California Regional Water Quality Control Board

San Francisco Bay Region

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Arnold Schwarzenegger
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Date: AUG 0 5 2004

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Mr. Robert Floerke
California Department of Fish & Game
P.O. Box 47
Yountville, CA 94599

NOTICE: Final Order and Self-Monitoring Program for Napa River Salt Marsh Restoration – Lower Ponds Project, Napa and Solano Counties

Dear Mr. Floerke:

Attached is a copy of Final Order No. R2-2004-0063 adopted by the Board on July 21, 2004. The requirements of this Order are effective starting on July 21, 2004.

You may contact Tobi Tyler at (510) 622-2431 or by email at tt@rb2.swrcb.ca.gov if you have any questions.

Sincerely,

Bruce H. Wolfe
Executive Officer

Attachments: Order No. R2-2004-0063

Cc:
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California Coastal Conservancy
1330 Broadway, 11th Floor
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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

ORDER NO. R2-2004-0063
WASTE DISCHARGE REQUIREMENTS WATER QUALITY CERTIFICATION FOR:

CALIFORNIA DEPARTMENT OF FISH & GAME

NAPA RIVER SALT MARSH – LOWER PONDS RESTORATION PROJECT, NAPA COUNTY AND SOLANO COUNTY

The California Regional Water Quality Control Board, San Francisco Bay Region, hereinafter Water Board, finds that:

1. This Order serves as Waste Discharge Requirements (WDRs) and water quality certification under Section 401 of the Clean Water Act for the first of two phases of the Napa River Salt Marsh Restoration Project (hereafter the Project). The California Department of Fish and Game owns and manages the Project area and is, hereinafter, referred to as the Discharger.

2. There are two other public agencies that are involved in cost sharing and assisting the Discharger with the Project. The California State Coastal Conservancy (CSCC) is sponsoring (cost-sharing) the Feasibility and the Pre-Construction Engineering and Design components of the Project. The Discharger, in addition to being the property owner, will be the non-Federal sponsor during the Construction and Operations and Maintenance components. The United States Army Corps of Engineers (USACE) will likely be the Federal sponsor during the initial ten years of the Project.

3. The Project site is immediately north of Highway 37 and west of the Napa River and encompasses portions of Napa and Solano Counties. The eastern edge of the Project area borders the Napa River approximately five to ten miles upstream from the confluence of the Napa River and Carquinez Strait. Napa Slough borders the western edge, South Slough and San Pablo Bay border the southern edge, and Southern Pacific railroad tracks border the northern edge of the Project. The Project area is within the Napa-Sonoma Marshes State Wildlife Area (NSMWA). (Figure 1)

4. This Order provides receiving water limits and discharge specifications, as well as monitoring and reporting requirements, to regulate salinity reduction and habitat restoration activities for this first phase of the Project, referred to as the Napa River Salt Marsh Lower Ponds Restoration Project (hereafter the Lower Ponds Project). The Water Board will take appropriate action at a future time to provide discharge authorization for the Upper Ponds Project.

Site History

5. The Project area was first diked off from San Pablo Bay during the 1850s for hay production and cattle grazing. Much of the land was converted to ponds for salt production in the 1950s. The final operator of the salt production facility, Cargill Salt, sold the property to the State of California in 1994. The State assigned ownership and management responsibilities to the Discharger. The primary goal of the Discharger's management since the acquisition of the salt ponds has been to prevent the progressive concentration of seawater constituents in the ponds, where annual evaporative water loss substantially exceeds annual water replacement by rainfall. The degree of success which the Discharger has achieved with their management effort has been constrained by the limited budget to run high output intake pumps, and by the limited means to maintain the large system of levees separating the ponds from the Napa River and adjoining sloughs. Difficulties in maintaining the ponds occasionally led to intermittent drying of some of the ponds, accompanied by sharp increases in salinity. Pond 2A was breached in January 1995 by the Discharger following serious threats to the levee system due to strong winds, high tide and heavy rainfall. The Discharger obtained verbal permission from the Water Board to proceed with the breach under emergency conditions. Pond 2A has since been restored to tidal marsh.

6. Pond 3 was breached on its northern levee (to South Slough) by unknown parties in August 2002. To relieve pressure on this breach and help stabilize the levee, a second breach was created on the Pond 3 southern levee (to Dutchman Slough) by the Discharger in September 2002. The breach to South Slough widened to approximately 75 feet by March 2003, and the salinity in Pond 3 since that time has not exceeded 15 parts per thousand (ppt) (similar to the adjacent Napa River). It appears that the salinity in Pond 3 will continue to track the salinity in the adjacent Napa River without further management inputs. In August 2002, the installation of intake pumps in the southern portion of Pond 8 was completed and the pumps were put into operation. The pumps bring in water from Mud Slough at rates varying from 20 to 80 cubic feet per second. The highest salinity measurement recorded in the year 2003 to date is 21 ppt (similar to the adjacent Napa River). The Discharger will use existing, re-constructed, and new intake siphons to maintain Pond 8 near ambient Napa River salinity through the managed salinity reduction period, supplementing siphon flows with the pumps on a contingency basis.

Napa River Salt Marsh Restoration Project

7. The Project proposes to restore 9,456 acres of the NSMWA to a mixture of tidal marsh and freshwater ponds. The Project area includes 7,190 acres of shallow ponds that were used for production of salt by wind/solar evaporation between the 1950s and the early 1990s. The Project area also includes an additional 2,266 acres of fringing marsh and slough.

8. The Project consists of two primary components: habitat restoration and salinity reduction. Habitat restoration will consist of restoring tidal exchange and constructing starter channels and berms in some of the ponds so that tidal marsh habitat is obtained, and by upgrading

the remaining ponds to function as pond habitat. Salinity reduction would be accomplished by discharging accumulated pond water, after pre-dilution by blending of rainfall, to the Napa River (lower ponds) and to Napa Slough (upper ponds). The second phase of the Project (with a future amendment to this Order) may also include the use of tertiary-treated wastewater (recycled) water to reduce salinity and dilute the pond water prior to discharge.

9. A portion of the costs of the Project will most likely be Federally authorized and funded (65%), pursuant to the Water Resources Development Act of 2003. The State of California will fund the balance.

10. The Discharger applied to the Water Board on June 6, 2003 with a Report of Waste Discharge (ROWD) for WDRs and water quality certification under Section 401 of the Clean Water Act for the Project.

11. After review and consideration of the ROWD, Water Board staff elected to consider two separate phases for the Project. This Order is for the first phase of the Project, the Lower Ponds Project, which is described below. The Upper Ponds (Ponds 7, 7a, and 8) will be permitted separately in the future.

Lower Ponds Project

12. Nine of the former salt evaporator ponds located within the Project area are located south of Napa Slough (Ponds 1, 1A, 2, 2A, 3, 4, 5, 6, and 6A), and are collectively referred to as the Lower Ponds. (See Figure 2, Lower Ponds Project Site Map) Three of the former salt evaporator ponds located within the Project area (Ponds 7, 7A, and 8) are located north of Napa Slough, and are collectively referred to as the Upper Ponds.

13. The Lower Ponds Project includes salinity reduction and habitat restoration in Ponds 4, 5, 6, and 6A, habitat restoration monitoring in Pond 3, and infrastructure maintenance in all ponds. Ponds 1, 1A, 2, 2A, and 3 do not require salinity reduction because wildlife habitat restoration has been in progress for the past ten years for Ponds 1, 1A, 2, and 2A, and since August 2002 for Pond 3. Ponds 1, 1A, and 2 will continue to be maintained as managed pond or marsh habitat. Pond 2A will continue to be maintained as tidal marsh habitat and Pond 3 will be adaptively managed to achieve tidal marsh habitat. Ponds 4 and 5 will be breached and restored to tidal marsh habitat. Ponds 6 and 6A will initially be maintained as managed pond habitat, and may eventually be restored to tidal marsh habitat.

14. Without the Lower Ponds Project, salinity and other seawater constituents in Ponds 4, 5, 6, and 6A are expected to increase in concentration over time, creating a potential for negative impacts on surrounding waters and on wildlife in the area. Maintenance of the levees and ponds in their present hydraulic circulation configuration would be unduly burdensome and expensive to the present owner, the State of California. The Lower Ponds Project has identified an opportunity to create significant new wildlife habitat in the North San Pablo Bay area, while preventing the negative impacts expected from the "no project" alternative, by restoring tidal exchange between the Lower Ponds and the Napa River with an initial

controlled breach on the levee separating Pond 4 from the Napa River.

Project Description

15. The long term goal of the Lower Ponds Project is the creation of an array of self-sustaining habitats that can function with a minimum of management inputs, and provide increased habitat for a variety of fish and wildlife species. The existing condition and planned endpoint condition for each pond in the Lower Ponds Project area are shown in Table 1, below.

Table 1 – Existing Condition and Planned Endpoint for Ponds

Pond	Pond acreage	Levee acreage	Current pond habitat function and value	Future pond habitat function and value
1	371	12	Muted tidal, shallow-water pond	Muted tidal, shallow-water pond
1A	573	17	Muted tidal, shallow-water pond	Muted tidal, shallow-water pond
2	738	22	Managed deep-water pond	Managed deep-water pond
2A	525	19	Restored to tidal marsh	Restored to tidal marsh
3	1.255	29	Evolving into tidal marsh	Tidal marsh
4	907	27	Hypersaline managed pond	Tidal marsh
5	742	18	Hypersaline managed pond	Tidal marsh
6	721	16	Hypersaline managed pond	Muted tidal pond; possible conversion to tidal marsh after 10-20 years
6A	425	18	Hypersaline managed pond	Muted tidal pond; possible conversion to tidal marsh after 10-20 years

16. Construction activities associated with the salinity reduction breach on Pond 4 would be conducted over a one-year period. Construction activities associated with habitat restoration in the ponds that will be opened to tidal action would be conducted over approximately a three-year period. Maintenance of levees will be conducted on an as-needed basis throughout the 10-year life of the Lower Ponds Project.

17. The Lower Ponds Project would require the use of heavy equipment, including but not necessarily limited to land-based bucket excavators, barge-mounted clamshell excavators, barge mounted suction dredges, dozers, and front end loaders. Some of the excavations will be created using explosives. The activities proposed as part of the Lower Ponds Project include: the creation of a breach on the levee between Pond 4 and the Napa River to initiate salinity reduction in Ponds 4, 5, 6, and 6A; the re-distribution of sediment within the boundaries of the Lower Ponds Project area for purposes of levee maintenance and habitat restoration; and the installation or replacement of water control structures for purposes of habitat restoration and maintenance.

18. The major earthwork-related construction features of the Lower Ponds Project are

described below. The Lower Ponds Project would involve the excavation/placement of approximately 650,000 cubic yards of material. A detailed description of the proposed activities is provided in Attachment B. The major construction features are:

a. The initial breach on the Pond 4 levee for salinity reduction will involve the displacement of 15 to 30 cubic yards of soil. The breach may be created with explosives or construction equipment. Most of the displaced soil would be deposited on the levee adjacent to the breach.

b. Initial levee repair in Ponds 1, 1A, 2, 6, and 6A would involve the repair of approximately 42,800 linear feet of levee, and the excavation/placement of 120,000 cubic yards of soil. The required fill would be taken from the borrow ditches at the base of the levees. Approximately 50 acres would be impacted.

c. The construction of up to 27,500 linear feet of starter channels and adjacent berms in Ponds 3, 4 and 5 would involve the excavation/placement of as much as 275,000 cubic yards. The excavated soil from the starter channels would be deposited in non-continuous berms along one side of the channel. The footprint of the starter channels (cut) would be as much as 50 acres, and the footprint of the berms (fill) would be as much as 85 acres. The top elevation of the berms would be approximately equal to mean high high water (MHHW).

d. A total of 30 additional breaches (22 restoration breaches and 8 interior levee breaches) would be created after salinity reduction, for habitat restoration purposes. Where starter channels meet exterior levees, a 100-foot wide levee breach would be created and, in some locations, a pilot channel would be created on the river or slough side of the levee to ensure that adequate hydraulic connectivity develops between the starter channel inside the levee and the river or slough. The restoration breaches and pilot channels may be created with explosives. The construction of the restoration breaches, interior levee breaches, and pilot channels would involve the excavation of 67,400 cubic yards. The footprint of the excavations would be approximately 10 acres.

e. The construction of up to 22 ditch blocks in Ponds 3, 4, 5 would involve the placement of as much as 35,200 cubic yards. The soil would be taken from adjacent levee tops, which would be lowered as part of the habitat restoration plan. As much as 15 acres of levee would be lowered, and up to 4 acres of pond area would be filled.

f. Approximately 22,000 linear feet of levee would be lowered, in addition to the levees used as borrow areas for ditch block construction. Supplemental levee lowering would generate up to 150,000 cubic yards of fill. As much as 25 acres of levee would be lowered, and up to 23 acres of pond area would be filled.

g. Annual levee maintenance over the life of the Lower Ponds Project will involve the maintenance of 10,800 linear feet of levee per year, and the excavation/placement of

30,000 cubic yards of soil per year. The required fill would be taken from the borrow ditches at the base of the levees.

h. A water intake structure would be constructed between Napa Slough and Pond 6A. A water discharge structure would be constructed between Pond 2 and China Slough. The existing siphons between Ponds 1 and 2, and between Ponds 5 and 6, would be re-built. The existing pump station, which moves water from Pond 1 to Pond 2, may be re-built. Construction of water control structures may require the installation of sheet piling, de-watering, placement and compaction of granular pipe bedding material, and in some locations, pile driving.

19. These fill and dredge related features of the Lower Ponds Project are summarized in the following table:

Pond Number	Amount	Purpose	Method	Acres Impacted
4	15-30 cubic yards (cy)	Levee breach	Explosives	< 1 acre
1, 1A, 2, 6, 6A	42,800 linear ft (lf) and 120,000 cy (10,800 lf/yr and 30,000 cy/yr)	Levee repair &/or maint. (Annual levee maint.)	Excavator	50 acres
3, 4, 5	27,500 lf and 275,000 cy	Starter channel and berm construction	Excavator	135 acres
3, 4, 5, 6, 6A	67,400 cy	30 Habitat Restoration breaches	Explosives and excavator	10 acres
3, 4, 5	35,200 cy	Construction of 22 Ditch Blocks	Excavator	27 acres (Pond) 15 acres (levee)
3, 4, 5	145,500 cy	Levee lowering	Excavator	48 acres

20. The proposed construction activities in the Lower Ponds are described in detail in Attachment B – Project Description – Lower Ponds Restoration Project.

Beneficial Uses

21. The beneficial uses for the Napa River, as set forth in the Basin Plan include:
    a. Agricultural Supply
    b. Cold and Warm Freshwater Habitat
    c. Fish Migration and Spawning
    d. Navigation
    e. Preservation of Rare and Endangered Species
    f. Noncontact Water Recreation
    g. Wildlife Habitat

22. The Lower Ponds, after hydraulic modification to achieve salinity reduction, will be tributary to the Napa River at the location of the proposed initial breach on the Pond 4 levee. The Basin Plan does not explicitly identify beneficial uses for the waters of the Lower Ponds. However, the Basin Plan states that "beneficial uses of any specifically identified waterbody generally apply to all of its tributaries".

23. The water depths in the ponds generally range from three to four feet, which is too shallow for navigation. Navigation should not be considered a beneficial use of the former salt ponds.

24. The salinity in the Lower Napa River approaches 20 ppt in the dry season, and the lower ponds after salinity reduction are expected to be characterized by salinities similar to the adjacent Napa River. Brackish water is not suitable for irrigation of agricultural crops. Agricultural Supply should not be considered a beneficial use of the former salt ponds.

25. The beneficial uses for the former salt ponds in the Lower Ponds Project area include:
    a. Cold and Warm Freshwater Habitat
    b. Fish Migration and Spawning
    c. Preservation of Rare and Endangered Species
    d. Noncontact Water Recreation
    e. Wildlife Habitat

<u>Impacts and Mitigation</u>

26. The initial breach of the levee between Pond 4 and the Napa River would create a short duration salinity increase in the Napa River.

27. The short duration salinity increase in the Napa River is expected to be no more than 12 parts per thousand (ppt) along the center flowline of the Napa River, on a depth-averaged basis, after the initial breach of the levee between Pond 4 and the Napa River. The salinity increase will be greater near the west bank of the River, but will be less near the east bank. A salinity increase of 12 ppt is greater than the typical daily salinity variation at this location (5ppt), but less than the typical annual salinity variation (0 to 20 ppt). A salinity increase of this magnitude is likely to be tolerable, given the adaptability and mobility of the estuarine species present in the system. The initial breach will be timed to coincide with a high flow event, to ensure that the salinity in the receiving water is not raised above a level normally occurring during low flow months. The initial breach will be timed to coincide with a high water level in Pond 4, to ensure that the salinity of the water to be discharged is as close as possible to the salinity of the receiving water. The hydraulic model supporting this finding was presented in Philip Williams & Associates Memo #1591 dated December 2, 2002, *Napa River Salt Marsh Restoration Phase 2 Stage 2 – Salinity Reduction Modeling*, which is included in this Order as Attachment D.

28. The initial breach of the levee between Pond 4 and the Napa River would create a short duration increase in turbidity and suspended sediment in the Napa River. However, the

breach will be scheduled to occur during a winter storm event when the mouth of the Napa River is already turbid. Given an estimated initial dilution of 10:1 and the receiving water limitations contained in Section C.3. of this permit that must be met, the discharge will comply with the numeric water quality objective for turbidity in the Basin Plan.

29. The short duration increase in turbidity and suspended sediment in the Napa River is expected to be minor in comparison to the sediment flushes that occur in the Napa River during and after a significant rain event. In addition, levee breaching as the method for salinity reduction in the Lower Ponds represents the method that would minimize turbidity impacts. The alternative (construction of pipe outfall structures) would involve additional major construction events to install and later remove the pipes, which would engender additional generation of turbidity and suspended sediment.

30. The conditions characteristic of shallow wetlands may be conducive to the formation and accumulation of methyl mercury. The Water Board, Coastal Conservancy and the Discharger will coordinate efforts to seek funding opportunities for the development and implementation of monitoring for methyl mercury formation and accumulation in pond water and sediments. Alternative management practices will be developed and implemented if data that becomes available indicate that negative impacts from the accumulation of methyl mercury are likely.

31. Several special status wildlife species are known to be present within the Lower Pond Project area. Due to self-mitigation activities, construction activities will not have a significant impact on these populations, both through disturbance due to noise and vibration, and due to direct mortality.

32. Construction activities will be scheduled to avoid the nesting periods of the special status wildlife species, to the extent practical, in areas where actual habitat exists or where species are likely to occur. When construction is conducted during the nesting period of a special status species known to be present, the activities will be restricted to maintain a 150-foot buffer between heavy equipment and the existing nesting sites. Construction activities will be scheduled in such a way as to limit the period of disturbance in a particular area to as brief a time window as is practical.

33. As water is brought into Pond 6A from Napa Slough through the proposed intake structure between Napa Slough and Pond 6A, fish and other organisms may become entrained in the flow. Once in Pond 6A, the fish may be vulnerable to predation by native and non-native species, or may be unable to escape the ponds to complete their life pattern.

34. In a Biological Opinion (BO) dated June 3, 2003, U.S. Fish and Wildlife Service (USFWS) staff stated that a fish screen would not be required for the Pond 6A intake, because the Lower Ponds are projected to reach ambient salinity within two years, and because the Lower Ponds feature a partial flow-through design, allowing entrained fish the opportunity to exit Ponds 6 and 6A twice each day during high tides. In a BO dated June 30, 2003, National Marine Fisheries (NMFS) staff stated similarly that no fish screens on Pond 6A

were necessary to adequately protect fish.

35. The beneficial use for preservation of rare and endangered fish species could be impacted through acoustic impacts generated by pile driving to anchor fish screens and intake pipes, and by detonation of explosives to create pilot channels.

36. Blasting and pile driving will be conducted in late summer or early fall, when few fish species are present, and will be conducted at low tide, when fish will be furthest away from the disturbance.

37. During the early years of the evolution of the site into tidal marsh, the hydraulic connectivity between all parts of the marsh may be incomplete, presenting the potential for fish to become stranded within the ponds as the tide recedes.

38. Ditch blocks will be located in such as way as to not trap fish at low tide. Berms adjacent to starter channels will be constructed on one side of the channel only, and will be discontinuous, in order that fish have easy access to the starter channels as the tide recedes.

39. Impacts to beneficial uses would include the deposit of fill associated with construction of berms adjacent to starter channels, construction of ditch blocks, and supplemental levee lowering. As much as 85 acres would receive some depth of fill, when berms adjacent to starter channels were constructed in Ponds 3, 4, and 5. Because the berm top elevations would be approximately equal to MHHW, much of the berms would be submerged through a large part of the tidal cycle. A total of 4 acres of pond bottom would receive some depth of fill when 22 ditch blocks were constructed in Ponds 3, 4, and 5. The ditch block top elevations would also be approximately equal to MHHW. A total of 23 acres would receive some depth of fill when 22,000 linear feet of levee was lowered to promote habitat development. The total acreage to be filled, including areas that will be intermittently submerged, would be 112 acres.

40. The Water Board finds that the creation of 1,694 acres of tidal marsh (Ponds 4 and 5), and the creation of 1,180 additional acres of freshwater pond habitat (Ponds 6 and 6A), within 10 years of Project initiation is adequate compensation for the filling of up to 112 acres with intermittently submerged fill. To assure that the functions of neither the existing 2,266 acres of wetlands on site or the existing salt ponds for birds (as breeding, foraging, or resting habitat) will be permanently lost or impaired, long-term habitat monitoring is essential to the Project. Long-term habitat monitoring is also important in determining whether the restoration goals and objectives for the Project have been met. Therefore, Ponds 4 through 6A will be monitored according to the Monitoring and Adaptive Management Plan (MAMP), which is currently in draft form (see Attachment E) and has been approved by all regulatory agencies except USACE Headquarters in Washington DC. Since this is primarily a restoration project, strict performance criteria are not set but general targets and monitoring strategies are provided in Attachment E.

41. It is understood that the portion of the Project that is cost-shared by the USACE and the

Discharger must be implemented as authorized by Congress. The Project, if authorized by Congress, will include a final habitat MAMP for Ponds 4, 5, 6, 6a, 7, 7a, and 8 (Ponds 1 through 3 are not included since these ponds are either being maintained as managed ponds for birds or are already restored to tidal marsh). After initial construction activities are complete, adaptive management and monitoring will be necessary to address uncertainties and to ensure project success. Construction and post-construction monitoring and adaptive management will be cost-shared by the USACE and the Discharger. The requirements to perform the adaptive management and monitoring tasks for Ponds 4, 5, 6, 6a, 7, 7a, and 8 will be specified in the contractual construction agreement between the USACE and the Discharger (Project Cooperation Agreement, or PCA) prior to initiation of construction. (The Board will issue a permit for Ponds 7, 7a, and 8 at a later time.)

42. This Permit acknowledges that the USACE will require a habitat MAMP if Congress authorizes the Project. Thus, this Permit does not specifically include a requirement for implementing a habitat MAMP. Funding for the adaptive management and monitoring tasks will be considered to be a construction cost of the Project, and will be funded by Congress and the State of California on an annual basis after construction authorization is granted by Congress. Completion of these activities will be required before the USACE can fiscally close out the Project and formally turn the Project over to the Discharger for ongoing operation and maintenance. In the event that the USACE is unable to obtain authorization from Congress, the Water Board may issue an amendment to this Order. See Attachment E for a draft of the MAMP that will be finalized when and if Congress authorizes the Project.

43. As the full restoration of several of the ponds is expected to extend up to 50 years or more and the MAMP is proposed to continue for 10 years, the Discharger is required to submit a Long-Term Habitat Monitoring and Adaptive Management Plan for Ponds 4 through 6a at the end of USACE involvement in the restoration project.

44. The U.S. Geological Survey (USGS) has been awarded CALFED funding for habitat monitoring of Ponds 3 through 5 from November 2003 through November 2006. Since this study is the only habitat monitoring proposed for Pond 3, which has only recently been breached, the Discharger, with the assistance of the Coastal Conservancy and USGS, will continue to seek to develop additional opportunities for habitat evolution monitoring for Pond 3 (as well as Ponds 4 and 5) to the extent feasible. To that end, this Order requires the Discharger to submit a Long-Term Habitat Monitoring Plan for Pond 3 by June 30, 2005 for Executive Officer approval in order to ensure a consistency and continuity in long-term habitat monitoring for Pond 3. The Water Board encourages a continuation of the three-year USGS study funded by CALFED through at least year 10 that will look at biological, hydrological, and water quality in Ponds 3, 4, 5, 6, and 6A. The USGS Habitat Restoration Monitoring Plan is included in Attachment J.

45. A major hypothesis of this Project is that the depths and salinities of the ponds that are maintained as managed ponds (Ponds 1, 1A, and 2) will provide habitat for waterfowl and shorebirds. The USACE, which initially proposed to monitor these ponds for adaptive

management throughout most of the Project, has had to scale back its monitoring efforts to ponds that have not been previously breached. Since funding is limited for the Discharger, less habitat monitoring of these ponds is required than was originally anticipated. However, habitat monitoring is an integral part of the Project. The Water Board, therefore, encourages the Discharger, California Coastal Conservancy, CALFED, USGS, and USFWS to continue to seek funding to conduct biological surveys in these ponds in order to determine whether birds, fish, and invertebrate populations remain stable, increase, or decrease following adaptive management principles. A summary of past monitoring surveys on each of the ponds is included in Attachment K.

46. To determine whether sufficient managed pond habitat has been retained for shorebird and waterfowl use in the Napa Salt Pond Restoration System, bird use in Ponds 1, 1A, and 2 will be monitored at least once in midwinter by the Discharger using the same, or equivalent, protocols used by USGS to sample Ponds 1, 1A, and 2 monthly or bimonthly between 1999 and 2004. If funding is found for more surveys of these ponds, they will continue for adaptive management purposes and in order to determine whether the balance of tidal marsh and managed pond species is being maintained. The Water Board also encourages other studies on Ponds 1, 1A, and 2, including USGS trophic surveys, USFWS waterfowl surveys, Point Reyes Bird Observatory surveys, Audubon bird surveys, Christmas bird counts, or any other surveys that might determine if shorebirds and waterfowl are using the managed ponds.

47. Impacts to beneficial uses from non-native plant species are a significant problem within and around the San Francisco Bay. With diminishing State budgets and other constraints, the Discharger's management of the wetland restoration sites as large as this one is hampered by these constraints. Therefore, the Water Board encourages and supports the Discharger's efforts to collaborate and develop partnerships with volunteer-monitoring organizations in order that volunteers may be used for restoration and monitoring where deemed appropriate, such as removing non-native plant species (e.g.: non-native Cordgrass and non-native Peppergrass, Fennel, Mustard, Iceplant, Wild Radish, Russian Thistle and Bristly Ox-Tongue).

48. In order that wetlands experts and interested parties are given an opportunity to comment and provide input to how this restoration project is being adaptively managed, an advisory forum for information sharing and guidance suggesting is required in the provisions. A multi-agency team, scientific peer review panel, or Technical Advisory Committee (TAC) will be formed to review the various monitoring activities and provide guidance on any adaptive management strategies. Workshops at the Biannual Estuary Conference are also highly encouraged.

Basis for Effluent Limitations

49. The Basin Plan states that the salinity characteristics of the receiving water shall be considered in determining the applicable water quality objectives. Freshwater objectives apply to discharges to waters both outside the zone of tidal influence and with salinities

lower than 5 parts per thousand (ppt) at least 75 percent of the time in a normal water year. Saltwater objectives shall apply to discharges to waters with salinities greater than 5 ppt at least 75 percent of the time in a normal water year. For discharges to waters with salinities in between the two categories or tidally influenced freshwaters that support estuarine beneficial uses, the objectives shall be the lower of the salt or freshwater objectives, based on ambient hardness, for each substance (Basin Plan, page 4-13).

50. The receiving waters for the proposed discharge are tidally influenced. The salinity of the Lower Napa River in the vicinity of the proposed discharge varies from near 0 parts per thousand (ppt) during high flow rain events in the wet season to approximately 20 ppt in the dry season. The receiving waters are estuarine, and the lower of the salt or freshwater water quality objectives, based on ambient hardness, are the appropriate criteria for the Lower Ponds Project.

51. The pH of the Lower Napa River in the vicinity of the proposed discharge ranges from 7.7 to 8.5 (ref: Collaborative Napa River Receiving Water Study, Napa Sanitation District, 2003).

52. The hardness of the Lower Napa River in the vicinity of the proposed discharge ranges from 2,000 mg/L as $CaCO_3$ in the wet season to 4,000 mg/L in the dry season (ref: Collaborative Napa River Receiving Water Study, Napa Sanitation District, 2003). Freshwater effluent limitations for toxic constituents were conservatively calculated based on a hardness of 2,000 mg/L as $CaCO_3$.

53. A sampling and analysis program (Sampling Program) was conducted in late 2001 to characterize the current water quality in the ponds and in the adjacent potential receiving water bodies. Water samples were collected from all ponds, the Napa River, Napa Slough, and San Pablo Bay in October-November 2001. The water analysis parameter list for this Sampling Program included general water chemistry parameters and priority pollutants. The list of priority pollutants was based on the memorandum published on August 6, 2001 by the Water Board titled "Requirements for Monitoring of Pollutants in Effluent and Receiving Water to Implement New Statewide Regulations and Policy" (13267 letter). The parameter list specified in the 13267 letter included all 126 priority pollutants identified on the California Toxics Rule (CTR) list (Federal Register, May 18, 2000). In addition, the parameter list included two commonly used organophosphate pesticides (Diazinon and Chlorpyrifos). The parameter list for this Sampling Program was expanded beyond the 13267 letter as follows: Methoxychlor was added to the list of chlorinated hydrocarbon pesticides tested by EPA Method 608; and 27 additional organo-phosphate pesticides were added to the list of compounds tested by EPA Method 8141A. Tributylin, a pollutant listed in the 13267 letter as required only for discharges from sewage treatment plants and cooling towers, was not included on the parameter list for this Sampling Program. A complete list of the sampling results is provided in Attachment H.

54. The water quality characterization was intended to illustrate a "worst case" type of scenario, and the timing of the sampling events (October-November 2001) was

intentionally coordinated with the lowest pond water levels during the rainfall year. The measurements of salinity made in October-November 2001 represent some of the highest salinity measurements for the ponds made during the entire period of the Discharger's management. The proposed project includes release of water from Ponds 4 and 5 via an initial levee breach to be opened up during the high river flow part of the rainy season, not during the time when the ponds are severely desiccated. The timing of the proposed breach release is intended to ensure that the ponds have filled with fresh water, up to the level of any control structures or within two feet of the levee crest, prior to release.

The effect of the timing of the proposed initial breach release on the concentrations of constituents in the ponds at the time of release is likely to be significant. Water levels in the ponds are expected to be significantly higher at the time of the proposed breach, relative to the levels existing at the time of sampling for this water quality characterization. Constituent concentrations are expected to be significantly lower at the time of the proposed breach, relative to the levels indicated in the sampling results presented in this water quality characterization.

Table 2, below, presents recent, wet-weather salinity data for the ponds. The samples were collected approximately every two weeks from January 14 to March 18, 2003.

Table 2: Recent Wet Season Salinity Measurements

Pond No.	January 14 & 16, 2003	January 31, 2003	February 18, 2003	February 27, 2003	March 18, 2003	Mean of five wet weather measurements
~	ppt	ppt	ppt	ppt	ppt	ppt
1	24	22	20	22	23	22
1A	23	22	11	10	22	18
2	18	10	9	10	12	12
2A	NM	NM	NM	NM	NM	NM
3	3	1	9.5	5.5	10.5	6
4	89	60	34.3	26	41.3	50
5	49	38	53.5	55	56	50
6	38	37	32	32	27	33
6A	33	23	15	11	12	19
Upper Ponds (not part of this Order)						
7	250	232	230	231	242	237
7A	51	49	44	40	35	44
8	16	8	7	6	10	9

Notes:
1. Salinity data collected by the Discharger
2. NM = Not measured

Table 3, below, presents the mean of the five salinity measurements presented in Table 2 (when water levels in the ponds were high) compared to the salinity measurements made by HydroScience Engineers, Inc. (HSe) in October-November 2001 (when pond water levels were very low). The Salinity Ratio calculated provides a measure of the likely dilution to be expected, relative to the HSe characterization constituent concentrations, at times when water levels in the ponds are high.

Table 3: Constituent Reduction Ratios Expected at Time of Proposed Water Discharges due to Water Level Variation within Ponds

	Jan-Mar 2003	Oct-Nov 2001	(Oct-Nov 2001) / (Jan-Feb 2003)
Pond No.	Recent High Water Level Salinity [1]	HSe Low Water Level Salinity [2]	Low WL: High WL Salinity Ratio [3]
~	ppt	ppt	~
1	22	40	1.8
1A	18	164	9.3
2	12	38	3.2
2A	NM	22	not known
3	6	66	11.2
4	50	323	6.4
5	50	324	6.4
6	33	92	2.8
6A	19	58	3.1
Upper Ponds (not part of this Order)			
7	237	354	1.5
7A	44	96	2.2
8	9	294	31.3

Notes:

[1] Average of results for five of the Discharger's sampling events conducted January 15, 31, February 18, 27, and March 18 2003, developed in Table 3 above

[2] Salinity data from HSe water quality characterization, samples collected in October-November 2001

[3] Calculated as the quotient of Oct-Nov 2001 salinity divided by Jan-Mar 2003 salinity

Table 3 indicates that the dilution factors expected due to water level increases at the end of the rainfall season are: approximately 6:1 for Ponds 4 and 5; approximately 3:1 for Ponds 6 and 6A; approximately 1.5 to 2 for Ponds 7 and 7A; and approximately 30:1 for Pond 8. In summary, recent water quality monitoring data collected by the Discharger support the expectation of significantly lower constituent concentrations during the high runoff part of the rainfall season, when compared to concentrations measured in October-November 2001.

55. The concentration of all constituents are expected to increase or decrease in proportion to

changes in salinity. Analysis of data supplied by Frontier Geoscience in Seattle Washington, for samples collected from the South Bay Salt Ponds in October 2002, indicates a positive correlation between salinity and metals. The analysis is attached to this Order as Attachment F.

56. It is expected that the salinity in Pond 4 will be well below 100 ppt at the time of the initial breach for salinity reduction. Given an estimated initial dilution of 10:1 and the effluent limitations contained in Section B.1. of this permit for salinity (daily maximum of 100 grams per liter (g/L) and monthly average of 50 g/L) that must be met, the discharge will comply with the narrative water quality objective in the Basin Plan.

57. No volatile organics, semi-volatile organics, polynuclear aromatic hydrocarbons, polychlorinated biphenyl compounds, pesticides, furans or dioxins were detected above stated laboratory method detection limits in water samples collected from any of the ponds.

58. Water samples collected in October-November 2001 from Ponds 3, 4, 5, and 6 were found to contain some high levels of total metals (copper and zinc). However, the results also indicated high detection levels, and, after considering the attenuation in concentrations expected when pond water levels are high (see Table 3), the only cases where there appears to be potential for metal to be present in the ponds above the lowest applicable water quality criterion (WQC) at the time of the proposed initial breach involve copper and zinc in Ponds 4 and 5. A near field mixing zone of approximately 10:1 is expected based on a modeling study performed by Philip Williams and Associates (Attachment D). However, a Napa River salinity level of 12 – 14 mg/L that is expected after the breach (Figure 13 from Attachment D) is not higher than typical salinities experienced during spring and summer flows. Using an estimate of 10:1 dilution in the near field mixing zone in the Napa River adjacent to the proposed breach, no metals concentrations, including copper and zinc, are expected to exceed the lowest applicable WQC at the boundary of the mixing zone. Findings 50 through 60, below, discuss the results of analysis from the October-November 2001 sampling events, for water samples collected from Ponds 3, 4, 5, 6, and 6A.

59. Arsenic was detected in water samples collected from one pond (Pond 5). The measured concentration of arsenic in Pond 5 was 87 μg/L (total). The lowest applicable WQC is 36 μg/L (the CTR salt water continuous criterion of 36 μg/L, adjusted by the EPA translator of 1.0). The concentration of arsenic in the pond water is expected to be reduced by a factor of 6.4 (to approximately 14 μg/L) at the time of the proposed breach release to the Napa River (see Table 3, above). The discharge is not expected to exceed the WQC of 36 μg/L prior to entering the mixing zone in the Napa River. Dilution by an additional factor of 10 is expected in the near-field Napa River mixing zone. The maximum concentration of arsenic at the boundary of the mixing zone is expected to be less than 2 μg/L (total), which is less than the lowest applicable WQC of 36 μg/L (total).

60. Cadmium was not detected in water samples collected from any pond.

61. Chromium was detected in water samples collected from one pond (Pond 6), at a

concentration of 28.7 µg/L (total), which is below the lowest applicable water quality criterion of 180 µg/L (the CTR fresh water continuous criterion). Chromium VI was not detected in any pond.

62. Copper was detected in water samples collected from three ponds (Ponds 3, 4, and 5). The measured concentrations in Ponds 3, 4, and 5 were 53, 288, and 253 µg/L respectively.

For the purpose of converting the numeric water quality criteria for copper set forth in the CTR to the total recoverable fraction, this Order uses the seasonal copper translators developed for discharges to the lower Napa River by the Napa Sanitation District (NSD) Wastewater Treatment Plant (Napa Plant). These seasonal copper translators were proposed to the Water Board in July 2002, in a report titled Napa Sanitation District Copper Translator Study Progress Report, dated June 28, 2002. The proposed translators were accepted by the Water Board, and were included in an amended WDRO (Order R2-2002-0111) and NPDES permit (No. CA0037575) issued for the Napa Plant in October 2002. The seasonal translators developed for the Napa Plant discharge describe, more accurately than the default EPA salt water copper translator of 0.83, the ratio of ambient dissolved copper to total recoverable copper in the lower Napa River. The discharge point for the Napa Plant is about 5 miles upstream from proposed discharge point for the Lower Ponds Project, and this Water Board finds that the NSD copper translators are appropriate for the river reach to which the Lower Ponds Project proposes to discharge.

The seasonal copper translators appropriate for the proposed Lower Ponds discharge are: Wet season, chronic - 0.42, and wet season, acute - 0.57.

The lowest applicable continuous/chronic numeric water quality criterion for copper is 7.38 µg/L (based on the CTR criterion for salt water, continuous of 3.1 µg/L as dissolved, and the NSD wet season chronic copper translator of 0.42). The lowest applicable maximum/acute numeric water quality criterion for copper is 8.42 µg/L (based on the CTR salt water maximum criterion of 4.8 µg/L as dissolved, and the NSD wet season acute copper translator of 0.57).

Sampling results for Pond 3 indicated a copper concentration of 53 µg/L (total). The concentration of copper in the pond water is expected to be reduced by a factor of 11.2 (to approximately 4.8 µg/L) at the time of the proposed breach release to the Napa River (see Table 3, above). The discharge is not expected to exceed the WQC of 7.38 µg/L prior to entering the mixing zone in the Napa River. Dilution by an additional factor of 10 is expected in the near-field Napa River mixing zone. The maximum concentration of copper at the boundary of the mixing zone is expected to be less than 1 µg/L (total), which is less than the lowest applicable WQC of 7.38 µg/L (total).

Sampling results for Pond 4 indicated a copper concentration of 288 µg/L (total). The concentration of copper in the pond water is expected to be reduced by a factor of 6.4 (to approximately 45 µg/L) at the time of the proposed breach release to the Napa River (see Table 3, above). The discharge is expected to exceed the continuous WQC of 7.38 µg/L prior to entering the mixing zone in the Napa River. Dilution by an additional factor of 10 is expected in the near-field Napa River mixing zone. The maximum concentration of copper at the boundary of the mixing zone is expected to be less than 5 μg/L (total), which is less than the lowest applicable WQC of 7.38 μg/L (total).

Sampling results for Pond 5 indicated a copper concentration of 253 μg/L (total). The concentration of copper in the pond water is expected to be reduced by a factor of 6.4 (to approximately 40 μg/L) at the time of the proposed breach release to the Napa River (see Table 3, above). The discharge is expected to exceed the continuous WQC of 7.38 μg/L prior to entering the mixing zone in the Napa River. Dilution by an additional factor of 10 is expected in the near-field Napa River mixing zone. The approximate maximum concentration of copper at the boundary of the mixing zone is expected to be less than 5 μg/L (total), which is less than the lowest applicable WQC of 7.38 μg/L (total).

63. Lead was not detected in water samples collected from any pond.

64. Mercury was detected in water samples collected from one pond (Pond 3), and in the Napa River receiving waters. Both detections were at a level of 0.2 μg/L; both measurements represent the dissolved fraction. The lowest applicable WQC is 0.025 μg/L as dissolved (the Basin Plan 4-day average criterion for salt water). The applicable maximum/acute numeric water quality criterion for mercury is 2.1 μg/L as dissolved (the Basin Plan 1-hour average criterion for salt water). The concentration of mercury in the pond water is expected to be reduced by a factor of 11.2 (to approximately 0.018 μg/L) at the time of the proposed breach release to the Napa River (see Table 3, above). The discharge is not expected to exceed the WQC of 0.025 μg/L prior to entering the mixing zone in the Napa River. Dilution by an additional factor of 10 is expected in the near-field Napa River mixing zone. The maximum concentration of mercury at the boundary of the mixing zone is expected to be less than 0.002 μg/L (dissolved), which is less than the lowest applicable WQC of 0.025 μg/L (dissolved).

65. Nickel was detected in water samples collected from one pond (Pond 3). The measured concentration of nickel in Pond 3 was 13 μg/L (dissolved). The lowest applicable WQC is 7.1 μg/L (the Basin Plan salt water 24-hour average criterion). The concentration of nickel in the pond water is expected to be reduced by a factor of 11.2 (to approximately 1.2 μg/L) at the time of the proposed breach release to the Napa River (see Table 3, above). The discharge is not expected to exceed the WQC of 7.1 μg/L prior to entering the mixing zone in the Napa River. Dilution by an additional factor of 10 is expected in the near-field Napa River mixing zone. The maximum concentration of nickel at the boundary of the mixing zone is expected to be less than 0.2 μg/L (dissolved), which is less than the lowest applicable WQC of 7.1 μg/L (dissolved).

66. Selenium was not detected in water samples collected from any pond.

67. Silver was not detected in water samples collected from any pond.

68. Zinc was detected in water samples collected from four ponds (Ponds 3, 4, 5, and 6). The measured concentrations in Ponds 3, 4, 5, and 6 were 59, 725, 1,027, and 75 μg/L respectively, all expressed as total. The lowest applicable WQC is 61.3 μg/L (the Basin Plan salt water 24-hour average criterion of 58 μg/L, adjusted by the EPA zinc translator of 0.946).

    Sampling results for Pond 3 indicated a zinc concentration of 59 μg/L. The concentration of zinc in the pond water is expected to be reduced by a factor of 11.2 (to approximately 5.3 μg/L) at the time of the proposed breach release to the Napa River (see Table 3, above). The discharge is not expected to exceed the WQC of 61.3 μg/L prior to entering the mixing zone in the Napa River. Dilution by an additional factor of 10 is expected in the near-field Napa River mixing zone. The maximum concentration of zinc at the boundary of the mixing zone is expected to be less than 7 μg/L (total), which is less than the lowest applicable WQC of 61.3 μg/L (total).

    Sampling results for Pond 4 indicated a zinc concentration of 725 μg/L. The concentration of zinc in the pond water is expected to be reduced by a factor of 6.4 (to approximately 114 μg/L) at the time of the proposed breach release to the Napa River (see Table 3, above). The discharge is expected to exceed the WQC of 61.3 μg/L prior to entering the mixing zone in the Napa River. Dilution by an additional factor of 10 is expected in the near-field Napa River mixing zone. The maximum concentration of zinc at the boundary of the mixing zone is expected to be less than 12 μg/L (total), which is less than the lowest applicable WQC of 61.3 μg/L (total).

    Sampling results for Pond 5 indicated a zinc concentration of 1,025 μg/L. The concentration of zinc in the pond water is expected to be reduced by a factor of 6.4 (to approximately 161 μg/L) at the time of the proposed breach release to the Napa River (see Table 3, above). The discharge is expected to exceed the WQC of 61.3 μg/L prior to entering the mixing zone in the Napa River. Dilution by an additional factor of 10 is expected in the near-field Napa River mixing zone. The maximum concentration of zinc at the boundary of the mixing zone is expected to be less than 17 μg/L (total), which is less than the lowest applicable WQC of 61.3 μg/L (total).

    Sampling results for Pond 6 indicated a zinc concentration of 75 μg/L. The concentration of zinc in the pond water is expected to be reduced by a factor of 2.8 (to approximately 27 μg/L) at the time of the proposed breach release to the Napa River (see Table 3, above). The discharge is not expected to exceed the WQC of 61.3 μg/L prior to entering the mixing zone in the Napa River. Dilution by an additional factor of 10 is expected in the near-field Napa River mixing zone. The maximum concentration of zinc at the boundary of the mixing zone is expected to be less than 7 μg/L (total), which is less than the lowest applicable WQC of 61.3 μg/L (total).

69. It is possible that the analytical results suggesting that copper and zinc may be present, at breach time, in the waters of Ponds 4 and 5 at concentrations exceeding the lowest applicable WQC may significantly overstate the metals concentrations in the ponds. The

2001 water samples were prepared for analysis by EPA 3020, and the high salinity of the samples required dilution of the samples. The sample preparation methods employed in 2001 may have allowed some interference with test accuracy. While it was expected that the concentrations of metals would increase with increasing salinity on something approximating a linear 1:1 ratio, the 2001 analytical results instead suggested that the rate of increase for metals concentrations was much higher than the rate of increase for salinity.

70. Samples subsequently collected at the Cargill South Bay ponds in October 2002 were sent to Frontier Geosciences in Seattle, Washington (FGS) and were prepared for analysis using a variety of proprietary sample preparation techniques prior to analysis by ICP-MS or by atomic fluorescence spectrometry. In recent years, FGS has developed refined sample preparation techniques specifically for high salinity waters to be analyzed for metals. The FGS sample preparation techniques avoid the dilution and associated increase in Method Detection Limit (MDLs) associated with EPA 3020. When analytical results using FGS methods were compared to results using EPA 3020/dilution for sample preparation, for common locations sampled 60 days apart in 2002, the comparison showed that in most cases, the sample preparation and analysis techniques for metals employing EPA 3020/dilution produced either dramatically higher measurements of the concentration of each metal than did the FGS methods, or produced non-detect results. The comparison of the 2002 analytical results for the two methods raises the possibility that the 2001 results were impacted by some type of interference which led to spuriously high measurements of some metals, including copper and zinc. Attachment G, Comparison of Analytical Results for Metals, presents the comparative data for five ponds.

71. After considering the discrepancies in metals results, which were apparent in the Cargill South Bay Ponds metals results, a second sampling event for Pond 4 was planned. Aqueous samples were collected from Pond 4 on October 1, 2003 and transmitted under Chain of Custody to Frontier Geosciences. All metals in Pond 4 were measured to be below the applicable WQCs except nickel, which was detected at a level approximately equal to the WQC (detected at 8.7 μg/L and the most stringent objective in the Basin Plan is 7.1 μg/L as total recoverable). The water levels in the ponds were low on October 1, 2003; the average depth of the water in Pond 4 on this date was 1.4 feet. The samples collected in October are likely to contain higher concentrations of dissolved constituents than samples collected in late winter/early spring, when the breach discharge is proposed. The average depth at the time of the breach discharge is anticipated to be at or near the maximum depth the pond can accommodate, which is 4.5 feet. The source of the additional water expected in Pond 4 at the time of the breach discharge will be primarily rainfall, which is expected to contribute no additional nickel to the pond. It is expected that the volume of water impounded in Pond 4 at the time of the breach discharge will be at least three times the volume of water present on October 1, 2003. Conservatively assuming that the volume of impounded water at the time of the breach is twice the volume impounded on October 1, 2003, the concentration of nickel in Pond 4 at the time of the proposed breach discharge would be expected to be approximately one half of 8.7 μg/L (or approximately 4.4 μg/L), which would suggest that there is no "reasonable potential" to cause or contribute to an excursion beyond the most stringent water quality objective for

nickel.

The results of analysis for metals for water samples collected from Pond 4 on October 1, 2003 are presented in Table 3, below.

Total Recoverable Metals in μg/L Pond 4 - October 1, 2003	
Arsenic	2.53
Cadmium	0.038
Chromium	0.65
Copper	1.51
Lead	1.05
Mercury	0.00626
Nickel	8.7
Selenium	0.160
Silver	< 0.40
Zinc	2.82

72. A sampling and analysis program was conducted to characterize the current soil and sediment quality in the ponds and in the adjacent potential receiving water bodies. Soil samples were collected from all ponds, the Napa River, and Napa Slough in October-November 2001. The soil analysis parameter list included general soil chemistry parameters and priority pollutants. The list of priority pollutants was based on San Francisco Bay Region Regional Water Quality Control Board Resolution 92-145, Sediment Screening Criteria and Testing Requirements for Wetland Creation and Upland Beneficial Reuse (adopted November 18, 1992). Soil samples were collected in October-November 2001. All analytical results were compared to two sets of assessment criteria: Resolution 92-145 (1992 Criteria); and proposed draft criteria included in the Draft Staff Report – Beneficial Reuse of Dredged Materials: Sediment Screening and Testing Guidelines (2000 Draft Guidelines), which presents proposed updates to the 1992 Criteria released by the Water Board in May 2000.

73. No soil samples exceeded either of the 1992 Criteria for cadmium. The Napa River, Napa Slough, and Pond 1A exceeded the 2000 Draft Guideline for cadmium in surface material. The Draft Guideline for surface material is 0.33 mg/kg. The results for Napa River, Napa Slough, and Pond 1A were 0.4 mg/kg, 0.5 mg/kg, and 0.9 mg/kg respectively. The data suggest that ambient levels of cadmium in soils in the Salt Marsh Project area are above the Draft Guideline estimate of the average general condition of surface soils in the San Francisco Bay region. The levels detected are well below the adopted criterion for wetlands cover and levee maintenance criterion of 5 mg/kg (1992 Criteria). Soil from Pond 1A is considered suitable for levee maintenance in the vicinity of Pond 1A. No other ponds, nor receiving waters, exceeded either of the 2000 Draft Guidelines for cadmium.

74. No soil samples exceeded either of the 1992 Criteria for copper. Pond 2A exceeded the 2000 Draft Guideline for copper in surface material by 7 mg/kg (the Guideline is 68.1

mg/kg and the soil analysis result was 75 mg/kg). No work is proposed in Pond 2A. No other ponds, nor receiving waters, exceeded either of the 2000 Draft Guidelines for copper.

75. No soil samples exceeded either of the 1992 Criteria for nickel. Pond 2A exceeded the 2000 Draft Guideline for nickel in surface material by 4 mg/kg (the guideline is 112 mg/kg and the soil analysis result was 116 mg/kg). No work of any kind is proposed in Pond 2A. No other ponds, nor receiving waters, exceeded either of the 2000 Draft Guidelines for nickel.

76. Soil samples collected from all ponds, the Napa River, and Napa Slough exceeded one or both of the selenium 1992 Criteria, and the 2000 Draft Guidelines for wetland surface material. The 2000 Draft Guidelines do not publish a selenium criterion for foundation (non-cover) use. The surface material adopted (1992) and proposed (2000) criteria are similar (0.7 and 0.64 mg/kg respectively), and the analytical results indicated levels in the range of 1 to 3.5 mg/kg. The rationale behind the proposed criterion for cover material is to use ambient levels, and the data suggest that the ambient levels of soil selenium in the Project vicinity are slightly higher than those in the entire San Francisco Bay area in general.

77. Soil samples collected from three ponds (Ponds 2A, 5, and 7A) exceed the total DDT 1992 Criterion for wetland cover and levee maintenance material of 3 ug/kg. Analytical results for total DDT for Ponds 2A, 5, and 7A were 4.3, 7, and 6.2 ug/kg respectively. The 2000 Draft Guideline criterion for wetland surface material is 7 ug/kg. None of the ponds, nor the receiving waters, exceed any of the 2000 Draft Guidelines for total DDT.

78. Beyond the constituents discussed above, there were no detections of any constituent, in any soil sample, at levels above any criterion included in either the 1992 Criteria or the 2000 Draft Guidelines.

79. The proposed breach discharge will be conducted during the wet season (between November 1 and April 30), and will be considered a deep water discharge.

Applicable Plans, Policies, and Regulations

80. State authority to regulate the discharge, and threatened discharge of waste to Waters of the State, including surface water, groundwater, and wetlands was granted to the State Water Resources Control Board in the Porter-Cologne Water Quality Act (Act). Water Quality Control Plans implement the Act by designating the beneficial uses to be protected, and the water quality objectives reasonably required for that purpose.

81. The Water Board, on June 21, 1995, adopted, in accordance with Section 13244 *et. seq.* of the California Water Code, a revised Water Quality Control Plan for San Francisco Bay Basin (Basin Plan). The State Water Resources Control Board and the Office of Administrative Law approved this updated and consolidated revised Basin Plan on July 20, 1995, and November 13, 1995, respectively. A summary of regulatory provisions is

contained in 23 CCR 3912. The Basin Plan defines beneficial uses and water quality objectives for waters of the State, including surface waters and ground waters. This Order is in compliance with the Basin Plan.

82. Effluent limitations in this Order are based on the plans, policies, and water quality objectives of the Basin Plan, Quality Criteria for Water (EPA 440/5-86-001, 1986; Gold Book and 63 Federal Register 68354, December 10, 1998), Applicable Federal Regulations (410 CFR Parts 122 and 131), the National Toxics Rule (57 FR 60848, 22 December, 1992; NTR), the California Toxics Rule (40 FR Part 131; CTR) and best professional judgment.

83. The Basin Plan Wetland Fill Policy establishes that there is to be no net loss of wetland acreage and no net loss of wetland value when the Project and any proposed mitigation are evaluated together, and that mitigation for wetland fill projects is to be located in the same area of the Region, wherever possible, as the Project. The Policy further establishes that wetland disturbances should be avoided whenever possible, and if not possible, should be minimized, and only after avoidance and minimization of impacts should mitigation for lost wetlands be considered. The analysis of project alternatives presented in the DEIR demonstrated that an appropriate effort was made to avoid and then to minimize impacts to the waters of the State, as required by the Basin Plan. The Water Board concurs with this finding.

84. *303(d) Listed Pollutants* · On May 12, 1999, USEPA approved the State's list of impaired water bodies and added dioxins, furans, and dioxin-like polychlorinated biphenols (PCBs) to the State's list. The list (hereinafter referred to as the 303(d) list) was prepared in accordance with Section 303(d) of the federal Clean Water Act to identify specific water bodies where water quality standards are not expected to be met after implementation of technology-based effluent limitations on point sources. The Napa River is tributary to San Pablo Bay, and both are listed as impaired water bodies on the 303(d) list. The Napa River is currently 303(d) listed as being impaired by nutrients, pathogens, and sedimentation/siltation. TMDL development for these stressors will likely be completed by 2005. Potential sources of the these stressors include: agriculture (for all three stressors), urban runoff and storm sewers (for sediment and pathogens), and construction/land development (for sediment). San Pablo Bay is currently 303(d) listed as impaired for three chlorinated hydrocarbon pesticides (chlordane, DDT, Dieldrin), one organophosphate insecticide-acaricide (Diazinon), dioxin and furan compounds, polychlorinated biphenyl (PCB) compounds, and two metals (mercury and selenium). Development of a TMDL for mercury is currently in progress. Other TMDLs are in various states of development, and are targeted for completion by 2010. The only identified potential source of dioxins and furan compounds for San Pablo Bay is atmospheric deposition.

85. The Project meets the goals set forth in the San Francisco Bay Conservation and Development Commission's Bay Plan, the San Francisco Bay Estuary Program's Comprehensive Conservation and Management Program, the Ecosystem Restoration Program Plan developed by CALFED's Bay-Delta Program, and the Baylands Ecosystem Habitat Goals Project.

86. USACE has analyzed the Project for consistency with Section 404(b)(1) Guidelines (40 CFR 230 *et seq.*), promulgated by the USEPA, for disposal of dredged or fill material into waters of the US. USACE found that the Project complies with the applicable provisions of the Guidelines in that the Project is the preferred alternative with the least adverse impact on the aquatic ecosystem, and includes appropriate practical steps to minimize adverse impacts of the discharge of dredged materials on the aquatic ecosystem. The Water Board concurs with this assessment.

87. USFWS prepared a Draft Fish and Wildlife Coordination Act Report for the Project in September of 2002. USFWS found that the Lower Ponds Project "...poses relatively low risks of impacts or consequences of failure to meet habitat objectives, avoids no-project risks to levees, has a reasonable probability of meeting or exceeding habitat objectives in the near term, and is necessary to initiate prior to anticipated restoration of the adjacent Cullinan Ranch site."

88. USFWS issued a BO dated June 3, 2003 which concluded that the Lower Ponds Project was consistent with special status species recovery objectives, was not likely to jeopardize the continued existence of special status species found within the area, and would not destroy or adversely modify any critical habitat. The Opinion included an Incidental Take Statement (Attachment I).

89. NMFS issued a BO dated June 30, 2003 which concluded that the Lower Ponds Project is not likely to adversely affect endangered and threatened salmonid species or designated critical habitat, and that Essential Fish Habitat Conservation Recommendations are not necessary.

90. This Order does not apply to stormwater discharges associated with construction activities. The Discharger is responsible for obtaining and complying with the rules and regulations of National Pollutant Discharge Elimination System (NPDES) permit requirements for such activities.

91. The California Environmental Quality Act (CEQA) requires all discretionary projects approved by public agencies to be in full compliance with CEQA, and requires a lead agency to prepare an appropriate environmental document for such projects. In May 2003, CSCC prepared a Draft Environmental Impact Report (DEIR) for the Project and circulated it for review and comment. An amended DEIR was prepared in July 2003 and addressed comments received concerning the May 2003 DEIR. On May 3, 2004, the Discharger, as the lead public agency undertaking the Project subject to CEQA, certified the Final Environmental Impact Report (FEIR) that concluded the Project will not cause significant environmental impacts provided that mitigation measures are implemented. On May 7, 2004, the Discharger adopted a Notice of Determination for the Project (SCH # 1998072074). The Water Board, as a responsible agency, has considered the FEIR and concurs with the lead agency's determination. The Water Board further finds the Project will not have a significant impact on water quality if Discharger complies with this Order.

Mitigation Measures are listed in Attachment L, along with the monitoring requirements and responsible parties.

92. The Water Board finds that no pollutants have been added to the ponds by the process of salt making and, through the Project, the water in the Lower Ponds are merely returning to the hydrologic water system from which it came. Pond sediments are not expected to add pollutants to discharges, because the net movement of sediment is expected to be into the ponds, not out of them. Pollutant levels in the sediments in the Lower Ponds are essentially equal to those found in sediments found in the adjacent Napa River, and are well below any hazardous material thresholds. Finally, no effluent guidelines exist for the discharge of solar-evaporated Bay water for purposes of restoration of former salt evaporator ponds to tidal wetlands and brackish-water ponds, as this Project proposes. This discharge has not been regulated previously.

93. Pursuant to Title 23, California Code of Regulations Section 3857 and 3859, the Water Board is issuing Waste Discharge Requirements (WDRs) and water quality certification for the Project.

94. The Water Board has notified the Discharger and interested parties of its intent to issue WDRs and water quality certification for the Project.

95. The Water Board, in a public meeting on May 19, 2004, heard and considered all comments pertaining to the discharge.

IT IS HEREBY ORDERED that the Discharger, in order to meet the provisions contained in Division 7 of the California Water Code (CWC) and regulations adopted thereunder, shall comply with the following, pursuant to authority under CWC Sections 13263 and 13267:

A. DISCHARGE PROHIBITIONS

1. Project activities that result in the direct discharge of waste, as described in CWC Section 13050(d), (k), and (l), from construction sites to surface waters or surface water drainage courses, are prohibited.

2. Project activities subject to these requirements shall not cause a nuisance as defined in CWC Section 13050(m).

3. The discharge of oil, gasoline, diesel fuel, any petroleum derivative, any toxic chemical, or hazardous waste is prohibited.

4. Discharges of materials other than storm water, or materials which are not otherwise regulated by a NPDES permit, or materials not allowed by this Order, to waters of the State are prohibited.

5. Groundwater beneficial uses shall not be degraded as a result of the Project.

B. EFFLUENT LIMITATIONS

1. Conventional Pollutants. The effluent shall not exceed the following limits:

Constituent	Unit	Monthly Average	Daily Maximum
Salinity*	g/L	50	100

*assumption: breach during high flow event will achieve a 10:1 dilution ratio for the discharge

2. The pH of the effluent shall not exceed 8.5 nor be less than 6.5.

C. RECEIVING WATER LIMITATIONS

For the following Receiving Water Limitations, the Project Boundary shall be defined as the limit of the receiving waters at mean low-low water level, which is the topographic contour representing an elevation of 0 ft. NAVD88.

1. The Lower Ponds Project activities shall not cause:

   a. Floating, suspended, or deposited macroscopic particulate matter or foam at any place more than 100 feet from the Project Boundary or point of discharge, which persists for longer than 24 hours;

   b. Bottom deposits or aquatic growths to the extent that such deposits or growths cause nuisance or adversely affect beneficial uses;

   c. The temperature of any cold or warm freshwater habitat to be increased by more than 5 degrees Fahrenheit above natural receiving water temperature, unless a qualified biologist can demonstrate that such alteration in temperature does not adversely affect beneficial uses;

   d. Visible, floating, suspended, or deposited oil or other products of petroleum origin; and

   e. Toxic or other deleterious substances to be present in concentrations or quantities which will cause deleterious effects on wildlife, waterfowl, or other aquatic biota, or which render any of these unfit for human consumption, either at levels created in the receiving waters or as a result of biological concentration.

