Moro Cojo Slough
Management and Enhancement Plan

Final Report

The Habitat Restoration Group

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Moro Cojo Slough
Management and Enhancement Plan

Final Report

Adopted by Monterey County Board of Supervisors on October 22, 1996

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Monterey County Planning and Building Inspection Department
and
State Coastal Conservancy

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CHAPTER 1
EXECUTIVE SUMMARY

The Moro Cojo Slough Management and Enhancement Plan describes the environmental resources of the Moro Cojo Slough watershed (hydrologic features, biologic resources, agricultural practices and water quality and land use issues) and recommends actions to enhance, restore and manage the significant resources on both public and privately-owned lands within the slough system.

The management and enhancement plan was initiated by Monterey County in response to land use conflicts and development pressures within the slough watershed. The project was funded jointly by a grant from the State Coastal Conservancy; with contributions from Monterey County, Monterey County Water Resources Agency (MCWRA), State Water Resources Control Board and the Elkhorn Slough Foundation. The study was conducted during 1993 and 1994.

The administrative draft of Volume I - Existing Conditions was submitted to the County of Monterey and the Elkhorn Slough National Estuarine Research Reserve Advisory Committee (RAC) on November 1, 1993. A Draft report was prepared and submitted to the County and the RAC on March 21, 1994. Following review of the existing conditions report and meetings with the RAC; the County, RAC, individual RAC members, and State and Federal agencies submitted comments on the Draft Existing Conditions Report. These comments, and their responses, are presented in the Volume I - Existing Conditions, Response to Comments Report.

Volume II - Resource Alternatives Report was prepared following completion of the Existing Conditions Report and concurrent with the Existing Conditions, Response to Comments Report. The Alternatives Report examines five various alternatives for the lower watershed (Moss Landing Road to Castroville Boulevard) and presents recommended Best Management Practice's (BMP's) practices for the entire watershed.

The alternatives report provided information to Monterey County and the RAC on the various alternatives to enhance and manage the Moro Cojo Slough watershed and provided an objective, planning-level analysis of the various actions that may be pursued within the watershed, including issues regarding land use, biological resources, hydrologic resources, and agricultural activities.

The RAC selected a preferred alternative which is presented in the Final Management and Enhancement Plan. Public hearings on the preferred alternative will be conducted by Monterey County to solicit input from interested parties, with final approval by the Monterey County Board of Supervisors.

Appendices to this report are included in a separate Technical Appendix.

PHYSICAL FEATURES

The Moro Cojo Slough watershed encompasses approximately 17 square miles within northern Monterey County (Figure 1-1). The project study area encompasses the entire watershed, and in general, is bound by Moss Landing Harbor and State Highway 1 to the west, State Highway 156 to the south, Prunedale/ San Miguel Canyon Road to the east and Paradise Canyon, Dolan Road and Elkhorn Slough to the north. Castroville Boulevard and the Southern Pacific Railroad (SPRR) tracks bisect the study area in a north-south direction. Meridian Road and Dolan Road bisect the study area in an east-west direction (Figure 1-2).

The watershed can be characterized into two geographic areas: 1) the lower slough; and 2) the upper watershed. The lower Moro Cojo Slough is characterized by a gently sloping valley floor confined by old marine and fluvial terraces constructed by the Salinas River; the salient topographic features are the slough channels and the adjacent floodplain. The lower slough is primarily occupied by wetland slough habitat and both wetland and upland agricultural and grazing lands. The lower slough area is generally bound by Moss Landing Harbor and Highway 1 to the west, Castroville to the south, Castroville Boulevard to the east and Elkhorn Slough to the north.

The upper watershed area is comprised of low-lying slough drainages and gently to moderately sloping terrace slopes that bound the slough. The upper watershed is a mixture of low-elevation wetlands, upland grassland and chaparral, agriculture, cattle grazing and rural residential development. The upper watershed is generally bound by Castroville Boulevard to the west, Highway 156 to the south, Prunedale to the east and Paradise Canyon to the north.

HISTORICAL INFLUENCES

Historical influences within the Moro Cojo Slough watershed can be categorized into four periods: pre-1850, 1850-1910, 1910-1947, and 1947-present. Prior to the 1750's, indigenous people, known as the Ohlone, inhabited the Moro Cojo region. The earliest known accounts of the area were from Spanish explorers during the late 1500's. Their journals described the greater Monterey Bay region as an environment much wetter than today, with wetlands of large size stretched over lowland areas and water channels, and upland areas of native bunchgrass. The Ohlone are known to have practiced land management and harvesting techniques, including burning grasslands, burning woodland understory and cutting of shrubs. It is expected that these land management activities were occurring within the Moro Cojo Slough watershed area. By the mid-1700's Spanish missionaries and large ranching families occupied the lands and began grazing large herds of cattle and sheep. This began the conversion of many of the upland native perennial grasslands to non-native annual grasslands and the reduction in many of the native large mammal populations.

Accounts of environmental conditions in 1854 depict the lower Moro Cojo Slough as subject to tidal seawater exchange from the ocean, as well as winter freshwater runoff and spring flow from the Moro Cojo watershed. A bridge connected the current Moss Landing Peninsula to the mainland, however, no channel structures were evident. A ferry was in operation across Elkhorn Slough at its confluence with the Salinas River. Salt marsh vegetation was recorded along both the Elkhorn Slough and Moro Cojo Slough from its confluence with the Salinas River (now Moss Landing Harbor) and upstream, probably a distance beyond the present location of the SPRR tracks. Open water ponds were evident adjacent to Moro Cojo Slough channel, as were numerous side channels and low-lying wetland areas. The upland areas surrounding the slough were grassland; the upper watershed areas were dominated by annual grasslands, chaparral and oak woodland habitat.

Between 1850 and 1910, major changes in the resources of the study area occurred as tidal control structures were installed across the Moro Cojo Slough channel. By 1886 the Pajaro Valley Railroad and SPRR had crossings over the slough. A county road (near the current Moss Landing Road) and Castroville Road crossed the slough at or near their present locations. The Pajaro Valley railroad crossing and the county road (e.g., Moss Landing Road) crossing were earthen fill across almost all of the slough, resulting in a restriction in tidal exchange (e.g., Sandholdt Dam). Agricultural land uses, predominantly cattle grazing, were common above the tidal range within the watershed. Reports of surfperch, steelhead and other fish were recorded from the slough from the turn of the century until the 1930's.

Between 1910 and the mid-1940's, extensive reclamation of wetlands for agricultural use occurred around Monterey Bay. Reclamation of tidal land around Moro Cojo Slough appears to have occurred in the 1930's and 1940's, primarily through ditching, levees and berms. Also during this time was the loss of shallow groundwater in the Moss Landing and surrounding areas, presumably by agricultural and other uses. Industrial uses, such as the Pacific Gas & Electric (PG&E) Moss Landing Power Plant and Kaiser Refractories Plant, were built before 1949. Wetland habitats during this period were confined between levees or berms, and cut off from tidal exchange. In 1946-47, the Moss Landing Harbor entrance was constructed which created a deep tidal inlet at the mouth of Moro Cojo Slough. This action, coupled with the relocation of the Salinas River in 1910, ensured that marine conditions prevailed in the slough.

Between 1947 and the present, land uses such as residential development, grazing and agriculture (i.e., crops of artichokes and strawberries) intensified within the watershed. Additional levees and ditches were constructed adjacent to the slough to facilitate year-round agriculture (1940 through 1989), industrial development occurred along the northwestern portion of the watershed (e.g., expansion of the PG&E and National Refractories developments between 1949 and 1968), land fill activities relating to commercial development near Moss Landing (1949 through 1976), and residential and school development (1976 through 1979). Portions of riparian corridors were channelized and/or dammed between 1976 and 1979. There are reports of the presence of steelhead, striped bass and salmon in the slough as late as the 1940's. In 1988, the culverts of Sandholdt Dam under Moss Landing Road were replaced so that very limited tidal inflow now occurs.

HYDROLOGY

The hydrology of the Moro Cojo Slough watershed is complex having changed significantly over geologic and historic time. Fluvial processes, coastal processes, groundwater and human modifications have affected the hydrologic features of the slough system. The Moro Cojo Slough watershed is located within the northeastern corner of the Salinas Valley groundwater basin. The hydrologic regime has been modified by the construction of a tide gate at the mouth of the slough, man-made drainage channels, levees, and use of ground and surface water for agriculture and residential development.

The lower watershed includes the remnants of Moro Cojo Slough, which is incised within a valley floor of recently deposited estuarine muds. Elevations on the valley floor range from 0.0 feet mean sea level (MSL) at the top of the slough channel to about +8.0 feet MSL at the valley edges. The lower slough, between Moss Landing Road at the mouth and the confluence with Castroville Slough, exhibits channel widths up to 500 feet, narrowing gradually to less than 50 feet at the SPRR and then less that 5 feet at its head near Castroville Boulevard A nearly continuous levee system bounds Moro Cojo Slough between the SPRR and Highway 1; behind these levees are drainage ditches serviced by pump systems. Castroville Slough drains the northeastern side of the town of Castroville into Moro Cojo Slough about 2 miles above Moss Landing Road. Other tributaries have been filled or reclaimed.

A variety of hydraulic structures have been constructed in and around Moro Cojo Slough to drain marsh land for agricultural use or to provide road crossings over the slough, including Sandholdt Dam. The MCWRA manages tide levels in the slough between −2.0 and −1.5 feet MSL to prevent flooding of residential and agricultural lands. The culverts at Highway 1 forms a constriction in addition to the SPRR crossing and Castroville Boulevard culverts.

Annual precipitation averages 17.3 inches in the Moro Cojo area and conveyance of flood flows is restricted by the artificial hydraulic controls at SPRR, Highway 1, Moss Landing Road and the levee and ditch system surrounding the slough, flood control facilities are managed and administered by the

MCWRA. Local farmers operate the Sea Mist Dam and pump system on Castroville Slough, as well as small scale drainage around farm lands.

BIOTIC RESOURCES

Vegetation

The vegetation within the Moro Cojo Slough watershed is comprised of several plant communities: wetlands (coastal salt marsh, freshwater marsh, herbaceous wetlands, and central coast arroyo willow riparian forest); grasslands (coastal alkali grasslands, mixed and non-native grasslands); maritime chaparral; coast live oak woodland; coyote brush scrub; and several types of non-native plant communities (residential landscaping, agricultural lands, ruderal, and non-native landscape trees).

The wetland communities are the dominant feature along the slough channels and form almost continuous bands along the watercourses. The width of the coastal salt marsh has been limited historically by the construction of man-made levees, berms and drainage ditches along the border of the slough. The modified tidal regime also restricts the linear extent of the salt marsh vegetation from the mouth of the slough to just upstream of the SPRR tracks. Areas previously inhabited by salt marsh vegetation show evidence of conversion to a species composition that is more tolerant of freshwater. Above Castroville Boulevard there are stands of arroyo willow riparian forest; small freshwater tributaries to the slough are vegetated with a combination of herbaceous wetlands and willow riparian habitat. Much of the upland plant communities within the watershed have been modified by various land uses. Areas historically inhabited by maritime chaparral are now a mixture of chaparral and residential landscaping, including non-native trees (i.e., eucalyptus groves). Remnant grasslands remain throughout the study area, the most prominent are in areas being used as pasture land; a portion of the historic alkali grasslands remain near Highway 1.

The records of the California Department of Fish and Game's (CDFG) California Natural Diversity Data Base (CNDDB) and other reports for the region indicate the following rare, endangered and/or locally unique plant species have the potential to occur or have been reported within the study area: Hooker's manzanita, Pajaro manzanita, Santa Cruz Mountains pussypaws, Monterey ceanothus, Monterey spineflower, Lewis's clarkia, seaside bird's-beak, Eastwood's goldenbush, fragrant fritillary, small-leaved lomatium, curly-leaved monardella, Dudley's lousewort, Gairdner's yampah, wild petunia, Yadon's piperia, Hickman's cinquefoil, round woolly marbles and Santa Cruz microseris. Gairdner's yampah was observed within the mixed grassland community and Hooker's manzanita and Pajaro manzanita were observed in the maritime chaparral (Figures 5-3 and 5-4).

Wildlife

The Moro Cojo Slough watershed is a valuable resource to a great variety of wildlife species. The slough and its associated wetlands habitats, with its close proximity to the nearby Elkhorn Slough system, Old Salinas, Salinas and Pajaro River mouth areas and Monterey Bay, combine to make the most important wetland system on the central coast for wildlife. Wildlife habitats are comprised of the plant communities mentioned above, as well as hypersaline ponded areas, mudflats and perennial and seasonally inundated freshwater and brackishwater ponds. Wildlife species diversity and abundance varies depending on the season and the water levels of the slough wetlands. While some wildlife species may be restricted to certain plant communities due to specific habitat requirements, many of them utilize several of the habitats in the watershed.

Several significant wildlife uses have been identified in the watershed. These include amphibian migration corridors, potential amphibian breeding sites, potential nesting/foraging habitat for hawks and warblers, egret foraging/roost area, black-shouldered kite roosting area, shorebird and waterfowl nesting and foraging habitat, potential tricolored blackbird nesting habitat, potential amphibian upland habitat and known occurrences of rare and endangered species (Santa Cruz Long-toed Salamander [SCLTS]) and species of special concern (California tiger salamander, California red-legged frog).

Fisheries and Aquatic Resources

The fishery resources of the slough are known from very limited sampling. Anecdotal accounts indicate that large numbers of red-tailed sea perch (surfperch), steelhead and other fish populated Moro Cojo Slough from before the turn of the century until the 1930's (Hansen, 1976). Studies during the 1970's and 1990's recorded the presence of native and non-native non-game fishes. Fish species typical of the lower slough include threespine stickleback, long-jaw mudsucker, staghorn sculpin, jacksmelt and mosquitofish. Tidewater goby, a Federal endangered species, may inhabit the lower slough.

The study assessed the presence of the brackishwater snail, an aquatic species of special concern and candidate for Federal threatened listing. Studies documented widespread presence of the snail from approximately half-way between Moss Landing Road and Highway 1, east to just upstream of the confluence with Castroville Slough. The snail appears to utilize the area of shallow, slow-moving tidal waters and depositional mud deposits of the slough.

AGRICULTURAL RESOURCES

Agriculture is a major land use in the study area, with approximately 10,000 acres in agricultural production within the Moro Cojo Slough watershed. The crops include artichokes, strawberries, flowers, vegetables and cattle operations. The row crops are grown year-round, mostly on land adjacent to the lower slough. Artichokes, the predominant vegetable crop, are grown by Sea Mist Farms on approximately 875 acres on three ranches within the lower slough.

Strawberries are the largest fruit crop in production within the watershed for a total of approximately 2,000 acres. The strawberry fields are located in the upper watershed and are farmed by lessees which tend to be renewed on a yearly basis. Most individual farms are between 10 and 50 acres. In addition to fertilization of the ground prior to planting, the land is fumigated to kill weed seeds, nematodes and plant diseases. Although approximately 20 pesticides are regularly used on the strawberry crop, some growers are using biological controls for some pests (i.e., mites). Several of the strawberry farms within the watershed have crops planted immediately adjacent to the slough, where problems with soil erosion (development of hard pans) and water contamination from sprays and fertilizers are evident.

Vegetables are grown in many areas of the slough, primarily near Highway 1 and Dolan Road. Crops include brussels sprouts, broccoli, lettuce, spinach and cauliflower. Crop production activities are similar to artichokes, except for more intensive application of fertilizer. Vegetable growers are implementing practices to minimize erosion and runoff into the slough and typically cover crop their fields every 2-3 years to replenish soil fertility.

Nurseries growing cut flowers are located in the upper watershed area near Elkhorn Road. Fumigants, pesticides and fertilizers are utilized prior to or during production with irrigation occurring by sprinklers and drip tape. The nurseries have recently improved management practices to collect runoff and correct hillside erosion problems.

Cattle operations occur along Highway 1, Highway 156, Dolan Road and Castroville Boulevard and two dairies are located along Dolan Road. Many of the operations border the slough, and some have no separation between operations and the watercourses. Small grazing operations exist in the upper watershed rural residential areas, including acreage with horses, pigs, chickens and cattle.

WATER QUALITY

Water quality of the Moro Cojo Slough has been altered by a variety of human activities. These include diking and draining of wetlands, point and non-point discharges by industry, reduction in surface and groundwater supply, and uncontrolled runoff from some agricultural practices. One package treatment plant (a factory which gathers wastes and conducts all treatment on-site), the WaterTek facility, serves the Oak Hills community near Castroville Boulevard and consists of percolation ponds and a spray field. With the exception of Oak Hills, the areas served by the Castroville County and Moss Landing County Sanitation Districts, the watershed developments are on septic systems.

The primary threats to the resources of the slough are due to increased nutrient input, septic system failure, inadvertent release of hazardous materials, and persistent pesticide residue. Many the agricultural operations bordering the slough implement land management practices to minimize impacts to the slough water quality. These include roads to prevent irrigation runoff, fertilizer runoff or pesticide over-spray from entering the slough.

Nutrients enter the slough from uncontrolled agricultural runoff, seepage from holding ponds and poorly placed or faulty septic systems. The nutrient enrichment can cause eutrophication, resulting in algal blooms that ultimately reduce oxygen availability for aquatic animals.

Persistent pesticide residues from past use of DDT, toxaphene, dieldrin, endrin, and aldrin are suspected of being present in the water and underlying slough sediments. Endosulphan, a pesticide currently in use, may also be present in the water. Detailed water and sediment testing is required to determine whether these pesticides or their derivatives are present.

LAND USE

Moro Cojo Slough is a major wetland resource occupying a significant percentage of land within the study area. Other predominate land uses include agriculture and low density rural residential development on uplands surrounding the slough. Industrial uses occupy a small percentage of land in the lower slough, with some commercial and high density residential development in Castroville and along Highways 1 and 156. All of these land uses have had some impact on the slough system over the last 100+ years.

The 1982 North County Land Use Plan (LUP) is the County Planning document which guides future land use changes in the study area. This plan places a strong emphasis upon preservation of natural resources including environmentally sensitive habitats (wetlands and rare-endangered species), as well as protection of viable agricultural lands. On lands without sensitive resources and unsuited for agricultural use, coastal-dependent development has priority. Other types of development (residential, non-coastal dependent commercial) are designated in parts of the study area. The Local Coastal Program also includes implementation plans (1988a, b) which provide development regulations and permit processing requirements to enact policies within the LUP.

