20 February 2017
TO: Peter MacLaggan and Josie McKinley
FROM: Scott Jenkins
RE: Responses to Regional Board Questions

ABSTRACT: The original 3 September 2015 report, Appendix C to the Carlsbad Desalination Plant NDPES Application, used different models and environmental input than the other two reports, dated 6 April 2016 and 12 July 2016 Appendix BB to the Carlsbad Desalination Plant NPDES Application Addendum. The 3 September 2015 Appendix C was intended to extend the original EIR dilution study to the 60 mgd upgrade of the CDP, as that study was the basis for the original NPDES permit. After reviewing the 3 September 2015 Appendix C report, The Regional Board staff issued a directive to change the environmental input assumptions of the study to a quiescent ocean receiving water body. That directive changed the model selection, and efforts were made to use EPA dilution models over as much of the solution domain as possible. The following reports of 6 April 2016 and 12 July 2016 Appendix BB used identical model combinations and input parameters, but differed in presentation formats of the model results. The primary difference between these two reports was the interpretation of what the effluent was in the calculation of the initial dilution factor, Dm. In the 6 April report the interpretation of effluent in the Dm definition was 60 mgd of raw brine at 67 ppt as it exits from the R.O. facility. This interpretation was made directly from the Ocean Plan definition that Dm is the ratio of parts seawater per parts effluent; and it was believed the 178 mgd of by-passed seawater used for in-plant dilution should be accounted for in the seawater term of the equation rather than as an effluent constituent. In the 12 July 2016 Appendix BB report, the bypassed seawater was included in 238 mgd of partially diluted brine at 42 ppt in the discharge pond based on guidance in comment #1 of an e-mail from Brandi Outwin-Beals, PE to Peter MacLaggan dated 16 June 2016. While this change resulted in a significant reduction in the Dm, the calculated salinity in the receiving water is the same in both of the 2016 reports because the overall dilution of the brine discharge is same. Difference appearances of the coastline is primarily due to the use of different land overlays between the two reports.

The 3 September 2015 Appendix C report used the same land overlay as previously used in the project EIR to delineate the shoreline and adjacent land features. This land overlay was a computer scan of the USGS 7.5-minute San Luis Rey Quadrangle chart (series V895) that was last photo-revised in 1975. On the other hand, the land overlay used in the 6 April 2016 and the 12 July 2016 Appendix BB reports was derived from a 2016 *Google Earth* satellite image. Shoreline changes occurring between 1975 and 2016 produce different features in these two land overlays that cause the coastline to appear different.

IN DEPTH RESPONSES

Question 1: Describe underlying assumptions and why different from each report?

Response 1: This response is sub-divided among the three separate reports:

1.1) Appendix C dated 3 September 2015: File Name <Appendix C - Hydrodynamic Discharge Study v11 Final September 3 2015.pdf>. This was the first dilution report addressing the 60 mgd capacity upgrade.

1.1.1 Model Selection: This study was conducted with the same hydrodynamic model used previously in the project EIR, namely the SEDXPORT nearshore mixing and transport model (see appendix in EIR 2005). This model was selected for two reasons: 1) continuity with the EIR studies which supported the original NPDES permit for the Carlsbad Desalination Project (CDP); and 2) none of the EPA certified mixing models (CORMIX or Visual Plumes UM3) contain the physics for surf zone mixing processes that dominate the dilution of discharges from the CDP. SEDXPORT is the only available model that accounts for these types of nearshore dilution processes, and was approved by Domenic Gregorio at the California State Water Resources Control Board for modeling dilution of storm drain discharges into the surfzone in previous studies conducted by the City of San Diego (see AMEC, 2012, 2013).

1.1.2: Model Assumptions and Initialization: SEDXPORT was initialized with dynamic (time-varying) inputs based on 20.5 year-long historic records of waves, currents, winds, ocean salinity and temperature derived from the archival data bases of Scripps Institution of Oceanography (Scripps Pier Shore Station, SIO, 2010) and the Coastal Data Information Program (CDIP, 2012), supplemented by site monitoring data from the monitoring reports by MBC (2001-2015). The model also utilized dynamic bathymetry that was interactive with ocean historic wave forcing. The dynamic bathymetry was built from baseline historic surveys by the San Diego Gas and Electric Company (SDG&E) and Ewany, et al., (1999); and time varying corrections were applied to that baseline to resolve beach erosion and accretion, based on the elliptic cycloid representation of the equilibrium beach profile as prescribed by Jenkins and Inman (2006). The dynamic bathymetry was constructed from a series of coupled 2-dimensional control cells aligned shore-normal at 1 arc-second intervals. A land overlay derived from the USGS 7.5-minute San Luis Rey Quadrangle was added to this bathymetry to delineate the mean shoreline and adjacent land features.

From these time-varying inputs, the model produced 7,523 time-stepped modeled outcomes for brine salinity dispersion and dilution factor evaluated on the boundaries of a 200 m radius BMZ. For each of these 7,523 solutions, brine salinity, temperature and discharge rate were static inputs with constant values of: total discharge Q = 238 mgd at S = 42 ppt; and $\Delta T = 0^0$C relative to ocean water temperature.

1.1.3 Results & Presentation Formats: The large ensemble of modeled outcomes (7,523 time-stepped solutions) derived from historic ocean and beach conditions were used to make probabilistic assessments of brine salinity and dilution on the boundaries of a 200 m radius *Brine Mixing Zone* (BMZ). The BMZ was measured from the seaward end of the discharge jetties. Outcomes where discharge salinity exceeded 2 ppt above daily ambient ocean salinity at the 200 m BMZ accounted for only 2 % of the dilution results over the 20.5-year period of record, and none of these over-limit outcomes persisted for a month. These rare over-limit outcomes occurred during extreme low tides and/or during beach disposal periods when Middle Beach and South Beach are built out with dredged sands from Agua Hedionda Lagoon, resulting in the seaward ends of the discharge jetties becoming *high-and-dry*, i.e. outside the receiving water.

