Salton Sea Funding and Feasibility Action Plan

Benchmark 7: Project Summary

May 2016

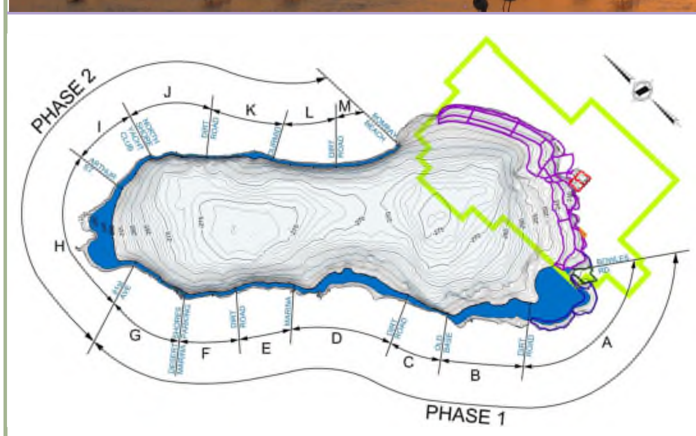

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Figure 14, Page 48 updated 5/28/20.

Executive Summary

The Salton Sea Funding and Feasibility Action Plan constitutes a set of scientific, engineering, and economic analyses to develop recommendations for future restoration and development activities at the Sea, performed over 2014-2016. This work was funded by a grant from the California Natural Resources Agency to the Salton Sea Authority. The grant was managed by the Authority and by a consulting team led by Tetra Tech Inc., with the support of key subcontractors. The primary objective of the work was to develop a roadmap toward a comprehensive solution to the Salton Sea's numerous environmental concerns in the context of current funding opportunities and constraints, while satisfying regulatory and regional requirements. This work was performed in parallel with a similar large-scale effort performed by the Imperial Irrigation District and Imperial County, identified as the Salton Sea Restoration and Renewable Energy Initiative (SSRREI). The SSRREI, or Initiative, considers the development of shallow habitat, potential geothermal energy development, and air quality mitigation over playa that is exposed as the Salton Sea recedes. Project concepts developed as part of this Action Plan are intended to work in concert with concepts developed through the Initiative as well as smaller projects such as the Red Hill Bay Restoration and the Species Conservation Habitat (SCH) projects and do not overlap geographically. It is anticipated that elements of the Action Plan and the Initiative and the other smaller projects will together form the basis of the Salton Sea Management Plan now being developed by the State of California.

This project was completed in a series of seven Benchmarks with separate reports for each Benchmark. Each of these reports was reviewed by stakeholders and final versions of all these documents and supporting data and analysis tools are in the public domain. Benchmark 1 was the Work Plan, which laid out the scopes for the remaining Benchmark documents. This Benchmark 7 report provides a summary of the material presented in the documents prepared for Benchmarks 2 through 6.

Benchmark 2: Review and Update Existing Condition Data presents an overview of historical and current hydrology and water quality of the Sea and its tributaries, projected inflows and salinity, dust mitigation alternatives from areas of exposed playa, and future data needs for management. The report is intended to inform those who are engaged in designing options for the restoration and management of the Sea. Because many of the topics addressed in this report have been considered in prior efforts, the particular focus was on recent data and trends in the Salton Sea, the New, Alamo and Whitewater Rivers and several major agricultural drains. New data have been analyzed and compiled in a way that emphasizes these near-term changes. Trends in hydrology and water quality are important for modeling future conditions that can be used to evaluate alternatives and options. The Benchmark 2 document is summarized in Chapter 2 of this report.

Benchmark 3: Evaluation of Alternatives with Respect to Existing Conditions provides a review of past alternatives that have been considered for management of the Salton Sea over the past few decades. This work includes a review of full-sea restoration alternatives and other restoration concepts that may help to control salinity and/or manage water levels. Significant prior alternatives, including the State of California's preferred approach in 2007 and the Salton Sea Authority's preferred plan in 2006 were evaluated in the context of current and projected hydrology. A summary of the material presented in the Benchmark 3 document is provided in Chapter 3 of this report, which specifically focuses on the preferred alternatives previously developed by Salton Sea Authority and the State of California. In addition, although not a full restoration alternative, the State's SCH Project is discussed because it is in the process of being implemented at this time and forms a key part of the overall feasibility study.

Benchmark 4: Conceptual Plans and Cost Estimates was divided into two volumes:

- Volume 1: Water Import and Export Options; and
- Volume 2: Smaller Sea Options.

Benchmark 4, Volume 1 is summarized in Chapter 4 of this report. Volume 1 explores various options for importing and exporting water to and from the Salton Sea to support current water levels. Ten potential inflow conveyance alternatives were evaluated, including the Santa Ana Regional Interceptor (SARI) Pipeline, the Metropolitan Water District of Southern California (MWD) Concentrate Pipeline and pipelines to the Gulf of California and the Pacific Ocean. Conceptual plans were developed, and in each case, the export/import alternatives were ranked according to the following elements: water quantity, water quality, operational cost, capital cost, approvals and environmental requirements, and community impacts and the need for easements. Benchmark 4, Volume 2, summarized in Chapter 5 of this report, presents smaller lake and other options within the existing Salton Sea footprint. This document introduces the Perimeter Lake concept. This takes into account the immediate need for action, the limitations on water supply for the lake, and the possibility of constructing a project with incremental funding. The proposed approach would involve constructing a lake around the perimeter of the Sea along with a central saline pool within the current

Sea footprint. This concept is anticipated to work with other projects such as the Salton Sea Restoration and Renewable Energy Initiative discussed above, as well as other future projects that may be developed by the State of California as part of an overall Salton Sea Management Program. As part of Benchmark, the following evaluation was performed for the Perimeter Lake: presentation of conceptual construction details; water inflow requirements and water quality improvement in inflow; conceptual design of spillways and air quality mitigation; geotechnical feasibility study; and a construction scenario, cost estimates, and cost comparisons to past alternatives. .

The **Benchmark 5: Infrastructure Financing Feasibility Analysis** was conducted by a subconsultant team led by Development Planning and Financing Group (DPFG) with support from the Concord Group, Economics and Politics Inc., and FORMA. The results of their analysis are summarized in Chapter 6 of this document. This work finds that the Authority has statutory authority to form Infrastructure Financing Districts ("IFD") in part or all of the Authority's area "for the purpose of funding the construction of, and purchasing power for, projects for the reclamation and environmental restoration of the Salton Sea…"(Calif. Gov. Code 53395.9). This work assumes that IFDs will be funded by property tax increments generated by development that is enabled by the funded seaside infrastructure. This analysis considers that the Authority will have the ability to fashion the Salton Sea along the former shoreline with combinations of dikes and dredging to produce water features that will be able to sustain recreationally attractive water near the shoreline (defined as "Seaside Improvements"). This Infrastructure Financing Feasibility analysis was prepared to estimate the total revenues generated by development attracted by the recreational water and Seaside Improvements ("Landside Development"), and the total estimated Seaside Improvement costs that can be repaid with such revenues. While the potential revenues from improvements occur over a long-term horizon, the improvements need to occur over a shorter duration, creating a funding gap in the early years that needs to be met through other sources. Different scenarios were developed, taking into account the percentage of the tax increment that may be available to the IFD and the interest rate, to be paid back on State, Federal, or other loans obtained to fund the Seaside Improvement costs.

As part of the Funding and Feasibility Action Plan, the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) was commissioned to conduct financing evaluations for **Benchmark 6: The Potential for Renewable Energy Development to Benefit Restoration of the Salton Sea: Analysis of Technical and Market Potential**. This study was focusing on refining potential revenue estimates, provide a technical review of the renewable energy technologies under consideration, and develop estimates of the region’s developable production potential through the year 2030. Of the commercially available renewable energy technologies, geothermal, solar photovoltaics (PV) and concentrating solar power (CSP) have the greatest technical potential for development. Technologies and revenue streams considered in this work included electricity production from solar PV; CSP; geothermal technologies; and mineral recovery from geothermal fluids. Wind was not evaluated in the report due to the minimal resource potential within the Salton Sea region. Despite their large total resource potentials, this study found that constraints such as proximity to transmission access and regional cost-competitiveness of the electricity generated may limit the technical potential of the power generation technologies before 2030. Further, development on the playa itself will be constrained by the rate at which the shoreline recedes, and although playa may be exposed in a given year, there will likely be an additional lag in development due to variability in Salton Sea water levels and potentially muddy site conditions. Based on extensive modeling of potential scenarios, it was determined that any additional tax on generation to support Salton Sea development could significantly disadvantage the development of these resources by making them more expensive than the competing regional supply pool, and thus limiting the potential revenue stream for restoration. The results of the NREL evaluation are summarized in Chapter 7 of this report.

Chapter 8 of this report provides recommendations for additional design, engineering, a demonstration projects that would advance the concepts presented in the Benchmark reports. References used in the project are provided in Chapter 9.

Acronyms and Abbreviations

Acronyms and abbreviations used in the Work Plan are listed below.

ATEs	Affected Tax Agencies
Authority	Salton Sea Authority
BACM	Best Available Control Measures
BACT	Best Available Control Technologies
BAM	Beta Attenuation Monitor
BLM	Bureau of Land Management
CAAA	Clean Air Act Amendments
CAISO	California Independent System Operator
CARB	California Air Resources Board
CCAA	California Clean Air Act
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CFD	Community Facilities District
CNRA	California Natural Resources Agency
CSP	Concentrating Solar Power
CVWD	Coachella Valley Water District
DCM	Dust Control Measure
DO	Dissolved Oxygen
DOE	Department of Energy
DRECP	Desert Renewable Energy Conservation Plan
DWR	California Department of Water Resources
EIFD	Enhanced Infrastructure Financing District
EIS	Environmental Impact Statement
EIR	Environmental Impact Report
ERAF	Educational Revenue Augmentation Fund
FAQ	Frequently Asked Questions
GIS	Geographic Information Systems
IFD	Infrastructure Financing District
IID	Imperial Irrigation District
IRFD	Infrastructure and Revitalization Financing District
MAP	Monitoring and Assessment Plan
MMRP	Mitigation Monitoring and Reporting Plan
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act

NGO	Non-governmental Organization
O&M	Operations & Management
OHV	Off-Highway Vehicle
OMER	Operation, maintenance, energy and repair
PEIR	Programmatic Environmental Impact Report
PFA	Public Financing Authority
PUC	California Public Utilities Commission
PV	Photovoltaic
QSA	Quantification Settlement Agreement
R&D	Research & Development
RE	Renewable Energy
Reclamation	US Bureau of Reclamation
RFP	Request for Proposals
RFQ	Request for Qualifications
ROI	Resolution of Issuance
RPS	California Renewables Portfolio Standard
SCAQMD	South Coast Air Quality Management District
SCH	Species Conservation Habitat (Project)
SIP	State Implementation Plan
SWAMP	Surface Water Ambient Monitoring Program
SRA	
TCT	Technical Coordination Team
TEOM	Tapered Element Oscillating Microbalance Monitor
TMDL	Total Maximum Daily Load
TOT	Transient Occupancy Taxes
TSS	Total Suspended Solids
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VLF	Motor Vehicle in-lieu Fees
VOC	Volatile Organic Carbon

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1.0 Introduction

The Salton Sea Funding and Feasibility Action Plan was developed using a grant from the California Natural Resources Agency to the Salton Sea Authority in 2014. The project was completed in a series of Benchmarks over 2014-2016 with separate reports for each Benchmark. These included a review of existing conditions; previous alternatives for restoration; review of options for importing and exporting water from the Sea, and for performing in-Sea improvements; opportunities for funding improvements through the development of real estate around the Sea; and estimation of funding streams from development of alternative energy sources around the Sea. This chapter provides an overview of these analysis topics, with key findings associated with each topic summarized in individual chapters of this final report (Benchmark 7). This work was performed in parallel with a similar large-scale effort performed by the Imperial Irrigation District and Imperial County, identified as the Salton Sea Restoration and Renewable Energy Initiative (SSRREI). It is anticipated that elements of the Action Plan and the Initiative will together form the basis of the Salton Sea Management Plan now being developed by the State of California.

1.1 Background

The Salton Sea is located in a closed portion of the Colorado River basin in Riverside and Imperial Counties within the Colorado River Basin Regional Water Quality Control Board (CRBRWQCB). The Sea is currently at about 233 feet below mean sea level (msl) and has no natural outlet. The Salton Basin is part of the Lower Colorado River Delta system. Lakes have historically existed in the basin as the course of the Colorado River shifted, most recently several hundred years ago.

The climate in the Salton Basin is one of great extremes. The local rainfall is about 2.5 inches per year while the temperatures can often reach above 110° F in the summer and below freezing in the winter (DWR and DFG 2011). The presence of the Sea has a micro-climate effect in the Imperial Valley which provides some regulation of extremes in temperature and humidity which is beneficial to agriculture. However, the temperature extremes can have an adverse effect on the fish population in the Sea (DWR and DFG 2011). Low temperatures in the winter can result in fish mortality while high temperatures in the summer can suppress oxygen levels in the water which can also lead to fish mortality.

Water temperature stratification occurs annually and sometimes more frequently, causing oxygen depletion in the lower portion (hypolimnion). When the Sea mixes, oxygen can be depleted throughout the water column, causing fish die offs and releasing toxic ammonia and hydrogen sulfide. On the other hand, reducing conditions in the bottom of the lake appears to be an important mechanism that enables selenium sequestration in sediments. Due to selenium concerns, research has been conducted to quantify the release of selenium from sediments. Water quality data indicate that there will be an initial, temporary flush of selenium released but the effects can be mitigated (DWR and DFG 2011). These factors need to be considered when planning for habitat expansion.

The Sea and its adjacent areas have supported a diverse wildlife habitat for over 400 bird species (Shuford et al. 2000, 2002 and 2004). The Sea also serves as a critical link on the 5,000 mile international Pacific Flyway for bird migration as most of the remaining rest stops for birds--such as the Colorado River delta in Mexico--have dried up (Hurlbert et al. 2007, Cohen and Hyun 2006, Detwiler et al. 2002, and Cohen 2014).

Even though the Sea was relatively stable in size and elevation over the last 40 years, the dissolved salts present in the inflow water (about 2.5 tons per acre-foot) have been continuously accumulating in the water (except for the amount that precipitates and settles to the bottom). Declines in the inflow discharge have caused the Sea’s water surface elevation to drop by about 5 feet over the past 10 years. Consequently, salt concentrations are rising even faster than before and are currently about 55 grams per liter (g/L). This is about 50% saltier than ocean water. If no remedial actions are taken, the Sea will become so saline within 15 years (over 60 g/L salt) that the remaining fish that serve as a food source for piscivorous birds will be effectively eliminated. If the current inflow projections are correct, the Sea will evolve into a hypersaline water body (over 120 g/L salt) within 20 years, similar to Mono Lake in Inyo County. Some have suggested an even more rapid deterioration in habitat values (Pacific Institute, 2006). As inflows are reduced by water transfers and other factors as discussed below, the Sea will eventually become a semi-solid brine pool (over 200 g/L salt) surrounded by hard-surface salt flats similar to the Great Salt Lake in Utah and the Laguna Salada basin southwest of Mexicali.

In addition to high salinity, the Sea is also highly eutrophic, meaning that it has high levels of phosphorus and nitrogen compounds that result from agricultural (fertilizer) drainage and municipal wastewater, a significant fraction of which, until 2007, was discharged without treatment into the New River from Mexicali south of the border. These nutrients stimulate algal growth which settles to the bottom of the Sea, and upon decay, creates oxygen deficiencies in the water. The near absence of oxygen in the deep bottom-water of the Sea leads to the formation and accumulation of substances such as hydrogen sulfide and ammonia that have unpleasant odors and can be toxic to fish in water and to humans when inhaled. When wind events overturn the Sea's natural stratification, these harmful gases rise to the surface and have caused sudden fish kills involving millions of fish. The Sea's eutrophic state also causes the unpleasant odors that permeate the residential areas surrounding the Sea (and occasionally as far away as Los Angeles and the San Fernando Valley) in certain months of the year (Salton Sea Authority 2006).

Projected inflow reductions in the upcoming years will shrink the Sea's wetted surface area and further concentrate salinity and possibly increase eutrophication problems. There are two primary reasons for the projected inflow reductions. First, the Quantification Settlement Agreement (QSA) was signed in October 2003 by Imperial Irrigation District (IID), Coachella Valley Water District (CVWD), other California Colorado River water users, the U.S. Department of Interior, and the California Department of Water Resources (DWR). Under this landmark agreement, about 300,000 AFY of Colorado River water (counting both contractual transfers and other reductions) that previously flowed into the Salton Sea will be supplied instead to other users outside the Salton Sea basin. Second, New River inflows from Mexico, recently estimated at about 61,600 AFY, are projected to decline as a result of plans by the city of Mexicali to reclaim treated-effluent and farm-drainage flows. Some of this decline has already occurred.

There have been numerous attempts to address the water quality, biology, recreational and economic issues at the Salton Sea over the past five decades. Many investigations have sought to control the salinity and elevation with large engineering projects but recently a shift in thinking has renewed focus on achievable, incremental progress toward avoiding the imminent human health and ecological disaster caused by the shrinking Sea. One of the first reports on the subject was authored by the Colorado River Basin Regional Water Pollution Control Board in 1963 and recommended a partial Sea concept with a concentration pond for removing salts. Two years later the California State Water Quality Control Board concluded that the fishing and recreational values of the Sea would decline sooner than anticipated without immediate measures of action and also recommended a partial Sea (Pomeroy, Johnston and Bailey Engineers, 1965). A wider range of alternatives was proposed by the US Department of the Interior, Aerospace Corporation, and the California Natural Resources Agency from 1969-1971. During this time, controlling nutrients, salinity and sediment were identified as the highest priority, and eutrophication was seen as the most insurmountable issue (DOI and The California Resources Agency, 1969). The idea of incorporating geothermal energy was evaluated in 1976 and 1978 by the Lawrence Livermore Laboratory and the California Institute of Technology (Layton 1976). In 1983 the California Department of Fish and Game (now the California Fish and Wildlife Service) evaluated the potential to expand geothermal development and put in a large solar pond. The California Resources Agency (now the California Natural Resources Agency) in 1988 evaluated three main solutions to the problems of salinity and flood control at the Sea, including evaporation ponds, solar ponds and a canal to the Gulf of California (that was written off as unfeasible). Previous alternatives were evaluated in 1994 by the newly-created Salton Sea Authority. Components included a smaller diked Sea, solar ponds, constructed wetlands, import-export to the Gulf of California with energy generation, desalination plants to reduce salinity for freshwater wetlands, and called for studies on selenium toxicity. Other restoration alternatives continued to be proposed and evaluated based on maintaining elevation and salinity throughout the 1990's and 2000's.

In 2005 Reclamation and USGS reviewed the Salton Sea Authority's 2004 preferred project report and identified several issues that were not recognized in the report: dust control, selenium management and the accommodation of seasonal and annual inflow fluctuations. The Programmatic Environmental Impact Report (PEIR) completed by the Department of Water Resources (DWR) and the Department of Fish and Game (DFG) in 2007 evaluated and analyzed potential environmental impacts of alternatives developed for the restoration of the Salton Sea. The Bureau of Reclamation produced a study in 2007 that determined a preferred alternative action for restoring the Salton Sea.

In 2013 an EIR/EIS was completed to evaluate the impacts of alternative methods of implementing the Species Conservation Habitat Project (SCH Project), which is a proof of concept for restoring shallow water habitat that supports fish and wildlife dependent upon the Sea. Key restoration alternatives are described in detail in the Benchmark 3 document. As a result of the most recent environmental impact studies, extensive water quality analysis and modeling was performed. Local and state agencies have conducted pilot projects to control salinity, establish habitat ponds (fresh, saline and in between), and to control dust. Academic studies have characterized the Sea's salinity, biological communities, nutrient dynamics, selenium dynamics, and other water quality parameters. Even though there have been advances in those research areas, major gaps in knowledge still exist that prevent a complete understanding of the consequences of the proposed alternatives or even the future under the status quo.

1.2 Scope of the Document

This project was completed in a series of seven Benchmarks with separate reports for each Benchmark. The present report constitutes Benchmark 7 and is a summary of the material presented in the documents prepared for Benchmarks 2 through 6. Key technical analysis in each of the prior Benchmarks is summarized in individual chapters as outlined below.

Chapter 2 is based on Benchmark 2: Review and Update Existing Condition Data and presents an overview of historical and current hydrology and water quality of the Sea and its tributaries, projected inflows and salinity, dust mitigation alternatives from areas of exposed playa, and future data needs for management.

Chapter 3 is based on Benchmark 3: Evaluation of Alternatives with Respect to Existing Conditions and provides a review of past alternatives that have been considered for management of the Salton Sea over the past few decades, and serve as a starting point for future management plans.

Chapter 4 is based on Volume 1 of Benchmark 4: Conceptual Plans and Cost Estimates, Water Import and Export Options and explores various options for importing and exporting water to and from the Salton Sea to support current water levels. Ten potential inflow conveyance alternatives were evaluated, including the Santa Ana Regional Interceptor (SARI) Pipeline, the Metropolitan Water District of Southern California (MWD) Concentrate Pipeline and pipelines to the Gulf of California and the Pacific Ocean.

Chapter 5 is based on Volume 2 of Benchmark 4: Conceptual Plans and Cost Estimates, Smaller Sea Options. This chapter introduces the Perimeter Lake concept. This concept takes into account the immediate need for action, the limitations on water supply for the lake, and the possibility of constructing a project with incremental funding. The proposed approach would involve constructing a lake around the perimeter of the Sea along with a central saline pool within the current Sea footprint. The Perimeter Lake concept was developed through the presentation of conceptual construction details; water inflow requirements and water quality improvement in inflow; conceptual design of spillways and air quality mitigation; geotechnical feasibility study; and a construction scenario, cost estimates, and cost comparisons to past alternatives.

Chapter 6 is based on Benchmark 5: Infrastructure Financing Feasibility Analysis. This analysis considers that the Authority will have the ability to fashion the Salton Sea along the former shoreline with combinations of dikes and dredging to produce water features that will be able to sustain recreationally attractive water near the shoreline (defined as Seaside Improvements). This Infrastructure Financing Feasibility analysis was prepared to estimate the total revenues generated by development attracted by the recreational water and Seaside Improvements ("Landside Development"), and the total estimated Seaside Improvement costs that can be repaid with such revenues.

Chapter 7 presents a summary of Benchmark 6: The Potential for Renewable Energy Development to Benefit Restoration of the Salton Sea: Analysis of Technical and Market Potential. This study was focusing on refining potential revenue estimates for future Salton Sea management through the development of renewable energy in the region.

Chapter 8 of this report provides recommendations for additional design, engineering, a demonstration projects that would advance the concepts presented in this report.

1.3 Relationship of this Work to Other Activities in the Salton Sea

The Salton Sea is currently the focus of a significant restoration effort by the State of California, managed by the California Natural Resources Agency. Specifically, the State is in the process of developing the Salton Sea Management Plan (SSMP) to address the multiple environmental concerns in the region. Also, this work was performed in parallel with a similar large-scale effort performed by the Imperial Irrigation District and Imperial County, identified as the Salton Sea Restoration and Renewable Energy Initiative (SSRREI). The SSRREI, or Initiative, considers the development of shallow habitat, potential geothermal energy development, and air quality mitigation over playa that is exposed as the Salton Sea recedes. Project concepts developed as part of this Action Plan are intended to work in concert with concepts developed through the Initiative and do not overlap geographically. It is anticipated that elements of the Action Plan and the Initiative, and other project components, will together form the basis of the SSMP.

2.0 Review and Update of Existing Condition Data: Hydrology, Water Quality, and Air Quality

A description of the riverine inflows to the Sea, in terms of flow volumes and water quality, as well as measurements of the elevation and water quality in the Sea, can explain recent trends and provide the background for future management activities. This chapter is based on the Benchmark 2 report, and highlights recent changes in water surface elevation, future projections of elevation, area, and salinity, and the potential exposure of emissive playa area. Trends in other parameters which are important for sustaining current and future beneficial uses of the Sea, such as nutrients and selenium, are described. Future data needs for improved characterization of the physical, chemical, and biological processes in the Sea are also discussed.

