CHAPTER 4
ENVIRONMENTAL CONSEQUENCES OF PHASE 1 ACTIONS

The CEQ regulations for implementing NEPA state that "the discussion will include the environmental impacts of the alternatives including the proposed action, [and] any adverse environmental effects which cannot be avoided should the proposal be implemented . . . " (40 CFR 1502.16). The discussion should include direct and indirect effects and their significance. The significance of an impact should be evaluated in consideration of the context and intensity of the effect. Likewise, the Guidelines for Implementation of CEQA state that "An EIR shall identify and focus on the significant environmental effects of the proposed project" (14 CCR, Article 9, Section 15126.2). The cumulative effect of the action with other past, present, and reasonably foreseeable future actions also must be considered.

The discussions of the environmental consequences of Phase 1 of the Salton Sea Restoration Program covering all aspects of the human environment are provided here in the same order of resources as discussed for the affected environment in Chapter 3. The environmental consequences of each Phase 1 alternative, including No Action, are included. Discussions of the environmental consequences of Phase 1 common actions are provided in Chapter 5, and the environmental consequences of Phase 2 actions are discussed in Chapter 6.

4.1 SURFACE WATER RESOURCES

4.1.1 Summary of Environmental Consequences

For the No Action Alternative with continuation of existing inflows, salinity would continue to rise at a nearly constant rate, as the elevation would gradually increase. The current elevation is –227 ft msl. At current inflows, the rate of evaporation is approximately equal to the rate of inflow (5.78 ft/yr evaporation equals about 1.36 maf/yr at the current Sea elevation). By 2030, the salt concentration of the Sea would increase from the current value of around 44,000 mg/L to approximately 53,000 mg/L.

As salinity increases, the rate of evaporation per unit area decreases slightly, causing the Sea to rise in elevation. Elevation would gradually rise from –227 ft msl to –226 ft msl by 2030.

With reduced inflows, the rate of evaporation would exceed the rate of inflow, and the Sea level would decline until a new balance is achieved. The amount of salt added to the Sea each year would decrease slightly with the reduced inflows. However, the combination of a shrinking Sea and continued inflow of salts would cause the salinity to rise much faster than it would under current inflows. If the annual inflow is gradually reduced to 1.06 maf/yr by the end of Phase 1, the elevation of the Sea would reach –234 ft msl, and the salinity would increase to over 75,000 mg/L.

In addition to the salinity increase, the concentration of nutrients and other constituents that are carried into the Sea also would increase. Many of these nutrients are processed by organisms that live in the water column or in the bottom sediments of the Sea. Much of the waste produced by these organisms is ultimately deposited on the bottom, and some is converted to gasses that escape into the atmosphere. As the salts and nutrients accumulate in the Sea, the biological community would evolve. The changes in the biological community may affect water quality by altering the rate at which nutrients and certain mineral salts are removed from the water column.

Slight declines in elevation would not substantially change the general circulation pattern of the Sea. However, further declines might affect the rate of change in temperature, increase the velocity of wind-driven currents in certain areas, and increase the hydraulic separation of the northern basin from the southern basin.

Alternative 1 would reduce the volume and surface area of the Sea, displacing part of the Sea with concentration ponds. If the average annual inflow to the Sea continues at its current value of 1.36 maf/yr, the elevation of the Sea is projected to reach -229 ft msl by 2030. The salinity at that time is projected to be about 37,000 mg/L compared to 53,000 mg/L for the No Action Alternative. If the average annual inflow declines to 1.06 maf/yr, the elevation is projected to reach –237 ft msl for Alternative 1. For this case, the salinity is projected to be about 46,000 mg/L in 2030 compared to 75,000 mg/L for the No Action Alternative with reduced inflows. A significant adverse impact on water quality would occur if the ponds were to breach and the brine contained in them were to drain into the Sea.

Alternatives 2 and 3 would have identical impacts on elevation and water quality. If the average annual inflow to the Sea continues at its current value of 1.36 maf/yr, the elevation of the Sea is projected reach -232 ft msl by 2030. The salinity at that time is projected to be about 45,500 mg/L. If the average annual inflow declines to 1.06 maf/yr, the elevation is projected to reach –237 ft msl for either Alternative 2 or 3. For this case, the salinity is projected to be about 54,000 mg/L in 2030 compared to 75,000 mg/L for the No Action Alternative with reduced inflows.

Alternative 4 would combine an EES with concentration ponds. If the average annual inflow to the Sea continues at its current value of 1.36 maf/yr, the elevation of the Sea is projected reach -229 ft msl by 2030. The salinity at that time is projected to be close to 40,000 mg/L compared to 53,000 mg/L for the No Action Alternative. If the average annual inflow declines to 1.06 maf/yr, the elevation is projected to reach –235 ft msl for Alternative 4. For this case, the salinity is projected to be about 47,000 mg/L in 2030 compared to 75,000 mg/L for the No Action Alternative with reduced inflows.

Alternative 5 would combine a concentration ponds with an in-Sea EES. If the average annual inflow to the Sea continues at its current value of 1.36 maf/yr, the elevation of the Sea is projected reach -232 ft msl by 2030. The salinity at that time is projected to be about 41,000 mg/L compared to 53,000 mg/L for the No Action Alternative. If the average annual inflow declines to 1.06 maf/yr, the elevation is projected to reach –236 ft msl for Alternative 5. For this case, the salinity is projected to be about 46,000 mg/L in 2030 compared to 75,000 mg/L for the No Action Alternative with reduced inflows.

4.1.2 Significance Criteria

Impacts on surface water resources include changes in water quality, changes in the quantity of water available for existing or potential beneficial uses, changes in hydraulic conditions (for example, changes in depth or configuration of the Sea that could affect current velocity, mixing, sediment deposition, or other limnologic processes), and changes in drainage patterns that increase the potential for flooding or desiccation of existing wetlands. In general, change is measured relative to existing conditions and then with respect to expected conditions if the project is not implemented (No Action Alternative). Inflows to the Salton Sea are highly dependent on the amount of water imported to the Salton Sea Basin from the Colorado River. Current inflow to the Salton Sea has been defined as an average of 1.36 maf/yr of water entering the Salton Sea, based on the historical average inflow during the past 50 years.

Impacts are judged to be significant if they result in noncompliance with existing regulatory standards, plans, or policies. See Chapter 9 for a discussion of the applicable regulatory standards. Otherwise, the significance is based on the degree of harm they may cause to people or the environment. In general, any degradation of water quality that may reduce the existing or potential beneficial uses of the water is considered significant. The significance of a reduction in the quantity of water available for beneficial uses depends on the size, timing, duration, and permanence of the reduction. The significance of changes in hydraulic conditions depends on the context in which the change occurs. Increased flooding potential is deemed significant if it increases the 100-year flood zone or if it could result in increased potential for injury, loss of life, or damage to existing structures or property. Desiccation is considered significant if it could result in a loss of wetlands.

4.1.3 Assessment Methods

Quantitative versus Qualitative Methods. Two quantitative mathematical modeling tools were used to evaluate the potential effects of the alternatives on future conditions. A spreadsheet-based mass-balance and water budget accounting model, the Salton Sea

Accounting Model, was used to predict the range of future effects of the alternatives on salinity, elevation, and surface area of the Sea. The UC Davis Hydrodynamic Model of the Salton Sea was used to estimate the effects of changes in Sea elevation. The modeling efforts described below represent the preliminary effort to quantify these effects. Further modeling may be conducted as the need arises or as the alternatives are further refined. However, the preliminary results provide a basis for identifying the principal effects.

Except for the results of this mathematical modeling, the impacts on water resources discussed in this section are based on professional judgment. In general, the hydrologic effects of the alternatives are expected to result in beneficial impacts on water resources relative to expected conditions if no action is taken. Where uncertainty exists in the choice of assumptions affecting future conditions, an attempt has been made to identify the range of potential effects, whether adverse or beneficial, and to focus on the causes.

Qualitative evaluation of impacts has been aided by consultation and input from members of the Salton Sea Science Subcommittee. This input was especially important due to the complexity and interconnectedness of physical and biological conditions within the Salton Sea ecosystem and because of the rapidly evolving scientific understanding of the physical and biological environment of the Sea. In this regard, the research being conducted under the supervision of the Science Subcommittee already represents an important part of the database available for describing and interpreting these conditions.

Salton Sea Accounting Model. The potential impacts of the project alternatives are assessed by comparison to existing conditions and to predicted conditions extended into the future, assuming that the project is not built (the No Action Alternative). A numerical model first developed by Thiery (1998) and significantly enhanced for the Salton Sea Restoration Project (Reclamation 1999b) was used to predict the salinity, elevation, and surface area of the Salton Sea over time. The most significant enhancement being a new ability to perform stochastic simulations. The model was used to predict how salinity, elevation, and surface area would change over time for the No Action Alternative and for the project alternatives. The planning horizon addressed by the model is 100 years.

A detailed description of the modeling process, assumptions, and results is presented in a document prepared by Reclamation (Weghorst 1999). A summary of the modeling assumptions and results is provided in this section, but the reader should consult the Reclamation document for further details.

The Salton Sea Accounting Model developed by Reclamation requires that certain input variables be defined by the user. The choice of values for these variables is based on certain assumptions about current and future conditions. The model then calculates the elevation, salinity, and surface area of the Salton Sea at the end of each year.

For modeling purposes, the concentration of dissolved salts in the inflow was assumed to change as a function of the annual inflow. Three average long-term inflow scenarios were modeled. The current average annual inflow was assumed to be 1.363 maf/yr (this value is rounded to 1.36 maf/yr in the remainder of this document). This assumption is based on the average historical inflow rate during the past 50 years. Two reduced inflow scenarios of 1.06 maf/yr and 0.8 maf/yr, as described in section 2.3 of chapter 2, were also modeled. For the current inflow rate of 1.36 maf/yr, the average annual dissolved salt concentration in the inflow was assumed to be 2,800 mg/L. For 1.06 maf/yr and 0.8 maf/yr, the average annual salt concentrations in the inflow were assumed to be 3,460 mg/L and 4,110 mg/L, respectively. This is based on the assumption that conservation measures would have the effect of concentrating salts in the inflow.

In the model, the inflow rate and salinity of the inflow can be varied each year. For the reduced inflow scenarios, the reductions would occur in 10,000 af (or 0.01 maf) annual increments, beginning in 2002. Based on this assumption, it would take 30 years to reduce the average annual inflow rate from 1.36 maf/yr to the intermediate reduced inflow rate of 1.06 maf/yr. After 30 years, no further reductions would occur in the 1.06 maf/yr scenario. For the maximum reduction in inflow, it would take an additional 26 years to reach an average inflow rate of 0.8 maf/yr, after which no further reductions would occur.

Historically, the inflow rate to the Salton Sea has varied from year to year. Average inflow rate over that 50-year period has remained fairly stable. In any one year, changes in cropping patterns, weather, municipal use, water use in the Mexicali Valley, or variations in the deliveries through the All American Canal cause the inflow rate to the Sea to vary. The historical record indicates that in 95 percent of the years the inflow rate will not be higher than 1.55 maf/yr or lower than 1.19 maf/yr.