When these *high-and-dry* conditions occur, the volume of receiving water available for dilution inside the 200 m radius BMZ is diminished, increasing the likelihood of an over-limit outcome, especially when concurrent with minimal wave heights. The SEDXPORT solutions for August 1992 were identified by statistical search as representing the worst-case month for assessing minimum dilution factor Dm at the BMZ; and the average over all 31 daily solutions for that month was Dm = 10.4, based on the assumption that the effluent was the partially diluted brine in the discharge pond at 42 ppt.

1.2) Note on ZID in a Quiescent Ocean dated 6 April 2016: File Name <Jenkins_CDP_ZID_Report_4April2016_v3.pdf>. Following its review of the original Appendix-C dilution analysis, on January 20, 2016, via email from Ben Neill to Peter MacLaggan, the Regional Water Quality Control Board, San Diego Region staff requested a subsequent *initial dilution* analysis for a perfectly quiescent ocean, i.e., in the absence of any motion or mixing in the receiving waters due to waves, currents, tides, or winds (see Attachment A). Given this directive, the dilution assessment had been reduced to a static problem and there was no longer any need for a surfzone mixing model using dynamic (time-varying) inputs. Therefore, the decision was made to invoke one of the EPA certified mixing models, i.e. PDSWIN, Visual Plumes (UM3) or CORMIX.

1.2.1 Model Selection: PDSWIN is a 1990's vintage model, (Baumgartner, et al., 1994), primarily used to estimate dilution of tributary channels entering into larger water bodies; but it has never been validated in a marine environment on the mixing length scales relevant to a 200 m BMZ. Visual Plumes (UM3) is primarily suitable for problems of single port and multiport diffusers with simple merging geometries, and performs best when plumes are discharged in deep water. It is not suitable for resolving dilution of open channel flows discharging into a shallow water body. Late versions of CORMIX (versions 5 and above) have been developed for discharges of open channel flows into open water bodies (like the mixing zone of the CDP), but even these models have limitations. CORMIX is an empirically based *expert systems model*, that takes accumulated laboratory and field experience to compile a set of rules to bridge the gaps evident in the theoretical UM3 models. CORMIX is most effective when the real-world prototype conditions and model variables and conditions match closely. When they do not, the CORMIX predictions can degrade substantially (Frick, et al., 2003). The fundamental limitation of CORMIX at the CDP site is that its rule-based architecture has no provisions for sloping bottom bathymetry across length scales on the order of kilometers, as exists offshore of the CDP discharge. Therefore, the decision was made adopt CORMIX 5.0 as the credentialed arbitrator of Ocean Plan compliance within the 200 m BMZ nearfield mixing zone; and then supplement those results with a model that is capable of resolving the downslope gravity flow dynamics of the negatively buoyant CDP brine once it has dispersed beyond the 200 m BMZ. A more rigorous model was needed to predict the dispersion of brine into the farfield where the plume will finally come to rest with the completion of initial dilution, i.e. at the outer limit of the zone of initial dilution (ZID). That rigor is provided by computational fluid dynamics (CFD).

The CFD model chosen for the farfield solutions was the commercially available COSMOS/FloWORKS codes that were originally developed by the French aerospace company Dassault Systems, and are presently marketed in the United States by its US subsidiary SolidWorks as an add-on to the SolidWorks Professional computer-aided design (CAD) software package under the name "FlowSimulation". In general, CFD models do not make simplifying assumptions in the way the Visual Plumes UM3 model does with its Projected Area Entrainment (PAE) approximation, or CORMIX with its empirical rule-based processing. Instead CFD models use the brute force of modern high-speed computers to perform enormous numbers of iterations that converge on exact solutions to the equations of motion (Navier Stokes Equations). The unique ability of COSMOS/FloWorks is that it provides CFD simulation capability inside a 3-dimensional CAD system. In the 6 April 2016 report, the SolidWorks Professional CAD system was used to build a 3-dimensional CAD model of the CDP discharge channel and merge it with the beach and offshore bathymetry; while COSMOS/FloWORKS technology solves for exact solutions to the brine flows over that CAD model. The CAD embedded CFD codes of COSMOS/FloWORKS and SOLIDWORKS Flow Simulation have been substantially validated in the peer reviewed literature (Balakin, et al., 2004; Oberkampf, W.L. and Trucano, 2002; Melnik, et al., 2015). As with all novel technologies, considerable attention is paid to Validation and Verification (V&V). It is these capabilities and pedigree which makes the embedded COSMOS/FloWORKS and SolidWorks Professional technology the best available technology for resolving the farfield dispersion of brine at the CDP, as well as a providing a separate predictive skill check on the nearfield CORMIX 5.0 solutions.