2.1 Introduction

The Salton Sea Funding and Feasibility Action Plan Benchmark 2: Review and Update of Existing Condition Data report provides an overview of historical and current hydrology and water quality of the Sea and its tributaries, projected inflows and salinity, dust mitigation alternatives from areas of exposed playa, and future data needs for management. The report is intended to inform those who are engaged in designing options for the restoration and management of the Sea. Because many of the topics addressed in this report have been considered in prior efforts, the particular focus here is recent data and trends in the Salton Sea, the New, Alamo and Whitewater Rivers and several major agricultural drains. New data have been analyzed and compiled in a way that emphasizes these near-term changes. Trends in hydrology and water quality are important for modeling future conditions that can be used to evaluate alternatives and restoration options.

Major findings from each of the topic areas discussed in the Benchmark 2 report are summarized below.

2.2 Hydrology

Stream flow observations provide insight into the changes in the hydrology of Salton Sea basin. Recent changes include reductions in flows from Mexico, and with the full implementation of the Quantification Settlement

Agreement in the near future, stream flows are expected to decrease further. Historical flow data from the Alamo, New and Whitewater River Basins, focusing on the last two decades, are summarized to provide a general understanding of the flow contributions in the basin, and to provide a baseline for this work.

Key features of the Salton Sea hydrology include the following:

- The elevation of the Salton Sea is now at about -234 feet below mean sea level (National Geodetic Vertical Datum of 1929 or NGVD 29) as of February 2015.
- The elevation of the Sea declined at an accelerated rate after 1995 and has decreased by 5.5 feet since 1987 (Figure 1).

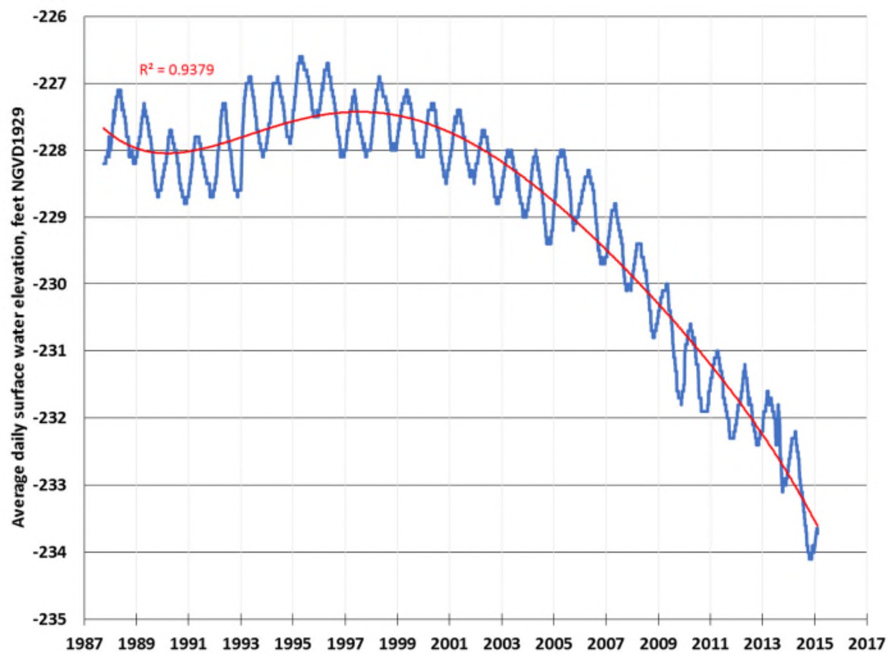

Figure 1: Daily surface water elevation above NGVD1929 for Station 10254005 located along Salton Sea near Westmorland, CA from October 1987 to February 28, 2015 (USGS). Trend line (polynomial fit) with R^2 shown in red.

- New River inflows to the Sea averaged 411,760 acre feet/year (2004-2014). Daily discharge averaged 568 cubic feet per second (cfs) from 2004-2014.
- Flows from Mexico have decreased over the past 10-20 years, reducing flows into the New River and the Sea.

- Alamo River inflows to the Sea averaged 592,500 acre feet/year (2004-2014). Daily discharge averaged 829 cubic feet per second (cfs) from 2004-2014.
- Flows from the Alamo River have decreased at the border but flows to the Sea have remained fairly consistent.
- New and Alamo Rivers reach their highest flows during the months of March to May during peak irrigation season.
- Whitewater River/Coachella Valley Stormwater Channel (CVSC) inflows to the Sea averaged 39,600 acre feet/year (2004-2014). Daily discharge averaged 55 cubic feet per second (cfs) from 2004-2014.
- Whitewater River/CVSC flow showed the sharpest decline among the rivers and the hydrograph has levelled off considerably.
- Other drains and channels that flow directly to the Sea averaged 128,000 acre feet/year (2004-2014).
- Total Salton Sea inflows averaged 1,221,000 acre feet/year (2004-2014).

2.3 Salinity and Other Water Quality Parameters

Salinity originates from imported Colorado River water that is used to irrigate agricultural fields where salt is concentrated via evaporation and subsequently leached from soils. The water is routed through surface and subsurface drains to the major rivers or directly to the sea. Imperial Valley contributes the majority of flows and salt to the Salton Sea (DWR and DFW 2013). In 2002, Holdren and Montaño calculated total dissolved salt loading of 3,434,000 tonnes/year, consistent with other calculated salt loads to the sea (Holdren and Moñtano 2002; Amrhein et al. 2001). These estimates were updated in the present work. Average flow from the Alamo, New and Whitewater Rivers was multiplied by the corresponding average TDS concentration to obtain annual dissolved salt loads. Direct drain flow loads were calculated by multiplying measured TDS in 2010 by typical drain flow (10% of combined Alamo River and New River flow; DWR and DFW 2007). The average annual TDS load from 2004-2014 was 3,236,000 metric tons, varying annually by 287,000 tonnes. Agricultural drains from Imperial Valley that discharge directly into the sea accounted for 10% of the salt load at 312,000 metric tons per year from 2004-2014.

The salt in the inflows accumulates in the Salton Sea with time, resulting in continually increasing salinity in the remaining water. Key features of the Salton Sea salinity include the following:

- Salinity in the Sea has increased steadily since 2004 to an average of 55.7 g/L total dissolved solids (TDS) in 2014 (Figure 2).
- Average salinity concentrations over the past decade were lowest in the Whitewater River/CSVC, followed by the Alamo River and New River, which averaged 1.2, 2.1, and 2.7 g/L TDS, respectively.
- Annual average salt load to the Sea was about 3.2 million metric tons/year. The Alamo River contributed 47%, the New River 42%, 2% was from the Whitewater River/CVSC and 10% was from other drains and small watercourses.

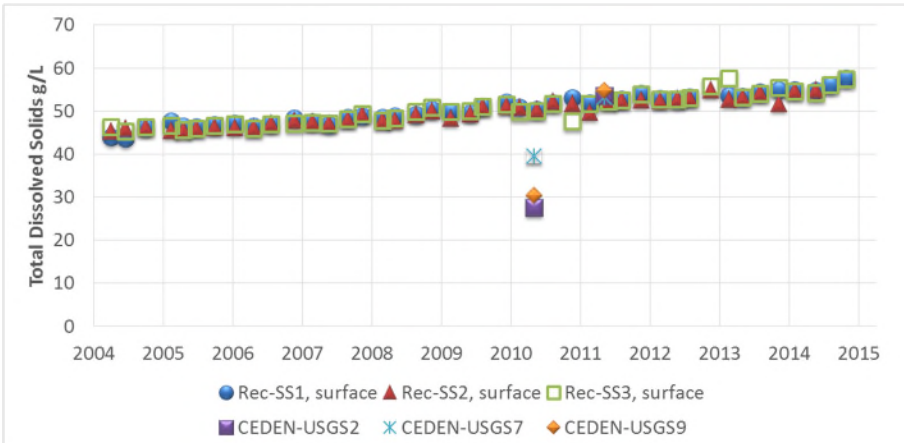

Figure 2: Salinity as total dissolved solids (TDS; g/L or ppt) of Salton Sea Stations. CEDEN data stations and Reclamation (Rec) stations.

2.4 Nutrients and Other Water Quality Parameters

Excess nutrients in the Salton Sea are a major issue affecting many physical and biological processes. Two important nutrients are nitrogen (as total N) and phosphorus (as total P). In excess amounts, nutrients stimulate exponential algal growth. Algal respiration and decay reduces oxygen in the water to levels toxic for fish. This process is known as eutrophication. Untreated wastewater was a significant portion of flows from Mexico into the New River and delivered nutrients to the sea until 2007 when wastewater treatment improved in Mexico and was routed away from the New River (DWR and DFG 2011). Although reduced in volume, partially treated wastewater remains a part of the New River flow. Fertilizer application in the Salton Sea watershed is also a significant contributor of nutrients, and nutrient levels remain high in the Sea and rivers.

Key features of nutrient loading in the Sea are as follows:

- Annual average P load (mostly as ortho-phosphorus) to the Sea was about 1,130 metric tons, with the New and Alamo Rivers contributing 43% and 42%, respectively, and the Whitewater River and other drains contributed 7% and 10%, respectively of the Total P load.
- Annual average N load (mostly as ammonia and organic-N) to the Sea was 11,550 metric tons; the Alamo River added 47%, the New River contributed 36%, the Whitewater River contributed 7% and other drains accounted for 10%.

Dissolved oxygen depletion at depth coincided with stratification. During the summer months the average DO concentration was 2.15 mg/L, less than the threshold of 4 mg/L recommended for aquatic organism survival. Tilapia can survive in oxygen concentrations less than 1 mg/L and can migrate upward when oxygen is low (DWR and DFG 2011). Thus, low dissolved oxygen concentrations are a bigger concern for relatively immobile benthic organisms that form the basis of the food web (DWR and DFG 2011; Anderson et al 2009). As algae photosynthesize during the day, oxygen saturates the epilimnion (upper layer). The abundance of nutrients, warm temperatures, and an available carbon source encourages rapid, short-lived algal growth. The warm summer temperatures and algal production increases oxygen depletion during the night when algal respiration and algal decay demands oxygen in already low DO water. When oxygen depletion occurs along the entire depth profile, it typically corresponds to an algal bloom and often immense fish kills.

2.5 Selenium

Selenium (Se) is a naturally occurring element found in seleniferous rocks in the Colorado River Valley. Selenium enters waterways as selenate via weathering and erosion of rock and soil in the region. It is an essential nutrient for organisms but becomes toxic at elevated concentrations that are very near ideal concentrations.

The biogeochemistry of selenium in aquatic systems is complex and controlled by several factors. Similar to sulfur, selenium can exist in four different oxidation states (6 species): organo-Se (Se-II), elemental selenium (Se 0), selenite (Se 4+ or SeO_3 2-), and selenate (Se 6+ or SeO4 2-; Presser and Luoma 2010). Under reducing conditions that occur frequently in the Sea, selenium can be converted to elemental Se, which is relatively insoluble and settles out of the water column.

Conditions related to Se in the Salton Sea and inflows can be summarized as follows:

- Dissolved selenium (Se) levels in the Sea water column are considered to be below the level of concern for aquatic life within the Sea, generally below 2 micrograms per liter (µg/L),
- Total Se measured in sediment samples ranged from 1.5-11.8 µg/g and averaged 5.37 µg/g between 2005 and 2014 and are a concern for toxicity. Sediment-bound Se may also leach out when aquatic chemistry changes.
- Higher concentrations of dissolved Se were found in the source Rivers, averaging 6 and 6.8 µg/L at the New and Alamo Rivers, respectively.

2.6 Inflow Projections

Hydrology is projected based on the best available estimates of inflows in Chapter 4 of the Benchmark 2 report. Historical data were used as a baseline for future inflows predicted for the Salton Sea by the Salton Sea Accounting Model (SSAM). The reduction of flows due to Mexicali's plans to reclaim treated effluent and agriculture drainage that would typically flow from the New River into the Sea were identified as the major causes for declining inflows. This analysis focused on the transition period of 2014-2025 which includes the end of Quantification Settlement Agreement (QSA) mitigation flows in 2018. Less flow from Mexico, agricultural efficiency, urban water demand, climate change, drought and less groundwater inflow are additional factors that will contribute to lower elevations at the Sea. The future inflows to the Sea are discussed as components of flow from the Imperial Valley, Coachella Valley and Mexico.

Under the most recent projected inflows to the Sea by Imperial Irrigation District (IID), two conditions were examined utilizing a similar methodology to previous reports: California Environmental Quality Act (CEQA) conditions and variability conditions. CEQA conditions yielded higher estimated annual inflows that were based solely on known inflows, and the effects of the QSA transfer agreements. Under variability conditions, anticipated conditions and projects will result in a somewhat lower inflow estimate; the result of many factors as discussed in this document. Since the future contains uncertainty regarding water supply and availability, these two conditions provide a range of possibilities for future inflows. The range of estimated flows is useful for engineering design considerations.

- Imperial Valley will contribute 558,000 – 667,000 acre feet/year (AFY), or 76 - 78% of the total inflow.
- Coachella Valley flows to the Sea will be an estimated 61,000 – 98,000 AFY or 9 - 11% of total inflow. This estimate is much lower

than previous estimates because Coachella Valley Water District (CVWD) intends to recycle more water, desalinate and use more water for recharging aquifers, and comply with new water conservation mandates due to the drought.

- Flows from Mexico will average 40,390 - 96,834 AFY, contributing about 6 - 11% of total inflow to the Sea. This is due to a 30% reduction in flows relative to 2010 as Mexico intends to reuse its dry weather flows and agricultural water use efficiency increases.
- Groundwater flows to the Sea have not been adequately characterized and contribute a relatively minor quantity of flow.
- Due to the severe and potentially long-term drought, flows from the watershed (minor channels and washes) will be increasingly allocated and decreasing in reliability.
- Therefore the estimated "Other" flow contribution is likely 20,000 AFY or 2-3% of the total inflow.

All estimates of future flows contain a certain amount of uncertainty but will provide a design criteria in order to progress with alternative planning and evaluation. It is still a reasonable assumption that inflows to the Sea can vary by up to 200,000 AFY. Evaporation will be much larger than total inflows by 2020, and the inflows will also need to be used for air quality management and habitat creation. Habitat flows will be returned to the Sea after evaporation and transpiration losses occur.

2.7 Salinity and Elevation Forecasts

Using hydrology inflow projections and current plans for shallow habitat development, anticipated changes in the area of the Sea and in-Sea salinity is evaluated over the 21st century. The US Bureau of Reclamation's Salton Sea Accounting Model (SSAM), originally developed in 2000, was used for this evaluation with several modifications to represent current inflows and bathymetry. Two flow scenarios were considered: baseline and uncertainty, the latter allowing for lower flows (Figure 3). Updated bathymetry data for the Salton Sea was used in this analysis to obtain a more accurate area-volume-depth relationship that is essential for siting future habitat and potential barriers and dikes. The model shows a continued drop in elevation, with a major change in 2018 following the end of mitigation flows to the Sea (Figure 4), and accompanying decreases in area and increasing salinity (Figure 5).

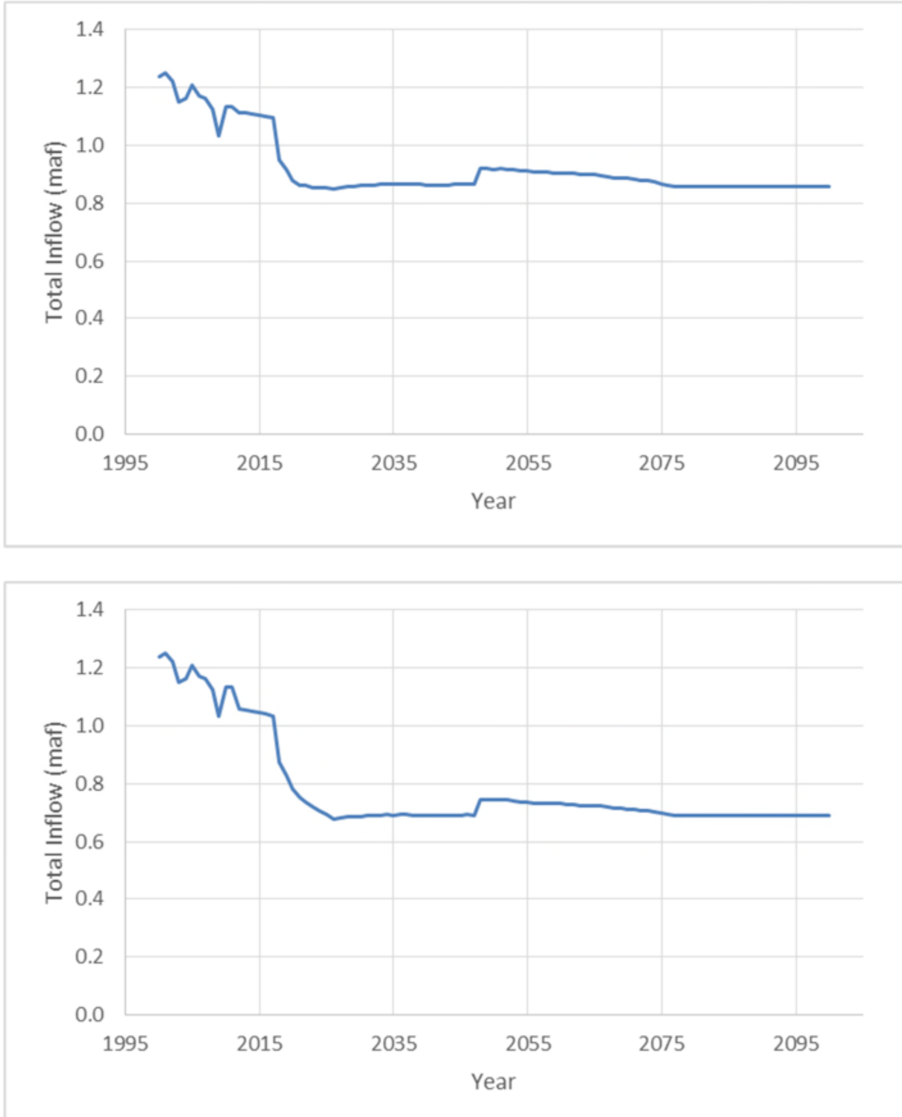

Figure 3: Inflows used in SSAM implementation: baseline flow scenario (top) and uncertainty flow scenario (bottom)

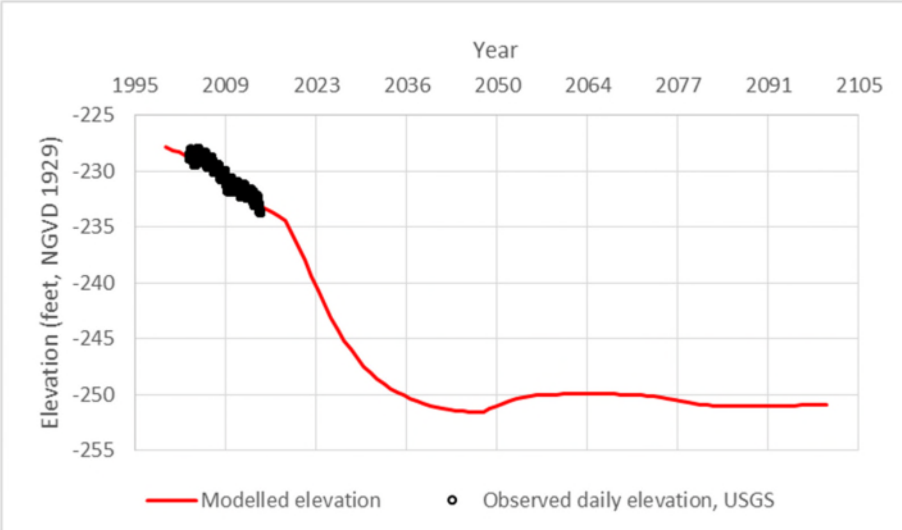

Figure 4: Elevation change over time predicted by the SSAM utilizing implementation: baseline flow scenario.

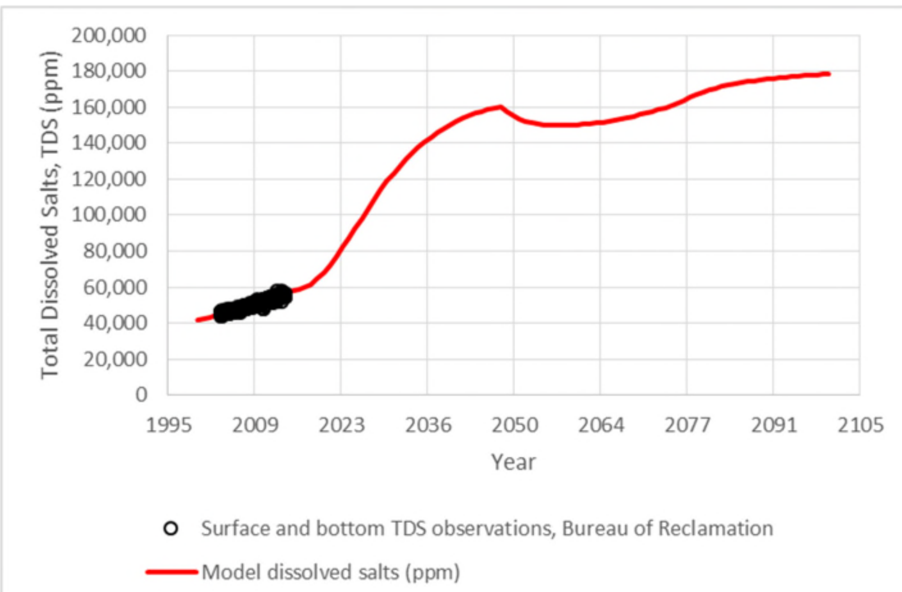

Figure 5: Salinity change over time predicted by the SSAM utilizing implementation: baseline flow scenario.

2.8 Air Quality and Dust Mitigation Review

Air quality conditions and dust mitigation strategies for exposed playa that are essential for any restoration alternative are evaluated in Chapter 6 of the Benchmark 2 report. Significant data disparities exist regarding the extent and variability of Salton Sea playa emissivity (dust-emitting), future emissivity, and dust loading of particulate matter less than 10 microns (PM_{10}) in the region. Exposed playa is expected to increase substantially over the next 15 years (2015-2030), creating a significant health risk that has yet to be fully characterized. The Imperial Irrigation District's JPA Dust Mitigation Plan includes an adaptive management framework to monitor ambient air quality, research and monitoring efforts to identify and map playa surface characteristics related to erosion and emission potential. Pollutants of concern include PM10, particulate matter less than 2.5 microns ($PM_{2.5}$), ozone, hydrogen sulfide, arsenic, Se and others.

IID's JPA Dust Mitigation Plan includes an adaptive management framework to monitor ambient air quality, research and monitoring efforts to identify and map playa surface characteristics related to erosion and emission potential. Pollutants of concern include PM_{10}, $PM_{2.5}$, ozone, hydrogen sulfide, arsenic, selenium and others.

The IID Air Quality Mitigation Program contains four components that contribute toward the implementation of a science-based adaptive management plan to detect, locate, assess and mitigate PM_{10} emissions associated with the Water Transfer Project. Each component of the Air Quality Program will attempt to answer a set of questions or achieve a goal. The **Air Quality and Playa Characterization** component seeks to differentiate the emissions sources, whether they are a direct consequence of the Water Transfer Project or not by analyzing data from an extensive ambient air quality monitoring network. In order to capture intermittent dust events, PM_{10} and $PM_{2.5}$ will be measured with continuous monitors (i.e. Tapered Element Oscillating Microbalance Monitor (TEOM) or a Beta Attenuation Monitor (BAM)) and verified with filter-based federal reference method monitors (i.e. BGI or Partisol). The filters could initially be analyzed for contaminants (i.e. arsenic, selenium, pesticides) at regular intervals to characterize the problem of contaminated dust particle transport (IID 2013). Permanent and portable air quality stations will be used as necessary to document the spatial heterogeneity of dust emissions.

Hydrologic modeling will use the hydrologic analysis from the Water Transfer EIR/EIS and high-resolution bathymetry data to yield the estimated extent and time frame for additional playa exposure. The result will be planning level information about the location of projected playa exposure and ownership information. Research and monitoring will aid the understanding of salt crust formation, vulnerability to erosion and overall emission potential of various salt crust surfaces. The potential sources of PM_{10} emissions include playa salt crusts, sand sheets, beach deposits and soil surfaces. The main focus of research will be assessing the vulnerability of each potential emission source to erosion.

The **Dust Control Measure (DCM) Research and Monitoring** component will test and evaluate DCMs for feasibility and cost-effectiveness. Existing DCMs will be derived from a literature review, modeling studies and screening-level tests. Novel and untested measures will be incorporated into the DCM research via pilot field testing. The performance of DCMs will be monitored at the pilot project scale for overall performance and sensitive parameters such as habitat quality.

