Revised Poseidon Huntington Beach Desalination Facility Marine Life Mitigation Plan: Bolsa Chica

Huntington Beach, Orange County, California

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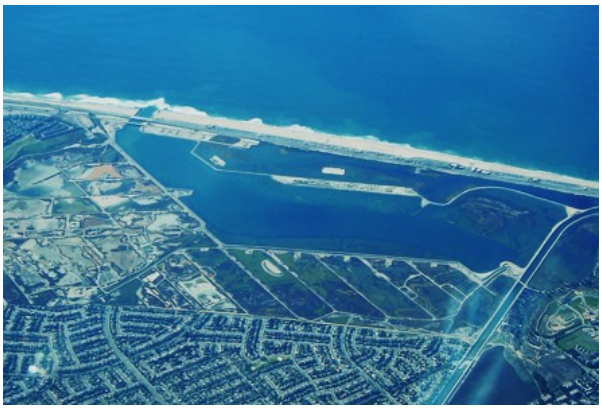

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ACRONYMS AND ABBREVIATIONS

APF	Area of Production Foregone
BMZ	Brine Mixing Zone
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
Corps	U.S. Army Corps of Engineers
ETM	Empirical Transport Model
FTB	Full Tidal Basin
ha	Hectare
LLW	Lower Low Water
MLMP	Marine Life Mitigation Plan
MLMR	Marine Life Mortality Report
MGD	Million Gallons per Day
MTB	Muted Tidal Basins
MPA	Marine Protected Areas
MPM	Muted Pocket Marsh
ppt	Parts per trillion
SANDAG	San Diego Association of Governments
SCCWRP	Southern California Coastal Water Research Project
SONGS	San Onofre Nuclear Generating Station
SLC	State Lands Commission
SWRCB	State Water Resources Control Board

1.0 INTRODUCTION

Poseidon Water (Poseidon) is proposing the development of a desalination facility (Project) in Huntington Beach, Orange County, California (Figure 1). As part of the desalination project's permitting process, Poseidon is required to offset the plant's operational impacts to marine life. The amount of off-set is determined through the calculation of the Area of Production Foregone (APF) to determine the number of replacement habitat credits needed in terms of wetland or estuarine habitat restoration (State Water Resources Control Board 2015).

This Marine Life Mitigation Plan (MLMP) details the proposed mitigation activities that Poseidon will undertake and demonstrates compliance with the desalination amendment to the State Water Resources Control Board's (SWRCB) Water Quality Control Plan for the Ocean Waters of California (Desalination Amendment) as well as the California Coastal Commission (CCC) past precedents related to the preparation of a MLMP. Specifically, this MLMP is designed to demonstrate compliance with the provisions found in Section III.M2.e. of the SWRCB's Desalination Amendment, which requires the use the best available mitigation measures feasible to minimize the intake and mortality of all forms of marine life. This MLMP is also consistent with the goals set forth by the California State Lands Commission related to its management of Bolsa Chica Ecological Reserve (Bolsa Chica; Figure 2).

Poseidon proposes to undertake restoration actions through rehabilitation of tidal action to the Bolsa Chica wetlands. This restoration action will assure long-term and effective tidal action to support estuarine and coastal fish populations in this important regional wetland habitat. Without this action, the inlet will fill with sand and tidal exchange will be greatly, if not entirely, eliminated. The result will be a decline in water quality, a diminishment of fish diversity, and a reduction in the contribution of the estuarine productivity to nearshore waters. In addition, Poseidon, in cooperation with the Bolsa Chica Steering Committee, will undertake wetland re-establishment and re-habilitation in portions of the Bolsa Chica Ecological Reserve.

The project will provide restoration credits to be established through long term inlet rehabilitation and wetland creation. Poseidon examined used a functional lift calculation based on an improvement in the fish richness under full tidal conditions compared to lagoons with a closed inlet. Poseidon found that the functional lift associated with the inlet rehabilitation was 0.62 over the closed condition such that the credit applicable is 198 acres. An alternative formula (Mitigation Ratio Calculator) was used by the Regional Water Quality Control Board. Poseidon used this formula to determine that the applicable credit for inlet rehabilitation was 214 acres.

In addition, the implementation of the wetland re-establishment and re-habilitation opportunities within the Reserve may provide up to 11 additional acres of credit. Final wetland credit acres may vary depending upon further refined site design analysis to be completed as part of the MLMP implementation.

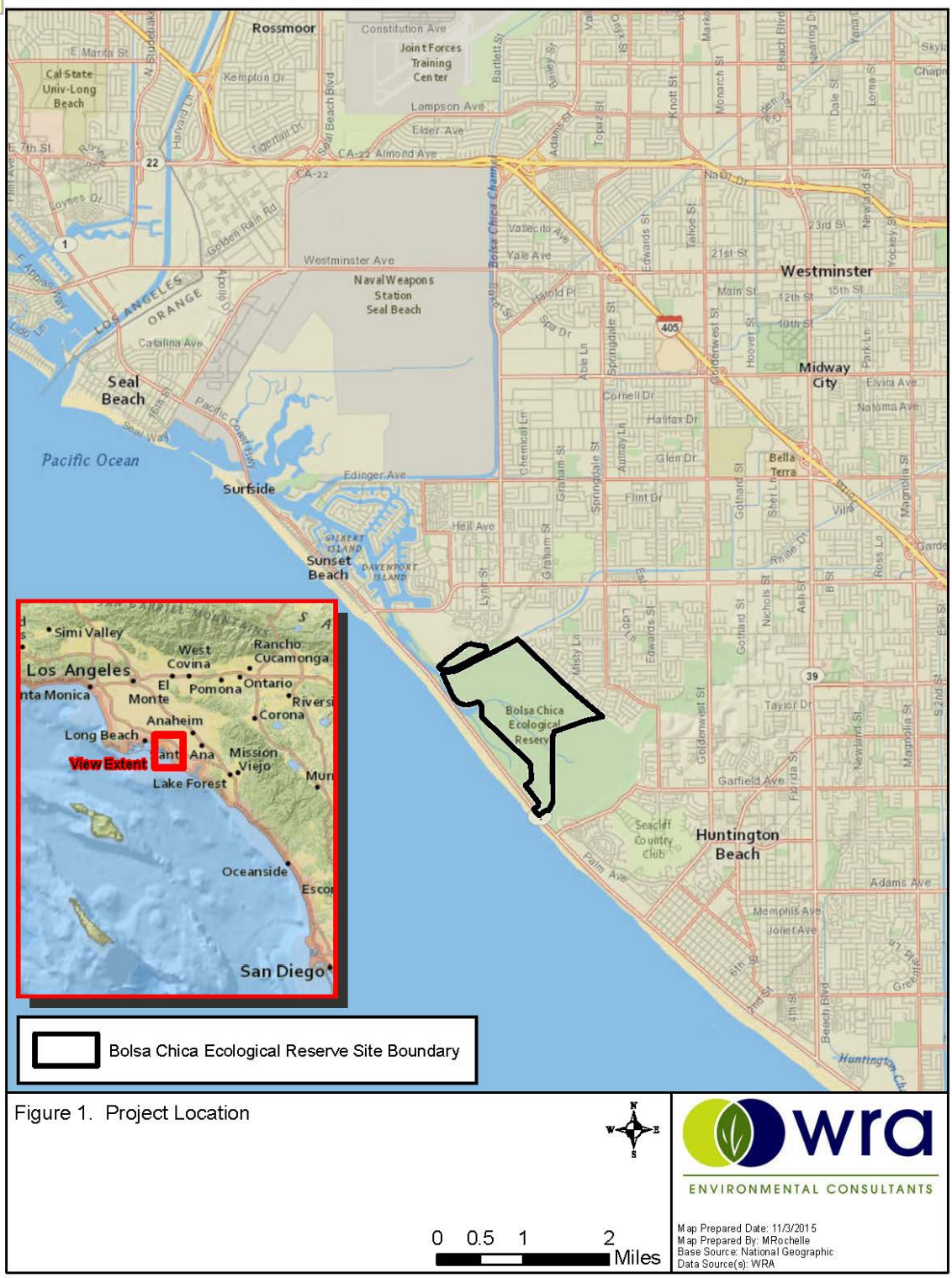

Figure 1. Project Location

Figure 1. Project location.

Figure 2. Site overview.

2.0 MARINE LIFE MORTALITY REPORT SUMMARY

The Desalination Amendment requires the development of a Marine Life Mortality Report (MLMR) estimating the marine life mortality resulting from construction and operation of a desalination facility in order to determine appropriate mitigation for those impacts. Mitigation may be accomplished through "expansion, restoration or creation" of kelp beds, estuaries, coastal wetlands, natural reefs, MPAs, or other projects that mitigate for intake and mortality of marine life associated with the facility. *See* Desalination Amendment Chapter III.M.2.e(3)(b)(i).

The amount of habitat credits required to offset the impacts associated with the operation of the Huntington Beach Desalination Facility is based upon the guidance for calculating the APF found in the Desalination Amendment. An Expert Review Panel undertaken for the SWRCB provided recommendations on mitigation for residual impingement and entrainment caused by intakes that withdraw water directly from the ocean without any filtration (surface intakes) (Foster et al. 2012). The Desalination Amendment requires project proponents use the Empirical Transport Model (ETM) coupled with the Area of Production Forgone model (APF) to estimate the area needed to mitigate the impacts. Mitigation is then used to replace the lost production through expansion, restoration, or creation of productive habitat.. An APF was calculated to characterize the impacts to marine plankton by the intake of surface water and shearing caused by the discharge of brine through a multiport diffuser. Additional mitigation acreage is required to offset any temporary and permanent impacts caused by the construction and installation of submerged infrastructure including diffusers and cylindrical wedge wire screens. Use of the 1-millimeter slot width, cylindrical wedgewire screens and a through-screen intake water velocity of 0.5 feet per second will eliminate impingement. Therefore, no mitigation is needed for impingement.

The Neutral Third-Party Review conducted by Dr. Peter Raimondi (Raimondi 2019) culminated in an APF estimate for the Huntington Beach Desalination Plant seawater surface intake. Raimondi (2019) estimated 162.4 acres of habitat is needed to mitigate for entrainment losses to taxa representing estuarine habitats and taxa representing low-productivity, open-coast habitat. This estimate of 162.4 acres is before any scaling has been applied to account for any productivity differences between the habitats producing the entrained larvae and the mitigation site. The Desalination Amendment allows a ratio of up to 10 acres of impacted APF mitigated by 1 acre of mitigation based on the differences in biological productivity (Ocean Plan Section M.2.e.(3)(b)vi). The surface water intake will be fitted with 1-millimeter slot width cylindrical wedgewire screens thereby qualifying for a 1 percent reduction in APF. This reduces the intake APF to 8.1 acres contributed by estuarine taxa and 152.8 acres contributed by open coast soft bottom taxa (Table 1). The total intake APF after accounting for the 1 percent credit equals 160.9 acres.

At the Huntington Beach Desalination Plant, a linear diffuser is proposed to be installed near the existing Huntington Beach Generating Station discharge tower. This is in close proximity to the currently proposed intake structure allowing for the use of the surface water intake APF in calculating the discharge shearing APF. Raimondi (2019) provided guidance for deriving the shearing APF in situations where the intake and diffuser were in such close proximity that the same larval concentration data can be used. In these cases, the ratio of the estimated volume of water in which lethal shearing occurs is divided by the surface water intake volume. This ratio is multiplied by the surface water intake taxon-specific APF before calculation of the 95 percent confidence interval to derive the multiport diffuser shearing APF. An estimated 168 MGD of water will contain lethal shearing forces for the Huntington Beach Desalination Plant. The surface water intake will withdraw 106 MGD. This equates to a ratio of 1.58. When multiplied by the surface intake APF, the diffuser shearing APF is 256.7 acres (Table 1). Like the intake APF above, this

represents the unscaled APF. For mitigation, scaling is appropriate to account for the productivity differences between the open coast habitats and the proposed mitigation project.

Table 1. Estimated Area of Production Forgone (APF in acres) for each impact and the habitat producing the larvae impacted (water intake and brine discharge) and each habitat impacted by construction.

Impact	Estuary APF	Soft-Bottom APF	Total APF	Soft-Bottom Scaled Acres	Total Acres
Water Intake*	8.1	152.8	160.9	20.4	28.5
Brine Discharge	13.0	243.7	256.7	32.5	45.5
Subtotal	21.1	396.5	417.6	52.9	74.0
Brine Mixing Zone		1.09	1.09	0.15	0.15
Intake Construction		0.88	0.88	0.12	0.12
Diffuser Construction		0.15	0.15	0.02	0.02
Total Mitigation Acreage					74.26

*Water Intake APFs are reduced by 1 percent as allowed by the Desalination Amendment for use of 1-millimeter slot width cylindrical wedgewire screens.

The total, unscaled APF combining surface water intake entrainment impacts (after accounting for 1 percent reduction for using the 1-millimeter slot width cylindrical wedgewire screens) and diffuser shearing impacts totals 417.6 acres. (Table 1) Of these, species from open-coast, low-productivity habitats accounted for 398.0 acres. Mitigation for these impacts is subject to the scaling provision of the Desalination Amendment to account for productivity differences between source habitat and mitigation habitat. Miller (2019) calculated the habitat value (Bond et al. 1999) for the open-coast, soft-bottom habitat using data compiled by the Southern California Coastal Water Research Project (SCCWRP) Bight Regional Monitoring Program's first five surveys (1994, 1998, 2003, 2008, and 2013). A habitat value of 535.27 was derived using the recent SCCWRP data. Comparing this 535.27 to the estuarine habitat value presented in Bond et al. (1999) of 4005.4 results in a 7.5 scalar to balance the biological productivity of estuarine habitat such as that Poseidon proposes to use in mitigation and the shallow soft-bottom habitat that produced the entrained larvae. Using the scalar, the 396.5 acres of open-coast, soft-bottom habitat is offset by 52.9 acres of estuarine habitat mitigation. The 21.1 acres of APF representing taxa sourced from estuarine habitat are mitigated at a 1:1 ratio. Therefore, the total mitigation to offset plankton impacts caused by the intake of seawater and discharge of brine is 74.0 acres.