2. The discharge of waste shall not cause the following limits to be exceeded in waters of the

State at any one place within 1 foot of the water surface:

a. Dissolved Oxygen: 5.0 mg/L, minimum

When natural factors cause lesser concentrations, then these activities shall not cause further reduction in the concentration of dissolved oxygen.

b. Dissolved Sulfide: 0.1 mg/L, maximum

c. pH: Variation from normal ambient pH by more than 0.5 pH units.

d. Un-ionized Ammonia: 0.025 mg/L as N, annual median; and 0.16 mg/L as N, maximum.

e. Nutrients: Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

3. Turbidity of the waters of the State, at any place more than 100 feet from the Project Boundary or point of discharge, shall not increase by more than the following for more than 24 hours, to the extent practical:

Receiving Waters Background	**Incremental Increase**
< 50 NTU	5 NTU maximum
≥ 50 NTU	10% of background, maximum

4. The discharge shall not cause a violation of any particular water quality standard for receiving waters adopted by the Water Board or the State Board as required by the Clean Water Act and regulations adopted thereunder. If more stringent applicable water quality standards are promulgated or approved pursuant to Section 303 of the Clean Water Act, or amendments thereto, the Water Board will revise and modify this Order in accordance with such more stringent standards.

D. PROVISIONS

General Provisions

1. The Discharger shall comply with all the Prohibitions, Limitations and Provisions of this Order, immediately upon adoption of this Order, unless otherwise provided below.

2. The Discharger shall notify the Water Board immediately whenever violations of this Order, for which the Discharger is responsible, are detected.

3. The Discharger shall remove and relocate any wastes that are discharged at any sites in

violation of this Order.

4. The Discharger shall implement and comply with appropriate Best Management Practices (BMPs) during the entire course of the Lower Ponds Project, including the successful reestablishment of native vegetation as appropriate, to enhance wildlife habitat values, and to prevent and control erosion and sedimentation.

5. No debris, soil, silt, sand, cement, concrete, or washings thereof, or other construction related materials or wastes, oil or petroleum products or other organic or earthen material shall be allowed to enter into or be placed where it may be washed from the Project site by rainfall or runoff into waters of the State. When operations are completed, any excess material shall be removed from the Project work area and any areas adjacent to the work area where such material may be washed into waters of the State.

6. Construction contractors working on the Project will be required to provide their employees with spill prevention and response training, and will be required to have spill response equipment available at the job site, as directed by the Project sponsors. Contractors will provide double containment for any hazardous materials or wastes at the job site. Contractors will be prepared to respond to any spill immediately and to fully contain spills in the Project area, including any open-water areas.

7. Only trained experts will be allowed to transport, place, or detonate the explosive charges required for levee breaches. These experts shall be under direct supervision of the Project sponsors, and may not be subcontracted as part of the overall construction effort.

8. The Project sponsors will ensure that a site-specific health and safety plan is developed and implemented by the contractor as part of contract specifications.

9. To minimize the potential for disturbance of salt crusts, the contractor will be instructed to avoid disturbing the salt crusts, where possible. When work has to occur in areas with salt crusts, the contractor will conduct dust monitoring. If dust levels exceed the regulatory standard for nuisance dust, the contractor will implement dust control measures such as watering the work area and installing wind breaks. Specific acceptable dust control measures for salt crusts will be included in the contract specifications.

10. To prevent channel erosion and potential damage to adjacent levee systems, the Project sponsors will repair unintended levee breaches that are not consistent with the restoration option selected for implementation.

11. Prior to the initiation of any of the Project's construction activities, the applicant shall apply for coverage under, and comply with, the State's National Pollutant Discharge Elimination System General Permit for Storm Water Discharges Associated with Construction Activity, and incorporate appropriate Best Management Practices into the Project that promote the following conditions: a) prevention and control of erosion and sedimentation, b) source control of potential pollutants, c) control and treatment of runoff,

and d) protection of wetlands and water quality resources.

12. The Discharger shall maintain a copy of this Order at the Lower Ponds Project site at all times. The Order shall be available at all times to site personnel. The Discharger shall ensure that all individuals working on the Lower Ponds Project site, including all contractors and sub-contractors, are familiar with the contents and requirements of this Order, and with all relevant plans and BMPs.

13. The Discharger shall permit the Water Board or its authorized representative, upon presentation of credentials:
    a. Entry onto to premises on which wastes are located and/or in which records are kept.
    b. Access to copy any records required to be kept under the terms and conditions of this Order.
    c. Inspection of any monitoring equipment, construction area(s), or monitoring method completed as part of the Project.
    d. Sampling of any discharge or surface water covered by this Order.

14. This Order does not authorize commission of any act causing injury to the property of another or of the public; does not convey any property rights; does not remove liability under federal, state, or local laws, regulations or rules of other programs and agencies; nor does this Order authorize the discharge of wastes without appropriate permits from this agency or other agencies or organizations.

Soil Excavation and Placement Provisions

15. To minimize the effects on special status fish species caused by temporary increases in suspended sediment and turbidity, the use of silt trapping devices shall be employed during all in-water work conducted in the Napa River or in Napa Slough, where appropriate.

16. To minimize the effects on special status fish species resulting from the loss of existing habitat, construction activities in river or slough areas having emersed or submersed aquatic plants shall be avoided to the maximum extent practical.

17. Blasting and pile driving shall be conducted in late summer or early fall, when few fish species are present, and shall be conducted at low tide, when fish will be further away.

18. Ditch blocks shall be located in such as way as to not trap fish at low tide. Berms adjacent to starter channels shall be constructed on one side of the channel only, and shall be discontinuous, in order that fish have easy access to the starter channels as the tide recedes.

19. Construction activities shall be scheduled to avoid the nesting periods of the special status wildlife species, to the extent practical. When construction is conducted during the nesting period of a special status species known to be present, the activities shall be restricted to maintain a 150-foot buffer between heavy equipment and the nesting sites. Construction activities shall be scheduled in such a way as to limit the period of disturbance in a

particular area to as brief a time window as is practical.

20. Before constructing facilities within tidal marsh habitat, the Project sponsors will conduct clearance surveys for all species of concern in the construction area as needed and determined by USFWS and the Discharger. If surveys indicate the presence of any such species, the Project sponsors will consult with USFWS to identify appropriate methods for avoiding construction-related effects on the species.

21. To the extent feasible, the Project sponsors will avoid construction activities in or near marsh habitat suitable for the salt marsh harvest mouse. If construction activities must occur in this habitat, the Project sponsors will consult with USFWS to determine appropriate methods for avoiding construction-related mortality of salt marsh harvest mice. These methods may include installing exclusion fencing or trapping and relocating individuals.

22. For habitats determined to be suitable for soft bird's-beak, the Project sponsors will conduct pre-construction botanical surveys using USFWS protocols to map and inventory any populations of soft bird's-beak in the area of ground disturbance and the surrounding area that would be directly and indirectly affected by construction, maintenance, repairs, and slough channel scouring. If no populations of soft bird's-beak are located in the affected habitats, the Project would have no impact on this species, and no additional mitigation is required. If populations are found, the site of the structures and ground disturbance will be relocated, if feasible, to avoid direct and indirect impacts on the identified populations and individuals. Implementation of this mitigation measure is expected to avoid adverse impacts on soft bird's-beak. If it is not feasible to avoid adverse effects on individuals or occupied habitat for soft bird's-beak while still meeting the purpose and need of the Project, the Project sponsors will consult with USFWS and the Discharger under Section 7 of ESA and the CNPPA, respectively, to develop appropriate impact avoidance measures or additional mitigation measures.

Design Provisions

23. The proposed initial breach shall be timed to coincide with a high flow event, to ensure that the salinity in the receiving water is not raised above a level normally occurring during low flow months.

24. The initial breach shall be timed to coincide with a high water level in Pond 4, to ensure that the salinity of the water to be discharged is as close as possible to the salinity of the receiving water.

25. The Project sponsors will have a California-licensed civil engineer evaluate the stability of the levee system with respect to wind-driven wave erosion resulting from Project implementation. If necessary, the civil engineer will recommend measures to reduce the risk of erosion. These measures may include monitoring and adding sacrificial soil material at the toe of the levee as needed, limiting fetch by installing in-pond barriers or deflectors,

or repairing levees as needed.

26. The Project sponsors will conduct site-specific surveys of the power towers to ensure that the towers are not adversely affected. Surveys will include an assessment of the potential marsh erosion around the tower footings. If necessary, site-specific measures will be implemented to ensure stability of the utility towers. These measures may include encasing the towers with concrete to above the high-water mark and relocating levee breaches to reduce impacts.

27. The Project sponsors will coordinate with Napa County Mosquito Abatement District during the design, implementation, and operations of the Project.

28. Before beginning construction, the contractor will develop, in consultation with the appropriate representative(s) of the Discharger, a plan indicating how public access to the Project area will be maintained during construction. If needed, flaggers will be stationed near the construction activity area to direct and assist members of the public around the activity areas while maintaining access to the Project area.

29. In accordance with CWC Section 13260, the Discharger shall file a report with this Water Board of any material change or proposed change in the character, location, or volume of effluent or sediment to be discharged. Any proposed material change in the operation shall be reported to the Executive Officer at least 30 days in advance of implementation of any such proposal. This shall include, but not be limited to, all significant new soil disturbances, any new modifications to site drainage, or any modifications or adjustments to the effluent discharge.

30. The Discharger shall submit Final Design Plans (95% complete) acceptable to the Executive Officer to the Water Board to be reviewed for consistency with the EIR, with the Permit Application, and with previously approved design changes. A summary report of changes, if any, shall be submitted with the 95% design. If there are no changes, then no further Executive Officer or Water Board action is required.

Monitoring and Reporting Provisions

31. The Discharger shall notify the Water Board in writing 30 days prior to the actual start dates of major construction phases.

32. The Discharger shall conduct monitoring activities according to the Self-Monitoring and Reporting Program (SMP) (Attachment C), attached to this Order, and as may be amended by the Executive Officer. At any time after adoption of this order, the Discharger may file a written request proposing modifications to the attached SMP. If the proposed modifications are acceptable, the Executive Officer may issue a letter of approval incorporating the revisions into the SMP.

33. As described in the findings, for adaptive management purposes in order to determine

whether the balance of tidal marsh and managed pond species is being maintained and whether sufficient managed pond habitat has been retained for shorebird and waterfowl use in the ponds, bird use in Ponds 1, 1A, and 2 shall be monitored at least once by the Discharger using appropriate monitoring protocols. Within 90 days of the adoption of this Order, the Discharger shall submit a proposal for a Habitat Monitoring Plan for Ponds 1, 1a, 2 and 2a.

34. By June 30, 2005, the Discharger shall submit a proposal for a Long-Term Habitat Monitoring Plan for Pond 3. This Plan shall strive to provide a continuation of the CALFED-funded USGS study for Pond 3 and shall include aerial photographs from years 1 through 10, 15, and 20. The Year 1 aerial photographs shall be geo-rectified, while subsequent aerial photographs shall be geo-rectified on an as-needed basis as determined by a technical advisory team. By June 30, 2007, the Discharger shall submit the results of the 3-year USGS study.

35. At the conclusion of the period covered by the USACE's MAMP, the Discharger shall submit a Long-Term Habitat Monitoring and Adaptive Management Plan for Ponds 4 through 6a for the period between the conclusion of USACE involvement in the Project (approximately 2015) and full restoration.

36. When available, final monitoring plans for the restoration site along with the spatial and temporal sampling plan for each monitoring component will be sent to the Water Board and be subject to the approval of the Executive Officer. A technical advisory team comprising staff from agencies including the Water Board will be appointed to review the status of the Project and advise on the need for changes to the monitoring or adaptive management strategy. Annual reports detailing the progress of the restoration Project shall be sent to the Water Board and presented annually to agencies and interested parties to a forum such as the Wetland Monitoring Group under the San Francisco Bay Wetland Restoration Program or some other forum for input and feedback on the Project's progress and adaptive management strategies.

37. The Discharger shall immediately notify the Water Board by telephone whenever an adverse condition occurs as a result of the proposed discharge or construction activities. An adverse condition includes, but is not limited to, a violation or threatened violation of the conditions of this Order, significant spill of petroleum products or toxic chemicals, or other events that could affect compliance. Pursuant to CWC Section 13267(b), a written notification of the adverse condition shall be submitted to the Water Board within two weeks of occurrence. The written notification shall identify the adverse condition, describe the action(s) necessary to remedy the condition, and specify a time schedule for performance, subject to modification by the Water Board.

38. The Discharger shall halt work activities if dead or dying fish, or fish exhibiting stress, are observed within 1,000 feet of work activity or discharge. The Discharger shall immediately assign a qualified biologist to investigate the cause of the problem, and to identify an acceptable response, if the cause is determined to be the work activity or

discharge. The Discharger shall immediately report all incidents of dead, dying, or stressed fish, as well as prescribed action plans, to the Water Board.

39. All reports pursuant to this Order shall be prepared under the supervision of a suitable professional in the State of California.

40. This certification action is subject to modification or revocation upon administrative or judicial review, including review and amendment pursuant to Section 13330 of the CWC and Section 3867 of Title 23 of the California Code of Regulations (23 CCR).

41. This certification action is not intended and shall not be construed to apply to any discharge from any activity involving a hydroelectric facility requiring a Federal Energy Regulatory Commission (FERC) license or an amendment to a FERC license unless the pertinent certification application was filed pursuant to 23 CCR Subsection 3855(b) and that application specifically identified that a FERC license or amendment to a FERC license for a hydroelectric facility was being sought.

42. Certification is conditioned upon total payment of any fee required under Title 23 of the California Code of Regulations (CCR) and owed by Discharger. The total fee required for this Waste Discharge Requirement and water quality certification of the subject Project is $800.00. The fee has been paid in full.

The Water Board may modify, or revoke and reissue, this Order if present or future investigations demonstrate that the discharge(s) governed by this Order will cause, have the potential to cause, or will contribute to adverse impacts on water quality and/or beneficial uses of the receiving waters. The Water Board may reopen this Order to review results of the Discharger's and Water Board staff's studies and new data on Section 303(d) listed contaminants and decide whether effluent limits should be revised.

I, Bruce H. Wolfe, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an order adopted by the California Regional Water Quality Control Board, San Francisco Bay Region, on July 21, 2004.

Bruce H. Wolfe
Executive Officer

Attachments:

Attachment A: Figures
Figure 1. Site Location
Figure 2. Lower Ponds Project Site Map
Attachment B: Project Description
Attachment C: Self-Monitoring and Reporting Program

Attachment D: Philip Williams Associates Memo #1591, 02 December 2002
Attachment E: Monitoring and Adaptive Management Plan
Attachment F: Salinity/Metals Correlation for South Bay Ponds
Attachment G: Comparison of Analytical Results for Metals Using Different Sample Preparation Procedures
Attachment H: Sampling Results
Attachment I: U.S. Fish and Wildlife Service Endangered Species Consultation
Attachment J: USGS Habitat Restoration Monitoring, Phase I
Attachment K: Existing Monitoring Surveys for Ponds 1 through 6A
Attachment L: CEQA Mitigation Requirements

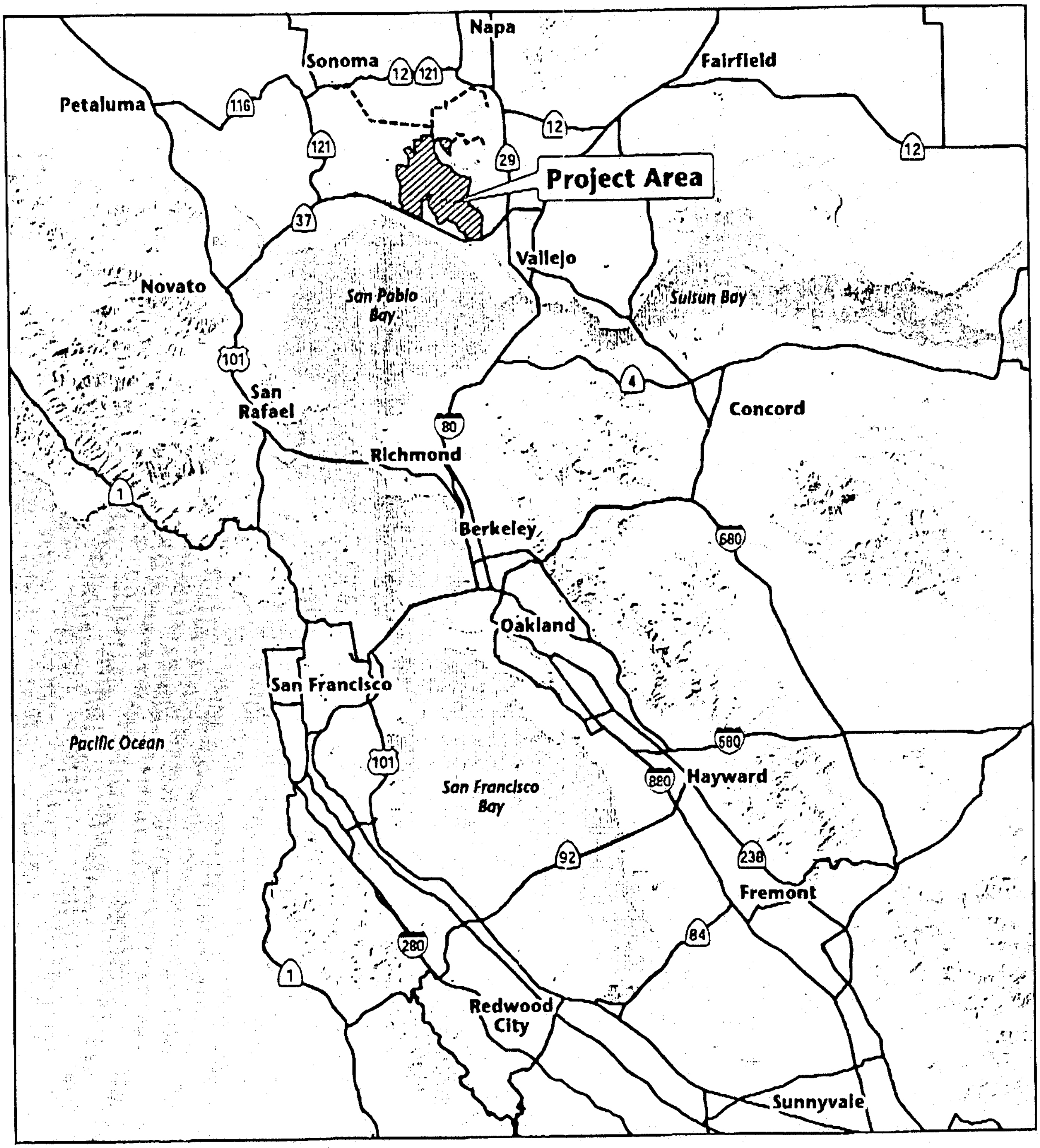


Figure 1

Site Location

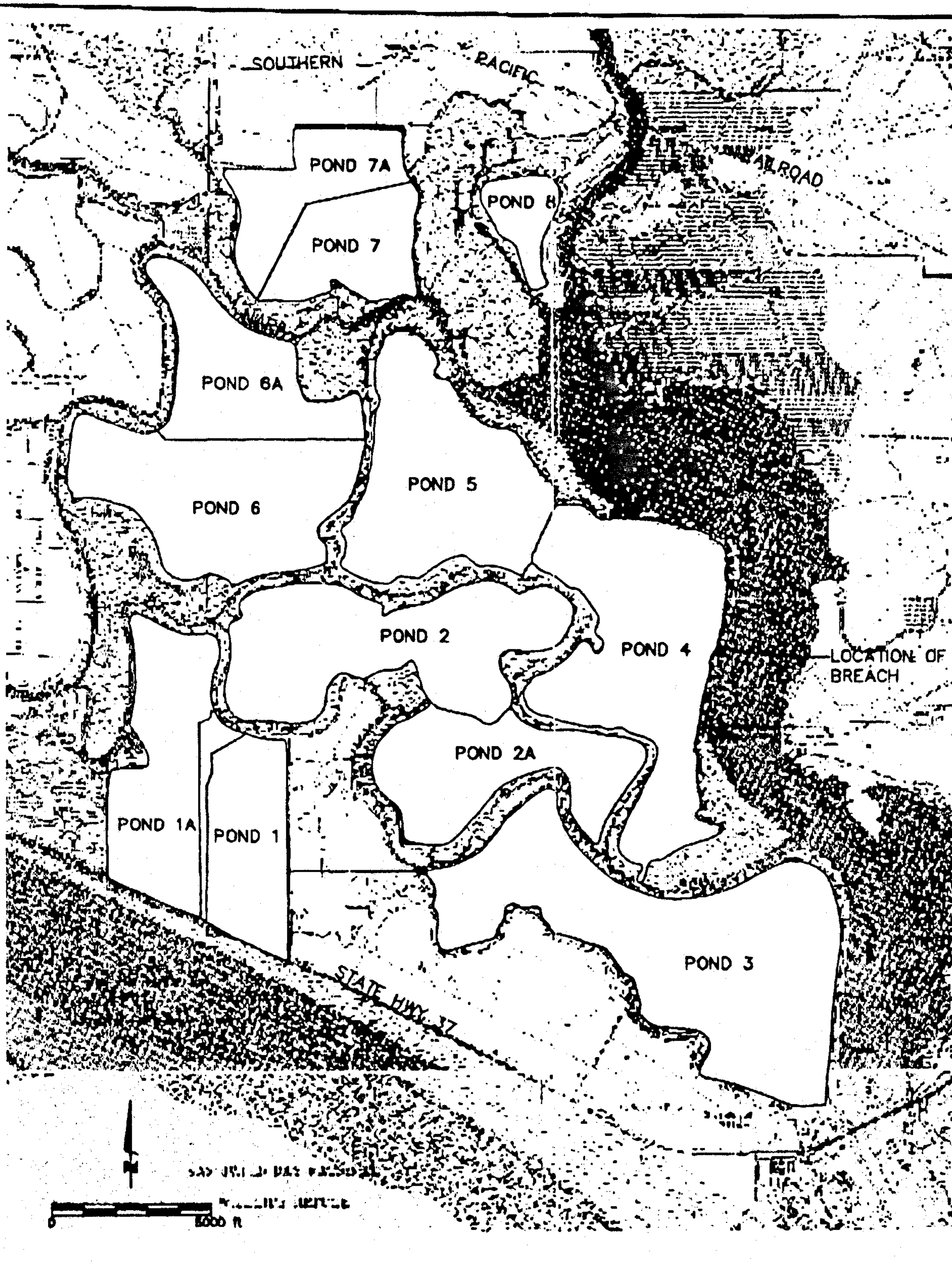


Figure 2
LOWER PONDS RESTORATION PROJECT
SITE MAP

ATTACHMENT B

NAPA RIVER SALT MARSH – LOWER PONDS RESTORATION PROJECT

PROJECT DESCRIPTION

Two types of construction activities are proposed in connection with the salinity reduction project and with the habitat restoration to follow: (1) re-distribution of soil/sediment within the project boundaries; and (2) construction of water control structures on the former Cargill property. The text describes the proposed activities associated with the Lower Ponds (Ponds 1, 1A, 2, 3, 4, 5, 6, and 6A) only; construction activities for the Upper Ponds (Ponds 7, 7A, and 8) will be described in a separate document when the Upper Ponds project is permitted.

1. RE-DISTRIBUTION OF SEDIMENT WITHIN THE PROPOSED PROJECT

The proposed Lower Ponds Project includes five tasks that involve the re-distribution of soil/sediment within the footprint of the proposed Project. These tasks consist of levee repair and maintenance, construction of starter channels and berms, installation of breaches, construction of ditch blocks, and supplemental levee lowering. The types of activities to be conducted, the estimated volume of soil to be moved, and the proposed construction process are described in more detail below.

1.1 Levee Repair and Maintenance

Levee repairs will occur during the first three years of the Project, and maintenance activities will be on-going for the life of the Project. Levee repair and maintenance will be conducted at ponds retained as managed ponds (Ponds 1, 1A, 2, 6, 6A, 7, 7A, and 8). Repairs are currently proposed for a total of approximately 42,840 lineal feet of levee in Ponds 1, 1A, 2, 6 and 6A. No levee repairs are proposed for ponds that can be are open to the tide or that can desalinated quickly and will subsequently be opened to tidal action (Ponds 3, 4 and 5).

1.1.1 Levee Repair and Maintenance Activities

Levee repairs and maintenance in general involve the removal of soil/sediment from a pond interior close to the intended maintenance location, and the placement of that fill on the levee. The activity involves no import or export of fill from the Project footprint. Maintenance and repairs of this type have been ongoing for many years under existing regulatory oversight. No significant detrimental effects have been noted.

1.1.2 Construction Process

For slough/river accessible ponds (Ponds 2, 6, and 6A), repairs would be conducted using a barge-mounted clamshell excavator or land-based equipment from the levee, with spreading and compaction of sediment on the levee using front-end loaders where required. For land-accessible ponds (Ponds 1 and 1A), repairs would be most likely conducted using a hydraulic excavator instead of a barge-mounted clamshell excavator. The process of levee maintenance requires no import or export of fill. This process requires the removal of sediment from a pond interior to the intended location.

1.1.3 Estimated Volumes and Affected Areas

Estimated levee repairs at Ponds 1, 1A, 2, 6, and 6A will affect an estimated 42,820 lineal feet of levee, and involve the placement of an estimated 120,000 cy of sediment excavated from the borrow ditches. Currently, it is estimated that 10% of the levees will require maintenance each year. Annual maintenance of the same levees would therefore affect an estimated 10,800 lineal feet of levee, and result in the placement of 30,000 cy of sediment dredged from the borrow ditches. The construction methods would be the same as for the levee repair.

1.2 Levee Breaching

Levee breaches would be constructed for the initial salinity reduction effort in Ponds 4 and 5, and to aid restoration in Ponds 3, 4, and 5. In addition, internal levee breaches would be constructed in the levees separating Ponds 4 and 5, and Ponds 6 and 6A. The breach created for salinity reduction in Ponds 4 and 5 would initially be undersized, and is expected to widen rapidly to its design size and depth, due to the significant volume of water that would be discharged through that breach.

Breaches created for habitat restoration (up to 9 breaches on Pond 3, up to 13 breaches on Ponds 4 and 5 combined, and up to 4 breaches on the All American Canal) and interior levee breaches (4 each in the Pond 4/5 levee and Pond 6/6A levee) would be constructed to their design size and depth. The water flow through the restoration breaches would be less than through the salinity reduction breach, because the water levels in the ponds will be lower than during salinity reduction. Interior levee breaches are constructed to their design size to ensure adequate circulation between the ponds. Restoration breaches are designed to create sufficient water flow into and out of the ponds so that the tidal signal in the ponds is the same as for the surrounding sloughs and Napa River. In several areas, the restoration breaches will require a pilot channel through the outboard marsh. The pilot channels would be constructed in the same manner as the breaches.

1.2.1 Breaching Process Activities

One breach will be constructed for salinity reduction, 8 interior levee breaches will be constructed, and up to 26 breaches will be constructed for restoration. The restoration and salinity reduction breaches will be located be at or near historic channel locations, and near Napa River or major sloughs to minimize the potential for tidal muting and provide sources of tidal and fluvial sediment. Levee breaching for restoration is conducted after salinity reduction.

1.2.2 Construction Process

Interior and exterior levee breaches would be created using explosives or excavators. If explosives are used, the quantity of explosives will be adjusted in proportion to the volume of levee material. The material displaced from a levee breached by explosives would be dispersed over a wide area, so no earthmoving equipment would be required. Most of the displaced earth is expected to be deposited on adjacent areas of the levee. If an excavator is used to create the breach, the excavated soil would be placed on adjacent portions of the levee (i.e., provides an opportunity to conduct levee maintenance in the vicinity of the breach).

For the salinity reduction breach on Pond 4, the flow of water through the levee and subsequent tidal action will open the levee beyond the size of the initial breach. The extent of scour depends on the water height differential between the pond and the receiving water. As pond water levels are generally above mean tide level, the initial salinity reduction breach will scour more heavily due to the greater discharge of water. The initial salinity reduction breach (a V-shaped wedge approximately 5 feet wide at the top by 10 feet deep by 15 feet long) would be sized to lead to a scoured breach approximately 50 feet wide.

If explosives are used to create a breach, the explosives would be placed through PVC tubes drilled into levees. The explosives will be placed into the PVC pipes. Sizing of charges, placement, and detonation will be carried out by certified explosives experts from a state or federal agency. The Discharger has previously conducted several similar levee breaches at the site. Excavators would be brought to site on barges at high tide.

1.2.3 Estimated Volumes and Affected Areas

The initial breach of the Pond 4/Napa River levee will be created by the displacement by explosives of approximately 15-30 cubic yards (cy) of earth, most of which is expected to be deposited on adjacent areas of the levee. The flow of water through the initial breach on Pond 4 is expected to open the levee beyond the size of the initial breach to an ultimate width of approximately 50 feet.

Flow through a restoration breach may be enhanced by the construction of up to 100 feet of pilot channel exterior to the levee. A pilot channel is an excavated channel extending from a restoration breach through existing vegetated marsh to tidal waters. The pilot channel is intended to facilitate tidal exchange through a breach by providing a small initial flow path and removing erosion-resistant marsh vegetation so the channel can gradually enlarge through tidal scour. To minimize impacts to existing marsh and minimize construction costs, pilot channels are generally narrower and shallower than breach excavations. The pilot channels have a minimum depth associated with complete clearing and grubbing of marsh vegetation. The target maximum depth is the same as the restoration breach depth, or about -4 feet NAVD, and the average pilot channel is 50 feet wide by 4 feet deep. However, this depth may be exceeded for construction access. In two locations on Pond 3, longer (500-foot long) pilot channels may be required.

Excavated material, including vegetation, is placed in the salt pond or on the adjacent levees. The pilot channels would also be created using explosives or excavators. The estimated volume of pilot channel and restoration breach excavation is 28,500 cy, 18,100 cy, and 20,700 cy respectively for Ponds 3, 4, and 5. The corresponding excavated acreages are 3.6, 2.0, and 2.8 acres, respectively.

1.3 Construction of Starter Channels and Berms

The construction of starter channels is proposed in the interior of Ponds 4 and 5 prior to levee breaching. Starter channels may also be constructed in Pond 3, depending on the evolution of habitat within that pond; starter channels in Pond 3 would be limited to the northeastern portion of the pond, away from the existing breaches. Starter channels help establish a desired channel pattern, typically similar to the historical pattern, which is likely to result in maximum habitat value. The starter channels also enhance site drainage, which may increase the rate of vegetation establishment, provide habitat for fish soon after construction, and promote the more rapid formation of smaller channels, which could provide important habitat to biota. The starter channels are expected to help tidal flows penetrate further into ponds and thus accelerate sediment deposition and reestablishment of mudflat and marsh habitat. Approximately 17,500 lineal feet of starter channels and berms are proposed; starter channels would only be constructed in Ponds 3, 4, and 5.

1.3.1 Starter Channel and Berm Description

The preliminary design sizing for starter channels is based on a fourth order channel at the breach (about 100 feet wide at the top, 7 to 8 feet deep, and 20 feet wide at the bottom) transitioning to a smaller cross section at the other end, consistent with a third order channel (about 50 feet wide at the top, 4 feet deep and 10 feet wide at the bottom). This is representative of a 4th order channel transitioning to a 3rd order channel (however, natural channel dimensions are highly variable). Thus, starter channel dimensions 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 requires the removal of roughly 5 to 18 cubic yards of material, depending on the size of the channel.

Excavated material would be used to construct berms along one side of starter channels. The berm elevation would vary around mean higher high water (MHHW). Berms will have an estimated side slope of 7:1. The width of the berms will depend on the amount of sediment generated from the starter channel construction. Berms limit wave generation by limiting reducing the open water fetch lengths, and dissipating waves incident to the berms. Reduced wave action will increase sedimentation rates and will provide a calmer environment conducive to vegetation establishment. Increased sedimentation will facilitate evolution of the site toward higher elevations and vegetated marsh.

1.3.2 Construction Process

A barge-mounted hydraulic suction dredge or clamshell excavator would be used to dredge out starter channels along the alignments of historic channels. Using barge-mounted equipment allows construction without draining the ponds, thus minimizing habitat impacts during construction. The berms would be constructed simultaneously along-side the channels. This approach assumes that the location of the channels could be determined and marked without drawing down the ponds. Recent geotechnical testing in the ponds indicates that the sediment in the historic channels is much softer than in the adjacent areas, making it relatively easy to identify the course of the historic channels. This approach also avoids the risk of getting equipment stuck in sediment during excavation. This method results in slower construction than land-based equipment, which would require pond draw-down of the ponds.

The entire volume of sediment removed from the channels would be used to construct the berms. Acreage calculations for berms are based on an approximate elevation of MHHW, and a 7:1 side slope. The estimated average height of berms in Pond 3 would be 1.8 feet; due to the lower pond bottom elevation, berms in Ponds 4 and 5 would be approximately 3 feet high to reach an elevation of MHHW.

1.3.3 Excavation Volumes and Areas Affected

The estimate assumed an average channel width of 75 feet, and an average depth of 6 feet, leading to an average estimate of 10 cy sediment removed for each foot of channel constructed. The estimated volume of sediment excavated is 35,000 cy, 98,000 cy, and 90,000 cy for Ponds, 3, 4, and 5, respectively. At Pond 3, an estimated 6 acres of pond bottom will be excavated; an estimated 16.9 and 15.5 acres of pond bottom will be excavated at Ponds 4 and 5, respectively. The berms will have a footprint of approximately 13, 26, and 24 acres, respectively for Ponds 3, 4, and 5.

1.4 Construction of Ditch Blocks

Ditch blocks will be constructed in the borrow ditches of Ponds 3, 4, and 5 prior to levee breaching for restoration. The purpose of a ditch block is to prevent borrow ditches at the interior toe of a levee from capturing the tidal supply of water and becoming a permanent site feature. Ditch blocks are placed only where existing ditches are located or configured differently than desired, based on a consideration of natural marsh morphology.

1.4.1 Ditch Block Description

Up to 22 ditch blocks may be constructed. The precise number of ditch blocks required will depend on the number of breaches constructed. Ditch blocks will be constructed between levee breaches to avoid fish entrapment at low tide. The ditch blocks will cover the entire borrow ditch. Ditch blocks will be constructed to an approximate top elevation of MHHW. A typical ditch block is approximately 100 feet long, 40 feet wide and 4 feet high (measured from the adjacent pond bottom), with side slopes of 5:1. Borrow ditches are assumed to be 4 feet deep relative to the adjacent pond bottom.

1.4.2 Construction Process

Construction of ditch blocks would take place prior to opening a pond to tidal action. The blocks will typically be constructed using land-based equipment and utilizing soil from the top of levees as fill material. Front-end loaders would collect and transport fill from the top of the levee to a large hydraulic excavator. The excavator would push the soil into the pond and slowly build the ditch block out from the levee into the pond. The levee would be lowered to a elevation slightly above MHHW (i.e., to retain sufficient strength to support the construction equipment).

1.4.3 Excavation and Fill Volumes and Areas Affected

Assuming that the borrow ditch volume is roughly the same as the levee, and assuming an additional 50 percent in volume to account for losses in the pond waters during construction and subsidence after construction, each ditch block will require 1,600 cubic yards of soil, which is expected to be derived by lowering 670 lineal feet of levee by approximately three feet. For 22 ditch blocks, the total estimated volume of soil to be excavated and placed would be 35,200 cy, with approximately 7,300 lineal feet of associated levee lowering. An estimated 5.9, 4.4, and 4.4 acres of levees would be lowered at Ponds 3, 4, and 5, respectively. An estimated 1.6, 1.2, and 1.2 acres of ditch blocks (fill) would be created at Ponds 3, 4, and 5, respectively.

1.5 Supplemental Levee Lowering

In addition to the levee lowering performed to create ditch blocks, supplemental levee lowering may be performed to accelerate the establishment of marsh vegetation.

1.5.1 Supplemental Levee Lowering Description and Construction

Up to 22,200 linear feet of levee not associated with ditch blocks may be lowered to an elevation around MHHW. Levee lowering would likely be performed after the ponds are open to tidal action, to avoid the potential for an accidental pond breach. Levee lowering for habitat enhancement is expected to generate approximately 6 cubic yards of excavation per lineal foot of levee lowered. The material would be collected from the top of the levee and pushed into the borrow ditch at the interior toe of the levee with front-end loaders. The borrow ditch would be narrowed but not blocked along areas of levee lowering.

1.5.2 Excavation and Fill Volumes and Areas Affected

The preliminary design assumes a levee width of 50 feet, levee side slopes of 3:1 on the external side and 3:1 on the internal side, and a lowering distance of 3 feet. This corresponds to an excavation volume of 60,500 cy, 49,500 cy, and 35,500 cy for Ponds 3, 4, and 5, respectively. The amount of levees being lowered at Ponds 3, 4, and 5 would be 10.6, 8.7, and 6.2 acres, respectively. The corresponding acreage of borrow ditches partially filled is estimated to be 9.4, 7.7, and 5.5 acres, respectively.

2 CONSTRUCTION OF WATER CONTROL STRUCTURES WITHIN THE PROPOSED PROJECT

The proposed Lower Ponds Project involves the construction of three types of water control structures: intakes/outfalls, siphons, weirs, and potentially fish screens (on the Pond 6A intake). New and replacement water control structures would be installed in Ponds 1, 1A, 6 and 6A, and Fly Bay. Fly Bay is the area located between Pond 8 and Pond 7/7A; it is within the footprint of the Project as originally scoped. These structures consist of an outfall on Pond 1 and on Pond 6, an overflow weir on Pond 6, intakes on Ponds 1A and 6A, and a small water control structure (culvert and gate) at Fly Bay. Replacement water control structures would be constructed for Ponds 1, 1A, 2, 6, and adjacent Little Island. Little Island is the area located between Pond 1A and Pond 6, east of Napa Slough; it is within the footprint of the Project as originally scoped. These replacement water control structures consist of a pump station (Pond 1), siphons and related donut structures at Ponds 1, 1A, and 6, an outfall and a combined intake and outfall at Ponds 1A and 2, and a water control structure on Little Island.

2.1. Intakes

Intake structures connecting to South Slough to Pond 2A, Napa Slough to Pond 6A, and a replacement combined intake and outfall structure for Pond 2 are proposed. Intake structures consist of a pipe or series of pipes penetrating a levee, and convey water from the river and sloughs into ponds during high tide. Pipes may be made of high-density polyethylene (HDPE) for ponds that will be retained as ponds in the long-termor a less chemically-resistant material if appropriate. The pipes for the intakes on Ponds 2A and 6A will be fitted with flap and screw gates that only open when the elevation of the river or slough is above that of the pond. These gates will prevent back-flow from the pond into the river or slough when flooding is desired. The Pond 2, Little Island, and Fly Bay intakes will be equipped with valves that allow flow in either direction. Manual knife valves will also be included on all pipes within the levees.

Construction of the intakes would be conducted using construction equipment brought to the needed location via levee tops and/or barges. Cofferdams would be constructed using sheetpiles on the river/slough side of the levee. The inner areas of the cofferdam would be dewatered during construction as necessary. The levee would then be excavated, intake pipes would be installed in the trench through the levee, the levee would be back-filled and compacted, and the cofferdams would be removed. On the slough side of the Pond 6A levee, additional pipe will be installed so that the intake elevation is 3 to 4 feet below lower low tide. In areas where the terrain is above high tide, inlet pipes may be installed in a trench dug out by a clamshell digger. In areas where the design pipe elevation is under water at high tide, the pipe will be attached to support piles driven by a pile driver. All intakes will be accompanied by associated hardware, such as gangways to the valve location.

2.2 Pond 6A Fish Screens

If required, a fish screen would be attached to a flange on the end of any intake structures on the intake end of the pipe. Screens would be made of stainless steel and epoxy-coated components that are cathodically protected. The screens would be self-cleaning and powered by a solar panel system. The frequency of cleaning will be set manually to meet field conditions. Fish screens would be lowered onto the inlet at the end of an intake structure using a crane and dive crew. The screens will be supported by a number of piles and additional piles will be installed around the screens to protect them from large floating debris. Biological Opinions provided through consultation with both the National Marine Fisheries Service and with the United States Fish and Wildlife Service considered, but did not recommend, installing fish screens on the Pond 6A intakes, or any other locations.

2.3 Outfalls

The outfalls will run from the pond through the external levee and straight out into the receiving water. A manual knife valve is included on the outfall within the levee so that flow through the outfall can be controlled. The outfalls will be constructed of HDPE or a less chemically-resistant material, if appropriate. The Pond 2 outfall is about 300 feet in length, and consists of a 48-inch-diameter culvert. The outfall was sized to replace the existing structure. A new outfall will be added from Pond 6 to Napa Slough/Little Island. The Pond 6 outfall will be approximately 200 feet long, and 48 inches in diameter. The outfalls will be equipped with a flap gate that only open when the water level in the pond is higher than the water level in the slough and will be constructed in a similar fashion to the intakes. The outfalls will be accompanied by associated hardware, such as gangways to the valve location.

2.4 Pond 6 Weir

To ensure flexibility in water management in Pond 6, an overflow weir discharging to Devil's slough will be constructed on the Pond 6 donut. Thus, if water levels in Pond 6 exceed acceptable levels, and the discharge capacity for the Pond 6 to Pond 5 siphon is not sufficient to quickly lower the water levels in Pond 6, the weir would be used as alternative discharge measure. Construction of the weir would also occur from the levee top, and use the same type of equipment as the intakes and outfalls.

2.5 Siphons

The proposed Project includes new or refurbished siphons in all locations where siphons will be used for salinity reduction or pond maintenance, including Ponds 1 to 2 and Pond 6 to 5, and the shorter siphons leading to the donuts at these ponds. All siphons would be installed with manually controlled knife valves. All siphons will be accompanied by associated hardware, such as gangways to the valve location.

Replacement siphons would be constructed using construction equipment brought to the needed location via levee tops and/or barges. The construction area would be dewatered if necessary. The levees between the ponds and the slough would be excavated. A trench would then be excavated across the slough from one levee breach to another. A gravel bed would be placed in the trench, and the siphon placed on to the bed using divers and a crane. Once the siphon and valve were in place, the trench along the bottom of the slough and the levee at each pond would be back filled. Any cofferdams constructed to help dewater the excavation would be removed after back filling was completed.

2.6 Pond 1 to 2 Pump Station

The proposed Project includes a new or refurbished pump station at Pond 1. The existing pump station has a capacity of 30,000 gpm, and was used to transfer water from Pond 1 (the intake pond) into Pond 2, and to create sufficiently high water levels in Pond 2 to continue to move water through the pond system. The current pump station is old and deteriorated. At minimum, refurbishment of the pump station will include replacement of the existing pumps with new, energy-efficient pumps. The construction activities may also include replacement of the electrical system and pump shed.

The pump station is land-accessible, and all construction would be conducted using land-based equipment brought to the site via Highway 37 and the Pond 1 levee. Due to the large size and weight of the pumps a crane will be required to remove the old pumps and install the new pumps. Debris from demolition of the existing pump shed would be removed by a front-end loader and dump trucks. Replacement of associated buried piping would be coordinated with the replacement of the Pond 1-2 siphon, and would be conducted partially from the water and partially from the land. Removal and installation of the associated piping would occur in the same manner as described for the siphons.

Location	Item	Quantity
Pond 1	300-foot-long, 54-inch diameter siphon to Pond 2 (in-kind replacement of one existing 73-inch diameter siphon of the same length)	2
	30,000-gpm Pump Station (in-kind replacement of existing structure)	1
	Levee repair	10,650 linear feet
	Levee maintenance (annual)	1,775 linear feet
	48"inch, 200 ft long, culvert from donut to South Slough	1
	Replace existing 24-inch structure from donut to Pond 1 and 36-inch structure from donut to Pond 1A	2
Pond 1A	Levee repair	3,790 linear feet
	Levee maintenance (annual)	2,525 linear feet
	Internal, 100-foot-long levee breach between Ponds 1 and 1A to improve water circulation and quality.	5
	New 100 foot-long, 48-inch combination gate between Pond 1A and China Slough.	1
Pond 2	200-foot-long, 48-inch diameter outfall (in-kind replacement of existing structure)	1
	Levee repair including placement of borrow fill from inside of pond, and (for Northern Levee) placement of berms or rip-rap on inboard (pond-side) to protect levee from wind fetch and erosion	24,200 linear feet
	Levee maintenance (annual)	3,025 linear feet
Pond 2A	200-foot-long, 48-inch diameter combined intake and outfall (in-kind replacement of existing structure to All American Canal/China Slough)	1
All American Canal	Levee lowering	2,000 linear feet
	100-foot-long habitat breach between Pond 2A and China Slough	4
Pond 3	100-foot-long habitat restoration breach (includes pilot channels)	Up to 9
	Ditch block (40-foot ditch block [length parallel to levee], 4 feet deep)	Up to 8
	Starter channel with berm (berm may be placed near existing spoil piles to enhance existing tern nesting colonies off of Dutchman Slough)	Up to 3,500 linear feet
	Levee lowering	9,227 linear feet
Pond 4	50-foot-long salinity reduction breach	1
	100-foot-long interior levee breach between Pond 4 and 5	4
	100-foot-long habitat restoration breach (includes pilot channels)	Up to 7
	Ditch block (40-foot ditch block [length parallel to levee], 4 feet deep)	Up to 6
	Starter channel with berm	9,800 linear feet
	Levee lowering	7,549 linear feet

Location	Item	Quantity
Pond 5	100-foot-long habitat restoration breach (includes pilot channels)	Up to 6
	Ditch block (40-foot ditch block [length parallel to levee], 4 feet deep)	Up to 6
	Starter channel with berm	9,000 linear feet
	Levee lowering	5,424 linear feet
Pond 6	250-foot-long, 52-inch diameter siphon from Pond 6 to Pond 5 donut / canal	1
	Replace existing gates and structures from donut to Ponds 6, 6A, and internal canal	3
	Overflow weir to Devil's Slough	1
	New 48-inch, 200 ft long, culvert with flap gate from Pond 6 to Napa Slough/Little Island	1
	100-foot-long Interior levee breach between Pond 6 and 6A	4
	Levee repair	930 linear feet
	Levee maintenance (annual)	1,850 linear feet
Pond 6A	250-foot-long, 52-inch diameter intake with fish screen	5
	Levee repair	3,250 linear feet
	Levee maintenance (annual)	1,625 linear feet
	Replace existing donut structures from donut to Pond 6A and to internal canal	3
	Install new structure from Pond 6A donut to Napa Slough	1
Little Island	Replace existing 40 foot, 48-inch water control structure	1
	Internal ditching to improve water circulation for mosquito abatement	3000 linear feet
Fly Bay	New 30-foot-long, 24-inch water control structure between former ranch site and borrow ditch to improve water circulation for mosquito abatement	1

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

SELF-MONITORING PROGRAM

FOR

NAPA RIVER SALT MARSH – LOWER PONDS RESTORATION PROJECT

ORDER No. R2-2004-0063

A. GENERAL

1. Reporting responsibilities of waste dischargers are specified in Sections 13225(a), 13267(b), 13383 and 13387(b) of the California Water Code, and in this Regional Board's Resolution No. 73-16.

2. The principal purposes of a monitoring program by a waste discharger, also referred to as self-monitoring program, are: (1) to document compliance with waste discharge requirements and prohibitions established by this Regional Board, (2) to facilitate self-policing by the waste discharger in the prevention and abatement of pollution arising from waste discharge.

B. SAMPLING AND ANALYTICAL METHODS

1. Sample collection, storage, and analyses shall be performed according to Code of Federal Regulations Title 40, Section 136 (40 CFR S136), or other methods approved and specified by the Executive Officer of this Regional Board.

2. Water and soil analyses shall be performed by a laboratory approved for these analyses by the State Department of Health Services (DOHS), or a laboratory waived by the Executive Officer from obtaining a DOHS certification for these analyses, or by properly calibrated field equipment when approved by the Executive Officer of this Regional Board.

3. The director of the laboratory whose name appears on the certification, or his/her laboratory supervisor who is directly responsible for the analytical work performed shall supervise all analytical work including appropriate quality assurance/quality control procedures in his/her laboratory and shall sign all reports of such work submitted to the Regional Board.

4. All monitoring instruments and equipment shall be properly calibrated and maintained to ensure accuracy of measurements.

C. DEFINITION OF TERMS

1. Grab sample is defined as an individual sample collected in a short period of time not exceeding 15 minutes. It is used primarily in determining compliance with daily maximum limits and instantaneous maximum limits. Grab samples represent only the condition that exists at the time the wastewater is collected.

2. Duly authorized representative is one whose:

   a. Authorization is made in writing by a principal executive officer or ranking elected official;

   b. Authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such chief engineer, project manager, or field supervisor.

3. Instantaneous maximum is defined as the highest measurement obtained for the calendar day.

4. Median of an ordered set of values is that value below and above which there is an equal number of values, or which is the arithmetic mean of the two middle levels, if there is no one middle value.

5. Receiving waters refers to any water which actually or potentially receives surface water discharged from the Lower Ponds Project Area. The receiving waters in this case are the Napa River and Napa Slough.

6. Construction phase is defined as that period of time when the site is prepared for marsh restoration and includes all activities leading up to the restoration of tidal action.

7. Construction phase activities are defined as all site activities including the movement of soil or sediment, such as placement of dredged material via slurry techniques, excavation of trenches and toe drains, and all other soil handling such as berm and levee construction.

8. Post-construction phase is defined as the period of time beginning when site construction is substantially completed, and tidal action has been restored to Ponds 4 and 5.

9. Post-construction phase activities are defined as all monitoring, site maintenance, and adaptive management activities which take place after construction is completed and tidal action has been restored to Ponds 4 and 5.

10. Project boundary shall be defined as the limit of the receiving waters at mean low low water level, which is the topographic contour representing an elevation of 0 ft. NAVD88.

11. Salinity reduction endpoint shall be considered to be achieved one year after the final day

when the salinity in either Pond 4 or Pond 5 is measured to exceed ambient Napa River salinity by more than 10 parts per thousand (ppt).

12. Monitoring period for purposes of reporting shall be defined as that period of time beginning on the day the levee separating Pond 4 from the Napa River is breached, and ending when the salinity reduction endpoint has been reached.

13. Ambient Napa River salinity shall be defined as the salinity measure in the Napa River at a point 50 feet upcurrent from the breach in the levee separating Pond 4 from the Napa River.

D. SPECIFICATIONS FOR SAMPLING AND ANALYSES

The Discharger is required to perform sampling and analyses according to the schedule in **Table A** in accordance with the following conditions:

1. Pond Water

   a. Grab samples of pond water shall be collected during periods of maximum peak discharge flows, and shall coincide with receiving waters sample days.

   b. If analytical results are received showing any instantaneous maximum limit is exceeded for any organic constituent, a confirmation sample shall be taken within 24 hours and results known within 24 hours of the sampling.

   c. If any instantaneous maximum limit for a constituent is exceeded in the confirmation sample(s), then the discharge shall be restricted to the extent practical, until the cause of the violation can be found and corrected.

   d. For other violations, the discharger shall implement procedures that are acceptable to the Executive Officer on a case by case basis.

2. Receiving Waters

   a. Receiving water sampling shall be conducted on days coincident with pond water of effluent.

   b. In tidally-influenced receiving waters, samples shall be collected at each station on each sampling day during the period within 1 hour following low slack water. Where sampling at lower slack water period is not practical, sampling shall be performed during higher slack water period.

   c. Samples of downstream receiving water shall be collected within the discharge plume and downcurrent of the discharge point so as to be representative, unless otherwise stipulated.

d. Samples of background receiving water shall be collected upcurrent of the discharge point.

e. Samples shall be collected within one foot below the surface of the receiving water body, unless water depth is less than one foot, in which case a mid-depth sample shall be taken.

E. DESCRIPTION OF SAMPLING STATIONS

1. A site plan drawing showing the location of all sampling points is included as **Figure 1**. A site plan drawing showing the location of all sampling points shall be submitted with all monitoring reports submitted under this Plan.

2. Receiving water sampling point NR-U shall be established at a point 50 feet upstream from the point of discharge into the receiving water, or if access is limited, at the first point upstream which is accessible.

3. Receiving water sampling point NR-D shall be established at a point 50 feet downstream from the point of discharge into the receiving water, or if access is limited, at the first point downstream which is accessible.

F. STANDARD OBSERVATIONS

1. Receiving Water

   a. Floating and suspended materials of waste origin (to include oil, grease, algae, and other macroscopic particulate matter): presence or absence, source, and size of affected area.

   b. Discoloration and turbidity: description of color, source, and size of affected area.

   c. Odor: presence or absence, characterization, source, distance of travel, and wind direction.

   d. Evidence of beneficial water use: presence of waterfowl or wildlife, fishermen, and other recreational activities in the vicinity of the sampling stations.

   e. Hydrographic condition, if relevant:

      1) Time and height of corrected high and low tides (corrected to nearest NOAA location for the sampling date and time of sample and collection).

      2) Depth of water columns and sampling depths.

   f. Weather condition:

1) Air temperature.

2) Wind - direction and estimated velocity.

3) Precipitation - total precipitation during the previous five days and on the day of observation.

2. Pond Water

a. Floating and suspended materials of waste origin (to include oil, grease, algae, and other macroscopic particulate matter): presence or absence, source, and size of affected area.

b. Discoloration and turbidity: description of color, source, and size of affected area.

c. Odor: presence or absence, characterization, source, distance of travel, and wind direction.

d. Evidence of beneficial water use: presence of waterfowl or wildlife, fishermen, and other recreational activities in the vicinity of the sampling stations.

e. Hydrographic condition, if relevant:

1) Time and height of corrected high and low tides (corrected to nearest NOAA location for the sampling date and time of sample and collection).

2) Depth of water columns and sampling depths.

f. Weather condition:

1) Air temperature.

2) Wind - direction and estimated velocity.

3) Precipitation - total precipitation during the previous five days and on the day of observation.

G. REPORTS TO BE FILED WITH THE REGIONAL BOARD

1. **Start-Up Report**: A report on the start-up phase shall be submitted to the Regional Board no more than 45 days after the initial salinity reduction breach on the levee dividing Pond 4 and the Napa River has been created. The Start-Up Report shall contain the same elements stipulated below under 2, Quarterly Self-Monitoring Reports, and shall include all data collected during the first 30 days following the breach of the Pond 4 levee.

2. **Quarterly Self-Monitoring Reports**: Written reports shall be submitted on a calendar quarter basis, not later than 30 days following the last day of the quarter. The reports shall be comprised of the following:

   a. Letter of Transmittal: A letter transmitting self-monitoring reports should accompany each report. Such a letter shall include identification of changes to the project design, and any unplanned releases or failures that may have occurred since the preparation of the previous self-monitoring report. If unplanned releases are noted, then a discussion of the corrective actions taken or planned, and a time schedule for completion, shall be included.

   b. Map or Aerial Photograph: A map or aerial photograph shall accompany the report showing sampling and observation station locations.

   c. Results of Analyses and Observations: The report format shall be a format that is acceptable to the Executive Officer.

      1) If the discharger monitors any pollutant more frequently than required by this permit using test procedures approved under 40 CFR Part 136 or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the Self-Monitoring Report.

      2) Calculations for all limitations that require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in this permit.

      3) The report shall also include a table identifying by method number the analytical procedures used for analyses. Any special methods shall be identified and should have prior approval of the Board's Executive Officer.

      4) Lab results shall be summarized in tabular form, but do not need to be included in the report.

3. **Annual Reports**: For monitoring activities associated with both the Construction Phase and the Salinity Reduction Phase, the Discharger shall submit an annual report to the Regional Board by January 30 of each year, covering the previous calendar year. The annual report shall contain all data required for the fourth quarter in addition to summary data required for annual reporting. This report may be submitted in lieu of the report for the fourth quarter of a calendar year. The Annual Report shall contain both tabular and graphical summaries of the monitoring data obtained during the previous year. In addition, the Annual Report shall contain a comprehensive discussion of the compliance record and the corrective actions taken or planned, which may be required to bring the Discharger into full compliance with Order No. R2-2004-0063.

4. **Final Report**: Reporting requirements under Order No. R2-2004-0063 will end after the

reduction endpoint has been reached, according to the criteria set forth under "Definitions", above. A Final Report will be submitted to the Regional Board that contains both tabular and graphical summaries of the monitoring data obtained during the entire Lower Ponds Project. In addition, the Final Report shall contain a comprehensive discussion of the compliance record and the corrective actions taken.

5. **Spill Reports**: If any hazardous substance is discharged in or on any waters of the state, or discharged and deposited where it is, or probably will be discharged in or on any waters of the state, the discharger shall report such a discharge to this Regional Board, at (510) 622-2300 on weekdays during office hours from 8 a.m. to 5 p.m., and to the Office of Emergency Services at (800) 852-7550 during non-office hours. A written report shall be filed with the Regional Board within five (5) working days and shall contain information relative to:

   a. nature of waste or pollutant,
   b. quantity involved,
   c. duration of incident,
   d. cause of spilling,
   e. Spill Prevention, Control, and Countermeasure Plan (SPCC) in effect, if any,
   f. estimated size of affected area,
   g. nature of effects (i.e., fish kill, discoloration of receiving water, etc.),
   h. corrective measures that have been taken or planned, and a schedule of these activities, and
   i. persons/agencies notified.

6. Monitoring reports, and letters transmitting monitoring reports, shall be signed by a principal executive officer or ranking elected official of the Discharger, or by a duly authorized representative of that person. The letter shall contain the following certification: "I certify under penalty of law that this document and all attachments are prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who managed the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

H. RECORDS TO BE MAINTAINED

1. Written reports, laboratory analytical reports, maintenance records, and other records shall be maintained by the Discharger and retained for a minimum of five years. This period of retention shall be extended during the course of any unresolved litigation regarding this discharge or when requested by the Regional Board or Regional Administrator of the U.S. Environmental Protection Agency, Region IX. Such records shall show the following for each sample:

a. Identity of sampling and observation stations by number.

b. Date and time of sampling and/or observations.

c. Method of sampling (See Section C - Definition of Terms).

d. Complete procedure used, including method of preserving sample and identity and volumes of reagents used. A reference to a specific section of Standard Methods is satisfactory.

e. Calculations of results.

f. Results of analyses and/or observations.

I, Bruce H. Wolfe, Executive Officer do hereby certify the foregoing Self-Monitoring Program:

1. Has been developed in accordance with the procedure set forth in the Regional Board's Resolution No. 73-16 in order to obtain data and document compliance with waste discharge requirements established in Regional Board Order No. R2-2004-0063.

2. Was adopted by the Board on July 21, 2004.

3. May be revised by the Executive Officer pursuant to U.S. EPA regulations (40 CFR 122.36); other revisions may be ordered by the Regional Board.

Bruce H. Wolfe
Executive Officer

Attachments: Table A
Figure 1

TABLE A - SCHEDULE FOR SAMPLING, MEASUREMENTS, AND ANALYSIS

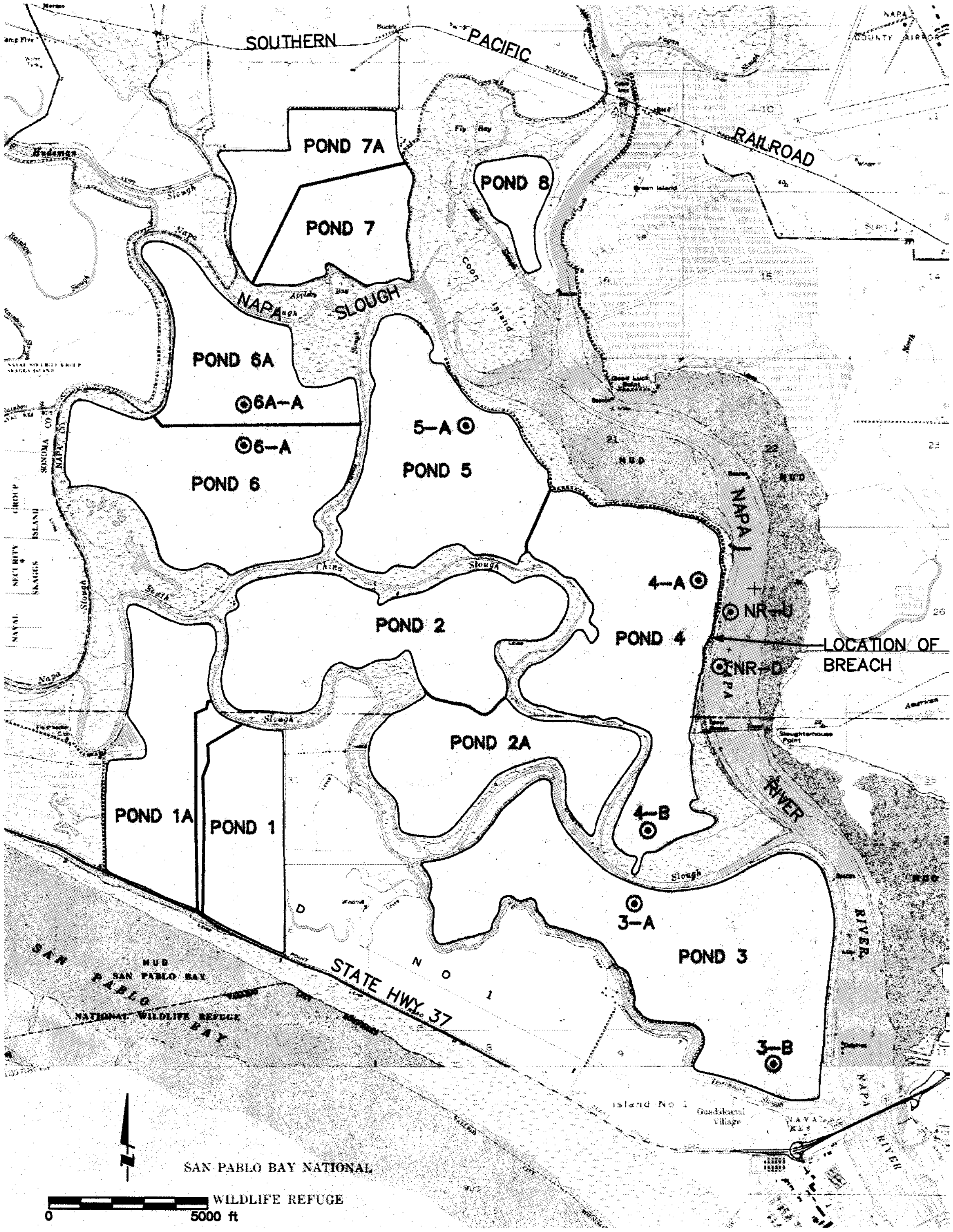
SAMPLE POINT:	METHOD	3-A	3-B	4-A	4-B	5-A	6-A	6A-A	NR-U	NR-D
MATRIX: WATER										
Salinity [1]		M	M	D/M	D/M	M	M	M	D/M	D/M
pH [1]		M	M	D/M	D/M	M	M	M	D/M	D/M
Temperature [1]		M	M	D/M	D/M	M	M	M	D/M	D/M
Turbidity [1]		M	M	D/M	D/M	M	M	M	D/M; DC	D/M; DC
Dissolved oxygen [1]		M	M	D/M	D/M	M	M	M	D/M	D/M
Total ammonia	SM 4500	M	M	M	M	M	M	M	M	M
Total mercury [2]	EPA 1631	M	M						M	
Methyl mercury [2]	EPA 1630	M	M						M	

Note: Un-ionized ammonia will be calculated from measurements of pH, temperature, salinity, and total ammonia.

