POSEIDON WATER

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Via E-mail: SanDiego@waterboards.ca.gov

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2375 Northside Drive, Suite 100
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Subject: Comment – Tentative Order R9-2019-0003

Dear Mr. Neill:

On December 21, 2018 the California Regional Water Quality Control Board, San Diego Region (San Diego Water Board) released for public review and comment Tentative Order No. R9-2019-0003 (NPDES permit CA0109223), *Waste Discharge Requirements for Poseidon Resources (Channelside) LP Claude "Bud" Lewis Carlsbad Desalination Plant Discharge to the Pacific Ocean (Tentative Order), which include a California Water Code section 13142.5(b) determination*. Poseidon Resources (Channelside) LP (Poseidon), the owner and operator of the Carlsbad Desalination Plant (CDP), has reviewed the Tentative Order and is submitting the enclosed comments for the San Diego Water Board's consideration.

Poseidon's comments address 9 provisions in the Tentative Order that are presented in the order that they appear in the Tentative Order.

1. **Permitted Discharge Flows (Tentative Order page 5, Table 4; and page F-3, Table F-1)**

Issue Presented. The Amended Report of Waste Discharge contemplates that the Carlsbad Desalination Plant would operate at a production rate of 60 million gallons per day (MGD) with **average annual reverse osmosis (RO) concentrate discharges of up to 60 MGD** and backwash flows of up to 7 MGD, for combined waste streams totaling 67 MGD. Table 4 of the Tentative Order, on the other hand, limits the **RO concentrate discharge to an average daily flow of 60 MGD**. The discharge of RO concentrate flow in excess of 60 MGD in 24-hour period is prohibited.

The use of an average daily RO concentrate flow limit of 60 MGD instead of an average annual RO concentrate flow limit of 60 MGD would significantly constrain CDP operations. Under routine operating conditions described below, an average daily flow limit would reduce CDP output by up to 5 MGD (8 percent reduction in plant capacity) without providing any improvement in the quantity or quality of the combined discharge contemplated under the Tentative Order. This permitting limitation, particularly during times when other regional water supplies are constrained or limited, could impact the San Diego County Water Authority's ability to sustain regional water supply reliability.

Analysis of Problem. The CDP normally operates at product water recovery rates[1] between 48% to 50%. At 50% recovery, the CDP can produce 60 MGD of product water without exceeding the permitted discharge flows. However, CDP operations often requires a recovery rate of less than 50% to optimize energy consumption and ensure the plant operations do not exceed the maximum operating pressure. When operating at less than 50% recovery, the plant operator would need to scale back in production to less than 60 MGD to stay within the permitted flow rates as currently structured in the draft Order. As noted in Table 1, under the individual flow limits for brine and backwash discharges, the CDP production would need to be reduced to 57.65 MGD (4% decrease) to stay within the permitted flows when operating at 49% recovery; and production would need to be reduced to 55.38 MGD (8% decrease) to stay within the permitted flows when operating at 48% recovery.

Table 1
CDP Operations with Average Daily RO Concentrate Flow Limit

RO Recovery Rate	48%		49%		50%	
	Flow (MGD)	Salinity (ppt)	Flow (MGD)	Salinity (ppt)	Flow (MGD)	Salinity (ppt)
Intake	299.00	33.50	299.00	33.50	299.00	33.50
Product Water	55.38	0.00	57.65	0.00	60.00	0.00
Brine Discharge (M-001)	60.00	64.42	60.00	65.69	60.00	67.00
Backwash Discharge (M-001)	7.00	33.50	7.00	33.50	7.00	33.50
Combined Discharge (M-001)	67.00	61.19	67.00	62.32	67.00	63.50

To allow the CDP to operate at full production across the normal range of plant recovery rates without deviating from the regulatory purpose of the permitted discharge flows, Poseidon requests the San Diego Regional Water Board modify Table 4 (and make conforming changes to Table F-4) of the Tentative Order to reflect an average annual RO concentrate flow limit of 60 MGD.

The proposed modification to Table 4 would provide the plant operator the flexibility to adjust the allocation of flow between the RO concentrate and backwash waste streams to efficiently and effectively manage plant operations. As noted in Table 2, under all three operating scenarios, the combined discharge flow continues to be 67 MGD and the salinity is 63.5 ppt.[2] At 50% recovery, the brine discharge rate would be 60 MGD, the backwash discharge rate would be 7 MGD, the combined discharge would be 67 MGD, and the salinity of the combined discharge would be 63.5

[1] The recovery rate is the ratio of quantity of fresh water produced to the quantity of seawater processed by the RO system. At 48% recovery, the RO system produces 48 gallons of product water for every 100 gallons of seawater processed. At 50% recovery the RO system produces 50 gallons of product water for every 100 gallons of seawater processed.

[2] The reason why the salinity in the combined discharge is the same under all three operating scenarios is because the quantity of salt entering and leaving the system is the same. The RO system processes 127 MGD of seawater to produce 60 MGD of fresh water and 67 MGD of combined waste streams. At lower recovery, the RO concentrate has a higher flow and lower salinity. At higher recovery the RO concentrate has a lower flow and higher salinity. The quantity of backwash water remaining for mixing with the RO concentrate is the equalizing factor.

ppt. At 49% recovery, the brine discharge rate would increase to 62.45 MGD, the backwash discharge rate would decrease to 4.55 MGD, the combined discharge would be 67 MGD, and the salinity of the combined discharge would be 63.5 ppt. At 48% recovery, the brine discharge rate would be increased to 65 MGD and the backwash discharge rate decrease to 2 MGD, the combined discharge would be 67 MGD, and the salinity of the combined discharge would be 63.5 ppt.

Table 2						
CDP Operations with Average Annual RO Concentrate Flow Limit						
RO Recovery Rate	**48%**		**49%**		**50%**	
	Flow (MGD)	**Salinity (ppt)**	**Flow (MGD)**	**Salinity (ppt)**	**Flow (MGD)**	**Salinity (ppt)**
Product Water	60.00	0.00	60.00	0.00	60.00	0.00
Intake	299.00	33.50	299.00	33.50	299.00	33.50
Brine Discharge (M-001)	65.00	64.42	62.45	65.69	60.00	67.00
Backwash Discharge (M-001)	2.00	33.50	4.55	33.50	7.00	33.50
Combined Discharge (M-001)	67.00	63.50	67.00	63.50	67.00	63.50

Attachment 1 provides a Comparison of information in Amended Report of Waste Discharge to proposed modifications to Table 4 of the Tentative Order. With the proposed modifications to Table 4, the Tentative Order (and the CDP operations) would be consistent with the Amended Report of Waste Discharge in all material aspects. The information and analyses provided in the ROWD accurately reflect CDP operations with an average annual RO concentrate discharge of 60 MGD.

Furthermore, as noted in Table 3, the proposed modifications to Table 4 would not change the quantity or quality of the combined discharge contemplated under the Tentative Order:

- The intake flow would continue to be an average daily flow of 299 MGD;
- The combined discharge flow would continue to be an average daily flow of 67 MGD; and
- The maximum salinity in the discharge pond after mixing with the dilution water from the flow augmentation system would continue to be 42 ppt.

Table 3			
Comparison of Permitted Flows and Salinity			
Criteria	**Amended Report of Waste Discharge**	**Tentative Order (Dec 21, 2018)**	**Tentative Order with Proposed Modification**
Intake Flow (daily average MGD)	299	299	299
Combined Discharge Flow (daily average MGD)	67	67	67
Discharge Pond Salinity (ppt)	42	42	42

Requested Modifications of Tentative Order. The Tentative Order acknowledges that the Discharger requested an average annual RO concentrate discharge of 60 MGD (page F-6), yet the permitted RO concentrate flow shown in Table 4 is restricted to a maximum daily flow rate of 60 MGD. For the reasons stated above, Poseidon respectfully requests that the San Diego Water Board modify Table 4 (and make conforming changes to Table F-4) of the Tentative Order as shown in red below to reflect the plant operations described on page F-6 of the Tentative Order and in the Amended Report of Waste Discharge. These modifications would provide the plant operator flexibility to adjust the allocation of flow between the individual waste streams internal to the CDP operations, without causing any change in the quantity or quality of the combined discharge contemplated under the Tentative Order. These modifications would also eliminate an unnecessary permitting constraint that would curtail production at the CDP, potentially hindering the San Diego County Water Authority's ability to sustain regional water supply reliability.

Table 4	
Permitted Discharge Flows at Monitoring Location M-001	
Wastewater	**Maximum ~~Daily~~ Flowrate (MGD)**
Media Filtration Backwash (Daily Average)	7
Reverse Osmosis Concentrate (Annual Average)	60
Total Flow (Daily Average)	67

2. **Brine Discharge Technology Empirical Study (Tentative Order pages 17-18, F-40-42, Appendix H-1 Finding 31, Appendix GGG)**

   a. **Analysis of Multiport Diffuser Brine Discharge Technology**

Finding 31 of Appendix H-1 of the Tentative Order states that the San Diego Water Board staff has determined that flow augmentation is the best available discharge technology feasible. Finding 31 provides the following support for this determination:

- The San Diego Water Board staff analyzed Poseidon's calculation of the marine life mortality resulting from the operation of a theoretical multiport diffuser in accordance with the guidance reported by Foster et al in the in *Final Staff Report Including the Final Substitute Environmental Documentation* (SED) approved by the State Water Board with the adoption of the desalination amendment to the *Water Quality Control Plan for the Ocean Waters of California* (Ocean Plan) in May, 2015. This analysis shows that the flow augmentation discharge technology provides a comparable level of intake and mortality of all forms of marine life as a theoretical multiport diffuser designed in accordance with the guidance in the SED.

- The San Diego Water Board also analyzed potential diffuser designs using the methods described in a report prepared by Roberts after the adoption of the Ocean Plan Amendment. According the San Diego Water Board's analysis, Roberts diffuser design also results in a comparable level of intake and mortality of all forms of marine life as the flow augmentation brine discharge technology.

- The San Diego Water Board arrived at its conclusion that impacts were comparable for both SED and Roberts diffuser designs on the basis that the volume of water exposed to shearing-related mortality would be comparable to the volume of water used by the flow augmentation technology.

- The Tentative Order states that the San Diego Water Board will further review Poseidon's assessment of the impacts due to a multiport diffuser as part of the Brine Discharge Technology Empirical Study required in section VI.C.2.a.

While Poseidon agrees with the San Diego Water Board's tentative determination that flow augmentation is the best available discharge technology, we object to the plan to revisit the multiport diffuser impacts as part of the Brine Discharge Technology Empirical Study, and we disagree with the methodology staff used to arrive at the tentative determination that flow augmentation is the best available discharge technology.

With respect to the methodology staff used to arrive at the tentative determination that flow augmentation is the best available discharge technology, chapter III.M.2.d.(2)(c) of the Ocean Plan provides:

> *Brine discharge technologies other than wastewater dilution and multiport diffusers, may be used if an owner or operator can demonstrate to the reginal water board that the technology provides a comparable level of intake and mortality of all forms of marine life as wastewater dilution if wastewater is available, or multiport diffusers if wastewater is unavailable. ... When determining the intake and mortality associated with a brine discharge technology or combination of technologies, the regional water board shall require the owner or operator to use empirical studies or modeling to:*
>
> *i. Estimate intake entrainment impacts using ETM/APF approach.*

Staff has determined that wastewater dilution is unavailable. Therefore, the analysis shifts to whether the flow augmentation brine discharge technology provides a comparable level of intake and mortality of all forms of marine life as a multiport diffuser. However, rather than assess the entrainment impacts of the two brine discharge technologies using the ETM/APF approach required by Ocean Plan, staff arrived at its tentative determination that intake and mortality associated with the flow augmentation brine discharge technology was comparable to the diffuser designs on the basis that the volume of water exposed to shearing-related mortality.

Poseidon evaluated entrainment effects of the brine discharge alternatives using the ETM/APF approach required by Ocean Plan (Appendix K of the 2015 ROWD). The analysis in Appendix K determined that the flow augmentation brine discharge technology provides a "comparable level of intake and morality of all forms of marine life" as a multiport diffuser. Poseidon subsequently revised ETM/APF calculations (Appendix GGG to the ROWD) to reflect the guidance provided by the Science Advisory Panel (SAP). The analysis presented in Appendix GGG reaffirmed that the flow augmentation brine discharge technology provides a "comparable level of intake and morality of all forms of marine life" as a multiport diffuser. A copy of Appendix GGG (including the ETM/APF calculation worksheets) is enclosed with this letter (Attachment 2 - Appendix GGG Revised Entrainment Analysis for Brine Discharge Operations revision 2).

Appendix GGG provides an estimate of the ETM/APF of a multiport diffuser analyzed in accordance with the SED guidance for a multiport diffuser with an intake of 943 MGD and a deleterious shear volume of 217 MGD. At the request of State Water Board staff, Poseidon revised Appendix GGG (revision 1) to also include an ETM/APF estimate for a theoretical diffuser with 170 MGD deleterious shear volume (Roberts 2018). Poseidon believes that Roberts' diffuser analysis does not conform to the SED guidance[3] because: (i) it is based on a model, so by definition, it does not reflect additional "data"; (ii) the model used by Dr. Roberts is not approved by the State Water Board or the U.S. Environmental Protection Agency and has not been peer reviewed; (iii) unlike the guidance in the SED developed by the State Water Board's Brine Discharge Panel (Foster et al.), Roberts diffuser impact assessment has not been through public review and a formal rule making process; and (iv) the Ocean Plan has not been updated to reflect this modified approach for analyzing diffuser impacts. Poseidon understands that State Water Board staff has different view regarding the applicability of Roberts diffuser design, so the revised entrainment analysis for brine discharge options presented in Appendix GGG includes ETM/APF calculations following both the SED guidance and Roberts approach. The results of the brine discharge technology entrainment analysis presented in Appendix GGG is summarized in Table 4.

Table 4
Brine Discharge Technology Entrainment Analysis
Area of Production Foregone (acres)

Taxa Category	Flow Augmentation (171 MGD)	Flow Augmentation (196 MGD)	Roberts Diffuser (170 MGD)	SED Guidance Diffuser (217 MGD)
Estuarine	36	40.9	17.6	22.2
Coastal Ocean	39.8	47.5	441.0	562.5
Total	**75.8**	**88.4**	**458.6**	**584.7**

The San Diego Water Board staff determined that flow augmentation is the best available brine discharge technology. Such a determination requires Poseidon conduct an empirical study that evaluates the intake and mortality of all forms of marine life associated with the flow augmentation brine discharge technology in accordance with chapter III.M.2.d.(2)(c) of the Ocean Plan:

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[3] The SED notes that there are few studies that estimate shearing-related mortality at brine multiport diffusers and, to date, there is no empirical data showing the level of mortality caused by multiport diffusers. In recognition of the limited understanding of the level of mortality caused by multiport diffusers, the SED approved by the State Water Board with the adoption of the desalination amendment to the Ocean Plan included the following guidance for assessing the mortality caused by multiport diffusers:

> *However, **until additional data is available**, we assume that larvae in 23 percent of the total entrained volume of diffuser dilution water are killed by exposure to lethal turbulence. The actual percentage of killed organisms will likely change as more desalination facilities are built and more studies emerge. **Future revisions or updates to the Ocean Plan may reflect additional data that becomes available.*** (Emphasis added).

iv. Within 18 months of beginning operation, submit to the regional water board an empirical study that evaluates intake and mortality of all forms of marine life associated with the alternative brine discharge technology. The study must evaluate impacts caused by any augmented intake volume, intake and pump technology, water conveyance, waste brine mixing, and effluent discharge. Unless demonstrated otherwise, organisms entrained by the alternative brine discharge technology are assumed to have a mortality rate of 100 percent. The study period shall be at least 12 consecutive months. If the reginal water board requires a study period longer than 12 months, the final report must be submitted to the regional water board within 6 months of the completion of the empirical study.

v. If the empirical study shows that the alternative brine discharge technology results in more intake and mortality of all forms of marine life than a facility using wastewater dilution or multiport diffusers then the facility must either (1) cease using the alternative brine discharge technology and install and use wastewater dilution or multiport diffusers to discharge brine waste, or (2) redesign the alternative brine discharge technology system to minimize intake and mortality of all forms of marine life to a level that is comparable with wastewater dilution if wastewater is available, or multiport diffusers if wastewater is unavailable, subject to regional water board approval.

The Brine Discharge Technology Empirical Study requirements are described in section VI.C.2.a. of the Tentative Order. Section VI.C.2.a.(iii) states that the San Diego Water Board will reassess and reconsider the analysis of projected marine life impacts caused by brine discharged through multiport diffusers using the Roberts Report and possibly other yet to be determined methodologies after the flow augmentation system is placed in service:

The Final [Brine Discharge Technology Empirical Study] Report shall include an analysis of projected marine life impacts caused by brine discharged through multiport diffusers using the Roberts Report and any other methodology described in the Work Plan.

According to the Tentative Order, if a yet to be determined analysis finds that the marine life impacts caused by brine discharged through multiport diffusers are lower than previously projected such that the impacts are no longer comparable the flow augmentation, Poseidon is required to cease using flow augmentation and install and use a multiport diffuser.

Poseidon acknowledges its obligation to conduct the post-construction assessment of the intake and mortality of all forms of marine life associated with the flow augmentation technology. Poseidon has no objection to conducting such a study and living with the results because we select the technology and its performance is within our control. On the other hand, Poseidon strongly objects to the requirement in the Tentative Order that would revisit the assessment of the intake and mortality of all forms of marine life associated with the multiport diffuser technology based on some yet to be determined criteria that is beyond its control. Leaving open the determination of the ETM/APF calculation for the hypothetical multiport diffuser until after the flow augmentation discharge technology is constructed and operating places an $80 million investment in intake and discharge improvements at risk of having to be replaced shortly after being placed in service. It is unreasonable for the San Diego Board to require Poseidon, and ultimately San Diego County Water Authority ratepayers, to proceed with this investment in the face of such uncertainty.

The California Water Code section 13142.5(b) determination (Water Code Determination) is being made now, not in several years when the new intake technology is put into service. A second look at that determination through an open-ended study is an unreasonable burden on the applicant.

b. Availability of Wastewater to Dilute CDP Brine Discharge (TO page 18, Appendix H-1 Findings 14 and 29).

The Tentative Order states that the San Diego Water Board finds that wastewater is unavailable to dilute the CDP discharge brine discharge, and flow augmentation is the best available brine discharge technology feasible. (Appendix H-1, Findings 14, 29, and 31).

However, section VI.C.2.a.(iii) requires the San Diego Water Board reconsider its finding that wastewater is unavailable following completion of the new intake structure. If wastewater dilution is found to be available at that time, Poseidon is required to cease using the alternative brine discharge technology and install and use wastewater dilution.

Similar to our concerns related to the multiport diffuser, leaving open the determination whether wastewater is available until after the flow augmentation discharge technology is constructed and operating, places an $80 million investment in intake and discharge improvements at risk of having to be replaced shortly after being placed in service. It is unreasonable for the San Diego Board to require Poseidon, and ultimately the region's ratepayers, to proceed with this investment in the face of such uncertainty that is outside our control.

Requested Modifications to the Tentative Order. Poseidon requests the San Diego Water Board revise the Tentative Order to clarify that:

- The determination that flow augmentation provides a comparable level of intake and mortality of all forms of marine life as a multiport diffuser is based on an ETM/APF approach as required by Ocean Plan.
- The ETM/APF calculation for the multiport diffusers is a one-time determination that is made at the time of the Water Code determination and is not subject to reconsideration.
- The finding that wastewater is unavailable is a one-time determination that is made at the time of the Water Code determination and is not subject to reconsideration.

