POSEIDON CHANNELSIDE
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Appendix VV (Revision 3)

Carlsbad Desalination Project
Establishing the Location of the Zone of Initial Dilution for Stand-Alone Operation

1. Introduction

The California Ocean Plan requires chronic toxicity testing of discharges where the minimum initial dilution of the effluent falls below 100:1 at the edge of the zone of initial dilution (ZID). Under the Ocean Plan, minimum initial dilution is defined as the "lowest average initial dilution that occurs during any single month of the year." Initial dilution of shallow water non-buoyant discharges is considered to be completed when the momentum induced velocity of the discharge ceases to produce significant mixing, or the diluting plume reaches a fixed distance from the discharge specified by the Regional Board. Hydrodynamic discharge modeling conducted for the Carlsbad Desalination Project (CDP) under permanent stand-alone operation found that significant mixing of the discharge ceases at a distance 6,071 feet (1,851 meters) from the point of discharge (Appendix BB to the ROWD Revised Hydrodynamic Modeling Report). The minimum initial dilution achieved at this location is 52:1. The Ocean Plan requires dischargers to conduct chronic toxicity testing if the minimum initial dilution at the edge of the mixing zone is less than 100:1.

The San Diego Regional Water Quality Control Board and State Water Resources Control Board (Water Boards) requested information to be used in establishing the location of the edge of the ZID for permanent stand-alone operation of the CDP. This Appendix VV is responsive to the Water Boards' request.

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Figure 1 Zone of Initial Dilution

2. Co-Located and Temporary Stand-Alone CDP Operations

Under the co-located and temporary stand-alone operation described in Order R9-2006-0065 (the current Order), the CDP uses effluent from the EPS once-through cooling system for processing and for initial dilution of the brine discharge (Figure 2). The current Order establishes a daily average salinity limit for the combined CDP and EPS effluent in the discharge pond of 40 parts per thousand (ppt) and assigns a 15.5:1 dilution factor for the combined discharge as it proceeds seaward to the edge of a ZID located 1,000 feet (304.8 meters) from the end of the EPS discharge channel. The chronic toxicity testing procedure set forth in the current Order takes into consideration the 15.5:1 dilution of the CDP's brine discharge with the receiving water in the ZID, but does not take into consideration the initial dilution of the CDP discharge when it is co-mingled with effluent from the EPS. A minimum of four gallons of the EPS discharge must be mixed with every gallon of brine leaving the CDP in order to maintain a salinity of 40 ppt salinity in the discharge pond.