The area exposed to elevated salinity, termed the brine mixing zone (BMZ), will also suffer mortality and requires mitigation. The BMZ area measures 1.09 acres (Table 1). Permanent construction impacts will impact 0.88 acres of soft-bottom habitat. The discharge structure will impact 0.146 acres of soft-bottom habitat. The benthic habitat impacts total 2.116 acres of soft-bottom habitat which is likewise eligible to scaling in recognition of the productivity differences of the impacted soft-bottom habitat and the proposed mitigation in Bolsa Chica. After applying the

same 7.5 mitigation scaling ratio, the soft-bottom impacts will be mitigated by 0.282 acres of mitigation in Bolsa Chica.

To mitigate for an estimated impact of 74.26 acres for the total operational marine like impacts of the Project, Poseidon proposes to undertake restoration through rehabilitation[1] of the tidal inlet to the Bolsa Chica wetlands in Huntington Beach. While the Bolsa Chica wetlands have been subject to extensive restoration to full tidal and muted tidal habitat, these benefits are threatened by shoaling of the tidal inlet such that tidal exchange is reduced and the inlet could potentially close, placing at risk of loss the existing benefits from the restoration activities. On behalf of the Bolsa Chica Lowlands Restoration Project, the SLC has been undertaking inlet rehabilitation to date; however, funds have been exhausted and no long-term funding is available to continue this action in the future. SLC has indicated its interest in having Poseidon fund the inlet rehabilitation to allow for estuarine and coastal fish populations to be sustained and support other wildlife benefits of this important coastal habitat in Orange County.

[1] See Section 3.1.3 for an explanation of the meaning of rehabilitation as a category of restoration.

3.0 BOLSA CHICA INLET RESTORATION THROUGH REHABILITATION

3.1 Project Objectives

3.1.1 Project Need

Bolsa Chica is an approximately 1,341-acre coastal estuary located in Huntington Beach, Orange County, California (Figure 1). The property is owned by the SLC and managed by the California Department of Fish and Wildlife (CDFW). Historically, the site was used for oil and natural gas production. Previous rehabilitation actions at Bolsa Chica included the construction and opening of the Full Tidal Basin (FTB) to the ocean, which was completed at the end of 2006 (Figure 2). Within Bolsa Chica, 317 acres were restored as fully tidal habitat and require tidal exchange to function and provide ecological value to marine fish. However, since completion, the Bolsa Chica inlet has nearly closed once, and tidal exchange is muted due to sediment shoaling inside the inlet. This has resulted in a smaller volume of ocean water exchanged during the tidal cycle, a narrower tidal range, and lowered marine wetland functions. In addition, the 200 acres of muted tidal areas that are connected to the FTB do not adequately drain when the inlet shoaling occurs, causing lowered water quality within these areas as well.

In a September 3, 2013 letter to the CCC, the SLC wrote:

> *"…the State Lands Commission staff feels there is an equally important need to ensure the preservation of coastal wetland systems that have been restored through prior actions. In particular, many of these tidal wetland systems, such as the Bolsa Chica Lowlands Restoration, were underfunded and have insufficient funds to preserve and maintain the full tidal range the restoration was designed to achieve. This is the situation at Bolsa Chica. As a result of sand accumulating in the ocean inlet area, tidal muting has occurred. If prolonged, this can result in the loss of marsh vegetation and degradation of other habitat areas; or, in a worst-case scenario, the system may close to tidal action. Should a closure occur, it is likely to have a severe impact on many of the species that now utilize the wetland system. Without the implementation of corrective actions such as dredging to offset this condition, the high quality habitat created at Bolsa Chica is threatened. As a consequence, we now believe that priority should be placed on ensuring that existing wetland systems continue to function at a high level through mitigation funding augmentation as well as continuing to pursue restoration of other historic wetland areas on a case-by-case basis. The Bolsa Chica wetland site in Huntington Beach is an example of an underfunded restoration project in need of additional funds to maintain the high value habitat that was created. Given its close proximity to the proposed desalination project area, it would be an ideal candidate for this type of mitigation derived funding augmentation."*

In 2009 and 2011, two dredging events restored full tidal connectivity at Bolsa Chica. In 2015, there was a reduced dredging event that did not remove all the sediment from the sediment basin, yet it appears to have been effective in restoring the tidal range. The SLC believes that this latter type of inlet rehabilitation will be necessary in order to sustain the tidally influenced habitats within Bolsa Chica. The SLC and CDFW do not have the funds needed to pay for continued rehabilitation dredging of the inlet. Without continued rehabilitation dredging, the inlet is likely to close completely. If closure were to occur, the FTB would be effectively isolated from the ocean and would no longer provide habitat for coastal marine fish, water quality would decline, and tidal marsh areas would become inundated. The muted tidal area would also suffer degradation under a closed inlet condition as it would not drain fully during low tides.

In coordination with the SLC and CDFW, Poseidon proposes to restore and maintain tidal connectivity at Bolsa Chica by providing funding for rehabilitation dredging of the inlet, as detailed in this MLMP. In addition, Poseidon has identified a number of wetland restoration opportunities that it will undertake with agency approval within muted and full tidal portions of the Ecological Reserve.

3.1.2 Precedent for Inlet Rehabilitation as Mitigation

Precedents associated with providing habitat credits for inlet rehabilitation have been established by the CCC at the San Dieguito wetland restoration for marine fish killed by the operation of the San Onofre Nuclear Generating Station (SONGS) (CDP 6-04-88) and at Batiquitos and Los Peñasquitos Lagoons for wetland fill associated with transportation projects in San Diego County (CDPPWP-6-NCC-13-0203-1).

At San Dieguito, the CCC determined that Southern California Edison could receive up to 35 acres of wetland habitat credit towards its 150-acre overall requirement for the restoration for the rehabilitation of a tidal inlet at San Dieguito. This action would assure that marine and estuarine fish would be sustained within the existing and restored portions of the lagoon and was deemed as providing a significant offset to the marine fish impacted by the operation of SONGS. The frequency of inlet rehabilitation was expected to be every 18 to 24 months.

In the case of the San Diego Association of Governments (SANDAG) transportation projects, habitat credits were provided at Batiquitos Lagoon and Los Peñasquitos Lagoon for inlet rehabilitation to be conducted every three years to partially offset wetland impacts associated with the highway widening and other transportation elements of the project. At Batiquitos, inlet rehabilitation habitat credits were provided to SANDAG in addition to the marine fish habitat credits previously provided to the Port of Los Angeles for the restoration of the lagoon, which also included initial inlet construction and rehabilitation. These additional credits were provided when mitigation credit had already been given for the lagoon.

3.1.3 The Bolsa Chica Restoration Project Qualifies as Restoration under the Desalination Amendment

The Bolsa Chica MLMP provides for the restoration and long-term rehabilitation of the tidal inlet to the Bolsa Chica wetlands. The previous restoration benefits of the Bolsa Chica wetlands are threatened by shoaling of the tidal inlet such that tidal exchange is reduced and the inlet could potentially close placing at risk of loss the existing benefits from the restoration activities. The Bolsa Chica MLMP was prepared in accordance with the Desalination Amendment mitigation conditions and meets the requirement for “expansion, restoration, and creation of habitat” to offset unavoidable impacts of the project.

The terms "expansion, restoration and creation" are not defined in the Desalination Amendment, the Desalination Amendment Staff Report, or the Substitute Environmental Document for the Desalination Amendment. Regional Board staff have indicated that they will rely on the U.S. Army Corps of Engineers' (Corps) definition of “restoration” because these definitions have been adopted by the State Board in its Draft Wetland Policy. The Bolsa Chica MLMP satisfies the Corps' definition of restoration. The Corps defines "restoration" as:

> "the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. For the purpose of tracking net gains in aquatic resource area, restoration is divided into two categories: re-establishment and rehabilitation."

The Corps defines “rehabilitation”, a category of restoration, as

> "the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded aquatic resource. Rehabilitation results in a gain in aquatic resource function, but does not result in a gain in aquatic resource area”.

The Bolsa Chica MLMP fits squarely within the definition of the rehabilitation category of restoration because the goal of the inlet rehabilitation is to manipulate a crucial physical characteristic (tidal exchange) to return Bolsa Chica to a more productive condition following previous restorations. In addition, the Bolsa Chica MLMP will result in an overall gain in aquatic resource function as compared to the conditions that occur when the inlet is closed as further described in the MLMP. These two considerations—manipulation of a vital characteristic and a gain in aquatic resource function—squarely meet the definition of restoration as adopted by the Corps and as published in the draft State Wetland Policy.

The Bolsa Chica MLMP provides mitigation to contribute to California's Marine Protected Areas (MPA) network, which is recognized as acceptable and preferred mitigation in the State Water Resources Control Board's Final Staff Report and Substitute Environmental Document for the Desal Amendment, adopted May 6, 2015 ("Desai Amendment Staff Report").

3.2 Benefits to Aquatic Ecosystems

The Desalination Amendment provides:

> *For out-of-kind mitigation, an owner or operator shall evaluate the biological productivity of the impacted open water or soft-bottom habitat calculated in the Marine Life Mortality Report and the proposed mitigation habitat. If the mitigation habitat is a more biologically productive habitat (e.g. wetlands, estuaries, rocky reefs, kelp beds, eelgrass beds, surfgrass beds), the regional water boards may apply a mitigation ratio based on the relative biological productivity of the impacted open water or soft-bottom habitat and the mitigation habitat. The mitigation ratio shall not be less than one acre of mitigation habitat for every ten acres of impacted open water or soft-bottom habitat.*

The proposed activity would restore, through rehabilitation, tidal flows through to the Bolsa Chica wetlands that will result in increased benefits to wetlands and eelgrass beds as described below. The primary benefits of preventing inlet closure at Bolsa Chica and maintaining a fully tidal system to fisheries resources include providing supportive physical habitat for coastal marine organisms, access to heterogeneous habitat types used for cover and foraging, a nutrient base to support a productive food web, establishment and sustainability of an extensive eelgrass habitat, and high quality rearing habitat for larval and juvenile life stages for fish.

Tidal wetland restoration for the Carlsbad desalination plant was found to be acceptable mitigation under Water Code section 13142.5(b) in a published Court of Appeal opinion, *Surfrider Foundation v. California Regional Water Quality Control Board, San Diego Region* (2012) 211 Cal.App.4th 557. Under the plan at issue in that case, Poseidon agreed to restore up to 55.4 acres of estuarine wetlands in Southern California for the purpose of creating a habitat in which fish populations will increase and thereby offset the marine life mortality caused by operation of the desalination facility. *Id.* at 566-67. The court concluded: “the compensatory measure of creating additional marine life habitat in Southern California’s coastal wetlands can be defined as mitigation.” *Id.*

3.2.1 Fish Habitat

Many marine fish species require coastal wetland habitat to complete at least a portion of their life cycle. The vegetative edge of the wetlands is important for foraging juvenile fish as it provides cover for predator avoidance (Herbold et al. 2014). Studies have shown that small fish, such as California killifish (*Fundulus parvipinnis*) were able to consume six times more food in marsh habitat than in habitat with no marsh access (West and Zedler 2000). Madon (2008) found that food consumption rates of topsmelt (*Atherinops affinis*) were 50 percent lower when the tidal inlet at Los Peñasquitos is closed (Figure 3). In addition, halibut were affected by closure due to their sensitivity to higher temperatures in less flushed systems.

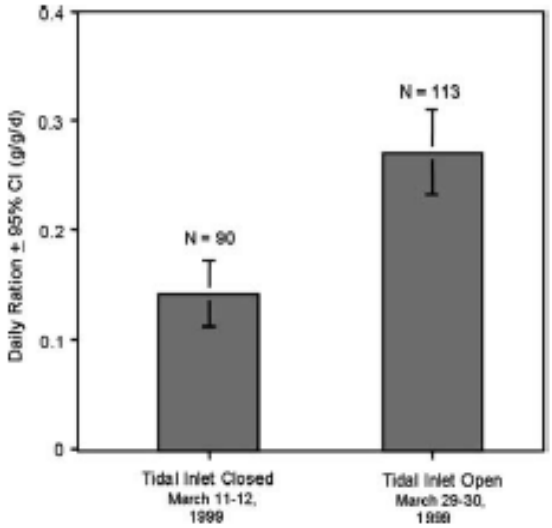

Figure 3. Field estimates of daily amounts of food consumed by topsmelt (Madon 2008).

Nearly every fish species captured during post-restoration monitoring conducted at Bolsa Chica was represented by juvenile size classes and usually adults, demonstrating the role of the basin as nursery habitat for spawning or post-larval settlement and rearing (Merkel & Associates 2013). Restricting tidal exchange at Bolsa Chica due to lack of rehabilitation could eliminate access to the tidal wetlands for marine fish as well as degrade or completely eliminate the salt marsh vegetation habitat that many species depend on. Severe tidal muting would likely result in permanent inundation, which would kill salt marsh vegetation (e.g. cordgrass) that needs periodic drainage and exposure typical of tidal systems to survive. The loss of salt marsh vegetation would degrade habitat complexity used for small fish rearing and reduce intertidal spawning substrate (Farrugia et al. 2014).

Results of the annual monitoring reports and previous work by Farrugia et al. (*ibid*) indicate that significant fish population and habitat benefits at Bolsa Chica would be lost if the inlet is not maintained and the system becomes closed. Fully tidal systems allow greater species richness to occur compared to closed or muted systems (Figure 4). For example, nearby Batiquitos Lagoon had only 11 species observed before restoration when the lagoon's inlet was closed, while 75 species have been observed during open inlet conditions (Merkel & Associates 2009). Open access to coastal wetland areas allows for seasonal variation in species utilizing the habitat, which results in a larger number of species benefiting from the habitat (Gewant and Bollens 2010).

