ND	ND	ND	ND	ND	ND	ND
Iodide	EPA 9056M	µg/L	ND	ND	ND	ND	ND	ND	PENDING
Iron	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND
Iron, Dissolved	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND
Kjehldahl Nitrogen, Dissolved	SM4500-NH3 B,C,E	mg/L	ND	ND	ND	ND	ND	ND	ND
Lithium	EPA 200.8	µg/L	166	156	153	132	138	124	141
Magnesium	EPA 200.7	mg/L	1,000	1,080	1,060	1,140	1,130	1,130	1,140
Magnesium, Dissolved	EPA 200.7	mg/L	968	1,060	1,040	1,060	1,130	1,090	1,120
Manganese, Dissolved	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND
Manganese, Total	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND
MBAS (Surfactants)	SM5540C	mg/L	ND	ND	ND	ND	ND	ND	ND
Nitrate as NO3	EPA 300.0	mg/L	3	5	4	4	5	4	4
Nitrate+Nitrite as N	EPA 300.0	mg/L	0.6	1.1	1.1	1.0	1.1	1.0	1.2
Nitrite as NO2-N, Dissolved	EPA 300.0	mg/L	ND	ND	ND	ND	ND	ND	ND
Odor Threshold at 60 C	SM2150B	TON	1	1	1	1	1	1	1
o-Phosphate-P	Hach 8048	mg/L	0.11	0.10	0.10	0.10	0.10	0.09	0.08
pH (Field Test)	SM4500-H+B	pH	7.06	7.06	7.08	7.09	7.09	7.10	7.02
pH (Laboratory)	SM4500-H+B	pH (H)	7.2	7.2	7.1	7.2	7.0	7.2	7.2
Phenoxy Acid Herbicides (515.3)	EPA 515.3	µg/L	-	-	-	-	-	-	-
Phosphorus, Dissolved Total	HACH 8190	mg/L	0.10	0.07	0.11	0.08	0.07	0.10	0.06
Potassium	EPA 200.7	mg/L	269	273	273	271	283	286	285
Potassium, Dissolved	EPA 200.7	mg/L	271.0	272	269	278	282	276	286
QC Ratio TDS/SEC	Calculation	-	0.69	0.66	0.67	0.66	0.68	0.69	PENDING
Reg. Org. Compounds (EPA 525)	EPA 525	µg/L	-	-	-	-	-	-	-
Salinity	SM2520B	psu	29.4	29.3	29.3	29.6	29.4	29.4	29.5
Silica as SiO2, Dissolved	EPA 200.7	mg/L	12	12	13	12	13	11	14
Sodium	EPA 200.7	mg/L	9,202	8,531	8,425	9,567	9,636	9,467	9,613
Sodium, Dissolved	EPA 200.7	mg/L	9,010	8,520	8,080	9,680	9,280	9,240	9,710
Specific Conductance (E.C)	SM2510B	µmhos/cm	45,450	45,260	45,250	45,680	45,380	45,420	45,610
Specific Conductance (E.C) (Field)	SM2510B	µmhos/cm	45,669	45,720	45,362	45,682	45,648	45,682	45,775
Strontium, Dissolved	EPA 200.8	µg/L	7,458	7,875	7,415	7,158	7,293	7,430	7,259
Sulfate, Dissolved	EPA 300.0	mg/L	2,285	2,337	2,355	2,365	2,353	2,342	2,537
Temperature (Field)	SM2550	°C	16.1	16.2	16.1	16.1	16.1	16.4	16.3
Total Diss. Solids	SM2540C	mg/L	31,200	30,000	30,200	30,300	30,800	31,400	PENDING
Turbidity	EPA 180.1	NTU	0.25	0.15	0.25	0.20	0.15	0.10	0.20
Turbidity (Field)	EPA 180.1	NTU	0.34	0.21	0.11	0.13	0.09	0.25	0.27
Volatile Org. Compounds (524)	EPA 524	µg/L	-	-	-	-	-	-	-
Zinc	EPA 200.7	µg/L	ND	ND	ND	ND	ND	ND	ND
Zinc, Total	EPA 200.8	µg/L	-	-	-	-	-	-	-
PCBs, Total	EPA 508	µg/L	-	-	-	-	-	-	-
Total PCB	EPA 1668C	pg/L	-	-	-	-	-	-	-

Notes:

°C = Degrees Celsius
CU = Color Units
Meq/L = Milliequivalents per Liter
mg/L = Milligrams per Liter
NTU = Nephelometric Turbidity Units
pg/L = Picograms per Liter
TON = Threshold Odor Number
µg/L = Micorgrams per Liter
µmhos/cm = Micromhos per Centimeter

ND = NOT DETECTED at or above the Reporting Limit (RL) or Practical Quantitation Limit (PQL). See laboratory water quality reports for RL and PQL values.

[1] Using EPA Method 200.8, Arsenic values are overstated due to matrix interference caused by high chloride levels. The overstated values are in laboratory reports through February 11, 2016. Going forward, EPA Method 1640 will be used for Arsenic analysis only.

EXHIBIT B

EXECUTION COPY

BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF CALIFORNIA

Application of California-American Water Company (U210W) for Approval of the Monterey Peninsula Water Supply Project and Authorization to Recover All Present and Future Costs in Rates	Application No. 12-04-019 (Filed April 23, 2012)

SETTLEMENT AGREEMENT ON

MPWSP DESALINATION PLANT RETURN WATER

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Dated: June 14, 2016

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BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF CALIFORNIA

Application of California-American Water Company (U210W) for Approval of the Monterey Peninsula Water Supply Project and Authorization to Recover All Present and Future Costs in Rates	Application No. 12-04-019 (Filed April 23, 2012)

SETTLEMENT AGREEMENT ON

MPWSP DESALINATION PLANT RETURN WATER

Pursuant to Article 12 of the Rules of Practice and Procedure of the California Public Utilities Commission ("CPUC"), California-American Water Company ("Cal Am"), Coalition of Peninsula Businesses ("CPB"), Landwatch Monterey County ("Landwatch"), the Monterey County Farm Bureau ("MCFB"), the Monterey County Water Resources Agency ("Agency"), the Monterey Peninsula Regional Water Authority ("Authority"), Monterey Peninsula Water Management District ("MPWMD"), Monterey Regional Water Pollution Control Agency ("MRWPCA"), Planning and Conservation League Foundation ("PCL"), and the Salinas Valley Water Coalition ("SVWC") (collectively, the "Parties") agree on the terms of this Settlement Agreement, which they now submit for review, consideration, and approval by the CPUC.

RECITALS

A. Cal Am is seeking permits and approvals for the Monterey Peninsula Water Supply Project ("Project"), including a certificate of public convenience and necessity from the CPUC.

B. The Project includes a desalination plant that will provide a potable water supply for Cal Am's Monterey Peninsula service area. Rather than using an open-ocean intake that would produce only seawater as source water for the desalination plant, the Project desalination plant will produce its source water from subterranean slant wells drilled adjacent to the ocean, which will draw water from strata underlying the ocean. The location of the wells overlies the western portion of the Salinas River Groundwater Basin ("SRGB").

C. Cal Am characterizes its Project as proposing to develop seawater and brackish groundwater originating from the SRGB to produce source water that would be desalinated to provide a potable water supply for Cal Am's Monterey Peninsula service area.

D. The SVWC, MCFB and Landwatch contend that—rather than proposing to use an open-ocean intake that would produce only seawater—Cal Am's Project proposes to use wells developed in the SRGB to produce source water for desalination to provide Cal Am's Monterey Peninsula service area with a new source of water supply.

E. The ratio of seawater to brackish SRGB groundwater in the Project source water is anticipated to change over time, with more seawater and less SRGB groundwater anticipated later in the Project's life.

F. Cal Am contends that source water production by the Project is unlikely to cause significant adverse environmental effects with respect to SRGB groundwater resources and is unlikely to cause injury to prior groundwater rights in the SRGB but submits that the Monterey County Water Resources Agency Act ("Agency Act") authorizes the Agency to obtain an injunction prohibiting the export and use of SRGB groundwater outside of the SRGB and certain areas of Fort Ord.

G. The Agency, SVWC, MCFB and Landwatch submit that the Agency Act directly prohibits the export and use of SRGB groundwater outside of the SRGB and certain areas of Fort Ord without the need for the Agency to obtain an injunction.

H. The Project's slant intake wells are designed to produce source water for treatment by the selected desalination plant ("Project Source Water Production"). To meet applicable requirements of the Agency Act, Cal Am has proposed as part of the Project to make available for delivery to groundwater users overlying the SRGB a volume of water ("Return Water") equal to the percentage of SRGB groundwater in the total Project Source Water Production, as calculated on a water year basis and determined by the Agency.

I. The SVWC, MCFB and Landwatch contend there is no surplus SRGB groundwater available for Cal Am's use in providing public water service within or outside of the SRGB and that the law of California groundwater rights requires that any production and use of SRGB groundwater by the Project must be returned for use within the SRGB in lieu of existing groundwater pumping.

J. For Project planning and engineering purposes, Cal Am submits that the Project source water wells have been designed so that approximately 4% of the source water produced by the Project will originate as brackish groundwater from the SRGB.

K. For planning purposes, Cal Am has assumed that the Return Water volume for the large desalination plant will be 1,080 acre feet annually ("afa") and, for the small desalination plant, 690 afa.

L. The CPUC is conducting environmental review of the Project under the California Environmental Quality Act ("CEQA"), and the Monterey Bay National Marine Sanctuary is conducting environmental review of the Project under the National Environmental Policy Act ("NEPA").

M. The modeling used in the CPUC's April 2015 CalAm Monterey Peninsula Water Supply Project Draft Environmental Impact Report ("DEIR") estimates that the volume of SRGB groundwater produced as source water for the large-scale (9.6 million gallons per day) Project would be approximately 7 percent, or 1,889 afa, under existing land-use conditions and would be approximately 4 percent, or 1,080 afa, under projected future 2060 land-use conditions, and would average approximately 5.5 percent, or 1,485 afa, over the life of the Project. (DEIR at 4.4-67.)

N. Note C to the CPUC's DEIR Table 2-5 states that "groundwater modeling indicates that as much as 1,080 afa may need to be returned to the Salinas Valley Groundwater Basin (based on 4 percent of total source water intake being drawn from the Salinas Valley Groundwater Basin)" and states that "Project supply would be sufficient to provide this larger quantity of return water."

O. The CPUC is preparing a revised DEIR/Environmental Impact Statement (RDEIR/DEIS) for the Project that will assess the significance of effects to SRGB groundwater resources, and the modeling in the revised RDEIR/DEIS will be updated and calibrated to include test well production data obtained to date (over 100 days of pumping). Cal Am also is working to gather additional (up to two years) test well production data to inform analysis of those effects. The full data set is not expected to be available before the CPUC's completion of CEQA/NEPA review and its decision whether to approve a certificate of convenience and necessity for the Project.

P. The Parties and the State Water Resources Control Board are in agreement, and the DEIR concludes, that delivering Return Water by injecting desalinated water from the Project into the SRGB is less desirable than delivering Return Water for beneficial use in in the SRGB.

Q. The Castroville Seawater Intrusion Project ("CSIP") is an Agency project that provides recycled water and diverted Salinas River water for use in lieu of groundwater pumping for irrigated agricultural use in the Castroville area of the SRGB.

R. It has been proposed that Cal Am Return Water obligations be fulfilled, in part, by delivery of Return Water to CSIP. Prior environmental analyses reveal that there may be limitations in the capacity of CSIP to accommodate all of the Project Return Water under some conditions. (DEIR, p. 2-45, 6-4, 6-114; Pure Water Monterey, GWR DEIR, Appendix Q, Table B-3).

S. The SVWC, MCFB and Landwatch contend that the Project's well production may cause injury to the SRGB and senior groundwater rights holders in the SRGB under California groundwater law, even if the RDEIR/DEIS concludes that the well production would not cause a significant adverse effect under CEQA.

T. MCFB, SVWC and Landwatch oppose any scenario where Return Water would be used outside the SRGB, rather than for use in lieu of existing groundwater pumping in the SRGB.

U. In the July 31, 2013 Settlement Agreement among 16 parties to Proceeding A.12-04-019, MCFB, SVWC, Landwatch, the Agency, and Citizens for Public Water reserved all rights to challenge production of water from the SRGB by Cal Am in any appropriate forum based on their concerns for potential harm to the SRGB and users thereof.

V. MCFB and SVWC have stated they may litigate these issues if they are not resolved through agreement.

W. Cal Am and the Authority maintain that any obligation to return SRGB groundwater to the SRGB arises only as a requirement of the Agency Act, except to the extent that Return

Water is necessary as part of a physical solution to avoid harm to the SRGB and senior groundwater rights holders in the SRGB under California groundwater law or to mitigate significant adverse effects to the SRGB or particular groundwater users pursuant to CEQA.

X. Cal Am, with the encouragement of the Authority, also desires to maximize revenue for Return Water to offset water costs and water rates for Cal Am customers on the Monterey Peninsula.

Y. Cal Am must obtain CPUC approval to deliver or sell any Return Water for use outside of Cal Am's service area.

Z. A controversy has now arisen as to Cal Am's obligation to deliver Return Water to the SRGB, and as to the responsibility for the costs of producing the Return Water, and the Parties to this Settlement Agreement seek to resolve these issues through this Settlement Agreement.

AA. Pursuant to the terms of this Settlement Agreement, the Parties propose that Cal Am deliver Return Water to the Castroville Community Services District ("CCSD") and to the CSIP to satisfy Return Water requirements that may arise out of the Agency Act, CEQA, or California groundwater law, in accordance with terms and conditions and general principles contained in this Settlement Agreement and separate Return Water Purchase Agreements between Cal Am as seller and CCSD and the Agency, respectively, as purchasers of Return Water.

BB. To facilitate planning and review, the Parties and CCSD executed a Return Water Planning Term Sheet ("Planning Term Sheet") on January 22, 2016 (Appendix A). At a regular meeting called and held on January 19, 2016, the Board of Directors of CCSD adopted Resolution No. 16-2 (Appendix B) approving execution of the Planning Term Sheet. The form of the Planning Term Sheet approved by Resolution 16-2 is consistent with the Planning Term Sheet executed by the Parties and CCSD on January 22, 2016. CCSD and the Parties have met and conferred since January 22, 2016 concerning the terms for a Return Water Purchase Agreement between CCSD and Cal Am ("CCSD RWPA") consistent with the Planning Term Sheet. The Board of Directors of CCSD reviewed the draft CCSD RWPA at a regular meeting on April 19, 2016 and adopted Resolution 16-4 (Appendix B) approving the draft CCSD RWPA in concept for submission to the CPUC for planning purposes and review. CCSD submits that CCSD would sign a CCSD RWPA after expiration of the statute of limitations for challenging a decision by the CPUC certifying the Project environmental impact report and approving this Settlement Agreement.

CC. In the Planning Term Sheet, CCSD submits that it provides municipal and domestic water service to the Town of Castroville, which overlies the SRGB in an area north of the City of Marina and west of the City of Salinas.

DD. In the Planning Term Sheet, CCSD submits that it currently relies on groundwater from the SRGB to meet Castroville's water demands, which use averages approximately 780 afa.

EE. In the Planning Term Sheet, CCSD submits that it increasingly has experienced water supply challenges due to water quality degradation of its water supplies, primarily from increased salinity.

FF. In the Planning Term Sheet, CCSD submits that poor water quality, including elevated sodium levels in CCSD's groundwater supplies, can contribute to health risks of individuals susceptible to high sodium.

GG. In the Planning Term Sheet, CCSD submits that it has been identified as a disadvantaged community (Greater Monterey County IRWM Regional Water Management Group Disadvantaged Community Outreach Plan, Prepared for the Environmental Justice Coalition for Water by Nilsen & Associates, Approved April 18, 2012), and was an active participant in the Regional Plenary Oversight Group process established by the Office of Ratepayer Advocates to determine whether the Regional Desalination Project, a predecessor project to the Project, would be a source of supply for Castroville.

HH. In the Planning Term Sheet, CCSD submits that many of CCSD's customers contribute significantly to agricultural and hospitality industries in the Salinas Valley and on the Monterey Peninsula.

II. In the Planning Term Sheet, CCSD submits that it is actively pursuing alternative water supplies and has applied to the State for funding to develop deeper groundwater wells and other projects to serve its customer demands.

JJ. In the Planning Term Sheet, CCSD submits that it is interested in taking delivery of a Return Water supply from the Project to replace all or part of CCSD's current reliance on groundwater from the SRGB.

KK. Cal Am contemplated two separate pipelines delivering Return Water from the Project desalination plant, one to CSIP ponds and one to CCSD's wellsite #3 ("CCSD Wellsite"). Through negotiations and discussions, the Parties determined the cost of new infrastructure could be decreased by connecting with existing CSIP infrastructure. That connection allows a single pipeline, rather than two pipelines, to be constructed from the desalination plant to the CCSD Wellsite that will connect with an existing CSIP pipeline ("CSIP Connection"). The elimination of a separate pipeline to the CSIP ponds avoids certain pipeline and pump station costs and results in an estimated cost savings to Cal Am of approximately $1,300,000. A preliminary cost estimate for a pipeline and ancillary facilities necessary to convey water from the Project desalination plant to the CCSD Wellsite ("Delivery Pipeline") is approximately $6,500,000. Cal Am believes that if the Delivery Pipeline is constructed by Cal Am there will economies of scale achieved which may reduce the cost of the Delivery Pipeline to approximately $4,400,000, assuming that Cal Am will secure contracts for construction of the pipeline and that environmental review and permitting will be performed in conjunction with the Project. CCSD estimates its cost to construct a new deep well with treatment facilities would cost approximately $2,800,000. Thus, CCSD submits that it may not be able to prudently fund the Delivery Pipeline for more than $2,800,000, and that capital obligations for the Delivery Pipeline would necessitate long-term commitments by CCSD and certainty of source water supply for CCSD.

LL. The SVWC, MCFB, and Landwatch support Cal Am's delivering Return Water to CCSD and to CSIP for use in lieu of existing groundwater pumping in the SRGB.

MM. The Parties submit that Cal Am's delivery of Return Water to CCSD and CSIP pursuant to the terms of this Settlement Agreement is a fair and equitable resolution of the disputed matters described above, and is consistent with the law and policy controlling the CPUC's approval of the Project, and therefore desire to settle the differences between and among them discussed in the preceding Recitals by entry into this Settlement Agreement.

AGREEMENT

NOW, THEREFORE, as a COMPROMISE and SETTLEMENT of the above-stated dispute, and to provide for an efficient and effective resolution of this dispute, the Parties do hereby AGREE to the following terms:

1. The recitals are hereby incorporated in this Settlement Agreement as if fully set forth herein.

2. Cal Am will deliver Return Water to the SRGB for use in lieu of existing groundwater production as follows:

    a. Subject to Cal Am's Return Water obligations under this Settlement Agreement, Cal Am anticipates delivering Return Water pursuant to two Return Water Purchase Agreements, attached hereto in draft form as Appendix C, and Cal Am, CCSD and the Agency intend to enter into the Return Water Purchase Agreements.[1]

    b. In order to ensure Cal Am's compliance with the Agency Act, the Parties agree that upon start-up of the Project, the first 175 acre-feet of Return Water delivered by Cal Am pursuant to this Settlement Agreement ("Reserve Water") shall be delivered to CSIP.

    c. Cal Am shall have annual Return Water requirements ("Annual Return Water Obligation") that shall be calculated based on the percentage of SRGB groundwater in the total Project Source Water Production. Cal Am's Annual Return Water Obligation under this Settlement Agreement shall not begin until the day after the full

[1] Cal Am is in discussions with the Monterey Regional Waste Management District ("MRWMD") regarding the potential for potable water supply delivery by Cal Am to MRWMD's landfill site that is contiguous to the desalination plant facilities in an amount not to exceed MRWMD's historical average pumping amount estimated at 6 afa. The landfill site cannot use its existing wells for human consumption due to nitrate contamination and, currently, potable water is trucked-in to provide service. In addition, Cal Am is also in discussions with MRWPCA regarding the potential for potable water supply delivery by Cal Am to MRWPCA's site located near the desalination plant facilities in an amount not to exceed MRWPCA's historical averaging pumping amount estimated at 11.9 afa. MRWPCA is currently pumping SRGB groundwater for use at its site and any such potable water supply provided by Cal Am would directly reduce the corresponding amount of groundwater pumping by MRWPCA. The Parties agree that if Cal Am delivers potable water supply to MRWMD's landfill site and/or MRWPCA's site, such water (a) will be counted toward Cal Am satisfying its return water obligations under the Agency Act and this Settlement Agreement, (b) will be subject to Cal Am's applicable commercial customer tariff for its Monterey District, (c) will be included in Cal Am's reporting of Return Water delivered by Cal Am as contemplated by Section 2.h. of this Settlement Agreement, and (d) will be in lieu of existing groundwater pumping from the SRGB.

amount of Reserve Water has been delivered to CSIP (the "Obligation Start Date").

i. During the first three months after the Obligation Start Date, the Annual Return Water Obligation shall be 7% of total Project Source Water Production during that period. For the remainder of the water year after the first three months have passed, the Annual Return Water Obligation shall be the percentage of SRGB groundwater in the total Project Source Water Production calculated during the first three months after the Obligation Start Date.

ii. Beginning in the first full water year after the time period set forth in subsection i. above expires, the Annual Return Water Obligation in any given year shall be the sum of (a) the Base Return Water Obligation for that year, as determined pursuant to subsection iii. below, plus (b) any Return Water Shortfall for the prior year, as determined pursuant to subsection iv. below, minus (c) any Return Water Surplus for the prior year, as determined pursuant to subsection v. below.

iii. The volume of the Base Return Water Obligation shall be initially calculated each year by Cal Am based on the methodology set forth in Appendix D and Cal Am shall notify the other Parties, in writing, of the result of such calculation by December 1 of each year. Such notification shall include all calculations leading to such result. Within 14 days following receipt of such notification, the Agency shall notify the other Parties, in writing, of its determination regarding the accuracy of Cal Am's calculation of the volume of the Base Return Water Obligation. If the Agency determines the result is not accurate, its notification shall explain the reason for such determination. Within 21 days after any written notification by the Agency that it has determined that Cal Am's calculation is not accurate, the Parties shall meet to seek to reach agreement regarding the volume of the Base Return Water Obligation for that year. If the Parties do not reach agreement within 30 days after the initial meeting, any Party may on or after the 31st day, but no later than the 91st day, invoke the provisions of Section 9.

iv. The volume of any Return Water Shortfall for a given year shall be determined by subtracting the amount of Return Water made available by Cal Am in that year from the amount of the Annual Return Water Obligation for that year. If the amount of Return Water made available by Cal Am in that year equals or exceeds the Annual Return Water Obligation, the Return Water Shortfall for that year shall be equal to zero.

v. The volume of any Return Water Surplus for a given year shall be determined by subtracting the amount of the Annual Return Water Obligation for that year from the amount of Return Water provided by Cal Am to CCSD and the Agency in that year. If the amount of Annual Return Water Obligation in that year equals or exceeds the amount of Return Water provided by Cal Am to CCSD and the Agency, the Return Water Surplus for that year shall be equal to zero.

d. Subject to Section 8, Cal Am's obligation to make Return Water available for use in lieu of existing groundwater pumping in the SRGB to meet its Annual Return Water Obligation shall survive for a period of 30 years following start-up of the Project even if the Return Water Purchase Agreements are not executed, do not become effective, or are otherwise amended or terminated.

e. Cal Am shall make available for delivery to CCSD 690 afa of Return Water ("CCSD Delivery Volume").

f. If the Annual Return Water Obligation is less than the CCSD Delivery Volume, Cal Am shall make available for delivery potable water in an amount equal to the difference between the Annual Return Water Obligation for that year and the CCSD Delivery Volume ("Excess Water").

g. Cal Am shall make available for delivery to CSIP any Annual Return Water Obligation in excess of the CCSD Delivery Volume, according to procedures agreed to in the Return Water Purchase Agreement by and between the Agency and Cal Am.

h. For the first two years that Cal Am is delivering Return Water pursuant to this Settlement Agreement, Cal Am will report to the Parties on a quarterly basis the quantity of Return Water delivered to each recipient under this Settlement Agreement. Such reports shall be issued by Cal Am on or about December 1 (for the quarter July 1 to September 30), March 1 (for the quarter October 1 to December 31), June 1 (for the quarter January 1 to March 31), and September 1 (for the quarter April 1 to June 30) of each year. For the following three years that Cal Am is delivering Return Water pursuant to this Settlement Agreement, Cal Am will report to the Parties on a semi-annual basis (on or about December 1 for the period April 1 to September 30, and on or about June 1 for the period October 1 to March 31) the quantity of Return Water delivered to each recipient under this Settlement Agreement. Thereafter, Cal Am will report to the Parties on an annual basis (on or about December 1 for the period October 1 the previous year to September 30 the current year) the quantity of Return Water delivered to each recipient under this Settlement Agreement.

i. All references in this Settlement Agreement to a "year" shall mean a "water year," and all references to a "water year" shall mean the 12-month period beginning on October 1 of a given year and ending on September 30 of the following year. All calculations herein based on the period of a year shall be prorated to account for any time frame that is less than a 12-month period.

3. Cal Am shall comply with the Agency Act. Notwithstanding any other provisions of this Settlement Agreement, the Agency will retain all rights, discretion and authority conferred on the Agency under the Agency Act to ensure that the pumping, production, desalination, and distribution of project source water from the SRGB for the selected desalination plant complies with the Agency Act, and to protect the long-term viability of the SRGB as a water supply for water for agricultural, domestic and municipal use. Neither this Section 3 nor any other provision of this Settlement Agreement shall be interpreted: (a) to affect, diminish, or enhance the Agency's regulatory authority under the Agency Act; (b) to affect, diminish, excuse, or forgive Cal Am's obligation to comply with the Agency Act; or (c) to preclude any argument by any Party to this Settlement Agreement that there is no violation of the Agency Act.