1.2.2: Model Assumptions and Initialization: CORMIX 5.0 and COSMOS/FloWORKS were initialized with static (time-invariant) inputs. No excitation of receiving water motion from waves, currents, tides or winds were input to either the CORMIX 5.0 or *COSMOS/ FLowWorks* models. Ocean water levels were set at a constant elevation of 0 m MSL. Rigid-boundary bathymetry referenced to mean sea level was used to build a 3-dimesinal CAD model of the CDP discharge jetties and beach and offshore bathymetry. This fixed bathymetry was obtained in 1 arc-second resolution from the National Geophysical Data Center http://maps.ngdc.noaa.gov/viewers/wcs-client/ using the Southern California Coastal Relief Model (1 arc-second)" layer. Additional bathymetric data were added in the very nearshore using a combination of post-dredging bathymetric surveys by the San Diego Gas and Electric Company (SDG&E) during the 1997-98 lagoon re-construction and maintenance dredging; followed by additional surveys at higher resolution conducted by Ewany, et al., (1999), in a study prepared for the California Coastal Commission. This composite digital bathymetric data base was then input to ARC GIS kriging algorithms to create a 3-dimensional CAD model of the seafloor off Agua Hedionda Lagoon at 0.1 arc-second horizontal resolution and covering an area of receiving water 6 km x 6 km. To delineate the shoreline and adjacent land features, a 2016 Google Earth land overlay was added to the CAD model, aligned with the mean sea level contour. The *Manning Roughness Coefficient* used to initialize the CORMIX 5.0 and *COSMOS/ FLowWorks* models in the discharge channel was $n = 0.06$.

The receiving water salinity/temperature profile from September 2008 was used to define worst case scenario for determination of "*the lowest average initial dilution within any single month of the year*" per Provision III.C.4.d of the Ocean Plan. The salinity profile is fairly uniform with depth of water, (with an average salinity of 33.5 ppt), and the temperature is found to gradually decline with water depth, varying between 19.9 ^{0}C on the surface to 13.4^{0} C at the seafloor This is the same salinity/temperature profile used in the discharge permit for the nearby San Juan Creek Ocean Outfall (NPDES NO. CA0107417 ORDER NO. R9-2012-0012), per

RWQCB (2012, 2015). Both the CDP and the San Juan Creek Ocean Outfall reside in the same littoral cell (the Oceanside Littoral Cell), and therefore consistency in using the same temperature/salinity depth profile to define worst-case is sensible. Brine salinity and discharge rate were static inputs with constant values of total discharge Q = 238 mgd at S = 42 ppt. These brine discharge rates and salinity were modeled for two separate delta-T: $\Delta T = 0^0$ C and $\Delta T = +2\ ^0C$ relative to ocean surface water temperature which was T = 19.9 ^{0} C. Initial dilution was considered to be complete along the loci of points in the receiving water where the gradient in dilution factor is less than 1%. Initial dilution was considered to have reached a steady state along that loci of points when the variance in dilution factor between two adjacent computational steps became less than 1%.

1.2.3 Results & Presentation Formats: Results from matched CORMIX 5.0 or *COSMOS/ FLowWorks* models are static single-event solutions based on worst-case month. There were no ensembles of time-varying solutions from which probability statics could be derived, as was done in the original Appendix-C study. We find that the salinity maxima along the worst case radial at the 200 m radius BZM is 35.50 ppt. Only very weak sensitivity of brine dilution to Delta-T was found due to the fact that the mass diffusivity of NaCl in water (a proxy for sea salts) is relatively insensitive to increases of temperature, and a small $\Delta T = 2\ ^0C$ was not sufficient to cause a difference brine salinity at the BMZ which CORMIX 5 could resolve. There was however, some ambiguity in how to present the initial dilution results. The brine discharge Q = 238 mgd at S = 42 ppt is actually the result of in-plant blending of 178 mgd of by-passed seawater with 60 mgd of raw brine at 67 ppt. Provision III.C.4.d of the Ocean Plan defines Dm as “parts seawater per parts effluent;” and this definition guided us to calculate Dm based on considering the raw brine at 67 ppt to be the “effluent”. We tried to make this interpretation clear when we wrote in the Abstract: “The corresponding dilution factor at the BMZ relative to raw brine as it leaves the reverse osmosis facility is $D_m = 15.75$. This dilution factor represents the sum of 2.94 to 1 in-plant dilution due to blending the raw brine with 178 mgd of flow augmentation, followed by an additional 12.81 to 1 dilution (of the raw brine) occurring in the BMZ due to turbulent mixing and entrainment induced by the discharge stream”. The negatively buoyant brine plume was found to extend well beyond the BMZ, spreading offshore and down-slope as gravity flow which eventually lost momentum and became stationary at distance of 1,851 m from the ends of the discharge jetties. At this point, the change in dilution factor D_m with distance offshore becomes less than 1% and dilution is considered complete, marking the seaward limit of the *zone of initial dilution* (ZID). Initial dilution at the ZID reached a robust dilution factor of $D_m = 180$ to 1 for a $\Delta T = 0\ ^0C$; increasing slightly to $D_m = 182$ to 1 for a $\Delta T = +2\ ^0C$, where Dm was again based on the assumption that the “effluent” was the raw brine at 67 ppt.

1.3) Appendix BB dated 12 July 2016: File Name: < Appendix BB Jenkins_CDP_ZID_Report_12July2016_v5_final SENT.pdf> This report is a revision of the 6 April 2016 “*ZID in a Quiescent Ocean”* report in response to questions and comments received from the Regional Water Quality Control Board, San Diego Region staff regarding the Report of Waste Discharge (ROWD) for the Carlsbad Desalination Plant (CDP). These questions and comments were in an e-mail from Brandi Outwin-Beals, PE to Peter MacLaggan dated 16 June 2016, (see Attachment-B). Revisions found in the Appendix BB report were intended to be responsive to questions/comments #1 - #4 in the 16 June 2016 e-mail.

1.3.1 Model Selection: No change relative to the antecedent 6 April 2016 "*ZID in a Quiescent Ocean"* report.

1.3.2: Model Assumptions and Initialization: No change relative to the antecedent 6 April 2016 "*ZID in a Quiescent Ocean"* report.