In a muted system, the restricted access can impair or prevent species from accessing the wetland habitat. In Malibu Lagoon, where 14 fish species are known to occur, there is a lower species richness compared to other southern California coastal wetlands that are not tidally muted (Ambrose and Meffert 1999; The Bay Foundation 2015). Similarly, 14 species have been found in the tidally muted Los Peñasquitos Lagoon (Williams 1997). For fully tidal systems where there is no seasonal limitation for marine species to utilize the wetland habitat, greater species richness occurs, which is evident by the 80 species documented in San Diego Bay, and 75 species each in both Los Angeles Harbor and Batiquitos Lagoon (Merkel & Associates 2013).

Following restoration in 2006, the fish community in Bolsa Chica was abundant, diverse, and contained biomass levels equivalent to the relatively unaltered Upper Newport Bay and the larger San Diego Bay (Farrugia et al. 2014). Over five years of quarterly monitoring, a total of 52 species have been observed within the FTB at Bolsa Chica (Figure 4) (Merkel & Associates 2013). The average species richness of eight primarily open coastal wetlands in southern California was 58.5 ± 16 and was only 19.5 ± 11 in closed or highly muted lagoons (Figure 5). According to the same rationale that the Ports of Los Angeles and Long Beach used when they received credits for their muted tidal area, the difference in fish species richness between closed and open lagoons (19.5/58.5) indicates that closed systems are only about 33 percent as valuable as that fully tidal systems. Annual monitoring has identified many ecologically and commercially valuable fish species within the FTB that will likely be lost if the inlet is allowed to close. Commercially desirable species found at Bolsa Chica include white seabass (*Atractoscion nobilis*) and California halibut (Merkel & Associates 2013). Fodrie and Levin (2008) found that about 58 percent of juvenile halibut in southern California had embayment origins in 2003 and 2004, and that lagoon-type habitats such as Bolsa Chica provided nurseries for 16 percent of halibut in 2004. While most of the fish common in southern California bays, lagoons, and estuaries are low in trophic level (Zedler 1982), the species composition within the FTB currently includes coastal marine fishes from 3-4 trophic levels, including top predators such as leopard shark (*Triakis semifasciata*), brown smooth-hound (*Mustelus henlei*), gray smooth-hound (*M. californicus*), and bat ray (*Myliobatis californica*). These relatively large fish act as energy links that transfer nutrients among coastal areas (Farrugia et al. 2014).

In contrast, closed and severely muted systems are dominated by species with a salinity tolerance greater than seawater, or approximately 35 parts per thousand, including various gobies (Gobiidae), California killifish, and topsmelt (Merkel & Associates 2009; MEC Analytical Systems 1993); these species, however, are also known to be resident within southern California embayments including open systems (Zedler 1982). Species within closed systems also include those that occur in stagnant water and/or are tolerant of poor water quality and elevated temperatures, such as non-native Western mosquitofish (*Gambusia affinis*), rainwater killifish (*Lucania parva*), and sunfish (Centrarchidae) (Wetland Research Associates 1994; MEC Analytical Systems 1993).

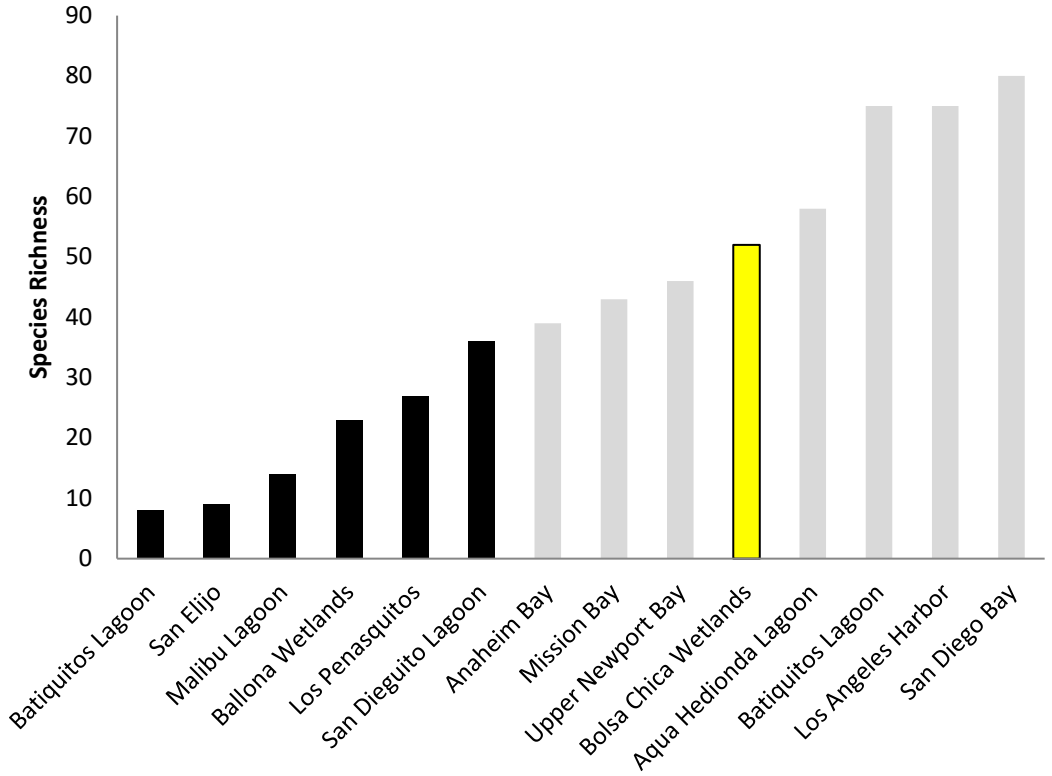

Figure 4. Fish species richness observed during monitoring events.

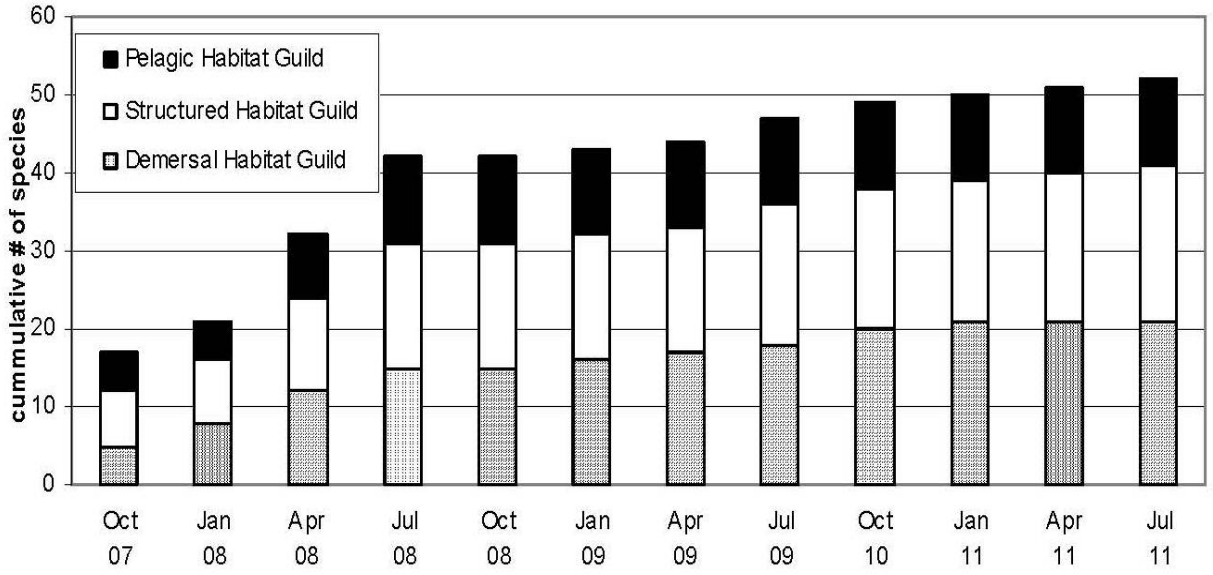

Figure 5. Cumulative total of fish species by guild in the Full Tidal Basin of Bolsa Chica following the restored tidal influence (Merkel & Associates 2013).

Overall, the habitat within the FTB supports more complex habitat and higher species richness than closed or severely muted systems. Significant areas of eelgrass and cordgrass have expanded in the FTB after the initial restoration, and this enhanced habitat would be lost or degraded if the FTB was allowed to close (Merkel & Associates 2013). Extensive eelgrass meadows increase the complexity of the system as they support resident fish species, provide egg-laying substrate and protection for breeding species, perform essential ecosystem functions, and form the basis of detritus- and grazing-based food webs (Merkel & Associates 2013; Bernstein et al. 2011). This structured habitat provides ideal conditions for fish species such as croaker (Sciaenidae), surfperch (Embiotocidae), kelpfish (Chironemidae), and seabass (Sciaenidae) that would be lost if the inlet is allowed to fill with sediment (Merkel & Associates 2013). In contrast, the restricted tidal influence and periodic water quality extremes of a closed or highly muted system limit eelgrass establishment and the fish community to a small number of hardy species.

3.2.2 Food Web

More complex food webs and greater productivity occur when a coastal wetland experiences tidal flushing (Kwak and Zedler 1997). Kwak and Zedler compared isotopic enrichment of consumers within a fully tidal system with abundant California cordgrass (*Spartina foliosa*) in the Tijuana Estuary and a system with a history of frequent and prolonged inlet closure at the San Dieguito Lagoon prior to restoration. They found that there were four trophic levels in the Tijuana Estuary and only three levels within San Dieguito. The food web of San Dieguito had fewer trophic links, fewer species, and fewer interconnections, which represents the ability of organisms to engage in optimal foraging behavior and consume the full variety of organisms suitable for their diet (Cohen and Newman 1988).

There is a significant food web linkage between tidal marshes and channels in Tijuana Estuary where channel fishes and invertebrates support birds in the salt marshes (Kwak and Zedler 1997). The Federal-listed endangered Ridgway's rail (*Rallus obsoletus levipes*) occupies the highest trophic level in these systems and feeds on intertidal invertebrates and fishes (Kwak and Zedler *ibid*.). Until the Batiquitos wetlands were restored to tidal action, no Ridgway's rails were found; they currently number over 36 pairs since restoration (Zembel and Hoffman 2012). Similarly, the endangered California least tern (*Sterna antillarum browni*) nests on areas adjacent to the FTB at Bolsa Chica and preys upon anchovy (Engraulidae), smelt (Osmeridae), silversides (Atherinopsidae), shiner surfperch (Cymatogaster aggregate), and small crustaceans. When Batiquitos Lagoon was restored to tidal action, the number of least terns nesting in the lagoon increased from several dozen to several hundred within two years with most of the adults foraging within the lagoon itself (Josselyn et al. 1997).

Annual monitoring conducted at Bolsa Chica found large numbers of Northern anchovy (*Engraulis mordax*) in 2011 that move seasonally into the FTB and feed on zooplankton (Merkel & Associates 2013). Northern anchovy then provide an important prey species for nesting birds. The arrow goby (*Clevelandia ios*) is a common resident benthic species within southern California estuaries and is an important food source for California halibut (*Paralichthys californicus*) and Pacific staghorn sculpin (*Leptocottus armatus*). Most of the fish common to southern California bays and estuaries consume plants, detritus, or small invertebrates. These fish are common prey species to larger marine fish and are an important link between coastal and marine systems (*Zedler 1982*).

Full tidal flows allow for larval dispersal into the system and a steady supply of invertebrate colonists that serve as food for fish (Farrugia et al. 2014; Lopez-Duarte et al. 2012). Studies on recruitment in southern California embayments demonstrate rapid recovery of marsh

invertebrates with planktonic larvae and suggest that active dredging at lagoon inlets is an effective restoration tool for these species (Lopez-Duarte et al. 2012). Following restoration, invertebrates were diverse in the FTB with species from eleven phyla. In contrast, invertebrates within the MTB were more limited, with tunicates, bubble snails, and shore crabs being the primary taxa found (Merkel & Associates 2013).

3.2.3 Water Quality

Wetland restoration design at Bolsa Chica relies on tidal exchange to maintain habitat function of the 367-acre FTB as well as allowing for tidal drainage of the 200 acre muted tidal area. Severe shoaling and possible closure of the inlet at Bolsa Chica will significantly harm the restored lagoon habitat by reducing tidal circulation and degrading water quality.

Longshore currents carrying sand move along the coast and enter the inlet during flood tides. Gross longshore transport carries an average of about 1,962 cubic yards (1,500 cubic meters) of sand per day past California lagoons (Corps 1991). Small lagoons have weak outflow velocities that are incapable of flushing the sand back out of the lagoon inlet, so the sand builds up and closes the inlet over time (Elwany 2011). Closure of small lagoons results from natural processes. However, urbanization along the southern California coast can restrict natural inlet dynamics, often causing or increasing the likelihood of closure; this is the case at Bolsa Chica. While the original wetland system was over 2300 acres in size, development around and within the wetland have greatly restricted its size and ability to flush out sand within the inlet. The restoration project, while large in size, is not sufficient in itself to maintain an open inlet. In addition, Bolsa Chica does not benefit from winter rains that often break the sand bar and assist in preventing closure of inlets (Zedler 1982). Therefore, rehabilitation dredging is required to maintain an open inlet for tidal exchange at this location.

Tidal circulation is particularly important for southern California coastal marshes due to low and seasonal rainfall, low amounts of runoff, and frequent drought. Runoff that does occur from the surrounding landscape may also contain excess nutrients, which can greatly enhance algal growth. Therefore, interruption in tidal influence can significantly alter the physical habitat and associated plant and animal communities. When tidal systems are completely isolated from water exchange, evaporation within the closed system increases the concentration of salt up to 60 parts per trillion, compared to the average of 35 parts per trillion for sea water. Higher increases in salinity are more likely in systems with little to no freshwater inputs such as Bolsa Chica and can be lethal to many organisms (Farrugia et al. 2014; Zedler *ibid*.).