4. The Parties acknowledge that Cal Am could be legally required by a regulatory agency, including the CPUC in this proceeding, or by a court, to make water deliveries to other locations in the SRGB to the extent necessary to mitigate any groundwater impacts from the Project that were demonstrated in relation to a specific location overlying the SRGB ("Other Return Water Obligation"). Such Other Return Water Obligation could also serve to satisfy Cal Am's obligations to return water to the SRGB under the Act, CEQA, or common-law water law principles. Under such circumstances, the Parties agree that it would be inequitable to Cal Am and its ratepayers to fund both the Other Return Water Obligation and the Return Water obligations specified herein as this would result in a duplicative liability to Cal Am and its ratepayers. Cal Am's obligation to make available the CCSD Delivery Volume shall be reduced in the event and to the extent that a regulatory agency or court has required Cal Am to deliver Return Water in a manner or to a location different than as specified in the Settlement Agreement. CCSD shall not be obliged to purchase Return Water if it determines that the reduced amount of Return Water would not be sufficient to justify a Water Purchase Agreement as contemplated herein. In the event that CCSD determines that its water purchase is not justified due to an Other Return Water Obligation, the Parties to this Settlement Agreement will meet and confer in good faith to effect other arrangements to make the remaining Return Water, net of the Other Return Water Obligation, available for use in lieu of existing groundwater pumping in the SRGB in order to ensure that Cal Am will meet its Annual Return Water Obligation under this Settlement Agreement.

The Parties further acknowledge that the CCSD must be assured of a specific volume of Return Water to justify investment in the capital facilities necessary to convey the Return Water from the Project to the CCSD (the "CCSD Facilities"), and therefore Cal Am's obligation to the CCSD Delivery Volume specified herein cannot be terminated during the term of the anticipated Return Water Purchase Agreements after such time as CCSD has obligated itself to finance such capital facilities. To afford the best foresight in relation to potentially competing Return Water obligations, while also facilitating the certainty relating to Return Water deliveries required by CCSD, Cal Am's obligation to make available the CCSD Delivery Volume under the terms of the CCSD Return Water Purchase Agreement shall become unconditional on the date that is the latest of the following dates:

a. the date on which the CPUC has issued a CPCN for the Project and the period to challenge the legality of the CPUC's issuance of the CPCN (based on CEQA compliance or otherwise) has expired and no challenge has been brought;

b. the date on which any challenge against the CPUC's issuance of the CPCN is resolved with finality following all available appeals and petitions; or

c. 60 days following the date on which the CCSD provides notification to Cal Am that it has secured financing, acceptable to CCSD, to acquire the CCSD Facilities.

In the event of any challenge against the CPUC's issuance of the CPCN, the Parties to this Settlement Agreement shall meet and confer in good faith to effect other arrangements to make the total amount of the Return Water, as adjusted by any Other Return Water Obligation, available for use in lieu of existing groundwater pumping in the SRGB in order to ensure that Cal Am will meet its Annual Return Water Obligation under this Settlement Agreement during the pendency of that litigation.

After the above dates, Cal Am may not terminate its obligation to deliver the CCSD Delivery Volume in the event Cal Am is subsequently required to meet Other Return Water Obligations. Cal Am and CCSD shall meet and confer as necessary within a reasonable amount of time before or after any of the above dates if it appears that Cal Am's obligation to make available the CCSD Delivery Volume may not become unconditional. Due to the urgent nature of the Project and other regulatory pressures to implement the Project, Cal Am and CCSD may mutually agree at any time to amend and move forward with the CCSD Water Purchase Agreement, notwithstanding Other Return Water Obligations, provided all other required approvals have been attained and provided that Cal Am will meet its Annual Return Water Obligation under this Settlement Agreement through some combination of some or all of the CCSD Water Purchase Agreement, the CSIP Water Purchase Agreement, Other Return Water Obligations, or arrangements made pursuant to Section 7 of the Settlement Agreement.

5. Return Water and Excess Water pricing shall be as follows:

   a. CCSD: For each acre-foot of Return Water or Excess Water made available for delivery to CCSD:

      i. CCSD shall pay a rate intended to represent its avoided cost to produce groundwater to meet customer demand, currently estimated to be $110 per acre-foot, which will be the rate as of the Obligation Start Date, for Return Water made available for delivery to meet the Annual Return Water Obligation. CCSD plans to continue operation of its existing wells so they may be available in emergency circumstances. This continuing operation will enable CCSD to provide future updates to the avoided cost of pumping. If CCSD is unable to provide such updated avoided costs of pumping, then the percentage increase of PG&E's A-6 tariff for off-peak summer distribution rate (with a base of $0.07311 / kWh as of the tariff existing on March 24, 2016) will be used as the escalation factor for the increase in avoided cost of pumping in the future. After the Obligation Start Date, the rate will be reviewed annually and updated, if necessary, via Tier 2 advice letter filing with the CPUC.

ii. CCSD shall pay a rate intended to represent the marginal operation and maintenance costs for the Project to produce one acre-foot of potable water, currently estimated to be $580 per acre-foot, which will be the rate as of the Obligation Start Date, for any Excess Water calculated as set forth in Appendix F. After the Obligation Start Date, the rate will be reviewed annually and updated, if necessary, via Tier 2 advice letter filing with the CPUC.

b. CSIP: Subject to rights to terminate established in Section 10 of the Return Water Purchase Agreement between the Agency and Cal Am, for each acre-foot of Return Water delivered by Cal Am, the Agency shall pay a rate intended to represent the CSIP customers' marginal avoided cost for groundwater produced for use by the CSIP customers, currently estimated to be $102 per acre-foot which will be the rate as of the Obligation Start Date. After the Obligation Start Date, the rate will be reviewed annually and updated, if necessary, via Tier 2 advice letter filing with the CPUC.

6. The Parties support Cal Am negotiating and entering into Return Water Purchase Agreements substantially in the form attached in Appendix C to this Settlement Agreement. To the extent any conflict is noted or alleged to exist between the terms of this Settlement Agreement and the terms of either Return Water Purchase Agreement, the Parties agree to meet and confer to seek to arrive at a mutually-agreeable reconciliation of the terms of the three agreements.

   a. The Return Water Purchase Agreements shall have an initial term of at least 30 years.

   b. Prior to the expiration of the Return Water Purchase Agreements contemplated herein, CCSD and CSIP shall have a right of first refusal to enter into new water purchase agreements on terms to be negotiated at the time.

7. If the Return Water Purchase Agreements are not executed, do not become effective, or are otherwise amended or terminated, the Parties to this Settlement Agreement shall meet and confer in good faith to effect other arrangements to make the total amount of the Return Water reduced by any Other Return Water Obligation available for use in lieu of existing groundwater pumping in the SRGB in order to ensure that Cal-Am will meet its Annual Return Water Obligation under this Settlement Agreement. Regardless of whether the Return Water Purchase Agreements are not executed, do not become effective, or are otherwise amended or terminated, Cal Am shall not be excused from meeting its Annual Return Water Obligation under this Settlement Agreement.

8. Upon termination, expiration or non-renewal of the Return Water Purchase Agreements,

Cal Am shall continue to make Return Water available for delivery to the SRGB for use in lieu of existing groundwater production, unless Cal Am demonstrates that Return Water is not needed to prevent legal injury to prior groundwater rights holders in the SRGB or to avoid significant adverse effects to SRGB groundwater resources. If Cal Am desires to make such a showing, it shall initially do so by providing a demonstration in writing to all Parties to this Settlement Agreement using the notice provisions of Section 24. Within 21 days thereafter, the Parties shall meet to seek to reach agreement regarding whether Cal Am has made the requisite demonstration. If the Parties do not reach agreement within 30 days after the initial meeting, any Party may on or after the 31st day, but no later than the 91st day, invoke the provisions of Section 9. For the avoidance of doubt, nothing in this section 8 in any way affects the provisions, scope and application of Section 3.

9. If a dispute arises concerning any controversy or claim arising out of or relating to this Settlement Agreement or the breach thereof, or relating to its application or interpretation, such dispute shall be resolved as follows:

   a. Disputes. The aggrieved Party will notify the other Parties of the dispute in writing within twenty (20) days after such dispute arises. If the Parties fail to resolve the dispute within sixty (60) days after delivery of such notice, each Party will promptly nominate a senior officer of its organization to meet at any mutually-agreed time and location to resolve the dispute. The Parties shall use their best efforts to reach a just and equitable solution satisfactory to all Parties. If the Parties are unable to resolve the dispute to their satisfaction within sixty (60) days thereafter, the dispute will be subject to mediation, as described below in Section 9.b. The time periods set forth in this section are subject to extension if agreed to by the Parties.

   b. Mandatory Non-binding Mediation. If a dispute is not resolved pursuant to Section 9.a., the Parties agree to first endeavor to settle the dispute in an amicable manner, using mandatory non-binding mediation initiated and conducted under the applicable rules of the American Arbitration Association in effect as of the Effective Date or other rules agreed to in writing by the Parties, before having recourse in a court of law or equity. Each Party shall bear its own legal expenses, and the expenses of witnesses for either side shall be paid by the Party producing such witnesses. All expenses of the mediator, including required travel, and the cost of any proofs or expert advice produced at the direct request of the mediator, shall be borne equally by the Parties, unless they agree otherwise. Any resultant agreements from mediation shall be documented in writing. All mediation proceedings, results, and documentation, including without limitation any materials prepared or submitted or any positions taken by or on behalf of any Party, shall be confidential and inadmissible for any purpose in any legal proceeding (pursuant to California Evidence Codes sections 1115 through 1128), unless such admission is otherwise agreed upon in writing by the Parties. Mediators shall not be subject to any subpoena or liability, and their actions shall not be subject to discovery. The mediation shall be completed within sixty (60) days after selection of the mediator, unless the Parties agree to extend the mediation period.

c. Judicial Relief. If mediation pursuant to Section 9.b. does not resolve a dispute, any Party may seek relief in a court of competent jurisdiction.

d. Limitations on Damages. No Party shall be entitled to consequential damages, incidental damages, or punitive or exemplary damages from any other Party in any action or proceeding in connection with this Settlement Agreement.

e. Attorneys' Fees and Costs. In any action or proceeding to enforce a term or condition of this Settlement Agreement, in any disputes relating to this Settlement Agreement, and in any actions for breaches, defaults, or misrepresentations in connection with the Settlement Agreement, a prevailing Party (as determined by a court of competent jurisdiction) shall be entitled to recover its reasonable costs and expenses, including without limitation reasonable attorneys' fees and costs.

10. The Parties agree that Cal Am's certificated service area for the Monterey County District shall be extended to include: (1) a delivery point near the intersection of Nashua Road and Monte Road (located between Cal Am's desalination plant facilities and the CCSD service area) that is necessary for Cal Am to serve CCSD and the Agency at the delivery point set forth in the anticipated Return Water Purchase Agreements; (2) the territory contiguous to the desalination plant facilities that is necessary for Cal Am to deliver water to Monterey Regional Waste Management District ("MRWMD"); and (3) to MRWPCA's wastewater treatment plant site which is located next to the MRWMD site, and that Cal Am shall update its service area map accordingly through a Tier 2 advice letter filing to describe the territory served on the utility's tariffs. The Parties further agree to support Cal Am's ability to implement and update its tariffs accordingly through a Tier 2 advice letter.

11. The Parties agree that the proposed tariff set forth in Appendix E, which may be modified from time to time with CPUC approval to reflect adjustments to the terms of service as set forth herein, shall govern the rates and provision of service to CCSD and the Agency, subject, however, to rights to terminate established in Section 10 of the Return Water Purchase Agreements between Cal Am and each of CCSD and the Agency.

12. Pursuant to the Return Water Purchase Agreements, Cal Am would collect revenue from CCSD and the Agency. All revenue collected under the Return Water Purchase Agreements would be through an approved tariff with the CPUC and would be used to offset the operations and maintenance costs of the Project to customers in the Monterey District in accordance with Section 8.3 of the document known as the "Large Settlement Agreement." Revenues collected from MRWMD would be under an existing General Metered Non-Residential tariff that is subject to regulation by the CPUC.

13. Cal Am shall provide notice of advice letters filed pursuant to this Settlement Agreement to the Parties and to CCSD upon their filing and in accordance with applicable CPUC requirements.

14. This Settlement Agreement reflects a settlement and compromise of putative claims and remedies of the Parties hereto.

15. If the Return Water settlement described in this Settlement Agreement is not approved by

the CPUC and implemented by Cal Am, the Agency, SVWC, MCFB and Landwatch reserve their rights to challenge Cal Am's production of water from the SRGB in any appropriate forum.

16. The Parties agree to expeditiously, substantively and in good faith support this Settlement Agreement and cooperate with Cal Am in any administrative or judicial proceeding challenging this Settlement Agreement and/or Cal Am's obligations and responsibilities with respect to Return Water.

17. Among other things, this Settlement Agreement helps to define a stable and finite project description that will facilitate the CPUC's completion of CEQA review for the Project. The legal effectiveness of this Settlement Agreement is contingent on the completion of CEQA review and this Settlement Agreement does not irretrievably commit the Parties to carrying out any physical activities that would be required for Cal Am to meet the Annual Return Water Obligation or would otherwise be required for the Parties to comply with the terms of this Settlement Agreement, including through the anticipated Return Water Purchase Agreements whose future approval will be conditioned upon the completion of CEQA review by the CPUC as lead agency for the Project and by those Parties playing the role of a responsible agency with respect to the anticipated Water Supply Agreements. The Parties acknowledge and intend that the lead agency and responsible agencies will retain full discretion with respect to deciding whether to approve the Return Water Supply Agreements or any other commitments necessary or convenient for Cal Am to meet the Annual Return Water Obligation, including discretion to modify commitments to avoid or reduce any significant adverse physical environmental effects (i) from Return Water activities that are within their jurisdiction, and (ii) from the Parties' compliance with other terms of this Settlement Agreement.

18. If the CPUC approves the Settlement Agreement with modifications, the Parties request the CPUC to provide a reasonable period for the Parties to consider and respond to such modification.

19. If the CPUC approves the Settlement Agreement with modifications, each Party shall determine no later than two business days before the deadline imposed by the CPUC for acceptance of the modification whether it will accept the modification and shall notify the other Parties of its determination.

20. If any Party declines to accept the CPUC's modification, the other Parties may still accept the modification and request the CPUC to approve the revised Settlement Agreement in the absence of the agreement of the Party or Parties who decline to accept the CPUC's modification; provided, however, that Parties who accept the modification and request approval of a revised Settlement Agreement may not accept the modification and request the CPUC to approve the revised Settlement Agreement if the applicant Cal Am is among the Parties who decline to accept the CPUC's modification. If the CPUC's proposed modification of this Settlement Agreement is not consented to by Cal Am, the Settlement Agreement shall be void and the CPUC will establish a procedural schedule to address the disputed issues.

21. This Settlement Agreement does not currently impact the terms of section 3.1(b) of the document known as the Large Settlement Agreement. To the extent later binding agreements may specifically do so, they will not impact the Agency's authority and responsibilities under or Cal Am's obligation to comply with the Agency Act.

22. This Agreement shall be binding upon, and shall inure to the benefit of and be enforceable by, the Parties hereto and their respective successors and assigns permitted hereunder.

23. Nothing in this Settlement Agreement is intended, either expressly or by implication, to confer any rights or remedies under or by reason of this Settlement Agreement on any persons other than the Parties hereto; nothing in this Agreement is intended, either expressly or by implication, to relieve or discharge the obligation or liability of any third person to any Party; and nothing in this Settlement Agreement creates, either expressly or by implication, any duty, liability or standard of care to any person who is not a Party.

24. All notifications, notices, demands, requests and other communications herein provided for or made pursuant hereto shall be in writing and shall be sent by: (i) registered or certified mail, return receipt requested, and the giving of such communication shall be deemed complete on the third (3rd) business day after the same is deposited in a United States Post Office with postage charges prepaid; or (ii) reputable overnight delivery service, and the giving of such communication shall be deemed complete on the immediately succeeding business day after the same is deposited with such delivery service; and (iii) so long as a Party has notified the other Party by means of a method described in clauses (i) or (ii) above of such Party's email address for notification purposes, email transmission of notices to such Party are also permitted provided an original is also sent via one of the other permitted means and the giving of such communication shall be complete when such email is received if such email is received on a business day before 3:00 pm Pacific Time; otherwise, such communication shall be deemed complete the next business day. The date on which notifications, notices, demands, requests and other communications are deemed complete shall be the earliest date arising under subsections (i), (ii) or (iii) of this Section 24. All notifications, notices, demands, requests and other communications shall be sent to the Parties as follows:

To Agency:

David E. Chardavoyne
General Manager
Monterey County Water Resources Agency
893 Blanco Circle
Salinas, CA 93901

To Authority:

Bill Kampe
Acting President
Monterey Peninsula Regional Water Authority

580 Pacific Street, Room 6
Monterey, CA 93940

To Cal Am:

Eric J. Sabolsice
Director, Operations
Coastal Division
California-American Water Company
511 Forest Lodge Road, Suite 100
Pacific Grove, CA 93950

To CPB:

Bob McKenzie
Water Issues Consultant
Coalition of Peninsula Businesses
P.O. Box 223542
Carmel, CA 93922

To Landwatch:

Chris Fitz
LandWatch Monterey County
P.O. Box 1876
Salinas, CA 93902-1876

To MCFB:

Norman C. Groot
Monterey County Farm Bureau
P.O. Box 1449
1140 Abbott Street, Suite C
Salinas, CA 93902-1449

To MPWMD:

David J. Stoldt
General Manager

Monterey Peninsula Water Management District
PO Box 85
Monterey, CA 93942

To MRWPCA:

Paul Sciuto
General Manager
Monterey Regional Water Pollution Control Agency
5 Harris Court, Bldg D
Monterey, CA 3940

To PCL:

Jonas Minton
Planning and Conservation League Foundation
1107 – 9th Street, Suite 901
Sacramento, CA 95814

To SVWC:

Nancy Isakson
President
Salinas Valley Water Coalition
3203 Playa Court
Marina, CA 93933

A Party may change the person and/or address for provision of notice by delivering written notice to the other Parties.

25. Each Party to this Settlement Agreement represents and warrants that it has the capability and authority to carry out the rights and obligations of this Settlement Agreement. Each person whose signature appears hereon represents and warrants that he/she has been duly authorized and has full authority to execute this Settlement Agreement on behalf of the Party on whose behalf this Settlement Agreement is executed.

26. This Settlement Agreement may be executed in any number of counterparts, each of which shall be an original, and such counterparts together shall constitute but one and the same instrument.

Respectfully submitted,

Dated: 6/13/16 CALIFORNIA-AMERICAN WATER COMPANY

By ____ for: Robert MacLean
Robert MacLean,
President

Dated: COALITION OF PENINSULA BUSINESSES

By ____
Bob McKenzie,
Water Issues Consultant

Dated: LANDWATCH MONTEREY COUNTY

By ____
Chris Fitz,

Dated: MONTEREY COUNTY FARM BUREAU

By ____
Norman C. Groot,
Executive Director

Dated: MONTEREY COUNTY WATER RESOURCES AGENCY

By ____
David Chardavoyne,
General Manager

Respectfully submitted,

Dated: CALIFORNIA-AMERICAN WATER COMPANY

By ___________________________
Robert MacLean,
President

Dated: June 14, 2016 COALITION OF PENINSULA BUSINESSES

By ___________________________
Bob McKenzie,
Water Issues Consultant

Dated: LANDWATCH MONTEREY COUNTY

By ___________________________
Chris Fitz,

Dated: MONTEREY COUNTY FARM BUREAU

By ___________________________
Norman C. Groot,
Executive Director

Dated: MONTEREY COUNTY WATER RESOURCES AGENCY

By ___________________________
David Chardavoyne,
General Manager

Respectfully submitted,

Dated: CALIFORNIA-AMERICAN WATER COMPANY

By ______________________
Robert MacLean,
President

Dated: COALITION OF PENINSULA BUSINESSES

By ______________________
Bob McKenzie,
Water Issues Consultant

Dated: 6/13/16 LANDWATCH MONTEREY COUNTY

By ______________________
Chris Fitz,

Dated: MONTEREY COUNTY FARM BUREAU

By ______________________
Norman C. Groot,
Executive Director

Dated: MONTEREY COUNTY WATER RESOURCES AGENCY

By ______________________
David Chardavoyne,
General Manager

Respectfully submitted,

Dated: CALIFORNIA-AMERICAN WATER COMPANY

By ____________
Robert MacLean,
President

Dated: COALITION OF PENINSULA BUSINESSES

By ____________
Bob McKenzie,
Water Issues Consultant

Dated: LANDWATCH MONTEREY COUNTY

By ____________
Chris Fitz,

Dated: June 14, 2016 MONTEREY COUNTY FARM BUREAU

By ____________
Norman C. Groot,
Executive Director

Dated: MONTEREY COUNTY WATER RESOURCES AGENCY

By ____________
David Chardavoyne,
General Manager

Respectfully submitted,

Dated: CALIFORNIA-AMERICAN WATER COMPANY

By ______________________
Robert MacLean,
President

Dated: COALITION OF PENINSULA BUSINESSES

By ______________________
Bob McKenzie,
Water Issues Consultant

Dated: LANDWATCH MONTEREY COUNTY

By ______________________
Chris Fitz.

Dated: MONTEREY COUNTY FARM BUREAU

By ______________________
Norman C. Groot,
Executive Director

Dated: MONTEREY COUNTY WATER RESOURCES AGENCY

By ______________________
David Chardavoyne,
General Manager

Dated: 6/11/16 MONTEREY PENINSULA REGIONAL WATER AUTHORITY

By Bill Kampe
Bill Kampe,
Acting President

Dated: MONTEREY PENINSULA WATER MANAGEMENT DISTRICT

By ______________________
David J. Stoldt,
General Manager

Dated: MONTEREY REGIONAL WATER POLLUTION CONTROL AGENCY

By ______________________
Paul Sciuto,
General Manager

Dated: PLANNING AND CONSERVATION LEAGUE FOUNDATION

By
Jonas Minton,
Water Policy Adviser

Dated: SALINAS VALLEY WATER COALITION

By
Nancy Isakson,
President

Dated: MONTEREY PENINSULA REGIONAL WATER AUTHORITY

By ______________________
Bill Kampe,
Acting President

Dated: July 1, 2016 MONTEREY PENINSULA WATER MANAGEMENT DISTRICT

By ______________________
David J. Stoldt,
General Manager

Dated: MONTEREY REGIONAL WATER POLLUTION CONTROL AGENCY

By ______________________
Paul Sciuto,
General Manager

Dated: PLANNING AND CONSERVATION LEAGUE FOUNDATION

By ______________________
Jonas Minton,
Water Policy Adviser

Dated: SALINAS VALLEY WATER COALITION

By ______________________
Nancy Isakson,
President

Dated: MONTEREY PENINSULA REGIONAL WATER AUTHORITY

By ______________________
Bill Kampe,
Acting President

Dated: MONTEREY PENINSULA WATER MANAGEMENT DISTRICT

By ______________________
David J. Stoldt,
General Manager

Dated: July 28, 2016 MONTEREY REGIONAL WATER POLLUTION CONTROL AGENCY

By ______________________
Paul Sciuto,
General Manager

Dated: PLANNING AND CONSERVATION LEAGUE FOUNDATION

By ______________________
Jonas Minton,
Water Policy Adviser

Dated: SALINAS VALLEY WATER COALITION

By ______________________
Nancy Isakson,
President

EXHIBIT C

FILED
3-14-16
04:59 PM

BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF CALIFORNIA

Application of California-American Water Company (U210W) for Approval of the Monterey Peninsula Water Supply Project and Authorization to Recover All Present and Future Costs in Rates.	A.12-04-019 (Filed April 23, 2012)

AMENDED APPLICATION OF CALIFORNIA-AMERICAN WATER COMPANY (U210W)

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Attorneys for Applicant

Date: March 14, 2016

BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF CALIFORNIA

Application of California-American Water Company (U210W) for Approval of the Monterey Peninsula Water Supply Project and Authorization to Recover All Present and Future Costs in Rates.	A.12-04-019 (Filed April 23, 2012)

AMENDED APPLICATION OF
CALIFORNIA-AMERICAN WATER COMPANY (U210W)

I. INTRODUCTION

The *Assigned Commissioner's Ruling Directing California-American Water Company to Amend Application with New Project Description* was filed in this matter on February 22, 2016 ("February 22 Ruling"). Pursuant to the February 22 Ruling, California-American Water Company ("California American Water") submits this amended Application.

II. DISCUSSION

On April 23, 2012, California American Water filed Application No. ("A.") 12-04-019 ("April 23, 2012 Application"), requesting California Public Utilities Commission ("Commission") approval of the Monterey Peninsula Water Supply Project ("MPWSP") and authorization to recover all present and future costs for the MPWSP in rates. The April 23, 2012 Application contained "Appendix H: Updated CEQA Project Description," which contains the MPWSP Project Description, as well as other Appendices relating to the Project Description.

The February 22 Ruling notes the Commission's Energy Division and consultant are conducting the environmental review required under California's Environmental Quality Act, and, as part of that review process, California American Water recently provided the Energy Division with an amended project description.[1] The February 22 Ruling then ordered California

[1] February 22 Ruling, at pp. 1-2.

American Water to "file and serve an amended application in this proceeding that provides a project description reflecting its proposed project configuration."[2]

Through this Amended Application, California American Water provides an updated project description reflecting the proposed project configuration. California American Water does so by providing updated versions of Appendices B (Project Schedule), C (Project Map), E (Project Cost Estimate), and H (Project Description) (individually and collectively, "Updated Appendices"), which are included as Attachments hereto. California American Water previously provided the revised Project Schedule and Cost Estimate (Updated Appendices B and E) to the parties in this proceeding.[3] The Updated Appendices B, C, E, and H shall replace in their entirety the corresponding Appendices in the April 23, 2012 Application.[4] The Updated Appendices shall also supersede any portions of the April 23, 2012 Application with which the Updated Appendices are inconsistent. Finally, the Application, showing changes in red-lined and clean fashion, will be posted to the "watersupplyproject.org" website under the documents tab.

Date: March 14, 2016

By: /s/ Sarah E. Leeper
Sarah E. Leeper, Attorney
California-American Water Company
555 Montgomery Street, Suite 816
San Francisco, CA 94111
(415) 863-2960
(415) 397-1586
sarah.leeper@amwater.com
For: California-American Water Company

[2] February 22 Ruling, at p. 2.

[3] Specifically, (1) the Project Schedule in Updated Appendix B was provided to parties on December 15, 2015 with the Supplemental Testimony of Richard Svindland as "Attachment 2," thereto; (2) the Project Cost Estimate, Updated Appendix E, was also provided to parties on December 15, 2015, with the Supplemental Testimony of Richard Svindland, as "Attachment 1," thereto.