This annual variation could be important to the successful design and implementation of a restoration alternative. Therefore, the modeling process took into account the historical variation. In addition to estimating the average future values of the salinity, elevation, and area over time, the model was designed to calculate the standard deviation from the mean and the upper and lower 95 percent confidence limits for each of the parameters simulated. The method used to obtain these statistical estimates is described further in the Reclamation (1999).

The accounting model has the ability to simulate the importation of flood flows, which are periodically available from the Colorado River. As with the other inflows discussed above, the amount of flood flows vary from year to year. In many years, no flood flows are available at all. The availability of flood flows in the future was estimated using probability distributions described in the Reclamation (1999).

The ability to import flood flows also depends on the availability of excess carrying capacity in the All American and Coachella canals. In order to ensure that available flood flows can be delivered to the Sea, an assumption was made that the total excess carrying capacity of the canals is 1,250 cfs over a four-month period. One thousand two-hundred and fifty cfs over a four-month period is equivalent to 300,000 af/yr. The annual volume of flood flows, between 0 and 300,000 af/yr, was determined from probability distributions for each year in the 100-year simulation period. The results were added to the probabilistically determined base inflow for each year corresponding to the appropriate inflow scenario (current or reduced conditions). The concentration of salts in the flood flows is assumed to be the maximum allowed at Imperial Dam, 800 mg/L.

The model assumes that the evaporation rate from the Sea depends on the salt concentration of the water. At higher salt concentrations, the evaporation rate decreases. The process is described in Reclamation (1999).

In modeling, an attempt was made to achieve the salinity and elevation objectives of the project as closely as possible. A target elevation of –232 ft msl was used for modeling purposes. Upon further refinement of the modeling process in the future, this value will likely be adjusted to –230 ft msl. The target salt concentration was set at 37,500 mg/L. The model simulations assume that the construction of the Phase 1 evaporation pond and/or EES facilities would be completed in 2008.

Hydrodynamic Modeling

Only preliminary simulations of the effects of the alternatives on hydrodynamic conditions in the Salton Sea have been performed to date. Model simulations have been performed to estimate changes in direction and speed of currents, and changes in temperature and salinity, under specific meteorological conditions. The simulations were performed to compare the horizontal component (plan view) of the current velocity field when the elevation of the Sea is reduced from –227 ft msl (current elevation) to –236 ft msl (approximate stable elevation when inflow is reduced under the No Action Alternative).

The model input assumptions, such as the particular sequence of wind velocities (speed and direction) and the estimated frictional and turbulence coefficients that were used to simulate the future reduced inflow condition were the same as assumed for calibrating the model to observed conditions. Wind velocity inputs were based on the measured data set for the period from October 8 to October 29, 1997. The effects of the tributary inflows, based on the level of inflow that existed during the calibration period, were included, but were not varied.

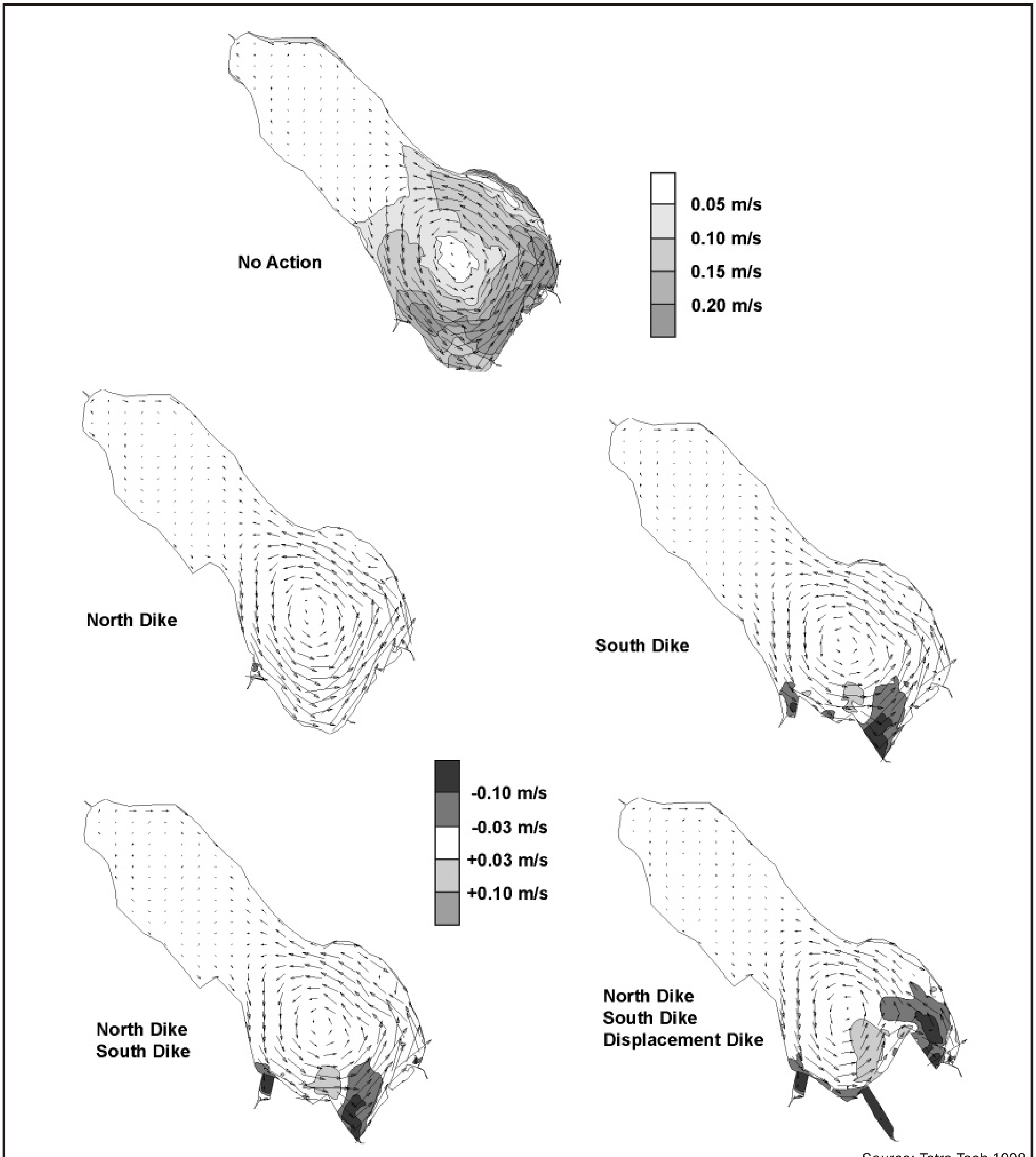
The shoreline boundaries were modified to approximate the shoreline configuration with the alternatives in place. Simulations were performed at the current elevation of –227 ft msl, for the No Action Alternative, with the North Concentration Pond dike in place, with the South Concentration Pond dike in place, with both the North and South Concentration Pond dikes in place, and with the North, South, and Displacement Pond dikes in place.

Simulations were also performed to investigation hydrodynamic conditions at a lower elevation. The elevation of –236 ft msl was selected because the Sea is expected to decline to this elevation (or approximately to this elevation) under all of the alternatives at some time during Phase I operation. Simulations assuming this elevation were performed with shorelines representing No Action, and for various alternative configurations, all with the Displacement Pond dike in place (since the Displacement Dike would likely be present if the elevation declines significantly. The alternative configurations included the Displacement dike alone and in combination with the North Concentration Pond dike, with the South Concentration Pond dike, and with both the North and South Concentration Pond dikes in place.

Figure 4.1-1 shows the direction and magnitude (speed) of the currents near the surface of the Sea with each of the dike configurations at the current elevation of the Sea. The figure portrays conditions at the height of a storm that moved through the area on October 23, 1997. The direction of the arrows shows the direction of the current, but the speed of the current is shown by the length of the arrow. The plot showing conditions under the No Action Alternative is shaded to highlight the distribution of current speeds, with the higher speeds shaded darker. This plot highlights the fact that velocities in the south basin of the Sea tend to be significantly higher than in the north basin. In addition, shading is used on the plots of the alternative configurations to portray the areas in which the speed of the currents would increase or be reduced relative to the No Action Alternative. In this case, darker shading represents a larger change.

Figure 4.1-2 shows information similar to that in Figure 4.1-1, for the same time period, except that the elevation has been reduced to –236 ft msl in order to simulate conditions that would occur if the Sea level decreased due to reduced inflows. All of the configurations include the Displacement Pond dike. The results shown in the figures are discussed further below, relative to each of the alternatives.

Figure 4.1-3 shows the results of simulations of salinity in the Sea for calm conditions that occurred on October 18, 1997. Conditions at two elevations are shown for the No Action Alternative and for a configuration that includes the



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Source: Tetra Tech 1998

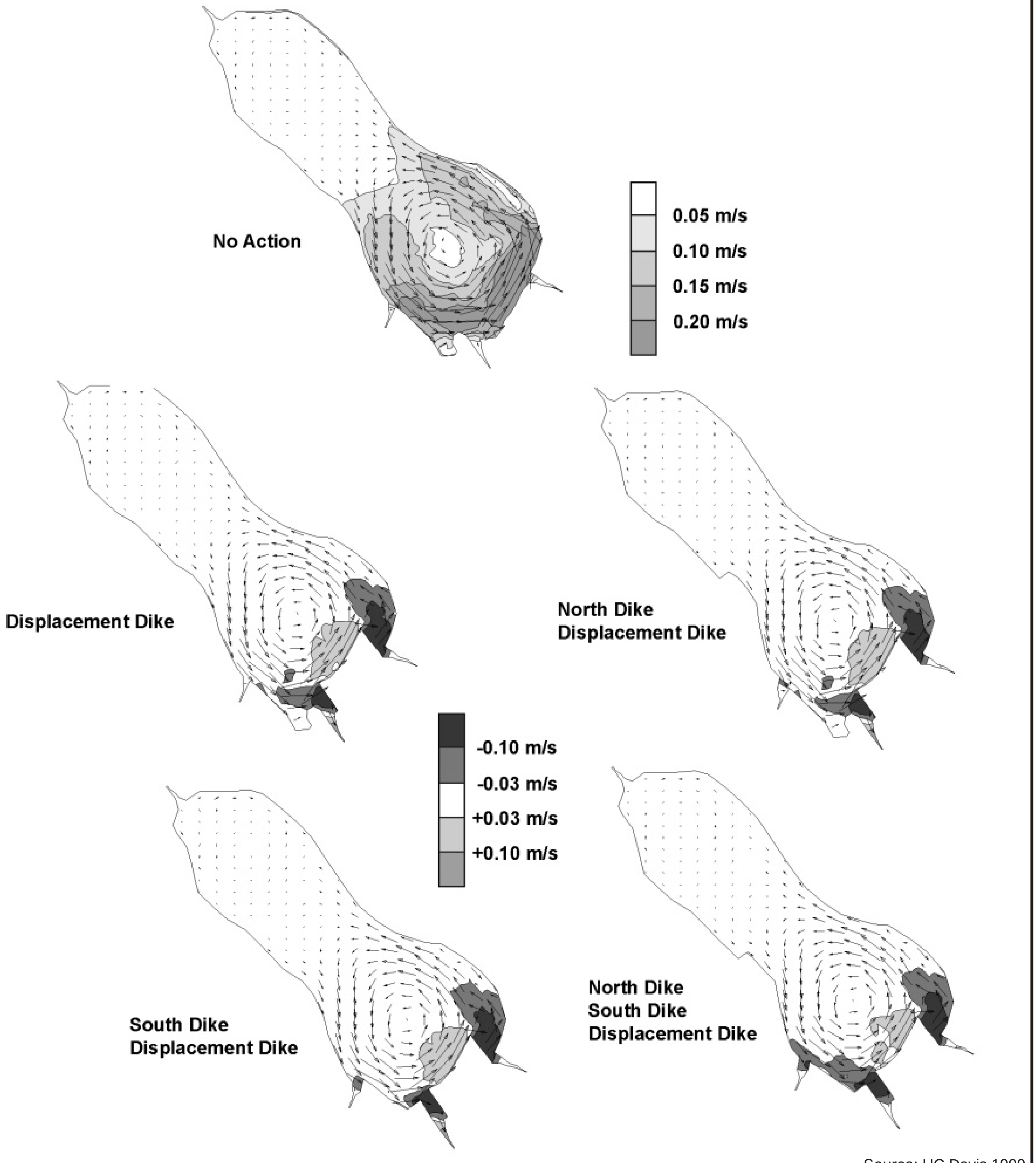
Current velocity simulation generated from meteorologic data for October 8-29, 1997. Conditions shown are for peak wind October 23, 1997.

