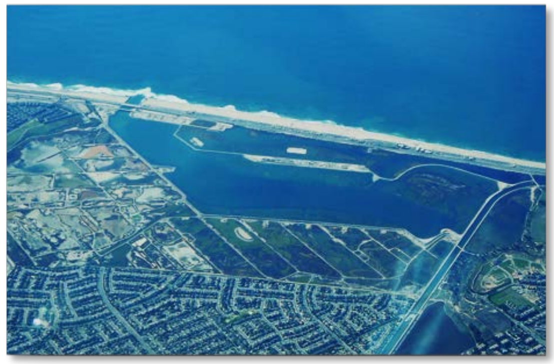
Poseidon Huntington Beach Desalination Facility
Marine Life Mitigation Plan: Bolsa Chica

Huntington Beach, Orange County, California



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Date:
July 2016

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LIST OF ACRONYMS AND ABBREVIATIONS

APF	Area of Production Foregone
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
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
MPM	Muted Pocket Marsh
SANDAG	San Diego Association of Governments
SONGS	San Onofre Nuclear Generating Station
SLC	State Lands Commission
SWRCB	State Water Resources Control Board

APPENDICES

1.0 INTRODUCTION

Poseidon Water (Poseidon) is proposing the development of a desalination facility (Project) in Huntington Beach, Orange County, California. 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.

Poseidon proposes to complete the restoration and maintenance of tidal action to the Bolsa Chica Ecological Reserve (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. The expected benefits are described in this MLMP. Consistent with Sections III.M2.e.(3) and (4) of the Desalination Amendment, Poseidon will undertake the restoration through either a fee-based agreement with the California State Lands Commission (SLC) and/or through a lease agreement to undertake the restoration actions proposed in this MLMP. Both options are discussed in Section 11 of this report.

This MLMP provides the basis for the proposed restoration program, the benefits that will be achieved, and the details on the plan's implementation and financial commitments.