[4] The project cost estimates in Appendix E do not include Allowance for Funds Used During Construction ("AFUDC"). The estimated AFUDC is reflected in recent calculations provided in the Supplemental Testimony of Jeffrey T. Linam, served on January 22, 2016.

Attachment H
Monterey Peninsula Water Supply Project
Project Description
March 2016

PROJECT DESCRIPTION OVERVIEW

The Monterey Peninsula Water Supply Project (MPWSP) will produce desalinated water and convey it to the existing California American Water Company (CalAm) distribution system. The MPWSP supplements portions of CalAm's existing water sources on the Carmel River and Seaside Basin so their use may be reduced to stay within legal limits. The MPWSP consists of the construction of up to ten subsurface slant wells and a desalination plant to produce on average approximately 10,627 acre feet per year (afy) of desalinated water to meet service area demand and return water requirements to the Salinas Valley Groundwater Basin. The production capacity of the proposed MPWSP desalination plant is 9.6 million gallons per day (mgd). The proposed MPWSP consists of several components: a seawater intake system; a desalination plant; a brine discharge system; product water conveyance pipelines; water storage facilities; and an Aquifer Storage and Recovery (ASR) system. Refer to Figure 1, *Project Overview and Index Map*.

The MPWSP also includes a variation of the proposed action that combines a reduced-capacity desalination plant with a water purchase agreement for 3,500 afy product water from the Monterey Regional Water Pollution Control Agency's (MRWPCA) proposed Pure Water Monterey Groundwater Replenishment (GWR) Project. The MPWSP variant consists of the construction of up to eight subsurface slant wells and a desalination plant to produce on average approximately 6,752 acre feet per year (afy) of desalinated water to meet service area demand and return water requirements to the Salinas Valley Groundwater Basin. The MPWSP variant would change the desalination facility to a 6.4 mgd.

Construction of the MPWSP is anticipated to commence in second half of 2017 and be completed by mid-2019 (approximately twenty-four months). Additional Project Description information and technical studies are available on the MPWSP's website (www.watersupplyproject.org).

PROJECT OBJECTIVES

The primary objectives of the Monterey Peninsula Water Supply Project are to:

- Satisfy CalAm's obligations to meet the requirements of SWRCB Order 95-10;
- Diversify and create a reliable drought-proof water supply;
- Protect the Seaside Groundwater Basin for long-term reliability;
- Protect the local economy from the effects of an uncertain water supply;
- Minimize water rate increases by creating a diversified water supply portfolio;
- Minimize energy requirements and greenhouse gas (GHG) emissions per unit of water delivered to the extent possible;
- Explore opportunities for regional partnerships;
- Provide flexibility to incorporate alternative water supply sources, such as GWR; and

- To eliminate the hydraulic trough that exists between Seaside and Monterey in an energy efficient manner.

SEAWATER INTAKE SYSTEM

The proposed MPWSP would employ subsurface slant wells to produce the seawater source water for the desalination plant. The slant wells are located primarily within the City of Marina, in the active mining area of the CEMEX sand mining facility, with intake well tips located below the Mean Higher High Water line of Monterey Bay and beneath the Monterey Bay National Marine Sanctuary (MBNMS). The slant well intake system will consist of 10 subsurface slant wells (eight active and two on stand-by), which includes conversion of existing test slant well to a production well. The slant wells are approximately 700 to 1,000 feet long and slant downwards and towards the Monterey Bay, with the end of each well approximately 200 to 220 feet below mean sea level. Each well screen is approximately 400 to 800 linear feet long at depths corresponding to both the Dune Sand Aquifer and the underlying 180 foot equivalent aquifer of the Salinas Valley Groundwater Basin (SVGB).

The eight operating slant wells and two redundant wells (10 total) will typically pump approximately 24.1 mgd of source water to a proposed desalination plant 24 hours a day, 365 days per year. The slant wells will be constructed using a telescoping drill casing of various sizes of diameter, from 36-inch to 22-inches, depending on the final design length. All ground disturbing activities from construction occur above the mean higher high water line and within a previously disturbed area. Refer to Figure 2, *Subsurface Slant Wells at CEMEX Active Mining Area.*

The 10 slant wells will be arranged into six wellhead sites as shown in Figure 2. Wellhead Site 1 is the existing test slant wellhead. Site 2 and Site 6 have three slant wells each and Sites 3, 4, and 5 have one slant well each. Site 1, the northernmost well site, is located approximately 50 feet southeast of the CEMEX settling basins. Site 2, consisting of three new permanent wells, will be located roughly 650 feet south of Site 1. Site 6, consisting of three new slant wells will be located roughly 1,500 feet south of Site 1. The three separate new wells (Sites 3, 4, and 5) will be spaced approximately 250 feet apart between Sites 2 and 3. Each of the wellheads will be located above the mean higher high tide elevation, outside of predicted coastal hazard zones and in an existing disturbed area of the CEMEX sand mining site.

Each well site will consist of: wellhead(s), submersible well pump, protective enclosure, mechanical piping (i.e., mag meter, gate valve, check valve), electrical equipment (i.e., VFD and MCC), and ingress and egress access. Each slant well is designed to convey approximately 2,500 gpm using a 300 hp rated submersible motor. Protective fiberglass enclosures will house the electrical equipment, protecting it from trespassers and the corrosive ocean environment (i.e., sand, wind, salt air, etc.). The enclosures at the single well sites are approximately 16 feet x 12 feet x 8 ft high. The two enclosures at Sites 2 and 6 (3 wells each) are approximately 18 feet x 24 feet x 8 ft high. The fiberglass enclosures will have flat sloped roofs and be colored to blend into the surrounding environment. The enclosures will be located approximately 10 to 15 feet from the wellheads to provide adequate access for future well maintenance (i.e., pulling the pump). The mechanical piping will be located in a below grade concrete vault approximately 8 feet x 8 feet x 6 feet deep.

A pump-to-waste concrete below-grade basin is required at each well Site. When a slant well is operated after not pumping for some time, the well must be pumped-to-waste to flush undesirable initial water quality (silt/sand) rather than convey that to the desalination plant. The well could pump for up to 3 minutes to the waste basin at start-up. The proposed pump-to-waste basins would be approximately 1500-square-foot, 6 to 8 -foot-deep basin on located at each well site cluster or each single well location. Each basin will discharge with an air gap through a fiberglass/aluminum open grate into the vaults for natural percolation. The basin is assumed to not require periodic maintenance since seawater and sand would be discharged to a sand basin.

MPWSP DESALINATION PLANT

The MPWSP Desalination Plant would be constructed on approximately 25 acres of a 46-acre vacant parcel owned by CalAm on Charles Benson Road, northwest of the MRWPCA Regional Treatment Plant and the Monterey Regional Environmental Park. The proposed MPWSP Desalination Plant at this location would include a pretreatment system, a Reverse Osmosis (RO) system, a post-treatment system, backwash supply and filtered water equalization tanks, desalinated product water storage and conveyance facilities, brine storage and disposal facilities, and an administration building and laboratory facility. Existing roads would provide access to the site. The proposed construction and operation of the Desalination Plant would occur at a nearly level marine terrace and create approximately 15 acres of impervious surfaces associated with the desalination facilities, buildings, driveways, parking, and maintenance areas. No U.S. Army Corps of Engineers' jurisdictional wetlands would be affected.

The MPWSP Desalination Plant would have a rated production capacity of 9.6 mgd and a maximum production capacity of 11.2 mgd. The MPWSP Desalination Plant would operate at an approximate overall recovery rate of 42 percent. Approximately 24.1 mgd of raw seawater would be needed to produce 9.6 mgd of desalinated product water. Components of the proposed Desalination Plant are discussed below.

Pretreatment System: Seawater (source water) from the subsurface intake wells would be conveyed directly through an on-site pre-treatment system (pressure filters) to prevent the RO membranes from becoming fouled or scaled due to microbial contamination, turbidity, and other contaminants. The pretreatment system would have the capacity to process 24.1 mgd of seawater. The majority of the pretreated source water would then be pumped directly to the RO system.

The pressure filters would be located within the MPWSP Desalination Plant site. Pretreatment filters would require routine backwashing (approximately once per day). The pretreated source water would be conveyed to two 300,000-gallon backwash supply and filtered water equalization tanks.

Waste effluent produced during routine backwashing would flow via gravity from the pretreatment filters to two 0.25-acre, 6-foot-deep open backwash settling basins lined with an impermeable liner to prevent the waste effluent from infiltrating into the ground. Suspended solids in the waste effluent would settle to the bottom of the basins, and the clarified water would be decanted. Approximately 0.4 mgd of decanted and dechlorinated backwash water might be pumped to the Brine Discharge Pipeline, blended with brine produced by the RO system, and discharged to the existing MRWPCA ocean outfall. Alternatively, the decanted backwash water could be blended with source water before undergoing pretreatment and the RO process. Sludge formed by the solids in the waste effluent would be periodically removed from the backwash settling basins and disposed of at a sanitary landfill.

A multi-purpose pump station located near the center of the proposed plant would be integral to the operation of facility. The pump station would be constructed on an outdoor concrete pad with an approximate area of 8,000 square feet. Equipment would include: seven cartridge filters; four Filtered Water Pumps (two 12 MGD and 350 HP each; and two 6 MGD and 200 HP each); two Backwash Supply Pumps (16 MGD and 150 HP each); four Treated Water Pumps (two 4.8 MGD and 600 HP each; and two 2.4 MGD and 300 HP each); two Salinas Valley Pumps (1.4 MGD and 10 HP each); and associated piping, valves, instruments and appurtenances.

Approximately 9.5 mgd of desalinated product water would be produced during the RO process. Waste effluent produced during the RO process would be diverted to the brine waste stream and discharged via the existing MRWPCA outfall and diffuser.

Reverse Osmosis System: Reverse osmosis is an ion separation process that uses semipermeable membranes to remove salts and other minerals from saline water. Pretreated source water is forced at very high pressures through RO membranes. Water molecules, which are smaller than salt and many other impurities, are able to pass through the membranes. A portion of the source water passes through the RO membranes to produce "permeate," or product water; source water that does not pass through the membranes increases in salt concentration and is discharged as brine. The RO system would be housed in an approximately 30-foot-tall, 30,000-square-foot process and electrical building located in the central portion of the MPWSP Desalination Plant site. This building would also house the UV disinfection system (if required) and the cleaning system for the RO membranes.

The RO process would incorporate an energy recovery system that utilizes pressure-exchange technologies. The use of high-pressure pumps to force saline water through the RO membranes would produce a concentrated brine solution (referred to as RO concentrate) in a continuous stream that contains a large amount of high-pressure energy. Pressure exchangers would be employed to transfer the energy from the high-pressure brine stream to the source water stream to reduce energy demand and operating costs. The accumulation of salts or scaling on the RO membranes causes fouling, which reduces membrane performance. The RO system is expected to require cleaning two to three times per year. The RO cleaning system would be housed in the same building as the RO system and would include chemical storage, chemical feedlines, and a collection tank.

For back-up power to power a portion of the facility, CalAm would install a 750-kilowatt (kW) (1,000 horsepower (hp)) emergency diesel fuel-powered generator and a 2,000-gallon double-walled, aboveground diesel storage tank adjacent to the process and electrical building.

Post-treatment System: After leaving the RO system, the desalinated water would pass through a post-treatment system to make the water more compatible with the other water supply sources in the CalAm system and provide adequate disinfection prior to distribution to customers. It is expected that post-treatment facilities would include chemical feedlines and injection systems for lime and carbon dioxide. The final design of post-treatment facilities would be based on the water quality data collected during operation of the test slant well and pilot program and the results of a geochemical mixing study.

Chemical Use and Storage: Facility operators would use various chemicals to treat the water as it passes through the pretreatment, RO, and post-treatment processes to ensure the water meets drinking water quality requirements and is compatible with native groundwater in the Seaside Groundwater Basin. The various chemicals used during the desalination process would be stored onsite in accordance with applicable regulatory requirements, and storage facilities would include secondary concrete containment, alarm notification systems, and fire sprinklers.

Brine Storage and Disposal: The RO process would generate approximately 14 mgd of brine (including 0.4 mgd of decanted backwash water). The brine storage and disposal system would consist of: 1) one Brine Storage Basin with a storage capacity of 3-million gallons that is uncovered and lined with two impermeable liners; 2) two Brine Discharge pumps, 6-mgd capacity each, 40-hp each; and 3) an aeration system to maintain 5 mg/L dissolved oxygen levels in the brine. Under continuous brine disposal scenarios, the brine from the RO system would be conveyed directly through the 1-mile-long, 30-inch diameter Brine Discharge Pipeline to a proposed connection with the existing MRWPCA outfall. Under intermittent brine discharge operating scenarios, the brine would be directed to the brine storage basin. The brine would be stored for approximately 5 hours, and then pumped to the Brine Discharge Pipeline at a rate of 6-mgd where it would combine with approximately 14 mgd of brine from the RO process and be discharged at a total flow of approximately 20 mgd. Further evaluation of the proposed brine dilution through the MRWPCA outfall could require modifications to the proposed brine storage and disposal system. Such modifications could include, but may not be limited to a larger brine storage basin or basins (open and lined, steel or concrete), greater brine pumping capacity and larger pumps, a larger aeration system and/or a larger diameter pipeline.

Administrative Building: A 6,000-square-foot single-story administrative building at the MPWSP Desalination Plant site would house visitor reception, offices, restrooms, locker rooms, break rooms, conference rooms, a control room, a laboratory, an equipment storage and maintenance area, and monitoring and control systems for the RO system, post-treatment system, chemical feed systems, and related facilities.

BRINE DISCHARGE SYSTEM

The reverse osmosis system at the MPWSP desalination plant generates approximately 14 million gallons per day (MGD) of brine, including 0.4 MGD of decanted backwash water. The brine is initially conveyed to a three million gallon lined open brine storage basin, then pumped through a 36-inch diameter brine discharge pipeline to a new connection with the existing MRWPCA outfall and diffuser located at the wastewater facility.

During the dry/irrigation season that typically extends from April through October, treated wastewater from MRWPCA's Regional Wastewater Treatment Plant is diverted to the Salinas Valley Reclamation Project's tertiary treatment facility for advanced treatment and is used for crop irrigation. During the wet/non-irrigation season that typically extends from November through March, the brine stream blends with treated wastewater from MRWPCA's Regional Wastewater Treatment Plant before being discharged into the Monterey Bay. During other times, the brine stream will discharge into Monterey Bay without blending.

The MRWPCA's existing outfall pipeline extends into the Monterey Bay about two miles offshore along the ocean floor. The diffuser is about 1,100 feet long with 172 2-inch diameter active ports (fifty two ports are closed) that are spaced 8 feet apart, which disperse the brine stream at the discharge point. This minimizes differences in salinity and other water quality parameters between the discharge brine and the surrounding seawater.

CONVEYANCE AND STORAGE FACILITIES

Water Conveyance: The proposed MPWSP consists of water conveyance and storage facilities, such as pipelines, pump stations, and treated water storage at a proposed Terminal Reservoir and at existing and proposed Aquifer Storage and Recovery (ASR) well sites. Various transmission pipeline segments would convey feed water from the intake wells to the Desalination Plant, while product water from the Desalination Plant site would be conveyed to storage and distribution systems as shown on Figure 2 and further described below. No U.S. Army Corps of Engineers' jurisdictional wetlands would be affected.

Feedwater Pipeline: The CEMEX Feed Water Alternative would convey seawater pumped from the seawater intake system to the Desalination Plant for a distance of approximately 11,469 LF. The conveyance of seawater from the proposed CEMEX Feed Water intake well site would traverse eastward beneath the private CEMEX access road and cross under the Highway 1 overpass and right-of-way. It would continue northeast into an abandoned railroad spur to Lapis Road, north into the Transportation Agency for Monterey County (TAMC) Right-of-Way (ROW) and onto Charles Benson Road to the desalination plant site.

An alternative alignment is identical to the previously described alignment, but turns east off of Del Monte Boulevardonto Nepsonet Road, which is the direct access road for the farms along it, to the desalination plant site.

Transfer Pipeline: For product water conveyance from the CalAm Desalination Plant to the CalAm water system, the desalinated water pump station would pump desalinated product water through the proposed Desalinated Water Pipeline and Transmission Main. From the Plant site pump station, the 9.5-mile-long, 36-inch-diameter desalinated product water pipeline would extend west for approximately 0.8 mile along Charles Benson Road (and/or Neponset Road), parallel to the proposed Feedwater Pipeline. At Del Monte Boulevard, the product water pipeline would cross Del Monte Boulevard and turn south and continue along the TAMC ROW for approximately 5.7 miles to just north of the interchange between Highway 1/Lightfighter Drive. The pipeline would traverse beneath Highway 1 via jack and bore and then continue south-easterly into land owned by the City of Seaside until it meets Lightfighter Drive. The pipeline would then continue east along Lightfighter Drive to General Jim Moore Boulevard, where it would tum south, continue beneath General Jim Moore Boulevard to just south of Coe Avenue, where it would connect to an existing pipeline.

Monterey Pipeline: The Monterey Pipeline, approximately 6.5 miles of 36-inch pipe, would continue from General Jim Moore Boulevard westward beneath Hilby Avenue, and turn south on Fremont Boulevard where it would cross Canyon del Rey Boulevard (Route 218) at the City of Monterey to Airport Road (or Casa Verde Way), where it would turn south and then turn west again along Fairgrounds Road. The pipeline would then be attached to the Fairgrounds Road/Mark Thomas Drive bridge over Highway 68 or a new pipe carrier bridge will be installed and continue onto Mark Thomas Drive turning northwest on to Fremont Street. The alignment travels west beneath Fremont Street, continuing beneath Webster Street, then turning north onto Hartnell Street and then west onto Madison Street. From Madison Street, the alignment turns north along Monroe Street and then west along Jefferson Street. The Monterey Pipeline then turns north onto Clay Street, then north onto W. Franklin St, and then north on High St. where it crosses the Presidio of Monterey (POM) along Stillwell Avenue. From POM, the pipeline alignment would exit on to Spencer Street, and then southwest to Hoffman Ave, northwest onto Cypress Ave, southwest onto Withers Avenue and finally north on Sinex Avenue connecting to an existing 30-inch pipeline in Sinex Avenue, near the Eardley Pump Station in the City of Pacific Grove. This pipeline route also improves the hydraulics of the existing system by eliminating the existing hydraulic though in the system that is located in the vicinity of Canyon Del Ray & 218 area and allows for maximum use of ASR and Carmel River excess diversion rights.

Terminal Reservoir: The Terminal Reservoir and related facilities will be located east of General Jim Moore Boulevard, north side of Watkins Gate Road, within former Fort Ord property in the City of Seaside. The Terminal Reservoir would consist of two 33-foot-tall, 130-foot-diameter aboveground concrete tanks. Each tank would have a storage capacity of 3 million gallons, for a total storage capacity of 6 million gallons. The Terminal Reservoir tanks would be constructed on an approximately 0.5-acre concrete pad. Security fencing would enclose a 4.5-acre area around the Terminal Reservoir. In order to reduce visual impacts, it may be required through the City of Seaside land development approval to partially bury (bermed) or fully bury the reservoirs.

ASR Facilities: The ASR Facilities include two injection/extraction wells (Wells ASR-5 and ASR-6), and supporting pipelines. The two additional ASR wells would be located immediately east of General Jim Moore Boulevard in the area of Fitch Park. These ASR wells will provide storage capacity in the winter, by injecting water into the Seaside Groundwater Basin, and support peak water supply in the summer by drawing on the stored water, thus reducing the need for surface water diversions from Carmel River.

Salinas Return Pipeline: From 1.0 to 1.6 mgd of product water may be used to replenish aquifers from which seawater is extracted at the intakes. The pipeline would be operated between May and October of each year and deliver product water to the existing Castroville Seawater Intrusion Project (CSIP) infiltration pond located at the MRWPCAWastewater Treatment Plant. The Salinas Return Line would be approximately 1.1 miles in length.

Castroville Salinas Valley Return Pipeline: In addition to the Salinas Return Line, return flow requirements of product water may be conveyed to the Castroville Water District. The Salinas Valley Return Pipeline to Castroville will be a 8 to 12-inch diameter pipe approximately 4 miles long. . The route alternatives are depicted on **Figure 1**.

Pump Stations: In addition to pump stations at the intake wellheads and at the desalination plant site, conveyance pump stations are also proposed on the Monterey County Fairgrounds property, and at the CalAm owned Rancho San Carlos Well Site in Carmel Valley, locations are depicted in **Figure 1**. The proposed Monterey Pump Station, located at the County Fairgrounds, would be equipped with one, 400 horsepower (hp) and two, 200 hp pumps, with a combined pumping capacity of 6,400 gallons per minute (gpm) and 3,200 gpm, respectively. The proposed Valley Greens Pump Station would be equipped with three, 60 hp, 1,400 gpm pumps. The mechanical appurtenances would be enclosed in an approximately 1300-square-foot pump house for both sites.

Highway 68 Satellite Water System Interconnect Pipelines: CalAm Monterey District includes five small satellite water located along the Highway 68 corridor. Three of these systems depend on groundwater from the adjudicated Seaside basin whose allocation will be reduced to zero by 2018. This project proposes two small water main extensions that allow MPWSP to provide adequate water supply to these systems, the extensions are shown in Figure 1.

PIPELINE CONSTRUCTION METHODS

Pipeline installation would generally progress at a rate of 150 to 250 feet per day. The majority of the pipeline installation would be through an open-cut trench construction method. However, where it is not feasible or desirable to perform open-cut trenching, trenchless methods would be used. Pipeline depth would vary depending on pipe size and topography but will be typically have 4 feet of cover. Installation would use conventional equipment such as flatbed trucks, backhoes, excavators, pipe cutting and welding equipment, haul trucks for spoils transport, trucks for materials delivery, compaction equipment, Baker tanks, pickup trucks, arch welding machines, generators, air compressors, cranes, drill rigs, and skip loaders.

Pipeline segments would typically be delivered and installed in 16 to 40-foot-long sections. Soil removed from trenches and pits would be stockpiled and reused, to the extent feasible, or hauled away for offsite disposal. Under typical circumstances, the width of the disturbance corridor for pipeline construction would vary from 50 to 100 feet, depending on the size of the pipe being installed. Trenchless technologies could require wider corridors at entry and exit pits. Pipeline installation would be ongoing throughout the entire 24-month construction period, with multiple pipelines being installed simultaneously. Pipeline installation would be sequenced to minimize land use disturbance and disruption to the extent possible.

Construction equipment and materials associated with pipeline installation would be stored along the pipeline easements and at nearby designated staging areas. Staging areas would not be sited in sensitive areas such as riparian or critical habitat for protected species. To the extent feasible, parking for construction equipment and worker vehicles would be accommodated within the construction work areas and on adjacent roadways.

Roadways and rail tracks disturbed during pipeline installation would be restored to existing or improved condition. A pre-construction and post-construction evaluation would be conducted to assess on-site conditions. Generally, trench spoils in the TAMC ROW would be temporarily stockpiled within the construction easement, then backfilled into the trench after pipeline installation. Any excess spoils would be disposed of at an appropriate facility. Locations for permanent removal of uncontaminated spoils would be coordinated with the selected contractor in coordination with the local jurisdiction.

The final location of pipelines within public ROWs, based on existing utilities, will determine whether certain traffic lanes or streets require closure during construction activities. Traffic Control Plans will be prepared in coordination with affected municipalities or Caltrans for temporary lane closures.

Open-Trench Construction: For pipeline segments to be installed using open-trench methods, the construction sequence would typically include clearing and grading the ground surface along the pipeline alignments; excavating the trench; preparing and installing pipeline sections; installing vaults, manhole risers, manifolds, and other pipeline components; backfilling the trench with non-expansive fills; restoring preconstruction contours; and revegetating or paving the pipeline alignments, as appropriate. A conventional backhoe, excavator, or other mechanized equipment would be used to excavate trenches. The typical trench width would be 6 feet; however, vaults, manhole risers, and other pipeline components could require wider excavations. Work crews would install trench boxes or shoring or would lay back and bench the slopes to stabilize the pipeline trenches and prevent the walls from collapsing during construction. After excavating the trenches, the contractor would line the trench with pipe bedding (sand or other appropriate material shaped to support the pipeline). Construction workers would then place pipe sections (and pipeline components, where applicable) into the trench, join the sections together as trenching proceeded, and then backfill the trench. Steel plates would be placed over trenches to maintain access to private driveways.

Trenchless Technologies: Where it is not feasible or desirable to perform open-cut trenching, trenchless methods such as jack-and-bore, drill-and-burst, horizontal directional drilling, and/or microtunneling would be employed. Pipeline segments located within heavily congested underground utility areas or in sensitive habitat areas may be installed using horizontal directional drilling or microtunneling. Jack-and-bore methods would also be used for pipeline segments that cross beneath Highway 1 or drainages.

Jack-and-Bore and Microtunneling Methods: The jack-and-bore and microtunneling methods entail excavating an entry pit and a receiving pit at either end of the pipe segment. A horizontal boring machine or auger is used to drill a hole, and a hydraulic jack is used to push a casing through the hole to the opposite pit. As the boring proceeds, a steel casing is jacked into the hole and pipe is installed in the casing.

Drill-and-Burst Method: The drill-and-burst method involves drilling a small pilot hole at the desired depth through a substrate, and then pulling increasingly larger reamers multiple times through the pilot hole until the hole reaches the desired diameter.

Horizontal Directional Drilling: Horizontal directional drilling requires the excavation of a pit on either end of the pipe alignment. A surface-launched drilling rig is used to drill a small horizontal boring at the desired depth between the two pits. The boring is filled with drilling fluids and enlarged by a back reamer or hole opener to the required diameter. The pipeline is then pulled into position through the boring. Entry and receiving pits range in size depending on the length of the crossing, but typically have dimensions of approximately 50 by 50 feet.

MPWSP VARIANT

The project includes a variation (Variant) that potentially combines a reduced-capacity desalination plant with a water purchase agreement for product water from the MRWPCA's proposed Pure Water Monterey Groundwater Replenishment Project. The Pure Water Monterey Groundwater Replenishment Project has its own separate environmental compliance documentation and otherwise has independent utility from the MPWSP (refer to the Draft Environmental Impact Report for the Pure Water Monterey Groundwater Replenishment Project, prepared by Denise Duffy & Associates, Inc. (dated April 2015), available on the Monterey Regional Water Pollution Control Agency website (http://www.mrwpca.org/).