Poseidon respectfully requests the San Diego Water Board modify the section VI.C.2, pages F-40 through F-42, and Finding 31 of Attachment H-1 of the Tentative Order as shown in red below to reflect the requested modifications listed above. These modifications would ensure that Poseidon is required to comply with the empirical study requirements set forth in chapter III.M.2.d.(2)(c)(iv) of the Ocean Plan by demonstrating that the marine life mortality associated with the flow augmentation brine discharge technology Poseidon installed is comparable to the marine life mortality of the multiport diffuser identified in the Water Code determination. The modifications clarify that findings in the Tentative Order related to: (i) the availability of wastewater dilution; and (ii) the ETM/APF calculation for the multiport diffusers; are one-time determinations made by the San Diego Water Board at the time of the Water Code determination.

Requested modifications to section VI.C.2. of the Tentative Order:

a. Brine Discharge Technology Empirical Study

In accordance with chapter III.M.2.d.(2)(c) of the Ocean Plan, within 180 days following the adoption of this Order, the Discharger shall submit a work plan for a study and final report designed to assess the intake and mortality of all forms of marine life associated with the flow-augmentation choice of brine discharge technology, consistent with the requirements of Ocean Plan chapter III.M.2.d(2)(c)iv, *Considerations for Brine Discharge Technology*.

i. Brine Discharge Technology Empirical Study Work Plan (Work Plan)

(a) The Work Plan shall establish baseline biological conditions at the discharge location and at a reference location. At its discretion, the San Diego Water Board may allow the use of existing data to meet this requirement.

(b) The Work Plan shall provide for the collection of information, including biological surveys, to evaluate impacts caused by an augmented intake volume, intake and pump technology, water conveyance, waste brine mixing, and effluent discharge. The San Diego Water Board has the discretion to allow the Discharger to use existing data to meet portions of this requirement. Unless demonstrated otherwise, organisms entrained by the discharge technology are assumed to have a mortality of 100 percent.

~~**(c)** The Work Plan shall provide for an analysis of the marine life impacts caused by brine discharged through multiport diffusers using the approach contained in the scientific report *Brine Diffusers and Shear Mortality*, Philip J.W. Roberts April 18, 2018, referenced as the Roberts Report in Finding 31 of Attachment H.1 of this Order. The Work Plan may also provide for conducting the analysis using an additional approach, in addition to using the Roberts Report approach.~~

(d) The Work Plan shall provide for a study period of at least 12 consecutive months following initial operation of the new intake structure unless otherwise specified by the San Diego Water Board.

(e) The Work Plan shall include a schedule for completion of all activities and submission of a Brine Discharge Empirical Study Final Report, as described in section VI.C.2.a.iii below. The schedule must provide for submittal of the Final Report within six months of the completion of the empirical study.

(f) The Discharger shall modify the Work Plan as requested by the San Diego Water Board.

ii. Brine Discharge Technology Empirical Study Work Plan Implementation

The Discharger shall implement the Work Plan no later than 60 days following startup of the new intake structure, unless otherwise directed by the San Diego Water Board. Before implementing the Work Plan, the Discharger shall:

(a) Notify the San Diego Water Board of the intent to initiate the proposed actions included in the Work Plan; and

(b) Comply with any conditions set by the San Diego Water Board.

iii. Brine Discharge Technology Empirical Study Final Report

Within six months of completing the Brine Discharge Technology Empirical Study in accordance with the Work Plan, the Discharger shall submit a Brine Discharge Technology Empirical Study Final Report (Final Report) to the San Diego Water Board. ~~The Final Report shall include the analysis of projected marine life impacts caused by brine discharged through multiport diffusers using the Roberts Report and any other methodology described in the Work Plan.~~ The Final Report shall also include an in-depth discussion, evaluation, interpretation, and tabulation of the data supporting the interpretations and conclusions reached.

If the Final Report shows that the flow augmentation choice for brine discharge technology results in more intake and mortality of marine life than if the Facility used ~~wastewater dilution or~~ multiport diffusers with an estimated intake and mortality of marine life described in Finding 31 of Appendix H, then the Discharger must also submit with the Final Report a proposed schedule to either:

(a) Cease using the alternative brine discharge technology and install ~~and use wastewater dilution or~~ multiport diffusers to discharge brine waste; *or*

(b) Re-design the alternative brine discharge technology system to minimize intake and mortality of all forms of marine life to a level that is comparable ~~with wastewater dilution if wastewater is available or~~ multiport diffusers ~~if wastewater is unavailable~~, subject to San Diego Water Board approval.

Requested modifications to pages F-40 through F-42 of the Tentative Order:

a. Brine Discharge Technology Empirical Study

The Ocean Plan provides that brine discharge technologies other than wastewater dilution and multiport diffusers may be used if an owner or operator of a desalination facility can demonstrate to the San Diego Water Board that the technology provides a comparable level of intake and mortality of all forms of marine life as wastewater dilution if wastewater to dilute the facility's brine is available, or multiport diffusers if wastewater is unavailable.

As described in Attachment H to this Order and required by the Ocean Plan, the Discharger evaluated all of the individual and cumulative effects of the proposed flow augmentation discharge method on the intake and mortality of marine life, including intake-related entrainment, osmotic stress, turbulence that occurs during water conveyance and mixing, and shearing stress at the point of discharge. The Discharger's evaluation has demonstrated to the San Diego Water Board's satisfaction ~~at this time~~ that wastewater dilution is not available, and that flow augmentation provides a comparable level of intake and mortality of all forms of marine life to the level of the multiport diffuser.

As described in Attachment H of this Order, the Water Code section 13142.5(b) determination must address the requirements of chapter III.M.2.d.(2)(c) of the Ocean Plan that when brine discharge technologies other than wastewater dilution and multiport diffusers are used, the Discharger must demonstrate that the alternative technology provides a comparable level of intake mortality as wastewater dilution or multiport diffusers, if feasible. Appendix CC of the 2015 ROWD and Attachment H of this Order conclude that wastewater dilution is not available ~~at this time~~ due to insufficient wastewater flow volumes, necessary capacity restrictions due to wastewater discharges during wet weather, and lack of access to the necessary infrastructure. Thus, for comparison purposes with the flow augmentation discharge method, the Discharger provided an evaluation based on a model multiport diffuser that would be located 4,000 feet offshore. The model multiport diffuser was designed to maximize dilution, minimize the size of the mixing zone, minimize the suspension of benthic sediments, and minimize marine life mortality.

The Discharger evaluated entrainment effects of each brine discharge alternative, consistent with chapter III.M.2.d.(2)(c)i through iii of the Ocean Plan, in Appendix A and K of the 2015 ROWD on the 2008 *EPS Impingement Mortality and Entrainment Characterization Study* performed by Tenera Environmental. The Discharger revised the entrainment effects calculations as recommended by the SAP and provided the results as Appendices FFF and GGG to the ROWD. The analysis determined that flow augmentation is at least equivalent when compared to the model multiport diffuser for marine life mortality.

Irrespective of the conclusions of the Discharger's ROWD and Attachment H of this Order, chapter III.M.2.d(2)(c)iv of the Ocean Plan requires that if an alternative brine discharge technology other than wastewater dilution and multiport diffusers (e.g. flow augmentation) is approved and implemented under this Order, an empirical study that evaluates intake and mortality of all forms of marine life associated with the alternative brine discharge technology must be submitted within a designated time frame. The requirements for submittal of a Brine Discharge Technology Empirical Study Final Report established in section VI.C.2.a of this Order are in conformance with the requirements mandated by chapter III.M.2.d.(2).(c).iv of the Ocean Plan. If the Final Report shows that the brine discharge technology results in more intake and mortality of marine life than if the Facility used ~~wastewater dilution or~~ multiport diffusers with an estimated intake and mortality of marine life described in Finding 31 of Appendix H, then the Discharger must also submit with the Final Report a proposed schedule to either:

iv. Cease using the alternative brine discharge technology and install and ~~use wastewater dilution or~~ multiport diffusers to discharge brine waste; *or*

v. Re-design the alternative brine discharge technology system to minimize intake and mortality of all forms of marine life to a level that is comparable with ~~wastewater dilution if wastewater is available or~~ multiport diffusers ~~if wastewater is unavailable~~, subject to San Diego Water Board approval.

~~At the time of this Order's adoption with the Water Code section 13142.5(b) determination, the San Diego Water Board is aware of a study by Dr. Philip Roberts, *Brine Diffusers and Shear Mortality*[4] April 2018 (Roberts report), that estimates the marine life mortality from a brine discharge through a multiport diffuser. As such, the Discharger's Brine Discharge Technology Empirical Study should include an analysis of the marine life impacts caused by brine discharged through multiport diffusers using the Roberts study. Poseidon may choose to include additional information for the San Diego Water Boards review, as warranted, in addition to an analysis using the Roberts study. The results of such analyses are subject to further review by the San Diego Water Board following Poseidon's submittal.~~

Requested modifications to Finding 31 of Attachment H-1 of the Tentative Order:

The San Diego Water Board analyzed the information provided by Poseidon for marine life mortality due to a discharge from a theoretical multiport diffuser by calculating the required volume of water to dilute the discharge to meet the salinity receiving water limit. This volume was then multiplied by 0.23 (23%) to estimate ~~the~~an ETM/APF of 585 acres for the volume of water where shearing-related mortality occurs, as was reported by Foster et al[1] and referenced in the *Final Staff Report Including the Final Substitute Environmental Documentation* (SED)[3]. Finally, an estimate of the size of the Brine Mixing Zone was calculated using modeling and a theoretical diffuser. This area is 12.3 acres according to Appendix A to the ROWD. This analysis shows that the flow augmentation discharge technology provides a comparable level of intake and mortality of all forms of marine life as the theoretical multiport diffuser. See Appendices A, K, WW, ZZ, FFF, and GGG to the ROWD.

A recent scientific report[1] by Dr. Philip Roberts has refined the methods to calculate marine life mortality caused by a brine discharge through a diffuser. These refined methods include a process to systematically determine the best available diffuser design to minimize mortality and the size of the BMZ.

San Diego Water Board staff analyzed potential diffuser designs using the methods in the most recent scientific report by Dr. Roberts has estimated that the shearing-related mortality from the best available diffuser design is comparable to Poseidon's estimate of the additional intake-related mortality from the flow-augmentation discharge technology. Specifically, a theoretical diffuser could be designed that would result in a volume of

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~~4 Brine Diffusers and Shear Mortality, Philip J.W. Roberts, April 18, 2018 is available at this website: https://www.waterboards.ca.gov/santaana/water_issues/programs/Wastewater/Poseidon/2018/4-18-18_Diffuser_Analysis_Method.pdf~~

approximately 170 MGD exposed to shearing-related mortality and a potential BMZ that might be as low as 1 acre. Poseidon's estimate of mortality from using flow augmentation discharge technology includes a 171 to 196 MGD volume of intake-related with an estimated entrainment mortality APF of 76 to 88 acres and a BMZ of approximately 18.5 acres. Poseidon conducted a similar analysis in Appendix GGG to the ROWD that concluded a diffuser could be designed that would result in approximately 170 MGD of shearing related mortality with an APF of 459 acres. ~~The San Diego Water Board will further review Poseidon's assessment of the impacts due to a multiport diffuser as part of the Brine Discharge Technology Empirical Study required in section VI.C.2.a. of the Order.~~

In Appendix N to the ROWD, Poseidon estimated the cost to construct a multiport diffuser with a surface water intake to be approximately $425 million. In Appendix EEE to the ROWD, Poseidon estimated the cost to construct Design Alternative 21, a surface water intake with WWS using flow augmentation discharge technology, to be $53 million. Poseidon's September 13, 2018 cost update for Alternative 21 put the expected cost of this alternative between $66.2 to $82.8 million.

Based on the discussion above, the San Diego Water Board has determined that flow augmentation provides a comparable level of intake and mortality of all forms of marine life as multiport diffusers and is the best available discharge technology feasible.

Due to uncertainties in estimating the marine life mortality through modeling and as required by the Ocean Plan, Section VI.C.2.a.v. of this Order requires a special study to evaluate intake and mortality of all forms of marine life associated with the discharge technology for permanent stand-alone operations. This study will evaluate the marine life mortality from a flow-augmentation discharge with empirical observation data for direct comparison to the marine life mortality from a diffuser as outlined above with an APF of 459 to 585 acres.

If the study shows that the flow-augmentation discharge technology results in more intake and mortality of all forms of marine life than a Facility ~~using wastewater dilution or~~ multiport diffusers with an estimated intake and mortality of marine life of 459 to 585 acres, then the Facility must submit a proposed schedule to either:

1. Cease using the flow-augmentation brine discharge technology and install and use ~~wastewater dilution or~~ multiport diffusers to discharge brine waste; or

2. Re-design the alternative flow-augmentation discharge technology system to minimize intake and mortality of all forms of marine life to a level that is comparable with ~~wastewater dilution if wastewater is available, or~~ multiport diffusers ~~if wastewater is unavailable~~, subject to San Diego Water Board approval.

[1]Desalination Plant Entrainment Impacts and Mitigation. Expert Review Panel III, Foster et al, 2013 available at: https://www.waterboards.ca.gov/water_issues/programs/ocean/desalination/docs/erp_final.pdf (as of June 25, 2018)

[2]Brine Diffusers and Shear Mortality, Philip J.W. Roberts, April 18, 2018 is available at the Santa Ana Water Board's website: https://www.waterboards.ca.gov/santaana/water_issues/programs/Wastewater/Poseidon/2018/4-18-18_Diffuser_Analysis_Method.pdf (as of June 25, 2018)

[3]The Final Staff Report Including the Final Substitute Environmental Documentation is available at: https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2015/rs2015_0033_sr_apx.pdf (Roberts' report)

3. Intake Specifications (Tentative Order page 12).

Please revise paragraph 7 as shown in red below to clarify that the in-plant recycling requirement is "to the maximum extent practical":

7. To the maximum extent practical, ~~In~~in-plant recycling of waste streams shall be maximized before intaking additional seawater;

4. Interim Operations Requirements (Tentative Order page 23).

Please revise the Interim Operations Requirements set forth in section VI.C.7.c of the Tentative Order the reflect the ongoing operations and maintenance requirements during interim operations shown in red below:

a. Interim Operations Requirements

Until the new intake structure is constructed and operational, the Discharger is required to implement the following measures to minimize the intake and mortality of all forms of marine life:

- **i.** Surface water intakes must be screened using the existing intake screens, and the screens must be functional while the Facility is withdrawing seawater, screen wash water and organic debris removed from the screens are discharged to the discharge channel;
- **ii.** The intake of seawater must not exceed a flowrate of 330 MGD with the existing intake pumps; and 299 MGD with the new intake pumps. An existing hypochlorite generator runs intermittently when the existing pumps are in operation. Seawater used to cool the DC rectifier and existing pumps is discharged to the discharge channel.
- **iii.** Axial-flow, low-turbulence pumps shall be constructed and made operational as soon as feasible but no later than the date specified in Table 7, Task 2;
- **iv.** The intake of seawater shall be reduced to the minimum volume necessary to maintain Facility operations and to comply with this Order, subject to the operational limitations of the existing pumps prior to the new intake pumps being operational;
- **v.** To the maximum extent practicable, in-plant recycling of waste streams shall be maximized before intaking additional seawater;
- **vi.** The Discharger shall cease intake of seawater except when intake of seawater is necessary to maintain Facility operations or to comply with this Order;
- **vii.** Heat treatment of the intake system is prohibited; and
- **viii.** Pump operations shall minimize abrupt changes in flow velocity, subject to the operational limitations of the existing pumps prior to the new intake pumps being operational.

5. Effluent Monitoring at M-001 when not Discharging Brine (Tentative Order page E-8).

Please revise the paragraph preceding Table E-4 as shown in red below to clarify that the monitoring requirements at M-001 when the Facility is not discharging brine are during such "temporary periods when the facility is not discharging brine":

> At times including but not limited to plant start-up, during or after plant maintenance, or other times when the Facility is not delivering product water to the regional water system, the Facility may temporarily discharge flows without the concentrated reverse osmosis brine. During such ~~times~~ temporary periods when the facility is not discharging brine, monitoring is required to ensure compliance with permit provisions. The Discharger shall monitor the effluent at monitoring location M-001 when not discharging brine as follows:

6. Table E-8 Offshore Monitoring Requirements (Tentative Order page E-17).

Please revise footnote 2 to Table E-8 to clarify that the depth profile measurements are to be "evaluated at a minimum of one-foot intervals":

> Temperature, depth, salinity, dissolved oxygen, light transmittance, and pH profile data shall be measured throughout the entire water column using a conductivity, temperature, and depth (CTD) profiler during the quarterly sampling events. Depth profile measurements shall be obtained using multiple sensors to measure parameters through the entire water column (from the surface to as close to the bottom as practicable), evaluated at a minimum of one-foot intervals.

7. Facility Description (Tentative Order page F-6).

Please revise the third paragraph of the Facility Description as shown in red below to reflect the correct flow rate during interim operations:

> Startup maintenance flows, product water, and off-spec water may be temporarily discharged in the Pacific Ocean during initial plant start-up, during or after plant maintenance, or other times when the Facility is not delivering potable water to the regional water system. To the maximum extent practicable, these flows must be recycled to the Facility headworks for potable water production. During such temporary periods, the total maximum allowable discharge flowrate shall not exceed 330 MGD with the existing intake pumps and 299 MGD with the new intake pumps, the maximum allowable intake flowrate. Temporarily discharging such water to the Pacific Ocean does not constitute a "bypass" as defined in Attachments A and D of this Order. All limits and requirements, including monitoring, specified in this Order remain applicable during these temporary discharges.

8. Reopener Provision (Tentative Order page F-40).

Please revise the second paragraph of the description of the Reopener Provision on page F-40 of the fact sheet as shown in red below to acknowledge that a potential reason the Discharger may request to modify provisions governing compliance with Water Code section 13142.5(b) and the Ocean Plan is that the Discharger's pilot test failed to confirm the expected performance and reliability of the wedgewire screens as the intake screening technology for the Facility.

1. **Reopener Provisions**

   This Order may be reopened to modify provisions governing compliance with Water Code section 13142.5(b) and the Ocean Plan if the Discharger proposes a change in design or operation of the Facility in a manner that could increase intake or mortality of all forms of marine life, consistent with the Ocean Plan definition of an expanded facility, beyond that which is approved in this Water Code section 13142.5(b) determination. Causes for modifications include, but are not limited to, the Discharger's pilot scale intake project to assess debris management and intake maintenance requirements fails to confirm the expected performance and reliability of the wedgewire screens in the Lagoon. This Order may be reopened at any time for modification of provisions governing compliance with the receiving water limitation for salinity as set forth in Ocean Plan chapter III.M.3.

9. **Finding 68 (Appendix H-1).**

Suggested correction to Finding 68 of Appendix H-1:

> Poseidon initially requested a facility-specific alternative receiving water limitation for salinity (see Appendix A to the ROWD) but did not ~~provide~~ pursue this request in the development of the ROWD. Consequently, the ROWD does not include adequate technical supporting information to demonstrate that an alternative receiving water limitation would be protective of water quality standards

Thank you for consideration of these comments. Please feel free to contact me if you have any questions.

Sincerely,

Peter M. MacLaggan
Senior Vice President

Cc: David Barker
Brandi Outwin-Beals
Maureen Stapleton

ATTACHMENTS

Attachment 1 - Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of the Tentative Order

Attachment 2 - Appendix GGG Revised Entrainment Analysis for Brine Discharge Operations Revision 2

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
Amended Application September 4, 2015	Amended Report of Waste Discharge (Amended ROWD)	Provides summary of requested NPDES permit modifications for permanent stand-alone operations after EPS retirement.	Page 4: <u>average annual</u> RO concentrate discharges of up to 60 MGD; Page 5: backwash flows of up to 7 MGD; Page 5: intake screen rinsing and fish return flow of 1 MGD Combined waste streams 68 MGD; Page 9: M-002 salinity limit 42 ppt	The Amended ROWD contemplated an <u>average annual RO concentrate flow of 60 MGD</u> to provide the operator sufficient flexibility to adjust the allocation of flow between the RO concentrate and backwash waste streams as needed to operate the plant to produce 60 MGD of product water at RO recovery rates varying between 48% to 50%. The ROWD contemplated 68 MGD combined waste streams. After the submittal of the Amended Report of Waste Discharge, a decision was made to replace the proposed travelling screens with wedgewire screens. This decision eliminated the need for the screen wash and fish return flow of of 1 MGD, which resulted in a reduction of the combined discharge from 68 MGD to 67 MGD. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with the Amended ROWD Application dated September 4, 2015.**
Amended Application September 4, 2015	EPA Form 2D	Describes proposed	60 MGD average annual RO concentrate; 7 MGD average annual backwash;	Form 2D request for <u>average annual flow of 60 MGD RO concentrate</u> provides sufficient flexibility to operate the CDP with wit RO concentrate flows intermittently greater than 60 MGD.

