Napa River Salt Marsh Restoration Project Draft Final Feasibility Report

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NAPA SALT MARSH RESTORATION FEASIBILITY STUDY – NAPA, SONOMA, AND SOLANO COUNTIES, CALIFORNIA

EXECUTIVE SUMMARY

INTRODUCTION

This study, prepared with the non-Federal sponsor, the California State Coastal Conservancy (CSCC) and the land owner, the California State Department of Fish and Game (DFG), identifies a feasible project to restore portions of the 9,460-acre (14.8 square mile) former Napa salt pond complex to valuable tidal wetland and pond habitat. A Draft Environmental Impact Statement/Environmental Impact Report (DEIS/R) accompanies this Draft Feasibility Report.

LOCATION AND STUDY AREA

The study area is located approximately 30 miles northeast of the City of San Francisco, in unincorporated portions of Napa, Sonoma, and Solano Counties, California. The study area is located on the northeast side of San Pablo Bay, immediately west of the Napa River, and immediately east of Sonoma Creek. The study area consists of the Napa River Unit of the Napa-Sonoma Marshes State Wildlife Area (NSMWA), which is comprised of 12 ponds formerly used for solar salt production.

OBJECTIVES

Diking or filling has destroyed approximately 90 percent of the original tidal wetlands of San Francisco Bay. The project site, historically dominated by tidal salt marsh, was diked and converted to hayfields approximately 150 years ago. In the early 1950s, the diked areas were converted to solar salt evaporation ponds. This project proposes to restore a portion of diked baylands to tidal action to support endangered and special status species recovery, improve water quality, and restore greater ecological balance to the San Francisco Bay.

There are three planning objectives:

- To create a mix of tidal habitat and managed pond habitat to serve a broad range of wildlife, including endangered and threatened species, fish and other aquatic species, and migratory shorebirds and waterfowl.
- To restore large areas of tidal habitats in a band along the Napa River to maximize benefits to fish and other aquatic animals, and ensure connections between the patches of tidal marsh (within the project site and with adjacent sites) to enable the movement of small mammals, marsh-dependent birds, and fish and aquatic species.
- To improve the ability to manage water depths and salinity levels in the managed ponds to maximize feeding and resting habitat for migratory and resident waterfowl and shorebirds.

The restoration plan formulation involved extensive coordination with other Federal and state agencies, as well as non-profit organizations, experts in the field of restoration, and the public.

SELECTED PLAN

Plan B (Ponds 4 through 6A, Ponds 7, 7A, 8, Neighboring Waters), is the Recommended Plan. This Plan is recommended because it would provide a balanced mix of pond and tidal habitat, would address the bittern problem in Pond 7, and is cost efficient based on the Incremental Cost Analysis. Plan B best meets the study objective of creating a mosaic of habitat types with an emphasis on naturally sustainable habitat (i.e., tidal marsh).

The Plan includes infrastructure features, primarily water control structures for desalination as well as earth-moving activities associated with the habitat restoration phase of the project. Long-term O&M includes on-going levee maintenance, maintenance of water control structures, and monitoring. The Plan includes a monitoring and adaptive management plan.

The project fulfills the Federal interest requirements, the needs of the non-Federal sponsor, and the needs of the landowner.

SUMMARY OF COSTS

The total final cost to construct the selected plan for the Napa Salt Marsh Restoration Project (April 2004 price levels) would be $55,092,000. Most of these costs would be shared 65% Federal, 35% non-Federal, based on cost sharing for wetland restoration projects, while approximately $1,747,000 would be cost-shared 50% Federal, 50% non-Federal for recreation features.

NAPA SALT MARSH RESTORATION
FEASIBILITY STUDY
NAPA, SONOMA, AND SOLANO COUNTIES, CALIFORNIA

TABLE OF CONTENTS

LIST OF FIGURES

Follows Page

LIST OF TABLES

On Page

APPENDICES

Note: Electronic copies of the appendicies are included on the Compact Disk.

1.0 INTRODUCTION

1.1 Study Authority

The Napa Salt Marsh Restoration Feasibility Study was authorized by a resolution adopted by the Committee on Public Works and Transportation of the U.S. House of Representatives on September 28, 1994 for the Napa River, California (Docket 2448).

The resolution states:

> *Resolved by the Committee on Public Works and Transportation of the U.S. House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers on the Napa River Basin, California, published as House Document 222, Eighty-ninth Congress, First Session, and other Pertinent reports, to determine whether modifications of the recommendations contained therein are advisable at the present time, in the interest of environmental protection and restoration, flood damage reduction, and other purposes.*

1.2 Study Purpose and Scope

This report summarizes the study process and results of the Napa Salt Marsh Restoration Feasibility Study. The purposes of the study are to evaluate potential Federal interest in habitat restoration at the Napa River Unit of the Napa-Sonoma Marsh Wildlife Area (NSMWA) and to identify a feasible project that fulfills the Federal interest requirements and meets the needs of the non-Federal sponsor. Project feasibility is assessed in terms of physical, environmental, and economic considerations.

Specifically, the Feasibility Study:

- Evaluates ecosystem opportunities and needs in the project area;
- Presents a range of Alternative Plans, along with potential costs and benefits associated with the plans;
- Determines the National Ecosystem Restoration (NER) Plan, which is the most cost-effective alternative based upon the economic costs and environmental benefits of alternative solutions.
- Assures that the project is in compliance with applicable statutes, executive orders and policies, and in accordance with current budgetary priorities;
- Prepares a sound and documented basis for decision makers to judge the need for and justification of the recommended restoration plan; and
- Assesses the level of public interest and support of non-Federal interests in the identified potential restoration plan.

The scope of the study is to investigate the feasibility of restoring a portion of diked baylands in the San Francisco/San Pablo Bay Area to support a range of fish and wildlife species, including endangered and threatened species, to improve water quality by restoring former salt ponds into usable habitat, and to restore greater ecological balance to the Bay Area overall.

1.3 Study Area Location

The study area consists of the 9,460-acre Napa River Unit of the Napa-Sonoma Marshes Wildlife Area (NSMWA), located on the west side of the Napa River (Figure 1-1 Regional Location; Figure 1-2 Project Area and Surrounding Areas Managed by California State Department of Fish and Game (DFG)).

1.4 Study Participants and Agency Coordination

The U.S. Army Corps of Engineers, San Francisco District, and the non-Federal sponsor jointly developed the restoration plan presented in this report. The non-Federal sponsor for the Feasibility Phase is the California State Coastal Conservancy (CSCC). The CSCC is acting as the non-Federal sponsor on behalf of the property owner, the DFG. The CSCC will continue to act as the local sponsor during Pre-Construction Engineering and Design (PED). The DFG will be a non-Federal sponsor during the Construction and Operations and Maintenance (O&M) phases. The Sonoma County Water Agency (SCWA) also participated in the planning process.

During the Feasibility Study, staff from the CSCC, DFG, and SCWA participated in the study technical team and contributed directly to the study effort. The non-Federal sponsor (CSCC) contributed its 50 percent cost share largely through in-kind services. Meetings of the project delivery team, which included representatives from the CSCC, DFG, and SCWA, occurred weekly or every other week as needed during the study phase.

1.4.1 Institutional Involvement

During the Feasibility Study, coordination with the United States Fish and Wildlife Services (USFWS) was conducted in accordance with the Fish and Wildlife Coordination Act. The USFWS provided the Corps with the Draft Coordination Act Report (DCAR), which includes its evaluation of the Alternative Plans studied (Appendix A). The DCAR was submitted in September 2002. All USFWS recommendations have been given full consideration.

1.4.2 Napa-Sonoma Marsh Restoration Group (NSMRG)

The NSMRG was originally established to exchange data among the various parties conducting studies in the Napa-Sonoma Marsh. The NSMRG includes a large number of public agencies, as well as researchers, environmental organizations, and other interested stakeholders.

Interaction between NSMRG and the study team can be characterized as outreach and information/opinion gathering. NSMRG has met on at least a quarterly-to-twice-annually basis since the beginning of project. NSMRG has provided feedback on various aspects of the planning process, such as the project goals and objectives, constraints, issues, and options and alternatives. Two subcommittees of the NSMRG - the Modeling Technical Group and the Restoration Technical Group, provided more detailed review of the hydrology work conducted by Philip Williams and Associates (PWA), a consultant to the Corps and the non-Federal sponsor.

Participating organizations in the NSMRG include:

- Bay Institute
- California State Coastal Conservancy
- Cargill Salt Company, Inc.
- Danish Hydrologic Institute
- Department of Fish & Game
- Ducks Unlimited
- GAIA Consulting, Inc.
- Jones & Stokes
- Napa Resource Conservation District
- Philip Williams & Associates
- Point Reyes Bird Observatory
- Regional Water Quality Control Board, Region 2
- San Francisco Bay Conservation and Development Commission
- San Francisco Bay Joint Venture
- San Francisco Estuary Institute
- Save the Bay
- Sonoma County Water Agency
- Southern Sonoma County Resource Conservation District
- United States Army Corps of Engineers
- United States Fish and Wildlife Service
- United States Geologic Survey
- University of California, Davis

1.5 Prior Studies and Reports

There have been numerous prior studies and reports relating to this project. Those most relevant are listed below. Additional prior studies and reports are listed in the Napa Salt Marsh Restoration Study DEIS/R.

Reconnaissance Report, Napa River, Salt Marsh Restoration, August 1997 (U.S. Army Corps of Engineers, San Francisco District)

Historical Napa Marsh Channels, Napa-Sonoma Marsh Color Photography (Mosaic), 1999 (San Francisco Estuary Institute)

Baylands Ecosystem Habitat Goals, San Francisco Bay Area Wetland Ecosystem Goals Project, March 1999 [San Francisco Bay Area Wetlands Ecosystem Goals Project]

Ground Control and Hydrographic Survey Report, Napa River Salt Marsh Restoration Project Phase II-Topographic and Hydrographic Surveys, 2001 (Towill, Inc.)

Napa River Salt Marsh Restoration Project, Water Quality and Sediment Characterization, February 2002 (Hydroscience Engineers)

Napa Sonoma Marsh Restoration Feasibility Study, Hydrodynamic Modeling Analyses of Existing Conditions-Phase I, March 2002 (Phillip Williams and Associates [PWA])

Napa Sonoma Marsh Restoration Feasibility Study Hydrodynamic Modeling Study, Phase 2 Stage I, March 2002 (PWA)

Sonoma County Water Agency Simulations Results with Variable Dilution. Technical Memorandum to Sean White, Sonoma County Water Agency. June 2002 (PWA)

Napa River Salt Marsh Restoration Habitat Restoration Preliminary Design; Phase 2 Stage 2 of the Hydrology and Geomorphology Assessment in Support of the Feasibility Study, November 2002 (Philip Williams and Associates).

Pond 7 Bittern Salinity Reduction Duration Estimate Report, 2003 (Gaia Consulting).

In 1997, the U.S. Army Corps of Engineers (Corps) initiated a reconnaissance-level study, which concluded that there is a Federal interest in continuing the study into the Feasibility Phase. The California State Coastal Conservancy (CSCC), as the non-Federal sponsor, and the Corps initiated the Feasibility Phase of the study in 1998. The Feasibility-Phase study cost was shared equally between the Corps and the non-Federal sponsor. This report presents the results of both phases of study.

1.6 The Planning Process and Report Organization

The six planning steps presented in the U.S. Water Resources Council's Principles and Guidelines form the basis of organization for this Feasibility Report. Chapter 2, The Need for and Objectives of Action, present the problems and opportunities associated with the Napa Salt Marsh. Chapter 3, Study Area Description, provides an inventory of existing and future Without-Project Conditions. In Plan Formulation, Chapter 4, planning objectives and constraints are considered as Alternative Plans are formulated. Plans are next evaluated and compared in Chapter 5 and the Recommended Plan that emerges from the process is described in greater detail in Chapter 6. Chapters 7 and 8 describe Plan Implementation and the Study's Conclusions and Recommendations.

Following the main report are several appendices documenting the technical studies completed for this Feasibility Study.

2.0 NEED FOR AND OBJECTIVES OF ACTION

The first step of the Corps's six-step planning process is to specify Problems and Opportunities. This chapter presents the water and related land resource Problems and Opportunities in the study area.

2.1 National Objective

Ecosystem restoration is one of the primary missions of the Corps of Engineers Civil Works program. The Corps's objective in ecosystem restoration planning is to contribute to National Ecosystem Restoration (NER). Contributions to National Ecosystem Restoration (NER outputs) are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of NER is based on changes in ecological resource quality as a function of improvement in habitat quality and/or quantity and expressed quantitatively in physical units or indexes (but not monetary units). These net changes are measured in the planning area and in the rest of the Nation. Single-purpose Ecosystem Restoration Plans shall be formulated and evaluated in terms of their net contributions to increases in ecosystem value (NER outputs), expressed in non-monetary units.

The San Francisco Estuary (San Francisco, San Pablo, and Suisun Bays) is a nationally significant estuary and is the largest estuary on the Pacific Coast of the contiguous 48 states. This restoration project represents a unique opportunity for large-scale ecosystem restoration because the Estuary:

- Had the largest amount of contiguous tidal marsh habitat on the Pacific Coast, prior to reclamation of most of these marshes;
- Is a critical stop for birds on the Pacific Flyway and is one of the most important wintering areas for migratory waterfowl on this flyway. (According to the U.S. Environmental Protection Agency (EPA), more ducks winter in the Estuary than in the much larger Chesapeake Bay);
- Has one of the largest concentrations of shorebirds on the Pacific Flyway, with more shorebirds wintering there than in any other location in California; and
- Provides habitat for a large number of Threatened and Endangered Species, including the California clapper rail, California black rail, San Pablo song sparrow, Western burrowing owl, salt marsh harvest mouse, Chinook salmon, steelhead trout, Delta smelt, Long-fin smelt, and splittail.

2.2 Public Concerns

To announce the start of the Feasibility Phase, a public notice was issued to residents, interest groups, and Federal, State and local agencies. The recipients were invited to provide input into the feasibility study, including determining the scope of environmental issues that should be addressed throughout the study. The notice announced a public meeting held by the Corps and CSCC, which also served as the Draft Environmental Impact Statement/Environmental Impact Report (DEIS/R) Scoping Meeting. The meeting was conducted on July 21, 1998 at the offices of the Napa County Board of Supervisors. Due to the duration of the feasibility study phase, a follow-up public meeting was held on October 23, 2001 at the Napa Main Library in Napa, California.

Issues that were raised during these meetings included:

- Effects on habitat and species:
  - Would fish be entrained in pumps or trapped in the ponds?
  - Would viable populations of threatened and endangered species be maintained in the area during construction and implementation?
  - Would construction of the project be planned around critical time periods for different species?
  - Would opening up the ponds too quickly lead to a scouring out of vegetation in the slough channels?
  - Would the waters become too deep for high-tide roosting birds and shorebirds?
  - Would wintering diving birds that use Ponds 1, 1A, 2, and 3 be adversely affected by the project?

- Water Quality and Recycled Water Use:
  - Would sources of fresh water be turned off when desalination is finished?
  - Would the use of fresh water change the salinity balance of the system?
  - Is dilution the most appropriate solution?
  - Would there be public health implications associated with the use of recycled water?
  - Would discharge of diluted salt pond water impact the Napa River, San Pablo Bay, or sloughs of the Napa-Sonoma Marsh?

- Other Issues/Concerns:
  - What other alternatives have been studied?
  - What are the potential impacts on privately and publicly held adjacent lands?
  - Will the non-Federal sponsor coordinate with the mosquito abatement districts and other agencies, particularly USFWS, to make sure this project does not interfere with their objectives?

These issues were presented and analyzed in the DEIS/R.

2.3 Problems

The first step of the Corps's Six-Step Planning Process is the identification of problems and opportunities in the project area.

2.3.1 Loss of Wetlands and Development in Wetlands

Diking or filling has destroyed approximately 90 percent of the original tidal wetlands of San Francisco Bay (*Baylands Ecosystem Habitat Goals, San Francisco Bay Area Wetland Ecosystem Goals Project, March 1999*). The loss of tidal wetlands has greatly reduced the amount of habitat available to many species of fish and wildlife. Several animal and plant species native to California, including the salt marsh harvest mouse and the California clapper rail, have been listed as endangered on State and Federal lists due to the severe reduction of wetland habitats.

2.3.2 Potential for Future High-Salinity Release into the North Bay

A number of high-salinity ponds in the NSMWA are considered a potential threat to the ecology of the North Bay due to the presence of large quantities and high concentrations of residual salts. Cargill Salt Company once manufactured salt in these ponds, but sold the ponds to the DFG in 1994, after they had ceased using the ponds for salt production. Current estimates suggest that there are 4.1 billion pounds (2.1 million tons) of salt in the ponds (*Napa Sonoma Marsh Restoration Feasibility Study Hydrodynamic Modeling Study, Phase 2 Stage I, March 2002*). A breach of a high salinity or bittern pond to a neighboring slough would result in fish kills and other ecological damage.

2.3.2.1 Salt and Bittern Concentration Continue to Increase in the Non-Operational Ponds

During the commercial production of salt, Bay water was moved through the 12-pond system as the salts were sequentially concentrated by solar evaporation. As a result, the later ponds in the system have salinity levels that exceed that of seawater and range to over 300 parts per thousand (ppt). The salt production process also concentrated soluble salts other than sodium chloride (table salt). These additional salts were generally not harvested and accumulated in the pond system as “bittern”. There are approximately 1.4 million metric tons of bittern in Pond 7 (*Pond 7 Bittern Salinity Reduction Duration Estimate Report, 2004*). Bittern is especially detrimental to aquatic organisms because it upsets the ion balance required for these organisms. Although none of these highly concentrated salts are considered “toxic” chemicals or hazardous waste under hazardous materials/waste laws, their uncontrolled release would be detrimental to the aquatic environment.

Annually, approximately twice as much water evaporates from the salt ponds as is replaced by rainfall. The net evaporative water loss must be replaced with make-up water. Make-up water available from nearby bodies of water (such as the Napa River and neighboring sloughs) is brackish to saline, causing increasing amounts of salt to accumulate in the ponds over time. Without active water management to maintain water levels and remove salt, the salt ponds would eventually turn into seasonally wet salt flats, resulting in the loss of most of their present habitat value.

2.3.2.2 Funding Constrains Ability of DFG to Repair and Maintain Existing Infrastructure, Making Breaches Likely in the Near Future

Funding and infrastructure constraints limit the DFG's ability to maintain the existing levee system and to control water levels (and thus salinities) in the ponds using the existing water control structures. Currently, only four of the ponds are capable of flow-through operation (i.e., both intake and discharge of water). The remaining ponds can only either intake or discharge to other ponds. Although water drawn from San Pablo Bay and the lower Napa River can compensate for evaporative water loss in these non-flow-through ponds, these nearby water sources also contain salts that would become concentrated in the ponds over time unless a flow-through mechanism is provided.

In addition, the project area currently contains 32 miles of levees, many of which were first built in the 1850s when the marsh was originally diked off for hay production. Many of the levees are in need of repair and breaches are likely to occur in the next 5-15 years, as the result of both erosion and seismic events (see Section 3.2.2. Geology and Soils).

2.4 Opportunities

The project also presents a number of rare opportunities for large-scale ecosystem restoration, due to the special character of the project site.

2.4.1 Ecosystem Restoration and Incidental Economic Benefits

Public acquisition of these former salt ponds in the NSMWA provides an opportunity to restore tidal salt marsh and related habitats on an unprecedented scale within the San Francisco Bay system. The NSMWA occupies a key position on the Pacific Flyway, a major migratory route used annually by waterfowl and other birds. The restoration of 6,980 acres of inactive salt ponds to productive wetland habitat, and the resulting restoration of over 2,200 acres of associated remnant sloughs and wetlands, would be a project of national significance. Restoring the health of the San Francisco Bay Area may also create indirect economic benefits (included in the discussion below).

Specifically, the restoration project represents an opportunity to:

- Improve habitat for a large number of threatened or endangered species, some of which are endemic to the region, by reducing pond salinity improving the ability to manage non-tidal ponds, and creating additional marsh and mudflat acreage;
- Improve the quality of resting and nesting habitat for migratory birds and waterfowl;
- Help lower mitigation requirements for projects in the Bay Area. By helping to stabilize populations of Threatened and Endangered species, mitigation requirements may be reduced, thus helping to ensure large public works projects (such as highways) can continue to be built in the Bay Area;
- Improve water quality. There would be water quality benefits to this nationally significant estuary. The Napa River is currently designated an "impaired body of water" by the RWQCB and under the Clean Water Act.

2.4.2 Deepening of Mare Island Ship Channel

Restoring some of the inactive salt ponds to tidal habitat would increase the scour in portions of the Napa River Channel, including the Mare Island Ship Channel (*Philip Williams and Associates, 2002. Napa River Salt Marsh Restoration Habitat Restoration Preliminary Design; Phase 2 Stage 2 of the Hydrology and Geomorphology Assessment in Support of the Feasibility Study, November 2002).* This channel has historically had high sedimentation rates. Due to the closure of the Mare Island Naval Shipyard, the Mare Island Ship Channel is no longer maintained, and no future dredging is planned unless the channel begins to restrict access to the Napa River Channel.

The high sedimentation rate in the Mare Island Ship Channel is associated in part with the relatively low tidal flow through the Mare Island Strait. Estimates suggest that the current tidal prism is less than 25% of the historical tidal prism. If the Napa River Salt Marsh Restoration Project were constructed, the estimated tidal prism would be on the order of 50% of historical levels and would result in a deeper natural depth in this area. Additionally, the ponds that are opened to tidal action would act as a sediment sink for sediment transported from San Pablo Bay.

2.4.3 Beneficial Use of Recycled Water

Recycled water would be available to the Project from a consortium of North Bay water agencies led by the SCWA (see Section 4.8.1.2 Pond 7 Bittern Removal and Salinity Reduction Measures). Using recycled water, rather than salt water from the Bay and Napa River, would speed desalination of the "bittern pond" (Pond 7) by increasing dilution. Recycled water could also be used to maintain water levels, thereby increasing management flexibility, particularly during dry years. This source of water would be highly beneficial due to the low availability of local groundwater and difficulty of transporting water from the Bay, sloughs, and River to the project.

The RWQCB has urged the Corps and non-Federal sponsor to maximize the use of recycled water in this project.

The RWQCB stated:

> *Such an approach would have the dual benefits of diminishing the need to withdraw fresh water from already over-allocated surface and ground water sources, and promoting the beneficial reuse of treated wastewater in keeping with Article X, Section 2 of California's constitution, which requires reasonable use of water and California's Water Reclamation Law, Water Code Section 13500 et seq, which declares it to be State policy to encourage development of recycled water to help meet California's water needs and prohibits use of potable water for nonpotable uses where recycled water is available.*

2.4.4 Recreation

The restored ponds and tidal areas would provide significant regional recreational opportunities. These opportunities would include educational activities, fishing, boating, hunting, and passive nature uses such as bird watching. The restored project site would have greater use by wildlife, as well as use by a more diverse range of wildlife. The large size of the project ensures that many recreational uses can be accommodated without interfering with wildlife enhancement and protection of endangered species. A small investment to upgrade the existing facilities could significantly enhance the recreational value of the Project Area without harming wildlife. The project would also be a valuable resource for researchers studying large-scale habitat restoration efforts and ecosystem recovery.

3.0 STUDY AREA DESCRIPTION

3.1 Setting

The term "study area" refers to the area that would be affected to significant degree by the implementation of any of the Alternative Plans considered in the study. The study area consists of the 9,460-acre Napa River Unit of the NSMWA, which is located on the west side of the Napa River. The study area contains 12 ponds (Ponds 1, 1A, 2, 2A, 3, 4, 5, 6, 6A, 7, 7A, and 8), formerly used in the salt-production process, that represent a range of conditions (Table 3.1 Summary of Pond Characteristics). These ponds include Ponds 1 – 8 and their subdivisions (i.e., Pond 1A, 2A, 6A, and 7A). The ponds are numbered sequentially from the southern ponds to the northern ponds, reflecting the order of brine (salty water) movement through the system. Figure 1-2 (Project Area and Surrounding Areas Managed by DFG) shows the locations of the ponds included in the study area. Ponds 1 though 6A are located south of Napa Slough and are referred to as the "Lower Ponds". Ponds 7, 7A, and 8 are located north of Napa Slough and are referred to as the "Upper Ponds".

The salt production process consisted of taking in Bay water at the southern edge of the pond system (Pond 1), allowing evaporation to occur, and then moving the brine to the next pond in the series for further concentration. Water transfers within the pond system occurred through a combination of pumps, tide gates, valves, siphons, and canals, all of which require on-going maintenance.

During the dry season, the salinity of the water in San Pablo Bay is approximately 30 to 32 ppt, similar to that of the ocean (typically 33 to 35 ppt). Through the 12-pond salt-production process, Bay water was concentrated to a salinity of approximately 350 ppt. The actual harvest of salt occurred in the "crystallizer" ponds (Ponds 9-12) on the east side of the Napa River, which are not part of the study area, but were acquired in March 2003 by the DFG.

Historically, the salinity in the ponds increased with the pond number; however, available pond water level and salinity management strategies have changed the historical conditions somewhat (See Table 3.1. for historic salinity ranges of each pond).

Table 3.1 Summary of Pond Characteristics

Pond number	Functioning habitat	Area (acres, including levees)	Historic Salinity Range (ppt)	Time of Likely Levee Breach	Notes
Lower Ponds					
1	X	394	1 - 11		Muted tidal, shallow-water pond
1A	X	609	1 - 11	5 - 10 yrs	Muted tidal, shallow-water pond
2	X	940	15 - 27	< 5 yrs	Managed, deep-water pond
2A	X	648	<1 - 4		Restored to tidal marsh
3		1,464	23 - 61	< 5 yrs	Immediately adjacent to Napa River, can be restored relatively quickly to tidal marsh. Two breaches created in August 2002 (see Section 3.2.4.2. Pond 3)
4		1293	61 - 112	> 10 yrs	Immediately adjacent to Napa River, suitable for restoration to tidal marsh.
5		990	64 - 131	> 10 yrs	Separated from Napa River by band of marsh. Suitable for restoration to tidal marsh, but would restore more slowly to tidal marsh than Ponds 3 and 4.
6		830	99 - 259		Shares levee with Pond 6A. Separated from Napa River, thus limited sediment supply. Candidate for adaptive management leading to either managed pond or tidal marsh.
6A		497	99 - 259	5 - 10 yrs	Shares levee with Pond 6. Separated from Napa River, thus limited sediment supply. Candidate for adaptive management leading to either managed pond or tidal marsh.
Upper Ponds					
7		410	246 - 415	< 10 yrs	Shares levee with Pond 7A. “Bittern Pond”; would require pre-dilution of water before discharge to Napa River. Make-up water must be either pumped in from Napa Slough or Pond 7A, or be provided in form of recycled water delivery. Candidate for managed pond.
7A	X	345	160 - 272		Shares levee with Pond 7. Salinity reduction can be quick, with sufficient fresh water. Levee between Ponds 7 and 7A must be maintained. Candidate for managed pond.
8		170	156 - 395		Low pH will need to be adjusted prior to salinity reduction. Deepest pond in the system. Candidate for managed pond.

Note: The acreages presented in this table, determined by the Real Estate Branch, San Francisco District Corps of Engineers, do not include the acreage of neighboring sloughs and adjacent uplands, which are included in the total study area acreage of 9,460.

3.2 Inventory of Existing Conditions

Information presented in this section was compiled from DFG publications, an extensive topographic and bathymetric survey conducted by Towill, Inc., and site-specific data. Site-specific data were collected by various agencies and organizations, including the DFG, U.S. Geological Survey, and the University of California at Davis, and were analyzed by PWA.

3.2.1 Climate

The San Francisco Bay region has a Mediterranean-type climate. Mediterranean climates are characterized by warm, dry summers and mild, wet winters. The San Pablo Bay and the Pacific Ocean dominate climatic conditions in the NSMWA. The mean annual temperature is 57°F, with a maximum mean of 67°F in September and a minimum mean of 41°F in December. Summer high temperatures rarely exceed 100°F and winter lows that fall below freezing are infrequent. Data collected between 1993 and 2001 indicate that rainfall in the project area averages 23 to 26 inches per year, with July rainfall averaging zero inches and January rainfall averaging between five and six inches.

Fog is a common occurrence in the summer. During periods of fog, visibility in the NSMWA is reduced to a quarter mile or less. These periods occur from 60 to more than 80 days a year. The area is subject to consistent winds, typically from the southwest (i.e., entering through the Golden Gate), with highest wind speeds typically in the early afternoon, especially during the spring. Wind speeds average four to six miles per hour over the course of a year.