The Variant, if approved, reduces the size of desalination plant capacity from 9.6 MGD to 6.4 MGD and the number of source wells is reduced to eight (six active and 2 standby), which includes conversion of existing test slant well to a production well, to produce up to 15.5 MGD of source water. Additionally, the volume of brine waste discharge is reduced. The remaining MPWSP proposed facilities are the same under the MPWSP and the Variant scenarios.

The primary objectives of the MPWSP Variant are the same as those for the proposed project. In order to provide 9,752 afy of additional water supplies to meet the estimated total annual demand in the Monterey District of 15,296 afy, the MPWSP Variant would provide 6,252 afy with a reduced sized desalination plant (6.4 mgd). The remaining 3,500 afy would be provided through a water purchase agreement between CalAm and the GWR project sponsors (in addition to existing Carmel River diversions, Aquifer Storage and Recovery [ASR], the Seaside Groundwater Basin and the Sand City Coastal Desalination Plant). The table below summarizes the future supplies for the Monterey District with and without the implementation of the MPWSP Variant.

Future Water Supplies for the Monterey District with Implementation of the MPWSP

Source	MPWSP with GWR Average Annual Yield (afy)a	MPWSP without GWR Average Annual Yield (afy)a
MPWSP Desalination Plant (Proposed)	6,252	9,752
GWR Project Water	3,500b	–
Carmel River Diversions (Existing)	3,376	3,376
ASR Project (Existing)	1,300	1,300
Seaside Groundwater Basin (Existing)	774c	774c
Sand City Coastal Desalination Plant (Existing)	94	94
Total	15,296	15,296

a. Average annual yields are rounded to the closest whole number.
b. CalAm would enter into a water purchase agreement with MPWMD for 3,500 afy of GWR project supply.
c. After CalAm has fulfilled its replenishment obligations to the Seaside Groundwater Basin (assumed to take 25 years at a replenishment rate of 700 afy), CalAm would increase pumping to its adjudicated right of 1,474 afy.
SOURCE: ESA Associates, 2015.

FIGURE 1

MPWSP FACILITIES OVERVIEW

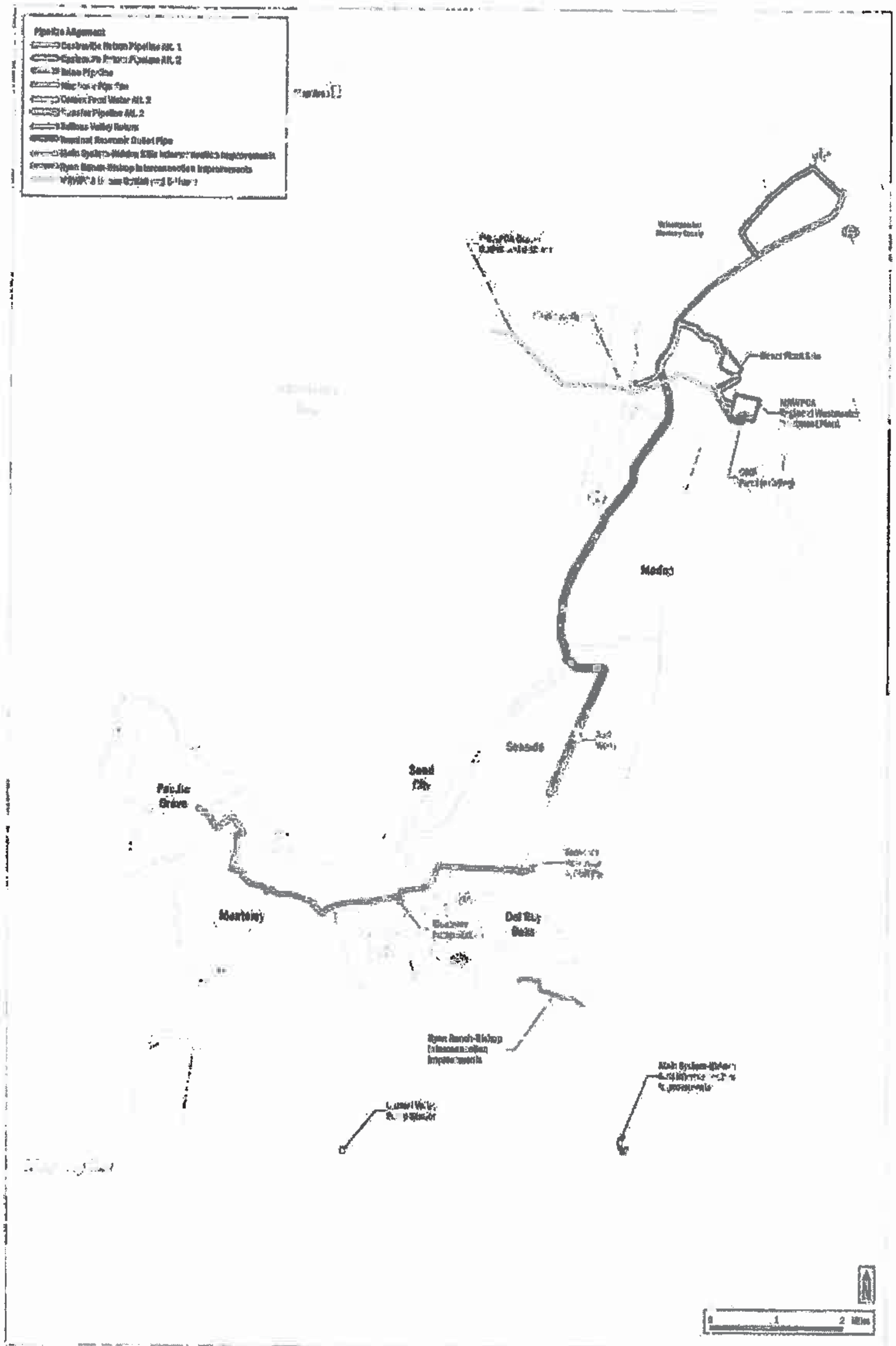
FIGURE 2

SUBSURFACE SLANT WELL LAYOUT

FIGURE 1

MPWSP FACILITIES OVERVIEW

Water Ratepayers Association of the Monterey Peninsula (WRAMP) Exhibits



URS
California American Water

PROJECT OVERVIEW
Project Pipeline Alignments

FIGURE 2

SUBSURFACE SLANT WELL LAYOUT

Water Ratepayers Association of the Monterey Peninsula (WRAMP)
Exhibits

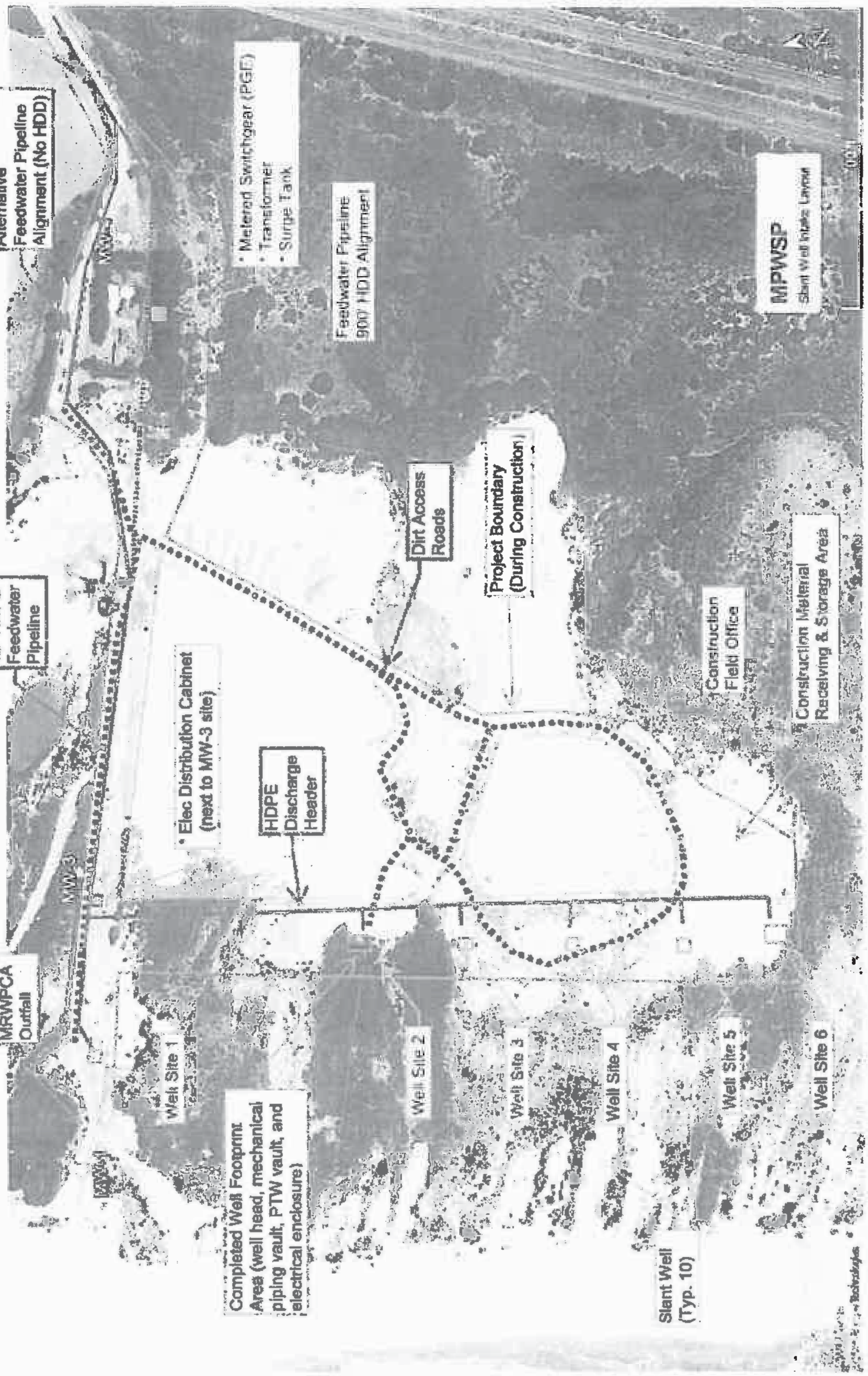


EXHIBIT D

HOPKINS
GROUNDWATER
CONSULTANTS, INC.
THE WATER RESOURCE SPECIALISTS

TECHNICAL MEMORANDUM

To: Mr. Keith Van Der Maaten
General Manager, Marina Coast Water District

From: Curtis J. Hopkins
Principal Hydrogeologist, Hopkins Groundwater Consultants, Inc.

Date: May 26, 2016

Subject: North Marina Area Groundwater Data and Conditions

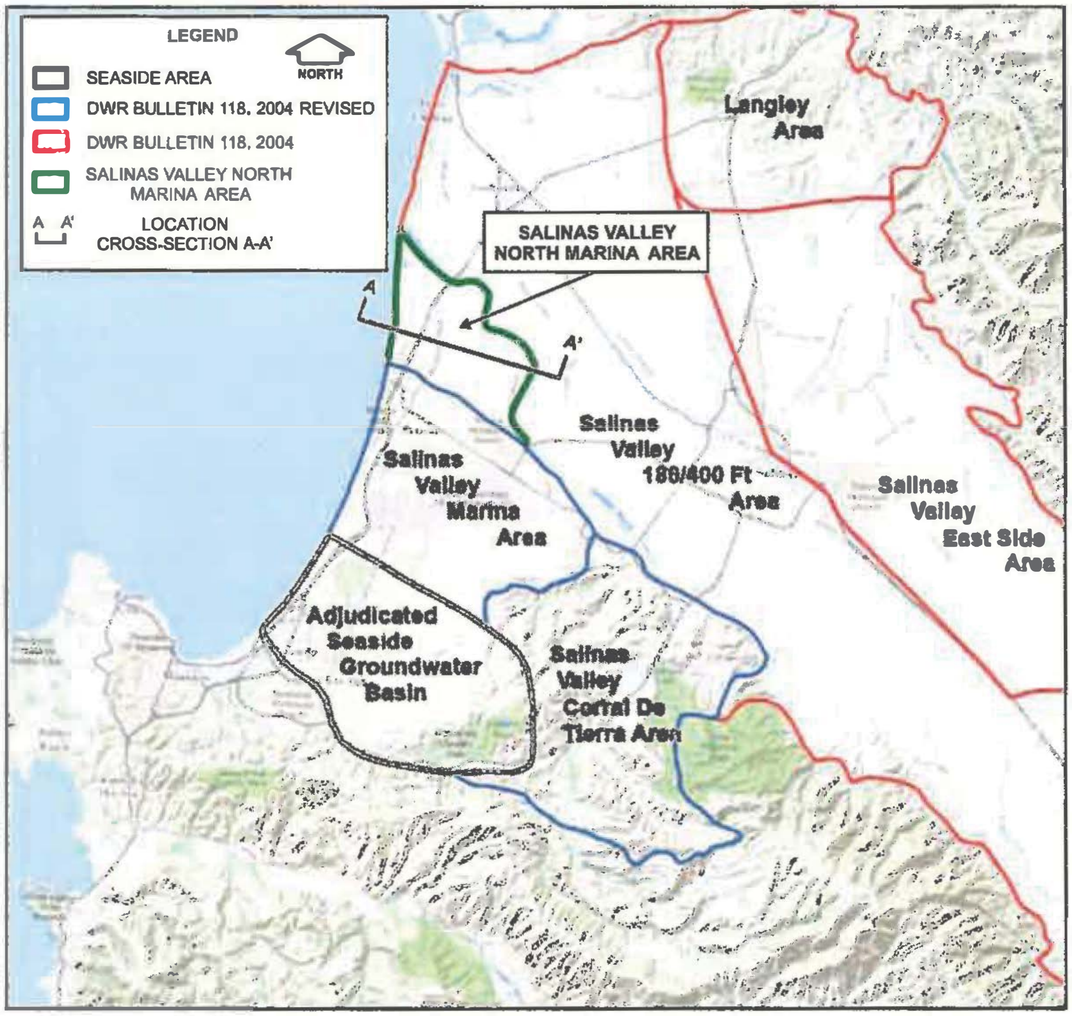
I. Introduction

Hopkins Groundwater Consultants, Inc. (Hopkins) has reviewed groundwater data provided by the California-American Water Company's (Cal-Am's) test slant well project for the Monterey Peninsula Water Supply Project (MPWSP) as requested by Marina Coast Water District (MCWD). This memorandum provides a summary of groundwater data and the conditions that are inferred from these data in the North Marina Area of the 180-400 Foot Aquifer Subbasin[1] within the Salinas Valley Groundwater Basin (SVGB). The North Marina Area is delineated for reference in Figure 1 – Groundwater Basin Boundary Map which shows its location within the SVGB. As shown, the North Marina Area is located between the northern boundary of the Marina Area and the Salinas River. This area of the basin has been largely undeveloped and historically contained very few wells to provide groundwater data.

The geology in the North Marina Area differs from the geology north of the Salinas River in the main portion of the 180-400 Foot Aquifer Subbasin and has been described in detail by studies conducted for the MPWSP. An interpretation of subsurface deposits within this specific coastal area is provided in Plate 1 – Cross-Section A-A', which is a portion of a subsurface profile constructed by Geoscience Support Services, Inc. from borehole data collected in the area (Geoscience, 2014). The approximate location of Cross-Section A-A' is shown in Figure 1. As shown and as described by previous study (Geoscience, 2014 and 2015, KJC, 2004), the terrace deposits that comprise the 180-Foot Equivalent Aquifer (180-FTE) in the North Marina Area grade into the alluvial deposits that comprise the 180-Foot Aquifer in the main portion of the basin around the present location of the Salinas River.

[1] / For purposes of the memorandum, the North Marina Area is defined as that portion of the 180/400 Foot Aquifer Subbasin located south of the Salinas River and north of the Salinas Valley Marina Area.

Figure 1 – Groundwater Basin Boundary Map

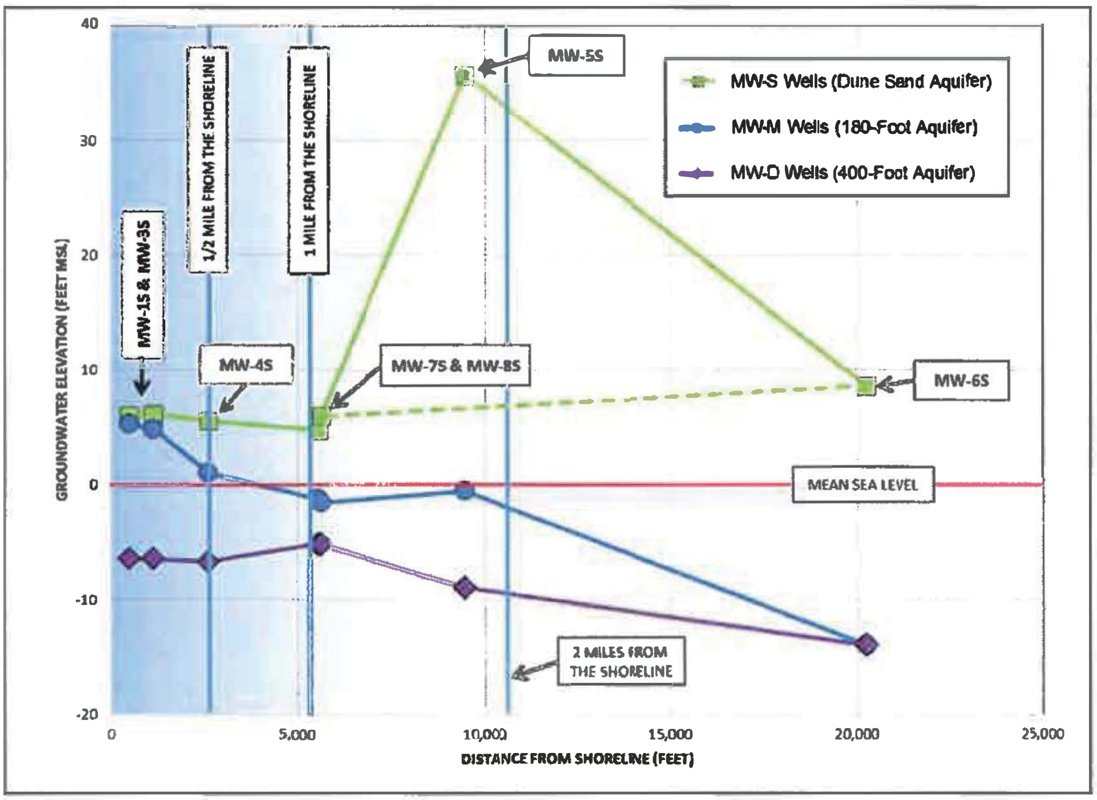


II. Coastal Groundwater Elevations

Recent investigation for the MPWSP includes the installation of a test slant well and multiple monitoring wells in and around the CEMEX property where the MPWSP intake wells are proposed to be located. The monitoring well network is being used to generate background water level and water quality data within the North Marina Area of the 180-400 Foot Aquifer Subbasin. The location of the monitoring facilities is shown on Plate 2 – Well Location Map. The construction details of these wells are included for reference as Attachment A – Well Construction Information.

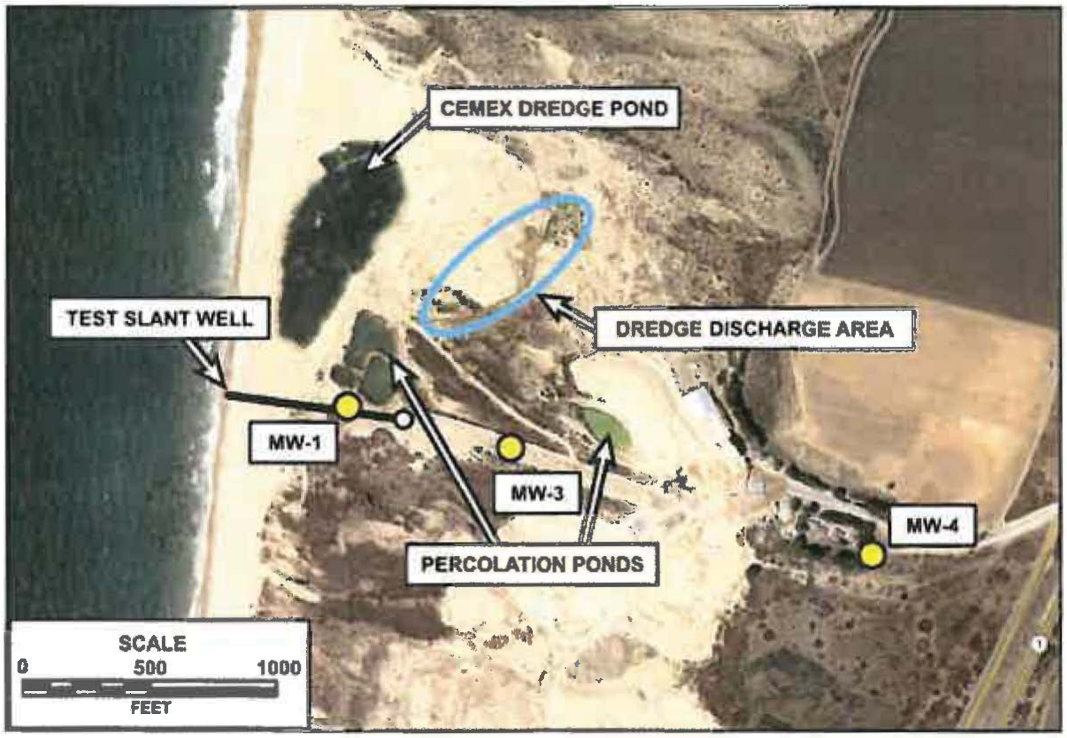
Routine monitoring of the well network is presented in weekly summary reports that are posted on the Cal-Am website. Water level data are graphically presented as hydrographs which show daily changes and seasonal trends. A set of hydrographs provided by the MPWSP test slant well long term pumping test Monitoring Report No. 55 are included as Attachment B – MPWSP Water Level Data. We must note that while we have over a year of data, the climatic conditions prior to initiation of testing have been extremely dry. For comparison of the groundwater conditions across the area prior to resumption of pumping, data from May 2, 2016 were used to construct Figure 2 – Groundwater Elevation From MPWSP Monitoring Wells. As shown, the water level elevations vary significantly between the shallow Dune Sand Aquifer (indicated by the MW-S Wells), the 180-FTE Aquifer (indicated by the MW-M Wells), and the 400-Foot Aquifer (indicated by the MW-D Wells).

Figure 2 – Groundwater Elevation From MPWSP Monitoring Wells



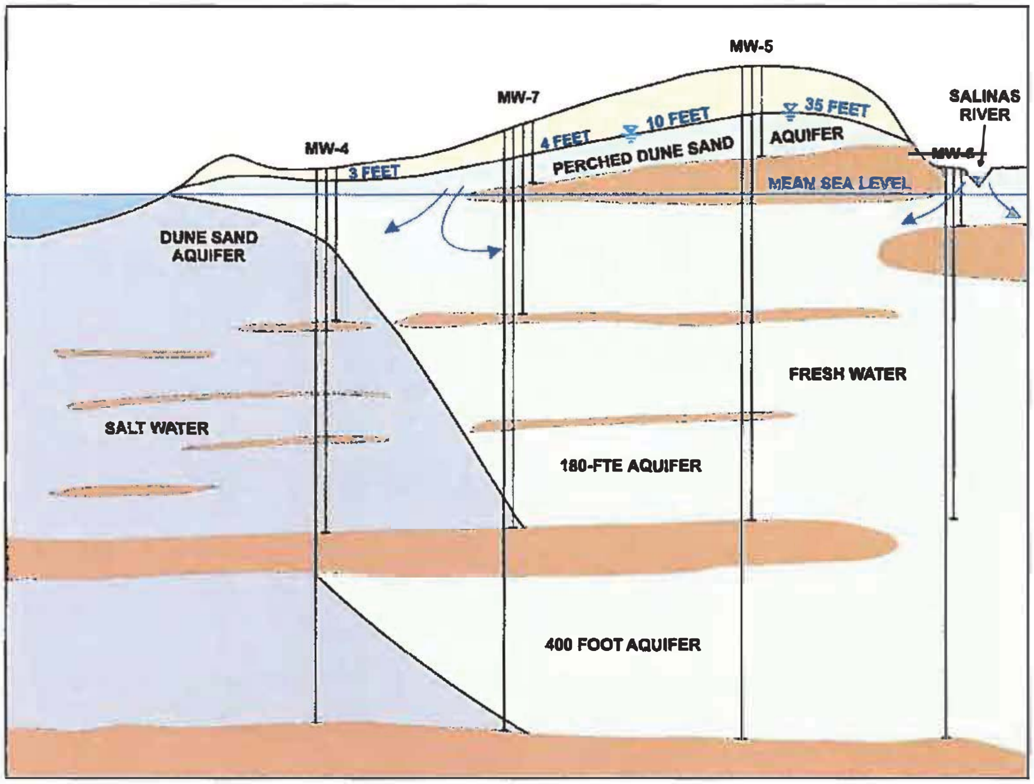
The Dune Sand Aquifer has water levels that are notably above sea level and maintain a protective head against seawater intrusion (Geoscience, 2013). The coastal groundwater mounding at MW-1 and MW-3 is believed to be maintained by the CEMEX dredge pond operation that is discharged on the landward side of the coastal dunes as well as process water that is discharged to percolation ponds. Figure 3 – CEMEX Salt Water Discharge Locations shows the surface water features that have influenced the groundwater levels and quality at this location along the coast for decades. The maintenance of these features undoubtably increases the amount of ocean water present in the vicinity of the test slant well.

Figure 3 – CEMEX Salt Water Discharge Locations



These data also show the perched groundwater condition in the vicinity of MW-5 where the groundwater elevation is 36 feet above mean sea level (msl). The groundwater perched above the Salinas Valley Aquitard equivalent flows toward the coast and results in downward recharge where the aquitard layer thins (or ends) and provides fresh water recharge into the coastal unconfined Dune Sand Aquifer and the underlying 180-Foot Aquifer in the vicinity of MW-7 and MW-8. Figure 4 – Conceptual Drawing of the Hydrogeology in the North Marina Area illustrates the subsurface conditions indicated by these available data.