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
				Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Form 2D.
Appendix A	Compliance with Ocean Plan Amendments	Proposed CDP operations are in compliance with all applicable provisions of the 2015 Ocean Plan, including requirements governing receiving water salinity; use of best available site, design, technology and mitigation; and consideration of preferred technologies. Subsurface intake alternatives were determined to be infeasible. The multiport diffuser is not the best technology measure feasible to minimize the intake and mortality of all forms of marine life. See Appendix JJ for errata to this Appendix A.	Appendix A analyzed worst case discharge 60 MGD RO concentrate at 67 ppt, combined with 7 MGD backwash at 33.5 ppt, resulting in a combined discharge of 63.5 ppt at M-001.	With the proposed modifications to Table 4, the salinity at M-001 would be 63.5 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix A.**
Appendix B	Intake Discharge Feasibility Report	Feasibility of four combinations of intake and discharge technologies as well as the Ocean Plan preferred technology requirements in developing an intake and discharge plan that provides the best combination of the best available site, design, technology, and mitigation feasible to minimize the intake and mortality of all forms of marine life. See Appendix II for the feasibility assessment of six additional combinations of intake and discharge technologies.	Appendix B analyzed worst case discharge 60 MGD RO concentrate at 67 ppt, combined with 7 MGD backwash at 33.5 ppt, resulting in a combined discharge of 63.5 ppt at M-001.	Under the combined flow request, the salinity at M-001 would be 63.5 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix B.**
Appendix C	Hydrodynamic Discharge Study	The existing discharge structure provides for significant additional dilution through a range of hydrodynamic conditions. Actual initial dilutions are projected to be in excess of the dilution credits assigned within Order No. R9-2006-0065. The hydrodynamic discharge modeling report contained in this Appendix C has been revised in response to comments received from the Regional	Appendix C analyzed a worst case combined discharge of 42 ppt at M-002.	With the proposed modifications to Table 4, the salinity at M-002 would be less than 42 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the**

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
		Water Board. See Appendix BB for the revised hydrodynamic discharge modeling report.		**Tentative Order are consistent with Appendix C.**
Appendix D	Coastal Process Effects of Reduced Intake	Reduced intake flows under permanent stand-alone operations will not create any significant adverse impacts on either the lagoon environment or local beaches, and will result in environmental benefits resulting from the reduced frequency of required lagoon maintenance dredging.	NA	NA
Appendix E	NPDES Order No. R9-2011-0028	The Order approves selection of the Otay River Floodplain wetlands restoration site for mitigating entrainment and impingement effects that may be caused by operation of the CDP.	NA	NA
Appendix F	Water Circulation in Agua Hedionda Lagoon	The location of the fish return system takes into account lagoon mixing that occurs as a result of tidal actions and other hydrodynamic drivers.	NA	NA
Appendix G	Acute Toxicity Study	The proposed salinity discharge standard of 42 ppt within the effluent pond will ensure that the CDP discharge will comply with Ocean Plan acute toxicity standards.	Appendix G analyzed a worst case combined discharge of 42 ppt at M-002.	With the proposed modifications to Table 4, the salinity at M-002 would be less than 42 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix G.**
Appendix H	Chronic Toxicity Study	The proposed salinity discharge standard of 42 ppt within the effluent pond will ensure that the CDP discharge will comply with Ocean Plan chronic toxicity standards.	Appendix H analyzed a worst case combined discharge of 42 ppt at M-002.	With the proposed modifications to Table 4, the salinity at M-002 would be less than 42 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix H.**

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
Appendix I	Brine Dilution Salinity Tolerance	The proposed salinity discharge standard of 42 ppt within the effluent pond is consistent with Ocean Plan requirements to minimize osmotic shock and consistent with ensuring protection of marine species.	Appendix I analyzed a worst case combined discharge of 42 ppt at M-002.	With the proposed modifications to Table 4, the salinity at M-002 would be less than 42 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix I.**
Appendix J	Fish-Friendly Pumping	The proposed fish-friendly flow augmentation pumps are consistent with the Ocean Plan requirements to minimize turbulence and shear stress on marine organisms.	NA	NA
Appendix K	Intake/Discharge Entrainment Analysis	Entrainment effect associated with the proposed CDP flow augmentation system are less than impacts that result from a multiport diffuser discharge.	Appendix K analyzed the entrainment impacts of (i) a flow augmentation system with 299 MGD intake; and (ii) a diffuser with 67 MGD discharge.	With the proposed modifications to Table 4, the intake flow would not exceed 299 MGD and the discharge flow would not exceed 67 MGD. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix K.**
Appendix L	CFD Modeling of Flow Augmentation System	Computational fluid dynamics (CFD) modeling using particle tracking was utilized to estimate exposure times of marine organisms in the CDP intake flow under permanent stand-alone conditions.	Appendix L analyzed the entrainment impacts of a flow augmentation system with 299 MGD intake.	With the proposed modifications to Table 4, the intake flow would not exceed 299 MGD. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix L.**
Appendix M	Antidegradation Analysis	Proposed CDP production rates, discharge flows, and effluent pond salinities are in keeping with Tier I antidegradation requirements for the	Appendix M analyzed worst case discharge 60 MGD RO concentrate at 67 ppt, combined with 7 MGD backwash at 33.5 ppt, resulting in a	With the proposed modifications to Table 4, the salinity at M-001 would be 63.5 ppt under all operating scenarios.

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
		protection of beneficial uses and maintenance of existing high quality receiving water.	combined discharge of 63.5 ppt at M-001.	**Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix M.**
Appendix N	Life Cycle Cost Analysis	Life cycle costs for CDP facilities demonstrate the economic superiority of surface intake with flow augmentation and surface discharge as the preferred intake/discharge alternative. The life-cycle cost analysis contained in this Appendix N has been revised in response to comments received from the Regional Water Board. See Appendix OO for the life-cycle cost analysis.	NA	NA
Appendix O	NPDES Order No. R9-2009-0038	Order No. R9-2009-0038 makes certain findings pursuant to Water Code Section 13142.5(b), approves the March 27, 2009 Minimization Plan submitted by Poseidon, and modifies NPDES CA0109223 to acknowledge Minimization Plan approval and to establish performance standards for Minimization Plan implementation.	NA	NA
Appendix P	Flow, Entrainment, Impingement Minimization Plan	The Minimization Plan implements Water Code 13142.5(b) requirements and establishes the best available site, design, technology, and mitigation feasible to minimize CDP intake effects associated operations under co-located and temporary stand-alone conditions.	NA	NA
Appendix Q	Final EIR	CDP facilities and operations under co-located and temporary stand-alone conditions are in compliance with requirements of the California Environmental Quality Act (CEQA).	NA	NA
Appendix R	California Coastal Commission	California Coastal Commission findings and habitat restoration requirements for mitigating	NA	NA

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
	Approval of Marine Life Mitigation Plan	against potential CDP entrainment and impingement effects.		
Appendix S	Hydrogeologic Investigation SDG&E Encina Power Plant, Carlsbad, CA	Prior hydrogeologic assessment of EPS site has identified opportunities and limitations associated with developing onsite groundwater supplies.	NA	NA
Appendix T	Drought Proofing Through Desalting the SDG&E Approach	Prior SDG&E assessment has identified opportunities and limitations at the EPS site for developing power plant water supplies through desalination of pumped groundwater.	NA	NA
Appendix U	Huntington Beach Desalination Project, ISTAP Phase I & II Reports	An Independent Scientific Technical Advisory Panel evaluated alternatives for subsurface intakes for the Huntington Beach Desalination Project.	NA	NA
Appendix V	U.S. Fish and Wildlife Service MOU	The Memorandum of Understanding establishes responsibilities for Poseidon and U.S. Fish and Wild Life Service in restoring and enhancing habitat in the San Diego Bay National Wildlife Refuge.	NA	NA
Appendix W	SDCWA 2010 Urban Water Management Plan and 2013 Facilities Master Plan Update	The San Diego County Water Authority (SDCWA) plans identify the importance of seawater desalination in meeting projected regional water supply demands and enhancing regional water supply reliability.	NA	NA
Appendix X	Construction Cost Estimates for Intake/ Discharge Alternatives	Construction cost estimates for intake/discharge alternatives considered in developing a recommended intake and discharge plan that provides the best combination of best available site, design, technology, and mitigation feasible to	NA	NA

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
		minimize the intake and mortality of all forms of marine life.		
Appendix Y	Implementation Schedules for Intake/Discharge Alternatives	Permitting and construction schedules for intake/discharge alternatives considered in developing a recommended intake and discharge plan that provides the best combination of the best available site, design, technology, and mitigation feasible to minimize the intake and mortality of all forms of marine life.	NA	NA
Appendix Z	Proposed Monitoring and Reporting Plan	The proposed CDP monitoring and reporting plan incorporates enhanced receiving water sediment, benthic, and water column monitoring in order to comply with monitoring provisions established within Section III.M.4 of the 2015 Ocean Plan amendments.	NA	NA
Appendix AA	California Coastal Commission Approval of CDP	California Coastal Commission revised findings to conditionally approve Carlsbad Desalination Project CDP #E-06-013, August 5, 2008.	NA	NA
Appendix BB	Revised Hydrodynamic Discharge Modeling Report	The hydrodynamic discharge modeling report contained in Appendix C was revised in response to comments received from the Regional Water Board. The mixing conditions modeled in the study were modified to reflect quiescent ocean conditions per the definition of Initial Dilution in the Ocean Plan.	Appendix BB analyzed a worst case combined discharge of 42 ppt at M-002.	With the proposed modifications to Table 4, the salinity at M-002 would be less than 42 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix BB.**
Appendix CC	Encina Wastewater Authority Response to Request for Information regarding the Encina Ocean Outfall as a	The San Diego Regional Water Board Staff requested that Poseidon consult the Encina Wastewater Authority about the possibility of diverting some of the effluent from the CDP to the Encina Ocean Outfall. The Encina Wastewater Authority's response addresses some	NA	NA

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
	Brine Discharge Alternative for the Carlsbad Desalination Plant	of the criteria necessary for assessing the feasibility of diverting some of the brine discharge from the CDP to the Encina Ocean Outfall for disposal.		
Appendix DD	Analysis of Potential for CDP Discharge to Cause Hypoxic Conditions	Technical memorandum describing why the project is not expected to cause hypoxic conditions outside the BMZ.	Appendix DD analyzed a worst case combined discharge of 42 ppt at M-002.	With the proposed modifications to Table 4, the salinity at M-002 would be less than 42 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix DD.**
Appendix EE	Comparison of Fish Return Options	Technical memorandum assessing the feasibility of fish return system options in Agua Hedionda Lagoon and the existing discharge pond.	NA	NA
Appendix FF	Fish Return System Cleaning Methods	Technical memorandum describing proposed fish return cleaning methods.	NA	NA
Appendix GG	Larval Fish Residence Time in Agua Hedionda Lagoon	Technical memorandum assessing the residence time of larval fish in Agua Hedionda Lagoon.	NA	NA
Appendix HH	Entrapment Evaluation	Technical memorandum assessing the potential for entrapment of fish and organisms in the proposed intake/discharge modifications.	NA	NA
Appendix II	Addendum to Intake Discharge Feasibility Report	Addendum to Appendix B. Collectively, these appendices assess the feasibility of 10 combinations of intake and discharge technologies as well as the Ocean Plan preferred technology requirements in developing an intake and discharge plan that provides the best combination of the best available site, design,	Appendix II analyzed worst case discharge 60 MGD RO concentrate at 67 ppt, combined with 7 MGD backwash at 33.5 ppt, resulting in a combined discharge of 63.5 ppt at M-001.	With the proposed modifications to Table 4, the salinity at M-001 would be 63.5 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the**

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
		technology, and mitigation feasible to minimize the intake and mortality of all forms of marine life. This Appendix II includes the for all ten combinations of intake and discharge alternatives considered along with the detailed analysis of alternatives 5-10. See Appendix B for the detailed analysis of intake and discharge technologies 1-4.		**Tentative Order are consistent with Appendix II.**
Appendix JJ	Appendix A Errata	Corrections to errors contained in Appendix A.	NA	NA
Appendix KK	Draft Final SEIR	Final Supplement to the Precise Development Plan and Desalination Plant Project Final Environmental Impact Report (EIR 03-05) evaluating the potential environmental effects resulting from the project as modified, which includes (1) seawater intake and discharge system improvements required to be constructed due to the decommissioning of the once-through cooling system of the EPS; and (2) desalination processing improvements that would increase production capacity of the CDP by approximately an annual average 5 million gallons per day (mgd).	Appendix KK analyzed 299 MGD intake flow with a combined discharge a salinity of 42 ppt at M-002.	With the proposed modifications to Table 4, the intake flow would be 299 MGD, salinity at M-002 would be less than 42 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix KK.**
Appendix LL	Draft Response to Comments	Response to Comments Supplement to the Precise Development Plan and Desalination Plant Project Final Environmental Impact Report (EIR 03-05).	NA	NA
Appendix MM	Draft Findings of Fact	Findings of Fact Supplement to the Precise Development Plan and Desalination Plant Project Final Environmental Impact Report (EIR 03-05)	NA	NA
Appendix NN	Draft Mitigation Monitoring and Reporting Program	Mitigation Monitoring and Reporting Program Supplement to the Precise Development Plan and	NA	NA

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
		Desalination Plant Project Final Environmental Impact Report (EIR 03-05)		
Appendix OO	Revised Life Cycle Cost Analysis	Life cycle cost analysis for all ten combinations of intake and discharge alternatives considered for the CDP transition to stand-alone operations and Ocean Plan Compliance.	NA	NA
Appendix PP	Intake/Discharge Design Modifications	Summarizes the changes made to the design of the New Screening/Fish-friendly Pumping Structure since the September 4, 2015 submittal of the Amended ROWD.	NA	NA
Appendix QQ	Response to Questions Regarding CDP Discharge Modeling Reports	This appendix addresses the Water Boards' September 27, 2016 questions regarding the Revised Hydrodynamic Discharge Modeling included in Appendix BB.	Appendix BB and Appendix QQ analyzed a worst case combined discharge of 42 ppt at M-002.	With the proposed modifications to Table 4, the salinity at M-002 would be less than 42 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix QQ.**
Appendix RR	Feasibility Assessment of Alternative Brine Discharge to the Encina Ocean Outfall	Analysis of the Encina Ocean Outfall brine dilution potential and an assessment of the facilities required to convey the CDP discharge to the Encina Ocean Outfall for blending with the discharge from the Encina Water Pollution Control Facility.	NA	NA
Appendix SS	Feasibility Assessment of Wedgewire Screen (WWS) Intake in Agua Hedionda Lagoon	During the September 27, 2016 meeting with State and Regional Water Board staff, staff requested a more detailed analysis of the WWS intake in the Lagoon. The technical aspects and potential feasibility of two WWS technologies in this lagoon are evaluated in this Appendix SS.	NA	NA

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
Appendix TT	Fish Return System Discharge Location Alternatives Analysis	During the September 27, 2016 meeting with State and Regional Water Board staff, staff requested additional information that can be used in their effort to reach a determination on the best location for the fish return system. This Appendix TT provides a comparison of the lagoon and discharge pond fish return systems, and where possible, quantifies the impacts of each alternative fish return discharge location.	NA	NA
Appendix UU	Brine Mixing Zone Habitat Assessment (Revised Jan 18, 2017)	This appendix provides an assessment of existing habitat value in the BMZ and proposes a mitigation ratio based on the productivity of the existing BMZ habitat as compared to that of the proposed restoration project.	NA	NA
Appendix VV	Establishing the Location of the Zone of Initial Dilution for Stand-Alone Operation	Supporting information, and rationale for Discharger's recommendation that the ZID should remain at the current location 1,000 feet from the discharge.	Appendix VV analyzed an intake flow of up to 299 MGD; combined RO and backwash discharge of up to 68 MGD; flow augmentation of up to 196 MGD; and combined discharge salinity of 42 ppt at M-002.	With the proposed modifications to Table 4, the intake flow would not exceed 299 MGD; the combined RO and backwash discharge would be less than 68 MGD; and the salinity at M-002 would be less than 42 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix VV.**
Appendix WW	Brine Discharge Mortality Calculations	Depending on the discharge method employed, mortality resulting from operational impacts can be comprised of the following components: • mortality associated with elevated salinity in the brine mixing zone (BMZ); and	NA	NA

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
		• mortality associated with shearing stress at the point of discharge; or • mortality associated with intake-related entrainment– relevant for a flow augmentation approach This appendix describes the three components of the brine discharge mortality calculation and the methods used to estimate the mortality.		
Appendix XX	Current and 2065 Area BMZ and Wetlands Restoration Project	This appendix provides a calculation of the soft bottom and hard bottom area within the BMZ as it exists today and expected conditions in the year 2065 and the current and 2065 area of the proposed Wetlands Restoration Project intertidal and subtidal alternatives.	NA	NA
Appendix YY	Marine Life Mortality Comparison between the Proposed Screening Location and the Lagoon Screen Locations	This appendix provides a comparison the marine life mortality expected with the proposed intake screening design versus a design with the screens located at the Lagoon shoreline.	NA	NA
Appendix ZZ	Marine Life Mortality Report and Mitigation Calculation	Ocean Plan Amendment requires that the owner of a desalination facility submit a report to the Regional Water Board estimating the marine life mortality resulting from the construction and operation of the facility after implementation of the required site, design, and technology measures and mitigate for the mortality of all forms of marine life determined in the report. This appendix is responsive to this requirement.	Appendix ZZ established the mitigation requirements for an intake flow of up to 299 MGD; combined RO and backwash discharge of up to 67 MGD; and combined discharge salinity of 42 ppt for the proposed flow augmentation system and 67 ppt for a project using a multiport diffuser.	With the proposed modifications to Table 4, the intake flow would not exceed 299 MGD; the combined RO and backwash discharge would not exceed 67 MGD; and the salinity at M-002 would be less than 42 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the**

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
				Tentative Order are consistent with Appendix ZZ.
Appendix AAA	Fish Return Discharge Antidegradation Analysis	The proposed fish return discharge to Agua Hedionda Lagoon represents a new discharge point. This appendix assesses water quality effects of the proposed fish return discharge and assesses compliance of the proposed fish return discharge with state and federal antidegredation regulations.	NA	NA
Appendix BBB	Evaluation of Intake Alternatives 1, 15, 16, 17, 18, 19, and 20.	This appendix assesses the feasibility of various enhancements to the Discharger's proposed intake and discharge Alternative 1 that are intended to further reduce the intake and mortality of all forms of marine life associated with Alternative 1.	NA	NA
Appendix CCC	Evaluation of Alternatives 1, 11-14	The evaluation of the costs and benefits of alternatives 11-14 compared to that of Alternative 1 was presented at the January 31, 2017 Carlsbad Permit Renewal Team meeting. This evaluation was based on cost and marine life mortality estimates for the baseline Alternative 1 that was prepared in 2016. Whereas, the evaluation of costs and benefits of alternatives 15-20 presented at the March 28, 2017 Carlsbad Permit Renewal Team meeting (Appendix BBB) was based on cost and marine life mortality estimates for Alternative 1 that were updated in April 2017. This Appendix CCC provides an updated evaluation of costs and benefits of alternatives 11-14 compared to Alternative 1 using the updated April 2017 cost and marine life mortality estimate for Alternative 1. This update is directly	NA	NA

Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
		comparable to the feasibility assessment of alternatives 15-20.		
Appendix DDD	Alternative 21 Feasibility Assessment	The appendix provides an assessment of performance and reliability of wedge wire screens in an estuarine environment similar to Agua Hedionda Lagoon.	NA	NA
Appendix EEE	Revised Feasibility Assessment for Alternatives 1, 15, and 21	Updated assessment of environmental, cost, and schedule feasibility criteria for Alternatives 1, 15, and 21. Alternatives 1 and 15 determined to be feasible. Currently there is no operational data available to assess the performance and reliability of wedge wire screens (WWS) in an estuarine environment similar to Agua Hedionda Lagoon. Poseidon is proposing a pilot-scale demonstration project to determine the feasibility of using WWS in Agua Hedionda Lagoon, refine the design an operation and maintenance (O&M) requirements for the WWS, and validate the capital and O&M cost assumptions presented in this Appendix.	NA	NA
Appendix FFF	Revised APF Calculations	This Appendix FFF provides revised calculations to establish the Area of Production Foregone (APF) estimates for the Carlsbad Desalination Plant (CDP) previously presented in Appendix K of the Report of Waste Discharge. The calculations were revised in response to comments received from the Science Advisory Panel.	Appendix FFF provides an update of the intake entrainment ETM/APF calculations in response to SAP guidance.	The proposed modifications to Table 4 would not result in increased intake flow. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix FFF.**
Appendix GGG [submitted 12/14/18,	Revised Entrainment Analysis for Brine Discharge Options	This Appendix GGG provides an updated comparison of the Area of Production Foregone (APF) estimates for the flow augmentation system and the multiport diffuser brine discharge	Appendix GGG analyzed the entrainment impacts of (i) a flow augmentation system with 171 MGD to 196 MGD intake; and (ii) a diffuser with 67 MGD discharge.	With the proposed modifications to Table 4, the intake flow augmentation flow would not exceed 196 MGD and the discharge flow would not exceed 67 MGD.