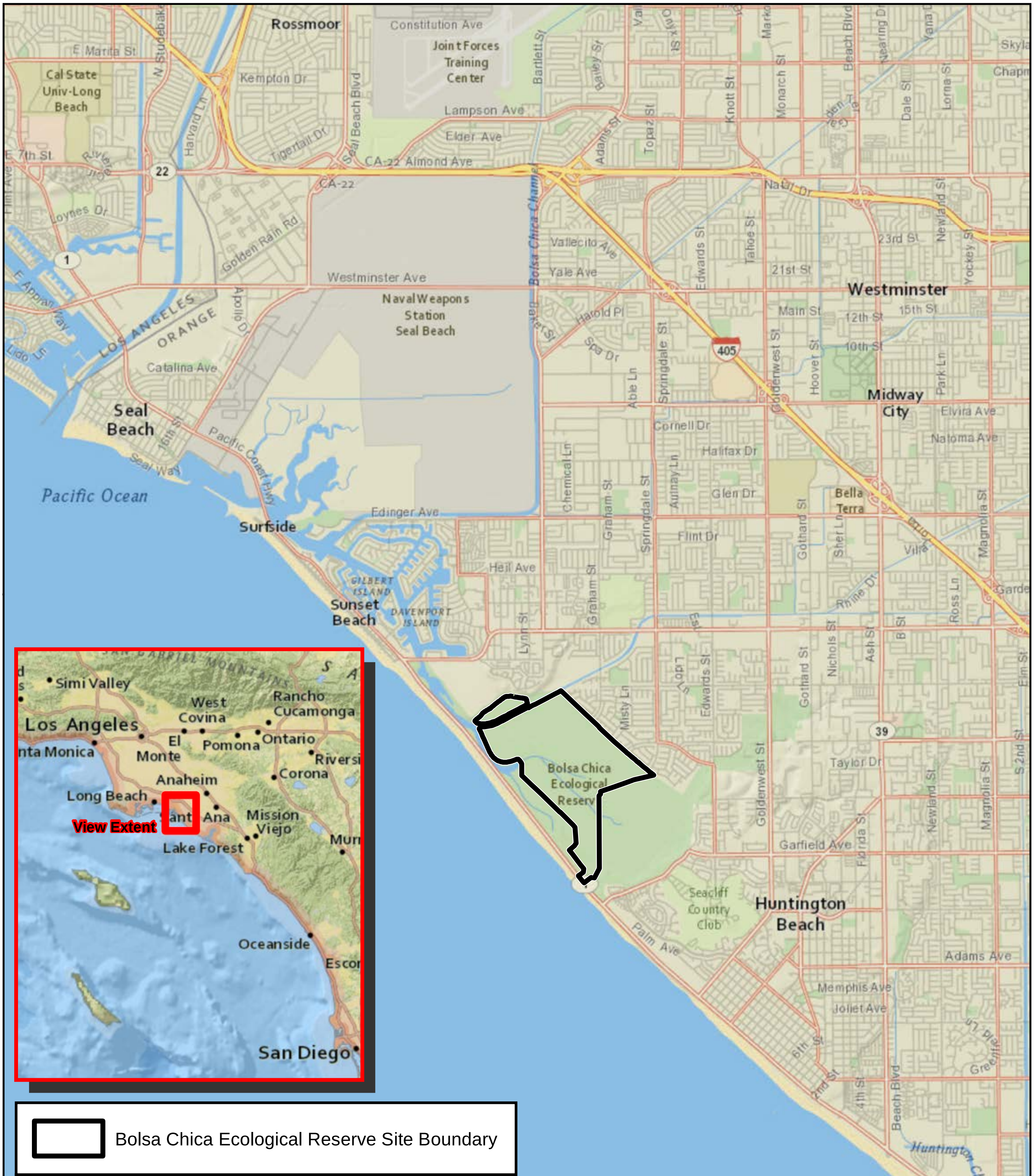

Figure 1. Location of Bolsa Chica Ecological Reserve

N
W E
S

0 0.5 1 2
Miles

Map Prepared Date: 11/3/2015
Map Prepared By: MRochelle
Base Source: National Geographic
Data Source(s): WRA

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Figure 2. Site Boundary for Bolsa Chica Ecological Reserve

N W E S

0 0.25 0.5 Miles

WRA ENVIRONMENTAL CONSULTANTS

Map Prepared Date: 11/3/2015
Map Prepared By: MRochelle
Base Source: 2014 NAIP Imagery
Data Source(s): WRA

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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. 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 SWRCB 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 approach recommended uses an Empirical Transport Model (ETM) to estimate the APF. Mitigation is then based on the cost of replacing the production lost ('foregone') to entrainment by restoration that replaces the lost production or other projects deemed equivalent. The APF approach has been adopted by California regulatory agencies to determine mitigation for entrainment by desalination plants. Estimates of APF are based on both intake of surface water as well as discharge of brines.

In support of this MLMP, a MLMR has been prepared that calculates the construction and operating (i.e. seawater intake and brine discharge) impact for the Project. For the seawater intake at the proposed Project, Tenera Environmental prepared a July 1, 2015 technical memorandum entitled *"Memorandum on Approach for APF Calculations at Huntington Beach*," which analyzes the potential entrainment of planktonic organisms from the long-term, stand-alone operation of the desalination project. The Desalination Amendment allows for a one percent reduction in the final estimate of APF for projects that incorporate a 1 mm screen into the intake design. As the final intake design for the desalination plant will include a screen with 1 mm mesh, the final APF estimate was reduced one percent. The Tenera memorandum estimates the Project's entrainment-related mitigation requirement to be 16.9 acres.

For the brine discharger impacts, the November 2015 MBC Applied Environmental Sciences technical memorandum entitled *"Huntington Beach Desalination Facility: Diffuser Discharge Analysis"* estimates the proposed Project could require an additional 23.43 acres of mitigation pursuant to the requirements of the Desalination Amendment that address salinity levels in the Project's discharge and the effects of the proposed brine diffuser. When the desalination plant becomes a stand-alone facility after the Huntington Beach Generating Station transitions away from once-through-cooling and is discharging 57 mgd of concentrated seawater into the diffuser, APF for the related entrainment from stand-alone diffuser operation totals 23.43 acres, with 9.12 acres contributed by estuarine taxa and 14.31 acres contributed by coastal taxa.