1.3.3 Results & Presentation Formats: Except for Figures 12 and 13, all figures and modeling results are the same as those in the antecedent 6 April 2016 "*ZID in a Quiescent Ocean"* report. In Figures 12 and 13 the convention used for calculating initial dilution values, Dm, was changed. In the first comment in the e-mail from Brandi Outwin-Beals, (Attachment-C) it became clear that The Regional Board staff was interpreting the effluent in the Dm calculation to be the 238 mgd of partially diluted brine at 42 ppt in the discharge pond (station # M-002). This contrasts with the convention used in the antecedent 6 April 2016 "*ZID in a Quiescent Ocean"* report where the effluent used in the Dm calculation was considered to be the 60 mgd of raw brine at 67 ppt. The example below shows how the same result for salinity = 35.5 ppt at the 200 m BMZ gives a different Dm result, depending on which interpretation of the effluent definition is used.

Example 1: Assume effluent is 60 mgd of raw brine at 67 ppt:

$$D_m = \frac{S_b(R.O.) - S_b(x)}{S_b(x) - S_0} = \frac{67\,ppt - 35.5\,ppt}{35.5\,ppt - 33.5\,ppt} = 15.75 \text{ (per 6 April 2016 report)}$$

Example 2: Assume effluent is 238 mgd of partially diluted brine at 42 ppt:

$$D_m = \frac{S_b(M002) - S_b(x)}{S_b(x) - S_0} = \frac{42\,ppt - 35.5\,ppt}{35.5\,ppt - 33.5\,ppt} = 3.25 \text{ (per 12 July 2016 report)}$$

Here: $S_b(R.O.)$ = 67 ppt and is the effluent discharge salinity as it leaves the R.O. facility, $S_b(M002)$ = 42 ppt and is the partially diluted brine salinity in the discharge pond at, $x = M002$; $S_b(x)$ is the effluent salinity in the discharge plume at a distance x from the point of discharge, where x = 200 m in these examples; and S_0 is the natural background salinity in the receiving water. Example-1 is based on a literal interpretation of the Ocean Plan, which defines Dm as "parts seawater per parts effluent"; and does not consider the 178 mgd of by-passed seawater in the discharge pond to be effluent. Example-2 is the apparent interpretation of effluent implicit in the Dm reference in comment #1 of the e-mail from the Regional Board staff, and it is that interpretation which was used in calculating the new Dm curves (shown in blue) in Figures 12 and 13 of the 12 July 2016 report.

Comment #2 of the e-mail from Brandi Outwin-Beals requests more granularity in the nearfield mixing zone modeling results, asking for salinity and Dm at 10 m intervals between 100 m and 200 m from the point of discharge, (Attachment-A). This required re-initializing the CORMIX 5.0 distance parameters and re-running the model. The new solution points from the high-density runs of CORMIX 5.0 are shown as the black crosses in Figures 12 and 13 of the 12 July 2016 report. These points are also listed in a new table (Table ES-1 and Table 2) that was added to the 12 July 2016 report. (Dm values from Table ES-1/Table-2 are compared in Attachment-C with their counterpart values when the effluent is interpreted as 60 mgd of raw brine). Table B.1 provides a summary of minimum initial dilution (Dm) of effluent defined as 238 MGD at 42 ppt (60 MGD of raw brine plus 178 MGD of bypassed seawater) as a function of distance in the receiving water from end of discharge jetties. Table B.2 provides a summary of minimum initial dilution (Dm) of effluent defined as 60 MGD of raw brine at 67 ppt as a function of distance in the receiving water from end of discharge jetties.

The new solution points from the CORMIX 5.0 re-runs reproduced the original solutions in the 6 April 2016 report with minor exceptions. Whereas the original model runs found brine salinity reaching 35.5 ppt at 200 m from the point of discharge, the follow-on model runs at closer solution intervals found 35.5 ppt salinity at 196 m from the point of discharge. Since no changes were made to any other model parameters or to the bathymetry, this small discrepancy is probably due to model error or accuracy limitations.

The only other changes to appear in the 12 July 2016 report were additional text which was added to address comments #3 and #4 in an e-mail from Brandi Outwin-Beals, PE to Peter MacLaggan dated 16 June 2016, (see Attachment-B). New text on mechanics of initial dilution was added to both the Abstract and to Section 5; explaining the momentum transfers that occur during the initial dilution process of a negatively buoyant plume, and how those plumes eventually lose momentum and come to rest after flowing down bottom slopes as a gravity flow. Additional new text was also added explaining the entrainment streamline patterns that are induced in a water body subject plunging downslope gravity flows of negatively buoyant plumes.

Question 2: Describe Dm differences from each report?

Response 2: This been discussed in Question #1 responses: To summarize, Dm was calculated in the 3 September 2015 Appendix C report based on the interpretation that the effluent was 238 mgd of partially diluted brine at 42 ppt in the discharge pond. In the 6 April 2016 "*ZID in a Quiescent Ocean"* report the interpretation of effluent in the Dm definition was changed to 60 mgd of raw brine at 67 ppt as it exits from the R.O. facility. This change was made after reconsidering the Ocean Plan definition that Dm is the ratio of parts seawater per parts effluent. By this definition, it was believed the 178 mgd of by-passed seawater used for in-plant dilution should not be counted as an effluent constituent. In the 12 July 2016 Appendix BB report, the interpretation of effluent was changed back to the original convention used in the 3 September 2015 Appendix C based on guidance in comment #1 of an e-mail from Brandi Outwin-Beals, PE to Peter MacLaggan dated 16 June 2016, (see Appendix-A). While these two different interpretations resulted in the different Dm values reported between the 6 April report and the 12 July 2016 report, the salinity modeling results are the same in both of the 2016 reports because the overall dilution of the brine discharge is same. Even though the 3 September 2015 Appendix C report and the 12 July 2016 Appendix BB report use the same the interpretation of effluent, the Dm values are bit higher in the 3 September 2015 report because additional ambient mixing was provided by waves and currents. These two reports also used different models.