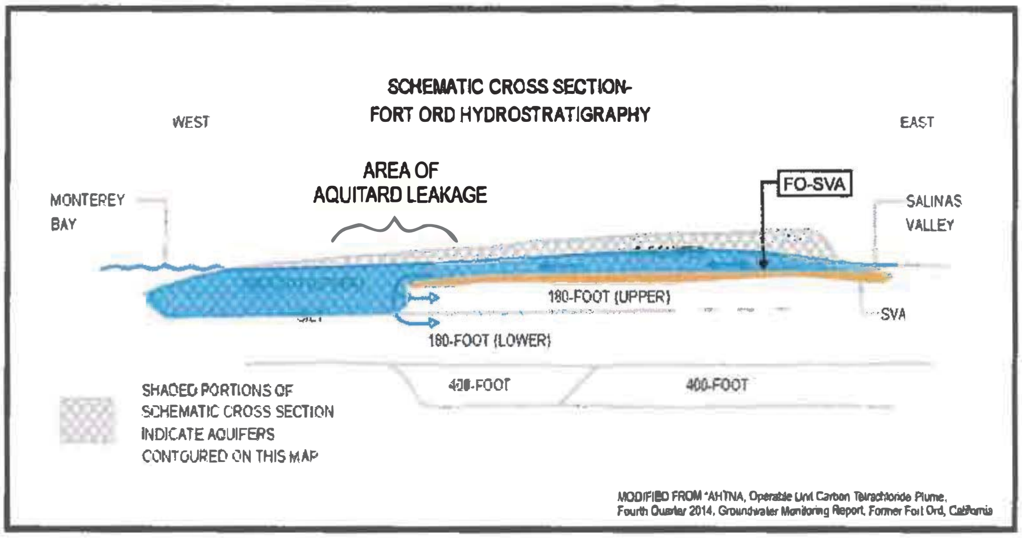
Figure 4 – Conceptual Drawing of the Hydrogeology in the North Marina Area



Years of reduced pumping has resulted in beneficial groundwater conditions that are apparently slowing the movement of seawater and providing a freshwater source that is replenishing the aquifers. Notably, the fact that the Dune Sand and 180-Foot Aquifers at Monitoring Well MW-7 are no longer contaminated by high concentrations of seawater can likely be explained by the changing hydrogeological conditions resulting from the efforts of MCWD (e.g., Annexation Agreement, etc.) and others to reduce pumping in the coastal area. As a result, recharge from rainfall into the Dune Sand Aquifer creates a mound of freshwater that flows toward the Salinas River and the ocean.

We further note this protective condition is not isolated in a small area. This coastal condition was previously documented as part of the Fort Ord cleanup effort located southeast of the CEMEX site. The study named the aquitard layer the "Fort Ord-Salinas Valley Aquitard" (FO-SVA). Figure 5 - Perched Dune Sand Aquifer Schematic from Fort Ord Groundwater Monitoring Program shows a drawing of this condition, which was modified to illustrate groundwater flow directions (Ahtna, 2014).

Figure 5 – Perched Dune Sand Aquifer Schematic from Fort Ord Groundwater Monitoring Program



This is a very significant development. Given that the groundwater found with a 36-foot elevation in the Dune Sand Aquifer at the location of MW-5S (and a 6-foot elevation at MW-7S), the Dune Sand Aquifer effectively provides a protective layer preventing seawater intrusion from moving into the Basin at a shallow depth and percolating downward into the underlying aquifers. Instead of allowing a shallow pathway for ocean water, the Dune Sand Aquifer having a potable fresh water quality based on its TDS concentration, appears to be slowly recharging the lower aquifers (i.e., the 180-Foot Aquifer and perhaps 400-Foot Aquifer), which has significantly reduced their TDS levels in this coastal area. This unique condition in the Marina Subarea is believed to provide recharge all along the coast in an area that effectively forms a linear recharge barrier within a mile of the shoreline. The extent of the Fort Ord-Salinas Valley Aquitard was estimated in a 2001 study conducted as part of the Fort Ord cleanup program (Harding ESE, 2001).

Monitoring data indicate that the elevation of the water levels in Monitoring Wells MW-7M and MW-8M are presently lower than the levels in both MW-4M and MW-5M. While the groundwater elevation is near mean sea level, the gradient indicated by the higher level at MW-5M shows that groundwater flows toward the coast up to MW-7 and MW-8 under these conditions. The significance is that after several years of drought conditions, the groundwater gradient between MW-4M (roughly ½ mile from the coast) and MW-5M (almost 2 miles from the coast) is relatively flat in the 180-FTE Aquifer. A significant decline in the groundwater level is observed to occur between MW-5M and MW-6M (see Figure 2). Further study would be required to understand if the mounding indicated in the 400-Foot Aquifer at MW-7 and MW-8 were from vertical recharge from the 180-FTE in this area along the coast.

III. Groundwater Quality Data

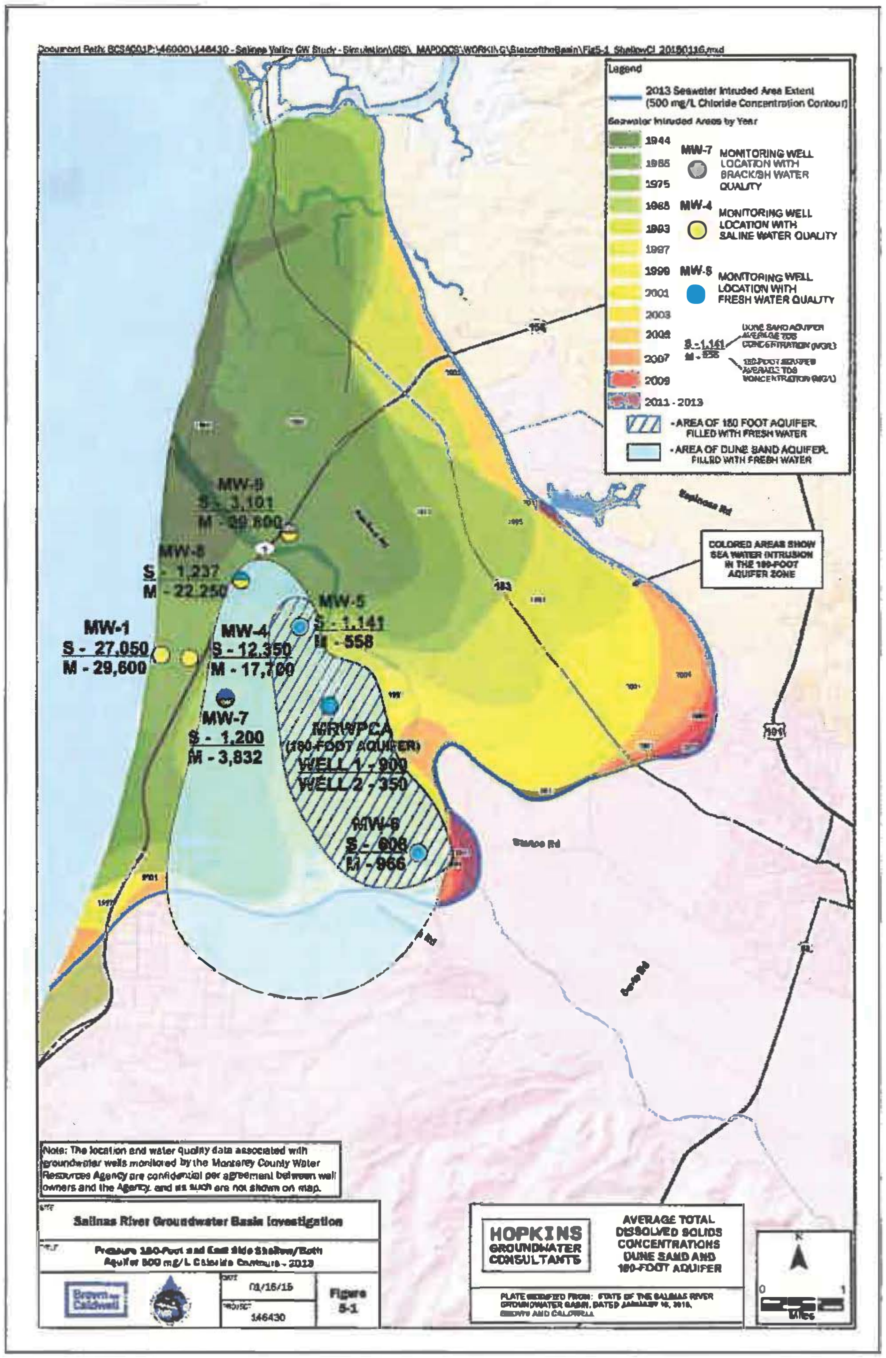
Water quality data developed as part of the test slant well project are summarized in the tables included in Attachment C – Laboratory Water Quality Test Results. The first table shown in Attachment C provides the only data published for wells other than the test slant well and MW-4 (Geoscience, 2015a). This table includes laboratory results for wells including MW-1, MW-3, MW-4, MW-5, and the test slant well. The second table in Attachment C is a compilation of laboratory data received by MCWD in October 2015 in response to a data request in the California Public Utilities Commission proceedings. This table includes data for monitoring wells MW-6, MW-7, MW-8, and MW-9 that to our knowledge, have not be published in any of the MPWSP documents.

The significance of these data is that they indicate beneficial conditions have developed (or have always existed) in the North Marina Area of the 180-400 Foot Aquifer Subbasin and may be contrary to information published by the Monterey County Water Resources Agency (MCWRA). The recent investigation that is being conducted in and around the North Marina Area as part of the MPWSP has discovered an occurrence of freshwater within the shallow Dune Sand Aquifer and the underlying 180-Foot Aquifer within the area delineated as seawater intruded by the MCWRA. As previously shown, water level data from wells in the shallow dune sand aquifer appear to show protective water levels that are sufficiently above sea level to prevent seawater intrusion in the shallower sediments. This condition, combined with the lack of pumping in the 180-Foot Aquifer in the North Marina Area, appears to have slowed seawater intrusion in this portion of the coastline. Water quality test results for total dissolved solids and chloride concentrations in these two uppermost aquifer zones are shown on Figures 6 and 7 – Average Total Dissolved Solids Concentrations in Groundwater and Average Chloride Concentrations in Groundwater, respectively.

These data suggest a change of groundwater conditions in this coastal section of the aquifer or alternatively, they may reveal the groundwater conditions that existed in an area largely lacking historical data. While the freshwater in this area contains salts and nutrients that are derived from overlying land uses that include agriculture, landfill, and wastewater treatment plant and composting facilities, the chemical character is not sodium chloride, which is indicative of seawater intrusion. Figure 8 and 9 – Stiff Diagrams of Dune Sand Aquifer Groundwater and 180-Foot Aquifer Groundwater, respectively show that the chemical character of groundwater in these new wells is predominantly calcium chloride and calcium bicarbonate. Additionally, elevated concentrations of nitrate are present in monitoring wells MW-5S, MW-7S and MW-8S and range from 115 mg/l to 237 mg/l. The concentration of nitrate decreases with depth at all of these sites, and is the highest at MW-5, which is closest to the landfill and the wastewater treatment facilities. Future use of this area for a direct potable groundwater supply may be unlikely; however, existing conditions do show abatement of seawater intrusion in the shallower aquifer zones in this coastal portion of the Salinas Valley Groundwater Basin. This condition may support the future beneficial uses of the 180-Foot Aquifer zone potentially including aquifer storage and recovery of highly purified recycled water for indirect potable reuse.

Water Ratepayers Association of the Monterey Peninsula (WRAMP) Exhibits

Figure 6 – Average Total Dissolved Solids Concentrations in Groundwater



Water Ratepayers Association of the Monterey Peninsula (WRAMP) Exhibits

Figure 7 – Average Chloride Concentrations in Groundwater

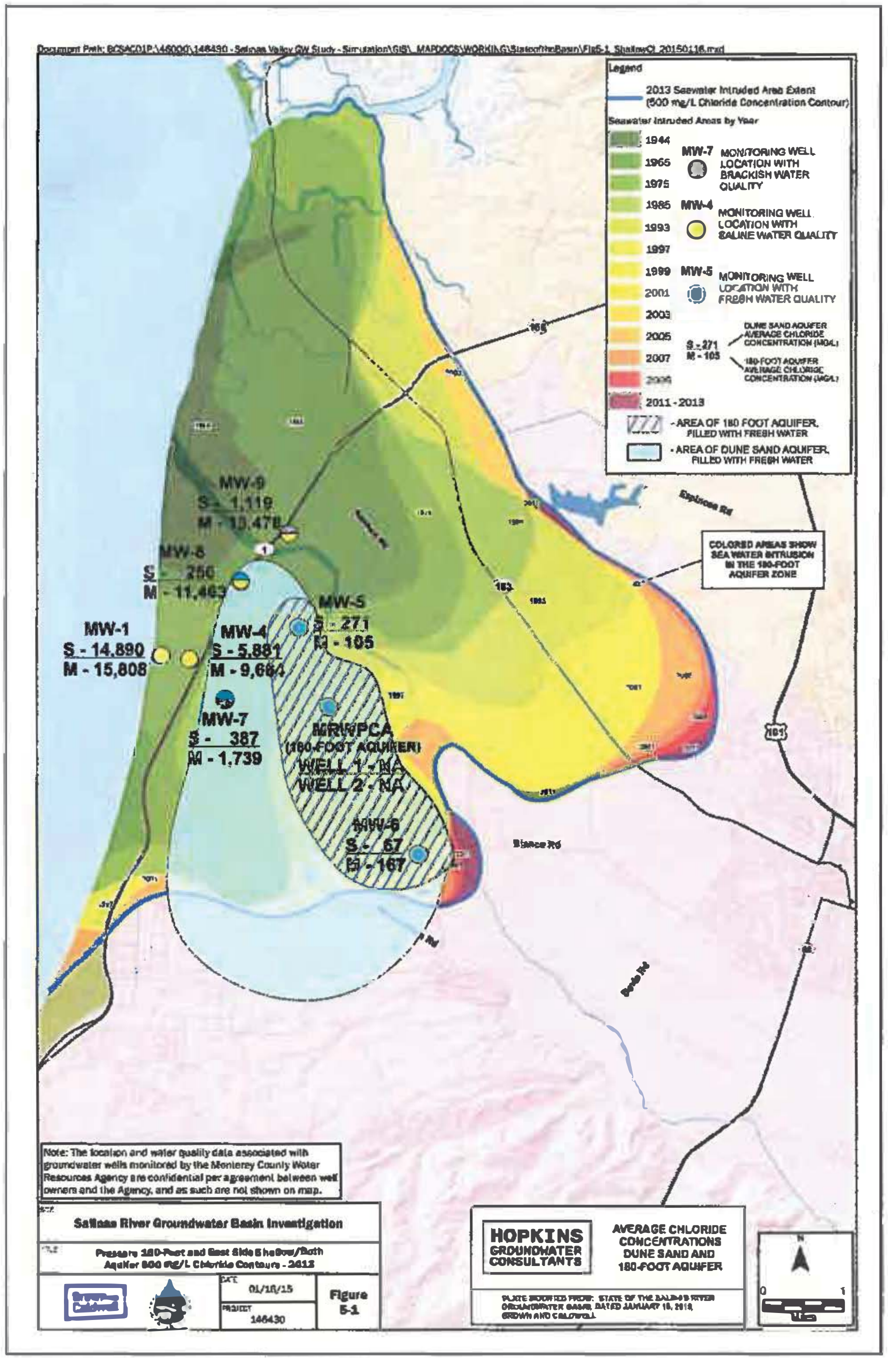


Figure 8 – Stiff Diagrams of Dune Sand Aquifer Groundwater

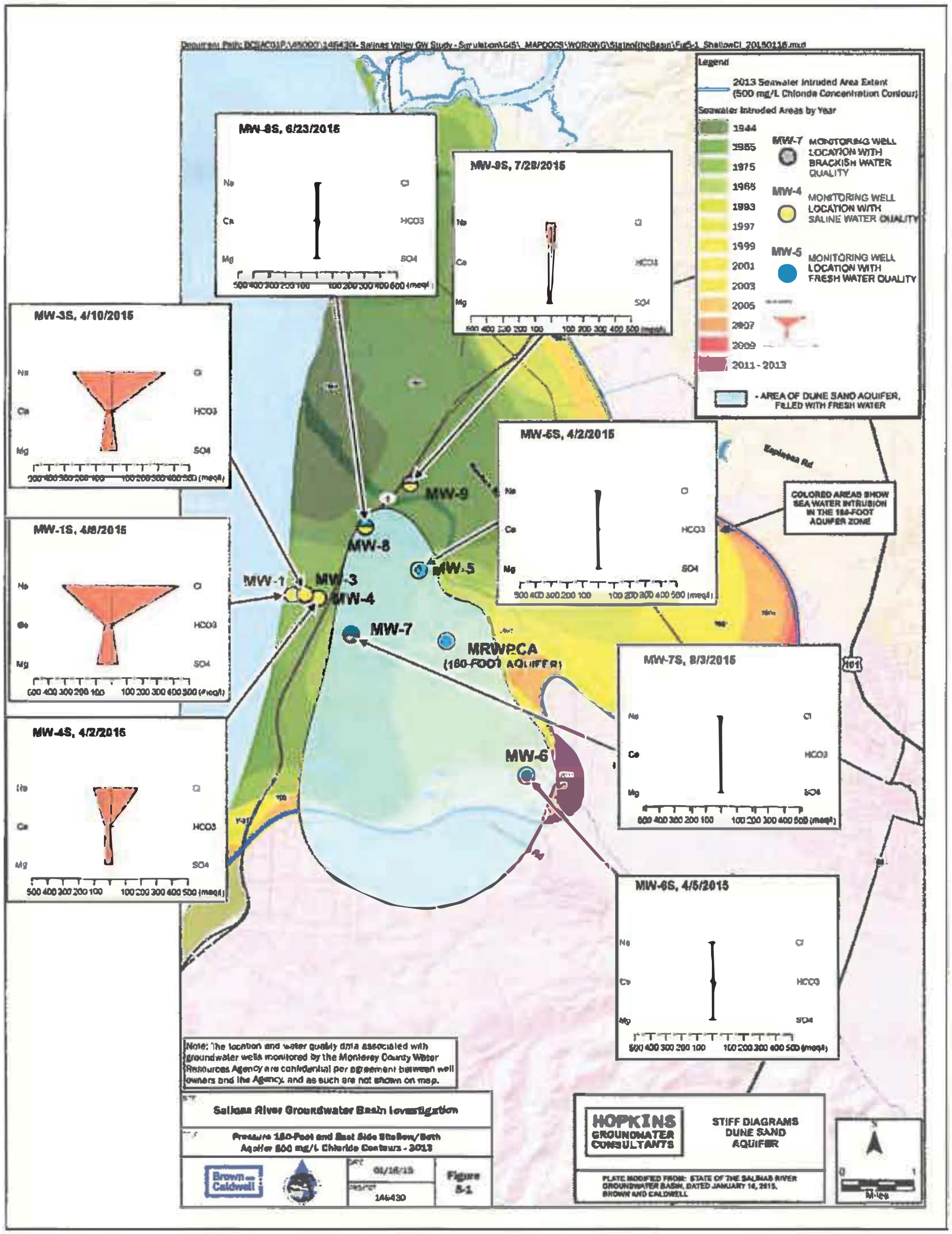
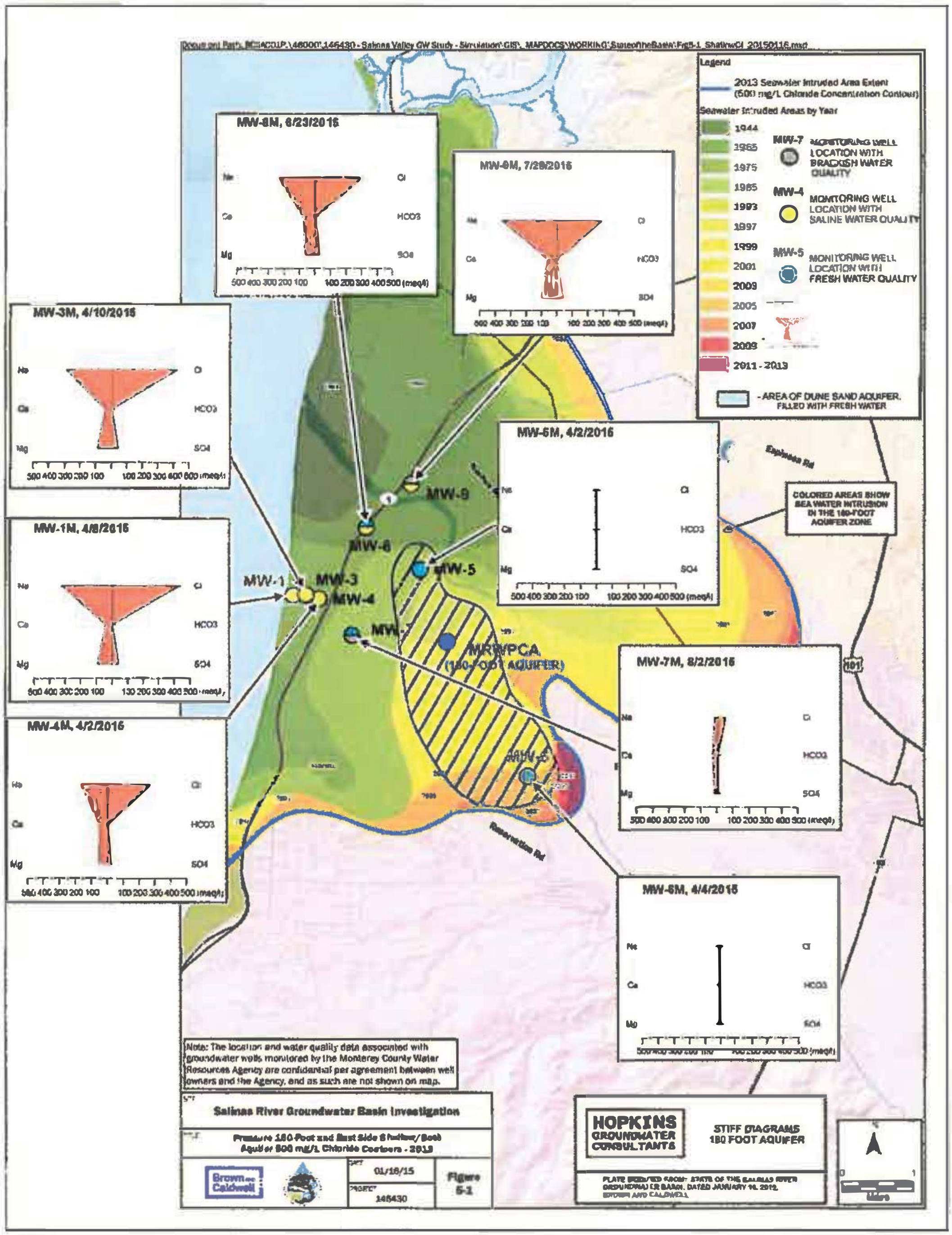


Figure 9 – Stiff Diagrams of 180-Foot Aquifer Groundwater

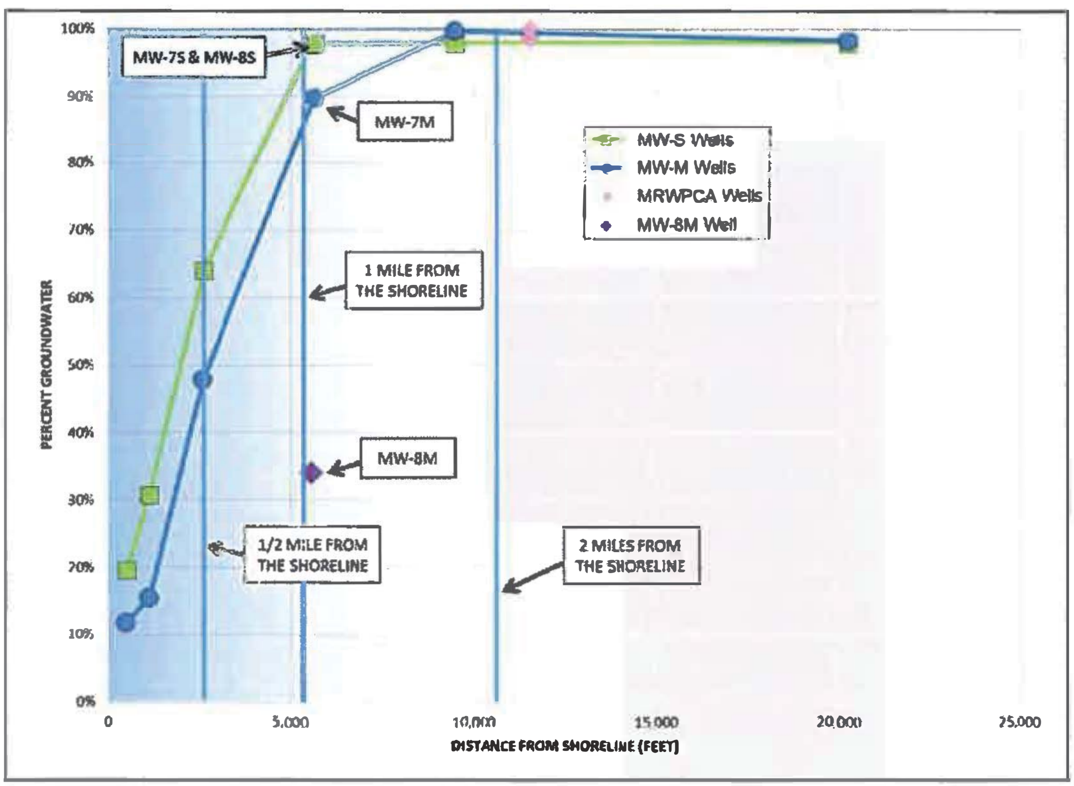


These data indicate a unique condition exists in the North Marina Subarea south of the Salinas River that provides a significant degree of protection against seawater intrusion in the shallower aquifers under the present and recent past hydrologic conditions. Figure 10 – Percent Groundwater with Distance From the Shoreline shows the rudimentary calculation of groundwater percentage versus ocean water percentage using the same equation applied to the test slant well discharge. The percentage of fresh groundwater in well water samples was calculated using the following equation:

GWP = [1 – (WSS – GWS/OWS – GWS)] X 100

Where:
GWP = Percent Groundwater
WSS = Well Sample Salinity (mg/l)
GWS = Groundwater Salinity (420 mg/l)
OWS = Ocean Water Salinity (33,500 mg/l)

Figure 10 – Percent Groundwater with Distance From the Shoreline



Water quality data for this analysis were provided by the laboratory test results summarized in Attachment C. These available data show that the percentage of ocean water decreases significantly within a short distance from the coastline in the North Marina Area and the salinity of groundwater that is comparable to seawater is not up to 8 miles inland in the 180-Foot Aquifer as assumed by previous study. Calculation of percent ocean water using this method cannot differentiate between salts from overlying land uses and salt from ocean water. This calculation assumes that all salt in groundwater with a TDS above a concentration of 420 mg/l is from ocean water.