To mitigate for an estimated APF of 40.3 acres for the total operational marine like impacts of the Project, Poseidon is proposing to undertake restoration and maintenance 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. The Bolsa Chica Lowlands Restoration Project has been undertaking inlet maintenance to date; however, funding is insufficient to continue this action and SLC has requested that a source of funding be found that can be used for inlet maintenance that will allow for estuarine and coastal fish populations to be sustained as well as supporting other wildlife benefits of this important coastal habitat in Orange County.

3.0 BOLSA CHICA INLET RESTORATION AND MAINTENANCE

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 restoration 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 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 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 in 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 maintenance 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 maintenance dredging of the inlet. Without continued maintenance 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. Similarly, other adjacent habitat areas would suffer degradation under a closed inlet condition.

In coordination with the SLC and CDFW, Poseidon proposes to restore and maintain tidal connectivity at Bolsa Chica by providing funding for maintenance dredging of the inlet, as detailed in this MLMP. As discussed below, mitigation credit that is appropriate for maintaining the inlet at Bolsa Chica was determined to be 0.63 acres of credit for every 1 acre of tidal habitat in the FTB (317 acres) in the area for a total of 199 acres of credit from the proposed inlet maintenance plan.

3.1.2 Precedent for Inlet Maintenance as Mitigation

Precedents associated with providing habitat credits for inlet maintenance 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 maintenance 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 maintenance 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 maintenance 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 maintenance 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 maintenance. These additional credits were provided when mitigation credit had already been given for the lagoon.

3.2 Benefits to Aquatic Ecosystems

Under the Desal Amendment to the Ocean Plan, the State Board states:

> *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 relates to the restoration and maintenance of 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. The Carlsbad desalination plant created similar mitigation at a ratio of 10 to 1.

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 parvipinis*) 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.

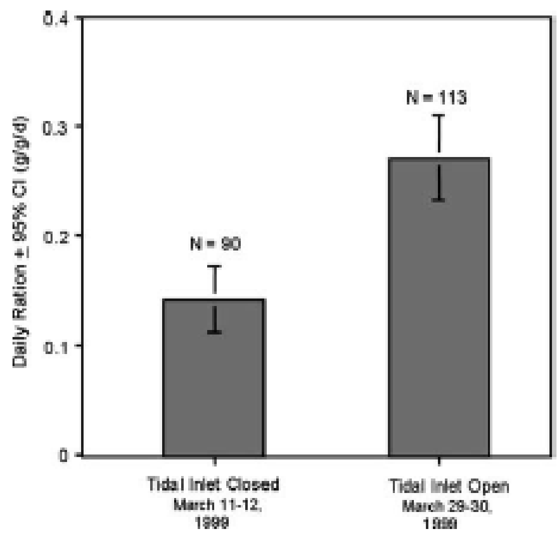

Figure 3. Field estimates of daily amounts of food consumed by topsmelt (Madon 2008).

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 maintenance 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.