The Napa River Unit was selected as a location for solar salt evaporation in part due to the combination of dry summers and consistent winds, which result in high net evaporation rates. Net evaporation is the difference between the total climate-driven evaporation and the average annual rainfall. As noted earlier, net evaporation in the project area is 22 to 23 inches per year.

3.2.2 Geology and Soils

The entire NSMWA area is underlain by varying thicknesses of Bay Mud, a soft, compressible, and organic-rich marine deposit of silt and clay with peat and local, thin sand and gravel lenses. The San Francisco Bay has two units of Bay Mud: Young Bay Mud is found closest to the surface, and Old Bay Mud (Yerba Buena Formation) is found below the non-marine deposits underlaying the Young Bay Mud. Additional non-marine deposits, including alluvial deposits, underlay the Old Bay Mud and also irregularly flank the margins of the marsh area. The hills that bound the NSMWA and the Napa and Sonoma Valleys are underlain by a variety of rock units, the most important of which are: the Franciscan formation (sandstone, shale, serpentine, and other rocks), the Chico foundation (mostly marine sandstone), the Merced formation (Tertiary marine sands and sandstone), and the Sonoma volcanic (Tertiary volcanic flows and tuffs). The groundwater hydrology in the Napa Marsh area consists of aquifers of alluvial deposits of recent geologic age, supported by volcanic and continental deposits with low water yields.

NSMWA soils are all of the Reyes series. These soils are silty clays deposited primarily by sediment-laden Bay waters, but also by tributary freshwater streams. Slopes in the marsh range from zero to two percent, but most are less than one percent. The soil is acidic in its undeveloped state, its permeability is low, and the erosion hazard of these soils is not considered significant. Seasonal and tidal fluctuations may increase channel flow, and the boundaries of the vegetated marsh and sloughs may change due to the resulting erosion and undercutting of the marsh banks. Levees in the project area were constructed from the native Bay Muds and peat, and repaired using the same material.

The San Francisco Bay Area has experienced severe shaking from the numerous earthquake faults in the area. The closest fault to the project site, the Rodgers Creek Fault (the northern section of the Hayward Fault) and has a 32% probability of one or more magnitude 6.7 earthquakes over the next 30 years (U.S. Geological Survey [USGS], 1999). Ground shaking would be amplified in the project area due to the soft soils and could lead to levee failure. Tsunamis and seiches do not pose a significant hazard within the NSMWA area, although run-ups of as much as 3.3 to 3.7 feet may occur with the 100- to 500-year Tsunamis.

3.2.3 Drainage Area

In addition to precipitation that occurs within the marsh area, the NSMWA receives freshwater inflow from three major streams. The largest and most important freshwater source to this system is the Napa River, which drains an area of approximately 426 square miles. The stream of secondary importance in the marsh is Sonoma Creek, which drains an area of about 143 square miles. Tolay Creek, an intermittent stream, is the third and a minor source of fresh water for the western extremity of the marsh. It drains an area of approximately 18 square miles. The total Napa Marsh drainage, therefore, is approximately 587 square miles.

3.2.4 Hydrology

3.2.4.1 Ponds 1, 1A, 2, and 2A

The tidal influence of San Pablo Bay is a major factor in the hydrological dynamics of the study area. Twice daily, the waters of the Bay extend into the marshlands, flooding the mudflats. The NSMWA is part of the Napa River and Sonoma Creek estuary, subject to the exchange of fresh and saline waters. Tidal influence on the Napa River and Sonoma Creek extends far upriver of the project area. Currently, tidal exchange within the salt ponds occurs in Ponds 1, 1A, 2, and 2A. Ponds 1 and 1A receive water from San Pablo Bay through a gated pipeline underneath Highway 37. Pond 2 has four water control structures; one of these, on the west side along China Slough, functions as both an inlet and an outlet, allowing tidal flow of water into the pond. The primary source of water to Pond 2, however, is a pump station transferring water from Pond 1 through a siphon into Pond 2. The third water control structure, on the east side of Pond 2, functions as an outlet to China Slough. The fourth water control structure is an outlet to the All American Canal, which transfers water to Pond 3. Pond 2A has already been restored to tidal marsh and is fully connected to the existing slough system.

3.2.4.2 Pond 3

Pond 3 receives water primarily from Pond 2 via the All American Canal. However, in August 2002, an unknown party dug a narrow, two-foot-wide ditch between Pond 3 and South Slough, resulting in tidal exchange between the two bodies of water. The DFG subsequently obtained an emergency exemption to create a small two-foot-wide ditch on the southeast side of Pond 3 to facilitate some circulation of water in and out of Pond 3, and take the pressure off of the ditch on

South Slough. USGS is currently monitoring salinity within and outside the small "ditches". As of February 2003, the width of the initial (unplanned) ditch has increased to 42 feet and significant exchange is occurring between Pond 3 and the adjacent South Slough.

3.2.4.3 Ponds 4, 5, 6, 6A, 7, 7A, and 8

The remaining ponds (Ponds 4-8) are largely hydrologically isolated from San Pablo Bay, the Napa River, and Sonoma Creek (Figure 3-1 Existing Conditions). A saline wedge often blocks the Pond 3 to Pond 4 siphon. Although it would be possible for Pond 4 and some of the other ponds to receive water via this siphon, if it were functioning, currently the only source of make-up water to Ponds 4 through 7 is from the canal leading from Pond 8 to the water control structure ("donut") at Ponds 7 and 7A.

Until recently, the only source of water to Pond 8 and the Pond 8 canal was a pipeline from the east side of the river that discharges to the canal at Pond 8. The DFG paid Cargill (the owner of the pipeline) to pump water through the pipeline into the canal, and then distributed the water among the upper and middle ponds. Ownership of this pipeline was transferred to DFG in March 2003. The amount of water that could be pumped was limited by the available funding (cost of electricity). Because hydraulic head drives all flows in the system, it is difficult to transfer water all the way from Pond 8 to Pond 4. Friction losses and the overall small head differential limit the amount of water that can be transferred south from Pond 8 to lower–numbered ponds. DFG's objective is to maintain as much water as possible in all the ponds throughout the year.

In the past year, the DFG has installed new water control structures (two 30-inch diameter intakes) on Pond 8, which allow direct intake from the adjacent Mud Slough into the pond. The new intakes have increased the amount of water available to the ponds substantially. Assuming that existing water control structures can be made to function effectively, the new intakes might reduce the likelihood that ponds would dry out in the short term. However, since there is no discharge of water from these ponds, current management of the system is a trade off between allowing the ponds to desiccate for part of the year, or increasing the salt content more rapidly (by increasing inflows).

3.2.5 Salinity Regime

Salinity levels in the functioning marsh are dependent on tidal influence, solar evaporation, precipitation, and runoff. Salinity records have been maintained in connection with the operation of the salt evaporation ponds. These records indicate a general trend of increasing salinities in the sloughs towards the southwest as the influence of the Napa River declines and the influence of San Pablo Bay increases. This trend is reinforced seasonally as Napa River flows decline in summer. Another general trend is caused by the influence of waters discharging from the San Joaquin-Sacramento Delta through the Carquinez Strait, which produces an increasing salinity gradient toward the west as the freshwater moves into San Pablo Bay.

3.2.6 Vegetation

Vegetation within the functioning portion of the NSMWA varies according to small differences in elevation and variations in the salinity regime of the adjacent tidal waters. The lower tidal marsh, adjacent to the mudflats along the banks of sloughs and rivers, is vegetated by cordgrass that is occasionally intermixed with alkali bulrush. Within the borders of the established marsh and quiet ponds are areas of alkali bulrush, jaumea, and pickleweed, accompanied by cattails. Curly dock and brass buttons, both highly adaptable introduced plants, are also common.

The middle tidal marsh is mainly vegetated by pickleweed, with the occasional occurrence of salt rush, tules, cattails, arrow grass, and jaumea. The higher tidal marsh is dominated by pickleweed and saltgrass. The lower portions of the levees, near the water's edge, support gumplant, saltgrass, sedges, tules, and cattails. The upper portions of the levees support grasses, herbs, coyote bush, California rose, Himalaya blackberry, and blue elderberry.

3.2.7 Fisheries

Sampling within habitable (low salinity) areas of the NSMWA has shown 25 fish species, representing 17 families. The most abundant fish was juvenile striped bass (which are stocked in Pond 2). Also abundant were the yellow-fin goby, tule perch, Pacific staghorn sculpin, Sacramento splittail, longfin smelt, and threadfin shad. The Napa River and associated estuaries are an important nursery area for juvenile steelhead and striped bass. Fish have also been found in some of the Lower Ponds; they were most likely introduced with the seawater. Several of the salt ponds have salinity ranges that are suitable for brine shrimp, which are an important food source for some species of waterbirds, such as avocets and black-necked stilts.

3.2.8 Wildlife

The NSMWA is one of the largest expanses of contiguous wildlife habitat on the periphery of San Francisco Bay. The tidal wetlands and diked salt ponds of the marsh are vital habitats sustaining migrating and wintering waterfowl and shorebirds along the Pacific Flyway and resident species that remain in the area throughout the year. At least 25 species of waterfowl have been observed in the marsh. The North Bay, including the NSMWA, provides the main wintering grounds along the Pacific Flyway for the canvasback duck; over 12,000 individuals have been counted at one time in the NSMWA. At least 31 species of shorebirds and wading birds have been recorded in the NSMWA. Other common waterbirds in the marsh include coots, rails, pelicans, terns, cormorants, and nine species of gulls. At least ten species of raptors and numerous species of other land birds have been recorded in the NSMWA.

Other wildlife species in the marsh include at least nine species of reptiles and amphibians and 22 species of mammals.

3.2.9 Rare, Threatened, and Endangered Species

Several State- or Federally-listed threatened and endangered animal species are present in the study area. The California clapper rail, California black rail, salt marsh yellowthroat, San Pablo song sparrow, western snowy plover, salt marsh harvest mouse, Sacramento River winter-run chinook salmon, Delta smelt, and Sacramento splittail have been known to use the marsh system. Central California steelhead trout have been found in the Napa River.

Several special-status plant species have been reported to occur in the study area and/or vicinity as well. These include the Suisun Marsh aster, San Joaquin spearscale, Delta tule pea, Mason liliaeopsis, Marin knotweed, and California cordgrass. The USFWS Planning Aid Report (Appendix B) lists the species of potential concern that may exist in the study area.

3.2.10 Land Use

The marshes in the study area were first diked for hay production and cattle grazing in the 1850's. In the 1950's, the land was converted to salt production by the solar evaporation of bay water. Salt production stopped in the 1980's due to the loss of the sole industrial consumer for salt harvested in the pond complex. The land is now managed as wildlife habitat by the DFG.

3.2.11 Cultural Resources

No historic properties or archaeological or historical resources eligible for the National Register of Historic Places were identified within the project's Area of Potential Effect (APE). Archival records indicate that no cultural resources eligible for the National Register of Historic Places (NRHP) were identified within the project APE, which consists of a marshland component (NSMWA) located between the Napa River and Sonoma Creek, and three upland pipeline components extending approximately from the cities of Schellville, Napa, and American Canyon to the NSMWA in the north San Pablo Bay Region. Jones & Stokes, Sacramento, California, submitted a *Cultural Resources Inventory and Evaluation Report for Napa River Salt Marsh Restoration Project, Napa and Sonoma Counties, California* (Appendix C).

Native Americans of Patwin and Coast Miwok occupied locations surrounding the Napa Salt Marsh. Spanish explorers made contact with the Native people in the late 1700's and by 1776 Franciscan missionaries began a process of forced Christianity and brought local Native Americans to work and live on mission lands, leaving many villages abandoned. Later settlement by Mexican ranches and American farms and ranches converted lands to grazing and agricultural production. By the 1870's, European settlers had replaced the native peoples and conversion of the land for crop production was completed. The project area is currently largely covered by water, and would remain covered by water and fluctuate slightly with tidal influence following restoration.

The built environment includes a total of 24 buildings, structures, and linear features more than 50 years old. The structures include duck blinds, fishing sheds, farm and ranch building remnants, docks, levees, salt ponds, water conveyance structures and a pump house. The structures are scattered throughout the former salt pond complex and were evaluated for eligibility on the National Register of Historic Places (NRHP) and the California Register of Historical Resources (CRHR). None of the structures were found to meet the criteria for eligibility to the NRHP or the CRHR. The project would not result in adverse effects or significant impacts to any of the resources identified within the project APE.

A total of five prehistoric archaeological sites were recorded within and immediately adjacent to the project APE, the three prehistoric archaeological sites recorded within the project APE could not be relocated during the current survey. Initial identification occurred over 90 years ago and geographic features used to reference site locations have disappeared. Disturbance to the area has increased significantly as a result of settlement and urban development activities (agriculture, industrial salt mining, road construction, off-road vehicle use, and underground utility installation) and sites may have been significantly displaced or destroyed. Prehistoric archaeological sites immediately adjacent to the APE were relocated and it is possible that cultural material exists beneath the disturbed ground surface. The COE is recommending that a qualified archaeologist be present to monitor all ground-disturbing activities within the locations of previously identified sites. The COE archaeologist, in cooperation with the non-Federal sponsor and contractors, would arrange the necessity and duration of these activities.

If unmonitored cultural resources or cultural material such as burned, ground or chipped stone, shell concentrations, carved bone or wood, blown glass, bottles, ceramics or pottery fragments, adobe, brick or stone linear arrangements, hand forged tools, square nails, or farm or ranch equipment are discovered work activity within the area and an area within 100 feet of the find would stop, and be redirected around the site or redirected to another location until a qualified archaeologist can evaluate the significance and, if necessary, develop appropriate treatment measures. The COE archaeologist must be notified immediately or as soon as possible on the same workday.

Of special concern are human remains. California Health and Safety Code Section 7050 states that in the event human remains are found during construction, work must cease in the vicinity of the discovery and any surrounding area reasonably suspected to contain human remains, until the coroner of Napa or Sonoma County has been informed.

California State Law, California Health and Safety Code, Section 8100, recognizes six or more human burials in a single location as a cemetery, and Section 7052 advises that disturbance of Native American cemeteries is a felony offense. If human remains are discovered, Section 7050.5 requires construction activities in the vicinity of discovery to stop until the coroner can determine if the remains are Native American. If they are determined to be Native American in origin, the coroner must contact the NAHC, and the COE and the non-Federal sponsor must comply with State and Federal laws regarding the disposition of Native American burials.

Additional details on Cultural Resources in the NSMWA are provided in Appendix C (Cultural Resources Report).

3.2.12 Contaminants

A comprehensive testing program was conducted to evaluate whether hazardous, toxic, or radioactive wastes and/or contaminants were present in the study area. The testing program consisted of collecting two to four water and sediment samples per pond, and background samples from Napa Slough, Napa River and San Pablo Bay (a total of 79 samples, consisting of 39 sediment samples and 40 water samples). Each of the samples was analyzed for total dissolved solids, pH, heavy metals, and certain anions and cations. A percentage of the samples were also analyzed for priority pollutant organic compounds including pesticides, polynuclear aromatic hydrocarbons, and polychlorinated biphenyls. The testing was conducted to support the permitting effort for discharges during salinity reduction.

No hazardous, toxic, or radioactive waste was identified in the study area. As expected, the testing indicated that salinity was generally elevated. Only trace levels of a few organic compounds were detected. Heavy metals were also detected; concentrations were generally consistent with anticipated background (natural) conditions. Nonetheless, copper and zinc were elevated in some ponds relative to their likely discharge criteria.

3.2.13 Recreation

The NSMWA is currently a “Type C” wildlife area that does not require any special permits or fees for general entry. The NSMWA lends itself to many public uses. It is located within a one-hour drive of most San Francisco Bay Area cities as well as the Sacramento area. Public and group meetings have already been held at the DFG North Bay Field Office conference room. It is anticipated that educational and interpretive programs would be developed as part of the wildlife area's management program.

The area is open daily for all authorized, wildlife-related activities, such as boating, wildlife viewing, fishing, hunting, and nature study. Some of the fastest growing uses of the marsh include bird watching, nature study, and educational and scientific programs. The NSMWA is recognized as one of the better places in the North Bay to observe wildlife because of the variety of habitats and species present.

Fishing is a popular activity occurring throughout the numerous sloughs, Sonoma Creek and Napa River, and some salt ponds. Although the NSMWA has no improved facilities on-site, there are facilities at the Vallejo Launch Ramp, Hudeman Slough Launch Ramp, and Cutting’s Wharf fishing access in Napa. Facilities include parking, launching ramps, docks, and restrooms at some locations. Where access is available, bank fishing takes place along the rivers, creeks, sloughs, and Ponds 1 and 1A. Currently, access to the NSMWA is primarily by boat because most of the area is comprised of island ponds, or ponds adjacent to numerous sloughs, rivers and waterways. Specific regulations on boating apply within the wildlife area.

Public land access for Ponds 7 and 7A is via Buchli Station Road (a county road) near State Highway 12. The Buchli Station Road parking lot has a voluntary check station where visitors can fill out “use cards” related to their activities. There is a five-acre, freshwater pond with a wildlife viewing blind on the east side of the pond adjacent to the parking lot. This blind is available to the public for bird watching. On the east side of the check station is a footbridge across an internal ditch which affords access to a maintenance road which leads to Ponds 7 and 7A, internal levees, viewing of Coon Island, and Napa Slough. Pond 8 is accessible via Milton Road, a public road. A small paved parking lot is provided at the end of Milton Road. For the southern-most ponds (Ponds 1 and 1A), access can be gained through State Highway 37 pullouts.

Currently, there are no improved facilities (drinking water, toilets, boat launches, trails, interpretive signs, public telephones, etc.) at any of the parking lots. There are electrical connections at the Buchli Station Road parking lot for future use and infrastructure enhancement.

The DFG maintains limited constructed facilities for the NSMWA. The DFG’s Marsh Headquarters consist of a former Dairy Farm and its associated structures. The main building has employee housing, a conference room, offices, a restroom, and a kitchen. Other buildings include: a bunkhouse used for office space, a garage used as a maintenance shop, a pole barn used for vehicle and equipment storage, and a barn used for storage and special events as needed. The DFG has developed an outdoor amphitheater area with a fire pit and barbecue that can be used for school groups, educational events, etc. Additionally, the DFG has set up a native plant nursery on-site.

3.3 Future Without-Project Conditions

Without the proposed project, site conditions would continue to deteriorate due to the aging infrastructure and inability to remove salt from the ponds. This situation would continue to reduce the value of the Project Area for wildlife habitat.

There are three potential scenarios for "Future Without-Project Conditions", of which the third was selected to predict future conditions:

- Scenario 1: Uncontrolled Levee Breach (Levee Failure)
- Scenario 2: Pond Desiccation
- Scenario 3: On-Going Department of Fish and Game Maintenance

The first two scenarios represent a sudden loss of habitat value, and the third represents a more gradual loss as the DFG continues its best efforts to maintain the ponds and surrounding land. Scenario 3 is the most predictable and most likely over the long term and was chosen as the basis for evaluating Without-Project Conditions.

3.3.1 Scenario One – Uncontrolled Levee Breach (Levee Failure)

Under this Scenario, a levee breach occurs at one of the higher salinity ponds, resulting in substantial adverse effects on the fish and invertebrate population in the affected portion of the slough or River. Levee breaches could occur as a result of either erosion or seismic events.

Although breaches are likely to occur under the Without-Project Condition, the timing and specific habitat impacts would require extensive computer simulations to predict accurately. Therefore, the effects of uncontrolled breaches were not quantified or used as the basis for establishing habitat benefits, except for Pond 2, for which levee repairs are being proposed to prevent a breach that is anticipated within 5 years (Section 3.3.3.7 Uncontrolled Breaches Occur).

3.3.2 Scenario Two – Pond Desiccation

Under this scenario, the State of California would become unable to fund on-going maintenance at the study area or would cease its current operations and maintenance regime after deciding that further increasing the salt load in the ponds would be more detrimental to habitat values than having seasonally dried salt ponds. Consequently, the ponds would rely solely on rainwater as their means of maintaining habitat value.

This scenario is unlikely in the short term because the State of California would attempt to maintain the ponds' habitat value as much as possible. Although it is possible that allowing the ponds to dry out in the long term may be preferable to a continuing build-up of salts, such a decision would be made by the State at some point in the future, and cannot be anticipated at this time.

3.3.3 Scenario Three – On-Going DFG Maintenance (Most Likely Without-Project Scenario)

This scenario is the most predictable and quantifiable, as well as the most probable in the short-term. Given the limitations on predicting levee breaches as described in Scenario 1, and knowing that the DFG would continue its best efforts to manage the pond system, Scenario 3 was identified as the most likely Without-Project Condition and used as the basis for establishing project benefits.

Under this scenario, the DFG would maintain the system in its current configuration with one change. Instead of relying on the Cargill pump to provide water to the Upper Ponds, the water control structure at Pond 8 would serve the same function. The water intake structures were installed by the DFG and Ducks Unlimited in early 2002, and are capable of delivering approximately 20 cubic feet per second (cfs) (9,000 gallons per minute [gpm]), a 50% higher flow than the Cargill pump. More importantly, the new intakes are available all year and are not constrained by funding available for electricity, as was the case for the Cargill pump.

3.3.3.1 Water Control Structures Function in Long Term

This scenario assumes that most water control structures would continue to function in the long term. However, short-term (seasonal to several year) failures or blockages in water control structures have been common because the DFG lacks sufficient funding to fully maintain and/or replace the aging infrastructure. Such blockages are unpredictable and have not been factored into this scenario. As a result, the Without-Project Condition analysis slightly exaggerates the long-term habitat value of the area.

The construction of additional water control structures to the system is unlikely due to DFG funding constraints.

3.3.3.2 Ponds 1, 1A, and 2 Remain High-Quality Habitat

Ponds 1 and 1A have a direct connection to San Pablo Bay via the pipeline under Highway 37. The scenario assumes that this intake would be maintained so that there is continued flushing of Ponds 1 and 1A. Similarly, Pond 2's intake and two outfalls would be maintained to allow continued flushing. If levee breaches do not occur, or are repaired, these ponds should remain high-quality deep-water pond habitat. However, Pond 2 levee breach is assumed to occur in Year 5 of the HEP analysis for the future without-project condition (Section 3.3.3.7 Uncontrolled Breaches Occur).

3.3.3.3 Import of Water from Napa River and San Pablo Bay for Maintaining Water Levels

The DFG would import approximately 11,400 afy (acre-feet per year) from the Napa River via the Pond 8 intake. This water would be used to maintain water levels in Ponds 4, 5, 6, 6A, 7, and 7A, as well as in Pond 8.

The DFG would import 3,700 afy from San Pablo Bay via Pond 1. This estimate more than doubles the current rate of water intake because additional electricity would be available to operate the Pond 1 pump station (since pumping is no longer required at Pond 8) and operational problems encountered recently are assumed to have been corrected. This water would be used to maintain water levels in Ponds 1, 1A, and 2.

3.3.3.4 Water Exchange between Ponds 3 and 4

Because two small ditches have been constructed recently (August 2002) on Pond 3, no additional water is required for this pond. It is anticipated that these ditches will eventually widen to achieve extensive tidal exchange. Pond 3 therefore might be able to provide additional water to Pond 4, assuming that the siphon between Ponds 3 and 4 can be made operational, and that the water level in Pond 3 is higher than that in Pond 4 (this occurs only during high tides). Due to the salinity differential between Ponds 3 and 4 (which results in a high likelihood of continuing blockage) and the difference in the water levels of the two ponds, this assumption may over-predict the habitat quality in Pond 4.

3.3.3.5 Continued Salt Accumulation in Ponds

The primary concern associated with the Without-Project scenario is the increase in salt in the ponds. For a portion of the year, both water sources (the Napa River and San Pablo Bay) are moderately-to-highly saline. Therefore, the amount of salt in each pond would continue to increase in direct proportion to the amount of water brought in to maintain water levels. The annual addition of salt would be substantial because the evaporation rate is high and the ponds have a large surface area. Because evaporation rates are lower for higher salinities, the volume of imported water required to maintain water levels and the associated rate of salt accumulation would decrease slightly each year.

3.3.3.6 Habitat Values Decrease with Increasing Salinity

Pond conditions would worsen significantly over time. As the total salt mass in each pond increases, salinities increase and habitat value deteriorates**.** As salinities exceed 350 ppt, the ponds would start to accumulate significant quantities of precipitated sodium chloride (NaCl) and bittern, even when there is brine in the ponds. As the majority of the NaCl precipitates, the overlying brine would become bittern. The presence of large quantities of bittern in the ponds, coupled with the likely deteriorating levee conditions as described for Scenario 1, results in a high risk of an accidental release of bittern into the sloughs or River.

The estimated total increase in salt mass in the system over a 50-year period of analysis under the Without-Project Condition is 18.2 billion pounds. This is over four times the total estimated salt mass currently in the system.

The accumulation of salt in the ponds is unavoidable as long as an attempt is made to maintain water in the ponds while full flow-through conditions are not established. Thus, the DFG may determine that allowing the salt ponds to dry out is preferable to creating multiple large bittern ponds, as described under Scenario Two. In either case, the habitat value of Ponds 4 through 7A becomes effectively zero, and the risk of a high-saline brine or bittern spill is substantial.

3.3.3.7 Uncontrolled Breaches Occur

Due to the extensive levee system (32 miles) and the poor condition of some of the levees (Figure 3-1. Existing Conditions), uncontrolled breaches are expected to occur under the Without-Project Condition. The severity of the resulting negative impacts, such as salinity and bittern releases and scouring, would vary depending on the location and timing of the breach. For purposes of quantifying the benefits of proposed Alternative Plans, simplifying and conservative assumptions were made regarding the without-project habitat values. With the exception of Pond 2, future habitat values were estimated under the assumption that no breaches would occur; therefore this assumption results in an over-estimated habitat value for without-project conditions and underestimated benefits associated with each Alternative Plan. A breach was assumed for Pond 2 because of the severe deterioration of its levees (a breach is expected within 5 years, see Figure 3-1. Existing Conditions).

Pond 7 Hazard and Risks

The bittern in Pond 7 poses an ecological hazard if released. It is predicted that a breach to the Pond 7 levees will occur within 10 years (Figure 3-1 Existing Conditions), which would result in fish kills and unknown impacts to the threatened and endangered species known to inhabit the area. However, an uncontrolled-breach scenario was not used for determining the without-project habitat value of Pond 7. The listed species most threatened by a bittern spill would be the Delta smelt, which could face direct mortality and could not readily evade the bittern. The steelhead trout could also be affected. The salt marsh harvest mouse and the California clapper rail could lose some habitat temporarily.

4.0 PLAN FORMULATION

Plan Formulation is the process by which Alternative Plans are created to address specific Planning Objectives. Plan Formulation typically begins with the identification of Measures, the building blocks from which Alternative Plans are created. After Alternative Plans are created, they might be "reformulated" to make them more effective, efficient, reliable, or acceptable.

4.1 Planning Objectives

The National Objective (Section 2.1) is a general statement and not specific enough for direct use in Plan Formulation. Planning objectives are directly related to identifying the problems and opportunities and represent desired positive changes in the Without-Project Condition.

The planning objectives for the Napa River Salt Marsh Restoration Project are:

- To create a mix of tidal habitat and managed pond habitat to serve a broad range of wildlife, including endangered and threatened species, fish and other aquatic species, and migratory shorebirds and waterfowl;
- To restore large areas of tidal habitats in a band along the Napa River to maximize benefits to fish and other aquatic animals, and ensure connections between the patches of tidal marsh (within the project site and with adjacent sites) to enable the movement of small mammals, marsh-dependent birds, and fish and aquatic species; and
- To improve the ability to manage water depths and salinity levels in the managed ponds to maximize feeding and resting habitat for migratory and resident waterfowl and shorebirds.

4.2 Planning Constraints

Planning constraints are those concerns that must be considered while developing Alternative Plans. The following descriptions are not environmental assessments; instead, these constraints were used to limit the range of features proposed for this study. The environmental conclusions regarding these constraints are presented in the attached DEIS/R.

4.2.1 Regulatory and Policy Constraints

- Ecosystem restoration must be consistent with Corps's policy as established under EC 1105-2-210, Ecosystem Restoration in the Civil Works Program;
- Implementation of ecosystem restoration must not adversely affect operation of the existing Napa River navigation channel; and
- Implementation of ecosystem restoration must not have a significant adverse impact on the water quality of the Napa River or San Pablo Bay. This includes the following specific constraints as determined by the Regional Water Quality Control Board (RWQCB):
    - Effluent discharge limitations (for salinity, dissolved oxygen, temperature, nutrient load, heavy metals, and other criteria);
    - Mixing zone restrictions around discharge location(s); and
    - Maximum reuse of recycled water.