As shown in Figure 10, monitoring wells MW-5M and MW-6M along with the Monterey Regional Water Pollution Control Agency (MRWPCA) Wells are located in the 180-Foot Aquifer and the average TDS concentration for samples from these wells ranges from approximately 454 to 966 milligrams per liter (mg/l) and is also considered fresh water (See Figure 4 and Attachment C). However, the TDS concentration for MW-7M (3,832 mg/l) and MW-8M (22,250 mg/l) show that closer to the coast and closer to the main portion of the Basin north of the river, seawater has impacted the underlying 180-Foot Aquifer as shown in Figure 9 and 10.

We trust this review of available data provides a better understanding of what the MPWSP test slant well monitoring program has discovered. It is clear that without the new monitoring wells, this type of understanding about groundwater conditions in the North Marina Area could not have been provided from available data.

Sincerely,
HOPKINS GROUNDWATER CONSULTANTS, INC.

Curtis J. Hopkins
Principal Hydrogeologist
Certified Engineering Geologist, EG1800
Certified Hydrogeologist, HG114

Attachments: Plate 1 – Cross-Section A-A'
Plate 2 – Well Location Map
Attachment A – Well Construction Information
Attachment B – MPWSP Water Level Data
Attachment C – Laboratory Water Quality Test Results

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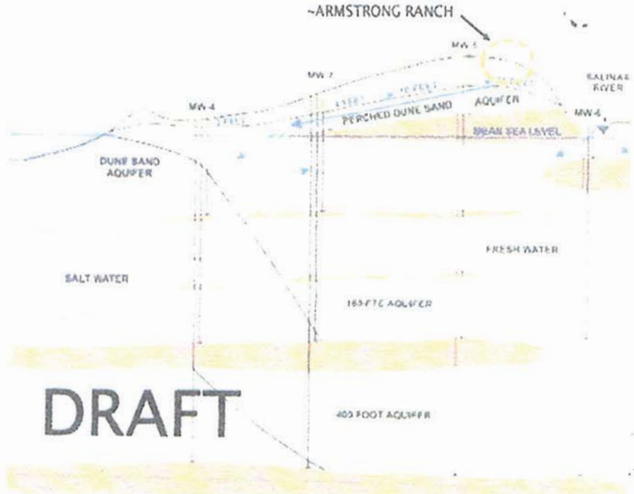
EXHIBIT A

Margaret-Anne Coppernoll
Exhibits

ARMSTRONG RANCH PROJECT (EKI STUDY)

PROJECT DESCRIPTION

- UTILIZES EXISTING FRESHWATER LENSE IN DUNE/180
- NATURAL FLOW PATH FROM DUNES TOWARD OCEAN AND BACK INTO 180
- DUNES RECHARGE PROVIDES SEAWATER BARRIER AND 180 RECHARGE
- STUDY CONFIRMED HOPKINS ANALYSIS OF FRESHWATER LENSE THROUGHOUT ENTIRE AREA



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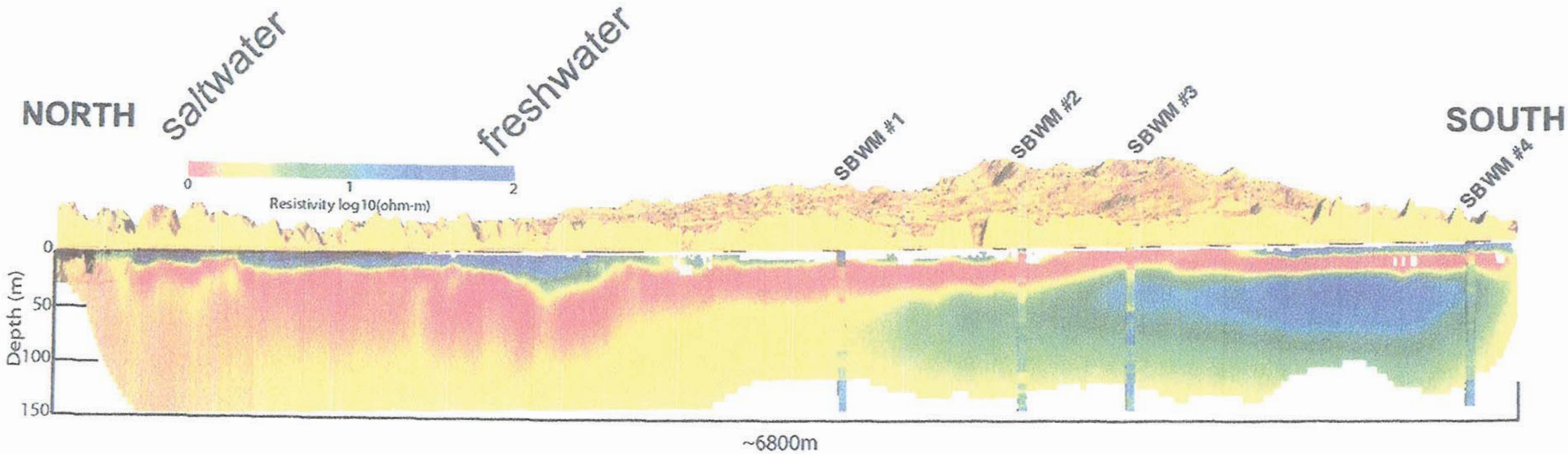
10

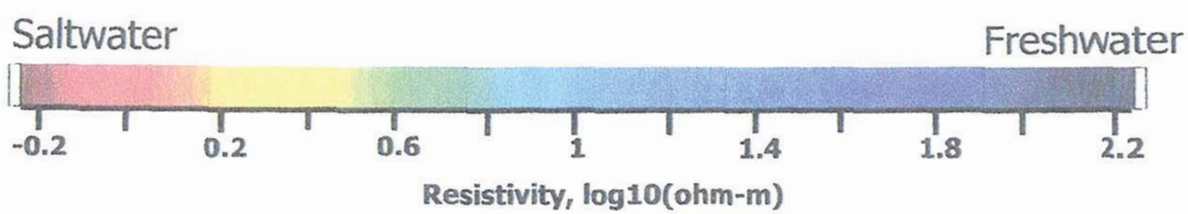
EXHIBIT B

Margaret-Anne Coppernoll
Exhibits

Sentinel Geophysics
Electrical Resistivity Image of Saltwater Intrusion

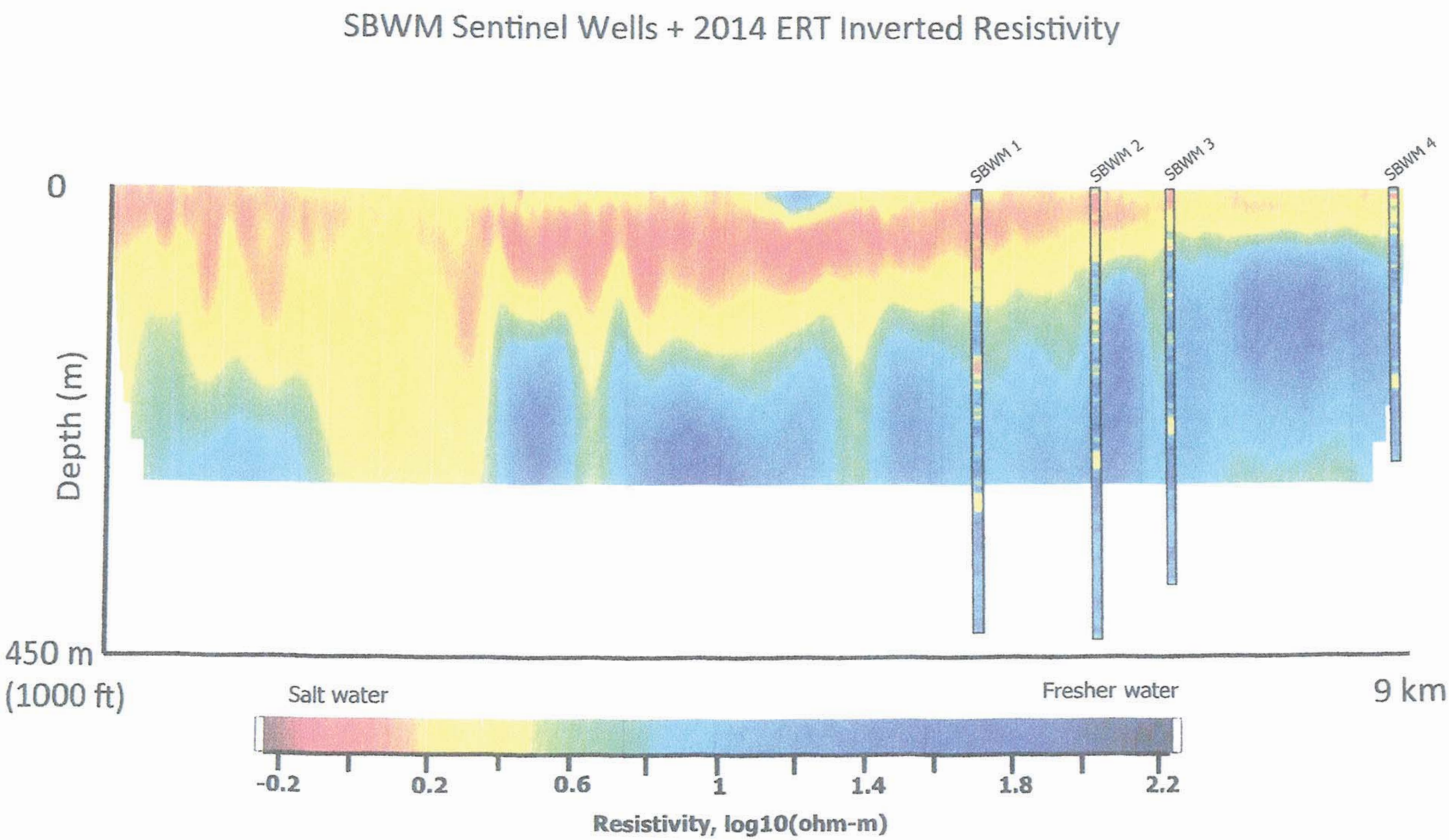


Shows the distribution of saltwater and freshwater to a depth of ~500 ft.



SLIIDE FROM R.KNIGHT
Pidlisecky, Moran, Hansen, Knight (2015)

Margaret-Anne Coppernoll
Exhibits



SLIIDE FROM R.KNIGHT

Nancy Selfridge – Letter 1
Attachment

[redacted]

Statement of Qualifications

Prepared For:

Moss Landing Commercial Park
157 Grand Ave Ste 108
Pacific Grove, CA 93950-2752

We Build Savings

400
2014 Top Solar Contractors

COMMERCIAL REGIONAL TOP PRODUCER
SUNPOWER

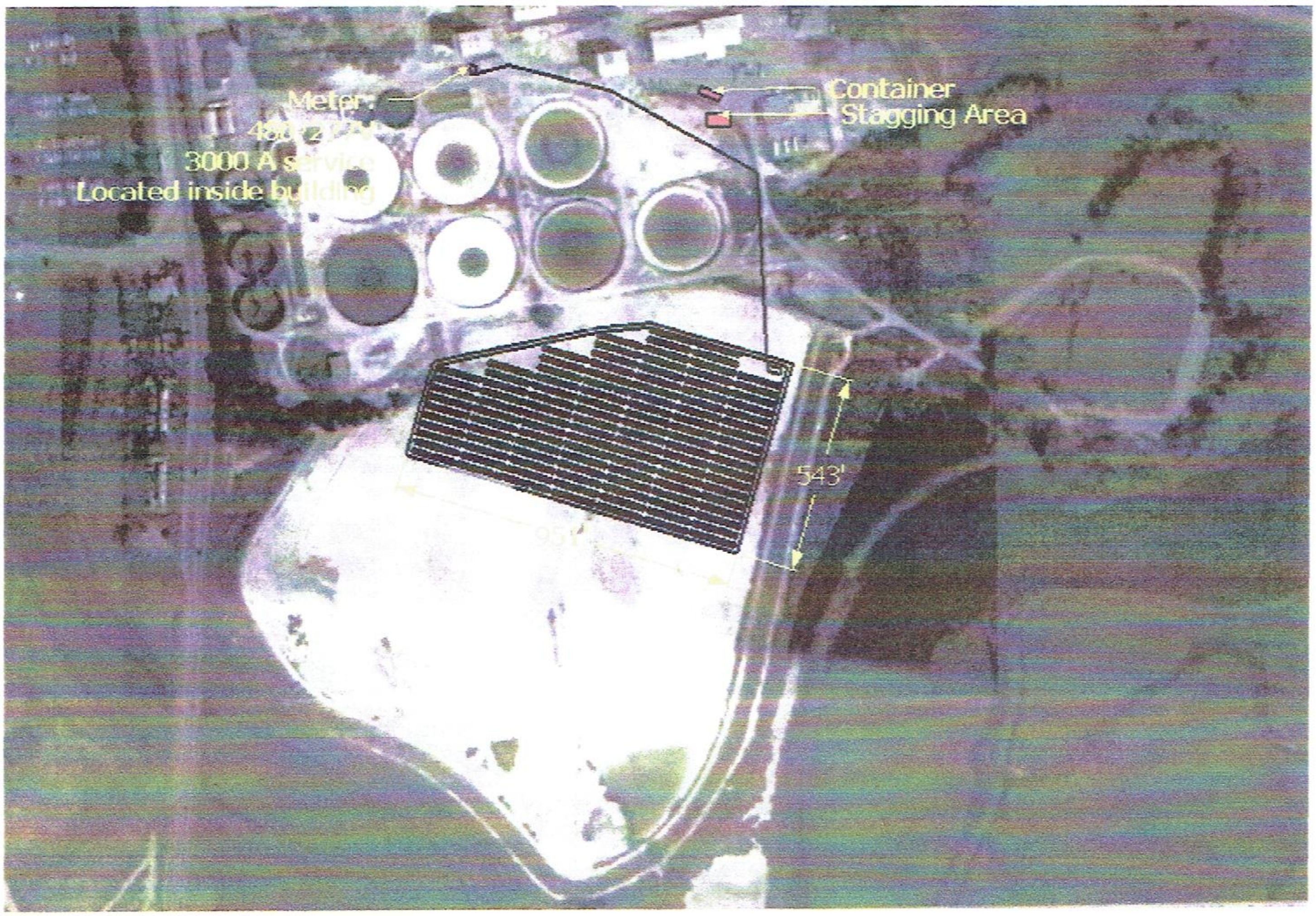
SUNPOWER | 2012

SILICON VALLEY'S TOP SOLAR INSTALLERS
Vista Solar
#3

Nancy Selfridge – Letter 1
Attachment

System Description

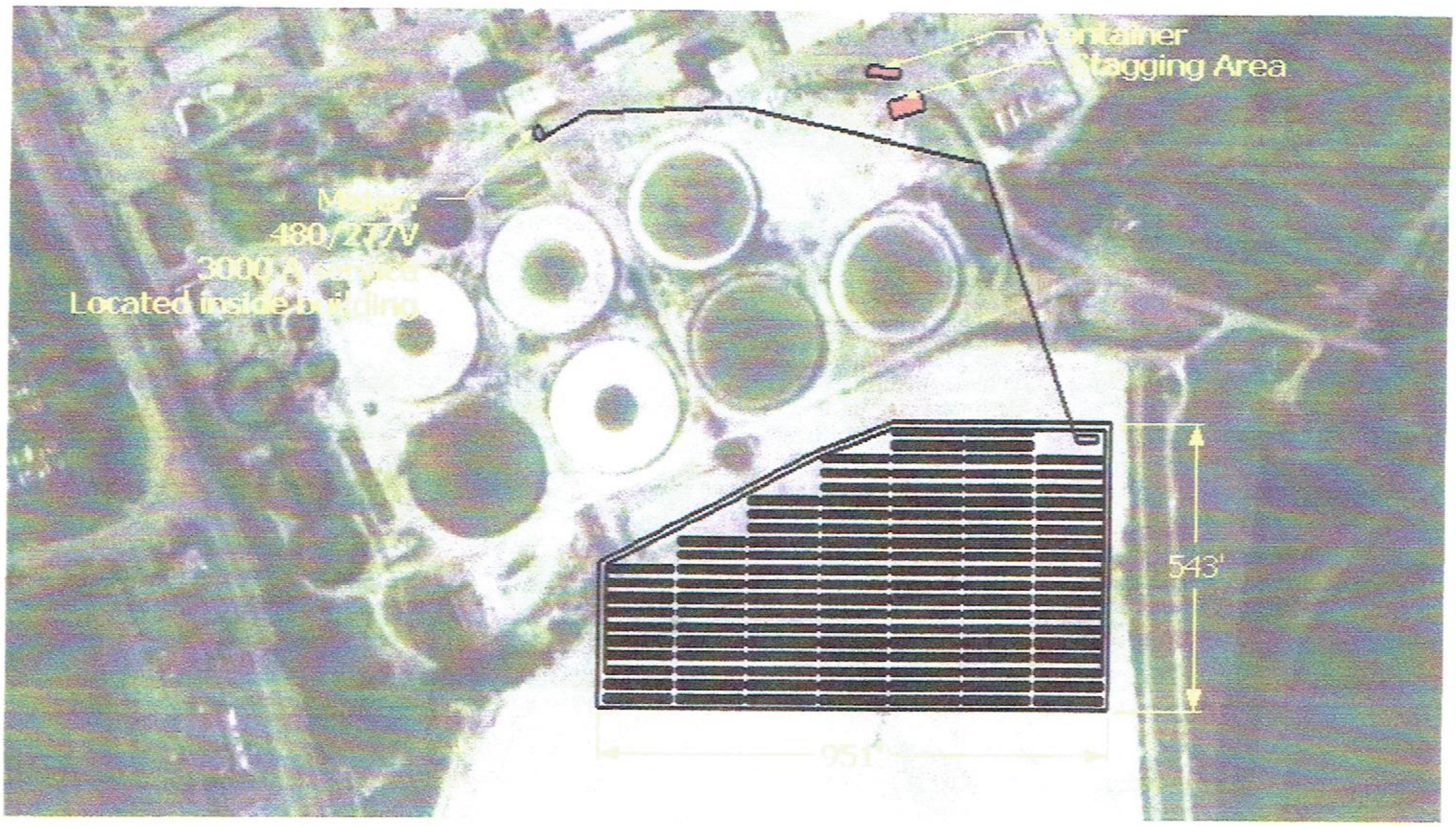
[redacted]



Nancy Selfridge – Letter 1
Attachment

System Description

[redacted]



4.18 Energy Conservation

This section presents the impacts of the proposed project related to energy use and conservation. Existing energy supply sources and energy use in Monterey County and California as a whole are discussed. Regulatory requirements pertaining to energy use and conservation are described. Mitigation measures are prescribed to avoid or reduce the inefficient, wasteful, and unnecessary energy consumption associated with project implementation.

CEQA § 21100(b) requires evaluation of the potential energy impacts of a proposed project, and consideration of mitigation measures that would avoid or reduce the wasteful, inefficient, and unnecessary consumption of energy associated with the project. Appendix F of the CEQA Guidelines provides three goals for energy conservation:

- Decrease overall per capita energy consumption;
- Decrease reliance on natural gas and oil; and
- Increase reliance on renewable energy sources.

In addition, Appendix F of the CEQA Guidelines indicates that EIRs may include consideration of the following six energy conservation-related environmental impact types:

1. The project's energy requirements and its energy use efficiencies by amount and fuel type for each stage of the project including construction, operation, maintenance and/or removal. If appropriate, the energy intensiveness of materials may be discussed.
2. The effects of the project on local and regional energy supplies and on requirements for additional capacity.
3. The effects of the project on peak and base period demands for electricity and other forms of energy.
4. The degree to which the project complies with existing energy standards.
5. The effects of the project on energy resources.
6. The project's projected transportation energy use requirements and its overall use of efficient transportation alternatives.

With regard to NEPA, the Council on Environmental Quality (CEQ) regulations 40 CFR 1502.16(e) require analysis of "energy requirements and conservation potential of various alternatives and mitigation measures."

fuel economy standards. The project would be consistent with the Act because all passenger cars and light trucks that would be used directly or indirectly associated with the project would be required to comply with the applicable fuel economy standards.

Energy Policy Act of 2005

The Energy Policy Act of 2005 seeks to reduce reliance on non-renewable energy resources and provide incentives to reduce current demand on these resources. For example, under the Act, consumers and businesses can obtain federal tax credits for fuel-efficient appliances and products, including buying hybrid vehicles, building energy-efficient buildings, and improving the energy efficiency of commercial buildings. Additionally, tax credits are available for the installation of qualified fuel cells, stationary microturbine power plants, and solar power equipment. It is unknown whether or not CalAm will attempt to obtain any federal tax credits associated with the project under the Energy Policy Act of 2005.

4.18.2.2 State Regulations

California Coastal Act

The California Coastal Act (Public Resources Code Section 30000 et seq.) was enacted by the State Legislature in 1976 to provide long-term protection of the State's 1,100-mile coastline for the benefit of current and future generations. The Coastal Act provides for the long-term management of lands within California's coastal zone boundary, as established by the Legislature and defined in Coastal Act (Section 30103). The width of the coastal zone varies across the State, extending inland a couple hundred feet in some locations to 5 miles in others, and offshore out to 3 miles. A map of the coastal zone in the project vicinity is shown in **Figure 4.8-1**.

The Coastal Act includes specific policies for management of natural resources and public access within the coastal zone (see Division 20 of the Public Resources Code). Of primary relevance to energy conservation is a Coastal Act policy concerning minimizing adverse impacts by requiring new development to minimize energy consumption and vehicle miles traveled. A preliminary assessment of project consistency with these priorities is provided below. Final determinations regarding project consistency are reserved for the Coastal Commission.

With respect to minimizing energy consumption and vehicle miles traveled, MPWSP construction will be consistent with Coastal Act policies. The proposed project would be required to comply with State and local regulations regarding energy efficiency and would be designed to maximize energy efficiency and minimize energy consumption. With respect to vehicle miles travelled, the proposed project would result in both short-term and long-term increases in traffic on regional and local roadways. However these increases would be reduced with the implementation of mitigation.

State of California Integrated Energy Policy

In 2002, the Legislature passed Senate Bill 1389, which required the California Energy Commission (CEC) to develop an integrated energy plan every 2 years for electricity, natural gas, and transportation fuels, for the California Energy Policy Report. The plan calls for the state to assist in the transformation of the transportation system to improve air quality, reduce congestion, and increase the efficient use of fuel supplies with the least environmental and energy costs. To further this policy, the plan identifies a number of strategies, including assistance to public agencies and fleet operators in implementing incentive programs for Zero Emission Vehicles and their infrastructure needs, and encouragement of urban designs that reduce vehicle miles traveled and accommodate pedestrian and bicycle access.

The CEC adopted the 2013 Integrated Energy Policy Report on February 20, 2014. The 2013 Integrated Energy Policy Report provides the results of the CEC's assessment of a variety of issues, including: ensuring that the state has sufficient, reliable, and safe energy infrastructure to meet current and future energy demands; monitoring publicly-owned utilities' progress toward achieving 10-year energy efficiency targets; defining and including zero-net-energy goals in state building standards; overcoming challenges to increased use of geothermal heat pump/ground loop technologies and procurement of biomethane; using demand response to meet California's energy needs and integrate renewable technologies; removing barriers to bioenergy development; planning for California's electricity infrastructure needs given potential retirement of power plants and the closure of the San Onofre Nuclear Generating Station; estimating new generation costs for utility-scale renewable and fossil-fueled generation; planning for new or upgraded transmission infrastructure; monitoring utilities' progress in implementing past recommendations related to nuclear power plants; tracking natural gas market trends; implementing the Alternative and Renewable Fuel and Vehicle Technology Program; addressing the vulnerability of California's energy supply and demand infrastructure to the effects of climate change; and planning for potential electricity system needs in 2030 (CEC, 2013a). Although the integrated energy plan is not directly applicable to the project given that the project would not include utility-scale energy generation or transmission infrastructure, it is applicable to the operations of PG&E, which is the public utility that would provide the required electricity for the project. Given that PG&E is required to comply with the applicable provisions of the integrated energy plan, electricity obtained for the project would be generated in a manner consistent with the spirit of the integrated energy plan.

Title 24 Building Energy Efficiency Standards (California Energy Code)

The California Building Standards Commission first established Energy Efficiency Standards for California in 1978, in response to a legislative mandate to reduce California's energy consumption. The standards, which are contained in the California Code of Regulations, Title 24, Part 6 (also known as the California Energy Code) are updated periodically by the CEC to allow consideration and possible incorporation of new energy efficiency technologies and methods. The standards regulate energy consumed in nonresidential buildings for heating, cooling, ventilation, water heating, and lighting (CEC, 2013b). Title 24 is implemented through the local planning and permit process and therefore project components requiring building permits would be required to comply with Title 24. Title 24 is updated approximately every 3 years. The newest version was adopted in January 2016, and continues to improve upon the standards for new construction of, and additions and alterations to, residential and nonresidential buildings (CEC, 2016f and 2016g). All heating, cooling, ventilation, water heating, and lighting systems in buildings developed as part of the project would be required to incorporate the applicable standards of Title 24. The project would be required to be consistent with Title 24 Building Energy Efficiency Standards.