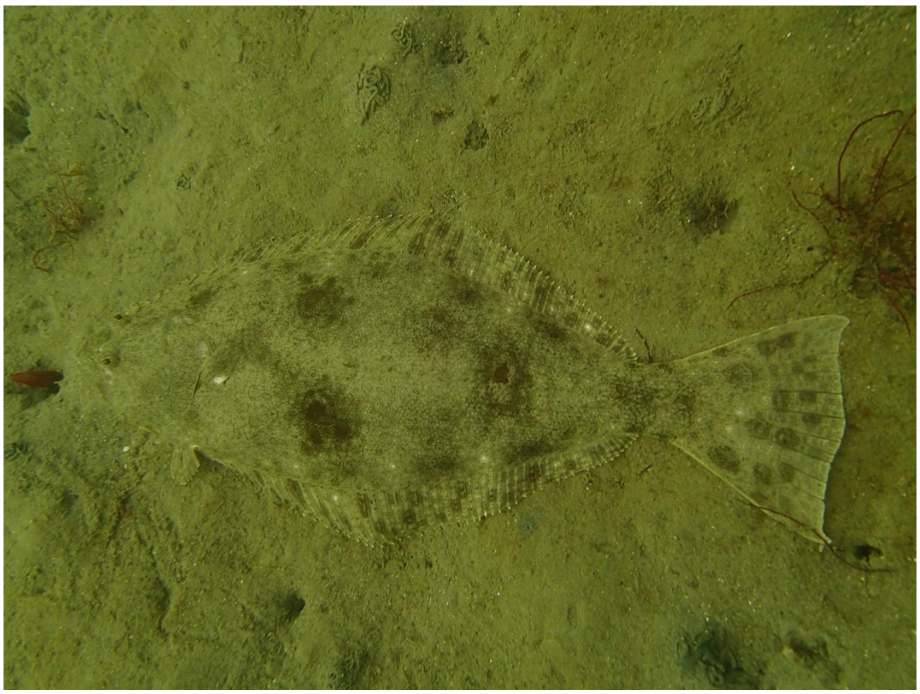
Attachment 1
Carlsbad Desalination Project
Comparison of Information in Amended Report of Waste Discharge to Proposed Modifications to Table 4 of Tentative Order

Report of Waste Discharge	Document Title	Summary of Content	Characterization of Discharge	Comparison of ROWD Submittals to Combined Flow Request
resubmitted 12/18/18 and 1/14/19]		technologies. This information was previously presented in Appendix K of the Report of Waste Discharge. The calculations were revised in response to comments received from the Science Advisory Panel.		**Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix GGG.**
Appendix HHH	Relative Salinity Impacts in the Brine Mixing Zone of the CDP at Various Discharge Rates	This Appendix HHH provides calculations for estimates of relative BMZ salinity impacts for CDP production rates of 60 MGD, 54 MGD, and 50 MGD of potable water production from 299 MGD of intake flow, with discharges of 249 MGD and 245 MGD of brine at 40.24 ppt and 40.91 ppt, respectively.	Appendix HHH analyzed an intake flow of up to 299 MGD; combined RO and backwash discharge of up to 67 MGD; flow augmentation of up to 196 MGD; and combined discharge salinity of up to 42 ppt at M-002.	With the proposed modifications to Table 4, the intake flow would not exceed 299 MGD; the combined RO and backwash discharge would not exceed 67 MGD; and the salinity at M-002 would be less than 42 ppt under all operating scenarios. **Conclusion: The proposed modifications to Table 4 of the Tentative Order are consistent with Appendix HHH.**

May 8, 2019
Item No. 10
Supporting Document No. 3a

CARLSBAD DESALINATION PLANT

REVISED ENTRAINMENT ANALYSIS FOR BRINE DISCHARGE OPTIONS



Prepared For	POSEIDON WATER CARLSBAD DESALINATION PLANT
Prepared By	ERIC MILLER MILLER MARINE SCIENCE & CONSULTING, INC ALISO VIEJO, CA
Date	JANUARY 2019
Application Appendix Number	GGG-R2

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PURPOSE

Chapter III.M.2.d.(2)(c)(i) of the Ocean Plan states that when determining the intake and mortality associated with a brine discharge technology, the Regional Water Board shall require the owner or operator estimate the intake entrainment impacts using an ETM/APF approach. In response to this requirement, Poseidon submitted flow augmentation and multiport diffuser APF calculations to the Regional Water Board September 4, 2015 (Appendix K Intake/Discharge Entrainment Analysis). The Science Advisory Panel review of the APF calculations prompted a need to update the APF calculations in Appendix K. Poseidon submitted updated flow augmentation and multiport diffuser APF calculations to the Regional Water Board December 14, 2018 (Appendix GGG Revised Entrainment Analysis for Brine Discharge Operations). Based on a December 17, 2018 request from the State Water Board staff, Poseidon revised Appendix GGG to include an assessment of an alternative multiport diffuser design (Roberts 2018). The revised Appendix GGG (Revision 1) was submitted to the Regional Water Board on December 18, 2018, and includes a calculation of the APF of a multiport diffuser analyzed in accordance with the SED guidance for a multiport diffuser with a 217 MGD deleterious shear volume, a calculation of the of a APF for a theoretical diffuser with 170 MGD deleterious shear volume (Roberts 2018), and a calculation of the APF for flow augmentation at 171 MGD and 196 MGD. The Regional Water Board and State Water Board met with Poseidon January 7, 2019 to review Appendix GGG. That meeting led to a request for further amendments to Appendix GGG, which have been incorporated in this Revision 2 to Appendix GGG.

Appendix K to the Report of Waste Discharge (ROWD) the Carlsbad Desalination Plant (CDP) provides an estimate of the intake and discharge entrainment impacts associated with stand-alone operations of the CDP. This Appendix was submitted to the San Diego Regional Water Quality Control Board (RWB) in 2015 and includes a comparison of the estimated entrainment impacts of alternative brine discharge technologies (flow augmentation and a multiport diffuser). Poseidon's entrainment calculations were subsequently reviewed by a third-party science advisory panel (SAP) that revised the methodology used to calculate the Area of Production Foregone (APF) that is used to estimate the entrainment impacts presented in Appendix K. The purpose of this Appendix GGG is to update the Area of Production Foregone (APF) for the brine dilution options under consideration for the CDP to reflect the SAP's guidance. A copy of the SAP's report is included in Attachment 1 to this Appendix GGG. Appendix FFF to the ROWD presents the calculations of 171 MGD of flow augmentation in accordance with the SAP report and is included as Attachment 2 to this report. Calculations used to derive the proportional mortality under each diffuser deleterious volume considered are included in Attachments 3 through 6.

METHODS

Site Selection

Encina Power Station 316(b) plankton sampling (EPS) stations N1 through N5 were evaluated as potential locations for the multiport diffuser (Figure 1). Site selection criteria considered included minimize mortality of all forms of marine life; site the diffuser to avoid sensitive habitat; and minimize construction impacts. An important consideration in the siting analysis was the proximity of the giant kelp beds (*Macrocystis pyrifera*) located offshore of the CDP to the potential diffuser sites. The location and size of kelp beds were mapped in QGIS (v3.0.1) using the persistent kelp layer provided by the California Department of Fish and Wildlife (DFW 2019).

As shown in Figure 1, Stations N1, N2, and N3 are in close proximity ($\leq$ 100 m) to the kelp beds, so these stations were removed from further consideration as potential sites for the multiport diffuser. The diffuser would presumably be connected to the plant in a straight line similar to the one depicted in Figure 1 extending to Station N4 without any angles or turns. A diffuser installed at Station N1 would need to pass through, under or very near the giant kelp bed depicted nearly offshore the mouth of Agua Hedionda Lagoon. The resulting brine plume from a diffuser at Station N1 would have a high potential to be distributed into the nearby giant kelp bed posing a threat to the viability of both the giant kelp and the community relying on it as biogenic habitat. At Station N3, a diffuser would have the same construction and brine plume dispersal patterns as were noted for Station N1. The brine plume from a diffuser at Station N3 would be dispersed upcoast at times when the ambient alongshore currents reversed and flowed upcoast as measured during the 2004-05 study (Figure 2). A diffuser at Station N2 would not pose similar construction impact concerns for the giant kelp beds as diffusers at Station N1 or N3, but the same periodic alongshore current reversals depicted in Figure 2 and described for Station N3 would likewise carry the brine plume upcoast into the nearby giant kelp bed.

Stations N4 and N5 are sufficient distance from the kelp beds to be considered suitable sites to avoid impacts to this sensitive habitat. Station N4 is located approximately 322 m southwest and down current of the North Kelp Bed and, while it is up current from the South Kelp Bed, it is more than 1.2 km away from the northern edge of this kelp bed. Station N5 is located the farthest from the kelp beds. However, the larval concentrations at Station N5 are greater than Station N4, and it would result in greater construction impacts than Station N4 because is located further offshore. Based on this assessment, Station N4 is be the best available site to serve as the basis for analyzing the multiport diffuser impacts.

Data Source

The EPS impingement mortality and entrainment characterization study (Tenera 2008) was used as the primary larval-entrainment data source, similar to prior CDP assessments. Entrainment estimates in the EPS study were calculated for both the actual cooling-water flow and the maximum permitted cooling-water flow. This was possible because entrainment estimates were the result of multiplying the sampled larval concentration by the water volume in question, such as the monthly maximum permitted cooling water withdrawn through the intake. Entrainment estimates were directly proportional to the quantity of water flowing through the intake.

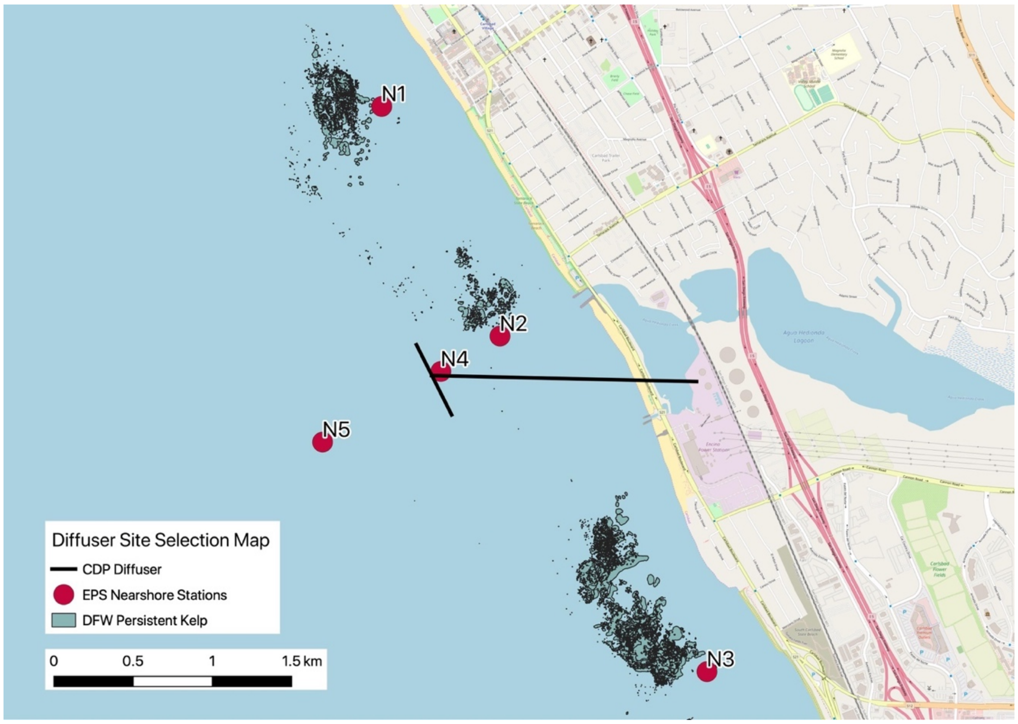

Figure 1. Encina Power Station 316(b) plankton sampling (EPS) stations occupied during the 2004-05 study overlaid with the location and extent of persistent giant kelp beds in the area and the potential multiport diffuser located at Station N4.

Potential diffuser-induced entrainment estimates were calculated using data from stations near the potential diffuser site located at Station N4 (Tenera 2008), which was 1.2 km offshore of the Agua Hedionda Lagoon mouth and 1.7 km offshore of the CDP (Figure 1). Under the multi-port diffuser option, the CDP is expected to discharge 67 MGD at 63.5 ppt. This discharge will result in the intake and entrainment of 943 MGD of the surrounding receiving water to dilute the brine to within 2 ppt of the ambient salinity.

The Staff Report and Substitute Environmental Documentation for the Desalination Amendment (SED) noted that there are few studies that estimate shearing-related mortality at brine multiport diffusers, and, to date, there is no empirical data showing the level of mortality caused by multiport diffusers. In recognition of the limited understanding of the level of mortality caused by multiport diffusers, the SED approved by the State Water Board at the adoption of the Desalination Amendment included the following guidance for assessing the mortality caused by multiport diffusers:

> *However, until additional data is available, we assume that larvae in 23 percent of the total entrained volume of diffuser dilution water are killed by exposure to lethal turbulence. The actual percentage of killed organisms will likely change as more desalination facilities are built and more studies emerge. Future revisions or updates to the Ocean Plan may reflect additional data that becomes available.*

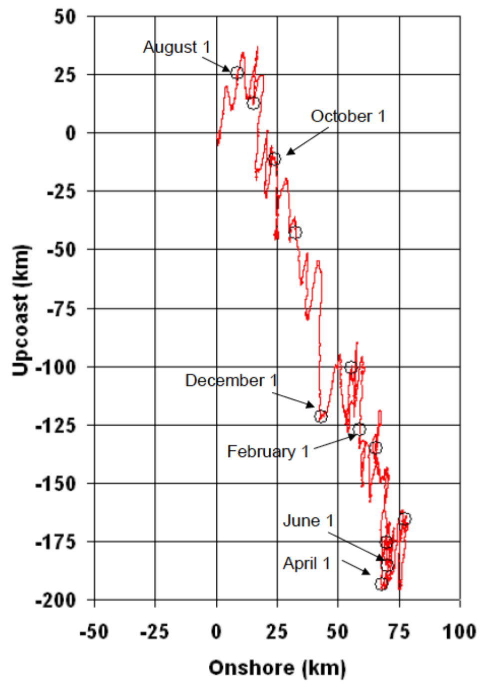

Figure 2. Cumulative current displacement measured by an uplooking acoustic Doppler current meter 0.5 mi (800 m) offshore the Encina Power Station, 33º08.5012'N 117º21.1734'W, -15.2 m (-50 ft) MLLW depth, 7 July 2004 (1000 hr) to 12 July 2005 (1000 hr). From (Tenera 2008).

Based on the guidance in the SED, this Appendix GGG analyzed marine life mortality due to a discharge from the theoretical multiport diffuser described above by calculating the required volume of water to dilute the discharge to meet the salinity receiving water limit. This volume was then multiplied by 0.23 (23%) to estimate the volume of water where shearing-related mortality occurs, as was reported by Foster et al. in the SED. Therefore, for the theoretical multiport diffuser described above, the entrained volume of water exposed to 100% larval mortality is 217 MGD. At the request of the State Water Board, a second theoretical multiport diffuser design and its estimated shearing-related mortality (Roberts 2018) was also modeled resulting in 170 MGD of water where shearing forces would induce 100% larval mortality.

Taxa Selection

Taxa selected for this analysis were the same as those analyzed during the EPS study (Tenera 2008) and used in prior ETM/APF analyses for the CDP (Attachments 2 and 3). The eight taxa used (Table 1) differed in relative abundance between the lagoon and coastal sampling sites. While none of the taxa common to the lagoon support a fishery (commercial and/or recreational), all five of the coastal taxa are fished to varying degrees. Northern Anchovy supports the largest fishery of the group with 378,210 lbs. commercially landed in San Diego County in 2013 (the most recent year with data available; DFW 2014). California Halibut supported the next largest commercial fishery of the group with 15,527 lbs. landed in San Diego County, while the remaining taxa had either less than 510 lbs. landed or are not open to commercial harvest. Spotfin Croaker is not open to commercial harvest but is taken by recreational anglers fishing in the surf zone (Miller et al. 2011). Garibaldi is the California State Marine Fish and is thus protected from fishing harvest. California Halibut supports a prized recreational fishery, while Queenfish and White Croaker are commonly taken by recreational anglers fishing from public piers (Love 2006; Miller et al. 2011).

Table 1. Taxa selected for inclusion in the Area of Production Foregone Calculations. Parameters used in the decision to choose these taxa as representative include percent of the samples collected in the Agua Hedionda Lagoon and the coastal waters offshore the lagoon entrance, existence and relative size of the fishery (commercial and/or recreational), the pounds commercially landed in San Diego County in 2013, and whether or not the taxon is protected from any harvest.

Taxa	Percent of Lagoon Sample	Percent of Coastal Sample	Fishery	Pounds Landed	Protected
CIQ goby	62%	5%	No	0	No
combtooth blennies	28%	12%	No	0	No
Garibaldi	1%	1%	No	NA	Yes
Northern Anchovy*	4%	46%	Large	378,210	No
White Croaker	<1%	5%	Small	183	No
California Halibut	<1%	4%	Medium	15,257	No
Queenfish	<1%	2%	Small	504	No
Spotfin Croaker	<1%	2%	Small	NA	No
Total All Taxa	20,601	16,763			
*Unidentified anchovies assumed to be Northern Anchovy					
NA = Not Allowed					

Modeling

The proposed flow augmentation brine discharge technology will result in the intake and entrainment of 171 MGD to 196 MGD of seawater from Agua Hedionda Lagoon to pre-dilute the brine prior to discharge to the Pacific Ocean. The entrainment impacts for 171 MGD of flow augmentation was confirmed by the Science Advisory Panel and documented in Appendix FFF of the ROWD (Attachment 3). The entrainment impacts for 196 MGD of flow augmentation was derived by proportionally adjusting the taxon-specific APFs derived for 171 MGD reported in Appendix FFF to 196 MGD as 196/171 = 1.15. The new proportionally adjusted, taxon-specific APFs were assigned to their respective habitat categories (estuarine or coastal and soft-bottom).