MATRIX: SEDIMENT		3-A	3-B	4-A	4-B	5-A	6-A	6A-A	NR-U	NR-D
Total mercury [2]	FGS 066	M	M						M	
Methyl mercury [2]	FGS 045	M	M						M	

Notes:
[1] Field test only
[2] Methyl mercury / total mercury monitoring to be conducted for one year, in one pond, contingent on CalFed funding; Pond 3 is tentative choice

D/M	Once during the first and fifth day following breach; weekly during the first month; monthly thereafter
DC	Daily during construction activities conducted in receiving waters
M	Monthly
FGS	Frontier Geosciences



LEGEND:

—— INTERNAL POND LEVEE

—— POND LEVEE

⊙ 3–B SAMPLE COLLECTION LOCATION

Figure 1

LOCATION OF SAMPLE COLLECTION POINTS

SELF MONITORING PROGRAM

Napa River Salt Marsh – Lower Ponds Restoration Project

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MEMORANDUM

DATE: December 2, 2002

TO: Amy Hutzel, California State Coastal Conservancy

Cc: Susanne von Rosenberg, GAIA
George Harris, HSE
Bob Battalio, PWA

FROM: Don Danmeier
Chris Campbell

RE: **Napa River Salt Marsh Restoration Phase 2 Stage 2 – Salinity Reduction Modeling**
PWA # 1591

INTRODUCTION

The California State Coastal Conservancy (Conservancy), California Department of Fish and Game (CDFG), and the U.S. Army Corps of Engineers (USACE) are in the process of planning ecological restoration of former salt ponds in the Napa-Sonoma Marsh Wildlife Area. Under contract with the Conservancy, Philip Williams & Associates (PWA) has assisted in the planning process by providing technical services associated with salinity reduction and restoration design development. The purpose of this memorandum is to provide an overview of salinity reduction options screened in earlier stages of the planning process (Stage 1), and present results from recent modeling efforts (Stage 2). Work in support of the restoration design has been presented separately (PWA 2002a, 2002b).

Maintaining suitable bird habitat in the ponds prior to restoration has been difficult because of aging infrastructure, prohibitive pumping costs, and intense evaporation during summer and fall. Consequently, salinity levels have continued to increase and complete drying of some pond areas has been observed after long periods of dry weather. The screening of salinity reduction options carried out in Stage 1 assumed continued buildup of salt based on each of the ponds. However, the no-project conditions assumed during the Stage 2 modeling effort were different due to recent changes to Pond 3. On August 12, 2002 CDFG personnel discovered a small hand-dug ditch along the Pond 3 levee to South Slough and subsequently constructed a second small ditch on September 9, 2002 to reduce pressure on the first ditch. Over the past three months, these two small ditches have had the effect of raising water levels, but tidal action remains extremely muted (approximately 0.1 ft in range in Pond 3).

KEY FINDINGS AND CONCLUSIONS

Results from the Stage 2 salinity reduction modeling lead to the following key conclusions:

- Breaching the exterior levee of Pond 4 during higher river flows would produce relatively short desalination times in Pond 6A, 6, 5 and 4. Increases in Napa River salinity are expected to be substantial but also of limited temporal extent. With tidal exchange through a 50-ft breach, simulated depth-average salinity in Napa River shows an increase of about 20 parts per thousand (ppt) in the vicinity of the breach and an increase of 10 – 12 ppt over a 2 km reach one day after the breach. After about a week, impacts are expected to decrease to approximately 5 – 10 ppt but cover a 6 km reach. River salinity is expected to return to no-project conditions after approximately one month, based on model results. These results assume initial salinities in Ponds 4 and 5 can be diluted to about 100 ppt before breaching the levee, and salinities in Ponds 6 and 6A can be reduced to about 30 ppt.

- Based on a qualitative assessment, a saline dense bottom plume is expected to develop and sink to the lowest sections of the river due to the density differences between pond and river waters. This saline bottom layer is likely to persist at concentrations similar to the pond levels, since turbulent mixing in the river would not likely overcome the stabilizing effect of the heavy saline plume and lighter river water. The dense saline water is expected to sit on the river bed in a fairly stationary manner, moving primarily due to gravitational forces (density differences), and have limited exchange along its interface with overlaying water.

- Elevated salinity levels in lower Napa River are not expected to restrict safe passage of fish following breaching. Simulated depth-averaged salinity levels are well below acceptable levels for steelhead trout and striped bass (as reported in JSA 2002) for most, if not all, of the lower Napa River over the entire desalination period. Although density differences between the effluent and receiving waters will increase the near-bottom salinities, concentrations near the surface will be below simulated values and provide connectivity between low salinity waters. Impacts to benthos are expected to be greater, since there is the potential for a plume of saline water to develop along the river bed (see above). However, this saline layer of water would be confined to the deepest sections of the river and follow a rapid substantial – and natural – decrease in salinity due to high river flows.

- Releasing water from Pond 7 at a 1:100 dilution ratio results in very slow flushing times for bittern. Discharges at a 1:20 dilution produce much more rapid flushing of bittern from Pond 7, but slough concentrations of bittern under these conditions are close to the 1% bittern toxicity threshold. Neither discharge rate produces a long-term build-up of bittern in the barotropic mixing zone, and time scales of the slough concentrations are similar to the time scales of the concentrations in Pond 7.

DESCRIPTION OF THE NUMERICAL MODELS

ONE-DIMENSIONAL NAPA RIVER MODEL

PWA applied a numerical model of the pond and slough systems in Stage 1 to screen various salinity reduction options. This model coupled a two-dimensional (2D) representation of the ponds and a one-dimensional (1D) schematization of the slough and river network. The model domain extended from the upstream reaches of Sonoma Creek and Napa River to their mouths, and included the looped slough network that connect the two. Detailed descriptions of the model, and its numerical schemes, calibration, and applications may be found in previous reports (PWA 2002a, 2002c, 2002d).

The efficiency of the 1D slough and river schematization allowed several proposed salinity reduction options to be examined at a cursory level during the early planning stages. Although this was appropriate for screening purposes, mixing processes in Napa River were greatly simplified by its 1D representation. In particular, only the longitudinal variation in salinity could be simulated since concentrations were assumed uniform across the width and depth of the river. This is analogous to instantaneous and complete mixing across the river, and is not appropriate if detailed descriptions of the vertical and transverse gradients in salinity are required. However, the sectionally-averaged salinity computed during the Stage 1 screening process can be interpreted as representative of ambient conditions beyond the initial mixing zone.

TWO-DIMENSIONAL BAY AND NAPA RIVER MODEL

A refined numerical model of the pond and slough systems was applied in Stage 2 to examine the preferred salinity reduction option as well as various restoration options. Due to the large tidal prism associated with restoration of the ponds and the proximity of the former model boundary at lower Mare Island Strait, the model domain was extended to include the entire San Francisco Bay. Additionally, the 1D schematization of lower Napa River was replaced by a 2D depth-averaged representation. The 1D schematizations of the sloughs, Sonoma Creek and upper Napa River were retained.

Although the 2D schematization of lower Napa River simulates transverse mixing processes, flow parameters are depth-averaged and cannot resolve vertical variations in density or concentration. Therefore, we applied approximate analytic tools when interpreting the model results in order to qualitatively assess the potential for a dense bottom plume to develop after release of hypersaline water from the ponds.

SCREENING OF SALINITY REDUCTION OPTIONS (STAGE 1)

PWA screened various salinity reduction scenarios as part of the Stage 1 modeling effort in order to identify feasible salinity reduction options. These model results were subsequently used to develop the salinity reduction options described in the Environmental Impact Report/Statement (EIR/S) (JSA 2002). Options 1A and 2 were variations on a common theme, in which make-up water from Napa River and the surrounding sloughs is used to raise the water levels in the northern ponds and drive flow in a southward direction before discharge into lower Napa River (Option 1A) or San Pablo Bay (Option 2). In these options, water is conveyed through a series of culverts, siphons and diffusers. The exception to this approach are Options 1B and 1C, which include a planned levee breach during a high river flow event.

The proposed options are briefly described below along with general findings. Complete descriptions of the Stage 1 model runs and conclusions of the screening analysis are included in PWA 2002a and PWA 2002d. Detailed descriptions of the proposed salinity reduction options can be found in JSA 2002. Note that in some instances details of the salinity reduction options vary slightly from the preliminary model runs.

Note that all screening simulations carried out in Stage 1 used the 1D Napa River schematization described above, and increases to the sectionally-averaged salinity were kept to +5 ppt (parts per thousand) or below. Thus, the times required for salinity reduction may increase if more stringent discharge criteria are applied. Additionally, the model runs do not consider dissolution of precipitated salts, which could increase desalination times. Unusually dry weather and/or poor circulation within the pond system may also extend the time required to effectively desalinate the system.

SALINITY REDUCTION OPTION 1A

The configuration of Salinity Reduction Option 1A is shown in **Figure 1** for the Lower Ponds (Ponds 3 through 6A). In general, make-up water is introduced at the northern end of the ponds and discharged into Napa River in the southern reaches of the pond complex. This option uses constructed intakes and outfalls for all ponds, including Ponds 3 and 4/5. These hydraulic structures include:

- an intake from Napa Slough to the north-central section of Pond 6A,
- an intake from Napa Slough to the north-central section of Pond 5,
- a siphon under Devil's Slough to route water from Pond 6 to Pond 5,
- an outfall to Napa River from the south-central portion of Pond 4,
- an intake from Napa River to the northeast corner of Pond 3,
- an intake from Dutchman Slough to southwestern side of Pond 3, and

- an outfall to Napa River from the southeast side of Pond 3.

For the purposes of the Stage 1 modeling, each intake and outfall was modeled as four 48-inch circular culverts fitted with flap gates. Additionally, four 100-ft breaches were assumed to be constructed in each of the two interior levees in Ponds 4/5 and 6/6A in order to enhance mixing. Note that under Option 1A, Pond 3 is hydraulically disconnected from Ponds 6A through 4.

Numerical simulations of this configuration showed sectionally-averaged increases in Napa River salinities were at the target maximum level of 5 ppt despite only moderate initial pond salinities (about 60 – 70 ppt in Ponds 4 and 5) due to the fact that hypersaline waters were not mixed in the low-salinity Pond 3 prior to discharge. These impacts could be lessened by reducing the number or sizes of the outfall culverts.

SALINITY REDUCTION OPTION 1B – LOWER PONDS

Figure 2 shows the configuration of Salinity Reduction Option 1B for the Lower Ponds. This option uses a controlled levee breach to desalinate Pond 3 during a high flow event. The remaining intakes and outfall locations are the same as for Option 1A. Note that although the 50-ft breach to Napa River was later relocated to the southeastern corner of Pond 3, the modeled configuration shown in **Figure 2** is not expected to produce findings that would be materially different.

Results from the screening-level analysis indicate that Pond 3 could be flushed to ambient levels in a several weeks, and that sectionally-averaged salinities in Napa River would increase by about 8 ppt before returning to no-project levels in approximately two months. However, since breaching would coincide with a high flow event when salinities are at a minimum, the sectionally-averaged concentration in the Napa River computed by the model was below conditions during normal dry periods.

SALINITY REDUCTION OPTION 1C – LOWER PONDS

Salinity Reduction Option 1C is shown in **Figure 3**, and consists of planned breaches along the Pond 4 and Pond 3 levees to Napa River during a high flow event. This configuration is similar to Option 1B, but with an additional 50-ft breach into Napa River from Pond 4.

Results from the screening-level analysis indicate that the Lower Ponds could be flushed to ambient levels after several months. Sectionally-averaged salinities in Napa River are expected to increase by about 20 ppt before returning to no-project levels in approximately two months. However, since breaching would coincide with a high flow event when salinities are at a minimum, the sectionally-averaged concentration in the Napa River computed by the model was similar to conditions during normal dry periods.

Initial screening by PWA indicated that this option might be feasible and offer other benefits (see below) if discharge criteria could be modified during a high Napa River flows. Therefore, the Project Team decided to analyze a breach desalination option more closely in Stage 2. Results from the Stage 2 effort are summarized later in this memorandum.

SALINITY REDUCTION OPTION 1 – UPPER PONDS

Screening of salinity reduction in the Upper Ponds (Ponds 8, 7A and 7) was carried out independently since this complex is hydraulically separated from the Lower Ponds for all salinity reduction options except for Option 2. Flows from Ponds 7, 7A and 8 are combined with recycled water at a mixing chamber before discharging into the Napa Slough, as shown in **Figure 4**. Constant flow rates of 5,000 and 15,000 ac-ft/yr of freshwater were assumed to determine if desalination could be accelerated using recycled water. A complete description and results of the proposed desalination option in the Upper Ponds are presented in a memorandum to the Sonoma County Water Agency (PWA 2002d).

The following hydraulic structures were included in the modeling of salinity reduction in the Upper Ponds under Option 1:

- intake from Mud Slough to Pond 8 via two 30-inch diameter circular culverts with flap gates,
- discharge from Pond 8 into the canal passing to the north of Pond 8 towards the mixing chamber via a 48-inch culvert with a flap gate,
- intake from Napa Slough to Pond 7 via a 48-inch diameter circular culvert with a flap gate,
- discharge from Pond 7A into the mixing chamber via a 48-inch culvert with flap gate,
- discharge from Pond 7 into the mixing chamber via a gate such that flow is adjusted to meet a pre-determined dilution ratio of bittern, and
- a recycled-water pipeline to Pond 7 and the mixing chamber.

Since bittern is toxic to aquatic organisms when released in concentrated form, discharges from Pond 7 were restricted. Therefore, the model was configured such that bittern discharges from Pond 7 to the mixing chamber achieved a specified dilution (1:100) prior to release to Napa Slough. This greatly reduced the flow through Pond 7 and led to significantly longer predictions of desalination times for this pond.

Although Ponds 7A and 8 desalinate more quickly than Pond 7, strong seasonal fluctuations are expected due to limited tidal exchange and intense summer evaporation. These variations will be stronger during unusually dry years and increase the flushing time for these ponds.

SALINITY REDUCTION OPTION 2 – PONDS 3 THROUGH 5

Like Option 1A, Salinity Reduction Option 2 relies on the extensive use of hydraulic structures to route water through the pond system. Desalination in Ponds 3 through 5 is shown in **Figure 5**, and uses the following hydraulic structures:

- an intake from Napa River to the northeast corner of Pond 3,
- an intake from Napa Slough to the north-central section of Pond 5,
- a siphon under South Slough to route water from Pond 4 to Pond 3, and
- an outfall to Napa River from the southeast side of Pond 3.

As before, the interior levee for Pond 4/5 would have four 100-ft breaches to enhance mixing.

In this approach, Pond 3 is used as a mixing chamber before discharging hypersaline water into Napa River. Salinity reduction is carried out in a phased approach, starting in Pond 3 and continuing to Ponds 4 and 5 after the salinity in Pond 3 reaches ambient levels. Screening-level analyses indicate that salinity reduction in the Lower Ponds may be accomplished within approximately two years under the phased approach given initial salinities of about 160 – 170 ppt in Ponds 4 and 5, and moderate salinity levels (under 40 ppt) in Pond 3.

Use of Pond 3 as a mixing pond prior to discharge into Napa River has the benefit of minimizing impacts to the receiving waters. Stage 1 results show that sectionally-averaged salinity in Napa River outside the initial mixing zone increases by approximately 2 ppt, well below the maximum criterion of 5 ppt

SALINITY REDUCTION OPTION 2 – PONDS 1 THROUGH 8

Option 2 combines salinity reduction in the Upper and Lower Ponds, as shown in **Figure 6**. It was initially expected that this configuration may lead to more rapid desalination time for Pond 7. The intakes at Ponds 7, 7A, and 8 would be similar to those under Salinity Reduction Option 1, although the outfall into Napa Slough would not be constructed, and no intakes would be required for Ponds 6/6A. Additional infrastructure for this option includes:

- installation of two 54-inch siphons from Pond 6 to Pond 2,
- replacement of an existing 72-inch siphon that connects Pond 2 to Ponds 1 and 1A with two 54-inch siphons, and
- construction of one new 72-inch outfall underneath Highway 37, allowing water to flow between San Pablo Bay and Pond 1.

As with Salinity Reduction Option 1, the interior levee for Pond 6/6A would have four 100-ft breaches to enhance mixing.

Numerical results show that combining the Upper and Lower Ponds during salinity reduction accelerates the flushing of Pond 7 by a factor of 2 to 3, but at the expense of introducing bittern to other ponds and negatively impacting aquatic habitat. Additionally, Option 2 would require more infrastructure than the other proposed salinity reduction options.

STAGE 2 SALINITY REDUCTION MODELING

Information learned during the screening process led to refinement of the salinity reduction options, and the Project Team chose to examine a levee breach option more closely due to the limited infrastructure involved, quicker desalination times, and the expectation that elevated salinity levels in Napa River would rapidly return to no-project conditions after a large initial release of salt from the ponds. Therefore, PWA applied the 2D bay and river model described above to assess the short-term salinity impacts to Napa River of a breach along the Pond 4 levee.

SALINTIY REDUCTION OPTION 1C – LOWER PONDS, PHASE 2

Salinity reduction modeled in Stage 2 is shown in **Figure 7** and includes desalination of Ponds 6A through 4. Make-up water is conveyed into Pond 6A via four 48-inch intake culverts fitted with flap gates, and limited tidal exchanged occurs through the 50-ft breach in the Pond 4 levee. Breaching of the levee was assumed to coincide with a 2-yr flood event in order to examine salinity reduction under the peak discharge of a typical winter season. The small ditches along Pond 3 constructed in the summer of 2002 (see Introduction) are expected to widen by natural means or intervention, and the increased tidal exchange will gradually reduce salinity in Pond 3 to ambient levels. Therefore, salinity levels in Pond 3 were assumed to be at ambient river levels, and this configuration shown in **Figure 7** is essentially Phase 2 of Salinity Reduction Option 1C.

Figure 8 shows the mean hourly streamflow along Napa River near Napa for February 2000 that was used as upstream boundary data. Daily mean salinity simulated by a separate predictive model (Knowles 2000) is plotted in the same figure to illustrate the rapid decrease in river salinity in response to freshwater runoff. Breaching of the Pond 4 levee was chosen to occur at 08:00 February 14, 2000 so that mixing is enhanced by flood discharges and river salinity is at a minimum. Measured water levels and salinity in the ponds from February 2002 (Table 1) were used since these represent the most likely conditions during a wet winter month given the existing conditions of the ponds.

Table 1. Assumed Initial Conditions

Pond	Salinity (ppt)	Water Level (m, NAVD88)
Pond 4	111	1.5
Pond 5	110	1.5
Pond 6	38	1.7
Pond 6A	35	1.7

Source: CDFG, Feb 2002 measurements

RESULTS

We extracted data at various points and times to characterize the temporal and spatial scales of salinity reduction and the associated impacts to Napa River. The paragraphs below present time series from the data points shown in **Figure 9** and 'snapshots' of salinity in lower Napa River after breaching. Salinity tolerances for indicator species are used to assess the impacts to the existing aquatic resources.

Salinity Reduction in the Ponds

Time series of water levels are plotted in **Figure 10** and show significant muting of the tidal fluctuations in the ponds due the undersized breach. These results show that a diurnal tide range of about 1.7 m in Napa River is reduced to approximately 0.2 m in Pond 4. Variance at the spring/neap frequency is of similar magnitude and produces a slowly varying water level with a period of about two weeks.

After its initial release to Napa River immediately after breaching, Pond 4 acts as a quasi-mixing chamber. Water from Ponds 6A through 5 slowly mixes within Pond 4 before limited tidal exchange discharges saline pond water into Napa River. This is demonstrated by the time series of pond salinities plotted in **Figure 11**. Note that salinities in the ponds drop before the levee breach due to the introduction of make-up water from Napa Slough and precipitation preceding the February 14 peak streamflow. Salinities in Ponds 4 and 5 drop from their initial values of 110 to below 20 ppt approximately one month after breaching. Salinities in Ponds 6 and 6A are less due to their lower initial values and dilution from make-up water from Napa Slough.

Note that these results do not include the effects of dissolution, which may attenuate the desalination process as pond salinities drop and precipitated salts are brought into solution. Although this would not significantly change the amount of salt discharged immediately after breaching, and hence the short-term impacts, leaching may extend the total desalination time of the ponds.

Salinity in Lower Napa River

Time series of depth-averaged salinity near the center of Napa River at the point of discharge are shown in **Figure 12** for with- and without-project conditions. These results show a 12 ppt increase immediately following breaching. Impacts at this location drop to approximately a 6 – 8 ppt increase after two weeks and less than a 2 ppt difference after a month. As evident in this plot, river salinity under no-project conditions is close to zero for much of the simulation time. Therefore, the absolute salinity simulated under with-project conditions closely approximates increases due to discharge from Pond 4.

Increases in Napa River salinity are greatest during ebb tides, as the water level in the river drops and saline water discharges from Pond 4. **Figure 13** shows contour plots of salinity along an 8-mile reach of Napa River near the point of discharge at various stages of the salinity reduction process during these ebb tides. The magnitude of salinity increases in Napa River is greatest immediately after breaching but limited in spatial and temporal extents. One day after breaching, increases in river salinities greater than 20 ppt are restricted to a local zone within about 200 m of the breach. More moderate increase of about 10 – 12 ppt cover a 2 km reach. After approximately one week, increases in salinity have dropped to between 5 – 10 ppt but cover a 6 km reach due to longitudinal dispersion. River salinities throughout the reach are elevated about 2 – 3 ppt three weeks after breaching.

Discharges from Pond 4 may be higher if circulation due to strong prevailing westerly winds changes the horizontal distribution of salinity in the pond. However, the relative importance of this effect is expected to be weaker in the breach option than in non-breach options since tidal mixing dominates in the immediate vicinity of the breach.

Effects on Aquatic Resources

Physical and chemical parameters play an important role in determining ecological productivity, and in estuarine settings such as Napa River, aquatic species must be able to tolerate naturally occurring changes in salinity or move to more favorable conditions. These naturally varying changes in salinity will be modified by discharges from the salt ponds, and impacts to the existing fish and benthic communities must be addressed.

PWA compared results from the numerical model to salinity tolerances of steelhead trout and striped bass to assess impacts of discharges from Pond 4 to the aquatic resources in Napa River. The salinity tolerances and likely presence at site by time of year of these indicator species are listed in Table 2. **Figure 14** and **Figure 15** plot the depth-averaged salinity in lower Napa River following the breach in terms of tolerable levels for steelhead and striped bass, respectively. Also shown are contour lines of the mid-salinity ranges that are well below the maximum tolerable levels. These figures indicate that only a very limited area immediately adjacent to the breach is above acceptable salinity levels for steelhead, and only for a matter of days. In less than one week, conditions in the river are well below the tolerable salinity concentrations for both fish, and large portions of Pond 4 also have acceptable salinities.

Table 2. Salinity Tolerance for Indicator Species

Species	**Salinity Tolerance (ppt)**	**Likely Presence at Site**
Steelhead trout (juvenile)	0 – 25	January – May
Striped bass (juvenile, adult)	0 – 35	Year round

Source: JSA 2002

Discussion of Results

Although the 2D schematization of lower Napa River provided better representation of mixing processes in the receiving waters than the previous 1D description, limitations of the depth-averaged model require careful interpretation of the results. Therefore, we applied approximate analytic methods to assess the potential for a dense bottom plume to develop in Napa River following the Pond 4 levee breach. These order-of-magnitude estimates may be refined in the future as monitoring data is collected from the Pond 3 ditches described above. Additionally, near-field modeling that is currently underway for pond discharges through diffusers may also increase our understanding of the mixing processes in Napa River and lead to revised interpretations of the dense bottom plume.

Although the results presented in **Figure 13** assume a uniform salinity over depth, the initial mixing may be strongly affected by differences between heavy hypersaline pond water and lighter river water. Additionally, these density differences may continue to affect mixing further downstream where the mixing is driven by the turbulence of the river. The non-dimensional parameters B/du^{*3} and B/Wu^{*3} can be used to qualitatively estimate the importance of density effects (Fischer *et al* 1979). Here, B is the flux of buoyancy in the effluent[1], u^* is the shear velocity in the river[2], and d and W are the depth and width of the river, respectively. B/du^{*3} and B/Wu^{*3} express the stabilizing power of the density difference per unit width and depth, respectively, relative to the mixing power in the stream.

In the case of hypersaline discharges through the Pond 4 breach, $B/du^{*3} >> 1$, indicating that water discharged from Pond 4 will spread rapidly across the river in the form of a density driven circulation and form a layer at the bottom. The vertical mixing between this dense bottom layer and the overlying river water is expected to be weak since B/Wu^{*3} is also large, and the heavy saline plume will likely persist at least until water in Pond 4 reaches near-ambient conditions.

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1 $B=()\Delta/\Delta)gQ_E$, where $)\Delta$ is the density difference between the pond and river water, Δ is the ambient density in the river, g is the gravitational acceleration, and Q_E is the discharge rate of effluent.

2 $u^* = \sqrt{\tau_b/\rho}$, where τ_b is the resistance of the river bed to the flow.

Figure 16 and **Figure 17** show, at a conceptual level, how salinity may be distributed along a cross-section of Napa River downstream of the breach (see **Figure 18** for location map) under modeled and actual conditions, respectively. As illustrated in these two figures, a strong bottom plume of saline water may significantly change the distribution of salt in the river from the depth-averaged values simulated by the numerical model. Vertical variations in salinity caused by the more dense pond water would increase near-bottom salinity. Conservation of salt would require that this increase in near-bottom concentration be accompanied by a reduction in salinity closer to the surface.

Although a comprehensive biologically-based assessment is beyond the scope of the present modeling exercise, a few points seem relevant when determining the significance of a potential bottom layer of hypersaline water. Firstly, model results suggest connectivity of waters within acceptable salinity levels is maintained within the river when considering depth-averaged salinity. The development of a dense bottom plume is not likely to reduce this connectivity significantly since near-surface water would be at a salinity level below the depth-averaged values. Also, increases in river salinity due to pond discharges follow a rapid decrease preceding the breach. This variability occurs due to natural processes in the river and would already have an effect on the habitat. Finally, effects from a saline bottom plume should be assessed while keeping in mind that the existing benthos may already be impacted by previous dredge activity along Napa River.

TRANSPORT OF BITTERN IN THE SLOUGHS

Simulated salinity reduction in Pond 7 is complicated by the presence of concentrated liquid end products associated with commercial salt production (bittern) that are toxic to aquatic organisms if discharged in concentrated form. Therefore, discharges from this pond require significant dilution prior to discharge in order to prevent adverse impacts on existing ecological resources. The reduced flow rates through Pond 7 result in salinity reduction times that may span decades.

Given these lengthy desalination times, PWA simulated bittern discharges from Pond 7 to assess the potential for chronic water quality problems that may develop. Of particular interests are the point of discharge into Napa Slough and the barotropic convergence zone in the middle of the slough network, where tidal exchange is limited and effluent may accumulate (Warner 2000).

DESCRIPTION

PWA simulated flow through the Upper Ponds desalination option shown in **Figure 4** but used a conservative tracer to track bittern instead of sodium chloride salt. Flows through Ponds 7A and 8 were tidally driven, but discharges from Pond 7 were metered to achieve a high (1:100) or low (1:20) dilution at the mixing chamber.

In order to easily measure the dilution of bittern throughout the system, initial concentrations were assumed to be 100 ppt in Pond 7 and zero throughout the sloughs, in other ponds, and at the model boundaries. Two-year long simulations were carried out for each dilution criteria in order to capture the effects of residual transport processes in the sloughs and the reduction of bittern in Pond 7.

RESULTS

Data were extracted at the point of discharge into Napa Slough, inside Pond 7, and in the barotropic convergence zone (**Figure 9**) in order to plot the time series of bittern concentration. Sectionally-averaged concentrations from the 1:100 simulation are shown in **Figure 19**. A seasonal trend is clearly evident in the pond, as concentrations drop during the wet months and increase during the dry. Overall, the bittern concentration in Pond 7 drops to about 60% of its initial value after two years. Although Pond 7 discharges occur at 1:100 into the mixing chamber, sectionally-averaged concentrations in Napa Slough are an order of magnitude less than 1 ppt due to additional dilution in the slough.

Bittern concentrations in Napa Slough are significantly higher with Pond 7 discharges at a 1:20 dilution rate into the mixing chamber, as shown in **Figure 20**. Under these conditions, peak sectionally-averaged concentrations at the point of discharge is approximately 0.7 ppt, indicating an overall dilution of about 1:142. Seasonal trends are less apparent than in the 1:100 scenario since bittern discharged from Pond 7 quickly outpaces evaporation and masks the influence of rainfall. After two years of 1:20 discharge, bittern concentration in the pond is about 10% of its initial level.

Results from these simulations indicate that transport across the barotropic mixing zone is sufficient to preclude effluent build-up, and concentrations in the interior sections of the slough system follow trends in the pond levels.

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List of Figures

List of Tables

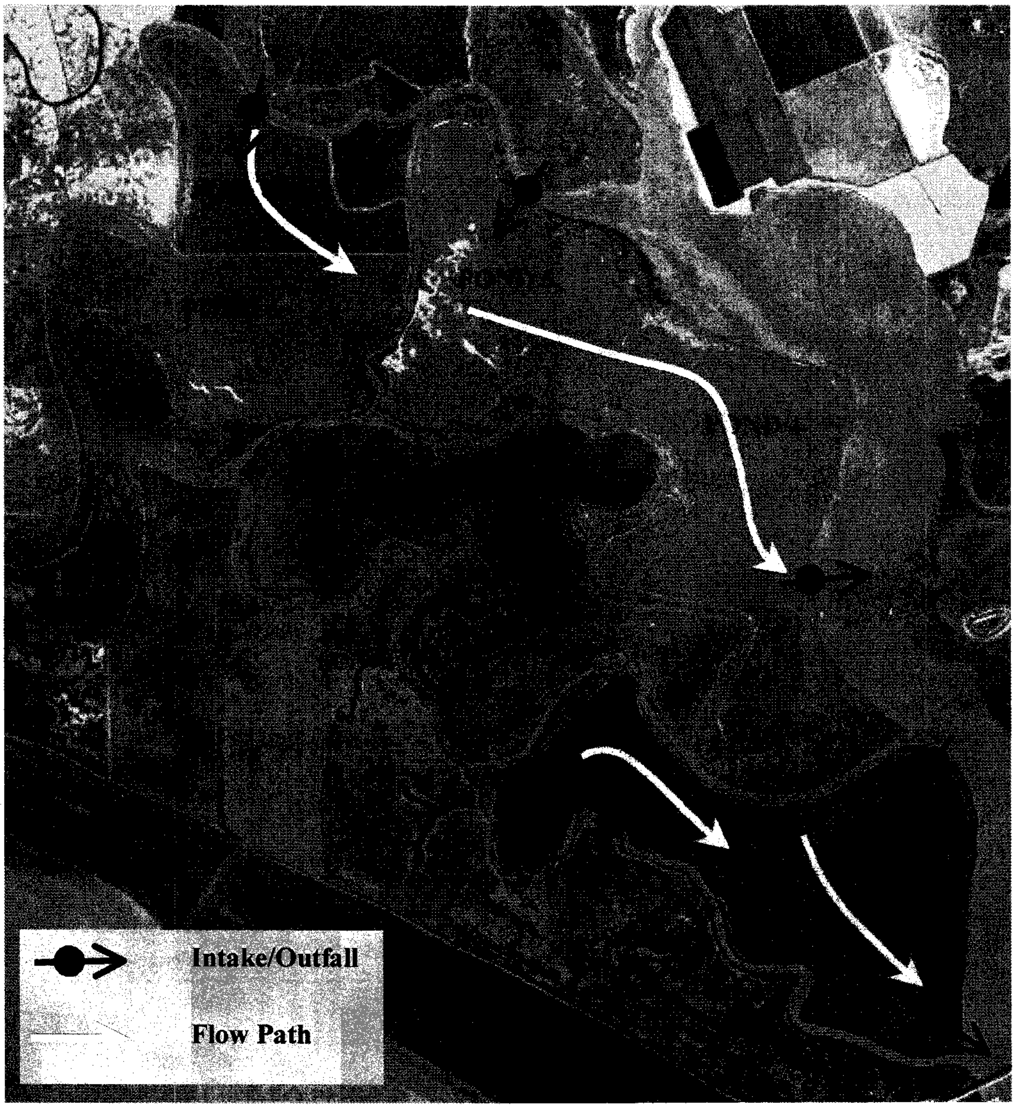

Figure 1 Salinity Reduction Option 1A – Lower Ponds

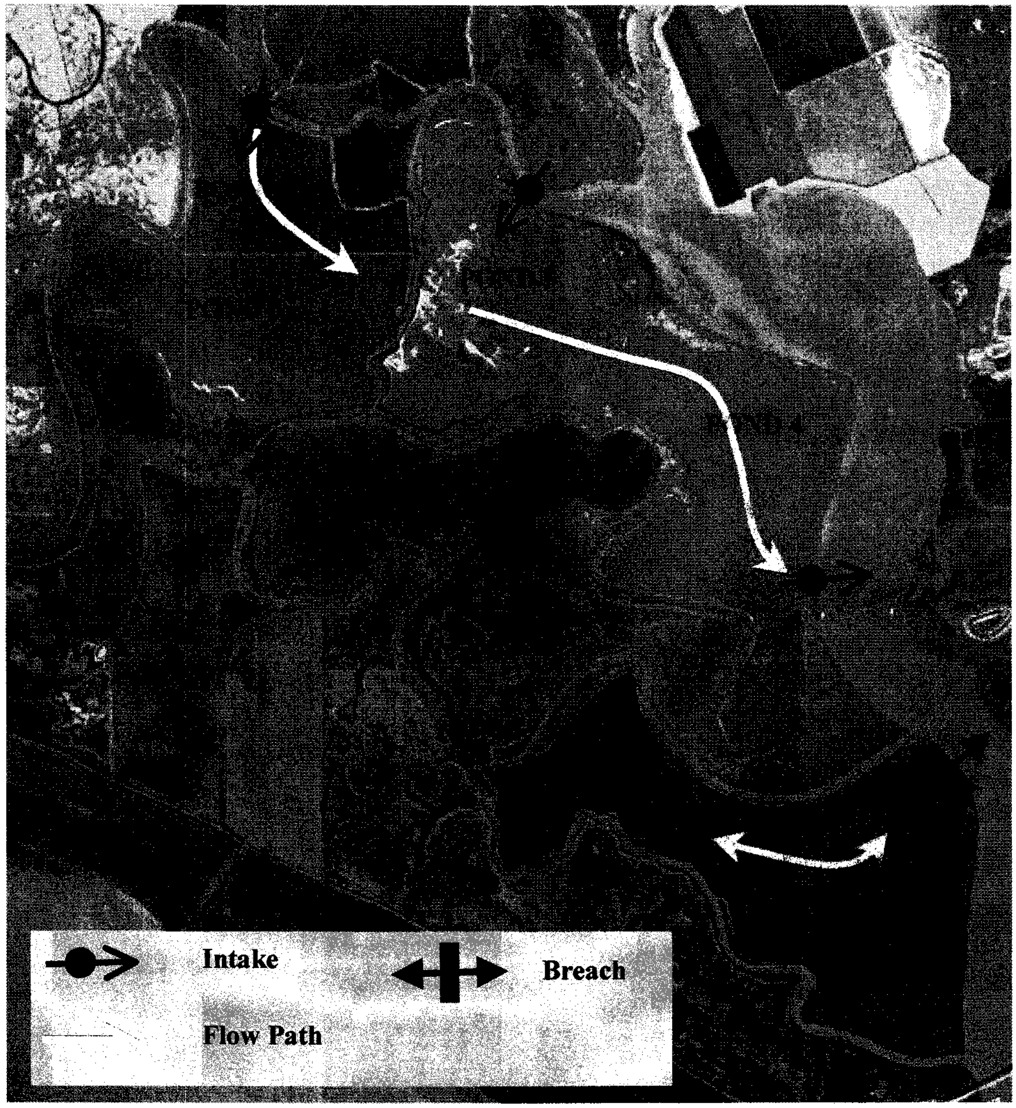

Figure 2 Salinity Reduction Option 1B – Lower Ponds

* Pond 3 breach to Napa River was modeled at northeast corner. Location later changed to southeast corner

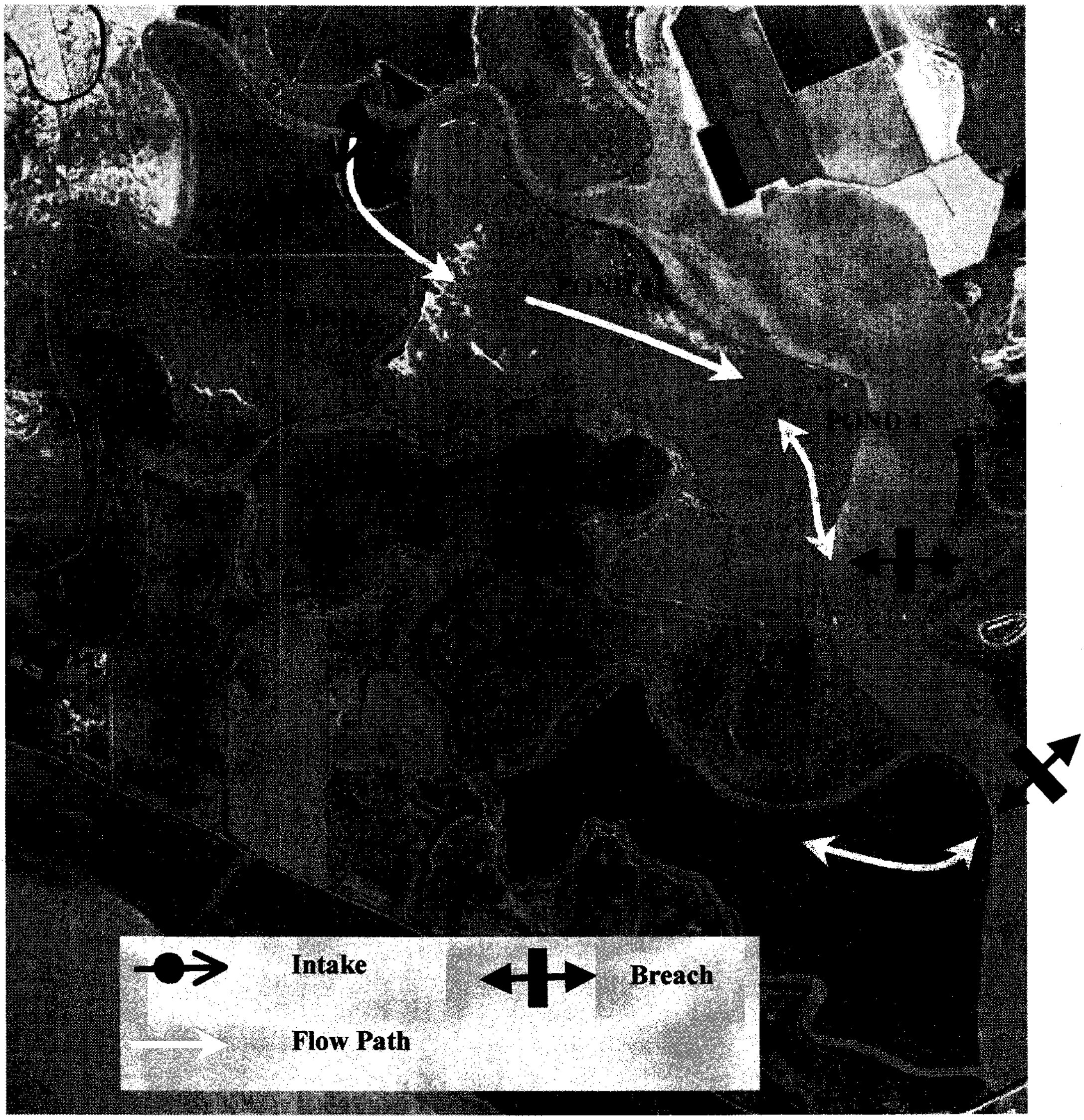

Figure 3 Salinity Reduction Option 1C - Lower Ponds

* Pond 3 breach to Napa River was modeled at northeast corner. Location later changed to southeast corner