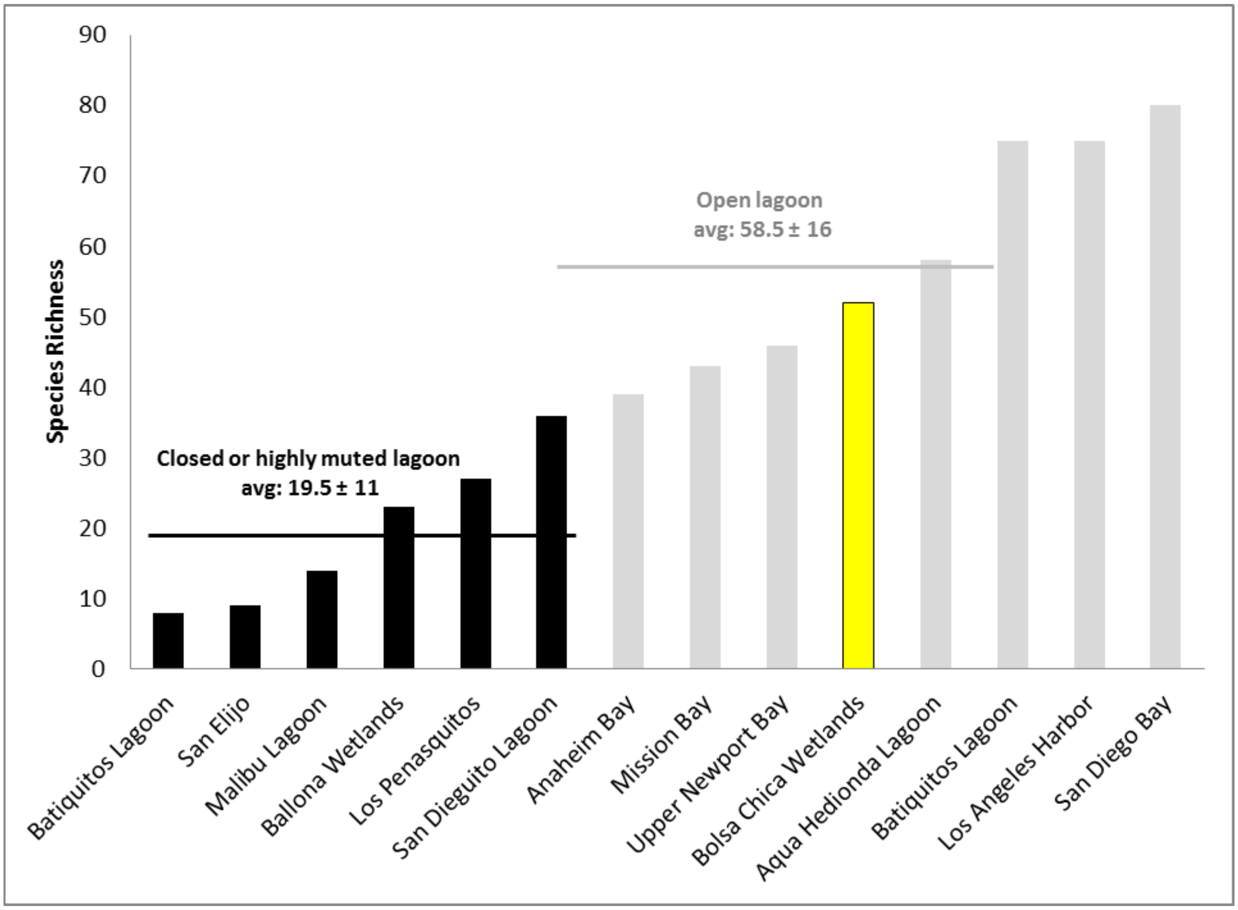

Figure 4. Fish species richness observed during monitoring events.