Fully tidal wetland systems are generally reflective of ocean water quality and are reliant upon tidal exchange to maintain good water quality. However, lagoons with restricted tidal exchange have much warmer temperatures because they receive less of a cooling effect during the influx of tidal ocean water. Elevated water temperatures can result in lower dissolved oxygen, which can be particularly detrimental to sensitive life stages of fish, particularly larvae and juveniles (Harper and Wolf 2009).

Monitoring at Los Peñasquitos Lagoon following closure has shown that dissolved oxygen levels decline rapidly to levels below those known to support fish (NOAA, undated) (Figure 6). Undesirable biological changes within a closed lagoon may therefore include expansion of algae and pest insects such as midges and mosquitoes that thrive in such environments (Zedler, *ibid*.). Algae populations expand with the excess nutrients from runoff and consume dissolved oxygen in the water during decay; this process leads to further reduction of dissolved oxygen, eutrophication, and fish kills (Elwany 2011).

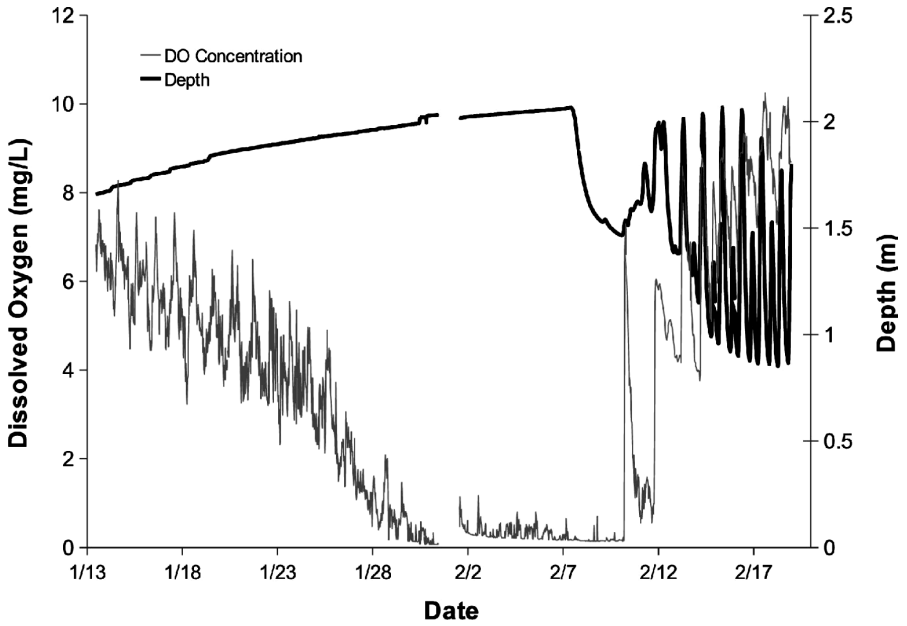

Figure 6. Los Peñasquitos lagoon oxygen levels (thin line) declined with closure (shown as bold line) (From NOAA, undated)

3.2.4 Benefits to Eelgrass Habitat

Eelgrass (*Zostera marina*) habitat expanded greatly in the FTB with the opening of the inlet and subsequent tidal influence in the system (Merkel & Associates 2013) (Figure 7). While eelgrass was initially planted in the FTB, its size of the habitat that eventually was established was never considered as part of the original benefits of tidal restoration nor was any credit allocated to this important habitat to the Ports of Los Angeles and Long Beach which provided the initial funding to the project. This community-structuring plant forms expansive meadows or smaller beds in subtidal and intertidal habitats and is considered a foundation species that creates biological, physical, and chemical values. Eelgrass performs essential ecosystem functions, as it traps and removes suspended particulates, improves water clarity, and reduces erosion by stabilizing sediment. It also facilitates nutrient cycling, oxygenates the water column during daylight, and may be a significant source of carbon sequestration (Bernstein et al. 2011).

Eelgrass is a major source of primary and secondary production and is the basis of detritus-based food webs (Bernstein et al. 2011). Eelgrass beds provide habitat and nurseries for commercially and recreationally important marine fish and invertebrates and structural environments for resident bay and estuarine species (Hoffman 1986; Kitting 1994; Bernstein et al. 2011). Juvenile fish, including salmon (*Salmonidae*) and other anadromous species, use eelgrass for foraging habitat and cover (Simenstad 1994; Bernstein et al. 2011). Eelgrass is also an important resource for migratory birds and waterfowl that feed on plants and many other species that consume eelgrass directly or epiphytes that grow on the leaves (Bernstein et al. *ibid*.).

Higher fish diversity, abundance, and biomass have been observed in eelgrass areas versus areas without eelgrass. Studies in the San Diego Bay compared data from several eelgrass and non-eelgrass stations throughout the bay and show a marked increase in diversity. One method to measure the amount of biodiversity within an ecological community is the Shannon- Weiner index, which takes into account the number of species present (richness) and their relative abundances (evenness). In most ecological studies, values are typically between 1.5 and 3.5;

rarely is it greater than 4. The index increases as both richness and evenness of the community increase. The calculation is as follows:

$$H' = -\sum p_i \ln p_i$$

Where p_i is the proportion of individuals found in species *i*.

Data from a comparison of fishery utilization of eelgrass versus non-vegetation shallow water areas in San Diego Bay (Hoffman 1986) reveals the difference in the biodiversity of fish populations in eelgrass versus non-eelgrass communities. Both communities had the same number of species (27) with 19 species in common. In the non-eelgrass community, 81.3 percent of the total individuals were topsmelt, versus 39.5 percent of the total individuals in the eelgrass community. The calculated Shannon Weiner index value for the non-eelgrass community was 0.7349 while the value for the eelgrass communities was 1.3059.

In addition to fish habitat, Cole and Moksnes (2015) identify and quantify the value of carbon and nitrogen uptake of eelgrass beds in Sweden. Sequestration of carbon and nitrogen within eelgrass itself as well as within sediment offsets impacts to climate change, reduces eutrophication, and increases nutrient cycling within trophic levels. Carbon is fixated directly within the leaves, roots, and rhizomes of eelgrass, and sediments trapped within eelgrass beds can be up to 3.3 feet (1 meter) thick and preserved for hundreds of years. Similarly, estimates of nitrogen accumulation within the top 2 inches (5 centimeters) of sediment of restored eelgrass beds after nine years was three times higher than the nitrogen content of unvegetated adjacent areas (Cole and Moksnes *ibid*.).

According to the currently known extent of significant beds of eelgrass in southern California coastal wetlands, eelgrass beds only occur in intertidal or subtidal systems. Distribution of eelgrass within these systems is likely dependent on several physical factors, including waves, current, substrate, and turbidity; temperature also likely plays a role as Hoffman (1986) speculates that seasonal variability in eelgrass coverage in south San Diego Bay could be due to high temperatures the south bay experiences versus the cooler, more tidally flushed central and northern portions of the bay. Inlet rehabilitation would increase tidal flushing at Bolsa Chica, which would in turn result in lower water temperatures and potentially create more suitable conditions for eelgrass.

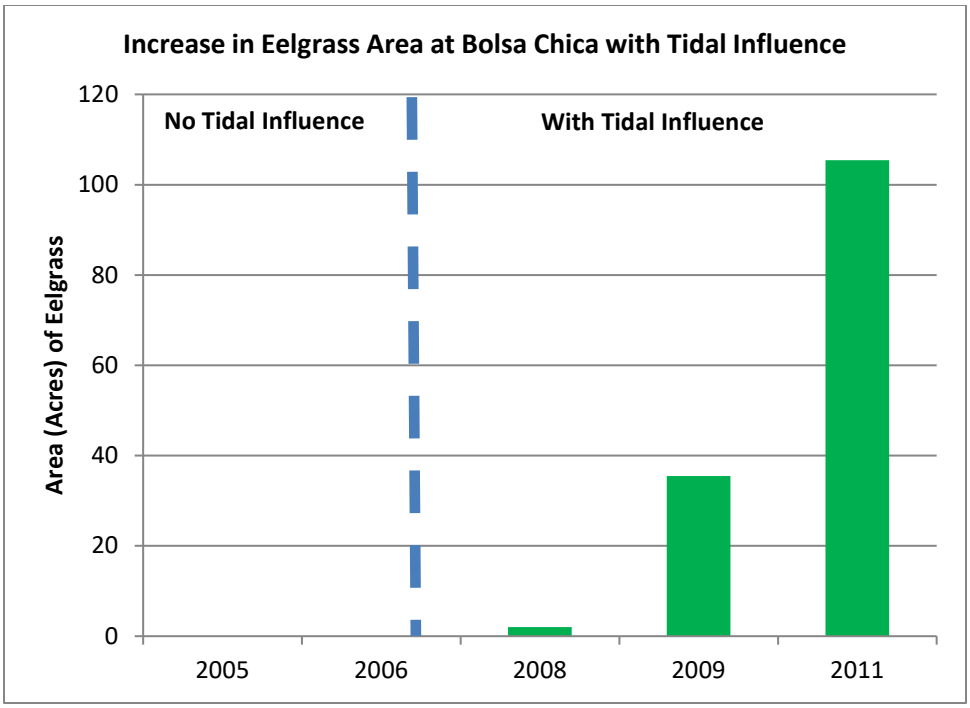

Figure 7. Change in eelgrass area following restoration of tidal action at Bolsa Chica (Merkel & Associates 2013).

4.0 SITE SELECTION

The proposed restoration through rehabilitation of tidal action at Bolsa Chica will satisfy the Desalination Amendment's standards and past CCC precedent for mitigation for marine life impacts resulting from the proposed desalination plant. In addition, Poseidon evaluated opportunities for restoration actions at a number of sites in southern California and determined that restoration of the Bolsa Chica full tidal inlet was highly ranked as meeting the requirements of the Desalination Amendment and CCC minimum standards. The basis for meeting the Desalination Amendment standards and CCC minimum standards is summarized in Tables 2 and 3 below.

Table 2. Basis for meeting SWRCB Desalination Amendment standards under operator/owner Mitigation Plan.

Desalination Amendment for Operator Mitigation	Basis for Compliance
Submit a Mitigation Plan, including project objectives, site selection, site protect instrument, baseline site conditions, a mitigation work plan, a rehabilitation plan, a long-term management plan, an adaptive management plan, performance standards, success criteria, monitoring requirements, and financial assurances.	This document is the Mitigation Plan and it contains the specific required elements.
Mitigation shall be accomplished through expansion, restoration, or creation of one or more of the following: kelp beds, estuaries, coastal wetlands, natural reefs, MPAs, or other projects approved by the regional water board.	The proposed mitigation will restore and maintain the tidal inlet to the Bolsa Chica full tidal wetlands and prevent the potential loss of previously restored coastal wetlands at Bolsa Chica.
The owner/operator shall demonstrate that the project fully mitigates for intake-related marine life mortality by including expansion, restoration, or creation of habitat based on the APF acreage calculated.	Section 3.2 describes the benefits to coastal and estuarine fish, wetlands, and eelgrass beds. Without the proposed inlet rehabilitation, the tidal inlet will close over time. Inlet rehabilitation has always been a key element of the Bolsa Chica wetland restoration. As a result of Poseidon's MLMP, this element of the restoration will be achieved. The area of anticipated benefit at Bolsa Chica exceeds the estimated scaled APF.
The mitigation project's production area shall overlap the facility's source water body. Impacts on the mitigation project due to entrainment by the facility must be offset by adding compensatory acreage to the mitigation project.	The Bolsa Chica wetlands are within proximity to the proposed project; however, the fish within the wetlands are predominately estuarine species that may provide a forage base for marine species but are not the same species as found in the vicinity of the intake/discharge of the project.
The owner/operator shall demonstrate that the project fully mitigates for discharge- and construction-related marine life mortality projected in the MLMR.	The anticipated benefit at Bolsa Chica exceeds the scaled APF estimated in the MLMR.
The regional water board may permit out-of-kind mitigation for mitigation of open water or soft bottom species. In-kind mitigation shall be done for all other species whenever feasible.	This project is out-of-kind but provides substantial benefits to wetlands and eelgrass beds and the estuarine and near shore coastal fishes affected by the project.

Table 3. Compliance with CCC Minimum Standards.

Minimum Standard	Basis for Compliance
Location within Southern California Bight.	Bolsa Chica is located within the Southern California Bight.
Potential for restoration as tidal wetland, with extensive intertidal and subtidal areas.	Bolsa Chica has been restored to tidal action with 175 acres of subtidal, 122 acres of intertidal mudflat, and 19 acres of intertidal habitat within the FTB. In addition, approximately 200 acres of muted tidal habitat is also affected by the inlet remaining open. The inlet rehabilitation is a necessary component to retain the benefits of these habitats to the coastal ecosystem.
Creates or substantially restores a tidally influenced habitat thorough inlet rehabilitation and wetland restoration.	Total benefit of inlet rehabilitation and restoration exceeds the scaled APF requirement.
Provides a buffer zone of a size adequate to ensure protection of wetland values, and at least 100 feet wide, as measured from the upland edge of the transition area.	Bolsa Chica full tidal area is located within the State Ecological Reserve and is fully buffered.
Any existing site contamination problems would be controlled or remediated and would not hinder restoration.	Bolsa Chica was cleaned up to required standards prior to restoration. No known contamination at the inlet where rehabilitation is proposed.
Site preservation is guaranteed in perpetuity (through appropriate public agency or nonprofit ownership.	Land is owned by the State of California.
Feasible methods are available to protect the long-term wetland values on the site(s), in perpetuity.	Land is owned by the State of California for its ecological values.
Does not result in a net loss of existing wetlands.	No existing wetlands will be lost with inlet rehabilitation; in fact, rehabilitation is required to sustain existing wetlands
Does not result in an adverse impact on endangered animal species or an adverse unmitigated impact on endangered plant species.	No adverse impacts to endangered plants and animals from inlet rehabilitation or wetland restoration. Inlet rehabilitation will sustain fish populations that are used by least terns and snowy plover.

