Appendix K

Draft Monitoring and Adaptive Management Plan

Bel Marin Keys Unit V Expansion of the Hamilton Wetland Restoration Project
DRAFT CONCEPTUAL MONITORING AND
ADAPTIVE MANAGEMENT PLAN
October 2002

INTRODUCTION

After construction is completed the site will be monitored for a period of 13 years to ensure that the site is maturing and performing as designed. The Corps of Engineers will participate in the monitoring and adaptive management program for 13 years after the end of construction. Subsequent inspection and surveillance of the project in connection with its obligation for operating, maintaining, repairing, rehabilitating and replacing the project will be the responsibility of the non-Federal Sponsor.

At any time during the 13-year monitoring period, if the results of monitoring indicate that any features of the constructed project require modification or if new features are required for the project to perform as intended, then adaptive management measures may be implemented. This plan provides a general framework for monitoring and managing the success of the Bel Marin Keys Unit V Expansion of the Hamilton Wetlands Restoration Project after construction. Included is guidance for monitoring levee performance, site hydraulics including channel and creek morphology, biological success, public health (mosquito breeding habitat), and water quality. This conceptual plan will be greatly expanded and quantified in the detailed design phase of the study.

It should be noted that a separate operation and maintenance (O&M) manual will be prepared by the Corps and provided to the Sponsor upon completion of construction. O&M tasks will be performed by the Sponsor to ensure that the project features are maintained in their as-built condition (or as modified by adaptive management measures) for the entire project life.

This plan covers the period after the completion of construction. Prior phases of the project include the detailed design phase and the construction phase. The SEIR/EIS identifies specific project features and mitigation measures to be implemented during the design phase (such as development of specific trail designs or development of a water management plan) or to be implemented during the construction phase (such as pre-construction nest surveys). Maintenance and monitoring during construction (e.g., spill prevention, erosion control, discharge of decant water, avoidance of special-status species) will be further described in the plans and specifications for construction. Testing of sediments for contaminants and evaluation of sediment quality will be completed by responsible parties for proposed dredged material for reuse and the DMMO prior to transportation to the site during the construction phase.

At the beginning of the post-construction phase period, dredged material will have been placed and the outboard levees breached.

Contemporaneously with the commencement of the Monitoring and Adaptive Management Period, the non-Federal Sponsor will assume exclusive responsibility for the performance and funding of the operation, maintenance, repair, rehabilitation, and replacement of the project, and the two programs will run concurrently. The distinction between the Sponsor's maintenance, repair, rehabilitation, and replacement responsibilities, on the one hand, and the adaptive management activities shared for the 13-year period by the Government and the Sponsor, on the other hand, will be determined as the detailed Monitoring and Adaptive Management Plan and the OMRRR Manual are developed.

Monitoring of biological, hydrological, topographic, bathymetric, and water quality conditions will track the evolution of the site after breaching of the outboard levees. Periodic comparisons of measured

conditions with expected conditions will determine whether the development of the site is progressing as planned.

Restoration goals and objectives for the project are qualitative statements in the SEIR/EIS regarding expected future conditions. Quantitative standards intended to measure progress towards these goals and objectives will be developed later for the detailed monitoring, and adaptive management plan.

LEVEES AND WATER MANAGEMENT STRUCTURES

Monitoring

SETTLEMENT. Monitoring of settlement of the levees due to foundation consolidation should be performed annually by means of precision level surveys of settlement monuments installed during construction. The greatest rate of settlement is expected to occur during the first ten years after the levees are constructed. The data should be reduced, plotted, and compared with the expected design rate. Settlement monitoring of the levees should continue annually until the analyses of the survey data shows that the rate and amount of settlement are within design expectations. At that time the frequency of settlement monitoring may be adjusted to longer intervals of time. If the rates and amount of settlement are unacceptable, then corrective measures should be recommended and action taken.

