REVIEW OF:
"Proposed Amendments to Statewide Water Quality Control Plan to Address Desalination Facility Intakes, Brine Discharges, and to Incorporate Other Non-substantive Changes".

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Comments are provided here on conclusions supporting the proposed amendments and on the *Substitute Environmental Document* that contains the draft staff report.

I reviewed the documents with the understanding that the Amendments provide procedures for Regional Water Boards to evaluate 1)the best site, design, technology, and mitigation measures to minimize adverse impacts to aquatic life at new or expanded desalination facilities; 2) industry-specific receiving water limits for salinity; 3) implementation and monitoring provisions for discharges of waste brine; and 4) provisions protecting sensitive habitats, species, Marine Protected Areas, and State Water Quality Protection Areas from degradation associated with desalination intakes and discharges; and 5) monitoring requirements.

As requested I provide a critique of the 5 conclusions and general assessments of the materials provided.

Conclusion 1: A receiving water salinity limit of two parts per thousand (ppt) above natural background salinity is protective of marine communities and beneficial.

This statement may be true in some places and in some years but will probably not be true at all sites and times. In stable settings with little salinity variation a 2 ppt elevation of salinity may not be tolerated, and while not necessarily lethal could induce sublethal effects. Continuous measurements at the recurrent location of squid egg beds at 25 m water depth off So. Cal. yielded a salinity range of 33.22-33.90 over a year (Navarro 2014). With such constant values it hard to believe that an increase of 2 (to 35.2) would have no effect on embryo or paralarval development. Establishing natural variability and local adaptation seem important.

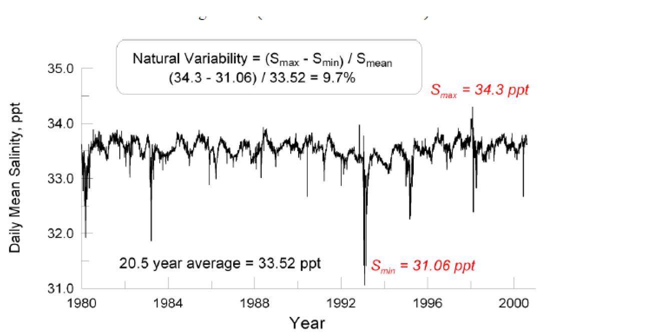

Figure 5-2. Long-term salinity variation typical of the Southern California Bight. Data from NPDES monitoring reports for AES and OCSD outfalls in Huntington Beach.

Variability. The nature of variability is just as important in establishing receiving water limits as the amount of variation, as indicated by this plot of salinity variation at the outfall off Huntington Beach. Natural variability involves significant episodic *drops* in salinity by 2 ppt, but never a rise of this magnitude. Representing variability as 9.7% in this case does not tell a realistic story, since natural exposures rarely rise above 34. Another measure of variability should be considered since the disturbance at hand involves elevated salinity – perhaps by calculation of variance above the mode or mean. Certainly 37 for a numeric limit seems unrealistic for California waters (except perhaps in our inverse, hypersaline estuaries.

Climate change must be considered as a growing stressor on the CA shelf. Drought in particular is likely to alter background salinities and salinity gradients and place additional stress on estuaries. Beyond absolute changes in salinity, alteration of gradients may negatively affect species that depend on estuarine salinity gradients for reproduction, migration or osmoregulation.

Salinity Testing. Salinity tolerance testing is described for a suite of species to achieve standardization (WET testing). Among the initial targets was *Mytilus galloprovincialis*, invasive species originating from the Mediterranean (where salinity is 38ppt). Although this species is farmed in Carlsbad, it is a bay species sure to be more tolerant of high salinity than for example the California mussel, *M. californianus*, an open coast species that plays key roles in habitat formation. Few commercially important species were tested. The red urchin, *S. franciscanus*, anchovy, CA halibut, market squid, sardine and others would be appropriate. The argument that only lab reared /standard testing species should be used to establish salinity limits and regulations is unfounded. Most wild populations exhibit various forms of local adaptation. It is this region-specific adaptation in wild populations that should be the basis of the regulations. I recommend testing key (commercial for foundational) local species in each system.

Research Needs and Additional Considerations. In general available data for responses to hypersalinity (brine discharge) are very limited.