5.0 BASELINE SITE CONDITIONS

5.1 Summary of Past Restoration Activities

In 1996, eight state and federal agencies entered into an agreement to conduct wetland acquisition and restoration at the Bolsa Chica. Restoration construction began on October 6, 2004. The FTB was opened to the ocean on August 24, 2006. The basin was designed to support 71.0 hectares (ha) (175.5 acres) of non-wetland waters, 49.6 ha (122.6 acres) of tidal flats, and 7.7 ha (19.1 acres) of pickleweed – a component of salt marsh habitat.

In addition to the FTB, additional habitat was restored to dampened or muted tidal action. Three muted tidal basins (MTB), connected to the FTB, were established by placing water control structures through the berm separating these basins from the FTB to allow regular but muted tidal influence from the FTB to each of three MTBs. The west MTB was opened to tidal influence from the FTB through its water control structure in March 2008, while the central and east basins remained closed in 2009 while additional oil spill and flood control protections were put into place. Each of these MTBs are now connected to the FTB and provide important fish habitat.

The project also returned muted tidal influence to the Muted Pocket Marsh (MPM), north of Wintersberg Channel. The MPM is not hydrologically connected to the FTB of Bolsa Chica, rather it receives muted tidal influence through a water control structure that was installed connecting it to outer Bolsa Bay, through Huntington Harbor, which ultimately opens to the ocean over 6.5 km (4 miles) to the northwest.

5.2 Summary of Monitoring Results

The 2013 monitoring report for Bolsa Chica (Merkel & Associates 2013) documented the following conditions through monitoring year seven.

5.2.1 Vegetation/Habitat

The most notable changes in habitat distribution observed were the continuing shifts in the proportions of open water and salt marsh in the MTBs, the expansion of eelgrass and cordgrass in the FTB, and the expansion of non-native weeds on the avian nesting sites. While many elements have been installed to facilitate water management within the low-lying and substantially subsided wetlands of Bolsa Chica, the site still faces significant challenges relative to water management for the sake of habitat development and rehabilitation.

5.2.2 Fish Community

The Year 5 monitoring documented that the FTB provides habitat for a well-balanced ratio of fish guilds that has remained nearly the same since shortly after monitoring began in Year 2 post-restoration and the introduction of eelgrass as a habitat structuring element in 2007. Since that time, the basin has maintained a relatively stable distribution of demersal, open water, and structure-associated species, despite the rapid shift of great expanses of habitat from bare mud bottom to eelgrass beds. The captured species represented the full spectrum of trophic levels, from small juvenile schooling fish to adult predatory species.

In the MTBs, restricted tidal influence and periodic water quality extremes limited the fish community to a small number of hardy species. The MPM (not hydrologically connected to the FTB of Bolsa Chica) was generally found to be low in diversity but high in abundance of a few species.

5.2.3 Benthic Community

Findings during the fifth-year post-restoration documented the persistence of benthic food resources available to birds, fish, and other invertebrates in the FTB. The created basin was found to support eleven phyla of infauna, with polychaetes and amphipods being the dominant taxa. Densities were similar at both tidal elevations. Comparisons between stations and with the Year 2 findings found high variability between all parameters with no clear seasonal or annual patterns between stations or elevations.

5.2.4 Water Quality

The data collected evidenced the tidal marine influence that persists in the basin, reflecting the daily and monthly tidal fluctuations seen in the open ocean. All parameters were within acceptable ranges to support the fish, invertebrate, and vegetation communities in the FTB, and were indicative of a well-flushed marine environment. There is concern that restrictions in the basin inlet could lead to partial or full closure of the basin and loss of any tidal circulation.

5.2.5 Avian Community

The habitats with the highest bird densities were intertidal sandy shoal, inundated salt panne, and intertidal mudflat. In the winter there were large numbers of shorebirds, gulls, and pelicans loafing on the intertidal sand shoals and mudflats and a large number of shorebirds foraging on the mudflats. In the early spring there were migrating ducks and shorebirds using the inundated salt panne and mudflats to rest and forage. Surveys for the state endangered Belding's Savannah sparrow (*Passerculus sandwichensis beldingi)* and the federally endangered California least tern (*Sternula antillarum browni*) were conducted. Belding's Savannah sparrow are present in the pickleweed habitats surrounding Rabbit Island and throughout the muted tidal wetlands. Least tern nesting occurs on the nesting areas adjacent to the full tidal basin and adults and juveniles regularly forage within the open water area.

5.3 Inlet Rehabilitation Baseline Conditions

Everest International Consultants evaluated existing conditions at Bolsa Chica as they relate to the dredging that has been conducted to keep the inlet open, the degree and rate to which the inlet shoal fills with sediment, and the proposed inlet rehabilitation plan to sustain tidal action to the full and muted tidal portions of Bolsa Chica in the future.

Dredging the inlet shoal is a necessary action to assuring that the habitat values as discussed in Section 3.0 are maintained over time. According to modeling and initial monitoring undertaken at Bolsa Chica when the inlet was first opened, the inlet would need to be managed by dredging every two years and the placement of the dredged sand on the down coast beach (Moffat & Nichol 1999, Jin and McCarthy 2010). The first rehabilitation dredging event occurred approximately 2.5 years after the opening (January 8, 2009 to April 14, 2009), the next occurred two years later (January 11, 2011 to April 17, 2011) and the most recent occurred four years later (November 2014 to January 2015) to remove large quantities of sediment deposited from the ocean. Complete dredging of the FTB inlet and sediment basin was conducted during the first two rehabilitation events with only inlet channel dredging during the third event (Table 4).

Table 4. Historical rehabilitation dredging summary.

	Dredge Cycle 1	Dredge Cycle 2	Dredge Cycle 3
Dredge Start Date	1/8/2009	1/11/2011	11/14/2014
Dredge End Date	4/14/2009	4/17/2011	1/2015
Duration (days)	96	96	*
Dredged Volume (cubic yards)	235,490	395,959	101,820
Pre-Dredging LLW Difference (ft)[1]	1.3	2.0	2.1
Post-Dredging LLW Difference (ft)[1]	0.66	1.3	1.5
Recovery Time (months)	9.3	9.7	Still recovering

[1]This is the difference in the 30-day LLW moving average, and LLW=lower low water

*This data was not provided by Merkel & Associates

Following each dredging event, sand accumulates within the inlet channel and the larger sediment basin. As the sand accumulates, it reduces the ability of the FTB to drain completely at low tide. A time series of the difference in the daily low tide after dredging is shown in Figure 8. Various approaches have been used during each of these dredging events to allow for sand accumulation without substantial reduction in tidal muting (e.g., reduction in drainage during low tides). To date, the quantity of sand removed is not as important to the duration of the optimal tidal range as is the frequency.

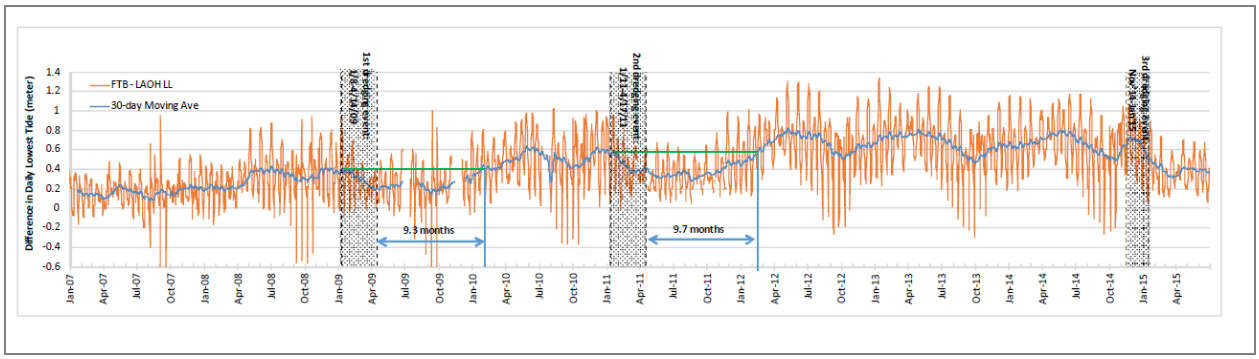

Figure 8. Difference in daily low tide at Bolsa Chica Inlet following rehabilitation dredging.

For all three rehabilitation dredging cycles the difference in lower low water (LLW) between the FTB gage and Los Angeles Outer Harbor gage decreased by about 0.65 feet (0.2 meters) following dredging. The duration of the improved drainage at low tide (hence greater tidal exchange) is approximately 9 months regardless of the amount of sand removed. In the most recent dredging, only the inlet channel and a small area inside of the FTB were excavated.

At this time, it does not appear that larger scale dredging such as implemented in 2009 and 2011 effectively improves tidal drainage and circulation. More frequent and less extensive inlet rehabilitation on a yearly basis appears to be as effective. Originally, the sand trap on the interior of the tidal inlet was intended to extend the period of improved tidal circulation in the basin. This area was dredged in the second dredging event. The trap served its function to provide for sand storage capacity and thus curb the extent to which the flood shoal extends inward from the inlet

mouth. However, the sand trap did not substantively assist in curbing the tidal muting within the FTB due to the fact that the muting is principally the result of sedimentation immediately inside the flare of the FTB as the basin widens out from the inlet channel.

6.0 MITIGATION WORK PLAN

6.1 Bolsa Chica Inlet Rehabilitation

Future inlet rehabilitation at Bolsa Chica will involve dredging to address three functions within the wetlands. The first and most important function is the rehabilitation of the tide range within the FTB to limit the amount of muting that occurs at low tides (e.g., higher low water and LLW). Based on an analysis of the past three dredging events, approximately 100,000 cubic yards (+/- 10 percent) will need to be dredged on an annual basis to achieve an increase of 0.67 feet (0.2 meters) in the LLW following dredging activities. The second function is the rehabilitation of various habitat types within the wetlands. The third function is the rehabilitation of the tidal prism, which is the volume of ocean water that enters and exits the wetlands between high tide and low tide (e.g., LLW and higher high water). It is also estimated that approximately 40,000 cubic yards (+/- 25 percent) may need to be dredged on a less frequent basis to maintain the various habitat types near the mouth.

The proposed approach to inlet rehabilitation would be similar to the third dredging cycle in that the work would be confined to dredging within the inlet (Figure 9). The sand trap would not be dredged for purposes of maintaining tidal range; however, it may be necessary should it expand and affect habitat conditions within the FTB.

As with the past three dredging events, future rehabilitation dredging will likely be done with a hydraulic cutterhead dredge, whereby beach suitable sediment (sand) dredged from the wetlands just east of the inlet channel is pumped via pipeline to the beach just south of southern jetty. The sand will be discharged onto the beach where it will be spread along the beach using conventional earth moving equipment (e.g., bulldozer) to provide a beneficial reuse as beach fill.

6.2 Functional Lift from Inlet Rehabilitation

6.2.1 Background

Restoration functional lift is determined by the improvement in habitat within a specific location where restoration is being proposed. For Bolsa Chica wetlands, substantial data has been collected on the aquatic and wildlife habitat present when the inlet is open. In comparison, habitat conditions when tidal inlets are closed are available for other project sites. The improvement in habitat as a result of the restoration actions being proposed in this MLMP can therefore be compared to those of closed systems.

In fulfillment of its MLMP for the Carlsbad Desalination Facility, Poseidon Water is undertaking a wetland restoration project in south San Diego Bay involving the creation of tidal wetland along the Otay River and restoration of tidal action in a current operating salt evaporator. The CCC staff, in consultation with the Science Advisory Panel, developed a methodology to evaluate the change in condition and how much mitigation credit would accrue to Poseidon from the restoration

Figure 9. Location of the previous dredging.

of the salt evaporator. The methodology compared the current biological diversity and richness in the salt evaporator with tidal reference wetlands that are used to assess the performance of restoration, once it is completed. The restored habitat in both the Otay River and the salt evaporator will need to be at least as good as the tidal reference wetlands in meeting vegetation coverage and invertebrate, fish, and bird diversity and density in order to receive credit. Comparing existing conditions to these reference wetlands provides a means to determine the expected change in habitat value due to the restoration actions.

The functional lift associated with maintaining the inlet at Bolsa Chica can be determined by comparing fish species composition and richness for comparable reference sites representing

both good conditions for fish with open inlet conditions and those with closed inlet conditions, which are less favorable for fish.

6.2.2 Methodology

As described in Section 3.0, inlet rehabilitation will result in multiple benefits to marine life; however, the most significant benefit relative to the impacts associated with the desalination plant is the improvement in fish production.

Currently, the CCC has contracted with the University of California at Santa Barbara to collect fish data from three reference wetlands to represent good fish species richness for fully tidal lagoons within the southern California region. These data are being collected using standardized methods and analysis and have been collected over a number of years. While post-restoration fish data from Bolsa Chica (Merkel & Associates 2013) has also been collected, the methods are not entirely similar, especially in the determination fish density. As a result, only fish diversity could be compared between Bolsa Chica and the reference wetlands. This comparison found that Bolsa Chica currently supports greater fish richness, with 52 total species and 40 species during summers of 2008 to 2011 (Merkel and Associates 2013) than the reference wetlands, which had an average of 38 species (Table 5).

In order to determine the likely conditions should Bolsa Chica partially or fully close, fish richness from lagoons in the vicinity that have experienced similarly closed inlet conditions were used as a baseline in order to determine functional lift (see calculations below). Sites with available fish richness data included Batiquitos Lagoon (prior to restoration) (Merkel & Associates 2009), San Dieguito Lagoon (prior to restoration) (MEC Analytical Systems 1993), and Malibu Lagoon (Abramson et al. 2015). Because Batiquitos Lagoon only had data from August 1994, data from the closed inlet richness was compared to Bolsa Chica fish species richness from late summer sampling events only.