PUBLIC ACCESS AND EDUCATION

Public access to the slough is limited for all modes of transportation. Vehicular access is supplied by intersections of the slough with county roads and State Highway 1. Pedestrian access is limited to public rights-of-way, with little separation from traffic. No public trails exist adjacent to the slough itself. The existing public trails in the watershed are limited to the hiking/equestrian trails in Manzanita Regional Park and the California Coastal Bicycle Route, although ad hoc trails do exist in scenic easement areas within the Oaks Hills community. The North County Trails Plan proposes numerous new trails in the Moro Cojo Slough watershed. These include trails along existing roadways and trails within scenic easements.

There are five public schools within the watershed, providing opportunities for education activities on the slough's resources. An existing agreement with North Monterey County High School specifies the development of a wetland educational program.

MANAGEMENT AND ENHANCEMENT

The present ecological condition of Moro Cojo Slough is substantially degraded as introduced land uses have altered both tidal influences, groundwater-spring flow and, consequently, the backbone of most of the original habitat. Significant hydrologic changes have occurred, including blockage of tidal seawater inflows with the construction of a dam at the mouth of the slough, reclamation of vast marsh lands to agricultural uses, clearing and urbanization of the upper watershed and Castroville areas, and over exploitation of groundwater resources throughout the watershed. A recent lack of freshwater due to the extended drought (1987-1992 and 1994) and a decline in groundwater quality has reduced the agricultural value of land in the former tidal areas surrounding the slough.

Moro Cojo Slough is degraded and has far less ecological value than the original system; however, an opportunity exists to enhance, manage and restore what are now relatively rare habitats in the Monterey Bay area.

Habitat enhancement and restoration often involves physically manipulating land and water (raising or lowering levees or berms, removing dam structures, grading land, etc.) in order to re-introduce the hydrologic conditions that support vegetation and wildlife habitat. However, physical manipulations must also be designed for other land uses that were absent in the pre-European era, such as flood control, mosquito control, agricultural use, and infrastructure. Restoration must look to the past for guidance and examples but the design must recognize that modern conditions may not allow for the restoration of the original and natural conditions. In order to optimize environmental values, the design must be compatible with the current conditions.

Preferred Lower Watershed Plan

Five alternatives to enhance resources within the lower watershed of Moro Cojo Slough (e.g., Moss Landing Road to Castroville Boulevard) were developed. These alternatives were evaluated by the RAC, who then selected the preferred resource management alternative for the lower watershed. The five alternatives reviewed were; Alternative A, Tidal Regime; Alternative B, Partially Tidal Regime; Alternative C, Enhanced Existing Conditions; Alternative D, Winter/Spring Freshwater Conditions; and Alternative E, No Project.

Each of the five alternatives evaluated suggest actions to protect existing significant biotic resources, increase overall habitat values within the slough environs, resolve existing resource problems and land

use conflicts and provide passive recreational/educational uses. The RAC reviewed each of the alternatives presented in the Resource Enhancement Alternatives report and, through consensus, selected Alternative D, Winter/Spring Freshwater Conditions as the Preferred Plan (Figure 10-1).

The Preferred Plan - Winter/Spring Freshwater Conditions creates areas for freshwater impoundments within the lower slough watershed between Moss Landing Road and Castroville Boulevard The plan does not modify the existing tidal environment below the SPRR. The tide gates at Moss Landing Road will be retained and operated in the same manner as the existing operation. A flashboard dam will be installed at SPRR to restrict tidal movement and to allow upstream impoundment of freshwater during the winter and spring. Freshwater impoundments would also be created in existing alkali grasslands, and/or excavated into the grassland, between Highway 1 and the SPRR. The RAC has recommended the use of "eco-engineering" (e.g., hay bales) to create barriers between the freshwater impoundments and the main slough channel. The hay bale barriers will need to be constructed so they are effective in impounding water, to create the desired freshwater "lakes", as well as preventing excessive leakage of freshwater into the adjacent salt/brackish main slough channel, to protect habitat for the brackishwater snail. Existing brackishwater areas above the SPRR would convert to more freshwater conditions due to the construction of a flashboard dam at the SPRR overcrossing. Areas currently freshwater near Castroville Boulevard would persist. Most areas below the 10-foot contour between Highway 1 and SPRR would be subject to freshwater inundation during the winter and spring, depending upon rainfall. The RAC has recommended the use of reclaimed water to maintain the freshwater impoundments during the winter and spring, if rainfall and/or runoff from the watershed is not sufficient to keep the impoundments inundated. The preferred plan incorporates agriculture and/or grazing on lands above the 10-foot contour.

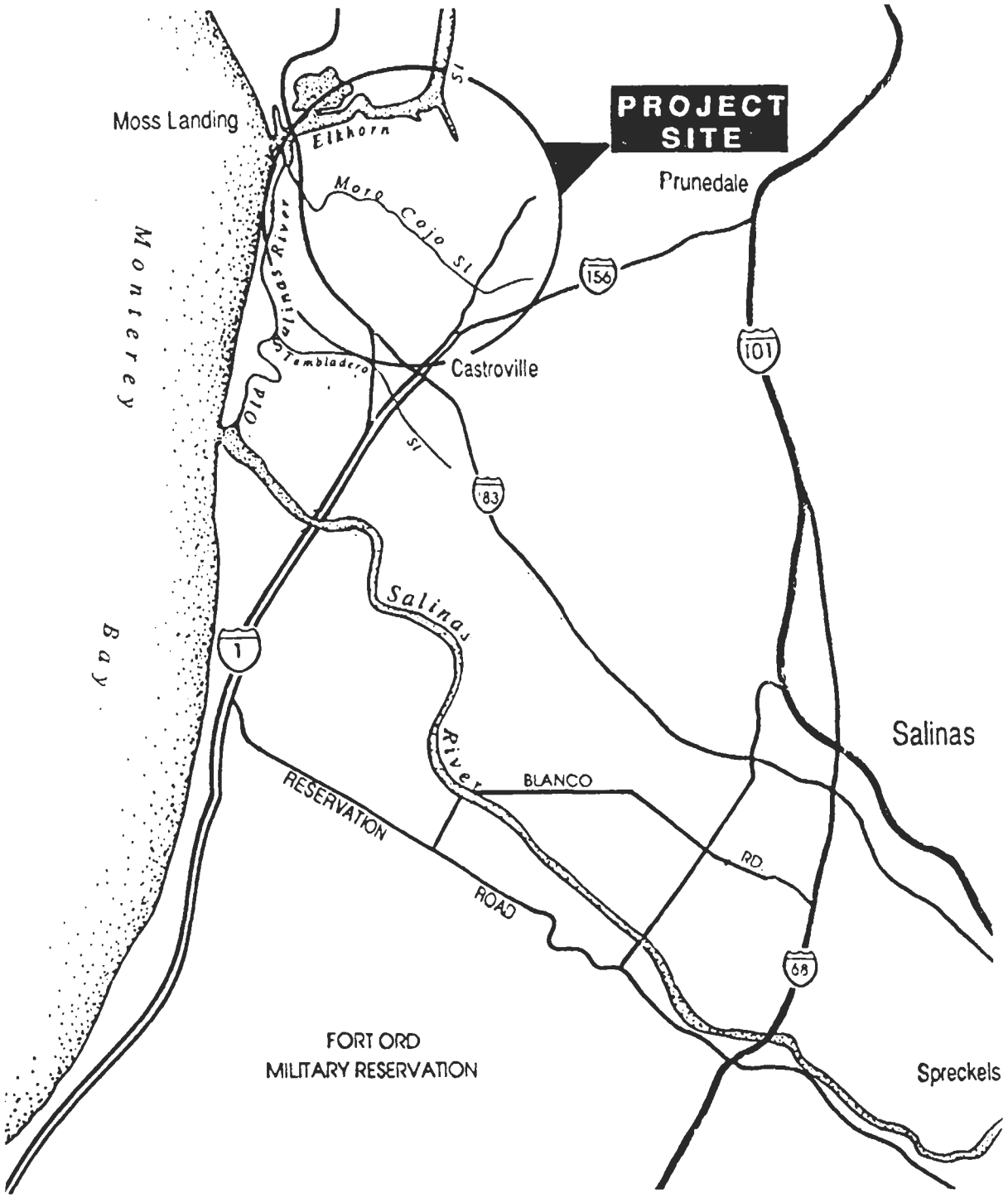
The preferred plan offers several features that meet the project goals and objectives. The plan also poses several constraints, including hydrologic, biological, and agricultural land use issues. The alternative will also require several permits from regulatory agencies. An analysis of the key actions and the anticipated impacts and mitigations of this alternative are described below and summarized on Table 10-2.

Project-wide Best Management Practices (BMP's)

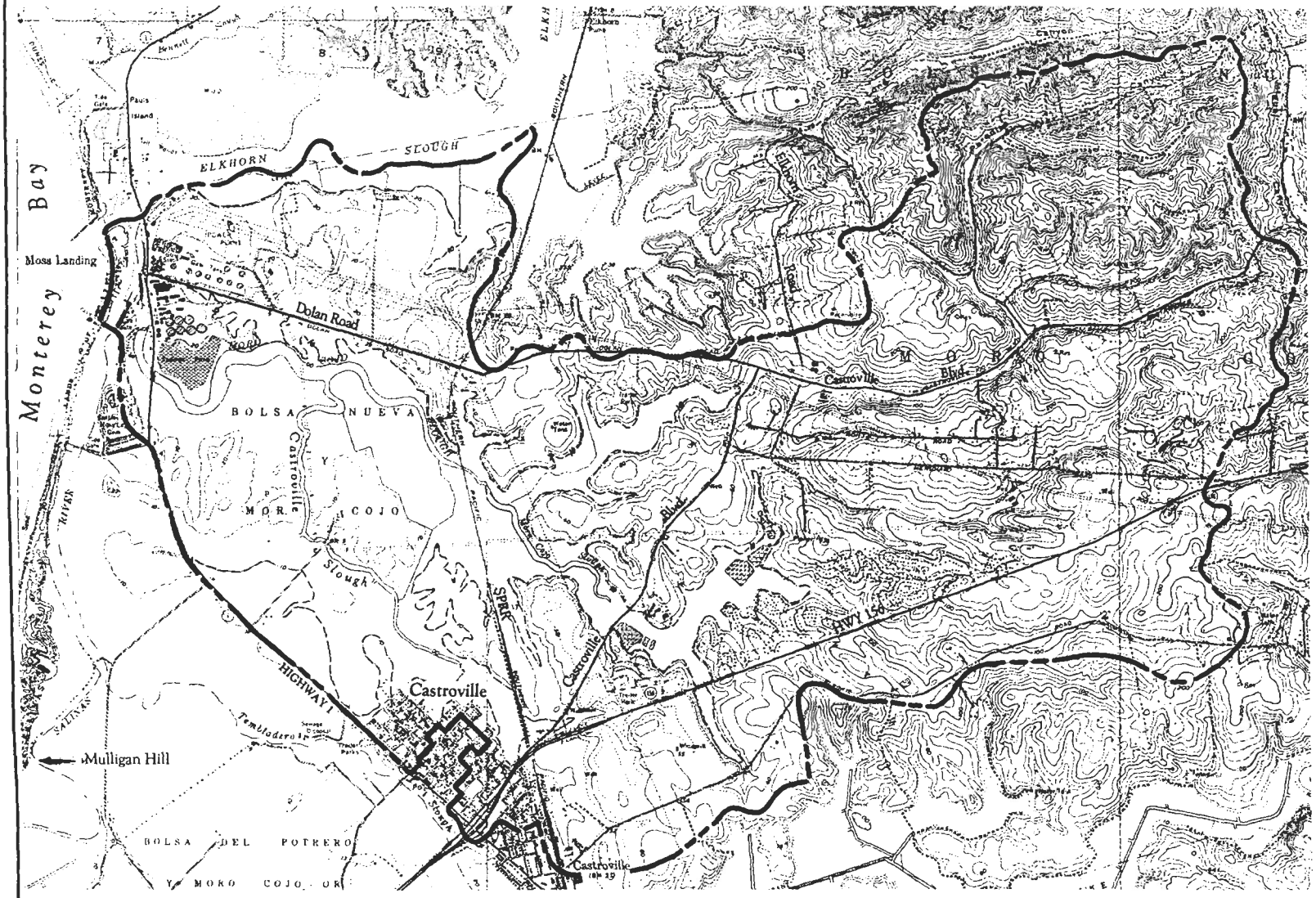
BMP's are recommended for the entire watershed to provide resource protection and enhancement (Figure 11-1). The BMP's are consistent with guidance documents developed as part of Section 6217 of the Coastal Zone Reauthorization Amendments of 1990 (CZARA). This act requires states with federally approved coastal zone management programs, such as California, to develop and implement Coastal Nonpoint Pollution Control Programs to ensure the protection and restoration of coastal waters.

The BMP's address sediment/erosion, confined animal facilities, nutrient management, pesticide management, livestock grazing, new development, sewage systems, pollution prevention, stormwater runoff, protection and restoration of wetland and riparian areas, and public education. The BMP's also recommend actions to protect and manage rare, threatened, endangered and locally unique plant and animal species and their habitats.

The locations for each action are depicted in Figure 11-1. Landowners are encouraged to voluntarily implement these actions in order to meet the overall project goal of enhancement and resource values of the Moro Cojo Slough watershed. Each action is intended to be implemented by/with willing landowners.



The Habitat Restoration Group Mitchell Swanson & Associates VB Agricultural Services Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Project Vicinity Map	Figure 1-1 2/96 705-01



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• Applied Marine Sciences

Moro Cojo Slough Management and Enhancement Plan
Project Study Area

2/96
705-01

Figure 1-2

CHAPTER 2
INTRODUCTION

PURPOSE OF MANAGEMENT AND ENHANCEMENT PLAN

The purpose of the Management and Enhancement Plan for the Moro Cojo Slough is to identify actions and measures to enhance, restore and create a diverse and productive mix of wetland habitats, improve water quality, manage flood waters consistent with the protection of natural and agricultural resources and provide for public access and education in appropriate areas adjacent to the slough. The plan indicates specific wetland enhancement alternatives and conceptual restoration designs for selected sites. The plan also identifies actions to: control erosion and sedimentation on the watershed, improve water quality of the slough, protect endangered and threatened species, manage flood control and agricultural practices to maximize compatibility with wetland viability, and indicates opportunities for public access and recreation.

This plan addresses wetland resources that are identified in the Monterey County General Plan and the LUP, a segment of the Monterey County Local Coastal Program. The plan addresses resource management measures for both public and privately-owned lands, including those owned and/or managed by MCWRA, Elkhorn Slough Foundation, CDFG, and National Oceanic and Atmospheric Administration (NOAA) for the Monterey Bay National Marine Sanctuary.

The request for a management and enhancement plan was initiated in 1990 by Monterey County in response to land use conflicts and development pressures within the slough watershed, as identified in the Local Coastal Program. The project was funded jointly by a grant from the State Coastal Conservancy; with in-kind contributions from Monterey County, MCWRA, State Water Resources Control Board and Elkhorn Slough Foundation.

Monterey County Planning and Building Inspection Department and the State Coastal Conservancy coordinated the preparation of the plan. The Habitat Restoration Group (HRG) was selected as the consultant to prepare the plan in 1993. The Elkhorn Slough National Estuarine Research Reserve Advisory Committee (RAC) provided review and guidance on development of the plan.

GOALS AND OBJECTIVES

GOALS

The goals of the Moro Cojo Slough Management and Enhancement Plan are derived from the LUP and RAC. Goals and objectives developed at the July 1993 RAC meeting are designated as "(RAC)" in the text below.

- Preserve, enhance and restore the natural resource values of the wetlands and adjacent upland habitat of the slough for maximum biological resource values.

- Reduce the impacts of human activities (including water quality, sedimentation and erosion) on the slough's wetland resources.

- Utilize resources of other projects as a vehicle for restoration (e.g., CalTrans, Moss Landing Harbor, Elkhorn Slough National Estuarine Research Reserve [where property within the reserve lies within the Moro Cojo Slough watershed] and other agencies, as applicable).

- Provide passive recreational uses of the slough and adjacent habitat where compatible with natural resource management and adjacent land uses.

- Increase freshwater supply to benefit wetland habitat values (RAC).

- Develop BMP's for the slough and immediate vicinity.

- Restore and enhance habitat for plant and wildlife species of special status.

- Provide natural resource interpretation for the residents of, and visitors to, the Moro Cojo Slough region.

OBJECTIVES

The objectives of the Moro Cojo Slough Management and Enhancement Plan are the derived measurable results of implementing the goals.

General Overall Objectives

G-1 Examine the benefits of maximizing freshwater retention (RAC).

G-2 Achieve habitat diversity through non-mechanical, low-maintenance and low-cost projects that have minimum habitat disturbance (RAC).

Biological Objectives

B-1 Evaluate the benefits, costs and feasibility of separating and increasing freshwater marshes and wetlands (RAC).

B-2 Evaluate the benefits, costs and feasibility of separating and increasing salt/brackish water marshes and wetlands.

B-3 Control and/or eradicate invasive non-native plant species. Minimize opportunities for non-native plant species to establish in and around the natural habitat areas.

B-4 Create barriers to deter domestic pets, feral animals and non-native wildlife from habitat areas. These animals reduce the value of natural habitats for waterfowl and other species naturally associated with such resources.

B-5 Manage habitat in and around the wetlands in a manner conducive to maintaining and/or enhancing wildlife habitat values.

B-6 Where possible, create buffers between existing and/or proposed agricultural/urban developments and the sensitive slough habitat areas, consistent with the Local Coastal Program.

B-7 Revegetate barren and degraded areas with native plant species to enhance botanical and wildlife values.

B-8 Maintain the local gene pool of native vegetation by planting locally native species.

Water Quality and Non-Point Pollution Objectives

W-1 Identify alternative methods to address water quality problems at the source (RAC).

W-2 Minimize sedimentation and soil erosion through the use of vegetation cover and other surface erosion control measures.

W-3 Improve and/or create stormwater detention facilities to protect/enhance water quality of the slough from agricultural and urban runoff.

W-4 Manage water and drainage to accommodate agricultural uses on adjacent lands.

W-5 Avoid actions that impact groundwater.

W-6 Coordinate with mosquito abatement district on measures to minimize impacts to sensitive habitat features.

W-7 Develop a monitoring program to evaluate the success of the slough management program.

Agricultural Objectives

A-1 Identify alternative management practices (RAC).

A-2 Identify practices which can benefit agricultural drainage and wetland resources (RAC).

A-3 Develop management plans for current agricultural crops to minimize impacts to wetlands.

A-4 Identify practices to minimize erosion, control irrigation drainage and minimize pesticide and fertilizer runoff into wetlands.

A-5 Identify agricultural-wetland conflicts and mitigation measures for solutions.

Land Use Objectives

L-1 Evaluate potential habitat restoration areas on marginal agricultural lands (RAC).

Public Access and Education Objectives

P-1 Evaluate linking public access with educational facilities within and adjacent to Moro Cojo Slough (RAC).