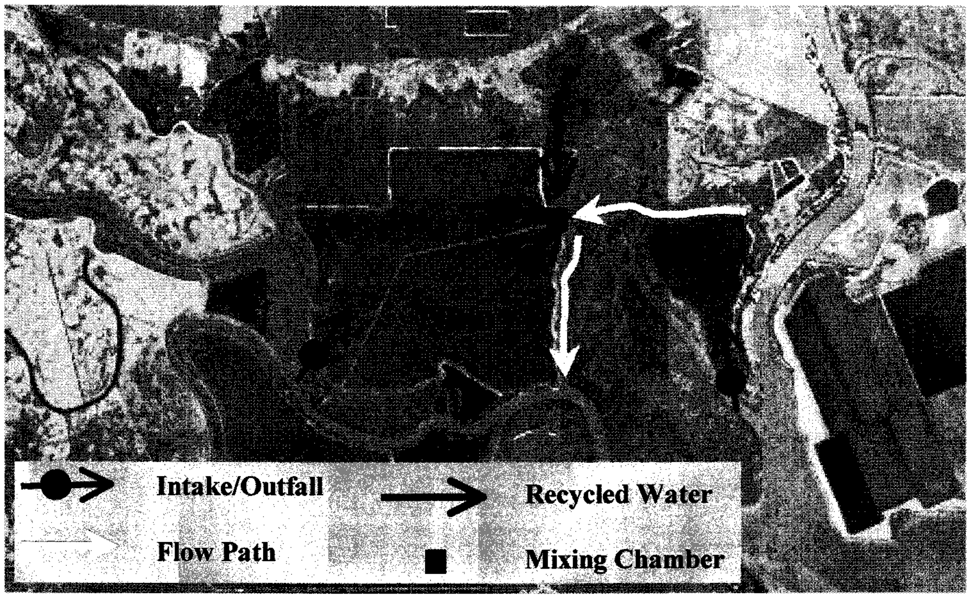

Figure 4 Salinity Reduction Option 1 – Upper Ponds

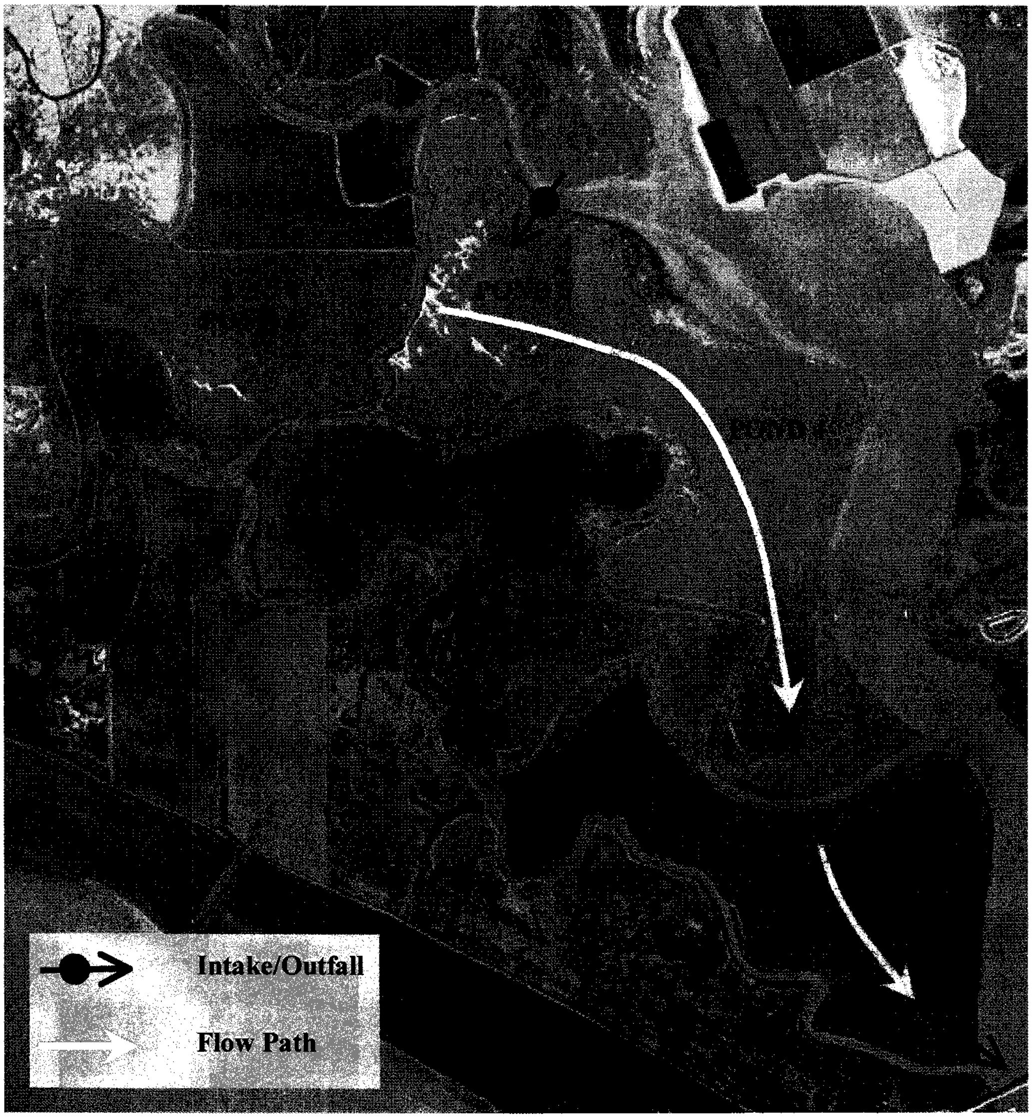

Figure 5 Salinity Reduction Option 2 – Ponds 3 through 5

Figure 6 Salinity Reduction Option 2 – Ponds 1, 1A, 2, 6, 6A, 7, 7A, and 8

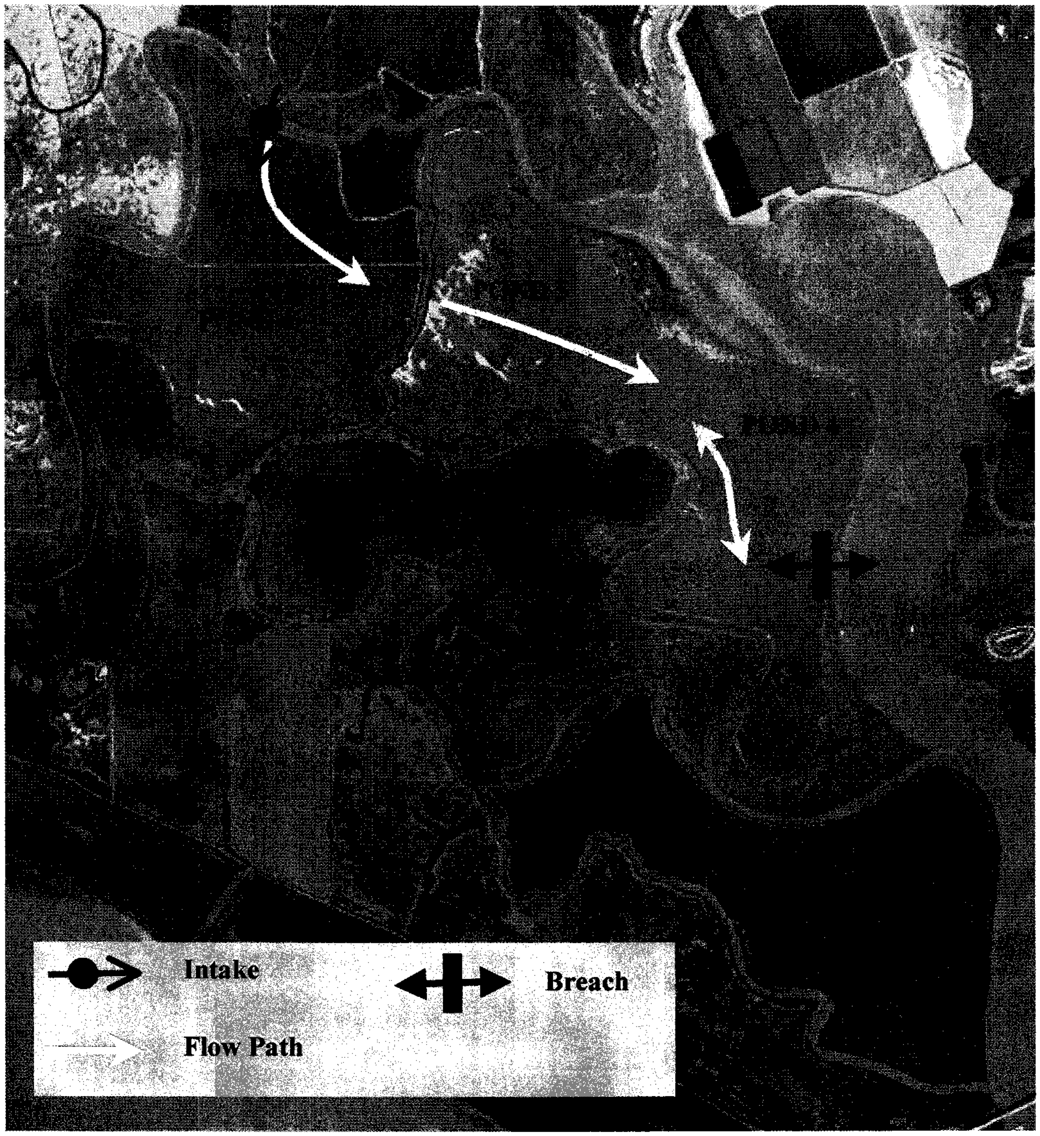

Figure 7 Salinity Reduction Option 1C – Lower Ponds, Phase 2

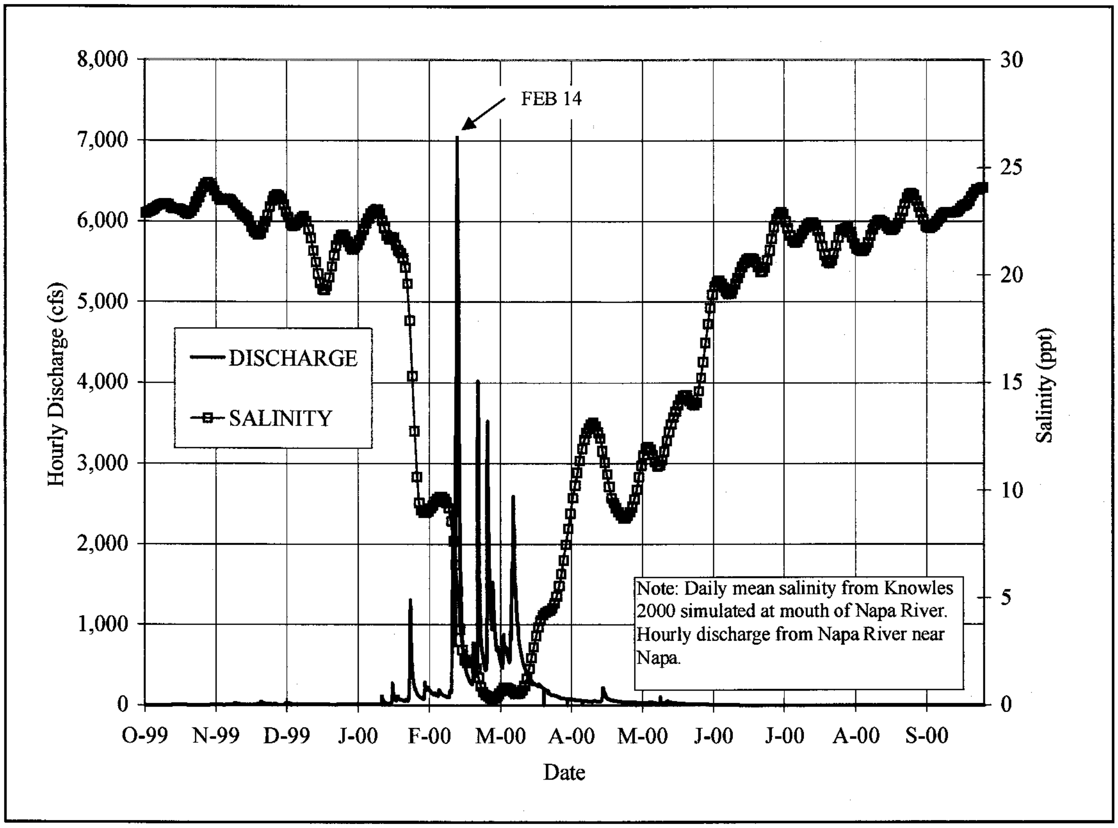

Figure 8 Napa River Streamflow

Figure 9 Location Map of Extraction Points

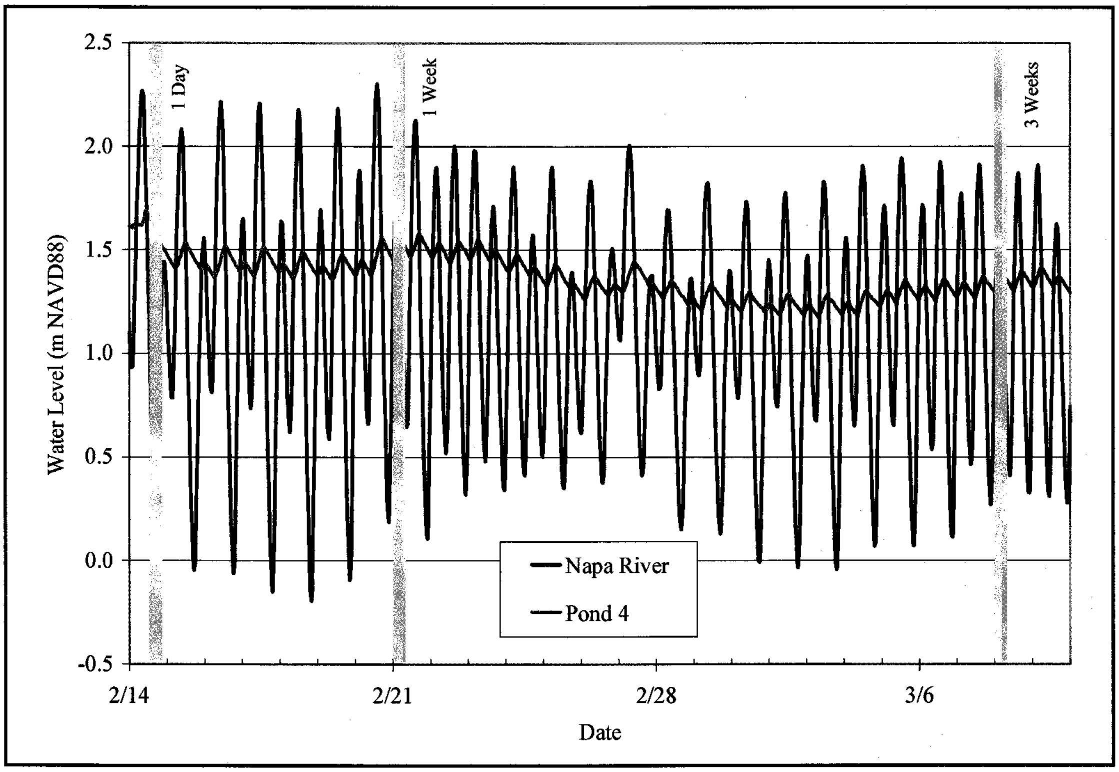

Figure 10 Water Levels in Ponds and River

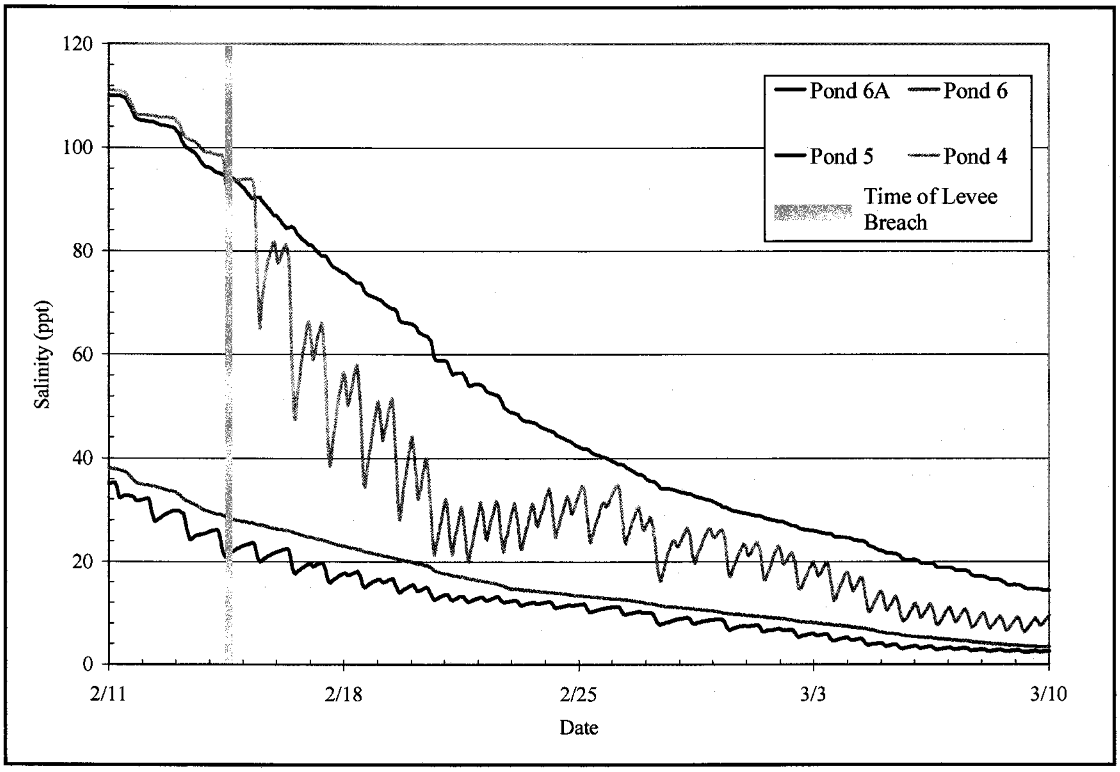

Figure 11 Salinity Reduction in Ponds

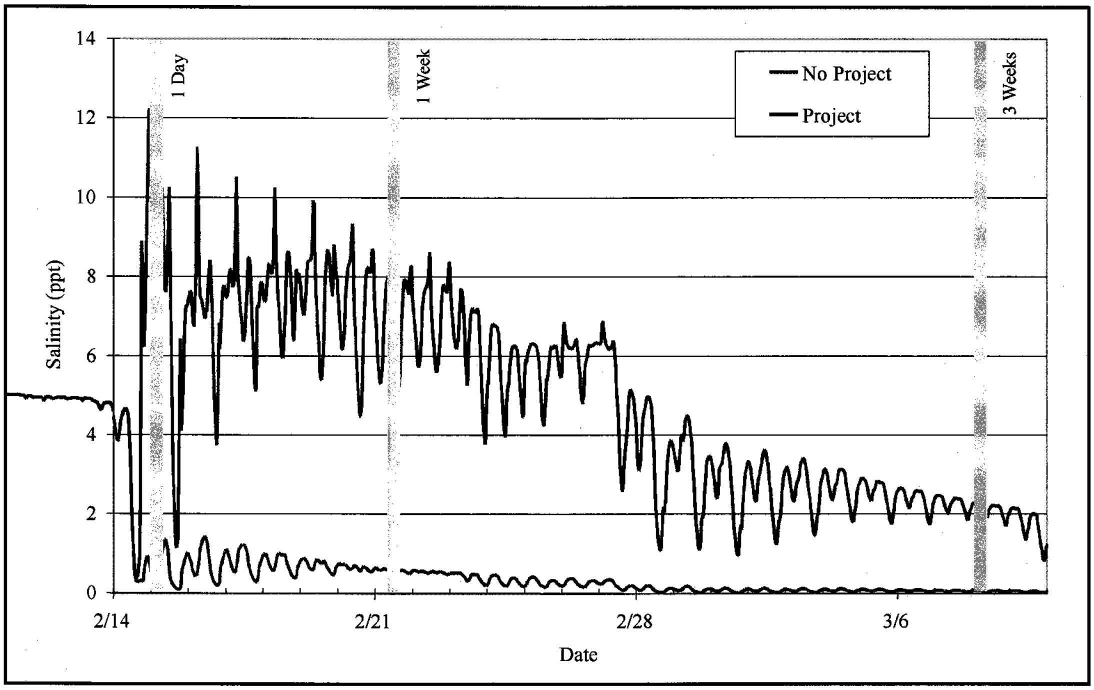

Figure 12 Napa River Salinity at Thalweg near Breach

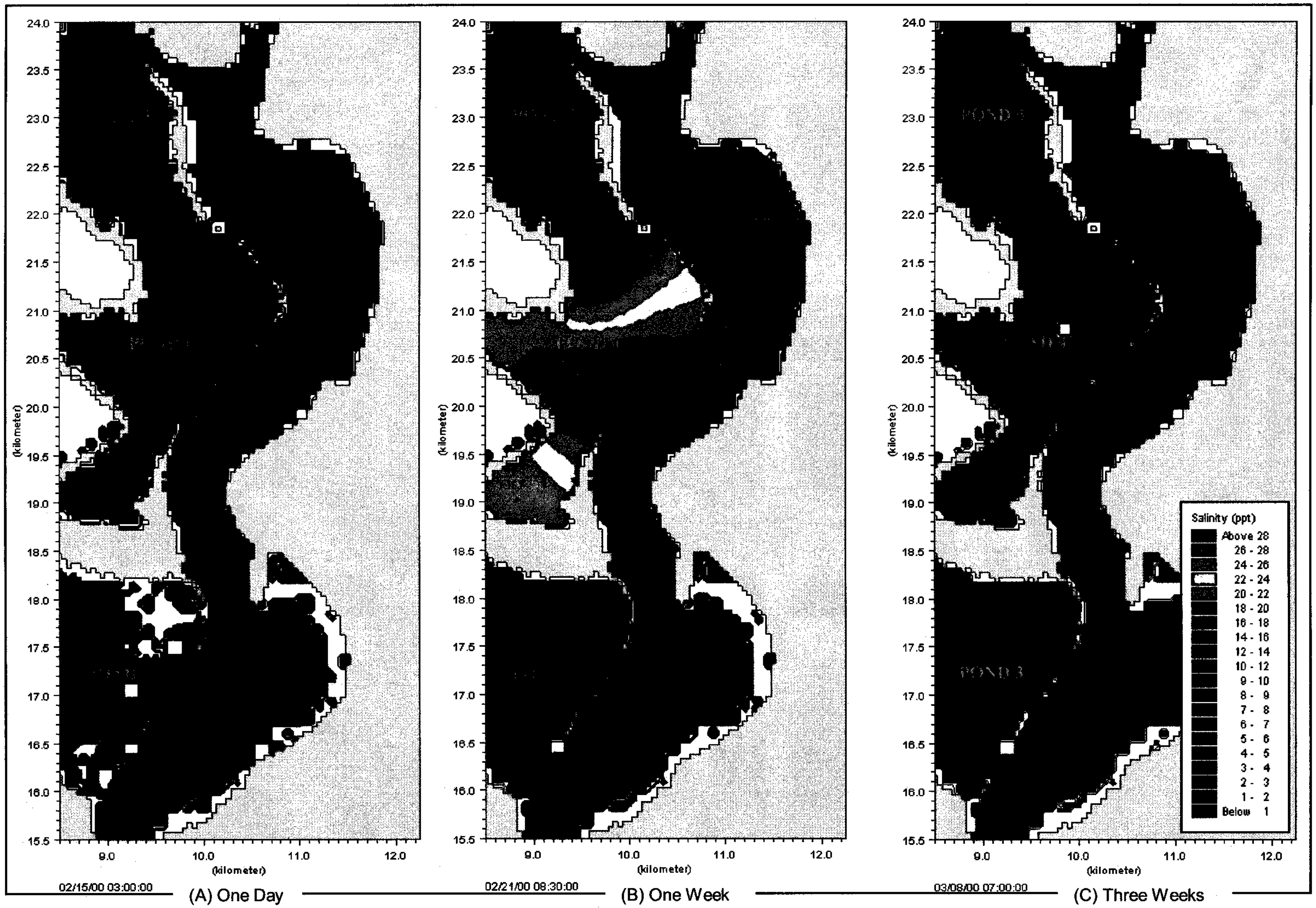

Figure 13 Salinity In Lower Napa River after Breach

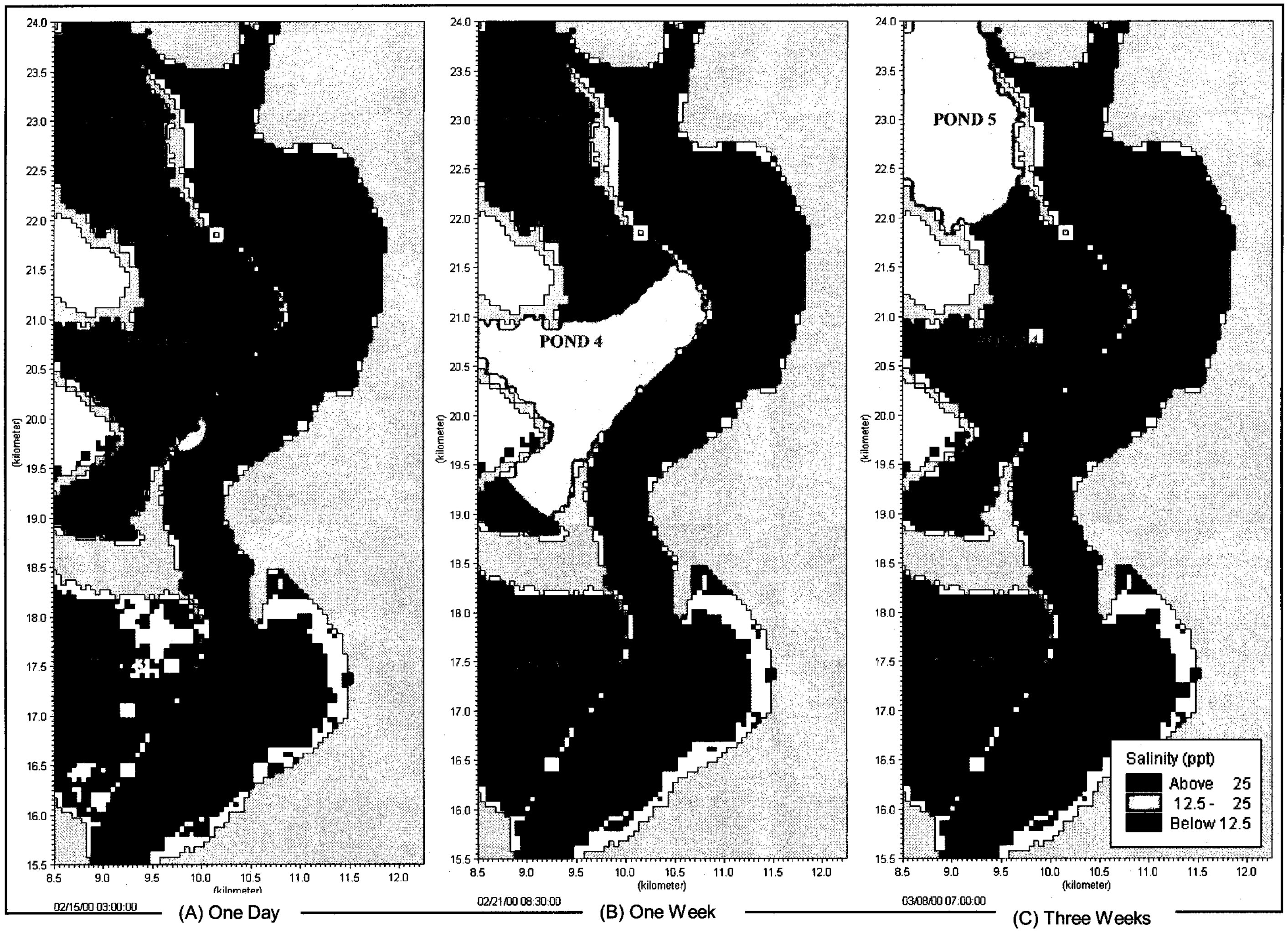

Figure 14 Salinity Tolerance for Steelhead Trout

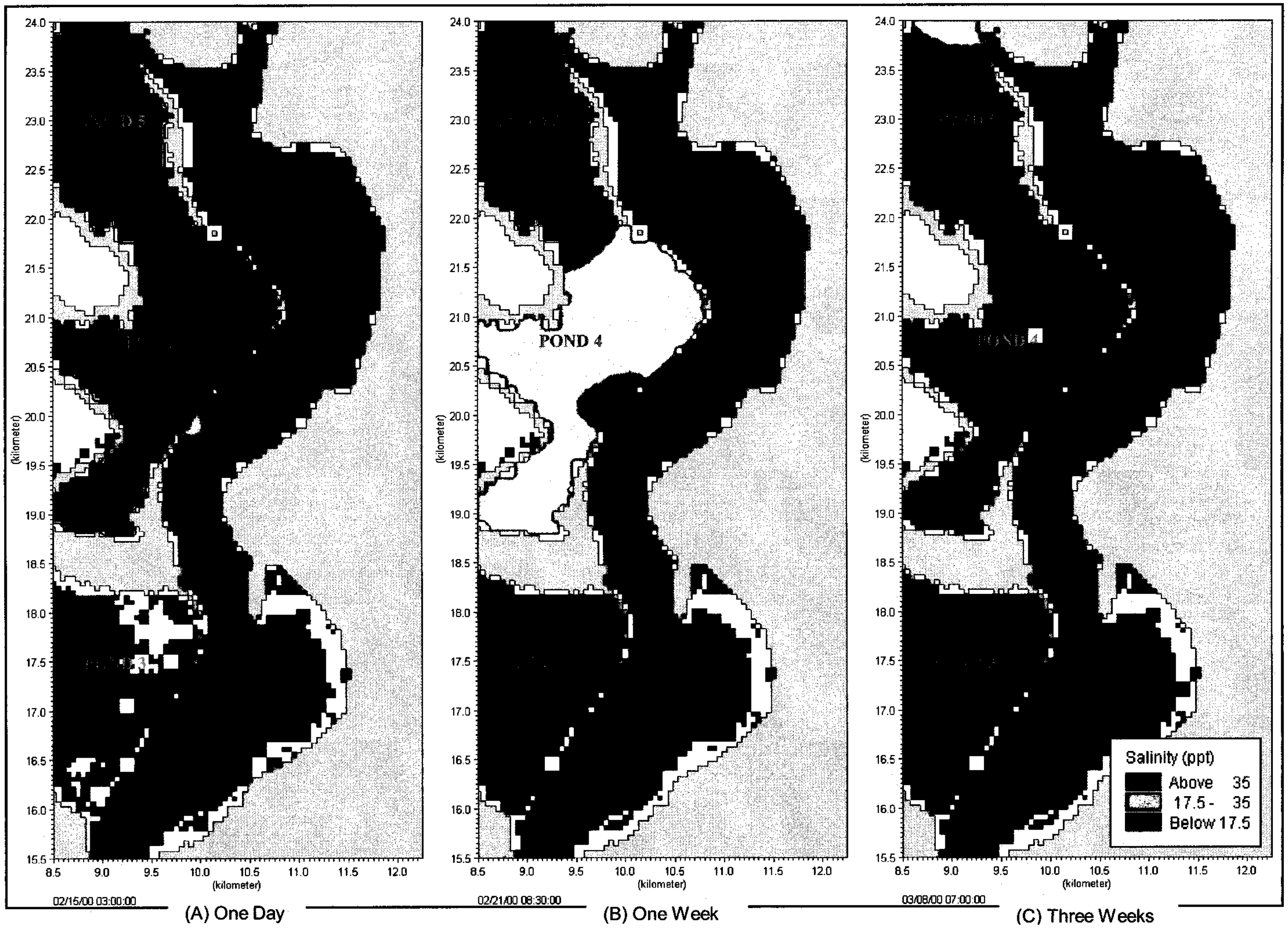

Figure 15 Salinity Tolerance for Striped Bass

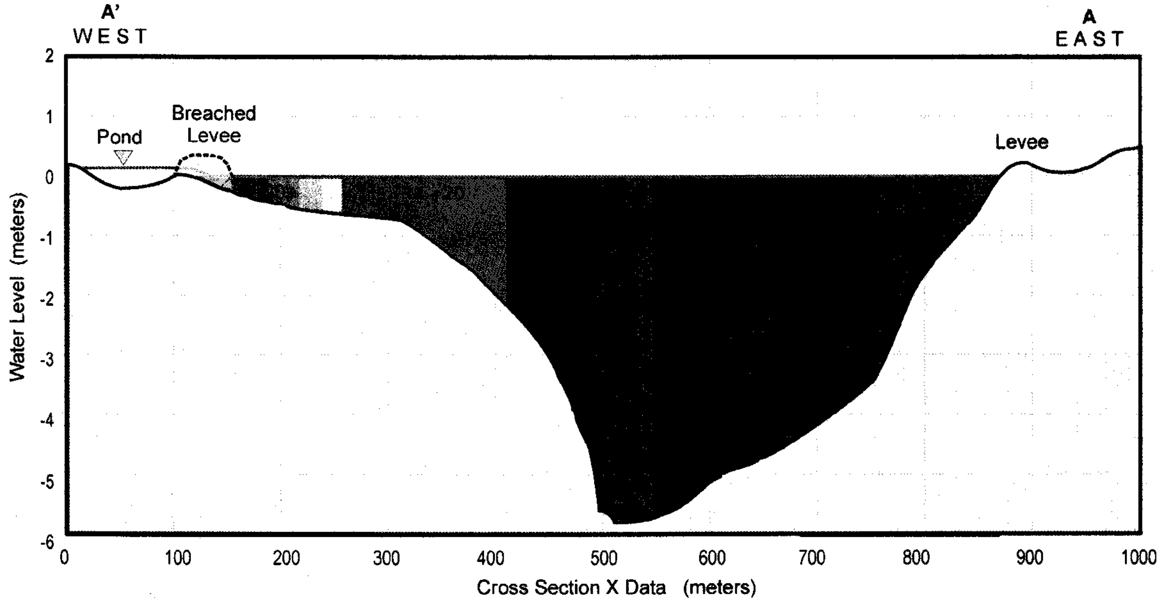

Figure 16 Description of Modeled (Depth-Averaged) Salinity Distribution

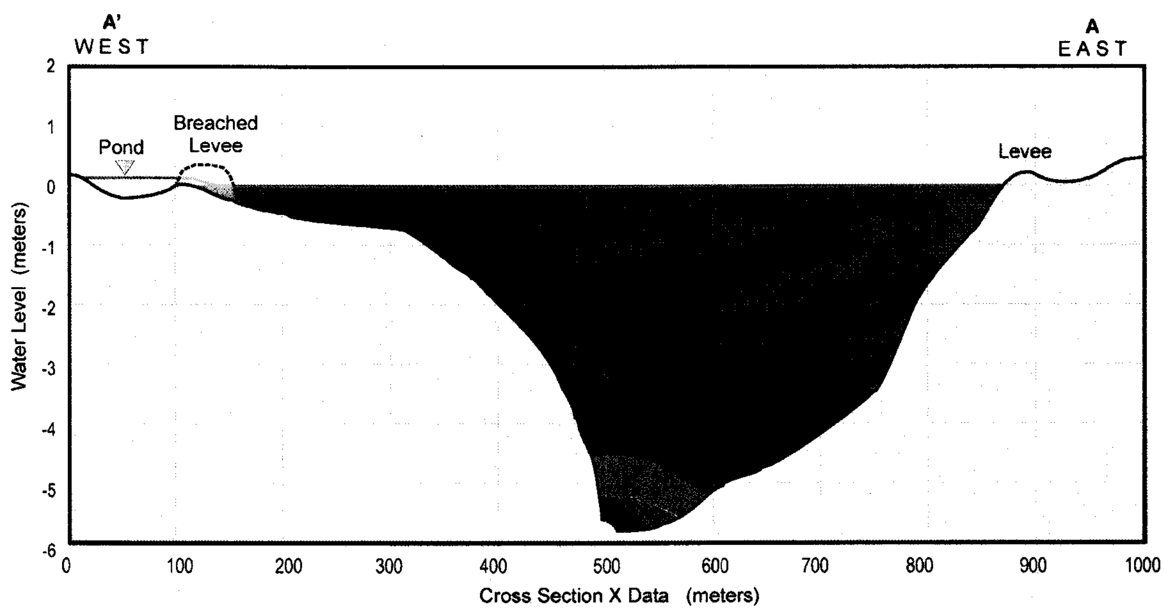

Figure 17 Conceptual Description of Salinity Distribution with Dense Bottom Plume

Figure 18 Location of Downstream Cross-Section

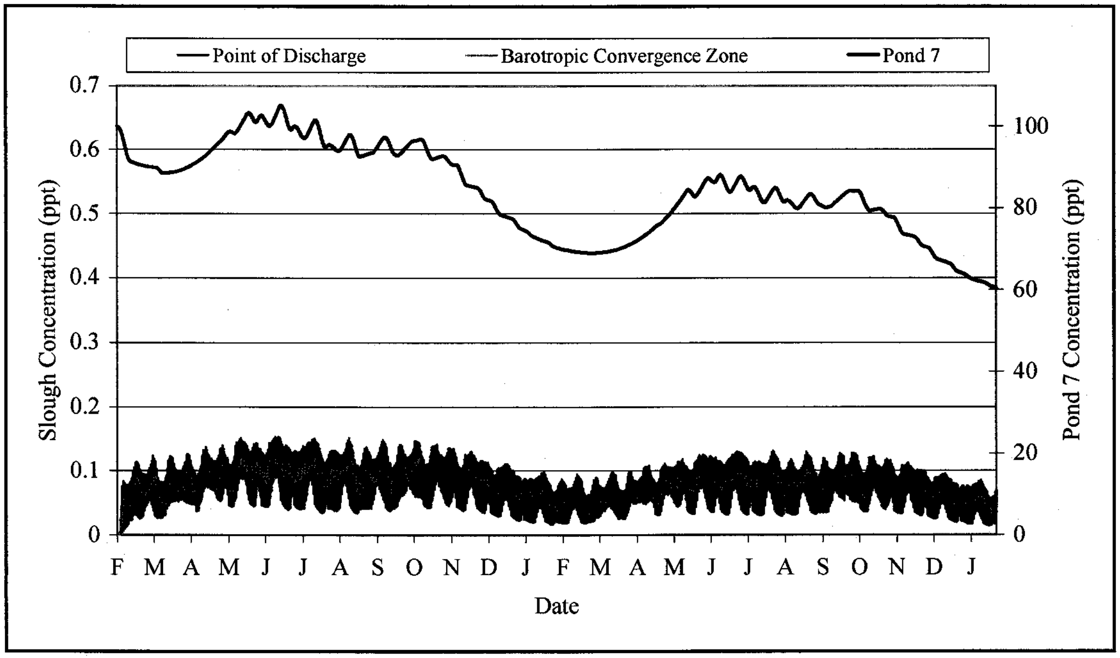

Figure 19 Results from 1:100 Bittern Discharges

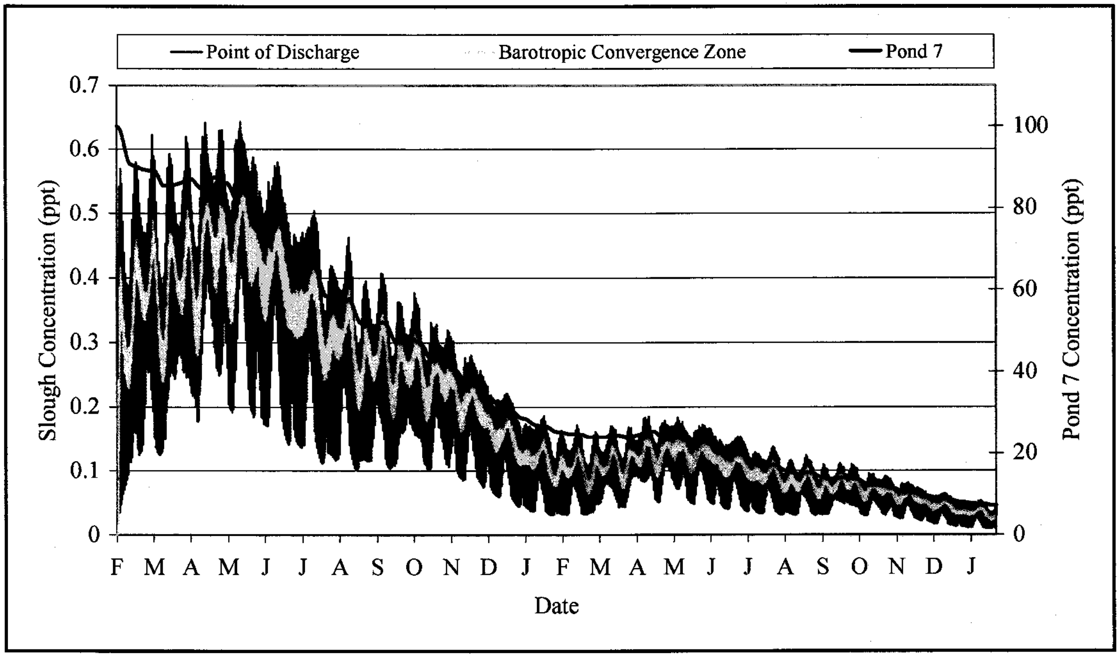

Figure 20 Results from 1:20 Bittern Discharges

APPENDIX E
MONITORING AND ADAPTIVE MANAGEMENT PLAN
Draft

TABLE OF CONTENTS

APPENDIX E
MONITORING AND ADAPTIVE MANAGEMENT PLAN
Draft

I. BASIS FOR MONITORING AND ADAPTIVE MANAGEMENT

A. Introduction

The Napa Salt Marsh Restoration (NSMR) project proposes to restore approximately 9,460 acres of formerly commercial salt ponds and associated habitats to a mix of tidal habitats and managed open water ponds. Tidal habitat restoration will be achieved mainly through reliance on natural processes, such as tidal action and sedimentation, to restore habitat rather than through constructed physical features or plantings. Managed pond enhancement will be achieved with water control structures and levee repairs.

After initial construction activities are complete, adaptive management and monitoring are necessary to address uncertainties and ensure project success. Success criteria were defined based on specific hypotheses, which were formed based on the three project 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.

B. Project Planning Objectives

The three planning objectives are:

1. 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;

2. 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

3. 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.

C. Hypotheses to be Tested by Monitoring and Assessment

Two broad and six specific hypotheses were formed from the planning objectives. The broad hypotheses are that:

1. The project planning objectives can be achieved employing selected salinity reduction and habitat restoration measures, and
2. A mix of tidal habitat restoration and enhancement of managed ponds in the Napa-Sonoma Marshes is an important contribution to the recovery of sustainable populations of native fish, wildlife, and plants, including threatened and endangered species.

APPENDIX E
MONITORING AND ADAPTIVE MANAGEMENT PLAN
Draft

The specific hypotheses below fall into three categories:

1. Salinity Reduction Hypotheses: Salinity reduction of the former commercial salt ponds can be achieved using Napa River water;
2. Tidal Marsh Hypotheses: After salinity reduction, ponds can successfully be restored, using natural sedimentation, to self-sustaining tidal marsh and associated tidal habitats that support wildlife species and complex food webs; and
3. Managed Ponds Hypotheses: The depths and salinities of non-tidal ponds can be sustainably managed to provide habitat for migratory shorebirds and waterfowl.

Salinity Reduction Hypotheses

1. The salinities of ponds can be reduced to allow for tidal restoration or continued management as ponds, without negatively impacting aquatic species in the receiving waters (Napa River and neighboring sloughs):
   a. Salinities in Pond 3 can be reduced using breaches;
   b. Salinities in Ponds 4, 5, 6 and 6A can be reduced over a relatively short period of time using water control structures that allow for the intake of Napa River water and the discharge of diluted pond water;
   c. Short-term discharge of water in Ponds 3, 4, 5, 6, and 6A via breaches or water control structures will not result in adverse effects to beneficial resources in the receiving waters;
   d. The bittern pond (Pond 7) can be diluted over 8 to 10 years using Napa River water and a dilution ratio of 1:100; and
   e. Release of bittern into the Napa Slough will not result in chronic adverse effects or a build-up of bittern in the slough system.

Tidal Marsh Hypotheses

2. Restoration of tidal habitats in Ponds 3, 4, and 5 will be an important contribution to the recovery of sustainable populations of native fish, wildlife, and plants, including endangered and threatened species:
   a. Increased tidal habitat will increase primary productivity and increase the volume and diversity of aquatic and benthic invertebrates, creating more robust populations and more complex food webs and benefiting a wide range of native fish and wildlife species;
   b. Increases in subtidal, intertidal, and tidal marsh habitats will benefit special-status anadromous fish, specifically Central Coast steelhead trout and chinook salmon, which could benefit from the tidal habitats during their upriver migration or in the smoltification process by having more places to take refuge and more food sources;
   c. Increases in tidal marsh habitat will benefit special-status resident fish, such as Sacramento splittail, by providing more places to take refuge and more food sources;
   d. Increases in tidal marsh habitat will benefit special-status birds and mammals that depend upon tidal wetlands in the San Francisco Bay, specifically California clapper rail, salt marsh harvest mouse, San Pablo song sparrow, and black rail, by providing increased foraging and nesting habitat;

e. Increases in subtidal and intertidal habitat will benefit migratory shorebirds and dabbling ducks by providing feeding and resting areas; and
f. Tidal restoration projects in the Napa-Sonoma Marshes are less susceptible to invasions of introduced *Spartina* (cordgrass) species, due to salinity regimes and because initial introductions and the majority of the current infestation of *Spartina* are in the South San Francisco Bay.

3. Large-scale tidal marsh restoration can be conducted using natural sedimentation:
   a. Natural sedimentation will be adequate to restore the slightly and moderately subsided Ponds 3, 4, and 5;
   b. Sedimentation rates are dependent on the suspended sediment concentration, wind-wave resuspension, vegetation colonization, and elevation of the area to be restored, parameters that were included in the modeling effort and have been accounted for in the design features; and
   c. Mare Island Straight is the primary source of sediment, and locations closer to the primary source (Pond 3) will accrete faster than locations farther from the source (Ponds 4 and 5).

4. The proposed tidal restoration design features will accelerate and enhance tidal habitat formation, will compensate for short-term loss of tidal marsh in the project area, and will minimize negative impacts of increased tidal prism:
   a. Starter channels will promote reestablishment of historic slough/channel networks;
   b. Long fetch resulting in wind-driven waves can be controlled through the use of berms to achieve adequate rates of sediment deposition;
   c. Borrow ditch blocks will promote the reestablishment of historic slough/channel networks by inhibiting existing borrow ditches from capturing the tidal supply;
   d. Historic channel networks will reestablish and marsh vegetation will colonize formerly farmed baylands (the ponds were used as agricultural lands prior to conversion to commercial salt ponds);
   e. Levee lowering to high marsh elevations will compensate for the loss of tidal marsh as slough channels deepen and widen due to increased tidal prism, and will reduce predator pathways; and
   f. Breach locations and phasing will minimize impacts to adjacent levees, properties, and utilities, and will reduce predator pathways.

<u>Managed Pond Hypotheses</u>

5. The depths and salinities of former commercial salt ponds can be sustainably managed, using predominately tidally driven water control structures:
   a. Functioning water control structures that enable the intake and discharge of Napa River and San Pablo Bay water will allow for resource managers to better control pond depths and salinities while keeping salt from accumulating in the ponds;
   b. Water control structures that do not require pumping, and instead rely on the tides, are more sustainable and economical, while still allowing for active

management of water depths and salinities; and

c. Intake and discharge of water from the managed ponds will not negatively impact aquatic species in the Napa River, sloughs, and ponds.

6. Managed ponds will provide habitat for resident and migratory shorebirds and waterfowl:
   a. Resident and migratory dabbling waterfowl and shorebirds will use the managed shallow-water ponds or ponds that are drawn down to shallow levels during the migration season (such as Ponds 1 and 1A) for feeding and resting;
   b. Migratory diving waterfowl will use the managed deep-water ponds (such as Pond 2) for feeding and resting; and
   c. Food sources (invertebrates and plants) in the ponds will increase with improved water management and water quality.

D. Project Uncertainties

<u>Analysis of Salinity Reduction and Habitat Restoration</u>

Several analysis methods were used to predict salinity reduction and habitat restoration impacts and timelines. These analyses examined the following parameters and drew the following conclusions:

Salinity Reduction Time Period

A hydrodynamic model of the pond system was developed to determine the feasibility and effectiveness of salinity reduction options. Salinity reduction of the ponds was modeled to analyze time periods for salinity reduction and impacts on the Napa River, San Pablo Bay, and local sloughs. In addition, a mass balance analysis was conducted for bittern reduction in Pond 7. The analyses indicated that:

- Salinity reduction in the Lower Ponds is expected to occur within very short time frames (1 month for Ponds 3, 4, and 5; 6 to 12 months for Ponds 6 and 6A) using Napa River water and a combination of breaches and water control structures; and
- With a 1:100 bittern to water discharge ratio and use of neighboring waters (Napa River and sloughs), salinity and bittern reduction in Pond 7 could take 8 to 10 years.

Tidal Marsh Evolution

To analyze the predicted evolution and impacts of habitat restoration options, a habitat evolution assessment was conducted, which consisted of geomorphic analysis and hydrodynamic modeling. The habitat evolution assessment, based on the sediment budget, vegetation rates, wind-wave analysis, and analysis of other natural processes, predicted the following estimated time periods for tidal marsh development:

- Pond 3 is expected to evolve from intertidal habitat to tidal marsh within 20 to 30 years post construction;
- Pond 4, which is more subsided than Pond 3, is expected to evolve from predominantly intertidal habitat to tidal marsh within approximately 40 years post construction; and

- Pond 5, which is also more subsided than Pond 3 and is relatively isolated from sediment sources, is expected to take longer than 50 years to evolve from predominately intertidal habitat to tidal marsh.

Uncertainties in Project Outcome

The analyses identified sources of uncertainty in the salinity reduction and habitat restoration, which will be addressed through monitoring and adaptive management activities:

Pond Discharges, Habitat Quality and Usage

Monitoring of the discharge from ponds will be needed to ensure the project is not negatively impacting beneficial resources in the Napa River, San Pablo Bay, and sloughs. The water quality of the ponds will need to be monitored to determine if applicable surface water quality standards supportive of aquatic life are being met. Use of the managed ponds by birds, fish, and invertebrates will need to be monitored, in order to determine whether the project objective of providing pond habitat for shorebirds and waterfowl to feed and rest has been met. If necessary, adaptive management would involve the construction of additional water control structures and/or changes in water management.

Habitat Endpoint in Tidal Ponds

Due to the long time frame for tidal marsh evolution and the difference in wildlife values of various types of tidal habitats, it is difficult to determine the end-point for project success. The project incorporates post-construction monitoring and adaptive management to assess: 1) whether natural processes, such as sedimentation, will accomplish the long-term evolution of ponds to tidal marsh, and 2) the use of the tidal habitats by wildlife (birds, mammals, fish, and invertebrates). Adaptive management could include an increase or decrease in design features.

This project is the first large-scale restoration of salt ponds to tidal marsh in the United States and will serve as a model for future U.S Army Corps of Engineers tidal marsh restoration projects. Because there are no precedents to guide this restoration, there are a number of uncertainties that could affect the project's outcome, including:

1. Project scale: the Napa Salt Marsh project is approximately 9,460 acres and would be the largest restoration project undertaken west of the Mississippi River;

2. Time periods and impacts of salinity reduction may deviate from modeled predictions, due to weather patterns, salinities, intake capacity, discharge impacts, or other unpredictable factors;

3. Sediment accretion rates for tidal marsh evolution are dependent on river flow rates and sediment supply which are driven by unpredictable weather patterns; and

4. Wildlife use of evolving tidal habitats and managed ponds is subject to unpredictable fluctuations based on site-specific conditions.

E. Project Success Criteria

Due to the size of the area to be restored and the timeline for restoration, acreages for specific tidal habitats (subtidal, intertidal, and marsh) have not been established as quantified project success criteria, although acreages have been predicted using modeling and other quantitative analysis tools, as described above and shown in the anticipated marsh evolution table below. The project targets a broad range of wildlife, including endangered and threatened species, fish and other aquatic species, and migratory shorebirds and waterfowl. Quantitative changes to wildlife populations and densities are not identified as project success criteria; instead, the qualitative project success criteria to be used as the basis for adaptive management decisions consist of the following, with the anticipated habitat acreages and wildlife species shown in tables:

Water Quality

1. Salinity in Ponds 3, 4, 5, 6, 6A, 7, 7A and 8 are reduced to salinity levels that meet discharge criteria as established by the Regional Water Quality Control Board and allow for tidal restoration or continued management as ponds.

2. Applicable surface water quality standards as established by the Regional Water Quality Control Board are achieved in the receiving waters and beneficial resources in the receiving waters are not impacted.

Wildlife

3. The project area provides beneficial wetland habitat for an array of targeted native wildlife species resulting in a net increase in biological diversity and productivity.

Potential Wildlife by Habitat

Managed Ponds (1/1A, 2, 6/6A, 7/7A, 8)		Tidal Ponds (3, 4, and 5)	
Managed Shallow-Water Ponds	Managed Deep-Water Ponds	Subtidal and Intertidal Habitats	Low, Middle, and High Marsh
Fish (examples: striped bass, sculpin spp., goby spp., longjaw mudsucker) Invertebrates (examples: nematodes, clams, polychaetes, shrimp) Shorebirds (examples: American avocet, black-necked stilt, western sandpiper, dunlin) Dabbling Waterfowl (examples: northern	Fish (examples: striped bass, sculpin spp., goby spp., longjaw mudsucker) Invertebrates (examples: nematodes, clams, polychaetes, shrimp) Diving Waterfowl (examples: scaup, canvasback, bufflehead, ruddy duck) Other Waterbirds (examples: American	Resident Estuarine Fish (examples: striped bass, Sacramento splittail, topsmelt, sculpin spp., perch spp., goby spp.) Anadromous Fish (steelhead trout, Chinook salmon) Invertebrates (examples: Dungeness crabs and other crabs, polychaetes, shrimp, isopods, mussels, clams)	Resident Estuarine Fish (examples: striped bass, Sacramento splittail, topsmelt, sculpin spp., perch spp., goby spp.) Invertebrates (examples: Dungeness crabs and other crabs, polychaetes, shrimp, isopods, mussels, clams) Special Status Birds and Mammals (Salt Marsh Harvest Mice, California Clapper Rail, California Black Rail, San Pablo

shoveler, northern pintail, green-winged teal, mallard, gadwall)	white pelican, double-crested cormorant, eared grebe, tern spp.)	Shorebirds (examples: American avocet, black-necked stilt, western sandpiper, dunlin) Diving Waterfowl (examples: scaup, canvasback, bufflehead, ruddy duck) Dabbling Waterfowl (examples: northern shoveler, northern pintail, green-winged teal, mallard, gadwall)	Song Sparrow) Other Birds (examples: Virginia Rail, great-blue heron, great egret, snowy egret, northern harrier)

4. Invasive plant species and introduced predators are not negatively impacting populations of targeted native wildlife.

<u>Marsh Evolution</u>

5. A stable sediment deposition process is established in the ponds opened to tidal action and quantifiable evolution to tidal marsh habitat is occurring in Ponds 3, 4 and 5.

6. Fringe tidal marsh that is lost due to widening of external slough channels is replaced by the formation of new vegetated tidal marsh within the ponds opened to tidal action.

Anticipated Habitat Evolution

Year	Present	10	50
Pond Interiors			
Subtidal	0	140	150
Intertidal Mudflat	0	2410	1550
Lower Marsh	0	260	50
Middle Marsh	0	100	1170
Managed Pond	6460	3550	3550
Upland/Transition	200	190	190
External Sloughs			
Subtidal	430	620	630
Intertidal Mudflat	80	80	80
Lower Marsh	30	30	30
Middle Marsh	1210	1020	1010

II. MONITORING AND ADAPTIVE MANAGEMENT DECISION-MAKING

A. Introduction

This section describes the monitoring and adaptive management decision-making process, which consists of the following steps (also see Figure 1 – Monitoring Justification and Figure 2 – Adaptive Management Decision Matrix):

1. Evaluate in-field monitoring data and assess progress of restoration compared to success criteria;

2. If restoration effort is not progressing as expected, identify potential adverse conditions impacting progress of restoration;

3. Assess the causes of adverse conditions and whether adverse conditions can or should be remedied;

4. Implement the appropriate adaptive management action, as required; and

5. Monitor the effects of adaptive management actions.

As part of the adaptive management process, the project team and a panel of senior scientists/engineers will first confer to assess the results of the monitoring effort and determine whether adaptive management actions are necessary. Recommended actions could include reductions in construction activities, increased construction activities, or changes in operations, particularly water management.

B. Monitoring Objectives and Categories

<u>Monitoring Objectives</u>
Monitoring activities are linked to the project success criteria (as shown in Figure 1 – Monitoring Justification) and their results will help determine potential adaptive management activities (as shown in Figure 2 – Adaptive Management Decision Matrix). The primary objectives of the project monitoring are to:

1. Assess water quality in the ponds, sloughs, and Napa River;

2. Gauge compliance with applicable water quality standards in receiving waters;

3. Evaluate the changes in wildlife use of restored tidal habitats and managed ponds; and

4. Monitor and evaluate the physical evolution of restored tidal habitats and the external slough channels.

APPENDIX E
MONITORING AND ADAPTIVE MANAGEMENT PLAN
Draft

In general, monitoring of managed ponds (1,1A, 2, 6, 6A, 7, 7A and 8) will focus on salinity and general water quality parameters within the ponds, water elevation in the ponds, water quality in the receiving waters, and wildlife use in the ponds (invertebrates, fish, and birds). Water quality parameters will be monitored in order to determine the success of salinity reduction and pond management. Invertebrates, fish, and bird use will be monitored to understand wildlife use of the managed ponds, and occasional contaminant surveys of wildlife will be used to understand impacts of pollutants.

Monitoring of ponds opened to tidal action (3, 4, and 5) will focus first on salinity reduction (water quality in ponds and receiving waters), and then on tidal habitat evolution and wildlife use (invertebrates, fish, mammals, and birds). Water quality parameters will be monitored in order to determine the success of salinity reduction and changes to water circulation patterns. Aerial surveys, bathymetry surveys, sedimentation measurements, tidal level surveys, vegetation surveys, and levee breach and external slough cross sections surveys will be used to evaluate marsh evolution rates and internal and external channel development. Vegetation surveys will also be used to understand vegetation colonization by species and identify introduced species. Invertebrates, fish, mammal, and bird use will be monitored to understand wildlife use of the restored tidal ponds, and occasional contaminant surveys of wildlife will be used to understand impacts of pollutants.

Monitoring information will be used to determine whether success criteria are being achieved and project hypotheses are correct, which will indicate whether the three project planning objectives are being met. The three project planning objectives are, in short, to 1) create a mix of tidal habitat and managed pond habitat to serve a broad range of wildlife; 2) restore large areas of tidal habitats; and 3) improve the ability to manage water depths and salinity levels in the managed ponds.

<u>Monitoring Categories</u>

If success criteria are not being achieved, the results of monitoring will be used to assess whether adaptive management measures need to be implemented and to determine the type, extent and duration of adaptive management measures. Monitoring activities can be grouped into four categories:

1. Water quality monitoring in the ponds;
2. Water quality monitoring in the receiving waters;
3. Monitoring of wildlife use/presence in the managed and tidal ponds; and
4. Monitoring of habitat evolution in tidal ponds.

Each of these types of monitoring will be used in the adaptive management decision-making process described above. Figure 2, the Adaptive Management Decision Matrix, shows the decision/analysis process for each category of monitoring.

All cost-shared monitoring is needed to collect information to make adaptive management decisions. In addition, water quality, marsh evolution, and biological monitoring will also be required in order to document compliance with applicable state and federal environmental requirements, and overlaps with some of the monitoring being conducted for adaptive management purposes. Table 3 illustrates how each monitoring topic applies to compliance with state and federal environmental law. The discharge from the ponds to receiving waters will be regulated under a Waste Discharge Requirements (WDR) order or National Pollutant Discharge Elimination System (NPDES) permit from the Regional Water Quality Control Board (RWQCB). The possible impacts of construction activities on federally listed threatened and endangered species will require biological monitoring. Biological, hydrodynamic, and bathymetric monitoring will be required to satisfy mitigation requirements under the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA), the Biological Opinion (BO) issued by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS), the 401 certification issued by the RWQCB, and the Consistency Determination issued by the San Francisco Bay Conservation and Development Commission (BCDC).

C. Adaptive Management Scenarios

Adaptive management would be used to address the following potential conditions, which would be revealed through monitoring:

1. Tidal marsh is evolving faster than predicted;
2. Tidal marsh is evolving more slowly than predicted and/or scour of fringe marsh is greater than expected;
3. Salinity reduction of the ponds is more difficult than anticipated;
4. Management of depths and salinities in the managed ponds is more difficult than anticipated;
5. There are adverse impacts to receiving water (sloughs, Napa River) or pond water quality;
6. Introduced plants or predators are causing decreases in native wildlife populations; and/or
7. Wildlife use/presence in project area is decreasing for targeted groups of wildlife.

These conditions would be identified through the monitoring program. Possible adaptive management actions for responding to the conditions outlined above are summarized below. The decision-making process for adaptive management decisions is illustrated in Figure 2 (Adaptive Management Decision Matrix) and a description of the adaptive management process applicable to each category of monitoring is provided below.

D. Adaptive Management Process by Monitoring Category

Water Quality Monitoring in the Ponds

Basic water quality parameters (such as dissolved oxygen, pH, salinity, temperature, water depth) in Ponds 3, 4, 5, 6, 6A, 7A, and 8 will be monitored as salinity reduction is being conducted. Water quality will continue to be monitored for 5 years after construction in the ponds that remain as managed ponds (Ponds 1, 1A, 2, 6, 6A, 7A, and 8). Pond 7 (the bittern pond) will be monitored for water quality for 10 years after construction.

Water quality monitoring in the ponds (combined with wildlife monitoring in the ponds) will determine whether modifications to pond operations to meet salinity reduction objectives or improve pond management for wildlife are required. If water quality parameters are not acceptable, the most likely cause is lack of water circulation. The project team will determine whether inadequate circulation or flow is the cause of the poor water quality before beginning adaptive management efforts. The first step in the adaptive management process is to modify the water flows as much as possible in the desired direction using existing water control structures. If running the water control structures at maximum flow does not fully resolve the impaired water quality, then additional water control structures may be required to meet water quality objectives. Changes in the total discharge flow, whether through existing water control structures or through additional water control structures, will be monitored in order to ensure that there are no adverse consequences on the receiving waters due to changes in water management.

Water Quality Monitoring in the Receiving Waters

The discharge from the ponds to receiving waters will be monitored in order to establish whether applicable surface water quality standards are being met and to ensure that beneficial resources are not being negatively impacted. Monitoring of surface water quality will determine whether modifications in salinity reduction operations or to managed pond operations are required. If water quality standards in the receiving water are not being met, the most likely cause is excess discharge flow. In this case, the adaptive management measure is to reduce discharge flows. If discharge rates must be altered, pond water quality will be monitored to ensure that the alterations do not result in adverse consequences to water quality within the ponds, decreasing wildlife habitat values and slowing or reversing salinity reduction. If discharge criteria cannot be met without reducing flows at the discharge point, and reducing the flows results in adverse water quality in the ponds, then additional discharge locations (water control structures) will be added on Pond 6/6A, 7, and/or 7A.

Habitat Evolution Monitoring in Tidal Ponds

Habitat evolution monitoring (changes in bathymetry, tidal range, and vegetation) will be used to assess whether tidal habitat is developing at the projected rate. If habitat evolution is slower than anticipated, the data collected will be used to determine whether there is an overall sediment deficit, or whether re-suspension of sediment is causing the slow rate of accretion. In addition, the project team will assess whether the reduced rate of habitat formation, in combination with fringe marsh erosion, could lead to unacceptably high interim losses of tidal marsh habitat. If the projected interim loss of tidal marsh habitat is unacceptably high, one of two adaptive management approaches will be implemented. If a sediment deficit is causing the slow rate of accretion, then additional levee lowering will be constructed in Ponds 4 and 5 to increase areas that are at the proper elevations for rapid vegetation colonization. Vegetation colonization in these areas will increase the total tidal marsh acreage quickly, and will also increase sediment trapping rates. Additional starter channels and berms may also be constructed in Pond 5 to increase water flow and thus sediment loads to the interior of the pond, to provide sacrificial sources of sediment, and to increase areas at the proper elevations for rapid vegetation colonization. If sediment re-suspension is the cause of slow habitat formation, then additional starter channels and berms will be constructed in Pond 5 to reduce wind-wave action in the ponds.

If monitoring indicates that habitat evolution in Pond 3 is happening faster than anticipated, then the extent of habitat design features in Ponds 4 and 5 can be reduced prior to construction. The Pond 3 habitat evolution monitoring data will be used to reassess the need for these habitat design features in Ponds 4 and 5 as part of the detailed design effort.

Fish and Wildlife Use and Presence in the Monitoring Area

The project is designed to provide improved habitat to a wide range of species. Fish and wildlife monitoring will be conducted to ensure that there are no unacceptable losses of certain fish and wildlife types/species as a result of the project, and to document the benefits of the project. If monitoring shows that fish and wildlife use is stable and/or increasing, then no adaptive management actions are required. If monitoring indicates that fish and wildlife use/presence is decreasing or that food sources are not available, then the cause for the decrease will be identified. If the cause is associated with changes in pond management (e.g. water level or salinity), then pond management will be modified so that the pond(s) will become more attractive to fish and wildlife. If the cause is associated with landscape-level changes (e.g. the loss of pond habitat and creation of tidal habitat), then regional patterns of fish and wildlife use/abundance will be evaluated to assess whether the affected species have migrated to another area. In the event that insufficient appropriate habitat is available regionally for the affected species, the project team will work with other projects in the area to ensure that sufficient regional habitat is provided. (This latter adaptive management action is not likely to be required, would require authorization for additional studies, and a cost estimate has not been developed for this contingency as part of the Napa River Salt Marsh Project.)

III. MONITORING ACTIVITIES

A. Timing of Monitoring During Project Phases

Proposed monitoring activities vary according to pond and project phase (see Table 1 – Proposed Monitoring Schedule), but can be summarized as follows and are further described below:

Pre-Construction and Construction Monitoring

- Cost-shared construction monitoring will take place prior to and during construction.
- Construction time for each pond ranges from 1 to 5 years.

Post-Construction Monitoring

- The first five years of post-construction monitoring for Ponds 1, 1A, 2, 6, 6A, 7A, and 8 will be cost-shared.
- The first ten years of post-construction monitoring for Ponds 3, 4, 5, and 7 will be cost-shared.
- Receiving waters will be monitored for five years off the lower pond discharge and ten years off the upper pond discharge.

Adaptive Management

- The adaptive management period runs concurrent with the monitoring period, with two additional years added for adaptive management measures to be completed for each pond after cost-shared monitoring ends.
- The cost-shared adaptive management period for Ponds 1, 1A, 2, 6, 6A, 7A, and 8 is seven years post-construction.
- The cost-shared adaptive management period for Ponds 3, 4, 5, and 7 is twelve years post-construction.

Pre-Construction and Construction Monitoring

Baseline information regarding wildlife use, bathymetry, hydrology, and water quality in the project area will be based upon related past and present monitoring (see Section II.C.) that has not been cost-shared. A minimal amount of cost-shared, baseline monitoring of wildlife use and water quality survey in the ponds will be conducted prior to commencement of construction and during the construction period to augment the baseline information and provide a continuous picture of wildlife use and water quality in the system. In addition, pre-construction breeding surveys will be conducted for Western snowy plovers and California clapper rails, as required in the U.S. Fish and Wildlife Service's Biological Opinion. These pre-construction surveys will be cost-shared. Other required construction monitoring (i.e. archaeological monitoring, monitoring of dust concentrations, and surveys of power towers) will also be cost-shared.

Post-Construction Monitoring

Cost-shared, post-construction monitoring is necessary to assess whether the project is achieving the success criteria and to support the adaptive management decision-making process. Post-construction monitoring data will be used to determine the necessity for and timing of adaptive management actions. Post-construction monitoring will be performed concurrently with the adaptive management phase. Therefore, post-construction monitoring is planned for five years after construction for managed ponds (Ponds 1, 1A, 2, 6, 6A, 7A and 8), ten years for ponds opened to tidal action (Ponds 3, 4, 5) and ten years for Pond 7 (the bittern pond). The level of monitoring will not be the same each year and will be phased and conducted differently for tidal ponds, which will be slowly evolving systems, than for managed ponds, which will not be evolving systems and will need early analysis and refined development of water management regimes.

Water Quality Monitoring in Ponds
During salinity reduction, water quality monitoring will be conducted in all of the ponds to ensure that the salinities of the ponds are decreasing and water quality is improving, prior to conversion to pond management or tidal marsh restoration. Additionally, water quality monitoring within the ponds will ensure that discharges will meet surface water quality standards, or allow for changes in discharge rates if there are changes in water quality.

Water Quality Monitoring in Receiving Waters
During salinity reduction, there will be two discharge points. For the lower ponds, there will be a combined discharge to the Napa River from Ponds 4, 5, 6, and 6A, and for the upper ponds there will be a combined discharge to the Napa River/ Napa Slough from Ponds 7, 7A and 8 out of the mixing chamber. Both of these discharges will be permitted by the RWQCB under a NPDES permit or WDR order. Because the monitoring of the receiving waters will have a major role in adaptive management decisions, the project proposes to cost share the NPDES or WDR monitoring costs for the Lower Pond discharge for five years (the time period of the permit) and the Upper Pond discharge for ten years. It may take longer than ten years to reduce bittern and salinity in the upper ponds, but any monitoring conducted after year 10 will be considered to be OMRR&R and will not be cost shared.

Habitat Evolution and Wildlife in Tidal Ponds (Ponds 3, 4, and 5)
An aerial survey documented with digital photography to assess vegetation rates in the tidal ponds and erosion rates in the neighboring sloughs will be conducted annually, along with annual vegetation transects and annual monitoring of sediment pins. Wildlife and bathymetric surveys will take place one year after the initial breach of each pond to characterize wildlife responses and physical changes, and the schedule for additional wildlife and bathymetric surveys will be based upon the development of vegetation within the restored ponds. For planning and cost-estimating purposes, these surveys have been scheduled every two years after construction, for a total of no more than five years of wildlife and bathymetric surveys during the ten year post-construction monitoring period. Wildlife surveys for tidal ponds will include invertebrates, fish, mammals, and birds, including contaminant monitoring of indicator wildlife. The marsh evolution surveys will include a bathymetric survey along the vegetation transects and levee breach and internal and external slough channel cross-section surveys. Based upon monitoring

results, adaptive management measures, such as additional levee lowering or starter channel creation, may be implemented, as described in Section II.

Water Quality and Wildlife Use in Managed Ponds (Ponds 1, 1A, 2, 6, 6A, 7, 7A, and 8)
Monitoring data will occur in the managed ponds during the five years after construction. Once levees are repaired and water control structures repaired or replaced, and after a water management regime is in place, ponds will be monitored for basic water quality parameters, water depths, and wildlife use (invertebrates, fish, and waterbirds) for five years post-construction. Based upon monitoring results, adaptive management measures, such as changes in water management regimes or additional water control structures, may be implemented, as described in Section II.

Operations and Maintenance
Activities and monitoring associated with operations and maintenance (OMRR&R) will not be cost-shared and will commence at the conclusion of the construction phase for each pond. OMRR&R will occur primarily at managed ponds and will consist of operating water control structures and maintaining levees and water control structures. OMRR&R is generally not required for the areas opened to tidal action, although limited removal of non-native invasive cordgrass *(Spartina spp.)* may be conducted.

Post-construction monitoring is not considered to be part of OMRR&R except for routine monitoring of levee repairs, operation and maintenance of new water control structures and monitoring that exceeds the scope of this monitoring program or exceeds the five-year monitoring time period for Ponds 1, 1A, 2, 6, 6A, 7A, and 8 or ten-year time period for Ponds 3, 4, 5, or 7. For example, NPDES or WDR monitoring required in excess of the 10-year time period for the combined discharge from Ponds 7, 7A, and 8 will be considered to be OMRR&R and will not be cost shared.

B. Specific Monitoring Activities

Water Quality in the Receiving Waters
A comprehensive water-quality monitoring program will be prepared and implemented for the duration of the salinity reduction process. The monitoring will have well-defined data quality objectives, monitoring procedures, and data analysis and reporting protocols. Monitoring of the receiving waters will ensure that project operations are meeting the requirements of the NPDES permit or WDR order, that surface water quality standards are met, and that there are no impacts to beneficial resources. Monitoring at specific locations will be completed and phased out as each successive pond is restored and salinity has been reduced to ambient levels. Cost-shared monitoring of the receiving waters will occur for five years off the lower ponds and ten years off the upper ponds.

Monitoring of basic water quality parameters (flow, water level stage, salinity, dissolved oxygen, pH, temperature, and TSS/turbidity) will be conducted at several receiving water locations. Grab samples will be used to conduct the water quality monitoring and may also periodically include analysis of metals and/or priority pollutants. Aquatic toxicity tests may also be conducted on a periodic basis, in order to determine if there could be higher discharge rates for bittern.

Monitoring of Wildlife Use/Presence

Tidal Ponds (Ponds 3, 4, and 5)

Macroinvertebrate, fisheries, mammalian, and avian species data will be collected at locations within the tidal ponds during the ten-year post-construction phase of the project. This monitoring will be conducted approximately every two years post-construction, based upon vegetation colonization rates, and will be compared to a reference site within the system (such as Pond 2A or Coon Island) to determine progress towards the success criteria for wildlife presence/use. Pre-construction and construction surveys in Ponds 3, 4, and 5 will include invertebrates, fish, and birds as described in the Managed Pond section below.

Invertebrates

Invertebrates will be sampled in the water column by net sweeps and in the benthos with Eckmann grab samples twice per year every two years during the ten-year post-construction period. Ten sweep and ten grab samples will be taken in each pond (60 samples total during each sample period); sweep sampling will consist of 3 sweeps per sample, and each benthic sample will be a composite of 5 cores. Biomass (dry weight) and diversity of invertebrates will be measured.

Fish

Fish species assemblages will be surveyed seasonally every two years during the ten-year post-construction period. Multiple sampling gear will be used to assess distribution and relative abundance of juvenile and adult fishes. Captured fish will be identified to species with taxonomic keys and counted. The first 25 of each species will be measured for standard length and weight. Twenty-five individuals from selected species will be analyzed for stomach contents. A small number of individuals from selected species will also be analyzed for contaminants, particularly mercury.

Mammals

Once marsh vegetation begins establishing, live trapping for small mammals will be conducted to determine absence/presence of salt marsh harvest mice and other small mammals. U.S. Fish and Wildlife Service protocols for trapping will be followed.

Birds

Ponds will be overlayed with 250 m Universal Transverse Mercator (UTM) grids (6.25 ha cells), and all integrated samples will be located within this grid. Locations of flocks, species identification and densities will be mapped in the grid overlay and displayed in GIS maps. A small number of individual birds will also be analyzed for contaminants, particularly mercury. Once tidal marsh vegetation begins colonizing, vocalization surveys for rail species and point count or breeding surveys for selected passerine species (such as song sparrows) will be conducted in the spring during the same years as the general avian surveys.

Managed Ponds (Ponds 1, 1A, 2, 6, 6A, 7, 7A, and 8)
Macroinvertebrate, fisheries, and avian species data will be collected at locations within the managed ponds during the pre-construction and post-construction phases of the project. This data will be collected as part of the intensive monitoring surveys conducted to assess the impacts of the restoration upon wildlife through time. This survey information will be collected for five years post-construction in Ponds 1, 1A, 2, 6, 6A, 7A, and 8 and ten years post-construction in Pond 7.

Invertebrates
Invertebrates will be sampled in the water column by net sweeps and in the benthos with Eckmann grab samples twice per year. Ten sweep and ten grab samples will be taken in each pond (60 samples total during each sample period); sweep sampling will consist of 3 sweeps per sample, and each benthic sample will be a composite of 5 cores. Biomass (dry weight) and diversity of invertebrates will be measured.

Fish
Fish species assemblages will be surveyed seasonally. Multiple sampling gear will be used to assess distribution and relative abundance of juvenile and adult fishes. Captured fish will be identified to species with taxonomic keys and counted. The first 25 of each species will be measured for standard length and weight. Twenty-five individuals from selected species will be analyzed for stomach contents. A small number of individuals from selected species will also be analyzed for contaminants, particularly mercury.

Waterbirds
Ponds will be overlayed with 250 m Universal Transverse Mercator (UTM) grids (6.25 ha cells), and all integrated samples will be located within this grid. Locations of flocks, species identification and densities will be mapped in the grid overlay and displayed in GIS maps. A small number of individual birds will also be analyzed for contaminants, particularly mercury.

<u>Monitoring of Habitat Evolution in Tidal Ponds (Ponds 3, 4, and 5) and Sloughs</u>
Pre-breach monitoring will include some additional surveys for consistency with post-project monitoring locations, plus installation of sedimentation markers. Post-construction (post-breach) monitoring of tidal ponds will focus on geomorphic evolution to document rates and patterns of habitat evolution or fringe marsh erosion and key underlying physical processes (e.g. sedimentation rates, water velocity) and vegetation colonization and spread. Post-construction monitoring will last for ten years in Ponds 3, 4, and 5.

Geomorphic Evolution

Sedimentation will be monitored to understand rates and patterns of marsh evolution within breached ponds. Digital aerial photography of Ponds 3, 4 and 5 and neighboring sloughs will be taken during annual aerial flights. The digital photography will be rectified and habitat delineated for Ponds 3, 4 and 5 and neighboring sloughs on an annual basis, to determine trends in marsh evolution within the ponds and amount of fringe marsh erosion in neighboring sloughs. Trends in sedimentation processes will be ground-truthed with the use of annual monitoring of sedimentation markers, and topographic/bathymetric surveys of vegetation transects conducted every two years during the ten-year post-construction monitoring time period.

Levee Breach and Slough Channel Cross Sections
Every two years, cross-section surveys of levee breaches, external sloughs, and pond-internal sloughs and adjacent berms will be conducted to understand patterns of tidal scour and drainage and to determine when the widths and depths of the breaches and external and internal sloughs reach equilibrium in response to the tidal prism.

Tidal Surveys
For ponds opened to tidal action, the progress of the tidal regime towards reference conditions will be monitored using appropriate recording equipment. Measurements of tide elevations will be recorded periodically at locations within the site and at a nearby reference location. The tidal regime and tidal prism will be determined from these measurements.

Vegetation Colonization
Vegetation transects will be conducted once per year at the end of the growing season within breached ponds to document rates and patterns of vegetation colonization. This data will be used to ground-truth the results of annual aerial photography surveys and identify plant species. Vegetation data will also play a major role in determining when and how to conduct wildlife monitoring, as wildlife changes will primarily correspond to vegetation rates.

Introduced Vegetation
Vegetation surveys will also include monitoring for introduced species of cordgrass *(Spartina spp.)* and other invasive species of concern such as *Lepidium*. The project team will work with the San Francisco Estuary Invasive *Spartina* Project to monitor and control introduced and invasive *Spartina,* in order to ensure regional coordination.

C. Past and Current Monitoring

<u>Wildlife Use of Ponds</u>
U.S. Geological Survey has been monitoring six ponds of varying salinities (Ponds 1, 2, 2A, 3, 4, and 7) since 1999. This interdisciplinary study, involving biologists and hydrologists, has included avian, macroinvertebrate, and fish surveys, along with collection of salinity and other water quality data in the ponds and collection of hydrodynamic, salinity, and suspended sediment concentration data in the sloughs.

(Takekawa, *et al.* 2001). The ongoing nature of this monitoring effort will allow for before and after comparisons of wildlife use, water quality, and physical processes.

Hydrodynamics

U.C. Davis, in collaboration with USGS, conducted an intensive hydrologic and water quality data collection project in the Napa-Sonoma Marsh tidal slough network and in the Napa River and Sonoma Creek to determine the physical processes controlling circulation patterns of water and suspended sediment (Warner, *et al.* 1999). Velocity, water level, conductivity, temperature and suspended sediment concentration were measured at 17 sites from September 1997 to March 1998. Future monitoring of physical processes can be compared to this baseline data.

Wildlife Use and Habitat Evolution of Pond 2A

Marsh evolution and wildlife use in the restored Pond 2A site was monitored first by Philip Williams and Associates and then by MEC Analytical Systems, Inc. from 1996 to 2000 (PWA, 1997 and MEC, 2000), and funded by the California Department of Fish and Game. The physical and biological evolution of the 550-acre Pond 2A marsh was monitored through surveys of levee breach and natural slough channel width equilibrium, sediment chemistry and grain size, sedimentation rates, tidal range and response, fish usage, avian usage, and plant colonization. Although Pond 2A has different characteristics than the remaining ponds (Pond 2A was slightly less subsided and was never farmed prior to conversion to a salt pond), it can be used as one point of comparison. Comparisons can also be made to other restoration projects in the North Bay that are currently being monitored (such as Guadalcanal and Tolay Creek), and to the fringing marsh that exists along the slough channels within the salt pond complex.

Topographic and Bathymetric Survey

A topographic and bathymetric survey of the salt ponds, slough channels, and associated marsh plain was conducted by Towill, Inc. as part of the Feasibility Study with the U.S. Army Corps of Engineers (Towill, 2001). The survey included a very accurate primary control level loop through the site, which was connected to high confidence benchmarks outside the site. This survey was used in the development of the hydrodynamic model by Philip Williams and Associates and will be useful for before and after comparisons of elevations.

Water Quality

Water and sediment samples from 40 sites within the pond complex, along with sites in the Napa River, Napa Slough, and San Pablo Bay were collected in October, 2001, by Hydroscience, after development of a Sampling and Analysis Plan and Quality Assurance Project Plan approved by the RWQCB (Hydroscience, 2001). Samples were analyzed by MEC Analytical Laboratories for volatile and semi-volatile organics, pesticides, PCBs, heavy metals, dioxins, and general water quality parameters, including nutrients, TDS, TSS, pH, temperature, salinity, and DO.

III. MONITORING AND ADAPTIVE MANAGEMENT COSTS

A. Introduction

Current USACE guidance limits spending on monitoring and adaptive management to 5% of construction costs, including contingencies. For the NSMR project, the combined monitoring and adaptive management costs approach X % of total construction costs, with total monitoring costs at approximately X % of total construction costs and adaptive management costs at X % of construction costs.

The costs for monitoring and adaptive management are summarized below and shown in more detail in Table 2 – Monitoring and Adaptive Management Costs.

B. Monitoring Costs

Totals cost for monitoring, with an additional 20% in administration costs added for administration and supervision, is approximately $2,500,000. Monitoring costs can be broken down by the four major categories of monitoring. Monitoring of water quality in the receiving waters (Napa River and neighboring sloughs) totals approximately $800,000. Monitoring of water quality within the ponds totals approximately $80,000. Monitoring of habitat evolution, including sedimentation, bathymetry, hydrology, and vegetation, totals approximately $400,000. Monitoring and fish and wildlife presence and use totals $800,000.

C. Adaptive Management Costs

The estimated cost of evaluation activities is approximately $50,000, and the estimated cost of adaptive management construction is approximately $2,200,000, with an additional $300,000 (15%) in administration, totaling approximately $2,500,000. Costs for adaptive management tasks and personnel are summarized in Table 2 (Monitoring and Adaptive Management Costs) and include those associated with the evaluation of monitoring results and the construction of additional features. Adaptive management actions are divided into actions for tidal areas and managed pond areas.