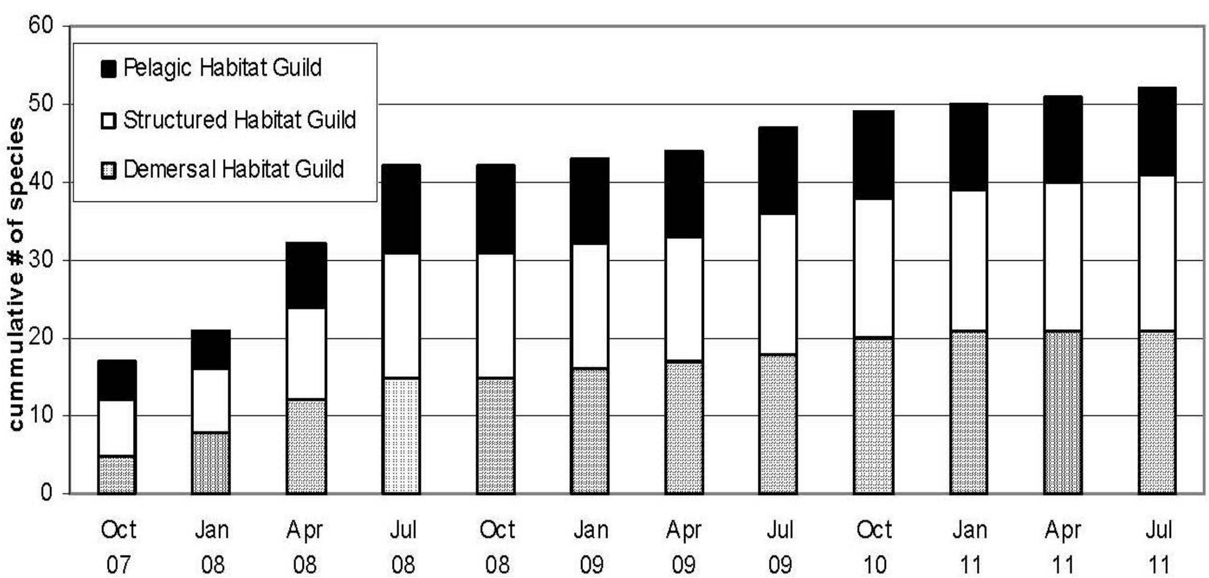

Figure 5. Cumulative total of fish species by guild in the Full Tidal Basin of Bolsa Chica following the restored tidal influence (Merkel & Associates 2013).

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).

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, maintenance 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).

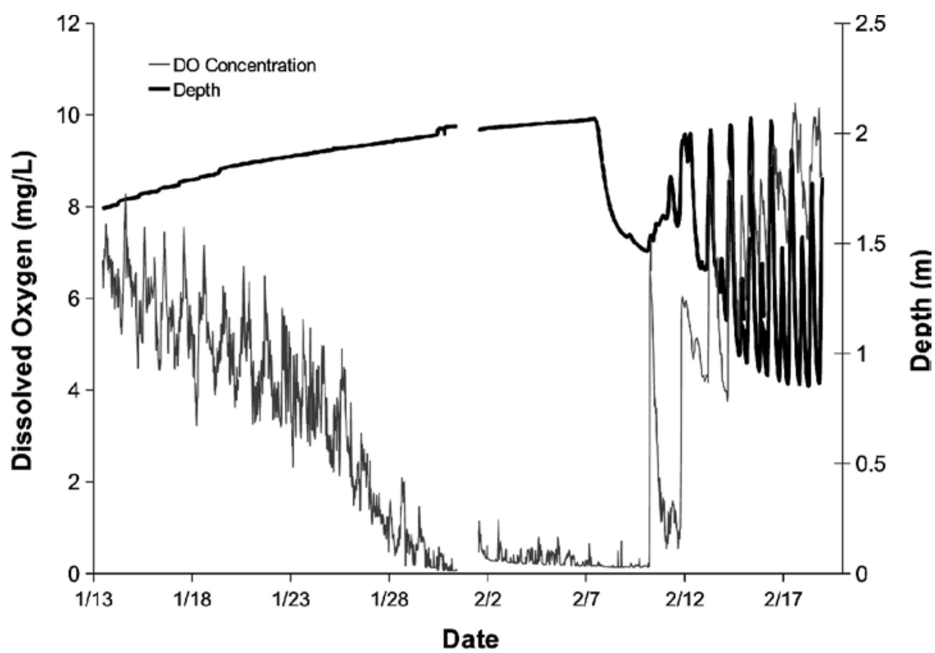

Figure 6. Los Peñasquitos lagoon oxygen levels (thin line) declined with closure (shown as bold line) (From NOAA, undated)

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 maintenance would increase tidal flushing at Bolsa Chica, which would in turn result in lower water temperatures and potentially create more suitable conditions for eelgrass.