ANNUAL INSPECTIONS. During the first few years after breaching of the outboard levees, a walkover inspection of the levees and water management structures should be performed twice annually for pre- and post-winter conditions. Subsequently, the frequency of inspection of levees can be reduced to one annual post-winter inspection. The reduced frequency would be based upon determining that the performance of the levee features, and of the site in general, are in accordance with design expectations. Inspection of water management structures should continue on a twice-annual schedule.

The inspection should look for erosion problems such as rills, gullies, and other evidence of erosion on the newly constructed levees, and for evidence of burrowing mammals. Burrowing mammals, when present in large enough numbers, are detrimental to the overall stability of a levee. Burrowing mammals should be eradicated when infestations endanger the perimeter levee system, and the damage repaired. The breach openings should also be inspected for any obstructions or debris that would limit tidal flows. The walk over inspection should document the implementation of previously recommended corrective actions (or the lack thereof) and the effectiveness of that action.

The inspection of water management structures should look for structural integrity, settlement vegetation accumulation, sediment accumulation, or other features that may impede operation of the structure.

The annual inspections may be supplemented as necessary following a major storm event or an earthquake of magnitude 5 or greater located within 50 miles of the project, or a smaller magnitude event if specific reports of local damage are received.

CROSS SECTIONS. Surveyed cross-sections of the perimeter levees and any waterside, wave-erosion protection berms should be performed annually until they have stabilized, but no less than five years after the breaching of the outboard levees. Supplemental surveys should be made after a severe storm event or a major El Nino winter.

INSPECTION REPORT. An inspection report should be written for each inspection documenting the observations and finding, recommended corrective action items, and actions taken. In general, the monitoring and inspection report should include but not be limited to the following:

A. A site map indicating the areas of significant findings and/or observations.

B. Condition of the breaches, once they are created, noting obstructions and debris.

C. Condition of the levees and any recent repairs, noting any unusual, abnormal, or unexpected conditions or occurrences that could bear on the effectiveness of the structure.

D. Results of the settlement monitoring and interpretation of the data.

E. Condition of hard structures, water management structures (such as culverts or weirs), and pipelines.

F. Condition of access and service roads, especially areas where problems are likely to develop.

G. Availability of emergency supplies necessary for immediate repairs of major storm related damages.

H. An emergency action plan that includes phone numbers and means of contacting operating personnel.

I. Corrective measures taken (date temporary measures taken, permanent repairs, etc.) and the cost of corrective actions for the report period.

J. A summary of findings, proposed corrective actions, and an implementation plan for those actions.

Maintenance and Adaptive Management

Corrective actions in response to problems identified when monitoring levee conditions as described in the section on monitoring, above, may entail either maintenance activities or adaptive management activities. The distinction between these two categories of activities will be developed in greater depth in the detailed Monitoring and Adaptive Management Plan and the OMRRR Manual, respectively. Corrective actions could include adding material to compensate for excessive settling or erosion, repair of earthquake damage, reinforcing the levee surface to withstand erosion in problem areas (to the minimum extent necessary), repair of drainage structures, or control of burrowing rodents. Any rodent-control efforts will need to be carefully planned and executed to avoid negative impacts on adjacent habitats and wildlife. Such efforts would be confined to levees; rodent populations in other habitat areas including berms would not be controlled except under unusual conditions.

HYDRAULICS

Monitoring

DREDGED MATERIAL FILL ELEVATION AND TIDAL SEDIMENTATION. The surface elevation of the dredged material fill after consolidation will be an important determinant of the success of the project. Proper development of the tidal marsh requires that the fill elevation be low enough to allow additional sedimentation and development of tidal channels on the site after breaching of the outboard levees. If significant portions of the fill are placed above the intended elevation, formation of small marsh channels will be inhibited and the eventual quality of the marsh habitat will be reduced. In contrast, if the fill elevation is lower than intended, the only negative impact would be a delay in marsh development while additional sedimentation raises the grade level to the intended elevation.

Dredged material placed on the site will consolidate over time, with the fastest consolidation occurring initially. The degree of consolidation and its duration will depend upon the texture and depth of the dredged material. By the time that the outboard levees are breached, most consolidation will have already occurred. During the next several years, some additional consolidation may occur and could counteract tidal sediment deposition during that period.