California Green Building Standards Code (Cal Green)

On January 1, 2014, the California Building Standards Commission adopted the California Green Building Standards Code (Part 11 of the Title 24 Building Standards Code) for all new construction statewide (CBSC, 2014). The code sets targets for energy efficiency, water consumption, dual plumbing systems for potable and recyclable water, diversion of construction waste from landfills, and use of environmentally sensitive materials in construction and design, including eco-friendly flooring, carpeting, paint, coatings, thermal insulation, and acoustical wall and ceiling panels. The code identifies non-residential mandatory measures regarding site selection, building design, building siting and development to protect, restore, and enhance the environmental quality of the site and respect the integrity of adjacent properties. The proposed project would be required to incorporate the applicable provisions of the California Green Building Standards Code and would therefore be consistent with this set of regulations.

4.18.2.3 Applicable Regional and Local Land Use Plans, Policies, and Regulations

Table 4.18-2 presents the state, regional, and local land use plans, policies, and regulations pertaining to energy conservation that are relevant to the MPWSP and that were adopted for the purpose of avoiding or mitigating an environmental effect. **Table 4.18-2** also indicates project consistency with such plans, policies, and regulations. The analysis concludes that the proposed project would not conflict with the applicable plans, policies, or regulations, and no further discussion is provided.

Nancy Selfridge – Letter 1 Attachment

TABLE 5.6-1 (Continued)
ALTERNATIVES IMPACT SUMMARY

Impact	Proposed Action 10 Slant Wells at CEMEX	No Action	Alt. 1: Slant Wells at Potrero Road	Alt. 2: Open Water Intake at Moss Landing	Alt. 3: Deep Water Desal	Alt. 4: People's Project	Alt. 5: Reduced Size Desal
Section 4.18: Energy Conservation							
Impact 4.18-1: Use large amounts of fuel and energy in an unnecessary, wasteful, or inefficient manner during construction.	LSM	NI ↓	LSM ↑	LSM ↑	LSM ↑	LSM ↑	5a: LSM ↓ 5b: LSM ↑
Impact 4.18-2: Use large amounts of fuel and energy in an unnecessary, wasteful, or inefficient manner during operations.	LS	NI ↓	LS ↑	LS ↑	LS ↑	LS ↑	LS ↓
Impact 4.18-3: Constrain local or regional energy supplies, require additional capacity, or affect peak and base periods of electrical demand during operations.	LS	NI ↓	LS ↑	LS ↑	SU ↑	LS ↑	LS ↓
Impact 4.18-C: Cumulative impacts related to Energy Resources.	LSM	NI ↓	LSM ↑	LSM ↑	SU ↑	LSM ↑	5a: LSM ↓ 5b: LSM ↓
Section 4.19: Population and Housing							
Impact 4.19-1: Induce substantial population growth directly during project construction.	LS	NI ↓	LS =	LS =	LS =	LS =	LS =
Impact 4.19-2: Induce substantial population growth directly during project operations.	LS	NI ↓	LS =	LS =	LS =	LS =	LS =
Impact 4.19-C: Cumulative impacts related to Population and Housing.	LS	NI ↓	LS =	LS =	LS =	LS =	LS =
Section 4.20 Socioeconomics and Environmental Justice							
Impact 4.20-1: Reductions in the rate of employment, total income, or business activity in Monterey County.	LSM	SU ↑	LSM =	LSM =	LSM =	LSM =	LSM =
Impact 4.20-2: Disproportionately high and adverse effects on low-income or minority populations.	LS	SU ↑	LS =	LS ↓	SU ↑	SU ↑	LS ↓
Impact 4.20-C: Cumulative impacts related to Socioeconomics and/or Environmental Justice.	LSM	SU ↑	LSM =	LSM =	SU ↑	SU ↑	LSM ↓

Nancy Selfridge – Letter 1
Attachment

5.5.18 Energy Conservation

The evaluation criteria for Energy Conservation address: use of large amounts of fuel and energy in an unnecessary, wasteful, or inefficient manner during construction and decommissioning; use of large amounts of fuel and energy in an unnecessary, wasteful, or inefficient manner during operations and maintenance; and, constrain local or regional energy supplies, require additional capacity, or affect peak and base periods of electrical demand during operations.

5.5.18.1 Setting/Affected Environment

The setting/affected environment for alternatives is the same as described for the proposed project in Section 4.18, Energy Conservation, and the reader is referred to that section for a detailed description.

5.5.18.2 Direct and Indirect Effects of Proposed Project (Slant Wells at CEMEX)

Impact 4.18-1: Use large amounts of fuel and energy in an unnecessary, wasteful, or inefficient manner during construction and decommissioning.

Construction of the proposed project (and decommissioning) would require the use of fuels for operation of heavy construction equipment (e.g., dozers, excavators, and trenchers), construction vehicles (e.g., dump and delivery trucks), and construction worker vehicles. Operation of some construction equipment (e.g., welding machines and electric power tools) would require the use of electricity. Construction (and decommissioning) would also result in indirect energy use associated with the extraction, manufacturing, and transportation of raw materials to make construction materials.

Construction (and decommissioning) activities could result in wasteful or inefficient use of energy if equipment is not well maintained, if equipment is left to idle when not in use, or if haul trips are not planned efficiently. The potential to use large amounts of fuel or energy in a wasteful manner is considered a significant impact. However, implementation of **Mitigation Measures 4.18-1 (Construction Equipment Efficiency Plan)** and **4.10-1c (Idling Restrictions)** would reduce the impact to a less-than-significant level.

Impact 4.18-2: Use large amounts of fuel and energy in an unnecessary, wasteful, or inefficient manner during operations and maintenance.

Operation and maintenance of the proposed project would result in the consumption of fuel for CalAm staff commute trips to and from the MPWSP Desalination Plant, and vehicle trips associated with routine maintenance and operations. Project operations would also result in the consumption of electricity to operate the MPWSP Desalination Plant (i.e., reverse osmosis [RO] modules, pumps, lighting, process controls, heating, ventilation, and air conditioning [HVAC] systems) and other proposed facilities (i.e., ASR Pump Station, Carmel Valley Pump Station, etc.). Although implementation of the proposed project would result in a substantial increase in electrical power demand (63,164 MWh/year minus a baseline energy use of 11,466 MWh/year equals a net increase of 51,698 MWh/year), the use of energy for operation of the MPWSP

Desalination Plant is necessary because it would provide a reliable supply of water to meet existing demand for the Monterey District. Therefore, electricity consumed as a result of project operations would not be wasteful or inefficient and the impact related to the use of fuel and energy during project operations would be less than significant.

Impact 4.18-3: Constrain local or regional energy supplies, require additional capacity, or affect peak and base periods of electrical demand during operations.

Implementation of the proposed project would increase CalAm's total electrical demand by an amount that would represent approximately two percent of the County's electricity usage in 2014. The preliminary review of the proposed project's annual and maximum electrical demand by the electricity provider, Pacific Gas and Electric (PG&E), has indicated that PG&E has adequate capacity and infrastructure to support the proposed project. Therefore, this impact would be less than significant.

Impact 4.18-C: Cumulative impacts related to energy conservation.

Implementation of mitigation would ensure that the proposed project construction activities would be conducted in a fuel-efficient manner. Idling times would be limited for construction equipment and vehicles to ensure that energy waste and inefficiency would be minimized. The cumulative use of energy resources during construction would be consistent with normal construction practices and would comply with efficiency- and conservation-related policies intended to address cumulative energy consumption statewide. Implementation of **Mitigation Measures 4.18-1 (Construction Equipment Efficiency Plan)** and **4.10-1c (Idling Restrictions)** would reduce the cumulative impact to a less-than-significant level.

During project operation, the anticipated increase in electricity consumption for the proposed project would represent approximately 2 percent of Monterey County's annual usage, and an even smaller fraction of PG&E's overall service area usage. In the event that other cumulative projects listed in **Table 4.1-2** that would be high demand electricity users, such as the Monterey Bay Regional Water Project (DeepWater Desal, No. 34), which would require 25 times the amount of energy, request electrical service from PG&E, additional wholesale electric energy may need to be purchased by PG&E. This would be considered a significant impact. In addition, some reinforcement of the existing distribution system may also be required, but this would not substantially constrain local or regional energy supplies. However, the proposed project would not have a cumulatively considerable contribution to this significant cumulative impact associated with the unnecessary, wasteful, or inefficient use of energy, or with energy supply, either at a local or regional level, during operation.

5.5.18.3 Direct and Indirect Effects of No Project Alternative

Under the No Project Alternative, no new facilities would be constructed or operated. Consequently, there would be no construction-related energy use associated with the No Project Alternative. Under the No Project Alternative, there would be less pumping from the Carmel River, resulting in a decrease in the use of energy. Because the No Project Alternative would have regional level, during operation. Overall, Alternative 3 would result in an ***increased impact conclusion*** compared to the proposed project, significant and unavoidable.

5.5.18.7 Direct and Indirect Effects of Alternative 4 – People's Moss Landing Water Desalination Project (People's Project)

Alternative 4 includes the construction and operation of an open ocean intake, a brine discharge system and pipelines, and supporting ballast rock located on the seafloor in Monterey Bay within MBNMS, as well as a 12 mgd desalination plant and associated facilities to provide 13,400 afy of water supply to meet the current and future needs of the Monterey Peninsula. Several components would be identical to the proposed project: the new Transmission Main, new desalinated water pipeline south of the "Connection to CalAm" Point on **Figure 5.4-4**, ASR-5 and -6 wells and ASR pipeline, Highway 68 interconnection improvements, and Carmel Valley Pump Station would be as described in Chapter 3, Description of the Proposed Project. Because this alternative would have an open water intake that would eliminate the need for returning source water drawn from the Salinas Valley Groundwater Basin, the Castroville Pipeline, Pipeline to CSIP Pond, and operational components related to delivering water to CCSD would not be implemented. The desalination plant, open water intake system, brine discharge system, and the additional 6.5 miles of desalinated water pipeline are the components unique to Alternative 4 (see **Figure 5.4-4**). Therefore, the impact analysis of Alternative 4 focuses primarily on these components; however, impact conclusions are made for the whole of Alternative 4.

Construction Effects

Construction of Alternative 4 would require the use of marine construction equipment (e.g., barges) and HDD equipment for the new open-water intake and new outfall, and there would be an increase in gasoline and diesel fuel use compared to the proposed project resulting in a potentially significant impact. Implementation of **Mitigation Measures 4.18-1 and 4.10-1b** would reduce the significant impact to a less-than-significant level. Alternative 4 would have the ***same impact conclusion*** as the proposed project, less than significant with mitigation.

Operational Effects

Long-term operations of the People's Project would produce approximately 25 percent more product water that would require an approximately 25 percent increase in energy demand compared to the proposed project. In addition, the electricity used would be less efficient given the longer distance to pump product water to CalAm's Monterey District service area compared the proposed project. However, the additional electricity required would not be a large amount of energy compared to the energy supplies in the County and would be accommodated by the local and regional energy supplies. The long-term consumption of fuel required for worker commute trips and vehicle trips associated with routine maintenance would be the same as the proposed project. Overall, Alternative 4 would have the ***same impact conclusion*** as the proposed project, less than significant.

Cumulative Analysis

Cumulative impacts associated with energy and energy conservation during construction and decommissioning would be the same as those described for the proposed project. Alternative 4 would have a cumulatively considerable contribution to a significant cumulative impact on the supply and/or availability of fuel sources during construction and decommissioning; however, the incremental contribution would be reduced to less than significant with implementation of **Mitigation Measures 4.18-1** (**Construction Equipment Efficiency Plan**) and **4.10-1b** (**Idling Restrictions**) to ensure construction activities would be conducted in a fuel-efficient manner.

Although operation would result in long-term consumption of substantial amounts of electricity, the anticipated increase in electricity consumption for Alternative 4 would represent small percentages of Monterey County's annual usage and PG&E's overall service area usage. In the event that other cumulative projects, such as the DeepWater Desal Project (No. 34 in **Table 4.1-2** in Section 4.1) and GWR Project (No. 59), request electrical service from PG&E, additional wholesale electric energy may need to be purchased by PG&E. For example, the increase in energy required to operate the Deep Water Desal co-located data center would be significant; the efficiency of the data center and the associated cooling system is currently unknown and the impact would likely be significant and unavoidable. In addition, some reinforcement of the existing distribution system may also be required for the DeepWater Desal Project, but this would not substantially constrain local or regional energy supplies. For the same reasons described for Alternative 1, Alternative 4 would not have a considerable contribution to a significant cumulative impact associated with the unnecessary, wasteful, or inefficient use of energy, or with energy supply, either at a local or regional level, during operation and maintenance. Overall, Alternative 4 would result in an ***increased impact conclusion*** compared to the proposed project, significant and unavoidable.

5.5.18.8 Direct and Indirect Effects of Alternative 5 – Reduced Desal Project 5a (CEMEX) and 5b (Potrero Road)

Alternative 5a would include the seawater intake system at the CEMEX site (the same location as the proposed project), but would include only seven subsurface slant wells (the converted test well and six new wells) and the same source water pipeline as the proposed project. Alternative 5b would include seven new wells at the western end of Potrero Road (the same location as Alternative 1) and the same source water pipeline as Alternative 1. Both Alternatives 5a and 5b would include a reduced-capacity desalination plant (6.4 mgd), and all other components would be the same as the proposed project.

Construction Effects

The facilities that would be constructed under Alternative 5a would be the same as those constructed under the proposed project, but there would be three fewer slant wells than under the proposed project. There would be an overall decrease in gasoline and fuel use during construction under Alternative 5a compared to the proposed action. With implementation of **Mitigation Measures 4.18-1** and **4.10-1b,** the significant impact would be reduced to a less-than-significant level. Therefore, Alternative 5a would have the ***same impact conclusion*** as the proposed project, None of the alternatives would avoid all of the above-listed significant unavoidable impacts of the proposed project and several alternatives would result in additional significant impacts, as noted below. There would be tradeoffs in impacts on terrestrial biological resources due to the differences in locations of alternative components. All of the action alternatives would result in significant and unavoidable construction noise, air quality and GHG emissions impacts, including from temporary cumulatively considerable contributions to health effects on sensitive receptors, similar to the proposed project and in some cases, more severe than the proposed project.

5.6.1.3 Key Impact Differences Between Alternatives

The following discussion summarizes key differences in the significant environmental impacts among the alternatives and the proposed project, including consideration of resource impacts that are of particular importance to MBNMS.

Three of the alternatives would use screened, open water intakes, which would reduce or avoid several proposed project impacts but result in new significant impacts. These alternatives would have similar or increased impacts compared to the proposed project with regard to air quality, GHG, traffic and noise. The key differences in impacts pertaining to open water intakes included in Alternative 2 (Open-Water Intake at Moss Landing), Alternative 3 (DeepWater Desal Project), and Alternative 4 (People's Project), compared to the proposed project include:

- The construction of a new open water intakes would require the use of barges and other activities in the waters of MBNMS, including the placement of ballast rock on the seafloor, and could result in temporary and permanent direct and indirect effects on marine habitat and associated marine biological resources, as well as historical resources (i.e., shipwrecks) in Monterey Bay, resulting in significant and unavoidable impacts.
- The construction and operation of new intake facilities, located within a ravine of the Monterey Submarine Canyon, could result in temporary and permanent direct and indirect effects due to unstable slopes and the potential for landslides on the seafloor as well as alteration of the seafloor and oceanic processes such as sediment transport, resulting in potentially significant impacts.
- Operation of screened open-water intakes would result in long-term direct and indirect effects on marine biological resources within MBNMS in Monterey Bay as a result of impingement and entrainment, resulting in a significant and unavoidable impact.
- Operation of these open water intake alternatives would avoid less than significant direct or indirect effects on groundwater resources because of the absence of slant well pumping for source water.

The following impacts are unique to Alternative 3 (DeepWater Desal Project) and Alternative 4 (People's Project):

- Due to the proximity of live-aboard boats in Moss Landing Harbor, construction activities would result in exposure of more sensitive receptors to substantial pollutant concentrations from construction equipment emissions, resulting in a significant and unavoidable impact.
- Operation of a new, brine-only outfall (no co-mingling with wastewater or other diluent flows) could result in long-term direct and indirect effects on water quality related to

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increased levels of salinity and concentrations of certain constituents, resulting in a significant and unavoidable impact.

- Each of these alternatives would produce more desalinated water than the proposed MPWSP, resulting in more water being available that would remove an impediment to growth in the three county-region resulting in a significant and unavoidable impact:
  - Alternative 3 (DeepWater Desal) would produce 22 mgd
  - Alternative 4 (People's Project) would produce 12 mgd

The following impacts are unique to Alternative 3 (DeepWater Desal Project):

- Operation of the co-located data center would require the use of substantial quantities of energy that would constrain local or regional supplies and require additional capacity, resulting in a significant and unavoidable impact.
- Operation of emergency generators would use large amounts of fuel in a manner that would be unnecessary and wasteful, resulting in a significant and unavoidable impact.

The following impacts are unique to Alternative 4 (People's Project):

- Construction of the desalination plant could impact (currently unsurveyed) historical resources, resulting in a significant and unavoidable impact.
- Operation and siting of the intake pumping facilities on top of the existing caisson at the existing shoreline could result in long-term direct effects on coastal erosion and scour processes that could expose adjacent properties to coastal flooding and a change in sediment transport, resulting in potentially significant impacts.
- Operation and siting of the desalination plant facilities within a 100-year flood zone could cause long-term direct effects related to redirection of flood flows, resulting in a significant and unavoidable impact.
- Operation and siting of the intake pumping facilities on top of the existing caisson would result in impacts on the visual quality of the shoreline in Moss Landing and interrupt views of MBNMS resources, resulting in potentially significant impacts.

The following impact would be unique to slant well pumping at Potrero Road (Alternative 1 and 5b):

- Operation of the slant wells at Potrero Road for a 6.4 mgd desalination plant (Alternative 5b) would lower groundwater levels in the Dune Sands/Perched-A aquifer in the Moss Landing area; operation of the wells for a 9.6 mgd desalination plant (Alternative 1) would additionally lower groundwater levels in the 180- and 400-Foot aquifers, thereby capturing groundwater that would have otherwise flowed into Elkhorn Slough. The direct and indirect permanent effects on marine and terrestrial biological resources at Elkhorn Slough from the lowering of groundwater levels would result in significant and unavoidable impacts.

For Alternative 3 (DeepWater Desal Project) and Alternative 4 (People's Project), operation of a new, brine-only outfall (no co-mingling with wastewater or other diluent flows) could result in a significant and unavoidable water quality impacts from increased levels of salinity and concentrations of certain other constituents. However, both of these alternatives would produce more desalinated water than the proposed MPWSP, resulting in more water being available that would remove an impediment to and potentially support increase growth in the three county-region. Due to the proximity of live-aboard boats in Moss Landing Harbor, construction activities would result in exposure of more sensitive receptors to substantial pollutant concentrations from construction equipment emissions, resulting in a significant and unavoidable impact.

Alternative 3 (DeepWater Desal Project) may result in significant and unavoidable impacts from energy use from operation of the co-located data center, that would constrain local or regional supplies and require additional capacity. Operation of emergency generators would use large amounts of fuel in a manner that would be unnecessary and wasteful, resulting in a significant and unavoidable impact.

For Alternative 4 (People's Project), Construction of the desalination plant could impact (currently unsurveyed) historical resources, resulting in a significant and unavoidable impact. Operation and siting of the intake pumping facilities on top of the existing caisson at the existing shoreline could result in long-term direct effects on coastal erosion and scour processes that could expose adjacent properties to coastal flooding and a change in sediment transport, resulting in potentially significant impacts. In addition, being within a 100-year flood zone could cause long-term direct effects related to redirection of flood flows, resulting in a significant and unavoidable impact. The intake pumping facilities on top of the existing caisson would result in impacts on the visual quality of the shoreline in Moss Landing and interrupt views of MBNMS resources, resulting in potentially significant impacts.

For (Alternative 1 and 5b), operation of the slant wells at Potrero Road, Alternative 5b would lower groundwater levels in the Dune Sands/Perched-A aquifers in the Moss Landing area; operation of Alternative 1 would additionally lower groundwater levels in the 180- and 400-foot aquifers, thereby capturing groundwater that would have otherwise flowed into Elkhorn Slough. The direct and indirect permanent effects on marine and terrestrial biological resources at Elkhorn Slough from the lowering of groundwater levels would result in significant and unavoidable impacts.

ES.7.2 Environmentally Superior/Environmentally Preferred Alternative

This EIR/EIS identifies Alternative 5a as the environmentally superior/environmentally preferred alternative, assuming implementation of the GWR Project. While the combined Alternative 5a and GWR Project would result in a larger physical footprint than the proposed project alone, the pairing of Alternative 5a and the GWR project would result in reduced operational energy use, reduced GHG emissions, and reduced effects on groundwater levels influenced by fewer slant wells and less volume of pumping, compared to the proposed project. The GWR project would

TABLE ES-1
ALTERNATIVES IMPACT SUMMARY

Impact	Proposed Action 10 Slant Wells at CEMEX	No Action	Alt. 1: Slant Wells at Potrero Road	Alt. 2: Open Water Intake at Moss Landing	Alt. 3: Deep Water Desal	Alt. 4: People's Project	Alt. 5: Reduced Size Desal
Section 4.2: Geology, Soils, and Seismicity							
Impact 4.2-1: Substantial soil erosion or loss of topsoil during construction.	LSM	NI ↓	LSM ↑	LSM ↑	LSM ↑	LSM ↑	LSM ↓
Impact 4.2-2: Exposure of people or structures to substantial adverse effects related to fault rupture.	LS	NI ↓	LS =	LS =	LS =	LS =	LS =
Impact 4.2-3: Exposure of people or structures to substantial adverse effects related to seismically-induced groundshaking.	LS	NI ↓	LS =	LS =	LS =	LS =	LS =
Impact 4.2-4: Exposure of people or structures to substantial adverse effects related to seismically-induced ground failure, including liquefaction, lateral spreading, or settlement.	LS	NI ↓	LS =	LS =	LS =	LS =	LS =
Impact 4.2-5: Exposure of people or structures to substantial adverse effects related to landslides or other slope failures.	LS	NI ↓	LS =	LS =	LS =	LS =	LS =
Impact 4.2-6: Exposure of people or structures to substantial adverse effects related to expansive soils.	LS	NI ↓	LS =	LS =	LS =	LS =	LS =
Impact 4.2-7: Exposure of structures to substantial adverse effects related to corrosive soils.	LS	NI ↓	LS =	LS =	LS =	LS =	LS =
Impact 4.2-8: Exposure of people or structures to substantial adverse effects related to land subsidence.	NI	NI ↓	NI =	NI =	NI =	NI =	NI =
Impact 4.2-9: Exposure of people or structures to substantial adverse effects related to alternative wastewater disposal systems.	LS	NI ↓	LS =	LS ↓	LS ↓	LS ↓	LS =
Impact 4.2-10: Accelerate and/or exacerbate natural rates of coastal erosion, scour, or dune retreat, resulting in damage to adjoining properties or a substantial change in the natural coastal environment.	LSM	NI ↓	NI ↓	NI ↓	NI ↓	SU ↑	5a: LSM = 5b: NI ↓
Impact 4.2.11: Degrades the physical structure of any geologic resource or alters any oceanographic process, such as sediment transport, that is measurably different from pre-existing conditions.	NI	NI ↓	NI =	SU ↑	SU ↑	SU ↑	NI =
Impact 4.2-C: Cumulative impacts related to Geology, Soils, and Seismicity.	LSM	NI ↓	LSM =	SU ↑	LSM =	SU ↑	LSM =

TABLE ES-1 (Continued)
ALTERNATIVES IMPACT SUMMARY

Impact	Proposed Action 10 Slant Wells at CEMEX	No Action	Alt. 1: Slant Wells at Potrero Road	Alt. 2: Open Water Intake at Moss Landing	Alt. 3: Deep Water Desal	Alt. 4: People's Project	Alt. 5: Reduced Size Desal
Section 4.3: Surface Water Hydrology and Water Quality							
Impact 4.3-1: Degradation of water quality associated with increased soil erosion and inadvertent releases of hazardous chemicals during general construction activities.	LS	NI ↓	LS ↑	LS ↑	SU ↑	SU ↑	LS ↓
Impact 4.3-2: Degradation of water quality from construction-related discharges of dewatering effluent from open excavations and water produced during well drilling and development.	LSM	NI ↓	LSM ↑	LSM =	LSM ↑	LSM ↓	LSM ↓
Impact 4.3-3: Degradation of water quality from discharges of treated water and disinfectant from existing and newly installed pipelines during construction.	LS	NI ↓	LS ↑	LS =	LS ↑	LS ↓	5a: LS = 5b: LS ↑
Impact 4.3-4: Violate water quality standards or waste discharge requirements or degrade water quality from increased salinity as a result of brine discharge from the operation of the MPWSP Desalination Plant.	LSM	NI ↓	LSM =	LSM =	LSM ↑	SU ↑	LSM =
Impact 4.3-5: Violate water quality standards or waste discharge requirements or degrade water quality as a result of brine discharge from the operation of the MPWSP Desalination Plant.	LSM	NI ↓	LSM =	LSM =	LSM ↑	SU ↑	LSM =
Impact 4.3-6: Degradation of water quality due to discharges associated with maintenance of the subsurface slant wells and the ASR -5 and ASR-6 Wells.	LS	NI ↓	LS =	LS ↑	LS ↑	LS ↑	LS ↓
Impact 4.3-7: Alteration of drainage patterns such that there is a resultant increase in erosion, siltation, or the rate or amount of surface runoff.	LS	NI ↓	LS ↓	LS ↓	LS ↑	LS ↓	LS =
Impact 4.3-8: Alteration of drainage patterns such that there is an increase in flooding on- or offsite or the capacity of the stormwater drainage system is exceeded.	LS	NI ↓	LS ↑	LS ↓	LS ↑	LS ↓	LS ↓
Impact 4.3-9: Impedance or redirection of flood flows due to the siting of project facilities in a 100-year flood hazard area.	LS	NI ↓	LS ↓	LS =	LS ↓	SU ↑	5a: LS = 5b: LS ↓
Impact 4.3-10: Exposure of people or structures to a significant risk of loss, injury, or death from flooding due to a tsunami.	LS	NI ↓	LS ↓	LS =	LS ↓	SU ↑	LS =
Impact 4.3-11: Exposure of people or structures to a significant risk of loss, injury, or death from flooding due to sea level rise.	LS	NI ↓	LS ↓	LS =	LS ↓	SU ↑	LS =
Impact 4.3-C: Cumulative impacts related to Surface Water Hydrology and Water Quality.	LSM	NI ↓	LSM =	LSM =	SU ↑	SU ↑	LSM =

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TABLE ES-1 (Continued)
ALTERNATIVES IMPACT SUMMARY

Impact	Proposed Action 10 Slant Wells at CEMEX	No Action	Alt. 1: Slant Wells at Potrero Road	Alt. 2: Open Water Intake at Moss Landing	Alt. 3: Deep Water Desal	Alt. 4: People's Project	Alt. 5: Reduced Size Desal
Section 4.13: Public Services and Utilities (cont.)							
Impact 4.13-4: Exceed wastewater treatment requirements of the Central Coast RWQCB, or result in a determination by the wastewater treatment provider that it has inadequate treatment or outfall capacity to serve the project.	LSM	NI ↓	LSM =	LSM =	LS ↓	LS ↓	LSM =
Impact 4.13-5: Increased corrosion of the MRWPCA outfall and diffuser as a result of brine discharge associated with project operations.	LSM	NI ↓	LSM =	LSM =	NI ↓	NI ↓	LSM =
Impact 4.13-C: Cumulative impacts related to Public Services and Utilities.	LSM	NI ↓	LSM =	LSM =	LSM ↓	LSM ↓	LSM =
Section 4.14: Aesthetic Resources							
Impact 4.14-1: Construction-related impacts on scenic resources (vistas, roadways, and designated scenic areas) or the visual character of the project area and its surroundings.	LS	NI ↓	LS =	LS =	LS =	LSM ↑	LS =
Impact 4.14-2: Temporary sources of substantial light or glare during construction.	LSM	NI ↓	LSM ↑	LSM ↑	LSM ↑	LSM ↑	LSM =
Impact 4.14-3: Permanent impacts on scenic resources (vistas, roadways, and designated scenic areas) or the visual character of the project area and its surroundings.	LSM	NI ↓	LSM =	LSM ↓	LSM ↓	LSM =	LSM =
Impact 4.14-4: Permanent new sources of light or glare.	LSM	NI ↓	LSM =	LSM =	LSM ↑	LSM ↑	LSM =
Impact 4.14-C: Cumulative impacts related to Aesthetic Resources	LSM	NI ↓	LSM =	LSM =	LSM =	LSM =	LSM =
Section 4.15: Cultural and Paleontological Resources							
Impact 4.15-1: Cause a substantial adverse change in the significance of a historical resource as defined in Section 15064.5 of the CEQA Guidelines or historic properties pursuant to 36 CFR 800.5 during construction.	NI	NI =	NI =	NI =	NI =	SU ↑	NI =
Impact 4.15-2: Cause a substantial adverse change during construction in the significance of an archaeological resource pursuant to Section 15064.5 of the CEQA Guidelines or historic properties pursuant to 36 CFR 800.5.	LSM	NI ↓	LSM ↑	LSM ↑	LSM ↑	LSM ↑	5a: LSM = 5b: LSM ↑
Impact 4.15-3: Directly or indirectly destroy a unique paleontological resource or site, or unique geological feature during construction.	LS	NI ↓	LS ↑	LS ↑	LS ↑	LS ↑	5a: LS = 5b: LS ↑

provide water to growers that would benefit the groundwater basin. In addition, Alternative 5a paired with the GWR project, would be consistent with the 2016 California Action Plan seeking integrated water supply solutions, the Governor's drought proclamations, the CPUC Water Action Plan goal of promoting water infrastructure investment, and the Ocean Plan and MBNMS Desalination Guidelines.