Comparison of Current Velocity Distributions at -227 feet msl

Salton Sea, California

Tetra Tech, Inc.

Figure 4.1-1



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Source: UC Davis 1999

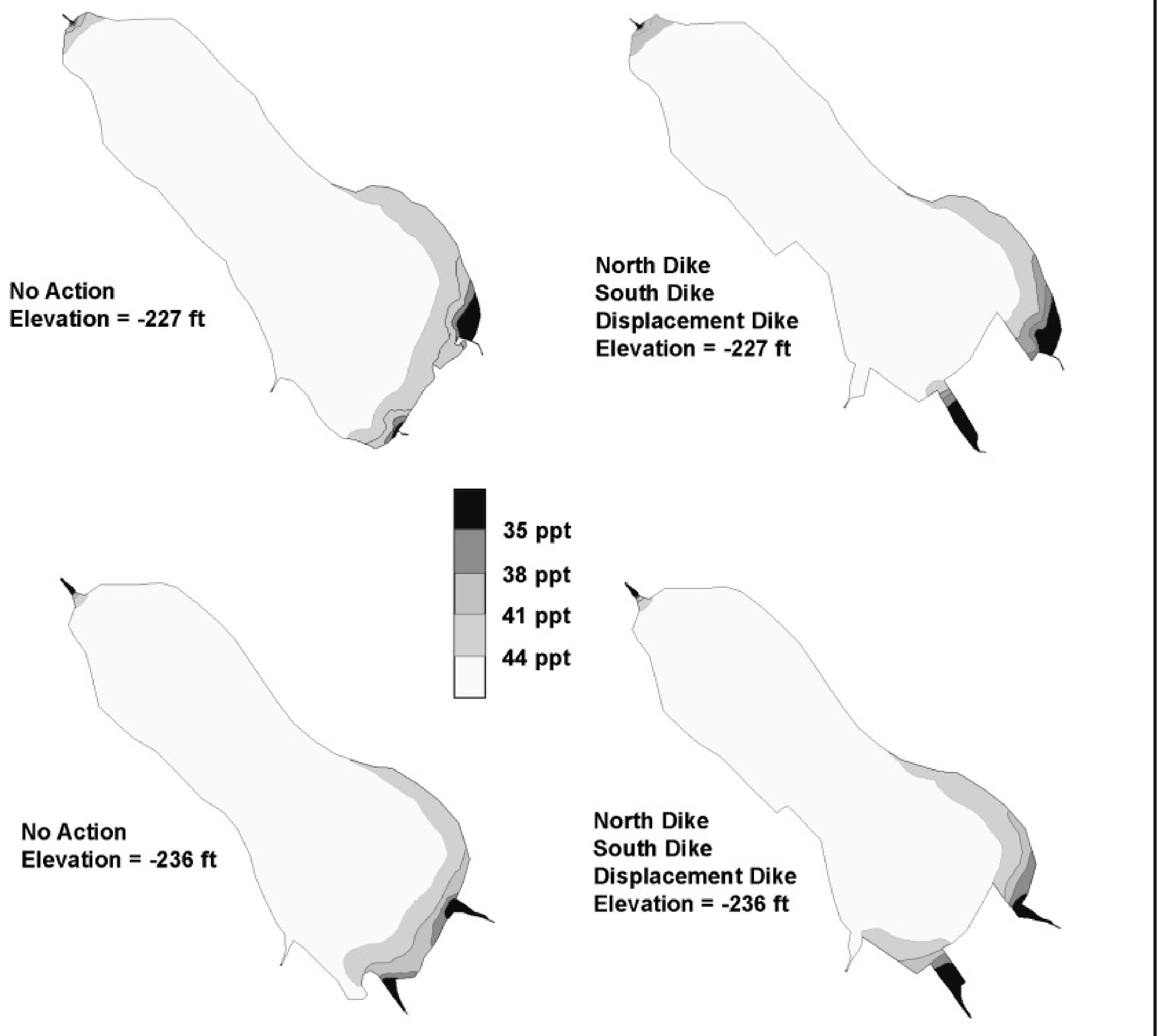
Current velocity simulation generated from meteorologic data for October 8-29, 1997. Conditions shown are for peak wind October 23, 1997.

Comparison of Velocity Distributions at -236 feet msl

Salton Sea, California

Tetra Tech, Inc.

Figure 4.1-2



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Simulations generated by
meteorologic data for
October 8-29, 1997.

Comparison of Simulated Salinity in Calm Conditions (October 18, 1997)

Salton Sea, California

Tetra Tech, Inc.

Figure 4.1-3

North and South Concentration Pond dikes and the Displacement Pond dike. The dark areas represent fresher water (lower salinity) than the light areas. The plots show the salinity near the surface of the Sea. Results not presented on the plots show that a salt water wedge would form near the mouths of the tributaries, in which fresher water overlies saltier water. Therefore, as a rule, if the plots had shown conditions at a greater depth, the area of transition from fresh to salt water would be narrower at depth.

Figure 4.1-4 shows the same information as Figure 4.1-3, except at the height of the storm event of October 23, 1997, when current speeds were higher.

Figure 4.1-5 shows the effects of differences in wind velocity, elevation, and shoreline configuration on temperature at the surface of the Sea. The plot showing No Action conditions during the storm of October 23, 1997 is presented because it is illustrative of the temperature distribution with lower Sea elevation and with a different shoreline configuration. Based on the results of the simulations, current velocities in the range that occurred in that storm period would produce nearly homogeneous surface temperatures throughout the Sea. The simulations suggest that temperature variations develop during calm conditions, probably mainly due to differences in water depth.

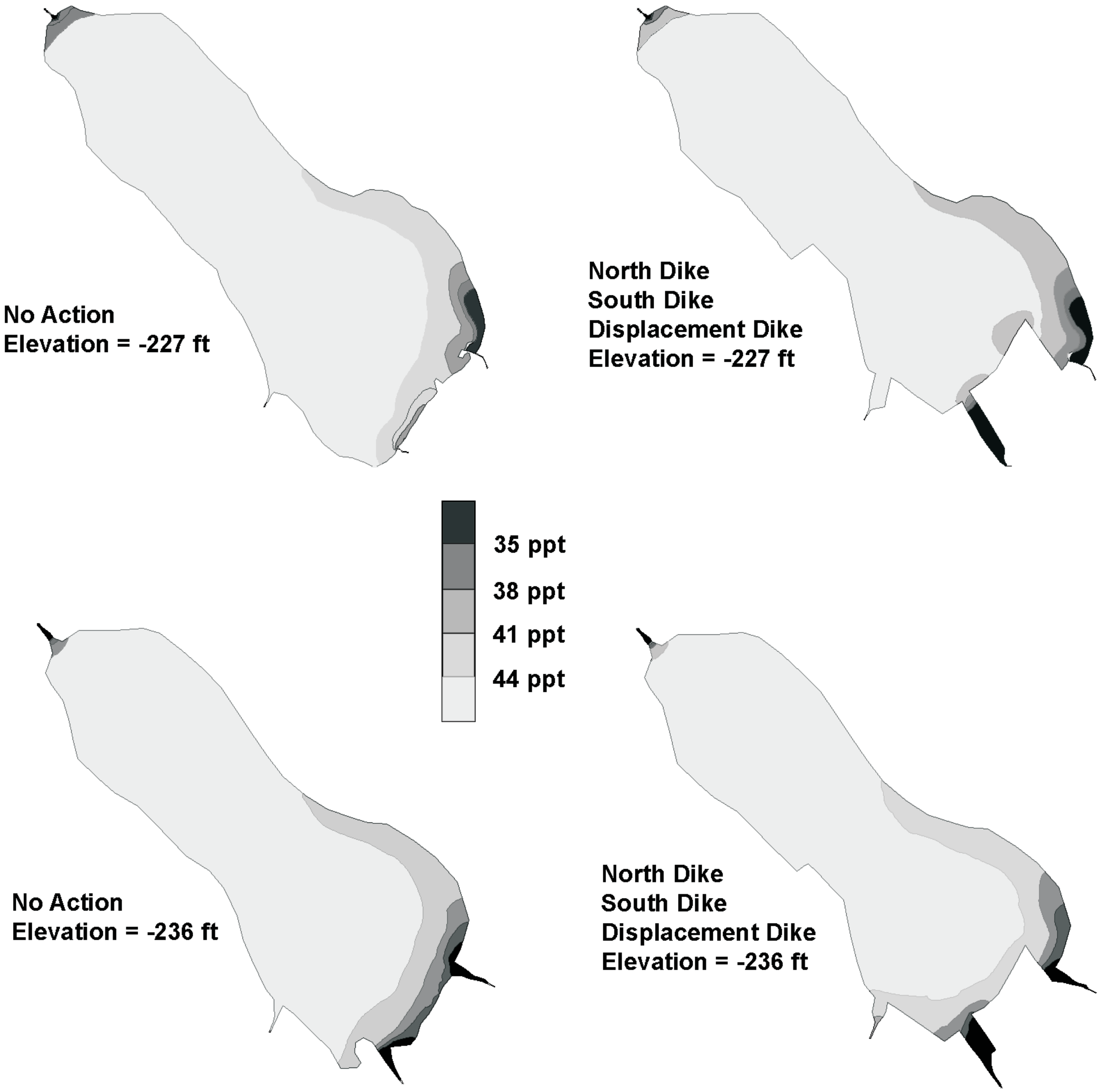
4.1.4 No Action Alternative

Effect of No Action with Continuation of Current Inflow Conditions

Table 2.4-1 summarizes the modeling outcomes for each of the alternatives in the middle of Phase 1 (2015), at the end of Phase 1 in 2030 and in 2060 (30 years into Phase 2). Figures 2.4-1 through 2.4-3 compare the changes in the elevation and salinity of the Salton Sea over time, for average inflow rates of 1.363 maf/yr, 1.060 maf/yr, and 0.8 maf/yr, respectively. Figure 4.1-6 illustrates the range of annual variability of No Action conditions. Figure 4.1-6 shows the upper and lower 95 percent confidence limits and one standard deviation above and below the mean Figure 4.1-6 was prepared using current inflow conditions by stochastically modeling a large number of randomly selected sequences of annual inflows.