While monitoring the surface elevation of the fill material during and immediately after completion of placement is important, this is part of the construction process and is not part of post-construction monitoring. Measurement of the fill elevation as part of the post-construction monitoring of the site will commence upon the breaching of the outboard levees, and will continue thereafter primarily to measure ongoing sedimentation on the site. These elevation data will also provide the baseline for measuring the physical development of the marsh plain and channels following the introduction of tidal action.

Monitoring of sediment deposition rates and patterns will provide useful information regarding the accuracy of predictive sedimentation models and will help to quantify the acceleration of marsh restoration achieved by using dredged material. This information will be important in future decisions regarding the use of dredged material in marsh restoration projects. Information regarding sediment deposition patterns will also assist in understanding changes in vegetation patterns as the marsh develops and will provide a basis for evaluating the effectiveness of the interior peninsulas in accelerating sediment deposition. The techniques to be used in monitoring site elevations will be determined during the detailed design stage, but could include transects across the site and/or resistivity staffs as used at the Sonoma Baylands project.

EXTERIOR TIDAL CHANNELS. To provide initial tidal access to the site, channels will be excavated to connect the site to the waters of San Pablo Bay and Novato Creek. These channels will be large enough to provide substantial tidal circulation, but will be smaller than the final equilibrium size. As the tidal hydrology of the site and its connecting channels evolves, the channels are expected to increase in size until they reach equilibrium with the tidal prism of the site. As the tidal prism eventually decreases due to sedimentation on the site, the channels will decrease in size in response. To ensure that the site is developing properly, the geometry of these channels will be monitored periodically and will be compared to expected conditions.

NOVATO CREEK CHANNEL MORPHOLOGY. To provide tidal exchange to the site, a breach will be constructed in the outboard levee to connect the site to Novato Creek. Additionally, during high flow periods, outlet flows from Pacheco Pond will be diverted to provide a source of freshwater for the seasonal wetland habitat area. These activities may result in changes in Novato Creek channel morphology (i.e., creek width and depth); although based on study to date, the changes are expected to be favorable in terms of navigation (due to the addition of tidal prism) and less than significant in terms of habitat and levee stability. Baseline conditions will be monitored for several years prior to breach of the BMKV/Novato Creek levee. The geometry of the Novato Creek channel will be monitored annually at designated locations upstream and downstream of the site and compared to the baseline conditions to quantify the magnitude of these changes. Specific monitoring locations will be determined during the detailed design phase. If monitoring identifies any significant adverse changes in channel morphology (e.g., excessive project-related sediment deposition, or erosion of adjacent levees), adaptive management measures will be identified and implemented as appropriate. Monitoring of the Novato Creek channel will be coordinated with the Bel Marin Keys Community Services District, given the interest of the BMK community in navigation via the channel and due to the periodic dredging of the channel by the BMK CSD.

TIDAL REGIME. The intent of the project is to create a tidal marsh with physical and biological conditions similar to natural marshes in the general area. The creation and maintenance of a normal tidal

regime is a very important component of restoration, as tidal action and suspended sediment circulation are essential to the creation and maintenance of tidal marsh topography and vegetation. The progress of the site's tidal regime towards reference conditions will be monitored using appropriate recording equipment. Measurements of tide elevations will be recorded periodically or continuously at locations within the site and at a nearby reference location. The tidal regime and tidal prism will be determined from these measurements.

INTERNAL PENINSULA CREST ELEVATIONS. The internal peninsulas are intended as temporary features to reduce wind and wave fetch, direct tidal flows away from levees, and encourage sedimentation. They are expected to gradually erode away and eventually disappear. The elevation of the peninsula crests will be periodically measured to monitor their progress towards specified standards.