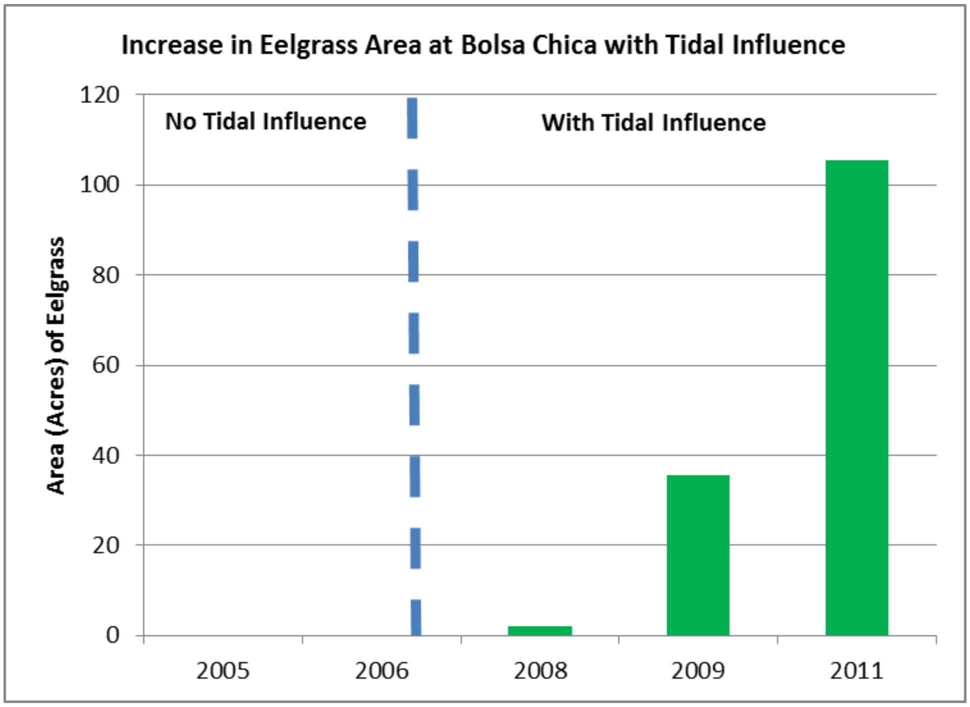

Figure 7. Change in eelgrass area following restoration of tidal action at Bolsa Chica (Merkel & Associates 2013).

The establishment of eelgrass within Bolsa Chica was not an initial requirement of the restoration plan for which the Ports of Los Angeles and Long Beach received habitat credits. As such, it is the position of the Bolsa Chica Steering Committee that unassigned habitats are available for mitigation purposes, making the established eelgrass an additional opportunity for mitigation credit, especially since inlet maintenance is needed to assure its long-term survival. It was initiated through a small scale planting effort after restoration was complete, and it has now become well established throughout the FTB and is currently approximately 105 acres in size. The eelgrass also provides nursery habitat for species such as topsmelt, which lay eggs on the eelgrass in estuaries and bays. The creation of shallow-water habitat rich with primary production supplies detritus-based and grazing-based food webs with energy. Ultimately, this energy is transferred to fish and used to support increased biomass and abundance in the basin. This increased production is also transferred offshore with individuals that leave the basin. Its continued presence and health is dependent upon the maintenance of the tidal inlet.

4.0 SITE SELECTION

The proposed restoration and maintenance 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 and maintenance of the Bolsa Chica full tidal inlet was highly ranked as meeting the requirements of the Desal Amendment and CCC minimum standards.

The basis for meeting the Desal Amendment standards and CCC minimum standards is summarized in Table 1, 2, and 3, below.

Table 1. Basis for meeting SWRCB Desal 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 maintenance 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 maintenance, the tidal inlet will close over time. Inlet maintenance 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 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	The anticipated benefit at Bolsa Chica far

Desalination Amendment for Operator Mitigation	Basis for Compliance
project fully mitigates for discharge- and construction-related marine life mortality projected in the MLMR.	exceeds the 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.

Table 2. Basis for meeting standards under Fee-based Mitigation Program between Poseidon and State Lands Commission.

Desalination Amendment Standards for Fee-based Mitigation Program	Basis for Compliance
The agency that manages the fee-based program must have legal and budgetary authority to accept and spend mitigation funds, a history of successful mitigation projects documented by having set and met performance standards for past projects, and stable financial backing in order to manage mitigation sites for the operational life of the facility.	As discussed in Section 11, if a fee-based program is selected, SLC would be the legal entity managing the mitigation funds. SLC has the legal and budgetary authority to accept and spend mitigation funds, and has a long history of successful mitigation projects.
The amount of the fee shall be based on the cost of the mitigation project, or if the project is designed to mitigate cumulative impacts from multiple desalination facilities or other development projects, the amount of the fee shall be based on the desalination facility's fair share of the cost of the mitigation project.	The amount of the fee would be based on the cost of the restoration and routine maintenance of the inlet at Bolsa Chica as well as an addition amount for monitoring the existing eelgrass population to assure its continued distribution in the FTB.
The manager of the fee-based mitigation program must consult CDFW, the Ocean Protection Council, the CCC, SLC, and state and regional water boards to develop mitigation projects that will best compensate for intake and mortality of all forms of marine life caused by the desalination facility.	These agencies would be consulted to develop the mitigation 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 maintenance is a necessary component to retain the benefits of these habitats to the coastal ecosystem.
Creates or substantially restores 40.3 acres of APF as required under the Desalination Amendment excluding buffer zone and upland transition area.	Total benefit of inlet maintenance far exceeds the APF requirement. Basis for calculation of benefit is provided in this report.
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 maintenance 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 maintenance; in fact, maintenance 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 maintenance. Inlet maintenance 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 restoration 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 Harbour, 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.