The methodology follows that recommended by the Science Advisory Panel for the south San Diego Bay salt evaporator credit calculation, as follows:

$$\mathrm{FLI} = \frac{\mathrm{FB} - \mathrm{FA}}{\mathrm{FB}}$$

FB is the fish richness for Bolsa Chica, and FA is the average for closed or partially closed inlets. The FLI will be between 0 and 1, with 0 representing no improvement and 1 representing 100 percent improvement.

Table 5. Total fish species richness in Bolsa Chica, reference lagoons, and lagoons with closed inlet conditions.

Lagoon	Condition	Richness	Date(s) sampled	Number of samples	Data Source
Bolsa Chica	Open	52 (40)*	Quarterly from 2008 to 2011	24	Merkel & Associates 2013
Carpinteria Salt Marsh	Reference	37	Unknown	Unknown	UC Natural Reserve System 2015
Mugu Lagoon	Reference	39	Nine months in 1977	Unknown	Onuf 1987
Tijuana Estuary	Reference	37	December, March, June, and September from 1987 to 1999	44	Desmond et al. 2002; total richness from 3 sites, Tijuana Estuary being the most species rich.
Batiquitos Lagoon	Closed	7	August 1994	6	Wetlands Research Associates 1994
San Dieguito Lagoon	Closed	25	March through August, October through December 1992; January, March, and April 1993	108	MEC Analytical Solutions. 1993
Malibu Lagoon	Open/ Closed	14	June 2005, January 2013, May 2014, December 2014	24	Bay Foundation 2015

*WRA used total species richness observed during late summer sampling events only for Bolsa Chica (40 species), because one of the closed sites only had data from August.

6.2.3 Reference Wetlands Data

The SONGS reference wetlands include Carpinteria Salt Marsh, Tijuana Estuary, and Mugu Lagoon. These wetlands are used by a large diversity and high abundance of fish indicative of highly functioning intertidal marshes that eventually export productivity to the bay-wide system rather than act as a sink. The average species richness among the three reference sites was 38 species (Table 5). Note that for Tijuana Estuary, total richness data was not available. However, a study by Desmond et al. (2002) determined that Tijuana Estuary had greater species richness than Sweetwater Marsh and Los Peñasquitos Lagoon; a total of 37 fish species were observed at Tijuana Estuary. WRA therefore considered Tijuana Estuary to have 37 total species.

6.2.4 Bolsa Chica Full Tidal Basin – Open Inlet Condition Data

When the tidal inlet is maintained, the FTB supports a high diversity of fish. In addition, following restoration of tidal action, eelgrass expanded greatly in the FTB. The FTB provides habitat for well-balanced ratio of fish guilds (Merkel & Associates 2013). Fish species include a spectrum of small juvenile schooling fish to adult predatory species.

The northern Back Bay area of the FTB has a soft mud bottom, limited vegetation, and high summer water temperatures. The southern FTB is mostly vegetated with dense eelgrass, which supports a fish community typical of well-circulated waters and structured habitats, including

croaker, surfperch, kelpfish, and bass. Commercially and ecologically important demersal species, such as flatfish and sharks, white seabass, California halibut, anchovy, and atherinids are located here as well.

The total species richness at Bolsa Chica during post-restoration monitoring was 52 species, and the total species observed during summer sampling events in July or August was 40. This is comparable to the reference wetlands used by the CCC to set performance standards. Species richness data from summer sampling events was used in the FLI calculation, because one of the closed inlet sites, Batiquitos Lagoon, only had data from August.

6.2.5 Closed Inlet Lagoons Data

Prior to restoration, the FTB primarily consisted of bare mud bottom habitat with no connection to the ocean or to freshwater. Large portions of the area were filled in for oil production and there was no fish habitat. Therefore, there is no pre-restoration habitat at Bolsa Chica to compare post-restoration improvements. However, nearby lagoons that have been closed in the past provide an indication of the likely fish species richness that may be expected if the inlet at Bolsa Chica is allowed to close without further rehabilitation dredging. The average number of species for Batiquitos Lagoon in 1994, for San Dieguito Lagoon in 1992 and 1993, and for Malibu Lagoon in 2005, 2013, and 2014 was 15 species.

6.2.6 Calculated Functional Lift based on Fish Richness

Using the data from the full tidal and closed lagoons for fish richness, the calculated functional lift is 40-15/40 = 0.625. When applied to the 317 acres of the FTB, the amount of credit applicable to Bolsa Chica is 198 acres from inlet rehabilitation.

6.2.7 Uncertainties in Functional Lift Calculation

A primary source of uncertainty in this analysis of functional lift involves differences in sampling methodologies, dates, and effort among the sites included (Bolsa Chica, reference sites, and the closed lagoon reference sites). Fish density data in the functional lift calculation was not used because differences in sampling methods between Bolsa Chica and the reference sites made the data incomparable (i.e., the reference wetlands used blocking nets, which were not used at Bolsa Chica). In addition, the extensive meadows of eelgrass within Bolsa Chica may have also affected the effectiveness of beach seine in capturing fish. The lead line of the net would roll as it passed over the bryozoan encrusted eelgrass, breaking the connection with the bottom and allowing fish to escape. It is likely fish density at Bolsa Chica was lower due to interference by eelgrass and more fish escapes due to disturbance of the eelgrass providing both advance warning of the net arrival or refuge from capture. Sampling also occurred over different years and dates. Due to the limited data available, WRA was only able to control for equipment type and included data from sampling events in which a beach seine was used for fish capture.

As mentioned above, only data from summer months at Bolsa Chica was used because Batiquitos Lagoon was only sampled in August. For other sites, richness data for summer periods was not available. However, limiting Bolsa Chica data used in the calculation to summer months only makes the functional lift calculation more conservative than it would have been using the total richness observed over all events because summer numbers are generally higher than the rest of the year.

For San Dieguito Lagoon, the assumption was that data collected for the Biological Baseline Study (MEC Analytical Systems 1993) represented closed inlet conditions. During some of the

individual sampling events for this study, the lagoon may have been open (San Dieguito Lagoon Restoration Project 2003). However, if the lagoon were open for one or more sample events, it is likely that fish richness and density would be higher for those events, making the final functional lift calculation more conservative.

There is also not as much data available for pre-restoration periods that are representative of closed lagoon conditions. For example, there was only one sampling event before restoration with fish density data for Batiquitos Lagoon (Wetlands Research Associates 1994). In contrast, post-restoration monitoring generally occurs on a quarterly basis for many years. Long-term monitoring at Batiquitos Lagoon took place over the ten-year period immediately following restoration (Merkel & Associates 2009).

Without continued rehabilitation dredging at the inlet of Bolsa Chica, the inlet will likely close or be severely muted, at least periodically. However, the timing, frequency, and duration of the closure are uncertain. Recent experience has shown that without inlet rehabilitation, the tidal range is diminished which adversely affects water quality, affects tidal marsh plant survival, and greatly reduces habitat suitability for marine fish.

6.2.8 Use of Mitigation Ratio Calculator

The Regional Water Quality Control Board, in consultation with the National Marine Fisheries Service, employed a Mitigation Ratio Calculator (MRC) as published King and Price (2006). Poseidon undertook an analysis of the MRC to estimate the credits available from inlet rehabilitation. King and Price (2006) provide two equations, one used for functional lift estimates and a second for conservation actions.

The functional lift calculation is based on a number of factors related to changes expected by the actions proposed under the MLMP. The equation is provided below:

$$MR = \frac{\sum_{t=0}^{T_{max}} (1+r)^{-t}}{(B(1-E)(1+L)-A)\left[\sum_{t=-D}^{C-D} \frac{(t+D)}{C(1+r)^{t}} + \sum_{C-D+1}^{T_{max}} (1+r)^{-t}\right]}$$

The formula is calculated in an Excel table provided by King and Price and requires that variables be determined based on the project design and expected time frame during which the benefits would accrue at the site (Table 6).

Table 6. Variables used in MRC for functional lift.

Variable	Description	Value
A	The level of wetland function provided per acre at the mitigation site prior to the mitigation project, expressed as a percentage of the level of function per acre at the wetland impact site based on functional lift using fish diversity of closed lagoon	37%
B	The maximum level of wetland function each acre of mitigation is expected to attain, if it is successful, expressed as a percentage of the per acre level of function at the wetland impact site. Tidal prism lowers between maintenance events within 10 months. 10/12 = 83%	83%
C	The number of years after construction that the mitigation project is expected to achieve maximum function;	1
D	The number of years before destruction of the impacted wetland that the mitigation project begins to generate mitigation values (negative values of D represent delayed compensation);	1
E	The percent likelihood that the mitigation project will fail and provide none of the anticipated benefits (with mitigation failure, wetland values at the mitigation site return to level A); High likelihood that inlet maintenance will be effective based on past experience.	5%
L	The percent difference in expected wetland values based on differences in landscape context of the mitigation site when compared with the impacted wetland (positive values represent more favorable landscape context at mitigation site); No change	0
r	The discount rate used for comparing gains and losses that accrue at different times in terms of their present value (tables provide estimates based on discount rates of 0%, 5%, and 10%);	3
Tmax	The time horizon used in the analysis. Used 25 years (see explanation under sea level rise), however, inlet maintenance will occur for duration of action but may require additional action(s) after 2050-60.	25

Using these variables, the R value calculated with the MRC is 2.39 which is then divided into the FTB acreage of 317 to reach a credit calculation of 132 acres.

The second equation is called the Conservation Equation is used when the primary outcome of the project is ongoing conservation or preservation of a restoration site. This equation is as follows:

$$MR = \frac{\sum_{t=0}^{T_{max}} 1}{\left[\sum_{t=0}^{T_{max}} \frac{\left(1-(1-k)^{t}\right)}{(1+r)^{t}}\right]\left(A(1+L)\right)}$$

Though there are fewer variables, a new variable, k, is used in this formula. The variable, k, is defined as likelihood that inlet would not function if Poseidon's conservation action did not occur or ceased. Therefore, it is dependent upon assumptions related to both the likely outcome should the inlet not be rehabilitated and the effective duration of the inlet rehabilitation. The former is defined as Td or the time to when the inlet would close or be substantially muted, resulting in a decline in functional quality and the latter is defined as cTd or the confidence in the estimate that the inlet would close or be muted without the proposed inlet maintenance.

Poseidon estimates that Td is five years based on historic data collected following tidal exchange and the lack of financial support from the existing State funds used for the inlet maintenance. That is, the inlet will exhibit conditions of closure after cessation of inlet dredging but will not entirely close for until 5 years. In addition, State endowment funds will have been exhausted by as early as 2021, so no additional funding will be available for inlet dredging.

The variable cTd is a measure of the confidence in that closure. Poseidon has used an estimate of 60% meaning that based on the evidence available, it is more likely than not that the inlet would close and that State funds would not be available to open the lagoon. While there is some chance (40%) that some other program may be available to fund inlet maintenance, it is not likely to be long duration or be undertaken in sufficient time to overcome the deleterious effects of inlet closure.

These two variables are used to determine a k value using an Excel table provided by King and Price (2006). The calculated k value is 14.2.

In addition, a Tmax variable is required for both the functional lift and the conservation equation. It represents the time horizon used in the analysis during which the conservation action is likely to be effective. Poseidon determined a Tmax of 25 years was appropriate for its restoration action at the inlet based on projected sea level rise estimates for the southern California coast line[2].

[2] http://data.pointblue.org/apps/ocof/cms/index.php?page=flood-map

While Poseidon would be responsible for maintenance of the inlet for the life of the desalination plant; however, there may be additional measures to be undertaken should sea level rise compromise the inlet structures. According to the California Coastal Commission Sea Level Rise Policy Guidance (2018), the projected rise for a 1:200 Medium-High Risk Aversion for this area is 1.8 feet by 2050 (see Appendix G). When 1.8 feet is projected onto map for the Bolsa Chica inlet from the web site referenced above for sea level rise, it shows that the inlet as currently designed is still functional (e.g. not overtopped) and therefore, we expect that current inlet maintenance actions would be effective as long as the inlet revetment is not overtopped (Figure 10). Sea level rise beyond that level may require additional actions which will be determined in conjunction with the agencies and the State Lands Commission.

Figure 10. Inlet conditions under sea level rise of 1.8 feet. Blue shaded areas show increased tidal waters and orange shows higher flood conditions. Map from OCOF.

Based on the Tmax of 25 years and k value of 14.2, the MRC calculates an R value of 1.48. Dividing into 317 acres reaches a value of 214 acres of credit under that formula.

6.2.9 Summary of Acreage Credit for Inlet Rehabilitation

A variety of methods show that inlet rehabilitation can achieve substantial credits to offset fish impacts associated with the construction and operation of the Huntington Beach desalination plant. Using a functional lift calculation based on the differences in fish richness between open and closed coastal lagoons, it is estimated that inlet rehabilitation will provide 198 acres of credit. The MRC calculator for functional lift equation determined that 132 acres of credit would be available and the conservation equation found 214 acres of credit.

7.0 ADAPTIVE MANAGEMENT PLAN

Adaptive management is an iterative process where monitoring or learning by doing better informs future management decisions when precise information is lacking or uncertainty remains as to the extent, intensity, and duration of effects resulting from a set of actions (e.g., shoreline stabilization or management) or long-term trends (e.g., effects of climate change and sea-level rise). Subsequent management decisions are improved through the incorporation of new information obtained by monitoring the effects of previous actions. In the case of the inlet rehabilitation, each inlet rehabilitation event will be monitored and subsequent rehabilitation activities may be necessary to adjust the depth and footprint of the inlet dredging to assure that performance standards are being met and tidal exchange is within the range expected to provide for the expected ecological benefits. Rehabilitation will be based on actual performance of the inlet instead of the predicted performance based on engineering and mathematical modeling.

Long-term trends during the duration of the Project may affect the magnitude and frequency of dredging as well. Stochastic variables include long-shore sand transport and wave patterns which may change due to variable weather conditions affecting sand input to the coast and shifts in storm patterns affecting wave direction. Long-term trends such as sea level rise may also affect inlet rehabilitation frequency. These factors affect future inlet rehabilitation activities or disposal locations on the beach. Should modifications be required from current practice to meet performance standards, Poseidon will work closely with State Lands in assuring that work is being performed in compliance with the Memorandum of Agreement and other agency permit authorizations.