Question 3: Why is the coastline different?

Response 3: All figures showing coastlines are identical between the 6 April 2016 "*ZID in a Quiescent Ocean"* report and the 12 July 2016 Appendix BB report. Variance in the apparent coastline is only found between the original 3 September 2015 Appendix C report and the other two. The difference is primarily due to the use of different land overlays between the two sets of reports. The 3 September 2015 Appendix C report used the same land overlay as previously used in the project EIR (see EIR 2005) to delineate the shoreline and adjacent land features. This land overlay was a computer scan of the USGS 7.5-minute San Luis Rey Quadrangle chart (series V895) that was last photo-revised in 1975. On the other hand, the land overlay used in the 6 April 2016 and the 12 July 2016 reports was derived from a 2016 *Google Earth* satellite image. Shoreline changes occurring between 1975 and 2016 produce different features in these two land overlays that cause the coastline to appear different. (The Carlsbad coastline around the CDP is well known for long-term shoreline changes related to erosion/ accretion cycles from El Nino and from periodic beach nourishment from Agua Hedionda dredging and from the SANDAG Regional Beach Sand Replenishment Program). In addition, these two sets of reports used different bathymetry data bases with differing resolution. The 3 September 2015 Appendix C report used dynamic bathymetry constructed from late 1990's survey data that were assembled in series of 2-dimensional control cells aligned shore-normal at 1 arc-second intervals. The 6 April 2016 and the 12 July 2016 reports used more recent digital bathymetry (from the National Geophysical Data Center http://maps.ngdc.noaa.gov/viewers/wcs-client/) that was entered into ARC GIS for kriging to 0.1 arc-second horizontal resolution, and subsequently assembled in a 3-dimensional CAD model of the coastline. These differences in the resolution and dimensional rendering of the offshore bathymetry could also contribute to differences in how the coastline appears.

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ATTACHMENT A

From: Neill, Ben@Waterboards [mailto:Ben.Neill@waterboards.ca.gov]
Sent: Wednesday, January 20, 2016 2:51 PM
To: Peter MacLaggan
Cc: Outwin-Beals, Brandi@Waterboards; Dan Connally; Tenggardjaja, Kimberly@Waterboards; Barker, David@Waterboards
Subject: Hydrodynamic Dilution Analysis

Hi Peter,

Poseidon submitted a report entitled *Hydrodynamic Dilution Analysis for the Carlsbad Desalination Project Operating at Sixty Million Gallons per Day Production Rate* (Dilution Analysis), dated September 3, 2015, as Appendix C to the application for renewal of the NPDES permit for the Claude "Bud" Lewis Carlsbad Desalination Plant (Facility) owned by Poseidon Resources (Channelside) LLC (Poseidon). This report provides details of a hydrodynamic dilution analysis related to a potential increase in production capacity of the Facility. The Dilution Analysis concludes that a minimum monthly initial dilution of 3.25:1 is required to ensure compliance with receiving water standards for salinity in the Pacific Ocean.

Several of the assumptions made as part of the Dilution Analysis are inconsistent with the requirements of the *Water Quality Control Plan for Ocean Waters of California* (Ocean Plan). The San Diego Water Board has reviewed the Dilution Analysis and provides the following comments:

<u>Comment #1: The Dilution Analysis incorrectly incorporates currents.</u>

Section III.C.4.d of the Ocean Plan states:

> "For the purpose of this Plan, minimum initial* dilution is the lowest average initial* dilution within any single month of the year. Dilution estimates shall be based on observed waste flow characteristics, observed receiving water* density structure, and the assumption that no currents, of sufficient strength to influence the initial* dilution process, flow across the discharge structure."

Since currents were incorporated into the dilution model, the resulting dilution factor is not based on the conservative assumptions in section III.C.4.d of the Ocean Plan. Poseidon will need to conduct the Dilution Analysis again, setting the current to zero. Also, the San Diego Water Board requests that Poseidon also run the Dilution Analysis setting the waves and wind to zero to ensure that the Dilution Analysis considers the most conservative scenario.

<u>Comment #2: The Dilution Analysis fails to provide sufficient information to support the assumption that the temperature of the pre-diluted brine will be the same as the temperature of the Pacific Ocean.</u>

The Dilution Analysis assumes a temperature difference of 0 degrees Celsius between the pre-diluted brine and the Pacific Ocean. Poseidon must provide additional information to support this assumption.

<u>Comment #3: The Dilution Analysis fails to provide sufficient information in support of the effluent inputs for salinity from the Facility.</u>

The Dilution Analysis assumes that the operating scenario included an effluent salinity of 42 ppt after blending with the brine from the Facility. Poseidon must provide additional information to support this assumption.

Comment #4: The Dilution Analysis fails to provide sufficient information to determine when the momentum-induced velocity of the discharge ceases to produce significant mixing of the waste.

The Ocean Plan defines Initial Dilution as follows:

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

The Dilution Analysis was based on a specified fixed distance of 200 meters to evaluate initial dilution. Consistent with the definition of Initial Dilution in the Ocean Plan, Poseidon must provide additional information regarding the location where the momentum induced velocity of the discharge ceases to produce significant mixing of the waste.

It's important to note that the San Diego Water Board will be unable to complete its draft of the NPDES permit for the Facility until such time as the revised Dilution Analysis has been submitted. Please let me know if you have any questions regarding this email.