4.2.2 Biological Constraints
Implementation of ecosystem restoration must minimize impacts to the existing habitat and sensitive species in the area.

Minimization of such impacts would involve:

- Avoiding entrainment of organisms in discharges and diversions;
- Avoiding or minimizing loss of existing habitat in the ponds/loss of existing food sources (e.g., brine shrimp) during salinity reduction;
- Observing protection periods for listed species including salmonids, Delta Smelt, Clapper Rail, Sacramento Splittail, and Long-Fin Smelt (e.g., salmonids: April to June);
- Constraints on construction noise within 250 feet of Clapper Rail habitat (February 1 to August 31);
- Avoiding or minimizing erosion of existing fringing marshes along sloughs;
- Monitoring and honoring the salt, temperature, dissolved oxygen (DO), and pH tolerance of organisms present in the receiving water;
- Monitoring and regulating the nutrient, DO, and heavy metals content of imported water (especially if recycled water is imported for dilution purposes); and
- Monitoring and minimizing the temperature differential between incoming water and the receiving body of water.

4.2.3 Utilities
There is only one utility in the project area, a Pacific Gas and Electric (PG&E) transmission line. Four footings for transmission line towers are located in the project area, of which two are located in existing sloughs while the other two are located in Pond 2A and in Pond 4. Potential erosion of the footings would have to be addressed as part of the project design.

4.3 Planning Considerations
Planning Considerations include issues that contributed to plan formulation, but were not considered to be limiting factors.

4.3.1 Regional Habitat Goals
Planning considerations for this study include the regional habitat goals for the North Bay, as determined in the *Baylands Ecosystem Habitat Goals Report* (the Goals Report) and the California Bay Delta Program *Multi-Species Conservation Strategy* (MSCS).

The Goals Report was a multi-agency regional planning effort defining the habitat restoration goals for the entire Bay Area. The Report was a product of the San Francisco Estuary Project, which was established by the U.S. Environmental Protection Agency in 1987 as part of its National Estuary Program.

Recommendations from the Goals Report for the Napa River Area and Sonoma Creek applicable to the project area and complementary to Federal objectives include the following:

- Restore a continuous band of tidal marsh along the entire shoreline of San Pablo Bay, particularly near the mouths of sloughs and major streams, and enhance existing marsh patches by improving tidal circulation;
- Restore large areas of tidal salt marsh along both sides of the Napa River, including former salt ponds and Cullinan Ranch;
- Manage the remaining inactive salt ponds on both sides of the Napa River as salt pond or shallow, open water habitat to support waterfowl; and
- Establish managed marsh or enhanced seasonal pond habitat on diked baylands that are not restored to tidal marsh.

4.4 Design Considerations

The following issues will be taken into consideration during PED, but were not treated as constraints during the planning phase.

4.4.1 Physical and Hydrological Considerations

Physical and hydrological considerations affect the ability to move water through the system, and include:

- Existing bathymetry and topography;
- Change in tidal prism that would occur with opening of ponds;
- Siltation rates in ponds opened up to tidal action;
- Quantity of additional water available; and
- Potential erosion of levees.

The need to control erosion would limit the number of ponds opened to tidal action at any one time, and would also limit the number of locations where intakes, outfalls, and breaches can be located.

PWA has conducted extensive modeling of the proposed project area as part of the hydrodynamic and geomorphologic analysis. The report titled *Hydrodynamic Modeling Analysis of Existing Conditions* (Appendix D (Engineering Appendix)) presented the baseline or existing hydrodynamic conditions and the hydrodynamic model that simulated these conditions. In addition, geomorphic interpretation of the response of slough channels to the tidal restoration of the marsh system was investigated.

The existing physical conditions characterized include parameters such as water surface elevation and salinity and sediment transport, which were used in a combination of one-and two-dimensional computational modeling.

PWA also concurrently prepared the *Napa Sonoma Marsh Restoration Feasibility Study Phase 2 Stage 1* report, which describes and evaluates the Salinity Reduction Options, and the *Napa Sonoma Marsh Restoration Feasibility Study Phase 2 Stage 2* report, which describes and evaluates the Habitat Restoration Options. These studies provide the foundation for the Plan Formulation for this project and are included in Appendix D (Engineering Appendix).

4.4.2 Chemical Considerations

Solution kinetics would determine the rate at which precipitated salts would dissolve as less saline waters are added to the ponds. Certain chemical compounds would not redissolve once they solidify. These salts could form a hard crust that would constrain sediment movement (i.e., the reestablishment of antecedent marsh channel networks) in ponds reopened to tidal action.

4.4.3 Pond Access by Construction Equipment

Most of the ponds in the project site are on islands and therefore are not accessible by land-based construction equipment or watercraft (water levels in sloughs are too low most of the time to allow access by barges). Work inside the ponds would also be difficult because the ponds, even when mostly dry, would not support land-based construction equipment. Conversely, even when full, the ponds are too shallow for water-based construction equipment.

4.4.4 Nearby Projects

The presence of the following planned and potential restoration and flood control projects in the area might pose substantial limitations on the design of the project.

4.4.4.1 Cullinan Ranch

Immediately south of Ponds 2 and 3 is the Cullinan Ranch parcel owned by the U.S. Fish and Wildlife Service (USFWS) as part of the San Pablo Bay National Wildlife Refuge. If Pond 3 levees are breached incorrectly, and/or if the tidal prism in Dutchman Slough increases too rapidly, levees at Cullinan Ranch might be accidentally breached before that project has been completed. Under current estimates, the earliest the Cullinan parcel could be opened to tidal action is 2004.

The following problems might occur as a result of an unplanned levee breach at Cullinan Ranch:

- Since it is deeply subsided, the Cullinan Ranch parcel may act as a substantial sediment sink once it is breached, reducing the sediment available for restoring the salt ponds;
- Dutchman Slough may naturally reroute itself through the Cullinan Ranch parcel (i.e., away from Pond 3) once that parcel is breached;
- The tidal prism in the area may be increased by as much as 40%, resulting in erosion of sloughs beyond that desired by the restoration of the salt ponds.

4.4.4.2 Skaggs Island

Skaggs Island, located immediately west of Ponds 6 and 6A, is a former Navy base that is being transferred to the USFWS under the Base Realignment and Closure (BRAC) program. No restoration project has been defined yet for this parcel, but it is likely to include the establishment of both pond and tidal habitat. Opening the Skaggs Island parcel to tidal action could dampen tidal flows in Sonoma Creek and/or lead to extensive scouring of the Creek as it widens to accommodate additional tidal demand. Any restoration activities that involve breaching Ponds 6 and 6A would have to consider such effects on Skaggs Island.

4.4.4.3 Sonoma Creek Flood Control Study

The Corps (San Francisco District) is currently undertaking a flood control study along Sonoma Creek, located to the west of Skaggs Island. The Sonoma Creek watershed drains a 170 square-mile area, and discharges into San Pablo Bay in the area of the former salt ponds. The overall findings of the San Pablo Bay Watershed Management Plan indicate a Federal interest in providing solutions to environmental and flood protection to the Sonoma Creek and its tributaries. Potential solutions to be considered in the Feasibility Study are setback levees for flood protection and stream restoration; beneficial reuse of dredged material; geomorphic modifications to protect, restore, and enhance restoration of over 14,000 acres of tidal, seasonal, and freshwater wetlands; environmental enhancement of 10 to 15 miles of riparian corridor; and protection to over 20 threatened or endangered species. The Sonoma Creek study only includes areas found within the Sonoma Creek Watershed and thus does not include Skaggs Island or the NSMWA.

4.4.5 Other Design Considerations

Other engineering considerations include:

- The condition and capacity of existing water control structures (for water intake, diversion, transfer, or discharge);
- The condition of existing levees;
- Seismic risks at the site (liquefaction, amplification of ground shaking); and
- The presence of Highway 37.

4.5 Formulation of Alternative Plans

Plan Formulation is the process of developing and evaluating Alternative Plans to meet the needs and desires of the Nation and the Region. These needs and desires were summarized in Section 4.1 as Planning Objectives.

Pond groupings, based on hydrological connections, provided the basis for the Alternative Plans. The four groupings (Ponds 1, 1A, 2; Pond 3; Ponds 4, 5, 6, 6A; and Ponds 7, 7A, 8) represent different problems and therefore require different solutions.

Due to the complexity of this restoration effort, the Planning Objectives would be achieved in a approach that first involves salinity reduction (Ponds 4, 5, 6, 6A; Ponds 7, 7A, 8) and/or bittern removal (Pond 7), levee reinforcement (Ponds 1, 1A, 2), and finally, 3) habitat restoration (Ponds 3 through 8). Because the Plan Formulation process resulted in a large number of measures for salinity reduction, bittern removal, and habitat restoration, measures were first combined into “options” to address the challenges of each pond grouping. Alternative Plans were then formulated by combining options to address one, two, or all of the pond groupings, representing a range of Federal investment levels.

Levee Reinforcement, Salinity Reduction, Bittern Removal, and Habitat Restoration are presented separately in the following sections. Measures that were considered but discarded are described briefly at the end of each subsection.

4.6 Ponds 1, 1A, 2 Levee reinforcement

Salinity reduction is not currently required for Ponds 1, 1A, 2, and 2A. Ponds 1, 1A, and 2 have salinities that are at, or near, ambient conditions (i.e., salinity levels near San Pablo Bay/Napa River levels), and Pond 2A has been restored to tidal marsh. Ponds 1, 1A, and 2 have functioning water-exchange mechanisms and can continue to function as ponds in the long term without salinity build-up. These three ponds will be retained as shallow and deep-water pond habitat, but will require levee reinforcements (Figure 4-1. Ponds 1, 1A, 2 Levee reinforcements) to offset the risk of breaches, which are expected to occur within 5 years for Pond 2 and 5 – 10 years for Pond 1A (Figure 3-1. Existing Conditions). A cost-effectiveness justification for maintaining these ponds as managed ponds is provided in Chapter 5 (Plan Evaluation, Comparison, and Selection).

4.7 Lower Pond Salinity Reduction (Ponds 3, 4, 5, 6, 6A)

[Note: Since the release of the Draft Feasibility Report, salinity reduction has been achieved for Pond 3, via to the breaches that were created in August 2002 (Section 3.2.4.2 Pond 3). However, salinity reduction will still need to be performed in Ponds 4 through 6A. The original plan formulation (including Pond 3) has been retained and is described in the following sections; however, alternative costs no longer include salinity reduction features for Pond 3, only habitat restoration features).]

4.7.1 Lower Pond Salinity Reduction Measures

Salinity reduction would be the first step in the habitat restoration process for Ponds 3 through 6A. Currently, many of the ponds have salinities that either preclude use of the ponds by wildlife, or limit use of the ponds to a very small number of species seasonally. Reducing the salinities in the ponds to a level that makes the ponds usable for a wide range of wildlife would be the first step in enhancing the habitat value of the ponds. Generally, once the ponds are desalinated, they could be opened up to tidal action or maintained as managed ponds. Economic justification for the habitat for each of these ponds is provided in Chapter 5 (Plan Evaluation, Comparison, and Selection).

To reduce salinity in the Pond 3 through 6A, brine from these ponds would be discharged to the Napa River rather than into the sloughs that border many of the Lower Ponds. The low flow in the sloughs provides only limited dilution capacity; therefore, the volume of brine that could be released into the sloughs is insignificant compared to the volume that can be released to the Napa River. Furthermore, under certain Salinity Reduction Options the capacity of the Napa Slough to accept saline discharges would have to be reserved for discharge of water from the Upper Ponds.

Currently, no discharge structures to the Napa River exist for these ponds. The two potential measures for discharging water to the Napa River are: 1) constructing outfall structures or 2) breaching levees.

4.7.1.1 Discharge via Breaches

Controlled, managed breaches, especially for the less saline ponds, represent a potentially effective means of desalinating some of the ponds.

Brine may be discharged into Napa River by breaching one or more levees surrounding the Lower Ponds. Breaches would be placed near or at the locations of historical major slough mouths and would be approximately 50 feet wide, with the bottom of the breach extending several feet below the pond elevation to increase discharge rates.

Two scenarios were considered:

- Breach Pond 3 only
- Breach Pond 3 and Ponds 4/5 (combined discharge)

Using levee breaches to desalinate ponds avoids the installation of intake and outfall structures. It also avoids the environmental impacts associated with fish entrapment in these water-control structures (refer to the DEIS/R for a discussion of these impacts). Thus, fish protection structures, such as fish screens, would be avoided.

4.7.1.2 Discharge via Outfall Structures

The alternative to breaching levees to desalinate ponds is to construct intake and outfall structures at some combination of ponds. Both intake and outfall structures would be placed near historical major slough mouths. Fish screens may be required on the intakes, and diffusers would be required on the outfalls.

It is estimated that fish screens would reduce flow capacity of the intakes by 50 percent, thus doubling the required number of intakes. In addition, the number of intakes required would be greater (especially if fish screens are required) than the number of outfalls due to density and pressure differences between the incoming water and the more saline water in the ponds (head differential).

4.7.1.3 Use of Natural Flood Events in Salinity Reduction

Because dilution is such an important factor in determining the quantity of brine that may be released at any one time, using natural flood events for salinity reduction was also considered. Under this measure, brine would be discharged during flood events. Relying on flood events exclusively to discharge brine would potentially increase the time required for desalination, as only one pond could be addressed during each flood event and flood events do not occur every year. This measure could not be used for the bittern pond (Pond 7), but may be appropriate for the other high-salinity ponds when combined with other Salinity Reduction Measures.

4.7.1.4 Lower Pond Salinity Reduction Measures Considered and Discarded

The following measures were discarded because: (1) they did not meet project objectives; (2) they were too environmentally damaging; or (3) a more cost-effective measure that accomplished the same goal was identified.

REVERSE OPERATION OF THE PONDS

This measure would involve reversing the flow in the ponds, so that the high salinity (northernmost) ponds would discharge into lower salinity ponds closer to the Bay. Numerous permutations of this measure were considered including reverse operation of all the ponds (including the Upper Ponds) and reverse operation of selected ponds, as well as different discharge locations.

Hydrologic modeling indicated that reverse operation would delay both salinity reduction and habitat restoration processes because desalination of the lower-salinity ponds would be delayed until desalination of the high-salinity ponds is complete. In addition, salinity in the lower salinity ponds would increase initially as water from the Upper Ponds is discharged to the Lower Ponds.

CONCENTRATION OF BRINE INTO ONE OR MORE CENTRAL PONDS

Another potential measure for salinity reduction would be to make one or more of the central ponds into holding chambers for the brines from the other ponds, including the Upper Ponds. Under this measure, the brines from high-salinity ponds would be emptied into the holding ponds, which would then release the brines slowly out of the pond system over a longer period of time. By discharging all the brines into a small number of ponds, the remaining ponds would be restored sooner than under the reverse flow scenario. Preliminary analysis indicated that under this measure one or more of the ponds would have a very large increase in salinity and one or more ponds might dry out completely. In addition, very high water volumes would be required for most of these alternatives. The loss of habitat value and potential long-term damage to one or more of the ponds associated with desiccation of the ponds made this measure unacceptable.

4.7.2 Lower Pond Salinity Reduction Options

The Lower Pond Salinity Reduction Options (Table 4.1 Overview of Salinity Reduction Options) differ with respect to where brine is discharged, and whether water exchange is accomplished through water control structures or breaches:

Table 4.1 Overview of Lower Pond Salinity Reduction Options

Option	Measure				
	Discharge Location		Discharge Method		
	Napa River	San Pablo Bay	Pond 3	Ponds 4/5	Pond 6/6A
1A	X (via P3, P 6/6A via P4/5)		WCS	WCS	WCS, via P4/5
1B			Breach	WCS	
1C			Breach	Breach	
2	X (P 4/5 via P3)	X (P 6/6A via P1)	WCS	Siphon	WCS, via P1

P3 = Pond 3; P4/5 = Ponds 4/5; P6/6A = Ponds 6/6a; P1 = Pond 1
WCS = Water control structures
Siphon = Existing siphon between Pond 3 and Pond 4

[NOTE: Since the original plan formulation, Pond 3 has been breached by an unknown party and by DFG (Section 3.2.4.2 Pond 3) and tidal exchange has been established; additional breaches to this pond would not be necessary under Lower Pond Salinity Reduction Options 1B or 1C.

Option 1A would involve repairing the two existing Pond 3 breaches before installing water control structures.]

4.7.2.1 Common Features of Lower Pond Salinity Reduction Options

The following features apply to all of the Lower Pond Salinity Reduction Options.

Use and Refurbishment of Existing Infrastructure

All four Lower Pond Salinity Reduction Options would use the existing water conveyance infrastructure to the greatest degree possible. However, the existing water conveyance structures are deteriorated, and the engineering evaluation suggests that all siphons would require refurbishing or replacement. In addition, all four Options require construction and/or repair of existing and/or new intakes, outfalls, and other water conveyance structures (such as pumps, siphons, weirs, and fish screens).

Levee repairs

Levee repairs would be conducted at the start of the salinity reduction phase for those ponds requiring salinity reduction. The amount of repairs required depends on the Salinity Reduction Option selected, because different ponds would be desalinated at different rates under the various Options (i.e., the duration for which the levees would have to retain their integrity, and which levees are required to retain their integrity, vary by option). For ponds that require a long time for salinity reduction and/or bittern dilution (i.e., Pond 7), levee maintenance would be required before and during the desalination period. It is estimated that 5% of all levees would require repairs every year.

4.7.2.2 Lower Pond Salinity Reduction Options 1A, 1B, and 1C: Napa River and Napa Slough Discharge

Salinity Reduction Options 1A, 1B, and 1C all discharge brine from the Lower Ponds (Ponds 3, 4, 5, 6, and 6A) to Napa River and brine from the Upper Ponds to the Napa Slough. However, these Options differ in whether salinity reduction of the Lower Ponds would be conducted via water control structures (Option 1A; Figure 4-2 Salinity Reduction Option 1A: Napa River and Napa Slough Discharge), via a breach and water control structures (Option 1B; Figure 4-3 Salinity Reduction Option 1B: Napa River and Napa Slough Discharge and Breach of Pond 3), or via breaches only (Option 1C; Figure 4-4 Salinity Reduction Option 1C: Napa River and Napa Slough Discharge and Breaches of Ponds 3 and 4/5).

Option 1A: Napa River and Napa Slough Discharge (Figure 4-2)

Under this Option, water would enter and leave all ponds via constructed intakes and outfalls. The ditches dug in the Pond 3 levees during August 2002 would be closed. This option provides the most control over the rate of pond discharge and resulting salinity increases in the Napa River.

- Pond 3: water-control structures
- Ponds 4, 5: water-control structures

Option 1B: Napa River and Napa Slough Discharge, with Breach of Pond 3 (Figure 4-3)
This Option would result in a shorter period of salinity reduction for Pond 3 than under Option 1A as well as eliminate the need to install water control structures in Pond 3.

- Pond 3: levee breach
- Ponds 4 and 5: water-control structures

Option 1C: Napa River and Napa Slough Discharge, with Breaches of Ponds 3 and 4/5 (Figure 4-4)
This Option would result in a shortest period of salinity reduction for Ponds 4 and 5 and would eliminate the need to install water control structures in Ponds 3, 4, and 5. However, due to the higher discharge rate of brine from these ponds and the higher salinity of brines in Ponds 4 and 5, a special permit must be granted by the RWQCB.

- Pond 3: levee breach
- Ponds 4, 5: levee breach

Common Characteristics of Options 1A, 1B, and 1C:
Lower Pond Salinity Reduction
Salinity reduction in the Lower Ponds would be achieved through a phased approach. Salinity reduction would first occur at Pond 3, then at Ponds 4/5, and then at Ponds 6/6A. Brine would be discharged directly to the Napa River from each of these ponds or set of adjacent ponds.

With a phased salinity reduction process, each pond would achieve full habitat value as soon as possible. Ponds that are slated to remain managed ponds would be fully functioning habitat as soon as salinity reduction is completed. Ponds that are slated for opening to tidal action could be opened as soon as their salinity and water quality parameters are in the appropriate range, as determined by the RWQCB and other regulatory agencies.

Upper Pond Salinity Reduction
Under Lower Ponds Salinity Reduction Options 1A-1C, salinity reduction in the Upper Ponds (Ponds 7, 7A, and 8; if applicable) would be carried out in a parallel phase. Brine from Pond 7 would first be combined in a mixing chamber with water from Ponds 7A and 8 and either water from neighboring sloughs or imported recycled water (see Section 4.8.1.2 Pond 7 Bittern Removal Measures). The combined water would then be discharged from the Upper Ponds to Napa Slough, via a Pond 7 water control structure.

4.7.2.3 Salinity Reduction Option 2: Napa River and San Pablo Bay Discharge
This modified-reverse-flow option addresses the issues of delaying pond opening and controlling the salinity increases in the Lower Ponds, while still allowing discharge to San Pablo Bay. Under Salinity Reduction Option 2 (Figure 4-5. Salinity Reduction Option 2: Napa River and San Pablo Bay Discharge), salinity reduction in the Lower Ponds and Upper Ponds would occur concurrently:

Lower Pond Salinity Reduction
Lower-pond salinity reduction differs between Option 2 and Options 1A-C in that under Option 2:

- Pond 3 would act as a mixing chamber for brines from Ponds 4/5 rather than be opened to tidal action immediately after it has completed salinity reduction; and
- Ponds 6/6A brine would be discharged to San Pablo Bay via Ponds 1 and 2, rather than flow through Ponds 4/5 and discharge to Napa River.

Water control structures, not breaches, would be used in Ponds 3, 4, and 5 and water from all three of these ponds would discharge to the Napa River via Pond 3.

Upper Pond Salinity Reduction
Brine from Ponds 7, 7A, and 8 would discharge to San Pablo Bay, via Ponds 6/6A, 2, 1, and 1A, rather than be discharged to Napa Slough (Options 1A-C).

Reversing the sequence of water flow through the ponds under Salinity Reduction Option 2 would enable discharge of high-salinity water from the Upper Ponds to San Pablo Bay, via the lower salinity Lower Ponds. This approach might increase the RWQCB's allowable discharge rate for salt, since San Pablo Bay is more saline than the Napa River, has a larger tidal flow, and has much better mixing and dispersion.

4.8 Upper Pond pH Reduction, Salinity Reduction and Bittern Removal (Ponds 7, 7A, 8)
The low pH of the brine in Pond 8 and the presence of bittern in Pond 7 pose additional challenges to the restoration of the Upper Ponds. The Pond 7 bittern may require a dilution as high as a 100:1 before it can be discharged into another body of water without posing a hazard to wildlife.

4.8.1. Upper Pond Measures
4.8.1.1 Reduction of Acidity in Pond 8 Through Addition of Lime
The Pond 8 pH is below the likely applicable discharge standard of 6.5, even when the Pond is relatively full. To avoid impacts to the receiving waters, the pH of the water in this pond must be reduced prior to discharge.

This measure consists of using a flow-through treatment chamber at the Pond 8 discharge to the canal north of the pond. The chamber would be filled with lime or a similar, low cost high pH chemical. It is anticipated that this treatment would be required for several years, until the underlying sediment in Pond 8 has achieved a pH closer to neutral. By installing a treatment chamber rather than adding chemicals directly to the pond, the water from Pond 8 would be raised to a more desirable pH at a more consistent rate; treatment chemicals would be removed and replaced more easily after use, and precipitation of undesirable by-products in the pond would be avoided.

4.8.1.2 Pond 7 Bittern Removal and Salinity Reduction Measures

Neighboring Waters Measure-- Dilute Bittern and Reduce Salinity Using Water from Adjacent Sources

The Pond 7 bittern could be diluted using water from neighboring sources of water, including Napa Slough, Hudeman Slough, and Mud Slough (Figure 4-6. Neighboring Waters measure). Saline water from these sloughs would enter via Ponds 7A and 8 (which are adjacent to Pond 7) into the Upper Ponds mixing chamber before entering Pond 7. Napa and/or Hudeman Slough would supply water to Pond 7a and Pond 8 water would come from Mud Slough. Additional water control structures and fish screens would need to be installed.

Recycled Water Pipeline Measure-- Dilute Bittern and Reduce Salinity Using Imported Recycled Water

Recycled water from nearby water agencies could be used to conduct salinity reduction and dilution in the ponds. While some recycled water is currently available within about one-half mile of the upper ponds, significant initial infrastructure would be required to provide the estimated quantities of recycled water to the site.

Three water districts (Sonoma, Napa, and City of American Canyon) have expressed interest in supplying recycled water to the project. To transport water from all three potential sources to the project area, approximately 14 miles of new pipeline would have to be constructed (Figure 4-7 Recycled Water Pipeline):

1) Seven miles of new pipeline would be constructed from the Sonoma Valley treatment plant (to supply approximate 2,600 acre-feet/year) to the Upper Ponds;
2) Six miles of pipeline would have to be constructed on the east side of the Napa River from the City of American Canyon treatment plant (to supply approximate 400 acre-feet/year) to the existing Cargill pipeline under the Napa River; and
3) Three and a half miles of new pipe would transport water from the Napa Sanitary District (to supply approximate 5,500 acre-feet/year) to the new mixing structure.

4.8.1.3 Discharge routes for Upper Ponds, via water control structures

The following discussion applies to the Neighboring Water and Recycled Water Pipeline measures (Section 4.8.1.2 Pond 7 Bittern Removal Measures) for Pond 7 Bittern Removal and Salinity Reduction. There are four potential discharge locations for the Upper Ponds: 1) Napa Slough, 2) Napa River, 3) San Pablo Bay, and 4) a combination of Napa Slough and Napa River.

All of these scenarios share some common infrastructure. Because the dilution requirements for bittern are high, water from Pond 7 would first be mixed with water from Pond 7A, Pond 8 and imported recycled water and/or neighboring slough water before the combined water is discharged through one of the four locations listed above. The mixing chamber would be located near, or consist of an improvement on, the existing “donut,” a structure located near the eastern margin of and between, Ponds 7 and 7A (See Figure 3-1 Existing Conditions).

DISCHARGE TO NAPA SLOUGH

The most direct way to discharge water from the Upper Ponds would be from the mixing chamber into Napa Slough. A new outfall structure would be constructed near the south end of the canal that currently connects the mixing chamber and the siphon and runs underneath Napa Slough.

DISCHARGE TO NAPA RIVER

Existing infrastructure could also be employed to discharge water from the mixing chamber to the Napa River, via the Lower Ponds. Discharging the water through the Lower Ponds would provide increased dilution before the brine is released from the pond system, although this water would create short-term salinity increases in the Lower Ponds.

Water from the mixing chamber could be routed under Napa Slough through the existing siphon and then either:

- Directly into Pond 6A; or
- Into Pond 5, via the canal along the east side of Ponds 6 and 6A.

Once in the Lower Ponds, the water would be discharged to the Napa River.

DISCHARGE TO SAN PABLO BAY

Under this scenario, water from the Upper Ponds would first be routed from the mixing chamber into Pond 6A, via the siphon under Napa Slough. The water would then be discharged to San Pablo Bay via Ponds 6, 2, and 1/1A. A new siphon, approximately 300 feet long, would have to be constructed between Ponds 6 and 2. A new culvert would also be constructed under HWY 37 to allow increased water flow from Pond 1 to the San Pablo Bay.

The salinity in the Lower Ponds (1, 1A, and 2) would increase substantially during the initial phase of Upper Ponds desalination, but would decrease as the salinities in the Upper Ponds decrease. In addition, there would be bittern concentrations in excess of 1% in the Lower Ponds until Pond 7 bittern is sufficiently diluted. Ponds 1, 1A, and 2 would return to ambient conditions after approximately 1 to 2 years, as Ponds 7A and 8 reach ambient salinities.

The advantage of discharging brine from the Upper Ponds to San Pablo Bay would be that the higher salinity in the receiving water would allow a greater amount of brine to be discharged. In addition, circulating the upper-pond water through the Lower Ponds would provide for additional dilution, increasing the possible bittern discharge rate (and reducing the corresponding desalination time) by a factor of approximately 2.5 (PWA, 2002).

COMBINED DISCHARGE TO NAPA SLOUGH AND NAPA RIVER

Water would be discharged to both Napa Slough and Napa River, through the routes described above. Initially, the Upper Ponds would discharge only to the Napa Slough. Once salinity reduction has been accomplished in Ponds 5, 6 and 6A, water would be discharged to the Napa River via these ponds.

Discharging to both Napa River and Napa Slough would primarily achieve an increased rate of bittern discharge, since the water being discharged to the Napa River under all of these scenarios would contain relatively little salt. Ponds 7A and 8 are expected to achieve ambient or near-ambient salinities quickly; Pond 7A may reach ambient salinity within one season; Pond 8 may reach ambient salinity in a few years.