Salinity Effects. The model results show that with inflows averaging 1.36 maf/yr, the salinity would increase at a steady average rate of a little less than 400 mg/L/yr. The salinity would be about 53,000 mg/L by 2030. The salinity might range from the mean due to variations in actual annual inflows. Based on the modeling assumptions, the salinity in any year can be expected, with 95 percent confidence, to be within about seven to nine percent of the salinity expected if the average inflow were maintained.

Currently, there are no regulatory criteria for salinity in the Salton Sea. Therefore, the projected increase in salinity does not have any regulatory significance. However, an increase in salinity is likely to have impacts on a



Source: UC Davis 1999

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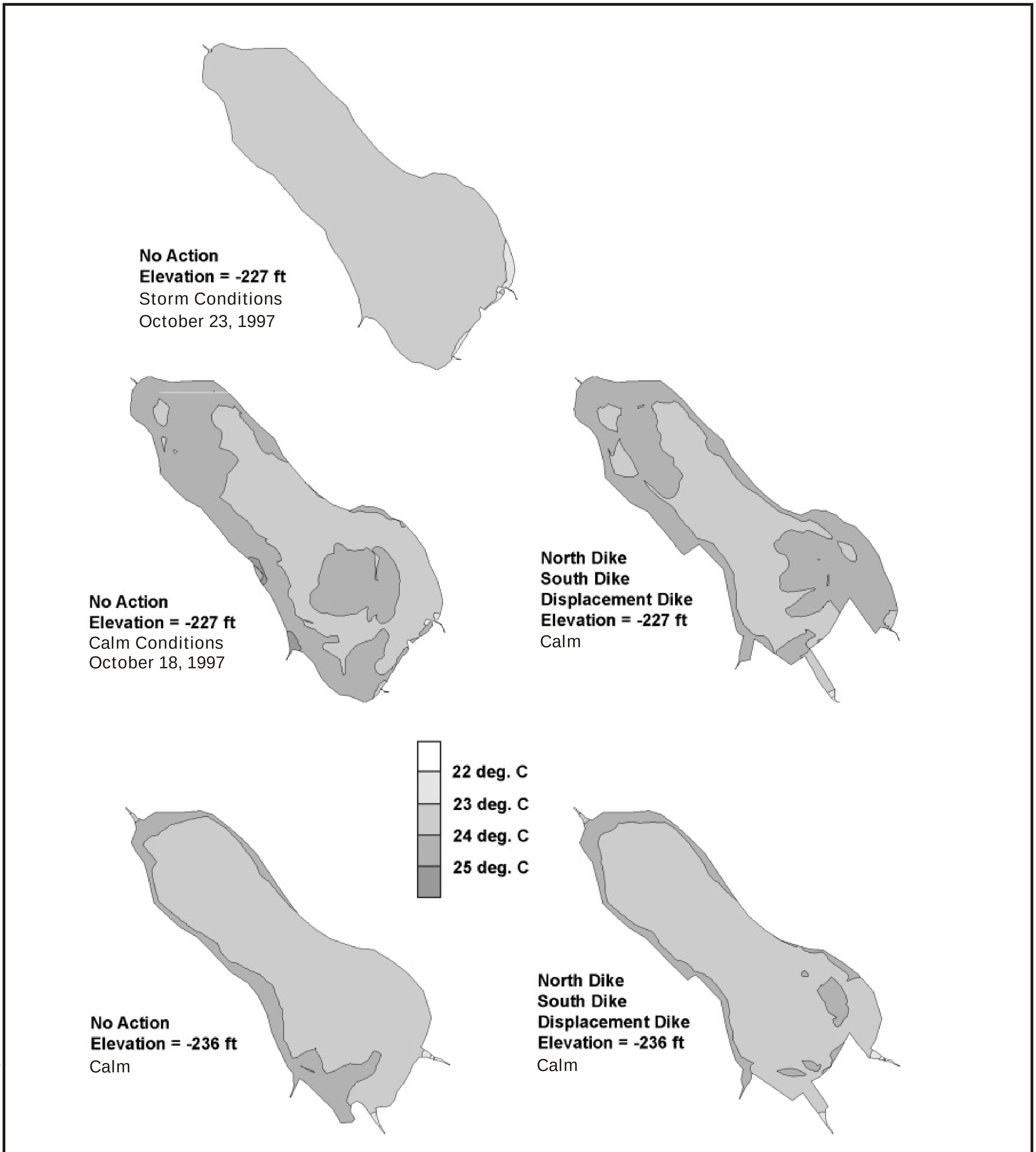
Simulations generated by meteorologic data for October 8-29, 1997.

Comparison of Simulated Salinity in Storm Conditions (October 23, 1997)

Salton Sea, California

Tetra Tech, Inc.

Figure 4.1-4



Source: UC Davis 1999

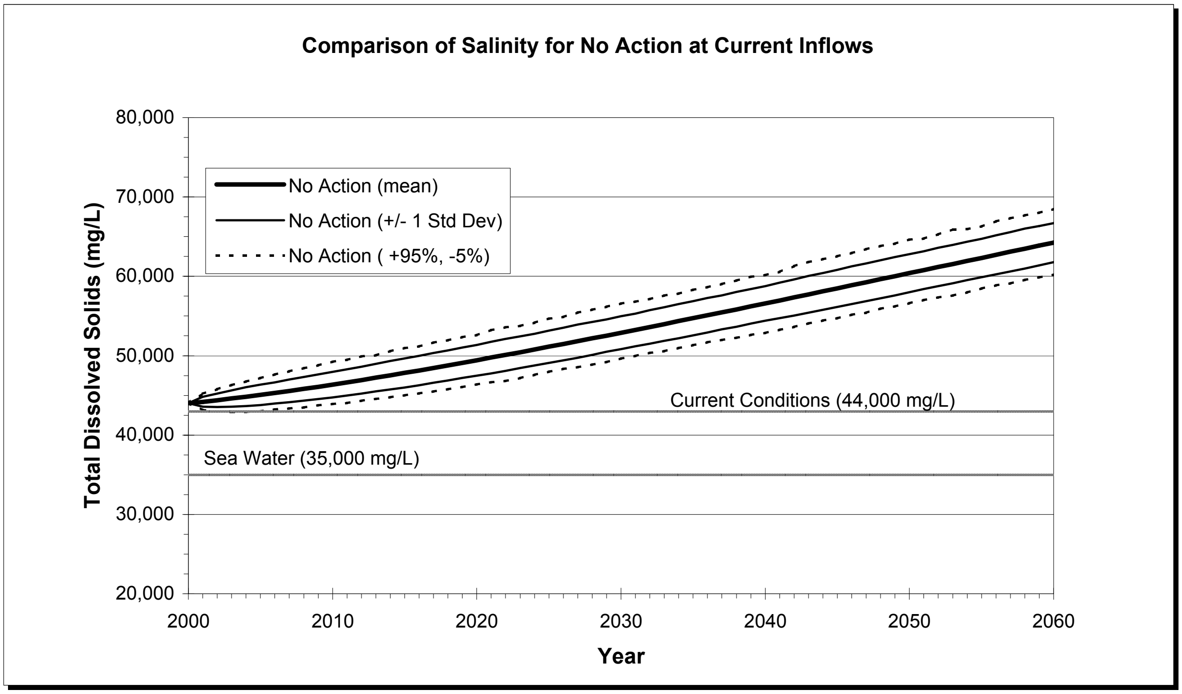
Simulations generated by meteorologic data for October 8-29, 1997. Temperature was nearly homogeneous for storm conditions for all alternatives.

Comparison of Temperature Distribution at Surface of Sea under Storm and Calm Conditions

Salton Sea, California

Tetra Tech, Inc.

Figure 4.1-5



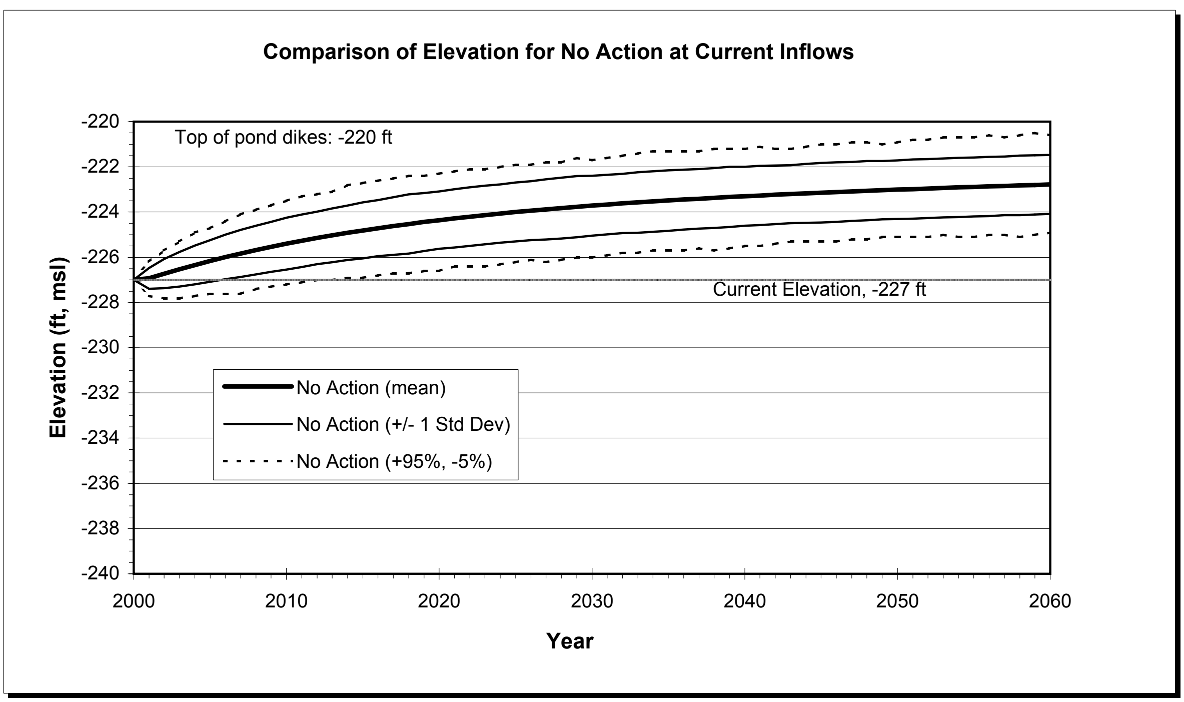


Figure 4.1-6 Range of Variability in Salinity and Elevation due to Variable Annual Inflows, No Action with Current Inflow Scenario (1.36 maf/yr)

number of other resources, including biological, recreational, and socioeconomic. The significance of the salinity increases with respect to these other resources is discussed in subsequent sections.