Potential DCMs in Imperial County include surface stabilizers, vegetated swales, plant community enhancement, moat and row, water-efficient vegetation, tillage, alternative land use, species conservation habitat and other habitat-based uses (IID 2013).

The **Dust Prevention and Mitigation** component will answer the question: how can dust emissions including from off-highway vehicle (OHV) use be prevented or mitigated? Off-highway vehicles cause considerable surface disturbance and erodibility. An adaptive management framework will be in place to prevent dust emissions from OHVs. Dust mitigation strategies include creating or purchasing off-setting emission reduction credits, similar to a cap-and-trade program and direct emissions reductions at the sea. IID would negotiate with the local air pollution control districts to create a long-term program that would enable the creation or purchase of off-setting PM_{10} emission reduction credits (IID 2013).

Plan Implementation will occur throughout the duration of the Water Transfer Project. In fact, ambient air quality and DCM pilot projects have already begun. IID will coordinate with regulatory agencies and provide periodic updates on the implementation of the Air Quality Program. As of 3013, IID has installed six ambient air quality stations in 2009, playa exposure modeling, playa shoreline monitoring, playa surface characterization, and playa emission characteristics have been underway. Pilot projects including a surface stabilizer product evaluation, shallow flooding at the New River and plant community enhancement at the New River have been completed. In addition, a vegetation swale pilot project is being planned (IID 2013). Remote sensing and advanced satellite-based radar techniques have been employed to characterize active OHV traffic areas on the playa.

2.9 Future Data Needs

Key aspects of the additional data that might be required are divided into three general categories: water quality processes, biological uptake processes, and air emission and dust control processes. The most important areas to focus on include mixing and nutrient dynamics in a shrinking Sea, especially ammonia and hydrogen sulfide production and release, quantification and transport of dust emitted from the exposed playa surfaces, and Se fate, transport, and potential biological uptake.

2.9.1 Water Quality Processes

There is a need to continue the monitoring in the Sea as well as in the new habitats that are created as part of any restoration plan.

For newly created shallow habitat, both saltwater and brackish, an extensive effort at characterization is needed. The most important water quality concerns identified in the SCH final EIS/EIR are salinity, temperature, dissolved oxygen, nutrients, and Se (also a concern in sediment, bird eggs and other biota). These key indicators will be monitored within the SCH habitat in order to determine the effects of various operational scenarios under an adaptive management framework (DWR and CDFW 2013; CNRA 2015). The water quality science panel created by the Salton Sea PEIR process in 2007 identified Se, hydrogen sulfide, water temperature and dissolved oxygen as a potential problem for birds and fish (DWR and DFG 2007). A similar protocol of monitoring and analysis needs to be developed for brackish water and lower salinity habitats, some of which are already in existence.

Monitoring in the Sea needs to be continued so that changes associated with increasing salinity, and reduced area and depth can be evaluated. The annual loading of nutrients, proportional to the volume of the Sea, may increase over time and change the eutrophication characteristics. Numerous gaps in knowledge create uncertainty for restoration. Important areas to focus on include:

- Selenium dynamics (characterization of inorganic/organic, different oxidative states, elemental species and their distributions) and biogeochemical cycling in the Sea, including sediment settling, re-suspension and volatilization
- Projected Se concentrations in brine sink under declining inflows
- Phosphorus in sediment and re-suspension: effect on internal cycling and water column concentrations
- Temperature and dissolved oxygen dynamics related to mixing and the effects on nutrient cycling and ammonia and hydrogen sulfide production.

2.9.2 Biological uptake processes

Because of the terminal character of the Sea, all contaminants that flow into it accumulate in water or sediments, unless there is a volatilization pathway. This last pathway has not been quantified for many contaminants in the Sea, and a conservative assumption is that all inflowing contaminants will continue to add to the sediment and water concentrations over time. Given the ecological importance of the Sea, it is very important to understand the transfer and uptake of the contaminants into the food web, from plankton to fish to bird eggs. To date, the characterization of contaminants in tissues has been limited, and a more systematic approach is needed. A recent US Geological Survey Monitoring and Assessment Plan (MAP) provides a strong foundation for the data needs for the Sea (Case III et al., 2013). The full scope of the MAP is broad, and includes characterization of biological resources (bird, fish, and algae species), water column concentrations, and tissue concentrations. The characterization is focused on the Sea as well as the different created habitats. Some of the key data requirements identified in that report include:

- Algal and zooplankton species composition
- Fish type and abundance
- Endangered desert pupfish abundance in Sea and inflowing waters, as well as created habitats
- Avian use of different habitats, both existing and created
- Selenium transfer into particulate matter and bioaccumulation/ effects in piscivorous birds at the Salton Sea

2.9.3 Air Emission and Dust Control Processes

The changing volume and elevation of the Sea over the next 15 years is expected to result in tens of thousands of acres of newly exposed playa. Managing the emission of PM10 from these areas effectively is a high priority component of any planned restoration. Some of the key data needs associated include:

- Playa surface mineralogy dynamics including crust formation, erodibility and potential to contribute fine particulate matter
- Evaluation and design of multiple dust control measures
- Plant community optimization for dust control
- Water availability and requirements for dust control measures

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3.0 Previous Alternatives for Management of the Salton Sea

A review of past alternatives was conducted and documented in the Salton Sea Funding and Feasibility Action Plan, Benchmark 3: Evaluation of Alternatives with Respect to Existing Conditions. A summary of the material presented in the Benchmark 3 document is provided in this chapter, which specifically focuses on the preferred alternatives previously developed by Salton Sea Authority and the State of California. In addition, although not a full restoration alternative, the State's SCH Project is discussed.

3.1 Introduction

Management of the Salton Sea has been an on-going process occurring over the past twenty plus years. Various organizations, including the SSA and the CA Department of Water Resources, have conducted on-going research into Salton Sea restoration alternatives and their components to determine how well they would perform under current and future inflows. Alternatives are considered with respect to existing hydrologic conditions at the Sea, as of 2014, and projected future hydrology. Research is intended to expect the changing conditions at the sea, and it is intended to inform those who are engaged in planning the restoration and management of the Sea. The Salton Sea Funding and Feasibility Action Plan Benchmark 3 report provides an overview of previous alternatives that have been considered for management or restoration of the Salton Sea. Some of the most important of these alternatives are discussed in this chapter.

3.2 Salton Sea Authority Preferred Restoration Plan, 2006

In 2006, the Salton Sea Authority (The Authority) formulated a plan to provide a restored Sea along the current shoreline that could stimulate the development and improve the economic conditions for the Tribe and Imperial and Riverside counties. The plan involved five essential components: in-Sea barrier and circulation channels; water treatment facilities; habitat enhancement features; Colorado River water storage; and park, open space, and wildlife areas. Clear objectives in the plan are not placed in order of priority, but they include both human and ecological concerns.

Figure 6: Salton Sea Authority Preferred Restoration Plan, 2006.

3.2.1 Restoration Objectives of the Authority

The Authority developed a combined, multi-purpose revitalization/ restoration project with six clear objectives: (1) restoring the Sea as a nationally important wildlife refuge, (2) maintaining the Sea as a vital link along the international Pacific Flyway, (3) preserving local tribal heritage and cultural values associated with the Sea, (4) reducing odor and other water and air quality problems, (5) reestablishing the Sea as a tourist destination and recreational playground, and (6) revitalizing the Sea as a local economic development engine.

The Authority's proposed project design was also being considered as an alternative in the separate Salton Sea restoration project feasibility studies that were conducted concurrently by the Resources Agency of the State of California (the Agency) and Reclamation. In this regard, the Authority's project objective was to achieve the habitat restoration and air and water quality goals set out in State and Federal legislation, while simultaneously meeting the needs of the residents of the region, local property owners, and civic leaders in the Imperial, Coachella and Mexicali Valleys. These interests expressed a desire for a large, sustainable recreational lake with reduced odor which could serve as a catalyst for regional economic development.

In 2006, the Authority proposed a "Large Lake" program to address the following issues: harmful nutrient buildups, air quality, and funding. In relation to harmful buildups of nutrients, the Authority's program was designed to be essentially self-mitigating, and it would allow for Selenium sequestration in sediments to act as a control on the bioavailability of naturally occurring contaminants in the Sea (a mechanism that has previously prevented selenium-related wildlife impacts at the Sea). In relation to air quality issues, the current lakebed in the 60,000-acre salt deposit area in the south basin in the Authority project design would be covered with a thick, hard-surface sodium-chloride salt deposit that was designed to control dust emissions as the water level recedes in that basin. However, other dust control methods identified by the State and posted on their website were also considered for use in selected areas. Finally, in relation to funding, it was proposed that critical components in the Authority project design could be heavily financed with local funds, and it was proposed that all project components can be completed within 20 years.

3.2.2 Conceptual Plan

The basic conceptual project design for the Authority's Plan that was outlined in 2006 is illustrated below. This locally-preferred project design included the following essential components:

- **In-Sea Barrier & Circulation Channels** were proposed to separate the Sea into two separate bodies (an outer "two lake" water system and multiple habitat complex areas, salt deposit area, and brine pool) with a channel for circulating water between the two lakes in the outer water system.
- **Water Treatment Facilities** were proposed to improve both the existing water in the Sea and the inflow water as necessary to lessen or greatly reduce the Sea's eutrophication problem and to improve the clarity and quality of the water in both lakes to meet the recreational water quality standards set by the Regional Water Quality Control Board.
- **Habitat Enhancement Features** were proposed to meet the needs of fish and bird populations consistent with State laws that required the "maximum feasible attainment" of specified ecosystem restoration goals.
- **A Colorado River Water Storage Reservoir** was proposed to enable the water agency to store Colorado River water to have greater flexibility for balancing supply and demand of Colorado River water use.
- **Park, Open Space, and Wildlife Areas** including the Salton Sea State Recreation Area and the Sonny Bono National Wildlife Refuge would be preserved although it was envisioned that the boundaries of the Refuge would be modified to match the newly created habitat features.

In addition to the previously outlined features that were designed to address water quality problems and the potential air quality concerns associated with exposed lakebed, a plan for development of areas around the Sea was prepared. The plan was prepared to guide creation of "Seaside Villages" and the build-out of over 250,000 new homes with accompanying entertainment, recreational, retail and business establishments within specified areas of the Authority's 300,000-acre planning and financing district around the Sea.

The signature feature of the Authority's project was an approximately 33.5-mile-long, rock-fill, in-Sea barrier. This engineered structure would have permanently separated the present 360-sq.-mile Sea into two separate water bodies, namely:

- **An outer 180-sq.-mile lake water system**. This outer water body was proposed to provide a relatively stable elevation so the shorelines of the two newly created lakes and the interconnecting boating channel on the west shore would remain unchanged as long-term inflows decrease. According to the plan, the water in the two joint-use recreational/habitat lakes would be treated as required and circulated to maintain recreational water-quality standards. The larger northern salt water lake (140 sq. miles) would be maintained at ocean-like salinity (35,000 mg/L salt), and the smaller southern estuary lake (40 sq.-miles) would be held at a lower salinity (20,000 mg/L salt). The south lake elevation (-228' msl) would be held at about 2 feet above the north lake (-230' msl) since a slight hydraulic gradient would be needed for circulating the water in both lakes in a continuous counter clockwise loop for blending and aeration. An earthen channel would be excavated along the east shore of the south basin to convey north lake water to the south lake and to support the 12,000-acre saline habitat complex in the south basin. Furthermore, the Authority proposed a pumping plant that would be built at the end of this channel to lift the extracted and treated north lake water into the south lake to blend with the Alamo and New River inflows.

- **An inner 180-sq.mile habitat and salt deposit area in the south end of the current Sea**. According to the plan proposed in 2004, the wetted surface area of this inner water body would shrink, and its elevation was predicted to decline as inflows decrease over time. A salt-purge stream from the north lake was designed to discharge into the inner basin after being used in the saline habitat complex. The purpose of this purge stream was to balance salt inflows and outflows in the outer lake-water system. By sending salt to the inner basin in this manner, the two lakes could be held at relatively constant and controlled salinity levels. The lower inner basin would also serve as an overflow basin in the event of storm activity. According to previous statements by the Authority, salt pond pilot projects conducted at the Salton Sea indicate that if the shoreline inside the inner basin recedes, hard-surface salt deposits 12-to-24 inches thick would form on top of the old lakebed. The cement-like salt deposits would prevent blowing dust, but other air-quality mitigation techniques would also be used if needed. Furthermore, a permanent hypersaline brine pool was expected to eventually form in the lower depths.

3.2.3 Water Treatment Facilities

The Authority anticipated that water treatment facilities would include a bottom drain and treatment system for the removal and destruction of hydrogen sulfide, ammonia, and other contaminants from the 50-foot-deep saltwater lake. A second treatment plant was planned to remove phosphorus and other contaminants from the Alamo River inflows. The lake-water circulation system of the plan was designed to change out the larger saltwater lake's water volume every four to five years. The circulation system would also serve to increase oxygen levels and avoid stagnation in the saltwater lake, and the circulation system would reduce selenium levels in the southern estuary lake. These measures would also improve overall water quality and fish habitat and greatly reduce odors.

3.2.4 Whitewater, New and Alamo Rivers Wetlands

The Authority's plan included water treatment wetlands along the New and Alamo Rivers in Imperial County. Similar wetlands were planned on Torres Martinez tribal land using water from the Whitewater River. These wetlands coupled with a stable, better quality lake should significantly improve conditions for the Tribe and stimulate economic opportunities. Although designed primarily for improving water quality (i.e., removing silt, nitrogen and phosphorus and increasing dissolved oxygen levels), these wetlands also provide wildlife habitat. The value of this type habitat has been questioned because of the potential for bioaccumulation of selenium, although pilot wetlands along the New River have not shown significant bioaccumulation in the limited data available.

3.2.5 Habitat Enhancement Features

The Authority has stated that the greatest ecosystem benefit of its conceptual project design is the retention of a 90,000-acre, 50-foot-deep lake that would be restored to ocean-like salinity (35 g/L salt) and would be managed to maintain habitat-safe water quality. This restored saltwater lake would enhance the existing fishery and thus reestablish an abundant food source for the fish-eating birds that have historically resided at the Sea or migrated along the Pacific Flyway. The Authority project design also includes a 12,000-acre saline habitat complex (SHC) located in the south and a 1,250-acre estuarine habitat complex near the mouth of the Whitewater River. In addition, half of the 26,000-acre estuary lake located in the south basin and a 6,000-acre area in front of the barrier across the north lake would be designated "habitat zones" in which motorized watercraft would be prohibited.

3.2.6 Colorado River Water Storage Reservoir

At the time of the Authority's planning process, the IID was considering a storage reservoir within the district's water system. A storage reservoir incorporated into the Authority Plan was designed to address this need. This facility would have been created by constructing a second barrier in 30-feet of water outside the initial barrier. The enclosed 11,000-acre area would create a 250,000 AF storage reservoir creating wildlife habitat. In addition, the reservoir would provide air quality mitigation by covering areas that would otherwise have exposed sediments.

3.2.7 Park, Open Space, and Wildlife Areas

The Authority's plan accounts for the preservation of park, open space, and wildlife areas. These areas include the following: Salton Sea State Recreation Area (SRA, commonly referred to as the State Park), and the Sonny Bono National Wildlife Refuge. While the Wildlife Refuge will be preserved, it is envisioned that the boundaries of the Refuge would have to be modified to match the newly created habitat features. The SRA provides camping, fishing and boating opportunities and the Wildlife Refuge provides bird watching opportunities. With five campgrounds totaling approximately 1,600 campsites, the SRA provides more public access points than any other single shoreline access area. The estimated historic peak seasonal use of the SRA was approximately 660,000 visitors in 1961-62, and the last three years reveal evidence of a resurgence in public attendance, with a doubling of the total number of visitors in that period to 275,000. With improved water quality and habitat values at the Salton Sea, the recreation experience at both the SRA and the Wildlife Refuge is expected to be significantly improved.

3.2.8 Master Plan for Planning District around the Sea

In December 2005, the Authority released a Master Development Plan for the 300,000-acre planning district surrounding the Sea. Conceptual plans for creating separate and distinct seaside villages that incorporate smart growth and sustainable development concepts have been developed. This plan could accommodate 250,000 new homes with associated entertainment, recreational, retail and business establishments being built over the next 75 years on 78,000 acres (less than 25% of the 300,000-acre planning district). Under this plan, over 50% of the land around the Sea would remain as habitat, parks and open space; and 20% would remain as farmland.

Historical water quality data from the Alamo and New River Basins were compiled and summarized for this study. Sources of data included state and federal government agencies, international agencies, and universities. Data were compiled for several key locations in each river basin. These locations included multiple sites on each of the rivers, major agricultural drains, and the Salton Sea itself. For each of these sites, available data for nutrients, suspended solids, or key parameters of concern (e.g., total coliforms and selenium) were compiled. A more detailed discussion of the historical data collected from the rivers and agricultural drains can be accessed in Benchmark 3.

Historical water quality data collected within the Salton Sea and the Alamo, New and Whitewater Rivers were compiled from USGS's NWIS database, the

Imperial Irrigation District (IID), the Bureau of Reclamation Salton Sea website, and the State Water Resources Control Board's CEDEN website. The CEDEN website contained water quality data collected as part of the Surface Water Ambient Monitoring Program (SWAMP) that assesses water quality in California's surface waters to fulfill the requirements of the federal Clean Water Act, i.e. TMDL development. The period of record and number of analysis varied depending on the parameter. The following parameters were consistently analyzed at the Sea: total nitrogen, total phosphorus and selenium. Temperature, dissolved oxygen and total suspended solids (TSS) and coliform data are also examined for the Salton Sea.

The majority of the historical water quality data for the New and Alamo Rivers came from the Bureau of Reclamation and the SWRCB's CEDEN website. The Reclamation sampling sites are in close proximity to the USGS gage site near the outlet to the Sea. The USGS NWIS database included two sites on the New River: the international boundary and near Westmorland, two sites on the Alamo River: Drop 3 near Calipatria and near Niland, and one site on the Whitewater River near Mecca.

Data were obtained from the Imperial Irrigation District (IID) in several electronic databases (Excel spreadsheets). The IID data were collected from agricultural drains in the area on a monthly basis from 2004-2014. The parameters of interest included in this data set were the following: total N, total P, and TSS. In 2005 water quality data on suspended solids, nutrients, coliforms, and selenium, were analyzed at river, drain, and pilot wetland stations in the Imperial Valley. The results of the synoptic study are presented for the New River and drain stations.

More recent data from the Alamo River at the international border, Drop 3, Niland, numerous agricultural drains and up to 5 USGS sampling locations within the Salton Sea were obtained from the State Water Resources Control Board's CEDEN. Data for New River at the international boundary and the outlet, along with major and minor agricultural drains were obtained from CEDEN. Data were also obtained from the Whitewater River, Salt Creek and agricultural drains from CEDEN. Similar to other water quality databases in the region, the period of record and number of analysis varied depending on the parameter. The following parameters were analyzed in this study: total salinity, specific conductivity, total nitrogen, total phosphorus, ortho-P, dissolved selenium and total suspended solids (TSS). Several agricultural drains located along the New and Alamo Rivers between the international boundary and outlet were also sampled in 2002, 2010 and salinity, selenium and specific conductivity in 2012.

A consistent set of data collected on a monthly basis from 2004 to 2014 was provided by the Bureau of Reclamation Salton Sea website (http://www.usbr.gov/lc/region/programs/saltonsea.html). Some of the measured constituents include salinity (TDS and specific conductivity), TSS, selenium, nitrogen, and phosphorus.

3.3 State Preferred Alternative, 2007

3.3.1 Preferred Alternative

Eight alternatives were evaluated in the Draft PEIR. The Preferred Alternative closely resembles a previous alternative, Alternative 5, but takes aspects from many of the other alternatives that have been evaluated. The Preferred Alternative, shown below, includes Saline Habitat Complex in the northern and southern seabed, a Marine Sea that extends around the northern shoreline from San Felipe Creek to Bombay Beach in a “horseshoe” shape, Air Quality Management facilities to reduce particulate emissions from the exposed playa, brine sink for discharge of salts, Sedimentation/Distribution facilities, and Early Start Habitat to provide habitat prior to construction of the habitat components. The Preferred Alternative also could be configured to accommodate future geothermal development. These components are described below.

3.3.2 Saline Habitat Complex (SHC)

Bordering parts of the Marine Sea and the exposed playa will be a Saline Habitat Complex to support indigenous food webs present in the area. Excavated areas of up to 15 feet in depth would be incorporated to increase habitat diversity and provide shelter for fish and invertebrates, as shown in the figure below. To reduce vegetation growth, selenium ecorisk, and vector populations the salinity in the complex will range from 20,000 mg/L to 200,000 mg/L. Water supplied would come from the New, Alamo and Whitewater rivers plus water recycled from the brine sink or upgradient Saline Habitat Complex cells to achieve a minimum salinity of 20,000 mg/L. The first rows of the eastern and western southern Saline Habitat Complex would serve as a mixing zone for the inflows and saline water and would be maintained at a salinity of 20,000 to 30,000 mg/L. Berms would be constructed of suitable earthfill materials excavated from the seabed with 3:1 side slopes. A 20-foot wide gravel road on top of each Berm would allow access for maintenance. Rock slope protection would be placed on the water side of the Berm. Water depths would be less than 6 feet (2 meters). Berms could not be constructed until the brine sink (residual Salton Sea) recedes to an elevation below the Berm location

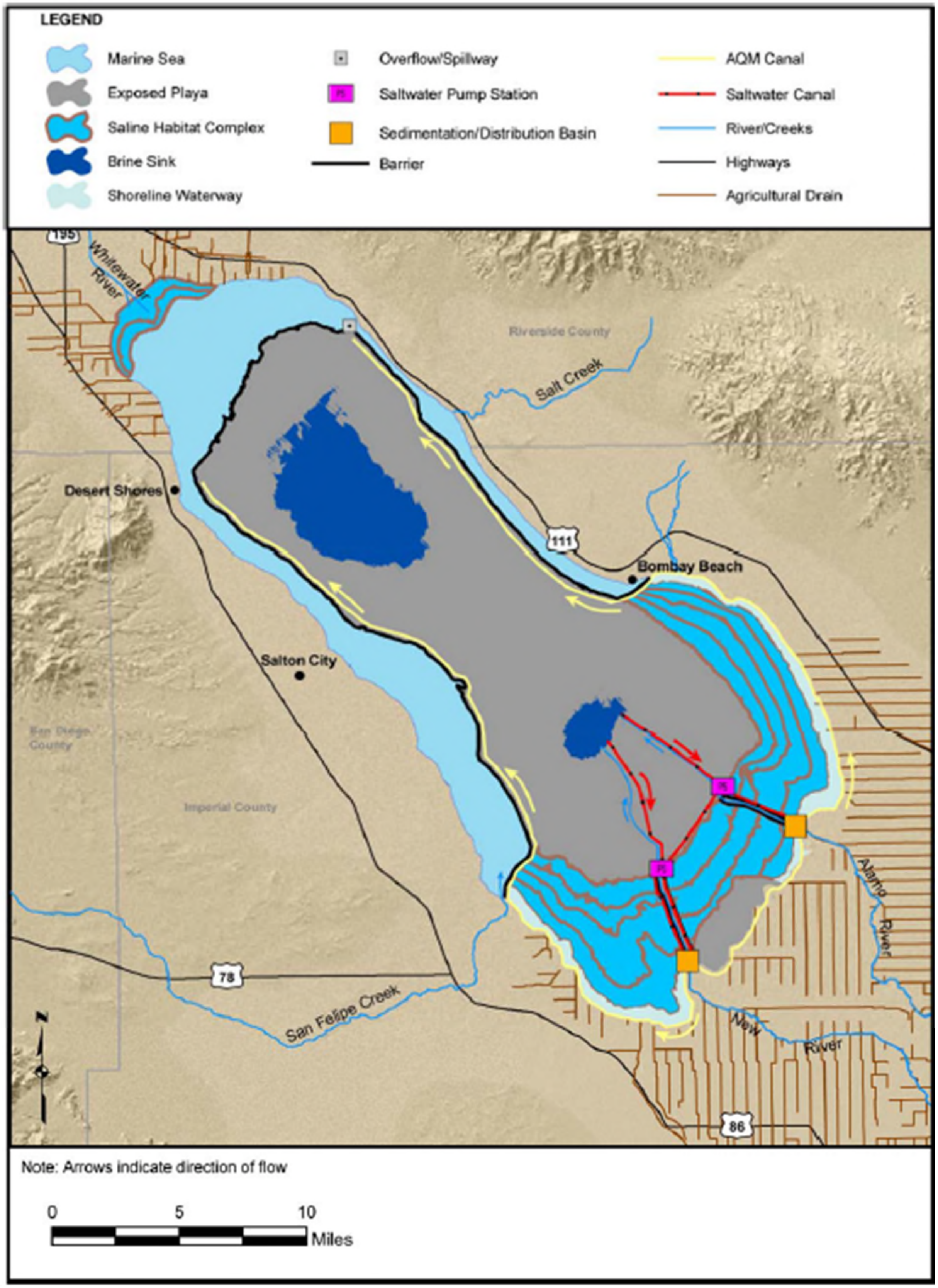

Figure 7: State's Preferred Alternative Layout.