4.8.1.4 Eliminated Pond 7 Bittern Removal Measures

USE OF GROUNDWATER FOR SALINITY REDUCTION

A potential source of freshwater for salinity reduction is the groundwater beneath the site. When hay production was occurring in the project area, groundwater was used for irrigation. This measure was eliminated from further consideration because of the relatively small volume of water available, the cost of installing the required infrastructure, the risk of causing saltwater intrusion into the shallow aquifer, and opposition from the RWQCB. However, limited use of groundwater would be appropriate for certain aspects of the long-term maintenance program for the project area, and the non-Federal sponsor may choose to use limited quantities of groundwater during long-term maintenance.

REDUCTION OF BITTERN TOXICITY USING HIGH SALINITY BRINES FROM OTHER PONDS

Brines from Ponds 4, 5, 8, and the crystallizer ponds (Ponds 9 through 12, which were transferred to the State of California in March 2003) are potential sources of relatively concentrated sodium chloride. Recent studies suggest that bittern's toxicity is largely associated with the imbalance of bittern's component ions relative to ion concentrations in seawater. Therefore, restoring bittern's ion balance to be more similar to that of seawater might reduce its toxicity. Since sodium chloride removal is the most significant change in the transformation of seawater into bittern, restoring all or a portion of the removed sodium chloride could potentially reduce the toxicity of the bittern.

This measure was discarded for the following reasons:

1) While adding substantial amounts of brine to bittern reduces the toxicity of the combined solution, the dilution created by the brine would result in a lower total bittern discharge rate; reducing bittern's toxicity would not reduce the need to dilute the bittern solution with additional water before discharging it. There would not be any significant gains (i.e., reduction in toxicity) until a mix of 90% saline brine/10% bittern was achieved, and at that point, very little bittern is being discharged once the additional dilution water is factored in. Additional time and water would be needed to fully remove the bittern from Pond 7;
2) The Pond 8 canal is good habitat; bringing high salinity brine through that habitat would destroy that existing habitat; and
3) The pipeline under Napa River that connects the Upper Ponds and the crystallizer ponds is old and may leak, especially if heavy brine is being transported through the pipeline.

Disposal of Bittern to San Pablo Bay via Pipeline

Bittern could be released into the San Pablo Bay, using the receiving waters to achieve some of the required 100:1 dilution (under current estimates) prior to release. A pipeline would need to be constructed to connect Pond 7 and the Bay (Figure 4-8. San Pablo Bay Pipeline). The bittern would need to be diluted prior to release, either before it enters the pipeline or after exiting the pipeline.

In either dilution scenario, the material would need to be pumped from Pond 7 down to the deep-water channel in San Pablo Bay, through 4 siphons and through approximately 6 to 7 miles of pipeline. If the bittern were prediluted to a 10:1 mixture of brine and bittern, approximately 9,000 acre-feet (2,940 million gallons) would be pumped to San Pablo Bay. Pumping undiluted bittern would involve a smaller volume of material; however pumping costs would be greater due to the weight of the undiluted bittern. In addition, undiluted bittern is very corrosive, so the pipeline materials would need to be highly resistant to corrosion (stainless steel or better).

The pipeline to San Pablo Bay would run from Pond 7 (or the Upper Ponds mixing chamber) and through or under the following structures:

1) A siphon underneath Napa Slough;
2) Pond 6A canal levee;
3) A siphon under the Pond 6A canal;
4) Ponds 6 and 6A (where it would need to be anchored or buried to stay in place);
5) (Underneath) China Slough between Ponds 6 and 2;
6) Pond 2 (where it would need to be anchored or buried to stay in place) and levees;
7) A siphon under South Slough;
8) Pond 1 (anchor or bury) and levees, under Highway 37 (you could not use the existing culvert-to-canal connection because you would not want bittern at that concentration (even diluted 10-fold) getting out into the environment), through a pipeline and diffuser to the deepwater channel in SPB.

The second big issue (besides cost) is that we would be massive construction in a wetland. Getting permits for that will be nearly impossible (think Section 404(b)(1) analysis) if another good option is available.

Levee Armoring and Capping Bittern
This measure would involve first repairing and reinforcing the Pond 7 levees, which, without repair, are in danger of breaching within the next 10 years (Figure 3-1 Existing Conditions). Pond 7 would then be filled with sediment or other natural substrate. This measure was eliminated in favor of Pond 7 measures that would not result in filling in a diked wetland or incur a net loss of wetland acreage. DFG is opposed to importing sediment (1.5 mil cu yards to fill pond to height of 3 feet (during wet season). In addition to the physical considerations associated with filling Pond 7, permit requirements (BCDC and Corps) assoc w/this measures require that all practicable alternatives be considered prior to filling in a wetland. Filling in would be inconsistent with the Bay Plan (BCDC’s plan)

DREDGING MEASURE-- PHYSICAL REMOVAL OF THE POND 7 BITTERN
Physical bittern removal would consist of pumping out and/or scraping up the contents of Pond 7 and then disposing of, or reusing, these materials off-site. Several variations of this measure were considered, including ocean dumping, land-based disposal, and reuse. Additional salinity reduction would not need to occur.

The possibility of selling the bittern was investigated as an alternative to disposal, since Cargill had identified a limited market for a portion of the bittern salts. However, when Cargill tested the bittern to determine if it could be sold, tests found that the bittern in Pond 7 does not meet the magnesium content specifications for dust control or de-icing applications (the two potential markets for bittern). Additionally, Cargill is able to easily meet all identified demand from its existing operations in the South Bay and has extensive stores of bittern in the South Bay from decades of salt production operations.

This measure was screened out during the plan formulation process because its estimated cost is approximately $212 million (San Francisco District, Specifications and Cost Estimating Section), a cost almost ten times higher than that of the other Pond 7 solutions evaluated (neighboring waters and recycled water pipeline).

4.8.2 Upper Pond Salinity Reduction and Bittern Removal Options

The Options for addressing the problems of the Upper Ponds (Table 4.2) were formulated by combining two of the Pond 7 Bittern measures with measures to: 1) discharge Upper Pond water to Napa Slough via water control structures (Section 4.8.1.1; for Neighboring Waters and Recycled Pipeline Options only) and/or 2) reduce the acidity of Pond 8 through the addition of lime (Section 4.8.1.1). The other three potential discharge scenarios (Napa River, San Pablo Bay, and Napa Slough plus Napa River) were eliminated due to potential negative impacts of moving high-salinity brine and bittern through the lower ponds.

Table 4.2 Upper Pond Salinity Reduction and Bittern Removal Options

Upper Ponds Option	Discharge Location	Pond 8 Acidity	Pond 7 Bittern Removal
1			Neighboring Waters only
2	Napa Slough	Lime addition	Recycled Water Pipeline w/Neighboring Waters

Chapter 5 (Plan Evaluation, Comparison, and Selection) provides an incremental cost analysis examining the three sections of recycled water pipeline (Napa, Sonoma, and City of American Canyon) to determine their cost effectiveness.

4.9 Habitat Restoration

4.9.1. Habitat Restoration Measures

The Habitat Restoration Phase would begin for each pond as Salinity Reduction is achieved. The following measures would be applied to some or all of the ponds, depending on the character of the pond.

4.9.1.1 Maintain Ponds as Managed Ponds After Salinity Reduction

Some of the ponds in the study area currently provide habitat for various types of birds. This habitat is especially valuable due to the project's location on the Pacific Flyway. Under this measure one or more of the ponds would be retained as managed ponds to ensure continued availability of waterfowl habitat. The ponds would be equipped with new and/or upgraded water control structures to allow effective management of water level and salinities in the ponds.

Ponds would be managed at a variety of depths and target salinities. Because the large size of the ponds and the high evaporation rate during the summer would make it difficult to maintain precisely targeted pond depths, a depth range as well as a salinity range would be established for each pond retained as a pond. These ponds could either be non-tidal or muted tidal (experience limited tidal influence as water control structures are kept full-open).

4.9.1.2 Breach Ponds to Reestablish Tidal Exchange

For this measure, ponds would be breached at the locations of major historical slough mouths to reestablish tidal action within the ponds and allow tidal marsh formation. The breaches would be created either with excavation equipment or with explosives. The breaches would vary in length, consistent with the width of the former slough channels. Breach construction might be phased to reduce potential erosion concerns at nearby levees and the accreted fringing marsh. Some breaches might have to be placed in areas where marsh has accreted. In these areas, pilot channels would be cut through the marsh to encourage tidal exchange between the river/slough and the pond.

4.9.1.3 Ditch Blocks

All of the ponds have “borrow ditches” at the toe of the levee slope on the inboard (pond) side of the levee. These borrow ditches were used to supply sediment during levee construction and have been used during levee maintenance. These ditches might divert water entering through levee breaches around the perimeter of the ponds, rather than allowing it to flow through the ponds.

Ditch blocks would keep these ditches from capturing the tidal supply and impeding re-establishment of the natural historical channels. A ditch block is simply an area of earth fill that crosses an existing borrow ditch or other channel to inhibit flow. It is placed between breaches to avoid fish entrapment at low tides.

4.9.1.4 Lower Levees

For this measure, a portion of the levees around ponds opened to tidal action would be lowered to improve habitat continuity between the existing fringing marshes and the marshes that are expected to form within the ponds. Levees could also be lowered in areas where anticipated erosion of fringing marsh would compromise existing migration corridors.

Levee lowering would also be beneficial because levees can provide access and habitat for predators that compromise the ecological objectives of restoration. However, the extent of levee lowering would be limited because levees also provide habitat for “desirable” species.

Construction would consist of excavating the upper portion of an existing levee and partially filling an adjacent “borrow” ditch or pond with the excavated material. A portion of the levee lowering effort would be combined with the construction of ditch blocks described above; however, levee lowering could be conducted in areas other than near the ditch blocks.

4.9.1.5 Starter Channels and Berms

Starter Channels

This measure would involve the excavation of starter channels from the breaches into the ponds, along the alignment of major historical slough channels. Since the tide would transport sediment into ponds opened to tidal action, the further the tide can penetrate into the ponds, the larger the area that can act as a sediment sink.

Starter channels would benefit habitat restoration by facilitating more rapid channel and marsh development. They would provide habitat for fish soon after construction, and would promote more rapid formation of smaller channels that may ultimately become habitat for rails and other wildlife. The starter channels would also improve site drainage, which would enhance the rates of sedimentation and vegetation establishment.

Berms

A berm is an embankment of earth fill located within a pond. Sediment excavated from starter channels would be placed into berms on one or both sides of the starter channel. Berms would be discontinuous so that side channels are not obstructed. Berms would directly facilitate rapid development of a diversity of marsh habitat by providing ground elevations conducive to vegetation establishment. Berms would also facilitate marsh establishment by serving as dissipaters of wave energy, by creating more sheltered conditions conducive to sedimentation and vegetation colonization, and by acting as sacrificial sources of sediment to the rest of the pond.

4.9.1.6 Fill up to 100 Acres for Replacement Mid-Marsh

Valuable habitat, in the form of fringing marsh, might be lost as existing slough channels deepen and widen after ponds are opened to tidal action. This measure would address this concern by filling a small section of one of the ponds opened to tidal action. The approximately 100-acre fill area would compensate for the maximum loss that might be generated during the habitat evolution.

Up to 100 acres of earthen fill (sediment) would be placed into the southern portion of Pond 4 or the northern portion of Pond 5, or a similar location with low historical channel density and easy access to the Napa River. Sediment would either be imported from a North Bay source, or be generated by dredging the Napa River (from a maintenance dredging event) or existing sloughs.

4.9.1.7 Habitat Restoration Measures Considered and Discarded

Opening All Ponds to Tidal Action (Species-Focused Measure 1)

Opening all ponds to tidal action would support certain endangered species, assuming that the entire area eventually became tidal marsh. This measure does not meet the project objective of creating mosaic of habitats to support a range of species. This measure would also result in negative impacts by eliminating excellent high-tide refugia and feeding habitat for shorebirds, and substantial feeding and resting habitat for waterfowl.

Finally, opening all ponds to tidal action might reduce sediment availability to such a degree that none of the ponds or only a small percentage of pond area would accrete to tidal marsh, thus undermining the key potential benefit of this measure.

This measure was discarded because it does not meet project objectives.

Retaining All Ponds as Ponds (Species-Focused Measure 2)

Retaining all ponds as managed ponds would not increase habitat for endangered species and would not improve water quality in San Francisco Bay. This outcome would conflict with Federal and State plans for endangered species recovery and would be widely considered unacceptable to agencies and other stakeholders. Because this measure does not meet project objectives, it was discarded.

LAND EXCHANGE WITH USFWS

One possibility for optimizing habitat development in the region would be to integrate activities at adjacent or nearby restoration sites. Cullinan Ranch, which is owned by the USFWS, is deeply subsided and is slated for redevelopment into tidal marsh. One possible measure for restoring habitat would be to exchange the Cullinan parcel for a DFG parcel in the project area so that land more suitable for tidal marsh restoration is used to create tidal marsh, and deeply subsided areas such as Cullinan Ranch are used to create pond habitat. This measure, although technically and economically sound, is logistically infeasible because of Congressional funding constraints on the USFWS, and was therefore not carried forward.

LARGE-SCALE SEDIMENT IMPORT

The import of large quantities of sediment would accelerate habitat evolution and/or the creation of seasonal wetland and upland habitat by increasing site elevation. Sediment would be placed into the ponds before breaching to avoid most or all of the need for sediment accretion prior to the establishment of marsh vegetation.

Large-scale sediment import was eliminated from consideration because: 1) sediment import would not enhance the environmental values substantially over natural accretion; 2) the site does not lend itself to constructing the infrastructure required for sediment delivery; 3) cost; and 4) the non-Federal sponsor and other stakeholders support only the limited use of imported sediment.

WAVE-BREAK PENINSULAS

Waves as high as four feet tall can occur at the ponds (*field observation, DFG*). The wind-wave activity in the ponds might prevent sediment deposition and resuspend sediments deposited during more quiescent periods.

Wave-break peninsulas are low-profile embankments that would be placed throughout the ponds to reduce wave activity. The peninsulas would also act as sacrificial sources of sediment to other areas of the ponds. Sediment would come from clean, local sources, and would meet wetland cover criteria. Potential sources include sediments excavated during the deepening of existing slough channels, O&M dredging in the Napa River, and other North Bay O&M dredging projects.

This measure was discarded in favor of the measure to construct berms with the starter channels (Section 4.6.2.5), which would serve a similar purpose. Starter channels provide an adjacent source of sediment that would not be available otherwise.

DEEPEN EXISTING SLOUGH CHANNELS

Under this measure, a portion of the existing sloughs would be deepened through dredging. This measure would augment natural channel evolution resulting from increased tidal flow. When flows increase, channels typically deepen first, and then widen due to sloughing of the banks.

The existing sloughs are narrower and shallower than they had been historically (*Historical Napa Marsh Channels, Napa-Sonoma Marsh Color Photography (Mosaic), 1999*). As a result, slough channels between the ponds might not have sufficient tidal flow capacity to achieve the project’s habitat restoration goals once the ponds are opened to tidal action, due to the large increase in tidal prism. Since the volume of water entering the ponds would determine the mass of sediment entering the system, insufficient capacity in the sloughs would lead to damped tidal flow in the sloughs and ponds, reducing the rate of sediment deposition and increasing the potential for flooding.

This measure was eliminated from further consideration because of cost and because hydrologic modeling indicated that deepening the channels would not substantially accelerate marsh formation in the ponds opened to tidal action.

PRE-VEGETATE PONDS PRIOR TO BREACHING

Marsh vegetation requires a higher pond-bottom elevation to colonize a site than it requires for survival once established (*Napa River Salt Marsh Restoration Habitat Restoration Preliminary Design; Phase 2 Stage 2 of the Hydrology and Geomorphology Assessment in Support of the Feasibility Study, November 2002*). This measure would lower pond water levels (effectively increasing bottom elevations) to encourage vegetative colonization prior to breaching the ponds. Lowering water levels would allow vegetation to spread laterally by exposing more land in the pond margins.

This measure was eliminated from further consideration because of uncertainty in its effectiveness and potential for success. As noted earlier, controlling water levels and salinities in the ponds is difficult due to the shallow depth and large surface area of the ponds. Since the ponds would have to dry out for at least a portion of each tide cycle, lowering the water level would create a significant risk of drying out the ponds on a longer-term basis.

In addition, lowering the levees would provide a more effective means of encouraging mid-marsh vegetation colonization than would reducing pond water levels because lateral spreading accounts for a relatively small portion of overall vegetative colonization.

4.9.2 Habitat Restoration Options

The Habitat Restoration Options presented below (and in the Draft Feasibility Report) assume the inclusion of all ponds in all Alternative Plans, and were originally intended to offer different ratios of tidal marsh to managed pond. Because the Alternative Plans have been reformulated for the Final Feasibility Report to incorporate a range of investment levels (and will not necessarily include all ponds), the Habitat Restoration Options will be used instead as a guide to the preferred fate of individual ponds as they are appear in the Alternative Plans.

Chapter 5 (Plan Evaluation, Comparison, and Selection) examines the cost effectiveness of turning individual ponds into either managed pond or tidal marsh. This cost-effectiveness analysis will help determine which habitat fate is recommended for each pond.

Each of the four Habitat Restoration Options (Table 4.3 Overview of Habitat Restoration Options) described below would provide for a mix of tidal habitat and managed ponds, but the options vary with respect to the proportion of the two habitat types. The Options also differ in their timing and rate of habitat evolution. Pond 2A acreage has been included in total Tidal Habitat for the project area, but no further restoration action is required for that pond.

Table 4.3 Overview of Habitat Restoration Options

Option	Endpoint	Managed Pond Habitat		Tidal Habitat		Total Acres (if all ponds included)
		Ponds	Acres	Ponds	Acres	
1	Mix tidal habitat and managed ponds	1, 1A, 2, 6, 6A, 7, 7A, 8	4,194	[2A], 3, 4, 5	4,395	8,589
2	Tidal habitat emphasis	1, 1A, 2(West), 7, 7A, 8	2,398	2(East), [2A], 3, 4, 5, 6, 6A	6,192	8,589
3	Managed pond emphasis	1, 1A, 2, 5, 6, 6A, 7, 7A, 8	5,184	[2A], 3, 4	3,405	8,589
4	Mix tidal habitat and managed ponds; Accelerated restoration	1, 1A, 2, 6, 6A, 7, 7A, 8	4,194	[2A], 3, 4, 5	4,395	8,589

4.9.2.1 Common Features of Habitat Restoration Options

Refurbishment and Adaptation of Water Control Structures for Habitat Restoration
Where necessary, water control structures for the ponds that would be preserved as ponds would need to be repaired or replaced. Fish screens may be required for some of these structures, and other structures may need to be adapted after salinity reduction is complete.

Additional Common Features
The following features, included in all Habitat Restoration Options, are described in Section 4.6.2 (Habitat Restoration Measures):

- Management of Pond Depths and Salinity
- Additional Breaches, for Habitat Restoration
- Ditch Blocks

- Levee Lowering
- Starter Channels and Berms

4.9.2.2 Habitat Restoration Option 1: Mix of Tidal Habitat and Managed Ponds

This Option would create a balanced mix of tidal marsh and pond habitat (Table 4.4 Summary of Habitat Restoration Option 1). Under this Option, habitat restoration of the existing ponds would be managed as follows:

Table 4.4. Summary of Habitat Restoration Option 1

	Actions	Habitat Endpoint	
		Managed Pond	Tidal Marsh
Lower Ponds			
1	Levee repairs and repair and refurbishment of water control structures, as needed	X	
1A		X	
2, East		X	
2, West		X	
2A	No action required		X
3	Opened to full tidal action w/ additional breaches, removal of any water control structures after completion of salinity reduction		X
4			X
5			X
6	Managed ponds for first 10-20 years of project. Adaptive management will determine whether opened for tidal habitat evolution	X	Possible in long term
6A		X	Possible in long term
Upper Ponds			
7	Levee repairs and repair and refurbishment of water control structures, as needed	X	
7A		X	
8		X	

Habitat Restoration features associated with this Option are shown in Figure 4-9 (Habitat Restoration Option 1: Mixture of Ponds and Tidal Marsh) and Habitat Endpoint is shown in Figure 4-10 (Habitat Restoration Option 1: Habitat Endpoints).

4.9.2.3 Habitat Restoration Option 2: Tidal Habitat Emphasis

This Option would emphasize the creation of tidal marsh habitat (Table 4.5 Summary of Habitat Restoration Option 2). Under this Option, habitat restoration of the existing ponds would be managed as follows:

Table 4.5 Summary of Habitat Restoration Option 2

	Actions	Habitat Endpoint	
		Managed Pond	Tidal Habitat
Lower Ponds			
1	Levee repairs and repair and refurbishment of water control structures, as needed	X	
1A		X	
2, East	Opened to tidal action w/ breaches		X
2, West	Levee repairs and repair and refurbishment of water control structures, as needed	X	
2A	No action necessary		X
3	Opened to tidal action w/additional breaches, removal of any water control structures after completion of salinity reduction		X
4			X
5			X
6			X
6A			X
Upper Ponds			
7	Levee repairs and and repair refurbishment of water control structures, as needed	X	
7A		X	
8		X	

Habitat Restoration features associated with this Option are shown in Figure 4-11 (Habitat Restoration Option 2: Tidal Marsh Emphasis) and Habitat Endpoint is shown in Figure 4-12 (Habitat Restoration Option 2: Habitat Endpoints).

4.9.2.4 Habitat Restoration Option 3: Pond Emphasis

This Option would emphasize the creation of pond habitat (Table 4.6 Summary of Habitat Restoration Option 3). Under this Option, habitat restoration of the existing ponds would be managed as follows:

Table 4.6 Summary of Habitat Restoration Option 3

	Actions	Habitat Endpoint	
		Managed Pond	Tidal Habitat
Lower Ponds			
1	Levee repairs and repair and refurbishment of water control structures, as needed	X	
1A		X	
2, East		X	
2, West		X	
2A	No action necessary		X
3	Opened to full tidal action w/ additional breaches, removal of any water control structures after completion of salinity reduction		X
4			X
5	Levee repairs and repair and refurbishment of water control structures, as needed	X	
6		X	
6A		X	
Upper Ponds			
7	Levee repairs and repair and refurbishment of water control structures, as needed	X	
7A		X	
8		X	

Habitat Restoration features associated with this Option are shown in Figure 4-13 (Habitat Restoration Option 3: Pond Emphasis) and Habitat Endpoint is shown in Figure 4-14 (Habitat Restoration Option 3: Habitat Endpoints).

4.9.2.5 Habitat Restoration Option 4: Mix of Tidal Habitat and Managed Ponds with Accelerated Restoration

This Option is identical to Habitat Restoration Option 1 with respect to habitat endpoint, management, and most construction features (see Section 4.7.2.2 (Habitat Restoration Option 1)). However, additional construction activities, which are intended to accelerate habitat evolution, would occur at the ponds opened to tidal action:

Fill 100 Acres of Pond 4 (or a Similar Location).

This measure, described in Section 4.6.2.6 (Fill up to 100 Acres for Replacement Mid-Marsh), would accelerate initial vegetative colonization by raising the initial pond-bottom elevation of the site and help compensate for the anticipated temporary reduction in fringing marsh from tidal action immediately after breaching.

Increase Number and Length of Starter Channels and Berms.

The total length of starter channels and associated berms would roughly double compared to those identified in Option 1. As discussed in Section 4.6.2.5 (Starter Channels and Berms), increasing the number and length of starter channels would increase the rates of channel formation within the marsh and sediment transport into the interiors of the ponds. The additional berms would provide more wave breaks, sacrificial sediment sources, and opportunities for early colonization by marsh vegetation.

Habitat Restoration features associated with this Option are shown in Figure 4-15 (Habitat Restoration Option 4: Accelerated Restoration) and Habitat Endpoint is shown in Figure 4-16 (Habitat Restoration Option 4: Habitat Endpoints).

4.10 Preliminary Alternative Plans and Initial Screening

Since the release of the Draft Feasibility Report, the plan formulation process has been updated in order to create plans that represent different levels of Federal investment (pond increments, rather than all plans including all ponds) and two more potential solutions for Pond 7, the neighboring waters and dredging options (screened out earlier in this chapter due to the high cost estimate [$212 Million]). The following discussion, from the Draft Feasibility Report, has been retained (with minor modification) to show the history of the alternative numbering and to show the relationship between the new plans (and numbering) to the plans presented in the Draft Report.

The revised plan formulation (Section 4.10.2 Revised Plan Formulation) is presented subsequent to the Draft Feasibility Report Plan Formulation discussion.

4.10.1 Draft Feasibility Report Plan Formulation

4.10.1.1 Draft Report Preliminary Screening

For the Draft Feasibility Report, four Salinity Reduction Options and four Habitat Restoration Options were combined into 16 Alternative Plans. The Plans listed below represent all possible combinations of the Habitat Restoration and Salinity Reduction Options. Combined with the No Action Plan, the preliminary array of Alternative Plans consists of 17 Plans.

The Alternative Plans was subjected to a screening process to determine the final array of candidate Plans. The screening focused on feasibility, effectiveness, compatibility of Salinity Reduction and Habitat Restoration Options, environmental impacts, and cost effectiveness (Table 4.7 Summary of Preliminary Alternative Plans and Initial Screening)

Table 4.7 Summary of Preliminary Alternative Plans and Initial Screening

Alternative	Alternative Number in DEIS/R	Salinity Reduction Option (SR)	Habitat Restoration Option (HR)	Retained	Remarks
1	***"No Action"***	**NA**	**NA**	**X**	No Action Plan. Retained as required by NEPA and Corps guidance.
2	***1***	**1A**	**1**		Eliminated because SR 1A is not as cost effective as SR 1B, would require a longer period of salinity reduction, and would result in same level of environmental impacts as SR 1B.
3	***9***		**2**		
4	***10***		**3**		
5	***11***		**4**		
6	***2***	**1B**	**1**	**X**	Retained because these plans are feasible and cost effective relative to the eliminated plans.
7	***3***		**2**	**X**	
8	***4***		**3**	**X**	
9	***5***		**4**	**X**	
10	***6***	**1C**	**1**		Eliminated because it is uncertain whether a

Alternative	Alternative Number in DEIS/R	Salinity Reduction Option (SR)	Habitat Restoration Option (HR)	Retained	Remarks
11	***12***		**2**		discharge permit would be granted by the RWQCB for SR 1C, based on available information. However, because SR 1C is more cost effective than SR 1B, further studies may be conducted during PED to revisit SR 1C, if a discharge permit is granted by the RWQCB.
12	***13***		**3**		
13	***14***		**4**		
14	***15***		**1**		Eliminated because reduction in desalination time for Pond 7, relative to Alt 6, does not compensate for interim loss of habitat benefits in lower ponds.
15	***16***	**2**	**2**		Eliminated because combined SR and HR are incompatible.
16	***17***		**3**		
17	***7***		**4**	**X**	Retained because it provides the most accelerated salinity reduction and habitat restoration overall.

Note: The DEIS/R analyzes an additional Alternative (DEIS/R Alternative 8) that was not analyzed in the Feasibility Study. This Alternative is identical to Feasibility Study Alternative 6 (DEIS/R Alternative 2) but does not include the import of recycled water.

4.10.1.2 Final Array of Draft Feasibility Report Alternative Plans

The No Action Plan and five Alternative Plans were retained for further evaluation and comparison (Table 4.8 Summary of Final Array of Alternative Plans in Draft Feasibility Report).

Table 4.8 Summary of Final Array of Alternative Plans in Draft Feasibility Report

Plan	Features										
	Salinity Reduction								Habitat Restoration		
	Discharge locations					Discharge type			Option	Habitat Emphasis	Accel?
	Option	Lower Ponds		Upper Ponds							
		Napa River	San Pablo Bay	Napa Slough	San Pablo Bay	Pond 3	Ponds 4/5	Pond 6/6A			
1	No Action Plan										
6	1B	X via P3, P4/5		X		Breach	WCS	WCS via P4/5	1	Balanced mix	
7									2	Tidal marsh	
8									3	Pond	
9									4	Balanced mix	X
17	2	X via P3	X via P1		X	WCS	WCS via P3	WCS via P1		Balanced mix	X

4.10.2 Revised Plan Formulation

The new plan formulation approach addresses three issues raised during the review of the Draft Feasibility Report: 1) the need to present other solutions (non-pipeline options) for Pond 7; 2) the need to provide cost-effectiveness justification for each pond's habitat fate (managed pond or tidal marsh); and 3) the need to represent incremental levels of Federal investment (pond increments) in the array of alternative plans.