Elevation Effects. The elevation of the Sea would increase slightly from its current level of –227 ft msl due to the reduced rate of evaporation caused by the salinity increase. Under current inflow conditions, the elevation is expected to rise to about –223 ft msl by 2060.

Circulation Effects. Hydrodynamic conditions in the Sea are not expected to be significantly affected by the increase in salinity or the small increase in elevation. The average density of the water in the Sea would increase, possibly increasing the stability of density stratification in some parts of the Sea where stratification occurs, such as near the mouths of the major tributaries. Based on anecdotal evidence, this stratification effect, which occurs locally in the Sea under current conditions, does not appear to be very stable at current salinities. This is probably because the amount of inflow is small relative to the surface area of the Sea, which causes the fresher surface layer to be thin. Under these conditions, wind and the high evaporation rates at the surface of the Sea promote rapid mixing of freshwater inflows. Density stratification would have the effect of causing circulation patterns in the less dense surface layer to differ from circulation patterns in the underlying layer.

Effects on Colorado River Downstream of Flood Flow Diversion. Under the No Action Alternative, flood flows (flows in excess of the amount of the 1944 Treaty obligation to Mexico that cannot be used or stored within the U.S.), will continue to be released. The quantity of these flood flows is expected to decrease over time as the storage and diversion capacity within the U.S. expands. None of this expanded diversion or storage capacity is expected to affect the Salton Sea. However, baseline flood flow conditions on the lower Colorado River are likely to change.

Effect of No Action with Reduced Inflows

Salinity Effects. Table 2.4-1 and Figure 2.4-2 show the results of simulating No Action conditions, with inflow gradually reduced to 1.06 maf/yr during Phase 1.

The salinity is expected to reach more than 75,000 mg/L by the end of Phase 1. As the salinity increases, carbonate and sulfate salts are likely to precipitate from solution, and the Sea water would become enriched in sodium and potassium chloride salts. This precipitation is not included in the modeling assumptions, but it would have the effect of reducing the salinity compared to the model projections. Chemical and biological precipitation of carbonates and sulfates would probably occur near the mouths of tributaries, where contrasts in water quality are greatest and where new loading to the Sea originates. As indicated above, the increase in salinity would not exceed any existing regulatory thresholds. However, the impacts of increased salinity on other resources would likely be significant and are discussed elsewhere in this chapter.

Elevation Effects. The elevation of the Sea would decrease with reduced inflows. Figure 2.4-2 shows that the elevation would initially drop at a rate of about one-half to three-quarters of a foot/yr. The Sea would reach a minimum elevation of about –234 ft msl at the end of Phase 1.

Circulation Effects. Currently, the maximum depth of the Sea is about 51 ft. The maximum depth of the Sea would be reduced to about 44 ft at the end of Phase 1 and to about 37 ft after another 30 years. The shape of the Sea would be similar to its current shape. However, the depth of the low ridge separating the northern and southern depressions would be reduced to about 28 to 29 ft, compared to its current depth of about 42 to 43 ft.

The results of hydrodynamic modeling of a 9 ft decline in Sea elevation suggests that the overall circulation pattern would be nearly identical to the pattern that exists when the Sea is at –227 ft msl. For both existing and reduced elevations, the model showed that a counterclockwise gyre is produced in the southern basin of the Sea by the prevailing northwest winds, while a less pronounced clockwise rotation occurs in the northeastern portion of the Sea. The highest current velocities would still occur along the southwest shore, south of Salton City. The magnitude of nearshore currents would decrease somewhat relative to existing conditions along the east shore, near Bombay Beach. In general, current velocities tend to be highest in shallow water near the shore. However, with shallower water, more rapid changes in current velocities are expected in certain areas, in response to wind forces.

The model simulations show that the distribution of salinity in the Sea would remain much the same at –236 as at –227 ft. Emergent bottom topography might have a localized effect on salinity. For example, the area of fresher water that exists between the mouth of the Alamo River and Mullet Island when the Sea is at its current elevation would disappear when the Sea level declines to –236 ft.

In addition to the direct effects of circulation, increased velocities may have the effect of transporting dissolved oxygen to greater depths within the water column. However, higher current velocities also could result in greater disturbance of bottom sediments. Bottom sediments are high in organic matter, which uses up oxygen as it decays. Similarly, bottom sediments tend to contain high concentrations of chemically reduced forms of nitrogen (ammonia), phosphorous, iron, and sulfur (hydrogen sulfide), which can combine with and remove dissolved oxygen from the water column. Some substances, including selenium, can become more soluble or biologically available in their oxidized forms. Increased current velocities could increase the turbidity of the water, reducing the depth to which light can penetrate and therefore the effective depth of photosynthesis, which is a source of dissolved oxygen in near-surface waters. Increased current velocities would tend to speed up the transport and distribution of particulates or substances generated within the Sea, including, perhaps, algal toxins. The causes and ecological consequences of algal toxins in the Sea is a subject of current research. Chemical-biological interactions are discussed more fully in the aquatic biology section.

Effects on Colorado River Downstream of Flood Flow Diversion Point. Reduced inflows to the Salton Sea would not affect the amount of excess water delivered to Mexico from the Colorado River. Downstream impacts would be the same as described above for current conditions. Future reduced flood flow deliveries to Mexico resulting from have been factored in to this analysis.

4.1.5 Alternative 1

In this analysis, the Salton Sea is defined as that portion that lies outside the concentration ponds. The ponds perform two restoration functions. They help reduce the salinity of the Sea by removing salts and concentrating them in the ponds. They also displace a portion of the Sea, and thus enable the elevation of the Sea to be maintained closer to the target elevation under reduced inflow conditions.

Two ponds, with a combined surface area of about 34 mi^2, would be created by constructing dikes outward from the shore, beginning at the four points where they intersect the –220-foot topographic contour. The location and configuration of the ponds is shown on Figure 2.4-4, and a typical cross-section of the dikes is shown on Figure 2.4-5.

The dikes would be constructed outward to approximately the –250 ft msl bathymetric contour. The seaward portions of the dikes would be constructed on firm deposits that are estimated to underlie an average of about five feet of soft sediments. The soft sediments would be removed by dredging, and the dredged sediments would be disposed of in the Sea, as construction of the dikes progresses, between sediment curtains designed to reduce the dispersion of suspended sediments in near surface water. The dikes would be constructed outward by dumping quarried material from the ends of the dikes. The tops of the dikes would be 30 ft wide, the maximum height of the dikes would be 35 ft (above the firm sediments at the -250 ft msl contour). The dikes are intended to have a minimum freeboard of five ft. The maximum width at the base of the dikes would be 275 ft (assuming 3.5:1 side slopes). The dikes would cover a bottom area of about 750 acres, requiring dredging and in-Sea disposal of an estimated 6 million yd^3 or more of soft sediments. The maximum water depth along the dikes would be 23 ft.

The ponds would be operated by pumping water from the Sea into the ponds until the elevation inside the ponds reaches –227 ft msl (the current Sea elevation). In practice, as water evaporates from the ponds, more Sea water would be pumped in. But due to the simplifying assumptions of the model, all of the water is assumed to be transferred at the end of each year. The ponds reduce the salinity of the Sea because they remove water containing the average concentration of salts in the Sea, while the inflow to the Sea is at a much lower concentration. The maximum pumping rate to the ponds is determined by the evaporation rate from the ponds. Initially, when the concentration of the Sea is 50,000 mg/L, the evaporation rate from the surface of the ponds would be nearly 121,000 af/yr. However, as the concentration of salts inside the ponds increases, the evaporation rate will decrease. The salt concentration inside the ponds would increase rapidly until it reaches the concentration at which solid salts are precipitated from the saturated brine when the concentration reaches 244,000 mg/L (equivalent to about 200 ppt, or 20 percent by weight). It is assumed that this would occur in about the seventh year of operation. At this time, the rate of evaporation would be about 4.7 ft/yr, instead of 5.8 ft/yr, and the maximum rate of evaporation from the ponds would be 98,000 af/yr.

Effect of Alternative 1 with Continuation of Current Inflow Conditions

North and South Evaporation Ponds

Salinity Effects in the Sea. Modeling results comparing the change in salinity and elevation for three inflow rates are plotted in figures 2.4-1 through 2.4-3. For modeling purposes, the ponds were assumed to begin operating in 2008. The first seven years shown on the graphs are equivalent to the first seven years of the graphs of no action. The plot of the change in salinity with current inflows shows that the salinity of the Sea would be approximately 37,000 mg/L (about the salinity of sea water) by the end of Phase 1 (2030). (It should be noted that the model simulation results are based on the assumption that an accelerated Phase 2 pump-out component would be available by 2015 to prevent the sea elevation from rising too high. This is discussed further below, under Elevation Effects).

The model output provides an estimate of the overall variability in inflows from all causes, which, in turn, would effect the salinity and water surface elevation. This is reflected in the upper and lower 95 percent confidence intervals and the standard deviation from the mean. The one standard deviation confidence interval for salinity for all alternatives is about +/- 3,000 mg/L.

Effects of Salinity in the Ponds. Some of the dissolved elements present in the Sea may be concentrated in the brine rather than precipitating out of solution; a six- or seven-fold concentration could occur. The specific chemical precipitation sequence for the constituents of Salton Sea water have not been quantified. Many of the metals of concern, such as lead, zinc, copper, and cadmium may precipitate from the brine as chlorides. Any compounds that do not form insoluble chemical compounds could become concentrated in the brine, creating a potential toxic hazard to wildlife using the ponds.

Elevation Effects. Preliminary modeling results have shown that the elevation of the Sea would gradually rise to the elevation of the top of the dikes after about 25 years of operation. This rise in elevation would be caused by the difference between the evaporation rate from the ponds and the net annual inflow to the Sea (less evaporation from the surface of the Sea). In order for Alternative 1 to remain viable for the range of potential inflow rates and the rate of decrease in inflow that has been assumed, it is necessary to remove water from the Sea beginning in about 2015. Therefore, subsequent modeling simulations, shown in Figures 2.4-1 through 2.4-3 incorporate the assumption that by the year 2015 excess water would be pumped out of the Salton Sea as needed in order to prevent the increase in elevation of the Sea that would otherwise occur. The export of water from the Sea in 2015 is considered to be an "accelerated"

Phase 2 action, similar to other Phase 2 export actions, but brought on-line earlier. It could be accomplished by pumping water to an enhanced evaporation system (EES) facility on shore, although other options would be considered. The impacts associated with an EES would be similar to those described below under Alternatives 2 and 3. Impacts of other export options are discussed further in Chapter 6. This alternative would require additional NEPA/CEQA analysis before implementation of the accelerated Phase 2 action.

With the elevation control capability made possible by an accelerated Phase 2 export, the model simulations show that by 2030 the elevation would be about –229 ft msl. The ponds are assumed to continue in operation for 30 years, until 2038, by which time, the elevation would reach about –231 ft msl. Thus, as shown in Figure 2.4-1, the elevation would increase from –227 ft to about –224 ft by 2015, and would decline from 2015 to 2038 to about –231 ft.