- What are the tolerances of the organisms comprising the planktonic food web? The brine discharge will affect everything from microbes and phytoplankton to copepods and chaetognaths, but these are not considered. Why? Ecosystem-level consequences must be addressed.
- Where is the discussion of sublethal effects on reproduction of key species?
- Why is there no mention of salinity effects in combination with other compounds associated with RO? Is salinity the *only* alteration relative to normal seawater?

Before setting final salinity limits, studies are also needed to address the interaction of seasonal hydrographic variation and climate change consequences (ocean acidification, hypoxia, warming) with brine effects. O_2 and pH vary seasonally and are declining on the shelf (Booth et al. 2014). At stressful levels do these affect tolerance to elevated salinity? What are the lethal and sublethal effects? Do these lead to altered prey capture? altered aggregation/schooling mechanisms?

I would re-emphasize the statements in Jenkens et al. on brine discharge that make clear the need for additional research – I would argue before setting limits. *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. *Studies are also needed on different types of concentrates and mixtures with antiscalants and other chemicals associated with RO.*

Conclusion 2: A subsurface seawater intake will minimize impingement and entrainment of marine life.

The use of subsurface intake systems is purported to improve water quality, reduce chemical use and environmental impact, reduce C footprint and cost of treated water (Missimer et al. 2013). As stated, Conclusion 2 is incomplete, as it claims minimization of impingement and entrainment of marine life – but relative to what? Presumably this is relative to a surface seawater intake? The conclusion may not be true relative to water from other sources (e.g. reuse from a power plant where 100% mortality has occurred, stormwater, rainwater) or to a no-action alternative.

Subsurface seawater intake construction and operation will have ecological impacts but there appear to be no studies of these. How will water overlying the intake bottom be affected and will intake drawdown rates be slower than swim speeds of larvae? Often the assumption is made that shallow, nearshore, sand-covered seabed is more or less expendable, but it does serve important ecological functions. For example subtidal sands provided habitat for infaunal invertebrates fed on by demersal fishes, or as nursery grounds (e.g. for CA halibut – Fodrie and Levin, 2007). Water sucked downward through sediments will involve some loss of invertebrates and fishes – as larvae and adults – and thus loss of ecosystem services. Although they will be localized, these should be quantified and compared to losses from other sources.

As intake technology advances there needs to be options for new approaches. The amendment should include adaptive language to accommodate (and require use of) new, improved technologies as they develop.

Subsurface intake options need to be evaluated in light of cumulative impacts and habitat status. For example sand mining for beach replenishment is a growing practice off southern California. Cumulative impacts on the seabed of mineral removal, seawater intake, trawling and other sources of disturbance (hypoxia or other water quality issues) should be evaluated together.

Conclusion 3: A 0.5 mm, 0.75 mm, 1.0 mm, or other slot size screens installed on surface water intake pipes reduces entrainment.

This statement is vague… as it does not specify screen size – only suggests that some sort of screen should be used. It is true that the screen will reduce entrainment relative to no screen, especially for fish. The screens are most effective for larger organisms but the mitigation requirements are based on organisms that presumably will go through the mesh. Many invertebrate larvae (bivalves and gastropods, some echinoderms, polychaetes are < 500 microns (0.5 mm in size), even when they are ready to settle. It seems the focus of the amendment is on fish larvae (and head size), but of course the food those fish eat (shellfish and polychaete larvae) will be entrained.

Generally organisms impinged on the screen will die. Accurate data are needed on how many and who is impinged and how the screens will avoid clogging. Next–generation /quantitative sequencing could be used to evaluate the composition of impinged residue and entrained individuals to accurate evaluate mortality ratios.

Conclusion 4: Multiport diffusers and commingling brine with other effluents can dilute brine discharge and provide protection to aquatic life.

This conclusion is probably true as stated… assuming that the concept of protection to marine life is in comparison with brine discharge in the absence of multiport diffusers and in the absence of dilution with other effluent. However, there is less protection than if there were no discharge at all.

There seems to be a lively debate afoot about whether multiport diffusers are a preferred alternative to in-plant dilution. Since not all organisms are killed that come in contact with turbidity from multiport diffusers, but 100% mortality is assumed for water used with in-plant dilution – then multiport diffursers would seem to be the preferred alternative. However, if the water used for dilution already had organisms killed (via power plant use) than this seems like a preferred option.