Ben Neill, P. E.
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Source Control Regulation
San Diego Regional Water Quality Control Board
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CA.GOV CalEPA San Diego Water Board

ATTACHMENT-B

From: Outwin-Beals, Brandi@Waterboards [mailto:Brandi.Outwin-Beals@waterboards.ca.gov]
Sent: Thursday, June 16, 2016 10:08 AM
To: Peter MacLaggan
C: Barker, David@Waterboards; Neill, Ben@Waterboards; Waggoner, Claire@Waterboards; Tenggardjaja, Kimberly@Waterboards; Isorena, Philip@Waterboards; Jauregui, Renan@Waterboards
Subject: Carlsbad Desalination Plant Questions - 6-16-16

Good morning Peter-

The following are questions/comments that we have regarding the Report of Waste Discharge (ROWD) for the Carlsbad Desalination Plant (CDP):

1. The Hydrodynamic Discharge Study in Appendix C of the ROWD indicates that a minimum monthly initial dilution (Dm) of only 3.25:1 would be required to ensure that a 42 parts per thousand (ppt) effluent concentration at M-002 complies with the Ocean Plan receiving water standard that salinity not exceed 2 ppt above ambient receiving water salinity beyond a brine mixing zone (BMZ) of 200 meters. In light of the Note on the Zone of Initial Dilution in a Quiescent Ocean Due to Discharges of Concentrated Seawater from the Carlsbad Desalination Project (April 2016 Dilution Study), please provide the horizontal distance from the effluent discharge point where a dilution ration of 3.25:1 is modeled in the receiving waters.

2. In order to assist us with reviewing Poseidon's request for a 200 meter BMZ for consistency with the Ocean Plan requirements including the Desalination Amendment, please provide the minimum monthly dilution at 100, 110, 120, 130, 140, 150, 160, 170, 180, 190 and 200 meters from the point of discharge into the receiving water.

3. The April 2016 Dilution Study incorporates a dilution factor based on the potential energy due to brine density being greater than the ambient density of seawater. Please explain how and why this is consistent with the Ocean Plan's definition of Initial Dilution which is considered to be complete when the momentum induced velocity of the discharge ceases to produce significant mixing of the waste.

4. Figures 9 and 10 in the April 2016 Dilution Study show the "streamline pattern of brine discharge jet and entrainment flow." The streamline patterns in the figure appear to imply that the brine discharge and entrainment flow will recirculate back towards the shoreline, i.e. upslope of the ocean floor bathymetry. Please provide clarification regarding the streamline pattern of the brine discharge jet and entrainment flow Figures 9 and 10 in the April 2016 Dilution Study.

5. Figure 7 in the ROWD states that the concentrate discharge is 67 million gallons per day (MGD) at salinity of 65 ppt. Based on our review of the ROWD, the concentrate discharge will have a maximum of 60 MGD of brine at a salinity of 65 parts per thousand blended with 7 MGD of filter backwash at a salinity closer to an ambient level of approximately 33.5 ppt. The mixing of these two waste streams would result in 67 MGD with a salinity somewhat less than 65 ppt. Please provide clarification, and if needed, a revised Figure 7.

6. Please provide a status update on an amended ROWD that includes additional information/supporting material on a new fish return discharge point to the lagoon including but not limited to the antidegradation analysis.

7. Please provide a status update on discussions with the Encina Wastewater Authority regarding the possibility of discharging a portion of the brine to the Encina Ocean Outfall.

I thank you in advance for your urgent attention to these questions/comments. As we continue to develop the draft permit, we may have additional questions/comments. In order to continue to develop the draft permit as quickly as possible, I will pose those questions/comments as they arise.

Brandi Outwin-Beals, PE

Senior WRCE, Source Control Regulation Unit

San Diego Regional Water Board

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Attachment-C: Comparison of Initial Dilution Values, Dm, Based on Effluent Definition

Table B.1: Summary of minimum initial dilution (Dm) of effluent defined as 238 MGD at 42 ppt (60 MGD of raw brine plus 178 MGD of bypassed seawater) as a function of distance in the receiving water from end of discharge jetties.

Distance, *x*, from Discharge Jetties, (m)	$S_b(x)$ Maximum Salinity of Discharge for $\Delta T = 0^0$ C, (ppt)	$S_b(x)$ Maximum Salinity of Discharge for $\Delta T = +2^0$ C, (ppt)	*Initial Dilution Factor, Dm, for $\Delta T = 0^0$ C	*Initial Dilution Factor, Dm, for $\Delta T = +2^0$ C
0.00	42.000	42.000	0	0
10.78	40.956	40.956	0.14	0.14
21.07	39.528	39.485	0.41	0.42
50.19	37.435	37.435	1.16	1.16
54.90	37.311	37.294	1.23	1.24
73.17	36.807	36.794	1.57	1.58
100.0	36.381	36.371	1.95	1.96
110.0	36.233	36.232	2.11	2.11
120.0	36.131	36.130	2.23	2.23
130.0	36.060	36.059	2.32	2.32
140.0	35.956	35.949	2.46	2.47
150.0	35.901	35.894	2.54	2.55
160.0	35.760	35.754	2.76	2.77
170.0	35.685	35.679	2.89	2.90
180.0	35.614	35.609	3.02	3.03
190.0	35.543	35.538	3.16	3.17
196.0	35.502	35.495	3.25	3.26
200.0	35.472	35.467	3.31	3.32
264.0	35.100	35.097	4.31	4.32
**304.8	34.979	34.970	4.75	4.78
328.1	34.900	34.898	5.07	5.08
600.0	34.420	34.419	8.23	8.24
1000	34.174	34.164	11.6	11.8
1300	34.011	33.994	16.0	16.2
1600	33.830	33.828	24.7	24.9
1800	33.700	33.698	41.4	41.9
1851	33.660	33.651	52.1	55.0
2000	33.621	33.618	69.8	71