Water Quality Effects of Construction. The discharge of the dredged material would be subject to the permitting requirements of Section 404 of the Clean Water Act. The proposed discharge would be evaluated by the permitting agency (the US Army Corps of Engineers) and would be subject to review by other agencies, including the RWQCB. Impacts on water quality could result from increased turbidity and resuspension of contaminants entrained in the bottom sediments. Under optimal conditions, the amount of suspended material that would escape from the silt screen is likely to cause only a marginal local increase in the ambient turbidity of Sea water. The dredging project would occur over several years, just ahead of the dike construction. Based on the estimated volume of dredged material, the rate of sediment loading would be approximately 2 million yd^3/yr, or about 0.5 million yd^3, discharged from each of the four ends of the dikes where construction occurs. Assuming that the dry bulk density of fine solids in the sediment is about 0.3 tons/yd^3, then 0.5 million yd^3 of sediment contains about the same quantity of fine solids as entered the Sea via the Alamo River annually in 1996 and 1997. As a rough estimate, the impacts on turbidity in the area of the dredging would probably be roughly comparable to the impacts on turbidity of the inflows from the Alamo River.

Scattered elevated concentrations of some metals, such as copper, cadmium, or selenium, may be present in the bottom sediments in the dredge areas. Recent sampling of sediment cores, performed by Levine-Fricke Recon (1999) as part of the Salton Sea Reconnaissance Studies conducted for the Science Subcommittee, suggest that the average concentrations of most contaminants are relatively low in the southwestern region of the Sea. For example, one core sample contained a selenium concentration of 0.9 mg/kg. Selenium is precipitated at low aqueous concentrations under the reducing conditions found in the deeper waters of the Salton Sea, but aeration of dredged material during handling conceivably could increase the mobility of selenium or other potentially toxic substances contained in it. The effects likely would be temporary, and the selenium or other oxidized substances would be precipitated again in the reducing conditions that predominate at depth.

The more likely effect of the dredged material would be to remove dissolved oxygen from the waters in the dredging area by the reaction of organic material and the reduced forms of minerals in the sediments. The release of hydrogen sulfide from the dredged sediments might result in odor problems and even potentially hazardous conditions for workers. One of the probable conditions of obtaining a Section 404 permit would be a requirement to perform representative sediment sampling and analysis within the proposed dredge area, possibly including a bioassay to evaluate the toxicity of suspended sediments to fish. Although these data are not currently available, compliance with the requirements of a Section 404 permit is expected to ensure that the impacts on water quality are less than significant. If some or all of the sediment cannot be discharged in the Sea, it may either be disposed of on land or discharged in one of the ponds.

Water Quality Effects of Dike Failure During Operation. Dike failure could occur from a number of causes, including settlement or ground shaking along a nearby fault. A failure of one of the dikes, which could be directly caused by strong ground shaking, by liquefaction of dike materials or underlying sediments during a large earthquake, or by displacement if movement occurred along a fault located beneath the dikes, could result in discharge of brine to the Salton Sea. The magnitude of the impact on the Sea of a release of brine would depend on the volume and concentration of the discharge, which in turn would depend on the extent of the failure, the relative height of water in the ponds compared to the Sea, and the amount of time that the dike remains breached until it is repaired. The probability of a large magnitude earthquake in the Salton Sea area is relatively high, but the probability of a dike failure cannot be estimated from existing information. Assuming that a catastrophic breach occurs, the maximum volume of brine in the ponds at any one time, at a concentration of 200,000 mg/L, would be the volume in the seventh year of operation. At this time, the total volume of brine would be nearly 250,000 af, containing a total of nearly 70 million tons of salts. After the seventh year of operation, the salt would begin to precipitate. Solid salt would accumulate on the bottom, and would be less mobile than dissolved salt. While it is not likely that all of the brine in the ponds would be discharged back into the Sea following a breach, the effect of discharge of a large volume of brine into the Sea would be to reverse the beneficial effects of salinity reduction. A release of 70 million tons of salts (the maximum that may be available) from the ponds would result in an increase in the average salinity of the Sea on the order of 5 mg/L from whatever it was at the time. Since the salts would be dispersed gradually, a salinity gradient would be created that decreases from 200,000 mg/L in the vicinity of the breach areas to the ambient concentration of the Sea along the direction of the counterclockwise currents in the Sea. Due to density differences, the hypersaline brine probably would sink initially, and then would gradually mix with the ambient water. Therefore, the effects would propagate over a period of time along the path of the currents in the Sea. While the long-term management would include repairs to the dike, if the breach in the dikes were not repaired, any solid salt in the bottom of the ponds would also gradually dissolve.

Water Quality Effects of Dike Failure After Phase 1 of the Evaporation Ponds. After Phase 1 is complete, about year 2030, if the dikes have not failed, they will continue to contain crystalline salt and possibly a small quantity of brine, due to the solution of salts in the water that enters the ponds from rainfall, runoff, or seepage. Some management is assumed to continue even without implementation of a Phase 2 alternative. Any dike failures at this time would have impacts less than defined above, since most of the salt would be in solid form, and the managing entity would effect repairs to prevent the entire salt deposit from dissolving and re-entering the Sea.

Circulation Effects. Dikes would be constructed near the mouths of the New River and San Felipe Creek, and the dikes would change the configuration of the southwestern shoreline of the Sea. These changes could alter the circulation pattern of the Sea. Hydrodynamic modeling results suggest that the North Concentration Pond dike would have almost no effect on current velocities in the Sea, except for creation of a very localized eddy south of the dike, near the mouth of San Felipe Creek. However, the South Concentration Pond would create a larger eddy to the east of the dike, at the mouth of the New River. The decrease in velocity would probably result in a small increase in the rate of sediment deposition in this area. The presence of the South Concentration Pond dike is also likely to reduce the rate of mixing of tributary flows with the main body of the Sea, resulting in an extended area with salinities below the ambient salinity of the Sea. This effect would be most pronounced under calm wind conditions.

Because of the high biological oxygen demand (BOD) of the inflow from these streams, a reduction in mixing could reduce the already low dissolved oxygen concentration in this portion of the Sea. However, the saturation concentration of dissolved oxygen in fresher water is higher than in saline water, so more oxygen could be dissolved in the freshwater under favorable conditions. In any case, the dikes would create enclaves separated from the general circulation pattern of the Sea, in which different water quality conditions than those in the rest of the Sea would develop.

Mitigation of Circulation Effects. If warranted by the results of more detailed hydrodynamic studies, the dikes should be armored to withstand expected wave action and erosion by currents.

Effects on Colorado River Downstream of Flood Flow Diversion. No flood flows are required under Alternative 1 with current inflow conditions. Therefore, there would be no flood flow impacts.

Pupfish Pond

Water would be pumped into the pond from drains or from the New River. Salinity may be controlled by mixing with water from the Sea. Many of the effects discussed for the larger evaporation ponds would also occur with the Pupfish Pond, but on a smaller scale. For example, minor water quality effects could occur during the installation of the dikes. There would also be some minor circulation effect in the Sea once the pond is installed. These effects are considered minor and not significant.

Water quality in the New River contains a mixture of agricultural wastewater and municipal wastewater discharges, and future water quality could be affected by conservation measures, improvements in wastewater treatment, increased development, and possibly by spills or releases upstream. Drain water contains tile water combined with tailwater, and a decrease in the tailwater component may lead to an increase in the salt concentration. Drain water contains nutrients and farm chemical residues, but is likely to contain relatively low levels of bacteria and suspended sediments compared to the New River.

Since the pond would be shallow, temperatures will fluctuate with ambient air temperature, becoming cold in winter and warm in summer. Reduced oxygen levels in the pond water, growth of algae, sedimentation, and concentration of some contaminants may occur. Due to the length of the pond and the high evaporation rate in the area, the salinity at the lower end of the pond could be significantly higher than the salinity at the upper end. The magnitude of these effects would be dependent on the flow-through velocity. Many of the potential adverse effects, such as over-heating, sedimentation, growth of algae, and concentration of salts could be managed by increasing the flow-through velocity. However, while the upper limit on the flow-through velocity is not known, it would likely be constrained by the needs of pupfish, and possibly by erosion and scouring rates. Mitigation could also include shading of the pond, such as by introducing salt-tolerant vegetation, or allowing natural vegetation to grow.

Runoff from the shoreline during storms may contribute to the flow in the pond for short periods. Some storms may carry enough runoff to exceed the discharge capacity of the pond, resulting in overflows. The flow is likely to occur in the form of discharges from washes. Such flows may temporarily carry significant amounts of sediment into the pond.

As illustrated in Figure 2.4-7, the shoreline protection dikes would be designed so that the elevation of water in the pond would be at about –227 ft. The water would then be three feet deep at the dike, which would approximately follow the –230 elevation contour. The depth would decrease shoreward. Some freeboard would be built in. The dikes could be constructed by about 2008. However, the model simulations for alternative 1 show that from 2008 until 2015, the elevation of the Sea would probably rise as high as –223 ft, or four feet above the desired maximum elevation inside the dikes. The elevation might not return to –227 feet until about 2023. Since the dikes are designed to be open to the Sea at one end, a rise in Sea level would cause a rise in the water level behind the dikes. Therefore, if they were completed in 2008, the dikes might be completely submerged during most of the eight to ten years after they were completed, and would not function as intended for nearly 15 years. In the meantime, they might have some effects on water quality in the near shore area. The presence of the dikes would create a narrow strip of water along the shore that is isolated from the main body of the Sea. There is a potential for this trapped water to become heated, stagnant, and more saline than the water in the adjacent Sea. If isolated from the adjacent Sea, water quality within the dikes might change such that the character of the shoreline habitat would be affected.

As the elevation of the Sea declines below the elevation of the water in the pupfish pond, (after about 2023) some seepage can be expected to occur from the pond to the Sea. The amount of seepage will depend on the difference in water elevation and the permeability of the sediments along the shoreline as well as the permeability of the shoreline protection dike itself. If significant leakage occurs, it would be necessary to increase the inflow to the pond in order to maintain flow through the pond. The result would be a gradual decrease in the velocity of the flow through the pond. The difference between the velocity at the inflow end compared to the velocity at the outflow end could potentially be large, since the pond is long. One result could be that sediment scouring could occur at the upper end of the pond, and sediment deposition could occur at the lower end of the pond.

North Wetland Habitat

The effects of these ponds would be similar to those discussed for the pupfish pond. However, depending on how the flows through the ponds are operated, and the degree to which tributary flows are directed through the ponds, the water quality in the North Wetland Habitat may be significantly different from the water quality in the pupfish pond. With future agricultural conservation measures in response to reduced inflows, the proportion of tail water is likely to decrease, resulting in increased concentrations of agricultural constituents. Among these are selenium, boron, and pesticide and herbicide residues. Thus, water quality in the North Wetland Habitat will likely be dominated by the quality of water in the Whitewater River. As a result, each of the ponds may have different water quality condition.