7.1 Adaptation to Sea Level Rise

Sea-level rise will be occurring within the time frame of the inlet management restoration program. As described in the credit calculation for Tmax, the sea level rise until 2050 is not likely to affect the inlet revetment or Pacific Coast Highway. Further, downscaled 2012 NRC scenarios for 2070 in Huntington Beach (Moffatt and Nichol 2017) project an increase between ~0.7 ft (~213 mm) to ~3.3 ft (~1006mm) above the current tidal datum (Figure 11). Currently, the Bolsa Chica Land Trust was selected to receive a CDFW - 2017 Prop. 1 Watershed Restoration & Delta Water Quality and Ecosystem Restoration grant to complete the Bolsa Chica Lowlands Restoration Project: Sustainability Alternatives Study. The Land Trust developed a scope of work and solicited bids from firms to assist with the technical analysis. The study will provide essential information on how the State will address future management for sea level rise and will be used to inform actions that may be necessary after 2050. Poseidon will participate in those deliberations and coordinate its program with State Lands actions.

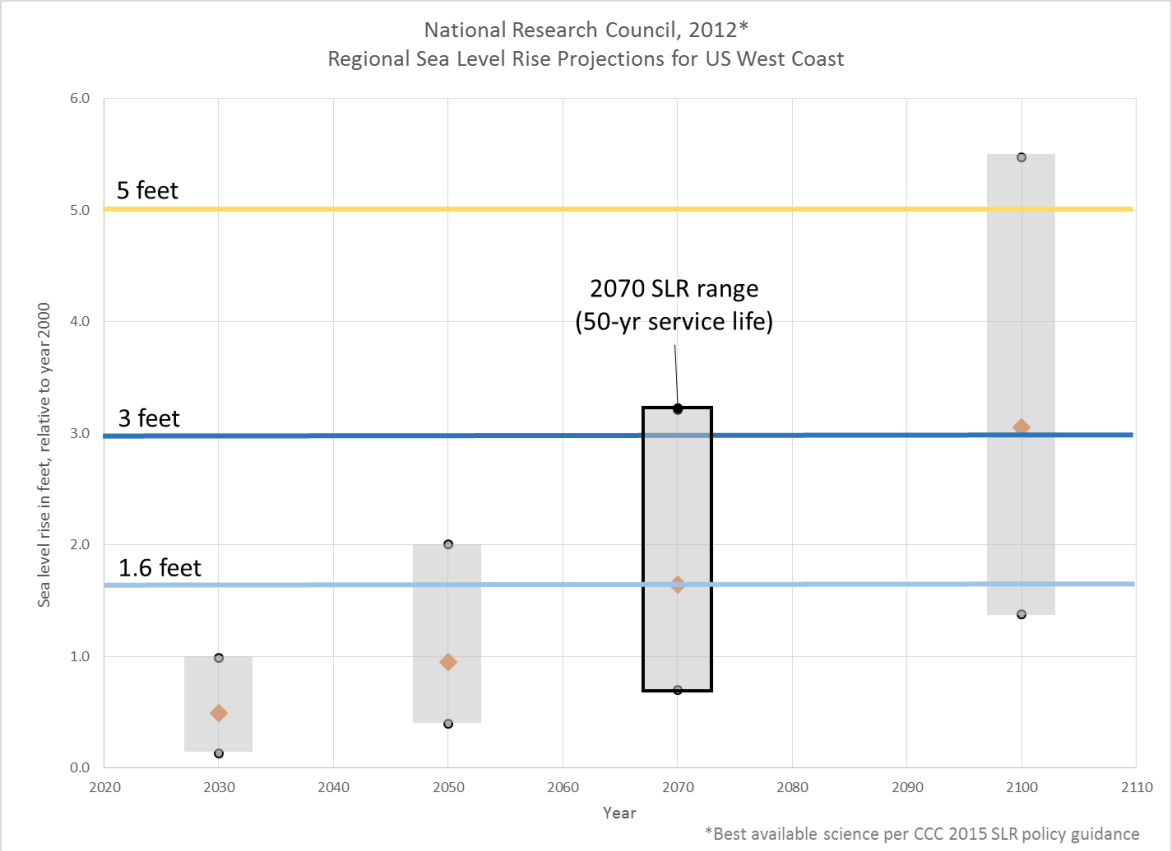

Figure 11. National Research Council's sea level rise projections for U.S. West Coast (Moffat and Nichol 2017).

7.2 Additional Issues to be Addressed

SLR will impact the tidal inlet as well as the seaward sediment supply from the near coast beaches. In other words, the seaward sediment supply is likely to decline over time (Figure 12) due to rising sea level inundating the beaches and reducing sand supply to the inlet.

Moffat and Nichol (personal communication, 2018) believe that with a slight increase in the tidal prism that the increased ebb velocities will also help to stabilize the inlet (Moffat and Nichol, personal communication, 2018). An increase in tidal prism and sediment movement may not equate to more shoaling or dredging requirements

However, down shore beach width is likely to decrease without placement of the sand following inlet maintenance. Poseidon will work with State Lands to continue beach nourishment with the sand dredged from the inlet.

Figure 12. Bolsa Chica shoreline projections with and without beach nourishment.

Other potential issues include inlet jetty protection measures under rising sea-level. Currently the inlet jetties are at 13.5 feet above sea level and are expected to operational during the life span of the project. Poseidon will work with State Lands to identify any overtopping of the levees and any repair that must be undertaken to keep them functional during the life of the project activities. The levees surrounding the full tidal area are projected to be sufficient high to not require any further increases in height during the life of the project.

8.0 PERFORMANCE STANDARDS

Performance standards will be set for inlet rehabilitation and for additional land based projects to be undertaken by Poseidon within Bolsa Chica. These standards will be refined based on inlet maintenance experience and the specific design of the land based restoration prior to Poseidon actions (Table 7).

Table 7. Performance Standards.

Performance Standard	Performance Measure
Inlet Rehabilitation Performance Standards:	
Tidal Muting	Tidal muting within the Bolsa Chica Full Tidal Basin shall not be greater than 0.5 meters above 30 day moving lower low water average (as compared to the fully tidal reference station NOAA 9410660 Los Angeles Outer Harbor) for a period of nine months after initiation of inlet maintenance. This standard is subject to revision based on data collected following inlet maintenance activities by the State Lands Commission prior to Poseidon's actions. Any proposed changes will be reviewed and accepted by the Executive Director.
Eelgrass: extent	Eelgrass aerial extent shall remain above 100 acres within the Full Tidal Basin, based on a four year running mean of annual surveys. The annual surveys shall be completed between the months of July-October. Annual surveys may be reduced after five years if eelgrass extent has not exhibited significant change over time. If eelgrass prior to the project initiation or any time after project initiation show that the extent of eelgrass is below the metric established by this standard, comparison to other eelgrass systems where ongoing measurements have been undertaken (e.g. Newport Harbor, San Diego Bay) will be used to determine if there are regional changes in eelgrass extent that may be responsible for not meeting the standard. Any proposed changes in the standard will be reviewed and accepted by the Executive Director.
Eelgrass: density	Prior to inlet maintenance assumption by Poseidon, an initial survey of eelgrass within Bolsa Chica will be undertaken to determine mean eelgrass turion density using the methods in the California Eelgrass Mitigation Program (CEMP). Mean eelgrass turion density within Bolsa Chica Full Tidal Basin shall be not less than 20% below that level.
WQ: Dissolved Oxygen (DO)	The daily mean shall not fall below 5 mg/L, with no individual measurement falling below 3 mg/L at Bolsa Chica Water Quality Station 1 in the Full Tidal Basin for more than 12 hours. Dissolved oxygen shall be measured continuously at a point as close to the benthos as possible but no greater than 1 m above the bottom.
WQ: Salinity	Salinity levels shall not be greater than 38 ppt at Bolsa Chica Water Quality Station 1 in the Full Tidal Basin
For Fish performance factors, two out of the three listed below shall be met:	
Fish: Richness	Fish richness in summer months shall be greater than 25 species as determined by three replicate purse seine, otter trawl, and beach seine hauls conducted at least two fisheries stations in the Full Tidal Basin. No more than 3 sampling events can be used to meet this standard and they cannot be considered cumulatively.
Fish: Density	Fish density shall equal or exceed 1 fish/m^2 as an average of densities derived from the replicate beach seine and purse seine sampling conducted at least two fisheries stations in summer months, with the average reflecting the gear type results, not cumulative area sampled combination. No more than 3 sampling events can be used to meet this standard and cannot be used cumulatively.

Performance Standard	Performance Measure
Fish: Diversity	Should one of these criteria not be met, Poseidon shall propose that other reference sites be used where similar data is being collected using similar methodology (e.g. for Otay River Estuary Restoration Project). Fish diversity during summer months in Bolsa Chica shall not be less than any of these reference sites.
Land based Restoration Actions	
Hydrologic conditions	Frequency of inundation of land-based restoration projects in muted tidal and full tidal areas will be similar to equivalent elevations within similar muted tidal areas or full tidal areas.
Vegetative cover	Vegetative cover on land-based areas designed for salt marsh vegetation will have a percent cover similar to or exceeding that of reference areas within the muted tidal or full tidal areas.
Intertidal habitat	Invertebrate richness and diversity on land-based areas designed for intertidal mudflat will support similar richness and diversity, or exceeding that, of reference areas within the muted tidal or full tidal areas

9.0 MONITORING PROGRAM

The monitoring program will be focused on methods to achieve the performance standards listed above. Monitoring will utilize methods stations and methods used at Bolsa Chica for their post-construction monitoring conducted by Merkel and Associates (2013). Monitoring will occur as long as the proposed desalination plant is in operation.

9.1 General Methodology for Inlet Rehabilitation

Tidal monitoring was initiated in the FTB in December of 2006 and has been continuous since then with data collected at 6-minute intervals (with certain exceptions). Tidal data will continue to be collected using similar methodology and station location. Tidal data will be analyzed to produce comparisons of tidal lag and tidal muting between the FTB tides and the Los Angeles Harbor (NOAA 9410660).

Eelgrass monitoring methods are modeled on eelgrass monitoring methods previously employed at Bolsa Chica. Eelgrass will be monitored to determine the extent and distribution of eelgrass using combination of side scan sonar and/or diver surveys. Sidescan sonar traces will be geographically registered, plotted on a georeferenced aerial image, and digitized to calculate the amount of coverage and to show its distribution. Turion density will be measured by divers in standardized plots placed within 10 stations. Reference sites where eelgrass data is currently being collected will be used to assess regional changes. Poseidon will identify those locations for approval by the Board prior to inlet rehabilitation.

Water quality measurements will be taken using standard recording submersible instruments. The depths at water quality are approximately –1.2 to 1.3 meters NAVD. Regular maintenance and data retrieval will be completed and the instruments will be regularly calibrated. Data will be assessed for accuracy and malfunctions due to fouling or equipment failure.

Fish sampling in the Full Tidal Basin will follow methods used by Merkel and Associates (2013). Sampling will be conducted in summer months at two Stations (see Figure 1-6 in Merkel and Associates (2013)). Using an otter trawl, purse seine, and a large beach seine. To characterize the fish communities, three replicates hauls were made across each station. The otter trawl consists of a 4.6-meter trawl with 2-centimeter mesh in the body and 0.3-centimeter mesh in the cod end. The otter trawl was deployed at offshore sampling locations using a small vessel traveling between 1.5 and 2 knots along 250-meter transects. The trawl was used to sample primarily demersal offshore fish at Stations 1 and 2 in the FTB.

- The purse seine consists of a 66-meter x 6-meter seine with 1.2-centimeter mesh in the wings and 0.6-centimeter mesh in the bag. The purse seine was deployed at offshore sampling locations using a small vessel. This gear was used to sample adult and juvenile fish species in the water column as well as demersal fish at Stations 1 and 2 in the FTB.

- The large beach seine consists of a 15-meter x 1.8-meter net with a 1.8- meter x 1.8-meter x 1.8- meter bag in the center. The seine has 1.2-centimeter mesh in the wings and 0.6-centimeter mesh in the bag. It was utilized to sample shoreline waters between the bottom and surface at depths of 0 to 1 meter. The seine was positioned parallel to shore between 7 and 35 meters from the water's edge, depending on bottom contours. The seine was held in place for 3 minutes and then walked slowly to shore.

If fish reference sites are needed to meet the one of the three parameters (i.e. should on site standards not be met), Poseidon will utilize data that is being collected from existing reference sites being used for the Otay River Estuary Restoration Program. Poseidon will identify the reference sites prior to implementation of the inlet rehabilitation program.

9.2 General Methodology for Land based Restoration Program

Appropriate reference sites will be located within the muted tidal basins and Outer Bolsa Bay to measure hydrologic, vegetative, and invertebrate density. At least three reference stations will be established in each location. Tidal inundation frequency and duration will be measured using either recording staff gauges or other recording instrumentation. Vegetative cover will be measured using standardized quadrats established in the reference sites and restoration sites or drone aerial photography with ground trothing. Invertebrate sampling will be conducted as described in Merkel and Associates (2013).

10.0 FINANCIAL ASSURANCES AND AGREEMENTS

10.1 Projected Annual Costs

Based on an expected dredging of up to 100,000 cubic yards (77,000 cubic meters) on an annual basis with an expected 10 percent contingency, the expected annual cost would be approximately $1.3 million. Additional costs are anticipated to support monitoring of rehabilitation triggers and reporting of performance standards. This amount is estimated to be approximately $25,000 to 35,000 per year. Mitigation costs would be restricted to inlet rehabilitation under the assumption that existing infrastructure, such as inlet rock riprap, bridges and other existing facilities) continue to function as designed.