P-2 Encourage citizen involvement and participation in the planning and implementation phases of the watershed management plan.

P-3 Explore potential revenue sources and regulatory mechanisms to implement the plan.

RELATIONSHIP WITH LOCAL COASTAL PROGRAM

The LUP, a segment of the Monterey County Local Coastal program, guides development within the coastal zone in the Moro Cojo Slough areas of the county. The LUP focuses on critical planning issues identified in the Coastal Act, including agriculture,

Several policies within the LUP relate to the management of the area's slough resources.

Policies include the following:

- Resource management and enhancement plan should be developed for Moro Cojo Slough.
- Environmentally sensitive habitat areas shall be protected against any significant disruption of habitat values, and only uses dependent on such resources shall be allowed within such areas.
- Development in areas adjacent to environmentally sensitive habitat areas and parks and recreation areas shall be located and designed to prevent impacts which would significantly degrade such area and shall be compatible with the continuance of such habitat areas.
- Prime farmland should be permanently preserved unless there is an overriding need to protect the public health and safety or where conversion is necessary to establish a stable boundary between agriculture and adjacent urban uses or sensitive habitat,
- Views along Highways 1 and 156 should be preserved and restored consistent with their scenic highway designation.
- Prohibit development to the fullest extent possible in beach, dune, estuary and wetland areas, and protect viewsheds.

Planning guidelines specific to the County's wetland resources have been developed in the LUP; these include: development of low intensity recreational uses, research and education, grading setbacks adjacent to wetland areas, reduction of impervious surface coverage, a 100-foot setback established from the edge of wetlands, and encouragement for preservation and restoration of wetlands.

OTHER PLANNING DOCUMENTS

Several other plans also affect land use decisions and the development of sensitive environmental resource areas in the Moro Cojo Slough area, including the Moss Landing Harbor District (MLHD) Master Plan (1986), the North County Area Plan (1988), the Moss Landing Community Plan (1982) and the Elkhorn Slough Wetland Management Plan (1989).

EXISTING POLICIES AND REGULATIONS

Land use activities within the Moro Cojo Slough watershed are subject to regulations by several agencies. Monterey County is the primary land use authority which regulates development-related activities within the watershed, however, other agencies may be involved depending upon the location, activity and resources involved. Other agencies may include: California Coastal Commission (CCC) (permit within tidal, wetland areas, appealable areas), CDFG (Streambed Alteration Agreements), permits relating to State-listed plants and animals and Federally-listed plants, USFWS (relating to Federally-listed plants and animals), Regional Water Quality Control Board (RWQCB) (discharges into waterbodies), NOAA Mon-

terey Bay Sanctuary (discharges into Monterey Bay) or U.S. Army Corps of Engineers (COE) (fill or excavation of jurisdictional wetlands or waters of the U.S.).

Monterey County

The County of Monterey has policies within the Local Coastal Program for new development within and adjacent to environmentally sensitive resources, such as riparian corridors, wetlands and rare and endangered species habitat. Policies include preparation of biological reports, setbacks to environmentally sensitive habitats, and protection of sensitive areas through deed restrictions or dedication of permanent conservation easements. Where development has already occurred in areas supporting sensitive habitat, property owners are encouraged to voluntarily establish conservation easements or deed restrictions.

Recently, in 1993, development projects have occurred adjacent to and outside of the coastal zone within the town of Castroville, and have resulted in the deposition of fill materials in areas of apparent wetlands along Castroville Slough (areas depicted on Figure 3-5). Because this area is largely outside of the coastal zone, it is unclear whether permits were obtained from regulatory agencies, such as COE or RWQCB. The developments have resulted in the fill of apparent wetlands and development within the 100-foot riparian setback. Local permits were obtained and pursuant to Monterey County's restoration ordinance, restoration plans have been prepared. The restoration plan is required for any unauthorized work within the wetland area within the 100-foot setback but outside of the coastal zone. Under the ordinance, restoration includes, but is not limited to, the revegetation of native plants and the reconstruction of natural land features (Section 21.84.130).

U.S. Army Corps of Engineers (COE)

The U.S. Environmental Protection Agency (EPA), as administered by the COE, regulates the discharge of dredged and fill materials into waters of the U.S. and has established a permit program to ensure that discharges comply with environmental requirements. Since 1972 and the implementation of amendments to the Federal Water Pollution Control Act (renamed Clean Water Act), the COE has had permit authority on filling and draining activities within navigable waters of the U.S. Since 1977, this authority was extended to include wetlands and adjacent waters. Also in 1977, a Section 404(f) amendment was added to the regulations which allowed for specific permit exemptions. These exemptions included normal farming practices, maintenance of dikes, dams, levees, and construction and maintenance of farm/stock ponds, irrigation ditches and drainage ditches (Section 404[f][1]). However, the exemptions do not apply to activities whose purpose is to convert an area of waters of the U.S. into another use, where the flow of waters may be impaired or the reach of such waters reduced (Section 404[f][2]). For example, a permit would be required for the discharge of fill into wetlands in order to convert the wetland area to produce upland crops.

In 1891, an Act of the Legislature declared the Moro Cojo Slough "unnavigable", in the interests of reclamation (Clark, 1991). It therefore appears that actions following the implementation of Section 404 in 1977 would require permitting by the COE. Within the Moro Cojo Slough watershed, there have been exempt, permitted and unpermitted alterations of jurisdictional waters and wetlands. As depicted in Figure 3-5, the activities performed prior to 1977 appear to be considered pre-existing and would not be subject to regulatory permitting. Activities conducted since 1977 that are considered exempt include the continued farming of wetland areas (i.e, farming/agricultural activities in areas below the approximately 10-foot contour) and continued maintenance activities along levees and agricultural drainage ditches. Examples of permitted actions include culvert and tidegate installation at Moss Landing Road and culvert replacement at Highway 1. Unauthorized actions have included deposition of fill materials into previously

undisturbed (pre-1977) portions of Castroville Sough and expanded farming or development activities into previously undisturbed wetland areas.

California Department of Fish and Game (CDFG)

Through Fish and Game Code 1601/1603, the Streambed Alteration Agreement, the CDFG has regulatory authority on activities affecting the bed and bank of stream courses. Streambed Alteration Agreements are required for construction-related activities within stream courses relating to new flood control projects, road construction and development activities. The Department has a policy of no-net-loss of riparian resources and often recommends a 2:1 or 3:1 replacement of riparian acreage lost. In addition, CDFG also has permit authority on the take of State-listed threatened and endangered wildlife and plant species through Section 2180 of the Fish and Game Code. CDFG also regulates the take of plant species which are both State and Federally-listed through an agreement with the USFWS. Within the Moro Cojo Slough watershed, CDFG has regulatory authority on the following species: seaside bird's beak, Santa Cruz tarplant, Dudley's lousewort, Hickman's cinquefoil, Santa Cruz long-toed salamander, California brown pelican, southern bald eagle, peregrine falcon, and California clapper rail.

U.S. Fish and Wildlife Service (USFWS)

The USFWS regulates, through permitting, the take of Federally-listed wildlife species on both private and public lands. USFWS regulates Federally-listed plant species when they occur on federal lands or where other federal agencies and/or funding is involved. USFWS also comments on issues relating to natural resources through the California Environmental Quality Act (CEQA). Within the Moro Cojo Slough watershed, USFWS requires consultation and permitting on the take of the following species and/or their habitat: Monterey spineflower, SCLTS, California brown pelican, southern bald eagle, peregrine falcon, tidewater goby, and California clapper rail. Additionally, USFWS consults with the COE regarding wetland permitting issues.

California Regional Water Quality Control Board (RWQCB)

The Regional Board has permit authority on discharges into California's waterways. They are responsible for certifying compliance of discharges with the State's clean water program. A certificate of compliance (or waiver) is necessary prior to issuance of a Section 404 permit from the COE.

California Coastal Commission (CCC)

The CCC regulates development activity within the coastal zone in areas where the Commission has retained jurisdiction, in conjunction with Monterey County's implementation of the North County segment of the Local Coastal Program. Selected coastal permit actions by Monterey County can be appealed to the CCC. The CCC retains original jurisdiction on tidelands, submerged lands, and other public trust lands (whether filled or unfilled) and for development by a public agency for which a Monterey County permit is required. The entire Moro Cojo Slough watershed, with the exception of the unincorporated town of Castroville, is in the coastal zone. If an activity occurs without the required permit, the CCC can issue a cease and desist order and/or subject the violator to fines (Section 30809).

Moss Landing Harbor District (MLHD)

The MLHD gained jurisdiction over all open water, to the point where tidal influence ceases for all sloughs which drain into Moss Landing Harbor, including Moro Cojo Slough. This grant was made by State Lands Commission in 1947. In 1991, the Harbor District established a permit process for any acti-

vity involving structures within, or physical use of open water areas. MLHD has issued permits for the Harbor area and Elkhorn Slough, but to date has received no permit applications for Moro Cojo Slough above Moss Landing Road. This discussion will be inserted into Chapter 7.

National Oceanic and Atmospheric Administration (NOAA)

The Monterey Bay National Marine Sanctuary, under authority of NOAA, regulates activities within the Sanctuary. The Sanctuary has permit authority on any human-induced deposition of materials from Moro Cojo Slough, and its tributaries, into the Bay.

Association of Monterey Bay Area Governments (AMBAG)

The Association of Monterey Bay Area Governments has proposed to develop a watershed management plan for the Tembladero, Espinosa, and Moro Cojo Slough drainages to address nonpoint source pollution (NPSP) from farm drainages. A companion Clean Water Act Section 319(h) implementation project has also been proposed. The 319(h) project involves the implementation of several wetland restoration projects, in a small portion of the watershed, to demonstrate their value as natural filters for reducing NPSP and facilitating groundwater recharge. AMBAG, through its CAMPITS project, has developed a Geographic Information System showing land uses in the Moro Cojo Slough Watershed.

Enforcement of Environmental Regulations

The reasons for non-permitted activities within waters and wetland resources within the watershed are probably numerous and varied. One probable reason is an overall lack of knowledge by landowners of what regulatory laws apply to their activities combined with poor communication between landowners and regulatory personnel. Secondary reasons include indifference to resource protection policies and/or regulations by landowners and lack of monitoring and enforcement by regulatory personnel.

IMPLEMENTATION PROGRAM

The focus of the implementation and cost estimate section is to identify potential sources of implementation, including both funded and volunteer activities. All activities will require coordination and approval from landowners. There are several avenues for implementation of the watershed enhancement and management recommendations. Activities could include the following:

Fully Funded Programs Administered by the County of Monterey. Funding could include General Fund allocations, Public Works Department funding, Planning and Building Department funds, Parks Department funding, or formation of a watershed-wide assessment district. If an assessment district is formed, the capital improvements and yearly maintenance costs could be divided among the parcels within the district.

Joint City and State/Federal Programs Administered by the County of Monterey. There are several funding programs available for restoration of wetland and coastal resources. Funding may be available from grant programs and/or matching fund programs for implementation of the enhancement and management recommendations. Once funding is secured, implementation could occur by contracted qualified personnel and/or volunteers (e.g., local schools, environmental groups, local residents).

State, Federal and Public Agency Programs. State, Federal or other public agencies that own land within the watershed should be responsible for implementation of the resource enhancement and management recommendations on their respective properties.

Private Industry Funded Program. Certain projects are suitable for implementation by private industry. These projects would be those that would be expected to potentially impact the wetlands, such as runoff from development or direct impacts to significant resources from development (i.e., commercial/residential development). Implementation would occur by contracting with qualified personnel.

Volunteer Programs. Certain projects are suitable for implementation by volunteers. Projects could include removal of invasive non-native plant species (where there is no use of herbicides or heavy equipment), monitoring of watershed features (i.e., water quality, vegetation, wildlife), and educational activities. Volunteer groups could include local school groups/classes, school science clubs, environmental groups, residents and neighborhood/homeowners associations.

IMPLEMENTATION MECHANISMS

For project-wide and/or lower slough enhancement and management recommendations, various implementation strategies are identified and described. Pond stewardship and education are suitable as project-wide tasks; many of the implementation strategies are also suitable to the lower watershed-specific plans. All activities will require coordination and approval from landowners.

Coastal Nonpoint Pollution Control Program

Section 6217 of the Coastal Zone Reauthorization Amendments of 1990 (CZARA) requires states with Federally approved coastal zone management programs such as California, to develop and implement Coastal Nonpoint Pollution Control Programs to ensure the protection and restoration of coastal waters. Within three years of program approval by NOAA and EPA (i.e., January 1999), states must provide for landowner implementation of the measures. Following a two-year monitoring period (to January 2001) to assess the effectiveness of the measures, states will then have an additional three years (until January 2004) to obtain landowner implementation of additional, more stringent management measures where necessary to attain or maintain adequate water quality standards (EPA, 1993). A funding request, to prepare a more comprehensive NPS Pollution program for the Natividad/Gabilan Creek watershed (which includes the Moro Cojo Slough drainage), has been submitted to the EPA under Section 205(j)(2) of the Clean Water Act (AMBAG, 1994). A companion project, under Section 319(h) of the Clean Water Act, is proposed to implement several wetland restoration projects to demonstrate their value as natural filters for reducing nonpoint source pollution and facilitating groundwater recharge (*ibid.*).

Watershed Stewardship/Education

The key feature in successfully implementing a watershed stewardship/education program is effective dissemination of information to area residents. Examples of implementation include:

Develop an Educational Brochure. An effective education device is the preparation of a brochure that is mailed to residents within the watershed. The brochure, or watershed guide, would describe the resources of the watershed and list actions residents can take to improve the resource quality of the area.

Funding Sources: Area businesses (through advertisements)
State Coastal Conservancy grants
Coastal Zone Management Program, NOAA
Section 314(b) Clean Lakes Program, EPA

Establish a Watershed Restoration and Management Committee. An advisory committee of concerned citizens could be established by the County to guide watershed activities.

Funding Sources: Coastal Zone Management Program, NOAA
Section 314(b) Clean Lakes Program, EPA

Establish an "Adopt-a-Habitat" Program. This program would utilize citizens, environmental groups, school groups (local K-12; adult school; science/math clubs) to adopt a habitat (i.e., wetland, oak woodland, grassland). The volunteers would establish a program to regularly monitor and/or conduct activities within their chosen habitat.

Funding Sources: Coastal Zone Management Program, NOAA
Section 314(b) Clean Lakes Program, EPA
State Coastal Conservancy grants
Intermodal Surface Transportation Efficiency Act (ISTEA)
Section 319 Non-Point Pollution Program, EPA

Examples of tasks that could be conducted include the following:

Bird monitoring: Monitor bird use of the slough a minimum of 4 times a year, in each major season. At each count (minimum of 10 minutes) all birds seen or heard are recorded. Use data to compare seasonal and yearly use.

Vegetation monitoring: Conduct vegetation monitoring along established transects (see Chapter 3) each spring, recording plant species along transect line. Monitor trends in vegetation composition and vegetation cover.

Fisheries monitoring: Conduct yearly sampling of slough to document species composition and habitat conditions. Conduct fish scale analysis to determine rate of growth of fish and fish condition analysis as a monitor of aquatic habitat conditions.

Reptile and amphibian monitoring: Conduct winter and spring sampling of water resources and known breeding areas to determine species composition and presence of sensitive species.

Water quality monitoring: Conduct seasonal measurements of water levels, Ph, temperature and salinity within the slough. Periodically collect samples for laboratory analysis for nitrates and other pollutants.

Debris and trash clean-up: Conduct yearly assessments of the slough and other watershed areas and clean up inorganic debris and trash.

Revegetation: Collect local native plant species propagules (seed); coordinate nursery propagation; and conduct revegetation of disturbed areas.

Non-native plant species control: Assess on a yearly basis the extent of non-native invasive plant species within the watershed; conduct field work to control/eradicate species from select areas; coordinate with qualified personnel on herbicide application.

Invertebrate monitoring: Conduct seasonal surveys of the slough to document presence and diversity of aquatic invertebrate species.

IMPLEMENTATION FUNDING

State and Federal programs are currently available to fund wetland restoration and management projects.

Watershed Protection Funding, Environmental Protection Agency (EPA)

The EPA has a number of funds available to implement watershed protection measures, many of which are applicable to projects proposed in the Moro Cojo Slough Enhancement and Management Plan.
Contact: EPA Office of Water Funds (202) 260-9113

Section 314(b) Clean Lakes Program. Funds available from the Restoration, Protection and Implementation Project to implement management techniques to protect water bodies. Funds are also available in the Post-Restoration Monitoring Project to monitor and determine effectiveness of various restoration techniques. Implementation programs are 50% matching monies. The Monitoring Project is 30% matching funds.

Section 319 (h) Nonpoint Source Implementation Program (NPSP). Funds available for implementation of NPSP, including post-implementation monitoring. Matching funds percentages vary on the type of project.

Coastal Zone Management Program, National Oceanic and Atmospheric Administration (NOAA)

This program is intended to provide funds for the implementation of State Coastal Zone Management Programs, including non-point pollution control programs.
Contact: Coastal Programs Division, Office of Ocean and Coastal Resource Management, National Ocean Service, NOAA, 1825 Connecticut Ave., NW, Washington, DC 20235.

Wetlands Reserve Program, Agricultural Stabilization and Conservation Service

The program is intended to restore and protect farmed wetlands by providing permanent or long-term easement with the Federal agency. Technical assistance from Natural Resources Conservation Service (NRCS) on restoration practices is also available. Funding is available through 1995.
Contact: County or State NRCS Office of Conservation and Environmental Protection Division, USDA (202) 720-6221.

Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, Federal Highway Administration

The ISTEA program, administered in California by CalTrans, has funding available for habitat enhancement when the enhancement is related to roadway improvements. Funding may be limited for projects in the lower slough adjacent to/within the CalTrans Right-of-Way.
Contact: CalTrans or Transportation Agency for Monterey County.

CHAPTER 3
HISTORICAL PERSPECTIVE

Moro Cojo Slough has experienced dramatic hydrologic changes since the introduction of European-style land uses in the mid-1800's. These changes were aimed at draining land for agriculture, which counteracted the natural hydrologic forces that originally formed Moro Cojo Slough and its wetlands. Management, enhancement and restoration efforts will involve reversing land reclamation efforts to an extent that does not impact remaining adjacent agriculture and other land uses. However, some of the historical changes will be impossible to reverse to the precise historical conditions, for example, re-establishing significant freshwater flows without the historical proximity of the Salinas River mouth. Therefore, restoration efforts must be based upon realistic modification of the present condition and geared toward maximizing biological values consistent with preservation of a healthy agricultural environment and local economy.