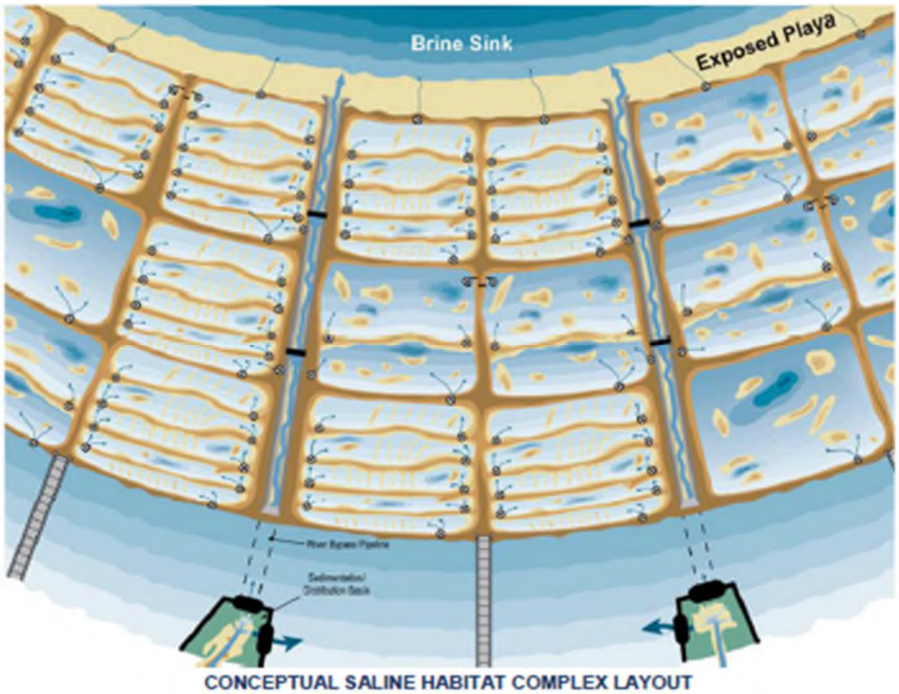

Figure 8: Conceptual Saline Habitat Complex Layout

3.3.3 Marine Sea

A Marine Sea would be formed through the construction of a Barrier. The Marine Sea would stabilize at a surface water elevation of -230 feet msl with salinity levels between 30,000 mg/L and 40,000 mg/L. Air quality Management Canals, Sedimentation/Distribution Basins, and Early Start Habitat would be constructed between the -228 and -230 foot msl contours and would avoid conflicts with existing land uses along the shoreline. Sources of inflows would include the Whitewater River, Coachella Valley drains, Salt Creek, San Felipe Creek, and local drainages. Flows from the New and Alamo rivers would be blended in a large Air Quality Management Canal and diverted into the Saline Habitat Complex and the southeastern and southwestern portions of Marine Sea. The portion of the Air Quality Management Canal located between the Sedimentation/Distribution Basins and Marine Sea would be located along the shoreline of the Saline Habitat Complex and would be siphoned under major drainages and agricultural drains. Air Quality Management Canals would continue on the interior side of the Barrier where the Marine Sea is located. Flows from the Marine Sea would be spilled to the brine sink to maintain salinity and elevation control.

The water depth would be less than 12 meters (39 feet), but additional data should be collected and the maximum water depth should be re-evaluated prior to final design in project-level analysis. The barrier would be constructed of rock with a seepage barrier on the upstream base. The Barrier would be up to 47 feet above the existing seabed and up to a half-mile wide at the base. The final slope of the Barrier would be 10:1 on the Marine side and 15:1 on the down gradient side, and it would need to comply with DWR, Division of Safety of Dams regulations. The barrier would be constructed using barges, and would need to be constructed before the brine sink recedes. Efficient methods of construction are still in need of evaluation.

3.3.4 Sedimentation/Distribution Basins

Inflows from the New and Alamo rivers would be captured in two 200-acre Sedimentation/Distribution Basins to divert desilted river water into one of Several Air Quality Management Canals or bypass flows into the brine sink. The unlined Sedimentation/Distribution Basins would be excavated along the shoreline and would be located from -228 to -230 feet msl. Water depths would be about 6 feet. Sediment collected in the basins would be periodically dredged and flushed into the brine sink.

3.3.5 Air Quality Management

For the purposes of the PEIR and the Preferred Alternative, assumptions were used to define Air Quality Management components:

- 30 percent of the total exposed playa would be non-emissive and require no actions;
- 20 percent of the exposed playa would use management options that do not require freshwater supplies, such as Brine Stabilization, sand fences, or chemical stabilizers; and
- 50 percent of the exposed playa would use water efficient vegetation that is irrigated with a portion of the inflows to the Salton Sea.

To control dust emission, Air Quality Management Canals could be used to convey water from the Sedimentation/Distribution Basins to a series of 2-square mile units on the exposed playa that would include water filtration and chemical treatment units. The drip irrigators would be buried to reduce potential for selenium toxicity to wildlife from the ponded water, and facilities would be included in each unit to increase the salinity of the water to 10,000 mg/L, if needed. Drains would be constructed under the irrigated area and drainage water would be conveyed to the brine sink. Construction of the irrigation system would require excavations up to 8 feet deep for trenches throughout the exposed playa. Salt bush, or similar vegetation, would be planted every 5 feet apart in rows that would be separated by 10 feet.

3.3.6 Brine Sink

The brine sink would provide the repository necessary to store excess salts, water discharged from the Saline Habitat Complex; Marine Sea; and Air Quality Management areas, and excess inflows. The elevation would fluctuate seasonally based upon the patterns of these tributary flows. During project-level analyses, partitioning of the brine sink could be considered to provide another area with salinities of less than 200,000 mg/L that could support invertebrates and provide additional habitat on the seabed.

3.3.7 Early Start Habitat

An Early Start Habitat would include 2,000 acres of shallow saline habitat for birds. Early Start Habitat was assumed to be located at elevations between -228 and -232 feet msl and could either be a permanent or temporary feature to be eliminated or assimilated as other components are constructed. The Early Start Habitat area would be located along the southern shoreline because the flat slope of the seabed would provide a stable source of inflows into the Early Start Habitat. Saline water from the Salton Sea would be pumped into the cells to be mixed with freshwater from the drains to provide salinity between 20,000 and 60,000 mg/L.

The area would be divided into cells with Berms excavated from seabed materials. Average water depths within each cell would be less than four feet, although deep holes located away from the Berms may extend to 15-foot depths. Specific design and testing criteria would be developed in a project-level analysis.

3.3.8 Land Ownership Assumptions

The Preferred Alternative assumes that easements or deeds would be obtained for the entire seabed below elevation -228 feet msl to allow construction and operations and maintenance activities. If other land uses extend into the seabed, the Preferred Alternative would need to be modified in project-level analyses. For example, if exposed lands were to be converted to cultivated agriculture to an elevation of -235 feet msl, either the components would need to be constructed at lower elevations or displacement dikes would be required to protect the agricultural land.

3.3.9 Implementing Entities Assumptions

The Preferred Alternative was defined and evaluated as if one entity or group of entities implemented the program in a uniform manner. However, the State acknowledged that it would be possible for several entities to implement facilities under separate programs with some level of coordination. For example, facilities located in the northern and southern area of the seabed could be implemented by separate entities with coordinated operations for conveyance of inflows. As another example, separate entities could implement components with different functions, such as conveyance, Air Quality Management, Marine Seas, and/or Saline Habitat Complex.

3.3.10 Construction Materials Assumptions

For the purposes of the PEIR, development of new rock sources or transportation facilities are not considered part of the Preferred Alternative. For stabilizing components of the Barrier Design rocks or boulders between 1 to 5 feet in diameter are ideal. This rock size was not found to be available in large quantities at existing quarries during the preparation of this PEIR. However, the Preferred Alternative assumption is that this rock would be provided from a permitted quarry and transported to within 10 miles of the shoreline by methods other than trucks. Gravel would also be necessary for the road needed on top of the Berms and Barriers.

3.4 Species Conservation Habitat

Although not a full Salton Sea management option, the SCH project was the first major program developed by the State following completion of their environmental planning process.

In the Frequently Asked Questions (FAQ) section of their website, written in August of 2011, the State of California defines the SCH. “The species conservation Habitat Project (SCH Project) is a State project that will be constructed at the Salton Sea to implement conservation measures necessary to protect the fish and wildlife species dependent upon the Sea. Up to 3,770 acres of shallow water habitat ponds may be constructed depending upon funding availability.” The SCH Project was developed under the authorization of California Fish and Game Code, Section 2932, which established the Salton Sea Restoration Fund.

The Species Conservation Habitat project is different from previously discussed restoration alternatives, as it is a proof-of-concept project for creating habitat ponds on playa as the Sea recedes. A list of six Alternatives was examined before the Preferred Alternative, Alternative 3, was selected. Three of the Alternatives cited the Alamo River as a potential location, and the other Alternatives cited the New River as a potential location. Some of the Alternatives would use pumped diversion while others would use gravity diversion, and some of the alternatives included Cascading Ponds. The Preferred Alternative, discussed below, will be located in the New River and implement a combination of pumped diversion with cascading ponds.

The California Department of Fish and Wildlife (DFW), on behalf of the California Natural Resources Agency, proposed to construct and operate the SCH Project, which would restore shallow water habitat lost due to the Salton

Sea's ever-increasing salinity and reduced area as the Sea recedes. The SCH ponds would use available land at elevations less than -228 feet mean sea level (msl) (the former Sea level in June 2005).

The SCH Preferred Alternative would use the large bay to the northeast of the New River (East New), the shoreline to the southwest (West New), and the shoreline continuing to the west (Far West New). Cascading ponds would be attached to each of the pond units, and the ponds would be constructed with the necessary infrastructure to allow for the management of water into and through the Project area. The newly created habitat would be contained within low-height berms. The water supply for the SCH Project ponds would be a combination of brackish river water and saline water from the Sea, blended to maintain an appropriate salinity range for target biological benefits.

3.4.1 Summary of SCH Alternatives

According to the State, the SCH Project goals are two-fold: (1) develop a range of aquatic habitats that will support fish and piscivorous birds dependent on the Salton Sea; and (2) develop and refine information needed to manage successfully the SCH Project habitat through an adaptive management process. Here is a brief summary of the alternatives proposed for the SCH:

- **Alternative 1 – New River, Gravity Diversion + Cascading Ponds2:** 3,130 acres of ponds constructed on either side of the New River (East New and West New), upstream gravity diversion of river water, and independent and cascading pond units.
- **Alternative 2 – New River, Pumped Diversion:** 2,670 acres of ponds constructed on either side of the New River (East New, West New, and Far West New), pumped river diversion at the SCH ponds, and independent ponds.
- **Alternative 3 – New River, Pumped Diversion + Cascading Ponds (Preferred Alternative):** 3,770 acres of ponds constructed on either side of the New River (East New, West New, and Far West New), pumped diversion of river water, and independent ponds extended to include Far West New and cascading pond units.
- **Alternative 4 – Alamo River, Gravity Diversion + Cascading Pond:** 2,290 acres of ponds constructed on the north side of the Alamo River (Morton Bay), gravity river diversion upstream of the SCH ponds, with independent ponds and a cascading pond unit.
- **Alternative 5 – Alamo River, Pumped Diversion:** 2,080 acres of ponds constructed on the north side of the Alamo River (Morton Bay

and Wister Beach), pumped river diversion at the SCH ponds, and independent pond units.

- **Alternative 6 – Alamo River, Pumped Diversion + Cascading Ponds:** 2,940 acres of ponds constructed on the north side of the Alamo River (Morton Bay, Wister Beach), pumped river diversion at the SCH ponds with independent and cascading pond units.

The environmentally preferable alternative is the alternative that will promote the national environmental policy as expressed in NEPA (National Environmental Policy Act) section 101. Ordinarily, this designation means the alternative that causes the least damage to the biological and physical environment; the designation also means the alternative that best protects, preserves, and enhances historic, cultural, and natural resources. Additionally, the USEPA's Section 404(b)(1) Guidelines require the Corps to issue a permit only for the LEDPA, which is the most practicable alternative that would result in the least damage to aquatic resources and is not contrary to the public interest. Therefore, the LEDPA will be the Corps' preferred alternative. The Corps has identified Alternative 3, New River, Pumped Diversion + Cascading Ponds as its preferred alternative/LEDPA.

3.4.2 Alternative 3 New River, Pumped Diversion + Cascading Ponds:

Alternative NR-3, identified as Alternative 3 in the EIS/EIR, would construct up to 3,770 acres of ponds on both sides of the New River (East New, West New, and Far West New) and would include pumped diversion of river water and independent ponds extended to include Far West New and cascading pond units. Alternative NR-3 is the applicant's proposed Project and would consist of the following facilities:

- A low-lift pump station on the New River;
- Saline water pump on a structure in the Salton Sea with associated pressurized pipeline;
- Two sedimentation basins adjacent to the river;
- Several independent pond units with interior berms to form individual ponds and cascading ponds that would drain to the Sea;
- Borrow material from pond excavations including borrow swales to create deeper channels;
- An interception ditch to direct flows from agricultural drains; and
- A tailwater return system.

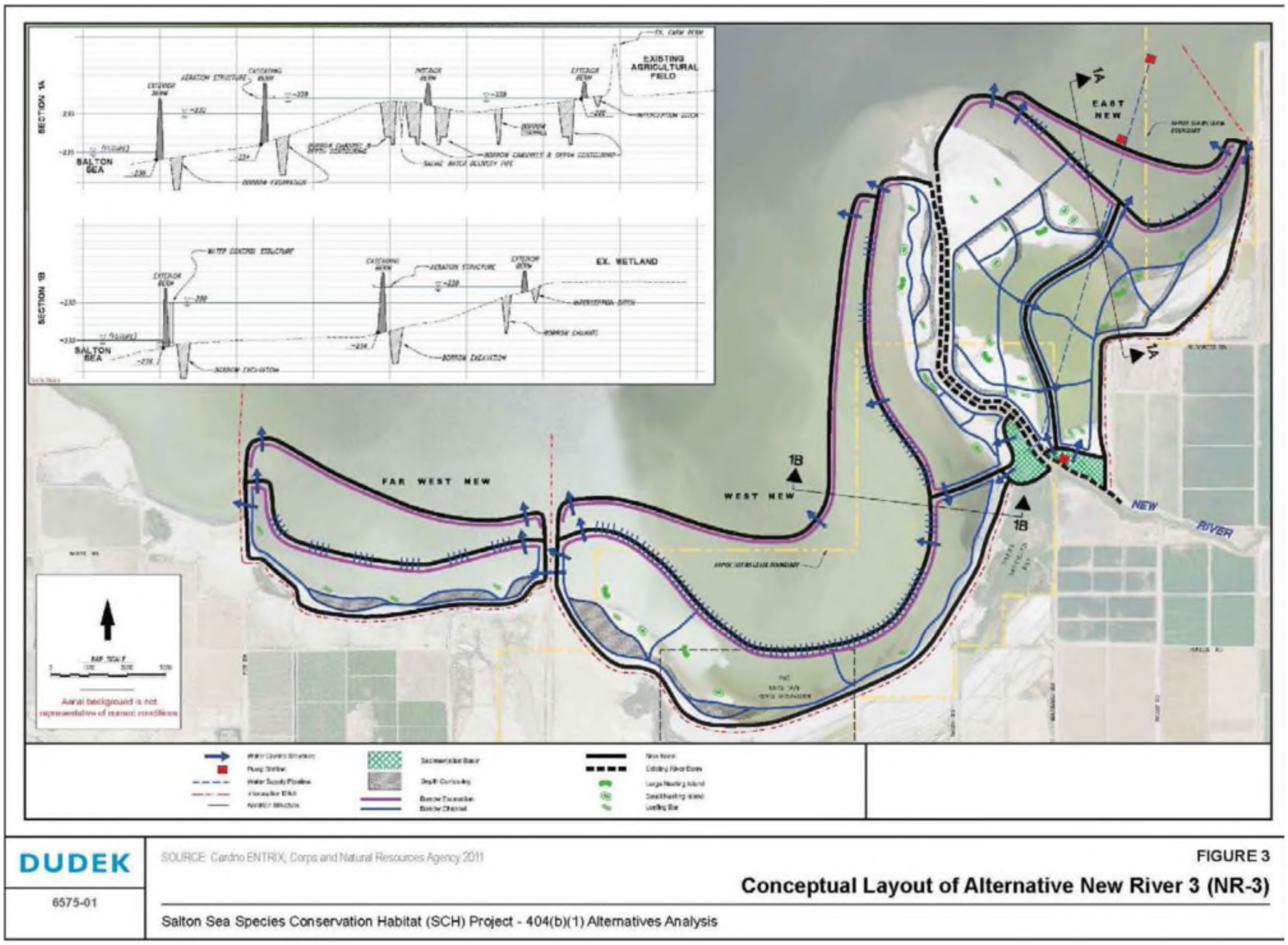

Figure 9: SCH Alternative 3, Preferred Alternative

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4.0 Import and Export Options

The Sea has high salinity and no outlet to remove accumulated salt, a high evaporation rate, and in the near future the Sea will undergo a period of inflow reduction. This task evaluated the potential for transport of water sources that can offset future inflow reductions and provide habitat benefits within and surrounding the Sea. Both small and large improvements will be required to slow or prevent rapid increase in salinity, and support species habitat conservation being planned at Salton Sea. A minimum of 50,000 AFY was identified as the low end of the beneficial supply quantity to the Salton Sea to warrant conceptual level design and cost analysis. Ten potential inflow conveyance alternatives are evaluated including the Santa Ana Regional Interceptor (SARI) Pipeline, the Metropolitan Water District of Southern California (MWD) Concentrate Pipeline, and pipelines to the Gulf of California and the Pacific Ocean.

4.1 Introduction

Benchmark 4 Volume 1 presents an overview of conveyance methods for importing and exporting water from the Salton Sea. In addition, Benchmark 4 Volume 1 also covers In-Sea Partitioning, Salinity and Water Quality Improvements, Air Quality and Dust Mitigation, and Habitat Improvements. When considering methods of conveyance, the following components were discussed: water quantity, water quality, conveyance system and hydraulics, consideration of capital and operational costs, institutional considerations, conceptual plans, cost evaluation, and summary. Benchmark 4 Volume 1 is intended to inform those who are engaged in designing options for the restoration and management of the Sea.

4.2 Inflow Conveyance

The Sea has high salinity and no outlet to remove accumulated salt, a high evaporation rate, and in the near future the Sea will undergo a period of inflow reduction. Due to these reasons, it is important to identify water sources that can offset future inflow reductions and provide habitat benefits within and surrounding the Sea. Both small and large improvements will be required to slow or prevent rapid increase in salinity, and support species habitat conservation being planned at the Salton Sea. A minimum of 50,000 AFY was identified as the low end of the beneficial supply quantity to the

Salton Sea to warrant conceptual level design and cost analysis. Several options that do not achieve this amount are discussed in more general terms. Concerning the issue of inflow conveyance, ten potential inflow conveyance alternatives are discussed in Benchmark 4 Volume 1:

- Santa Ana Regional Interceptor (SARI) Pipeline
- Metropolitan Water District of Southern California (MWD) Concentrate Pipeline
- Yuma Desalting Plant (YDP) Concentrate Pipeline
- Main Outlet Drain Extension (MODE) Pipeline
- Gulf of California
- Pacific Ocean
- Excess Colorado River Water
- Wastewater Treatment Plant (WWTP) Effluent
- Palm Desert Area – WWTP Effluent or Recycled Water Supplies
- Lining of Coachella Valley Stormwater Channel

Figure 10 presents an overview of the water sources evaluated, and other relevant figures for each of the alternatives can be accessed in Benchmark 4 Volume 2. Additionally, each of the alternatives is discussed in Benchmark 4 Volume 2 in terms of the following important aspects: water quantity, water quality, conveyance system and hydraulics, consideration of capital and operational costs, institutional costs. The report also includes a screening level analysis performed using the Modified SSAM for each of the ten inflow conveyance alternatives.

The screening analyses suggest that some of the concepts presented would have only minimal benefits to the full Salton Sea under the projected inflows. However, some of these options could be reviewed again when combined with smaller lake plans.

4.3 Conveyance of Water from the Sea

Due to the lack of an outlet at the Salton Sea, the salt content transferred to the Sea concentrates over time as evaporation occurs. To reduce or maintain salinity at the Salton Sea requires removal of salt content to a disposal location, or it may require evaporation in the Sea's nearby vicinity. Removal of salt is even more critical if one assumes that inflows to the Salton Sea will be reduced starting in 2018, and conveying water from the Sea has been studied to address the drastic rise of salinity that is expected to occur under No Action. A review of previously considered disposal sites and uses of Salton

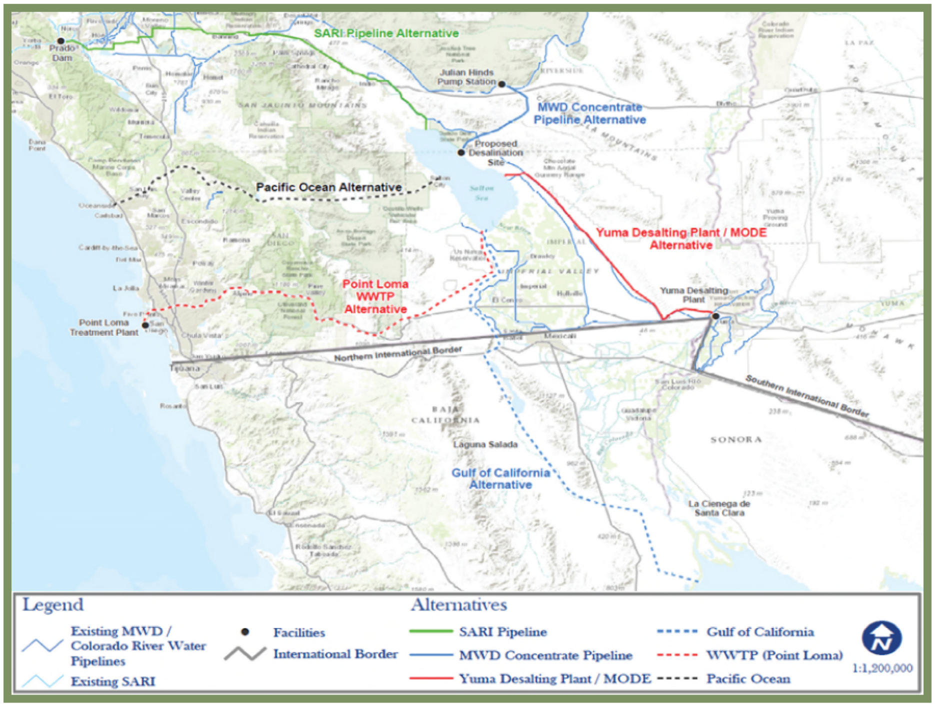

Figure 10: Overview of Alternatives - Inflow to Salton Sea

Sea water was completed and presented in Benchmark 4 Volume 1. In the report, five potential outflow conveyance alternatives are discussed:

- Laguna Salada
- La Cienega de Santa Clara
- Gulf of California
- Palen Dry Lake
- Local Water Use and Evaporative Systems

Figure 16 presents an overview of the conveyance methods evaluated, and other relevant figures for each of the alternatives can be accessed in Benchmark 4 Volume 1. Additionally, each of the alternatives is discussed in terms of the following important aspects: water quantity, water quality, conveyance system and hydraulics, consideration of capital and operational costs, institutional costs. The report also includes a screening level analysis performed using the Modified SSAM for each of the four outflow conveyance alternatives.