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 maintenance.

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.

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.

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.

Avian Community

The habitats with the highest bird densities were intertidal sand 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.

5.3 Inlet Maintenance 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 maintenance 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 downcoast beach (Moffat & Nichol 1999, Jin and McCarthy 2010). The first maintenance 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 maintenance events with only inlet channel dredging during the third event (Table 2).

Table 4. Historical maintenance 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.

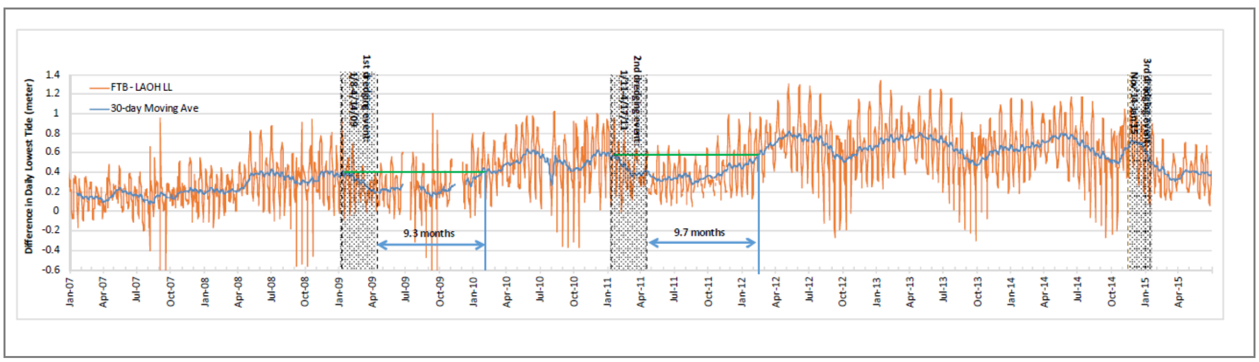

Figure 8. Difference in daily low tide at Bolsa Chica Inlet following maintenance dredging.

For all three maintenance 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 to 10 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 maintenance 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 Maintenance

Future inlet maintenance at Bolsa Chica will involve dredging to address three functions within the wetlands. The first and most important function is the maintenance 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 maintenance 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 maintenance of various habitat types within the wetlands. The third function is the maintenance 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). Based on an analysis of the past three maintenance dredging events, approximately 40,000 cubic yards (+/- 25 percent) will need to be dredged on an annual basis to maintain the various habitat types and tidal prism in addition to the 100,000 cubic yards of annual dredging needed to maintain the tide range within the FTB.

The proposed approach to inlet maintenance 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 maintenance dredging events, future maintenance 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., bull dozer) to provide a beneficial reuse as beach fill.

6.2 Calculation of Inlet Credit

6.2.1 Background

Restoration credit 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 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

Figure 9. Location of previous dredging.

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 credits 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 maintenance 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 3).

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.

Table 2 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.

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.

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 2). 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 maintenance 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 Fish Functional Lift Calculation

Using the data from the closed lagoons and the summer (August) data for Bolsa Chica fish diversity, WRA calculated the expected functional lift as 0.63. That is, the benefits of inlet maintenance to avoid a closed lagoon will result in 63 percent improvement in fish diversity.

$$\mathrm{FLI} = \frac{40 - 15}{40} = 0.63$$

6.2.7 Uncertainties

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. Not all data was limited to these months because species richness data for individual sampling dates for all of the sites 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.

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 maintenance 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 closure are uncertain. Therefore, the ultimate impact on fish communities and habitat is another uncertainty.

Based on the data available for conditions at Bolsa Chica and the SONGS reference wetlands, the FTB is comparable to reference wetlands of the area and currently provides good habitat for coastal marine fish. However, should the inlet close due to lack of needed maintenance, the mitigation credit that is appropriate for maintaining the inlet at Bolsa Chica is therefore 0.63 acres of credit for every 1 acre of the tidally influenced habitat in the FTB (317 acres) in the area for a total of 199 acres of credit from the proposed inlet maintenance plan.