The adaptive management costs may be substantially lower than proposed because it may not be necessary to build all of the adaptive management features included in the plan. In addition, potential cost savings associated with faster habitat evolution were not included in the adaptive management cost estimate. Significant savings would be realized if habitat evolution is faster than anticipated in Ponds 4 and 5, reducing the need for constructed restoration features. Costs associated with changes in operation would be the responsibility of the local sponsor under OMRR&R.

Tidal Area Adaptive Management Actions and Costs (Ponds 3, 4, and 5)
The greatest concern for the project's future tidal areas is that habitat evolution may occur more slowly than expected. This condition could be caused by: 1) an overall lack of sediment in the system; 2) excess sediment re-suspension due to wind-wave action; or

3) inadequate vegetation colonization. Constructing additional starter channels and berms and lowering additional levees would enhance sediment deposition, reduce sediment re-suspension, and create additional areas at high marsh elevation (Table 2 – Monitoring and Adaptive Management Costs).

Lengthening the starter channels and berms would decrease wave action and erosion and address the problem of inadequate sediment deposition in Pond 5. Additional levee lowering in Ponds 4 and 5 would improve connectivity between existing and developing tidal marsh areas and encourage tidal marsh formation. The estimated adaptive management cost for the tidal areas is approximately $2,000,000.

No adaptive management features are included to address vegetation colonization because the rate of vegetation colonization will probably be adequate (Pond 2A, which was opened to tidal action in 1995, vegetated rapidly, and there are other seed sources in the area). Similarly, adaptive management actions such as importing fill were not included in the adaptive management plan because the overall sediment supply is believed to be adequate although habitat evolution may occur more slowly during dry years, when the sediment supply may be lower.

Managed Pond Adaptive Management Actions and Costs

The greatest concern for the future managed ponds is that control of salinity and water levels might be more difficult than anticipated. This problem would occur if the water control structures installed during the salinity reduction phase are not adequate for long-term management of the water levels and salinities in the ponds, after salinity reduction is complete. This concern would be addressed by increasing the number of water control structures at Ponds 6, 6A, 7, 7A, and 8, since they present the greatest potential need for adaptive management.

It is unlikely that additional water control structures will be required for Ponds 1, 1A, and 2 under the adaptive management plan, since these ponds currently function effectively as managed ponds and the proposed project replaces the unreliable existing water control structures with new structures of the same size/capacity. The costs associated with fine-tuning operations at Ponds 1, 1A, and 2 would be included in the OMRR&R costs. Similarly, Pond 8 is operating successfully with the new intake structures installed by the California Department of Fish and Game. Because the operation of Pond 8 also affects the ability to operate Pond 7, long term management and oversight of the water control structures at Pond 8 is required.

Ponds 6 and 6A are relatively shallow and large, which means that moving water through these ponds by gravity flow can be difficult. Based on the current information, there will be a significant seasonal fluctuation in salinity in these ponds, even if the water control structures are operated at full capacity. If the seasonal fluctuations exceed the desired range, additional water control structures may be required. The adaptive management cost for Ponds 6 and 6A is based on adding an additional weir to Pond 6A.

Adaptive management measures for Ponds 7 and 7A include additional outfalls to the mixing chamber from both Ponds 7 and 7A. Although these ponds will probably be more manageable within a desired salinity and depth range because they are smaller and deeper than most of the ponds in the system, past operations suggests that discharges from the ponds may at times not be as effective as intakes, and that additional outfalls might be necessary.

In addition to these constructed features, Ponds 6/6A might be used as an additional outfall point for the upper ponds, and changes in the bittern discharge ratio based upon additional testing and assimilative capacity of the receiving waters. These adaptive management measures would allow the project team to increase the rate of discharge of bittern from Pond 7, should a greater discharge rate or change in discharge ratio be permissible following the on-going testing.

The estimated cost for adaptive management for the managed ponds is approximately $200,000.

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TABLE 1 – MONITORING AND ADAPTIVE MANAGEMENT SCHEDULE

Monitoring	Ponds	Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Managed Ponds (Wildlife and Water Quality in Ponds)	1/1A, 2	Pre-Construction Monitoring	Construction	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring									
	6/6A	Pre-Construction Monitoring	Construction	Construction	Construction	Construction	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring						
	7	Pre-Construction Monitoring	Construction	Construction	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring			
	7A, 8	Pre-Construction Monitoring	Construction	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring									
Tidal Ponds (Wildlife & Habitat Evolution)	3	Pre-Construction Monitoring	Construction	Construction	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring			
	4, 5	Pre-Construction Monitoring	Construction	Construction	Construction	Construction	Construction	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring	Post-Contruction Monitoring
Water Quality in Receiving Waters	Upper Ponds	Pre-Construction Monitoring	Construction	Construction	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters			
	Lower Ponds	Pre-Construction Monitoring	Construction	Construction	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters	Water Quality Monitoring in Receiving Waters								

Legend:
- Pre-Construction Monitoring
- Construction
- Post-Contruction Monitoring
- Water Quality Monitoring in Receiving Waters

Adaptive Management	Ponds	Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Managed Ponds	1/1A, 2				Change in Water Management	Change in Water Management	Change in Water Management	Change in Water Management	Change in Water Management	Change in Water Management; End Date									
	6/6A							Change in Water Management	Additional Water Control Structures	Change in Water Management	Change in Water Management	Change in Water Management	Change in Water Management; End Date						
	7				Change in Water Management	Change in Water Management	Additional Water Control Structures	Change in Water Management	Change in Water Management	Additional Water Control Structures	Change in Water Management	Change in Water Management	Additional Water Control Structures	Change in Water Management	Change in Water Management	Additional Water Control Structures; End Date			
	7A, 8				Change in Water Management	Change in Water Management	Additional Water Control Structures	Change in Water Management	Change in Water Management	Additional Water Control Structures; End Date									
Tidal Ponds	4, 5				Starter Channels and Berms	Starter Channels and Berms	Starter Channels and Berms			Additional Levee Lowering			Additional Levee Lowering			Additional Levee Lowering			Additional Levee Lowering; End Date

Legend:
- Change in Water Management for Managed Ponds
- Additional Water Control Structures on Ponds 6/6A or 7/7A
- Additional Levee Lowering in Ponds 4 and 5
- Reduced or Additional Starter Channels and Berms in Ponds 4 and 5
- End Date for Cost-Shared Adaptive Management (OMRR&R Begins)

TABLE 2– MONITORING AND ADAPTIVE MANAGEMENT COSTS

MONITORING ACTIVITY	# Times/ Year	Which Years?	# Years	Cost/Unit	Unit	# Units	Total Cost for Activity	Notes
Pre-Construction Endangered Species Surveys								
Clapper Rail Nest Surveys	1	0 - 4	5	$2,000	1 event	5	$10,000	
Snowy Plover Nest Surveys	1	0 - 4	5	$2,000	1 event	5	$10,000	
Water Quality in Receiving Waters								
Combined Discharge of Ponds 4, 5, 6, and 6A	12	3-7	5	$4,500	1 event	60	$270,000	Water quality monitoring of points outside ponds, in receiving waters
Combined Discharge of Ponds 7, 7A, and 8	12	3-12	10	$4,500	1 event	120	$540,000	
Habitat Evolution: Physical Surveys								
Tidal Level Surveys in Ponds 3, 4, and 5 and Sloughs	2	0, 2, 4, 6, 8, 10, 12, 14	8	$1,000	1 event	16	$16,000	
Levee Breach and Channel Cross Section Surveys	1	0, 2, 4, 6, 8, 10, 12, 14	8	$2,000	1 event	8	$16,000	
Monitoring of Sediment Pins in Ponds 3, 4, and 5	1	2-14	13	$2,000	1 event	13	$26,000	
Bathymetric Surveys of Vegetation Transects	1	2, 4, 6, 8, 10, 12, 14	7	$3,000	1 event	7	$21,000	
Habitat Evolution: Vegetation Surveys								
Aerial Surveys for Sedimentation/Vegetation Colonization in Ponds 3, 4, 5, Reference Site	1	3-15	12	$6,250	1 event	12	$75,000	includes rectification and assessment of habitat types
Vegetation Transects in Ponds 4 and 5	1	6, 8, 10, 12, 14	5	$14,000	1 event	5	$70,000	on-ground transect, verification of aerial photography, identification of plant species
Vegetation Transects in Pond 3	1	4, 6, 8, 10, 12	5	$14,000	1 event	5	$70,000	
Vegetation Transects in Reference Site	1	4, 6, 8, 10, 12, 14	6	$14,000	1 event	6	$84,000	
Water Quality Indicators in Ponds								
Pond 1	4	0-6	7	$240	1 event	28	$6,720	Basic water quality parameters within ponds
Pond 1A	4	0-6	7	$240	1 event	28	$6,720	
Pond 2	4	0-6	7	$240	1 event	28	$6,720	
Pond 4	4	0-2	3	$240	1 event	12	$2,880	
Pond 5	4	0-2	3	$240	1 event	12	$2,880	
Pond 6	4	0-9	10	$240	1 event	40	$9,600	
Pond 6A	4	0-9	10	$240	1 event	40	$9,600	
Pond 7	4	0-12	13	$240	1 event	52	$12,480	
Pond 7A	4	0-6	7	$240	1 event	28	$6,720	
Pond 8	4	0-6	7	$240	1 event	28	$6,720	
Toxicity Testing of Pond 7	1	unknown	2	$5,000	1 event	2	$10,000	Toxicity testing of the bittern in Pond 7 could allow for changes in the discharge ratio.
Wildlife and Productivity								

Avian Surveys								
Ponds 1, 1A and 2	6	0 – 6	7	$600	1 event	42	$25,200	
Pond 3	6	0, 2, 4, 6, 8, 10, 12	7	$600	1 event	42	$25,200	
Pond 4	6	0, 2, 4, 6, 8, 10, 12, 14	8	$600	1 event	48	$28,800	
Pond 5	6	0, 2, 4, 6, 8, 10, 12, 14	8	$600	1 event	48	$28,800	
Ponds 6, 6A	6	0 – 9	10	$600	1 event	60	$36,000	
Pond 7	6	3 – 12	10	$600	1 event	60	$36,000	
Pond 7A	6	0 – 6	7	$600	1 event	42	$25,200	
Pond 8	6	0 – 6	7	$600	1 event	42	$25,200	
Vocalization Surveys for Rails in Ponds 3, 4, and 5	1	0, 2, 4, 6, 8, 10, 12, 14	8	$600	1 event	42	$25,200	
Breeding Surveys for passerines in Ponds 3, 4, and 5	1	0, 2, 4, 6, 8, 10, 12, 14	8	$600	1 event	42	$25,200	
Reference Site (Avian, Rail, and Passerine Surveys)	6	0, 2, 4, 6, 8, 10, 12, 14	8	$1,800	1 event	48	$86,400	
Contaminant Monitoring in birds	1	0, 2, 4, 6, 8, 10, 12, 14	8	$2,500	1 event	8	$20,000	In years 0, 2, 4, and 6, a small number of birds using tidal and managed ponds will be monitored for contaminants. In years 8, 10, 12, and 14, only a small number of birds in the tidal ponds will be monitored for contaminants.
Small Mammals								
Pond 3	1	4, 6, 8, 10, 12	5	$1,000	1 event	5	$5,000	
Pond 4	1	6, 8, 10, 12	4	$1,000	1 event	4	$4,000	
Pond 5	1	6, 8, 10, 12	4	$1,000	1 event	4	$4,000	
Reference Site	1	4, 6, 8, 10, 12	5	$1,000	1 event	5	$5,000	
Invertebrates								
Ponds 1, 1A and 2	2	0 – 6	7	$1,700	1 event	14	$23,800	
Pond 3	2	0, 2, 4, 6, 8, 10, 12	7	$1,700	1 event	14	$23,800	
Pond 4	2	0, 2, 4, 6, 8, 10, 12, 14	8	$1,700	1 event	16	$27,200	
Pond 5	2	0, 2, 4, 6, 8, 10, 12, 14	8	$1,700	1 event	16	$27,200	
Ponds 6, 6A	2	0 – 9	10	$1,700	1 event	20	$34,000	
Pond 7a	2	3 – 12	10	$1,700	1 event	20	$34,000	
Pond 8	2	0 – 6	7	$1,700	1 event	14	$23,800	
Reference Site	2	0, 2, 4, 6, 8, 10, 12, 14	8	$1,700	1 event	16	$27,200	
Fish								
Ponds 1, 1A and 2	2	0 – 6	7	$1,800	1 event	14	$25,200	
Pond 3	2	0, 2, 4, 6, 8, 10, 12	7	$1,800	1 event	14	$25,200	
Pond 4	2	0, 2, 4, 6, 8, 10, 12, 14	8	$1,800	1 event	16	$28,800	

		10, 12, 14						
Pond 5	2	0, 2, 4, 6, 8, 10, 12, 14	8	$1,800	1 event	16	$28,800	
Ponds 6, 6A	2	0 – 9	10	$1,800	1 event	20	$36,000	
Pond 7A	2	3 – 12	10	$1,800	1 event	20	$36,000	
Pond 8	2	0 – 6	7	$1,800	1 event	14	$25,200	
Reference Site	2	0, 2, 4, 6, 8, 10, 12, 14	8	$1,800	1 event	16	$28,800	
Contaminant Monitoring	1	0, 2, 4, 6, 8, 10, 12, 14	8	$1,500	1 event	8	$12,000	In years 0, 2, 4, and 6, a small number of fish using tidal and managed ponds will be monitored for contaminants. In years 8, 10, 12, and 14, only a small number of fish in the tidal ponds will be monitored for contaminants.
TOTAL for surveys							**$2,085,640**	
Administrative Costs	1	0 to 15	8	$59,521	year	8	$417,128	Includes supervision and administration based on 20% of total cost of monitoring surveys
TOTAL for monitoring							**$2,502,768**	

ADAPTIVE MANAGEMENT COSTS								
Evaluation Activities	**Item**	**Which Years?**	**# Years**	**Cost/Unit**	**Unit**	**# Units**	**Total Cost for Activity**	**Rationale**
Evaluation of Monitoring Data		3, 7, 11, 14	4	$100	hour	160	$16,000	To assess effects of restoration and progress with tidal habitat evolution, to validate modeling efforts and to test model projections. Year 3 assessment is required to verify habitat restoration features required for Ponds 4 and 5.
Identification of Response Options and Recommendations								
	Experts' and Senior Management Staff time	3, 7, 11, 14	4	$100	hour	160	$16,000	To fund participation of a panel of experts in a yearly meeting to review monitoring data and project progress. Panel will identify appropriate plan of action, if any.
	Project Team Labor	3, 7, 11, 14	4	$100	hour	160	$16,000	To prepare for each panel meeting
	Report	3, 7, 11, 14	4	$100	hour	40	$4,000	Documents response options and recommendations
Budget Assessment		3, 7, 11, 14	4	$100	hour	40	$4,000	To determine ability to act on preferred plan of action
TOTAL for Evaluation Activities							**$52,000**	

Implementation Activities (Potential Physical Construction)							Includes only actions that would incur additional costs
	Location	Item	Cost/Unit	Unit	# Units	Total Cost for Activity	Rationale
TIDAL PONDS							
	Pond 4	Levee Lowering	$54	linear foot	3,500	$189,000	To increase rate of habitat evolution (starter channels and berms) and provide additional habitat connectivity (levee lowering) if tidal marsh evolution is slower than projected. Quantities listed would increase the extent of these measures to the level the represented by Habitat Restoration Option 4 (accelerated restoration).
	Pond 5	Starter Channels and Berms	$200	linear foot	8,400	$1,680,000	
		Levee Lowering	$54	linear foot	2,900	$156,600	
MANAGED PONDS							
	Pond 6	Weir	$6,200	lump sum	1	$6,200	Pond management is not meeting project goals of salinity reduction or water depth, due to water circulation issues. Proposed budget is based on doubling the design-level water flows.
	Pond 7	Additional discharge into mixing chamber	$100,000	lump sum	1	$100,000	
	Pond 7A	Additional discharge into mixing chamber	$100,000	lump sum	1	$100,000	
TOTAL for adaptive management implementation						**$2,231,800**	
Administrative Costs						**$334,770**	15% construction supervision and administration
TOTAL FOR ALL ADAPTIVE MANAGEMENT						**$2,566,570**	

MONITORING AND ADAPTIVE MANAGEMENT
APPENDIX E TABLES

TABLE 3 – COMPLIANCE MONITORING BREAKDOWN

Monitoring Topics	Monitoring Requirements				
	RWQCB NPDES/ WDR	RWQCB 401 Cert	BCDC	FWS and NMFS (Section 7 Biological Opinions)	EIR/S Mitigation Monitoring Requirements
WQ and Sediment within Ponds		Water and sediment quality			Monitor depths of managed ponds (need to be 2 feet below levee crest)
WQ and Sediment in Sloughs, Napa River, and Restored Tidal Habitats	Discharge Monitoring (water quality and sediment)	Water and sediment quality			Continuous recording devices for key parameters (flow, water level stage, salinity, temp, TSS/turbidity), and/or periodic grab samples for specific constituents of concern (DO, pH, selected inorganic ions and trace metals).
Wildlife in Tidal Habitats and Ponds		Monitor major wildlife groups from Goals Report (plants, fish, invertebrates, amphibians and reptiles, mammals, waterfowl and shorebirds, other birds); Wildlife (special status species and general abundance and diversity)	Presence/absence of wildlife (don't typically require wildlife surveys)	Pre-construction surveys for California clapper rails during nesting season using FWS 1/21/00 draft survey protocol. Avoid construction February through July or conduct pre-construction survey up to 72 hours in advance 150-300 feet from construction area. Develop survey protocol for snowy plover and conduct during breeding season (March 1 through September 30). Notify FWS within 24 hours of any injured or dead rail, smelt, splittail, harvest mouse, snowy plover or any harm caused by monitoring	Collect water quality and sediment samples periodically to document that accumulation of trace metal and inorganic compounds does not occur in restored wetlands. Conduct 10 years of monitoring for waterfowl and shorebirds after restoration of Ponds 3, 4, and 5, due to loss of open water habitat. Monitor exposure of wildlife to contaminants in restored wetlands over next 10 years. Monitor for entrainment of fish in ponds to assess whether measures could be implemented to reduce entrainment. Assess water quality changes on listed and sensitive fish species.
Introduced Species		Control of exotic species			Monitor for invasive *Spartina*.
Marsh Evolution in Tidal Habitats		Acreage of habitat types; Vegetation composition and percent cover; Bathymetry and sedimentation rates	Vegetative performance criteria (% cover). Once every 3 years over 10 years		
Hydrology and Channel Geomorphology		Hydrology and channel geomorphology			Monitor expansion of slough channels to ensure expansion does not threaten adjacent levees. Take adaptive management measures (additional levee breaches, phasing of pond breaching, levee repairs or revetment) to protect levees if needed
HazMats					Monitor perimeter dust concentrations in vicinity of Pond 8, to protect residents.
Utilities					Conduct site-specific surveys of power towers to ensure they are not impacted. Possibly encase towers with concrete above high water mark.
Public Health					Consult with Mosquito Abatement District and permit them to monitor and control mosquitos. Cost-share mosquito control if monitoring and control increase above pre-project levels.

FIGURE 1 – MONITORING JUSTIFICATION MATRIX

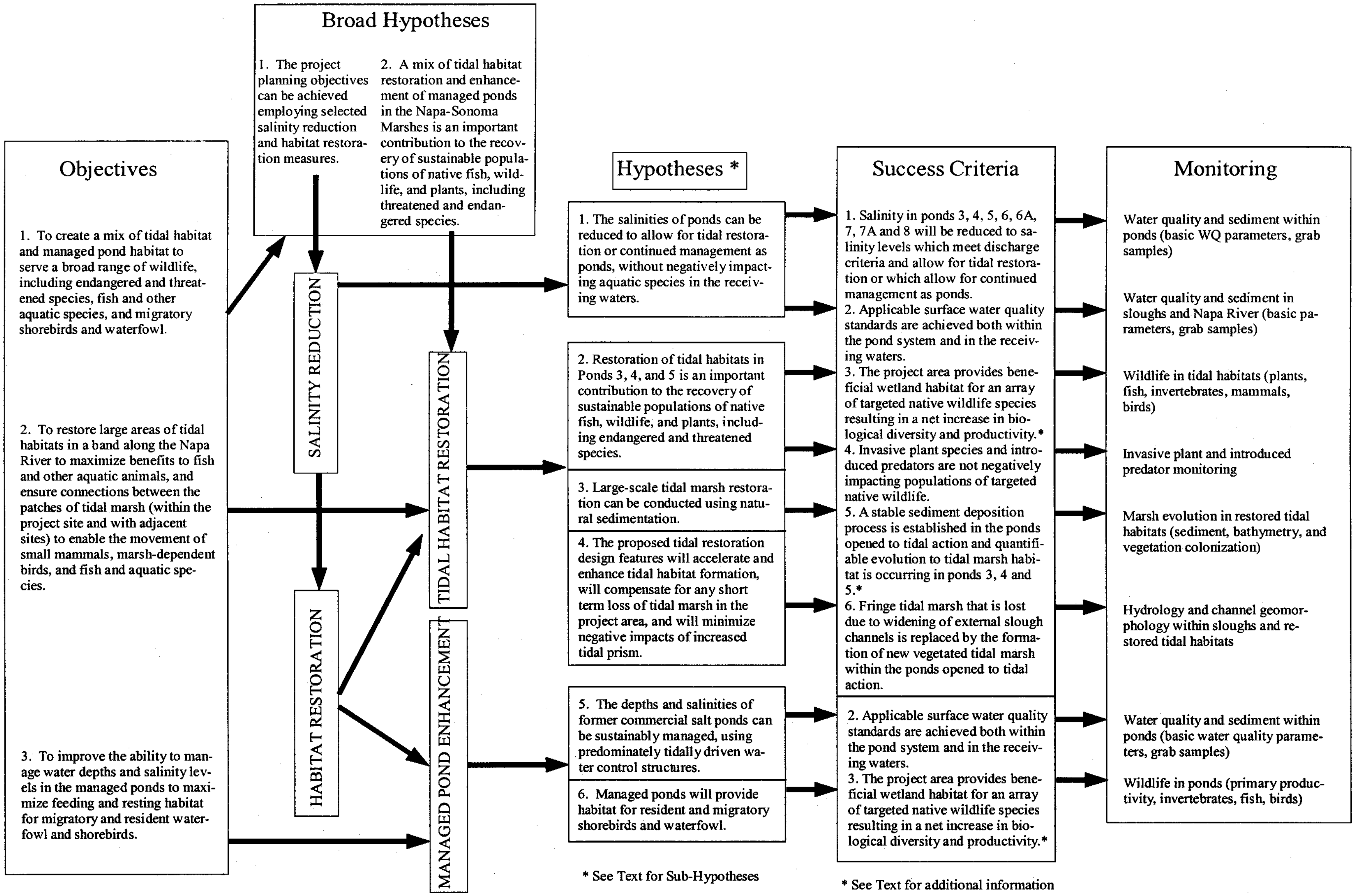
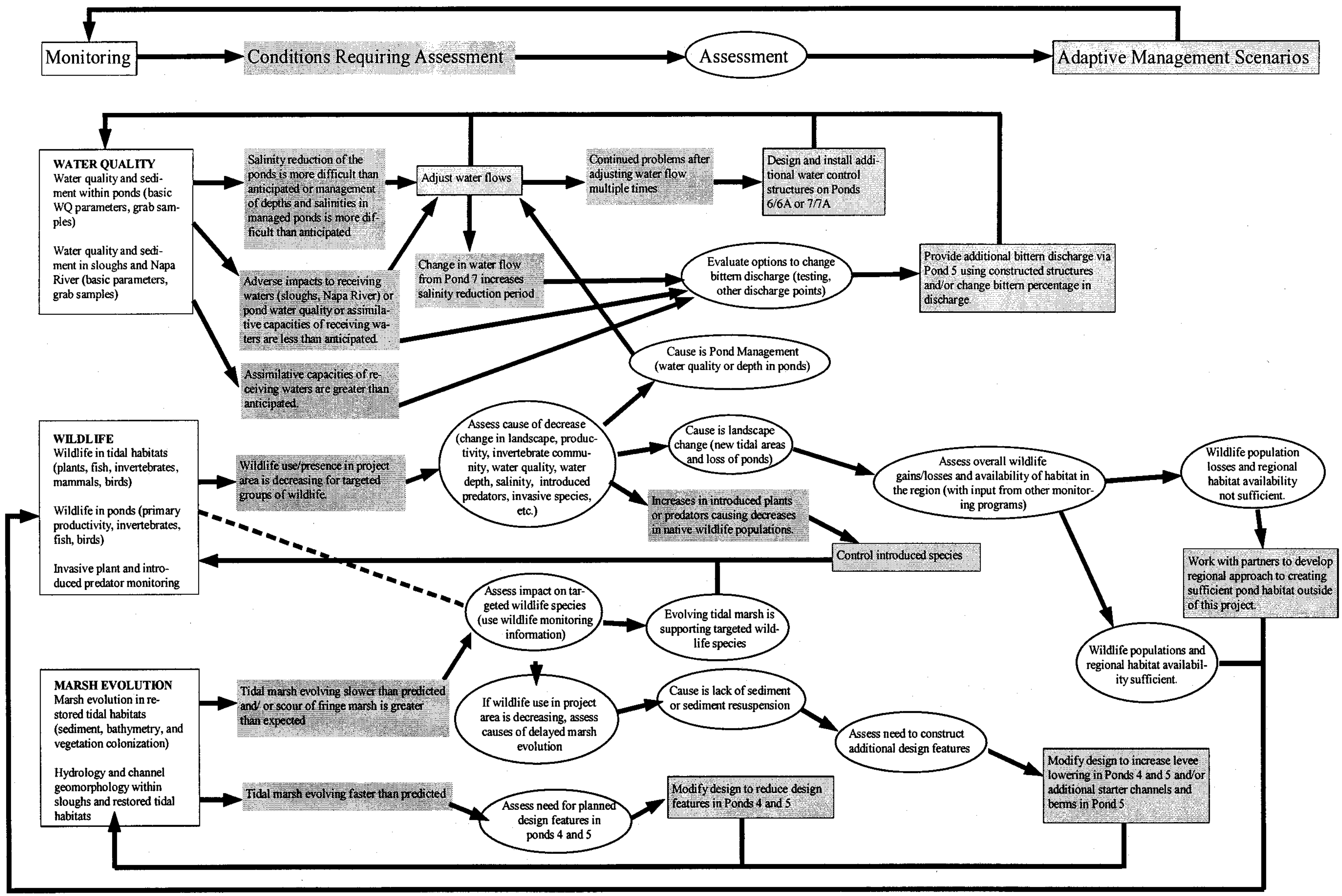


FIGURE 2 – ADAPTIVE MANAGEMENT DECISION MATRIX



SALINITY/METALS CORRELATION
SAMPLES COLLECTED FROM SOUTH BAY SALT PONDS
24 OCTOBER 2002

SOUTH BAY DATA FROM HANSEN/FRONTIER - SAMPLES COLLECTED 24OCT2002

Dissolved Concentration

Pond ID	Salinity (g/L)	Cr (ug/l)	Ni (ug/l)	Cu (ug/l)	Zn (ug/l)	As (ug/l)	Se (ug/l)	Ag (ug/l)	Cd (ug/l)	Hg (ng/l)	Pb (ug/l)
A2W	31.6	1.22	8.05	1.06	1.21	6.27	0.199	0.012	0.049	0.00126	0.264
A3W	42	1.22	7.45	1.1	0.65	10.7	0.128	0.01	0.044	0.00126	0.307
B2C	54.6	1.24	4.96	1.29	1.18	1.14	0.055	0.016	0.054	0.00036	0.28
A15	89.4	1.12	10.8	0.86	1.29	14	0.094	0.021	0.077	0.00138	0.313
A15 (DUP)	89.8	1.16	10.6	0.89	1.83	14.5	0.124	0.027	0.067	0.00128	0.33
A14	92.6	1.35	11	0.97	1.15	18.3	0.111	0.055	0.039	0.00221	0.309
A16	109	1.27	12.8	1.07	2.25	14.4	0.141	0.04	0.053	0.0014	0.446
A18	146	1.35	19.7	1.92	2.88	48.3	0.224	0.023	.899[a]	0.00114	0.748
I-3[b]	194	1.16	10.8	0.57	2.87	3.52	0.304	0.015	0.096	0.00056	0.572
I-3B[b]	224	1.47	13.3	2.64	4.02	3.14	0.142	0.039	0.124	0.00069	1.33
B9	279	1.34	14.5	2.21	3.8	30.9	0.14	0.028	0.423	0.00041	7.18

Total Recoverable Concentration

Pond ID	Salinity (g/L)	Cr (ug/l)	Ni (ug/l)	Cu (ug/l)	Zn (ug/l)	As (ug/l)	Se (ug/l)	Ag (ug/l)	Cd (ug/l)	Hg (ng/l)	Pb (ug/l)
A2W	31.6	2.36	11.8	2.15	1.8	6.36	0.274	0.022	0.063	0.0118	0.843
A3W	42	0.67	8.42	1.24	0.79	11.9	0.173	0.015	0.045	0.00478	0.324
B2C	54.6	0.67	7.09	1.59	1.28	1	0.092	0.013	0.05	0.00337	0.392
A15	89.4	0.83	14.3	1.37	1.82	15.1	0.16	0.03	0.054	0.032	0.351
A15 (DUP)	89.8	1.07	15.7	1.59	3.07	15.7	0.135	0.02	0.054	0.032	0.371
A14	92.6	1.17	13.5	2.04	3.16	20.1	0.22	0.063	0.053	0.0445	0.395
A16	109	1.23	18.1	2.01	3.38	17.1	0.159	0.15	0.062	0.0395	0.619
A18	146	1.3	21.8	3.39	4.49	56.2	0.31	0.045	0.119	0.0497	1.37
I-3[b]	194	1.47	9.73	2.07	6.77	4.28	0.295	0.128	0.119	0.0356	0.892
I-3B[b]	224	1.38	12.3	2.45	7.22	5.18	0.352	0.044	0.136	0.041	1.15
B9	279	1.12	15.1	2.61	4.28	33.1	0.143	0.416	0.123	0.03	6.48

SALINITY/METALS CORRELATION
SAMPLES COLLECTED FROM SOUTH BAY SALT PONDS
24 OCTOBER 2002

SOUTH BAY DATA FROM HANSEN/FRONTIER - SAMPLES COLLECTED 24OCT2002
ANALYSIS OF CORRELATIONS

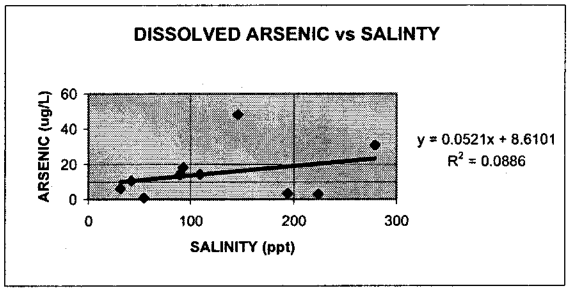
SUMMARY

METAL	BEST RELATION	R SQUARED CORRELATION COEFFICIENT
Arsenic	Total, log-log	0.1032
Cadmium	Total	0.7891
Chromium	Dissolved	0.2556
Copper	Dissolved	0.3914
Lead	Dissolved, lol-log	0.625
Mercury	Total, log-log	0.4946
Nickel	Disolved, log-log	0.5295
Selenium	Dissolved	0.1117
Silver	Total, log-log	0.5831
Zinc	Dissolved	0.8831

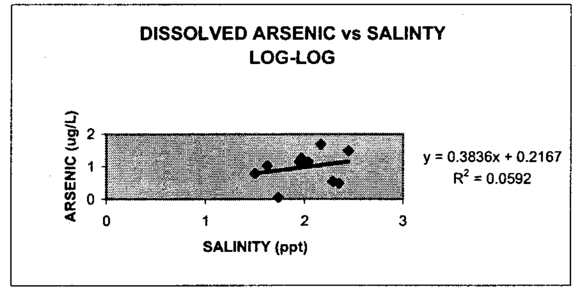
METAL	BEST RELATION	R SQUARED CORRELATION COEFFICIENT
Zinc	Dissolved	0.8831
Cadmium	Total	0.7891
Lead	Dissolved, lol-log	0.625
Silver	Total, log-log	0.5831
Nickel	Disolved, log-log	0.5295
Mercury	Total, log-log	0.4946
Copper	Dissolved	0.3914
Chromium	Dissolved	0.2556
Selenium	Dissolved	0.1117
Arsenic	Total, log-log	0.1032

SALINITY/METALS CORRELATION
SAMPLES COLLECTED FROM SOUTH BAY SALT PONDS
24 OCTOBER 2002

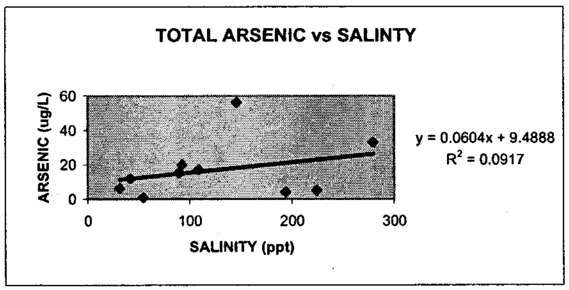
POND	SALINITY	ARSENIC DISSOLVED
A2W	31.6	6.27
A3W	42	10.7
B2C	54.6	1.14
A15	89.4	14
A15(DUP)	89.8	14.5
A14	92.6	18.3
A16	109	14.4
A18	146	48.3
I-3	194	3.52
I-3B	224	3.14
B9	279	30.9



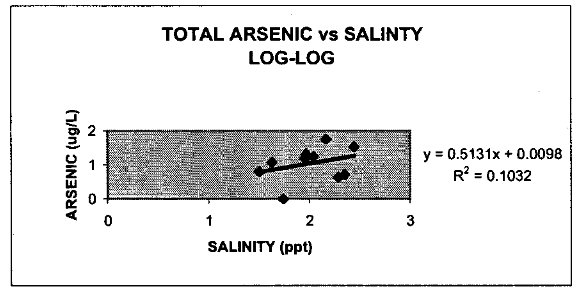
LOG SALINITY	LOG As DISSOLVED
1.4996871	0.7972675
1.6232493	1.0293838
1.7371926	0.0569049
1.9513375	1.146128
1.9532763	1.161368
1.966611	1.2624511
2.0374265	1.1583625
2.1643529	1.6839471
2.2878017	0.5465427
2.350248	0.4969296
2.4456042	1.4899585



POND	SALINITY	ARSENIC TOTAL
A2W	31.6	6.36
A3W	42	11.9
B2C	54.6	1
A15	89.4	15.1
A15(DUP)	89.8	15.7
A14	92.6	20.1
A16	109	17.1
A18	146	56.2
I-3	194	4.28
I-3B	224	5.18
B9	279	33.1

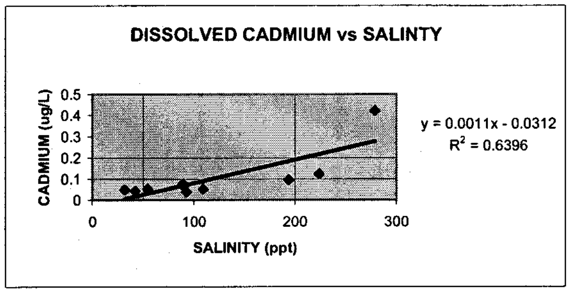


LOG SALINITY	LOG As TOTAL
1.4996871	0.8034571
1.6232493	1.075547
1.7371926	0
1.9513375	1.1789769
1.9532763	1.1958997
1.966611	1.3031961
2.0374265	1.2329961
2.1643529	1.7497363
2.2878017	0.6314438
2.350248	0.7143298
2.4456042	1.519828

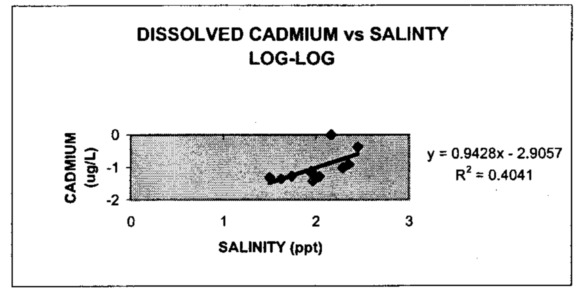


SALINITY/METALS CORRELATION
SAMPLES COLLECTED FROM SOUTH BAY SALT PONDS
24 OCTOBER 2002

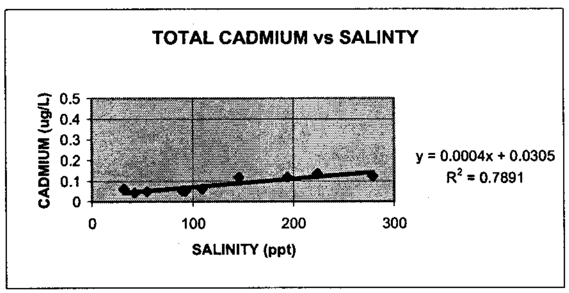
POND	SALINITY	CADMIUM DISSOLVED
A2W	31.6	0.049
A3W	42	0.044
B2C	54.6	0.054
A15	89.4	0.077
A15(DUP)	89.8	0.067
A14	92.6	0.039
A16	109	0.053
A18	146	
I-3	194	0.096
I-3B	224	0.124
B9	279	0.423



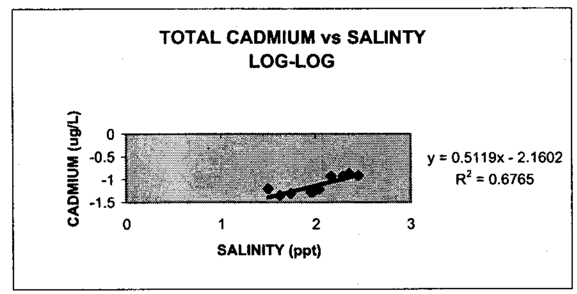
LOG SALINITY	LOG Cd DISSOLVED
1.4996871	-1.309804
1.6232493	-1.356547
1.7371926	-1.267606
1.9513375	-1.113509
1.9532763	-1.173925
1.966611	-1.408935
2.0374265	-1.275724
2.1643529	#NUM!
2.2878017	-1.017729
2.350248	-0.906578
2.4456042	-0.37366



POND	SALINITY	CADMIUM TOTAL
A2W	31.6	0.063
A3W	42	0.045
B2C	54.6	0.05
A15	89.4	0.054
A15(DUP)	89.8	0.054
A14	92.6	0.053
A16	109	0.062
A18	146	0.119
I-3	194	0.119
I-3B	224	0.136
B9	279	0.123

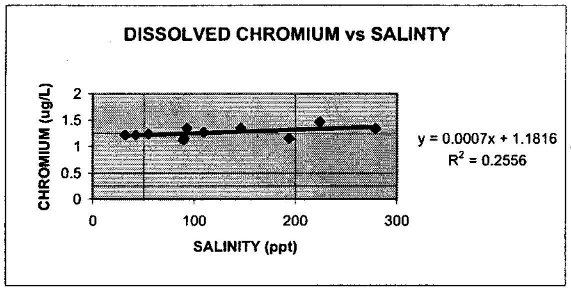


LOG SALINITY	LOG Cd TOTAL
1.4996871	-1.200659
1.6232493	-1.346787
1.7371926	-1.30103
1.9513375	-1.267606
1.9532763	-1.267606
1.966611	-1.275724
2.0374265	-1.207608
2.1643529	-0.924453
2.2878017	-0.924453
2.350248	-0.866461
2.4456042	-0.910095

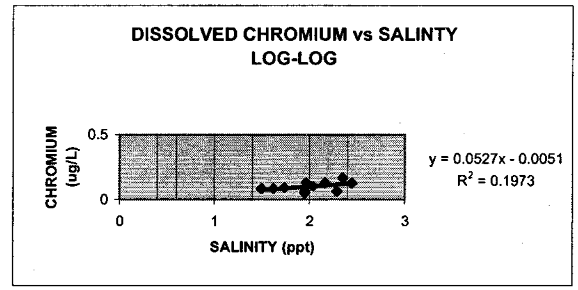


SALINITY/METALS CORRELATION
SAMPLES COLLECTED FROM SOUTH BAY SALT PONDS
24 OCTOBER 2002

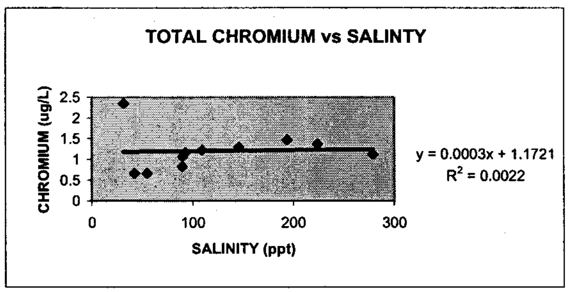
POND	SALINITY	CHROMIUM DISSOLVED
A2W	31.6	1.22
A3W	42	1.22
B2C	54.6	1.24
A15	89.4	1.12
A15(DUP)	89.8	1.16
A14	92.6	1.35
A16	109	1.27
A18	146	1.35
I-3	194	1.16
I-3B	224	1.47
B9	279	1.34



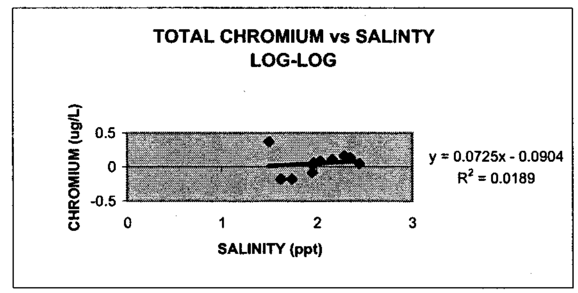
LOG SALINITY	LOG Cr DISSOLVED
1.4996871	0.0863598
1.6232493	0.0863598
1.7371926	0.0934217
1.9513375	0.049218
1.9532763	0.064458
1.966611	0.1303338
2.0374265	0.1038037
2.1643529	0.1303338
2.2878017	0.064458
2.350248	0.1673173
2.4456042	0.1271048



POND	SALINITY	CHROMIUM TOTAL
A2W	31.6	2.36
A3W	42	0.67
B2C	54.6	0.67
A15	89.4	0.83
A15(DUP)	89.8	1.07
A14	92.6	1.17
A16	109	1.23
A18	146	1.3
I-3	194	1.47
I-3B	224	1.38
B9	279	1.12

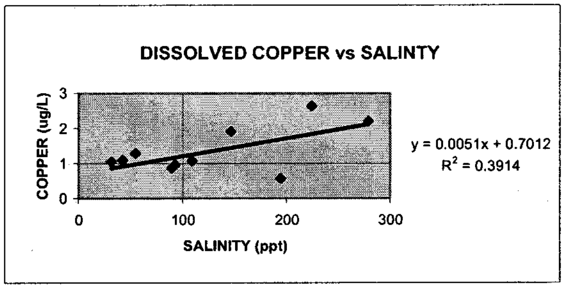


LOG SALINITY	LOG Cr TOTAL
1.4996871	0.372912
1.6232493	-0.173925
1.7371926	-0.173925
1.9513375	-0.080922
1.9532763	0.0293838
1.966611	0.0681859
2.0374265	0.0899051
2.1643529	0.1139434
2.2878017	0.1673173
2.350248	0.1398791
2.4456042	0.049218

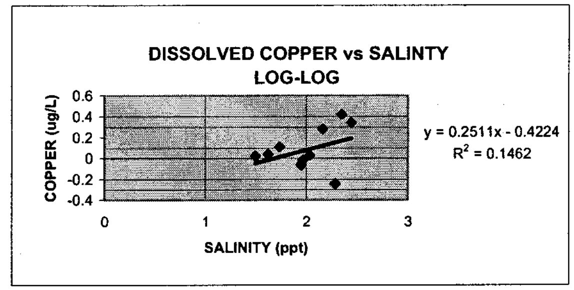


SALINITY/METALS CORRELATION
SAMPLES COLLECTED FROM SOUTH BAY SALT PONDS
24 OCTOBER 2002

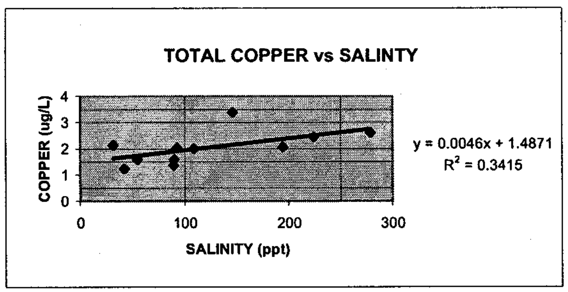
POND	SALINITY	COPPER DISSOLVED
A2W	31.6	1.06
A3W	42	1.1
B2C	54.6	1.29
A15	89.4	0.86
A15(DUP)	89.8	0.89
A14	92.6	0.97
A16	109	1.07
A18	146	1.92
I-3	194	0.57
I-3B	224	2.64
B9	279	2.21



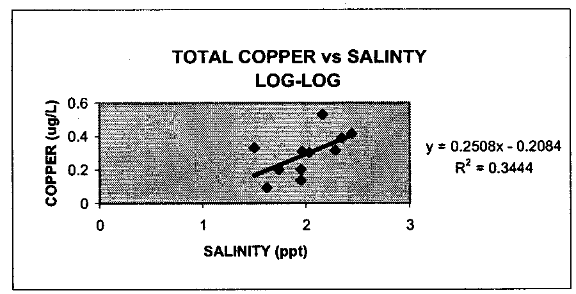
LOG SALINITY	LOG Cu DISSOLVED
1.4996871	0.0253059
1.6232493	0.0413927
1.7371926	0.1105897
1.9513375	-0.065502
1.9532763	-0.05061
1.966611	-0.013228
2.0374265	0.0293838
2.1643529	0.2833012
2.2878017	-0.244125
2.350248	0.4216039
2.4456042	0.3443923



POND	SALINITY	COPPER TOTAL
A2W	31.6	2.15
A3W	42	1.24
B2C	54.6	1.59
A15	89.4	1.37
A15(DUP)	89.8	1.59
A14	92.6	2.04
A16	109	2.01
A18	146	3.39
I-3	194	2.07
I-3B	224	2.45
B9	279	2.61

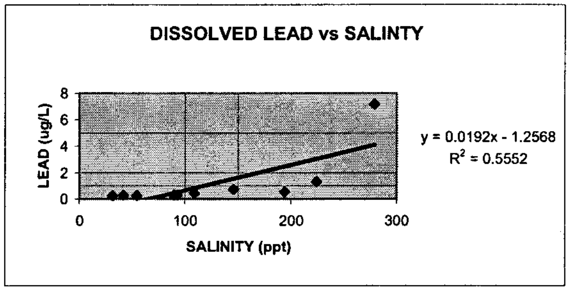


LOG SALINITY	LOG Cu TOTAL
1.4996871	0.3324385
1.6232493	0.0934217
1.7371926	0.2013971
1.9513375	0.1367206
1.9532763	0.2013971
1.966611	0.3096302
2.0374265	0.3031961
2.1643529	0.5301997
2.2878017	0.3159703
2.350248	0.3891661
2.4456042	0.4166405

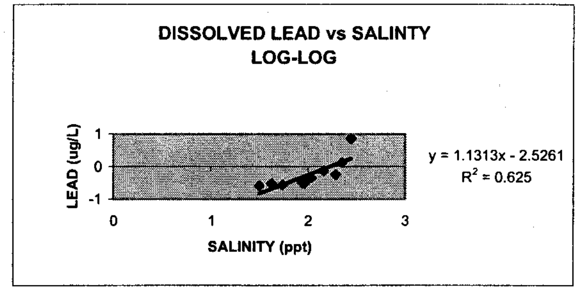


SALINITY/METALS CORRELATION
SAMPLES COLLECTED FROM SOUTH BAY SALT PONDS
24 OCTOBER 2002

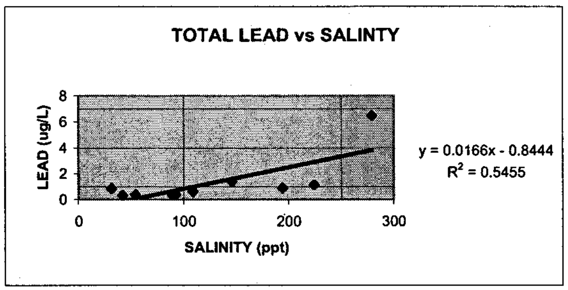
POND	SALINITY	LEAD DISSOLVED
A2W	31.6	0.264
A3W	42	0.307
B2C	54.6	0.28
A15	89.4	0.313
A15(DUP)	89.8	0.33
A14	92.6	0.309
A16	109	0.446
A18	146	0.748
I-3	194	0.572
I-3B	224	1.33
B9	279	7.18



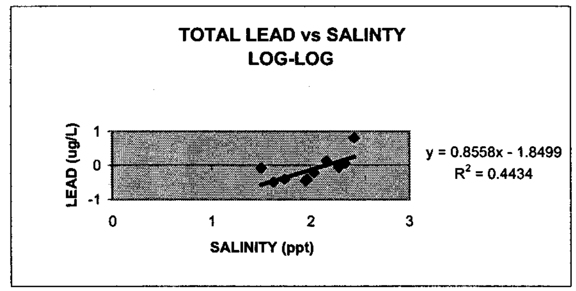
LOG SALINITY	LOG Pb DISSOLVED
1.4996871	-0.578396
1.6232493	-0.512862
1.7371926	-0.552842
1.9513375	-0.504456
1.9532763	-0.481486
1.966611	-0.510042
2.0374265	-0.350665
2.1643529	-0.126098
2.2878017	-0.242604
2.350248	0.1238516
2.4456042	0.8561244



POND	SALINITY	LEAD TOTAL
A2W	31.6	0.843
A3W	42	0.324
B2C	54.6	0.392
A15	89.4	0.351
A15(DUP)	89.8	0.371
A14	92.6	0.395
A16	109	0.619
A18	146	1.37
I-3	194	0.892
I-3B	224	1.15
B9	279	6.48

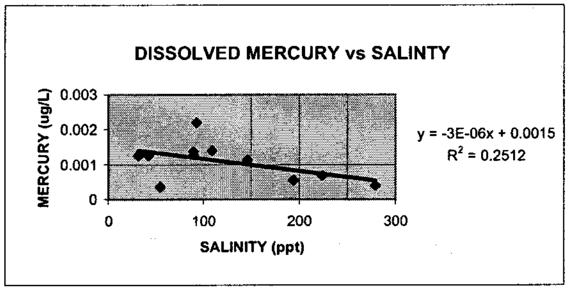


LOG SALINITY	LOG Pb TOTAL
1.4996871	-0.074172
1.6232493	-0.489455
1.7371926	-0.406714
1.9513375	-0.454693
1.9532763	-0.430626
1.966611	-0.403403
2.0374265	-0.208309
2.1643529	0.1367206
2.2878017	-0.049635
2.350248	0.0606978
2.4456042	0.811575

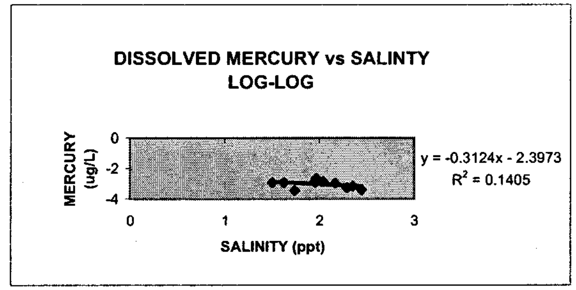


SALINITY/METALS CORRELATION
SAMPLES COLLECTED FROM SOUTH BAY SALT PONDS
24 OCTOBER 2002

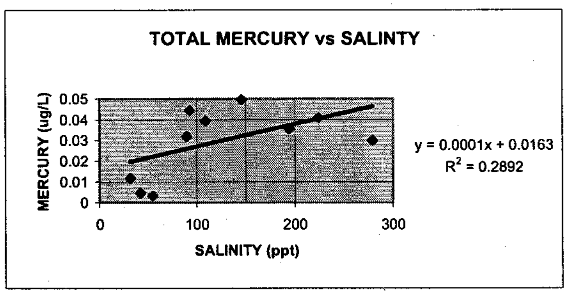
POND	SALINITY	MERCURY DISSOLVED
A2W	31.6	0.00126
A3W	42	0.00126
B2C	54.6	0.00036
A15	89.4	0.00138
A15(DUP)	89.8	0.00128
A14	92.6	0.00221
A16	109	0.0014
A18	146	0.00114
I-3	194	0.00056
I-3B	224	0.00069
B9	279	0.00041



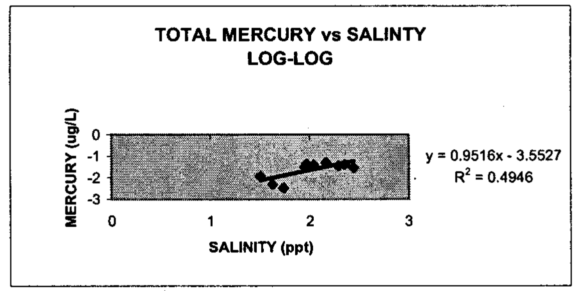
LOG SALINITY	LOG Hg DISSOLVED
1.4996871	-2.899629
1.6232493	-2.899629
1.7371926	-3.443697
1.9513375	-2.860121
1.9532763	-2.89279
1.966611	-2.655608
2.0374265	-2.853872
2.1643529	-2.943095
2.2878017	-3.251812
2.350248	-3.161151
2.4456042	-3.387216



POND	SALINITY	MERCURY TOTAL
A2W	31.6	0.0118
A3W	42	0.00478
B2C	54.6	0.00337
A15	89.4	0.032
A15(DUP)	89.8	0.032
A14	92.6	0.0445
A16	109	0.0395
A18	146	0.0497
I-3	194	0.0356
I-3B	224	0.041
B9	279	0.03

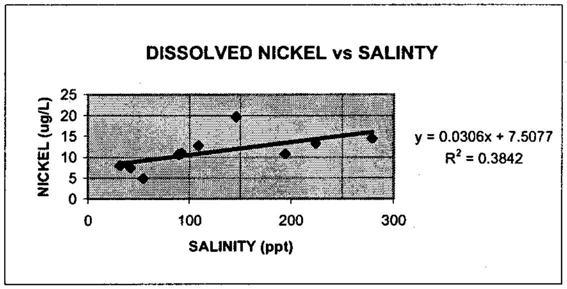


LOG SALINITY	LOG Hg TOTAL
1.4996871	-1.928118
1.6232493	-2.320572
1.7371926	-2.47237
1.9513375	-1.49485
1.9532763	-1.49485
1.966611	-1.35164
2.0374265	-1.403403
2.1643529	-1.303644
2.2878017	-1.44855
2.350248	-1.387216
2.4456042	-1.522879

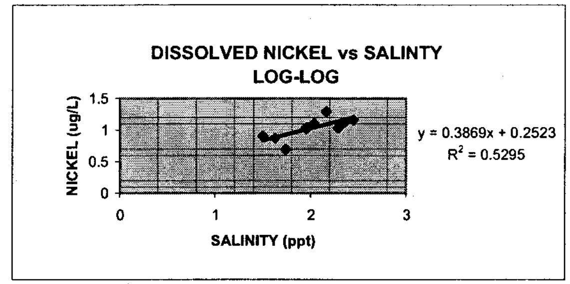


SALINITY/METALS CORRELATION
SAMPLES COLLECTED FROM SOUTH BAY SALT PONDS
24 OCTOBER 2002

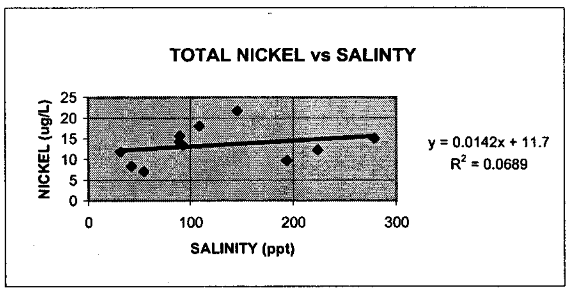
POND	SALINITY	NICKEL DISSOLVED
A2W	31.6	8.05
A3W	42	7.45
B2C	54.6	4.96
A15	89.4	10.8
A15(DUP)	89.8	10.6
A14	92.6	11
A16	109	12.8
A18	146	19.7
I-3	194	10.8
I-3B	224	13.3
B9	279	14.5



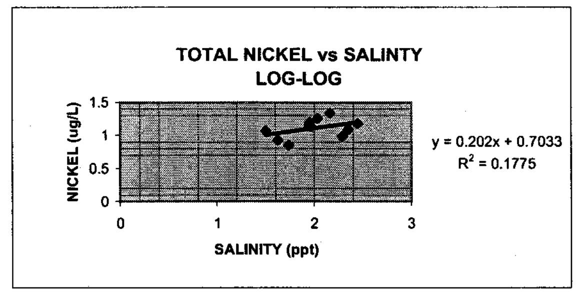
LOG SALINITY	LOG Ni DISSOLVED
1.4996871	0.9057959
1.6232493	0.8721563
1.7371926	0.6954817
1.9513375	1.0334238
1.9532763	1.0253059
1.966611	1.0413927
2.0374265	1.10721
2.1643529	1.2944662
2.2878017	1.0334238
2.350248	1.1238516
2.4456042	1.161368



POND	SALINITY	NICKEL TOTAL
A2W	31.6	11.8
A3W	42	8.42
B2C	54.6	7.09
A15	89.4	14.3
A15(DUP)	89.8	15.7
A14	92.6	13.5
A16	109	18.1
A18	146	21.8
I-3	194	9.73
I-3B	224	12.3
B9	279	15.1

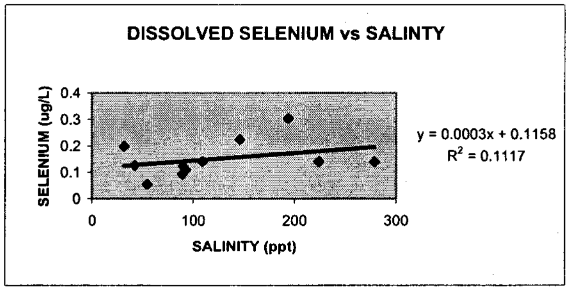


LOG SALINITY	LOG Ni TOTAL
1.4996871	1.071882
1.6232493	0.9253121
1.7371926	0.8506462
1.9513375	1.155336
1.9532763	1.1958997
1.966611	1.1303338
2.0374265	1.2576786
2.1643529	1.3384565
2.2878017	0.9881128
2.350248	1.0899051
2.4456042	1.1789769

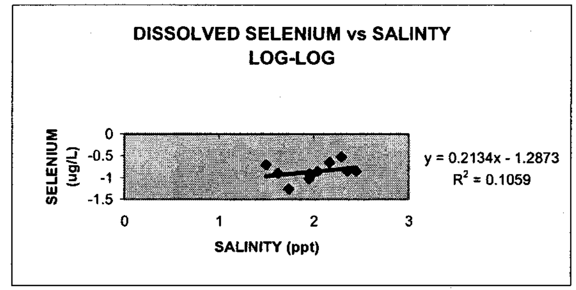


SALINITY/METALS CORRELATION
SAMPLES COLLECTED FROM SOUTH BAY SALT PONDS
24 OCTOBER 2002

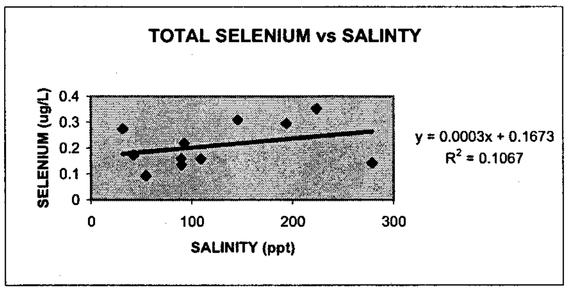
POND	SALINITY	SELENIUM DISSOLVED
A2W	31.6	0.199
A3W	42	0.128
B2C	54.6	0.055
A15	89.4	0.094
A15(DUP)	89.8	0.124
A14	92.6	0.111
A16	109	0.141
A18	146	0.224
I-3	194	0.304
I-3B	224	0.142
B9	279	0.14



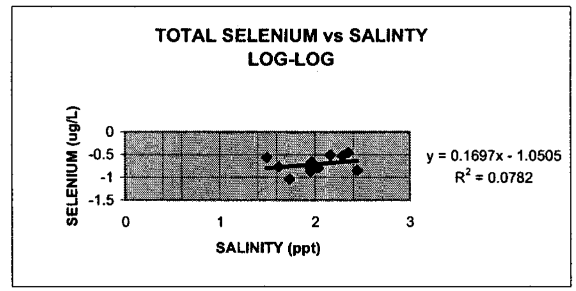
LOG SALINITY	LOG Se DISSOLVED
1.4996871	-0.701147
1.6232493	-0.89279
1.7371926	-1.259637
1.9513375	-1.026872
1.9532763	-0.906578
1.966611	-0.954677
2.0374265	-0.850781
2.1643529	-0.649752
2.2878017	-0.517126
2.350248	-0.847712
2.4456042	-0.853872



POND	SALINITY	SELENIUM TOTAL
A2W	31.6	0.274
A3W	42	0.173
B2C	54.6	0.092
A15	89.4	0.16
A15(DUP)	89.8	0.135
A14	92.6	0.22
A16	109	0.159
A18	146	0.31
I-3	194	0.295
I-3B	224	0.352
B9	279	0.143

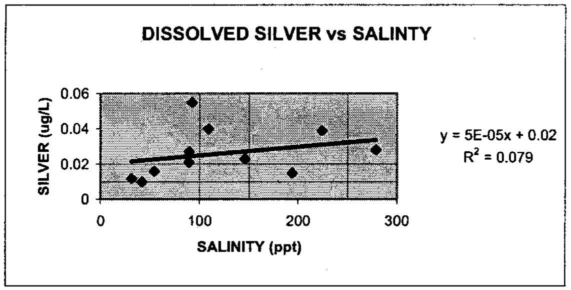


LOG SALINITY	LOG Se TOTAL
1.4996871	-0.562249
1.6232493	-0.761954
1.7371926	-1.036212
1.9513375	-0.79588
1.9532763	-0.869666
1.966611	-0.657577
2.0374265	-0.798603
2.1643529	-0.508638
2.2878017	-0.530178
2.350248	-0.453457
2.4456042	-0.844664