HISTORIC HYDROLOGIC CONDITIONS

Pre-1850's

Under conditions prior to the 1850's, Moro Cojo Slough was subject to tidal seawater exchange from the ocean, as well as winter freshwater runoff and spring flow from the Moro Cojo watershed. Periodically the slough also received runoff from the Salinas and Pajaro Rivers and Elkhorn Slough. These hydrologic and biotic features are partially displayed on an 1854 U.S. Coast and Geodetic Survey (CGS) map (Figure 3-1).

The 1854 map clearly shows that Moro Cojo Slough experienced regular tidal seawater exchange. The low tide line (which approximates Mean Low Water (presently −1.5 feet NGVD) extends well inland and connects Moro Cojo Slough to the tidal inlet at the historical mouth of the Salinas River. The width of the slough (up to 500 feet wide) resulted from constant scouring, the tidal ebb flows and a large tidal prism. Highly meandering tributary channels are also characteristic of tidal flows.

The 1854 map shows the Salinas River in its pre-1910 historic position, north of Moss Landing, along with remnant channels that connected the Pajaro River to the historical mouth of the Salinas River. This geometry of the Pajaro and Salinas River mouths would have brought winter freshwater inflows to Elkhorn and Moro Cojo Slough, as well as the broad floodplain areas to the south. The historic mouth of the Salinas River was relocated to its present position after 1908, when a major flood breached the barrier beach just south of Mulligan Hill. Farmers, seeking relief from flooding of the Salinas River lagoon, installed an earthen tide gate on the Old Salinas River inlet. The farmers, followed by the MCWRA, periodically breached the seasonal summer sand bar to maintain low lagoon levels.

Geologic evidence indicates that the Salinas River may have been at its present south position at Mulligan Hill for extended periods in the past (Gordon, 1987). Thus Moro Cojo Slough would have been periodically isolated from the Salinas River source of freshwater. Regarding this issue on Elkhorn Slough, with relevance to Moro Cojo Slough, Gordon states that:

> *"...comments on seasonally freshwater in the slough (Elkhorn) are confined to the historical period - that is, to conditions that have existed since European settlement began. There may well have been earlier periods when Elkhorn Slough was, as now, strictly speaking a marine estuary, with its waters saline throughout the year (for example, in the geologic past when the Salinas River emptied naturally into the bay near Mulligan Hill)."*

Gordon (*ibid.*) cites the deltaic bulge on bathymetric maps just offshore of the present mouth, as well as the groundwater outflow in the 140-foot aquifer through an old channel of the Salinas River, just offshore of the present location. It is probable that the Salinas River mouth switched between the two positions over the past several thousand years, perhaps related to the magnitude of flooding. The momentum of large floods would tend to take a more direct path, perhaps aided by erosion by wave storms on the ocean. During non-flood periods, or when more moderate floods prevailed, a tidal inlet near the present location would close due to insufficient tidal prism and ebb tide scour (as occurs presently). This would have flooded the areas behind the barrier dunes until a low spot through the dunes to the ocean could be overtopped. With the relatively large tidal prisms of the Elkhorn, Moro Cojo, Pajaro River/Watsonville Slough systems converging at Moss Landing, and a permanent or semi-permanent tidal inlet, a low area in the barrier dunes would persist.

Freshwater flows from the Salinas River to Moro Cojo Slough were, as they are today, tied closely to the seasonal occurrence of rainfall. A review of flow records collected by the U.S. Geologic Survey at the Spreckels gage prior to 1941, before the first reservoir was constructed, show extensive periods of no-flow or very low flow between April and October. The same hydrologic pattern applies to the Pajaro River. This means that freshwater inflows to Moro Cojo Slough from the Salinas River were seasonal, and that marine conditions would have predominated during the non-rainy season, even with the Salinas River mouth north of Moss Landing.

Freshwater flow from the Moro Cojo watershed to the slough consisted of both winter surface stormwater runoff during the rainy season combined with perennial spring flow. The highly permeable areas of the upper watershed are likely recharge sites for springs that emitted from the tributary valleys above the present SPRR crossing as well as, perhaps, some of the seeps and springs found at Moss Landing and the surrounding hillsides. Spring flow on hillslopes would have created perennial wetland areas within upland areas. Spring flow and stormwater runoff flowing into the major tributaries of Moro Cojo Slough would have created a zonation of brackish and freshwater marshes behind seawater in the tidal portions of Moro Cojo Slough. This zonation probably moved seasonally towards the ocean during the rainy season, but retreated landward in the summer months and during extended drought periods.

In summary, original hydrologic conditions in Moro Cojo Slough varied between fully tidal marine conditions and periods of brackish and freshwater influences. Moro Cojo Slough was clearly under tidal influence and, regardless of whether the Salinas River mouth was nearby, it undoubtedly experienced periods of full marine influence, perhaps seasonally. Freshwater appears to have been abundant in the east end of lower Moro Cojo Slough and on surrounding hillsides, due in large part to the presence of topographically higher recharge areas to the east.

1850's - 1910

The 1854 map (Figure 3-1) shows the beginning of European-style commerce and land use in the Moro Cojo and Moss Landing area. By the 1880's, extensive land reclamation was underway in Elkhorn Slough and perhaps around Moro Cojo Slough. The most significant event for Moro Cojo, however, was the construction of an early version of the Sandholdt Dam (Gordon, 1987) in the 1880's, which apparently was only partially effective in blocking tidal flow to the upper slough. A 1910 map shows a partial fill crossing over Moro Cojo Slough near the site of the present Moss Landing Road site (Figure 3-2). A photograph taken shortly after the April 1906 earthquake shows failure of this fill resulting from seismic shaking and lateral ground spreading (Figure 3-3). During this period, prior to 1906, the SPRR crossing was constructed, partially blocking the upper marsh plain of Moro Cojo Slough.

It is reported that the agricultural industry grew and spread through the coastal Monterey Bay Area during this period (ABA, 1989). It appears that agricultural uses occupied the hills surrounding Moro Cojo Slough above the tidal range. Reclamation of the tidal areas appears to have occurred later in the 1930's and 1940's.

In 1909, the Salinas River mouth was established south of Moss Landing at Mulligan Hill. Despite construction of an earthen dam between Mulligan Hill and the beach to block northward flow, flow spilled over to the Elkhorn Slough outlet in 1929, 1930, 1931, and 1934 (Gordon, 1987). The historic mouth of Elkhorn Slough remained an open tidal inlet during this period. In the absence of freshwater flows from the Salinas River, Elkhorn and Moro Cojo Sloughs became more marine in character.

1910 - 1947

Extensive reclamation of wetlands for agricultural use was underway in Monterey Bay by 1910. The reclamation of tidal lands around Moro Cojo Slough appears to have occurred in the 1930's and 1940's. Typical methods included ditching, levee, and berm construction. Electrical pumps were later used to drain ditches around reclaimed agricultural fields. Figures 3-4 and 3-5 shows the historical decrease in potential tidal prism for Moro Cojo Slough resulting from levee and berm construction and exclusion of marsh plains.

A significant change reported in the 1930's and 1940's was the loss of shallow groundwater in the Moss Landing and surrounding areas (ABA, 1989). Presumably groundwater pumping for agricultural and other uses depleted the shallow upper aquifer in the Moss Landing area. An increase in drilling and pumping of deeper aquifers at 180 and 400 feet after the 1950's caused salt water intrusion after the 1960's, which has progressively spread landward up the Salinas Valley aquifer, including the area immediately west of Castroville.

A review of historical aerial photographs taken between 1931 and 1993 found that reclamation activities on former tidal marsh areas adjacent to Moro Cojo Slough occurred during this time. The Highway 1 crossing appears on 1940 aerial photographs (Figure 3-5). The PG&E Moss Landing Power Plant and the Kaiser Refractories Plant were built prior to 1949 on the terrace between Moro Cojo and Elkhorn Sloughs. Castroville Slough was dammed in 1940's at the present SeaMist pump site.

The most significant change occurred when the Moss Landing Harbor entrance was constructed in 1946-47, creating a deep tidal inlet at the mouth of Moro Cojo Slough. The proximity of the harbor entrance to Elkhorn Slough, coupled with the relocation of the Salinas River mouth to the south in 1910, ensured that marine conditions prevailed in the estuary. The increased depth of the inlet has caused rejuvenation and erosion of the marsh plains around Elkhorn Slough, and deepening of Elkhorn Slough itself. Deepening of the slough mouth near the harbor has been accelerated in recent years by wetlands expansion in upper watershed, which has increased the tidal prism and, therefore, tidal scour (Oliver, *et al.*, 1993). Moro Cojo Slough has not been affected since Sandholdt Dam and Moss Landing Road block erosive tidal flows.

1947 - Present

The post-World War II period saw continuing land reclamation and expansion of agriculture into the 1950's and 1960's. The levees along Moro Cojo Slough between Highway 1 and the SPRR crossing appear in the 1956 air photos. Ditching and levee/berm construction continued into the 1970's. The marsh land below elevations of 10 feet mean sea level (MSL) along Moro Cojo Slough was cultivated, but eventually became grazing land for cattle; grazing continues as the dominant use below elevations of

10 feet today, although the pasture has degraded in many areas. Local landowners report that the pasture quality was in good condition up to the early 1970's. Causes for the pasture degradation are not known. Possible causes include cessation of irrigation, the extended drought between 1987 and 1992, overgrazing, a loss of groundwater and surface water from withdrawals in the watershed to the east, and continued construction of drainage improvements in lower Moro Cojo Slough in the early 1970's. In any event, most agricultural land below elevations of 10 feet MSL along the slough has been abandoned, or is being used for cattle grazing.

It has been reported that it was common practice to flush accumulated soil salts from drain tiles under agricultural lands with irrigation water and then discharge the highly saline waters into Moro Cojo Slough (Hansen, 1976 and Gordon, 1987). Water conservation practices now used on active farmlands of predominately artichokes and strawberries do not allow irrigation runoff.

The culverts of Sandholdt Dam under Moss Landing Road were replaced and upgraded in 1988. The present configuration includes four 48-inch reinforced concrete pipes with flap gates. These structures replaced older culverts that leaked some seawater into Moro Cojo Slough and maintained saline and brackish aquatic habitats. A slide gate was installed to restore a very limited tidal inflow between -1.5 and -2.0 feet MSL.

The Highway 1 culverts were replaced in the 1980's with 24-foot by 6-foot concrete box culverts. Highway 156 was constructed at the southeastern side of the watershed prior to 1949 and involved filling the upper end of Moro Cojo Slough.

The Kaiser National Refractories Plant adjacent to Highway 1 discharged waste effluent into Moro Cojo Slough from the early 1940's to 1972. The outfall was located in the vicinity of the Moss Landing Harbor. The effluent contained sediment consisting of calcium carbonate and magnesium hydroxide that became suspended in the water of the slough and was then deposited on the channel bottom. The sediment was concentrated around the outfall. During high tide, the solids would settle out of suspension. When the sediment reacts with the tidal water, the calcium and magnesium compounds form calcite $CaCO_3$ and magnesium hydroxide (brucite) $Mg(OH)_2$. The location of the outfall was moved in 1972 from the slough to an off-shore location in Monterey Bay. Although the historic and current effects of these discharges on biota of Moro Cojo Slough are unknown, Hansen (1976) found that sediment concentrations of calcium and magnesium at three stations above Highway 1 were very similar to those in soil from adjacent saltmarsh sites. This suggests that enrichment of these compounds in slough sediments, if it did occur in response to discharges from the Kaiser National Refractories plant, did not persist more than four years throughout most of the slough.

The 1970's brought a series of dense residential developments to the Moro Cojo Slough watershed above Castroville Boulevard. These projects involved grading and filling as well as the construction of groundwater wells, adding to the regional groundwater depletion and perhaps reducing spring flow to Moro Cojo Slough. A series of stock ponds and sewage effluent ponds were constructed in the valleys east of Castroville Boulevard in the 1970's.

During this period, the cultivation of strawberries and other crops on highly erodible hillslopes immediately adjacent to Moro Cojo Slough caused severe soils erosion. After World War II chemical fertilizers, pesticides and herbicides came into widespread use. Organochlorine pesticides such as DDT and Endosulphan were used in the areas surrounding Moro Cojo Slough in the 1950's through 1980's. Although DDT was banned in the late 1960's, toxic byproducts persist in soils and are transported to Moro Cojo Slough. Since there has been little flushing in Moro Cojo Slough, these compounds have accumulated in the slough sediments. This pattern of transport from farm fields to accumulation in

estuaries has been documented throughout the central coast area (Salinas River, Pajaro River, and Elkhorn Slough).

In summary, the present Moro Cojo Slough is cut off from tidal seawater exchange by the Sandholdt Dam. Significant hydraulic constrictions to flood and tidal flow occur at the SPRR crossing, Highway 1, and Sandholdt Dam at Moss Landing Road. Reclaimed agricultural lands along the slough have been abandoned or have been used for grazing. Limited tidal exchange and freshwater inflows have maintained brackish to hypersaline aquatic conditions in the slough. Residual salts in soils on the marsh plain support a remnant salt marsh below the SPRR crossing, brackish conditions above SPRR, and freshwater in tributary valleys.

HISTORIC BIOTIC CONDITIONS

Pre-1850's

Although little information is available regarding early biotic conditions specific to the Moro Cojo Slough area, there are many accounts and archaeological reports that describe conditions of nearby areas such as Monterey, Elkhorn Slough, Santa Cruz, and the Monterey Bay in general. From these descriptions and knowledge of local indigenous peoples, it is possible to build a picture of early historic faunal and human conditions in the vicinity of the Moro Cojo Slough.

Current scientific knowledge suggests that the first native peoples migrated into the Monterey Bay Area between 8,000 and 12,000 years ago. Archaeological evidence from the Moss Landing and Elkhorn Slough areas date back 6,000 years and has added significant insight to theories as to what habitats and fauna predominated in early times. Moro Cojo Slough is within the area historically occupied by people the Spaniards called Costanoan. More specifically, the slough lies in the area of the Kalintaruk tribelet of the Ohlone. It is likely that other nearby tribelets, such as the Mutsun, Ensen, Mustak, Imunakan, and the Sahon, found means of utilizing the sloughs' resources as well (Gordon, 1987; Margolin, 1978; Patch, 1979).

Spanish explorers as early as the late 1500's wrote accounts of the indigenous people, their daily practices of subsistence, as well as the predominant flora and fauna. Early documentation suggests that there existed an environment far richer than is evident today. Prior to the advent of early agricultural practices (draining, diking and irrigation) in the area, the water table was much higher, and the land consequently much "wetter". Wetlands of enormous size stretched over lowland areas near the bays and water channels, with tall stands of native bunchgrasses dominated open areas and higher elevations boasted dense redwood forests and pine and oak chaparral. The Vizcaino party in 1602 witnessed a grizzly bear feeding on a whale carcass near the water's edge in Monterey. Up through the time of early Anglo occupation, accounts of tule elk, wolves, pronghorn antelope, bald eagles, and California condors were common. Although no formal agricultural practices were employed, the Ohlone subsisted on carefully maintained edible plants. The Ohlone people practiced land management and harvesting techniques that resulted in the proliferation of edible plant species and botanical products used for utilitarian items. Their diet was commonly supplemented with game such as antelope, deer, elk, and a wide variety of sea and land birds. The Ohlone also subsisted on marine communities including sea lions, sea otters, mussels, urchins, and abalone.

The Ohlone set fire to the grasslands to maintain these areas in early successional stages and provide a supply of edible grasses and herbs. Burning in the understory of woodlands also facilitated the growth of edible herbaceous understory species. The tilling of the ground and specific harvesting techniques that were applied during the harvest of roots, bulbs and corms promoted the regrowth of new plants. The

loosing of the soil during harvesting was beneficial to the regrowth of new plants. The cessation of these management techniques has probably resulted in reduced reproduction of some species and some alteration of the native floral composition.

With the onset of intensive grazing and active suppression of controlled burning that was used widely by the Ohlone to retain native bunchgrasses, vast tracks of perennial grasslands began to slowly evolve into the annual, non-native grasslands now present around much of the Monterey Bay. Numerous non-native agricultural and horticultural plant species were cultivated. Many other non-native species, including composites, grasses, legumes, and crucifers, were introduced into California because the seeds were in the feed brought for domestic animals.

Substantial biotic changes began to take place with the occupation by Spanish missionaries and large ranching families in the mid-1700's. Land previously grazed by large herds of antelope was now fenced in for cattle and sheep, reaching a peak in the hundreds of thousands. In 1860, Monterey County had more sheep than any county in the United States (Gordon, 1987). Antelope were hunted for food and sport, or simply starved. Tule elk survived a little longer in marshy areas less useable by cattlemen.

1850's - 1900

By the turn of the century, most large carnivorous and grazing mammals had been extirpated; thus introduction of non-native plant and animal species was facilitated, and expansion of some native wildlife populations was able to take place. Those large mammals remaining, marine and terrestrial, were able to alter their behavior in response to their drastically changed environment. Grey foxes, bobcats, coyotes, and mountain lions, which were once commonly seen or even underfoot, are now highly secretive and rarely observed. Sea otters, which now spend their entire lives in the water, were once "readily captured on land" (Margolin, 1978). Numerous non-native agricultural and horticultural plant species were cultivated, and others, including composites, grasses, legumes, and crucifers, were established through various means and reproduced themselves in wilder areas. The clearing of riparian and woody areas for agriculture and ranching, enabled native rodents such as the California ground squirrel and the meadow mouse to proliferate far beyond their aboriginal populations. Altered grassland composition has also benefitted some native bird species, such as western mourning doves and meadowlarks, which have adapted to feed on a variety of non-native grasses and will nest and feed in close proximity to human developments.