INTERNAL CHANNEL DEVELOPMENT. Tidal channels are the most important physical feature of a tidal salt marsh. The extent, pattern, and density of the channel system determines many other attributes of the marsh, including hydrology, vegetation distribution, and habitat values. It is therefore important to document these attributes of channel development in the Hamilton restoration project for use in the design of future wetland restoration projects.

Channel development will be mapped from aerial photographs taken during appropriate tidal conditions. Transects may also be useful in measuring the development of these channels.

Maintenance and Adaptive Management.

Corrective actions in response to problems identified when monitoring project hydraulics may entail either maintenance activities or adaptive management activities. The distinction between these two categories of activities will be developed in greater depth in the detailed Monitoring and Adaptive Management Plan and the OMRRR Manual, respectively. Corrective actions will consist of removal of any debris that obstructs tidal flows.

WATER QUALITY

Water quality parameters to be monitored will include salinity, temperature, and dissolved oxygen. Measurements will be taken at several locations within the site and in the connecting channels. Due to the substantial tidal exchange that should exist immediately after breaching, water quality should be comparable to that in adjacent parts of the bay. If water quality deficiencies are substantial and persistent, remedial actions will be developed and implemented if practicable.

Additionally, a specific monitoring and adaptive management plan will be developed and implemented to address methylmercury production and accumulation in the restoration site. The plan including specific monitoring parameters (e.g., duration, frequency, constituents, protocols) will be developed in consultation with the responsible regulatory agencies. The purpose of the monitoring would be to determine whether methylmercury concentrations are found at substantially greater concentrations in the water column, sediments, or benthic invertebrate populations at the restoration site than at reference sites. Corrective actions, if required, will be developed and implemented in consultation with the responsible regulatory agencies.

Implementation of the project will also require coordination with the Marin County Flood Control Water Conservation District and the California Department of Fish and Game to ensure that any water quality monitoring aspects related to the new water management plan for Pacheco Pond are implemented. The

development of a new water management plan will be part of the design phase, but its implementation would occur after construction.

BIOLOGICAL RESOURCES

Monitoring

MARSH DEVELOPMENT (FROM MITIGATION MEASURE BIO-8). The Corps, in conjunction with the Conservancy or its successors in interest, will develop and implement a monitoring and adaptive management program to measure the rate of tidal coastal salt marsh establishment and the quantity and quality of established coastal salt marsh. Restored coastal salt marsh will be monitored annually for the first 5 years, and again in years 10 and 15 following breaching of the outboard levees. The Corps and Conservancy (or its successor) would be responsible for the first 5 years of monitoring and the monitoring in year 10. The Conservancy (or its successor) would be responsible for monitoring in year 15, because it is beyond the 13-year Corps monitoring period. The monitoring program will be designed to determine whether coastal tidal marsh is developing and whether its primary supporting physical processes (i.e., tidal exchange and sedimentation) are occurring at the estimated rate during the first 15 years following completion of construction. Subsequent inspection and surveillance of tidal salt marsh development at year 15 and beyond will be the responsibility of the non-Federal Sponsor in connection with its obligation for operating, maintaining, repairing, rehabilitating, and replacing the project. Because it will occur beyond the 13-year Project monitoring period, the Conservancy will independently assume (including on behalf of any successors) the responsibility for monitoring in year 15, in addition to its obligation to conduct inspection and surveillance of the project.

Major elements of the monitoring program will include the following:

- Measure the extent of tidal coastal salt marsh removed to determine the amount of tidal coastal salt marsh that would need to be restored to compensate for loss of tidal coastal salt marsh at an in-kind replacement ratio of 2 acres restored for every acre of tidal salt marsh removed.

- Monitor parameters, including tidal stage, tidal current, wind speed and direction, wave characteristics, suspended sediment concentrations, sedimentation rates and distribution, marsh elevations, mudflat elevations, areal extent and locations of established or colonizing salt marsh vegetation, composition and density of established and colonizing plant species, characteristics of subtidal channel and marsh surface sediments, and San Pablo Bay shoreline characteristics.

- Monitor locations, including the tidal wetland interior, tidal wetland perimeter, subtidal channels, and existing San Pablo Bay marsh shoreline.