4.4 Combined Water Source and Outlet Systems

To both offset inflow reductions and better reduce salt and nutrient accumulations in the Sea, combined solutions which provide inflow sources and outflow destinations have been considered at the Salton Sea. These

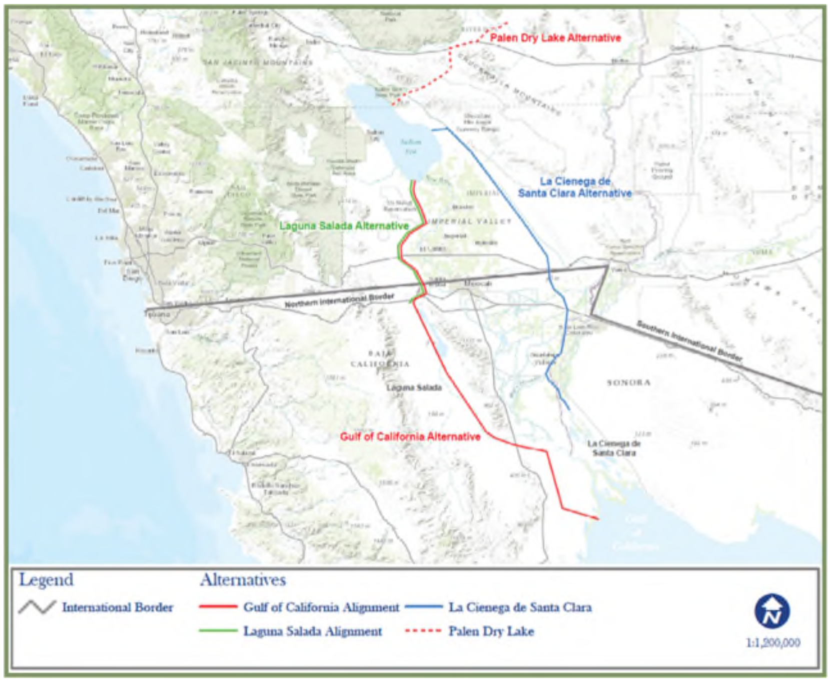

Figure 11: Overview of Alternatives - Outflow from Salton Sea

combined solutions of inflow and outflow conveyance are also discussed in section Benchmark 3 Volume 1. In the report, three potential inflow/outflow conveyance alternatives are discussed:

- Salton Sea to Gulf of California
- Salton Sea to Pacific Ocean
- Local Desalination

Relevant figures for each of the alternatives can be accessed in Benchmark 4 Volume 1. Additionally, each of the alternatives is discussed in terms of the following important aspects: water quantity, water quality, conveyance system and hydraulics, consideration of capital and operational costs, institutional costs. The report also includes a screening level analysis performed using the Modified SSAM for each of the three combined water source and outlet systems.

4.5 Performance of Alternatives

A screening level performance analysis was conducted for each of the alternatives using a modified version of the Salton Sea Accounting Model (Modified SSAM). The SSAM model was modified by Tetra Tech using the latest available bathymetry for the Salton Sea lake bottom. It was also adapted to operate in a user-friendly manner to evaluate various inflow and outflow options.

For each of the alternatives, the Modified SSAM was run for two future inflow scenarios. The baseline case assumes a future inflow of approximately 865,000 AFY by 2077, long after QSA mitigation flows end in 2017. The uncertainty future inflow scenario of about 689,000 AFY was also evaluated. The Modified SSAM and the future inflow assumptions are discussed in Salton Sea Funding and Feasibility Action Plan, Benchmark 2: Review and Update Existing Condition Data.

Running the model for No Action requires inputting a scenario of no pump in or pump out. The figures in this section will show the predicted impacts of No Action in the Modified SSAM, and these predicted impacts will provide a reference point for other alternatives discussed in subsequent sections. For No Action, the results of the model run for the baseline future inflow case of 865,000 AFY are shown in Figure 12, and the results of the model run for the baseline uncertainty inflow case of 689,000 AFY are shown in Figure 13.

For the baseline inflow case, the results shown in Figure 12 indicate that the lake level would fall about 14 feet below current sea level by the year 2030. Salinity would also continue to rise under No Action.

Key results of the baseline inflow model run are as follows:

- The water surface would stabilize around the year 2030 at an average elevation of around -248' NGVD which would result in an average water depth of around 19 to 20 feet and a maximum depth of about 25 to 26 feet.
- Salinity would continuously rise with this alternative, and the lake would be around 180 to 190 ppt by the year 2100.
- The lake area would stabilize at about 260 to 270 sq mi after the year 2030.
- The volume of water in the lake in the year 2050 is projected to be 3.06 MAF or about 40.2% of the lake volume as it was in 2000.

For the uncertainty inflow case, the results shown in Figure 13 indicate that the lake would fall to a lower elevation and the salinity will increase to a greater degree. Additionally, the lake volume would be reduced to an even smaller size than for the baseline inflow case, with the volume dropping to approximately 28.7% of the year 2000 volume.

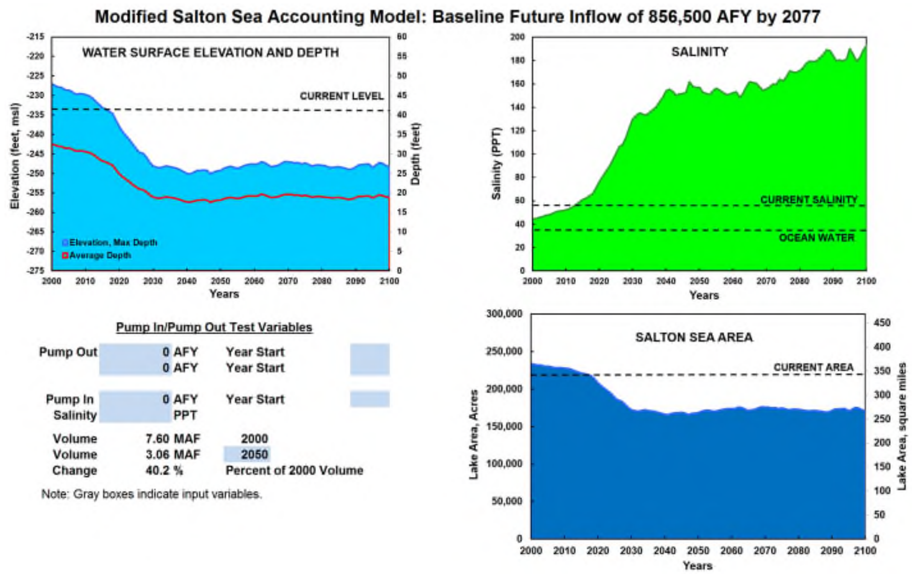

Figure 12: No Action Baseline Future Inflow

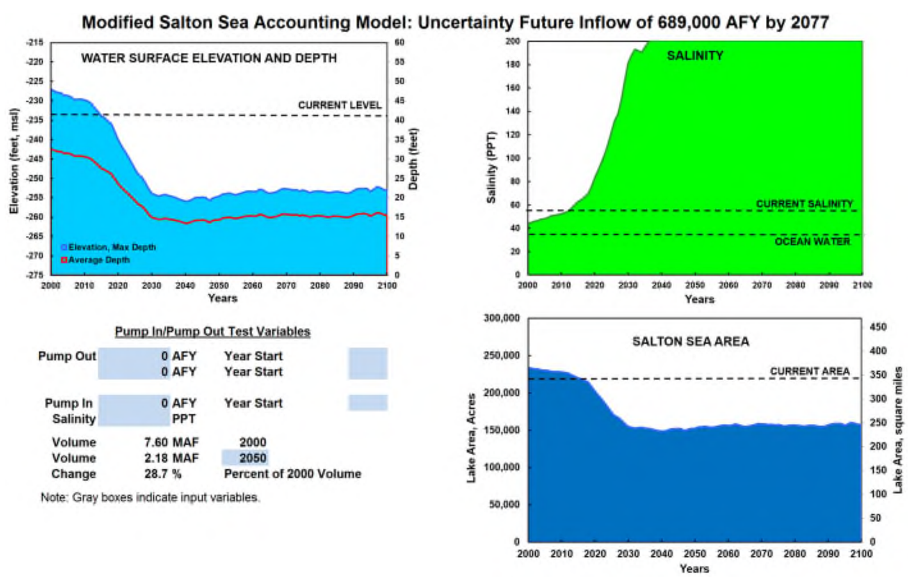

Figure 13: No Action Uncertainty Future Inflow

All of the other alternatives were analyzed using the modified SSAM, and they were compared to the No Action Scenario shown above.

4.6 Evaluation of Import/Export Alternatives

The feasibility of the alternatives presented in Benchmark 4 Volume 1 were assessed, and a ranking system was developed to compare alternatives in terms of cost and effectiveness. Three matrices were developed for inflow conveyance (Table 1), outflow conveyance (Table 2), and combined solutions

(Table 3). Each of the matrices ranks the alternatives on the basis of the following:

- Water Quantity
- Water Quality
- Operational Cost benefit
- Capital Cost Benefit
- Approvals and Environmental
- Community Impacts and Easements

Table 1: Ranking Matrix of Alternatives for Inflow to Salton Sea

	Water Source		Conveyance System		Institutional Considerations		
SALTON SEA IMPORTS	Water Quantity	Water Quality	Operational Cost Benefit	Capital Cost Benefit	Approvals and Environmental	Community Impacts and Easements	TOTAL
SARI	1	1	1	1	2	1	7
MWD	2	3	4	3	3	4	19
Yuma Desalting Plant (Concentrate)	2	3	3	3	3	4	18
MODE Pipeline	4	3	4	4	1	1	17
From Gulf of California	5	2	1	1	1	2	12
In from Pacific Ocean	5	2	1	1	1	1	11
Colorado Excess	n/a	-	-	-	-	-	-
Hyperion WWTP	5	4	1	1	1	1	13
Point Loma WWTP	5	4	1	1	1	1	13
Local WWTPs	2	4	4	4	2	3	19
Coachella Channel	1	4	5	3	1	3	17

Table 2: Ranking Matrix for Outlet Alternatives

SALTON SEA EXPORTS	Outlet		Conveyance System		Institutional Considerations		TOTAL
	Water Quantity	Outlet Impact	Operational Cost Benefit	Capital Cost Benefit	Approvals and Environmental	Community Impacts and Easements	
Laguna Salada	5	2	5	5	2	2	21
La Cienega de Santa Clara	5	1	5	4	1	1	17
To Gulf of California	5	4	4	3	2	1	19
Evaporation Facilities Dust Mitigation Evaporation Ponds Enhanced Evaporation	2	4	5	4	3	3	21
To Pacific Ocean	5	4	2	3	1	1	16
Palen Dry Lake	5	1	1	5	3	2	17

Table 3: Ranking Matrix of Combined Inlet and Outlet Alternatives

SALTON SEA – COMBINED IN/OUT	Water Source		Conveyance System		Institutional Considerations		TOTAL
	Water Quantity	Outlet Impact	Operational Cost Benefit	Capital Cost Benefit	Approvals and Environmental	Community Impacts and Easements	
Sea to Sea Gulf	5	1	2	2	2	1	13
Sea to Sea Pacific	5	1	1	2	1	1	11
Local Desalination	4	5	4	3	3	4	23

Part of the work put into Benchmark 4, Volume 1 also included evaluating the cost of each of the alternatives. Table 4 shows a summary of the cost evaluations. More detailed information on these estimates can be found in the Benchmark 4, Volume 1 report.

Table 4: Summary of Cost Evaluations

Alternatives	Flow (AF)	Subtotal	Contingency (30%)	Total
Inflow to Salton Sea - MWD Concentrate	43,000	$132,845,000	$39,854,000	**$172,699,000**
Inflow to Salton Sea - YDP Concentrate	32,000	$243,775,000	$73,133,000	**$316,908,000**
Inflow to Salton Sea - Local WWTPs	15,700	$24,783,000	$7,435,000	**$32,218,000**
Outflow from Salton Sea - Laguna Salada	150,000	$405,142,000	$121,543,000	**$526,685,000**
Outflow from Salton Sea - Gulf of California	150,000	$910,043,000	$273,013,000	**$1,183,056,000**
Outflow from Salton Sea - Evaporation Ponds	50,000	$34,765,000	$10,430,000	**$45,195,000**
Inflow/Outflow at Salton Sea - Desalination	75,000	$950,997,000	$285,299,000	**$1,236,296,000**

5.0 In-Sea Improvements

Following reviews of the features and benefits of past management plans for the Salton Sea, a new smaller lake concept has emerged, referred to as the Perimeter Lake for the Salton Sea. It takes into account the immediate need for action, the limitations on water supply for the lake, and the possibility of constructing a project with incremental funding. The new approach would involve constructing a lake around the perimeter of the Sea along with a central saline pool within the current Sea footprint. This concept is anticipated to work with other projects being planned by the State and the Imperial Irrigation District as part of an overall Salton Sea management program. Important aspects of the concept that are evaluated include the following: conceptual construction details; water inflow requirements and water quality improvement in inflow; conceptual design of spillways and air quality mitigation; geotechnical feasibility study; and construction scenario, cost estimate, funding, and cost comparisons to past alternatives.

5.1 Introduction

Following reviews of the features and benefits of past plans, a new smaller lake concept has emerged. The new concept is referred to as the Perimeter Lake for the Salton Sea. It takes into account the immediate need for action, the limitations on water supply for the lake, and the possibility of constructing a project with incremental funding.

The new approach would involve constructing a lake around the perimeter of the Sea along with a central saline pool within the current Sea footprint. This concept is anticipated to work with other projects being planned by the State and the Imperial Irrigation District (IID) as part of an overall Salton Sea management program. A complete management plan for the Salton Sea would include the Perimeter Lake concept combined with IID's SSRREI Initiative, an air quality management plan, and other smaller projects around the Sea such as the Red Hill Bay and SCH projects, as illustrated in Figure 14.

Benchmark 4 Volume 2 describes the Perimeter Lake in more detail. Important aspects of the concepts that are outlined in Benchmark 4 Volume 2 include the following:

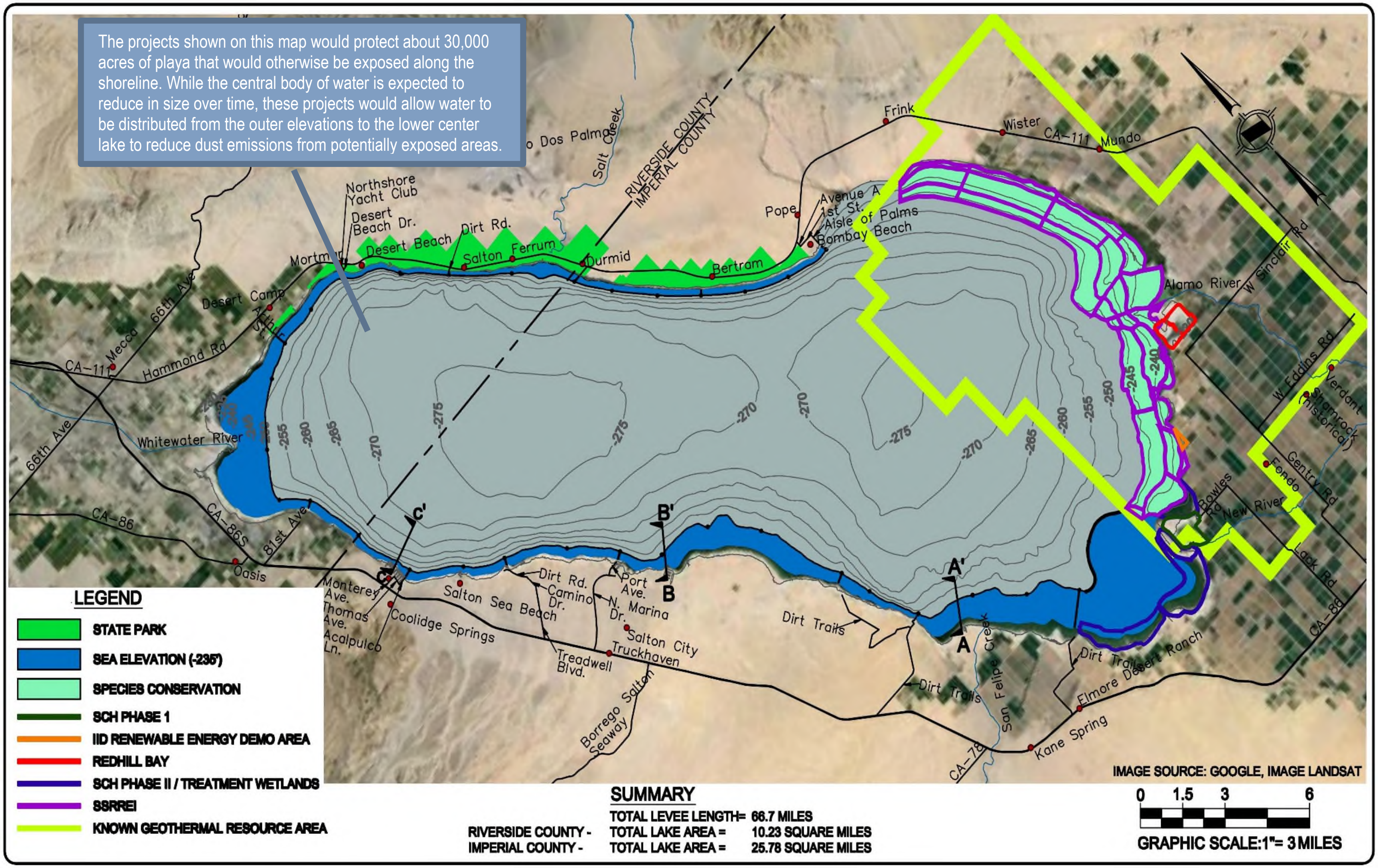

Figure 14: Perimeter Lake Concept

- Project goals and Perimeter Lake concept overview;
- Conceptual construction details;
- Water inflow requirements and water quality improvement in inflow;
- Conceptual design of spillways and air quality mitigation (AQM);
- Geotechnical feasibility study; and
- Construction Scenario, Cost Estimate, Funding, and Cost Comparisons to Past Alternatives

5.2 Project Goals and Perimeter Lake Overview

Without implementation of a sound management plan, the Salton Sea is expected to enter into a period of rapid decline over the next decade. The Perimeter Lake concept is designed to be a key part of such a management plan, and it is intended to meet a set of performance objectives proposed by the Authority that include the following:

- Preserve the Sea as a Repository for Agricultural Runoff
- Provide Lake with Stable Elevation
- Improve Water Quality: Salinity
- Improve Water Quality: Nutrients/Other Constituents
- Maintain and Improve Habitat
- Achieve Water Quality and Habitat Objectives in a Timely Manner
- Respond to Inflow Changes
- Increase Recreational and Economic Potential
- Address Air Quality (PM_{10}) Concerns
- Provide High Safety Rating/Low Risk of Failure
- Overcome Institutional Barriers/Public Acceptance (Permitting)
- Reasonable Cost/High Probability of Financing

5.3 Project Overview

The Perimeter Lake would rely upon a system of low profile levees to create a reasonably affordable and sustainable water body. This system would generally resemble an in-stream reservoir built along a slowly flowing river, it would include wider recreational areas in the north and south ends of the Sea, although boating would be accommodated along the entire 60+ mi of lake front property. The exposed playa on the southern end of the Sea near the Perimeter Lake project site would be designated for IID’s SSRREI. Built incrementally, the water used in the Perimeter Lake system would initially flow through a series of linked but separated elongated ponds.

Treatment wetlands, possibly those incorporated in the SCH project, are proposed near or upstream from the mouth of the New River to provide higher quality water entering the system, although no specific plans have been developed at this point. In sections ranging from 500 ft to over 2 mi in width, water entering the Perimeter Lake system would arrive in a wide area at the south end of the Sea, flow northward along the western shore, and arrive at another wide area in the north. Water would flow out of the northern area and move southward along the eastern shore to a terminus spillway. Here, at the terminus spillway, excess water would be channeled into a permanent saline pool in the center of the historic seabed.

Spillways at several locations within the system and the quantity and salinity of water diverted into the system would allow for management of salinity from near fresh to marine, with the expectation that the target salinity would be brackish (15-20 PPT). Excess salinity would concentrate in the saline pool located near the center of the Sea.

At full build out, the total length levee running parallel to the shore would be approximately 61 miles. Additionally, 13 perpendicular connector levees or dikes totaling 6 mi would connect to existing roads so that construction could proceed as individual cells. The total area of all 13 cells would be approximately 36 sq mi, with 10 sq mi in Riverside County and 26 sq mi in Imperial County. The levees would be constructed by dredging a channel along the lake side of the levee which would create a deep water habitat area of up to 25 ft in depth for the full length of the lake.

The annual inflow required to balance evaporative and seepage losses is estimated at 167,000 AFY (acre-ft per year). Initially, additional water could be run through the system to reduce salinity and nutrients in the water column and clean out detritus. Once in operation, the water body could be used to convey water to other habitat areas or for dust control.

As Figure 15 shows, salinity control is expected to occur near Bowles road and in the Bombay Beach area, and playa between those areas is expected to be used for SSRREI habitat and geothermal activity.

5.4 Conceptual Construction Details

The Perimeter Lake concept has evolved over time, and would work in concert with IID’s SSRREI Initiative Project, the State of California’s Species Conservation Habitat (SCH) project, Red Hill Bay Restoration Project, and Imperial County (AQM) objectives. The Benchmark 4, Volume 2 document describes concept development and conceptual construction details for the Perimeter Lake. Various depths, levee configurations and lake sizes for the Perimeter Lake were considered. Three embankment configurations were considered for use as levees on the Seaside of the new lake configuration: Earthen Levees with broad 15:1 side slopes created from local dredging, Geotube® Levees, and Sheet Pile Levees. Each design was evaluated with respect to the following performance criteria: constructability, cost, maintenance, environmental considerations, permitting, footprint derived from angle of repose, and risk and uncertainty.

The earthen levee embankment was considered to have multiple advantages and was selected for further analysis in the Perimeter Lake concept. It was expected to be the lowest cost solution and rated best in constructability and related considerations. Furthermore, because a significant allocation of the construction cost would be for dredging which would have the advantage of creating deep water areas which would have ecological and recreational benefits. Figure 9 illustrates the earthen levee concept.

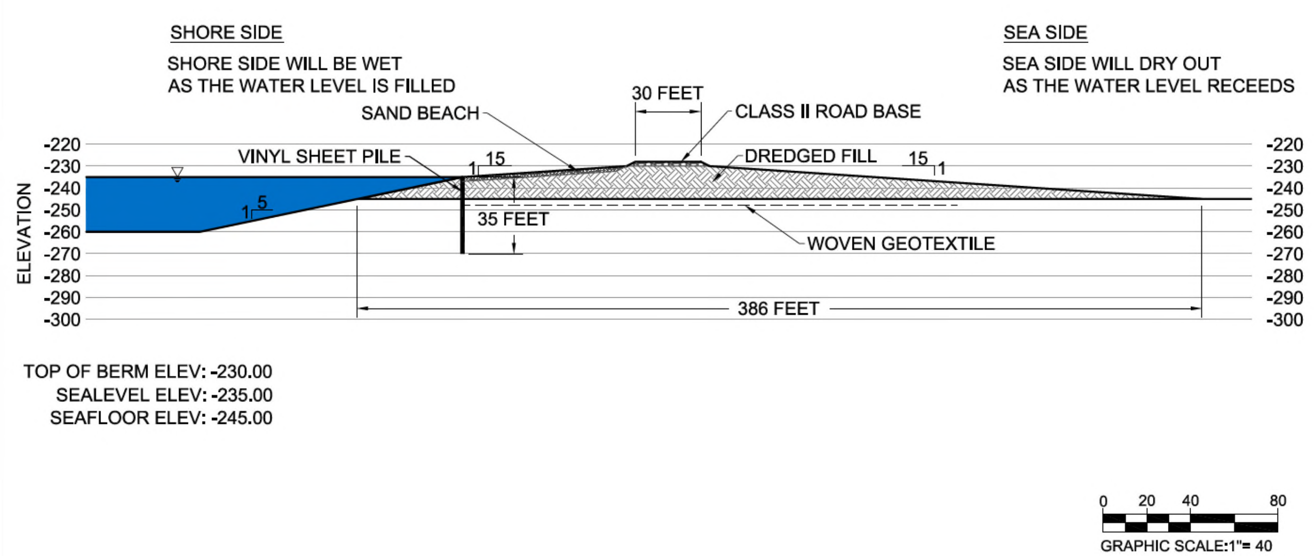

Figure 15: Levee Cross-Section Configuration with Seepage Barrier

Two possible scenarios were considered for construction of the levees. The levee construction could be completed with one team in approximately ten years, or it could be completed with two teams working in parallel in approximately five years. The selected scenario would depend on the availability of funding.