A major problem seems to be that turbulence studies have not been done with larvae many of the commercially harvested species in California (abalone, rockfish larvae, CA, Dungeness crabs, mussels, red urchin, squid etc.). Larvae may be rendered more vulnerable to turbulence-induced mortality through the effects of ocean acidification, warming or deoxygenation. Much more research is needed to evaluate multidiffuser effects on mortality of plankton and larvae via turbulence. The same is true for effects of low turbulence pumps for flow augmentation on mortality.

The amendment text should include adaptive language to accommodate (and require use of) new technologies that might be developed for brine discharge.

The discussion of discharge water options is very narrow and does not include the feasibility of (a) terrestrial disposal of brines (possible production of salt or other compounds) or (b) using stormwater or treated greywater for dilution. However, to consider dilution with municipal wastewater there needs to be research on the environmental consequences of brine + municipal wastewater.

I found frequent use of the term ‘any accessible approach’ for evaluating mortality (e.g., due to shear stress, construction etc.) to be disconcerting. The language must be stronger making one of several approaches mandatory so that assessments cannot state that there is no feasible approach.

There is a discussion of brine dilution with wastewater. The claim would be to use water not otherwise repurposed. But wastewater reuse is in its infancy in CA. Much water not currently recycled in California could be. It is likely that any water used for brine dilution will deflect consideration of recycling that water for other uses.

Conclusion 5: The Area Production Forgone (APF) method using Empirical Transport Model (ETM) can effectively calculate the mitigation area for a facility’s intakes.

I disagree with this conclusion. This is the method used for calculating mitigation in the case of power plant entrainment and mortality. But it is does not necessarily provide the optimal information required to understand what exactly is lost and what should be mitigated. Here are some of the issues I see.

a) The APF/ETM approach is one-dimensional and does not incorporate the ecosystem functions and services that are lost. Entrainment (and impingement) will kill everything from microbes, spores and phytoplankton to holo-zooplankton and meroplankton, in addition to fish larvae. Each of these functions as a component of the food web that supports higher trophic levels. In some cases the propagules develop into adult stages that serve as foundation species that provide habitat, refugia, nursery grounds and more (examples include mussel larvae that become mussel beds and kelp spores that become kelp beds). The focus on adults lost exacerbates this problem. E.g. p. 67 – the ultimate loss of 4 adult sheephead does not include the loss of 200,000 larval sheephead that may have been prey for squid or other commercial catch. None of these services are incorporated into the mitigation calculation. Marin facility loss of 229M herring, 1.8 M gobies, 0.615 M No. anchovy may not affect population sustainability but will surely affect the food web
b) There is large variability in the model estimates. The models are very sensitive to selection of mortality rates. Much of the life-history information needed for modeling (e.g. life tables and population growth rates under different environmental regimes) is not available.
c) There is no density dependence in the models. With fewer larvae growth rates should be faster.
d) There is no independent means to test the validity of the models used.
e) Many species are migratory and originate from or settle outside the project area. The APF does not recognize this. Recognition of source-sink properties of sites (in terms of larval connectivity) must be part of the loss calculations and mitigation determinations. Regulations address distance from an MPA or SWQPA but much research has shown that oceanographic connectivity and realized biological connectivity (determined from genetic or trace elemental fingerprinting tools) are not necessarily directly related to distance (White et al. 2010; Watson et al. 2011). In southern California connectivity can be highly seasonal (Carson et al. 2010) and exhibit interannual variation (Cook et al. 2014).
f) There is a need for more information on mortality of eggs and larvae and juveniles in low turbulence pumps for flow augmentation.
g) There is no discussion of mortality caused by monitoring or mitigation projects. There clearly will be some and these should be incorporated into mitigation calculations.
h) Cumulative impacts from like projects (desalinization/power plants) and unlike projects (sand mining, trawling, shipping, spills etc.) must be considered in estimating mitigation requirements. For example, multiple desalinization plants proposed for southern California will impact adults and larvae of species that occupy the entire range. While mortality estimates for each plant individually may be mitigated, the loss of 4x the number from 4 plants may have a disproportionate influence on the dynamics of the population, and on on

subsequent trophic levels, competitors etc.

i) Greenhouse gas emissions and other project-associated actions that degrade the environment should be calculated in the mitigation requirement. These are not estimated for Carlsbad or Huntington Beach… which claim carbon neutrality but this is unlikely and proof is required before installation.

j) New methodologies that can improve the estimation of lost individuals, species, functions and services should be adopted whenever possible. This might include visualization tools at the intake (optical particle counters), and next generation molecular tools that can accurately identify losses, biodiversity effects, numbers of species etc.

k) **Remediation** – very little is said about avoidance of impact through timing of intake or reducing flow. There is a need to think outside the box and develop innovative ways to deal with events – HAB, OA or hypoxia that heighten larval sensitivity or increase loss.