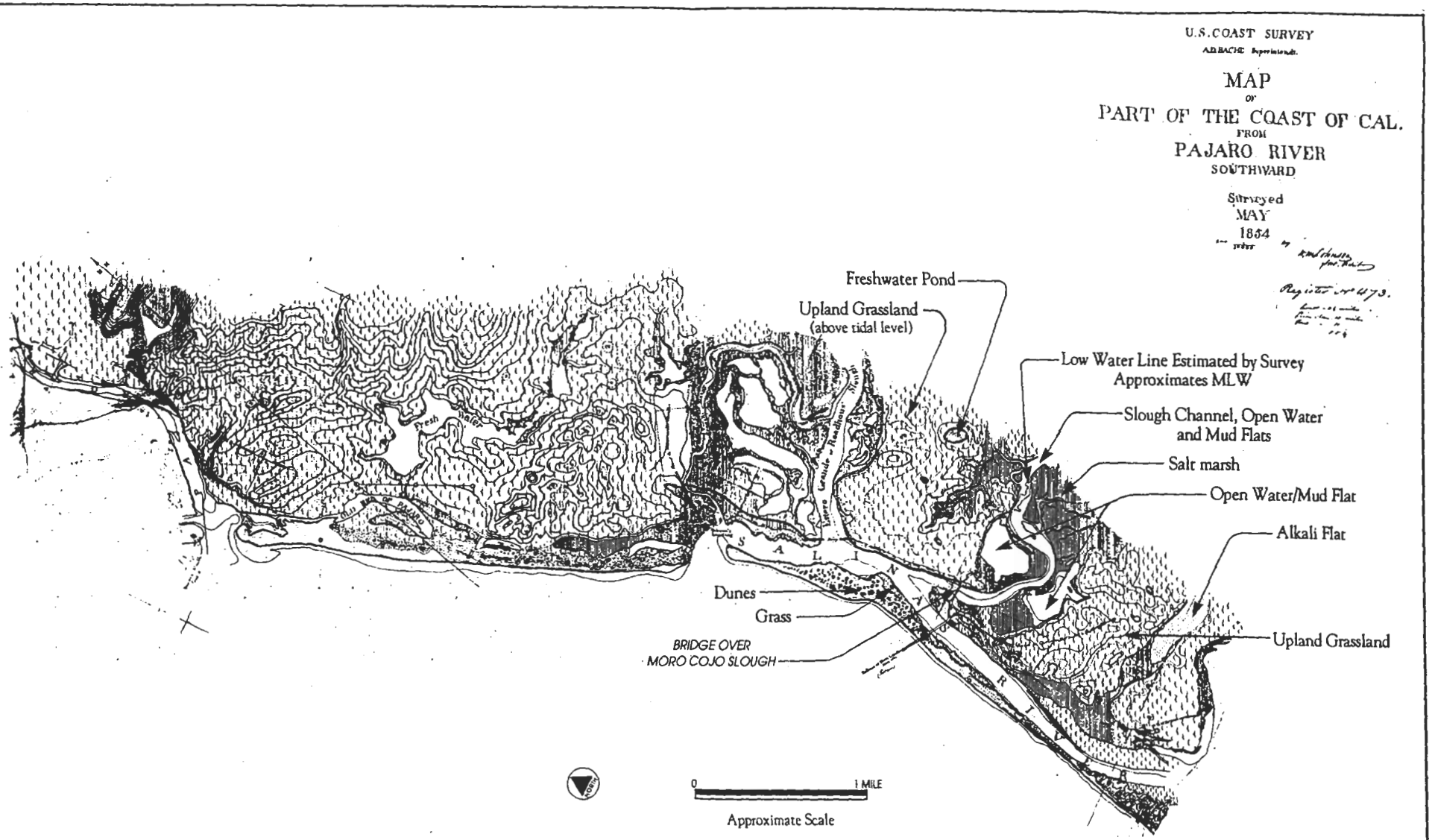
1900 - Present

When Moro Cojo and Elkhorn Sloughs were connected by the lower course of the Salinas River and subject, at least seasonally, to tidal influence, their mollusk faunas were similar. But since 1932, little seawater has been able to enter Moro Cojo Slough. The chemical content of the water in the slough has fluctuated greatly. In 1973, the water was brackish (with salt content dropping to around 4 parts per thousand [ppt] in the rainy season; low compared to seawater, which has 34 ppt). But since that time salty drainage water pumped from nearby fields into the slough has increased the salinity significantly (Hansen, 1976).

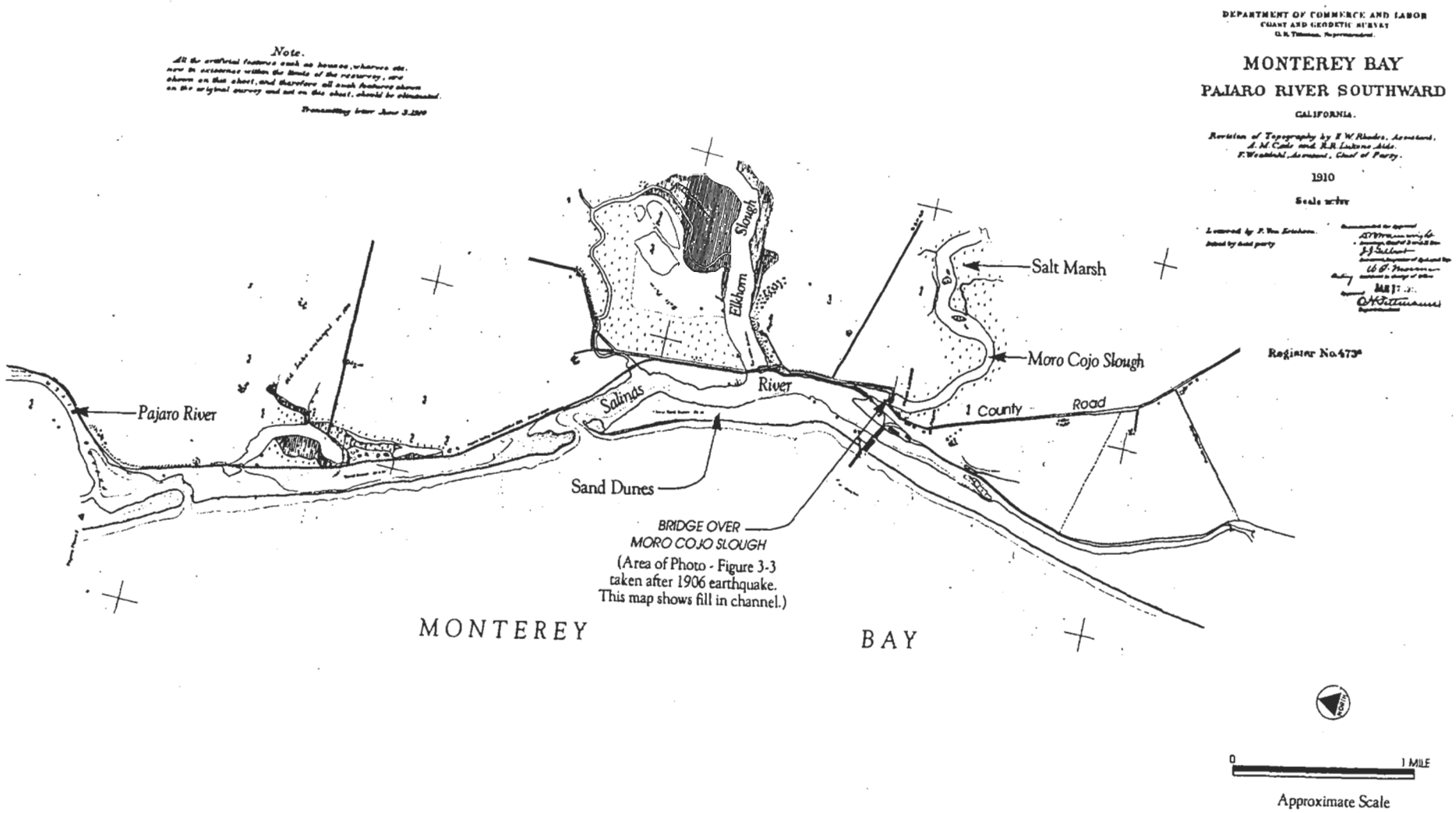
Evidence of the historic benthic infaunal community exists in the lower slough east of Highway 1. Soils excavated from a ditch near the slough were found to contain dead mollusks, including many bent-nosed clams, Washington clams, jackknife clams, Pacific littleneck clams, and bay mussels. Early hydrologic changes exterminated virtually the entire molluskan fauna of Moro Cojo Slough. All of these mollusks now live in the Elkhorn Slough (Gordon, 1987). In 1975, a large drainage ditch was excavated and a levee constructed along the south side of the slough, extending from its Castroville tributary upslough

to within 200 meters of the railroad crossing. Masses of shells were excavated in levee construction, indicating that a rich marine benthic community, including over a dozen species of mollusks, once extended 3 kilometers inland from the mouth of the slough. Above the railroad crossing, a narrow strip of salt-marsh vegetation (e.g., saltgrass and pickleweed) extends almost to Castroville Boulevard. Beyond Castroville Boulevard the headwaters of the slough are freshwater marshland. Research by Hornberger (Hornberger, 1991) and Schwartz (Schwartz, 1983) verifies that a range of conditions existed in the slough, from full-marine to brackish to full-freshwater.

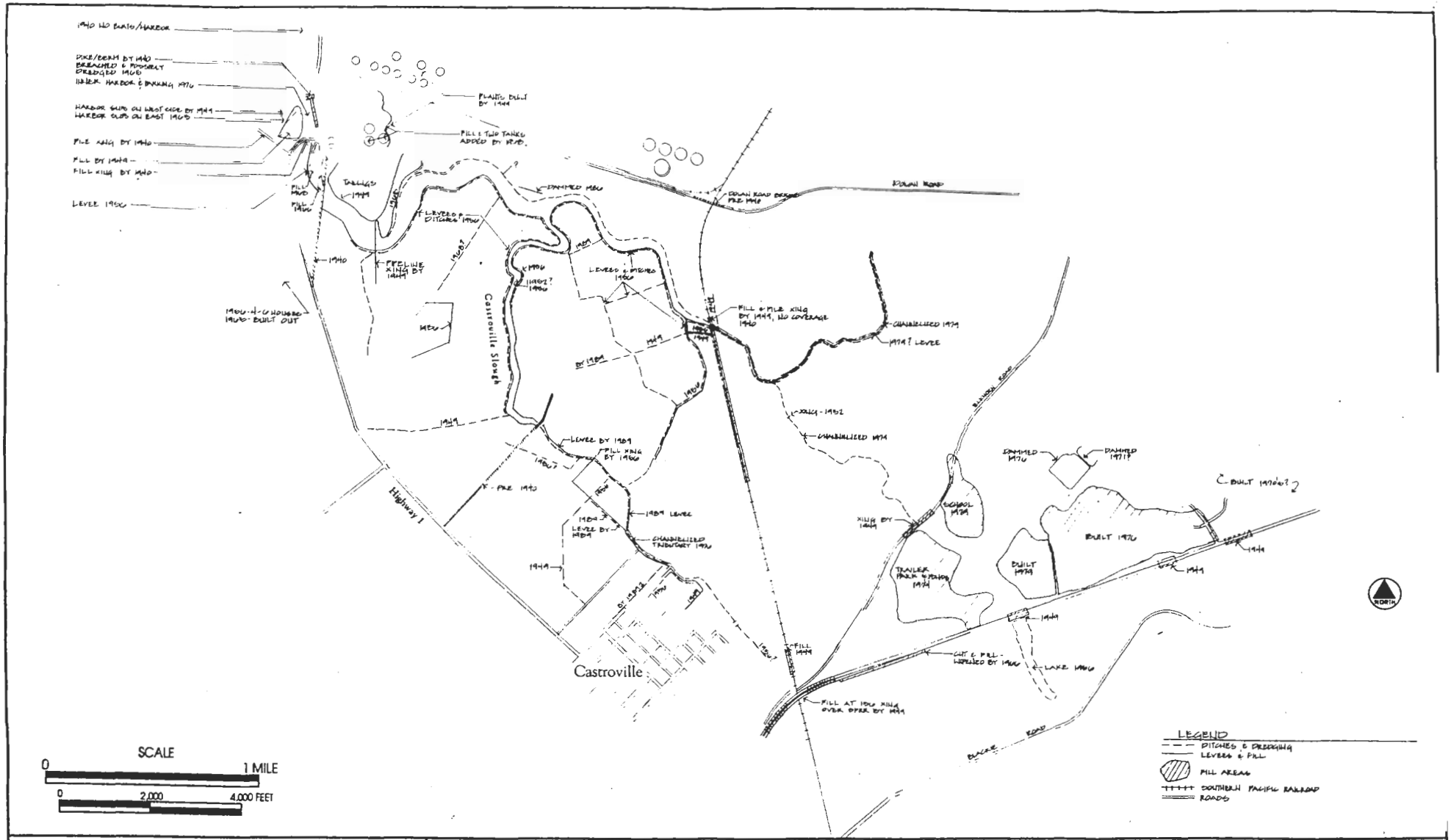
During this period, the wetlands on the slough margins have been diked and filled, reducing the extent of wetland habitat. Within the last 10 years, much of the Castroville Slough arm was filled as a result of the unauthorized conversion of wetlands to agricultural land. The natural vegetation in smaller tributaries, such as willows, herbaceous hydrophytes or mature coast live oak trees, have been removed for agriculture, or altered due to deposition of sediments from upland erosion. In some areas, these sediment-filled drainages have become a major problem. The habitats of the upper watershed have altered through time. Maritime chaparral and oak woodlands have been modified by residential development and agricultural land uses; non-native vegetation is common, including groves of eucalyptus and residential landscaping. Despite these changes, the watershed still supports unique habitat for wildlife, including habitat for rare, threatened and endangered amphibians such as the California brackishwater snail, SCLTS, California tiger salamander and California red-legged frog.



The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Historic Condition, Circa 1854	2/96 705-01	Figure 3-1



The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Historic Condition, Circa 1910	2/96 705-01	Figure 3-2



The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Historic Condition, Circa 1940-Present	2/96 705-01	Figure 3-5

1. INTRODUCTION

The purpose of this chapter is to introduce the Coastal Long Range Development Plan (CLRDP) for the University of California at Santa Cruz Marine Science Campus. This chapter is divided into four sections. The first section sets forth the purpose of the CLRDP. The second section discusses the preparation and use of the CLRDP. The third section summarizes the relationship of other plans to the CLRDP. Finally, the fourth section outlines the regulatory context within which the CLRDP functions.

1.1. Purpose of the CLRDP

This CLRDP is a comprehensive physical development and land use plan that governs development, land use, and resource protection at the UC Santa Cruz Marine Science Campus, including Younger Lagoon Reserve (YLR). The adoption of this plan by the University of California and subsequent certification by the California Coastal Commission results in the delegation to the University of California of the authority to authorize most on-Campus development consistent with the plan without a coastal development permit, subject to Commission oversight. This plan does not directly govern the National Oceanic and Atmospheric Administration (NOAA) Fisheries facility, a federal establishment on 2.5 acres of federal land near the center of the Marine Science Campus. The Plan also does not directly govern areas where the Coastal Commission retains direct coastal permit and other development review authority, such as on public tidelands.

A Long Range Development Plan (LRDP) identifies the physical development needed to achieve the mission and goals of the institution and the facilities and site improvements required for those aims. The University of California prepares Long Range Development Plans periodically to guide development on the University's main campuses.

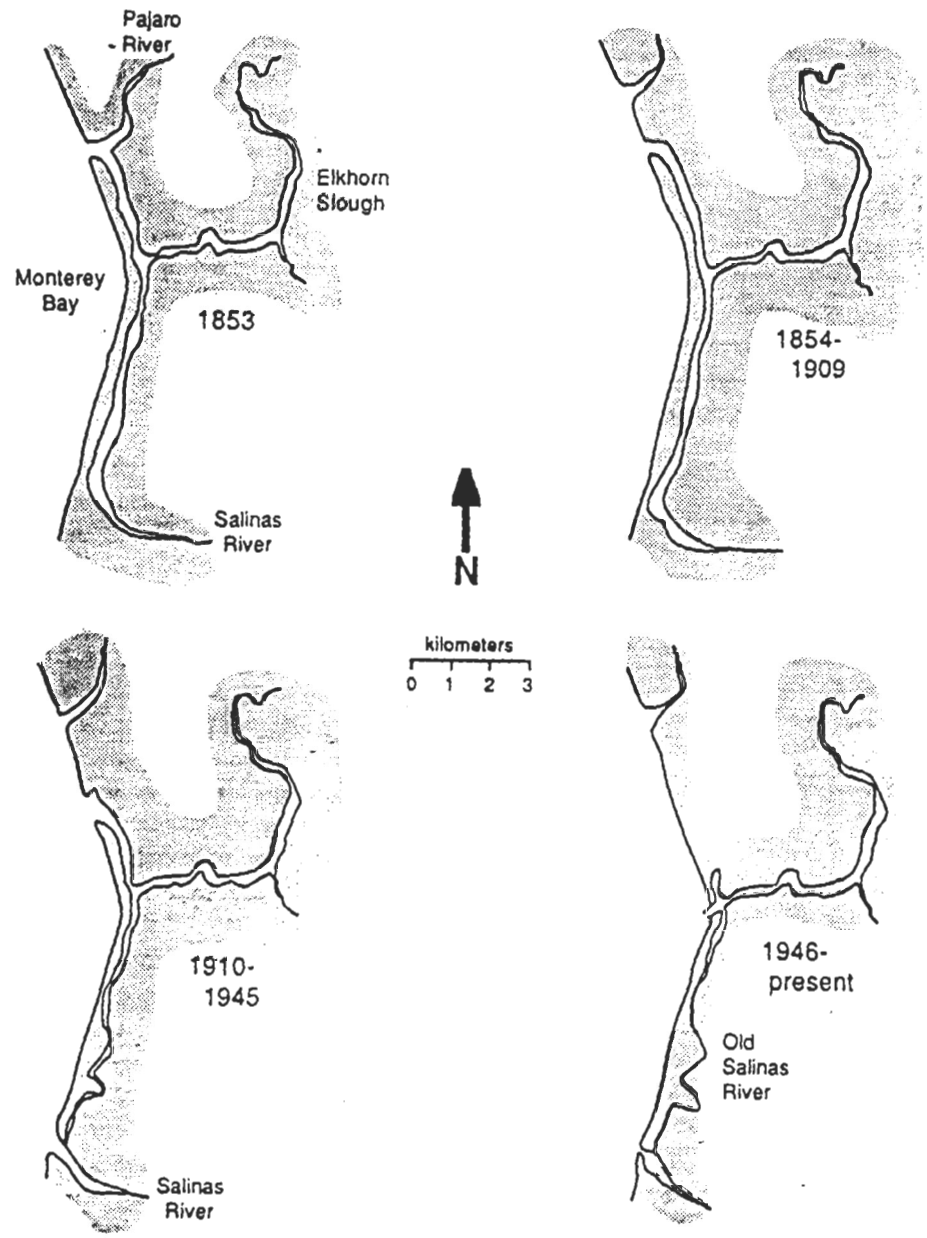
A Coastal Long Range Development Plan is provided for under the California Coastal Act of 1976. In addition to the elements normally found in a Long Range Development Plan, this document addresses issues arising from coastal proximity, resources specific to this site, and the urban edge location of the campus. Coastal Act policies relevant to these issues are reflected and incorporated throughout the CLRDP along with additional policies that also guide the University's stewardship of its lands.

An Environmental Impact Report (EIR) has been prepared for the CLRDP, in compliance with the California Environmental Quality Act (CEQA). The EIR includes a detailed discussion of the Marine Science Campus site environment, and the potential environmental impacts of implementing the planned facilities and site improvements described in this CLRDP. The EIR also presents mitigations to address these potential impacts and alternatives to the project as proposed.