ES.8 Areas of Controversy and Issues to be Resolved

Pursuant to Section 15123(b)(1) of the state CEQA Guidelines and NEPA regulations (40 CFR 1502.12), an EIR/EIS shall identify areas of controversy known to the lead agency including issues raised by agencies and the public and the issues to be resolved (including the choice among alternatives and whether or how to mitigate the significant effects).

The following areas of controversy and issues to be resolved were raised through the scoping and public meetings conducted in association with circulation of the NOP and NOI, as well as comments submitted on the 2015 MPWSP Draft EIR.

- **Demand to be Met by the Proposed Project and Desalination Plant Sizing**

  Comments were received advocating that the desalination plant be sized to provide supply to replace the portions of CalAm's existing Carmel River and Seaside Groundwater Basin supplies that have been constrained by legal decisions (in compliance with SWRCB Orders 95-10 and 2009-0060 and the adjudication of the Seaside Groundwater Basin) to meet current service area demand only. Other comments expressed support for sizing the plant to accommodate differing degrees of additional future demand (e.g., demand associated with the development of vacant legal lots of record, demand associated with full general plan buildout, etc.). Chapter 2, Water Demand, Supplies, and Water Rights, discusses existing service area demand and supplies and the level of demand the MPWSP proposes to meet, and Section 6.3, Growth-Inducing Impacts, evaluates the growth inducement potential of the water supply proposed to be provided by the MPWSP.

- **Groundwater Modeling, Impacts and Water Rights**

  CalAm's proposed use of subsurface slant wells to withdraw source water for the MPWSP Desalination Plant is the subject of two controversies: (1) whether CalAm has the legal right to extract groundwater from the Salinas Valley Groundwater Basin (SVGB); and (2) whether implementation of the MPWSP and operation of the subsurface slant wells would exacerbate seawater intrusion in the SVGB. The proposed subsurface slant wells at CEMEX would extend offshore and be screened in aquifer units of the SVGB that have long been intruded by seawater. Although the subsurface slant wells would draw seawater (i.e., source water for the MPWSP Desalination Plant) from beneath the ocean floor, a fraction of the source water would be drawn from inland portions of the SVGB.

  In 2012, the CPUC asked the SWRCB to provide an opinion regarding whether CalAm has the legal right to extract source water for the MPWSP Desalination Plant from offshore aquifers of the SVGB. The SWRCB has indicated that for CalAm to appropriate begun to address allocation of the proposed MPWSP supply, this analysis assumes that the same considerations that informed the past and current allocations will be relevant to the allocation of the MPWSP supply. This EIR/EIS assumes that water provided by the proposed project will be allocated to meet existing demand and that any water left over would be allocated in general proportion to projected growth in the CalAm service area jurisdictions.

2.6 Water Rights

The topic of water rights is not one typically addressed in an EIR/EIS. It is a legal matter that is rarely relevant to the question of whether a proposed project being evaluated under CEQA or NEPA will generate impacts on the environment. Here, however, the issue of water rights is addressed as one of project feasibility.

The proposed project (MPSWP) and Alternative 5a are designed to take supply water from the ocean via underground slant wells that draw water from the earth underneath the ocean. The wells would be located at the western edge of the Salinas Valley Groundwater Basin (SVGB, or the "Basin"), a large basin that extends approximately 100 miles between Monterey Bay (in the northwest) to the Salinas River headwaters (in the southeast). Details concerning the Basin conditions and stratigraphy (geologic conditions) are set forth in Section 4.4, Groundwater Resources, of this EIR/EIS. Particularly because the project supply wells could draw some water from the Basin, concerns have been expressed as to whether CalAm does or will hold legal rights to use the water that would be taken by the slant wells, treated at the desalination plant and supplied to CalAm customers located outside the Basin.

The CPUC is not the arbiter of whether CalAm possesses water rights for the project and nothing in this EIR/EIS should be construed as the CPUC's opinion regarding such rights, except to the extent that the CPUC must determine whether there is a sufficient degree of likelihood that CalAm will possess rights to the water that would supply the desalination plant such that the proposed project can be deemed to be feasible. Indeed, no government agency will formally grant water rights to CalAm for the proposed project. In California, groundwater other than subterranean streams and underflow of surface water is regulated through common law (court cases) rather than through the issuance of permits by government bodies. The SVGB is not an adjudicated groundwater basin, so use of the groundwater in the Basin is not subject to existing court decree, written agreements or oversight by an impartial watermaster.[32] There are three relevant types of groundwater rights: (1) overlying rights whereby those who own land atop the Basin may make reasonable use of groundwater on such land; (2) prescriptive rights whereby a water user has acquired another's rights to use water via an open, adverse and sustained use under a claim of right that such user would otherwise not be entitled to; and (3) appropriative rights whereby the groundwater may be used outside the Basin or for municipal purposes. While CalAm owns 46 acres of land (the proposed desalination plant location) overlying the Basin, that land would not support sufficient water for the

32 An adjudicated groundwater basin is one in which a court has determined the amount of groundwater that each party may extract per year, often based upon studies of the basin and a determination of the safe yield of the basin to sustain it in the long-term. Adjudicated groundwater basins have court-appointed watermasters, who oversee basin operations.

project and would not enable CalAm to use the water beyond the property that it owns. CalAm has no prescriptive groundwater rights in the Basin. Thus, CalAm would take any Basin water for the project via appropriative rights, which are junior to existing appropriations and to overlying users. If the proposed project is approved and any dispute arises as to whether or not CalAm possesses legal water rights, such dispute likely would be resolved through court action. Naturally, however, if CalAm does not have the right to the supply water for the proposed project, the proposed project could not proceed and would thus prove infeasible. This section examines whether, based upon the evidence currently available, the CPUC could conclude that there is a sufficient degree of likelihood that CalAm will possess rights to the water that would supply the desalination plant such that the proposed project can be deemed to be feasible.

Numerous court decisions have enunciated that an EIR for a large scale land use development project must analyze the reasonably foreseeable impacts of supplying water to the project. Such an EIR should show a reasonable likelihood that water will be available from an identified source and must evaluate environmental impacts from likely future water sources to serve the proposed project. Those cases arise in a different context than the MPWSP. Those cases are concerned with whether there will be enough water to support construction of land use projects and to supply the operational needs of the project occupants for drinking, cooking, bathing, waste water, industrial processes, irrigation, etc. Quite conversely, the MPWSP is itself a water supply project, aimed primarily at creating the water supply to replace current water supplies to which CalAm is not legally entitled. From a physical perspective, it is more than reasonably foreseeable that sufficient water is available to supply feedwater for the MPWSP desalination plant. There is knowledge as to where the water will come from and certainty that a sufficient quantity of water will be available. The physical effects of MPWSP's withdrawal of water are fully analyzed in Section 4.4, Groundwater Resources, of this EIR/EIS.

The primary purpose in requiring an EIR to identify the water supply source for a project and to analyze the effects of supplying water to the project is to ensure that land use development projects that will use water are not built without consideration of water supply.[33] Unlike with land use development projects, here, if CalAm did not possess legal rights to use the feedwater for the MPWSP desalination plant, then the desalination plant simply could not operate and the project would not go forward. That is why water rights factors in as a key project feasibility issue.

[33] Numerous court decisions have enunciated that an EIR for a large scale land use development project must analyze the reasonably foreseeable impacts of supplying water to the project. Such an EIR should show a reasonable likelihood that water will be available from an identified source and must evaluate environmental impacts from likely future water sources to serve the proposed project. Those cases arise in a different context than the MPWSP. Those cases are concerned with whether there will be enough water to support construction of land use projects and to supply the operational needs of the project occupants for drinking, cooking, bathing, waste water, industrial processes, irrigation, etc. Quite conversely, the MPWSP is itself a water supply project, aimed primarily at creating the water supply to replace current water supplies to which CalAm is not legally entitled. From a physical perspective, it is more than reasonably foreseeable that sufficient water is available to supply feedwater for the MPWSP desalination plant. There is knowledge as to where the water will come from and certainty that a sufficient quantity of water will be available. The physical effects of MPWSP's withdrawal of water are fully analyzed in Section 4.4, Groundwater Resources, of this EIR/EIS.

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2.6.1 State Water Resources Control Board Report

Questions have been posed in the CPUC's proceeding as to whether CalAm could demonstrate water rights to the MPWSP supply water. Furthermore, as noted above, CalAm's right to the project feedwater is a basic feasibility issue for the project. The SWRCB is the state agency authorized to exercise adjudicatory and regulatory functions in the areas of water rights, water quality and safe and reliable drinking water. By letter dated September 26, 2012, the CPUC asked that the SWRCB assist the CPUC and issue an opinion as to whether CalAm has a credible legal claim to the supply water for the MPWSP. The SWRCB carefully considered the then-available facts and evidence concerning the MPWSP, prepared a draft report on water rights, circulated that draft for public comments and ultimately issued its July 31, 2013, Final Review of California American Water Company's Monterey Peninsula Water Supply Project (Report). The Report is attached to this EIR as **Appendix B2**.

First off, the Report confirms that "Cal-Am needs no groundwater right or other water right to extract seawater from Monterey Bay." Report at 33. Thus, CalAm does not need a water right for the vast majority of the MPWSP supply water because most of the supply water for the 9.6 mgd desalination plant with supply wells at the proposed CEMEX location is projected to be seawater from the Monterey Bay. No water right need be secured for the seawater element of the MPWSP supply water.

Next, as to water that may be derived from the Basin itself rather than from the ocean, the Report explains (as discussed above) that there are three types of groundwater rights: (1) overlying rights for those who own land above the Basin; (2) prescriptive rights for those who have adversely established a pattern of use of Basin water; and (3) appropriative rights. CalAm would need an appropriative groundwater right to retrieve and export water from the Basin. The Report sets forth the view of the SWRCB as to the set of circumstances that must exist in order for CalAm to have the requisite appropriative rights to support the project. Essentially, if the extraction of otherwise unusable Basin groundwater will not harm lawful water users and any fresh water extracted can be returned to the Basin without injury to existing legal water users, then CalAm would have rights to the portion of feedwater that comes from the Basin because the MPWSP product water that contains such Basin water would be "developed water."

Developed water is water that was not previously available to other legal users and that is added to the supply by the developer through artificial means as a new water source. "The key principle of developed water is if no lawful water user is injured, the effort of an individual to capture water that would otherwise be unused should be legally recognized." Report at 37. Due to long-term seawater intrusion (where the seawater has moved inland) in the Basin, large areas of the Basin groundwater are impaired as to drinking and agricultural uses. The geographic areas from which the project supply wells could draw water inland of the sea are indeed intruded by seawater. (See Section 4.4, Groundwater Resources) "Since this groundwater is reportedly impaired, it is unlikely that this water is, or will be put to beneficial use." Report at 15. In fact, in response to concerns over seawater intrusion and historic overdraft in the Basin, the County adopted Ordinance No. 3709, which precludes the installation of new groundwater wells and

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prohibits groundwater pumping between mean sea level and 250 feet below mean sea level in certain areas.

The Report concludes that the withdrawal for creating developed water is appropriate so long as no injury is incurred by existing legal water users of the Basin. Setting up the test to discern whether CalAm possesses water rights for the proposed project, the Report states:

> [I]n developing a new water source Cal-Am must establish no other legal user of water is injured in the process. Even if Cal-Am pumps water unsuitable to support beneficial uses, the water could not be considered developed water unless users who pump from areas that could be affected by Cal-Am's MPWSP are protected from harm.
>
> Cal-Am proposes a replacement program for the MPWSP water that can be attributed to fresh water supplies or sources in the Basin. If Cal-Am can show all users are uninjured because they are made whole by the replacement water supply and method of replacement, export of the desalinated source water would be permissible and qualify as developed water. In the future, this developed water would continue to be available for export even if there are additional users in the Basin. Developed waters are available for use by the party who develops them, subject to the "no injury" standard discussed previously.

Report at 38. The Report specifies three categories of foreseeable injuries that conceivably could be experienced by overlying water users within the area of influence of the MPWSP supply wells: "(1) a reduction in the overall availability of fresh water due to possible incidental extraction by the MWPSP; (2) a reduction in water quality in those wells in a localized area within the capture zone; and, (3) a reduction in groundwater elevations requiring users to expend additional pumping energy to extract water from the Basin." Report at 45. Each of these possible forms of injury is examined below.

State water policy favors enhancement of beneficial uses of water. Specifically, Article X, section 2 of the California Constitution requires "that the water resources of the State be put to beneficial use to the fullest extent to which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented." In addition, Water Code sections 12946 and 12947 proclaim it state policy to economically convert saline water to fresh water, stating, "Desalination technology is now feasible to help provide significant new water supplies from seawater, brackish water and reclaimed water."

In light of these legal requirements, the Report discusses the physical solution doctrine of water rights law, which could come into play if the MPWSP would beneficially develop water, but would in so doing cause injury absent one or more mechanisms to address and ameliorate such injury. In such a circumstance, physical solutions could be employed by CalAm to alleviate the harm effected by the MPWSP and make whole the injured water rights holders. The types of physical solutions would be dictated by the actual harm caused by the MPWSP, but could include such actions as providing replacement water supplies or funding improvements or additional pumping costs needed to ensure that the senior water users in the Basin remain in the same position as they were prior to construction and implementation of the MPWSP. The Report stated that, "Under the physical solution doctrine, although the Basin continues to be in a condition of overdraft, to maximize beneficial use of the state's waters Cal-Am may be allowed to pump a

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Recording Requested by and
When Recorded Return To:

State Coastal Conservancy
1330 Broadway Suite 1100
Oakland, California 94612

Attn: Staff Counsel
Project: West Armstrong Property

Recorded at the Request of
FIRST AMERICAN TITLE CO.

DEC 23 1997

Time: 8:00 AM
Series # 9775713

EXEMPT FROM RECORDING FEES – GOVERNMENT CODE SECTION 6103

AMENDMENT (NO. 1)
TO
IRREVOCABLE OFFER TO DEDICATE INTERESTS IN REAL PROPERTY

This AMENDMENT TO THE IRREVOCABLE OFFER TO DEDICATE INTERESTS IN REAL PROPERTY, dated February 21, 1992, and recorded on March 6, 1992 at Reel 2766 Page 712 of Monterey County Records, is hereby made and entered into this 4th day of November, 1997, by the Monterey County Agricultural and Historical Land Conservancy, Inc., ("Offeror"), with the approval of the Executive Officer of the California State Coastal Conservancy (the "Conservancy").

I. WHEREAS, Offeror is the legal owner of fee title to certain real property in the County of Monterey, State of California, described in the attached Exhibit A ("the Property"), having purchased an undivided one-third (1/3) interest in the Property concurrently with the recordation of the IRREVOCABLE OFFER TO DEDICATE INTERESTS IN REAL PROPERTY dated February 21, 1992, and recorded on March 6, 1992 at Reel 2766 Page 712 of Monterey County Records ("the Original Offer"), and having purchased the remaining two-thirds (2/3) interest in the Property under the Grant Deed recorded contemporaneously with this Amendment to the Offer;

II. WHEREAS, Offeror purchased the first undivided one-third (1/3) interest and an option to purchase the remaining two-thirds (2/3) interest in the Property using funds provided by the California State Coastal Conservancy ("the Conservancy") pursuant to authority of the Conservancy under Division 21 of the California Public Resources Code to provide grants to nonprofit organizations for the acquisition of real property, and pursuant to an unrecorded agreement no. 88-027 between Offeror and the Conservancy;

III. WHEREAS, Offeror purchased the remaining two-thirds (2/3) interest in the Property pursuant to an additional grant of funds from the Conservancy under the unrecorded agreement no. 88-027 between Offeror and the Conservancy, as amended;

IV. WHEREAS, funding for the purchase of the remaining two-thirds interest in the Property was derived from federal Farmland Protection Program funds administered by the Commodity Credit Corporation and Natural Resources Conservation Service of the United States; from Habitat Conservation Funds allocated to the Conservancy under Sections 2786-2787 of the California Fish and Game Code; and from private funds raised by Offeror;

V. WHEREAS, Offeror's agreement with the Conservancy, as amended, requires that Offeror comply with the provisions of Public Resources Code Section 31116(b), concerning Conservancy grants to nonprofit organizations for land acquisitions, and with requirements of the federal Farmland Protection Program;

VII. WHEREAS, Offeror's purchase of the remaining two-thirds interest in the Property terminated the right and interest of California Artichoke and Vegetable Growers Corporation and the obligations of Offeror pursuant to the Memoranda of Co-Ownership and Partition Agreement recorded contemporaneously with the Original Offer;

VIII. WHEREAS, Offeror intends through this Offer (consisting of the Original Offer as modified by this Amendment) to bind itself and its successors in interest as to all of Offeror's interest in the Property; and

IX. WHEREAS, Offeror is executing this Amendment to comply with Public Resources Code Section 31116(b) and with the terms of the unrecorded agreement no. 88-027, as amended, including terms required under the Farmland Protection Program, and to protect the public's interest in the Property, which was acquired with the assistance of State and Federal funds;

NOW, THEREFORE, in consideration of the Conservancy and Farmland Protection Program grants to Offeror for the acquisition of the Property, and the preservation of the public's interest therein, Offeror hereby amends the Original Offer by offering to dedicate all of its right, title and interest in the Property to the State of California, acting by and through the Conservancy or its successor agency, or to the United States of America, as follows.

1. <u>ACCEPTANCE OF OFFER BY THE STATE OF CALIFORNIA.</u> This Offer may be accepted by the State of California <u>only</u> if the Conservancy finds that the existence of the Offeror has terminated; or that the Offeror or its successor in interest in the Property has violated an essential term of the unrecorded agreement no. 88-027 (as amended), which essential terms include the following:

(a) that Offeror has acquired the Property for the purpose of agricultural production as provided in the Monterey County Agricultural Program Plan approved by the Conservancy at its public meeting on August 16, 1984; and for the preservation of existing coastal dune habitat on the Property. No use of the Property that is inconsistent with these purposes shall be permitted.

(b) that Offeror's interest in the Property or any portion thereof may not be used as security for any debt without the written approval of the State of California, acting through the Executive Officer of the Conservancy or its successor.

(c) that Offeror's interest in the Property or any portion thereof may not be transferred without the written approval of the State of California, acting through the Executive Officer of the Conservancy or its successor, nor without the prior consent of the Secretary of the United States Department of Agriculture.

(d) that Offeror shall use, manage, operate and maintain the Property as provided in the unrecorded agreement no. 88-027 (as amended) between Offeror and the Conservancy.

Upon a finding by the Conservancy that any of the essential terms set forth above have been violated, or that the existence of the Offeror has been terminated for any reason, this Offer may be accepted by the Conservancy, or by another public agency or nonprofit organizations designated by the Conservancy which has agreed to accept the obligations of the Offeror hereunder, by recording in the Official Records of Monterey County a Certificate of Acceptance in substantially the form of the attached Exhibit B.

2. CONTINGENT RIGHT IN THE UNITED STATES OF AMERICA; UNITED STATES ACCEPTANCE OF OFFER. In the event the Offeror fails to prevent the property from being converted to non-agricultural uses, as determined in the sole discretion of the Secretary of the United States Department of Agriculture, the said Secretary of Agriculture and his or her successors and assigns shall have the right to enforce the agricultural restrictions of this Offer through any and all authorities available under Federal or State law.

In the event the Offeror attempts to terminate, transfer, or otherwise divest itself of any rights, title, or interests in the Property without the prior consent of the Secretary of Agriculture and payment of consideration to the United States, then, at the option of such Secretary, all right, title and interest in the Property shall become vested in the United States of America. Upon a finding by the Secretary of the United States Department of Agriculture that Offeror has attempted to terminate, transfer, or otherwise divest itself of any rights, title, or interests in the Property without the prior consent of the Secretary of Agriculture and payment of consideration to the United States, this Offer may be accepted by the United States by recording in the Official Records of Monterey County a Certificate of Acceptance in substantially the form of the attached Exhibit B.

3. BENEFIT AND BURDEN. This Offer shall run with and burden all of Offeror's right, title and interest in the Property, and all obligations, terms, conditions, and restrictions hereby imposed shall be deemed to be covenants and restrictions running with the land and shall be effective limitations on the use of the property from the date of recordation of this document and shall bind the Offeror and all its successors and assigns. This Offer shall benefit the State of California.

4. USE OF PROPERTY AS SECURITY FOR DEBT. Offeror and its successors and assigns shall not use the property as security for any debt without the written approval of the State of California, acting by and through the Executive Officer of the Conservancy or its successor.

5. TRANSFER OF PROPERTY. Offeror shall not transfer any interest in the Property without the prior consent of the Secretary of the United States Department of Agriculture and payment of consideration to the United States. Transfer of Offeror's interest in the Property shall also be subject to the approval of the State of California, acting by and through the Executive Officer of the Conservancy or its successor, and the transferee shall be subject to all terms, conditions and restrictions set forth in this Offer. In particular, but without limiting the restrictions set forth above, the transferee shall use the Property for the purpose of agricultural production and preservation of existing coastal dune habitat. If the Conservancy deems necessary upon approval of any transfer of the Property, the transferee and the Conservancy shall enter into a new agreement sufficient to protect the interest of the people of California.

6. CONSTRUCTION AND VALIDITY. If any provisions of these restrictions is held to be invalid or for any reason becomes unenforceable, no other provision shall be thereby affected or impaired.

7. SUCCESSORS AND ASSIGNS. The terms, covenants, conditions, exceptions, obligations, and reservations set forth in this Offer shall be binding upon and inure to the benefit of the successors and assigns of both the Offeror and the Conservancy, whether voluntary or involuntary.

8. IRREVOCABILITY. This Offer supersedes and replaces the Original Offer dated February 21, 1992, and recorded on March 6, 1992 at Reel 2766 Page 712 of Monterey County Records, by eliminating references to the possible repurchase of the Property by California Artichoke and Vegetable Growers Corporation, and adding provisions required in connection with Offeror's acquisition of the remaining two-thirds (2/3) interest in the Property, but does not affect the irrevocability of the Original Offer or this Amendment. The signature of the Executive Officer of the Conservancy on this Amendment attests to the Conservancy's approval of this Amendment.

8. TERM. This Offer is irrevocable, and upon recordation of an acceptance in the form of Exhibit B this Offer shall have the effect of a grant of all of Offeror's interest in the Property to the United States of America, the State of California or other accepting entity designated by the Conservancy and having executed a substantially similar acceptance, as provided herein.

IN WITNESS WHEREOF, Offeror has executed this document, and the Executive Officer of the Coastal Conservancy has approved it, as of the date and year first hereinabove written.

MONTEREY COUNTY AGRICULTURAL AND HISTORIC LAND CONSERVANCY
Offeror

By: Brian Rianda
Its PRESIDENT

APPROVED:
STATE COASTAL CONSERVANCY

By: ____________________
Its Executive Officer