Wetland restoration costs for the three areas proposed within the Reserve have not been determined at this time but will be funded by Poseidon directly.

10.2 Agreement with State Lands Commission for Use of the Inlet to Perform Mitigation

Poseidon will enter into an agreement with SLC for the right to conduct inlet rehabilitation, wetland restoration, beach replenishment, and monitoring at Bolsa Chica. Poseidon will retain contractors and consultants sufficient to assure that performance and success standards are met under the Plan. Poseidon Water will also install and maintain any monitoring devices necessary to measure tidal flow and beach width. Poseidon will be responsible for any environmental review, permitting, and modifications to the Plan as necessary to provide for tidal flows to Bolsa Chica sufficient to retain the mitigation credits needed to offset the APF.

11.0 WETLAND RESTORATION PROGRAM

In addition to the inlet rehabilitation, several areas suggested by the Bolsa Chica Restoration Project Steering Committee for saltmarsh re-establishment or re-habilitation will be undertaken (Figure13). These areas, once restored, could increase ecosystem function for fish and allow for additional saltmarsh habitat with rising sea levels. There have not been any engineering or feasibility studies performed these identified restoration areas; however, a conceptual approach is provided in this section. Acres that are potentially restorable are identified, but will be finalized once design phase work is completed.

11.1 Oil Pads/Road Restoration

Beginning in the 1960's, oil wells were drilled, pipelines were created, and roads were built within Bolsa Chica. Currently, the muted tidal basins contain active and inactive oil pads scattered throughout the area. In addition, there are remnants of roads within these basins. Removal of the inactive oil pads and roads would increase the muted tidal area and restore the connectivity between the basins. The removal of the oil pads and remnant roads could add up to 1 acre of habitat to the muted tidal area. The areas that have been identified would be graded and lowered to elevations suitable for subtidal, mudflat, or pickleweed habitat based on the surrounding habitats in that area. The type of habitat restored is also dependent upon the range of the tide within the cells.

The removal of the inactive oil pads has not been discussed with the oil companies and there may be other associated infrastructure, including pipelines that may need to be removed or relocated.

11.2 Fieldstone Property Restoration

The Fieldstone property is located from the northeast corner to the central portion of the muted tidal area and could be available as a restoration opportunity. Currently, this area is connected to the muted tidal basin through several culverts. The tidal range within this area will need to be monitored, but the tidal range at present is not sufficient to inundate all areas. Some of the areas identified have sparse pickleweed cover, but most are barren salt flats. It is possible that the culverts are undersized and/or blocked and additional or larger culverts are needed. Other areas may need to be lowered in order to be regularly inundated by the muted tides. The goal would be to create a range of habitat types that are inundated at frequencies of 40 to 60 percent of the time—mudflats and pickleweed areas. Excavated material will be retained on site for either levee enhancement, creation of habitat islands as needed, or stored for future use. The amount of acreage that could be restored to muted tidal wetland habitat is up to 6.2 acres.

11.3 Outer Bolsa Chica Bay Replanting/Regrading

The outer Bolsa Chica Bay is located to the northwest of Rabbit Island and immediately south of Warner Avenue, within the California Department of Fish and Wildlife's Bolsa Chica Ecological Reserve. This portion of the Reserve is subject to full tidal action via Huntington Harbor. The identified areas are currently sparsely vegetated upland areas; however, public access trails are present. The plan would relocate these public access trails and provide for a range of vegetated salt marsh habitats, e.g. dominated by cordgrass or pickleweed. These areas would be graded to provide a gentle slope to allow for transition of upland areas to salt marsh and public access provided along the upper edges. Excavated materials would be hauled off site. The area that could be restored to tidal marsh is up to 4 acres

Figure 13. Additional restoration options locations.

12.0 REFERENCES

Abramson, M; K Johnston; I Medel; R Dagit; D Cooper; and R Abbott. 2015. Malibu Lagoon restoration and enhancement project: comprehensive monitoring report (year 2). 135 pp.

Ambrose, R., and D.J. Meffert. 1999. Fish-assemblage dynamics in Malibu Lagoon, a small, hydrologically altered estuary in southern California. Wetlands 19: 327-340.

Bay Foundation, The. 2015. Malibu Lagoon Restoration and Enhancement Project: Comprehensive Monitoring Report (Year 2). Prepared for State of California, Department of Parks, and Recreation. June 9.

Bay Foundation, The. 2015. Spatial and temporal variation in estuarine fish and invertebrate assemblages. Prepared for State of California, Department of Parks, and Recreation. June 9.

Bernstein, B; K Merkel, B Chesney, M Sutula. 2011. Recommendations for a southern California regional eelgrass monitoring program. Prepared for the National Marine Fisheries Service. Technical Report 632.

[CDFW] California Department of Fish and Wildlife. 2017. Quarterly Progress Report: Initiation of Thin-Layer Sediment Augmentation on the Pacific Coast.

Cohen, JE, and CM Newman. 1988. Dynamic basis of food web organization. *Ecology* 69: 1655-1664.

Cole, SG, and P Moksnes (2015). Valuing multiple eelgrass ecosystem services in Sweden: fish production and uptake of carbon and nitrogen. Front. Mar. Sci. 2:121. doi: 10.3389/fmars.2015.00121.

Desmond, JS, DH Deutschman, and JB Zedler. 2002. Spatial and temporal variation in estuarine fish and invertebrate assemblages: analysis of an 11 -year data set. Estuaries 25(4A): 552-569.

Doughty, C., K. Cavanaugh, R. F. Ambrose, E. Stein. 2016. Assessment of sea level rise vulnerability for southern California Coastal Estuaries. University of Southern California Sea Grant Traineeship Program Report.

Doughty, C., K. Cavanaugh, R. F. Ambrose, E. Stein. 2017. Sea level rise impacts to coastal habitats in southern California Estuaries. University of Southern California Sea Grant Traineeship Program Report.

Elwany, MHS. 2011. Characteristics, restoration, and enhancement of southern California lagoons. *Journal of Coastal Research* 59: 246-255.

Farrugia, TJ, M Espinoza, and CG Lowe. 2014. The fish community of a newly restored southern California estuary: ecological perspective 3 years after restoration. *Environmental Biology of Fishes* 97: 1129-1147.

Fodrie, FJ, and LA Levin. 2008. Linking juvenile habitat utilization to population dynamics of California halibut. *Limnology and Oceanography* 53(2): 799-812.

Foster, M.S., Cailliet, G.M., Callaway, J., Raimondi, P. and Steinbeck, J. 2012. Mitigation and Fees for the Intake of Seawater by Desalination and Power Plants. Report to State Water Resources Control Board, Sacramento.

Gewant D, and SM Bollens. 2012. Fish assemblages of interior tidal marsh channels in relation to environmental variables in the upper San Francisco Estuary. *Environmental Biology of Fishes* 94: 483-499.

Harper, C, and JC Wolf. 2009. Morphological effects of the stress response in fish. *ILAR Journal* 50: 387-396.

Herbold, B; DM Baltz; L Brown; R Grossinger; W Kimmerer; P Lehman; PB Moyle; M Nobriga; and CA Simenstad.. 2014. The role of tidal marsh restoration in fish management in the San Francisco Estuary. San Francisco Estuary and Watershed Science 12(1).

Hoffman RS. 1986. Fishery utilization of eelgrass (Zostera marina) beds and non-vegetated shallow water areas in San Diego Bay. Administrative Report SWR-86-4. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Region. Long Beach, CA.

Jin, W and M McCarthy. 2010. Bolsa Chica Wetlands Restoration Inlet Design. Coastal Engineering 2010. Proceedings of 32nd Conference on Coastal Engineering, Shanghai, China, 2010.

Josselyn, MN, R Appy, and A Whelchel. 1997. Batiquitos Lagoon: Concept to Construction. Pp184-189. Wetland and Riparian Restoration: Taking A Broader View. USEPA (Region 10) Publication EPA.

Kitting, CL. 1994. Shallow Populations of Small Fishes in Local Eel Grass Meadow Food Webs. In: Proceedings of Alameda Naval Air Station's Natural Resources and Base Closure Planning for the Future. Prepared by the Golden Gate Audubon Society. Berkley, CA.

King, D.M. and E.Price. 2006. Developing Defensible Wetland Mitigation Ratios. Prepared for NOAA. Office of Habitat Protection. 54 pp.

Kwak, TJ, and JB Zedler. 1997. Food web analysis of Southern California coastal wetlands using multiple stable isotopes. *Oecologia* 110: 262-277.

Lopez-Duart, PC, HS Carson, GS Cook, FJ Fodrie, BJ Becker, C DiBacco, and LA Levin. 2012. What controls connectivity? An empirical, multi-species approach. Integrative and Comparative Biology 52(4) 511-524.

Madon, SP. 2008. Fish community responses to ecosystem stressors in coastal estuarine wetlands: a functional basis for wetlands management and restoration. Wetlands Ecol. Management. 16(3): 219-236.

MEC Analytical Systems, Inc. 1993. San Dieguito Lagoon restoration project biological baseline study March 1992-May 1993. Vols. 1 and 2. November.

Merkel & Associates, Inc. 2009. Batiquitos Lagoon long-term biological monitoring final report. Prepared for City of Carlsbad Planning Department and the Port of Los Angeles.

Merkel & Associates, Inc. 2013. Bolsa Chica Lowlands Restoration Project Monitoring Program, Annual Report 2013, Monitoring Years 4-7. Prepared for California State Lands Commission.

Moffat and Nichol. 2017. Huntington Beach Desalination Project Sea Level Rise Hazard Analysis Draft.

Moffat and Nichol. 2018. Personal communication.

Onuf, CP. The ecology of Mugu Lagoon, California: an estuarine profile. Prepared for U.S. Department of the Interior Fish and Wildlife Service, Research and Development, National Wetlands Research Center. Biological Report 85(7.15).

Patrick W. H. Jr., R. D. DeLaune, (1990), Subsidence. Accretion and sea level rise in South San Francisco Bay marshes, Limnology and Oceanography, 35, doi: 10.4319/lo.1990.35.6.1389.

Ray, G. L. 2007. Thin layer disposal of dredged material on marshes: A review of the technical and scientific literature. ERDC/EL Technical Notes Collection (ERDC/EL TN-07-1), Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Rosencranz, J.A., N.K. Ganju, R.F. Ambrose, S. M. Brosnahan, P. J. Dickhudt, G. R. Guntenspergen, G. M. MacDonald, J. Y. Takekawa, K. M. Thorne. Balanced Sediment Fluxes in Southern California's Mediterranean-Climate Zone Salt Marshes. Estuaries and Coasts (2016) 39: 1035. https://doi.org/10.1007/s12237-015-0056-y

Simenstad, CA. 1994. Faunal Associations and Ecological Interactions in Seagrass Communities of the Pacific Northwest Coast. pp. 11-18 in: S. Wyllie- Echeverria, A.M. Olson and J. Hershman (eds.), Seagrass Science and Policy in the Pacific Northwest. EPA 910/R-94-004. Environmental Protection Agency. Seattle, WA.

State Water Resources Control Board. 2015. Desalination Facility Intakes, Brine Discharges, and the Incorporation of other Non-Substantive Changes. Amendment to the Water Quality Control Plan for Ocean Waters of California. Final Staff Report Including the Final Substitute Environmental Documentation. 1303 pp.

Swanson, K. M, Drexler, J. Z, Schoellhamer, D. H, Thorne, K. M, Casazza, M. L, Overton, C. T, Callaway, J. C, & Takekawa, J. Y. (2014). Wetland Accretion Rate Model of Ecosystem Resilience (WARMER) and Its Application to Habitat Sustainability for Endangered Species in the San Francisco Estuary. Estuaries and coasts, 37(2), 476-492. doi: 10.1007/s12237-013-9694-0

Takekawa, J. Y., K. M. Thorne, K. J. Buffington, C. M. Freeman, and G. Block. 2013. Evaluation of subterranean subsidence at Seal Beach National Wildlife Refuge. Unpubl. Data Summary Report. U. S. Geological Survey, Western Ecological Research Center, Vallejo, CA. 24pp.

Thorne, K. M., J. Y. Takekawa, and D. L. Elliott-Fisk. 2012. Ecological Effects of Climate Change on Salt Marsh Wildlife: A Case Study from a Highly Urbanized Estuary. Journal of Coastal Research: Volume 28, Issue 6: pp. 1477 – 1487.

Thorne, K.M., MacDonald, G.M., Ambrose, R.F., Buffington, K.J., Freeman, C.M., Janousek, C.N., Brown, L.N., Holmquist, J.R., Gutenspergen, G.R., Powelson, K.W., Barnard, P.L., and Takekawa, J.Y., 2016, Effects of climate change on tidal marshes along a latitudinal gradient in California: U.S. Geological Survey Open-File Report 2016-1125, 75 p., http://dx.doi.org/10.3133/ofr20161125.

U.S. Army Corps of Engineers (Corps), 1991. Coast of California Storm and Tidal Wave Study (CCSTWS), State of the Coast Report, San Diego Region – Main Report. Corps of Engineers, Los Angeles District, Final Report, Volume 1.

West, JM, and JB Zedler. 2000. Marsh-creek connectivity: Fish use of a tidal salt marsh in Southern California. *Estuaries* 23: 699-710.

Wetlands Research Associates, Inc. 1994. Batiquitos Lagoon enhancement project: pre-construction monitoring report. Prepared for the Port of Los Angeles.

Williams, GD. 1997. The physical, chemical, and biological monitoring of Los Peñasquitos Lagoon Annual Report 20 September 1996 – 20 September 1997. Pacific Estuarine Research Laboratory. Cardiff, California.

Zedler, JB. 1982. The ecology of Southern California coastal salt marshes: a community profile. U.S. Fish and Wildlife Service, Biological Services Program, Washington, D.C. FWS/OBS-81/54. 110 pp.

Zembel, R, and S Hoffman. 2012. Status and Distribution of the Light-footed clapper rail in California. 2012 Season. Department of Fish and Game. 20 pp.