*Based on 42 parts per thousand (ppt) effluent concentration at station M-002 (discharge pond). From Table ES-1/Table 2 in Appendix BB dated 12 July 2016**:** File Name: < Appendix BB Jenkins_CDP_ZID_Report_12July2016_v5_final SENT.pdf>

**Based on proposed compliance point at 1,000 ft. from the point of discharge, cf. Figures B.1 & B.2

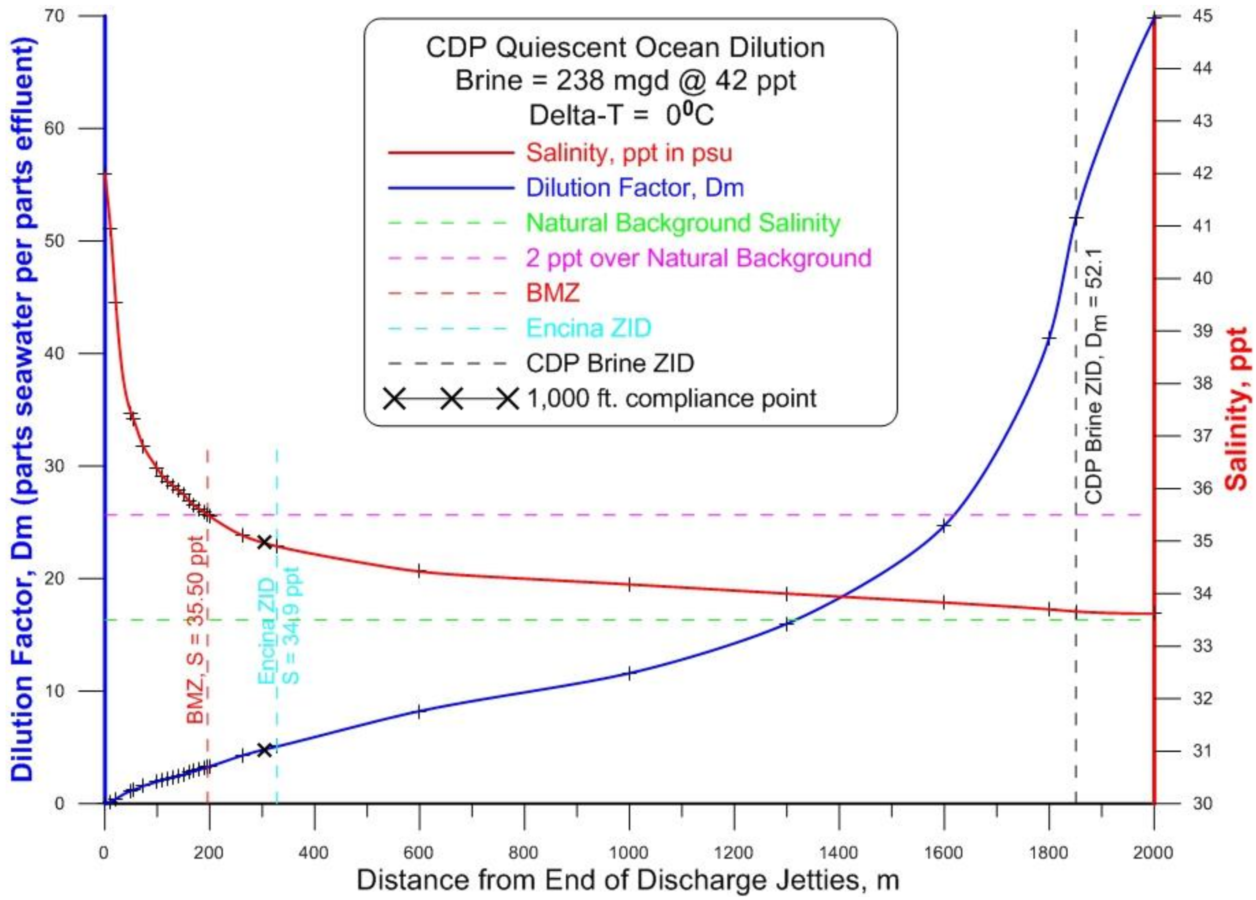

Figure B.1: CORMIX 5.0 and *COSMOS/ FLowWorks* matched solution of still water dilution of CDP brine discharge = 238 mgd at 42 ppt, with ΔT = 0 ^{0}C. Discharge salinity maximum (red, right hand axis) as a function of distance along worst case radial from end of discharge jetties. Dilution factor, Dm, (blue, left hand axis) as a function of distance along worst case radial from end of discharge jetties. Dm based on 42 parts per thousand (ppt) effluent concentration at M-002. Values for proposed compliance point at 1,000 ft. (per Table B.1) shown by the X-symbol.