The 95% confidence interval per habitat group (estuarine and coastal) using these proportionally-adjusted taxon-specific APFs was calculated for the 196 MGD flow augmentation volume.

Taxon-specific diffuser-induced ETM/APF calculations were completed for each month of sampling in accordance with the OPA SED Appendix E and recent modifications to ETM/APF methodology for estuarine taxa entrained at an open coast intake structure developed for the Huntington Beach Desalination Plant in conjunction with SAP member Dr. Peter Raimondi (MMSC 2018b).

Diffuser Impact Analysis

An analysis of the shear-related mortality caused by the multiport diffuser was conducted using the ETM/APF methods, separately, as described below for estuarine and coastal ocean taxa. Coastal ocean taxa were modeled using the standard ETM as described in Appendix E of the OPA SED. Estuarine taxa were modeled in accordance with the ETM calculation described in MMSC (2018b) where the traditional P_e term is modified and P_s term is removed:

$$P_M = 1 - f_i\left(1 - \left(\frac{E_i}{(SSWDi\ x\ TSWBV) + (Diest\ x\ TEWBV)}\right)\right)^d$$

Where

P_M = Proportional Mortality

f_i = Proportion of the total annual source water population present during the i^{th} survey

E_i = Estimated number of larvae entrained during the i^{th} survey

$SSWD_i$ = Estimated mean larval density in the sampled source water during the i^{th} survey

TSWBV = Total source water body volume was derived by multiplying the estimated larval duration of entrainment exposure (d) x the current speed (4.9 km/d per Tenera [2008]) x 3.0 km[1] (the offshore extent of the total source water population) x mean depth of sampled source water body.

D_{iest} = Estimated larval density in Agua Hedionda Lagoon during the i^{th} survey

TEWBV = Total estuarine source water body volume from the estuaries used in the analysis

d = Number of days that the larvae are exposed to entrainment per Tenera (2008)

For the coastal ocean taxa occurring at the diffuser site, the ETM/APF was conducted following the specifications detailed in the OPA SED Appendix E:

[1] On average, the 75-m isobath along the continental slope in the Carlsbad area is approximately 3 km offshore, or the nominal maximum depth of the taxa used in the ETM/APF. "This depth was based on Lavenberg et al. (1986) showing that ichthyoplankton transects in southern California shoreward of the 75 m (246 ft) depth were representative of the coastal zone." (Tenera 2008).

$$P_m = 1 - \sum_{i=1}^{n} f_i \, (1 - PE_i \cdot P_s)^d$$

Where

PE_i = Estimate of proportional entrainment for the i^{th} survey,

P_S = Estimate of the proportion of total source water body alongshore distance (TSWBA) captured in the total sampled source water body area (≈7.1 km)

f_i = Proportion of the total annual source water population present during the i^{th} survey

d = Number of days that the larvae are exposed to entrainment per Tenera (2008)

For all taxa, the d values used for the offshore diffuser entrainment impact analysis were those reported by Tenera (2008) and the same used for the intake entrainment impact analysis. Tenera (2008) figure 3-2 was georeferenced in QGIS to allow for measurement of the overall source water sampling area alongshore length (7.1 km) and measure the perimeter dimensions of each sampling cell in the source water grid (Figure 2). The perimeter dimensions of each grid cell were multiplied by the mean water depth per grid cell reported in Tenera (2008) to derive the cell volume and the total source water volume sampled (Table 2). To account for any differences in these measurements and those used by Tenera (2008) the ETM parameter f_i was calculated based on the new sampled source water estimate. The source water population corresponding to each sampling event used to calculate f_i for the coastal ocean taxa for that sampling event was calculated as follows:

$$SWP_t = V \; x \; M_t \; x \; D$$

Where

SWP_t = Source water population for taxon t

V = Static volume of the source water sampling grid (265,404,000 m^3)

M_t = Mean larval concentration recorded during the survey for taxon t

D = Number of days represented by the survey (listed in Appendix 2)

The ETM parameters used for the analysis of diffuser shearing impacts using larval concentration data collected at Station N4 are presented in Table 2.

Table 2. Empirical transport model parameters used in the analysis of potential diffuser impacts including days susceptible to entrainment (d), proportion of the total source water body alongshore distance sampled in the sampled source water (Ps), and the total source water body area (TSWB).

Taxon	d	Ps	TSWB acres
CIQ Goby	11.5	NA	NA
Northern Anchovy	7.7	0.23	27,970
White Croaker	26.5	0.14	96,260
Combtooth Blennies	2.7	NA	NA
Garibaldi	2.2	NA	NA
California Halibut	31.1	0.17	112,969
Spotfin Croaker	11.4	0.34	41,410
Queenfish	21.6	0.23	78,461

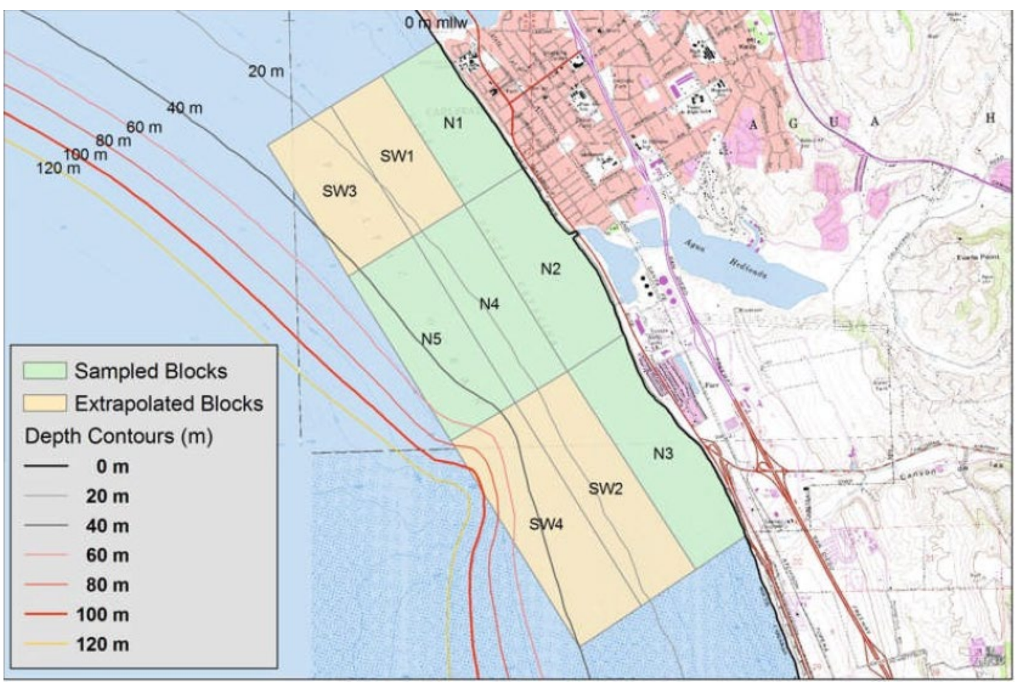

Figure 3. Source water sampling grid used in the Encina Power Station 316(b) entrainment study reported in Tenera (2008).

The total source water body area (TSWB) used in the diffuser ETM/APF was the alongshore displacement derived by multiplying the estimated larval duration of entrainment exposure (d) x the current speed (4.9 km/d per Tenera [2008]) x 3.0 km (the offshore extent of the total source water population). This TSWB was used in the APF calculations.

Table 3. Measured source water sampling grid cell length (L), width (w), reported depth (D), and resulting volume estimate. Depth as reported in Tenera (2008).

Grid Cell	L (m)	W (m)	D (m)	Volume (m^3)
N1	1900	760	6.0	8,664,000
N2	2400	850	8.8	17,952,000
N3	2900	750	7.2	15,660,000
N4	2400	710	17.6	29,990,400
N5	2400	840	34.1	68,745,600
SW1	1900	710	17.6	23,742,400
SW2	2900	710	17.6	36,238,400
SW3	1900	840	34.1	54,423,600
SW4	2900	840	4.1	9,987,600
Total Water Volume				265,404,000

RESULTS

The resulting diffuser APF estimates are presented in Table 4 for both the Roberts 170 MGD and SED 217 MGD deleterious volume estimates. For comparison, the APF estimates for flow augmentation assuming either 171 MGD or 196 MGD are used for brine dilution are presented in Table 5 with the two diffuser APF estimates.

The coastal taxa were comparatively rare in Agua Hedionda Lagoon, but were substantially more common at Station N4 located offshore. Unlike estuarine taxa, the coastal taxa TSWB was not constrained by the size of the source lagoon. Rather, the coastal taxa TSWB was a function of the number of days susceptible to entrainment and the ambient alongshore current speed. As a result, the estimated APF for the diffuser based on Roberts (2018) was 458.6 acres assuming 170 MGD of water contained deleterious shearing. The higher water volumes subjected to deleterious shearing calculated based on the guidance in the SED (217 MGD) would result in a calculated APF of 584.7 acres.

As noted in Table 1, the taxa most common in Agua Hedionda Lagoon were the primary contributors to the flow augmentation APF. The flow augmentation discharge technology would result in a 100% mortality in 171 MGD to 196 MGD with an associated APF of 75.8 to 88.4 acres.

Table 4. Taxon-specific proportional mortality (Pm), total source water body area (TSWB; acres), and area of production forgone (APF; acres) under each diffuser option.

Taxa	170 MGD Deleterious Diffuser				217 MGD Deleterious Diffuser		
	Pm	TSWB	APF		Pm	TSWB	APF
Estuarine and Rocky Reef Taxa							
CIQ Goby	1.96%	302	5.9		2.49%	302	7.5
Combtooth Blennies	6.07%	302	18.3		7.69%	302	23.2
Garibaldi	3.49%	302	10.5		4.43%	302	13.4
Mean			11.6				14.7
SE			3.6				4.6
95%CI			17.6				22.2
Coastal Taxa							
Northern Anchovy	0.10%	27,970	28.1		0.13%	27,970	35.9
White Croaker	0.10%	96,260	100.6		0.13%	96,260	128.4
California Halibut	0.62%	112,969	703.1		0.79%	112,969	896.6
Spotfin Croaker	0.08%	41,410	31.1		0.10%	41,410	39.7
Queenfish	0.37%	78,461	294.0		0.48%	78,461	375.0
Mean			231.4				295.1
SE			127.5				162.5
95%CI			441.0				562.5
Total APF (All Habitats)			458.6				584.7

Table 5. The calculated area of production foregone (in acres) for flow augmentation at 171 MGD and 196 MGD; and multiport diffuser at 170 MGD and 217 MGD.

Taxa Category	FA (171)	FA (196)	Diffuser (170)	Diffuser (217)
Estuarine & Rocky Reef	36	40.9	17.6	22.2
Coastal Ocean	39.8	47.5	441.0	562.5
Total	**75.8**	**88.4**	**458.6**	**584.7**

CONCLUSION

The estimate of the entrainment impacts using an ETM/APF approach indicates that the entrainment impacts associated with the flow augmentation are less than that of the multiport diffuser.

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Tenera. 2008. Cabrillo Power I LLC. Encina Power Station Clean Water Act Section 316(b) impingement mortality and entrainment characterization study. Prepared for Cabrillo Power I LLC.

ATTACHMENT 1: FINAL SCIENCE ADVISORY PANEL REPORT DATED SEPTEMBER 15, 2018.

Independent review: TOPICS FOR NEUTRAL THIRD PARTY REVIEW IN SUPPORT OF THE REISSUANCE OF THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR THE CARLSBAD DESALINATION PLANT

Review Panel: **Peter Raimondi, Richard Ambrose, Brett Sanders**

Date: **September 15, 2018**

This document is the result of an independent review based on questions posed in "**TOPICS FOR NEUTRAL THIRD PARTY REVIEW IN SUPPORT OF THE REISSUANCE OF THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR THE CARLSBAD DESALINATION PLANT"**. It is important to state that the questions posed to and addressed by the panel were focused on impacts related to intake of seawater. There was no consideration of discharge related impacts. Specifically we did not assess or make comparisons of impacts related to discharger designs or evaluate any assumptions related mitigation ratios associated with habitat affected by discharge water. In addition this panel did not evaluate the 316B study that is discussed in this review.

Reviewers are asked to address the proposed conclusions presented above and are asked to contemplate the following questions:

1. *If the mitigation acreage is increased by 11 acres, are the biological performance standards and associated fish productivity monitoring necessary to verify that the mitigation adequately compensates for impingement from the Facility* ***during co-located operations?***

The basis for the 11 acre estimate comes from Allen 1982. The logic as applied to compensatory mitigation is:

a. Estimates of fish production from a paper by Larry Allen (1982), extrapolated to an estimate of 151.36 kg (wet weight – WW) per acre).
b. The estimation of the impingement losses resulting from water use of 304 MGD of seawater (304 was the value originally estimated). The average impingement loss was estimated at 4.7 kg per day, (Note that this = 10.36 lbs. This is noted because both lbs and kg are used in documents). This led to an estimate an annual loss due to impingement of ~1715 kg per year.
c. Hence, the loss of 1715 kg per year (production) would be potentially compensated by 1715 kg/year / 151.36 kg per acre year = 11.33 acres.
d. Based on the current estimated use of water (299 MGD) the estimate of acres needed to compensate for impingement is (299/304) x 11.33 acres = 11.14 acres.

This estimate is based (in part) on the following assumptions:

a. The estimate of acreage required for compensatory mitigation for impingement, 11.14 acres, relies on the use of averages (~ 50% confidence level). There is nothing wrong with the use of averages as one estimate of effect; however, the use of averages as the only estimate of effect relies on the idea that estimates are made without error, which is unlikely to be true. We note that the concept of "compensatory" mitigation was evolving at the time these calculations were initially presented. In fact, the use of the 80% confidence interval for entrainment impacts was the first time the confidence interval approach was used in a desalinization powerplant determination for either entrainment or impingement, at least in California. A better approach (see later questions) is one based on degree of confidence (or certainty). Here estimates are expressed as the confidence that one has the real average is no higher that some value X. As an example, if the average impingement is 4.7 kg per day, then the equivalent statement using confidence limits is that we are 50% confident that the true average is no greater than 4.7 kg per day. In typical inferential statistics, confidence limits of 95% are often used. If a higher confidence limit was employed, the estimated impingement would be higher.
b. Fish production of the mitigation wetland will be similar to the production estimated in Allen (1982). Allen measured fish production at Upper Newport Bay; since no other comparable work has been conducted at other southern California wetlands, it is not known how representative fish production there (and at the time of Allen's study) is to other wetlands. In addition, the estimate of fish production (151.36 kg per acre per year) was specifically restricted to those areas not including vegetated marsh. Thus, the estimates of fish production are based on the assumption that the mitigation wetland will be made up entirely of intertidal mudflats and subtidal areas.
c. Estimates of acreage required for compensatory mitigation for impingement at 299 MGD, assuming the acreage is subtidal or intertidal mudflats, range from 11.14 (50^{th} percentile) to 17.5 (80^{th} percentile) to 21.11 acres (95^{th} percentile).

The key assumption for monitoring as applied to mitigation for impingement and entrainment is that if the restoration is similar to the overall performance of a natural and functioning set of reference areas, then its specific functions such as adult biomass and larval production are likely to also be comparable to those in the reference areas. Given that the estimates of loss are based on empirical estimates or models of functioning (reference-like) areas, this is a reasonable assumption, but it does depend on monitoring the biological performance standards. Moreover the approaches for estimating fish biomass and larval production may be invasive and counter-productive (see below). Hence, our conclusion is that so long as appropriate reference areas are selected and the mitigation area (here a wetland restoration) is comparable to the performance of reference areas (as determined by monitoring the biological performance standards), no additional specific monitoring of fish productivity is necessary.

2. *Would the methodology for fish productivity monitoring in Allen 1982 undermine the mitigation's restoration efforts? If yes, is there an alternative, less destructive methodology to monitor fish productivity that would still verify that the biological performance standard has been met?*

We conclude that that methodology described in Allen 1982, which was adopted by Poseidon in "Poseidon Resources Draft Productivity Monitoring Plan for the Otay River Estuary Restoration Plan," would likely be counter-productive to the goal for the mitigation for impingement. At best the sampling approach would lead to increased variability in the sample data (making it more difficult to assess compliance with mitigation requirements). At worse, the sampling approach could degrade the wetland over time. In addition it is very likely that underlying spatial and temporal variability would be large and lead to sampling assessment that had low statistical power, which again would lead to difficulty assessing compliance with mitigation requirements.

By contrast, an approach designed to assess general performance of the mitigation wetland relative to reference wetlands would be much less intrusive. Such an approach was thoroughly vetted as part of mitigation for intake impacts due to the operation of San Onofre Nuclear Generating Station (SONGS). The key assumption here is that a mitigation wetland could provide compensatory specific performance metrics given:

a. That it is functioning similarly to reference wetlands. This can be assured through a well-designed comprehensive monitoring program focused on comprehensive biological performance standards.
b. The size of the mitigation is sufficient to be compensatory. Here the key is that models relating acreage to impact (i.e. entrainment or impingement) are robust and that there has been a consideration of level of confidence desired (or required under regulatory authority).

Note that this approach assesses overall wetland function but not fish productivity directly. We know of no alternative methods for measuring fish productivity directly that are less destructive than the methods used by Allen (1982).

Reviewers are asked to address the proposed conclusions presented above and are asked to contemplate the following questions:

1. *Were the ETM/APF analyses provided by Poseidon done adequately to account for impacts to all forms of marine life that may be affected by the intake of seawater during stand-alone operations, including but not limited to potential impacts from a fish return system and entrapment in the intake channel? Were the ETM/APF analyses calculated in accordance with the Ocean Plan Requirements, including the one-sided, upper 95 percent confidence bound, and one percent mitigation credit?*

We are dividing this question into parts: entrainment, 1 percent mitigation credit (for entrainment) and impingement (including use of a fish return system [FRS]).

a. Entrainment: The original calculations in the submitted document were not consistent with the ETM algorithms used in the EPS 316B. This was acknowledged by Poseidon and there is now agreement on the approach. Appendix FFF to the Report of Waste Discharge contains the documents used to clarify the approach (submitted by the SAP and Poseidon). Based on the approach advocated by the SAP (and consistent with the EPS 316B) the estimate for APF (at the 95% confidence limit) assuming intake of 299 MGD is 66.63 acres. This is based on:
    i. 59.4 acres related to entrainment of estuarine species
    ii. 72.3 acres related to entrainment of open coast species.
    iii. Applying a 10 / 1 ratio of value restoration of open coast relative to estuarine habitat to the 72.3 acres (b) = 7.23 acres of estuarine habitat
    iv. Summation of 59.4 + 7.23 acres = 66.63 acres of estuarine habitat
b. 1 percent mitigation credit (relative to entrainment impacts): This credit reduces the APF for entrainment from 66.63 to 66.63 x 0.99 = 65.96 acres
c. Impingement: This is more complicated as the APF estimates currently applied by Poseidon were: (1) based on an approach for determining baseline impingement that departs from the approach originally taken by Poseidon and their consultants, (2) reduced based on explicit consideration of ability of fish to leave the intake pipes and forebay and, (3) not assessed at the 95% confidence limit. We will address these topics in the context of stand-alone operations
    i. In the original approach taken by Nordby, the impingement during EPS operations was generally but not completely calibrated to proposed intake flow required by CDP using the ratio MGD:CDP/MGD:EPS, where EPS flow was 657 MGD and the proposed CDP flow was 304 CDP. This seems like a reasonable approach because it assumes that the rate of organismal entrapment in intake flow (here we are talking about non – larval organisms) should be related to the rate and amount of water taken into the plant. It turns out that the empirical relationship is more complicated than this expectation. As noted the calibration was used generally but not completely. Specifically, it was used for 50 of the 52 events where impingement was assessed. Figure 1, below, shows the relationship between impingement and MGD for those 50 events.