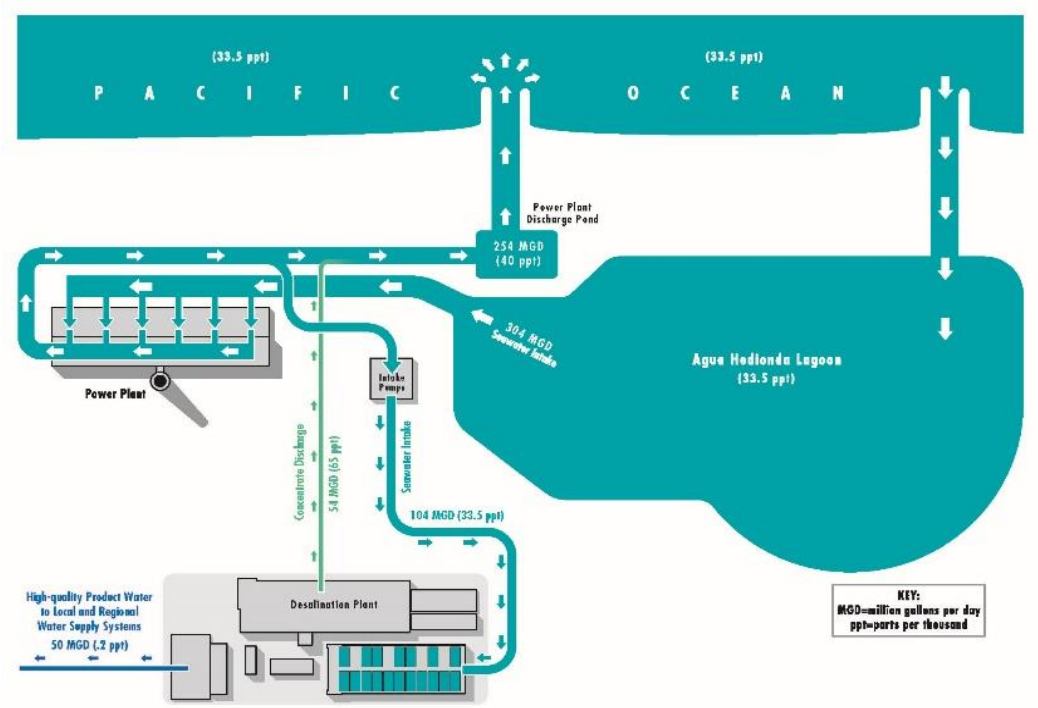


Figure 2 Co-Located and Temporary Stand-Alone CDP Operations

3. Permanent Stand-Alone CDP Operation

Under the proposed permanent stand-alone operations, the CDP would use seawater withdrawn directly from Agua Hedionda Lagoon for processing and brine dilution (Figure 3). The Ocean Plan establishes a receiving water limitation for salinity which provides that the CDP discharge shall not exceed 2.0 ppt above natural background salinity measured no further than 656 feet (200 meters) horizontally from the end of the EPS discharge channel. The Discharger is proposing to use flow augmentation to comply with the effluent limits established by the Water Boards for permanent stand-alone operations.