Other comments on the desalinization amendment and supporting materials.

General Comments:

(1) The amendments need to include adaptive language to accommodate (and require) use of new technologies that provide advantages over old ones. These could include advances in intake methods, avoidance, monitoring techniques (molecular), use of solar power, reducing in reject water volume. The one place this appeared was p. 93 option 5. This should be a part of nearly all other amendments.

(2) Desalinization plants are focused on developing potable water. There should be consideration of whether it is environmentally better to produce lower quality water (for non potable use) that can replace (conserve) potable water that is now used for irrigation, toilets etc.

(3) I found many items missing or treated inadequately in the discussions provided. Whether these are discussed elsewhere – I am not sure.

- Energy and carbon footprints of construction, operation, monitoring and mitigation should be quantified and incorporated into decision-making as well as mitigation requirements.
- Socioeconomic impacts of increased cost of water (via desalinization) should be considered.
- Climate change factors (warming, ocean acidification, ocean deoxygenation, sea level rise) should influence site selection, intake method and location, discharge sites, and timing of intake.
- There should be consideration of opportunities to use existing degraded areas for discharge (harbors or other).
- There is virtually no consideration of habitat loss and ecosystem services that derive from the environmental impacts. For example, while loss of eel grass bed services such as nursery habitat is considered, the value of eel grass for carbon sequestration, remediation of ocean acidification, storm buffering etc. is not. Secondary effects of larval loss as prey, and changes to food webs must also be considered. All of this should be incorporated in cost-benefit analyses and mitigation compensation.
- There was no discussion of the potential for harmful algal blooms and release of toxins (such as occurred in Lake Erie and affected drinking water). Is that an issue for So. California?

Comments on existing text.

Definitions of sensitive habitats do not include coastal salt marshes or mudflats, or estuarine habitat. While these are not being considered as site, intake or discharge locations (with direct impacts), coastal mudflats and marshes are transition zones with exchange of energy, sediments, larvae and are migratory pathways.

Definitions. Update the description of estuaries and lagoons… Southern California lagoons are largely inverse estuaries and are subject to closing. This produces very different dynamics and vulnerabilities.

Why is there no discussion of geohazards and connectivity for siting?

Why are all regulations about salinity? What about other constituents of brine (e.g. in Australia Ba, Ca, K.Sr, Mg – Dupavillon and Gillanders 2009)

Mitigation.

a. Very little is specified about mitigation. I may have missed these but where do specifications appear?

b. *One key recommendation I have is to consider funding research as mitigation.* Review of the documents reveals considerable need for experimental data regarding salinity tolerances, diffuser impacts and more. The desalinization industry should contribute to an independently administered research fund that addresses the many impacts of desalinization construction, intake, discharge and other operations.

c. Mitigation ratios of 1:1 are mentioned but these seem unusually low. Current approaches look only at loss of larvae as affecting adult populations, but not at the reverberations in the ecosystem or food web. When larvae are lost there are predators that go without food, effects on their predators, etc.

d. In the current plan area affects (> 2 ppt) are independent of food chain impacts.

e. Mitigation could expand MPAs or help enforce MPAs.

f. A fee based mitigation bank does not exist in CA for marine life. Do we really want to start this? It will remove direct responsibility from industry.

Research needs:

- There is little reporting on the vertical distributions of fish and invertebrate larvae. This should be determined to evaluate intake and discharge depths.

- Cumulative impacts are only mentioned on p. 64 of the staff report for same-source water body; it is unclear what this means.

- More creative thought is needed to address desalinization impacts and mitigation. The state should consider convening workshops on mitigation requirements and how to assess whether criteria are met.

- Housing and Development assessment. A ready supply of desalinated water may reduce pressure for landscape-based approaches to water conservation and infiltration/reuse.

Unclear statements

- p. 64. Clairfy 'same source water body' for cumulative impacts.

- Text missing in some places … low key language?

- Operator-determined construction impacts may not be wise.

- . Text p. 142. How can the Carlsbad desalinization proposal claim no operational impacts on biological resources? Is this because reused water already has 100% mortality? Does this apply to significant and non-significant impacts?

- The energy intensive nature of desalinization is pointed out but should be incorporated into decision-making.

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