Two other changes have occurred since the release of the Draft Feasibility Report: 1) Pond 3 salinity reduction is no longer necessary (as discussed in Section 3.2.4.2 Pond 3 and Section 4.7 Lower Pond Salinity Reduction) and 2) the breach of Ponds 4/5 (as described for Salinity Reduction Option 1C) has become feasible due to discharge permit negotiations with the RWQCB. Therefore, the new plans will include habitat restoration features for Pond 3, but no salinity reduction features. In addition, Salinity Reduction Option 1B (similar to Salinity Reduction 1C, except for the use of water control structures for Ponds 4/5) has been screened out for the plan reformulation because it is more expensive than Salinity Reduction Option 1C, and would not provide additional output. Whereas all of the plans in the Draft Report incorporated Salinity Reduction Option 1B, the plans in the Final Report now incorporate elements of Salinity Reduction Option 1C.

4.10.2.1 Comparison of Draft Feasibility Report and Final Feasibility Report Alternative Plans

New Alternative Plans Include Cost-effective Section(s) of Recycled Water Pipeline or Neighboring Waters Option for Pond 7

Alternative 10 (and all of the plans originally presented in the Draft Feasibility Report) included a three-section recycled water pipeline. The revised plans (if they include a solution for Pond 7) will include only cost-effective section(s) of pipeline (as demonstrated by a pipeline cost-effectiveness/incremental cost analysis in Chapter 5 (Plan Evaluation, Comparison, and Selection)), or the Neighboring Waters Option (Section 4.8.1.2 Pond 7 Bittern Removal and Salinity Reduction Measures).

New Alternative Plans Incorporate Elements of Salinity Reduction Option 1C and Habitat Restoration Option 1

During the plan evaluation process presented in the Draft Report, it was determined that of the options presented, Salinity Reduction Option 1C (which includes breaches for Ponds 3, 4/5) and Habitat Restoration Option 1 (which would produce a balanced mix of managed pond and tidal marsh habitat) best met project objectives and associated evaluation criteria (although SR Option 1C had been screened out at the time of Draft Report release due to permitting uncertainty with the RWQCB).

The new alternative plans are spin-offs from Alternative 10 from the Draft Feasibility Report (comprised of Salinity Reduction Option 1C and Habitat Restoration Option 1, but reflect the adjustments described in Section 4.10.2 (Revised Plan Formulation). However, the salinity reduction and habitat restoration options have been modified to reflect the sectioning of the pond system into plan increments and the possibility that all of the ponds might not be included in the project (discussed further in the section below, and in Chapter 5 (Plan Evaluation, Comparison, and Selection)). As discussed in Section 4.9.2 (Habitat Restoration Options), Habitat Restoration Option 1 was used to guide the habitat goal for individual ponds, but would not be included fully if the recommended plan did not incorporate all ponds.

The cost-effectiveness of each pond's habitat fate will be examined in Chapter 5 (Plan Evaluation, Comparison, and Selection).

New Alternative Plans Reflect Incremental Level of Federal Investment

The new alternative plans will contain either all or a subset of the ponds included in the Draft Report plans. Four potential pond groupings were identified within the project area, based on hydrological connections and design features required for salinity reduction and habitat restoration to occur (Table 4.9. Pond Groupings for Final Alternative Plans).

Table 4.9 Pond Groupings for Final Alternative Plans

Pond grouping		Rationale for grouping
1, 1A, 2		Water is currently pumped from Ponds 1/1A to Pond 2 to maintain water levels
3		Connections with other ponds are not necessary for salinity reduction or habitat restoration
4, 5, 6, 6A		Water from Ponds 6 and 6A must flow through Ponds 4 and 5 to Napa River for salinity reduction to be achieved
7, 7A, 8	Neighboring waters	Water from all three ponds are required to ensure sufficient dilution of bittern from Pond 7
	Recycled water pipeline	

The group consisting of Ponds 7, 7A, and 8 will have two options: one that includes a recycled water pipeline and one that includes the neighboring waters option. All possible combinations of these pond groups will be examined in the Final Cost-Effectiveness/Incremental Cost Analysis in Chapter 5 (Plan Evaluation, Comparison, and Selection).

Because many potential combinations of these elements will be generated and analyzed, the following discussion will focus on the No Action Plan and common elements of the overall array of action plans, rather than on the plans themselves. The final array of alternative plans will be generated and discussed in Chapter 5 (Plan Evaluation, Comparison, and Selection)

4.10.2.2 Alternative 1 - No Action Plan

Under the No Action Plan the Corps would not implement a project. The No Action Alternative is synonymous with the without-project condition.

As discussed in Section 3.3 (Without-Project Condition), site conditions would continue to deteriorate due to the aging infrastructure and inability to remove salt from many ponds. This situation would reduce the value of the Project Area for wildlife habitat and would not reduce the risk of brine or bittern spills into neighboring bodies of water.

4.10.2.3 Salinity Reduction and Habitat Restoration Features of Action Alternative Plans

The salinity reduction and habitat restoration features for the action plans have been previously described in this chapter. All of the Action Alternatives include some combination of the following features: levee repairs, water control structures, controlled breaches, starter channels, and berms. The number and total lengths of these features will ultimately depend on which ponds are included in the final alternatives. Monitoring and adaptive management will also be a feature of the alternative plans.

4.10.2.4 Additional Features of Action Alternative Plans

In addition, these Alternative Plans include the following features:

Recreational Features

Recreational features included in the project would support wildlife-compatible uses that are currently available at the NSMWA and are appropriate to the restoration project and the surrounding area, such as fishing, environmental education, scientific study, bird-watching, nature observations and photography. The NSMWA would allow public access to the maximum extent compatible with resource protection and maintenance of research and education programs.

Future public use would be qualitatively similar to the current usage of the NSMWA. However, it is anticipated that the area would see an increase in visitor use as recreational components and new structures are added. With the improvement of wildlife habitat, there would be an increase in wildlife numbers, thus increasing the demand for the wildlife-dependent activities listed above. These activities would be developed in an environmentally compatible way.

The existing infrastructure for public access would be improved through the addition of upgraded parking lots, internal roads, and visitor access points (Figure 4-17 Recreation Features). The current access locations would remain the same. Proposed new and improved recreational facilities that would be incorporated into the Project are described below. Economic justification for these features is presented in Appendix E (Economics Appendix).

Buchli Station (near Ponds 7 and 7A)

At the Buchli Station parking lot, a visitor's information kiosk would supplement the existing lean-to. Other new features would include:

- New interpretive signs, display boards, etc. (describing the area habitats and uses, and providing a map of the area);
- Lighting in the parking lot;
- Replacement gates and foot bridges that are compliant with the Americans with Disabilities Act;
- An improved foot path from the parking lot around the adjacent permanent pond to access the existing wildlife viewing blind;
- A new vault style toilet facility at the parking lot; and
- Fishing platforms.

Vegetative restoration would occur around the existing and proposed structures; native plants and trees would be planted and irrigated during establishment using an existing agricultural well on site. An existing well would be refurbished as a part of this project to help establish the vegetation and allow for long-term maintenance.

Ponds 1 and 1A

The existing Highway 37 pullout near Ponds 1 and 1A would be paved to provide safe access to the southern-most ponds. Currently, there is only a small pullout to the area from the westbound side of Highway 37, which is the DFG's main access point to the pump house, and Ponds 1, 1A, and 2.

The parking lot near Ponds 1 and 1A would be enlarged but maintained in the same location. Public access to the NSMWA would be improved by adding:

- An information kiosk, signs and displays;
- ADA-compliant gates;
- An improved footpath from the parking lot along the adjacent salt pond
- A new wildlife viewing blind;
- A fishing platform; and
- Garbage receptacles.

Access and Storage Features for Monitoring, Operations and Maintenance

Existing internal roads would be improved to provide year-round monitoring and maintenance access. A boat launch and dock would be developed on Napa Slough for pond monitoring and maintenance (DFG and other agency) use only. This launch would be used primarily for accessing the northern units within the wildlife area and during restoration.

The internal road near and the western levee of Pond 1 would be upgraded to allow year-round monitoring and maintenance access. The upgrade would include a turn-around area for heavy equipment at the end of the road near the pump house and a small boat launch facility for management purposes and access to the island ponds.

5.0 PLAN EVALUATION, COMPARISON, AND SELECTION

The fourth step of the Corps's six-step planning process is to evaluate the effects of each of the Alternative Plans, and the fifth step is to compare them. The sixth and final step is to select a Recommended Plan. Although it is possible to define the activities involved in each of these steps, in practice these steps overlap, run together, and are often indistinguishable from each other.

5.1 Evaluation of Alternative Plans

The Alternative Plans were evaluated on the basis of quantitative criteria, including cost effectiveness (comparing plan benefits to costs) and qualitative criteria such as completeness, effectiveness, efficiency, and acceptability.

5.1.1 Alternative Benefits

Each of the Action Alternatives restores a mosaic of managed pond and tidal habitats, designed to provide habitat for a wide array of wildlife and aquatic species, including special-status species. The benefits associated with the Alternatives were determined using a modified Habitat Evaluation Procedure (HEP) analysis and are presented in non-monetary terms (Habitat Units, or HUs).

Changes to Pond 7 Habitat Benefits

The estimated time for Pond 7 bittern removal has decreased since the release of the Draft Feasibility Report. According to studies conducted prior to the Draft report, bittern removal and salinity reduction would take approximately 30 years with recycled water, and approximately 50 years using exclusively neighboring waters (*Sonoma County Water Agency Simulations Results with Variable Dilution, 2002*). The new analysis estimates that it would take approximately 8 – 10 years using neighboring waters, and a slightly shorter period of time using additional recycled water (Appendix D, Engineering Appendix). The change in estimated time results from using a *mass-based* rather than a *flow-based* discharged restriction.

Based on toxicity studies, the regulatory agencies have indicated that bittern discharge from Pond 7 must be limited to 1% of the total flow from the Upper Ponds. While this restriction implies a certain mass removal (based on the Year 1 bittern concentration and flow), in earlier iterations of the Feasibility Report, this *flow-based* discharge restriction was assumed to apply throughout the life of the project. This flow-based approach resulted in very long time periods before bittern would be reduced sufficiently to create habitat value in Pond 7. Bittern removal using a flow-based discharge restriction requires a long time because as the bittern concentration in the pond drops, less and less bittern is removed each year.

Assuming that a constant mass of bittern (i.e., under a mass-based discharge restriction) can be removed each year means that the allowable flow discharged from Pond 7 can increase as the concentration of bittern in the pond decreases.

5.1.1.1 Overview of Alternative Benefits

As described in Chapter 4 (Plan Formulation), the Alternative Plans differ with respect to the number of ponds included and how Pond 7, if included, is addressed. Habitat outputs are first achieved when the ponds achieve ambient or near-ambient salinity. Further habitat outputs are achieved if the ponds are restored to tidal action; thus the timing of restoration under each Alternative is reflected in each Plan's habitat value.

Recycled Water Pipeline Benefits

Habitat benefits were derived to examine the cost effectiveness of the three sections of pipeline (Sonoma, Napa, and City of American Canyon) to the Pond 7 option that uses only neighboring waters (this analysis is presented in Section 5.2.1. Cost-Effectiveness Analysis and Incremental Cost Analysis). Pipeline benefits were derived from the USFWS HEP based on the estimated yearly volume of recycled water that would be available through each pipeline or combination of pipeline, plus the volume of neighboring slough water that would also be supplied to the system. Calculations took into account the differences in salinity between the recycled water and the neighboring slough water.

Habitat Benefits Associated with Habitat Fate for Individual Ponds/Inseparable Ponds

To help determine whether the most cost-effective habitat restoration approach (habitat fate) was selected for each pond, benefits were derived from the USFWS HEP for each of the following seven ponds: 1/1A, 2, 3, 4/5, 6/6A, 7/7A, and 8. For the pond-fate analysis, the project area can be divided into these seven groups (as opposed to the four groups used for the Final CE/ICA on Alternative Plans and presented in Chapter 4 (Plan Formulation) because the habitat restoration features designed for the purpose of this analysis (see Appendix D Engineering Appendix) assumed that salinity reduction and bittern removal had already occurred, and that ponds connected solely to accomplish those goals could be considered separately. Several pairs of ponds, however, were originally one pond separated into two ponds by an internal levee (i.e., Ponds 1/1A; Ponds 4/5; Ponds 6/6A, and Ponds 7/7A. These ponds were considered as one pond because the cost of fortifying the shared levee to separate them would be high (Table 5.1. Cost of Separating Ponds with Internal Levees; also see Appendix D Engineering Appendix).

Table 5.1. Cost of Separating Ponds with Internal Levees

Pond Pair	Cost for separating ponds
1, 1A	$23 M
4, 5	$15 M
6, 6A	$10 M
7, 7A	$16 M

Benefits were calculated for each pond for both a tidal marsh scenario and a managed pond scenario. The Pond 7/7A group benefits assumed the use of only neighboring waters (i.e., no recycled water). The rationale for these 7 pond groupings, the cost-effectiveness analysis, and the rationale for habitat fate selection are presented in Section 5.2.1. Cost-Effectiveness Analysis and Incremental Cost Analysis).

Habitat Benefits for Final CE/ICA on Alternative Plans

Once habitat fates were selected for each pond, taking into account the results of the habitat-fate cost-effectiveness analysis discussed above (and presented in Section 5.2.1) as well as other engineering and environmental considerations, the appropriate habitat benefit (based on managed pond or tidal marsh status) was selected for each pond and used in the Final CE/ICA on the alternative plans. As described in Chapter 4 (Plan Formulation), the new alternative plans are comprised of combinations of four pond groupings: 1) Ponds 1, 1A, and 2; 2) Pond 3; 3) Pond 4, 5, 6, and 6A; and 4) Ponds 7, 7A, and 8. Pond benefits were added to determine the total habitat benefits for each group. For the recycled pipeline option for Ponds 7, 7A, and 8, the appropriate recycled water benefits (as determined by the recycled water pipeline CE/ICA) were used instead of the neighboring waters benefits.

5.1.1.2 Overview of Habitat Types

The array of habitats that would be generated by the Action Alternatives can be generally categorized as Pond, Tidal, or Upland. The total habitat acreage produced by each alternative depends on which ponds are included in the plan.

POND HABITAT

- Salt Ponds – Retained under No Project Alternative, but not under any Action Alternatives. Inhabited almost exclusively by invertebrates, which are important food sources for birds that forage in lower-salinity ponds.
- Managed Ponds – managed at a range of pond depths and salinity to benefit a variety of birds and fish.

TIDAL HABITAT

- Sub-tidal – Contains water year-round and is rich in invertebrates that provide food for birds, fish, and benthic invertebrates.
- Mudflat – Important foraging and resting habitat for many species of migratory and wintering shorebirds and waterfowl. Composed of fine-grained silts and clays and is found along the Bay/Napa River side of perimeter salt marsh habitat that is outboard of the pond levees. Mudflat areas are largely barren of vegetation but support a rich invertebrate fauna that provide food for both shorebirds and waterfowl, as well as estuarine fish species (e.g., Chinook salmon and steelhead trout) that forage there.
- Tidal Marsh – Regularly inundated by tidal action and includes lower marsh, middle marsh, and upper (high transitional) marsh. Tidal marsh habitat provides food, cover, and breeding habitat for numerous species.

Upland Habitat (Levees)

Levees enclose all of the ponds in the project. These human-made structures provide upland nesting, refuge, and resting habitat for a diversity of birds. Reptiles, small mammals, and some ground-feeding, grain-eating birds also use levees for foraging and migration.

5.1.1.3 Summary of Species Usage

Pond, Tidal, and Upland habitat types in the project area would be utilized by a wide array of fish and wildlife (Table 5.2 Summary of Species Use, by Habitat).

5.1.1.4 Quantified Benefits (HEP Analysis)

The results of the USFWS HEP Analysis (HEP) were used to compare benefits of the final array of Alternative Plans. The HEP provided a measurable habitat output for each plan, in habitat units.

The HEP analysis for this project used five guilds of species to quantify habitat benefits:

- Estuarine fish
- Resident marsh wildlife
- Diving ducks
- Tidal shorebird guild
- Non-tidal avian (shorebird) guild

Table 5.2 Summary of Species Use, by Habitat

Species		Habitat Type					
		Pond		Tidal Habitat			Upland, including levees
		Salt (>75 ppt)	Managed (15 - 50 ppt)	Subtidal	Mudflat	Tidal Marsh	
Wildlife							
Birds	Grebes, plovers	X					
	Gulls	X					X
	Pelicans, terns, cormorants, herons, egrets		X			X	
	Shorebirds		X		X	X	
	Dabbling ducks		X			X	X
	Diving ducks	X	X	X		X	X
	Reptiles						X
	Small mammals						X
Special-status species	California clapper rail				X	X	
	California black rail				X	X	
	San Pablo song sparrow				X	X	X
	Western burrowing owl						X
	Aquatic Species						
	Invertebrates, phytoplankton (food source for birds and fish)	X	X	X	X	X	
Special-status species	Chinook salmon			X	X	X	
	Steelhead trout			X	X	X	
	Delta smelt			X		X	
	Long-fin smelt			X		X	
	Splittail			X		X	
Other species, including Pacific staghorn sculpin, yellowfin goby, striped bass, inland silverside, and Dungeness crab			X	X		X	

Benefits to the estuarine fish and resident marsh wildlife guild (and to a much lesser extent, tidal shorebird guild) also reflected benefits to endangered and threatened species that use the same habitats. The diving duck and non-tidal shorebird guilds represented the major groups of species that would benefit from retention of ponds. All of these guilds are important, but the consensus among regulatory agencies and scientists is that existing values of non-tidal habitats used by birds (i.e., ponds) should be retained to the extent feasible while habitats for tidal species should be increased. For this reason, the project objective is to create a mosaic of pond and tidal habitat that benefits a range of species, not just endangered species.

5.1.1.5 Other Benefits

There would be a number of benefits that are not covered in the HEP analysis that would be gained by implementing the project. These benefits include:

Lower Operation and Maintenance Costs

With the implementation of any of the Action Alternatives, O&M costs would be lower than they would if no project were implemented because there would be a shorter length of levees to maintain (because certain ponds would be open to tidal action rather than retained as managed ponds), and a lower pumping cost for Pond 2 (if included) because of new pumps. Opening ponds to tidal action would further reduce O&M costs because there would be fewer water control structures to repair or replace.

Water Quality Improvements

There would be unquantified water quality benefits to this nationally significant estuary. The Napa River is currently designated an "impaired body of water" by the RWQCB.

5.1.2 Alternative Plan Costs

Most of the costs of the Alternative Plans are associated with the construction of water control structures and the Pond 7 Options. Cost estimates were prepared by the Specifications and Cost Engineering Section, San Francisco District, Corps of Engineers for the recycled water pipeline CE/ICA, habitat-fate CE analysis, and Final CE/ICA. These analyses and the associated costs are presented in Section 5.2 (Comparison of Alternative Plans). Detailed project costs for the Recommended Plan are presented in Chapter 5 (The Recommended Plan) and Appendix F (MCACES).

Costs for Habitat-Fate Cost-Effectiveness Analysis

For the purpose of evaluating the cost effectiveness of habitat fates for individual ponds, the Civil Design section, San Francisco, determined the features that would be required to perform habitat restoration on the seven ponds discussed in Section 5.1.1.1 (Overview of Alternative Benefits): Ponds 1/1A, 2, 3, 4/5, 6/6A, 7/7A, and 8. Features and costs were determined for turning each pond into either managed pond or tidal marsh, and are presented in Section 5.2.1. (Cost-Effectiveness Analysis and Incremental Cost Analysis) and Appendix D (Engineering Appendix).

Costs for Final CE/ICA on Alternative Plans

Costs derived for actual Alternative Costs differ from those used in the habitat-fate cost-effectiveness analyses since the Alternative Plans reflect linkages between ponds necessary to achieve salinity reduction. The design of the four pond groups used in the Final CE/ICA on

Alternative Plans (Ponds 1, 1A, and 2; Pond 3; Ponds 4, 5, 6, and 6A; and Ponds 7, 7A, and 8) eliminates redundant structures that would be included if the ponds were considered separately as they were for the Pond Habitat Fate CE. The costs for the four pond groups included in the array of Alternative Plans are presented in Section (5.2.1. Cost-Effectiveness Analysis and Incremental Cost Analysis, and in Appendix D Engineering Appendix).

5.1.3 Environmental Impacts

Short-term negative impacts are expected to occur during construction, but the long-term environmental impacts would be largely beneficial. These impacts are described in detail in the DEIS/R. Significant, but short-term immitigable impacts associated with construction of any of the Action Alternatives would include noise in the project area. Beneficial impacts of all Action Alternatives would result from the reduction of salinity and bittern concentration as well as the restoration of usable habitat in the pond complex. However, the plans differ in the extent to which these benefits would occur.

5.1.4 System of Accounts

The Corps's Principles and Guidelines for its Planning Process have established four specific categories, or "accounts", which are used to facilitate Plan evaluation and display the effects of Alternative Plans. These accounts are: National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). These four accounts encompass all significant effects that a plan might have on the human environment as required by the National Environmental Policy Act of 1969 (NEPA) and encompass social well being as required by Section 122 of the Flood Control Act of 1970.

For an ecosystem restoration project such as the Napa River Salt Marsh Restoration Project, the National Ecosystem Restoration (NER) account is used in place of the NED account. The NED account identifies beneficial and adverse effects on the nation's economy. Beneficial effects in the NED account are increases in the economic value of the national output of goods and services from a plan and are expressed in monetary units. However, the Corps's objective in ecosystem restoration planning is to contribute to national ecosystem restoration (NER). Contributions to national ecosystem restoration (NER outputs) are increases in the net quantity and/or quality of desired ecosystem resources, and expressed quantitatively in physical units or indexes (e.g., Habitat Units). A Locally Preferred Plan (LPP) might also be identified, if the non-Federal sponsor wishes to request a plan that is not the NER Plan.

Each of these resource accounts (NER, EQ, RED, and OSE) and the results of the evaluation are described below.

5.1.4.1 National Environmental Restoration (NER)

The NER plan is identified through an Incremental Cost Analysis (ICA; Section 5.2.1) as the plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective. It is cost-effective and achieves the desired level of outputs. The NER plan is the restoration alternative that the Federal government would recommend in the Feasibility Report, unless an exemption from the NER is requested, as with a Locally Preferred Plan. If an LPP is designated, the Federal government would cost share up to the Federal share of the NER plan. For ecosystem restoration projects, the Federal share is 65%, while the non-Federal share is 35%. In accordance with the Corps's Policy Guidance Letter 59, the cost of approved recreation features would be cost shared at 50% Federal and 50% non-Federal, provided the Federal cost is not increased by more than 10%.

5.1.4.2 Environmental Quality (EQ)

Beneficial effects in the EQ account would include favorable changes in the ecological, aesthetic, and cultural attributes of the natural and cultural environment (Table 5.3 Summary of Environmental Quality Account). For the Napa River Salt Marsh Restoration Project, these changes include an increased value of overall wildlife habitat. Adverse effects in the EQ account are unfavorable changes in the ecological, aesthetic, and cultural attributes of these same resources. As described in the DEIS/R, there would be minor, unavoidable noise-related impacts associated with construction activities.

Table 5.3 Summary of Environmental Quality Account

Environmental Attributes	Alternatives		
	No Action	Action Alternatives	
		Including Some Ponds	Including All Ponds
Ecological Attributes (includes physical and biological aspects of ecosystems)			
Water quality	Significant Loss	Short-term temporary slight increase in salinity; potential positive impacts in long term*	Short-term temporary slight increase in salinity; potential positive impacts in long term
Air quality	No Impact	Minor construction-related impacts	
Overall Wildlife Habitat Value	Significant Loss	Significant positive effect*	Significant positive effect
Tidal Wetland Habitat Value	No Impact	Significant positive effect	
Pond Habitat Value	Significant Loss	Moderate positive effect*	Moderate positive effect
Upland Habitat Value	No Impact	Slight loss	
Cultural environment			
Cultural resources	No Impact	Potential disturbance of unknown sites	
Aesthetic environment			
Noise	No Impact	Minor construction-related impacts	
Visual Resources	No Impact	Minor temporary impacts during construction; long-term benefits	
* Positive effect assuming local sponsor implements water control structures and water management equivalent to Alternatives 10C or 10D on its own			

* Positive effect assuming non-Federal sponsor implements water control structures and water management associated with ponds not included in Federal Project.

5.1.4.3 Regional Economic Development (RED) and Other Social Effects (OSE)

The Regional Economic Development (RED) account is intended to illustrate the effects that the Alternative Plans would have on regional economic activity; specifically, regional income and regional employment (Table 5.4 Regional Economic Development and Other Social Effects Account).

Other Social Effects would involve urban and community impacts such as employment distribution, potential displacement of businesses, and local government's fiscal condition, as well as life, health, and safety effects. For the Napa River Salt Marsh Restoration Project, these impacts would be difficult to quantify; however, habitat restoration would improve the quality of life regionally by increasing the value of wildlife habitat. On-site and off-site fishing and hunting in the NSWMA would probably increase as the value of wildlife habitat increases.

5.2 Comparison of Alternative Plans

The fifth step of the Corps's six-step planning process is to compare the effects of each of the Alternative Plans. Plans can be compared on a number of different criteria, including their features and costs, costs and benefits, environmental impacts, and stakeholder acceptability.

5.2.1 Cost Effectiveness Analysis and Incremental Cost Analysis

The Incremental Cost Analysis (ICA) analyzes the cost-efficiency of the Alternatives in achieving the Planning Objective of ecosystem restoration, with benefits quantified from the HEP analysis.

5.2.1.1 Purpose of the Cost Effectiveness Analysis and Incremental Cost Analysis

While there is no generally accepted method for quantifying environmental benefits in monetary terms, two decision-making tools have helped planners decide how to allocate limited resources more effectively. *Cost effectiveness* analysis helps filter out plans with equivalent output levels that are more expensive. *Incremental analysis* allows planners to progressively proceed through available levels of output (increments) and asks if the next level of additional outputs is worth its additional cost. Another analysis that must be performed is an examination of the incremental cost-efficiency of different potential measures to create fish and wildlife habitat value. This analysis is normally performed as a mitigation tool to evaluate measures that mitigate the impacts of a project on fish and wildlife habitat. In contrast, in an Environmental Restoration Project, the Incremental Cost Analysis is used instead to compare the cost-efficiency of the project's Alternative Plans.

In an incremental analysis, each possible combination of increments is examined for cost-efficiency. As cost-efficiency in producing fish and wildlife habitat value is only one of the criteria used to evaluate alternatives, the conclusions of this analysis are not the sole determinant of which alternatives receive detailed consideration in the feasibility study, or which alternative is selected as the preferred plan.

Table 5.4 Regional Economic Development and Other Social Effects Account

	Alternative		
	No Action	**Plans Including Some Ponds, but not including Pond 7**	**Plans Including All Ponds**
I. Regional Economic Development			
a. Employment/Labor Force	No change expected	3-5 year temporary increase in construction-related employment	5 year temporary increase in construction-related employment
b. Business and Industrial Activity	N/A		
c. Local Government Finance	N/A	DFG to provide non-Federal share of funds	DFG to provide non-Federal share of funds
II. Other Social Effects			
a. Public Health and Safety	N/A	Improved well being due to enhanced habitat*	Improved well being due to enhanced habitat
b. Public Facilities and Services	N/A		
c. Recreation and Public Access	No change expected	Some increase in recreational opportunity from enhanced habitat	Increased recreational opportunities from enhanced habitat
d. Traffic/Transportation	No change expected	Negligible increase relative to total traffic in area during construction and as use of NSMWA increases	
e. Man Made Resources	N/A		
f. Natural Resources	Reduction in fishing and hunting opportunities as deteriorating conditions reduce uitility of habitat for key species; continued loss of endangered species	Reduction in fishing and hunting opportunities as deteriorating conditions reduce uitility of habitat for key species; Increase in fishing opportunities; increased productivity of tidal marshes. Improved recovery of endangered species. Risk to wildlife from Pond 7	Increase in fishing and hunting opportunities; increased productivity in SF Bay due to increase in spawning/ rearing habitat and productivity of tidal marshes. Improved recovery of endangered species.

* Positive effect assumes non-Federal sponsor implements water control structures and water management associated with the ponds not included in the Federal project

5.2.1.2 Use of Habitat Evaluation Procedure Results

The USFWS performed a HEP study to determine potential project impacts on wildlife habitat. The HEP study examined impacts on all habitats that either currently exist or would be created under the alternatives. In a HEP study, individual wildlife species serve as surrogates for entire habitats, with impacts on these *evaluation species* used to indicate impacts on the habitats they inhabit.