Figure 4.1-7 Probability Distributions of Future Colorado River Flood Flows Delivered to Mexico

Effect of Alternative 1 with Reduced Inflows

North and South Concentration Ponds

Salinity Effects in the Sea. Modeling results showing the salinity and elevation over time with reduced inflows are shown in Figure 2.4-2 (Chapter 2). The results are shown for the 60-year planning period, but the ponds are assumed to go off-line in 2038. By 2030, with an inflow rate of 1.06 maf/yr, the ponds, in combination with accelerated imports, would continue to hold the salinity at approximately 46,000 mg/L, which is the expected salinity of the Sea when the ponds begin operating in 2008. Reductions in salinity shown in Figure 2.4-2 after 2030 are the result of Phase 2 actions, discussed in the following chapter. With reduced inflows, accelerated Phase 2 pump-out action is needed to control salinity through 2030 and it is assumed to be implemented no sooner than 2015.

Effects of Salinity in the Ponds. The effects of salinity inside the ponds would be the same as described for current conditions.

Elevation Effects. As described above, elevation and salinity control are closely related. The results of reduced inflows to both 1.06 maf/yr and to 0.80 maf/yr are identical. The ponds reduce the volume and surface area of the Sea, but with the assumed rates of reduction in inflow, the elevation would drop below the target level of –232 ft by about 2025. By the end of Phase 1, in 2030, the elevation would be about –237 ft msl. In both of the reduced inflow scenarios, the level of the Sea would be well below the elevation of the brine in the ponds (-227 ft msl). The difference in head would increase the potential for leakage and erosion of the dikes under normal operating conditions, and would allow the brine in the ponds to drain to the elevation of the Sea in the event of a catastrophic failure of the dikes.

Circulation Effects. To the extent that they help to maintain the elevation relative to No Action at the corresponding inflows, the ponds would have a beneficial effect on circulation.

Effects of Dike Failure. As discussed for the current inflow scenario, any failure of the dikes caused by ground shaking or from other causes might result in rapid evacuation of the brine contained in the dikes if the elevation of the water in the ponds were above the elevation in the Sea.

Displacement Dike

The displacement dike would effectively reduce the surface area of the Sea. The effects of constructing the dike would be similar to the effects of constructing the dikes for the evaporation ponds discussed previously. There would be some changes to the circulation patterns in the south end of the Sea. The impacts of these changes have not been quantified through hydrodynamic modeling, but are not expected to be significant, with the exception of the creation of a deep indentation in the shoreline where the New River enters the Sea between the displacement dike and the Southwest Pond, and a potential eddy area on the east side of the displacement dike, where the Alamo River enters the Sea. Water quality conditions in these indented areas are likely to be different from conditions in the Sea. Salinity would likely be lower in these areas, because they will be dominated by the fresh water inflows from the tributaries. One of the effects might be to create a broader range of conditions and potential habitats for fish and other species. In essence, the effect is to lengthen the outlets of the tributaries and to increase the transition zone between the tributaries and the Sea. On the other hand, current velocities may be lower, and may be reversed in portions of these indented shoreline areas, which may lead to increased rates of sediment deposition in these areas.

The areas behind the dikes (on the shoreward side) could alternately be dry or contain standing water, depending on the time of year and the meteorological conditions. It is likely that any standing water would be highly saline and of generally poor quality.

4.1.6 Alternative 2

Effect of Alternative 2 with Continuation of Current Inflow Conditions

Modeling results for continuation of current inflow conditions for Alternative 2, in comparison to other alternatives, can be found in Figure 2.4-1.

EES Located North of Bombay Beach (150 kaf/yr showerline technology)

Salinity Effects in the Sea. Modeling results show that following construction of the EES, salinity would continue to gradually rise to a maximum of about 47,000 mg/L in the middle of Phase 1, and then decrease to about 45,500 mg/L at the end of Phase 1. The salinity would continue to decline if the EES system continued to be operated in the same way beyond 2030.

Elevation Effects. The elevation of the Sea would decline gradually from an elevation of about –226 ft at the start of operation to about –232 ft msl at the end of Phase 1. Although salinity could continue to be decreased after 2030 through continued operation of the EES, the elevation would decline. Therefore, importation of CASI water is included in Phase 2 so that both salinity and elevation can be controlled together. Comparison of the effects of continuing the Phase 1 action without additional Phase 2 action to the effects of implementing the Phase 2 alternatives is discussed in Chapter 6.

Circulation Effects. The effect of the EES on circulation patterns would be minimal, because the alternative would prevent the elevation from declining further than -232 ft level during Phase 1. Preliminary modeling results suggest that the circulation pattern of the Sea would be almost identical to the current pattern above an elevation of –240 ft, although small changes in current velocity might occur.

Effects on Colorado River Downstream of Flood Flow Diversion. No flood flows would be required in Alternative 2 with current levels of inflow, and therefore, no impacts would occur.

Effect of Alternative 2 with Reduced Inflows

Import Flood Flows

The modeling results for the reduced inflow scenarios shown in Figure 2.4-2 reflect the result of adding flood flows in 2015 for the reduced inflow scenario. The projected availability of these flood flows is based on probability distributions. Since flood flows are not available every year, the effects would be exaggerated in those years when the flood flows are available. If the maximum flood flow diversion of 300,000 af were imported over four months, the rate of delivery to the Sea would be about 1,250 cfs. At its current elevation, 300,000 af is approximately enough to raise the elevation of the Sea 1.7 ft. The increase in elevation would be greater if the Sea were initially at a lower elevation.

The imported flood flows would be discharged via existing channels, including the Alamo River, Salt Creek, and Evacuation Channel No. 1 at the north end of the Sea. The discharge to the Alamo River might exceed the existing channel capacity in some portions of the upper reach, and would likely cause scouring of the channel in others. No information was available at the time of writing to assess these potential impacts in detail. If flows were too high for the existing channel capacity, this would represent a significant impact.

During high flows in the Colorado River, the silt load is higher than normal. Diversion of this silt-laden water will increase the load on desilting works at Imperial Dam and on concrete-lined conveyance facilities.

Existing flows in Salt Creek are quite low, and are fed primarily by seepage from unlined portions of the Coachella Canal. Depending upon the amount of the discharge, a prolonged discharge of flood flows into Salt Creek for a period of four months is likely to significantly change the rate of flow and the water quality in the creek. Higher flows could result in channel scour and increased turbidity. The water could become cooler and would have lower dissolved solids concentrations than under No Action conditions.

Salinity Effects in the Sea. Comparison of Figure 2.4-2 with Figure 2.4-1 shows that with reduced inflows, it becomes increasingly difficult to control both salinity and elevation. The modeling results show that neither the salinity target nor the elevation target is achievable with reduced inflows. For 1.06 maf/yr of inflow, the modeled salinity increases from the initial 50,500 mg/L at the start of operation, to a peak of about 62,500 mg/L in 2030, after 17 years of operation. Without the import of water in Phase 2, the salinity would continue to increase and the elevation to decrease, after 2030.

Elevation Effects. For reduced inflows, the elevation and salinity cannot be managed to achieve the target levels of both. The modeling results in Figure 2.4-2 show that the salinity target could be achieved at the expense of elevation control, but the inverse is also possible (elevation could be controlled at the expense of salinity). The results shown in the figure illustrate the tradeoff, but this solution is not unique; many other combinations of salinity and elevation would be possible. The results show that the elevation would fall to about –237 ft msl at the end of Phase 1 with reduced inflow.

Circulation Effects. The effects on circulation of Sea water when the elevation is -237 ft would be similar to those discussed for the No Action Alternative for –236 ft. The decline in elevation would ultimately be less under Alternative 2 than for the No Action Alternative because of the importation of flood flows.

Effects on Colorado River Downstream of Flood Flow Diversion. Up to 300,000 AFY of flood flows would be diverted to the All American Canal at Imperial Dam when available, if needed to maintain the elevation of the Sea due to reductions in existing sources of inflow. The availability of flood flows, and the potential effects the flood flow diversion, have been evaluated based on assumptions about the probable size and timing of the flows.

Figure 4.1-7 shows the maximum flood flow diversion of 300,000 AFY, superimposed on the probability distribution curves for future flood flow deliveries to Mexico. (The probability distributions described in this analysis were introduced in Chapter 3). The line representing 300,000 AFY crosses the lower part of the probability curves. For example, it crosses the curve of the probability distribution of flood flows in 2010 at a point representing a probability of a little less than 22 percent.

The graph shows that the diversion of 300,000 AFY would consume all of the available flood flows that otherwise would have been delivered to Mexico in less than two percent of all years.

To put this into perspective, it should be remembered that under the No Action Alternative, no flood flows are likely to be delivered to Mexico in about 73 percent of the years under 2010 conditions (and about 68 percent of years in 2030 conditions). Thus, the flood flow diversion to the Salton Sea would result in a small increase in the likelihood that no flood flows would be delivered to Mexico.

As the size of the flood flows increases, the effect of a reduction of 300,000 AF is expected to lessen, because the diversion would be a smaller proportion of the flood flows that actually do reach Mexico. A flood flow reduction of 300,000 represents a reduction of only 10 percent relative to a flood flow of 3 MAFY, for example. Under 2010 No Action conditions, flood flows of 3 MAFY occur in about 10 percent of all years, and under 2040 No Action conditions this size of flood flow is expected to occur in less than 6 percent of all years. If a reduction in the magnitude of flood flows to Mexico of greater than 10 percent is taken as an indication of a potentially significant reduction, then the diversion of 300,000 AFY of flood flows to the Salton Sea would cause this level of flow reduction, in an additional 13 percent of the years relative to 2010 No Action conditions, and in and additional 11 percent of the years relative to 2040 No Action conditions.

The discussion in Chapter 3 indicated that in 14 of the past 49 years, about 10 percent of the available flood flows delivered to Mexico were diverted for irrigation, and the remaining flows were released in the Colorado River. The average amount of flood flows diverted to irrigation was about 500,000 AFY. By diverting less of the future flood flows to agricultural uses, existing levels of flow to the lower Colorado River Delta could be maintained. However, if historical levels of agricultural diversions of flood flows were to continue, then reductions in flood flows would result in a reduction in Colorado River flows. Based on the discussion in Chapter 3, one of the potential impacts would be to reduce flows to the Rio Hardy wetlands.

Another measure of comparison of the hydrologic impact of flood flows is on the rate of evaporation of the volume of the flood flow diversion. Assume that evapotranspiration rates in the Colorado Delta are about the same as in the Salton Sea (about 5.8 feet per year). Further assume that the 300,000 AFY of flood flows diverted to the Salton Sea would directly reduce the volume available to support the Rio Hardy wetlands. Based on these assumptions, 300,000 acre-feet is enough to keep about 25,000 acres of the Rio Hardy wetland moist for a period of about two years. This is about the size of the wetland in 1992, when about 3 MAF of the flood flows received by Mexico were released to the Colorado River from Morelos Dam.

It should be noted that under the existing treaty with Mexico, the U.S. has no obligation to deliver flood flows in any year, and that the diversion of flood flows to benefit the Salton Sea would occur only after all treaty obligations were fulfilled.

4.1.7 Alternative 3

Alternative 3 does not differ substantially from Alternative 2 with respect to its impacts on surface water resources. The only differences between the alternatives is the location of the EES system on land and the location of the intake in the Sea. Therefore, the surface water impacts are expected to be identical to those described under Alternative 2.