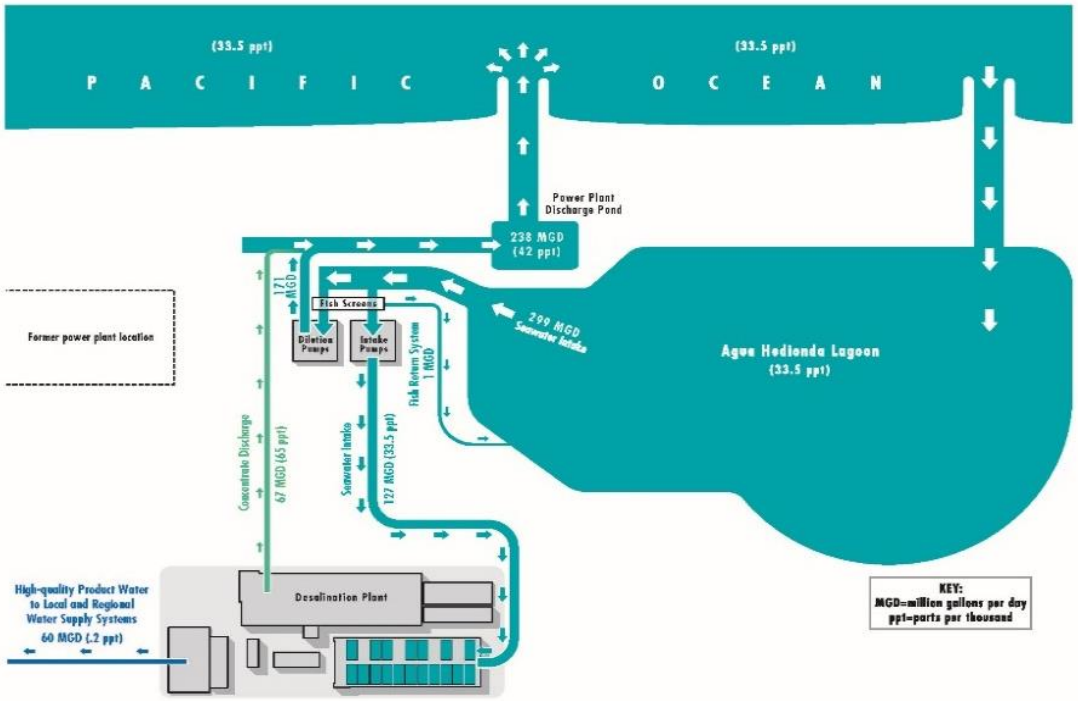


Figure 3 Permanent Stand-Alone CDP Operation

The quantity of water used for flow augmentation purposes will vary depending on plant production requirements and the amount of dilution water needed to meet the effluent limits in the revised Order adopted by the Regional Water Board for stand-alone operation. For example, as noted in Table 1, the combined discharge from the CDP could range from 239 MGD and 249 MGD for potable water production of 60 MGD and 50 MGD, respectively. At the maximum potable water production, the CDP would use 299 MGD of seawater withdrawn from Agua Hedionda lagoon to produce 60 MGD of potable water and a combined discharge to the Pacific Ocean of 238 MGD (62 to 68 MGD granular media filtration backwash and reverse osmosis (RO) brine discharge coupled with 170 to 176 MGD of flow augmentation). At 50 MGD potable water production, the CDP would use up to 299 MGD of seawater withdrawn from Agua Hedionda lagoon to produce 50 MGD of potable water and a combined discharge of 192 to 248 MGD (52 to 58 MGD granular media filtration backwash and RO brine discharge coupled with between 140 MGD to 196 MGD of flow augmentation as needed to ensure compliance with the discharge requirements).

Table 1
Summary of CDP Intake, Production and Discharge Flows
CDP Typical Operating Conditions During Permanent Stand-Alone Operation

Parameter		Permanent Stand-Alone Operating Conditions	
Potable water production capacity		50 MGD	60 MGD
Intake Flows	Intake from CDP Lagoon Intake Structure	Up to 299 MGD	299 MGD
Discharge Flows	Granular Media Filtration Backwash and RO Brine (discharge to Pacific Ocean)	52 to 58 MGD	62 to 68 MGD
	Screen Wash/Fish Return (discharge to lagoon)	1 MGD	1 MGD
	Flow Augmentation (discharge to Pacific Ocean)	140 to 196 MGD[1]	170 to 176 MGD
	Total Discharge to Pacific Ocean	192 to 248 MGD	238 MGD
Salinity	Natural Background Salinity (average)	33.5 ppt	33.5 ppt
	Discharge Pond Salinity	40 ppt to 42 ppt[2]	42 ppt

1. Flow augmentation would be adjusted as needed to ensure compliance with effluent limits at BMZ and ZID.
2. Discharge pond salinity would vary depending on the mixing ratio of brine with the discharges that are at the natural background salinity (flow augmentation and filter backwash water)

Table 2 provides a summary of the results from the Revised Hydrodynamic Modeling Report (ROWD Appendix BB) for operating condition when the CDP is discharging 238 MGD with a salinity of 42 ppt into a quiescent ocean. The combined discharge under this operating scenario consists of 60 MGD RO concentrate, 7 MGD filter backwash, and 171 MGD flow augmentation. The initial dilution of the combined discharge under these operating conditions ranges from 0 at the outside edge of the discharge channel, to 11.8:1 at a location 3,280 feet (1,000 meters) offshore of the discharge channel.

Table 2 Summary of Minimum Monthly Dilution (Dm) as a Function of Distance from the Point of Discharge in the Pacific Ocean CDP Discharge 238 MGD at 42 ppt (60 MGD RO Concentrate, 7 MGD Filter Backwash, and 171 MGD Flow Augmentation)					
Location	Distance from Discharge, (m)	Maximum Salinity of Discharge for ΔT = 0° C, (ppt)	Maximum Salinity of Discharge for ΔT = +2° C, (ppt)	Dilution Factor (Dm) for ΔT = 0° C	Dilution Factor (Dm) for ΔT = +2°C
End of EPS Discharge Channel	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
Existing ZID	**304.8**	**34.979**	**34.970**	**4.75**	**4.78**
	600.0	34.420	34.419	8.23	8.24
	1000.0	34.174	34.164	11.6	11.8