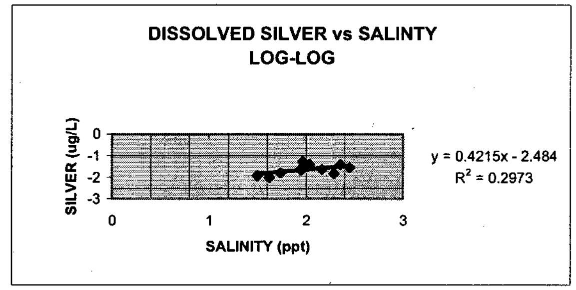


SALINITY/METALS CORRELATION
SAMPLES COLLECTED FROM SOUTH BAY SALT PONDS
24 OCTOBER 2002

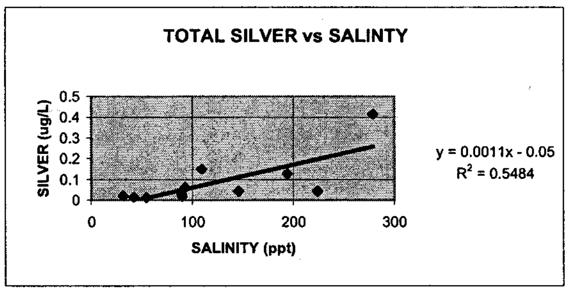
POND	SALINITY	SILVER DISSOLVED
A2W	31.6	0.012
A3W	42	0.01
B2C	54.6	0.016
A15	89.4	0.021
A15(DUP)	89.8	0.027
A14	92.6	0.055
A16	109	0.04
A18	146	0.023
I-3	194	0.015
I-3B	224	0.039
B9	279	0.028



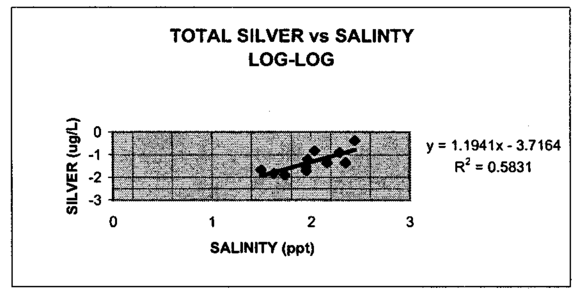
LOG SALINITY	LOG Ag DISSOLVED
1.4996871	-1.920819
1.6232493	-2
1.7371926	-1.79588
1.9513375	-1.677781
1.9532763	-1.568636
1.966611	-1.259637
2.0374265	-1.39794
2.1643529	-1.638272
2.2878017	-1.823909
2.350248	-1.408935
2.4456042	-1.552842



POND	SALINITY	SILVER TOTAL
A2W	31.6	0.022
A3W	42	0.015
B2C	54.6	0.013
A15	89.4	0.03
A15(DUP)	89.8	0.02
A14	92.6	0.063
A16	109	0.15
A18	146	0.045
I-3	194	0.128
I-3B	224	0.044
B9	279	0.416

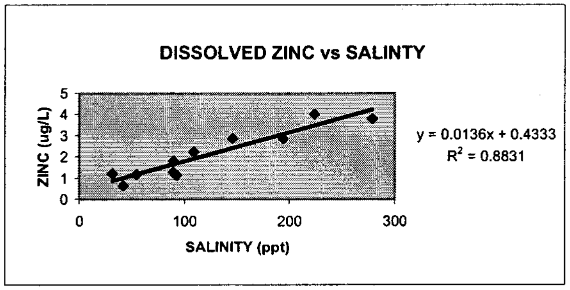


LOG SALINITY	LOG Ag TOTAL
1.4996871	-1.657577
1.6232493	-1.823909
1.7371926	-1.886057
1.9513375	-1.522879
1.9532763	-1.69897
1.966611	-1.200659
2.0374265	-0.823909
2.1643529	-1.346787
2.2878017	-0.89279
2.350248	-1.356547
2.4456042	-0.380907

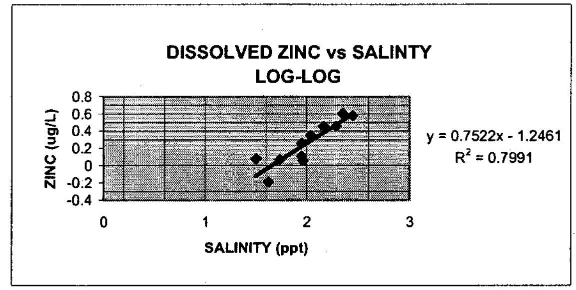


SALINITY/METALS CORRELATION
SAMPLES COLLECTED FROM SOUTH BAY SALT PONDS
24 OCTOBER 2002

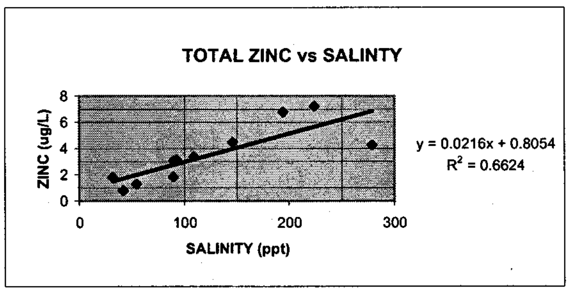
POND	SALINITY	ZINC DISSOLVED
A2W	31.6	1.21
A3W	42	0.65
B2C	54.6	1.18
A15	89.4	1.29
A15(DUP)	89.8	1.83
A14	92.6	1.15
A16	109	2.25
A18	146	2.88
I-3	194	2.87
I-3B	224	4.02
B9	279	3.80



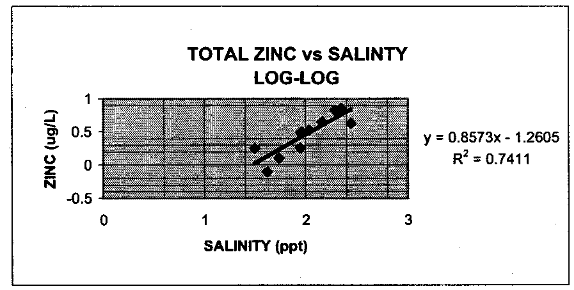
LOG SALINITY	LOG Zn DISSOLVED
1.4996871	0.0827854
1.6232493	-0.187087
1.7371926	0.071882
1.9513375	0.1105897
1.9532763	0.2624511
1.966611	0.0606978
2.0374265	0.3521825
2.1643529	0.4593925
2.2878017	0.4578819
2.350248	0.6042261
2.4456042	0.5797836



POND	SALINITY	ZINC TOTAL
A2W	31.6	1.8
A3W	42	0.79
B2C	54.6	1.28
A15	89.4	1.82
A15(DUP)	89.8	3.07
A14	92.6	3.16
A16	109	3.38
A18	146	4.49
I-3	194	6.77
I-3B	224	7.22
B9	279	4.28



LOG SALINITY	LOG Zn TOTAL
1.4996871	0.2552725
1.6232493	-0.102373
1.7371926	0.10721
1.9513375	0.2600714
1.9532763	0.4871384
1.966611	0.4996871
2.0374265	0.5289167
2.1643529	0.6522463
2.2878017	0.8305887
2.350248	0.8585372
2.4456042	0.6314438



Comparative Water Quality Analysis Results

Metals and Salinity

Averaged Results for Five Ponds

PARAMETER	MEC METHOD	MEC A2W-A-W 8/27/2002		FRONTIER A2W 10/24/2002		MEC A3W-A-W 8/27/2002		FRONTIER A3W 10/24/2002		MEC A15-A-W 8/27/2002		FRONTIER A15 10/24/2002		MEC A16-A-W 8/27/2002		FRONTIER A16 10/24/2002		MEC 2C-B-W 8/27/2002		FRONTIER B2C 10/24/2002		LIKELY WQO FOR NORTH BAY	
Metals (ug/L)		*MDL*	*Results*	*Total*	*Dissolved*	*MDL*	*Results*	*Total*	*Dissolved*	*MDL*	*Results*	*Total*	*Dissolved*	*MDL*	*Results*	*Total*	*Dissolved*	*MDL*	*Results*	*Total*	*Dissolved*	*Total*	*Dissolved*
Antimony	6020	10	110 J			10	110 J			10	140 J			10	140 J			5.0	ND				
Arsenic	6020	7.0	94.0	6.36	6.27	7.0	66	11.9	10.7	7.0	150	15.1	14.0	7.0	160	17.1	14.4	7.0	56	1.0	1.14	36	36
Arsenic	1632	-	6.09	6.36	6.27	-	12.2	11.9	10.7	-	19.5	15.1	14.0	-	18.1	17.1	14.4	-	3.17	1.0	1.14	36	36
Beryllium	6020	0.4	0.80J			0.4	ND			0.4	0.8 J			0.4	ND			2.0	ND				
Cadmium	6020	0.4	ND	0.063	0.049	0.4	ND	4.78	0.044	0.4	ND	0.054	0.077	0.4	ND	0.062	0.053	2.0	ND	0.050	0.054	12.2	9.3
Chromium	6020	0.9	ND	2.36	1.22	0.9	ND	0.67	1.22	0.9	ND	0.83	1.12	0.9	ND	1.23	1.27	4.5	ND	0.67	1.24	209	180
Copper	6020	3.0	72	2.15	1.06	3.0	54	1.24	1.10	3.0	100	1.37	0.86	3.0	110	2.01	1.07	12.5	39 J	1.59	1.29	7.4	3.1
Lead	6020	0.8	3.4 J	0.843	0.264	0.8	2.7 J	0.324	0.307	0.8	5.7 J	0.351	0.313	0.8	4.2 J	0.619	0.446	4.0	65 J	0.392	0.280	20.4	5.6
Mercury	7470	0.5	ND	0.0118	0.00126	0.5	ND	0.00478	0.00126	0.5	ND	0.032	0.00138	0.5	ND	0.0395	0.00140	0.08	ND	0.00337	0.00036	0.029	0.025
Nickel	6020	1.3	17 J	11.8	8.05	1.3	9.1 J	8.42	7.45	1.3	27 J	14.3	10.8	1.3	31 J	18.1	12.8	6.5	14 J	7.09	4.96	7.2	7.1
Selenium	6020	4.0	56	0.274	0.199	3.8	27 J	0.173	0.128	4	55	0.160	0.094	4	51	0.159	0.141	19	ND	0.092	0.055	5.0	5.0
Selenium	1632	-	0.207	0.274	0.199	-	0.153	0.173	0.128	0	ND	0.160	0.094	-	0.153	0.159	0.141	-	0.26	0.092	0.055	5.0	5.0
Silver	6020	0.6	ND	0.022	0.012	0.6	ND	0.015	0.010	0.6	ND	0.030	0.021	0.6	0.8 J	0.150	0.040	3.0	3.6 J	0.013	0.016	2.2	1.9
Thallium	6020	0.6	ND			0.6	1.3 J			0.6	ND			0.6	0.7 J			3.0	ND				
Zinc	6020	6.0	110	1.8	1.210	6.1	67 J	0.79	0.65	6	180	1.82	1.29	6	180	3.38	2.25	30.5	120 J	1.28	1.18	61.3	58
General Chemistry (mg/L or as noted)																							
pH (pH Units)	150.1	0.01	8.22			0.01	8.89			0.01	8.43			0.01	8.28			0.01	8.99				
BOD	SM 5210	20.0	21.4			20.0	2.85			20.0	30.0			20.0	25.3			20	66.3				
Hardness (mg CaCO3/L)	200.7	100	7,040			100	7,240			100	19,900			100	22,100			100	12,200				
Chloride	SM 4500	12.5	23,500			12.5	21,500			12.5	64,000			12.5	72,500			12.5	43,000				
Potassium	6010	10.0	441			100	389			10.0	1,350			10.0	1,540			10.0	844				
Sodium	6010	100	12,500			100	15,000			100	37,200			100	40,500			10	24,000				
Ammonia as N	SM 4500	0.10	0.110			0.10	0.140			0.10	0.100			0.10	0.170			0.10	ND				
Nitrate as N	SM 4500	0.05	0.890			0.05	0.670			0.50	3.02			1.25	4.75			0.25	1.24				
Organic Nitrogen	SM 4500	0.50	1.29			0.50	2.66			0.50	0.550			0.50	2.53			0.50	ND				
Phosphate, Total as P	SM 4500	0.05	0.260			0.05	ND			0.05	0.520			0.05	0.300			0.05	ND				
TKN	SM 4500	0.50	1.40			0.50	2.80			0.50	0.650			0.50	2.70			0.50	ND				
TSS	SM 2540	1.00	66			1.00	ND			2.00	160			2.00	130			2.00	158				
TDS	SM 2540	1.00	37,900	31,600	31,600	1.00	43,200	42,000	42,000	2.00	111,000	89,400	89,400	2.00	124,000	109,000	109,000	2.00	75,900	54,600	54,600		
Turbidity (NTU)	SM 2130	0.05	36.7			0.05	9.30			0.05	78.2			0.05	60.4			0.05	62.6				

NOTES:

MDL - Detection Limit

ND - Not Detected

J - detected, but below the reporting limit; therefore, result is an estimated concentration MDL method detection limit.

EPA 1632 for As and Se was performed in all cases by Frontier

MEC results are for total metals

Comparative Water Quality Analysis Results

Ratio of Total Metals Results

MEC / Frontier

PARAMETER	MEC METHOD	MEC A2W-A-W 8/27/2002	FRONTIER A2W 10/24/2002	MEC A3W-A-W 8/27/2002	FRONTIER A3W 10/24/2002	MEC A15-A-W 8/27/2002	FRONTIER A15 10/24/2002	MEC A16-A-W 8/27/2002	FRONTIER A16 10/24/2002	MEC 2C-B-W 8/27/2002	FRONTIER B2C 10/24/2002	AVERAGE RATIO
Metals (ug/L)		*Ratio of MEC/Frontier result*		*Ratio of MEC/Frontier result*		*Ratio of MEC/Frontier result*		*Ratio of MEC/Frontier result*		*Ratio of MEC/Frontier result*		*MEC / Frontier*
Antimony	6020											
Arsenic	6020	14.78		5.55		9.93		9.36		56.00		19.1
Arsenic	1632	0.96		1.03		1.29		1.06		3.17		1.5
Beryllium	6020											
Cadmium	6020											
Chromium	6020											
Copper	6020	33.49		43.55		72.99		54.73		24.53		45.9
Lead	6020	4.03		8.33		16.24		6.79		165.82		40.2
Mercury	7470											
Nickel	6020	1.44		1.08		1.89		1.71		1.97		1.6
Selenium	6020	204.38		156.07		343.75		320.75				256.2
Selenium	1632	0.76		0.88				0.96		2.83		1.4
Silver	6020							5.33		276.92		141.1
Thallium	6020											
Zinc	6020	61.11		84.81		98.90		53.25		93.75		78.4

NOTES:

EPA 1632 for As and Se was performed in all cases by Frontier

All results are for total metals

ATTACHMENT H

NAPA RIVER SALT MARSH – LOWER PONDS RESTORATION PROJECT

WATER QUALITY SAMPLING

At the request of the California State Coastal Conservancy, HydroScience Engineers (HSe) conducted a sampling and analysis program to characterize the current water quality in the ponds and in the adjacent potential receiving water bodies. A Sampling and Analysis Plan was prepared by HSe, and approved by the San Francisco District of the Army Corps of Engineers (USACE). USACE prepared a Quality Assurance Project Plan to provide guidance and ensure conformance of the SAP/QAPP to relevant standards, including the draft San Francisco District Public Notice 99-04, and EPA QA/G-5 – EPA Requirements for Quality Assurance Project Plans for Environmental Operations. Both Plans were finalized in October 2001. The samples were collected in October-November 2001. Additional samples for metals analysis were collected in October 2003. In addition, USGS and DFG collect salinity data in some of the ponds.

SAMPLING RESULTS

The water analysis parameter list for the 2001 Sampling Program included general water chemistry parameters and priority pollutants. The list of priority pollutants was based on the 13267 Letter published on August 6, 2001 by the San Francisco Bay Region Regional Water Quality Control Board titled *Requirements for Monitoring of Pollutants in Effluent and Receiving Water to Implement New Statewide Regulations and Policy* (RWQCB List). The RWQCB List includes all 126 priority pollutants identified in the California Toxics Rule (CTR) list, which was published in the Federal Register on May 18, 2000. In addition, the RWQCB List includes two commonly used organophosphate pesticides (Diazinon and Chlorpyrifos).

The parameter list for the 2001 Sampling Program was expanded beyond the RWQCB List as follows: Methoxychlor was added to the list of chlorinated hydrocarbon pesticides tested by EPA Method 608; and 27 additional organo-phosphate pesticides were added to the list of compounds tested by EPA Method 8141A. Tributylin, a pollutant listed in the RWQCB List as required only for discharges from sewage treatment plants and cooling towers, was not included on the parameter list for the 2001 Sampling Program.

The 2003 sampling event included analysis for priority pollutant metals for four ponds which represent the full range of salinities in the pond system.

The USGS salinity data were collected as part of an overall monitoring program in the ponds; salinity measurements were typically collected in the 4 corners of each sampled pond. USGS collected additional salinity measurements in Pond 3 following the breach of the South Slough levee in August 2002.

DFG collects water level and salinity measurements on a monthly basis as part of its ongoing management of the pond system. The results of each of these water quality sampling efforts are summarized below.

RESULTS OF ANALYSIS – GENERAL WATER CHEMISTRY (2001 Sampling Program)

Table 1: General Water Chemistry Results - Ponds 1 through 4

	Average for all sampling points in each pond					
Parameter	**Pond 1**	**Pond 1A**	**Pond 2**	**Pond 2A**	**Pond 3**	**Pond 4**
Total ammonia as N (mg/L)	0.25	0.32	0.25	0.40	0.23	3.38
Un-ionized ammonia as N (mg/L) [1]	NC	NC	NC	NC	0.010	0.057
Nitrate as N (mg/L)	0.70	0.60	0.50	0.30	1.98	5.98
Total Kjeldahl N (mg/L)	2.8	4.2	4.4	1.3	12.4	55.2
Organic N (mg/L)	2.6	5.3	4.1	0.9	9.8	51.7
Total phosphorous (mg/L)	ND	ND	ND	ND	0.12	0.59
PH	8.4	9.1	8.9	7.9	8.3	7.7
BOD (mg/L)	4.87	26.70	11.50	1.50	28.67	15.90
Turbidity (NTU)	9.5	23.6	29.2	7.2	59.4	92.0
TSS (mg/L)	62.0	47.0	ND	ND	167.5	443.8
Total dissolved solids (ppt)	40	164	38	22	66	323
Chloride (ppt)	23	34	22	12	39	174
Dissolved oxygen (mg/L) [2]	NM	NM	NM	7.1	5.7	5.4
Temperature (°F) [2]	66	70	64	60	66	68
Water depth (inches) [2]	18	18	37	18	17	18
Fecal coliform (MPN/100 mL)	72	2	2	105	94	ND

Table 2: General Water Chemistry Results - Ponds 5 through 6A

	Average for all sampling points in each pond		
Parameter	**Pond 5**	**Pond 6**	**Pond 6A**
Total ammonia as N (mg/L)	3.63	0.32	0.24
Un-ionized ammonia as N (mg/L) [1]	0.026	0.021	0.032
Nitrate as N (mg/L)	6.17	3.43	1.20
Total Kjeldahl N (mg/L)	59.9	7.0	5.4
Organic N (mg/L)	56.3	6.7	5.2
Total phosphorous (mg/L)	0.61	ND	ND
PH	7.6	8.4	8.8
BOD (mg/L)	4.07	8.73	8.83
Turbidity (NTU)	83.2	12.2	19.6
TSS (mg/L)	533.3	31.0	52.7
Total dissolved solids (ppt)	324	92	58
Chloride (ppt)	174	54	32
Dissolved oxygen (mg/L) [2]	3.5	6.3	6.2

Temperature (°F) [2]	64	63	64
Water depth (inches) [2]	3	24	24
Fecal coliform (MPN/100 mL)	ND	ND	1

Table 3: General Water Chemistry Results – Receiving Waters

Parameter	San Pablo Bay	Napa River	Napa Slough
Total ammonia as N (mg/L)	0.3	0.3	0.5
Un-ionized ammonia as N (mg/L) [1]	0.004	0.005	0.011
Nitrate as N (mg/L)	0.2	0.3	0.4
Total Kjeldahl N (mg/L)	NM	NM	NM
Organic N (mg/L)	0.7	20.2	2.4
Total phosphorous (mg/L)	.7	NM	ND
PH	7.7	7.7	7.8
BOD (mg/L)	NM	NM	68
Turbidity (NTU)	7.8	20.1	8.1
TSS (mg/L)	26	72	20
Total dissolved solids (ppt)	24	20	20
Chloride (ppt)	14	11	12
Dissolved oxygen (mg/L) [2]	8.1	8.0	7.2
Temperature (°F) [2]	62	62	60
Water depth (inches) [2]	NM	NM	NM
Fecal coliform (MPN/100mL)	50	500	50

Notes for Tables 1, 2, and 3:
ND = Not detected
NM = Not measured
NC = Not calculated
[1] The un-ionized fraction of ammonia N was calculated using a relationship developed by Emerson, et al. (1975). A technical memorandum by MEC describing the calculation of these values is included as an attachment to this Water Quality Characterization section.
[2] Field measurement

RESULTS OF ANALYSIS - PRIORITY POLLUTANTS (2001 SAMPLING PROGRAM)

No pesticides, PCBs, volatile organic compounds, semi-volatile organic compounds, or dioxins were detected above the stated laboratory method detection limits in any water sample taken from any of the Lower Ponds proposed for salinity reduction (Ponds 4, 5, 6 and 6A).

RESULTS OF ANALYSIS - METALS (2003 SAMPLING PROGRAM)

The 2001 water samples were prepared for analysis by EPA 3020, and the high salinity of the samples required dilution of the samples. The sample preparation methods employed in 2001 may have allowed some interference with test accuracy. While it was expected that the concentrations of metals would increase with increasing salinity at a rate approximating a linear

1:1 ratio, the 2001 analytical results instead suggested that the rate of increase for metals concentrations was much higher than the rate of increase for salinity.

In recent years, Frontier Geosciences in Seattle, Washington (FGS) has developed refined sample preparation techniques specifically for high salinity waters to be analyzed for metals. The analytical procedures employed by FGS involve a variety of proprietary sample preparation techniques prior to analysis by ICP-MS or by atomic fluorescence spectrometry. The FGS sample preparation techniques avoid the dilution and associated increase in Method Detection Limits (MDLs) associated with EPA 3020. When analytical results using FGS methods were compared to results using EPA 3020/dilution for sample preparation, for common locations sampled 60 days apart in 2002, the comparison showed that in most cases, the sample preparation and analysis techniques for metals employing EPA 3020/dilution produced either dramatically higher measurements of the concentration of each metal than did the FGS methods, or produced non-detect results, possibly due to high detection limits. The comparison of the 2002 analytical results for the two methods raised the possibility that the 2001 results were impacted by some type of interference which led to spuriously high measurements of some metals, including copper and zinc. Attachment G to this Permit, Comparison of Analytical Results for Metals, presents the comparative data for five ponds from the 2002 sampling events.

On October 1, 2003, aqueous samples were collected from Pond 4 and transmitted under Chain of Custody to Frontier Geosciences in Seattle Washington. The other three ponds sampled at this time were Ponds 7, 7A, and 8, which are not addressed in this Permit. All metals in Pond 4 were measured to be below the applicable WQCs except nickel, which was detected at a level approximately equal to the WQC (detected at 8.7 ug/L and the most stringent objective in the Basin Plan is 7.1 ug/L as total recoverable). The water levels in the ponds were low on October 1, 2003; the average depth of the water in Pond 4 on this date was 1.4 feet. The samples collected in October are likely to contain higher concentrations of dissolved constituents than samples collected in late winter/early spring, when the breach discharge is proposed. The average depth at the time of the breach discharge is anticipated to be at or near the maximum depth the pond can accommodate, which is 4.5 feet. The source of the additional water expected in Pond 4 at the time of the breach discharge will be primarily rainfall, which is expected to contribute no additional nickel to the pond. It is expected that the volume of water impounded in Pond 4 at the time of the breach discharge will be at least three times the volume of water present on October 1, 2003. Conservatively assuming that the volume of impounded water at the time of the breach is twice the volume impounded on October 1, 2003, the concentration of nickel in Pond 4 at the time of the proposed breach discharge would be expected to be approximately one half of 8.7 ug/L (or approximately 4.4 ug/L), which would suggest that there is no "reasonable potential" to cause or contribute to an excursion beyond the most stringent water quality objective for nickel.

The results of analysis for metals for water samples collected from Pond 4 on October 1, 2003 are presented in Table 4, below.

Table 4 - Total Recoverable Metals in ug/L Pond 4 - October 1, 2003	
Arsenic	2.53
Cadmium	0.038
Chromium	0.65
Copper	1.51
Lead	1.05
Mercury	0.00626
Nickel	8.7
Selenium	0.160
Silver	< 0.40
Zinc	2.82

RESULTS OF ANALYSIS – SALINITY

Conditions in Pond 3 have changed significantly since the fourth quarter of calendar year 2001. Pond 3 was breached on its northern levee (to South Slough) by unknown parties in August 2002. To relieve pressure on this breach and help stabilize the levee, a second breach was created on the Pond 3 southern levee (to Dutchman Slough) by the Department of Fish and Game (DFG) in September 2002. The DFG work was supported by a Standard Section 401 Water Quality Certification, an emergency permit from the San Francisco Bay Conservation and Development Commission, an emergency permit from the U.S. Army Corps of Engineers, and a Categorical Exemption notice submitted under Section 15303 of the CEQA Guidelines by RWQCB.

On 25 July, USGS recorded pre-breach Pond 3 salinity levels of 57-88 ppt. By 20 August, shortly after the pond was breached at South Slough, salinity levels had decreased to 52-75 ppt. On 17 September, after the second breach was made at Dutchman Slough, USGS found that salinity levels had decreased to 50-60 ppt. By November the salinity range had dropped to 42-46 ppt.

DFG measured Pond 3 salinity to be 47 ppt on 20 November and 22 ppt on 15 December. Salinity measurements made by DFG since January 2003 are shown in Table 5, below. In effect, by January 2003, the salinity in Pond 3 had decreased to ambient levels in the adjacent Napa River, and Pond 3 was functioning as a muted tidal pond.

TABLE 5
RECENT SALINITY MEASUREMENTS IN THE LOWER PONDS, parts per thousand

	Pond 1	Pond 1A	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6	Pond 6A
14&16-Jan-03	24	23	18	3	89	49	38	33
31-Jan-03	22	22	10	1	60	38	37	23
18-Feb-03	20	11	9	9.5	34	54	32	15
27-Feb-03	22	10	10	5.5	26	55	32	11
18-Mar-03	23	22	12	10.5	41	56	27	12
09-Apr-03	20	25	13	12	34	58	33	21
25-Apr-03	17	21	17	9	26	56	34	10
12-May-03	19	22	14	7	35	58	29	12
06-Jun-03	15	25	22	8	24	77	58	10
01-Jul-03	22	31	15	12	25	92	110	21
31-Jul-03	25	36	20	15	37	113	200	26
04-Sep-03	51	22	21	15	40	110	309	22
01-Oct-03	65	24	24	18	50	125	230	25
16-Oct-03	47	26	23	18	48	126	97	26
25-Nov-03	30	44	24	15	44	101	66	23
17-Dec-03	22	33	32	8	30	66	35	14
16-Jan-04	18	20	13	4	23	45	28	14
3-Mar-04	16	17	9	0	22	22	22	5

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

IN REPLY REFER TO:
1-1-03-F-0044

JUN 3 2003

Mr. Roderick A. Chisholm, II
Chief, Environmental Section
U.S. Army Corps of Engineers
San Francisco District
333 Market Street
San Francisco, California 94105-2197

Subject: Initiation of Formal Endangered Species Consultation on the Napa River Salt Marsh Restoration Project, Napa, Solano, and Sonoma Counties, California

Dear Mr. Chisholm:

This is in response to the U.S. Army Corps of Engineers (Corps) December 19, 2002, letter requesting formal consultation with the U.S. Fish and Wildlife Service (Service) on the effects of Napa River Salt Marsh Restoration Project, in Napa, Solano, and Sonoma Counties, California. Your letter was received in our office on December 23, 2002. This document represents the Service's biological opinion on the effects of the proposed project on the federally threatened delta smelt (*Hypomesus transpacificus*) (smelt), Sacramento splittail (*Pogonichthys macrolepidotus*) (splittail), and western snowy plover (*Charadrius alexandrinus nivosus*) (snowy plover), and the federally endangered California clapper rail (*Rallus longirostris obsoletus*) (clapper rail) and salt marsh harvest mouse (*Reithrodontomys raviventris*) (harvest mouse) in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

Based upon the information provided, the Service concurs with your determination that the proposed action is not likely to adversely affect the federally endangered soft bird's beak (*Cordylanthus mollis* ssp. *mollis*), Sonoma sunshine (*Blennosperma bakeri*), Tiburon paintbrush (*Castilleja affinis* spp. *neglecta*), Sebastopol meadowfoam (*Limnanthes viculans*), showy indian clover (*Trifolium amoenum*), and Contra Costa goldfields (*Lasthenia conjugens*). Additionally, based upon the information provided, the Service also concurs with your determination that the proposed action will have no effect to the federally endangered California brown pelican (*Pelcanus occidentalis californicus*), California least tern (*Sterna antillarum browni*), Callippe silverspot butterfly (*Speyeria callippe callippe*), Conservancy fairy shrimp (*Branchinecta conservatio*), vernal pool tadpole shrimp (*Lepidurus packardi*), California freshwater shrimp

(*Syncaris pacifica*), Calistoga allocarya (*Plagiobothrys strictus*), Clara Hunt's milk-vetch (*Astragalus clarianus*), Napa bluegrass (*Poa napensis*), Solano grass (*Tuctoria mucronata*), Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*), Sonoma spineflower (*Chorizanthe valida*), and few-flowered navarretia (*Navarettia leucocephala* ssp. *pauciflora*), the federally threatened California red-legged frog (*Rana aurora draytonii*), giant garter snake (*Thamnophis gigas*), Alameda whipsnake (*Masticophis lateralis euryxanthus*), bald eagle (*Haliaeetus leucocephalus*), northern spotted owl (*Strix occidentalis caurina*), Delta green ground beetle (*Ellaphyrus viridis*), valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), vernal pool fairy shrimp (*Branchinecta lynchi*), and Colusa grass (*Neostapfia colusana*), and the proposed federally threatened mountain plover (*Charadrius montanus*).

This biological opinion is based on information provided in (1) the biological assessment dated December 10, 2002, (2) numerous e-mails, meetings and telephone conversations between Corps staff and Michael Nepstad of the Service, and (3) additional information in Service files. A complete administrative record of this consultation is on file at the Sacramento Fish and Wildlife Office (SFWO).

Consultation History

On May 23, 2002, Mr. Nepstad, David Wooten, Jim Browning, and Peter Baye of the Service visited the project site.

On June 13, 2002, Mr. Nepstad and Ryan Olah of the Service participated in a conference call with Bill DeJager of the Corps.

On December 19, 2002, the Corps initiated formal consultation.

BIOLOGICAL OPINION

Description of the Proposed Action

Location

The project area was historically the marshland between the Napa River and Sonoma Creek in the north San Pablo Bay region and is now called the Napa River Unit of the California Department of Fish and Game's (DFG) Napa-Sonoma Marshes Wildlife Area (NSMWA). The Napa-Sonoma Marsh historically encompassed more than 38,000 acres extending from San Pablo Bay north to the historic limits of the tidal baylands and between the Napa River and Tolay Creek.

Of the 38,000 acres, 25,000 acres of the marshlands were in the Napa River watershed. Today, approximately 36% of this acreage remains classified as wetland habitat, while 25% consists of inactive solar salt production ponds (Cargill Salt Ponds - the proposed project area), 12% residential areas, and 20% cropland and pasture; the remaining 7% has miscellaneous uses. The salt ponds, cropland, and pasture are diked to prevent tidal and fluvial inundation under normal conditions. A majority of the remaining wetland areas are public lands and are under the management of DFG as part of the NSMWA.

The Napa River borders the majority of the Cargill Salt Pond property on the east, Highway 37 forms the southern border, and Napa slough forms the north and western borders. Ponds 7/7A and Pond 8 are periphery at the project area's north border. The Salt Ponds, associated marsh habitat, and levees combined equal 9,456 acres. The Salt ponds and associated land could serve as rearing, breeding, foraging, and nesting habitat for many listed species during various life stages of development.

Historical and Current Operation

Cargill Salt Company (Cargill) operated the salt ponds in sequence to concentrate salt by solar and wind evaporation. Tidal flows initiated the salt production process by pushing water into Pond 1 that could then be pumped consecutively to the other ponds (Pond 1A, Pond 2, Pond 2A, Pond 3, etc.), successively increasing the salinity concentration in each pond. After reaching Pond 8, the saline concentrate would be pumped to the east side of the Napa River to be further processed in one of the "pickle ponds" and then in one of the "crystallizer ponds" (the pickle ponds are not part of the current project area). Pond 7 was used as the bittern pond, a repository of concentrated soluble salts other than sodium chloride. In general, Cargill had target salinity ranges for each pond and maintained these salinities unless there were management problems in the system. Cargill added cross levees between Ponds 1 and 1A, 6 and 6A, and 7 and 7A to improve its management of salinities in these ponds. Cargill used materials excavated from borrow ditches to construct levees and as a part of their postconstruction maintenance. Cargill had a full-time operator and owned dredging equipment, in particular a specially modified shallow draft dredge for the maintenance of the ponds.

Under management of the DFG, current operations are designed to manage the site for wildlife. However, deteriorating infrastructure, existing salinity conditions, and limited funding often make this task difficult. The on-site DFG manager strives to use both San Pablo Bay water and Napa River water to reduce salinities to the extent possible and ensure appropriate water levels for wildlife. Generally, Napa River water is moved south and San Pablo Bay water is moved north. Salinity and elevation of each pond are recorded monthly. Activities currently underway by DFG as ongoing operation and maintenance include ongoing maintenance and replacement of water control structures, levee upgrades and maintenance, and water level/salinity management for wildlife habitat. Current operating conditions provide a mix of wildlife habitats including tidal mudflats, deep water, salt ponds, levees, and marsh sloughs.

Project Goals

1. Restore a mosaic of diverse habitats that will benefit a broad range of fish and other aquatic species, wildlife, migratory shorebirds and waterfowl, and plant species, including endangered and threatened species.

2. Restore natural, self-sustaining systems that can adjust to naturally occurring changes in physical processes with minimum ongoing intervention.

3. Implement habitat restoration using adaptive management techniques.

4. Recognize constraints which are drivers in determining restoration objectives.

5. Evaluate the restoration from a regional perspective, as not all regional objectives can be addressed within the project boundaries.

6. Protect special-status species, to the extent possible, during the restoration process.

7. Restore habitats in the NSMWA that will change over time as a result of inherent dynamic characteristics of the estuarine system (in terms of seasonal as well as longer-term changes).

8. Phase the restoration in the project site and time the restoration in relationship with restoration projects throughout the NSMWA, particularly Cullinan Ranch and Skaggs Island, to reduce negative impacts (such as erosion of existing marshes and unintended breaching of levees) resulting from excessive changes in the tidal prism.

9. Accelerate the speed of habitat restoration by conducting salinity reduction of the former salt ponds as quickly as is safely and financially possible.

10. Meet as many of the goals and objectives of the Baylands Ecosystem Habitat Goals report as feasible, focusing on how this project's goals and objectives fit within the entire north bay region.

11. Maximize use of available recycled water for desalinization. The Sonoma County Water Authority (SCWA) has formed a coalition of north bay water agencies with the intent of achieving 100% reuse (zero discharge) of recycled water. Minimizing discharge of recycled water is a requirement imposed by the State of California.

Summary of Actions

Implementation of the Napa River Salt Marsh Restoration project consists of three components: salinity reduction, water delivery, and habitat restoration. Each component is essential to ensure effective and efficient conversion of the existing pond matrix to a managed system of ponds and tidal marsh for fish and wildlife.

Current salinity is undesirable for several species of fish and wildlife. The proposed salinity reduction consists of levee breaches at Ponds 3 and 4/5. Salinity reduction of the lower ponds will occur by strategically timing the levee breaches during a large storm event when the Napa River flow is high. This salinity reduction method has been proposed because it minimizes construction activities, reduces the chance for entraining fish species, and speeds the desalinization process. Increased salinity in the Napa river will be short-term.

DFG will use of recycled water for dilution of the upper ponds (*i.e.*, Pond 7). Use of recycled wastewater is proposed as a method to facilitate faster completion of the desalinization process and to minimize environmental effects. Delivery of recycled water will occur from the Sonoma County Valley Sanitation District (SCVSD) wastewater treatment plant (WWTP), the Napa Sanitation District (NSD) WWTP, and the City of American Canyon WWTP.

Long-term habitat restoration plans include a balanced mix of tidal marsh and managed ponds, with an emphasis on restoring Ponds 3, 4, and 5 to tidal marsh and maintaining the remaining ponds as managed ponds. Ponds 6 and 6A would be managed as ponds in the short term (the initial 10-20 years). The following three categories highlight project actions that could affect listed species.

Salinity Reduction

Construct Water Intake and Outfall Structures

Intakes and outfalls will be constructed at locations that would minimize effects on existing marsh habitat and minimize the length of pipe. The intakes would take advantage of deeper slough channels close to the levee. New intake culverts would be built to connect: Napa Slough to the north-central section of Pond 6A (five 52-inch-diameter culverts that bisect the levee and extend approximately 250 feet into the slough); the Pond 7/7A canal to Pond 6A and the Pond 6/6A canal (one 52-inch- diameter, 350-foot-long siphon under Napa Slough); Napa Slough to the south side of Pond 7A (an 800-foot intake canal linked to culverts that bisect the levee); and the recycled-water pipeline to a mixing chamber; and the mixing chamber to an enlarged canal that discharges to Napa Slough. The connection between Napa Slough and Pond 7A will include a fish screen that meets existing NOAA Fisheries, DFG, and Service requirements. The required intakes and outfalls will be constructed in the late spring and summer to meet construction windows to minimize construction related effects. Salinity reduction will begin in the winter or early spring to take advantage of the rainy season (December-March) and low salinity.

Installation of water control structures would require the use of heavy equipment delivered to the site by barge at extreme high tide. Low-pressure, long-reach excavators, will generally be used to construct the intakes and outfalls. The equipment would have wide tracks and/or use mats to ensure that its weight is evenly supported and that compaction rates on existing levees and marsh soils would be low.

Approximate types and maximum quantities of equipment that will be used include one or two long-reach excavators, two or three diesel-powered barges, one or two small to medium bulldozers, trucks, a diesel generator, a sheet pile driver, and small boats for daily transportation to and from the site.

Construct Other Water Control Structures

The existing siphon between Ponds 5 and 6 would be refurbished or replaced with a new 250-foot-long, 52-inch-diameter siphon. Construction activities will take place in late spring and summer and will involve essentially the same equipment as installation of intake and outfall structures. The construction equipment will be barged into the site at extreme high tide. Two new discharge gates will be built connecting Ponds 7 and 7A to a mixing chamber. The gate at Pond 7 will be built so that a dilution ratio of 5:100, or other approved dilution ratio (*i.e.*, 1:100), could be achieved at the mixing chamber. New water control structures will connect Pond 8 to the Pond 8 canal, and the Pond 8 canal to the mixing chamber. Construction activities and timing of discharge gate installation associated with new discharge gates will be the same as the installment of other intake and outfall structures.

Levee Breaching

Levees will be breached to connect: the southeast side of Pond 3 to the Napa River (one 50-foot breach serving as both intake and outfall) and the south-central section of Pond 4 to the Napa River (one 50-foot breach serving as both intake and outfall). To ensure effective mixing in Ponds 4/5, the existing Pond 4/5 interior levee breaches will be expanded to four 100-foot-long breaches prior to breaching the exterior Pond 4 levee. Levee breaching will begin in the winter or early spring to take advantage of the rainy season (December-March). Breaching of Ponds 3 and 4/5 for salinity reduction will not be conducted simultaneously. It is likely that breaching of these ponds will be phased to allow for monitoring and adaptive management. The only equipment required for salinity reduction is a small bulldozer to dig trenches for explosives and excavate the exterior levee, and small boats to transport the explosives crew and their supplies.

Levee breaching for salinity reduction might be combined with site work for habitat restoration. Ditch blocks and starter channels may be emplored during development of these potential project components. Techniques, timing, and construction equipment associated with these activities are addressed in detail under the Habitat Restoration Component.

Levee Repair and Maintenance

Levee repairs will not be required at Ponds 3 and 4/5; levee repairs will be required for Ponds 1, 1A, 2, 6/6A, 7, 7A, and 8 to reinforce areas that could fail in the near future (within 5-15 years).

Levee repair and long-term maintenance will require the same type of activities. Soil will be added to the existing levees either through importing material or excavating soil from the internal borrow ditch in each of the ponds. In general, most work could be completed from the levee itself. Ponds 1, 1A, 7, 7A, and 8 are all accessible by land and imported material could be used. However, the cost would be high and it is likely that the material used to repair the levees at these ponds will be excavated from the borrow ditch. Ponds 2 and 6/6A will use borrow ditch material because barges would be unable to carry material to Pond 2 or Pond 6/6A.

Material to reinforce the levees will be excavated from the existing borrow ditches using a long-reach excavator. The excavated material will be placed at the sides and tops of the levees, with specific locations, soil heights, and slopes to be determined by a geotechnical engineer. After repairs are complete, the excavator will move forward along the top of the levee. The excavator could also work from a barge if needed; however, obtaining access to the levees by barge will be difficult in many locations because of the accreted outboard marsh. Limited dredging may be required to allow access for the barges associated with the levee repair work, as well as for the barges delivering materials and equipment to install the water conveyance structures.

Repair and long-term maintenance of levees at Ponds 1, 1A, 2, 6/6A, 7, 7A, and 8 will require the use of heavy equipment delivered to the site by road or barge (State Route 37 for Ponds 1, 1A, and 2; Buchli Station Road for Ponds 7 and 7A; SR 12/121 via Duhig Road, Las Amigas Road, Cuttings Wharf Road, and Milton Road for Pond 8; and via barge at high tide for Pond 2).

Low-pressure, long-reach excavators, will generally be used to construct the intakes and outfalls. The excavators will need to have a reach of at least 40 feet to complete work at Pond 2. They will have wide tracks and/or use mats to ensure that their weight is evenly supported and that compaction rates on existing soils would be low. The excavators will be brought to Ponds 7, 7A, and 8 on trucks, and to Pond 6/6A on barges that can travel at extreme high tides. Approximate types and maximum quantities of equipment that will be used for the project sites include one or two long-reach excavators, two or three diesel-powered barges, one or two small to medium bulldozers, five or six land-based dump trucks, a small clamshell dredge, a diesel generator, a sheet pile driver, and small boats for daily transportation to and from the site.

Salinity Reduction Timing

As noted above, levee breaches will coincide with winter storms to maximize freshwater availability. Salinity reduction for Pond 3 would be achieved in approximately 2 weeks compared to use of an outfall which will require approximately 12-18 months. Breaching Pond 4/5 would also take several weeks and will occur after Pond 3 reaches ambient salinity.

Breaching of Pond 6/6A may occur many years after it has reached ambient or near-ambient salinity. Pond 7A has relatively low salinity and of the three ponds is expected to reach ambient salinity levels first; the estimated time for Pond 7A to reach ambient salinity levels is 1-2 years. Pond 8 salinities have also decreased; however, Pond 8 has a low pH and will require adjustment of the pH prior to desalinization. The pH adjustment of Pond 8 will most likely be via use of lime (calcium oxide) or some other simple mineral alkali that would add natural ions to the pond that are already present in large amounts. Pond 7 not only has high salinity levels, but also contains significant levels of precipitated salts. Pond 7 will reach ambient salinity in approximately 30 - 50 years assuming that the salt mass in solution in the pond is the entire mass of the salt in the pond. The duration required for the desalinization of Pond 7 is much greater than that for the rest of the ponds because the bittern requires such high dilution prior to discharge.

Construction and Delivery of Pipelines

<u>Sonoma Pipeline</u>

The proposed Sonoma Pipeline will carry water from the SCVSD WWTP to the Napa River Unit Project site. The pipeline will have two segments. The first segment of the Sonoma Pipeline will be 3.3 miles long and consist of two 18-inch pipes constructed of polyvinyl chloride (PVC). One pipe exists; the other pipe will be added as part of project component construction. Segment 1 of the pipeline will carry water only from the SVCSD WWTP to the water storage reservoirs near the intersection of the railroad line owned by the Northwestern Pacific Railroad Authority (NWPRA) and Ramal Road. This segment will begin just south of the SVCSD WWTP, near an existing flow-splitting structure. This structure directs flow either to a wet-season discharge into Schell Slough or to a pipeline that conveys water to storage reservoirs used during the dry season. The existing pipeline, an 18-inch transmission line (T-1), carries water during the dry season but does not have enough capacity to handle higher wet-season flows (approximately 12 million gallons per day [mgd]). To increase the capacity of the existing pipeline, a pump station will be constructed near the splitting structure, and a second 18-inch PVC pipeline would be built to parallel the existing T-1 transmission line. This pipeline will travel east from the splitting structure for approximately 3,900 feet, then turn southeast and continue approximately 13,300 feet along the NWPRA alignment. Two portions of this pipeline segment, each less than 100 feet long, will be constructed to cross under a portion of Schell Slough and another unnamed creek. It is anticipated that the pipeline will be constructed using primarily open-trench methods; the trench will be approximately 6 feet wide and 8-10 feet deep. Trenchless construction methods will be used at specific locations along the pipeline route, such as when transitioning the pipeline alignment from one side of the railroad tracks to the other (two such crossings are proposed) and to cross beneath, rather than trench through, sloughs and streams. At least four such trenchless crossings are anticipated. The construction corridor activity zone for trenching and pipeline installation will typically be about 30 feet wide, but could be narrowed to 20 feet for short distances if necessary. Construction staging will occur near the proposed pipeline route and include either a single 2-acre staging area centrally located near the route, or two 1-acre staging areas, one near the beginning of the route and the other near the terminus of the route. Staging area location(s) will be selected in conjunction with final design/construction specifications and in coordination with the construction contractor. The staging area(s) will be situated within existing clearings or other disturbed areas. The typical construction equipment mix for the pipeline construction is likely to include: a loader/backhoe; a small crane; six dump trucks, each with a capacity of about 15-18 cubic yards; an excavator and/or excavator/compactor; a paver and a pavement distributor; a roller; a water truck; a 50-horsepower generator; and four pickup trucks for the construction crew. It is anticipated that the open-trench pipeline construction method will use 200- to 300-foot-long trench sections and that construction will proceed at an average rate of approximately 50 linear feet of pipeline completed per day. Three work crews will work simultaneously on different sections of the pipeline so that the pipeline could be completed in approximately 1 year, with workdays likely to be approximately 10 hours long. Work will typically occur Monday through Friday, beginning between 5 a.m. and 7 a.m. and ending between 3 p.m. and 5 p.m. The total duration of construction and days/hours of activity could vary from those described above based on weather, field conditions, contractor performance, and special circumstances. The pipeline will include a monitoring system to detect any sudden change in pressure (*e.g.,* pipeline break, leak, blockage, or other problem). The system could include a series of pressure meters, spaced along the pipeline or at critical locations, and connected to an alarm/autodialer unit or telemetry system that will immediately notify operations personnel of a potential problem..

The second segment of the Sonoma Pipeline will be 3.8 miles long, 36 inches in diameter, and constructed of either PVC or high-density polyethylene (HDPE). This segment of pipeline will carry water from both the SCVSD and WWTP. The new pipeline will begin near the terminus of both the T-1 transmission line and the new 18-inch transmission pipeline. A new pump station will be required at this location to provide additional capacity for accommodating the existing SCVSD WWTP peak flows and any future increases in peak flow that may result from the addition of recycled water from other treatment plants in the north bay region. The new pump station will be designed and constructed in a modular fashion so that additional capacity could be provided incrementally. The new pump station will seek to maximize use of the existing reclamation storage basins, conveyance pipelines, and pumping capacity to provide a seamless interaction with the existing system. From the new pump station, segment 2 will extend east along the south side of the NWPRA railroad tracks for approximately 3,100 feet to Skaggs Island Road. Depending on localized soil conditions and surface topography, it is anticipated that the pipeline will have a minimum burial depth of 4-6 feet along the entire alignment. At Skaggs Island Road, the pipeline will cross to the north side of the railroad tracks. The pipeline will continue east along the north side of the railroad for another 2.3 miles until it reaches the access road for Ponds 7 and 7A. At least two additional sections, each less than 100 feet long, will be required through this section to cross streams. At the access road, the pipeline will cross to the south side of the railroad tracks and continue south along the access road for approximately 4,200 feet to its terminus at the mixing chamber. Construction, timing, and monitoring components are the same as those described for segment 1.

Napa-CAC Pipeline

In general, the proposed alignment can be described in terms of the five segments described below. Construction, timing, and monitoring components are the same as those described for segment 1.

The first segment of the pipeline would exit the NSD WWTP and head in a southeast direction, parallel to an active California Northern Railroad line, for approximately 6,000 feet. This alignment will take the pipeline east of both the existing WWTP holding ponds and the Napa County Airport, while remaining on the west side of the railroad line.

Near the northern end of the Napa County Airport, the second segment of the pipeline will enter an existing 20-foot-wide utility easement owned by the City of American Canyon that has available space for additional utilities. The easement runs parallel to the eastern side of the airport for 6,200 feet, then turns southwest for 2,800 feet, and south again for 3,200 feet to intersect Green Island Road. Just north of Green Island Road, the pipeline will be required to cross an existing NWPRA railroad line using a jack-and-bore or other trenchless methods.

Where the easement intersects Green Island Road, the third segment of the pipeline will leave the City of American Canyon's easement and head west along Green Island Road onto Cargill's property. The length of the third segment is approximately 14,200 feet.

The fourth segment of the pipeline will make use of Cargill's existing conveyance pipeline crossing the Napa River. The segment will begin at an existing pumping station on the east side of the river and run directly west through an existing 24-inch and 16-inch rubber pipeline. The total length of this segment is approximately 2,500 feet. Once the tertiary treated water reaches the west side of the Napa River, it could be easily conveyed to the surrounding salt ponds using existing surface waterways within the salt pond complex.

The fifth segment of the Napa-CAC Pipeline originates at the City of American Canyon WWTP and runs for approximately 1,000 feet north underneath Mezzetta Road through a developed industrial area. The pipeline intersects the Napa portion of the Napa-CAC Pipeline at Green Island Road where the road turns north.

Habitat Restoration

Pond Management

The proposed habitat restoration component provides for a mosaic of tidal habitats and managed ponds. Under this component, the existing ponds will be handled as follows:

1. Ponds 1, 1A, 2, and 2A will be maintained as they are, with levee repair and water control improvements as needed.

2. Ponds 3 and 4/5 will be opened to the tidal prism in an orderly manner. Levee breaches will depend on accretion rates and sediment budget.

3. Pond 6/6A will be maintained as a managed pond during the initial restoration of Ponds 3 and 4/5, for an estimated 10-20 years.

4. Ponds 7, 7A, and 8 will be managed as ponds after their salinity has been reduced to ambient or near-ambient levels. Levees will be repaired and water control improvements will be made as needed.

The habitat restoration component will lead to the following habitat distribution when the project has matured:

1. Ponds 1, 1A, 2, 7, 7A, and 8-managed ponds;

2. Pond 2A and other existing tidal marsh and slough habitat;

3. Ponds 3, 4, and 5-new tidal marsh, mudflat, slough, and open water;

4. Ponds 6 and 6A: short term-managed ponds; and long term new tidal marsh, mudflat, slough, open water.

Construction Activities for Tidal Marsh Habitat Restoration

Tidal habitat restoration activities for Ponds 3 and 4/5, and possibly Ponds 6 and 6A, will be designed to facilitate evolution of the site to mature marsh. These activities will include: removing intake and outfall structures, constructing breaches that provide for optimal tidal exchange (23 breaches), breaching levees in areas with minimal existing marsh and near historical channels to minimize loss of fringing marsh and encourage the scouring of remnant slough channels, creating ditch blocks with associated levee lowering (22 blocks), regrading additional levees in areas where habitat continuity could be disrupted during the restoration period (22,200 linear feet), and installing starter channels in the ponds (27,500 linear feet).

The proposed Habitat Restoration Component relies both on natural sediment processes and natural colonization by marsh vegetation for the majority of the restoration area. Equipment used to create the habitat restoration features will be of the same types and quantities as those used during the salinity reduction process and will be delivered to the site in the same manner (via barge at high tide). Construction activities to restore Ponds 3, 4, and 5 to tidal action will consist of excavating or placing explosives to breach levees where needed, and using heavy equipment to remove intake and outfall structures, block the borrow ditches, reslope the levees near the breaches, lower levees, and excavate starter channels.

Operations will begin upon the reduction of salinity in the ponds and will start with the breaching of the Pond 3 levees, likely proceeding as follows. The evolution of Pond 3 to vegetated lower marsh habitat is expected to happen within 10 years because its elevation is higher than those of Ponds 4 and 5. Within no more than 5 years after Pond 3 is opened to the tide (depending on the evolution of Pond 3 and the continued availability of sediment), the exterior levees on Ponds 4 and 5 will be breached.

Repair/Replacement of Water Control Structures at Managed Ponds

It is proposed that water control structures will be repaired or replaced as needed at Ponds 1, 1A, 2, 7, 7A, and 8 which have all been designated as ponds intended for pond management. In particular, the siphon between Pond 1 and 2 would be refurbished or replaced with two 54-inch-diameter siphons, and the existing intakes and outlets at Pond 2 will be replaced with new culverts and pipes. Some of the valves and related equipment on Ponds 7, 7A, and 8 may require replacement when these ponds are converted to managed ponds. Initial levee repairs for all of these ponds will have been completed as part of the salinity reduction effort.

The estimated annual equipment required to complete maintenance, repair, and replacement activities for Ponds 1, 1A, 2, 7, 7A, and 8, including replacement of water control structures, is one or two barges, two long-reach excavators, a small bulldozer, refueling tanks, a diesel generator, and a small boat for transportation to and from the project site. Ponds 6 and 6A will include construction of barrier weirs that provide tidal continuity at higher tides but maintain water surface elevation above low tide levels. Construction activities are expected to be completed within 1 year.

Long-Term Maintenance of Water Control Structures

Ponds 1 and 1A will continue to be managed as ponds, and Pond 2 will continue to be managed as a deepwater pond. Ponds 7, 7A, and 8 will be variable-depth, managed ponds after the desalination process. Salinity and depth will be managed by DFG in Ponds 7, 7A, and 8 to provide habitat for migratory waterfowl. Water control structures for all six ponds will require ongoing maintenance and possibly replacement in the long term (as long as these ponds are managed as ponds). Construction equipment used will be the same as that described above. Maintenance and replacement of the water control structures will require several months of construction each year.

Habitat Restoration Acceleration Features

Design features described briefly above will be used to speed marsh evolution and to nurture the evolution of marsh components. Faster marsh evolution will reduce potential impacts associated with marsh habitat loss that will occur as a result of scouring of the existing slough channels once ponds are breached and the tidal prism is increased. The proposed design features include: 1) blocking the borrow ditches between the levee breaches with sediment to keep them from capturing tidal circulation; 2) regrading a portion of the levees to an elevation of MHHW by sloping them into the ponds; and 3) excavating starter channels and using the excavated sediment to create berms. Construction equipment and timing are the same as those described in the Pond Management and Tidal Habitat sections.

A ditch block is simply an area of earth fill that crosses an existing borrow ditch or other channel to inhibit flow. Borrow ditches are human-made drainage channels located adjacent to levees. The purpose of the ditch block is to inhibit existing borrow ditches from capturing the tidal supply and impeding reestablishment of the natural historic channels. Ditch blocks will be constructed based on a consideration of natural marsh morphology.

Levee lowering will consist of excavating the upper portion of an existing levee, and partially filling an adjacent borrow ditch or pond with the excavated material. Borrow ditches will not be filled completely; but will allow continued movement of aquatic species. Levee lowering as referred to here will be in addition to that accompanying the construction of ditch blocks. The crest of certain sections of levees will be lowered to an elevation consistent with marsh vegetation and habitat thus increasing marsh transitional habitat and high-tide refugial habitat. These habitats are preferred cover for juvenile fish. Levee lowering will consist of moving earth from the upper part of the levee sideways onto the back slope and into the adjacent borrow ditch, if appropriate.

A starter channel is an excavated channel extending from a breach into a pond. Starter channels will benefit habitat restoration by facilitating more rapid channel and marsh development, and may increase the eventual density of channel drainage. Starter channels will help establish a desired channel pattern, typically similar to the historic pattern, which is likely to result in maximum habitat benefits. A starter channel will typically follow a semisinuous path consistent with the historic channel path. The constructed cross section will be roughly trapezoidal. The optimal channel size is the estimated equilibrium channel size. However, actual channel dimensions may be smaller, depending on construction practicality and costs. For example, a much smaller channel can still provide benefit and a much larger channel can be constructed without adversely affecting the restoration. Starter channels could be excavated at some or all of the levee breaches. Sediment excavated from the starter channels will be placed into berms on one or both sides of the starter channel. The berms will be discontinuous so that side-channels are not obstructed. A *berm* is an embankment of earth fill located within a pond. Berms will directly facilitate rapid development of a diversity of marsh habitat by providing ground elevations conducive to vegetation establishment. Berms will also facilitate marsh establishment by serving as dissipaters of wave energy, creating more sheltered conditions conducive to sedimentation and vegetation colonization. The proposed berms will be located parallel to the starter channels. The berm crest elevation will vary around MHHW. The intent will be to create an irregular, wide, low-height mound with flat slopes and a sinuous shape roughly paralleling the starter channels. A berm will likely be constructed on only one side of the channel, but berms could be constructed on both sides.

Environmental Commitments

1. The available construction time is limited by protection periods established for endangered species. To minimize impacts on wildlife resulting from construction-related disruption and to minimize impacts on habitat, construction activities will be grouped by area. For example, all water control structures in a given area, the fish screen on Pond 7/7A intake, and monitoring equipment will be installed at one time. Construction of the required water control structures for all ponds will be completed as quickly as possible to allow improved management of pond water levels and ensure that salinity reduction can begin expeditiously.

2. The project sponsors will conduct preconstruction surveys for federally listed and state-listed plants and animals.

3. The Bay Area Air Quality Management District's (BAAQMD's) soil management best management practices (BMPs) will be implemented by the project sponsors and SCWA in areas with the potential to create airborne dust. These BMPs may include the following measures:

   a. All construction areas, unpaved access roads, and staging areas will be watered as needed during dry soil conditions, or soil stabilizers will be applied.

   b. All trucks hauling soil or other loose material will be covered or have at least 2 feet of freeboard. Wherever possible, construction vehicles will use paved roads to access the construction site.

   c. Vehicle speeds will be limited to 15 mph on unpaved roads and construction areas, or as required, to control dust.

   d. Streets will be cleaned daily to remove soil material carried onto adjacent public streets.

   e. Soil stabilizers will be applied daily to inactive construction areas as needed.

   f. Exposed stockpiles of soil and other excavated materials will be enclosed, covered, watered twice daily, or applied with soil binders as needed.

   g. Vegetation will be replanted in disturbed areas as quickly as possible following the completion of construction.

4. Water and sediment samples from 40 sites within the pond complex, along with sites in the Napa River, Napa Slough, and San Pablo Bay were collected in October 2001 by HydroScience Engineers after development of the *Sampling and Analysis Plan and*

Quality Assurance Project Plan, which was approved by the San Francisco Bay RWQCB (HydroScience Engineers 2001). Samples were analyzed by MEC Analytical Systems, Inc., for volatile and semivolatile organics, pesticides, polychlorinated biphenyls (PCBs), heavy metals, dioxins, and general water quality parameters, including nutrients, total dissolved solids (TDS), total suspended solids (TSS), pH, temperature, salinity, and dissolved oxygen (DO). A similar comprehensive water quality monitoring program would be prepared and implemented for the duration of the salinity reduction process. The monitoring will have well-defined data quality objectives, monitoring procedures, and data analysis and reporting protocols to ensure that project operations are controlled according to waste discharge requirements (WDRs) or the requirements of any National Pollutant Discharge Elimination System (NPDES) permit issued by the San Francisco Bay RWQCB. Monitoring at specific locations will be completed and phased out as each successive pond is restored and salinity has been reduced to ambient levels. The discharge monitoring will include continuous recording devices for key parameters and periodic grab samples for specific constituents of concern. Measurement of key continuous monitoring variables (flow, water level stage, salinity, temperature, and TSS/turbidity) will be implemented at several pond and receiving water locations to provide for real-time management of the intakes and discharges and ensure that changes in water quality will be within the acceptable range specified in the WDRs or NPDES permit requirements. Grab samples will be used to characterize long-term changes in other constituents of concern that might be identified by the resource agency. These constituents could include DO, pH, or selected inorganic ions and trace metals. Aquatic toxicity tests will also be conducted on a periodic basis.