- Compare predicted and measured site development and function.

- Analyze monitoring data to identify possible reasons for differences between observed and predicted conditions.

- Recommend corrective actions that could be implemented if the restoration is not proceeding as designed.

Monitoring reports will be submitted by the Conservancy, Corps, or successors in interest to DFG, USFWS, NMFS, and BCDC for each year in which monitoring of the development of coastal tidal salt marsh is done.

At the end of the initial 5-year monitoring period, if the development rate of the coastal salt marsh and the habitat quality of establishing coastal salt marsh do not appear to conform to the goals and projections established for the project, or do not appear sufficient to replace each acre of removed tidal coastal salt marsh with 2 acres of contiguous in-kind habitat within 10-years of levee breach, the Corps, in conjunction with the Conservancy or its successors in interest, will review the proposed BMKV expansion with representatives of DFG, USFWS, and NMFS to obtain input as to whether additional monitoring, adaptive management actions, or modifications are necessary to ensure the functions and values of the affected coastal salt marsh habitat will be replaced. The Corps, in conjunction with the Conservancy or its successors in interest, may initiate a similar review of marsh development following completion of monitoring in year 10 if the Corps or Conservancy concludes that additional actions or modifications are necessary to meet restoration goals. The Conservancy or its successors in interest, may initiate a similar review of marsh development following completion of monitoring in year 15 if they concludes that additional actions or modifications are necessary to meet restoration goals.

Monitoring or morphologic evolution will allow the Corps, in conjunction with the Conservancy or its successors in interest, to assess the success of habitat development and make decisions regarding corrective measures if necessary. Potential corrective measures include changing the breach and subtidal channel dimensions, altering perimeter levee berm morphology, and modifying channel characteristics within the restored tidal wetlands to ensure adequate morphologic evolution.

USE BY BIRDS. As intertidal mudflat and marsh habitats develop along with associated invertebrate fauna, use of these habitats by birds should gradually become similar to usage occurring on nearby intertidal habitats. As seasonal wetlands develop, winter use by waterfowl and shorebirds should become similar to such use on nearby seasonal wetlands. Periodic bird surveys will document trends in use of the site by birds in comparison to a nearby reference site and will provide an indication of the success of habitat restoration.

USE BY FISHES. Fish surveys early in the restoration process will document the initial suitability of the site for fishes. Ongoing surveys will document continued use of the site by fishes as marsh and channel formation occur.

USE BY ENDANGERED SPECIES (CALIFORNIA CLAPPER RAIL AND SALT MARSH HARVEST MOUSE). As marsh and channel development progress, habitats for the California clapper rail and the salt marsh harvest mouse are expected to gradually develop. After suitable habitat has developed over a portion of the site, periodic surveys will document the extent of these habitats and the presence of these species. Surveys will be coordinated with the U.S. Fish and Wildlife Service and the California Department of Fish and Game to ensure compliance with endangered species laws and regulations.

BENTHIC MACROINVERTEBRATES. Development of a benthic macroinvertebrate community should occur rapidly after the initial establishment of tidal action on the site. The presence of a thriving benthic macroinvertebrate community (together with abundant fish and bird populations) will indicate that the site is ecologically healthy even if it has not yet developed substantial tidal marsh habitat. However, the composition of this community can be expected to change rapidly and unpredictably due to normal natural fluctuations, which would lessen the value of monitoring trends in these species. Surveys of benthic macroinvertebrates will be conducted during the first year after breaching to document the colonization of the site by these species. Additional surveys may be conducted later if site deficiencies arise.

SEASONAL WETLAND, EMERGENT MARSH, AND OPEN WATER (FROM MITIGATION MEASURE BIO-9). The Corps, in conjunction with the Conservancy or its successors in interest, will develop and implement a 5-year monitoring program to measure the establishment rate, quantity, and quality of brackish open water, emergent marsh, and/or seasonal wetlands.

Major elements of the monitoring program will include the following.