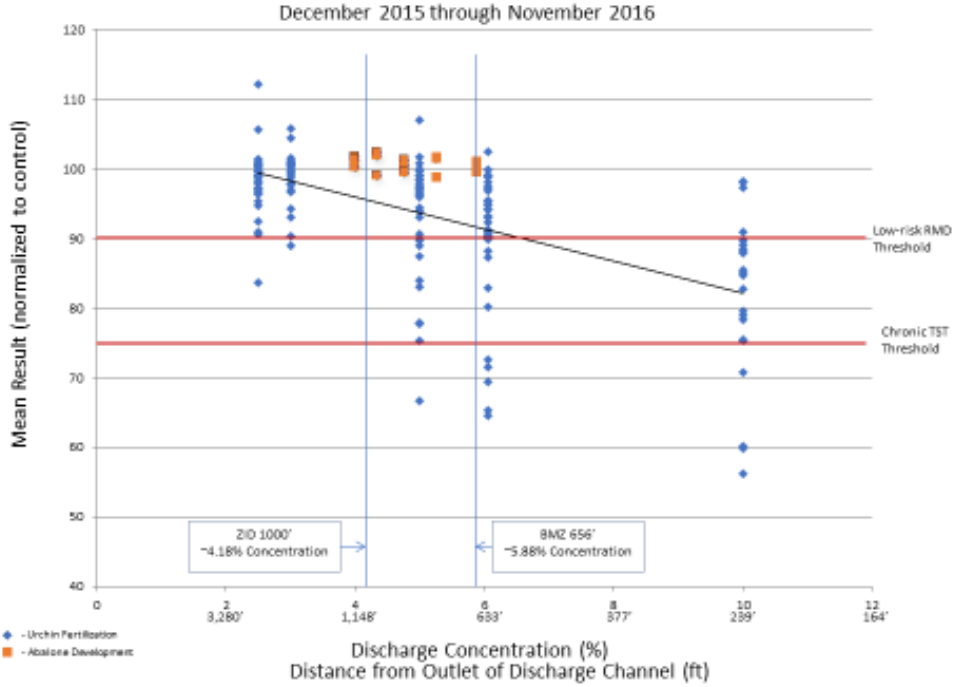
4. Chronic Toxicity Testing Results

Figure 4 provides a summary of the results of the CDP chronic toxicity testing results from December 2015 through November 2016. Toxicity test results shown in Figure 4 are for discharge concentrations ranging from 2.5% to 10%. The 6.06% discharge concentration (15.5:1 initial dilution) conforms to the chronic toxicity testing procedure provided in Order R9-0065-2006 (Chronic Toxicity Unit MDEL of 16.5) for determining compliance with the

chronic toxicity effluent limit at the ZID. This procedure takes into consideration the mixing of the CDP's brine discharge with the receiving water in the ZID, but does not take into consideration the dilution of the CDP discharge when it is co-mingled with effluent from the EPS (a minimum of four gallons of seawater from the EPS is mixed with every gallon of brine leaving the CDP). The 3% concentration (32.3:1 initial dilution) was derived from the 15% concentration of the 40 ppt adjusted sample, which corresponds to the combination of the dilution of the CDP effluent to 40 ppt in the discharge pond (40 ppt) followed by 5.67:1 dilution in the receiving water.

The toxicity test results shown in Figure 4 are arranged by concentration of CDP brine discharge to seawater, which correlates to a distance offshore of the discharge channel that was identified in the Revised Hydrodynamic Modeling Report. The blue diamond symbols represent the results of the Urchin Fertilization testing, and the red squares represent the results of the Abalone Development testing. The results shown at or above a Mean Result of 90 are considered to have a strong likelihood of passing result under the Test of Significant Toxicity (TST) test. The results shown between a Mean Result of 75 and 90 would potentially pass the test, and a Mean Result of less than 75 represents a likely failure of the TST test.

Figure 4
Chronic Toxicity Results from the CDP M-001 Brine Discharge
December 2015 through November 2016



5. Recommended Location of the ZID for Stand-Alone Operation

Regional Water Board staff informed the Discharger that the chronic toxicity test requirements in the revised Order will likely follow the TST testing protocol set forth in the U.S. Environmental Protection Agency's June 2010 National Pollutant Discharge Elimination System Test of Significant Toxicity Implementation Document. Staff also indicated that the test procedure will take into consideration dilution of the CDP discharge through the flow augmentation system. With this guidance, we look to the chronic toxicity testing results presented in Figure 4 to identify the recommended location for the ZID for stand-alone operation.

Objectives in determining the location of the ZID are that (1) the ZID is reflective of the actual area and physical environment in which initial dilution occurs, and (2) the ZID is no bigger than necessary to ensure compliance with the effluent limit for chronic toxicity and the Ocean Plan Table 1 Water Quality Objectives.