5.5 Water Inflow Requirements and Water Quality Improvement in Inflow

Benchmark 4, Volume 2 includes a water budget analysis and a discussion of the residual saline pool. The water budget and salinity analysis for the

Perimeter Lake is presented based on expected evaporation and seepage losses and other possible inflow considerations. Accounting for these variables, three scenarios were analyzed to estimate the water budget for the project: a base scenario that includes no releases for beneficial operations such as dust control, and two scenarios that would feature water releases for dust control or other beneficial uses.

Inflow water quality needs to be improved to achieve the full beneficial use potential of the Perimeter Lake. Treatment wetlands are proposed for this purpose and discussed in Section 4.0. These wetlands would be used to improve the water quality, particularly nutrients and suspended sediments, of the New River before they flow into the Perimeter Lake. Estimated area requirements are based on pilot wetland results from Brawley and Imperial, and to meet project targets of 2- 3 mg/l total nitrogen and 0.1-0.25 mg/l total phosphorus, the project would require surface areas from 590-1,150 acres under low infiltration conditions and 470-610 acres under mean infiltration conditions.

5.6 Conceptual Design of Spillways and Air Quality Mitigation

Although the Salton Sea is set in an arid region, it is subject to occasional floods, such that the Perimeter Lake design must account for them. Benchmark 4, Volume 2 includes conceptual designs of overflow spillways to address both the average annual inflow as well as the occasional flooding produced from the rare storm event. The intent of the structures is to allow the average inflow of water to circulate within the Perimeter Lake while maintaining a desired water level, provide emergency flood relief to prevent overtopping of the levee, and still maintain sufficient freeboard for safety purposes. The overflow structures include three 20 ft bellmouth spillways near the North Shore Yacht Club, the Bombay Beach and the old base; and a 1,000 ft wide broad crested weir near the North Shore Yacht Club. These structures would stimulate clockwise internal circulation and exchange water inside the Perimeter Lake up to a rate equal to the entire lake volume twice annually.

As the Salton Sea recedes due to declining inflows, windblown dust emissions from the exposed dry lakebed (the playa) would increase in some areas, potentially leading to violations of particulate matter standards and human health risks. Potential air quality impacts from exposed Salton Sea playa must be monitored and mitigated through various steps including restricted access, research and monitoring, dust control measure implementation, and purchase of emission reduction credits.

5.7 Geotechnical Feasibility Study

A feasibility-level geotechnical assessment was conducted to evaluate slope stability and seepage associated with the Perimeter Lake design. The evaluation did not identify any geotechnical factors that would preclude the successful design and construction of the project. However, several factors would require special consideration during the design, engineering and construction of the project. These factors would include dewatering of excavated materials and mechanical placement and compaction, mitigation of settlement and seepage, and soil liquefaction and seismic deformation mitigation, all of which were considered in developing the construction scenario and detailed cost estimates and schedules.

5.8 Construction Scenario and Cost Estimate

Construction would involve sheet pile installation, geotextile deployment, dredging and stockpiling of sediments, construction of spillway structures, grading and armoring of the levees, construct of roadways on top of the levees, and construction of causeways. Ferry barges or floating bridges would allow access to the levees for maintenance once causeways dividing the cells have been breached.

A detailed feasibility-level cost estimate was prepared for two construction scenarios: construction of Phase 1 and 2 in series and construction of Phase 1 and 2 in parallel. While funding sources are still being investigated, a review of the State's funding plan from 2007 is included. Details on the construction scenarios, the cost estimate, and the funding sources can be found in Benchmark 4, Volume 2. Table 5 provides a top-level cost estimate summary for each scenario. Alternative A is estimated at a total cost of $1.7 billion including contingencies. Alternative B is estimated at a total cost of $1.8 billion including contingencies. Table 6 shows an approximate breakdown of costs by cell. Cell locations are shown in Figure 16. Funding sources and more details on costs are presented in Benchmark 4 Volume 2.

5.9 Comparison to Past Alternatives

Table 7 provides a compares the Perimeter Lake to past alternatives. Note that is expected that a complete Salton Sea management plan would include the Perimeter Lake, IID's SSRREI, the State's SCH and other related projects.

5.10 Benefits of the Perimeter Lake Concept

The Perimeter Lake concept would revitalize the Salton Sea and the surrounding area by providing the following benefits: stable shoreline with elevation control in a lake with an area of 36 sq mi; improved water quality with reduced salinity; a source of water for AQM; compatibility with other Salton Sea management projects; and a deep water habitat that would also

Table 5: Summary of Cost Estimates for Perimeter Lake Construction Alternative Scenarios A and B

Permitting, Design and Construction of The Salton Sea Restoration Plan Alternative A and Alternative B Estimate Comparison PERIMETER LOW PROFILE LEVEE ALTERNATIVE					
Item	**Description**	**Alternative A ($Millions)**	**Alternative B ($Millions)**	**Difference ($Millions)**	**Comments**
1	**Initial Activities for Project Approval**	$24	$24	$0	
2	**Permitting, Engineering and Procurement**	$27	$28	$1	Additional Procurement and Inspection Expense for Equipment
3	**Construction Management and Support**	$163	$167	$5	Shorter Schedule Offset by Additional Personnel for Two Crews
4	**Salton Sea Authority Management/Other Direct Expenses**	$121	$109	($11)	SSA Management Organization on Site Less Time
5	**Mobilization**	$33	$47	$14	Mobilization and Assembly of Additional Equipment
6	**Quarry Operation and Aggregate Production**	$164	$191	$27	Increased Equipment Production and Operation Schedule
7	**PVC Sheetpile Installation**	$232	$238	$7	Added Another Independent Crew - Unit Price Slightly Higher
8	**Install Spillways and Flood Control Structures**	$65	$65	$0	
9	**Dredging and Levee Construction**	$509	$550	$41	Duplicate Equipment for Second Independent Crew
10	**Grade and Armor Levee/Construct Access Points**	$90	$100	$10	Increased Equipment and Operation Schedule
11	**Other Miscellaneous Works to complete the Project**	$10	$10	$0	Placeholder No Change
12	**OM&M of the Constructed Project (10 Years is Assumed)**	$47	$47	$0	No Change
	Subtotal	**$1,483**	**$1,576**	**$93**	
	Recommended Contingency (15%)	$222	$236	$14	
	Total	**$1,705**	**$1,813**	**$108**	

Table 6: Approximate Cost Distribution for Constructing Cells for Alternative A

Salton Sea Perimeter Levee Phased Cost Estimate
Direction: Clockwise Beginning from 6 O'Clock

Levee ID	Phase	Reach	Volume %	Sheetpile %	Earthwork ($M)	Sheetpile ($M)	Permit, Engineer, Procure & Owner Mgmt. ($M)	Total ($M)
Bowles Rd. to Dirt Rd	1	A	7.9%	7.8%	$95	$21	$13	**$129**
Dirt Rd to Old Base	1	B	9.5%	9.3%	114	25	16	**155**
Old Base to Dirt Road	1	C	4.5%	4.5%	54	12	8	**74**
Dirt Rd to Marina	1	D	14.1%	13.9%	170	38	24	**231**
Marina to Dirt road	1	E	6.4%	6.3%	77	17	11	**104**
Dirt Road to Desert Shores	1	F	5.2%	5.1%	63	14	9	**85**
Desert Shores to 81st Ave	1	G	6.5%	6.5%	79	17	11	**107**
81st Ave. to Arthur St.*	2	H	15.1%	12.0%	181	40	20	**242**
Arthur St to North Shore YC	2	I	4.4%	5.0%	53	12	8	**73**
North Shore YC to Dirt Rd	2	J	5.8%	6.5%	69	15	11	**96**
Dirt Rd to Crooker Dr	2	K	6.8%	7.6%	82	18	13	**113**
Crooker Dr to Dirt Rd	2	L	6.7%	7.6%	81	18	13	**112**
Dirt Rd to Bombay Beach	2	M	7.2%	8.1%	86	19	14	**119**
		Totals	100.0%	100.0%	$1,204	$266	$170	**$1,640**
Initial Activities for Project Approval (e.g. Demonstration Project, NEPA/CEQA)								**$24**
Program Mobilization								**$32**
Initial Project Approval and Mobilization Contingencies								**$8**
					Total		**Total**	**$1,705**

* From 81st Ave. to Arthur St. there is a deepened levee section

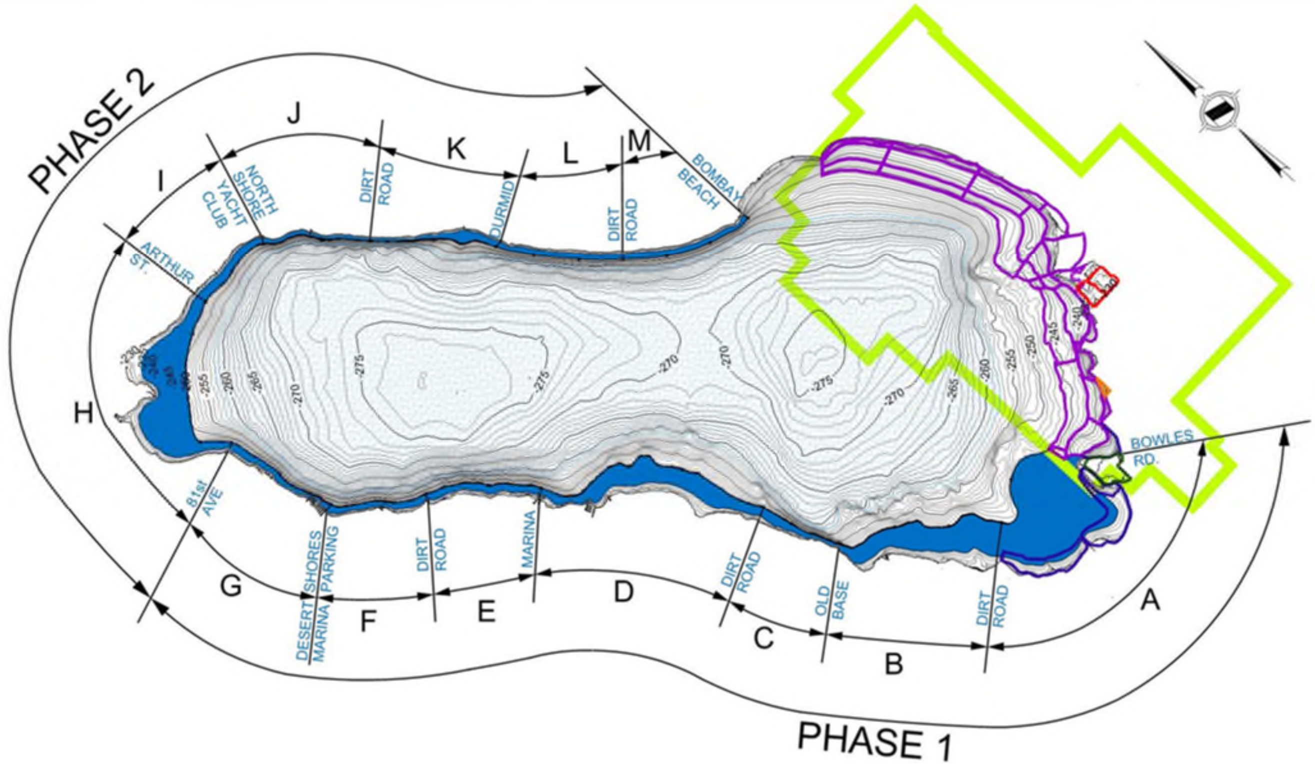

Figure 16: Access Levee Locations and Construction Phases

be suitable for recreational uses. Spillways in the north and south would provide salinity control and allow management of water in the Perimeter Lake at brackish levels (15-20 PPT). Initial flushing would help remove detritus and nutrients that are already present in the lake at high levels, and proposed treatment wetlands would improve the quality of water flowing in from the New River.

Lake elevation with this plan would be slightly below historic shorelines from 1960-2010 period; however, these levels would reduce the water requirement for the Perimeter Lake component to only 167,000 AFY, and remaining inflow (522,000-689,000 AFY) could be used for other projects such as SCH, IID's SSRREI, AQM, or other habitat projects. The Perimeter Lake is planned to be outside the boundaries of the KGRA and thus would not interfere with opportunities for development of geothermal or other renewable energy projects.

The deep water areas of up to 25 ft have recreational value for boating and fishing, and they would also benefit habitat by providing a food source for resident and migratory piscivorous birds. Additionally, the Perimeter Lake plan would include 130 mi of shallow habitat along the existing shoreline and

Table 7: Alternative Evaluation

Objectives	Perimeter Lake	State 2006	Authority 2006	Import/Export
Preserve the Sea as a Repository for Agricultural Runoff	Yes	Yes	Yes	Yes
Provide Large Lake with Stable Elevation	Yes / Smallest	Larger than Perimeter Lake	Larger than State	Full Sea
Improve Water Quality: Salinity	5 – 35 PPT	35 PPT	35 PPT	45 - 50 PPT
Improve Water Quality: Nutrients/Other Constituents	Yes	Yes	Yes	Yes
Maintain and Improve Habitat	Yes	Yes	Yes	Yes
Timeframe to Achieve Water Quality and Habitat Objectives	Short	Medium	Medium	Long
Respond to Inflow Changes (Required Water Inflow)	167,000 AFY for evap. and seepage	~700,000 AFY	~700,000 AFY	~700,000 AFY
Increase Recreational and Economic Potential	Yes	Yes	Yes	Yes
Air Quality Mitigation	Good	Good	Good	Very Good
Provide High Safety Rating/Low Risk of Failure	Low	Moderate	Moderate	Moderate
Institutional Barriers/ Permitting	Average	Average	Difficult	Very Difficult
Reasonable Cost/ High Probability of Financing	Lowest cost with the highest probability of financing from State and Federal sources	Higher cost than Authority 2006 plan with low probability of financing from State and Federal sources	Higher cost than Perimeter Lake with low probability of financing from State and Federal sources	Highest cost with the low probability of financing from State and Federal sources

levees for wading birds. At 36 sq mi, the Perimeter Lake would be significantly larger than all other lakes in southern California, including the 32-sq mi Lake Havasu. A comparison of the northern and southern areas of the Perimeter Lake to three California lakes is shown in Figure 17.

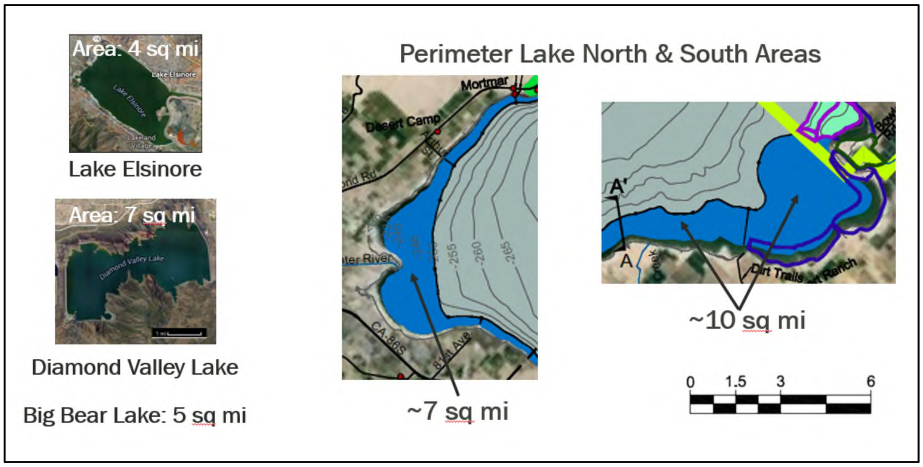

Figure 17: Comparison of North and South Areas of Perimeter Lake to Other Southern California Lakes

In addition to the general benefits of the Perimeter Lake plan, the plan would provide specific benefits in Imperial County and Riverside County.

Imperial County. Benefits in Imperial County include the following:

- A 26 square mile lake with areas up to 25 ft deep;
- A Lake with significantly cleaner and lower salinity water than the current Salton Sea;
- A stable shoreline for Imperial County communities such Bombay Beach, Desert Shores, Salton City & Salton Sea Beach;
- Dredging that would allow access to existing marinas;
- A deep reservoir in south to support the micro-climate for agriculture;
- A shallow habitat zone along nearly 100 miles along the existing shoreline and levees;
- Habitat/dust control in SSRREI area that allows full access to KGRA;
- Provisions for supporting the existing Air Quality Control Plan; and
- An irrigation source for emissive playa in Imperial County.

Riverside County. Benefits in Riverside County include the following:

- A 10 square mile lake with areas up to 25 ft deep;
- A shallow habitat zone along nearly 30 miles along the existing shoreline and levees;
- A lake with cleaner, lower salinity water;
- A Stable shoreline for Riverside County areas including the State Recreation Area;
- Dredging that would allow access to existing marinas such as North Shore Yacht Club; and
- An irrigation source for emissive playa in Riverside County.

As described in Benchmark 4 Volume 1, No Action would cause a rapid increase in salinity, a rapid decline in elevation, and a decreased Salton Sea area. Other efforts to address these concerns, such as importing and exporting large amounts of water, would require more money and water than what is needed for the Perimeter Lake Plan. As with any Salton Sea management project, funding and permitting the Perimeter Lake Plan would be a challenge; however, the needs (in terms of water and cost) along with the benefits of the plan make it a viable alternative.

6.0 Funding Options from Real Estate Sources

The Infrastructure Financing Feasibility analysis considers that the Authority will have the ability to fashion the Salton Sea along the former shoreline with combinations of dikes and dredging to produce water features that will be able to sustain recreationally attractive water near the shoreline (defined as "Seaside Improvements"). This Infrastructure Financing Feasibility analysis was prepared to estimate the total revenues generated by development attracted by the recreational water and Seaside Improvements ("Landside Development"), and the total estimated Seaside Improvement costs that can be repaid with such revenues. The Infrastructure Financing Feasibility Study was undertaken to determine if Landside Development could be a major funding source for Seaside Improvements. Objectives for this initiative are outlined, and the key tasks performed to create a comprehensive analysis are explained.

6.1 Introduction

The Salton Sea Authority ("Authority") has jurisdiction over approximately 300,000 acres adjacent to the Salton Sea in Riverside and Imperial Counties. The Authority has statutory authority to form Infrastructure Financing Districts ("IFD") in part or all of the Authority's area "for the purpose of funding the construction of, and purchasing power for, projects for the reclamation and environmental restoration of the Salton Sea…"(Calif. Gov. Code 53395.9). This "Feasibility Study" assumes that IFDs will be funded by property tax increments generated by development that is enabled by the funded seaside infrastructure. The Feasibility Study also considers the potential for sales tax and transient occupancy tax revenues.

Formation of an IFD requires a number of steps, one of which is the preparation of an infrastructure-financing plan (Section 53395.14). The Authority is asserting a leadership role in spearheading a reconnaissance level analysis of the feasibility of forming one or more Enhanced Infrastructure Financing Districts ("EIFD"s), Infrastructure and Revitalization Financing Districts ("IRFD"s), or a combination of both EIFDs and IRFDs (collectively referred to as "IFD"s), depending on existing legislation at the time of implementation. As the Salton Sea recedes, it is anticipated that the Authority will have the ability to fashion the Salton Sea along the former shoreline with combinations of dikes and dredging to produce water features that will be able to sustain recreationally attractive water near the shoreline ("Seaside Improvements").

This Feasibility Study has been prepared to analyze and determine the following:

1. Total estimated revenues generated by development attracted by the recreational water and Seaside Improvements ("Landside Development")
2. Total estimated Seaside Improvement costs that can be repaid with such revenues

6.2 Sources and Uses Summary

This Feasibility Study analyzes the estimated sources generated by the Landside Development and the amount of estimated Seaside Improvement costs that could be paid back with these sources. Four scenarios (1A, 1B, 2A, 2B) have been prepared to look at the impacts of the following:

- Percentage of the tax increment available to the IFD after making statutory deductions for ERAF and schools
- Remaining amount of tax increment allocated to the IFD and local affected taxing agencies to provide basic services such as police and fire. (Chapter 2.2.1 provides a description of the allocation of the 1% ad valorem property taxes)
- Interest rate, if required, paid back on State, Federal, or other loans obtained to fund the Seaside Improvement costs

The funds potentially available for Seaside Improvements and the interest to be paid for the four scenarios are summarized in Table 8. These funds may support Seaside Improvements in part or in total. The total funding requirements for Seaside Improvements are not defined as part of this document, and are addressed separately (Benchmark 4, Volume 2).

6.3 Sources and Uses Detail

The Feasibility Study looks at a variety of revenue sources that may be applied to repay the costs of the Seaside Improvements in part or in total. These revenue sources become available as Landside Development occurs and include, but are not limited to, the following:

- IFD Net Bond Proceeds (Chapter 2.2.2)
- IFD Tax Increment and Pay Go revenues (Chapters 2.2.1 and 2.2.3)
- Transient Occupancy Tax ("TOT") revenues (Chapter 2.2.4)
- Sales Tax revenues (Chapter 2.2.5)

The estimated revenue amounts, by type and scenario, are illustrated in Table 9.

Table 8: Sources and Uses Summary

($ Millions)					
Scenario	Ref	1A	1B	2A	2B
IFD % Available	2.2.1	50%	50%	25%	25%
Interest Rate - State/Fed/Other	2.4	3%	0%	3%	0%
Total Sources		**$2,224.2**	**$2,224.2**	**$1,760.2**	**$1,760.2**
Uses:					
Funding Available for Seaside Improvements (a)	2.4	$ 904.5	$2,224.2	$ 715.8	$1,760.2
Interest	2.4	1,319.8	-	1,044.4	-
Total Uses		**$2,224.2**	**$2,224.2**	**$1,760.2**	**$1,760.2**

(a) 10 year timline. Annual costs spread evenly over ten year period.

Table 9: Sources and Uses Detail

($ Millions)					
Scenario	Ref	1A	1B	2A	2B
IFD % Available	2.2.1	50%	50%	25%	25%
Interest Rate - State/Fed/Other	2.4	3%	0%	3%	0%
Sources:					
IFD Net Bond Proceeds	2.2.2	$ 570.1	$ 570.1	$ 276.2	$ 276.2
Tax Increment/Pay Go	2.2.3	340.4	340.4	170.2	170.2
TOT Revenues	2.2.4	920.4	920.4	920.4	920.4
Sales Tax Revenue	2.2.5	393.4	393.4	393.4	393.4
Total Sources		**$2,224.2**	**$2,224.2**	**$1,760.2**	**$1,760.2**
Uses:					
Seaside Improvements	2.4	$ 904.5	$2,224.2	$ 715.8	$1,760.2
Interest/Other Costs	2.4	1,319.8	-	1,044.4	-
Total Uses		**$2,224.2**	**$2,224.2**	**$1,760.2**	**$1,760.2**

6.4 Study Period

The Feasibility Study financial model allows for the following time horizons, assuming year 0 to be the formal beginning of the planning:

- Two years of planning and California Environmental Quality Act (CEQA) planning and evaluation of projects, followed by ten years of construction related to Seaside Improvements
- Fifty years of Landside Development based on annual absorption of 1,475 residential units

6.5 Fifty Year Landside Development Period

Assuming a 50-year Landside Development period commencing in year 8 and continuing through year 57, Table 10 and Figure 18 illustrate in five year increments, the cumulative annual IFD tax increment and revenue source additions generated by the Landside Development.

The cumulative annual IFD tax increment is shown graphically in Figure 19.

6.6 Funding Gap

The revenue sources identified above are generated from Landside Development spurred by stabilized, recreationally attractive water. This Feasibility Study assumes that Landside Development will not be triggered until after Seaside Improvement costs have been incurred, creating a "Funding Gap" between the time costs are incurred and Landside Development revenue sources become available. Other forms of financing (e.g. state funding, state loans, federal grants, etc.) will be required to bridge the Funding Gap until IFD tax increment and other Landside Development revenue sources become available.