7.0 INLET MAINTENANCE SUCCESS CRITERIA

As with the past three maintenance dredging events, future maintenance 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., bull dozer) to provide a beneficial reuse as beach fill. The maintenance dredging activities will likely be limited to the period between September 15 and February 15 to avoid impacts to sensitive bird species. At present, it is expected that maintenance will be conducted on an annual basis.

Based on an analysis of the past three maintenance dredging events, the following success criteria will be met:

- On an annual basis, approximately 100,000 cubic yards (+/- 10 percent) will be dredged;
- Achieve an increase of 0.67 feet in the LLW following dredging activities; and

The final implementation plan will include additional analyses to better define the amount and frequency of dredging as already planned.

8.0 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). 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 maintenance, each inlet maintenance event will be monitored and subsequent maintenance 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. Maintenance will be based on actual performance of the inlet instead of the predicted performance based on engineering and mathematical modeling. The Bolsa Chica Restoration Plan included an adaptive management approach to inlet management and placement of dredged sand in areas downcoast where needed and that will continue to be followed under this MLMP.

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 maintenance frequency. These factors affect future inlet maintenance 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 MOA and other agency permit authorizations.

9.0 PERFORMANCE STANDARDS

Performance standards are based on the extent of tidal muting, the beach width where nourishment is proposed, and the extent of eelgrass habitat.

- *Tidal Muting:* Muting of the average low tide elevations (Mean Low Water) will not exceed 0.5 feet for nine months following dredging events.
- *Beach Width:* Beaches will be wider than 50 feet (15.24 meters), based on two consecutive monthly beach width measurements. Any 12-month rolling average of beach widths will not deviate more than 2 standard deviations from the mean beach width (using the 20-year historic record to establish these means and standard deviations)
- *Eelgrass:* The area of eelgrass will not drop below 90 percent of its current acreage.

These performance standards will be measured in the monitoring program and reported directly to the agencies and the SLC. They may be modified by the agencies and the SLC under the Adaptive Management Plan.

10.0 MONITORING REQUIREMENTS

The proposed monitoring program will continue those aspects of the monitoring program already established for Bolsa Chica that are focused on beach and tidal monitoring. Monitoring will be conducted annually. Methods will be similar to methods employed during previous Bolsa Chica monitoring events. Additionally, the monitoring program will evaluate the extent and distribution of eelgrass if it is determined that credit will be awarded for eelgrass. Monitoring will occur as long as the proposed desalination plant is in operation.

10.1 Tidal Monitoring

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. Tidal data will be analyzed to produce comparisons of tidal lag and tidal muting between the FTB tides and open coastal tide data. Tidal data collection and analysis methods will be modeled on previous tidal monitoring activities conducted at Bolsa Chica.

10.2 Beach Monitoring

Beach profile survey data will be collected annually. Additionally, monthly beach width measurements will be obtained at each of the seven established profile sites. Data collection and analysis methods will be modeled on previous beach monitoring activities conducted at Bolsa Chica.

10.3 Eelgrass Monitoring

Eelgrass will be monitored every other year to determine the extent and distribution of eelgrass. Eelgrass surveys will be conducted from a vessel equipped with sidescan sonar. Following completion of the survey, 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. Eelgrass monitoring methods are modeled on eelgrass monitoring methods previously employed at Bolsa Chica.

11.0 SITE PROTECTION AND FINANCIAL ASSURANCES

11.1 Site Protection

Poseidon has entered into a Memorandum of Understanding (MOU) with SLC that contemplates a lease agreement between the parties that will ensure the long-term implementation of the mitigation project for the operation life of the desalination facility. Pursuant to this MOU, Poseidon will provide the resources necessary to complete the mitigation project, and all monitoring, reporting, and remediation requirements. A copy of this MOU is provided as Appendix B.

11.2 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 maintenance 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 maintenance under the assumption that existing infrastructure, such as inlet rock riprap, bridges and other existing facilities) continue to function as designed.

11.3 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 maintenance, 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.

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