Figure 4 shows that it is highly likely that a concentration of brine to seawater of 3% or less would pass the TST test. For concentrations of 5% or greater, the ability to pass the TST test is less certain, and at a 6% concentration, a significant number of the samples would have failed the TST test.

If the edge of the ZID is 1,800 feet (549 meters) offshore of the discharge channel, the discharge would achieve a 3% concentration at the edge of the ZID. If the edge of the ZID is established at 900 feet (274 meters) offshore, the discharge would achieve a 5% concentration at the edge of the ZID. The discharge would achieve a 6% concentration at the edge of the ZID if the edge of the ZID were established 633 feet (193 meters) offshore.

Based on initial dilution modeling and chronic toxicity test results, the Discharger is conditionally recommending that the ZID remain at its current location of 1,000 feet (304.8 meters) offshore of the discharge channel. The expected salinity at this location is 34.98 ppt.

The hydrodynamic modeling described in Table 2 contemplates that the salinity of 34.98 ppt would be achieved 1,000 feet offshore through the following steps:

1. Discharge of 60 MGD of RO brine with a salinity of 67 ppt to effluent monitoring location M-002;
2. Discharge of 178 MGD of seawater from the brine dilution pumps with a salinity of 33.5 ppt to M-002;
3. Steps 1 and 2 above result in a combined discharge of 238 MGD with a salinity of 42 ppt (dilution factor equals 178 MGD/60 MGD = 2.97);
4. The combined discharge receives an initial dilution of 4.75 in the ZID, resulting in a salinity of 34.98 ppt at the edge of the ZID (see Table 2).

The combination of these steps results in a 4.424.38% concentration of brine in the receiving water at the edge of the ZID, which is derived from the following equation:

100/(dilution factor resulting from steps 1-3 above)(dilution factor resulting from step 4)

(100%)/(2.97 + 1)(4.75 +1) = 4.38%

As shown in Figure 4, a brine concentration of 4.424.38% is greater than the 3% concentration that consistently passes the TST test and less than the 5% concentration that periodically fails the TST test. Given that the CDP has only been in operation for one year and there is no chronic toxicity data available for a 4.424.38% concentration, there remains some uncertainty as to

whether the CDP will be able to reliably meet the chronic toxicity effluent limit with a ZID is located 1,000 feet offshore of the discharge channel. However, there are ways to manage this uncertainty. The Discharger is requesting the Regional Water Board include the following conditions in the revised permit to assist with the management of this uncertainty.

1. The revised Order should provide for sufficient operational flexibility such that the quantity of water used for flow augmentation under permanent stand-alone operation could be adjusted within reasonable limits[1] to ensure compliance with the effluent limits in the revised Order. This would provide the Discharger flexibility to reduce CDP production and dedicate more of the plant influent to flow augmentation to reduce the concentration of the brine discharge as necessary to ensure compliance with the effluent limits in the revised Order. To take into consideration dilution of the CDP discharge through the flow augmentation system, samples would be collected at Effluent Monitoring Location M-002 for the effluent limits to be met at the BMZ and ZID.

2. The revised Order should provide that to the extent new information becomes available after the Regional Water Board adopts the revised Order, the permit may be reopened by the Regional Water Board to re-evaluate the chronic toxicity monitoring compliance methodology and/or the initial dilution and the location of the edge of the ZID. Factors to be considered by the Regional Water Board include whether the Discharger is able demonstrate that it is unable to comply with the effluent limits while operating the CDP at an annual average intake flow ≤299 MGD; average daily discharge pond salinity ≤42 ppt; and in compliance with applicable intake velocity requirements; while simultaneously meeting the water production requirements set forth in the 2012 Water Purchase Agreement between the Discharger and the San Diego County Water Authority.

1 The Discharger is proposing the following limitations on operational flexibility: (1) annual average intake flow ≤299 MGD; (2) average daily discharge pond salinity ≤42 ppt; (3) compliance with applicable intake velocity requirements; and (4) compliance with the water production requirements set forth in the Water Purchase Agreement between the Discharger and the San Diego County Water Authority.