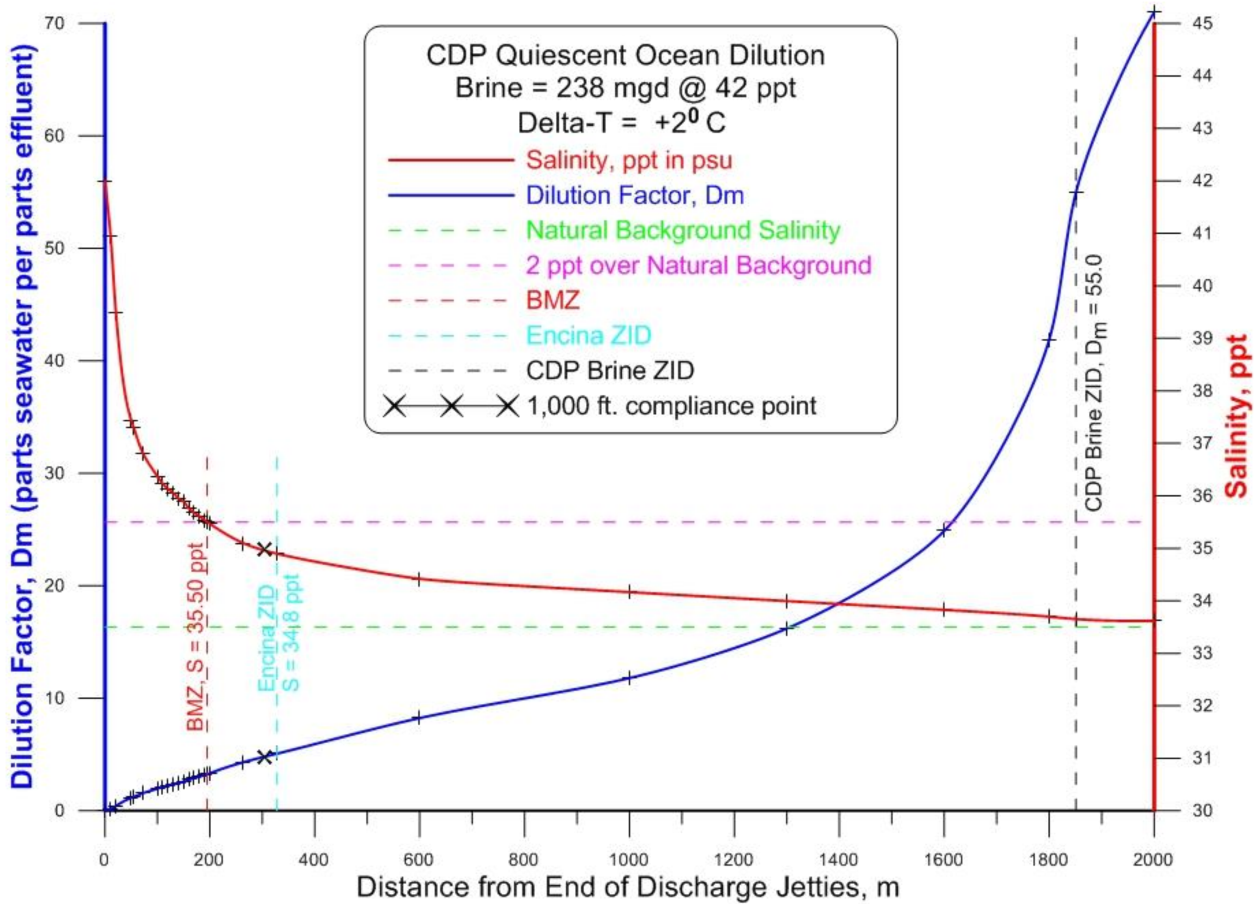

Figure B.2: CORMIX 5.0 and *COSMOS/ FLowWorks* matched solution of still water dilution of CDP brine discharge = 238 mgd at 42 ppt, with $\Delta T = + 2\ {}^0C$. Discharge salinity maximum (red, right hand axis) as a function of distance along worst case radial from end of discharge jetties. Dilution factor, Dm, (blue, left hand axis) as a function of distance along worst case radial from end of discharge jetties. Dm based on 42 parts per thousand (ppt) effluent concentration at M-002. Values for proposed compliance point at 1,000 ft. (per Table B.1) shown by the X-symbol.

Table B.2: Summary of minimum initial dilution (Dm) of effluent defined as 60 MGD of raw brine at 67 ppt as a function of distance in the receiving water from end of discharge jetties

Distance from Discharge Jetties, *x* in (m)	$S_b(x)$ Maximum Salinity of Discharge for $\Delta T = 0^0$ C, (ppt)	$S_b(x)$ Maximum Salinity of Discharge for $\Delta T = +2^0$ C, (ppt)	*Initial Dilution Factor, Dm, for $\Delta T = 0^0$ C	*Initial Dilution Factor, Dm, for $\Delta T = +2^0$ C
0.00	42.000	42.000	2.94	2.94
10.78	40.956	40.956	3.49	3.49
21.07	39.528	39.485	4.55	4.59
50.19	37.435	37.435	7.51	7.52
54.90	37.311	37.294	7.78	7.82
73.17	36.807	36.794	9.12	9.16
100.0	36.381	36.371	10.62	10.66
110.0	36.233	36.232	11.25	11.26
120.0	36.131	36.130	11.73	11.73
130.0	36.060	36.059	12.08	12.08
140.0	35.956	35.949	12.63	12.67
150.0	35.901	35.894	12.95	12.99
160.0	35.760	35.754	13.81	13.85
170.0	35.685	35.679	14.33	14.37
180.0	35.614	35.609	14.84	14.88
190.0	35.543	35.538	15.39	15.43
196.0	35.502	35.495	15.75	15.79
200.0	35.472	35.467	15.98	16.02
264.0	35.100	35.097	19.92	19.97
***304.8	34.979	34.970	21.65	21.79
328.1	34.900	34.898	22.92	22.96
600.0	34.420	34.419	35.37	35.41
1000	34.174	34.164	48.65	49.44
1300	34.011	33.994	66	66.78
1600	33.830	33.828	100.28	101.07
1800	33.700	33.698	166.10	168.07
1851	**33.684	**33.682	180.27	182.70
2000	**33.660	**33.657	208.03	212.76

*Based on 67 parts per thousand (ppt) effluent concentration at station M-001 according to:

$$D_m(x) = \frac{S_b(M001) - S_b(x)}{S_b(x) - S_0} = \frac{67\,ppt - S_b(x)}{S_b(x) - 33.5\,ppt}$$

where: $S_b(x)$ is the effluent salinity at distance, *x* from end of discharge jetties; and S_0 is the natural background salinity in the receiving water.

**Based on original CORMIX 5.0/FloWorks runs per 6 April 2016 draft report