5. U.S. Geological Survey (USGS) and DFG biologists and hydrologists, along with contractors as needed, will monitor the Napa River Salt Marsh Restoration Project. The primary objectives of the monitoring are to evaluate changes in wildlife use of restored tidal habitats, ponds, and fringing marsh and physical evolution of restored tidal habitats and the external slough channels. Monitoring will occur during salinity reduction of each pond and continue for a total of 10 years after each pond is breached. USGS has been monitoring six ponds of varying salinities (Ponds 1, 2, 2A, 3, 4, and 7) since 1999. This interdisciplinary study, involving biologists and hydrologists, has included avian, macroinvertebrate, and fish surveys, along with collection of salinity and other water quality data in the ponds and collection of hydrodynamic, salinity, and suspended sediment concentration data in the sloughs (Takekawa *et al.* 2001.) The ongoing nature of this monitoring effort would allow before-and-after comparisons of wildlife use, water quality, and physical processes. Marsh evolution and wildlife use in the restored Pond 2A site was monitored first by PWA and then by MEC Analytical Systems, Inc., from 1996 to 2000 (Philip Williams and Associates 1997, MEC Analytical Systems 2000). The physical and biological evolution of the 550-acre Pond 2A marsh was monitored through surveys of levee breaching and equilibrium of the width of the natural slough channel, sediment chemistry and grain size, sedimentation rates, tidal range and response, fish usage, avian usage, and plant colonization. Although Pond 2A has different

characteristics than the remaining ponds (Pond 2A was slightly less subsided and was never farmed before being converted to a salt pond), it can be used as one point of comparison. Comparisons would also be made to other restoration projects in the north bay region that are currently being monitored (such as Guadalcanal and Tolay Creek), and to the fringing marsh that exists along the slough channels within the salt pond complex.

6. A topographic and bathymetric survey of the salt ponds, slough channels, and associated marsh plain was conducted by Towill, Inc., as part of the feasibility study with the Corps (Towill 2001). The aerial survey included a very accurate, primary-control-level loop through the site that was connected to high-confidence benchmarks outside the site. This survey was used in the development of the hydrodynamic model by PWA and will be useful for before-and-after comparisons of elevations. Sediment, hydrology, and vegetation monitoring will be conducted immediately before levee breaching to establish baseline conditions, and annually for approximately 10 years after breaching. Prebreach monitoring will involve performing additional surveys for consistency with postproject monitoring locations, as well as installation of sedimentation monitoring stations. Postconstruction (postbreach) and some additional prebreach surveys of tidal geomorphic evolution will document rates and patterns of habitat evolution and key underlying physical processes in each pond restored to tidal habitats. Monitoring results will be used to identify the need for any adaptive management required to improve tidal circulation within restored ponds. They will also be used to inform and adaptively manage the tidal wetland restoration designs for future tidal restoration in other ponds.

7. Baseline, construction, and postconstruction macroinvertebrate, fisheries, and avian usage data will be collected at locations within restored and managed ponds to assess the impacts of the restoration upon the wildlife. The baseline condition will incorporate data collected by USGS during 1999 and 2000 (Takekawa *et al.* 2001). All surveys will be conducted within Universal Transverse Mercator (UTM) grids overlaid on the ponds. Results from initial waterbird surveys will be used to select a subsample of grids, based on bird presence (random grids would be selected if bird use is not evident), for further survey each quarter. Analyses will examine both temporal and seasonal variation in pond usage.

8. Water samples will be collected quarterly from each sample site within each pond for chlorophyll-a and nutrient (nitrogen and phosphorous) analyses. Chlorophyll-a concentration, a measure of algal community primary productivity, will be determined using spectrophotometry (Wetzel and Likens 1991). Nutrient concentration (soluble reactive phosphorous, total phosphorous, and nitrogen) will be determined using standard analytical methods (Clesceri *et al.* 1989). Zooplankton will be collected, preserved, and identified under a stereomicroscope (Pennak 1989).

9. Invertebrates will be sampled in the water column using net sweeps and in the benthos with Eckmann grab samples. Sweep and grab samples will be taken monthly in each

pond. Biomass (dry weight) and diversity of invertebrates will be measured on a seasonal basis.

10. Fish populations will be surveyed seasonally. Surveys will assess distribution and relative abundance of juvenile and adult fishes, with special emphasis on small species likely to occur in the study area (*e.g.*, rainwater killifish [*Lucania parva*], topsmelt [*Altherinops affinis*], and yellowfin goby [*Acanthogobius flavimanus*]) (Lewis Environmental Services and Wetland Research Associates 1992). Captured fish would be counted, identified to species, and subsequently released. A subset of the captured individuals of each species would be measured for standard length and weight. Relative weight (measured weight of an individual divided by a standard weight for the species), a measure of body condition, will be also calculated for these individuals (Wege and Anderson 1978; Anderson 1980). Stomach contents will also be collected and analyzed for a sample of individuals from selected species.

11. Bird surveys will be conducted bimonthly following current USGS protocols (Takekawa *et al.* 2001). Locations of flocks will be mapped in a grid overlay and displayed in geographic information systems (GIS) maps. Usage trends will be examined by comparing data from before and after installation of water control structures and/or restoration to tidal habitats. Water depth and foraging preferences will also be examined (Collazo *et al.*, in review).

12. Invertebrate samples will be analyzed yearly for chemical residues to determine the level to which elemental contaminants such as mercury are being transferred to animals feeding on pond-dwelling macroinvertebrates. Net sweeps samples and grab samples of benthic invertebrates will be collected during the month of maximum bird use. Contaminant presence will be analyzed using standard laboratory techniques.

13. Nighttime spotlight surveys and track surveys would be conducted to monitor for the presence of introduced mammalian predators, particularly red fox, on the project site. Surveys will be focused on marshes containing populations of California clapper rails. When possible, nighttime predator surveys will include searches for fox dens and surveys of wildlife remains near fox dens. Track stations will be set up for the track surveys. Staff from the U.S. Department of Agriculture's Wildlife Services will be hired to monitor for introduced mammalian predators, if staff are available. Otherwise, some other entity will conduct the monitoring.

14. Avoidance and minimization measures for aquatic species include the environmental commitments by the project sponsors to:

    a. minimize in-water construction during periods when listed species may be present;

b. utilize in-water Best Management Practices including the use of coffer dams and measures to prevent and control the potential for spills of hazardous materials into the river;

c. comply with San Francisco Regional Water Quality Control Board discharge water quality standards; and

d. time the breaches of Pond 3 and 4 to coincide with a large storm event.

16. A Service-approved biologist will train construction crews on the sensitive wildlife resources and exclusion zones within the proposed construction alignment.

17. A Service-approved biologist will be present to monitor construction activities in and near areas known to be occupied by black rail, California clapper rail, western snowy plover, and will have the authority to install or require wildlife protection measures such as fencing, noise buffers or noise level limitations during avian breeding seasons, and temporarily halting or redirecting construction activities to avoid impacts on sensitive species.

18. Surveys will be conducted for the California clapper rail and western snowy plover and their habitats during their known nesting period to determine the presence of each species in all areas with suitable habitat where construction activities, or their effects, are slated to occur. These surveys will be conducted by Service-approved biologists. Survey results will be used to plan subsequent actions, which may include implementation of appropriate avoidance and minimization measures, modifications to monitoring programs, and coordination with regulating agencies. Survey results will be submitted to, and/or otherwise coordinated with, the Service and DFG.

19. To the extent feasible, the project sponsors will avoid construction activities during the nesting period of the California clapper rail and western snowy plover, February through July. If construction activities must occur during nesting periods, a qualified biologist will conduct pre-construction surveys up to 72 hours before construction begins, using survey methods approved by the Service. Due to tidal influences on construction/survey areas, surveys will be conducted as close to the actual construction period as is practicable. Surveys will be conducted up to a distance at which these bird species are unlikely to be affected by project construction. This distance could vary according to terrain and type of construction activity, but is often 150 - 300 feet from the maximum limit of each construction site. The exact survey distance varies on construction site characteristics, such as natural barriers, between potential nests and construction activities. If nests are located an adequate distance from the limits of construction, construction may proceed. If nest sites are located in areas that would be disturbed by construction, the project sponsors will consult with the Service to determine what additional mitigation measures could be implemented to avoid or reduce mortality (*e.g.*,

establishing buffers around active nest sites or sequencing construction to avoid potential impacts on these species during their breeding season) while allowing construction to proceed. Construction activities in the area of concern may be rescheduled or modified to avoid adverse impacts to the nesting birds. The Service will be consulted on proposed schedule changes and any additional work or modifications to the work plan will be approved by the Service.

Action Area

The action area for the proposed Napa River Salt Marsh Restoration Project encompasses 9,460 acres (6,660 acres of ponds and 1,750 acres of sloughs) supporting habitats for the clapper rail, smelt, splittail, harvest mouse, and snowy plover.

Status of the Species/Environmental Baseline

California Clapper Rail

The clapper rail was federally listed as endangered in 1970 (35 **FR** 16047)(Service 1970). A detailed account of the taxonomy, ecology, and biology of the clapper rail is presented in the Recovery Plan (Service 1984). The clapper rail is a fully protected species under California law (See California Fish and Game Code Section 3511).

The clapper rail is endemic to tidally influenced salt and brackish marshes of California. Historically, the clapper rail occurred in tidal marshes along California's coast from Morro Bay, San Luis Obispo County, to Humboldt Bay, Humboldt County. Currently, clapper rails are known to occur in tidal marshes in San Francisco, San Pablo, Grizzly, Suisun and Honker Bays.

The clapper rail is distinguishable from other rails by its large body size of 32-47 cm from bill to tail, and weighs approximately 250-350 g. It has a long, slightly decurved orange bill, a rufous breast, black and white barred flanks, and white undertail coverts (Ripley 1977). Clapper rails are sexually dimorphic, the males are slightly larger than females (Garcia 1995). Juveniles have a pale bill and dark plumage.

Clapper rails are typically found in the intertidal zone and sloughs of salt and brackish marshes dominated by pickleweed, Pacific cordgrass (*Spartina foliosa*), gumplant (*Grindelia spp.*), salt grass, jaumea (*Jaumea carnosa*) and adjacent upland refugia. They may also occupy habitats with other vegetative components, which include, but are not limited to bulrush *(Scirpus americanus* and *S. maritimus*), cattails (*Typha spp.*), and Baltic rush (*Juncus balticus*).

Clapper rails are capable of producing several vocalizations, most common of which is a series of keks or claps. Pair bonds are typically established during the month of February, and nesting typically occurs from March through August. Estimates of California clapper rail clutch size range from 5-14 eggs (DeGroot 1927, Gill 1972). The clapper rail builds a bowl shaped platform nest of marsh vegetation and detritus (DeGroot 1927, Zucca 1954, Gill 1972, Harvey 1980, Foerster *et al.* 1990, Garcia 1995). The clapper rail typically feeds on benthic invertebrates, but its diet is wide ranging, and includes seeds, and occasionally small mammals such as the harvest mouse.

Similar to the harvest mouse, suitable habitat has been significantly reduced by approximately 84 percent of historic in the San Francisco Bay Area due to habitat conversions for urban and agricultural uses, and is a primary factor in the species decline. Additional impacts which have contributed to the decline in clapper rail populations include over-harvesting, environmental contaminants, and erosion or subsidence of habitat.

Gill (1972) surveyed the Napa River Unit for clapper rails and identified Dutchman Slough, Napa Slough, and Devil's Slough as having resident breeding populations. Gill estimated 1.0 rails/hectare (ha) at the Napa River Unit, compared to 1.4/ha in San Francisco Bay. Gill suggests that the Napa River Unit is a stronghold for the bay's clapper rail population (Lewis Environmental Services and Wetland Research Associates 1992.). The Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan (Service 1984) identifies several areas within the action area as habitat essential to the recovery of this species. These areas include: (1) tidal marshes and mudflats within or along Devil's Slough, China Slough, South Slough, Dutchman Slough, Napa Slough and the Napa River; and, (2) diked areas within Pond 5 and the western half of Pond 2 which are identified for restoration to tidal marsh habitat.

Delta smelt

Smelt was federally listed as a threatened species on March 5, 1993, (58 **FR** 12854). Please refer to the Service (1993a, 1994, 1996) and California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Reclamation) (1994) for additional information on the biology and ecology of this species.

Description: Smelt are slender-bodied fish that typically reach 60-70 mm standard length (measured from tip of the snout to origin of the caudal fin), although a few may reach 120 mm standard length. The mouth is small, with a maxilla that does not extend past the midpoint of the eye. The eyes are relatively large, with the orbit width contained approximately 3.5-4 times in the head length. Small, pointed teeth are present on the upper and lower jaws. The first gill arch has 27-33 gill rakers and there are 7 branchiostegal rays (paired structures on either side and below the jaw that protect the gills). Counts of branchiostegal rays are used by taxonomists to identify fish. The pectoral fins reach less than two-thirds of the way to the bases of the pelvic fins. There are 9-10 dorsal fin rays, 8 pelvic fin rays, 10-12 pectoral fin rays, and 15-17 anal fin rays. The lateral line is incomplete and has 53-60 scales along it. There are 4-5 pyloric caeca. Live fish are nearly translucent and have a steely-blue sheen to their sides. Occasionally there may be one chromatophore (cellular organelle containing pigment) between the mandibles, but usually there is none. Smelt belong to the family Osmeridae, a more ancestral member of the order Salmoniformes which also includes the family Salmonidae (salmon, trout, whitefish, and graylings) (Molye and Cech 1988).

Distribution: Smelt are endemic to the upper Sacramento-San Joaquin estuary. They occur in the Delta primarily below Isleton on the Sacramento River, below Mossdale on the San Joaquin River, and in Suisun Bay. They move into freshwater when spawning (ranging from January to July) and can occur in: (1) the Sacramento River as high as Sacramento, (2) the Mokelumne River system, (3) the Cache Slough region, (4) the Delta, and, (5) Montezuma Slough, (6) Suisun Bay, (7) Suisun Marsh, (8) Carquinez Strait, (9) Napa River, and (10) San Pablo Bay. It is not known if smelt in San Pablo Bay are a permanent population or if they are washed into the Bay during high outflow periods. Since 1982, the center of smelt abundance has been the northwestern Delta in the channel of the Sacramento River. In any month, two or more life stages (adult, larvae, and juveniles) of smelt have the potential to be present in Suisun Bay (DWR and Reclamation 1994; Molye 1976; and Wang 1991). Smelt are also captured seasonally in Suisun Marsh.

The Interagency Ecological Program's (IEP) 20mm Survey recorded smelt in the Carquinez Strait in 1995, 1996, 1997, 1998, 1999, 2000, and 2001 (DFG 2000). In 1995, 1996, 1997, 1998, 1999, 2000, 2001, and 2002 smelt were collected in Suisun Bay (DFG 2000). Smelt have been captured in the 20-mm surveys conducted by DFG in the Napa River Estuary from 1995 through 2001, with the exception of 1997 when delta smelt apparently were absent (DFG 2000). Three individuals were collected over a 4-year period at the Pond 2A Restoration Project in the Napa River Estuary (MEC Analytical Systems 2000).

Habitat Requirements: Smelt are euryhaline (a species that tolerates a wide range of salinities) fish that generally occur in water with less than 10-12 parts per thousand (ppt) salinity. However, smelt have been collected in the Carquinez Strait at 13.8 ppt and in San Pablo Bay at 18.5 ppt (DFG 2000). In recent history, they have been most abundant in shallow areas where early spring salinities are around 2 ppt. However, prior to the 1800's before the construction of levees that created the Delta Islands, a vast fluvial marsh existed in the Delta and the smelt probably reared in these upstream areas. During the recent drought (1987-92), smelt were concentrated in deep areas in the lower Sacramento River near Emmaton, where average salinity ranged from 0.36 to 3.6 ppt for much of the year (DWR and Reclamation 1994). During years with wet springs (such as 1993), delta smelt may continue to be abundant in Suisun Bay during summer even after the 2 ppt isohaline (an artificial line denoting changes in salinity in a body of water) has retreated upstream (Sweetnam and Stevens 1993). Fall abundance of smelt is generally highest in years when salinities of 2 ppt are in the shallows of Suisun Bay during the preceding spring ($p < 0.05$, $r = 0.50$) (Herbold 1994) (p is a statistical abbreviation for the probability of an analysis showing differences between variables, r is a statistical abbreviation for the correlation coefficient, a measure of the linear relationship of two variables). Herbold (1994) found a significant relationship between number of days when 2 parts per thousand was in Suisun Bay during April with subsequent smelt abundance ($p < 0.05$, $r = 0.49$) (Figure 2.2), but noted that autocorrelations (interactions among measurements that make relationships between measurements difficult to understand) in time and space reduce the reliability of any analysis that compares parts of years or small geographical areas. It should also be noted that the point in the estuary where the 2 ppt isohaline is located (X2) does not necessarily regulate delta smelt distribution in all years. In wet years, when abundance levels are high, their distribution is normally very broad. In late 1993 and early 1994, delta smelt were found in Suisun Bay region despite the fact that X2 was located far upstream. In this case, food availability may have influenced delta smelt distribution, as evidenced by the *Eurytemora* found in this area by DFG. In Suisun Marsh, smelt larvae occur in both large sloughs and small dead end sloughs. New studies are under way to test the hypothesis that adult fall abundance is dependent upon geographic distribution of juvenile smelt.

Life History: Wang (1986) reported spawning taking place in fresh water at temperatures of about 7°-15° Celsius (C). However, ripe smelt and recently hatched larvae have been collected in recent years at temperatures of 15°-22° C, so it is likely that spawning can take place over the entire 7°-22° C range. Temperatures that are optimal for survival of embryos and larvae have not yet been determined, although R. Mager, UCD, (unpublished data) found low hatching success and embryo survival from spawns of captive fish collected at higher temperatures. Smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the waters are well oxygenated and temperatures relatively cool, usually less than 20°-22° C in summer. When not spawning, they tend to be concentrated near the zone where incoming salt water and out flowing freshwater mix (mixing zone). This area has the highest primary productivity and is where zooplankton populations (on which delta smelt feed) are usually most dense (Knutson and Orsi 1983; Orsi and Mecum 1986). At all life stages smelt are found in greatest abundance in the top 2 m of the water column and usually not in close association with the shoreline.

Smelt inhabit open, surface waters of the Delta and Suisun Bay, where they presumably school. In most years, spawning occurs in shallow water habitats in the Delta. Shortly before spawning, adult smelt migrate upstream from the brackish-water habitat associated with the mixing zone to disperse widely into river channels and tidally-influenced backwater sloughs (Radtke 1966, Moyle 1976, Wang 1991). Migrating adults with nearly mature eggs were taken at the Central Valley Projects's (CVP) Tracy Pumping Plant, located in the south Delta, from late December 1990 to April 1991 (Wang 1991). In February 2000, gravid adults were found at both CVP and the State Water Projects' (SWP) fish facilities in the south Delta. Spawning locations appear to vary widely from year to year (DWR and Reclamation 1993). Sampling of larval smelt in the Delta suggests spawning has occurred in the Sacramento River, Barker, Lindsey, Cache, Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs, in the San Joaquin River off Bradford Island including Fisherman's Cut, False River along the shore zone between Frank's and Webb tracts, and possibly other areas (Wang 1991). In years of moderate to high Delta outflow, smelt larvae are often most abundant in Suisun Bay and sloughs of Suisun Marsh, but it is not clear the degree to which these larvae are produced by locally spawning fish and the degree to which they originate upstream and are transported by river currents to the bay and marsh. Some spawning probably occurs in shallow water habitats in Suisun Bay and Suisun Marsh during wetter years

(Sweetnam 1999 and Wang 1991). Spawning has also been recorded in Montezuma Slough near Suisun Bay (Wang 1986) and also may occur in Suisun Slough in Suisun Marsh (P. Moyle, UCD, unpublished data).

The spawning season varies from year to year, and may occur from late winter (December) to early summer (July). Pre-spawning adults are found in Suisun Bay and the western delta as early as September (DWR and Reclamation 1994). Moyle (1976) collected gravid adults from December to April, although ripe delta smelt were common in February and March. In 1989 and 1990, Wang (1991) estimated that spawning had taken place from mid-February to late June or early July, with peak spawning occurring in late April and early May. A recent study of smelt eggs and larvae (Wang and Brown 1993 as cited in Water Resources and Reclamation 1994) confirmed that spawning may occur from February through June, with a peak in April and May. Spawning has been reported to occur at water temperatures of about 7° to 15° C. Results from a University of California at Davis (UCD) study (Swanson and Cech 1995) indicate that although smelt tolerate a wide range of temperatures (<8° C to >25° C), warmer water temperatures restrict their distribution more than colder water temperatures.

Smelt spawn in shallow, fresh, or slightly brackish water upstream of the mixing zone (Wang 1991). Most spawning occurs in tidally-influenced backwater sloughs and channel edgewaters (Moyle 1976; Wang 1986, 1991; Moyle *et al.* 1992). Although smelt spawning behavior has not been observed in the wild (Moyle *et al.* 1992), some researchers believe the adhesive, demersal eggs attach to substrates such as cattails, tules, tree roots, and submerged branches in shallow waters (Moyle 1976, Wang 1991).

Laboratory observations have indicated that delta smelt are broadcast spawners (DWR and Reclamation 1994) and eggs are demersal (sinks to the bottom) and adhesive, sticking to hard substrates such as: rock, gravel, tree roots or submerged branches, and submerged vegetation (Moyle 1976; Wang 1986). At 14°-16° C, embryonic development to hatching takes 9 -14 days and feeding begins 4-5 days later (R. Mager, UCD, unpublished data). Newly hatched smelt have a large oil globule that makes them semi-buoyant, allowing them to maintain themselves just off the bottom (R. Mager, UCD, unpublished data), where they feed on rotifers (microscopic crustaceans used by fish for food) and other microscopic prey. Once the swimbladder (a gas-filled organ that allows fish to maintain neutral buoyancy) develops, larvae become more buoyant and rise up higher into the water column. At this stage, 16-18 mm total length, most are presumably washed downstream until they reach the mixing zone or the area immediately upstream of it. Growth is rapid and juvenile fish are 40-50 mm long by early August (Erkkila *et al.* 1950; Ganssle 1966; Radtke 1966). By this time, young-of-year fish dominate trawl catches of delta smelt, and adults become rare. Smelt reach 55-70 mm standard length in 7-9 months (Moyle 1976). Growth during the next 3 months slows down considerably (only 3-9 mm total), presumably because most of the energy ingested is being directed towards gonadal development (Erkkila *et al.* 1950; Radtke 1966). There is no correlation between size and fecundity, and females between 59-70 mm standard length lay 1,200 to 2,600 eggs (Moyle *et al.* 1992). The abrupt change from a single-age, adult cohort during spawning in spring to a population dominated by juveniles in summer suggests strongly that most adults die after they spawn (Radtke 1966 and Moyle 1976). However, in El Nino years when temperatures rise above 18° C before all adults have spawned, some fraction of the unspawned population may also hold over as two-year-old fish and spawn in the subsequent year. These two-year-old adults may enhance reproductive success in years following El Nino events.

In a near-annual fish like delta smelt, a strong relationship would be expected between number of spawners present in one year and number of recruits to the population the following year. Instead, the stock-recruit relationship for smelt is weak, accounting for about a quarter of the variability in recruitment (Sweetnam and Stevens 1993). This relationship does indicate, however, that factors affecting numbers of spawning adults (*e.g.*, entrainment, toxics, predation) can have an effect on smelt numbers the following year.

Smelt feed primarily on (1) planktonic copepods (small crustaceans used by fish for food), (2) cladocerans (small crustaceans used by fish for food), (3) amphipods (small crustaceans used by fish for food) and, to a lesser extent, (4) on insect larvae. Larger fish may also feed on the opossum shrimp, *Neomysis mercedis*. The most important food organism for all sizes seems to be the euryhaline copepod, *Eurytemora affinis*, although in recent years the exotic species, *Pseudodiaptomus forbesi*, has become a major part of the diet (Moyle *et al.* 1992). Smelt are a minor prey item of juvenile and subadult striped bass, *Morone saxatilis*, in the Sacramento-San Joaquin Delta (Stevens 1966). They also have been reported from the stomach contents of white catfish, *Ameiurus catus*, (Turner 1966 *in* Turner and Kelley (eds) 1966) and black crappie, *Pomoxis nigromaculatus*, (Turner 1966 *in* Turner and Kelley 1966) in the Delta.

Abundance: The smelt is endemic to Suisun Bay upstream of San Francisco Bay and throughout the Delta, in Contra Costa, Sacramento, San Joaquin, Solano and Yolo counties, California. Historically, the smelt is thought to have occurred from Suisun Bay and Montezuma Slough, upstream to at least Verona on the Sacramento River, and Mossdale on the San Joaquin River (Moyle *et al.* 1992, Sweetnam and Stevens 1993).

Since the 1850s, however, the amount and extent of suitable habitat for the smelt has declined dramatically. The advent in 1853 of hydraulic mining in the Sacramento and San Joaquin rivers led to an increase in siltation and the alteration of the circulation patterns of the Estuary (Nichols *et al.* 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94% of the Estuary's tidal marshes (Nichols *et al.* 1986, Monroe and Kelly 1992). The extensive levee system in the Delta has led to a loss of seasonally flooded habitat and significantly changed the hydrology of the Delta ecosystem, restricting the ability of suitable habitat substrates to re-vegetate.

Smelt were once one of the most common pelagic (living in open water away from the bottom) fish in the upper Sacramento-San Joaquin estuary, as indicated by its abundance in DFG trawl catches (Erkkila *et al.* 1950; Radtke 1966; Stevens and Miller 1983). Smelt abundance from year to year has fluctuated greatly in the past, but between 1982 and 1992 their population was consistently low. The decline became precipitous in 1982 and 1983 due to extremely high outflows and continued through the drought years 1987-1992 (Moyle *et al.* 1992). In 1993, numbers increased considerably, apparently in response to a wet winter and spring. During the period 1982-1992, most of the population was confined to the Sacramento River channel between Collinsville and Rio Vista (D. Sweetnam, DFG unpublished data). This was still an area of high abundance in 1993, but smelt were also abundant in Suisun Bay. The actual size of the smelt population is not known. Stevens *et al.* (1990) estimated the population size to be about 280,000, but they recognized that this value is based on a tenuous relationship between smelt numbers and numbers of young striped bass, and is imperfect. However, the pelagic life style of smelt, short life span, spawning habits, and relatively low fecundity indicate that a fairly substantial population probably is necessary to keep the species from becoming extinct.

Recreation in the Delta has resulted in the presence and propagation of predatory non-native fish such as striped bass (*Morone saxatilis*). Additionally, recreational boat traffic has led to a loss of habitat from the building of docks and an increase in the rate of erosion resulting from boat wakes. In addition to the loss of habitat, erosion reduces the water quality and retards the production of phytoplankton in the Delta.

In addition to the degradation and loss of estuarine habitat, delta smelt have been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of low salinity habitat to deep-water river channels of the interior Delta (Moyle *et al.* 1992). These adverse conditions are primarily a result of the steadily increasing proportion of river flow being diverted from the Delta by the Projects, and occasional droughts (Monroe and Kelly 1992).

Reduced water quality from agricultural runoff, effluent discharge and boat effluent has the potential to harm the pelagic larvae and reduce the availability of the planktonic food source. When the mixing zone is located in Suisun Bay where there is extensive shallow water habitat within the euphotic zone (depths less than four meters), high densities of phytoplankton and zooplankton may accumulate (Arthur and Ball 1978, 1979, 1980). The introduction of the Asian clam (*Potamocorbula amurensis)*, a highly efficient filter feeder, presently reduces the concentration of phytoplankton in this area.

According to seven abundance indices which provide information on the status of the smelt, this species was consistently at low population levels through the 1980's (Stevens *et al.* 1990). These same indices also showed a pronounced decline from historical levels of abundance (Stevens *et al.* 1990).

For a large part of its annual life span, this species is associated with the freshwater edge of the mixing zone, where the salinity is approximately 2 ppt. (Ganssle 1966, Moyle *et al.* 1992, Sweetnam and Stevens 1993). The relationship between the portion of the smelt population west of the Delta as sampled in the summer townet survey and the natural logarithm of Delta outflow from 1959 to 1988, indicates the summer townet index increased dramatically when outflow was between 34,000 and 48,000 cubic feet per second, placing X2 between Chipps and Roe islands (DWR and Reclamation 1994).

Specifically, the summer townet abundance index constitutes one of the more representative indices because the data have been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) for the longest period of time (since 1959) (DFG 2001). The summer townet abundance index measures the abundance and distribution of juvenile smelt and provides data on the recruitment potential of the species (DFG 2001). Since 1983, (except for 1986, 1993, and 1994), this index has remained at consistently lower levels than previously found (DFG 2001). These consistently lower levels correlate with the 1983 to 1992 mean location of X2 upstream of the confluence (DFG 2001).

The final summer townet index for 2000 was 8.0, a decline from the 11.9 index for the 1999 summer townet (DFG 2001). Both of these indices represent an increase from the 1998 index of 3.3. However, both 1999 and 2000 indices are still below the pre-decline average of 20.4 (1959-1981, no sampling in 1966-1968) (DFG 2001).

The second longest running survey (since 1967), the fall midwater trawl survey (FMWT), measures the abundance and distribution of late juveniles and adult smelt in a large geographic area from San Pablo Bay upstream to Rio Vista on the Sacramento River and Stockton on the San Joaquin River (Stevens *et al.* 1990, DFG 1999a). The FMWT indicates the abundance of the adult population just prior to upstream spawning migration (DFG 1999a). The index calculated from the FMWT uses numbers of sampled fish multiplied by a factor related to the volume of the area sampled (DFG 1999a). Until recently, except for 1991, this index has declined irregularly over the past 20 years (DFG 1999a). Since 1983, the smelt population has exhibited more low FMWT abundance indices, for more consecutive years, than previously recorded (DFG 1999a). The 1994 FMWT index of 101.2 was a continuation of this trend (DFG 1999a). This occurred despite the high 1994 summer townet index for reasons unknown (DFG 1999a). The low 1995 summer townet index value of 3.3 was followed by a high FMWT index of 839 reflecting the benefits of higher flows due to an extremely wet year (DFG 1999a, 2001).

The 1999 FMWT index of 717, which is an increase from 1998's index (417.6), is the third highest since the start of decline of smelt abundance in 1982 (DFG 1999a). The FMWT abundance index (127) for 1996 represented the fourth lowest on record (DFG 1999a). The 1997 abundance index (360.8) almost tripled since the 1996 survey, despite the low summer townet index (4.0) (DFG 1999a, 2001).

Both 2001 TNS and FMWT abundance indices for delta smelt decreased from 2000 (Souza and Bryant 2002, DFG 1999a and 2001). The 2001 TNS delta smelt index (3.5) is less than 1999 (11.9) and 2000 (8.0) but comparable to recent years (1995, 1997, and 1998) when the index ranged from 3.2 to 4.0 (Souza and Bryant 2002, DFG 2001). The 2001 FMWT smelt index (603) decreased by 20% from 2000 (756) (Souza and Bryant 2002, DFG 2001). Both surveys exhibited an overall trend of decline in the last three years, but this decline seems more pronounced in the TNS where the 2001 smelt index is 95% lower than the greatest index of record (62.5) in 1978 (Souza and Bryant 2002, DFG 2001).

Abundance in the Napa River is highly variable from year to year and the population has historically rebounded (*e.g.*, the increase in abundance from 1992 to 1993). Freshwater outflow to the project area has the greatest influence on delta smelt abundance in the project area. Smelt would be present in the Rapa River Salt Marsh Restoration Project area during the winter and through early summer when salinity levels are between 15 and 5 ppt. It is during this time that species abundance would be highest.

Swimming Behavior: Observations of smelt swimming in a swimming flume and in a large tank show that these fish are unsteady, intermittent, slow speed swimmers (Swanson and Cech 1995). At low velocities in the swimming flume (<3 body lengths per second), and during spontaneous, unrestricted swimming in a 1 m tank, smelt consistently swam with a "stroke and glide" behavior. This type of swimming is very efficient; Weihs (1974) predicted energy savings of about 50% for "stroke and glide" swimming compared to steady swimming. However, the maximum speed smelt are able to achieve using this mode of swimming is less than 3 body lengths per second, and the fish did not readily or spontaneously swim at this or higher speeds (Swanson and Cech 1995). Although juvenile smelt appear to be stronger swimmers than adults, forced swimming at 3 body lengths per second in a swimming flume was apparently stressful; the smelt were prone to swimming failure and extremely vulnerable to impingement (Swanson and Cech 1995). Smelt swimming performance was limited by behavioral rather than physiological or metabolic constraints (Brett 1976).

Sacramento Splittail

The splittail was federally listed as threatened on March 8, 1999, (64 **FR** 25). Please refer to the Service (1995, 1996, 1999), and DWR and Reclamation (1994) for additional information on the biology and ecology of the splittail.

Description: Splittail are large cyprinids (minnows), growing in excess of 300 mm standard length, and are distinctive in having the upper lobe of the caudal fin larger than the lower lobe. The body shape is elongate with a blunt head. Small barbels may be present on either side of the subterminal mouth. They possess 14 to 18 gill rakers, and their pharyngeal teeth are hooked and have narrow grinding surfaces. Dorsal rays number from 9-10, pectoral rays 16-19, pelvic rays 8-9, and anal rays 7-9. The lateral line usually has 60-62 scales, but ranges from 57-64. The fish are silver on the sides and olive grey dorsally. Adults develop a nuchal hump (*i.e.*, protuberance on the fishes' nape). During the breeding season, the caudal, pectoral, and pelvic fins take on a red-orange hue and males develop small white nuptial tubercles in the head region.

Distribution: The summer through fall distribution of adult splittail is primarily limited to tidal fresh and brackish waters of the Sacramento-San Joaquin Delta, Suisun Bay, Napa and Petaluma marshes (Baxter 1994, Meng and Moyle 1995, Baxter *et al.* 1996), yet in the past two years this range has expanded. In the Sacramento River, three adult splittail were collected at the Red Bluff Diversion Dam (river kilometer (rkm) 391): one each in April and April 1997 and one in October 1998. Red Bluff is the most upstream location capture for splittail in recent years, surpassing the Hamilton City area (rkm 331) reported in Sommer *et al.* (1997). An additional adult splittail was collected in August 1997 in a screw trap at the Glenn-Colusa Fish Screen (rkm 331). The splittail from August and October are also the first recent captures of adult splittail in the Sacramento River upstream of the delta in summer or fall (DFG 1999b). This indicates that some adult splittail now spend the summer in the main stem of the Sacramento River instead of migrating back to the estuary after spawning (DFG 1999b).

Splittail spawn in the Sacramento River upstream of Hamilton City, as evidenced by sporatic collection of adult and age-0 splittail at a screw trap near the Glenn-Colusa Fish Screen (DFG 1999b). Some age-0 splittail rear in the river through late fall, and the presence of an age-1 splittail in May 1997 indicates year-round rearing (DFG 1999b). Adults begin their spawning migration in December (Meng and Moyle 1995, CDFG unpublished data), so collection of adult fish in June, August, and October means that adult use of riverine habitat can extend at least 7 to 11 months (DFG 1999b).

Adult splittail forage and may spawn in tributaries of the Sacramento River upstream of the Feather River (DFG 1999b). Three adult fish were collected in tributaries of Big Chico Creek (rkm 312): two from Mud Creek in March 1996 and one from Kusal Slough in March 1997 (Maslin *et al.* 1997).

Plankton sampling also provides evidence of splittail spawning relatively high in the Sacramento River system. Johnson Wang identified larval splittail from archived plankton samples collected from 1998 through 1994 by the Striped Bass Egg and Larval Survey. Larval splittail were collected from the most upstream region the Striped Bass Egg and Larva Survey sampled annually. Catch of larval splittail in regions upstream of the City of Sacramento was frequently as high or higher than that of downstream regions. Except for years with some (1989, 1992) or substantial (1993) winter/spring outflows, splittail larvae were uncommon in Sacramento River collections downstream of the City of Sacramento. Splittail larvae were not collected in Suisun Bay or in Suisun Marsh except in 1993. Two interpretations are possible for these data: 1) splittail spawn relatively high in the Sacramento River system every year, but downstream dispersal of larvae increases with higher flows, or 2) some splittail are able to spawn in Suisun Bay or in Suisun Marsh during high flow years because of reduced salinities and increased small stream flooding (DFG 1999b).

The distribution of age-0 splittail from the Beach Seine Survey provides evidence of Sacramento River spawning in both high and low flow years, and also of extended riverine rearing. The age-0 splittail distribution from the Beach Seine Survey was similar to that of larvae from the plankton survey: age-0 fish were always collected from the most upstream region the survey sampled. Except for catches in the west and central delta in 1995 and the west delta in 1996, all juveniles caught in fall came from the north delta and Sacramento River. Although only 109 age-0 splittail were caught by the beach seine during the fall months (of which 55 were from the west delta in 1995), 80% of the remaining catch came from the far north delta and upstream. Thus, some age-0 splittail spent their first summer in the Sacramento River and not in the Delta. Assuming the Beach Seine Survey accurately depicts the distribution of age-0 splittail, then by fall most age-0 splittail were in the Sacramento River, outside the sampling area of the Bay Study and FMWT whose index periods include fall months (Sommer *et al.* 1997).

In Winter and spring, the Beach Seine Survey continued to collect age-0 splittail in relatively high numbers in the Sacramento River, though they were also collected frequently in delta regions. The Service expands the beach seine sampling in winter, so more data were available for comparison than for fall. The catch of splittail was high in the west delta in 1996 as a result of the strong 1995 year class. Nonetheless, about 50% of the 70 age-0 Sacramento splittail collected came from the far north delta and upstream. These data indicate that age-0 splittail are difficult to capture with a beach seine in fall and winter, probably because they are good swimmers and their ability to escape increases rapidly with size (Young and Cech 1996). The low catches in the central, west, and south delta during the fall suggests either upstream densities are higher or that age-0 splittail were not as restricted to edgewaters <1.5 m deep in the delta as they may have been in the river. In either case, some proportion of the population consistently spent its first summer, fall, and winter in the Sacramento River and was not indexed by other surveys (DFG 1999b).

Sampling in the Sutter Bypass also provides evidence of spawning and first year rearing in the bypass itself or upstream in Butte Creek. Butte Creek enters the Sacramento River between Colusa and Meridan (river kilometer [rkm] 224). At high river flows, Butte Creek and the overflow from Moulton and Colusa weirs are diverted down Butte Slough into the Sutter Bypass, which in turn enters the Sacramento River just upstream of Verona (rkm 129). In 1995, adult splittail were electrofished from the riparian strip separating the lower Sutter Bypass from the Sacramento River channel and larvae were caught in plankton tows in the Sutter Bypass plume (Baxter *et al.* 1996). In 1996, 32 adult splittail were caught in the flooded Sutter Bypass, 17 were radio tagged and seven tracked to potential spawning areas, also in the bypass (IEP Splittail Spawning Investigations, unpublished data). Light traps set in areas where tagged adults congregated caught 63 larvae in the riparian strip between East Canal and the main Sutter Bypass (IEP Splittail Spawning Investigations, unpublished data). In spring 1998, 102 ripening and ripe adult splittail were captured in 44 20-minute gill-net sets in the lower 12 kilometer (km) of the bypass (IEP Sacramento Splittail Spawning Investigations, unpublished data). Light traps set in areas where adults were captured caught 226 Sacramento splittail larvae. These data confirm splittail spawn in the lower Sutter Bypass (DFG 1999b).

Splittail inhabit the San Joaquin River and the valley portions of some tributaries during high outflow years, but are rarely caught in low outflow years (Sommer *et al.* 1997; T. Ford, Turlock Irrigation District, pers. comm.; Baxter *et al.* 1995). Age-0 splittail emigrate primarily in the late spring and early summer (Armor *et al.* 1996), so they are rarely collected during the summer or winter (Saiki 1984; Brown and Moyle 1993; Baxter *et al.* 1995).

The most upstream collection from the San Joaquin River occurred from June 15 to 19, 1998, when a joint Service/DFG crew collected juvenile splittail from Salt Slough in San Luis National Wildlife Refuge upstream of Lander Ave. (DFG 1999b). The mouth of Salt Slough is at rkm 208.5 and the collection site was about 10 km upstream. Juvenile splittail were also collected about 8 km from the mouth of Mud Slough (DFG 1999b). Thus, splittail were able to locate flooded habitat well upstream in the San Joaquin River and spawn when conditions were suitable (DFG 1999b).

In late June 1995 and in late April 1998, age-0 splittail were collected at Fremont Ford (rkm 201) on the San Joaquin River (Baxter *et al.* 1995; DFG unpublished data). In late June 1995, 26 age-0 splittail were captured from a single beach seine haul at Fremont Ford; seven more hauls made over two days in August caught no splittail (Baxter *et al.* 1995). Additional age-0 splittail were caught in 1995 at locations between Merced and Tuolumne Rivers in July and early August, but were absent in 15 seine hauls in late August and two hauls in early September. In late September, two juveniles were collected in one of five beach seine hauls at Turtle Beach (rkm 92) (Baxter *et al.* 1995). These data show Sacramento splittail spawned high in the San Joaquin River in 1995 and that age-0 fish remained in the river well into summer when the outflow was relatively high (DFG 1999b).

In 1998, age-0 splittail were again collected at Fremont Ford. High water levels and runoff from Great Valley Grasslands State Park and Kesterson National Wildlife Refuge, immediately to the south, attracted splittail out of the San Joaquin River channel to spawn (DFG 1999b). One of the samples containing splittail was collected several hundred meters into Great Valley Grasslands State Park and away from the connecting channel to the San Joaquin River.

When river flows create suitable spawning habitat, as occurred annually from 1995 through 1998, the San Joaquin River is used for spawning and can produce substantial numbers of age-0 Sacramento splittail (DFG 1999b). The 1995 beach seine data and data from trawling at Mossdale in the lower San Joaquin River suggest that most age-0 Sacramento splittail emigrate during the late spring and early summer (Armor *et al.* 1996).

The Petaluma River and Marsh supported splittail at the end of the 1987-1992 drought as evidenced by 31 adult fish caught in fyke traps within Petaluma City limits from February to May 1991 (Levy 1993) and six age-0 splittail caught by beach seine in the Petaluma Marsh in May 1992 (DFG Bay Study, unpublished data). Splittail continue to be collected from the Petaluma River: 142 in 1995, 4 in 1996 and an untallied number of age-0, age-1 and adult splittail in 1998 (DFG 1999b). These data indicate that splittail continuously inhabited the Petaluma River from the early 1980's to present and that they successfully spawned in 1992, 1995 and 1998 (DFG 1999b).

In the Napa Marsh, 40 age-0 splittail were collected from six locations sampled in September 21, 1995 (DFG 1999b). In another effort, Sacramento splittail of all ages were collected in Pond 2A of Napa Marsh, July 18 through August 14, 1996 (William Kier and Robert Blizzard 1997, monitoring the use by splittail of the Napa-Sonoma Marsh Wildlife Area, unpublished data).

Historic sampling in the Napa Marsh found splittail present during seasons and years with high freshwater outflow and rare or absent when the outflow was low (DFG 1999b). From June 1974 through February 1979, four sloughs each in the Napa and Suisun marshes were samples once each in February, June, and October (DFG 1999b). In Napa Marsh, splittail were captured in summer and fall of 1974 (a wet year), in winter and summer 1975 (an above normal year), but only in winter of 1976 (a critically dry year) (DFG 1999b). They were not collected in Napa Marsh again until the severe 1976-1977 drought ended in the winter of 1978 (DFG 1999b). In the winters of 1978 and 1979, splittail catch was higher than at any time before the drought (DFG 1999b). In Suisun Marsh, splittail catch declined from June 1976 through October 1977, except in October 1976, but a few fish were caught throughout the drought (DFG 1999b). Similar to Napa Marsh, Suisun Marsh numbers rebounded strongly when the drought broke in 1978 (DFG 1999b). These data suggest that splittail shift their distribution as a result of salinity conditions, and that they are quick to respond and move into an area when conditions become favorable (DFG 1999b).

Splittail were very infrequently collected in the DFG open-water and beach surveys but were regularly collected during the Pond 2A Restoration Project in the Napa River Estuary (MEC Analytical Systems 2000). The species is known to occur in the Napa and Petaluma Rivers and Petaluma Marsh (U.S. Fish and Wildlife Service 1993c, 1996) near the Petaluma River, Novato Creek, and South of SR 37 complexes.

Splittail are known to have inhabited Coyote Creek, a tributary to South San Francisco Bay, in the late 1800's, but were thought to be extirpated early in the 20th century (Aceituno *et al.* 1976). However, in 1983, splittail were again captured in Coyote Creek (Kinnetic Labs Inc. and L.W. Associates 1987). Three age-1 splittail were collected, two in May and one in December (DFG 1999b). These splittail may have migrated to Coyote Creek during the high flows of winter 1983 that created low salinity conditions in shallow waters throughout San Francisco Bay (DFG 1999b). The winters of 1995, 1997, and 1998 produced similar low salinity conditions.

Habitat Requirements: Splittail are primarily freshwater fish, but are tolerant of moderate salinities and can live in water with salinities of 10-18 ppt (Moyle 1976, unpublished observation). They have been collected in the Carquinez Straight at 11 ppt salinity (total dissolved solids)(DFG 2000). They have also been collected in the Napa Marsh at salinities ranging from 18 to 21 ppt, which is well above the range where they are normally collected (Sommer *et al.* 1997), yet still within their tolerance (Young and Cech 1996).

In the 1950s, they were commonly caught by striped bass anglers in Suisun Bay. During the past 20 years, however, they have been found mostly in slow-moving sections of rivers and in sloughs and have been most abundant in the Suisun Bay and Marsh region (Meng 1993). In 1995, after an unusually wet winter, over five million juvenile splittail were salvaged at the CVP and SWP indicating the magnitude of spawning success in favorable water years. However, substantial losses occur during salvage operations and recruitment may not reflect the high spawning success. They are year around residents in Suisun Marsh, concentrating in the dead-end sloughs that typically have small streams feeding into them (Daniels and Moyle 1983; Moyle *et al.* 1985). They tend to be most abundant where other native fishes are abundant as well. In Suisun Marsh, trawl catches are highest in summer when salinities are 6-10 ppt and temperatures are 15-23° C (Moyle *et al.* 1985), reflecting in part the increased vulnerability of young-of-year fish to capture with increased size. In Suisun Bay, splittail of all sizes are most consistently found in shallow water at salinities less than 2-3 ppt (Meng 1993). In spring, both adult and young-of-year splittail are frequently found in shallow, flooded areas, such as the Yolo and Sutter by-passes, low-lying parts of delta islands (*e.g.*, Sherman Lake), and river mouths.

Young-of-year and age-1 splittail were common in beach seine sampling by DFG during 1993 along the Sacramento River between Rio Vista and Chipps Island. Furthermore, in the DFG Bay Study samples, splittail are more common from stations less than 6.7 m deep. Thus, juvenile splittail may be concentrated in the shallow peripheries of the Sacramento River, and they may be more abundant there than indicated by sampling done to date.

Daniels and Moyle (1983) found that year-class success in splittail was positively correlated with Delta outflow, and Caywood (1974) found that a successful year class was associated with winter-runoff sufficiently high to flood the peripheral areas of the Delta. These observations were confirmed by the analysis of the State (DFG 1992). Meng (1993) found a strong negative relationship between amount of water diverted from the delta and abundance of young splittail, noting that the effect of diversions seemed to be particularly strong in dry years. However, entrainment at CVP and SWP south Delta diversions is highest in wet years as can be seen in the high 1995 salvage numbers.

Life History: Splittail are relatively long-lived (about 5-7 years) and are highly fecund (up to 100,000 eggs per female). Their populations fluctuate on an annual basis depending on spawning success and strength of the year class (Daniels and Moyle 1983). Both male and female splittail mature by the end of their second year (Daniels and Moyle 1983), although occasionally males may mature by the end of their first year and females by the end of their third year (Caywood 1974). Fish are about 180-200 mm standard length when they attain sexual maturity (Daniels and Moyle 1983), and the sex ratio among mature individuals is 1:1 (Caywood 1974).

There is some variability in the reproductive period, with older fish reproducing first, followed by younger fish that tend to reproduce later in the season (Caywood 1974). Generally, gonadal development is initiated by fall, with a concomitant decrease in somatic growth (Daniels and Moyle 1983). By April, ovaries reach peak maturity and account for approximately 18% of the body weight. The onset of spawning seems to be associated with increasing water temperature and day length and occurs between early March and May in the upper Delta (Caywood 1974). However, Wang (1986) found that in the tidal freshwater and euryhaline habitats of the

Sacramento-San Joaquin estuary, spawning occurs by late January and early February and continues through July. Spawning times are also indicated by the salvage records from the SWP pumps. Adults are captured most frequently in January through April, when they are presumably engaged in spawning movements, while young-of-year are captured most abundantly in May through July (Meng 1993). These records indicate most spawning takes place from February through April.

Adults migrate into fresh water in late fall and early winter prior to spawning. The onset of spawning is associated with rising water temperature, lengthening photoperiod, seasonal runoff, and possibly endogenous factors from the months of March through May, although there are records of spawning from late January to early July (Wang 1986). There is some variability in the reproductive period because older fish reproduce before younger individuals (Caywood 1974). Spawning occurs in water temperatures from 9° to 20° C over flooded vegetation in tidal freshwater and euryhaline habitats of estuarine marshes and sloughs, and slow-moving reaches along the margins of large rivers (Service 1999).

Splittail spawn on submerged vegetation in flooded areas. Because they require flooded vegetation for spawning and rearing, splittail are frequently found in areas subject to flooding. The eggs are adhesive or become adhesive soon after contacting water (Caywood 1974, and Bailey, UCD, pers. comm., 1994, as cited in DWR and Reclamation 1994). Spawning also occurs in the lower reaches of rivers (Caywood 1974), dead-end sloughs (Moyle 1976) and in the larger sloughs such as Montezuma Slough (Wang 1986). Larvae remain in the shallow, weedy areas inshore in close proximity to the spawning sites and move into the deeper offshore habitat as they mature (Wang 1986).

Strong year classes have been produced even when adult numbers are low, if outflow is high in early spring (*e.g.*, 1982, 1986). Since 1988, recruitment has been consistently lower than expected, suggesting this relationship may be breaking down (Meng 1993). For example, both 1978 and 1993 were wet years following drought years, yet the young-of-year abundance in 1993 was only 2% of the abundance in 1978.

Splittail are benthic foragers that feed extensively on opossum shrimp (*Neomysis mercedis*) although detrital material typically makes up a high percentage of their stomach contents (Daniels and Moyle 1983). They will feed opportunistically on earthworms, clams, insect larvae, and other invertebrates. They are preyed upon by striped bass and other predatory fishes. The preference for splittail by striped bass has long been recognized by anglers, who fish for splittail to use them for bait.

Abundance: Splittail are endemic to California's Central Valley where they were once widely distributed in lakes and rivers (Moyle 1976). Historically, splittail were found as far north as Redding on the Sacramento River and as far south as the site of Friant Dam on the San Joaquin River (Rutter 1908). Rutter (1908) also found splittail as far upstream as the current Oroville Dam site on the Feather River and Folsom Dam site on the American River. Anglers in Sacramento reported catches of 50 or more splittail per day prior to damming of these rivers

(Caywood 1974). Splittail were common in San Pablo Bay and Carquinez Strait following high winter flows until about 1985 (Messersmith 1966, Moyle 1976, and Wang 1986 as cited in DWR and Reclamation 1994). Since 1985, splittail have been rare in San Pablo Bay, reflecting a constriction of their distribution to the upper Bay-Delta areas and to isolated areas like the Petaluma and Napa Rivers.

In recent times, dams and diversions have increasingly prevented upstream access to large rivers and the species is restricted to a small portion of its former range. Splittail enter the lower reaches of the Feather and American rivers on occasion, but the species is now largely confined to the Delta, Suisun Bay, and Suisun Marsh (Service 1995). Stream surveys in the San Joaquin Valley reported observations of splittail in the San Joaquin River below the mouth of the Merced River and upstream of the confluence of the Tuolumne River (Saiki 1984 as cited in Water Resources and Reclamation 1994).

The 1985 to 1992 decline in splittail abundance is concurrent with hydrologic changes to the Estuary. Splittail have experienced a decline in population as a result of hydrologic changes in the Estuary and loss of shallow water habitat due to dredge and fill and channelization activities. These changes include increases in water diversions during the spawning period from January through July.

Most of the factors that caused delta smelt to decline have also caused the decline of splittail. These factors include (1) diversions, (2) dams and (3) reduced outflow, coupled with (4) occasional drought years, (5) introduced aquatic species such as the Asian clam (Nichols *et al.* 1986) and striped bass, and (6) loss of wetlands and shallow-water habitat, and appear to have perpetuated the species' decline. These factors have reduced the species' ability to reverse its decline (Moyle *et al.* 1992).

The IEP's spring 1999 20mm survey shows a significant decrease in splittail young of the year abundance. These surveys and spring 2000 20mm surveys also identified a portion of the population to be found in the central and south Delta in the spring and early summer (DFG 2000). In May and June 2000, the Projects entrained over 79,000 splittail (DWR, unpublished data, 2000).

The 2001 FMWT's Sacramento splittail index (all ages combined) was 27 (Souza and Bryant 2002, DFG 1999a). Although an increase from the 2000 index (10), the 2001 index is considerably lower than the strong year class of 1998 (281) (Souza and Bryant 2002, DFG 1999a). The age-0 component of the 2001 Sacramento splittail abundance index is 10 (Souza and Bryant 2002, DFG 1999a). Catch in the 2001 FMWT was dominated by age-1+ fish (67%), whereas catch in the 2000 FMWT was dominated by age-0 fish (80%)(Souza and Bryant 2002, DFG 1999a). A total of 24 age-0 and age-1+ splittail was caught throughout the survey (Souza and Bryant 2002, DFG 1999a). In September, 92% of the catch was accounted for by a single station on the western side of Montezuma Slough (Souza and Bryant 2002, DFG 1999a). No splittail were caught in November, and in December splittail were caught from the Napa River to the Sacramento River near Threemile Slough (Souza and Bryant 2002, DFG 1999a).

Analyses of survey data collected from 1967 to 1993 (Meng 1993, Meng and Moyle 1995), and data from 1967 to 1997 by the Service, DFG, UCD, and biologists from several different studies noted the following trends:

1. Overall, splittail abundance indices have declined. Splittail populations are estimated to be 35 to 60% of what they were in the 1940's, and these estimates may be high (Moyle in prep). Department FMWT data indicate a decline from the mid-1960s to the late 1970s, followed by a resurgence, with yearly fluctuations, through the mid-1980s. From the mid-1980s through 1994, splittail numbers have declined in the Delta, with some small increases in various years. The 1998 FMWT index of 281 was the highest on record, however, in 1999 the index dropped to 39, which is below mid 1980 levels.

2. Splittail abundances vary widely between years. Sommer *et al.* (1997) also found that splittail recruitment success fluctuates widely from year to year and over long periods of time. During dry years abundance is typically low. During the dry years of 1980, 1984, 1987, and 1988 through 1992, splittail abundance indices for young-of-the-year were low, indicating poor spawning success. Additionally, all year class abundances were low during these years. In 1994, the fourth driest year on record, all splittail indices were extremely low. Wet years are assumed to provide essential habitat for splittail and allow populations to rebound from dry years. Successful reproduction in splittail is often highly correlated with wet years. Large pulses of young fish were observed in wet years 1982, 1983, 1986, and 1995. In 1995, one of the wettest years in recent history, an increase in all indices was recorded, as in 1986, which was another wet year following a dry year. However, young of the year taken per unit effort (for example, either the number of fish per net that is towed or the number of fish per volume of water sampled) has actually declined in wet years, from a high of 37.3 in 1978 to 0.6 in 1993. The abundance indices of young of the year splittail during the years of 1995, 1996, and 1997 were 44.5, 2.1, and 2.6, respectively. In 1995, a very wet year, splittail abundances were high. However in 1996 and 1997, both wet years, abundance indices were low. 1998 was a wet year with a large splittail year class produced.

3. Concentration of splittail in shallow areas suggests that they are particularly vulnerable to impacts to shallow water habitat.

The above data indicate that splittail abundances vary widely in response to environmental conditions, and show that the general population numbers are declining.

Salt Marsh Harvest Mouse

The harvest mouse was federally listed as endangered in 1970 (35 **FR** 16047)(Service 1970). A detailed account of the taxonomy, ecology, and biology of the harvest mouse is presented in the Salt Marsh Harvest Mouse & California Clapper Rail Recovery Plan (Service 1984) and the references cited therein. The harvest mouse is a fully protected species under California law (see California Fish and Game Code Section 4700).

The harvest mouse is a rodent endemic to the salt and brackish marshes of the San Francisco Bay Area and adjacent tidally influenced areas. The harvest mouse closely resembles the western harvest mouse (*R. megalotis*). The harvest mouse typically weighs about 10 grams, has a head and body length ranging from 69-74 mm, a tail length ranging from 65-82 mm, and a hind foot length of 17-18 mm (Fisler 1965). As stated in the recovery plan, the harvest mouse, when compared to the western harvest mouse, have darker ears, belly and back, and a slightly thicker, less pointed and unicolored tail. The harvest mouse is further distinguished taxonomically into the northern and southern subspecies, *R. raviventris halicoetes* and *R. raviventris raviventris*, respectively. Of the two subspecies, *R. r. halicoetes* more closely resembles *R. megalotis*, and can be difficult to differentiate in the field; body color and color of ventral hairs as well as the thickness and shape of the tail have been used to distinguish the two.

The harvest mouse has evolved to a life in tidal marshes. Specifically, they have evolved to depend mainly on dense pickleweed (*Salicornia virginica*) as their primary cover and food source. However, harvest mice may utilize a broader source of food and cover which includes salt grass (*Distichlis spicata*) and other vegetation typically found in the salt and brackish marshes of this region. In natural systems, harvest mice can be found in the middle tidal marsh and upland transition zones. Upland refugia is an essential habitat component during high tide events. Harvest mice are highly dependent on cover, and open areas as small as 10 meters wide may act as barriers to movement (Shellhammer 1978, as cited in Service 1984). The harvest mouse does not burrow. It has been noted that the northern subspecies may build nests of loose grasses.

As described by Fisler (1965), male harvest mice are reproductively active from April through September, but may appear active throughout the year. Females are reproductively active from March to November, and have a mean litter size of approximately four offspring.

The historic range of the species included tidal marshes within the San Francisco and San Pablo Bay areas, east to the Collinsville-Antioch areas. It has been estimated that of the 193,800 acres of tidal marsh that existed in 1850, about 30,100 acres currently remain (Dedrick 1993). Based on this estimate, there has been an 84 percent reduction in tidal wetlands in the Bay Area. Since 1850, agriculture and urbanization has claimed much of the former tidal marshes. At present, the distribution of the northern subspecies occurs along Suisun and San Pablo Bays north of Point Pinole in Contra Costa County and Point Pedro in Marin County. The southern subspecies is found in marshes in Corte Madera, Richmond, and South San Francisco Bay mostly south of the San Mateo Bridge (Highway 92).

The California Natural Diversity Data Base (CNDDB) indicates that there is a 1960 report of an occurrence and collection of specimens of the harvest mouse in the marsh between O'Neill Slough and Bayshore Freeway in Foster City, which is approximately 1700 meters from the disposal basin. Other occurrences of the salt marsh harvest mouse include Bair Island between Steinberger Slough and Redwood Creek in Redwood City (1992), Greco Island, 2.5 miles northeast of Redwood City and marshland bordered on the north by Westport Slough and on the west by Seaport Boulevard in the Port of Redwood City. There are no CNDDB reports of the harvest mouse occurring in the disposal basin or Belmont Slough. However, the Environmental Impact Report for this project states that the harvest mouse is likely present in the marsh vegetation along Belmont Slough and, although separated from the marsh habitat along the Slough by a dike and a paved recreation trail, harvest mice could be present in the narrow strip of grassy and marsh vegetation around the perimeter of the basin.

Harvest mouse habitat in and near the project site of the Napa River Salt Marsh Restoration Project includes the upper (high) marsh south of SR 37 and South Slough west of Pond 2A, including the accreted marsh on the inside bend of Ponds 2 and 2A. The most recently trapped area in the project site of the Napa River Salt Marsh Restoration Project was the area along South Slough. Five harvest mice, the northern subspecies *(R. r. halicoetes),* were captured in 2,385 trap nights from June 3 to June 5 in 1983 (Shellhammer *et al.* 1982). Numerous trappings from the early 1970s and 1980s indicated relatively good populations south of SR 37. Captures on Fly Bay, the land between Pond 7 and Pond 8, also confirmed presence of this species. Overall, the narrow strips of tidal marsh surrounding the levees provide suitable habitat for this species. (Lewis Environmental Services and Wetland Research Associates 1992.) The Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan (Service 1984) identifies several areas within the action area as habitat essential to the recovery of this species. These areas include (1) tidal marshes and mudflats within or along Devil's Slough, China Slough, South Slough, Dutchman Slough, Napa Slough and the Napa River: and (2) diked areas within Pond 5 and the western half of Pond 2 which are identified for restoration to tidal marsh habitat.

Western Snowy Plover

The snowy plover was federally listed as threatened in 1993 (58 **FR** 12874) (Service 1993b). A detailed account of the taxonomy, ecology, and biology of the harvest mouse is presented in the *Western Snowy Plover (Charadrius alexandrinus nivosus) Pacific Coast Population Draft Recovery Plan* (Service 2001) and the references cited therein.

Charadrinus alexandrinus nivosus is a small shorebird distinguished from other plovers (family Charadriidae) by its small size, pale brown upper parts, dark patches on either side of the upper breast, and dark gray to blackish legs. The species was first described in 1758 by Linnaeus (American Ornithologists' Union, 1957).

The Pacific coast population of the snowy plover is defined as those individuals that nest beside or near tidal waters, and includes all nesting colonies on the mainland coast, peninsulas, offshore islands, adjacent bays and estuaries from southern Washington to southern Baja California, Mexico. Habitats used by nesting and non-nesting birds include sandy coastal beaches, salt pans, coastal dredged spoils sites, dry salt ponds, salt pond levees and gravel bars of the Eel River, Humboldt County, California.

Historic records suggest that nesting Western Snowy Plovers were once more widely distributed in coastal California. In coastal California, Snowy Plovers bred at 53 locations before 1970 (Page and Stenzel, 1981). Since then, no evidence of breeding birds has been found at 33 of these 53 sites, which represents a 62 percent decline (Page and Stenzel, 1981). The greatest losses were in southern California, within the central portion of the Snowy Plover's coastal breeding range. In 1990 only 6 nesting colonies remained, representing a 79 percent decline in active breeding sites.

A total of 20 plover breeding areas currently occur in coastal California (Page *et al.* 1991). Eight areas support 78 percent of the California coastal breeding population: San Francisco Bay, Monterey Bay, Morro Bay, the Callendar-Mussel Rock Dunes area, the Point Sal to Point Conception area, the Oxnard lowland, Santa Rosa Island, and San Nicolas Island (Page *et al.* 1991).