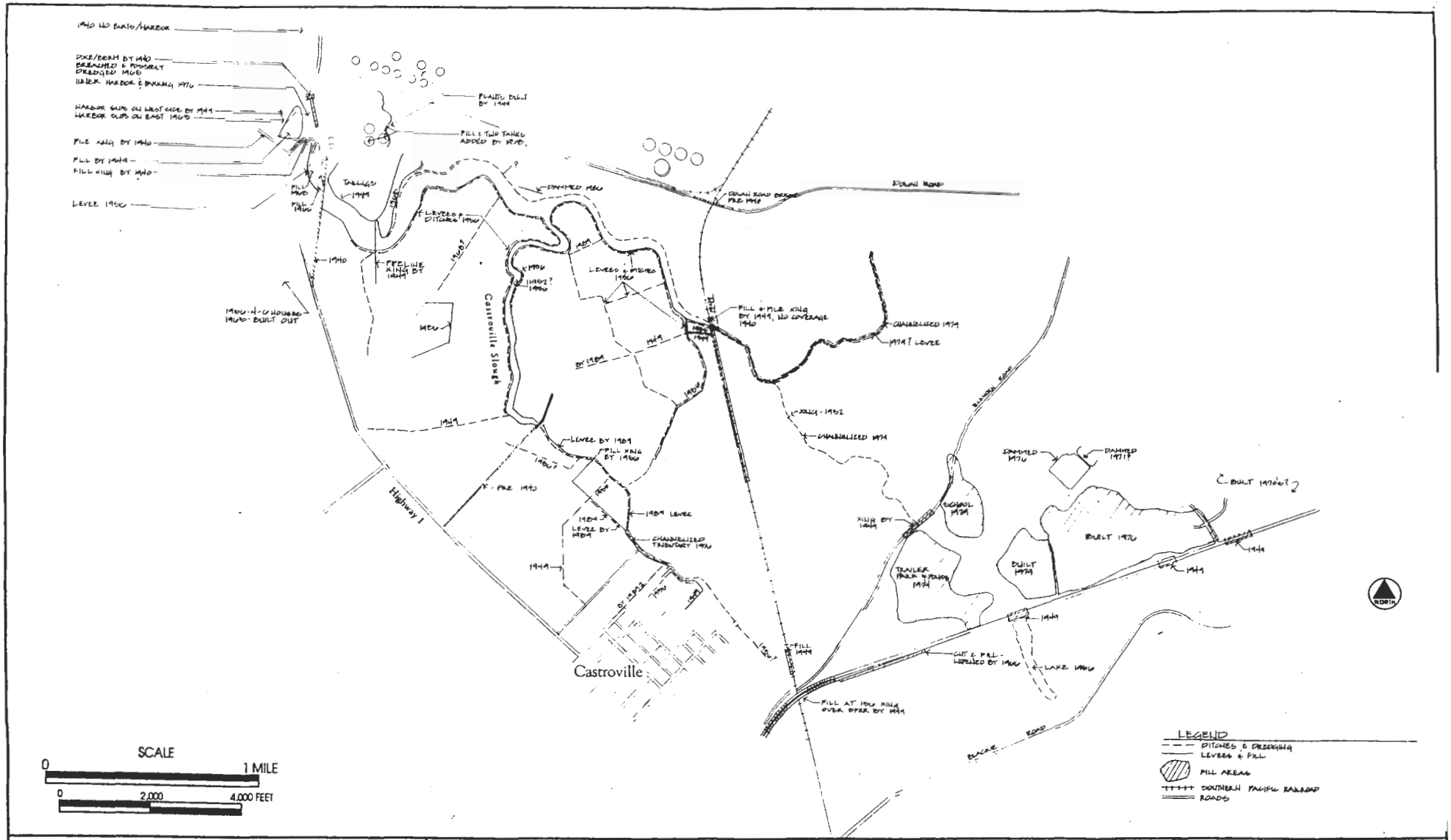
The CLRDP is a general plan for the physical development of the site and is intended as a commitment to plans and policies that relate to general land use, circulation and parking, public access and recreation, stormwater and other environmental management, utilities and services, resource protection, habitat management, and transportation demand management, within the scope and timeframes set forth herein. The CLRDP is not intended, however, as a commitment to any specific building project, building construction schedule, or building funding priority. Within the parameters established by this CLRDP, individual buildings

Photo apparently showing 1906 earthquake damage to the crossing over the mouth of Moro Cojo Slough. Caption for photo reads: "Ground ruptures in Moss Landing between Monterey Bay and Old Salinas River. View eastward toward bluffs between Elkhorn and Moro Cojo Slough." Although the caption locates the photo between Monterey Bay and Old Salinas River, the road cut in the upper left corresponds to the alignment shown on the 1910 USGS map and the crossing over Moro Cojo Slough. It appears that the road substantially blocked tidal inflow into Moro Cojo.
(Source: USGS, 1978.)

The Habitat Restoration Group Mitchell Swanson & Associates VB Agricultural Services Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Photo of Sandholdt Dam After 1906 Earthquake	**Figure 3-3** 2/96 705-01



The Habitat Restoration Group Mitchell Swanson & Associates VB Agricultural Services Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Schematic Maps of the Historical Position of the Salinas River Mouth	Figure 3-4 2/96 705-01



The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Historic Condition, Circa 1940-Present	2/96 705-01	Figure 3-5

CHAPTER 4
PHYSICAL PROCESSES

METHODOLOGY OF STUDY

The hydrologic study consists of four elements. The first involves characterizing the geologic, geomorphic, and climatic factors that dictate the hydrologic functioning of Moro Cojo Slough and its watershed. This has been accomplished by reviewing and compiling data from existing reports, maps, and other available information, as well as applying scientific principles and judgement. A topographic survey was conducted to document key flooding elevations and to provide data for the hydraulic analysis. A hydrologic model of the Moro Cojo watershed was developed using the U.S. Army Corps of Engineers (COE) HEC-1 hydrologic simulation model. A hydraulic model of Lower Moro Cojo Slough was compiled using the COE HEC-2 hydraulic simulation model. The goal for this element is to have a basic understanding of how present and potential restored habitats function, as well as an understanding of the physical definition of other key planning concerns, such as groundwater recharge, water quality, flood control, and infrastructure (bridges and roads) maintenance.

The second element is a quantitative description of the effects that historical land use changes have had on the hydrology of Moro Cojo Slough and its ecosystem. These changes have obvious immediate effects, such as the construction of a dam across the mouth to prevent tidal circulation; however, there are other affected processes that may take some time to fully adjust to the new conditions (sediment transport processes in the slough, for example). Historical conditions were documented through historical mapping of aerial photographs, personal accounts, and historical accounts and maps (Chapter 3).

The third element is to quantitatively define the key planning issues. This includes defining the key flood elevations at points where urban and agricultural areas require protection, the potential tidal volume of the slough, the duration of inundation that would be experienced in restoration areas, and water quality. These factors were determined through field data collection and mapping, tidal level recordings, and analytical methods.

The fourth element involves the hydrologic evaluation of restoration alternatives to assess their potential benefits as well as impacts. This element also includes defining any remaining issues that would require future detailed study and/or data collection.

The following analysis should be considered appropriate for a feasibility level analysis. This report will provide the basis for detailed designs once an overall restoration strategy is defined.

Physical Setting

Description of the Study Area. Moro Cojo Slough drains a 16.9 square mile watershed located along the eastern edge of Monterey Bay in northern Monterey County, California (Figure 4-1). The watershed extends from the foothills of the southern Santa Cruz mountains near Prunedale and Highway 101 on the east to Monterey Bay on the west, and from Castroville on the south to Elkhorn Slough on the north. Elevations range from over 500 feet above mean sea level (MSL) (equivalent to the National Geodetic Vertical Datum [NGVD] or MSL of 1929) at the eastern headwaters to over 6.0 feet below sea level in the channel at Moss Landing Road. The upper watershed from Castroville Boulevard eastward consists of rolling hills underlain by sand-dominated sedimentary rocks, and incised by several intermittent stream valleys. The predominant land uses in the upper watershed are residential, rural residential, and agricultural.

The lower watershed includes the remnants of Moro Cojo Slough, which is incised within a valley floor of recently deposited estuarine muds. Elevations on the valley floor range from 0.0 feet MSL at the top of the slough channel to about +8.0 feet MSL at the valley edges. The valley floor was once tidally inundated, and field inspection reveals salt marsh and numerous remnant tributary tidal sloughs. The low hills that surround the valley reach elevations 20 to 80 feet above MSL and consist of marine terraces and fluvial terraces constructed by the Salinas River. Terrace surfaces bounding the slough are characteristically flat with gentle to moderately sloping side slopes. Terrace use includes grazing, row crop production, rural residential development, urban cover, and fallow land.

Moro Cojo Slough is an elongated, channel-shaped basin extending over 3.0 miles inland at elevations below 0.0 feet MSL. The lower slough, between Moss Landing Road at the mouth and the confluence with Castroville Slough, exhibits channel widths up to 500 feet, narrowing gradually to less than 50 feet at the SPRR crossing and then to less than 5 feet at its head near Castroville Boulevard. The slough is bounded by broad, flat areas of former tidal marsh that have been diked and drained. A nearly continuous levee system bounds Moro Cojo Slough between the SPRR crossing and Highway 1; behind these levees are drainage ditches serviced by pump systems. A small ditch has been dredged in the bed of Moro Cojo Slough to an elevation of almost −6.0 feet MSL from just upstream of SPRR crossing to a point almost 1,000 feet upstream of Highway One. Castroville Slough drains the northeastern side of the town of Castroville into Moro Cojo Slough about 2.0 miles above Moss Landing Road. Other tributary sloughs have been filled or reclaimed.

Land use in the former marsh plain area adjacent to Moro Cojo Slough consists of fallow agricultural and grazing lands. The National Refractories Plant is located along the north bank of Moro Cojo Slough just east of Highway 1; this plant extracts chemical compounds from seawater before discharging a waste brine through an ocean outfall.

GEOLOGY

Description of Landscape Units

The Moro Cojo Slough watershed lies within a geologic-tectonic unit referred to as the Salinian Block. The Salinian Block is an elongated, northwest-trending segment of the coast ranges bounded to the northeast by the San Andreas Fault and to the southwest by the San Gregorio-Sur Nacimiento fault zone. The Salinian Block has Paleozoic high-grade metamorphic and Cretaceous granitic basement rocks overlain by a sequence of dominantly marine sediments of Paleocene to Miocene Age, and non-marine sediments of Pliocene to Pleistocene Age. In Moro Cojo Slough, recent Holocene (last 12,000 years) continental and marine sediments are several hundred feet thick.

Deposition of the recent surficial sediments that underlie Moro Cojo was controlled by regional tectonics and fluctuations in sea level. The Pajaro, Elkhorn, and Salinas valleys were eroded during a low stand of sea level prior to the last glacial period and were filled in with an upward-fining sequence of sediments as the last glacial period ended. Sea level rose approximately 300 feet.

The eastern half of the Moro Cojo watershed is underlain by roughly 500 to 700 feet of undivided Aromas sands that are, in turn, underlain by the Pleistocene Purisima Formation (Figure 4-2). Aromas Sands are exposed in the upper (eastern) third of the watershed, within valleys incised over the past 50,000 years, including Paradise Canyon and areas near upper Castroville Boulevard. These sediments consist of loosely consolidated fluvial and aeolian (dune) sand, silt, clay, and gravel. The sand dune deposits of the Aromas Formation are the predominant earth material exposed at the ground surface in the Moro Cojo Slough area.

The lower half of the watershed is occupied by recently dissected fluvial and marine terraces. The flight of fluvial terrace surfaces, apparently representing the old uplifted floodplain of the Salinas River, are found at elevations between 10 and 80 feet above MSL. These surfaces are clearly evident along much of the lower watershed and include the gently sloping agricultural fields along Elkhorn Road, Dolan Road, and portions of the city of Castroville. The earth materials associated with these terraces are referred to as the Antioch Terrace Deposits and consist of interbedded layers of sand, silt, and clay.

Found closer to the ocean and at elevations less than 10 feet (MSL) are the Coastal Terrace Deposits of Santa Ynez. These deposits are predominantly marine sands. Overlying these coastal and fluvial terraces are recently deposited aeolian sand dunes. Recent dune sediments are found inland in the vicinity of Meridian Road and near the northern end of Castroville Boulevard within the Moro Cojo Watershed.

Recent Geologic History and Seismicity

The Moro Cojo watershed lies within a very seismically active region of California. The watershed was uplifted by the ongoing tectonic movement along the San Andreas Fault system. Recent studies of estuarine systems near major fault zones (e.g., Humboldt Bay, California and Puget Sound, Washington) reveal that tectonic uplift and earthquake-induced ground movements and liquefaction can significantly affect the hydraulics of tidal estuarine systems. Displacement within the San Andreas system along the plate boundary is taken up along a series of faults of which the San Andreas is the most active. Other significant faults in the vicinity of the Moro Cojo watershed include the San Gregorio, Zayante-Vergales, King City, and Calaveras fault zones. Movement along these faults has resulted in horizontal displacement of several hundred miles as well as local compressional uplift of several thousand feet.

The Santa Cruz Mountains, as well as the uplifted marine terraces along the mouth of Moro Cojo Slough, reflect the uplift along the San Andreas fault system. The regional tectonics of the area has played a dominate role in shaping the Moro Cojo and surrounding watershed. For example, prehistoric fault motions along the San Andreas fault have beheaded the Elkhorn Valley, significantly reducing the watershed draining into Elkhorn Slough (Schwartz and others, 1986). Compressional uplift of the region is responsible for the development of stranded marine and fluvial terraces and may play a role in the natural draining and drying of many local sloughs. Regional uplift of the Moss Landing Harbor on the order of 0.5 feet, was measured following the 1989 Loma Prieta earthquake. However, there are also reports of land subsidence and greater tidal inundation in Elkhorn Slough following the quake.

Earthquakes occurring along one of the many nearby major faults subject the area to intense seismic ground shaking. Shaking may result in differential settlement, liquefaction, and lateral spreading, causing damage to buildings, roadways and utilities. Seismically induced ground failures were observed after the 1906 (Figure 3-3) and 1989 earthquakes on the San Andreas fault (USGS, 1978; Foxx, Nielsen and Associates, 1990).

Recent geologic history begins during the previous low sea level and glacial period (between approximately 17,000 to 12,000 years ago) when the Moro Cojo drainage was formed by erosions and incision through the surficial sediments described above. The infilling of the valley that holds Moro Cojo Slough occurred during the most recent rise in sea level after the end the last glacial period 12,000 years ago. Sea level rose approximately 300 feet between 12,000 and 5,000 years ago. Sediment inflows from the local watershed and mud inflow from tidal currents laid down a thick sequence of loose plastic and silty clay along the valley floor. These mud basin deposits, typically found at elevations less that 10 feet below sea level, occupy the majority of the valley floor of Moro Cojo Slough.

SOILS

Information regarding soil characteristics of the Moro Cojo watershed are based solely on published reports by the SCS for Monterey County (SCS, 1978) and some field observations. Soils found in the basin are shown on Figure 4-1 and their hydrologic characteristics are found in Table 4-1.

In general, fine sandy loams are developed on the Aromas Formation in the upper, eastern portion of the watershed. These soils are characteristically moderately-to-well developed with moderate-to-high permeability. The soils developed in the lower portion of the watershed are underlain by the fluvial and coastal terrace deposits; these soils are moderately-to-well developed and poorly drained with slow permeability. When vegetation is removed from these soils, they pose a significant erosion hazard.

HYDROLOGY

Moro Cojo Slough is a highly altered tidal system with a relatively small upland watershed that is covered by a variety of land uses. Human activity over the past 130 years has had an overwhelming influence on the present hydrologic and geomorphic functioning of Moro Cojo Slough and the amount and quality of its habitat.

There are four major components to the present hydrologic system of Moro Cojo Slough:
1) tidal inflows from the Pacific Ocean;
2) direct precipitation and stormwater runoff from watershed areas;
3) groundwater spring flow; and
4) man-made drainage systems.

A past connection to the Salinas River, and at times the Pajaro River, provided seasonal fresh water to Moro Cojo Slough prior to 1910.

Tidal Inflows

Although much of Moro Cojo Slough is topographically within the tidal range recorded in Monterey Bay, very little inflow occurs because of the highly effective tide gates at Moss Landing Road, which have also been referred to as "Sandholdt Dam" (Gordon, 1987). Figure 4-3 shows recent tidal monitoring results recorded above and below Sandholdt Dam. Only a small tidal inflow of seawater seeps through Sandholdt Dam into Moro Cojo Slough. Within tidal range, Moro Cojo Slough has over 1300 acre-feet of potential tidal volume (technically referred to as "tidal prism") (Figure 4-4). If Sandholdt Dam were not present, seawater would likely reach areas near Castroville Boulevard. Present management of the tide gates by MCWRA allows tidal inflow up to −2.0 feet MSL in elevation. Table 4-2 shows the tidal datums at Moss Landing Harbor and Figure 4-5 shows the tidal duration frequency recorded as part of this investigation in Moss Landing Harbor and in Moro Cojo Slough during summer, 1993.

A variety of hydraulic structures have been constructed in and around Moro Cojo Slough to drain marsh land for agricultural use or to provide road crossings over the slough. Sandholdt Dam has virtually eliminated seawater exchange and tidal inundation. The dam contains a set of four 48-inch diameter culverts, each fitted with a flap gate to prevent tidal seepage; one flap gate has a small 12-inch by 20-inch slide gate that allows minor tidal inflows. The MCWRA manages tidal levels in the slough between −2.0 and −1.5 feet MSL to prevent flooding of residential and agricultural lands.

The Highway 1 crossing forms a constriction with fill and a set of two 4-foot by 6-foot culverts. Levees constructed along the slough restrict or have eliminated the inundation of large former marsh plain areas.

The SPRR crossing consists of fill that blocks a large portion of the valley floor except for a 150-foot bridge section over the channel. The bridge section is supported by numerous timber piles. Castroville Boulevard also has extensive road fill bridged with two 60-inch culverts.

Drainage and tidal flows in the upper half of Castroville Slough are controlled by a tide gate pump system located at Sea Mist Ranch. Above the dam, Castroville Slough drains a mix of agricultural and urban lands up to Highway 156. Below the dam, Castroville Slough is bounded by levees and drainage ditch/ pump systems all the way down to Moro Cojo Slough.

Precipitation and Stormwater Runoff

The Moro Cojo Slough watershed produces stormwater runoff during intense or long-duration winter precipitation. Annual rainfall averages 17.3 inches in the Moro Cojo area. Statistical relations for precipitation, depth, duration, and frequency are shown on Table 4-3. Storm peaks are generated in the upper watershed.