A HEP study normally fulfills two functions in a Corps Flood Damage Reduction or Navigation Study where existing habitat must be protected. First, it determines impacts on various existing wildlife habitats to determine mitigation requirements. Second, it is used by the Corps to determine the cost effectiveness and efficiency of different mitigation increments. The incremental analysis for mitigation included in a Feasibility Report compares the cost and output of each mitigation increment to determine the optimal level of investment in mitigation. However, this approach has difficulties when applied to an Environmental Restoration study such as this one, as the HEP does not differentiate between Habitat Units (HUs) of a common species and HUs of a rare species, nor between the value of common and scarce habitats. Nor does it consider the ecological role of a species or habitat outside of the project site itself, that is, in the local or regional context.

In an ecosystem restoration project, the objective is to improve and create habitat; as a result, mitigation should not be required; therefore the mitigation-oriented HEP is used to determine the output of each Alternative, rather than mitigation requirements. In the case of the Napa River Salt Marsh Restoration Project, the USFWS HEP showed relatively small overall gains in habitat units as tidal marsh is being formed. This is because as tidal marsh develops, it replaces mudflats which themselves have habitat value. Accelerating the rate of tidal marsh development would merely accelerate the rate at which this tradeoff occurs, yielding little increase in total habitat units.

For this reason, the standard incremental mitigation analysis for this study has been modified to measure the cost-effectiveness and cost-efficiency of project increments in creating tidal salt marsh and other habitat. Tidal marsh habitat is of particular concern in the San Francisco Estuary (San Francisco, San Pablo, and Suisun Bays) due to the magnitude of historic losses of this habitat type, the high ecological value of this habitat, and its particular importance to endangered species (e.g., the California clapper rail and the salt marsh harvest mouse). The non-tidal wetlands evaluated in the modified HEP also have high ecological importance, have suffered major losses in the region and are a priority for restoration efforts.

The exclusion of some species/habitat combinations was made with the awareness that some of them would experience net losses. However, trading off these particular species and their habitats for species and habitats deemed more important has been endorsed (within certain limits) by various resource agencies, and in fact is an unavoidable consequence of implementing any of the Action Alternatives.

Existing and future habitats within the Napa Salt Marsh project area were assigned habitat values (habitat suitability indices) based upon the results of the USFWS HEP, with adjustments to reflect timing differences in habitat evolution. Cumulative and average annual habitat units were then calculated based upon these habitat values, habitat acreages, and construction phasing.

General information regarding the habitat units under the future without-project condition is provided in Sections 3.3 (Future Without-Project Conditions) and Section 3.3.3.6 (Habitat Values Decrease with Increasing Salinity. The HEP values used in the alternative plan comparison that follows reflect HEP values *above* the future without-project condition (i.e., No Action Plan).

HEP values for the without-project condition were derived by applying the HEP models to a simulation of pond salinities and water levels that used a mass-balance approach over time to determine pond conditions given a continuation of existing water control facilities and operations.

Caveats on use of HEP results in plan comparison

Although the HEP analysis is a useful tool for quantifying environmental benefits in ecosystem restoration projects, it should be noted that this procedure does not provide a full representation of the benefits for this project for the following reasons:

- **Original purpose of the HEP analysis (mitigation tool).** The HEP was initially conceived as a tool for mitigation purposes, and favors particular species over others. The objective of this restoration project was to provide a balanced mix of habitats to benefit all species in the project site, not only threatened and endangered species.
- **Effect of timing differences in pond versus tidal habitat accrual.** As shown in Table 5.2 (Summary of Species Use, by Habitat), tidal habitat (including subtidal, mudflat, and tidal marsh) would be used by a large number of species, including three special-status species (California clapper rail, California black rail, and the San Pablo song sparrow). In the HEP, the pond habitat more heavily influenced total habitat value than did tidal habitat because pond benefits would be more quickly realized. Pond benefits would accumulate as soon as salinities are reduced (within the first five years) whereas tidal marsh would take decades to evolve. Thus, tidal habitat benefits might not be fully realized during the 50-year period of analysis used for the HEP.

Due to the limitations of the HEP analysis and therefore the incremental cost analysis (Section 5.2.1), additional criteria (Section 5.2.2 Associated Evaluation Criteria) were considered selecting a Recommended Plan.

5.2.1.3 Cost Effectiveness/Incremental Cost Analysis

When a common measurement unit for comparing non-monetary project benefits with monetary project costs does not exist, a traditional benefit-cost analysis cannot be performed to evaluate the project alternatives and identify the most “optimal” plan – the plan that maximizes net benefits. For the proposed restoration of the Napa Salt Marsh, where project costs were measured in dollars and project benefits were measured in average annual habitat units, cost effectiveness and incremental cost analyses (CE/ICA) were used as an alternative approach to screen and evaluate plans.

Cost effectiveness analysis and incremental cost analysis are valuable planning tools that assist in the decision making process. For the Napa Salt Marsh Restoration project, CE/ICA allowed for the examination of environmental outputs, the elimination of economically irrational plans, and the comparison of the relative cost effectiveness of the remaining plans. The analysis and the results are explained below.

KEY ASSUMPTIONS AND DATA INPUT

Project outputs are expressed as average annual habitat units (AAHU), which represent the average annual habitat units of wetlands (ponds, tidal and non-tidal marsh) produced by each alternative.

Project costs are expressed as annual costs and include first costs of restoration, adaptive management costs, and interest during construction. Annual operation & maintenance costs were assumed to be 2% of the overall project cost.

For the Habitat Fate CE analysis (Analysis 2), it was assumed that the salinity was already reduced in the study area; thus, the costs do not include those associated with salinity reduction features, only habitat restoration features. The Final CE/ICA (Analysis 3) included the cost of salinity reduction features.

The construction period for all alternatives is 5 years; for the pipelines, the construction period is 1 year.

Benefits begin to accrue at different points of time for different alternatives and are reflected in the Average Annual Habitat Units.

The period of analysis is 50 years; the present (FY'04) discount rate is 5.625 percent.

Analysis 1—Recycled Water Pipeline Cost effectiveness/Incremental Cost Analysis

The three proposed pipeline sections were first sorted by increasing cost and compared on the basis of cost-effectiveness. A plan is considered to be non-cost effective if there exists another plan that either (1) produces the same level of output at less cost, (2) produces a greater level of output at the same cost, or (3) produces a greater level of output at less cost. In the pipeline CE/ICA, two plans were identified as non-cost effective: the Sonoma and the Sonoma/American Canyon pipelines. In both cases there exists another plan that produces more average annual habitat units for less cost.

Once the cost effectiveness test was completed, the Incremental Cost Analysis was performed as alternatives having the lowest incremental costs per unit were selected and formed the basis for subsequent iterations. The iterations and final array of best buys are shown in the sequential tables. The final array of plans demonstrates the "Best Buys" or potential NER or National Ecosystem Restoration plan. There are three pipeline "Best Buys." They are (1) the Napa pipeline, (2) the Sonoma/Napa pipeline and (3) the Sonoma/Napa/American Canyon pipelines.

Based on the results of the pipeline CE/ICA, the Napa pipeline was selected as the recycled water pipeline to be included in the array Final Alternative Plans.

Tables 5.5a-5.5g. Pipeline Cost-Effectiveness/Incremental Cost Analysis

Table 5.5a Array of Pipeline Alternatives used in the CE/ICA

Plan	Cost ($)	Incremental Cost: ($)	Output (AAHUs)	Incremental Output: (AAHUs)	Incremental Cost per Unit ($/AAHU)
No Action	$0	$0	0.0	0.0	$0
Neighboring Waters	$1,909,608	$1,909,608	597.2	597.2	$3,198
American Canyon (AC)	$2,552,697	$2,552,697	597.8	597.8	$4,270
Napa	$2,695,367	$2,695,367	605.1	605.1	$4,454
Sonoma	$3,002,044	$3,002,044	600.9	600.9	$4,996
Napa, AC	$3,338,456	$3,338,456	605.7	605.7	$5,512
Sonoma, AC	$3,645,133	$3,645,133	601.5	601.5	$6,060
Sonoma, Napa	$3,787,803	$3,787,803	608.9	608.9	$6,221
Sonoma, Napa, AC	$4,430,892	$4,430,892	609.4	609.4	$7,271

Table 5.5b 1st Iteration--Identifying non-cost effective plans

Plan	Cost ($)	Incremental Cost: ($)	Output (AAHUs)	Incremental Output: (AAHUs)	Incremental Cost per Unit ($/AAHU)
No Action	$0	$0	0.0	0.0	$0
Neighboring Waters	$1,909,608	$1,909,608	597.2	597.2	$3,198
American Canyon (AC)	$2,552,697	$2,552,697	597.8	597.8	$4,270
Napa	$2,695,367	$2,695,367	605.1	605.1	$4,454
~~Sonoma~~	~~$3,002,044~~	~~$3,002,044~~	~~600.9~~	~~600.9~~	~~$4,996~~
Napa, AC	$3,338,456	$3,338,456	605.7	605.7	$5,512
~~Sonoma, AC~~	~~$3,645,133~~	~~$3,645,133~~	~~601.5~~	~~601.5~~	~~$6,060~~
Sonoma, Napa	$3,787,803	$3,787,803	608.9	608.9	$6,221
Sonoma, Napa, AC	$4,430,892	$4,430,892	609.4	609.4	$7,271

Table 5.5c 2nd Iteration--Identifying the plan with the lowest $/AAHU and Removing Plans Preceding It

Plan	Cost ($)	Incremental Cost: ($)	Output (AAHUs)	Incremental Output: (AAHUs)	Incremental Cost per Unit ($/AAHU)
No Action	$0	$0	0.0	0.0	$0
Neighboring Waters	***$1,909,608***	***$1,909,608***	***597.2***	***597.2***	***$3,198***
American Canyon (AC)	$2,552,697	$2,552,697	597.8	597.8	$4,270
Napa	$2,695,367	$2,695,367	605.1	605.1	$4,454
Napa, AC	$3,338,456	$3,338,456	605.7	605.7	$5,512
Sonoma, Napa	$3,787,803	$3,787,803	608.9	608.9	$6,221
Sonoma, Napa, AC	$4,430,892	$4,430,892	609.4	609.4	$7,271

Table 5.5d 3rd Iteration--Identifying the plan with the lowest $/AAHU and Removing Plans Preceding It					
Plan	Cost ($)	Incremental Cost: ($)	Output (AAHUs)	Incremental Output: (AAHUs)	Incremental Cost per Unit ($/AAHU)
No Action	$0	$0	0.0	0.0	$0
Neighboring Waters	***$1,909,608***	***$1,909,608***	***597.2***	***597.2***	***$3,198***
~~American Canyon (AC)~~	~~$2,552,697~~	~~$643,089~~	~~597.8~~	~~0.6~~	~~$1,071,815~~
Napa	***$2,695,367***	***$785,759***	***605.1***	***7.9***	***$99,463***
Napa, AC	$3,338,456	$1,428,848	605.7	8.5	$168,100
Sonoma, Napa	$3,787,803	$1,878,195	608.9	11.7	$160,529
Sonoma, Napa, AC	$4,430,892	$2,521,284	609.4	12.2	$206,663

Table 5.5 e Final Array of Best Buys					
Plan	Cost ($)	Incremental Cost: ($)	Output (AAHUs)	Incremental Output: (AAHUs)	Incremental Cost per Unit ($/AAHU)
No Action	$0	$0			
Neighboring Waters	***$1,909,608***	***$1,909,608***	***597.2***	***597.2***	***$3,198***
Napa	***$2,695,367***	***$785,759***	***605.1***	***7.9***	***$99,463***
Sonoma, Napa	***$3,787,803***	***$1,092,436***	***608.9***	***3.8***	***$287,483***
Sonoma, Napa, AC	***$4,430,892***	***$643,089***	***609.4***	***0.5***	***$1,286,178***

Table 5.5f 4th Iteration--Identifying the plan with the lowest $/AAHU and Removing Plans Preceding It					
Plan	Cost ($)	Incremental Cost: ($)	Output (AAHUs)	Incremental Output: (AAHUs)	Incremental Cost per Unit ($/AAHU)
No Action	$0	$0			
Neighboring Waters	***$1,909,608***	***$1,909,608***	***597.2***	***597.2***	***$3,198***
Napa	***$2,695,367***	***$785,759***	***605.1***	***7.9***	***$99,463***
~~Napa, AC~~	~~$3,338,456~~	~~$643,089~~	~~605.7~~	~~0.6~~	~~$1,071,815~~
Sonoma, Napa	***$3,787,803***	***$1,092,436***	***608.9***	***3.8***	***$287,483***
Sonoma, Napa, AC	$4,430,892	$1,735,525	609.4	4.3	$403,610

Table 5.5g 5th Iteration -- Identifying the plan with the lowest $/AAHU and Removing Plans Preceding It					
Plan	Cost ($)	Incremental Cost: ($)	Output (AAHUs)	Incremental Output: (AAHUs)	Incremental Cost per Unit ($/AAHU)
No Action	$0	$0			
Neighboring Waters	***$1,909,608***	***$1,909,608***	***597.2***	***597.2***	***$3,198***
Napa	***$2,695,367***	***$785,759***	***605.1***	***7.9***	***$99,463***
Sonoma, Napa	***$3,787,803***	***$1,092,436***	***608.9***	***3.8***	***$287,483***
Sonoma, Napa, AC	***$4,430,892***	***$643,089***	***609.4***	***0.5***	***$1,286,178***

Analysis 2 -- Pond Habitat Fate Cost Effectiveness Analysis

Our second screening focused on the cost effectiveness of the ponds by habitat fate (i.e., whether it was more cost effective to convert a pond to a managed pond or to a tidal marsh). Fates with the lower average annual costs per unit of habitat benefit (measured in Average Annual Habitat Units) were deemed the "winners."

The results of this analysis can be summarized as follows:

- Ponds 1/1A: *Removed from further study* because no additional habitat value would be produced from restoration to either managed pond or tidal marsh. Marsh outputs for Ponds 1/1A are strongly negative, due to losses of estuarine fish, diving duck, and non-tidal shorebird habitats collectively outweighing gains for tidal shorebirds.

- Pond 2: *Removed from further study*. Habitat outputs from retention of Pond 2 as a managed pond are negative. This is due to tidal shorebird habitat quality under a marsh scenario being better than diving duck habitat under a pond scenario, according to the HEP[1]. Although habitat outputs would be realized by restoring Pond 2 to tidal marsh, the cost of $58,084 per AAHU was judged to be too high to justify, especially given stakeholder interest in maintaining Pond 2 (currently functioning pond habitat) as managed pond.

- Pond 3: *Removed from further study* because no additional habitat value would be produced.

- Ponds 4/5: *Retained for further study as tidal marsh.*

- Ponds 6/6A: *Retained for further study as managed ponds.*

- Ponds 7/7A: *Retained for further study as managed ponds.*

[1] The HEP methodology is limiting since it only examines a mix of species and fails to capture broader ecological considerations, time components, and temporary increases in habitat value.

- Pond 8: *Retained for further study as managed pond.* Due to the engineering design of the Neighboring Waters concept, Pond 8 must be included in the project with Ponds 7 and 7A for bittern dilution and salinity reduction to succeed in Pond 7. Pond 8 serves as a reservoir and conduit for slough water to the Upper Ponds mixing chamber (where Pond 7 water is diluted before discharge). Under the Neighboring Waters design, Pond 8 could be turned to either managed pond or tidal marsh. Because a cost of $78,335 per AAHU for tidal marsh was considered excessive, a managed pond fate was selected for Pond 8. There were no additional managed pond benefits to be gained from restoring Pond 8 because it is already functioning pond habitat.

Tables 5.6a – 5.6b Pond Habitat Fate Cost-Effectiveness Analysis

Table 5.6a Habitat Benefits and Costs for Managed Pond vs Tidal Marsh, by Pond

Pond	Managed Pond AAHU	Tidal Marsh AAHU	Managed Pond Ave Annual Cost	Tidal Marsh Ave. Ann Cost
1/1A	0	-342	$1,499,022	$2,313,508
2	-114	36	$578,886	$2,091,032
3	0	-5	$1,279,708	$659,285
4/5	1,041	590	$1,584,100	$843,448
6/6A	813	804	$799,892	$2,280,961
7/7A	619	274	$1,281,423	$3,330,513
8	0	19	$303,168	$1,488,361

Table 5.6b Habitat Fate Least Cost Alternative, by Pond

Pond	Managed Pond $/AAHU	Tidal Marsh $/AAHU
~~1/1A~~	~~0~~	~~-$6,765~~
~~2~~	~~-$5,078~~	~~***$58,084***~~
~~3~~	~~0~~	~~-$131,857~~
4/5	$1,522	***$1,430***
6/6A	***$984***	$2,837
7/7A	***$2,070***	$12,155
8	0	***$78,335***

- * denotes "Winner" of the habitat fate analysis
- Plans crossed out were removed from further study
- Managed Pond was selected as the habitat fate for Pond 8 (see text, above)

Analysis 3-- Cost Effectiveness/Incremental Cost Analyses for Pond Groupings

Once habitat "fates" (managed pond or tidal marsh) for each pond were determined, average annual costs (AAC) and average annual habitat units (AAHUs) for each pond grouping was estimated based on these fates. Average Annual Costs and Average Annual Habitat Units for each pond grouping are presented in the following table (Table 5.7. Pond Groupings, Average Annual Costs (AAC), and Average Annual Habitat Units (AAHU)).

Table 5.7 Pond Groupings, Average Annual Costs (AAC), and Average Annual Habitat Units (AAHU)

Pond Groupings	Average Annual Costs (AAC)	Average Annual Habitat Units (AAHU)
4, 5, 6, 6A	$3,662,802	1,403
7, 7A, 8 – Neighboring Waters	$1,909,608	597.2
7, 7A, 8 – Recycled Water Pipeline (Napa section)	$2,695,367	605.1

Because Analysis 3 reflects total restoration costs (bittern dilution, salinity reduction, and habitat restoration), pond groupings were reconfigured to reflect the design of bittern dilution and/or salinity reduction measures (Appendix D [Engineering Appendix]). Ponds 4-6A operate as a unit, as do Ponds 7, 7A,and 8. The costs used in Analysis 3 for these pond groupings are not simply the sum of the costs for the ponds in Analysis 2 because the Analysis 3 costs include salinity reduction features and eliminate redundant restoration features common to ponds that were grouped together.

Once these costs and habitat units were determined, every combination of pond groupings (hereafter referred to as a plan), their total costs, and their total AAHUs were derived using IWR-Plan. The total AAHUs and total AACs for each pond grouping combination (plan) reflect the addition of AAHUs and AACs for the respective pond grouping included in that particular plan. Table 5.8 (Array of Possible Pond Grouping Combinations) presents the six possible combinations of pond groupings (including the No Action plan); it also takes into account that pond groupings [7, 7A, 8 – Neighboring Waters] and [7, 7A, 8 – Recycled Water Pipeline] are not combinable.

Table 5.8 Array of Pond Grouping Combinations (sorted by increasing cost)

Plan	Average Annual Cost $	Incremental Cost $	Output (AAHU)	Incremental Output (AAHU)	Incremental Cost Per Unit ($/AAHU)
No Action	$0	$0	0	0	0
[Ponds 4, 5, 6, 6A]	$1,863,843	$1,863,843	1403	1403	$1,328
[Ponds 7, 7A, 8 -- Neighboring Waters]	$2,023,279	$2,023,279	597.2	597.2	$3,388
[Ponds 7, 7A, 8 -- Recycled Water Pipeline]	$2,809,038	$2,809,038	605.1	605.1	$4,642
[Ponds 4, 5, 6, 6A] and [Ponds 7, 7A, 8 -- Neighboring Waters]	$3,887,122	$3,887,122	2000.2	2000.2	$1,943
[Ponds 4, 5, 6, 6A] and [Ponds 7, 7A, 8 -- Recycled Water Pipeline]	$4,672,881	$4,672,881	2008.1	2008.1	$2,327

Finally, cost effectiveness/incremental cost analyses (CE/ICA) was performed using IWR-Plan. This process allowed for the elimination of all non-cost effective plans and the identification of the plans deemed to be “Best Buys” (i.e., those plans which provide the “biggest bang for the buck"). This process, as performed by the IWR-Plan program, is replicated below; an explanation of the process and results for each step is presented as well.

As seen in the pipeline CE/ICA (Analysis 1), the first step in the process is to identify and eliminate all plans that are non-cost effective (Table 5.9.a.1st Iteration—Eliminating Non-Cost Effective Plans). A plan is considered to be non-cost effective if there exists another plan that either (1) produces the same level of output at less cost, (2) produces a greater level of output at the same cost, or (3) produces a greater level of out put at less costs. In the following table, these non-cost effective plans are identified by a slash through its row. Of the 6 plans, 2 were identified as non-cost effective when compared to other plans. Pond groupings 7, 7A, 8 (neighboring waters) and 7, 7A, 8 (recycled water pipeline) do not generate as much habitat as the grouping comprised of Ponds 4, 5, 6, and 6A and are more costly, so these plans (taken by themselves) are eliminated in the first iteration.

Table 5.9.a.1st Iteration—Eliminating Non-Cost Effective Plans

Plan	Average Annual Cost $	Incremental Cost $	Output (AAHU)	Incremental Output (AAHU)	Incremental Cost Per Unit ($/AAHU)
No Action	$0	$0	0	0	0
[Ponds 4, 5, 6, 6A]	$1,863,843	$1,863,843	1403	1403	$1,328
~~[Ponds 7, 7A, 8 -- Neighboring Waters]~~	~~$2,023,279~~	~~$2,023,279~~	~~597.2~~	~~597.2~~	~~$3,388~~
~~[Ponds 7, 7A, 8 -- Recycled Water Pipeline]~~	~~$2,809,038~~	~~$2,809,038~~	~~605.1~~	~~605.1~~	~~$4,642~~
[Ponds 4, 5, 6, 6A] and [Ponds 7, 7A, 8 -- Neighboring Waters]	$3,887,122	$3,887,122	2000.2	2000.2	$1,943
[Ponds 4, 5, 6, 6A] and [Ponds 7, 7A, 8 -- Recycled Water Pipeline]	$4,672,881	$4,672,881	2008.1	2008.1	$2,327

Once all of the non-cost effective plans were eliminated, the plan that had the lowest cost per unit of output was identified (Table 5.9.b. 2nd Iteration—Identifying the Plan with the Lowest $/AAHU & removing plans preceding it). This plan was identified as a "Best Buy." Any plans cheaper than this "Best Buy" plan (i.e., those plans with lower outputs and higher costs per unit), are still cost-effective, but would be eliminated in subsequent iterations. The plan containing Ponds 4, 5, 6, 6A (Table 5.9.b; italicized) is the Best Buy Plan. There were no plans smaller than this plan that would be eliminated. All of the other plans remain in the ICA and their incremental cost and incremental output are recalculated using [Ponds 4, 5, 6, 6A] as the baseline.

Table 5.9.b. 2nd Iteration—Identifying the Plan with the Lowest $/AAHU and Removing Plans Preceding It

Plan	Average Annual Cost $	Incremental Cost $	Output (AAHU)	Incremental Output (AAHU)	Incremental Cost Per Unit ($/AAHU)
No Action	$0	$0	0	0	0
*[Ponds 4, 5, 6, 6A]**	*$1,863,843*	*$1,863,843*	*1403*	*1403*	*$1,328*
[Ponds 4, 5, 6, 6A] and [Ponds 7, 7A, 8 -- Neighboring Waters]	$3,887,122	$3,887,122	2000.2	2000.2	$1,943
[Ponds 4, 5, 6, 6A] and [Ponds 7, 7A, 8 -- Recycled Water Pipeline]	$4,672,881	$4,672,881	2008.1	2008.1	$2,327

*Best Buy

In the third step, each of the two remaining plans was compared to the first “Best Buy” plan to compute its incremental cost, incremental output, and incremental cost per unit of output (Table 5.9.c. 3rd Iteration—Identifying the Plan with the Lowest $/AAHU & removing plans preceding it). Once this was completed, the plan with the lowest incremental cost per unit of output above the baseline plan ([Ponds 4, 5, 6, 6A] with [Ponds 7, 7A, 8 – Neighboring Waters]) was also designated as a “Best Buy” plan.

Table 5.9.c. 3rd Iteration—Identifying the Plan with the Lowest $/AAHU and Removing Plans Preceding

Plan	Average Annual Cost $	Incremental Cost $	Output (AAHU)	Incremental Output (AAHU)	Incremental Cost Per Unit ($/AAHU)
No Action	$0	$0	0	0	0
[Ponds 4, 5, 6, 6A]	$1,863,843	$1,863,843	1403	1403	$1,328
*[Ponds 4, 5, 6, 6A] and [Ponds 7, 7A, 8 -- Neighboring Waters]**	*$3,887,122*	*$2,023,279*	*2000.2*	*597.2*	*$3,388*
[Ponds 4, 5, 6, 6A] and [Ponds 7, 7A, 8 -- Recycled Water Pipeline]	$4,672,881	$2,809,038	2008.1	605.1	$4,642

*Best Buy

In the final step, the last plan remaining [Ponds 4, 5, 6, 6A] with [Ponds 7, 7A, 8 – Neighboring Waters]) was identified as a “Best Buy” plan (Table 5.9.d. Final Array of “Best Buys”). The biggest and most expensive plan always ends up on the final list of Best Buy Plans, not necessarily because it is a good buy but simply because it serves as an end point to the ICA. Indeed, the incremental costs per unit are extremely high going from the [Ponds 4, 5, 6, 6A] with [Ponds 7, 7A, 8 – Neighboring Waters]) grouping to the [Ponds 4, 5, 6, 6A] and [Ponds 7, 7A, 8 -- Recycled Water Pipeline grouping. The additional gain of 7.9 AAHUs costs over $99,000 per AAHU. The final table lists all of the “Best Buys”. These Plans will be referred to as “Plan A”

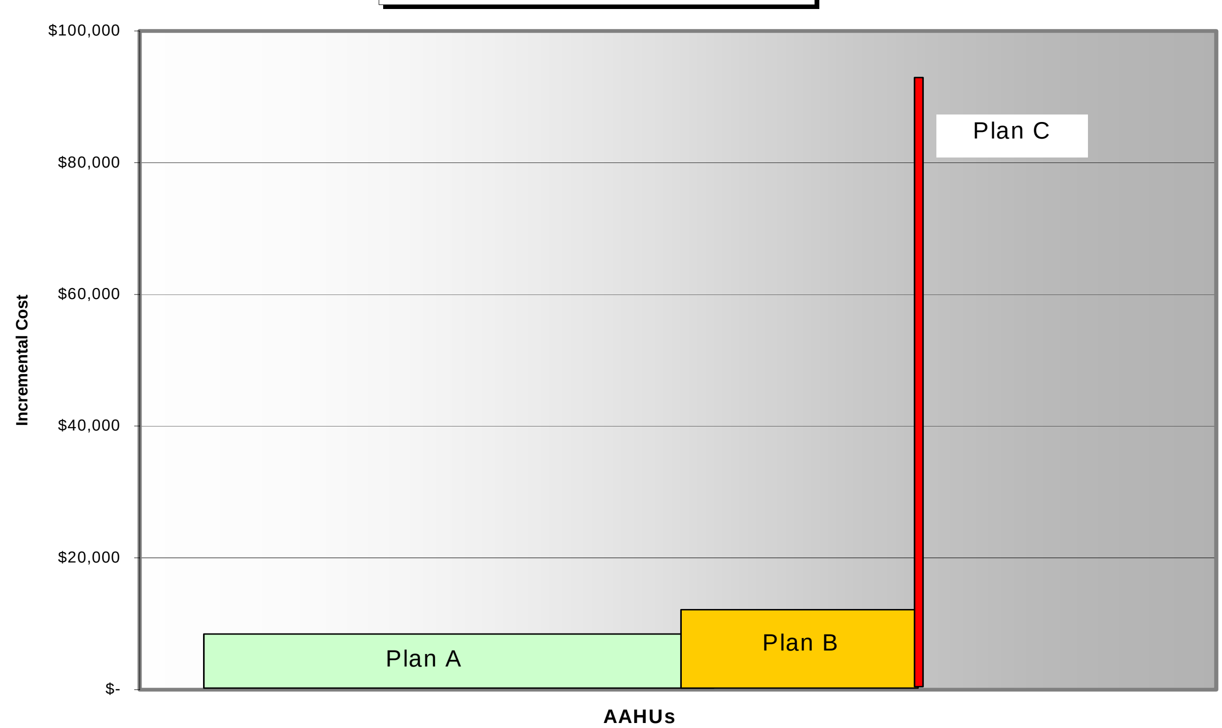
(Ponds 4 through 6A), "Plan B" (Ponds 6 through 6A and Ponds 7, 7A, 8 – Neighboring Waters), and "Plan C" (Ponds 6 through 6A and Ponds 7, 7A, 8 – Recycled Water Pipeline).