Table 10: Tax Increment and Revenue Sources (Scenario 1)

($ Millions)									
Period	**IFD Tax Increment**			**Sources**					
	Riv	**Imp**	**Total**	**Bond Sale**	**Pay Go**	**TOT Revenues**	**Sales Tax**	**Energy Revenues**	**Total**
Years									
1-5	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.1	$ -	$ 0.1
6-10	1.2	0.7	1.9	7.1	0.6	1.5	4.4	-	13.7
11-15	6.1	3.7	9.8	12.9	3.0	8.8	12.5	-	37.3
16-20	11.8	7.0	18.8	14.5	5.8	27.2	23.5	-	71.0
21-25	18.1	10.8	28.8	16.2	9.0	63.8	34.7	-	123.6
26-30	25.0	14.9	39.9	18.0	12.4	107.0	41.5	-	178.9
31-35	32.6	19.5	52.1	20.1	16.2	120.6	46.3	-	203.1
36-40	41.1	24.5	65.6	33.3	20.3	130.1	50.4	-	234.2
41-45	50.4	30.0	80.4	39.9	25.0	135.2	52.7	-	252.7
46-50	60.7	36.2	96.8	44.2	30.1	135.9	53.0	-	263.2
51-55	72.0	43.0	115.0	49.0	33.4	135.9	53.0	-	271.3
56-60	32.2	19.2	51.5	21.0	14.5	54.4	21.2	-	111.1
TOTAL	**$ 702.2**	**$ 418.9**	**$1,121.2**	**$ 570.1**	**$ 340.4**	**$ 920.4**	**$ 393.4**	**$ -**	**$2,224.2**

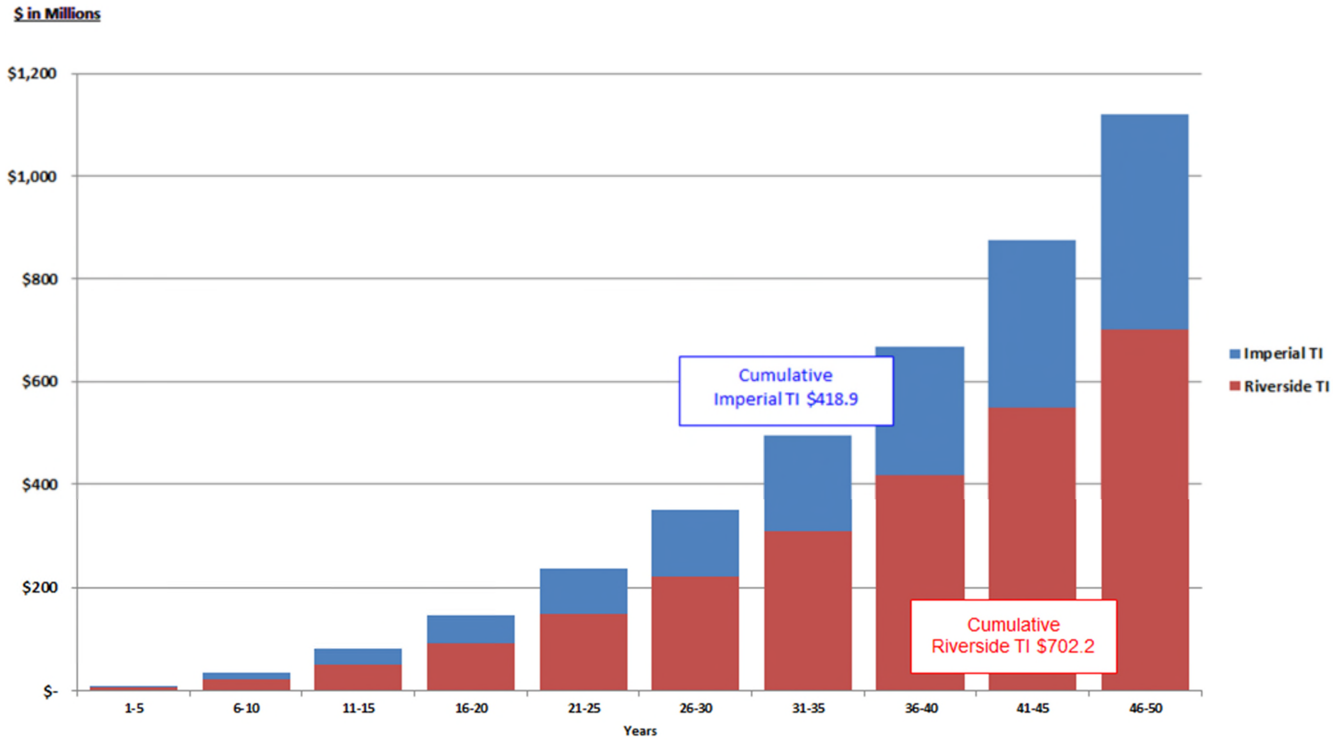

Figure 18: Cumulative IFD Tax Increment (Scenario 1)

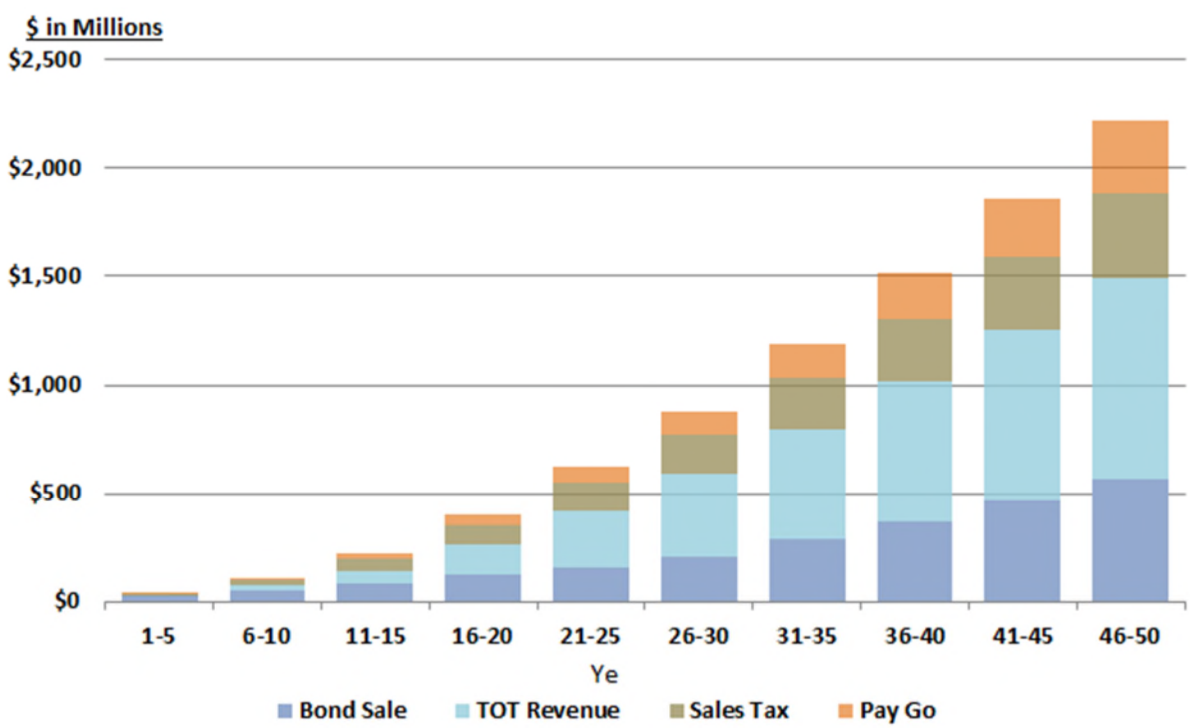

Figure 19: Cumulative Revenue Sources (Scenario 1)

The cumulative annual revenue sources are shown graphically in Figure 2.

Table 11 illustrates the Funding Gap between the timing of Seaside Improvements and Landside Development revenue sources, as well as loan additions and repayment, assuming a 3.0% interest-bearing loan, to bridge the Funding Gap. Note that the funding gap cannot be quantified fully until the seaside improvement costs are known. This table has been included for illustration purposes only, as the total funding requirements for Seaside Improvements are not defined as part of this document, and are addressed separately (Benchmark 4, Volume 2).

Table 11: Annual Sources Uses and Seaside Improvement Costs

($ Millions)					
		Uses			
Period	**Total Sources**	**Loan Additions**	**Interest @ 3.0%/ Other**	**Loan Repayment**	**Seaside Improvement Costs**
Years					
1-5	0.1	$ 308.5	$ 18.4	$ -	$ 308.6
6-10	22.4	403.2	84.1	-	425.6
11-15	55.0	151.7	147.2	(36.4)	170.2
16-20	93.1	-	164.8	(93.1)	-
21-25	150.5	-	172.0	(150.5)	-
26-30	211.1	-	170.4	(211.1)	-
31-35	241.1	-	161.4	(241.1)	-
36-40	289.6	-	145.3	(289.6)	-
41-45	319.2	-	119.6	(319.2)	-
46-50	339.2	-	86.2	(339.2)	-
51-55	355.5	-	44.6	(355.5)	-
56-60	147.3	-	5.7	(144.8)	-
TOTAL	**$2,224.2**	**$ 863.4**	**$1,319.8**	**$ (2,180.6)**	**$ 904.5**

6.7 Next Steps

The results of this Feasibility Study are subject to change based on the assumptions contained herein, and discussed in the attached Appendices. This Feasibility Study analyzes possible revenue sources that may be available to fund Seaside Improvements. Additionally, the estimated costs of the Seaside Improvements have not been calculated as part of this Feasibility Study, as such, any results are simply an illustration of potential scenarios.

Suggested next steps to move forward with infrastructure financing would include the following:

- Work with the Authority to identify Seaside Improvement costs
- Further analysis of the IFD allocation and preparation of the fiscal impact analysis
- IFD bonding assumptions (e.g. interest rate and debt service coverage)
- Development scenarios including timing of absorption
- Implementation steps for IFD
- Extend development scenario to 75 years

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7.0 Funding Options from Alternative Energy Sources

As part of the Funding and Feasibility Action Plan, the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) was commissioned to conduct a comprehensive analysis to evaluate the potential of various renewable energy technologies to provide funding support for management solutions at the Salton Sea.

7.1 Introduction

The U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) conducted a comprehensive analysis to evaluate the potential of various renewable energy technologies to provide financial contributions to management solutions at the Salton Sea.

In 2013, the Imperial Irrigation District (IID) commissioned a preliminary study on the potential for renewable energy projects in the Salton Sea region to provide partial funding of management actions at the Salton Sea. IID's feasibility study examined the revenue potential from land leases in the Imperial Valley for renewable energy projects, and estimated that roughly $4.1 billion might be realizable over the study period of 2016 to 2045.

The NREL report, The Potential for Renewable Energy Development to Benefit Restoration of the Salton Sea: Analysis of Technical and Market Potential (http://www.nrel.gov/docs/fy16osti/64969.pdf), was completed in November 2015. The NREL report specifically seeks to confirm and refine these prior revenue potential estimates, provide a technical review of the renewable energy technologies under consideration, and develop estimates of the region's developable production potential through the year 2030.

7.2 Study Areas

To identify the land available for renewable energy development in the Salton Sea study area (Figure 20), geographic information system methods were used to compile land use shapefiles from the multiple stakeholders in the region. The Desert Renewable Energy Conservation Plan (DRECP), Imperial County, Riverside County, Imperial Irrigation District, and the U.S. Bureau of Land Management (BLM) all contributed data to the analysis.

- The Salton Sea Study Area is as follows:

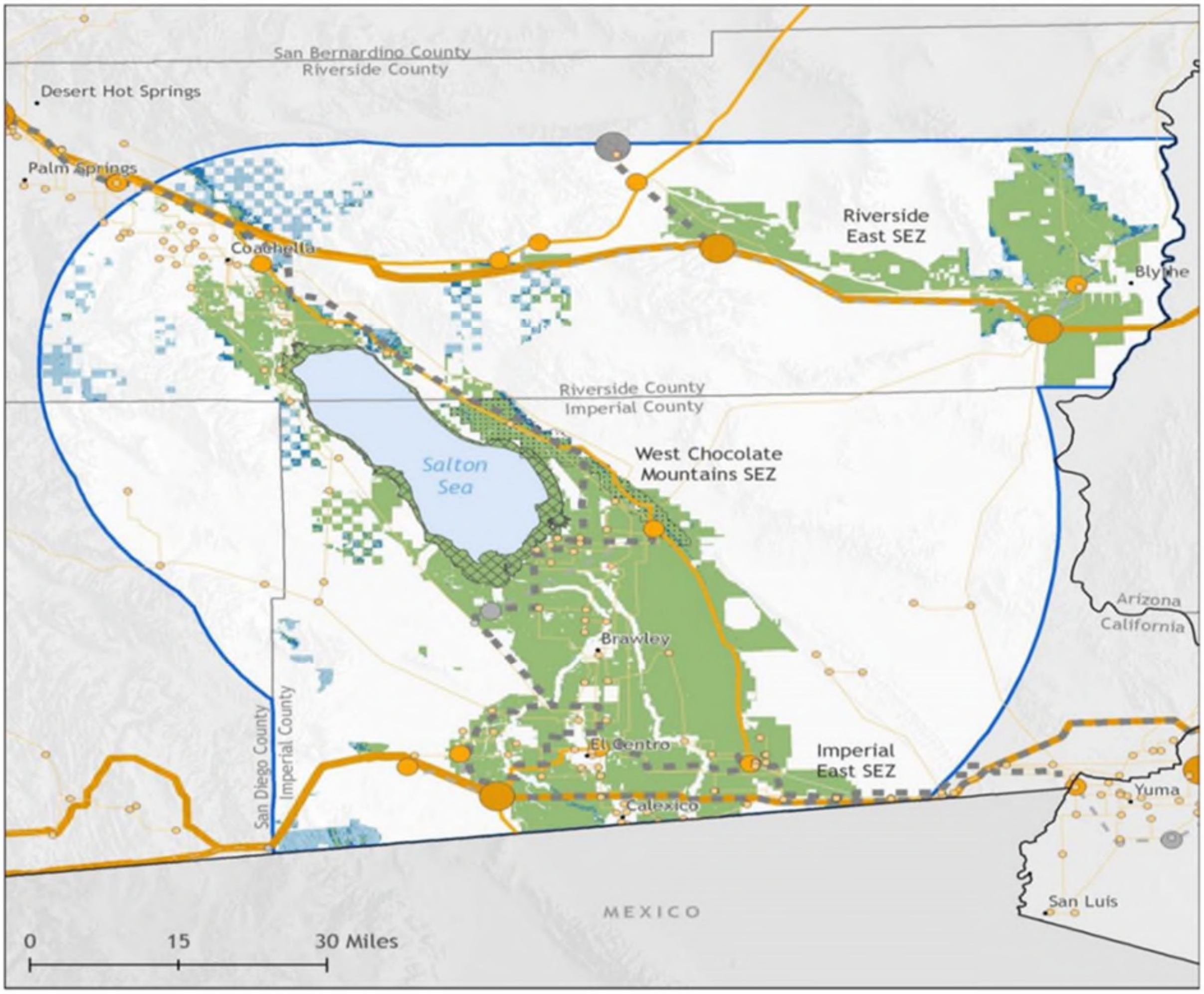

Figure 20: Total Developable Renewable Energy Land

- The national border with Mexico was established as the southern border.
- The northern and eastern borders were extended to the eastern extent of Riverside County in order to incorporate the BLM's Riverside East solar energy zone (SEZ).
- The western border was extended to roughly correspond to the DRECP.
- The Salton Sea playa was listed as a potentially developable area, although there is uncertainty concerning both the rate of recession and additional costs for development in this land area.

Within the Salton Sea study area, the southern half of the Salton Sea has been identified as the primary area of opportunity for significant development, primarily due to the presence of large tracts of potentially developable public and private land, existing and planned projects, and greater opportunity for future transmission export. This does not preclude development in other areas; potentially developable solar resources exist within the West Chocolate Mountains SEZ as well.

7.3 Evaluations

Technologies considered in NREL's report are the following:

- Electricity production from geothermal
- Mineral recovery from geothermal fluids
- Electricity production from solar photovoltaics (PV), concentrating solar power (CSP), and salinity-gradient solar ponds (SGSP)
- Hydrogen production
- Biofuels and nutraceutical production from algae pond cultivation.

Wind is not evaluated in the report due to the minimal resource potential within the region. In addition to renewable energy technologies and their coproducts, desalination of the Salton Sea from renewable energy is also discussed as a potential benefit to restoration.

7.4 Renewable Energy Potential

Of the commercially available renewable energy technologies, geothermal, solar photovoltaics (PV) and concentrating solar power (CSP) have the greatest technical potential for development. The resource potential, costs, and estimated revenue streams from these technologies are summarized in Table 12.

7.4.1 Constraints

Market factors are the biggest constraint on development. Development on the playa itself will be constrained by the rate at which the shoreline recedes, and although playa may be exposed in a given year, there will likely be an additional lag in development due to variability in Salton Sea water levels and potentially muddy site conditions.

Despite the large total resource potential, constraints such as proximity to transmission access and regional cost-competitiveness of the electricity generated may limit the technical potential of the power generation technologies before 2030.

Additionally, PV and CSP require between 5 and 10 acres per megawatt (MW), so larger scale projects over 20 MW could be limited by the availability of contiguous land parcels.

Table 12: Salton Sea Renewable Energy Resource Potential and Costs

Technology	Land Developable by 2030 (acres)	Undeveloped Energy Resource Potential	Resource Potential Developable by 2030	Current levelized-cost ($/MWh)***	Estimated levelized-cost in 2030 ($/MWh)***
New Geothermal power (KGRA*)	50,330	1.78 GW - 2.94 GW	1.05-1.81 GW	$107-$131	$107-$131
Mineral recovery from geothermal brines (KGRA)	50,330	115-222 thousand MT Lithium	54.3-122 thousand MT Lithium	Not commercial	Not available
Onshore Solar PV	14,405	31.9 GW	1.8 GW	$100-$113	$49-$94
Offshore Solar PV	9,938	4.2 GW	1.25 GW	$100-$113**	$49-$94**
Onshore CSP	13,147	23.9 GW	1.3 GW	$181	$84-$132
Offshore Algal Biofuels	32,821	39M gal/year	Not commercial	$>10/Gallon	$3/gallon
Offshore Salinity-Gradient Solar Ponds	9,938	0.444 GW	.1 GW	$80-110	Not available

*Known geothermal resource areas, **offshore playa construction requirements may result in higher LCOE,
***Exclude state and federal incentives, but are inclusive of MACRS depreciation. Deal provisions, such as: escalation rate, ITC, term length, state income and sales tax rates, project financing, and additional grid services can all result in a disparity between the LCOE and ultimate PPA price of a technology.

7.4.2 Assumptions and Conditions

Some key assumptions and conditions used by NREL include the following:

- The figures for geothermal power and mineral recovery include the developable land within the KGRAs for reference, but the resource potentials are solely calculated based on volumetric assessments of the geothermal resource.
- The figures for PV and CSP refer to developable land and resource potential within one mile of 138kV to 230kV transmission access, excluding the land within the KGRAs.
- The undeveloped potential for PV and CSP refers to developable land and resource potential within five miles of 138kV to 230kV transmission access.
- Resource potentials are mutually exclusive; developing a CSP system on a piece of land would preclude installing PV on the same piece of land.
- The underlying data set used for cost estimates in this report is the NREL Annual Technology Baseline and Standard Scenarios.

- The cost assumptions do not reflect state or federal incentives, such as the investment tax credit, but are inclusive of Modified Accelerated Cost Recovery System (MACRS) depreciation.
- Specific cost-related assumptions can be found in Appendix B of the full report.

7.4.3 Geothermal

The Salton Sea area has exceptional geothermal resources, with one of the largest geothermal anomalies in the United States located at the southern end of the Sea in Imperial County.

Electricity Production. There are roughly 232,000 acres of developable land within the various Imperial County KGRAs, of which 1,851 acres lie within 1 mile of a 138 kV to 230 kV substation. Approximately 50,000 acres lie within 5 miles of a 138 kV to 230 kV substation, which could allow for future geothermal development. Additionally, geothermal power plants have relatively small footprints; thus constructed wetlands, algae farms, and renewable energy projects could be interspersed with geothermal plants within the KGRA. An additional benefit of geothermal development is that infrastructure such as roads and berms will be created and can then be utilized by other projects.

The technical potential for geothermal development is constrained by both the availability of surface land area, as well as the underlying geothermal resource. For the purposes of this analysis, the required surface area is assumed to be available, and the technical potential is determined through volumetric resource estimates of the underlying reservoir. Using this volumetric resource assessment method, the maximum remaining developable geothermal capacity by 2030 within this area is roughly 1,800 MW. However, the Salton Sea KGRA comprises 1,350 MW of this capacity, and much of that resource is still under water within the Salton Sea.

Although the offshore resource is not currently accessible, Tetra Tech provided water recession forecasts that were used to estimate that 370 MW to 570 MW of the offshore resource could be developable by 2030.

Mineral Recovery. Mineral recovery of lithium from Salton Sea geothermal brines could potentially produce up to $860 million annually in total business revenues, with up to $25.8 million going to IID via annual royalties of 3% on gross revenues. For a high-temperature 50 MW geothermal power plant, mineral recovery of lithium at current market prices could yield $91 to $118 million in annual revenues. This is a nascent technology and revenue estimates are highly uncertain because: 1) the cost structure of such mineral recovery operations may not be adequate to encourage businesses to enter the market, and 2) the degree to which potential increases in demand for lithium-based products may outstrip supply and impact market prices.

7.4.4 Solar Technologies

Given the generally strong solar resource in the Salton Sea area, a variety of solar electric or solar thermal technologies may be suitable for development within the region. However, note that because both PV and CSP require similar conditions, developing a CSP system on a piece of land would preclude installing PV systems on the same piece of land. Although electricity production from salinity -gradient solar ponds has been technically proven, it has not been established in the U.S. as an economically viable power production technology to date. The low-grade heat produced by this technology may also be supplied to other processes, including: desalination, algae pond heating, food processing, and other industrial processes.

Solar Photovoltaics. There are 815,271 acres in the Salton Sea study area with less than 5% slope that could potentially accommodate 103 GW of PV generation. Within this area, 14,405 acres lie within 1 mile of 138 kV to 230 kV transmission access and could accommodate 1.8 GW of PV, which is a conservative estimate of the resource that could be developable by 2030. Although the total capacity potential is extremely large, the developable potential is significantly smaller, due to proximity to transmission, land access, financing, and utility demand, among others.

Concentrating Solar Power. There are 771,656 acres in the Salton Sea study area with less than 3% slope, which could potentially accommodate 77 GW of CSP. Within this area, 13,147 acres lie within 1 mile of 138 kV to 230 kV transmission access which could accommodate 1.3 GW of CSP.

Due to the strong solar resource and relatively low slope constraints, there is a very high technical potential for CSP projects in the Salton Sea study area. However, as was noted in the solar PV section, while this capacity may be technically feasible, CSP development is also constrained by numerous other factors, including its relative economic competitiveness and potential avian impacts. Capacity factors for CSP technologies vary widely, with a range between 25% and 49%.

Salinity-Gradient Solar Ponds. The total salinity-gradient solar pond (SGSP) resource potential in this area is estimated to be 444 MW, based on 26,628 acres of potential playa within 1 mile of transmission, and an assumed power density of 60 acres/MW. The current cost of power from SGSP is estimated to be within the range of $80 $110/MWh, but the technology is still nascent, making predictions about the likely cost in 2030 subject to significant uncertainty.

Given that SGSP projects have not yet been developed within the region, 100 MW was estimated to be technically developable by 2030, although this does not account for transmission or economic viability, which are still uncertain.

7.4.5 Hydrogen Production

Hydrogen can be produced by reforming natural gas or splitting water molecules using any primary energy resource, including the resources abundant in the Salton Sea region.

California has several policies in place to accelerate the adoption of hydrogen fuel cell electric vehicles (FCEV). The biggest market for FCEVs is expected to be Los Angeles, which currently leads California in hydrogen station installations. However, the Salton Sea is 150 miles from Los Angeles, with transportation/delivery costs adding significantly to the cost of the delivered hydrogen compared to facilities operating closer to the city, and there are considerable uncertainties surrounding the rate at which FCEVs might be deployed.

Current projections are that the total number of FCEVs in California might be roughly 18,500 by 2020. Based on projected FCEV adoption rates and due to the comparatively low cost of natural gas, it does not appear likely that hydrogen from the Salton Sea region would be competitive in the Los Angeles market until at least 2030.

7.4.6 Algae Pond Cultivation

Strains of algae have been identified that can grow in brackish, saline, and even hypersaline water.

Biofuels. The study area appears to be a favorable region for development of algal biomass resources due to the presence of large volumes of highly saline water, large tracts of unused playa and high insolation.