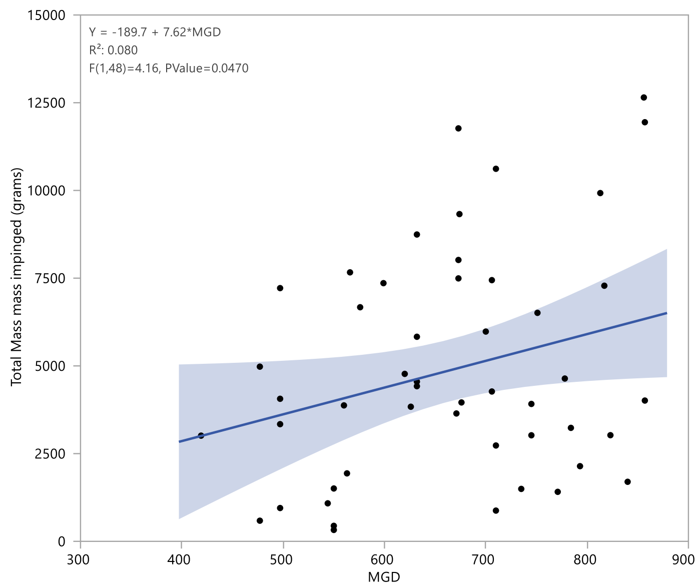

Figure 1: Relationship between Impingement and MGD for 50 "ordinary" events.

The relationship depicted in figure 1, as expected, shows an increase in impingement as MGD increases. However the relationship is much weaker than expected. This is due to the high level of simple temporal variability in impingement unrelated to flow (e.g. pulses of individuals near the intake structure). Adding the two extraordinarily high impingement events corrupts the relationship entirely (see figure 2 below).

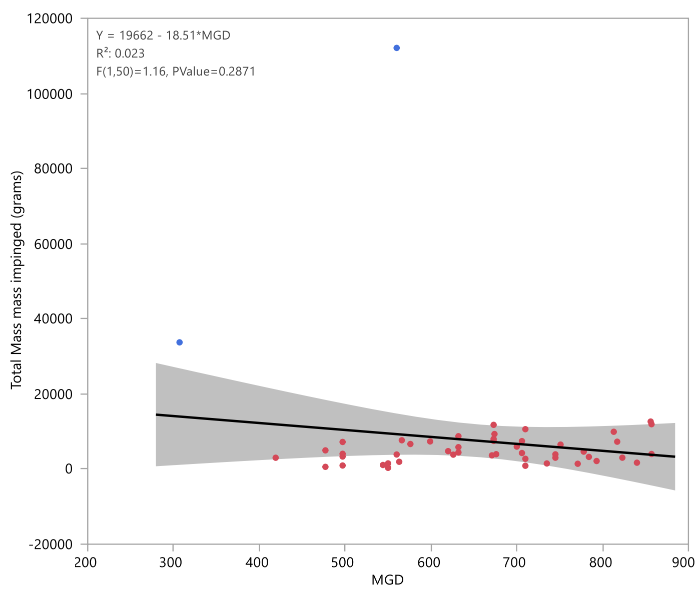

Figure 2: Relationship between Impingement and MGD for 50 "ordinary" (red) and "extraordinary" events (blue).

Including all 52 events causes the relationship to shift from positive (figure 1) to negative (figure 2). Note that the relationship is significant in figure 1 ($p = 0.047$) but not in figure 2 ($p=0.2871$). It is clear that the inclusion of all data corrupts the relationship between MGD and impingement. Nordby recognized this and derived an estimate of impingement related to CDP MGD that was based on a hybrid approach. The 50 ordinary events were calibrated by the MGD ratio noted above and the 2 extraordinary events were not. This lead to an estimated daily impingement rate of 4.7 kg per day (=10.36 lbs per day). For comparison, calibrating all the data and using the relationship shown in figure 2, the estimate for 304 MGD would have been 14.03 kg per day (at the 50% confidence limit).

In the recent submissions by Poseidon (Hogan et al.) a different approach was used. Here all the data were calibrated but differently than shown above. Poseidon assumed that impingement should be affected by flow rate even though the actual empirical relationship was weak. Here, however, events were considered replicates and not part of a regression relationship. Hogan calculated the average impingement for the 52 events (irrespective of MGD for particular event), which led to an estimate of 7.045 kg per day (15.50 lbs per day), This value was then calibrated by the putative CDP flow rate (299 MGD) relative to the average EPS flow rate (657 MGD). This equation (7.045 x (299/657)) yielded a value of 3.206 kg per day (7.06 lbs per day). A different and we think superior way to use the same data is to calibrate the impingement for each event by the event specific MGD. This approach yields an impingement estimate of 3.88 kg per day (8.54 lbs per day). This is equal to 1416 kg per year (see table 2). Note that all of these estimates are based on the 50% confidence interval. At the 95% confidence limit the values are 5.95 kg per day (2172 kg per year, see table 2)

ii. The effects of reduction in flow velocity resulting from stand-alone operations: As noted by Hogan, regardless of the impingement basis (3.206 – 4.7 kg per day), the change in flow velocity associated with stand-alone operations is likely to decrease potential impingement. This is separate from the effect due to reduction in water use. Poseidon assumes that certain individual fish with known swimming speeds (based on size) sufficient to swim against the mean velocity in the intake tunnels all do so and escape. The key, and at this point unanswerable, question is whether this is true. This relates more to fish behavior rather than capability. This is important given that this assumption (those that can escape do escape) has a marked impact on reduction of individuals potentially using the FRS. Given the assumption that all fish capable of escaping the intake tunnel do escape, Poseidon (appendix ZZ page 21) concludes that the biomass subject to impingement after accounting for escape by swimming range from 2.81 kg per day (6.19 lbs per day, alternative 1) to 2.55 kg per day (5.61 lbs per day, alternative 15).

iii. The effects of the FRS: The key metric associated with the FRS system is reduction in fish mortality. Hogan used an approach where species specific estimates (from Love et al. 1989) were used when available and if species specific estimates were not available a value of 15% mortality was used (based on EPRI 2010 for freshwater species). As acknowledged by Hogan, these estimates, while for different FRS and sometimes for freshwater species, are not optimal but are the only estimates available.

iv. Combining ii and iii, above, allows an estimate impingement related mortality due to decrease in flow velocity and the use of the proposed FRS, subject to key untested assumptions. The values are 0.386 kg per day (0.85 lbs per day) for alternative 1 and 0.354 kg per day (0.78 lbs per day) for alternative 15 (Appendix XX page 21). These equate to a reduction of impingement related mortality of 88% (alternative 1: (7.06-0.85)/7.06) and 89% (alternative 15: (7.06-0.78)/7.06). These percentages can then be applied to all impingement scenarios (see Table 1, below)

Scenario	Impingement kg/year	reduction (alt 1 at 88%), kg/year	reduction (alt 15 at 89%), kg./year	Estimated impingement alt 1 (kg/year)	Estimated impingement alt 15 (kg/year)
Nordby original estimate	1715	1509	1526	206	189
Based on slope calibrated MGD	5037 (14.03 x (299/304) x 365	4433	4483	604	554
Hogan revised estimate	1171	1030	1042	141	129
SAP revised estimate	1416	1246	1260	170	156

Table 1: estimated impingement for the models assessed

v. As noted above, all of these estimates are based on the 50% confidence limit. In order to estimate the 95% confidence limit there needs to be data where a variance term can be calculated. Currently this is not possible for either the reduction in impingement mortality due to a reduction in in flow velocity or the reduction due to the FRS. Our suggestion is that there be a post-implementation monitoring program to assess these assumed values in order to determine the realized APF related to impingement mortality. There is a variance term associated with data used to estimate base impingement. This can be used to calculate a preliminary 95% confidence limit. We calculated the upper 95% confidence level in two ways: (1) using the same approach as taken for entrainment by Poseidon using the NORM.INV function implemented in EXCEL, and (2) using a resampling approach with 2500 iterations of the 52 samples. These two approaches led to differing values. Using NORM.INV (using the standard error in place of the standard deviation, as per APF practice) the upper 95% limit is 5.95 kg per day. Using the resampling approach resulted in an estimate of 6.2 kg per day. As expected the difference between the two estimates is very small and for consistency with the approach used for entrainment we used the value associated with the NORM.INV estimate.

vi. Based on Allen's (1982) estimate of 151.36 kg per acre year of production for mudflats and subtidal habitat, we calculated the APF for the 95% confidence limit using the SAP revised estimates, which we consider the appropriate values (Table 2). These values were 1.8 acres for alternative 1 and 1.65 acres for alternative 2. We want to note again that: (1) these estimates assume 100%

escape from the intake tunnel for species of a given size and that FRS mortality estimates are accurate and, (2) that the assumptions should be assessed after implementation.

Scenario	Impingement kg/year	reduction (alt 1 at 88%), kg/year	reduction (alt 15 at 89%), kg./year	Estimated impingement alt 1 (kg/year)	Estimated impingement alt 15 (kg/year)	Estimated APF alt.1 (acres)	Estimated APF alt.15 (acres)
SAP revised estimate	1416	1246	1260	170	156	1.12	1.04
SAP revised estimate at the 95% confidence limit	2172	1911	1933	261	239	1.72	1.58

Table 2: estimated impingement and APF for SAP revised estimate and 95% confidence limit

vii. Based on the discussion above the total APF for intake effects should be: for alternative 1 = 65.96 + 1.72 = 67.68 acres and for alternative 15 = 65.96 +1.58 = 67.54 acres. Recall that the APF for entrainment, including the 1% mitigation credit, was 65.96 acres.

viii. If the assumption is that no fish escape from the intake tunnel then the estimated APF is 2172 kg /151.36 kg per acre = 14.34 acres

2. *Does Poseidon's proposed mitigation of 67.83 acres compensate for the intake and mortality to all forms of marine life resulting from the stand-alone operation of the Facility, including but not limited to potential impacts from a fish return system and entrapment in the intake channel?*

Based on the discussion above and the assumptions noted, the proposed restoration of 67.83 acres of estuarine habitat, should be adequate compensation with respect to intake related impacts under stand-alone operation if it is successful (assessment as described above).

3. *Do the ETM/APF analyses in Appendix K include species that are representative of a full range of life histories, habitats, and future productivity that may be subject to intake and mortality by construction and operation of the Facility? If not, please identify which additional species should be included in the ETM/APF analyses and explain the basis for including those species.*

We are going to address a slightly modified question. That question is "*Given the data and the ETM/APF modelling approach*, do the analyses in Appendix K include species that are representative of a full range of life histories, habitats, and future productivity that may be subject to intake and mortality by construction and operation of the Facility?". For this question the answer is yes. One of the key requirements for reliable use of the ETM/APF approach is adequate representation in the samples. This means that there has to be sufficient data to reliably estimate the Pm and when appropriate Ps for determination of the species-specific proportional mortality and source water bodies. Given this modification of the question, we think that the species evaluated are reasonable. One other set of candidate species for which there are likely to be sufficient data for analyses are the kelpfishes. Their omission may be explained by the second selection guideline used by Tenera for the 316B analysis: "The following eight taxa were selected for detailed evaluation of entrainment effects based on their abundance in entrainment samples and/or **importance as fishery species**:" (page 3-19)

4. *Did Poseidon and their consultants appropriately use and apply the information and data from Tenera Environmental's 2008 report, Encina Power Station Clean Water Act Section 316(b) Impingement Mortality and Entrainment Characterization Study, for calculating the mitigation acreage required for stand-alone operation and to adequately account for all impacts to all forms of marine life from the Facility during stand-alone operation, including but not limited to impacts from entrapment and a fish return system? If not, please cite the reasons for such.*

The original approach provided by Poseidon for the calculation of entrainment impacts was inconsistent with approach used in the 2008 316B approach. Following discussions with the SAP the approach has been reconciled with that in the 316B (see description above). With respect to impingement, there was no analytical approach to the calculation of acreage in the 316B, but the current approach proposed by Poseidon is inconsistent with both the original approach proposed by Nordby and the SAP proposed approach (see above). Having said this, the total acreage proposed by Poseidon slightly exceeds the SAP calculated value for compensatory mitigation.

5. *Were species that were included in the ETM/APF analyses in Appendix K appropriately classified by habitat? If not, please identify and explain what type of classification(s) would be appropriate to use. Where available, please provide references to peer-reviewed literature supporting any specific conclusion(s).*

Yes the designations are appropriate with respect to both species life history and sampling results. . Moreover the designations are consistent with those used in the 2008 316B. It is important to note that the key reasons for the designations are to allow identification of the source water bodies and the equations that should be used in the ETM models to calculate Pm and source water bodies (which are a function of Ps). These were originally proposed by Tenera and have been treated consistently in the Poseidon submissions.

Reviewers are asked to address the proposed conclusions presented above and are asked to contemplate the following questions:

1. *Were operational impacts to marine life that could result in the intake and mortality of all forms of marine life (e.g., entrainment, impingement, entrapment) from the onshore screen location adequately evaluated in Appendices HH and YY? If not, identify specific reasons for such conclusion and, where available, provide references to peer-reviewed literature supporting any specific conclusion(s). Is entrapment an additional source of impacts to marine life for the onshore screen location?*

Poseidon's submissions relative to intake related mortality are comprehensive and we think evaluated sufficiently in the context of a particular interpretation of the guidance afforded under NEPA and State law (e.g. SED: Final Staff Report Including the Final Substitute Environmental Documentation Adopted May 6, 2015). The key language is (from final 316B rules, USEPA 2014):

"Entrapment means the condition where impingeable fish and shellfish lack the means to escape the cooling water intake. Entrapment includes but is not limited to: Organisms caught in the bucket of a traveling screen and unable to reach a fish return; organisms caught in the forebay of a cooling water intake system without any means of being returned to the source waterbody without experiencing mortality; or cooling water intake systems where the velocities in the intake pipes or in any channels leading to the forebay prevent organisms from being able to return to the source waterbody through the intake pipe or channel."

This language is used in the Poseidon submission along with language from SED in the interpretation of "organisms caught in the forebay of a cooling water intake system without any means of being returned to the source waterbody without experiencing mortality" and "systems where the velocities in the intake pipes or in any channels leading to the forebay prevent organisms from being able to return to the source waterbody through the intake pipe or channel". While this language was provided under the context of power plant operations, it was applied as guidance for CDP. Given this language Poseidon argues that lowering the velocity in the intake pipes to ~2.6 feet per second (actual value driven by intake design) provides opportunity for certain sized individuals with known swimming speed capabilities to return to source water body without experiencing mortality. Poseidon assumed that this was 100 percent effective (meaning that all individuals that could return, based on documented swimming ability) would return. This is an untested assumption, which we recommend should be evaluated once flow reduction is implemented. Also as noted above the mortality rates for species being returned using the proposed FRS are also based on either a different FRS system or (model) test species that do not occur in the source water for CDP. Again we recommended that the assumed rate of mortality be assessed following implementation of the FRS

Hence, our opinion is that given available information, Poseidon did adequately evaluate operational impacts to marine life but that the current information is not adequate to make a strong and supportable prediction concerning operational impacts.

2. *Is it scientifically sound and reasonable to use the marine life survival data from a different fish return system design at SONGS to evaluate operational impacts of the fish return system for the onshore screen intake option for the Facility? If not, please identify specific reasons for such conclusion and, where available, provide references to peer-reviewed literature supporting any specific conclusion(s), and identify whether there are other readily available data that can be used for this purpose?*

Poseidon's use of survival data gathered from a different form of FRS used at SONGS was based on the unfortunate reality of the limited use of FRS systems and the paucity of monitoring efforts designed to assess their effectiveness. As such the inclusion of such information is reasonable to provide some context for the possible effectiveness of FRS systems in a general sense. Although this was a reasonable approach for Poseidon to use, there is a lot of uncertainty associated with it. Not only were the Love et al. (1989) survival data from a different type of FRS, those data have their own uncertainties and limitations.

Because the FRS estimates used by Poseidon have so much uncertainty but there are no alternatives available we know of in the peer- reviewed literature, a key recommendation concerning the effectiveness of the proposed FRS is to assess it after implementation, along with testing of the assumption of fish swimming out of intake tunnels and the forebay back to the source water body. These assessments should also be linked, if possible, to the possibility of modifying the mitigation requirements to ensure compensatory acreage (assuming APF use for establishing compensatory mitigation).

3. *Is it scientifically sound and reasonable to use total marine life mortality as measured in kg of fish/day for purposes of quantifying operational impacts of the onshore intake screen option that could result in additional intake and mortality of all forms of marine life? If not, please identify specific reasons for such conclusion and, where available, provide references to peer-reviewed literature supporting any specific conclusion(s). Please also describe the limitations to this approach of quantifying operational impacts and suggest more appropriate metric(s) for quantifying these impacts, if they exist.*

It is important to note that we are specifically limiting this discussion to impingement of larger organisms, Entrainment of smaller planktonic forms are treated using a different approach (the ETM/APF model). Kg of fish per day is an appropriate metric to use so long as "fish" is meant to include all species that are impinged. This primarily would include fin fish and invertebrates. This is especially true so long as mitigation is in the form of habitat creation or restoration under APF modeling. This is because, under APF mitigation models, both direct and indirect effects of impact are assumed to be covered. For example, assume that the loss of fish of certain mass leads, under APF modeling, to an acre of wetland creation. This would mean that quantitatively this acre would provide the same increase in fish mass and also that those species that would been affected by the direct loss mass of fish (e.g. predators) will be made whole.

ATTACHMENT 2: APPENDIX FFF – REVIEW OF THE CALCULATION METHODS USED IN THE CARLSBAD DESALINATION PLANT ENTRAINMENT ANALYSIS

POSEIDON WATER

Appendix FFF
Revised APF Calculations

Renewal of NPDES CA0109223
Carlsbad Desalination Project

May 31, 2018

Mr. Peter MacLaggan
Poseidon Water
Delivered via Email

Appendix FFF – Review of the Calculation Methods Used in Carlsbad Desalination Plant Entrainment Analysis

Dear Peter,

The purpose of this Appendix FFF, is to review the calculation methods used to establish the Area of Production Foregone (APF) estimates for the Carlsbad Desalination Plant (CDP) provided in Appendix K of the Report of Waste Discharge.

Table 2 of Appendix K presents two sets of APF estimates. The first set is labeled "With P_s in accordance with Appendix E", while the second set is labeled "Without P_s in accordance with Dr. Raimondi's CCC".

The Science Advisory Panel's (SAP) letter dated May 20, 2018 (the "SAP May 20 Memo") recommends Empirical Transport Model (ETM) calculations for estimating the entrainment impacts for the CDP that are consistent with the entrainment impact assessment conducted for the Encina Power Station (EPS) in January 2008 and the Carlsbad Desalination Plant in 2008.

The calculation methods used to derive the APF estimates in accordance with the SAP recommendations are summarized in Attachment 1. The ETM and APF estimates for the Flow Augmentation (FA 171 MGD) and Reverse Osmosis (RO, 127 MGD) presented in Appendix K (MBC 2015) were recalculated using Equations 2 and 4 in the SAP May 20 Memo. I also calculated the APF for the complete intake (298 MGD) to be consistent with the charge to Dr. Raimondi for his review of Appendix K. It should be noted that mathematical rounding occurring during the calculations resulted in slightly different values for FA+RO vs the complete intake. The revised calculation methodology indirectly followed the methodology used in the "Without P_s in accordance with Dr. Raimondi's CCC" estimates reported in Appendix K, and yielded the same results. The SAP May 20 Memo is included as Attachment 2, and a copy of Appendix K is included as Attachment 3.

Please let me know if you have any questions.