Table 5.9.d Final Array of Best Buys

Plan	Average Annual Cost $	Incremental Cost $	Output (AAHU)	Incremental Output (AAHU)	Incremental Cost Per Unit ($/AAHU)
No Action	$0	$0	0	0	0
PLAN A: [Ponds 4, 5, 6, 6A]	$1,863,843	$1,863,843	1403	1403	$1,328
PLAN B: [Ponds 4, 5, 6, 6A] and [Ponds 7, 7A, 8 -- Neighboring Waters]	$3,887,122	$2,023,279	2000.2	597.2	$3,388
PLAN C: [Ponds 4, 5, 6, 6A] and [Ponds 7, 7A, 8 -- Recycled Water Pipeline]	$4,672,881	$785,759	2008.1	7.9	$99,463

Graphically, one can see the spike in cost when moving from Plan B to the final best buy (Plan C). Decision-makers can then decide whether that final increment is worth selecting and ultimately financing (Figure 5-1. Final Array of Alternative Plans).

Figure 5-1 Final Array of Alternative Plans



5.2.1.4 Relationship of ICA Conclusions to the Study Alternatives

The Final CE/ICA determined that Plans A, B, and C would be the most cost-efficient plans for their level of output. All three plans are also “Best Buy” plans. The other plans were determined to be not cost-efficient for this output. However, other criteria are used in evaluating and screening potential Alternatives and are discussed below.

5.2.2 Associated Evaluation Criteria

The Alternative Plans were evaluated against the specific criteria (completeness, effectiveness, efficiency, and acceptability) presented in US Army Corps of Engineers Regulation ER 1105-2-100 (Planning Guidance Notebook). These four criteria, described below, are used to evaluate project plans under Federal guidelines. These criteria are also used to narrow down the array of Alternatives to a Recommended Plan.

5.2.2.1 Completeness

Completeness is the extent to which a given Alternative Plan provides and accounts for all necessary investments or other actions to ensure realization of the planned effects. This criterion assures that all measures required to achieve the desired outputs are included in the Alternative, or at least addressed.

Plan B (Ponds 4 through 6A and Ponds 7, 7A, 8 - Neighboring Waters) and Plan C (Ponds 4 through 6A and Ponds 7, 7A, 8 – Recycled Water Pipeline) are considered more complete than Plan A (Ponds 4 through 6A) because they address Pond 7, which would pose a substantial ecological risk to the Napa River and to developing habitat in the project area in the case of a levee breach and bittern spill (Section 3.3.3.7 Uncontrolled Breaches Occur). The No Action Plan is not complete because it does not address the identified Problems and Opportunities.

5.2.2.2 Effectiveness

Effectiveness is the extent to which an Alternative Plan alleviates the specified Problems and achieves the specified Opportunities. Effectiveness is a measure of a Plan’s ability to achieve the desired output and can be evaluated as follows:

- Plans must represent sound, safe acceptable engineering solutions to the problems and needs.
- Plans must be technically achievable and cannot contain obstructions that would prevent accomplishment of the desired output.
- Plans must be realistic and state-of-the-art. However, they must not rely on future research and development of key components.
- For restoration projects, plans must provide improved habitat.

Plan B (Ponds 4 through 6A and Ponds 7, 7A, 8 - Neighboring Waters) and Plan C (Ponds 4 through 6A and Ponds 7, 7A, 8 – Recycled Water Pipeline) are considered effective because they meet the Study Objectives of creating a mix of tidal habitat and pond habitat to serve the largest possible range of wildlife, restoring tidal marsh in a band along the Napa River to maximize benefits for fish and other aquatic animals, providing improved pond habitat for migratory birds and water fowl, and ensuring connections between the patches of tidal marsh (within the project site and with adjacent sites) to enable the movement of small mammals, marsh-dependent birds, and fish and aquatic species.

Plan A (Ponds 4 through 6A) and the No Action Plan are not considered effective because they do not include a solution for Pond 7 and the threat it poses to the quality of existing and developing habitat.

5.2.2.3 Efficiency

Efficiency can be examined in either economic or ecological terms for this project. Economic efficiency measures the amount of project outputs (such as habitat units) per unit of economic cost. Ecological efficiency measures the amount of project output per unit of ecological input.

ECONOMIC EFFICIENCY

The NER plan is considered the most efficient plan. As explained above in the CE/ICA discussion (Section 5.2.1. Incremental Cost Analysis), the most economically efficient study alternative in terms of creation of habitat units is Plan A (Ponds 4 through 6A), with an incremental cost of $1,328 per habitat unit over the No-Action Plan. Plan B (Ponds 4 through 6A, Ponds 7, 7A, 8, Neighboring waters) has a higher incremental cost, but is cost-efficient for its level of output and has an average cost per habitat unit of $1,943. Plan C (Ponds 4 through 6A and Ponds 7, 7A, 8 – Recycled Water Pipeline) has an even higher incremental cost, but is also cost-efficient for its level of output and has an average cost per habitat unit of $2,327. The other plans were not determined to be cost effective.

ECOLOGICAL EFFICIENCY

Plans must also be efficient in other resource areas, representing near optimal use of all resources including land, water, infrastructures, and energy. Ecological efficiency is more difficult to quantify than economic efficiency. One way to measure ecological efficiency is to measure the amount of desired habitat value created per acre of habitat created (for this project, habitat created are tidal marsh and ponds; Table 5.10 Comparative Ecological Efficiency of the Alternative Plans).

Table 5.10. Comparative Ecological Efficiency Of the Study Alternatives

Plan	Average Annual Habitat Units	Total Acres of Tidal Marsh and Pond Habitat	Wetland Habitat Value Gain Per Acre
A	1403	3609	0.39
B	2000.2	4534	0.44
C	2008.1	4534	0.44

All the Action Alternatives would increase the total amount of habitat on the site by converting high-saline ponds to wildlife habitat. However, the plans represent different levels of ecological efficiency, based on the number and identity of the ponds included.

Plans B and C, which include Ponds 4 through 6A as well as Ponds 7, 7A, and 8 would include greater pond acreage than Plan A, which includes only Ponds 4-6A. Plans B and C are also more ecologically efficient, with a Wetland Habitat Value Gain Per Acre of 0.44, compared to a gain of 0.39 for Plan A (Table 5.10 Comparative Ecological Efficiency of the Study Alternatives).

Plans B and C, which include a solution for the bittern problem in Pond 7, are more ecologically efficient than the plans that do not include Pond 7 (including Plan A), since the Pond 7 bittern represents a risk to the existing and developing habitat created in the lower ponds.

The No Action Plan maintains existing habitats in the Napa Salt Marsh project area, but fails to restore valuable habitats that have suffered severe historic losses and which provide endangered species habitat. As this Alternative would create neither ecological losses nor ecological gains, it cannot be considered to be ecologically efficient or inefficient. Nonetheless, it represents a lost opportunity for improving environmental quality.

Overall Efficiency

In terms of average costs, Plan A (Ponds 4 through 6A) is most cost-efficient at producing habitat on the project site, with Plan B (Ponds 4 through 6A, Ponds 7, 7A, 8, Neighboring Waters) and Plan C (Ponds 4 through 6A, Ponds 7, 7A, 8, Recycled Water Pipeline) being efficient for their level of output.

5.2.2.4 Acceptability

Acceptability is assessed as the workability and viability of the Alternative Plans with respect to acceptance by State and local entities, as well as the public, and compatibility with existing laws, regulations, and public policies:

- Alternative 1 (No Action Plan) - Not acceptable to any Federal or State agency involved in the project.
- Plan A – Not acceptable to non-Federal sponsor because it does not include a solution to the bittern problem in Pond 7.
- Plan B – Acceptable to the non-Federal sponsor, local agencies, and the resources agencies.
- Plan C – Acceptable to the non-Federal sponsor, local agencies, and the resources agencies.

5.2.3 Designation of an NER Plan

From the results of the Final CE/ICA, and considering the Associated Evaluation Criteria, Plan B (Ponds 4 through 6A, Ponds 7, 7A, 8, Neighboring Waters) was designated as the NER Plan.

5.3 Plan Selection

In the final step of the Corps's six-step planning process, Plan B (Ponds 4 through 6A, Ponds 7, 7A, 8, Neighboring Waters) was selected as the Recommended Plan because it best addresses the study objectives. It is a best buy plan, would create a balanced mix of tidal marsh and pond habitat, would address the bittern problem in Pond 7, and would also satisfy the other evaluation criteria of completeness, effectiveness, efficiency, and acceptability.

6.0 THE RECOMMENDED PLAN

This chapter provides additional detail regarding the features, costs, and benefits of the Recommended Plan, Plan B (Ponds 4 through 6, Ponds 7, 7A, 8, Neighboring Waters). It also summarizes the environmental compliance requirements and risk and uncertainty associated with the Plan.

6.1 General

The Recommended Plan would involve salinity reduction in Ponds 4, 5, 6, and 6A, via discharges to the Napa River, and bittern removal/salinity reduction in Ponds 7, 7A, and 8, via a discharge to Napa Slough. Water control structures would connect Ponds 4, 5, 6, and 6A, and discharge to Napa River would occur via a breach of the Pond 4 levee. The Recommended Plan would use a combination of natural water sources to achieve the required pre-discharge dilution in the Upper and Lower Ponds– seasonal rainfall and Neighboring Waters (Napa Slough and Mud Slough).

The Recommended Plan would create a mix of tidal and pond habitats by restoring Ponds 4 and 5 to tidal action and retaining Ponds 6, 6A, 7, 7A, and 8 as managed ponds. It is anticipated that Ponds 4 and 5 would be restored to tidal action within two to five years, depending on the rate of habitat evolution in Pond 3. Habitat evolution would be adaptively managed in Ponds 6 and 6A, with the possibility of opening these ponds to tidal action in the future, under a separate project initiated by the non-Federal sponsor. The Recommended Plan would rely on natural sediment processes for the majority of the restoration area, and on natural colonization by marsh vegetation.

Pond 4 is expected to become tidal marsh within approximately 40 years. Habitat evolution in Pond 5 would be somewhat slower than Pond 4, because it is further removed from the sediment supply. If Ponds 6 and 6A were opened to tidal action as part of the adaptive management of the area, they would be expected to become tidal marsh within approximately 100 years after start of construction (*Napa River Salt Marsh Restoration Habitat Restoration Preliminary Design; Phase 2 Stage 2 of the Hydrology and Geomorphology Assessment in Support of the Feasibility Study, November 2002*).

The Recommended Plan would not affect existing recreation activities. There would be no mitigation measures required for the Recommended Plan, with the exception of measures taken to minimize or avoid disturbance to sensitive habitat areas, such as scheduling construction activities to avoid work in sensitive areas during nesting seasons and monitoring before, during, and after construction.

6.2 Plan Description

The Plan's main features are described below. Additional detail regarding project features is provided in Chapter 4 (Plan Formulation) and in the DEIS/R. Additional information on the design of the Measures, including quantity estimates, costs, and construction methods, is presented in the Engineering Appendix (Appendix D) and in the MCACES (Appendix F).

6.2.1 Site Preparation

Site preparation would involve pre-construction surveys of the project area and installation of warning signs around the construction area. Pre-construction surveys, described in Section 6.3.5 and in the Monitoring and Adaptive Management Plan (Appendix G), would be completed for biological resources and cultural resources, as well as to establish baseline conditions for the monitoring effort.

Construction equipment would be transported to the needed location via levee tops and/or barges. Where necessary, cofferdams would be constructed using sheet piles on the pond and river/slough side of the levee. The inner areas of the cofferdam would be dewatered during construction.

There are PG&E transmission towers that would require reinforcement. This work is considered to be a relocation activity, not a construction item.

6.2.2 Installation of Water Control Structures

The Recommended Plan would use a combination of water conveyance and control structures including intakes, fish screens (if required by permit conditions), outfalls, diffusers, siphons, mixing chambers, and levee breaches. This section briefly describes these project features and how they would be constructed. Additional Details of the project design are presented in Appendix D (Engineering Appendix).

6.2.2.1 Intake Structures

Intake structures would consist of a pipe or series of pipes penetrating a levee, and would convey water from the Napa River and neighboring sloughs into ponds during high tide. Pipes would be made of high-density polyethylene (HDPE) for ponds that would be retained as ponds in the long-term (Ponds 7, 7A, and 8), but might be constructed with a less chemically resistant material for intakes that would be removed soon after installation to allow habitat restoration to proceed (Pond 5) or as a result of adaptive management (Pond 6A).

Fish screens would be installed on the river/slough side of intakes to protect fishery resources, as required. As a conservative measure, the preliminary design included fish screens on all intakes for Ponds 5, 6A, and 7A. The existing intakes on Pond 8 are already equipped with fish screens.

6.2.2.2 Fish Screens

If required, some or all of the intake pipes would include a cone-shaped fish screen that rests on top of the inlet at the end of the pipe. The screens would be self-cleaning and powered by a solar panel system. The frequency of cleaning would be set manually to meet field conditions.

Screens would need to be very large in order to achieve acceptable approach velocities at peak flow. They would range in height from approximately five to six feet and diameter from 16 to 18 feet, depending on the size and location of the intake pipe.

6.2.2.3 Pond 4 Outfall Structures

Outfall structures would be constructed to discharge water from Pond 4 to the Napa River during low tide. Ponds 5, 6, and 6A would discharge via the outfall on Pond 4.

The Pond 4 outfall would run through the external levee and straight out into the receiving water. Discharge from Pond 6 would occur via a siphon to Pond 5 (Section 6.2.2.4. Siphons). A manual knife valve would be included on the outfall within the levee so that flow through the outfall and siphon can be controlled. The outfall would be constructed of a less-chemically resistant material than HDPE, as it is only expected to be required for a maximum of five years.

The end of each outfall pipe would include a diffuser to enhance the dilution of saline pond water into receiving waters. Because the Pond 4 outfall diffusers are anticipated to border the Napa navigational channel within the Napa River, they would be identified with appropriate signs and lighting. The outfall would be constructed in a similar fashion to the intakes.

6.2.2.4 Siphons

Siphons would be required to move water from one pond to another under sloughs. The Recommended Plan includes new or refurbished siphons in all locations where siphons would be used for salinity reduction or pond maintenance (Ponds 1 to 2, Pond 5 to 6, and Pond 8 to the canal north of Pond 8). All siphons would be installed with manually controlled knife valves (except the siphon associated with Pond 8, since Pond 8 would have flow controlled at the pond outlet).

6.2.2.5 Mixing Chamber

Currently, a round, levee-enclosed structure called a “donut” connects flows from Ponds 7, 7A, and 8. The existing donut structure would be used as a mixing chamber to dilute the highly saline bittern from Pond 7 with less saline water from Ponds 8 and 7A, and imported recycled water.

To enhance turbulent mixing of the high-density brine with other inflows (including the recycled water), new inlet structures from Ponds 7 and 7A would discharge into a new, 25-foot diameter inner mixing chamber. Existing inlets that convey water from Pond 8 would be extended to the inner mixing chamber. The mixed flow from the inner chamber would flow up and out of the inlets into the outer mixing chamber area. It would then flow through outlet structures to a canal and be discharged to the Napa Slough (and potentially to Pond 6A or the Pond 6/6A canal).

6.2.3 Decommissioning of Water Control Structures

Water control structures on Ponds 4 and 5 would be removed before habitat restoration is initiated. In addition, some existing facilities (e.g., unused siphons) might need to be decommissioned early on during project construction. Many of these facilities would be left in place and plugged, and some piping, some gates, and most valves would be salvaged. The salvage value of these structures is estimated to be roughly equivalent to the cost of removal. Therefore, the cost estimate assumed that there is zero cost (and zero value) associated with the decommissioning of water control structures.

6.2.4 Initial Levee Repairs

Prior to salinity reduction, initial levee repairs would be required to upgrade existing levees on ponds that would be retained as ponds in the short- or long-term following salinity reduction (Ponds 6, 6A, 7, 7A, and 8). Levee repairs would not occur for ponds that can be desalinated quickly and are subsequently opened to tidal action (Ponds 4 and 5).

The Recommended Plan includes 16,609 lineal feet of initial levee repairs. Required footages of levee repair are based on reports from the DFG, and on-site sediment would be used for levee repair.

6.2.5 Levee Breaching

Interior and exterior levee breaches would be created using explosives. Typically, explosives would be packed into polyvinyl chloride (PVC) tubes that are drilled into the levee, with the quantity of explosives adjusted in proportion to the volume of levee material. The blast would disperse the levee material over a wide area, so no soil movement would be required.

The flow of water through the levee and subsequent tidal action would then open the levee beyond the size of the initial breach, which would be sized to lead to a scoured breach approximately 50 feet wide. DFG staff has previously conducted several similar levee breaches at the site.

As part of the restoration process, "restoration breaches" would be created where starter channels meet exterior levees. Because most of these restoration breaches would experience less scouring action, additional widening may be required by removing sediment on the River or slough side to ensure adequate hydraulic connection between the starter channel inside the pond and the River or slough. Restoration breaches would include a 100-foot-wide levee breach and up to 100 feet of pilot channel external to the levee, 50-feet wide by 5-feet deep. These breaches would be constructed to mate with starter channels on the interior side of the levee.

6.2.6 Construction of Starter Channels and Berms

The Recommended Plan includes 22,000 lineal feet of starter channels and berms.
Starter channel dimensions would range from 50- to-100-feet wide and 4- to-8-feet deep, with channels becoming smaller as they move into the ponds. The channel cross section is trapezoidal with side slopes on the order of 5:1. One foot of channel length would require the removal of roughly 5 to 18 cubic yards of material, depending on the size of the channel.

A barge-mounted hydraulic suction dredge or clamshell excavator would be used to dredge the starter channels and construct berms on one side of the starter channels, using the excavated material.

6.2.7 Construction of Ditch Blocks

A total of 13 ditch blocks are included in the Recommended Plan. Construction of the ditch blocks would occur prior to opening the ponds to tidal action. The blocks would be constructed using land-based equipment and utilizing soil from the top of levees as fill material. An excavator would push the soil into the pond and slowly build the ditch block out from the levee into the pond.

6.2.8 Levee Lowering

The Recommended Plan includes 5,800 lineal feet of levee lowering. Sediment generated by levee lowering would be pushed into the borrow ditch and would narrow, but not block, the borrow ditch. This material would be used to create habitat in the immediate vicinity of the levee lowering.

Levee lowering would be performed after the ponds are open to tidal action in order to avoid the potential for an accidental pond breach. As with ditch block construction, levee lowering would be performed using land-based equipment. Front-end loaders would collect fill from the top of the levee and push it into the borrow ditch of the pond.

6.2.9 Use of Neighboring Water for Pond 7 Bittern Dilution

Design features associated with the use of Neighboring Waters for bittern reduction in Pond 7 are described in the Engineering Appendix (Appendix D).

6.2.9.1 Environmental Impacts of Neighboring Water

Environmental impacts are documented in the DEIS/R that accompany this Feasibility Report.

Negative impacts that might be caused by the pipeline are largely associated with construction activities and would be minimized by observing construction windows, surveys for sensitive species in the construction area, training of construction crews, and the use of specialized construction equipment and techniques.

6.2.10 Recreational Features

Recreational features are described in Section 4.10.2.4 (Additional Features of Action Alternative Plans).

6.3 Plan Costs

The Specifications and Cost Engineering Section, San Francisco District, developed the costs of the Recommended Plan. The study team identified the project elements required to complete the work. Cost estimates were based on April 2004 price levels. These costs were used in the CE/ICA presented in Section 5.2 (Plan Evaluation).

In April 2004, the Cost Engineering Section, San Francisco District, completed an MCACES for the Recommended Plan (Appendix F MCACES). The total project first cost would be approximately $55.1 million (Table 6.1. Cost Summary for Recommended Plan).

6.3.1 Interest During Construction (IDC)

The Corps has accounted for the opportunity cost of capital used during the construction phase of project implementation by calculating IDC, which is used to determine the total investment costs of a project. Project costs would include: Construction; LERRDS; Engineering and Design; Supervision and Administration; and contingencies. The IDC was calculated using the present Federal Discount Rate of 5.625 percent (FY ‘04), was compounded quarterly, and was only applied after benefits began to accrue (after a 6-month period). The remaining construction and monitoring costs were not included in the IDC calculations. However, as noted earlier, the ICA was run using a variety of IDC assumptions, and consistently yields the same results.

6.3.2 Lands, Easements, Relocations, Rights-of-Way and Disposal Sites (LERRDS)

The sponsor shall provide all lands, easements, rights of way, relocations and disposal sites (LERRDS) for the construction, operation, and maintenance of the Project. This responsibility is in accordance with the provisions of the terms of Water Resources Development Act of 1986 (WRDA 86). The DFG will sign the PCA as the non-Federal sponsor. The DFG owns fee title to the salt ponds and associated levees and fringing marsh.

The real estate requirements for this project are a total of 4534 acres. This includes all salt ponds and associated levees and fringing marsh in the project area, as well as all easements required to install the recycled water pipeline. The total value of these land rights has been estimated at approximately $4.5 million. The real estate requirements are described in more detail in the Real Estate Plan, Appendix H.

Table 6.1. Cost Summary for Recommended Plan

ITEM	COST		
	Ponds 4, 5, 6, 6A	Ponds 7, 7A, 8	Total
Construction and Real Estate			
Construction Costs	$13,429,535	$18,846,261	$32,275,796
Recreation Construction	$0	$1,455,623	$1,455,623
Real Estate Costs	$3,609,151	$924,750	$4,533,901
Contingency	$2,563,000	$4,060,377	$6,623,377
PED	$243,790	$243,790	$487,580
Construction Management	$4,477,496	$2,148,407	$6,625,903
Monitoring	$853,978	$722,664	$1,576,642
Adaptive Management Features	$1,238,440	$273,130	$1,511,570
TOTAL FIRST COST	$26,415,390	$28,675,002	$55,090,392
Interest During Construction	$3,963,620	$4,302,675	$8,266,295
Gross Investment	$30,379,010	$32,977,677	$63,356,687
Average Annual Costs	$1,827,297	$1,983,607	$3,810,905
OMRRR	$36,546	$39,672	$76,218
TOTAL AVERAGE ANNUAL COSTS	$1,863,843	$2,023,279	$3,887,123

There are no Public Law 91-646 relocations in this project. There are no utilities being affected by the project that are considered to be relocations as defined in WRDA 86.

6.3.3 Monitoring and Adaptive Management

After initial construction activities are complete, adaptive management and monitoring would be necessary to address uncertainties and ensure project success. Success criteria (Appendix G – Monitoring and Adaptive Management Plan) were defined based on specific hypotheses, which were formed based on the three project planning objectives (Section 4.1. Planning Objectives). Monitoring activities were identified to determine whether the project met these success criteria and adaptive management actions were designed to redirect the restoration effort in the event that the system does not evolve as predicted (Appendix G, Figure 2 – Adaptive Management Decision Matrix). Activities summarized in Monitoring and Adaptive Management Plan will be expanded on during the detailed design phase of the study, and will only include the activities and features associated with the ponds included in the Recommended Plan (Ponds 4, 5, 6, 6A, 7, 7A, and 8).

Construction and post-construction monitoring and adaptive management would be cost-shared 65/35 with the non-Federal sponsor.

6.3.3.1 Construction Phasing for Desalination and Habitat Restoration

Completion of construction would be determined on a pond-by-pond basis (Appendix G, Table 1 – Proposed Monitoring Schedule). For Ponds 4 and 5, construction would be complete after salinity reduction has occurred and the initial habitat restoration features have been constructed. Completion of construction for Ponds 4 and 5 is expected to occur in Project Years 5 or 6. For Ponds 6 and 6A, construction would be considered complete after salinity reduction has been accomplished, in Project Year 4. For Ponds 7, 7A and 8, construction would be limited to levee repairs and the installation of water control structures and is estimated to be completed in Project Year 1.

6.3.3.2 Monitoring and Adaptive Management Time Period and Process

Adaptive management refers to the actions taken to manage the ponds post-construction, and include constructed features such as levee lowering, levee breaches and starter channels. Adaptive management actions, outlined in Appendix G (Monitoring and Adaptive Management Plan), would be tailored to address the specific habitat goals of each pond.

Upon completion of construction in each pond, a period of monitoring and adaptive management would commence concurrent with routine OMRR&R (Section 6.3.4. Operation, Maintenance, Repairs, Rehabilitation, and Replacement (OMRR&R)). A ten-year post-construction monitoring and adaptive management period is proposed for the ponds undergoing desalination and habitat restoration (Ponds 4 and 5) and for Pond 7, the bittern pond. For Ponds 6, 6A, 7A and 8, the length of the post-construction monitoring and adaptive management period would be five years.

Monitoring of biological conditions, bathymetry, topography and water quality would provide the necessary information for adaptive management decision making. Adaptive management actions would be recommended based on a technical peer review of monitoring data collected in the field. Aerial and ground surveys would track the geophysical evolution of each pond opened to tidal action and assess the impact to the existing slough network and fringing marsh after breaching of the levees. The results of water quality monitoring would be used to track compliance with applicable surface water quality standards as required by the Clean Water Act. The results of biological surveys would be compared to geophysical and water quality data to determine the impacts to wildlife populations over the project life. Periodic comparisons of measured conditions with expected conditions, such as those predicted by the hydrologic model, would determine whether the development of the site is progressing as planned.

6.3.3.3 Pre-Construction Monitoring

In order to establish the base-line conditions in the ponds prior to desalination and habitat restoration, a site-wide survey would be conducted before the start of construction. The site-wide survey would include biological monitoring such as fish, avian, invertebrate and vegetation surveys as well as bathymetric surveys and water quality monitoring. All further monitoring information collected at the ponds during the project life would be compared to the base-line data as part of the adaptive management decision-making process. The results of the monitoring period determine if impacts are positive or negative. Perceived negative impacts to wildlife, vegetation or slower or degraded tidal marsh evolution in comparison to the base line would be addressed by specific adaptive management actions.

6.3.3.4 Monitoring During Construction

During the desalination process the discharge from the ponds to receiving waters would be monitored as required under Section 402 of the Clean Water Act. The combined discharge from the Upper Ponds 7, 7A and 8 to the Napa Slough may be monitored under the requirements of a Waste Discharge Requirements (WDR) order issued by the RWQCB. The salinity reduction discharge from the Pond 4 water control structure to the Napa River is not likely to need a Section 401 certificate and may also be monitored under the requirements of a WDR. The WDR may require both receiving water and pond water quality monitoring. The monitoring plan in the Monitoring and Adaptive Management plan includes monthly water quality indicator monitoring in the ponds for salinity, pH and dissolved oxygen both during construction and the post-construction adaptive management period. The results of receiving water and pond water quality indicator monitoring may be used to adjust discharge and input rates in the ponds in order to meet permit conditions and/or water quality standards.

6.3.3.5 Determination of Habitat Outcomes for Ponds 6 and 6A

An analysis of the results of the final site-wide monitoring survey to be conducted in Year 13 of the project would be used to determine the long-term habitat outcome for Ponds 6 and 6A. The analysis would look at the over-all success of the tidal marsh restoration in Ponds 3, 4 and 5 as well as the habitat values associated with managed ponds versus tidal ponds. The assessment of habitat values would be based on a review of biological monitoring data. Depending on the results at Year 13 and the success or failure of habitat restoration in the tidal ponds, Ponds 6 and 6A might be retained as ponds or might be opened to tidal action ten to twenty years after the start of construction (under a separate project most likely done by the non-Federal sponsor without the Corps).

The determination of whether to open these ponds to tidal action would be made based on the following general criteria:

- The availability of sufficient, high-quality waterfowl and shorebird habitat in the NSMWA, including open-water habitat within the Napa River Unit (Ponds 1, 1A, 2, 7, 7A, and 8) and at nearby existing or restored sites;
- The success of tidal marsh restoration in Ponds 3, 4, and 5. Success would be determined by percentage of marsh vegetation cover;
- The availability of funding for the operation and maintenance of Ponds 6 and 6A as managed ponds. Funds would be needed to maintain levees and water control structures, and to operate the water control structures; and
- The physical feasibility of managing the ponds as ponds (i.e., is it possible to achieve sufficient water exchange on demand to maintain the ponds within the desired salinity range and water height?).

These criteria would be refined as a result of data collected during the first ten to twenty years of the project.

6.3.3.6 Extended Period of Monitoring and Adaptive Management

Normally, Corps monitoring of a non-reservoir Corps project would end upon completion of construction. All further operations and maintenance, including monitoring of the project's structural integrity, would then be the responsibility of the non-Federal sponsor. An exception might be made for monitoring of mitigation plantings, which might extend for five years beyond the end of construction.