Algal ponds offer similar benefits as solar ponds to the local environment: covering the recently exposed soil and thereby reducing the potential for dust emissions. There are currently 32,821 acres of total developable land on the playa (unconstrained by transmission access), which could produce roughly 39 million gallons of biofuels per year.

Current costs are roughly $17/gallon and would need to decrease substantially for this technology to be viable. Algal biofuel production is still pre-commercial and is unlikely to be cost-competitive with crude oil by 2030, barring the implementation of Renewable Fuel Standards for algal biofuel consumption.

Nutraceuticals. The production of cosmetic and dietary products, such as beta-carotene or spirulina, is commercial at scale, with operating plants in numerous countries. Notably, Synthetic Genomics, Inc. performs research and development and test-scale operations near the southern tip of the Salton Sea, and has been consulted concerning the feasibility of further development of algal ponds for nutraceutical products on the exposed Salton Sea playa. Further study of the Salton Sea's water quality is required, but development of an algal biomass pilot plant on exposed Salton Sea playa could verify whether this technology is viable in the region.

7.5 Economic Outlook

Table 13 summarizes potential mitigation revenues under current policy and technology conditions within the Salton Sea region. The development of geothermal and solar projects will generate tax revenues, environmental mitigation fees, regional economic development, geothermal royalty payments from development on BLM lands, and land lease revenues from development of IID owned playa for Salton Sea development from power generation projects.

Estimated restoration revenue streams in previous studies have typically assumed that development in the Salton Sea region is sufficiently attractive from an economic standpoint to absorb the additional impact of a restoration charge on a project's cash flows while still providing a regionally competitive return on investment. However, based on modeling of potential scenarios, it has been determined that any additional tax on generation to support Salton Sea restoration may disadvantage the development of these resources relative to other renewable resources in the region.

Any added tax would need to reflect market conditions, as even the addition of a relatively small $5 per megawatt-hour restoration charge to the cost of new Salton Sea geothermal projects could make them significantly more expensive than competing alternatives in the regional supply pool.

Similarly, a $5/MWh charge for solar could result in the area's best resources becoming more expensive than competing projects. As modeled in the CPUC RPS Calculator, the area's solar resources could slip by about 7 percentage points in competitiveness in the California renewable energy supply curve, meaning that 49,000 GWh of competing projects may become economically superior. For context, the modeled incremental demand from increasing California's RPS to 50% may be between 44,000 GWh and 74,000 GWh.

Table 13: Summary of Potential Mitigation Revenues under Current Conditions

	Current Conditions [Annual Millions]	Notes: See Appendix C for full calculations
Geothermal (KGRA)*	$7 to 15	Onshore: BLM land lease royalties: $1-3 Offshore: IID land lease royalties : $6 -12
Solar PV (onshore)	$0	Available onshore land is predominantly private, and BLM Solar Energy Zone royalties are currently fully allocated to the U.S. Treasury.
CSP (onshore)	$0	
Other:		
AB 1471 (CA 2014 Water Bond)	$0 to 14.3	Total CA water bond is $475M, $200M assumed as upper limit given other obligations.
Total (annual):	$7 to 29.3	Annual revenues calculated assuming 14 years, from 2016-2030. Figures do not account for inflation or the time value of money.
14 year total:	$98 to 410.2	Note: The mitigation revenues in Tables ES-2 and ES-3 are additive.

* Geothermal projects should be given first priority for development on the KGRA, but due to their small overall footprint once projects are established, this acreage may be developable for other technologies as well.

This might not be significant under scarcity conditions, but it could be a major handicap in a market characterized by large surpluses. There are some options, such as streamlined permitting or partnership with the North American Development Bank, that could be explored to improve the economic competitiveness of Salton Sea renewables such that they might be able to absorb a restoration tax while still remaining attractive to nearby power markets. However, in general developers are opposed to the concept of a restoration adder.

7.6 Future Revenue Potential

There is potential for greater demand for renewable energy beyond 2030, driven by California policy, such as AB 32, which calls for 80% greenhouse gas reductions below 1990 levels by 2050 and the recent passage of the 50% RPS target. However, with indications of minimal economic headroom for a Salton Sea restoration tax on renewable energy development in the region between 2015 and 2030, additional potential revenue generation mechanisms for the Salton Sea Authority were explored. The primary revenue potential mechanism examined was land lease royalties, as these are existing costs associated with development that would be less likely to disadvantage projects' regional cost-competitiveness. Table 14 summarizes these potential revenues in 2016 through 2030. Although there may be between $78.4 million and $1.09 billion in potential revenues, additional sources of revenues

Table 14: Summary of Potential Mitigation Revenues under Future Conditions

	Potential Future Conditions [Annual Millions]	Notes: See Appendix C for full calculations
Mineral recovery from geothermal brines (offshore KGRA)	$0 to 25.8	Assumes offshore development of up to 570 MW of geothermal, 3% IID royalty rate on gross lithium sales
Algal biofuels (offshore non-KGRA)*	$1.2 to 2.3	Assumes $3/gal cost competiveness by 2030, 1-2% IID land lease rate on gross proceeds.
Salinity Gradient Solar Ponds (offshore non-KGRA)*	$0.6 to 1.6	Assumes $80-$100/MWh PPA, 90% capacity factor, IID land lease rate (1-2% - gross proceeds).
Solar PV (offshore non-KGRA)*	$1 to 3	Assumes $40-60/MWh PPA, 23.2% capacity factor, IID land lease rate (1-2% - gross proceeds).
Solar PV (onshore BLM Solar Energy Zones)	$1.5-4.4	Assumes passage of S-1407and development of 1.8 GW of BLM SEZ's. Assumes $40-60/MWh PPA, 23.2% capacity factor, royalty rate between 1-2% of gross proceeds.
Other:		
Desert Renewable Energy Conservation Plan - Habitat Restoration	$3.5 to $44.6	Lower case based on allocable revenues to desert pupfish habitat, upper case is for full habitat restoration amounts for Imperial & Riverside Counties
Total (annual):	$5.6 to 77.8	The potential revenues above typically require a change in policy, development of the offshore playa, or technological developments.
14 year total:	$78.4 to 1,089.2	

* The potential development of off-shore acreage outside of the KGRA is mutually exclusive. e.g: Full development of the available acreage by algal biofuels precludes development by Solar PV or Salinity Gradient Solar Ponds. Total revenue estimates reflect the highest and lowest potential revenues from these three technologies ($0.6 to 3 million annually).

will still be required to fund the proposed restoration options ($2.3 billion to $8.9 billion).

7.7 Recommended Next Steps

7.7.1 Geothermal

Further analysis is required to refine estimates of the developable geothermal potential on the playa. The developable offshore potential is based on the percentage of playa exposed within the estimated bounds of the reservoir, but more accurate estimates can be achieved through volumetric assessment of the offshore resource. Further study of the geotechnical soil conditions of the playa, from a construction standpoint, would also be required to refine offshore cost estimates.

7.7.2 Geothermal Fluid Mineral Recovery

Since no geothermal recovery operations are commercially operating at the time of this report, a detailed manufacturing and supply chain study is needed to validate the likelihood that mineral recovery is a viable business opportunity for the region.

7.7.3 Salinity-Gradient Solar Ponds

Further analysis of the economic viability of salinity-gradient solar ponds, as well as the detailed investigation of the technical potential for synergy between this technology and algae development or desalination, will be required to determine if a commercial-scale plant would be feasible.

7.7.4 Algal Biofuels

Further study of the Salton Sea's water quality is required, but development of an algal biomass pilot plant on exposed Salton Sea playa could verify whether this technology is viable in the region. Development of an algal biomass pilot plant on exposed Salton Sea playa could verify whether this proposed renewable energy restoration mechanism is viable. NREL has discussed this proposed mechanism with two organizations currently exploring pilot studies at this location, UCSD and Synthetic Genomics, Inc., which operates an R&D facility next to the Salton Sea.

7.7.5 Interactive Analysis Tool

As part of the analysis conducted above, NREL has developed an interactive, web-based mapping tool that incorporates the data used in the report's analysis. This tool is intended to enable stakeholders to visualize renewable energy development scenarios under various conditions, such as proximity to transmission, estimated playa recession, and land ownership. Due to data use restrictions, some data is not viewable at the sub-county level. If the layers under the Developable Land Substation Buffer directory do not display on the map, please zoom out until the layer becomes visible, or uncheck this layer to zoom in on other layers. A screenshot of this tool, available at http://maps.nrel.gov/salton-sea, is shown in Figure 21.

7.7.6 Market Competitiveness

Due to ongoing significant changes in federal regulatory policies, increasing state RPS goals, shifts in technology costs and adoption, and accelerated plant retirements, further study of the role and value of the Salton Sea's renewable resources within regional power systems and markets is required. A variety of models and tools exist that can be utilized to assess the opportunities and challenges of developing the Salton Sea's renewable resources within the broader and rapidly changing California and Western markets. Capacity expansion models can be used to develop future scenarios of the market potential and transmission needs of different renewable and non-renewable options at high spatial resolution for particular focus regions, such as Southern California. Production cost models can be used to assess the operational impacts—including renewable curtailment, plant operational flexibility, transmission congestion, and changing electricity imports and exports—under future infrastructure conditions. Running these models for the Salton Sea region, with a focus on geothermal and solar, can help demonstrate the ability of regional resources to cost-effectively meet California's energy and climate objectives. Development of this analysis would help provide valuable input to ongoing planning efforts such as the

DRECP and the recently announced Renewable Energy and Transmission Initiative (RETI) 2.0.

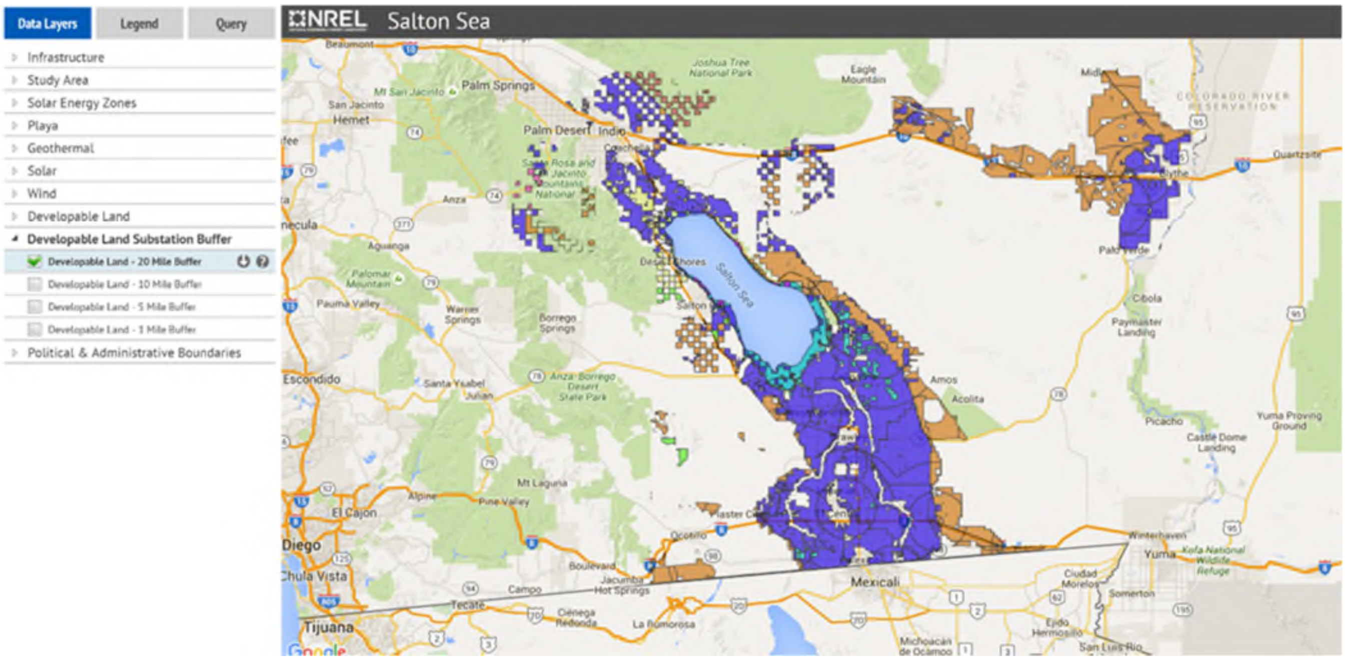

Figure 21: RE Development Scenario Mapping Tool Screenshot

7.7.7 Renewable Energy Policies

Policies favorable to renewable energy could create a unique benefit to development within the region. These could include utilizing the North American Development Bank for development expertise and to leverage interest rate cost savings, streamlining permitting requirements, and providing certainty surrounding environmental permitting costs. Additional potential developments which could affect these findings include the implementation of more aggressive in-state renewable energy capacity goals, and additional project cost declines uniquely benefitting the Salton Sea region (i.e., local incentives, exceptional transmission access).

7.7.8 Royalty Payment Structures

Geothermal royalty structures and mineral leasing receipts are current potential sources of funding for restoration efforts. Additional potential revenues could be realized through the passage of U.S. Senate bill 1407, which would amend the revenue distribution for solar and wind energy authorizations on BLM land to include distributions to states and counties. On payments associated with renewable energy development and production, the State of California could also make efforts to pass more specific support mechanisms, such as the CA Senate Bill 1139, which required 500 MW of geothermal energy between 2015 and 2024.

8.0 Recommendations

This chapter provides recommendations for additional design, engineering, a demonstration projects that would advance the concepts presented in the Benchmark reports.

8.1 Introduction

Continuing from the work completed for the Funding and Feasibility Action Plan, additional engineering evaluations will be needed to further develop the Salton Sea management concepts described in the Benchmark reports. An expanded engineering feasibility analysis is proposed to link Salton Sea management goals and engineering design requirements for the Perimeter Lake and to further develop the design concept. During this phase, the results of a demonstration project could be integrated into the Perimeter Lake and habitat design concepts. Current engineering cost estimates would be further refined to match the expanded conceptual engineering designs.

8.2 Design and Engineering

A preliminary list of design tasks for the next phase is provided below. The specific list and scope of design tasks will be developed in discussions with the State and other stakeholders as appropriate and incorporated into the Phase 2 work plan.

Feasibility Conceptual Details and Pricing for:

- Dust control system for irrigation of emissive playas
- Floating bridges or other access methods at causeways for levee maintenance
- Landside roadway access points
- Causeway section designs
- Deterrents to public access and safety systems around spillway structures
- Determination of potential economic benefits
- Determination of land ownership and necessary title transfers
- Levee alignment for maximum economic benefit and recreational use

Initial Cell:

- Tie in details and coordination with SCH levees and SSRREI geotubes along New River
- Dredging requirements for the New River Delta
- Improve levee alignment in the Phase 1 cell for economic benefits

Determination of Construction Means, Methods, and Sequence including:

- Soil/sediment sampling
- Sheet pile alternatives and construction
- Dredging alternatives and methods
- Environmental controls for suspended sediment plume during dredging
- Water level and water quality management within construction project

Geotechnical and Hydraulic Analysis for Final Condition of Single Cell Lake:

- Seismic modeling
- Stability and seepage analysis using field soil data
- Liquefaction analysis
- Sheet pile design
- Woven geotextile design
- Wick drain design
- Analysis of source quarry rock
- Access road section design
- Hydrology study for precipitation design event in the New River and San Felipe Creek
- Hydraulic analysis of spillway structures in single cell lake
- Determination of average annual flowrates through coordination with surrounding projects
- Analysis of desired salinity levels and water quality of single cell lake

10% Construction Documents for Permit Purposes:

- Road improvements
- Levee alignment and cross sections

- Spur levee alignments and cross sections
- Tie-in details with SCH and SSRREI
- Water level and salinity control features
- Overflow structures
- Energy dissipater structures
- Outline and Initialize Permitting Process

Any additional tasks and the scope of work for each task would need to be developed in coordination with various stakeholders. A summary engineering report will be prepared in draft form and submitted for review and a final report will be prepared which incorporates comments on the draft report.

8.3 Water Quality Evaluation and Conceptual Designs for Treatment Wetlands

Poor water quality in the Sea and its inflowing waters has been a long-standing concern for ecological and human health. For overall sustainability in the region, there is a need to improve water quality in the Sea and newly created habitats. This work will evaluate expected water quality changes (related to nutrients, dissolved oxygen, pathogens and selenium) in the Perimeter Lake, and how the adverse conditions might be addressed. The work will include a water quality and hydrodynamic model of the Perimeter Lake. The model will include an evaluation of multiple constituents including salt. The model will also evaluate flow velocities through the system. As part of the modeling effort, various treatment wetland scenarios will be assessed with a goal to determine the size and location of possible treatment wetland cells and develop conceptual designs.

8.4 Infrastructure Financing Phase 2

The current on-going infrastructure financing analysis indicates that infrastructure financing has a high probability of helping to fund Salton Sea management plans. The Phase 2 analysis will build on the work completed in Phase 1. The work will include development of bonding scenarios and work with the investment community and as well as local public officials. We anticipate the Phase 2 analysis will further address legislative changes that may be required to maximize bonding capacity and efficiency. The Phase 2 analysis will also refine existing scenarios to address comments received from the industry forum, the Salton Sea Authority Board and its members and constituents, and to make adjustments for the timing of alternatives for lakeside infrastructure construction and phasing.

Specific steps to be included in a second phase of analysis would include the following:

- Work with the Authority to identify Seaside Improvement costs
- Further analysis of the IFD allocation and preparation of the fiscal impact analysis
- IFD bonding assumptions (e.g. interest rate and debt service coverage)
- Development scenarios, including timing of absorption
- Implementation steps for IFD
- Extend development scenario to 75 years

8.5 Environmental Issues Documentation

An Environmental Issues Report should be prepared. The report would be prepared as a technical document to identify the environmental issues associated with the selected Salton Sea management concept. The environmental effects, both adverse and beneficial, of the various components of the plan would be identified. As an example, these would include the effects of dredging, stockpiling, and placing of lake-bottom sedimentary materials associated with the Perimeter Lake, as well as issues associated with the SSRREI and other management components. The report should be prepared for ease of incorporation into the Environmental Impact Report/Environmental Impact Statement (EIR/EIS) that is expected to be prepared for the overall Salton Sea Management Program.

8.6 Demonstration Project

A demonstration project is proposed to allow testing, data collection and observation of the main elements of the Perimeter Lake concept, especially the long-term behavior of placing fill in the sea and the dewatering behavior of the dredge spoils. The causeway may be left in the sea after the demonstration project and could be used as a fishing platform, boat ramp, or docking facility in the future as the lake levels recede. A figure of the conceptual causeway is shown schematically in Figure 22. Potential locations could include an area near the State Park, Yacht Club, or one of the Imperial County shoreline communities such as Salton City. The location could also be selected so that the structure could ultimately be converted into a causeway dividing two cells in the Perimeter Lake.

The project would generally consist of the following steps and items:

1. Subsurface exploration – Borings and sand cone penetrometer tests of the subsurface conditions under the demonstration project alignment.

2. Installation of foundation improvement geotextile over portions of the demonstration project alignment using anchors and micro piles. (estimate up to 100,000 sf of geotextile)

3. Building a causeway approximately 1,000 feet long using imported granular fill on top of the geotextile. The causeway would likely be constructed on the east side or north shore of the lake, to be closer to the existing quarries. The causeway would have a 50-foot crest with 1 vertical to 3 horizontal slopes. It would start on land at an elevation of -230' and terminate in the sea at a depth of -245'. The crest would be maintained at a -230' elevation. (estimate up to 25,000 cy of fill)

4. Install vertical sheet pile (vinyl of RFG) at the deep end of the causeway to test different methods of pile driving and materials. It is estimated that up to 1,000 lineal feet of sheet pile (35-60' deep) would be installed. The sheet pile could be installed in the location of the ultimate levee alignment. Test pad areas could be used to study alternative sheet pile configurations.

5. After the causeway and sheet pile are constructed, a large dredge mounted on a crane will be mobilized at the deep end of the causeway. This dredge would then excavate the sediments at the end of the causeway down to -260'. The dredges sediment (spoils) would be stockpiled in an adjacent area in the water such that it would from the water approximately 15-20 feet. This will allow for future testing and observation. (Estimate up to 5,000 cy excavated)

6. Test pads would be created stemming perpendicular from the demonstration causeway. These test pad areas would be used to test various scenarios in various depths of water and would be monitored as the sea level retreats.

Some of the goals of the demonstration project would be to observe and gauge the engineering response, constructability, performance, longevity, and durability of the Perimeter Lake levee construction methods and design concepts.

1. Drivability and loading using various sheet pile materials and installation methods.

2. Dredge production rates using various bucket sizes and reach lengths.

3. Shrinkage and bulking rate of material above and below water.

4. Angle of repose of stockpiled excavated and stacked dredge material above and below water.

5. Effects of geotextile in deep and shallow water.

6. Coffer dam constructability and seepage rates at various levels of head.

7. Drying and dewatering behavior of dredged native material and time required to allow for reworking with traditional earth moving equipment.

8. Settlement over time of various stockpile heights above and below water level with and without geotextile reinforcement.

9. Settlement of causeway with and without geotextile.

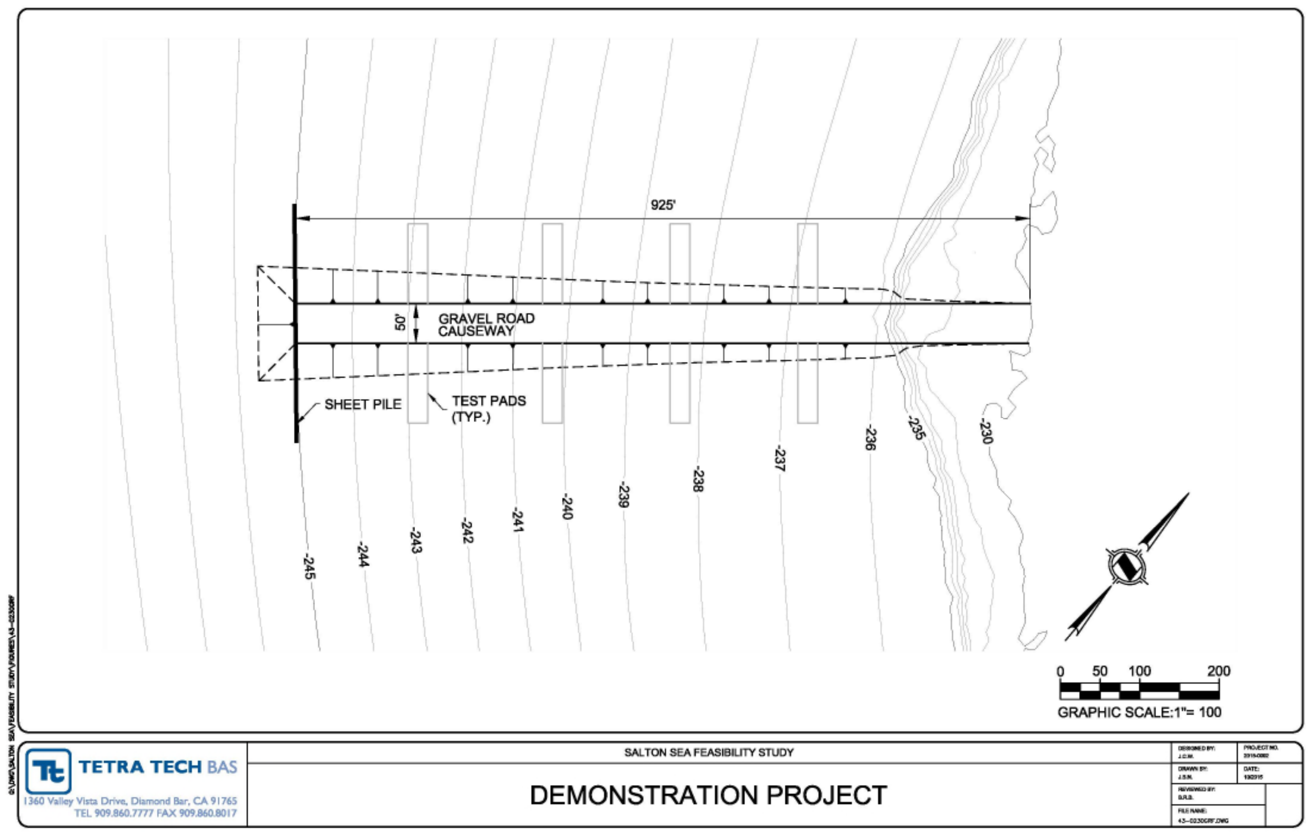

Figure 22: Schematic representation of causeway for potential demonstration project.

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