4.1.8 Alternative 4

The combination of an EES and a concentration pond provides flexibility to control both the salinity and the elevation. The EES enables water to be pumped out of the Sea when inflows are at current levels. Therefore, it removes the excess inflow that would cause the elevation of the Sea to rise if only an evaporation pond is installed. Additionally, with reduced inflows, the ponds reduce the size of the Sea, which helps to maintain the elevation when water is removed to control salinity. Alternative 4 addresses the problems of balancing the competing goals of maintaining both elevation and salinity, because if the elevation declines, the amount of water pumped into the ponds can be reduced, while the EES component can continue to be operated to control the salinity. Nevertheless, with decreased inflows, the elevation would decline. Therefore, a displacement dike is needed in order to maintain the elevation.

Effect of Alternative 4 with Continuation of Current Inflow Conditions

South Evaporation Pond and an EES Located at the Salton Sea Test Base (100 kaf/yr showerline technology)

Salinity Effects in the Sea. The salinity would level off and then begin to gradually decline several years after the ponds and EES are completed. Both would be operated initially at their maximum pump-out rates in order to achieve the maximum reduction in salinity as soon as possible, after which, the rate of pump-out could be reduced to help manage elevation. The model simulation shows that salinity would be reduced to about 39,500 mg/L by the end of Phase 1.

Effects of Salinity in the Ponds. The effects of salinity within the ponds would be identical to the effects described for Alternative 1. However, since the elevation would remain relatively high (compared to Alternatives 2 and 3), the head difference between the Sea and the water in the ponds would be small throughout Phase 1. The smaller the head difference, the less likely that a catastrophic failure of the pond dikes would cause all of the brine in the ponds to enter the Sea before repairs could be made.

Elevation Effects. There would be an initial increase in elevation of about one foot, to about –225 ft, and then the elevation would begin to decline, reaching a little less than –229 feet by 2030.

Circulation Effects. The circulation impacts of Alternative 4 would be due primarily to the configuration of the pond dikes rather than to a change in elevation, because the elevation of the Sea would be maintained above about –229 ft.

As can be seen in Figure 4.1-1, the South Concentration Pond would have the effect of creating an area of reduced currents (eddy) east of the South Concentration Pond dike, out from the New River. Salinity in this area would probably remain lower than in the main body of the Sea, especially during calm wind periods, due to reduced mixing of tributary inflows.

Effects on Colorado River Downstream of Flood Flow Diversion. With current inflows, no supplemental flows would be required. Therefore, there would be no flood flow-related impacts.

Pupfish Pond

The effects of this pond would be the same as under Alternative 1.

North Wetland Habitat

The effects of this pond would be the same as under Alternative 1.

Effect of Alternative 4 with Reduced Inflows

South Evaporation Pond and an EES Located at the Salton Sea Test Base (100 kaf/yr showerline technology)

Salinity Effects in the Sea. With reduced inflows the control of salinity requires a greater reduction in the Sea elevation than for current inflows. The modeling simulations show that the salinity would remain fairly constant throughout Phase 1 and that by the end of Phase 1 the salinity would be about 47,000 mg/L.

Effects of Salinity in the Pond. The change of salinity in the pond and its impacts would be identical to those described for Alternative 1 for reduced inflows, except that the elevation of the Sea would stand lower than the elevation of the brine in the ponds for more of the time.

Elevation Effects. The model simulations indicate that Alternative 4 would be more effective in controlling elevation at the end of Phase 1 than any of the other alternatives. However, with reduced inflows the elevation is still projected to decline to –235 ft msl for this alternative. The projected change in elevation is comparable to the projected change in elevation with the No Action alternative.

Circulation Effects. As illustrated in Figure 4.1-2, at an elevation of about –236 ft the eddy areas would be created east of the Displacement dike and between the South Concentration Pond and the Displacement dike, out from the mouths of the Alamo and New Rivers. Currents would tend to increase along the north wall of the Displacement dike. In eddy areas at the mouths of the tributaries, salinity would remain below the levels in the main body of the Sea, however, the change in salinity relative to the No Action alternative would be minor at low elevations.

Effects on Colorado River Downstream of Flood Flow Diversion. The effects of a diversion of flood flows would be the same as those discussed for Alternative 2.

Displacement Dike

The effects of the displacement dike would be the same as those discussed for Alternative 1.

Import Flood Flows

The effects of importing flood flows would be the same as those discussed for Alternative 2.

4.1.9 Alternative 5

The combination of an evaporation pond with an In-Sea EES and the ponds provides flexibility to control both the salinity and the elevation. The EES enables water to be pumped out of the Sea when inflows are at current levels. Therefore, it removes the excess inflow that would cause the elevation of the Sea to rise if only an evaporation pond is installed. However, with reduced inflows, the pond would reduce the size of the Sea, which would help maintain the elevation when water is removed to control salinity.

The pond would have a design life of about 23 years; therefore, an additional export mechanism would be needed after Phase 1.

Effect of Alternative 5 with Continuation of Current Inflow Conditions

Northwest Evaporation Pond and an In-Sea EES (150 kaf/yr spray technology)

Salinity Effects in the Sea. The salinity would begin to gradually decline soon after the ponds and EES are completed. Both would be operated initially at their maximum pump-out rates in order to achieve the maximum reduction in salinity as soon as possible. There would be an initial reduction in elevation to the target elevation, but as the salinity is controlled, the pump-out rate would be reduced. The model simulation shows that salinity would be reduced to about 41,000 mg/L by the end of Phase 1. As an illustration of the greater flexibility available to manage the tradeoffs between salinity and elevation control, Figure 2.4-1 shows that if elevation is managed identically to Alternatives 2 and 3, Alternative controls salinity better than Alternatives 2 and 3.

Effects of Salinity in the Ponds. The effects of salinity within the ponds would be identical to the effects described for Alternative 1.

Elevation Effects. The elevation of the Sea would decline gradually after the start of operation to about –232 ft msl at the end of Phase 1.

Circulation Effects. As can be seen in Figure 4.1-1, the North Concentration Pond would have almost no impact on velocities in the Sea, except for a very small decrease near the mouth of San Felipe Creek. Similarly, the distribution of salinity would remain nearly identical to that under the No Action Alternative. Because of the steep drop to deeper water east of the dike, water temperatures in this area would probably tend to decrease in this area, and this might reduce the temperature down-current of the dike somewhat. These effects are not expected to be significant.

Effects on Colorado River Downstream of Flood Flow Diversion. Since flood flows would not be imported under current inflow conditions, no impacts would occur.

North Wetland Habitat

The effects of this pond would be similar to those discussed for this alternative under Alternative 1, existing inflow conditions.

Effect of Alternative 5 with Reduced Inflows

Northwest Evaporation Pond and an In-Sea EES (150 kaf/yr spray technology)

Salinity Effects in the Sea. With reduced inflows of 1.06 maf/yr, the control of salinity results in a greater reduction in the Sea elevation than for current inflows. The modeling simulations show that the salinity would increase slightly, to about 48,000 mg/L during the first five or six years after construction. Salinity would then decline gradually, until by the end of Phase 1 the salinity would be about 46,000 mg/L.

Effects of Salinity in the Pond. The change of salinity in the pond and its impacts would be identical to those described for Alternative 1.

Elevation Effects. The model simulations indicate that Alternative 5 would be less effective than Alternative 4 in controlling elevation throughout Phase 1. The elevation is projected to drop below the target elevation about ten years after construction is competed, in 2018, and the elevation would continue to decline until it reached approximately –236 ft msl in 2030. However, as mentioned for other alternatives, there are tradeoffs between elevation control and salinity control, and within the range of uncertainty in the assumptions of the model, alternatives pond alternatives perform similarly.

Circulation Effects. Circulation effects would be similar to those described above for this alternative with current inflows. The elevation is not expected to decrease sufficiently to result in significant circulation impacts due to elevation alone.

The addition of the Displacement Pond dike would create an eddy east of the dike, outward from the mouth of the Alamo River, and would probably create an eddy on the west side, out from the mouth of the New River. In these areas, current velocities would be slower than they would be without the dikes. Reduced mixing would occur in these areas, and the salinity would remain lower than in the main body of the Sea because of the slower dispersion of tributary flows. More sediment would be deposited in these areas. Slightly increased temperatures might occur offshore from the east end of the Displacement dike during calm wind periods.

Effects on Colorado River Downstream of Flood Flow Diversion. The impacts downstream of the diversion of flood flows would be the same as described for Alternative 2.

Displacement Dike

The effects of the displacement dike would be similar to those discussed for this alternative under existing inflow conditions.

Import Flood Flows

The effects of importing flood flows would be the same as those discussed for Alternative 2.

4.1.10 Cumulative Effects

As discussed in Chapter 2 of this EIS/EIR, a number of regional projects could have long-term effects on the average annual inflow to the Sea. Likewise, a number of other processes could have long-term effects on the future inflows, including changes to agriculture practices, competing demands for water, and natural climatic adjustments. The most likely results of these processes is that future inflows to the Sea could be lower than current conditions, and the concentration of dissolved and particulate matter in the inflow would be increased. These cumulative impacts on the volumes and quality of inflow have been captured within the assumptions of the reduced inflow scenarios.

4.1.11 Mitigation Measures

Mitigation of Dike Failure Impacts. While a dike failure caused by a large earthquake cannot be prevented, it might be possible, depending on the size of the failure and the elevation of the brine relative to the elevation of the Sea at the time of the failure, to repair the dikes in time to prevent release or mixing of the Sea with all of the brine inside the ponds. Therefore, rapid assessment of the extent of the problem and the speed with which the dikes are stabilized may mitigate much of the damage to the Sea that could occur. Compartmentalizing the ponds could increase the likelihood that at least a portion of the brine would be contained if a breach occurred in one part of the dike system. Similarly, a compartmented pond system could be operated in such a way as to segregate more concentrated brine or to crystallize the salts in less vulnerable portions of the pond system. Continuous removal of brine from the ponds, and disposal and crystallization on land could reduce the volume of salt having the potential for release to the Sea, and it could help to maximize the evaporation rate from the ponds. The cost of any engineering measures that would reduce the potential for a failure, or the potential effects of a failure, would likely be very high, and must be weighed against the risks of a breach. An alternative type of mitigation measure has been built into the common actions in the form of the shoreline habitat protection ponds. These ponds would have the potential benefit of allowing a small portion of the Sea to survive even if the Sea itself collapses. However, the shoreline ponds themselves are not necessarily invulnerable to failure from various causes, and would not fully compensate for loss of the Sea.

Mitigation for Potential Impacts on Colorado Delta from Diversion of Flood Flows. It is not clear whether significant impacts might occur in the Colorado River Delta at some level of flow. If such impacts were found to be significant, mitigation could include making diversion of flood flows to the Salton Sea contingent on the delivery of additional water for specific purposes within the Delta. Such a contingency would need to be formalized by amendment to the 1944 Treaty, and in order to be effective, would probably require assurances that the water would be diverted to the intended uses (such as maintaining the Rio Hardy wetlands).

4.1.12 Potentially Significant Unavoidable Impacts

Release of brine to the Sea and the consequences of such a release on the water quality of the Sea is a potentially significant and unavoidable impact of failure of the concentration pond dikes in alternatives 1, 4, and 5. The potential for failure of the dikes is unknown.