Sincerely,

Eric Miller, MS

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Review of the Calculation Methods Used in Carlsbad Desalination Project Entrainment Analysis

1. The RO and FA ETM and APF estimates presented in Appendix K were prepared in two ways
    a. One to try and maintain consistency with the equations detailed in Appendix E of the Ocean Plan Amendment's (OPA) Substitute Environmental Document Appendix E
        i. This approach is titled "With P_s in accordance with Appendix E" APF estimates
    b. A second version (detailed in Steps 3-5 below) was presented to maintain consistency with the prior record for the site
        i. This approach is titled "Without P_s in accordance with Dr. Raimondi's CCC" APF estimates
2. P_e by survey and taxa was derived in the EPS using Equation 2 in the SAP May 20 Memo
    a. The P_e was derived for EPS flow of 857 MGD
        i. The derived P_e captures the adjustments to the source water population described in Equation 2 of the SAP Memo to account for tidal flux through the mouth of Aqua Hedionda Lagoon
3. The entrainment impact analysis was flow-extrapolated meaning the estimated number of plankton entrained is the product of sampled density at the designated intake sampling station multiplied by the intake water flow volume. Therefore it can be proportionally adjusted to other intake flow volumes.
    a. Source water population estimates are not adjusted based on the intake water flow volume. Instead, the P_e reported in EPS for maximum flow volume are scaled to reflect the proposed intake intake flow volume at the CDP, of 298 MGD intake flow (127 RO and 171 Flow Augmentation)
        i. This approach is consistent with Equation 4 in the SAP May 20 Memo
4. APF Calculations reported in Appendix K Table 2 included the following steps
    a. The source water population adjusted for the proposed CDP intake volume of interest (FA or RO) was used in the standard ETM model equation (Equation 1 in the SAP May 20 Memo) using the following steps for each taxon
        i. P_e = [(EPS entrainment survey 857 MGD intake flow entrainment estimate) X (CDP intake flow of interest (FA or RO)/857 EPS maximum intake volume)]/Source Water Population derived in Step 3a above
        ii. d = larval duration reported in EPS
        iii. f_i = as reported in EPS
5. The "Without P_s in accordance with Dr. Raimondi's CCC" estimates in Appendix K Table 2 did not include P_s in the ETM model
6. As a check, I conducted a new ETM and APF analysis for FA and RO in accordance with Equation 4 in the SAP May 20 Memo, reproduced here:
7. $P_m = 1 - \sum_{i=1}^{n} f_i \left(1 - \frac{Flow}{857} Pe\right)^d$
        i. Where:

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ii. P_m = proportional mortality
iii. f_i = estimated fraction of total source water larval population present during the i[th] survey (values presented in the EPS entrainment calculation were used in these new calculations)
iv. *Flow* = proposed Carlsbad Desalination Plant intake flow volume: 127 MGD for RO and 171 MGD for FA
v. *857* = maximum intake flow volume in MGD reported in EPS entrainment calculation
vi. P_e = estimated proportional entrainment (maximum intake flow volume derived in EPS entrainment calculation used)
vii. *d* = larval duration in days (values presented in EPS entrainment calculation were used in these new calculations)

8. All APF estimates represent the total APF at the 95% confidence level without any mitigation scaling applied to account for the productivity of the impacted habitat versus the productivity of the proposed mitigation habitat.
   a. Mean and standard error were calculated for each habitat group
   b. The mean and standard error were used with the MS-Excel function Norm.INV to calculate the 95% confidence level APF estimate
   c. CIQ Goby, Combtooth Blennies, Garibaldi were included in the estuarine habitat group
   d. Engraulidae (including Northern Anchovy), White Croaker, California Halibut, Spotfin Croaker, and Queenfish were included in the open coast habitat group
9. The results of the analysis detailed in Step 5 above ("Without P_s in accordance with Dr. Raimondi's CCC") and Step 7 above (in accordance with the SAP May 20 Memo) resulted in identical APF estimates for FA and RO, which are presented in Tables 1 and 2 below.

Table 1. Area of production forgone estimates (acres) derived for Reverse Osmosis (127 MGD), Flow Augmentation (171 MGD), and Total Intake (298 MGD) derived in the methods detailed above and shown in Appendix K Table 2 under the heading "Without Ps in accordance with Dr. Raimondi's CCC".

Habitat Group	Reverse Osmosis	Flow Augmentation	Total Intake
Estuarine	27	36	59
Open Coast	31	41	72
Total	58	77	131

Table 2. Area of production forgone estimates (acres) derived for Reverse Osmosis (127 MGD), Flow Augmentation (171 MGD), and Total Intake (298 MGD) using Equation 4 of the SAP May 20 Memo.

Habitat Group	Reverse Osmosis	Flow Augmentation	Total Intake
Estuarine	27	36	59
Open Coast	31	41	72
Total	58	77	131

ATTACHMENT 3: EMPIRICAL TRANSPORT MODEL CALCULATIONS FOR 170 MGD DIFFUSER

Species	Survey	Date	E (CDP Diffuser MGD)	Period flow	DaysinPeriod	Lduration	fi	Ps	Annual current speed (km/d)	TSWB (alongshore km)	TSWB acres	SW Pop	SWP*DinP	Pe	S
Engraulidae	EPSEA 001	6/1/04	192,700	51,910,896	16	7.7	0.025203	0.3	4.9	37.73	27969.81	352307419	5.637E+09	0.00054697	0.025
Engraulidae	EPSEA 002	6/17/04	34,157	42,177,603	13	7.7	0.001937	0.3	4.9	37.73	27969.81	33321024	433173308	0.0010251	0.002
Engraulidae	EPSEA 003	6/30/04	227,677	81,110,775	25	7.7	0.027861	0.3	4.9	37.73	27969.81	249253179	6.231E+09	0.00091343	0.028
Engraulidae	EPSEA 004	7/25/04	43,660	129,777,240	40	7.7	0.014758	0.3	4.9	37.73	27969.81	82522277	3.301E+09	0.00052907	0.015
Engraulidae	EPSEA 005	9/3/04	76,444	110,310,654	34	7.7	0.034347	0.3	4.9	37.73	27969.81	225944647	7.682E+09	0.00033833	0.034
Engraulidae	EPSEA 006	10/7/04	48,858	90,844,068	28	7.7	0.015087	0.3	4.9	37.73	27969.81	120509922	3.374E+09	0.00040543	0.015
Engraulidae	EPSEA 007	11/4/04	113,665	90,844,068	28	7.7	0.020431	0.3	4.9	37.73	27969.81	163202716	4.57E+09	0.00069646	0.020
Engraulidae	EPSEA 008	12/2/04	0	90,844,068	28	7.7	0.000244	0.3	4.9	37.73	27969.81	1951375.2	54638505	0	0.000
Engraulidae	EPSEA 009	12/30/04	52,569	113,555,085	35	7.7	0.009431	0.3	4.9	37.73	27969.81	60265672	2.109E+09	0.00087229	0.009
Engraulidae	EPSEA 010	2/3/05	26,697	113,555,085	35	7.7	0.014541	0.3	4.9	37.73	27969.81	92923885	3.252E+09	0.0002873	0.015
Engraulidae	EPSEA 011	3/10/05	1,954,487	90,844,068	28	7.7	0.375925	0.3	4.9	37.73	27969.81	3.003E+09	8.408E+10	0.00065088	0.375
Engraulidae	EPSEA 012	4/7/05	2,837,862	90,844,068	28	7.7	0.456705	0.3	4.9	37.73	27969.81	3.648E+09	1.021E+11	0.0007779	0.456
Engraulidae	EPSEA 013	5/5/05	9,506	87,599,637	27	7.7	0.00353	0.3	4.9	37.73	27969.81	29243993	789587822	0.00032507	0.004
Genyonemus lineatus	EPSEA 001	6/1/04	0	55,155,327	17	26.5	0	0.14	4.9	129.85	96259.75	0	0	0	0.000
Genyonemus lineatus	EPSEA 002	6/17/04	0	42,177,603	13	26.5	0.001404	0.14	4.9	129.85	96259.75	3555475.7	46221184	0	0.001
Genyonemus lineatus	EPSEA 003	6/30/04	19641.38	81,110,775	25	26.5	0.010656	0.14	4.9	129.85	96259.75	14034632	350865794	0.00139949	0.011
Genyonemus lineatus	EPSEA 004	7/25/04	7,978	129,777,240	40	26.5	0.023804	0.14	4.9	129.85	96259.75	19594940	783797599	0.00040715	0.024
Genyonemus lineatus	EPSEA 005	9/3/04	296,436	110,310,654	34	26.5	0.384809	0.14	4.9	129.85	96259.75	372670495	1.267E+10	0.00079544	0.384

Genyonemus lineatus	EPSEA 006	10/7/04	18205.08	90,844,068	28	26.5	0.028523	0.14	4.9	129.85	96259.75	33542006	939176164	0.00054275	0.028
Genyonemus lineatus	EPSEA 007	11/4/04	72,921	90,844,068	28	26.5	0.07125	0.14	4.9	129.85	96259.75	83788065	2.346E+09	0.00087031	0.071
Genyonemus lineatus	EPSEA 008	12/2/04	10,194	90,844,068	28	26.5	0.007885	0.14	4.9	129.85	96259.75	9272215.1	259622024	0.00109938	0.008
Genyonemus lineatus	EPSEA 009	12/30/04	39,593	113,555,085	35	26.5	0.054224	0.14	4.9	129.85	96259.75	51012794	1.785E+09	0.00077613	0.054
Genyonemus lineatus	EPSEA 010	2/3/05	125,608	113,555,085	35	26.5	0.175343	0.14	4.9	129.85	96259.75	164960023	5.774E+09	0.00076145	0.175
Genyonemus lineatus	EPSEA 011	3/10/05	138,884	90,844,068	28	26.5	0.199251	0.14	4.9	129.85	96259.75	234315234	6.561E+09	0.00059272	0.199
Genyonemus lineatus	EPSEA 012	4/7/05	6,589	90,844,068	28	26.5	0.037725	0.14	4.9	129.85	96259.75	44363675	1.242E+09	0.00014851	0.038
Genyonemus lineatus	EPSEA 013	5/5/05	6501.72	90,844,068	28	26.5	0.005128	0.14	4.9	129.85	96259.75	6030912.8	168865559	0.00107807	0.005
CIQ Goby	EPSEA 001	6/1/04	0	51,910,896	16	11.5	0.091451		4.9	56.35	41773.1	15777184	252434944	0	0.091
CIQ Goby	EPSEA 002	6/17/04	5,780	42,177,603	13	11.5	0.072891		4.9	56.35	41773.1	15477170	201203205	0.00037344	0.073
CIQ Goby	EPSEA 003	6/30/04	9,998	81,110,775	25	11.5	0.077344		4.9	56.35	41773.1	8539808	213495197	0.00117078	0.076
CIQ Goby	EPSEA 004	7/25/04	52,840	129,777,240	40	11.5	0.17375		4.9	56.35	41773.1	11990183	479607313	0.00440691	0.165
CIQ Goby	EPSEA 005	9/3/04	18,004	110,310,654	34	11.5	0.060996		4.9	56.35	41773.1	4952017	168368581	0.00363573	0.058
CIQ Goby	EPSEA 006	10/7/04	0	90,844,068	28	11.5	0.031996		4.9	56.35	41773.1	3154280	88319830	0	0.032
CIQ Goby	EPSEA 007	11/4/04	0	90,844,068	28	11.5	0.020243		4.9	56.35	41773.1	1995611	55877116	0	0.020
CIQ Goby	EPSEA 008	12/2/04	2,874	90,844,068	28	11.5	0.019668		4.9	56.35	41773.1	1938945	54290463	0.00148245	0.019
CIQ Goby	EPSEA 009	12/30/04	9,264	113,555,085	35	11.5	0.018363		4.9	56.35	41773.1	1448232	50688128	0.00639657	0.017
CIQ Goby	EPSEA 010	2/3/05	23,360	113,555,085	35	11.5	0.082099		4.9	56.35	41773.1	6474874	226620586	0.00360787	0.079
CIQ Goby	EPSEA 011	3/10/05	6,466	90,844,068	28	11.5	0.082653		4.9	56.35	41773.1	8148231	228150465	0.0007935	0.082

CIQ Goby	EPSEA 012	4/7/05	3,055	90,844,068	28	11.5	0.100204		4.9	56.35	41773.1	9878457	276596786	0.00030927	0.100
CIQ Goby	EPSEA 013	5/5/05	9,822	87,599,637	27	11.5	0.168341		4.9	56.35	41773.1	17210217	464675858	0.00057069	0.167
Hypsoblennius	EPSEA 001	6/1/04	22,845	51,910,896	16	2.7	0.046851		4.9	13.23	9807.597	2923343	46773482	0.00781454	0.046
Hypsoblennius	EPSEA 002	6/17/04	144,074	42,177,603	13	2.7	0.053479		4.9	13.23	9807.597	4107004	53391046	0.03508013	0.049
Hypsoblennius	EPSEA 003	6/30/04	16,784	81,110,775	25	2.7	0.099516		4.9	13.23	9807.597	3974066	99351640	0.00422334	0.098
Hypsoblennius	EPSEA 004	7/25/04	383,006	129,777,240	40	2.7	0.423579		4.9	13.23	9807.597	10572039	422881544	0.03622819	0.383
Hypsoblennius	EPSEA 005	9/3/04	71,959	110,310,654	34	2.7	0.133488		4.9	13.23	9807.597	3919660	133268430	0.01835843	0.127
Hypsoblennius	EPSEA 006	10/7/04	2,906	90,844,068	28	2.7	0.031152		4.9	13.23	9807.597	1110744	31100842	0.00261633	0.031
Hypsoblennius	EPSEA 007	11/4/04	6,201	90,844,068	28	2.7	0.016042		4.9	13.23	9807.597	571975	16015311	0.01084189	0.016
Hypsoblennius	EPSEA 008	12/2/04	0	90,844,068	28	2.7	0.000466		4.9	13.23	9807.597	16604	464903.46	0	0.000
Hypsoblennius	EPSEA 009	12/30/04	0	113,555,085	35	2.7	0.000748		4.9	13.23	9807.597	21335	746732.2	0	0.001
Hypsoblennius	EPSEA 010	2/3/05	0	113,555,085	35	2.7	0.000131		4.9	13.23	9807.597	3728	130495.15	0	0.000
Hypsoblennius	EPSEA 011	3/10/05	2,896	90,844,068	28	2.7	0.010016		4.9	13.23	9807.597	357109	9999041	0.00810994	0.010
Hypsoblennius	EPSEA 012	4/7/05	0	90,844,068	28	2.7	0.020535		4.9	13.23	9807.597	732187	20501227	0	0.021
Hypsoblennius	EPSEA 013	5/5/05	84,307	87,599,637	27	2.7	0.163998		4.9	13.23	9807.597	6064009	163728232	0.0139028	0.158
Hypsypops rubicundus	EPSEA 001	6/1/04	0	51,910,896	16	2.2	0.249123		4.9	10.78	7991.376	537635	8602153	0	0.249
Hypsypops rubicundus	EPSEA 002	6/17/04	2,481	42,177,603	13	2.2	0.047857		4.9	10.78	7991.376	127114	1652477.6	0.01951641	0.046
Hypsypops rubicundus	EPSEA 003	6/30/04	5,850	81,110,775	25	2.2	0.20285		4.9	10.78	7991.376	280174	7004345.2	0.02088131	0.194
Hypsypops rubicundus	EPSEA 004	7/25/04	0	129,777,240	40	2.2	0.04324		4.9	10.78	7991.376	37327	1493067.5	0	0.043

Hypsypops rubicundus	EPSEA 005	9/3/04	0	110,310,654	34	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 006	10/7/04	0	90,844,068	28	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 007	11/4/04	0	90,844,068	28	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 008	12/2/04	0	90,844,068	28	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 009	12/30/04	0	113,555,085	35	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 010	2/3/05	0	113,555,085	35	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 011	3/10/05	0	90,844,068	28	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 012	4/7/05	0	90,844,068	28	2.2	0.163028		4.9	10.78	7991.376	201046	5629301.3	0	0.163
Hypsypops rubicundus	EPSEA 013	5/5/05	14,072	87,599,637	27	2.2	0.293903		4.9	10.78	7991.376	375867	10148416	0.03743918	0.270
Paralichthys californicus	EPSEA 001	6/1/04	21,744	51,910,896	16	31.1	0.02907	0.17	4.9	152.39	112969	37529215	600467436	0.00057938	0.029
Paralichthys californicus	EPSEA 002	6/17/04	34157.43	42,177,603	13	31.1	0.032447	0.17	4.9	152.39	112969	51555365	670219745	0.00066254	0.032
Paralichthys californicus	EPSEA 003	6/30/04	275816.4	81,110,775	25	31.1	0.278481	0.17	4.9	152.39	112969	230090889	5.752E+09	0.00119873	0.277
Paralichthys californicus	EPSEA 004	7/25/04	91,271	129,777,240	40	31.1	0.100146	0.17	4.9	152.39	112969	51715058	2.069E+09	0.00176488	0.099
Paralichthys californicus	EPSEA 005	9/3/04	321,761	110,310,654	34	31.1	0.37354	0.17	4.9	152.39	112969	226934807	7.716E+09	0.00141785	0.371
Paralichthys californicus	EPSEA 006	10/7/04	5,866	90,844,068	28	31.1	0.054076	0.17	4.9	152.39	112969	39892316	1.117E+09	0.00014704	0.054
Paralichthys californicus	EPSEA 007	11/4/04	11,473	90,844,068	28	31.1	0.015755	0.17	4.9	152.39	112969	11622315	325424820	0.00098719	0.016
Paralichthys californicus	EPSEA 008	12/2/04	0	90,844,068	28	31.1	0.00504	0.17	4.9	152.39	112969	3718001.3	104104038	0	0.005
Paralichthys californicus	EPSEA 009	12/30/04	3,076	113,555,085	35	31.1	0.009668	0.17	4.9	152.39	112969	5705821.2	199703742	0.00053901	0.010
Paralichthys californicus	EPSEA 010	2/3/05	15,448	113,555,085	35	31.1	0.039406	0.17	4.9	152.39	112969	23256287	813970049	0.00066423	0.039

Paralichthys californicus	EPSEA 011	3/10/05	25,863	90,844,068	28	31.1	0.037661	0.17	4.9	152.39	112969	27782670	777914752	0.0009309	0.037
Paralichthys californicus	EPSEA 012	4/7/05	6,959	90,844,068	28	31.1	0.016412	0.17	4.9	152.39	112969	12107406	339007362	0.0005748	0.016
Paralichthys californicus	EPSEA 013	5/5/05	2,470	87,599,637	27	31.1	0.008298	0.17	4.9	152.39	112969	6347991.4	171395768	0.00038912	0.008
Roncador stearnsii	EPSEA 001	6/1/04	31,975	51,910,896	16	11.4	0.237896	0.34	4.9	55.86	41409.86	111617164	1.786E+09	0.00028647	0.238
Roncador stearnsii	EPSEA 002	6/17/04	60,745	42,177,603	13	11.4	0.138745	0.34	4.9	55.86	41409.86	80119177	1.042E+09	0.00075818	0.138
Roncador stearnsii	EPSEA 003	6/30/04	38,489	81,110,775	25	11.4	0.210051	0.34	4.9	55.86	41409.86	63073788	1.577E+09	0.00061023	0.210
Roncador stearnsii	EPSEA 004	7/25/04	0	129,777,240	40	11.4	0.072001	0.34	4.9	55.86	41409.86	13512733	540509326	0	0.072
Roncador stearnsii	EPSEA 005	9/3/04	18,994	110,310,654	34	11.4	0.341306	0.34	4.9	55.86	41409.86	75357929	2.562E+09	0.00025205	0.341
Roncador stearnsii	EPSEA 006	10/7/04	0	90,844,068	28	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 007	11/4/04	0	90,844,068	28	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 008	12/2/04	0	90,844,068	28	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 009	12/30/04	0	113,555,085	35	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 010	2/3/05	0	113,555,085	35	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 011	3/10/05	0	90,844,068	28	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 012	4/7/05	0	90,844,068	28	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 013	5/5/05	0	90,844,068	28	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Seriphus politus	EPSEA 001	6/1/04	49,768	51,910,896	16	21.6	0.14289	0.23	4.9	105.84	78460.78	79599757	1.274E+09	0.00062523	0.142
Seriphus politus	EPSEA 002	6/17/04	56014.07	42,177,603	13	21.6	0.200434	0.23	4.9	105.84	78460.78	137422609	1.786E+09	0.0004076	0.200
Seriphus politus	EPSEA 003	6/30/04	86538.52	81,110,775	25	21.6	0.156972	0.23	4.9	105.84	78460.78	55964559	1.399E+09	0.00154631	0.156