In the habitats remaining for the snowy Plover, human activity continues to be a key factor adversely affecting snowy Plover coastal breeding sites and breeding populations in California. Projects or management activities in plover nesting areas that cause, induce or increase human-associated disturbance during the snowy plover's breeding season (March 1-September 14) adversely impact snowy plovers. These activities may reduce the functional suitability of nesting, foraging and roosting areas. Activities that may adversely affect nesting and/or wintering plovers include beach nourishment (sand deposition, spreading of sand with machinery); beach cleaning (removal of wrack–surfcast kelp and driftwood); construction of breakwaters and jetties (interruption of sand deposition); dune stabilization/restoration using native and nonnative vegetation or fencing (decreased beach width, increased beach slope, reduction in blowouts and other preferred nesting habitat); beach leveling (increased tidal reach, removal of sparse vegetation used by chicks for shelter, destruction of wrackline feeding habitat); and off-road vehicles driven in nesting areas or at night.

Salt ponds of San Francisco Bay and San Diego Bay, which are filled and drained as part of the salt production process, provide breeding and wintering habitat for snowy plovers. Dry salt ponds and unvegetated salt pond levees are used as snowy plover nesting habitat. Ponds with shallow water provide important foraging habitat for plovers. Nesting plovers can be attracted to an area when ponds are drained during the breeding season, but flooding can then destroy the nests when the ponds are refilled. Also human disturbance resulting from maintenance activities associated with the operation of commercial salt ponds (*i.e.* levee reconstruction and maintenance of facilities) can result in the loss of snowy plovers and alteration or disturbance of their habitat. Feeney and Maffei (1991) observed a sizable population of snowy plovers at the Baumberg and Oliver salt ponds during the breeding and nonbreeding seasons, suggesting that these ponds are important to snowy plovers throughout the year. They suspected that these ponds are used by snowy plovers as both a pre-breeding and post-breeding staging area, based on the relatively high numbers of snowy plovers in mid-February and in late August/September, respectively. The conversion of salt ponds, which provide valuable breeding and wintering habitat for snowy plovers, into tidal marshes would result in a loss of suitable nesting and wintering habitat for snowy plovers.

In 1975, Gill (reported in Page and Stenzel 1981) found three snowy plover nests on the internal levee of Pond 6 of the Napa River Salt Marsh Restoration Project. However, no snowy plover nests were observed there in 1978 (Page and Stenzel 1981) or in 1989 (Carter *et al.* 1990). Nests and snowy plovers have also been observed on levees and mudflats throughout the region, and there is a potential that they could again nest in the project area. Snowy plovers were observed in the project area in April 2002 at Pond 7 of the Napa River Salt Marsh Restoration Project. The Western Snowy Plover Pacific Coast Population Draft Recovery Plan (Service 2001) identifies the levee along the northern edge of Pond 7A as a breeding location.

Effects of the Proposed Action

Direct and Indirect Effects

Sacramento Splittail and Delta Smelt

Fish and other organisms could be entrained with water diverted from 1,750 acres of adjacent sloughs and into Ponds 6A and 7A. The sloughs are known habitat to juvenile and adult splittail, and larval, juvenile, and adult smelt. Larval splittail are unlikely to be present near the diversions under most circumstances because spawning occurs in areas with very low salinity and flooded vegetation further upstream. The proportion of either species population affected would be small because the sloughs are peripheral to the distribution of the listed species and the diversions and proportion of tidal flow diverted them are relatively small. Diversions, however, are expected to occur for 20 to 50 years to facilitate reduction of salinity in Ponds 7, 7A, and 8 and to support habitat management in Ponds 6 and 6A. During the early stages of salinity reduction, fish and other aquatic organisms entrained into the Ponds 7, 7A, and 8 could be subjected to water quality conditions that are detrimental or even fatal. A fish screen would be constructed on the intake to Pond 7A to prevent entrainment of juvenile and adult smelt and splittail. The fish screen would also reduce entrainment of smelt larvae because approach velocities would be lower at the screen face than velocities through an unscreened diversion. The fish screen would meet the size and operations criteria set by NOAA Fisheries, DFG, and the Service for diversions from the Sacramento-San Joaquin estuary. A fish screen is not proposed for Pond 6 because salinity is projected to reach ambient conditions within 2 years, and thereafter fish entrained would not suffer salinity induced injury or mortality. In addition, Pond 6 and 6A would include a partial flow-through design that would provide continuity with the sloughs during at least part of each tidal cycle (*i.e.*, continuity would occur through the ascending and descending portions of high tides). Fish would be stranded in Ponds 6 and 6A during low tides, but water quality conditions would be similar to conditions in the sloughs and fish entrained in the ponds would not be stressed. Entrained fish would have the opportunity to exit Ponds 6 and 6A twice each day during high tides.

Construction activities would primarily affect water quality, including suspension of sediments associated with in water work and runoff from adjacent construction areas. In addition, contaminants could enter the water from fuel spills into the waterway during construction and spillage or runoff of fuel oils, grease, and other petroleum products used in construction activities. The duration of construction-related effects, however, is relatively short, usually no more than a few days.

Levee breaches would coincide with periods of potential delta smelt and splittail occurrence. The duration of breach activities and the resulting effects on sediment, however, would encompass no more than a few days. Levee breaching would also coincide with storm events to enable maximum dilution. The volume of sediment mobilized by levee breaching would be small relative to input of sediment associated with storm runoff.

Salinity in the existing ponds is currently higher than salinity in the adjacent channels. A primary project purpose is to reduce salinity to facilitate habitat restoration. Salinity in Ponds 3, 4 and 5 would be reduced over a relatively short period through breach of levees during storm events that provide high fresh water inflow for maximum dilution. Assuming the worst-case scenario where Pond 3 and Pond 4/5 are breached at the same time, the data indicate that salinity at the Pond 4/5 breach would increase by up to 18 ppt during the first 24 hours. The maximum salinity increase would drop to approximately 12 ppt the second day and to a differential of less than 5 ppt within 2 weeks. The change in salinity is within the range of normal variation in the Napa River estuary; however, the rate of change would be greater than under normal conditions. The simultaneous breach would overstate the expected increase in salinity associated with the proposed phased breaches of Pond 3 followed by Ponds 4 and 5. Smelt and splittail could occur in the project area during the levee breach. Adult and juveniles smelt and splittail could avoid the salinity plume. The plume of higher salinity would occur primarily near the river bottom. Also, given that smelt and splittail spawn in fresh water, salinity prior to the breach would likely exceed spawning requirements of both species so eggs are unlikely to occur within the affected area.

The habitat restoration component would reestablish 3,120 acres of subtidal, intertidal mudflat, lower marsh, and middle marsh. The habitat restoration component could result in a greater variety of slough channel sizes, a large increase in slough habitat, and greater continuity to San Pablo Bay, the Napa River, and the tidal salt marsh, benefitting delta smelt and splittail. There would be large tracts of tidal marsh that allow fish species to adjust to seasonal changes in salinity and provide rearing and foraging habitat. Production within the restored areas would be conveyed to the Napa River estuary and San Pablo Bay, potentially increasing food availability at those locations. Of course, non-native and/or predatory fish species would also benefit from the restoration of tidal marshes. Increased rearing and foraging habitat area and productivity are assumed to benefit smelt and splittail and offset any increase in competition and/or predation by non-native species.

Establishing tidal continuity between marsh and the main channels of the estuary would support movement of listed fish species into marsh and tidal channel habitat. Shallow pools could be temporarily isolated during the tidal cycle, potentially stranding listed species. During the period of isolation, dessication, water temperature, salinity, and avian predation could cause mortality of fish stranded in the pools. Restoration design, however, would not intensify stranding relative to temporarily isolated pools that naturally occur in tidal marsh, mudflat, and tidal channels. The design of borrow ditch blocks establishes clear tidal flow patterns that would minimize potential for stranding in existing borrow ditches along the edges of existing ponds.

California Clapper Rail

The proposed project would temporarily eliminate about 15 acres of tidal marsh habitat currently available for clapper rails. This loss would result mostly from the removal of existing intake and outfall structures, and the construction of 23 levee breaches and creation of 22 ditch blocks to optimize tidal exchange into ponds. About 36.7 acres of upland refugial habitat of varying quality also would be lost as a result of regrading and lowering 22,200 linear feet of levees. However, the proposed project is expected to substantially benefit clapper rails by restoring over 1,000 acres of tidal marsh habitat along the Napa River within 50 years. The establishment of this amount of tidal salt marsh habitat including high tide refugial areas is consistent with the recovery objectives for this area within the Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan (Service 1984). Lowering of the levees also would have the beneficial effect of reducing mammalian predator threats by removing access corridors within the marshes and eliminate resting/denning areas.

Construction activities could result in harassment, injury, or mortality of clapper rails. Disturbances from construction activities, including noise and vibration, could cause individual clapper rails to abandon their nests or reduce the ability of adults to properly care for their eggs or young. Displaced individuals and their eggs or young could be subjected to injury or mortality from starvation, physiological stress, and increased predation. Nests with eggs or young rails could be crushed by construction equipment operating in the tidal marsh and on levees. Disturbances associated with construction or replacement of the intakes and outfalls and other improvements necessary to reduce salinity levels in the ponds could harass clapper rails that have been observed nesting in or near the project area, or for which suitable nesting habitat exists at and adjacent to the project site.

To avoid or minimize disturbance effects to breeding rails, the project sponsors propose to conduct surveys for clapper rails and their habitats during their known nesting period to determine their presence in all areas with suitable habitat where construction activities, or their effects, are slated to occur. These surveys would be conducted prior to construction by qualified biologists holding appropriate Federal and State permits as required. Survey results would be used to plan subsequent actions, which may include implementation of appropriate avoidance and minimization measures, modifications to monitoring programs, and coordination with regulating agencies. Survey results would be submitted to, and/or otherwise coordinated with the Service and DFG.

To the extent feasible, the project sponsors propose to avoid construction activities from February through July which the project sponsors have established as the nesting period of clapper rails. However, if the project sponsors determine that construction activities must occur during this nesting period, a qualified biologist would conduct pre-construction surveys up to 72 hours before construction begins, using survey methods approved by the Service and/or DFG.

Due to tidal influences on construction/survey areas, surveys would be conducted as close to the actual construction period as is practicable. Surveys would be conducted up to a distance at which clapper rails are unlikely to be affected by project construction. According to the project sponsors, this distance could vary according to terrain and type of construction activity, but is considered to often be 150 to 300 feet from the maximum limit of each construction site. The exact survey distance would vary according to construction site characteristics, such as natural barriers, between potential nests and construction activities. If nests are located an adequate distance from the limits of construction (as determined by the project sponsors), construction would proceed. If nest sites are located in areas that would be disturbed by construction (as determined by the project sponsors), the project sponsors would consult with the Service and/or DFG to determine if any additional mitigation measures could be implemented to avoid or reduce mortality (*e.g.*, establishing buffers around active nest sites or sequencing construction to avoid potential impacts on these species during their breeding season) while allowing construction to proceed. Construction activities in the area of concern could be rescheduled or modified to avoid adverse impacts to the nesting clapper rails. The Service and DFG will be notified of these schedule changes, and any additional work or modifications to the work plan would be coordinated with these agencies.

The project sponsors postulate that nesting rails located more than 150 to 300 feet from construction sites are unlikely to be adversely affected by construction activities because this distance should provide an adequate buffer from noise, vibration, and visual disturbances. However, a buffer distance of 150 to 300 feet may not always be adequate to ensure that an individual rail would not be adversely affected by constriction activities, especially if the activities occur within the rail's actual breeding territory. Clapper rails vary in their sensitivity to human disturbance, both individually and between marshes. However, Albertson (1995) documented a clapper rail abandoning its territory in Laumeister, shortly after a repair crew worked on a nearby transmission tower. The bird did not establish a stable territory within the duration of the breeding season, but eventually moved closer to its original home range several months after the disturbance. Laumeister is a 36-hectare marsh, part of the San Francisco National Wildlife Refuge, and closed to public access. Clapper rails in Laumeister have little contact with people, and are apparently quite sensitive to human-related disturbance. A similar sensitivity to disturbance could exist with clapper rails within the Napa Sonoma marshes where public access is fairly limited.

The project sponsors also postulate that conducting surveys 72 hours prior to construction is an adequate timeframe for detecting the presence of clapper rails during the breeding season. The optimal time period for detecting rails during the breeding season is from mid-January through March which is considered the time period when the frequency of calls is typically highest. Also, the probability of detection is considered to be substantially higher if surveys are conducted over a longer time period (*i.e.*, a minimum of 4 weeks) during this period of increased vocalizations. Failure to conduct surveys which have a high probability for detecting rails in the survey area could result in rails being undetected and resultant disturbances from construction activities as discussed above. Further, clapper rails may still be nesting during the month of August so any activities conducted during this month could result in disturbances to breeding rails as discussed above.

Salt Marsh Harvest Mouse

The proposed project is also likely to result in injury or death, and harm to individual harvest mice through the temporary loss of their habitat. Construction of the proposed project may result in harvest mouse mortality through crushing by equipment and machinery. Implementation of the proposed restoration will result in the loss of about 15 acres of tidal marsh habitat and 36.7 acreas of upland refugial habitat along the levees. However, the proposed project is expected to benefit the harvest mouse through the restoration of over 1,000 acres of tidal marsh habitat and a reduction in predator threats by lowering existing levees. The establishment of this amount of tidal salt marsh habitat including high tide refugial areas is consistent with the recovery objectives for this area within the Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan (Service 1984).

In addition, the proposed project could impact harvest mice through increased disturbance. Increased levels of disturbance to harvest mice will result from noise and vibrations from equipment and construction activities. Operation of construction equipment may result in displacement of harvest mice from protective cover and their territories/home ranges (through noise and vibrations) and/or direct mortality (through crushing). These disturbances may disrupt normal behavior patterns of breeding, foraging, sheltering, and dispersal, and may result in the displacement of harvest mice from their territory/home range. Displaced harvest mice may have to compete for resources in occupied habitat, and are more vulnerable to predators. Female harvest mice are reproductively active from March through November (Fisler 1965), so disturbance during this period may mean abandonment or failure of the current litter. Thus, displaced harvest mice may suffer from increased predation, competition, mortality, and reduced reproductive success.

Western Snowy Plover

The proposed project is not anticipated to result in a significant level of habitat loss for snowy plovers. Snowy plovers likely use existing salt ponds, mudflats, and levees on an occasional or opportunistic basis as nesting, foraging, or roosting habitat. However, it is difficult to estimate the extent of this actual use or the habitat loss that would occur with the proposed restoration efforts. The one known breeding location along Pond Levee 7A identified in the recovery plan for this species would remain in place with implementation of the proposed project. Also, snowy plover habitat would still be available within the managed ponds and restored tidal wetlands after the project is implemented.

Construction activities could result in harassment, injury, or mortality of snowy plovers nesting at the time of the proposed work. Disturbances, including noise and vibration, from construction activities could cause individual snowy plovers to abandon their nests or reduce the ability of adults to properly care for their eggs or young. Displaced individuals and their eggs or young could be subjected to injury or mortality from starvation, physiological stress, and increased predation. Nests with eggs or young plovers could be crushed by construction equipment operating in the tidal marsh and on the levees.

To avoid or minimize disturbance effects to nesting snowy plovers, the project sponsors propose to conduct surveys for snowy plovers and their habitats during their known nesting period to determine their presence in all areas with suitable habitat where construction activities, or their effects, are slated to occur. These surveys would be conducted prior to construction by qualified biologists holding appropriate Federal and State permits as required. Survey results would be used to plan subsequent actions, which may include implementation of appropriate avoidance and minimization measures, modifications to monitoring programs, and coordination with regulating agencies. Survey results would be submitted to, and/or otherwise coordinated with the Service and DFG.

To the extent feasible, the project sponsors propose to avoid construction activities from February through July. However, if the project sponsors determine that construction activities must occur during this nesting period, a qualified biologist would conduct pre-construction surveys up to 72 hours before construction begins, using survey methods approved by the Service and/or DFG. Due to tidal influences on construction/survey areas, surveys would be conducted as close to the actual construction period as is practicable. Surveys would be conducted up to a distance at which snowy plovers are unlikely to be affected by project construction. According to the project sponsors, this distance could vary according to terrain and type of construction activity, but is considered to often be 150 to 300 feet from the maximum limit of each construction site. The exact survey distance would vary according to construction site characteristics, such as natural barriers, between potential nests and construction activities. If nests are located an adequate distance from the limits of construction (as determined by the project sponsors), construction would proceed. If nest sites are located in areas that would be disturbed by construction (as determined by the project sponsors), the project sponsors would consult with the Service and/or DFG to determine if any additional mitigation measures could be implemented to avoid or reduce mortality (*e.g.*, establishing buffers around active nest sites or sequencing construction to avoid potential impacts on these species during their breeding season) while allowing construction to proceed. Construction activities in the area of concern could be rescheduled or modified to avoid adverse impacts to the nesting snowy plovers. The Service and DFG will be notified of these schedule changes, and any additional work or modifications to the work plan would be coordinated with these agencies.

The project sponsors postulate that nesting plovers located more than 150 to 300 feet from construction sites are unlikely to be adversely affected by construction activities because this distance should provide an adequate buffer from noise, vibration, and visual disturbances. However, a buffer distance of 150 to 300 feet may not always be adequate to ensure that an individual snowy plover would not be adversely affected by constriction activities. Snowy plovers vary in their sensitivity to human disturbance, both individually and between breeding sites. The project sponsors also postulate that conducting surveys 72 hours prior to construction is an adequate timeframe for detecting the presence of plovers during the breeding season, from

February through July. However, plovers may still be nesting through September so any activities conducted during those months, in the absence of surveys, could result in disturbances to breeding plovers as discussed above.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions affecting listed species that are reasonably certain to occur in the area considered in this biological opinion. Future Federal actions not related to this proposed action are not considered in determining the cumulative effects, but are subject to separate consultation requirements pursuant to section 7 of the Act.

Sacramento Splittail and Delta Smelt

Any continuing or future non-Federal diversions of water that may entrain adult or larval fish would have cumulative effects to the smelt and splittail. Water diversions through intakes serving numerous small, private agricultural lands contribute to these cumulative effects. These diversions also include municipal and industrial uses. State or local levee maintenance may also destroy or adversely modify spawning or rearing habitat and interfere with natural long term habitat-maintaining processes.

Additional cumulative effects result from the impacts of point and non-point source chemical contaminant discharges. These contaminants include but are not limited to selenium and numerous pesticides and herbicides as well as oil and gasoline products associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality for smelt and splittail, these contaminants may adversely affect fish reproductive success and survival rates. Spawning habitat may also be affected if submersed aquatic plants, used as substrate for adhesive egg attachment, are lost due to toxic substances.

Other cumulative effects could include: the dumping of domestic and industrial garbage may present hazards to the fish because they could become trapped in the debris, injure themselves, or ingest the debris; golf courses reduce spawning and rearing habitat and introduce pesticides and herbicides into the environment; oil and gas development and production remove spawning habitat and may introduce pollutants into the water; levees built to protect agricultural lands from flooding reduce riparian and wetland habitats; and grazing activities may degrade or reduce suitable spawning and rearing habitat through siltation, sedimentation or erosion, and which could reduce vegetation in or near waterways.

Angling pressure on the splittail is not considered highly detrimental at this time but could become a significant adverse effect as human populations increase. Anglers seek gravid females as roe is considered a delicacy. Although removal of spawning females has the potential to reduce populations, the California Fish and Game Commission has elected not to regulate or prohibit sportfishing for the splittail.

California Clapper Rail and Salt Marsh Harvest Mouse

Numerous activities continue to eliminate habitats of harvest mice and clapper rails. Habitat loss and degradation affecting these species continues as a result of urbanization, road and utility right-of-way management, flood control projects, dredging and disposal, and contaminant inputs. Harvest mice and clapper rails are also affected by contaminants, increased predation associated with human development, and reduction of food sources. All of these non-Federal activities are expected to continue to adversely affect listed species considered in this opinion throughout their respective ranges.

Various habitats used by harvest mice and clapper rails may be degraded or destroyed by a variety of development and maintenance activities conducted by private organizations, State, or local governments. These include levee maintenance, marina operations, and dredging. Increased urban development has also increased problems associated with non-native predators, freshwater urban run-off, sedimentation, contaminants, and disturbance of breeding and foraging behavior.

Western Snowy Plover

The Service is not aware of any cumulative effects to snowy plovers within the action area.

These cumulative effects further contribute to reducing the respective environmental baselines for the clapper rail, smelt, Sacramento splittail, and harvest mouse.

Conclusion

After reviewing the current status of the smelt, o splittail, clapper rail, harvest mouse, and Pacific coastal population of the snowy plover, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the Napa River Salt Marsh Restoration Project is not likely to jeopardize the continued existence of these species. In addition, the restoration of up to 3,120 acres of tidal wetlands would have a beneficial effect on these species by providing additional habitat. Critical habitat has not been designated for delta smelt and the Pacific coastal population of the snowy plover at this location, therefore none will be destroyed or adversely modified. No critical habitat has been designated for the splittail, clapper rail, and harvest mouse, therefore none will be destroyed or adversely modified.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act, and Federal regulation pursuant to section 4(d) of the Act, prohibits the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as actions that create the likelihood of injury to listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount of Extent of Take

The Service anticipates that incidental take of thesmelt and splittail will be difficult to detect for the following reasons: the aquatic nature of the organisms and their relatively small body size make the finding of a dead specimen unlikely; the secretive nature of these species; losses may be masked by seasonal fluctuations in numbers or other causes; and the species occurs in habitats that makes it difficult to detect. For those reasons, the Service anticipates that the smelt and splittail residing within the 1,750 acres of sloughs within the action area would be subject to harm and harassment from construction related sedimentation and temporary increases in salinity following levee breaches, and the smelt and splittail residing within the 1,750 acres of sloughs within the action area would be subject to salinity induced harm, harassment, and mortality from entrainment into Ponds 6 and 6A for up to two years following levee breach.

The Service anticipates incidental take of the clapper rail, harvest mouse, and snowy plover will be difficult to detect or quantify because of the elusive nature of these species, their small size, and cryptic coloration makes the finding of a dead or injured specimen difficult to detect. The Service considers the number of clapper rails, harvest mice, and snowy plovers subject to harassment from noise, vibrations, etc., to be impracticable to estimate. The Service also considers it impracticable to estimate the level of take for snowy plovers associated with habitat loss. The Service is quantifying take incidental for the project as the number of acres of habitat for breeding, foraging, or shelter where killing, harm, or harassment of clapper rail and harvest mice is expected to occur. Upon implementation of the reasonable and prudent measures listed below, 15 acres of tidal marsh habitat and 36.7 acres of upland refugial habitat for these species will become exempt from the prohibitions described under section 9 of the Act for direct and indirect impacts associated with the proposed project. The Service anticipates the following levels of take as a result of the proposed project.

Incidental take for the clapper rail, harvest mouse, and snowy plover are expected in the form of:

a. zero (0) mortality of individual clapper rails and snowy plovers due to equipment and machinery use;

b. all clapper rail, harvest mouse, and snowy plover individuals may be harassed from project related noise, vibration, *etc.* and displacement of all individuals within the proposed project area;

c. approximately 15 acres of tidal marsh habitat and 36.7 acres of upland refugial habitat for clapper rails and harvest mice will become temporarily lost as a result of the proposed project.

The incidental take statement accompanying this biological opinion exempts take of the clapper rail, smelt, splittail, salt marsh harvest mouse, and snowy plover carried out in accordance with the following reasonable and prudent measures and terms and conditions from the prohibitions contained in section 9 of the Act. It does not address the restrictions or requirements of other applicable laws.

Effect of the Take

The SFWO determined this level of anticipated take is not likely to result in jeopardy to clapper rail, smelt, splittail, salt marsh harvest mouse, and Pacific costal population of the snowy plover.

Reasonable and Prudent Measures

The SFWO believes the following reasonable and prudent measures is necessary and appropriate to minimize incidental take of clapper rail, smelt, splittail, harvest mouse, and snowy plover:

1. Minimize the potential for harassment, harm, injury and mortality to clapper rail.

2. Minimize the potential for harassment, harm, injury and mortality to smelt and splittail.

3. Minimize the potential for harassment, harm, injury and mortality to snowy plover.

Terms and Conditions

To be exempt from the prohibitions of section 9 of the Act, the Corps must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary.

1. To minimize the potential for harm, harassment, or mortality to clapper rail, the Corps shall ensure the applicant complies with the following:

   The project sponsors shall conduct any pre-construction surveys following the Service's January 21, 2000, draft survey protocol (see enclosure) at individual work sites. Once a survey protocol has been developed for a work site(s), it shall be provided to the Service for final approval prior to implementation. The results of the surveys shall be provided the Service for review to evaluate the appropriateness of work being proposed by CDFG at the work site.

2. To minimize the potential for harm, harassment, or mortality to smelt and splittail, the Corps shall ensure the applicant complies with the following:

   a. To minimize the effects on smelt and splittail survival caused by the mobilization of sediments that may contain toxins, the use of silt trapping devices shall be employed during all levee and in-water work, where appropriate.

   b. To minimize the effects on smelt and splittail resulting from the loss of existing habitat, the Corps shall avoid construction activities in slough areas having emersed or submersed plants to the maximum extent possible.

3. To minimize the potential for harm, harassment, or mortality to snowy plover, the Corps shall ensure the applicant complies with the following:

   The project sponsors shall develop a survey protocol for the work sites to be approved by the Service prior to implementation. The survey shall be implemented where appropriate throughout the plover breeding season, from March 1 through September 30. The results of the surveys shall be provided to the Service for review to evaluate the appropriateness of the work being proposed by DFG at each worksite.

Reporting Requirements

The Service shall be notified within twenty-four (24) hours of the finding of any injured or dead clapper rail, smelt, splittail, harvest mouse, and snowy plover, or any unanticipated harm to their habitat as a result of biological sampling activities. Notification must include the date, time, and precise location of the specimen/incident, and any other pertinent information. The Service contact person is Michael Fris, Division Chief, Endangered Species Program in the Sacramento Fish and Wildlife Office (916) 414-6700. Any dead or injured specimen shall be preserved according to standard museum practices and deposited at an appropriate academic institution approved by the Service, or with the Service's Division of Law Enforcement, 2800 Cottage Way, Room W-2928, Sacramento, California 95825 (916) 414-6660). Any killed delta smelt or Sacramento splittail shall be preserved in accordance with Natural History Museum of Los Angeles County's policy of accessioning (10 percent formalin in a quart jar or freezing). Information concerning how the fish was taken, length of the interval between death and preservation, water temperature and outflow/tide conditions, and any other relevant information shall be written on 100% rag content paper with permanent ink and included in the container with the specimen.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species and the ecosystems upon which they depend. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service proposes the following conservation recommendations:

1. The Service recommends the development and implementation of restoration measures in areas designated in the Salt Marsh Harvest Mouse & California Clapper Rail Recovery Plan (Service 1984).

2. The Service recommends the development and implementation of restoration measures in areas designated in the Western Snowy Plover (*Charadrius alexandrinus nivosus*) Pacific Coast Population Draft Recovery Plan (Service 2001).

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation for the Napa River Salt Marsh Restoration Project. As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the proposed action may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (4) a new species or critical habitat is designated that may be affected by the proposed action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

If you have any questions regarding this opinion on the Napa River Salt Marsh Restoration Project, please contact Mike Nepstad or Dan Buford at (916) 414-6625.

Sincerely,

Cay C. Goude

Cay C. Goude
Acting Field Supervisor

Enclosure

cc:
ARD (ES), Portland, OR

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14 October 2003

Proposed Scope of Work

Habitat Restoration Monitoring for the Napa-Sonoma Marsh Restoration Project, Phase I

Background and Justification:

Most of the former Cargill salt evaporation ponds (4000 ha) along the Napa River northwest of Vallejo were purchased in 1992 for their outstanding wildlife value. California Department of Fish and Game (CDFG) became the agency responsible for managing the new Napa-Sonoma Marshes. The State Coastal Conservancy (SCC) joined with CDFG in 1998 to develop a Napa River Marsh Feasibility Study under the Corp of Engineers restoration program (COE 2003) to determine alternatives for maximizing wildlife values. In that same year, the U. S. Geological Survey (USGS) initiated a research and monitoring program on the ecology of salt ponds in the Napa-Sonoma Marshes through the USGS Place-based Program for ecosystem studies (Miles et al. 2000, Takekawa et al. 2001*a*). The goal was to better understand existing salt pond values and to develop monitoring methods and information for restoration planning.

Monitoring of water quality, primary productivity, plants, invertebrates, fishes, and birds was conducted from 1999-2002, providing a baseline of information to assess restoration progress. After salt production ceased, water levels fluctuated widely in the inner ponds (Ponds 3-7) from 1999-2002 because of the deteriorating water delivery system. By July 2002, Ponds 4 and 5 were dry and Pond 3 was shallowly inundated. Salinity levels on Pond 3 had increased to 59.7 ppt on 25 Jul 2002. Sometime in early August 2002, the north end of Pond 3 was breached near the siphon to Pond 4 with a narrow (<0.5m) channel extending 5 m across the levee. The breach provided a unique opportunity to obtain empirical data on a breached pond within the proposed restoration project, and an additional southern breach was opened on 12 September 2003. SCC supported additional monitoring by USGS and Phillip Williams and Associates (PWA; M. Orr) from Nov 2002 to May 2003.

On Pond 3, salinity increased near the breach in South Slough. The water level rose because of tidal pumping, which altered salinity, temperature, dissolved oxygen (DO) and pH. In mid-December, the combination of high tides and storms widened the breach from <0.5 m to 23 m and created a scour hole in the slough 8 m deep and 45 m long. Salinity decreased from 45 ppt to 20 ppt, a level similar to the Napa River. However, minimal erosion occurred at the southern breach to Dutchman Slough because the location and elevation allowed little exchange of water. Several new species of fish were detected in June 2003, and bird species that use shallowly inundated habitats increased. Continued monitoring of this breached pond will provide a wealth of data for predicting changes in the full restoration and optimizing monitoring and adapting Phase I of the restoration.

The primary objectives in the draft Napa River Salt Marsh Restoration Draft Feasibility Report (COE, 2003) are to: 1) create a mix of tidal and managed pond habitats for a broad range of wildlife; 2) restore large areas along the Napa River to benefit fish and aquatic animals with connections between patches; and 3) improve the ability to manage water depths and salinities to maximize habitat for birds. Phase I of the restoration project includes levee repairs, water control structures, habitat restoration components, and salinity reduction (COE 2003). Phase I was recently funded through a Calfed Grant (#31, Napa-Sonoma Marsh Restoration Project) with proposed habitat monitoring for each pond up to ten years after breaching (Appendix I), including a wildlife monitoring section submitted by USGS. Here, we have developed a scope of work to accomplish the first 3 years of wildlife monitoring within the framework of the Calfed project in support of Phase I of the Napa-Sonoma Marshes Restoration Project.

Objectives:

1. Summarize and continue baseline monitoring of primary productivity, macroinvertebrate, fish, and bird use to assess effects on wildlife for the Phase I Restoration.

2. Conduct construction and post-construction surveys with emphasis on Ponds 3-5 to track changes during the Phase I Restoration.

3. Establish avian point counts for passerines and rails and small mammal surveys on Ponds 3-5 to characterize fringing marshes and determine construction effects on tidal marsh species.

Procedures:

Objective 1. Summarize and continue baseline monitoring of primary productivity, macroinvertebrate, fish, and bird use to assess effects on wildlife for the Phase I Restoration.

Wildlife monitoring will continue in Ponds 3, 4, and 5 where construction will occur and data will be compared with Ponds 1, 2, and 7. Water quality will be sampled bimonthly, primary productivity and macroinvertebrates will be sampled quarterly, fish will be sampled semiannually (dry and wet seasons), and birds will be surveyed bimonthly.

Water pH, temperature, turbidity, and dissolved oxygen will be determined with water quality meters (Hach Hydrolab), and salinity will be measured with meters or hydrometers. Samples will be taken at 2-5 locations on the perimeter of the ponds to account for spatial variation. The water quality measurements will build on the existing USGS database to document baseline, construction and post-construction variation.

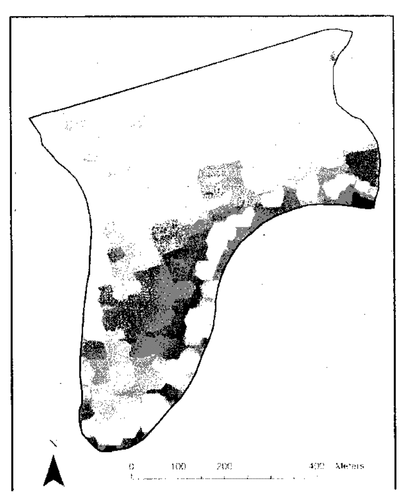
Primary production and macroinvertebrates will be sampled quarterly. Chlorophyll will be measured with a SCUFA (Self-Contained Underwater Fluorescence Apparatus) submersible fluorometer, and nitrogen (NH4-N and NO3-N), total and soluble phosphorus, and sulfur concentrations will be analyzed in the laboratory (Dep. of Natural Resources Lab, Univ. of Calif. at Davis). Samples will be taken at four locations within quadrants dividing each pond equally. Three sediment samples per quadrant will be sieved through 1.0 mm mesh screens to determine invertebrate composition and abundance. Samples will be preserved in ethanol, glycerol, and rose bengal and stored. Invertebrates from these samples will be sorted and identified at the UC Davis invertebrate lab, and then a sub-sample dried and weighed to estimate total biomass. Four pelagic sweep samples (one per quadrant) will be taken per pond for invertebrates, and processed as above.

Fish will be surveyed semiannually (dry and wet season). Dry ponds or those with salinities >70ppt are devoid of fishes and will not be sampled. Fish will be taken from 3-5 fixed sampling sites in each pond (see Miles et al. 2000, Takekawa et al. 2001*a*) with standard (15 m) hauls with a 5.5 m (1.8-m deep) bag seine (3.2 mm mesh) and with net sets (2 h) with monofilament gill nets (38 m x 1.8 m) of variable mesh (12.7 mm, 15.4 mm, 38.1 mm, 50.8 mm, and 63. 5 mm panels) where conditions allow. Other sampling gear types may be substituted to assess distribution and relative abundance of juvenile and adult fishes. Captured fish will be identified to species (Miller and Lea 1972, Moyle 2002, Eschmeyer et al. 1983, McGinnis 1984), or if needed, voucher specimens will be submitted to taxonomic specialists. All captured fish will be counted, and the first 25 of each species measured for total length. Fish assemblages will be characterized and related to environmental variables with cluster or multivariate analyses (Green and Vascotto 1978, Ludwig and Reynolds 1988).

Bird surveys will be conducted bimonthly on all ponds in the Napa-Sonoma Marshes to document changes in distribution of the bird community in response to the Phase I. USGS has provided baseline data through monthly to bimonthly bird population monitoring since 1999 restoration (*see* Takekawa et al. 2000, Takekawa et al. 2001*b*, Warnock et al. 2002); surveys will be conducted in all ponds following existing protocols (Miles et al. 2000, Takekawa et al. 2001*a*). Ponds will be divided into 250 m x 250 m grids (6.25 ha) mapped in Arcview coverages (ESRI, Inc.). All birds will be counted within 3 hours of high tide on each pond. Birds will be identified to species, enumerated, and recorded in a grid square. Data will be entered in spreadsheets, appended as point coverages, and grouped into abundance classes by grid. Birds will be analyzed by month, grid, foraging guild, and behavior. Feeding and non-feeding behavior will be recorded to estimate mean diurnal foraging rates. Water temperature will be taken, salinity measured with hydrometers, and water depths recorded at staff gauge levels during each survey.

Procedures for Objective 2. Conduct construction and post-construction surveys with emphasis on Ponds 3-5 to track changes during the Phase I Restoration.

Monitoring of project breaches and sedimentation changes are important tools to assess restoration progress. USGS will continue to measure breach dimensions and bathymetric slough cross-



sections on Pond 3 to determine changes in the width of the breaches. We will also sample cross-sections of the sloughs near breaches on a bimonthly basis. A pre-construction survey of the bathymetry of each pond exists (COE 2003). However, we will conduct 1-2 surveys of post-construction bathymetry in Ponds 3, 4, and 5 if water levels permit use of our echosounder system and boat. This will provide comparison of pre-construction bathymetry with Phase I changes. These point data will be interpolated into an ArcGIS grid coverage and will provide baseline bathymetry data to be compared to future surveys to determine changes in sedimentation within the ponds. Oblique digital photos from repeated photo point locations will also be taken to show the changes.

Water depth will be measured using water quality monitors and by reading staff gauges in the ponds, and tidal range of the breached ponds will be determined on a quarterly to semiannual basis. We will recommend installation of staff gauges as needed to properly monitor water levels if water levels are not uniform. USGS will place erosion pins (5-cm PVC pipe buried to 1 m) along transects of levee walls inside project ponds (3-5 places). These pins will allow measurement of any erosion of inner levee walls.

Wildlife monitoring methods will follow Objective 1 with increased frequency of surveys on Ponds 3, 4 and 5. Sampling in these ponds will be increased to help determine changes during construction and post-construction. Thus, water quality will be sampled monthly, elevations and breaches examined monthly, macroinvertebrates sampled quarterly, fish sampled semiannually (dry and wet seasons) or more frequently to improve surveys for new species, and birds will be sampled monthly.

Procedures for Objective 3. Establish avian point counts for passerines and rails and small mammal surveys on Ponds 3-5 to characterize fringing marshes and determine construction effects on tidal marsh species.

Little monitoring has been conducting on the fringing marshes in the Napa-Sonoma Marshes; however, these marshes will be the source of native populations expected to colonize the newly created wetland areas. In addition, construction will affect sections of the existing fringing tidal marshes along the pond levees. Loss of more than 79% of tidal marshes in the estuary since the late 1800s has caused significant reductions in distribution and abundance of several endemic species including the federally and state endangered California clapper rail (*Rallus longirostris obsoletus*) and salt marsh harvest mouse (*Reithrodontomys raviventris*), and state threatened California Black Rail (*Laterallus jamaicensis coturniculus*; Gill 1979, Harvey 1988, Evens et al. 1991, Harvey et al. 1992, Eddleman and Conway 1998, Goals Project 2000)

Therefore, we will conduct vegetation surveys, point counts, small mammal trapping following our existing protocols (Takekawa et al. 2002) to monitor effects of Phase I construction. We have existing federal and state permits to survey endangered species in tidal wetlands including trapping of the salt marsh harvest mouse (*Reithrodontomys raviventris*). Plots will be established in areas where construction will take place, as well as in an equal number of adjacent control areas. Monitoring will occur prior to, during, and following construction to document any changes in tidal marsh biota.

We will conduct variable circular plots to determine relative abundance and densities of tidal marsh passerines such as the San Pablo song sparrow (*Melospiza melodia samuelis*). In addition, we will conduct passive surveys or playbacks of recorded species-specific rail vocalizations to detect the presence of rails in the fringing areas of marsh surrounding the Napa-Sonoma salt ponds following standard agency protocols.

Trap grids (5x5: *see* Takekawa et al. 2002) or point samples (4 per point: *see* Padget-Flohr 2003) will be established in construction and control areas. Grids will be flagged and trapped for 3 nights. Each captured animal will be identified to species. Records for each captured animal will include: 1) species, 2) gender, 3) reproductive condition 4) external parasites or wounds which might affect survival and reproduction, 5) measurements (weight, body, tail, body/tail ratio, hindfoot length), and 6) color (ventor, chin, upper lip, forefeet, hindfeet) after Fisler (1965). On captured small mammals, small flank patches will be trimmed to identify recaptures. Densities will be reported as animals captured per trap night, or for species with enough samples, calculated per unit area with Program CAPTURE.

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Timeline: Initial work will commence from final signature of the agreement for three years unless extended by mutual agreement to continue monitoring and writing of the final report. A timeline for the work elements is given in the table below for quarters of the year.

Work Element	Year 1				Year 2				Year 3			
	1	2	3	4	1	2	3	4	1	2	3	4
Obj 1: Initial wildlife monitoring	X	X	X	X	X	X						
Obj 2: Construction surveys					X	X	X	X	X	X	X	X
Obj 3: Salt marsh species surveys	X	X	X	X	X	X	X	X	X	X	X	X
Report writing				X				X			X	X
Report review				X				X				X

Products: Quarterly summaries will be provided electronically. Databases will be updated monthly and provided for immediate use in the adaptive management planning processes. Annual reports will be completed in the first 2 years, with a final report within 6 months of the end of the third year. Pond coverages will be made available on CDROM for project partners as GIS grids in NAD83, NAVD29 datum with UTM coordinates. Scientific contributions including presentations and papers will be prepared from collected datasets.

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Table 1. USGS Current Scope of Work (November 2003 to November 2006)

	Ponds	Parameter	*No. of Samples*	Frequency
Water Quality	3, 4, 5	DO, Temp, pH, turbidity, salinity	2-5 perimeter samples/pond	Bimonthly (monthly in 3, 4, 5 after construction begins)
PP and nutrients	3, 4, 5	Chlorophyll, nitrogen, phosphorous, sulfur	4/pond	Quarterly
Macroinverte-brates	3, 4, 5	Composition /abundance	3 sediment samples /quadrant/pond + 1 pelagic sweep /quadrant/pond	Quarterly
Fish	3, 4, 5	Composition /abundance	3-5 fixed sites/pond	Semi-annually
Bird Use	1, 1A, 2, 3, 4, 5, 7, 7A, 8	Distribution	Grid, foraging guild, behavior	Bimonthly (monthly in 3, 4, 5 after construction begins)
Construction & Post-Construction Ssurveys	3	Breach dimensions; bathymetric slough x-sections		Bimonthly (monthly in 3, 4, 5 after construction begins)
Bathymetry	3, 4, 5		1-2 surveys	1 or 2 in 3 years
Hydrodynamics & Sedimentation	3, 4, 5	Water depth, tidal range, sedimentation	Erosion pins read bimonthly, tidal range determined semi-annually after pond is opened to tidal action	Semi-annually
Vegetation	3, 4, 5	Surveys	(see Takekawa et al. 2002)	Prior, during, post construction (3)
Passerines, Rails, Small Mammals	3, 4, 5	Density/abundance	Trap grids or point samples	Prior, during, post construction (3)

ATTACHMENT K

Existing Monitoring Surveys for Ponds 1 through 6A

Pond #	Water Quality	Fish/Wildlife Use	Bathymetry	Hydrology	Vegetation
1	USGS (monthly 2/99 – 11/01) DFG (monthly salinity, 1994 – 2004); HSe (priority pollutants, 2001)	USGS (birds monthly 1999 & 2000, bimonthly 2001 & 2002, monthly 10/02 – 5/04; inverts bimonthly 1999 & 2000, twice annually 2001 – Nov 2003; fish bimonthly 1999 & 2000)	Towill Survey, 1998	DFG 1994 – 2004 (monthly water surface elevation); PWA (siphon field data collection)	USGS (chl-a Jun99, bimonthly 2000, Feb01)
1A	DFG (monthly salinity, 1994 – 2004); HSe (priority pollutants, 2001)	USGS (birds monthly 9/02 – 5/04)	Towill Survey, 1998	DFG 1994 – 2004 (monthly water surface elevation); PWA (siphon field data collection)	
2	USGS (monthly 2/99 – 11/01); DFG (monthly salinity, 1994 – 2004); HSe (priority pollutants, 2001)	USGS (birds monthly 1999 & 2000, bimonthly 2001 & 2002, monthly 10/02 – 5/04; inverts bimonthly 1999 & 2000, twice annually 2001 – Nov 2003, fish bimonthly 1999 & 2000)	Towill Survey, 1998	DFG 1994 – 2004 (monthly water surface elevation); PWA (siphon field data collection)	USGS (chl-a Jun99, bimonthly 2000, Feb01)
3	USGS (monthly 2/99 – 11/01, bimonthly 3/02 – 10/02, monthly 11/02-5/04); DFG (monthly salinity, 1994 – 2004); HSe (priority pollutants, 2001)	USGS (birds monthly 1999 & 2000, bimonthly 2001 & 2002, monthly 10/02 – 5/04; inverts bimonthly 1999 & 2000, twice annually 2001 – Nov 2003 + Sept02, Mar03, May03, Jul03, fish bimonthly 1999 & 2000 + Jun03)	Towill Survey, 1998, PWA 2003 - 2004 (breach development and morphology)	PWA, USGS (breach hydrology, wind-wave turbulence, SPOOM model calibrated for Apr99-Oct01); DFG 1994 – 2004 (monthly water surface elevation); PWA (siphon field data collection)	USGS (chl-a Jun99, bimonthly 2000, Feb01, Oct02, Dec02, Feb03, Apr03, May 03)
4	USGS (monthly 2/99 – 11/01, bimonthly 3/02 – 10/02, monthly 11/02-5/04); DFG (monthly salinity, 1994 – 2004); HSe (priority pollutants, 2001); Frontier (metals, 2003)	USGS (birds monthly 1999 & 2000, bimonthly 2001 & 2002, monthly 10/02 – 5/04 ; inverts bimonthly 1999 & 2000, twice annually 2001 – Nov 2003 plus Sep02)	Towill Survey, 1998	USGS (SPOOM model calibrated for Apr99-Oct01); DFG 1994 – 2004 (monthly water surface elevation); PWA (siphon field data collection)	USGS (chl-a Jun99, bimonthly 2000, Feb01, Oct02, Dec02, Feb03, Apr03, May 03)
5	USGS (monthly 1/03 – 5/04); DFG (monthly salinity, 1994 – 2004); HSe (priority pollutants, 2001)	USGS (birds monthly 10/02 – 5/04)	Towill Survey, 1998	DFG 1994 – 2004 (monthly water surface elevation); PWA (siphon field data collection)	
6	DFG (monthly salinity, 1994 – 2004); HSe (priority pollutants, 2001)	USGS (birds monthly 10/02 – 5/04)	Towill Survey, 1998	DFG 1994 – 2004 (monthly water surface elevation); PWA (siphon field data collection)	
6A	DFG (monthly salinity, 1994 – 2004); HSe (priority pollutants, 2001)	USGS (birds monthly 10/02 – 5/04)	Towill Survey, 1998	DFG 1994 – 2004 (monthly water surface elevation); PWA (siphon field data	

ATTACHMENT L
Mitigation Measures and Summary of Future Monitoring Tasks

Mitigation Measure	Purpose	Implementation Timing	Monitoring Requirements	Responsible Party
Hydrology				
Mitigation Measure H-1: Repair Unintended Levee Breaches[1]	Prevent channel erosion and potential damage to adjacent DFG levee systems	As needed during construction Spring 2005-Fall 2006	Monitoring as needed during construction. Every 2 years following construction (if needed)	Corps[4]
Mitigation Measure H-3: Refine Project Design to Limit Adverse Effects of Increased Tidal Discharge	Minimize adverse effects of increased tidal discharge	Refine design: Fall 2003[2] Monitor: Fall 2005-2010	Monitoring every 2 years following construction for up to 10 years	Corps & Coastal Conservancy
Mitigation Measure H-4: Evaluate Susceptibility of Levees to Wind-Driven Wave Erosion and Conduct Repairs as Needed	Reduce risk of levee erosion	Annually beginning in Fall 2005	Routine monitoring may be recommended by engineer	Corps[4]
Water Quality				
Mitigation MeasureWQ-1: Obtain RWQCB Authorization under Waste Discharge Requirements or NPDES Stormwater Permit for General Construction Activity and Implement Best Management Practices	Minimize temporary water quality impairment due to construction activities	Prior to and during construction Spring 2005	Water quality monitoring during construction	Corps[4]
Mitigation Measure WQ-2: Design Project in Compliance with Resource Agency Permit Conditions and Conduct Water Quality Monitoring	Ensure timing of construction and potential salinity impacts are in compliance with WDRs	Prior to construction Fall 2003[2]	Water quality monitoring periodically for up to 5 years following construction for managed ponds and up to 3 years for tidal ponds	Corps[4] & Coastal Conservancy

ATTACHMENT L
Mitigation Measures and Summary of Future Monitoring Tasks

Mitigation Measure	Purpose	Implementation Timing	Monitoring Requirements	Responsible Party
Mitigation Measure WQ-3: Design, Operate, and Monitor Use of Recycled Water in Accordance with RWQCB Requirements	Avoid adverse water quality conditions resulting from use of recycled water	Prior to construction Fall 2003[2]	Recycled water monitoring program will include specific monitoring and data quality objectives. Monitoring for up to 5 years for managed ponds. Tidal ponds do not receive recycled water. Bittern removal monitoring period should stop when it is clear there will not be an impact. Recycled water NPDES monitoring will continue as specified in the permit.	Corps[4], Coastal Conservancy & SCWA
Mitigation Measure WQ-4: Monitor Pond Water Quality and Use Adaptive Management	Document that accumulation of trace metal and organic compounds do not occur in restored wetlands	Following construction Fall 2005-2010	Collect water quality and sediment samples periodically for up to 10 years for managed ponds and up to 5 years for tidal_ponds	DFG[5]
Mitigation Measure WQ-5: Prepare Levees and Time Breaches	Minimize the amount of sediment discharged into the water	During construction Fall 2005-2010	Monitoring during construction until breaches are stabilized	Corps[4]
Mitigation Measure WQ-6: Prepare and Implement Storm Water Pollution Prevention Plans	Reduce construction-related water quality impacts	Prepare SWPPP prior to construction Fall 2004 Implement SWPPP during construction Fall 2004-Fall 2006	Ensure BMP's are implemented as appropriate throughout duration of pipeline construction	SCWA
Vegetation				
Mitigation Measure V-1: Avoid Ground Disturbance in Populations of Soft Bird's-Beak	Avoid impacts to populations of Soft Bird's-Beak	Prior to construction Spring 2005	Pre-construction surveys for presence of species	DFG[5]

ATTACHMENT L
Mitigation Measures and Summary of Future Monitoring Tasks

Mitigation Measure	Purpose	Implementation Timing	Monitoring Requirements	Responsible Party
Mitigation Measure V-2: Conduct Preconstruction Surveys and Implement Avoidance, Minimization, and Mitigation Measures	Minimize impacts on biological resources	Prior to construction Spring 2005	Routine monitoring prior to construction	SCWA
Mitigation Measure V-3: Monitor and Manage Invasive Exotic Plant Species	Monitor and manage nonnative invasive cordgrass species	Following construction Spring 2005-Fall 2005-2010	Monitoring will start when vegetation surveys show that one or more areas of the restored tidal ponds have reached and elevation suitable for cordgrass colonization and will continue as part of the management of the wildlife area	DFG
Wildlife				
Mitigation Measure W-1: Avoid Construction Activities near Nesting Habitats during Breeding Season	Minimize adverse effects on nesting bird species in the area	Prior to and during construction Spring 2005	Pre-construction surveys for presence of species and monitoring during construction	DFG
Mitigation Measure W-2: Avoid Construction Activities near Occupied Suisun Ornate Shrew Habitat or Remove Shrews	Minimize adverse effects on Suisun ornate shrew	Prior to and during construction Spring 2005-Fall 2010	Pre-construction surveys for presence of species and monitoring during construction	DFG
Mitigation Measure W-3: Avoid Construction Activities near Occupied Salt Marsh Harvest Mouse Habitat	Minimize adverse effects on Salt Marsh Harvest Mouse	Prior to and during construction Spring 2005-Fall 2010	Pre-construction surveys for presence of species and monitoring during construction	DFG
Mitigation Measure W-4: Complete Focused Surveys for Special-Status Wildlife Species before Construction	Minimize impacts on special-status species	Prior to and during construction Spring 2005-Fall 20010	Pre-construction surveys for presence of species and monitoring during construction	SCWA

ATTACHMENT L
Mitigation Measures and Summary of Future Monitoring Tasks

Mitigation Measure	Purpose	Implementation Timing	Monitoring Requirements	Responsible Party
Mitigation Measure W-5: Educate Construction Crews regarding Special-Status Wildlife Species	Minimize impacts to special-status species	Prior to construction Fall 2004-Fall 2006	Monitoring as needed during construction	SCWA & DFG
Mitigation Measure W-6: Use Trenchless Construction Techniques for Special-Status Wildlife Species Protection	Minimize surface construction within sensitive locales	During construction Spring 2005-Fall 2006	Monitoring as needed during construction of pipeline	SCWA
Mitigation Measure W-7: Restore Habitat Modified by Construction	Restore habitat to preconstruction conditions	Following pipeline construction Fall 2005-2010	Monitoring as needed until habitat is restored along pipeline	SCWA
Aquatic Resources				
Mitigation Measure A-1: Minimize Entrainment of Sensitive Species	Minimize entrainment of fish species	During and following construction Spring 2005-Fall 2005-2010	Monitoring starts after water control structures are put into operation. Monitor during periods of potential presence of special status species	DFG[5]
Mitigation Measure A-3: Assess and Maintain Salinity Levels Protective of Aquatic Resources[3]	Minimize adverse effects on fish species due to salinity and other water quality requirements	Following construction Fall 2005-2010	Periodic monitoring of water quality for up to 5 years following construction for managed ponds and up to 10 years for tidal ponds	DFG[5]
Geology				

ATTACHMENT L
Mitigation Measures and Summary of Future Monitoring Tasks

Mitigation Measure	Purpose	Implementation Timing	Monitoring Requirements	Responsible Party
Mitigation Measure Geo-1: Maintain Water Level 2 Feet Below Levee Crest	Reduce potential for levee erosion	Following construction Fall 2005-2010	Periodic monitoring of water level in ponds for 5 years following construction for managed ponds	DFG[4]
Mitigation Measure Geo-2: Remove Unstable or Expansive Soils and Backfill with Engineered Fill	Minimize impacts due to construction of water pipeline on unstable soils	During construction Spring 2005-Fall 2010	Monitoring as needed during pipeline construction	SCWA
Hazards and Hazardous Materials				
Mitigation Measure Haz-1: Provide Enhanced Spill Prevention and Response Training, and Spill Response Preparation	Reduce exposure and/or release of hazardous materials	During construction Spring 2005- Fall 2010	Monitoring as needed during construction	Corps
Mitigation Measure Haz-2: Employ Explosives Experts when Breaching Levees	Reduce potential releases of residual hazardous materials	During construction Fall 2005-Fall 2010	Monitoring as needed during construction	Corps
Mitigation Measure Haz-3: Develop and Implement a Health & Safety Plan	Reduce potential exposure to irritant dust	Develop plan prior to construction; Fall 2005; Implement plan during construction on Pond 7; Spring 2006-Fall 2007	Monitoring as needed during construction	Corps & Coastal Conservancy
Mitigation Measure Haz-4: Monitor Perimeter Dust Concentrations during Work on and in the Vicinity of Pond 8	Reduce potential exposure to irritant dust	During construction Spring 2005-Fall 2006	Periodic monitoring during construction	Corps
Mitigation Measure Haz-5: Prepare and Implement a Safety Plan	Reduce potential impacts on human health	Prior to start of each construction contract and during construction Fall 2005-Fall 2006	Periodic monitoring during construction	Corps & SCWA
Transportation and Circulation				

ATTACHMENT L
Mitigation Measures and Summary of Future Monitoring Tasks

Mitigation Measure	Purpose	Implementation Timing	Monitoring Requirements	Responsible Party
Mitigation Measure T-1: Implement Safety Plan for Pipeline Construction along Rail Line	Reduce potential for construction-related traffic hazards during water pipeline construction	Develop plan prior to construction; implement during construction Fall 2005-Fall 2006	Monitoring as needed during pipeline construction	SCWA
Mitigation Measure T-2: Implement Safety Plan for Construction along Public Roads	Reduce potential for construction-related traffic hazards	Develop Plan Prior to construction; implement during construction Fall 2005-Fall 2006	Monitoring as needed during construction	Corps
Air Quality				
Mitigation Measure AQ-1: Minimize Dust Generation in and Implement Dust Control Measures for Work Areas with Salt Crusts	Minimize potential disturbance of salt crusts	During construction Spring 2006-Fall 2008	Monitoring as needed during construction	Corps
Noise				
Mitigation Measure N-1: Decrease Noise Levels with Use of Noise Reduction Devices	Minimize increases in ambient noise levels during water pipeline construction	During construction Fall 2005-Fall 2010	Monitoring as needed during pipeline construction	SCWA
Public Services and Utilities				
Mitigation Measure PS-1: Ensure the Stability of the Power Towers	Reduce potential of power tower instability	Prior to, during and following construction Spring 2005-Fall 2005-2010	Routine monitoring following construction	Corps
Recreation, Public Access, Visual Resources and Public Health				

ATTACHMENT L
Mitigation Measures and Summary of Future Monitoring Tasks

Mitigation Measure	Purpose	Implementation Timing	Monitoring Requirements	Responsible Party
Mitigation Measure R-1: Coordinate Project Activities with the Napa County Mosquito Abatement District	Minimize increase in mosquito production	Prior to, during and following construction Spring 2005-Fall 2005-2010	Monitoring as needed during project and following the implemented action	Corps & DFG
Mitigation Measure R-2: Prepare a Public Access Plan	Maintain public access to the wildlife area during construction	Prior to construction Fall 2005	Monitoring as needed during pipeline construction	SCWA
Cultural Resources				
Mitigation Measure C-1: Stop Work if Cultural Resources Are Discovered during Ground-Disturbing Activities	Minimize impacts to cultural resource sites	During construction Spring 2005-Fall 2006	Monitoring as needed during construction	Corps & DFG[5]
Mitigation Measure C-2: Comply with State Laws Pertaining to the Discovery of Human Remains	Minimize impacts to cultural resources	During construction Spring 2005-Fall 2006	Monitoring as needed during construction	Corps, SCWA & DFG[5]
Mitigation Measure C-3: Conduct Archaeological Monitoring of Construction Activities in the Vicinity of CA-NAP-224, C-164, and CA-NAP-230	Minimize impacts to archaeological resources	During construction Spring 2005-Fall 2006	Periodic monitoring during construction	SCWA
Cumulative Impacts and Other Required Analyses				
Mitigation Measure Cu-1: Implement Monitoring & Adaptive Management Program	Minimize cumulative impacts to hydrology of Lower Napa River	Following construction Fall 2005-2010	Periodic monitoring of key project parameters for 5 years following construction for managed ponds	Corps, Coastal Conservancy, & DFG[5]

Mitigation Measures and Summary of Future Monitoring Tasks

Mitigation Measure	Purpose	Implementation Timing	Monitoring Requirements	Responsible Party
Mitigation Measure Cu-3: Conduct Biological Surveys for Sensitive Biological Resources	Minimize cumulative impacts to biological resources	Prior to and during construction Fall 2005	Pre-construction surveys and monitoring 1 year after initial levee breach and would continue every 2 years for no more than 5 years	DFG[5]
Mitigation Measure Cu-3: Contribute to Regional Research Efforts on the Exposure of Wildlife to Contaminants	Reduce exposure of wildlife to contaminants	Following construction Fall 2005-2010	Periodic monitoring for 10 years after each pond is breached	DFG & USGS
Water Delivery Program Component				
Hydrology				
Mitigation Measure H-2: Avoid Drainage Pattern Alteration in Plans for Future Pipeline Alignments	Avoid substantial alteration of drainage patterns	Prior to construction	Coordinate with City of Petaluma, Novato SD, and LGVSD WWTPs to ensure pipeline alignments do not cause substantial alteration of drainage pattern	SCWA
Wildlife				
Mitigation Measure W-4: Complete Focused Surveys for Special-Status Wildlife Species before Construction	Minimize impacts on special-status species	Prior to and during construction	Pre-construction surveys for presence of species and monitoring during pipeline construction	SCWA
Mitigation Measure W-5: Educate Construction Crews regarding Special-Status Wildlife Species	Minimize impacts to special-status species	Prior to construction	Monitoring as needed during pipeline construction	SCWA
Mitigation Measure W-6: Use Trenchless Construction Techniques for Special-Status Wildlife Species Protection	Minimize surface construction within sensitive locales	During construction	Monitoring as needed during pipeline construction	SCWA
Mitigation Measure W-7: Restore Habitat Modified by Construction	Restore habitat to preconstruction conditions	Following pipeline construction	Monitoring as needed until habitat is restored along pipeline	SCWA
Aquatic Resources				
Mitigation Measure A-4: Use Trenchless Technology during Construction to Protection Aquatic Species	Minimize impacts to aquatic species	During construction	Monitoring as needed during construction	SCWA

ATTACHMENT L
Mitigation Measures and Summary of Future Monitoring Tasks

Mitigation Measure	Purpose	Implementation Timing	Monitoring Requirements	Responsible Party
Transportation and Circulation				
Mitigation Measure T-1: Implement Safety Plan for Pipeline Construction along Rail Line	Reduce potential for construction-related traffic hazards during water pipeline construction	Develop plan prior to construction; implement during construction	Monitoring as needed during pipeline construction	SCWA
Mitigation Measure T-2: Implement Safety Plan for Construction along Public Roads	Reduce potential for construction-related traffic hazards	Develop plan prior to construction; implement during construction	Monitoring as needed during pipeline construction	SCWA
Noise				
Mitigation Measure N-1: Decrease Noise Levels with Use of Noise Reduction Devices	Minimize increases in ambient noise levels during water pipeline construction	During construction	Monitoring as needed during pipeline construction	SCWA
Recreation, Public Access, Visual Resources and Public Health				
Mitigation Measure R-2: Prepare a Public Access Plan	Maintain public access to the wildlife area during construction	Prior to construction	Monitoring as needed during pipeline construction	SCWA
Cultural Resources				
Mitigation Measure C-4: Conduct Records Search and Visual Survey	Minimize impacts to archaeological resources during pipeline construction	Prior to construction	Ensure survey is completed before programmatic pipeline plans are released	SCWA

Note:

[1] Mitigation Measure H-2 is listed under the Water Delivery Program Component section.

[2] This portion of the mitigation measure has already been completed.

[3] Mitigation Measure A-4 is listed under the Water Delivery Program Component section.

[4] Except for ponds 1-3 and 8 which DFG will be responsible for evaluating as part of management of the wildlife area.

[5] Restoration, salinity and contaminant monitoring will focus on managed ponds 6, 6A, 7, 7A and 8, and on tidal ponds 3, 4 and 5. Ponds 1, 1A, 2 and 2A will continue to be monitored as part of the management of the wildlife area.