Runoff from the low-lying valley surrounding the slough adds to the peak flow volume by filling lower Moro Cojo Slough. No flow records exist for the slough itself. Runoff rates and volumes computed for this study are shown in Table 4-4.

Conveyance of flood flows in Moro Cojo Slough is restricted by artificial hydraulic controls at the SPRR, Highway 1, and Moss Landing Road, and the levee and ditch system surrounding the slough. Tidal elevations at the lower end of Moro Cojo Slough influence flood depths for most of the area up to SPRR. Additional discussion of flood control is provided in sections below.

Flood Control

Flood control facilities in Moro Cojo Slough are managed and administered by the MCWRA. Local farmers operate the Sea Mist Dam and pump system on Castroville Slough, as well as the small scale drainage around farm lands.

The Sandholdt Dam at the mouth of the Moro Cojo Slough is the primary flood control structure for the slough and for the agricultural areas east of Highway 1 extending east of the SPRR crossing. As previously mentioned, the dam consists of road fill and a set of culverts, one fitted with an adjustable slide gate to allow for some tidal inflow. The dam protects buildings located along the west bank of the slough below Moss Landing Road and west of Highway 1. Several buildings are sited below normal tidal range (the lowest foundation is at sea level, 0.0 feet MSL). Figure 4-3 shows the effect of the dam on tidal water levels. During storm runoff and flood conditions, flow from the watershed is stored in the lower slough until the water level difference between the ocean and the slough is approximately 0.2 feet, a difference that creates enough hydraulic force to open the flap gates and drain the slough to a lower water level. This flood control system essentially stores or detains stormwater runoff above Moss Landing Road until low tide. The system is thought to provide protection for a flood of 25-year recurrence (Moffitt and Nicol, 1984; MCWRA, pers. comm., 1993). The worst case for flooding occurs when the peak inflow coincides with a high tide; according to a long-time local resident, this apparently occurred during the April, 1958 flood when flow from Moro Cojo Slough overtopped the west bank below Moss Landing Road and west of Highway 1 and flowed through buildings in Moss Landing. Hydraulic modeling conducted for this study confirms this scenario with a 25-year flood with a tide level of 2.0 feet MSL.

Sandholdt Dam also strongly controls tidal and low water elevations between Highway 1 and the SPRR crossing. The protection afforded by the dam allows for positive draining of adjacent fields by ditching, pumping, and levees.

Water Quality

The quality of the surface water in Moro Cojo Slough is affected by past and present discharge from adjacent farmlands, seawater and fresh water inflows, and stagnation due to a lack of flushing. Basic water quality parameters have been measured by MCWRA (Koehn, pers. comm., 1993), ABA Consultants (1988 and 1990), and others (e.g., Hansen, 1976). Measurements of toxic pesticide compounds and heavy metals have been taken by the California RWQCB and by Hansen (1976).

The historical hydrologic changes in Moro Cojo Slough have reduced tidal and fresh water flushing while agricultural, industrial, and urban uses were introduced adjacent to the slough. These uses are sources of various chemical contaminants in Moro Cojo Slough.

Lower Moro Cojo Slough just upstream of Sandholdt Dam and west of Highway 1 has retained marine estuarine conditions with the limited seawater exchange allowed by the small slide gate (ABA, 1988). Prior to culvert repairs in 1988, leaky culvert flap gates allowed similar conditions. Salinity in the lower slough has ranged from brackish, during winter fresh water runoff events, to hypersaline when the slough experienced long periods of evaporation. It has been postulated in the past that irrigation and stormwater runoff has leached salts from adjacent agricultural lands and contributed to elevated salinity (Hansen, 1976). MCWRA has measured salinity as well as other water quality parameters at Moss Landing Road and just east of Highway 1; these are presented in Appendix A. This data shows that dissolved oxygen levels have decreased below 7.0 mg/l occasionally in late fall, likely the result of poor water circulation. The pH levels have occasionally been measured above 9.00; high pH levels have been attributed to seepage from the Kaiser Refractories Plant tailings ponds (Hansen, 1976). Fluctuations in pH and salinity have been related to environmental stress on the lower slough fauna (Hansen, 1976).

Nutrient levels in surface waters of Moro Cojo Slough can be elevated by tidal inflow and by point and non-point discharges from adjacent grazing, agricultural, and rural residential lands (ABA, 1989). Contamination can occur by seepage from septic systems. The primary hazard of nutrients is the stimulation of excessive algal growth and oxygen depletion or eutrophication. Nitrate and ammonia, common waste products of cattle, can be entrained in runoff and delivered to the slough. Monitoring by MCWRA for the period 1990-92 show occasional elevated levels of nitrates, ammonia, and phosphate.

A significant water quality problem in Moro Cojo Slough is the presence of residual pesticides and their by-products in the soils, waters, and muds of the slough and adjacent areas. These compounds accumulate in fatty tissues organisms, especially shell fish and aquatic species. Residual pesticide contamination occurs in soils that are transported by stormwater runoff to waterways. Strawberry fields situated on erodible soils are likely sources of contaminants. Contaminant exchange between the slough sediments and the overlying water column occurs when the sediments are disturbed and mobilized. Shell fish and benthic organisms accumulate these substances as they feed in the sediments; higher species, including humans, accumulate pesticide compounds by consumption of contaminated shell fish. Sampling conducted by the RWQCB in 1982 (pers. comm., 1994) found significant levels of DDT, endosulphan, and Toxaphene (Appendix B). High levels of toxicity were also found in sediment samples taken from Moro Cojo Slough. For additional compilation of water quality data, see California Coastal Commission, Data Evaluation Report for Elkhorn Slough Watershed (CCC, Santa Cruz).

Pesticides currently used in area agriculture are chemicals that break down quickly (matter of hours) and present less threat than past chemicals that persist in water, soil and food, and then biologically accumulate in tissue.

Nonpoint source pollution (NPSP) is considered a problem for the Moro Cojo Slough watershed, resulting in the degradation of wetland and riparian resource values. Pollution may occur from several sources, such as sediment/erosion, confined animal facilities, poor nutrient management, poor pesticide management, intensive livestock grazing, new development, failing sewage systems, and stormwater runoff (EPA, 1993). Section 6217 of the Coastal Zone Reauthorization Amendments of 1990 (CZARA) requires states with Federally approved coastal zone management programs, such as California, to develop and implement Coastal Nonpoint Pollution Control Programs to ensure the protection and restoration of coastal waters. Proposals to prepare a more comprehensive NPSP program for the region, and to implement projects to reduce NPSP and facilitate groundwater recharge have been submitted to Federal agencies for funding (AMBAG, 1994). For additional discussion of change detection in the watershed see California Coastal Commission, A Pilot Methodology for Assessing cumulative Impacts of Activities that Generate Polluted Runoff: Elkhorn Slough Watershed, Monterey County, San Francisco, January 1996, especially Appendix C-1. The Coastal Commission is undertaking additional change detection work under a federal grant for "Estuarian Wetland and Watershed Inventory Using NOAA's CoastWatch Change Analysis Project Protocol in California's Central Coast."

GROUNDWATER

Aquifers

The Moro Cojo watershed is located in the northwestern corner of the Salinas Valley groundwater basin. Principal aquifers occur in the underlying the Salinas River basin, an elongated basin extending approximately 70 miles along the Salinas Valley from Monterey Bay eastward to San Ardo (Boyle, 1986). Groundwater is a major source of water for agricultural and domestic water uses in the Moro Cojo area. Overdraft has resulted in saltwater intrusion and a significant decay in the water quality of many wells within the lower portion of the groundwater basin, including the Castroville and Moro Cojo Slough area.

The Salinas Valley groundwater basin is comprised of three major water-bearing strata referred to as the 180-foot, 400-foot and 800-foot or deep zone aquifers. The 180-foot aquifer is confined principally to the more recent Quaternary aged sediments; the 400-foot aquifer is found in the Aromas sands; and the 800-foot is composed of the Pliocene Purisima and Paso Robles formations (Johnson, 1980). In the lower Salinas Valley, the 180-foot and 400-foot aquifers are separated by apparently continuous clay deposits that restricts vertical flow between the water bearing units (termed an "aquitard" layer). In areas in upper Moro Cojo Slough watershed above Castroville Boulevard, however, the aquitard is locally discontinuous and a hydraulic link may exist between all three aquifers (Boyle Engineering, 1986 and 1987; Johnson 1980).

In addition to the three confined aquifers, a shallow unconfined groundwater table is present in Moss Landing and in hills surrounding Moro Cojo Slough. Shallow groundwater is commonly found at depths between 0 and 15 feet below the ground surface. Further groundwater information is contained in MCWRA, North Monterey County Hydrogeologic Study, Volume I (MCWRA, 1995).

Groundwater Movement and Recharge

Water enters the aquifers through recharge from direct precipitation and surface flow in streams in the shallow surface formations. The deeper aquifers are more expansive, receiving most of their recharge from precipitation falling over a larger regional area. Their groundwater movement is controlled by a structural and stratigraphic boundaries. In general, groundwater movement in the deeper aquifers underlying the Salinas Valley is north-westward toward the ocean (Johnson, 1980).

Very little information exists on the groundwater recharge potential of the area surrounding Moro Cojo Slough. The elevated hills in the upper portion of the watershed have moderate-to-high rates of infiltration and likely contribute recharge to all the aquifers. The lower portion of the basin, particularly along the valley floor of the slough, is underlain by a thick layer of silty clay-to-clayey loam soils with apparent low infiltration rates. It is unlikely that Moro Cojo Slough below Castroville Boulevard contributes a measurable amount of recharge to the major aquifers; however, detailed soils and subsurface geologic investigations are needed to clarify the issue.

Historically, springs and seeps around Lower Moro Cojo Slough and Moss Landing have been cited as important hydrological components of the Moro Cojo wetlands (ABA, 1988, 1989). Historic accounts from the early Spanish settlers report that numerous springs and seeps existed along many of the hillsides in Moro Cojo and Elkhorn Slough during the early 1800's. Some accounts refer to fresh water springs and shallow wells at Moss Landing that disappeared in the 1940's. Seeps are still visible in wet areas on top of terraces in cultivated fields. Springs originate from recharge in the shallow surface aquifer, and occur as spring flow where the groundwater table intersects the ground surface. Surface springs and seeps occur in topographically lower areas or in water-bearing units exposed by faulting or other geologic structures. Historically, fresh water inflows from the Salinas River, when its mouth was present near Moss Landing, could have contributed to the recharge of this shallow aquifer; however, the volume of water provided by direct rainfall on elevated recharge areas was likely greater.

Groundwater Levels and Quality

The 180-foot and 400-foot aquifers are the principal water bearing strata for domestic, commercial, and agricultural use within the Salinas Valley and the numerous wells in the Moro Cojo Slough area. The majority of wells in the lower portion of the Moro Cojo Slough watershed are used for agriculture, whereas more wells in the upper portions of watershed are used for domestic water use.

The primary water quality problem in the lower Salinas Valley is salt water intrusion into the 180-foot and 400-foot aquifers. In the last 75 to 100 years, groundwater levels in the Lower Salinas Valley and the Moro Cojo area have dropped markedly. Since roughly the turn of the century, a measurable drop in groundwater has been recorded in several of the wells within the Moro Cojo Slough area. Boyle Engineering (1986) reports that wells located in the northeastern portion of the Salinas Basin (in the general vicinity of the Moro Cojo Slough), have dropped about 85 feet between 1935 and 1965. Since 1965, the groundwater table appears to have stabilized, however. The drops in water table elevations within the 180-foot and 400-foot aquifer are in direct response to the on-going overdraft of the aquifers. Salt water intrusion was first recorded in the late 1930's when several wells in the 180-foot aquifer became contaminated and were abandoned. Since that time, salt water intrusion has affected about 13,000 acres overlying the 180-foot aquifer, and 8,000 acres overlying the 400-foot aquifer. Salt water intrusion into the 800-foot aquifer has not yet been observed. Other groundwater quality issues facing the Moro Cojo region are nitrates from residential septic leach fields, agricultural fertilizers, and local grazing.

Seawater Intrusion

There is sea water intrusion in Moro Cojo Slough between the Monterey Bay and the SPRR tracks. Three separate groundwater aquifers occur in the watershed, the 180-foot, the 400-foot, and the 900-foot aquifer. The two upper aquifers have some salt water intrusion. Due to high surface salinity, salt water intrusion occurs 200 feet below the ground surface; therefore, the 180-foot aquifer in this area is contaminated with salt water. The water in this aquifer is no longer usable for domestic or agricultural purposes. Some of the hypersaline water documented in the 180-foot aquifer may be from residual saltiness of the slough environment. The two factors that support this conclusion are (1) the clay layer within the soil above the 180-foot aquifer is minimal, and (2) the water observed in the 180-foot aquifer is highly mineralized and did not have the overall appearance of salt water intrusion (J. Snow, MCWRA, pers. comm., 1993).

In a small area in the southwestern portion of Moro Cojo Slough, and the area southwest of Highway 1 between Moss Landing and Castroville (outside the watershed boundary), the 400-foot aquifer has some salt water intrusion. A well located in this area has a salinity of approximately 500 mg/l. However, a well located in Moro Cojo Slough north of Dolan Road at the Moon Glow Dairy did not have salt water intrusion in 1989 (*ibid*).

Studies indicate that in 1983, greater than 10,000 acres of the 180-foot aquifer in the Castroville vicinity had sea water intrusion, and the effected area was expected to increase at a rate of approximately 250 acres per year (Seawater Intrusion Committee, 1987). The study also states that sea water intrusion has effected an area of approximately 3,000 acres in the 400-foot aquifer, and is expected to increase at a rate of approximately 120 acres per year. The study projects that between 1998 and 2003, the 180-foot and the 400-foot aquifers in Castroville will no longer be usable (*ibid*). Although these areas include a portion of the watershed, the problem appears to be increasing. The MCWRA plans to deliver reclaimed water for irrigation to the Castroville area by 1997 in order to halt the pumping of groundwater in this area (Pete Koehn, MCWRA, pers. comm.).

The Castroville Seawater Intrusion Project will use treated wastewater to augment groundwater supplies for irrigation uses in the Castroville irrigation area. The reclaimed water will be provided by the Monterey Regional Wastewater Treatment Plant. The Monterey Regional Water Pollution Control Agency (MRWPCA) will upgrade the plant from a secondary treatment to a tertiary treatment facility as part of the Salinas Valley Reclamation Project. The reclaimed water will be stored in a storage pond, and it will flow by gravity to the reclaimed water distribution system. The distribution system in the Castroville irrigation system area includes transmission and distribution pipelines, supplemental wells, booster pump stations, and an operations center (Figure ~~4-6~~ 7-3). The project also specifies the regulation of wells in the Castroville service area.

The MRWPCA will operate the reclamation plant and storage pond as part of the regional wastewater treatment plant. The MCWRA will operate the distribution system and regulate wells. The tertiary treatment plant would provide approximately 2,500 acre-feet of reclaimed wastewater per month to the Castroville irrigation system. In months with lower irrigation demand (i.e., October-March), excess secondary wastewater would be discharged through an existing ocean outfall. In months with higher irrigation demand (i.e., April-September), a deficit of reclaimed wastewater would exist, and groundwater would have to be pumped to augment the reclaimed wastewater supply.

The Castroville Irrigation Area Distribution system consists of 48 miles of reclaimed water transmission and distribution pipelines. A network of pipes will distribute reclaimed water to approximately 12,000 acres around Castroville on 220 parcels of farmland. Lateral pipelines, ranging from 8-27 inches in diameter, branch off the main trunk pipeline from the treatment plant (described above) to serve each farm parcel.

To provide a backup in the event reclaimed wastewater production is interrupted and to supplement the reclaimed water supply when needed, MCWRA will operate 24 supplemental wells with a combined discharge rate of 62,000 gallons per minute. Of the 22 wells selected, 19 of them are existing agricultural wells in the project area that will be acquired by MCWRA for rehabilitation and will be configured to discharge into the distribution system. The remaining three wells will be drilled. MCWRA would regulate all existing and future wells in the Castroville service area to minimize the pumping of groundwater in and near the seawater intrusion area.

The project is considered to be consistent with water resource policies to protect groundwater supplies, with agricultural policies to protect agriculture, and with most environmentally sensitive habitat policies to protect environmentally sensitive areas.

Table 4-1. Soil Characteristics for the Moro Cojo Watershed
(from Soil Conservation Service, 1980)

The Hydrologic Soil Group is an empirically derived value that provides a measure of infiltration and runoff potential of the a particular soil group and drainage area.

SCS Symbol	Soil Name and General Description	Approx. Depth (in)	Approx. Permeability (in/hr)	Hydrologic Soil Group[1]	Areas[2] of Exposure in Watershed
Ac	Alviso silty clay loam	45	0.06 - 0.6	D	Lower
Ad	Alviso silty clay loam	45	0.06 - 0.2	D	Lower
Ak	Arnold loamy sand	48	6.0 - 20	B	Upper
Ar	Arnold-Santa Ynez Complex: loamy fine sand	48	6.0 - 20	B	Upper
Cn	Cropley silty clay	69	0.06 - 0.2	D	Lower
Db	Diablo clay	53	0.06 - 0.2	D	Lower
Ed	Elkhorn fine sandy loam	63	0.2 - 0.6	B	Upper, Lower
Ee	Elkhorn Variant fine sandy loam	25	0.06 - 0.2	C	Upper
Oa	Oceano loamy sand	80	6.0 - 20	A	Lower
Rb	Rinde Muck: sapric material	60	0.06 - 0.2	D	Lower
Sh	Santa Ynez fine sandy loam	61	0.06 - 0.2	D	Lower

1 "A" soils are most the most well-drained while "D" soils are the least permeable.
2 Upper watershed areas tend to be more well-drained and lower watershed area tend to be the least permeable.

Table 4-2. Hydrologic Characteristics of Moss Landing Harbor and Adjacent Wetlands

MORO COJO TIDAL DATUMS
ELKHORN SLOUGH AT HIGHWAY 1 BRIDGE

	DATUMS	
	MLLW	NGVD
ESTIMATED 100-YEAR HIGH TIDE	+8.30 ft.	+5.60 ft.
MHHW	+5.33'	+2.63'
MHW	+4.64'	+1.94'
NGVD (MSL 1929)	+2.70'	0.00'
MLW	+1.08'	-1.62'
MLLW	0.00'	-2.70'

Epoch (1960 - 1978) - Series 4 months (6/76-7/76; 5/77-6/77)

Hydrologic Characteristics of Moss Landing Harbor and adjacent wetlands. (Source: NOS, 1978.)