Seriphus politus	EPSEA 004	7/25/04	8,640	129,777,240	40	21.6	0.039396	0.23	4.9	105.84	78460.78	8778640.4	351145616	0.00098423	0.039
Seriphus politus	EPSEA 005	9/3/04	147,006	110,310,654	34	21.6	0.447145	0.23	4.9	105.84	78460.78	117219199	3.985E+09	0.00125411	0.444
Seriphus politus	EPSEA 006	10/7/04	2,906	90,844,068	28	21.6	0.00809	0.23	4.9	105.84	78460.78	2575113.6	72103181	0.00112852	0.008
Seriphus politus	EPSEA 007	11/4/04	0	90,844,068	28	21.6	0	0.23	4.9	105.84	78460.78	0	0	0	0.000
Seriphus politus	EPSEA 008	12/2/04	0	90,844,068	28	21.6	0	0.23	4.9	105.84	78460.78	0	0	0	0.000
Seriphus politus	EPSEA 009	12/30/04	0	113,555,085	35	21.6	0	0.23	4.9	105.84	78460.78	0	0	0	0.000
Seriphus politus	EPSEA 010	2/3/05	0	113,555,085	35	21.6	0	0.23	4.9	105.84	78460.78	0	0	0	0.000
Seriphus politus	EPSEA 011	3/10/05	0	90,844,068	28	21.6	0	0.23	4.9	105.84	78460.78	0	0	0	0.000
Seriphus politus	EPSEA 012	4/7/05	0	90,844,068	28	21.6	0.005073	0.23	4.9	105.84	78460.78	1614772.5	45213629	0	0.005
Seriphus politus	EPSEA 013	5/5/05	0	90,844,068	28	21.6	0	0.23	4.9	105.84	78460.78	0	0	0	0.000

ATTACHMENT 4: EMPIRICAL TRANSPORT MODEL CALCULATIONS FOR 217 MGD DIFFUSER

May 8, 2019
Item No. 10
Supporting Document No. 3a

Species	Survey	Date	E (CDP Diffuser MGD)	Period flow	DaysinPeriod	Lduration	fi	Ps	Annual current speed (km/d)	TSWB (alongshore km)	TSWB acres	SW Pop	SWP*DinP	Pe	S
Engraulidae	EPSEA 001	6/1/04	245,976	51,910,896	16	7.7	0.025203	0.3	4.9	37.73	27969.81	352307419	5.637E+09	0.00069819	0.025
Engraulidae	EPSEA 002	6/17/04	43,601	42,177,603	13	7.7	0.001937	0.3	4.9	37.73	27969.81	33321024	433173308	0.00130851	0.002
Engraulidae	EPSEA 003	6/30/04	290,622	81,110,775	25	7.7	0.027861	0.3	4.9	37.73	27969.81	249253179	6.231E+09	0.00116597	0.028
Engraulidae	EPSEA 004	7/25/04	55,731	129,777,240	40	7.7	0.014758	0.3	4.9	37.73	27969.81	82522277	3.301E+09	0.00067535	0.015
Engraulidae	EPSEA 005	9/3/04	97,578	110,310,654	34	7.7	0.034347	0.3	4.9	37.73	27969.81	225944647	7.682E+09	0.00043187	0.034
Engraulidae	EPSEA 006	10/7/04	62,366	90,844,068	28	7.7	0.015087	0.3	4.9	37.73	27969.81	120509922	3.374E+09	0.00051752	0.015
Engraulidae	EPSEA 007	11/4/04	145,089	90,844,068	28	7.7	0.020431	0.3	4.9	37.73	27969.81	163202716	4.57E+09	0.00088901	0.020
Engraulidae	EPSEA 008	12/2/04	0	90,844,068	28	7.7	0.000244	0.3	4.9	37.73	27969.81	1951375.2	54638505	0	0.000
Engraulidae	EPSEA 009	12/30/04	67,103	113,555,085	35	7.7	0.009431	0.3	4.9	37.73	27969.81	60265672	2.109E+09	0.00111346	0.009
Engraulidae	EPSEA 010	2/3/05	34,078	113,555,085	35	7.7	0.014541	0.3	4.9	37.73	27969.81	92923885	3.252E+09	0.00036673	0.015
Engraulidae	EPSEA 011	3/10/05	2,494,845	90,844,068	28	7.7	0.375925	0.3	4.9	37.73	27969.81	3.003E+09	8.408E+10	0.00083083	0.375
Engraulidae	EPSEA 012	4/7/05	3,622,447	90,844,068	28	7.7	0.456705	0.3	4.9	37.73	27969.81	3.648E+09	1.021E+11	0.00099296	0.456
Engraulidae	EPSEA 013	5/5/05	12,134	87,599,637	27	7.7	0.00353	0.3	4.9	37.73	27969.81	29243993	789587822	0.00041494	0.004
Genyonemus lineatus	EPSEA 001	6/1/04	0	55,155,327	17	26.5	0	0.14	4.9	129.85	96259.75	0	0	0	0.000
Genyonemus lineatus	EPSEA 002	6/17/04	0	42,177,603	13	26.5	0.001404	0.14	4.9	129.85	96259.75	3555475.7	46221184	0	0.001
Genyonemus lineatus	EPSEA 003	6/30/04	25071.65	81,110,775	25	26.5	0.010656	0.14	4.9	129.85	96259.75	14034632	350865794	0.00178641	0.011
Genyonemus lineatus	EPSEA 004	7/25/04	10,184	129,777,240	40	26.5	0.023804	0.14	4.9	129.85	96259.75	19594940	783797599	0.00051972	0.024
Genyonemus lineatus	EPSEA 005	9/3/04	378,392	110,310,654	34	26.5	0.384809	0.14	4.9	129.85	96259.75	372670495	1.267E+10	0.00101535	0.383

Genyonemus lineatus	EPSEA 006	10/7/04	23238.25	90,844,068	28	26.5	0.028523	0.14	4.9	129.85	96259.75	33542006	939176164	0.00069281	0.028
Genyonemus lineatus	EPSEA 007	11/4/04	93,082	90,844,068	28	26.5	0.07125	0.14	4.9	129.85	96259.75	83788065	2.346E+09	0.00111092	0.071
Genyonemus lineatus	EPSEA 008	12/2/04	13,012	90,844,068	28	26.5	0.007885	0.14	4.9	129.85	96259.75	9272215.1	259622024	0.00140333	0.008
Genyonemus lineatus	EPSEA 009	12/30/04	50,539	113,555,085	35	26.5	0.054224	0.14	4.9	129.85	96259.75	51012794	1.785E+09	0.00099071	0.054
Genyonemus lineatus	EPSEA 010	2/3/05	160,335	113,555,085	35	26.5	0.175343	0.14	4.9	129.85	96259.75	164960023	5.774E+09	0.00097196	0.175
Genyonemus lineatus	EPSEA 011	3/10/05	177,281	90,844,068	28	26.5	0.199251	0.14	4.9	129.85	96259.75	234315234	6.561E+09	0.00075659	0.199
Genyonemus lineatus	EPSEA 012	4/7/05	8,410	90,844,068	28	26.5	0.037725	0.14	4.9	129.85	96259.75	44363675	1.242E+09	0.00018957	0.038
Genyonemus lineatus	EPSEA 013	5/5/05	8299.255	90,844,068	28	26.5	0.005128	0.14	4.9	129.85	96259.75	6030912.8	168865559	0.00137612	0.005
CIQ Goby	EPSEA 001	6/1/04	0	51,910,896	16	11.5	0.091451		4.9	56.35	41773.1	15777184	252434944	0	0.091
CIQ Goby	EPSEA 002	6/17/04	7,378	42,177,603	13	11.5	0.072891		4.9	56.35	41773.1	15477170	201203205	0.00047668	0.072
CIQ Goby	EPSEA 003	6/30/04	12,762	81,110,775	25	11.5	0.077344		4.9	56.35	41773.1	8539808	213495197	0.00149447	0.076
CIQ Goby	EPSEA 004	7/25/04	67,448	129,777,240	40	11.5	0.17375		4.9	56.35	41773.1	11990183	479607313	0.00562529	0.163
CIQ Goby	EPSEA 005	9/3/04	22,982	110,310,654	34	11.5	0.060996		4.9	56.35	41773.1	4952017	168368581	0.0046409	0.058
CIQ Goby	EPSEA 006	10/7/04	0	90,844,068	28	11.5	0.031996		4.9	56.35	41773.1	3154280	88319830	0	0.032
CIQ Goby	EPSEA 007	11/4/04	0	90,844,068	28	11.5	0.020243		4.9	56.35	41773.1	1995611	55877116	0	0.020
CIQ Goby	EPSEA 008	12/2/04	3,669	90,844,068	28	11.5	0.019668		4.9	56.35	41773.1	1938945	54290463	0.00189231	0.019
CIQ Goby	EPSEA 009	12/30/04	11,825	113,555,085	35	11.5	0.018363		4.9	56.35	41773.1	1448232	50688128	0.00816504	0.017
CIQ Goby	EPSEA 010	2/3/05	29,819	113,555,085	35	11.5	0.082099		4.9	56.35	41773.1	6474874	226620586	0.00460534	0.078
CIQ Goby	EPSEA 011	3/10/05	8,253	90,844,068	28	11.5	0.082653		4.9	56.35	41773.1	8148231	228150465	0.00101287	0.082

CIQ Goby	EPSEA 012	4/7/05	3,900	90,844,068	28	11.5	0.100204		4.9	56.35	41773.1	9878457	276596786	0.00039477	0.100
CIQ Goby	EPSEA 013	5/5/05	12,537	87,599,637	27	11.5	0.168341		4.9	56.35	41773.1	17210217	464675858	0.00072847	0.167
Hypsoblennius	EPSEA 001	6/1/04	29,160	51,910,896	16	2.7	0.046851		4.9	13.23	9807.597	2923343	46773482	0.00997504	0.046
Hypsoblennius	EPSEA 002	6/17/04	183,906	42,177,603	13	2.7	0.053479		4.9	13.23	9807.597	4107004	53391046	0.04477875	0.047
Hypsoblennius	EPSEA 003	6/30/04	21,424	81,110,775	25	2.7	0.099516		4.9	13.23	9807.597	3974066	99351640	0.00539097	0.098
Hypsoblennius	EPSEA 004	7/25/04	488,896	129,777,240	40	2.7	0.423579		4.9	13.23	9807.597	10572039	422881544	0.04624422	0.373
Hypsoblennius	EPSEA 005	9/3/04	91,853	110,310,654	34	2.7	0.133488		4.9	13.23	9807.597	3919660	133268430	0.023434	0.125
Hypsoblennius	EPSEA 006	10/7/04	3,710	90,844,068	28	2.7	0.031152		4.9	13.23	9807.597	1110744	31100842	0.00333966	0.031
Hypsoblennius	EPSEA 007	11/4/04	7,916	90,844,068	28	2.7	0.016042		4.9	13.23	9807.597	571975	16015311	0.01383935	0.015
Hypsoblennius	EPSEA 008	12/2/04	0	90,844,068	28	2.7	0.000466		4.9	13.23	9807.597	16604	464903.46	0	0.000
Hypsoblennius	EPSEA 009	12/30/04	0	113,555,085	35	2.7	0.000748		4.9	13.23	9807.597	21335	746732.2	0	0.001
Hypsoblennius	EPSEA 010	2/3/05	0	113,555,085	35	2.7	0.000131		4.9	13.23	9807.597	3728	130495.15	0	0.000
Hypsoblennius	EPSEA 011	3/10/05	3,697	90,844,068	28	2.7	0.010016		4.9	13.23	9807.597	357109	9999041	0.0103521	0.010
Hypsoblennius	EPSEA 012	4/7/05	0	90,844,068	28	2.7	0.020535		4.9	13.23	9807.597	732187	20501227	0	0.021
Hypsoblennius	EPSEA 013	5/5/05	107,615	87,599,637	27	2.7	0.163998		4.9	13.23	9807.597	6064009	163728232	0.01774652	0.156
Hypsypops rubicundus	EPSEA 001	6/1/04	0	51,910,896	16	2.2	0.249123		4.9	10.78	7991.376	537635	8602153	0	0.249
Hypsypops rubicundus	EPSEA 002	6/17/04	3,167	42,177,603	13	2.2	0.047857		4.9	10.78	7991.376	127114	1652477.6	0.02491212	0.045
Hypsypops rubicundus	EPSEA 003	6/30/04	7,468	81,110,775	25	2.2	0.20285		4.9	10.78	7991.376	280174	7004345.2	0.02665438	0.191
Hypsypops rubicundus	EPSEA 004	7/25/04	0	129,777,240	40	2.2	0.04324		4.9	10.78	7991.376	37327	1493067.5	0	0.043

Hypsypops rubicundus	EPSEA 005	9/3/04	0	110,310,654	34	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 006	10/7/04	0	90,844,068	28	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 007	11/4/04	0	90,844,068	28	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 008	12/2/04	0	90,844,068	28	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 009	12/30/04	0	113,555,085	35	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 010	2/3/05	0	113,555,085	35	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 011	3/10/05	0	90,844,068	28	2.2	0		4.9	10.78	7991.376	0	0	0	0.000
Hypsypops rubicundus	EPSEA 012	4/7/05	0	90,844,068	28	2.2	0.163028		4.9	10.78	7991.376	201046	5629301.3	0	0.163
Hypsypops rubicundus	EPSEA 013	5/5/05	17,963	87,599,637	27	2.2	0.293903		4.9	10.78	7991.376	375867	10148416	0.04779001	0.264
Paralichthys californicus	EPSEA 001	6/1/04	27,755	51,910,896	16	31.1	0.02907	0.17	4.9	152.39	112969	37529215	600467436	0.00073957	0.029
Paralichthys californicus	EPSEA 002	6/17/04	43600.95	42,177,603	13	31.1	0.032447	0.17	4.9	152.39	112969	51555365	670219745	0.00084571	0.032
Paralichthys californicus	EPSEA 003	6/30/04	352071.5	81,110,775	25	31.1	0.278481	0.17	4.9	152.39	112969	230090889	5.752E+09	0.00153014	0.276
Paralichthys californicus	EPSEA 004	7/25/04	116,505	129,777,240	40	31.1	0.100146	0.17	4.9	152.39	112969	51715058	2.069E+09	0.00225282	0.099
Paralichthys californicus	EPSEA 005	9/3/04	410,718	110,310,654	34	31.1	0.37354	0.17	4.9	152.39	112969	226934807	7.716E+09	0.00180985	0.370
Paralichthys californicus	EPSEA 006	10/7/04	7,487	90,844,068	28	31.1	0.054076	0.17	4.9	152.39	112969	39892316	1.117E+09	0.00018769	0.054
Paralichthys californicus	EPSEA 007	11/4/04	14,646	90,844,068	28	31.1	0.015755	0.17	4.9	152.39	112969	11622315	325424820	0.00126012	0.016
Paralichthys californicus	EPSEA 008	12/2/04	0	90,844,068	28	31.1	0.00504	0.17	4.9	152.39	112969	3718001.3	104104038	0	0.005
Paralichthys californicus	EPSEA 009	12/30/04	3,926	113,555,085	35	31.1	0.009668	0.17	4.9	152.39	112969	5705821.2	199703742	0.00068803	0.010
Paralichthys californicus	EPSEA 010	2/3/05	19,718	113,555,085	35	31.1	0.039406	0.17	4.9	152.39	112969	23256287	813970049	0.00084788	0.039

Paralichthys californicus	EPSEA 011	3/10/05	33,013	90,844,068	28	31.1	0.037661	0.17	4.9	152.39	112969	27782670	777914752	0.00118827	0.037
Paralichthys californicus	EPSEA 012	4/7/05	8,883	90,844,068	28	31.1	0.016412	0.17	4.9	152.39	112969	12107406	339007362	0.00073372	0.016
Paralichthys californicus	EPSEA 013	5/5/05	3,153	87,599,637	27	31.1	0.008298	0.17	4.9	152.39	112969	6347991.4	171395768	0.0004967	0.008
Roncador stearnsii	EPSEA 001	6/1/04	40,815	51,910,896	16	11.4	0.237896	0.34	4.9	55.86	41409.86	111617164	1.786E+09	0.00036567	0.238
Roncador stearnsii	EPSEA 002	6/17/04	77,539	42,177,603	13	11.4	0.138745	0.34	4.9	55.86	41409.86	80119177	1.042E+09	0.0009678	0.138
Roncador stearnsii	EPSEA 003	6/30/04	49,130	81,110,775	25	11.4	0.210051	0.34	4.9	55.86	41409.86	63073788	1.577E+09	0.00077893	0.209
Roncador stearnsii	EPSEA 004	7/25/04	0	129,777,240	40	11.4	0.072001	0.34	4.9	55.86	41409.86	13512733	540509326	0	0.072
Roncador stearnsii	EPSEA 005	9/3/04	24,246	110,310,654	34	11.4	0.341306	0.34	4.9	55.86	41409.86	75357929	2.562E+09	0.00032174	0.341
Roncador stearnsii	EPSEA 006	10/7/04	0	90,844,068	28	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 007	11/4/04	0	90,844,068	28	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 008	12/2/04	0	90,844,068	28	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 009	12/30/04	0	113,555,085	35	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 010	2/3/05	0	113,555,085	35	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 011	3/10/05	0	90,844,068	28	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 012	4/7/05	0	90,844,068	28	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Roncador stearnsii	EPSEA 013	5/5/05	0	90,844,068	28	11.4	0	0.34	4.9	55.86	41409.86	0	0	0	0.000
Seriphus politus	EPSEA 001	6/1/04	63,528	51,910,896	16	21.6	0.14289	0.23	4.9	105.84	78460.78	79599757	1.274E+09	0.00079809	0.142
Seriphus politus	EPSEA 002	6/17/04	71500.32	42,177,603	13	21.6	0.200434	0.23	4.9	105.84	78460.78	137422609	1.786E+09	0.0005203	0.200
Seriphus politus	EPSEA 003	6/30/04	110463.9	81,110,775	25	21.6	0.156972	0.23	4.9	105.84	78460.78	55964559	1.399E+09	0.00197382	0.155

Seriphus politus	EPSEA 004	7/25/04	11,029	129,777,240	40	21.6	0.039396	0.23	4.9	105.84	78460.78	8778640.4	351145616	0.00125634	0.039
Seriphus politus	EPSEA 005	9/3/04	187,649	110,310,654	34	21.6	0.447145	0.23	4.9	105.84	78460.78	117219199	3.985E+09	0.00160084	0.444
Seriphus politus	EPSEA 006	10/7/04	3,710	90,844,068	28	21.6	0.00809	0.23	4.9	105.84	78460.78	2575113.6	72103181	0.00144052	0.008
Seriphus politus	EPSEA 007	11/4/04	0	90,844,068	28	21.6	0	0.23	4.9	105.84	78460.78	0	0	0	0.000
Seriphus politus	EPSEA 008	12/2/04	0	90,844,068	28	21.6	0	0.23	4.9	105.84	78460.78	0	0	0	0.000
Seriphus politus	EPSEA 009	12/30/04	0	113,555,085	35	21.6	0	0.23	4.9	105.84	78460.78	0	0	0	0.000
Seriphus politus	EPSEA 010	2/3/05	0	113,555,085	35	21.6	0	0.23	4.9	105.84	78460.78	0	0	0	0.000
Seriphus politus	EPSEA 011	3/10/05	0	90,844,068	28	21.6	0	0.23	4.9	105.84	78460.78	0	0	0	0.000
Seriphus politus	EPSEA 012	4/7/05	0	90,844,068	28	21.6	0.005073	0.23	4.9	105.84	78460.78	1614772.5	45213629	0	0.005
Seriphus politus	EPSEA 013	5/5/05	0	90,844,068	28	21.6	0	0.23	4.9	105.84	78460.78	0	0	0	0.000