- Measure areal extent and locations of established or colonizing marsh vegetation.
- Measure composition and density of established and colonizing plant species.
- Compare predicted and measured site development and function.
- Analyze monitoring data to identify possible reasons for differences between observed and predicted conditions.
- Recommend corrective remedial actions that can be implemented if the restoration is not proceeding as designed.

Monitoring reports will be submitted by the Conservancy, Corps, or successors in interest to DFG, USFWS, and BCDC for each year in which monitoring of the development of seasonal wetland and emergent marsh areas is conducted. If the rate, quality, and quantity of created habitat are not meeting restoration goals at the end of the 5-year period, the sponsoring agencies will consult with the above agencies as regards to further monitoring and potential corrective actions.

Maintenance and Adaptive Management

Corrective actions in response to problems identified when monitoring biological resources conditions may entail either maintenance activities or adaptive management activities. The distinction between these two categories of activities will be developed in greater depth in the detailed Monitoring and Adaptive Management Plan and the OMRRR Manual, respectively. The focus in non-tidal areas will be directed towards encouraging appropriate native plant species and minimizing the presence of exotic plant species of particular concern such as non-native cordgrass, pampas grass, broom, and yellow star thistle. Corrective techniques may include mowing, burning, manual removal of unwanted plants, and herbicides (approved by the federal Environmental Protection Agency for use in wetlands) if needed. Mowing and manual removal have been effective so far at suppressing unwanted upland plant species at the Sonoma Baylands project, and herbicides have not been necessary. Any vegetation-control efforts will need to be carefully planned and executed to avoid negative impacts on adjacent habitats and wildlife. Control of non-native predators (feral cats and/or red foxes) may also be needed. A plan for controlling noxious plant species and non-native predators will developed in coordination with California Department of Fish and Game and U. S. Fish and Wildlife Service.

Biological maintenance in tidal areas will primarily be passive, with natural processes allowed to gradually restore habitats. However, tidal areas (and uplands) may be invaded by the non-native perennial pepperweed (*Lepidium latifolium*). Control of this plant is uncertain and cannot be guaranteed. Herbicides would most likely be required in any attempt to control this species, should it invade the site.

PUBLIC HEALTH (MOSQUITO BREEDING HABITAT)

Monitoring and management activities associated with potential creation of mosquito breeding habitat will be coordinated with the Marin-Sonoma Mosquito and Vector Control District. Activities may include: development and implementation of water management strategies to reduce site suitability for mosquito breeding (e.g., introduction of saline water); air and ground applications of Bti (*Bacillus thurigiensis var. israelensis*), methoprene growth regulators, or other Environmental Protection Agency approved pesticides as needed; ongoing monitoring of larval and adult mosquito populations, water quality, and vegetation density, and implementation of control and management measures as determined by MSMVCD.

ADAPTIVE MANAGEMENT

Adaptive management is a term that has been used to mean various things. As used here, it is an approach to resource management in which management goals remain the same, but management objectives and techniques may be modified in response to feedback (such as monitoring results) from the system being managed. Adaptive management recognizes that human knowledge regarding biological and physical systems is limited and that these systems may not always behave as expected. When a management or restoration project is to be implemented but there is some uncertainty regarding the response of the system to particular actions, adaptive management provides a way for management actions to respond to feedback from the system being managed. Adaptive management will be implemented if specific restoration standards are not met or if it appears that actual conditions will diverge sufficiently far from intended conditions to threaten the achievement of overall project goals. Funding for adaptive management will be included in the project cost estimates so that this option will be available in the future if needed.

Should the development of the site fail to meet quantitative standards to be stated in the detailed monitoring plan, action to correct these shortfalls will be undertaken if such action could reasonably be expected to assist in the achievement of these standards. Corrective action could include vegetation management, predator management, topographic modifications such as creation of or enlargement of channels, or levee repairs or modifications. Once corrective actions are taken, they become part of the completed project and will be maintained during and after the 13-year monitoring period as prescribed by the O&M manual.