However, a typical five-year monitoring period would not be adequate to determine the outcome of this project. The evolution of Ponds 4 and 5 from open salt pond to stable tidal marsh capable of supporting vegetation is a process dependent on natural sedimentation. A twenty-year monitoring period would adequately assess the likely success of the project as twenty-five percent of the new tidal marsh habitat is predicted to be established by project Year 20. For Pond 7, the salinity reduction process is expected to take a minimum of thirty years to complete due to the high dilution ratio required.

A twenty-year monitoring period was adopted for the Sonoma Baylands Wetland Demonstration Project, which is within the same geographical area. However, the Sonoma Baylands project covers only 289 acres of diked baylands to be restored to tidal marsh. A twenty-year monitoring period is practicable for a Sonoma Baylands due to the accessibility of the site and small size of the project. These factors have a significant impact on monitoring costs for the Sonoma Baylands project, which are within the required 3% of project costs. The Napa Salt Marsh project is almost an order of magnitude greater in terms of acreage and most of the levees are only accessible by water. These factors have a significant impact on the costs for annual monitoring and adaptive management construction activities. Cost constraints make the development of a twenty-year adaptive management and monitoring plan for the Napa Salt Marsh Project impracticable.

In order to balance the constraints of total project costs versus the need to determine project success, a minimum post-construction adaptive management and monitoring period of ten years was established for Ponds 4, 5 and 7. According to the hydrologic model used to predict sediment deposition rates in the project area (PWA 2002), ten years would be the minimum time period necessary to determine if sediment deposition is stable within the ponds opened to tidal action. Active monitoring of wildlife, vegetation and physical geomorphology within the ten-year period would establish whether the evolution of tidal marsh habitat is progressing in comparison with the baselines established by restoration projects within the area. Within the ten-year period for the ponds opened to tidal action, adaptive management actions can be taken to address problems associated with high erosion rates, water quality impacts and re-suspension of sediment. Actions can also be taken within this ten-year period to address predators and invasive and exotic plant colonization.

A five-year adaptive management and monitoring period was established for the managed Ponds 6, 6A, 7A and 8. This five-year monitoring period is within established guidance and would address short-term impacts to water quality and habitat.

Short-term negative impacts for all ponds would be identified by the collection and assessment of field data and would be addressed by either operational or constructed adaptive management measures. Continued monitoring after the five-and ten-year adaptive management and monitoring period for each pond would be the responsibility of the non-Federal sponsor.

As a component of their OMRR&R duties, the non-Federal sponsor would assume sole (i.e., non cost-shared) responsibility for operation and maintenance of each pond during and beyond the respective five or ten-year monitoring and adaptive management period. The non-Federal sponsor would be responsible for levee repair and maintenance as well as the operation, repair and maintenance of water control structures, siphons and conveyance ditches. Routine inspection and maintenance of levee repairs and water control structures post construction would not be considered to be part of monitoring and adaptive management and would be considered to be part of OMRR&R.

6.3.3.7 Monitoring and Adaptive Management Costs

The costs associated with monitoring and adaptive management for the project are outlined in Table 2 of the Monitoring and Adaptive Management Plan (Appendix G), and include the activities and estimated cost for all of the ponds studied. Monitoring and adaptive management under the Recommended Plan would include only those activities associated with Ponds 4 though 8.

Monitoring and adaptive management for the ponds included in the Recommended Plan is estimated to cost about $3.1 million during the ten-year monitoring and adaptive management period. Table 3 of the Monitoring and Adaptive Management Plan breaks out the monitoring costs associated with regulatory compliance. The costs for adaptive management actions are associated with construction activities such as levee lowering, breaches and starter channel construction. The total cost for adaptive management and monitoring is higher than the five percent of total project cost established under Corps policy. The percentage of total project costs for the combined monitoring and adaptive management program would be approximately 6%, of the project cost.

The District recommends establishing a five-year, cost-shared monitoring and adaptive management time period for Ponds 6, 6A, 7A and 8 and a ten-year, cost-shared monitoring period for Ponds 4, 5 and 7. As the project relies heavily on natural processes to complete desalination and restoration, a robust program of post-construction adaptive management and monitoring is recommended in order to optimize restoration and address possible adverse impacts.

If an adaptive management construction need is identified during the adaptive management period, the activity will be cost shared regardless of the appropriation situation and regardless of when it is constructed; the non-Federal sponsor would expect reimbursement for building these features without Federal funds if appropriations do not keep up with funding needs. If the need is identified after the adaptive management period, then the non-Federal sponsor would be responsible for the costs.

6.3.4 Operation, Maintenance, Repairs, Rehabilitation, and Replacement (OMRR&R)

Upon completion of construction at each of the ponds, and concurrent with the monitoring and adaptive management period, routine operation and maintenance would commence. Routine operation and maintenance would include operating water control structures on managed ponds, levee inspections, repairs, and removal of invasive exotic vegetation such as *Spartina*, where feasible, and operation and maintenance of the pipeline. The costs associated with OMRR&R would be the responsibility of the non-Federal sponsor.

The combined discharge from Ponds 7, 7A and 8 will be regulated under a WDR. This requirement may run for up to thirty years due to the high dilution rate needed for the bittern. Permit monitoring that exceeds the ten-year adaptive management period would be considered to be routine operation and maintenance and would be the responsibility of the non-Federal sponsor. Details on the non-Federal sponsor's ability to pay for OMRR&R are provided in Section 7.4 (Views and Financial Capability of the Sponsor).

6.4 Significance of Project Benefits

Benefits associated with the Recommended Plan were also presented in Section 5.1.1 (Summary of Alternative Benefits).

Plan B (Ponds 4, 5, 6, 6A and Ponds 7, 7A, 8, Neighboring Waters) has been chosen as the Recommended Plan because it would best meet the study purposes and the study goal. Plan B would provide a balanced mix of habitats in the long term. Habitat benefits for the Recommended Plan would be associated both with an improvement in pond habitat for ponds retained as ponds, and with creation of tidal habitat in other areas of the site.

The San Francisco Estuary (San Francisco, San Pablo, and Suisun Bays, plus the Sacramento-San Joaquin Delta) is a nationally significant estuary and is the largest estuary on the Pacific Coast of the contiguous 48 states (*Baylands Ecosystem Habitat Goals, San Francisco Bay Area Wetland Ecosystem Goals Project, March 1999*). Reasons for the importance of this estuary include:

- It had the largest amount of contiguous tidal marsh habitat on the Pacific Coast prior to reclamation of most of these marshes.
- It is a critical stop for birds on the Pacific Flyway and is one of the most important wintering areas for migratory waterfowl on this flyway.
- It has one of the largest concentration of shorebirds on the Pacific Flyway, and more shorebirds winter here than in any other location in California (U.S. Fish and Wildlife Service, 1992)
- The importance of this estuary was recognized in 1987 by the establishment of the San Francisco Estuary Project, a five-year study by the EPA and other agencies to describe the estuary's resources and create a comprehensive management plan.
- In 1990, the San Francisco Estuary was determined to be a site of "hemispheric importance" by the Western Hemisphere Shorebirds Reserves Network.
- The estuary drains 40% of California and functions as a sump for the Central Valley, the largest and most productive agricultural region in the western U.S., as well as for the San Francisco-Oakland-San Jose metropolitan area, the fifth-largest metropolitan area in the US. Marshes in the estuary improve its water quality, which is important given the non-point pollution sources in the watershed.

The Napa-Sonoma Marsh, a part of this estuary, has a high concentration of endangered and threatened species, most of which would benefit from this project. At least nine Federally-listed and State-listed species would benefit, including:

Mammal:
Salt marsh harvest mouse

Birds:
California clapper rail
black rail

Fish:
Delta smelt
Sacramento splittail
Sacramento River winter-run chinook salmon
Sacramento River spring-run chinook salmon
Central Valley steelhead trout
Central California coast steelhead trout

In particular, two Federally listed endangered species that are entirely dependent on salt marsh habitat, the salt marsh harvest mouse and the clapper rail, can only be moved towards recovery through creation of much more salt marsh. These two species are of very high public and regulatory concern. This project would substantially increase the amount of habitat for these species in the San Pablo Bay area.

Habitat benefits from this project can only be created in an estuarine environment. Sites for tidal marsh restoration on the San Francisco Estuary are severely constrained by extensive development, private ownership, and past subsidence of diked and reclaimed lands, which make restoration very expensive and time-consuming.

6.5 Environmental Requirements and Commitments

6.5.1 Water Resources Council Environmental Requirements

The sections below summarize the Recommended Plan compliance with the Water Resources Council environmental requirements.

6.5.1.1 NEPA Compliance

The project has been assessed through the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) processes. The environmental impacts of the Recommended Plan and other Alternatives are assessed in the Draft Environmental Impact Statement/Report (DEIS/R). The project has been designed to avoid significant impacts during construction or operation.

6.5.1.2 Clean Water Act

A preliminary Section 404(b)(1) report has been prepared to assess impacts to wetlands and waters of the United States and is included as an appendix to the DEIS/R. The Corps and the non-Federal sponsor is seeking Section 401 certification and will receive a WDR order from the RWQCB.

6.5.1.3 Fish and Wildlife Coordination

USFWS provided a Planning Aid Report for the Project in 1997 (Appendix B). USFWS also provided a Draft Coordination Act Report (DCAR (Appendix A)) in September 2002. The Final Coordination Act Report (CAR) is expected in Fall 2003.

6.5.1.4 Endangered Species Act

The Endangered Species Act (ESA) requires Federal agencies whose action may affect endangered species to go through a specified consultation process. Consultation with the USFWS and NFMS was formally initiated in July 2002. The Corps requested a list of proposed, threatened, and endangered species that may be present at the project site from the USFWS at that time. USFWS provided the most recent species list in August 2002.

A Biological Assessment (BA) was prepared by the Corps and submitted to USFWS in December 2002 (Jones and Stokes, December 2002). The BA analyzed the effect of the project on listed species that may be present in the project area, including California clapper rail, snowy plover, and salt marsh harvest mouse, and soft birds's beak.

After review of the BA, the USFWS issued a BO and NMFS issued a Letter of No Effect. Both documents are included in the Final EIR/EIS.

6.5.1.5 Coastal Zone Management Act

Prior to completion of PED, a Consistency Determination would be prepared. The responsible Coastal Zone Management Act (CZMA) agency is the San Francisco Bay Conservation and Development Commission (BCDC).

6.5.1.6 Cultural Resources Compliance

Upon completion of the inventory and evaluation of cultural resources within the project's Area of Potential Effect (APE) the Corps proceeded in accordance with implementing regulations of Section 106 of the National Historic Preservation Act (36 CFR Part 800), and requested the State Historic Preservation Office (SHPO) to review and comment on the study's findings.

The San Francisco District and the non-Federal sponsor performed a series of cultural resources investigations during the Feasibility Phase. The non-Federal sponsor contracted with Jones and Stokes Associates to conduct an inventory and evaluation of cultural resources within the project's APE. The results of the investigations are published in the Draft DEIS/R.

The other cultural resources studies conducted during the Feasibility Phase were: (1) consultation with cultural and historical interest groups and organizations, and (2) consultation with the State Historic Preservation Office (SHPO) and the Advisory Council on Historic Preservation (ACHP) who must be allowed to comment on the proposed actions.

In accordance with implementing regulations of Section 106 of the Historic Preservation Act (36 CFR Part 800), the Corps consulted with the SHPO, who reviewed and concurred with the cultural resources findings of non-eligibility of structures within the project area for the National Register of Historic Places.

A monitoring plan and plan of action in the event that cultural resources are inadvertently discovered during construction and agreement by consulting parties (e.g., Native Americans, non-Federal sponsor and other "interested parties") will satisfy the Corps responsibilities under Section 106 800.13.

6.5.1.7 Resources of Principal National Significance

Table 6.2 summarizes the effects of the Recommended Plan on Resources of Principal National Significance.

Table 6.2 Summary of Effects on Resources of Principal National Significance

Resource	Source of National Recognition	Description of Effects
Air Quality	Clean Air Act	Temporary Construction Impacts
Sensitive coastal zone areas	Coastal Zone Management	Creates new tidal areas
Endangered and threatened species	Endangered Species Act	Increases habitat for various special status species
Fish and Wildlife	Fish and Wildlife Coordination Act	Increases Habitat for Wetland Species
Floodplains	Watershed Protection Flood Control Act	None
Historic and Archeological properties	National Historic Preservation Act	None
Prime and unique farmland	Land and Water Conservation Fund Act	None in Project Area
Water Quality	Clean Water Act	Short-term: Temporary construction impact Long-term: Local improvement in water quality
Wetlands	Executive Order 11990 - Protection of Wetlands	Increase in tidal wetlands
Wild and scenic rivers	Wild and Scenic Rivers Act	None in Project Area

6.5.2 Environmental Commitments

The following environmental commitments are included in the Recommended Plan:

- The Corps has prepared a Clean Water Act Section 404(b)(1) Evaluation (See Draft DEIS/R). In addition, the sponsor would obtain California State Water Quality Certification after Plans and Specifications are completed and before the construction contract is awarded.
- Threatened and endangered species would be protected during construction, consistent with ESA requirements. This might include the use of fish screens for certain intakes.
- Pre-construction surveys would be conducted to ensure that sensitive species are protected.
- Contractors would use Air Quality Best Management Practices to minimize emissions during construction.
- On-going monitoring of water quality would be conducted as required by the RWQCB permit.

- Contractor(s) would prepare Storm Water Pollution Protection Plan for construction activities.

6.6 Risk and Uncertainty

6.6.1 Uncertainty in Projections

There would be both risks and uncertainties associated with the Recommended Plan. These would be addressed through adaptive management, as described in Section 6.3.3 (Monitoring and Adaptive Management). The main risk associated with the Plan would be the potential for breaching levees unintentionally as the sloughs start to scour. Because ponds would be opened to tidal action sequentially, rather than all at once, scour of the sloughs would be tracked during the project to minimize this potential risk. If necessary, levees could be repaired or armored to ensure that they remain intact for as long as they are needed.

6.6.1.1 Rate of Habitat Evolution

Uncertainties would be primarily associated with the large area of the site, the available sediment supply, rate of sediment deposition, the rate of habitat evolution, and impacts of adjacent and nearby projects. The proposed project would be the largest tidal wetland restoration project ever implemented on the West Coast. Consequently, information regarding the behavior of the system has to be extrapolated from information gathered from smaller projects. The extrapolated information might not fully predict how quickly vegetation would establish or reflect the variation in habitat formation rates across the larger ponds.

The available sediment supply and rate of sediment deposition would control how quickly the ponds opened to tidal action would evolve into tidal marsh. However, the interim evolution of subtidal areas and tidal mudflats would provide valuable habitat for species in the area. Thus the rate of tidal marsh formation, while somewhat difficult to predict, would not be the only determinant of the overall success of the project. Similarly, the habitat mix at the end of the project may be somewhat different than projected, but would nonetheless provide valuable habitat for a wide range of species and enhance the ecological health and productivity of San Francisco Bay.

Adaptive management measures, such as increasing the lengths of starter channels and associated berms, increasing the extent of levee lowering, or creating higher elevation areas through imported sediment would be used to accelerate habitat formation if the rate of tidal marsh formation is deemed to be too slow.

6.6.1.2 Impacts of Adjacent and Nearby Projects

Adjacent and nearby projects such as the Cullinan Ranch and Skaggs Island might reduce the available sediment supply and increase the tidal prism in the Napa Salt Marsh Project area. These uncertainties would be addressed through adaptive management (in the event that the rate of tidal marsh evolution is slower than expected).

6.6.2 Pre-construction Engineering and Design (PED) Studies

Several potential value-engineering initiatives were identified during the Feasibility Study and might be further examined during PED.

6.6.2.1 Construction Material for Water Control Structures

The cost estimate for all water control structures included materials (high-density polyethylene (HDPE) and stainless steel) that are highly resistant to chemicals. Less resistant materials would be appropriate for water control structures that are only required for a short period of time (at Ponds 4 and 5, and potentially at Ponds 6 and 6A) and might be substituted for the highly resistant materials in the PED cost estimate.

6.6.2.2 Alternative Construction Equipment for Levee Repair

Cost estimates for initial levee repairs assumed the use of hydraulic excavators and front-end loaders. Another potential cost-saving measure (applicable to both salinity reduction and habitat restoration) would be to lease, construct, or purchase a shallow-draft dredge to conduct levee repairs and maintenance. Further study would be required to determine whether the regulatory agencies would permit the use of such equipment in the project area.

6.6.2.3 Reducing Habitat Restoration Costs

Habitat restoration costs might be lowered by: 1) reducing the length and number of starter channels, or 2) reducing the cost of starter channel construction. The PED study would include an adaptive management approach to starter channel construction. The placement and extent of starter channels in Ponds 4 and 5 would be based on the success of these measures in Pond 3 (whose restoration will be undertaken separately by the non-Federal sponsor).

The proposed construction method for starter channels (barge-mounted equipment) is approximately twice as costly as land-based or dynamic excavation. These alternate methods would be reexamined in detail during PED to assess whether they would be feasible for the project.

7.0 PLAN IMPLEMENTATION

This chapter presents the requirements for implementing the Recommended Plan, including Federal and non-Federal cost sharing, and the division of responsibilities between the Federal Government and the non-Federal Sponsor, the State of California (DFG).

7.1 Construction Schedule

The schedule for project implementation assumes authorization in WRDA ‘04. After project authorization, the project would be eligible for construction funding in FY ‘05. The project would be considered for inclusion in the President's budget based on national priorities, magnitude of the Federal commitment, economic and environmental feasibility, level of local support, willingness of the non-Federal sponsor to fund its share of the project cost and budgetary constraints that may exist at the time of funding. Once Congress authorizes the project, the Corps and the non-Federal sponsor would enter into a Project Cooperation Agreement (PCA). This PCA would define the Federal and local responsibilities for implementing, operating, and maintaining the project, and is scheduled for execution in FY 2005. The construction schedule is summarized in Table 7.1 (PED and Construction Schedule).

Table 7.1 PED and Construction Schedule

Project Phase	Start Date	Finish Date
PED and Initial Contracting of Construction	Fall 2004	March 2006
Phase 1 Construction (Initial Levee Repairs, Installation of Water Control Structures, Salinity Reduction in Ponds 4 and 5, Acquisition of Pipeline Real Estates, Installation of Water Control Structures at Ponds 6, 6A, 7, 7A, and 8, Begin Salinity Reduction in Ponds 7, 7A, and 8)	April 2006	March 2007
Phase 2 Construction (Breaching of Ponds 4 and 5 for Habitat Restoration, Installation of Habitat Restoration Components at Ponds 4 and 5, Conduct Salinity Reduction in Ponds 6 and 6A, Complete Salinity Reduction in Ponds 7A and 8)	April 2007	March 2009
Phase 3 Monitoring and Adaptive Management; O&M (Adaptive Management of Breached Ponds, On-Going Salinity Reduction in Pond 7 [O&M])	April 2010	March 2019
Phase 4 O&M (Complete Salinity Reduction in Pond 7)	April 2020	March 2035
Phase 5 O&M (non-Federal sponsor O&M)	April 2035	No end date

7.2 Funding Requirements

Table 7.2 presents the Federal and non-Federal funding requirements.

Table 7-2. Funding Requirements

Item	Federal Share	Non-Federal Share	Total Federal and Non-Federal
PED	$317,000	$171,000	**$488,000**
LERRDS	$0	$4,534,000	**$4,534,000**
Construction & Associated costs	$32,350,000	$12,884,000	**$45,234,000**
Recreation	$874,000	$874,000	**$1,747,000**
Monitoring, cost-shared	$1,025,000	$552,000	**$1,577,000**
Adaptive Management, cost-shared	$983,000	$529,000	**$1,512,000**
TOTAL	**$35,549,000**	**$19,544,000**	**$55,092,000**

7.3 Division of Plan Responsibilities

7.3.1 Federal Responsibilities

The Federal Government would provide 65% of the First Cost of implementing the Recommended Plan including pre-construction Planning, Engineering and Design (PED), construction and construction management, monitoring, and adaptive management. The Federal Government would pay for 50% of the Recreation costs (approximately $1.7 million, including contingency). The total Federal share of these costs is estimated to total $35.5 million. In addition to its financial responsibility, the Federal Government would:

- Design and prepare plans and specifications for construction of the Recommended Plan; and
- Administer and manage contracts for construction and supervision of the project after authorization, funding and execution of a PCA with the State of California (DFG).

7.3.2 Non-Federal Responsibilities

The State of California would be responsible for providing 35% of the First Cost of implementing the Recommended Plan, not including Recreation. Recreation features would be cost shared 50/50 with the Federal Government. The non-Federal share of the project cost includes the State of California responsibility for providing all LERRDS. The estimated cost to the non-Federal sponsor is $19.5 million, including $4.5 million in LERRDS credit. Additional non-Federal Responsibilities are listed in Chapter 8 (Conclusions and Recommendations).

7.4 Views and Financial Capability of the Non-Federal Sponsor

The objective of this analysis is to conduct an initial financial assessment of the non-Federal sponsor for the Napa River Salt Marsh Restoration Project. This initial assessment is intended to demonstrate that the cost-sharing partner, DFG, has successfully met its financial commitments in the past, has a variety of funding sources available to it, and has the capacity to ensure that the non-Federal portion of the project funds would be available.

7.4.1 Current versus Post-Implementation Operations and Maintenance Needs

The project OMRR&R responsibilities are expected to cost significantly less than the cost to maintain the current levee system and the current water control structures, and therefore DFG is expected to have no problem operating and maintaining the project, post-construction.

To effectively maintain the existing system without the project, DFG would have to: 1) replace existing deteriorated water control structures, 2) install additional water control structures, and 3) conduct extensive levee repairs. Since obtaining the ponds in 1994, DFG has not been able to fully meet management needs of the project area due to funding constraints and has therefore had to balance water-related funding needs (cost of electricity to pump water, maintenance, repair, and/or improvement of water control structures, and operations of water control structures) with levee-repair needs.

Project implementation would eliminate the three construction needs outlined above, for the Ponds 4, 5, 6, 6A, 7, 7A, and 8. In addition, DFG has taken steps to reduce its reliance on electricity by recently installing additional intakes on Pond 8, reducing the need and associated costs for pumping water to the Upper Ponds.

Levee Repairs and Maintenance. Levee maintenance is estimated to cost approximately $12.66/linear foot (Brown and Caldwell, 2002). The maintain the current system, DFG would be required to conduct maintenance on approximately 24,600 linear feet of levees, of which 8,100 linear feet are land-accessible, and 16,500 linear feet are only accessible by water. Under the proposed project, DFG would be required to maintain a shorter length of levee, thereby reducing levee repair and maintenance costs.

Thus, by implementing the project, the annual O&M costs would drop compared to levels that would currently be required; in addition, capital costs would be cost-shared, and opening ponds to tidal action would reduce capital cost substantially compared to what would be required to maintain all the ponds as ponds. DFG is capable of maintaining the system once it has been modified through the establishment of tidal marsh and levee an infrastructure repairs to managed ponds; however DFG's current budget does not allow for both maintenance at the currently required level and capital improvements.

7.4.2 Prior Cooperation with the Corps

The DFG has successfully cooperated with the Corps on several previous occasions. The financial obligation of the sponsor with regard to these projects has been met in a timely and comprehensive manner. The DFG has also met all of its financial obligations with regard to cost sharing the present Feasibility Study. The successful participation and financial performance of the non-Federal sponsor in these and other non-Corps projects indicates the non-Federal sponsor's good faith effort to meet its financial obligations.

7.4.3 Funding Sources

7.4.3.1 DFG Funding Sources

DFG's operation and programs are funded through a variety of sources. Its fiscal year (July 1, 2002 to June 30, 2003) budget is approximately $253 million. The budget is financed primarily through the State of California's General Fund, the DFG preservation fund (sale of hunting and fishing licenses), and other legislated special funds. In addition, supplemental funding for specific projects can be obtained from a variety of alternative sources. In any given year, these funding sources can include the following revenue generating vehicles:

- CALFED: A State and Federal program to fund water resource and environmental conservation projects. In November 2002, the CALFED Ecosystem Restoration Program approved a grant application from the Conservancy for $4.5 million in State funds for implementation of the project.
- State Bond Measures: Several State park and water bond measures have recently passed, namely Proposition 12, Proposition 13, Proposition 40, and Proposition 50. These bond measures have included significant funds for the Conservancy, the State Water Quality Control Board, CALFED, the Wildlife Conservation Board (a branch of the California Department of Fish and Game), and other State agencies. These funds would be appropriated to the agencies by the State legislature over the next several years and could be directed towards the project.
- Habitat Conservation Fund: The Conservancy is legislatively mandated to receive funds accruing to the Habitat Conservation Fund and can make these funds available to the project.
- Federal Grants: The DFG recently received a $2 million grant under the North American Wetlands Conservation Act.
- Private Foundations and Individual Donations: The non-Federal sponsor applies for and receives grants from a variety of entities. One of the recent foundations committing funds to the DFG include Ducks Unlimited.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

Major conclusions of studies conducted to date are:

- The Recommended Plan would be economically feasible;
- The non-Federal sponsor would fully support the project. The non-Federal sponsor, DFG, purchased the Napa Salt Marsh project site in anticipation of implementing a habitat restoration project;
- The Financial Analysis completed for the Napa River Salt Marsh Restoration Project indicated that the non-Federal sponsor would be financially capable of participating in the Recommended Plan;
- The non-Federal sponsor fully understands the cost-sharing requirements for project construction and the responsibility for operation, maintenance, rehabilitation, replacement, and repair for the project; and
- The Recommended Plan would fully meet the Federal and non-Federal sponsor's ecosystem objectives.

8.2 Recommendations

In making the following recommendation herein, I have considered all significant aspects in the overall public interest, including environmental, social and economic effects, engineering feasibility, and regional needs.

I recommend that the wetland restoration project at the Napa River Unit of the Napa-Sonoma Marsh Wildlife Area, Napa, Sonoma, and Solano Counties, California, be authorized for implementation as a Federal project. I recommend that the modified project be authorized subject to cost sharing as required by Public Law 99-662, the Water Resources Development Act of 1986, as amended.

The total project implementation cost for the Napa Salt Marsh Restoration Project is the cost to design and construct the project. Total project implementation costs would be shared by the non-Federal sponsor and the Federal Construction General program.

The total project investment cost for the Napa River Salt Marsh Restoration Project is estimated to be $58.6 million, including escalation.

The total first project cost for the Napa Salt Marsh Restoration Project is $55.1 million under second quarter FY'04 prices; this figure would form the basis of cost sharing. The Federal share is currently estimated at $35.5 million. The non-Federal share is currently estimated to be $19.5 million. I recommend that the Corps participate in cost-shared monitoring and adaptive management that may be required to ensure the success of the project, as identified by the success criteria outlined within the Monitoring and Adaptive Management Plan.

My recommendation is subject to cost-sharing, financing, and other applicable requirements of Federal and State laws and policies, including Public Law 102-580, Section 204, the Water

Resources Development Act of 1992, and in accordance with the following requirements which the non-Federal sponsor shall agree to perform, prior to project implementation, the following items of local cooperation:

a. *Provide 35 percent of the separable project costs allocated to environmental restoration, 50 percent of the separate project costs allocated to recreation, as further specified below:*

   (1) Enter into an agreement that provides, prior to execution of a project cooperation agreement for the project, 25 percent of design costs for environmental restoration and recreation features and 100 percent of design costs allocated to the LPP that are in excess of the costs allocated to the NER;

   (2) Provide, during construction, any additional funds needed to cover the non-federal share of design costs;

   (3) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

   (4) Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

   (5) Provide, during construction, any additional costs as necessary to make its total contribution equal to 35 percent of the separable project costs allocated to environmental restoration and 50 percent of the separable project costs allocated to recreation;

b. *For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, including mitigation features, at no cost to the Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and any specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments thereto;*

c. *Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project;*

d. *Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;*

e. *Hold and save the Government free from all damages arising for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors;*

f. *Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs;*

g. *Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government;*

h. *Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project;*

i. *To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project and otherwise perform its obligations in a manner that will not cause liability to arise under CERCLA;*

j. *Prevent obstructions of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstruction or encroachments) which might reduce the level of protection it affords, hinder operation and maintenance, or interfere with its proper function, such as any new developments on project lands or the addition of facilities which would degrade the benefits of the project;*

k. *Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended (U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;*

l. *Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army", and all applicable Federal labor standards and requirements, including but not limited to 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a* et seq.*), the Contract Work Hours and Safety Standards Act(formerly 40 U.S.C. 327* et seq.*) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c* et seq.*);*

m. *Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with cost sharing provisions of the agreement;*

n. *Not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized by Federal law;*

o. *Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;*

p. *At its sole expense, obtain and provide all water necessary to implement, operate and maintain the project.*

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

____________________ ____

Date

Michael McCormick
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