Table 4-3. Point Rainfall Depth for the Moro Cojo Watershed

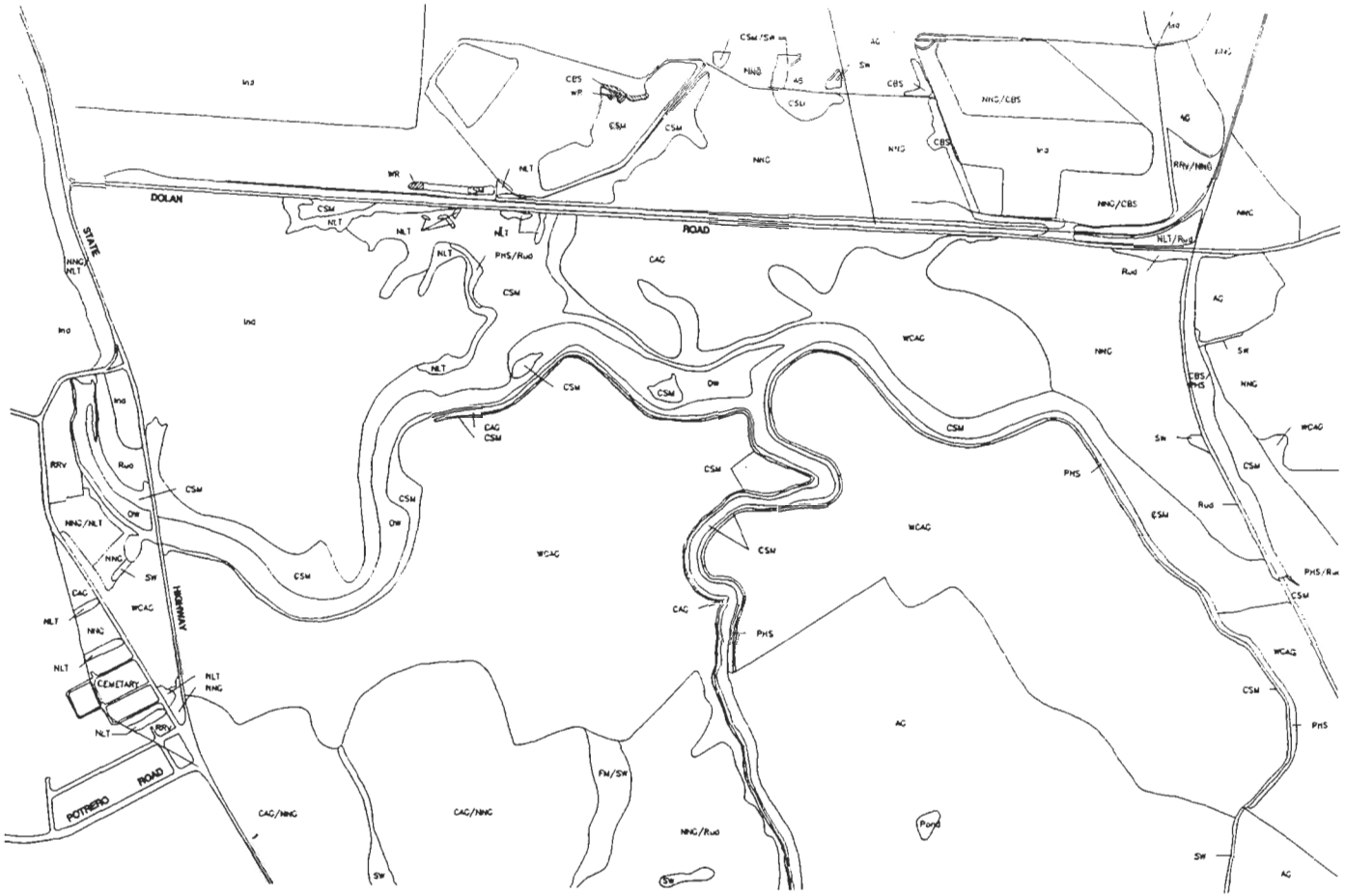
STORM FREQUENCY

Duration	2-yr	10-yr	25-yr	50-yr	100-yr
5 min.	0.16	0.24	0.27	0.30	0.35
10 min.	0.26	0.41	0.48	0.53	0.61
1 hr.	0.55	0.81	0.95	1.06	1.22
2 hr.	0.78	1.15	1.35	1.49	1.73
3 hr.	0.95	1.41	1.65	1.83	2.12
6 hr.	1.35 1.10	1.99 1.50	2.33 1.65	2.59 1.80	2.99 2.00
12 hr.	1.91	2.82	3.30	3.66	4.23
24 hr.	1.60	2.50	3.20	3.50	4.00

Point rainfall depths for the Moro Cojo Watershed (from Monterey County Department of Public Works Rainfall Intensities Chart; Plate No. 25, 1977, and NOAA, 1977).

Table 4-4. Runoff Peak Flow and Volumes Computed for Selected 12-hour Events Calculated by HEC-1 Simulation at Highway 1

Frequency (year)	Peak (cfs)	Total Volume (acre-feet)
2	506	513
10	891	894
25	1110	1110
50	1280	1277
100	1555	1543



SYMBOL LEGEND

SYMBOL	DESCRIPTION OF SYMBOL
	WETLANDS
CSM	COASTAL SALT MARSH
SW	SEASONAL WETLAND
FM/SW	FRESHWATER MARSH/SEASONAL WETLAND
CSM/SW	COASTAL SALT MARSH/SEASONAL WETLAND
OW	OPEN WATER
	RIPARIAN
WR	CENTRAL COAST ARROYO WILLOW RIPARIAN FOREST
	GRASSLANDS
CAG	COASTAL ALKALI GRASSLAND
WCAC	WET COASTAL ALKALI GRASSLAND
NNG	NON-NATIVE GRASSLAND
CAG/NNG	COASTAL ALKALI GRASSLAND/NON-NATIVE GRASSLAND
NNG/CBS	NON-NATIVE GRASSLAND/COYOTE BRUSH SCRUB
NNG/NLT	NON-NATIVE GRASSLAND/NON-NATIVE LANDSCAPE TREES
NNG/RRV	NON-NATIVE GRASSLAND/RURAL RESIDENTIAL VEGETATION
	SCRUB
CBS	COYOTE BRUSH SCRUB
RUD	RUDERAL
PHS	POISON HEMLOCK SCRUB
PHS/RUD	POISON HEMLOCK SCRUB/RUDERAL
CBS/PHS	COYOTE BRUSH SCRUB/POISON HEMLOCK SCRUB
	NON-NATIVE COMMUNITIES:
RRV	RURAL RESIDENTIAL VEGETATION
NLT	NON-NATIVE LANDSCAPE TREES
NLT/RUD	NON-NATIVE LANDSCAPE TREES/RUDERAL
AG	AGRICULTURAL LAND
POND	POND
IND	INDUSTRIAL

SCALE
0 1 MILE
0 1,000 2,000 3,000 4,000 5,000 FEET
NORTH

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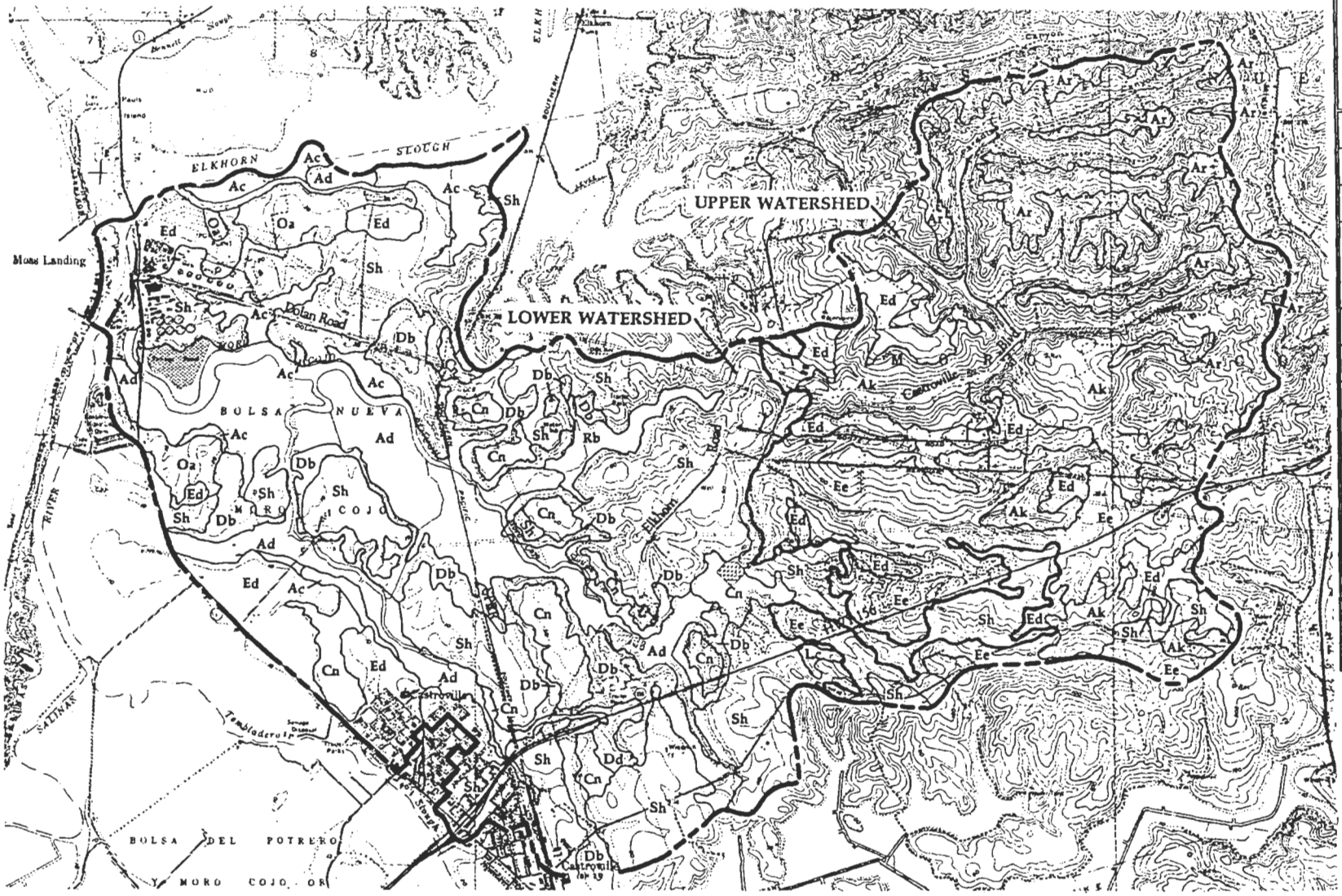
Moro Cojo Slough Management and Enhancement Plan
Plant Communities of Lower Watershed

2/96
705-01

Figure 5-1



SCS Symbol	Soil Name and General Description
Ac	Alviso silty clay loam
Ad	Alviso silty clay loam
Ak	Arnold loamy sand
Ar	Arnold-Santa Ynez Complex: loamy fine sand
Cn	Cropley silty clay
Db	Diablo clay
Ed	Elkhorn fine sandy loam
Ee	Elkhorn Variant fine sandy loam
Oa	Oceano loamy sand
Rb	Rinde Muck: sapric material
Sh	Santa Ynez fine sandy loam

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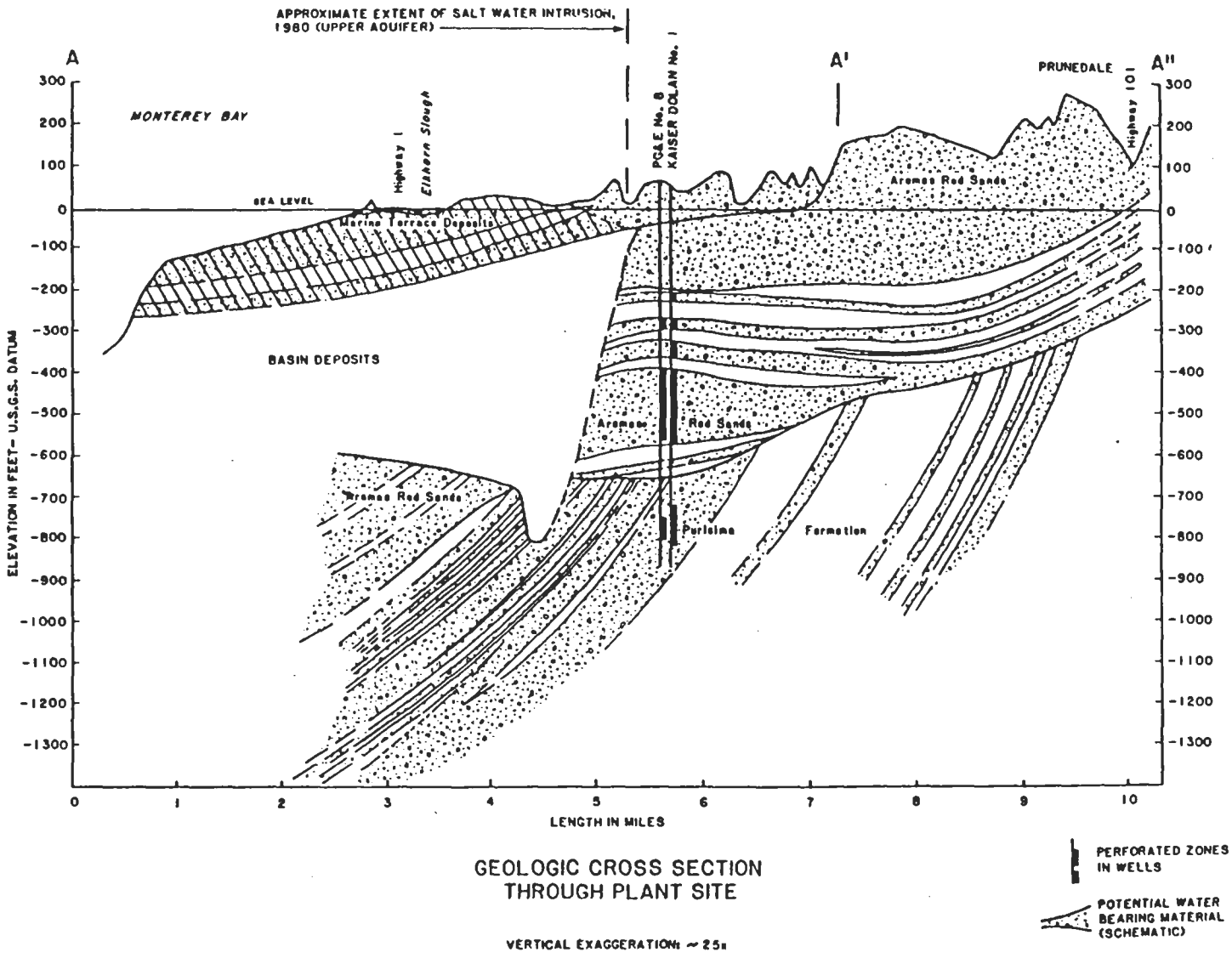
• Applied Marine Sciences

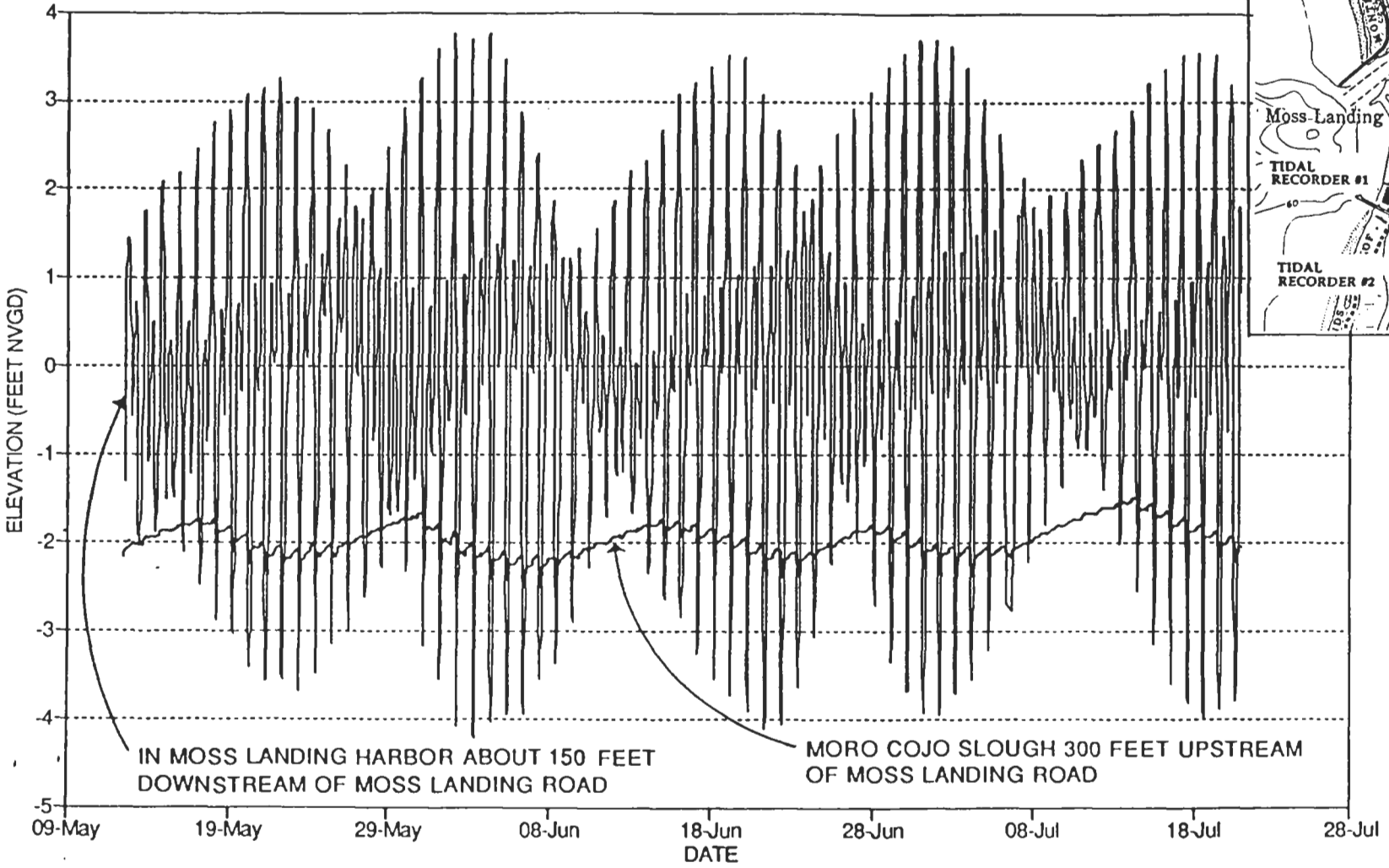
Moro Cojo Slough Management and Enhancement Plan
Watershed and Soils Map

2/96
705-01

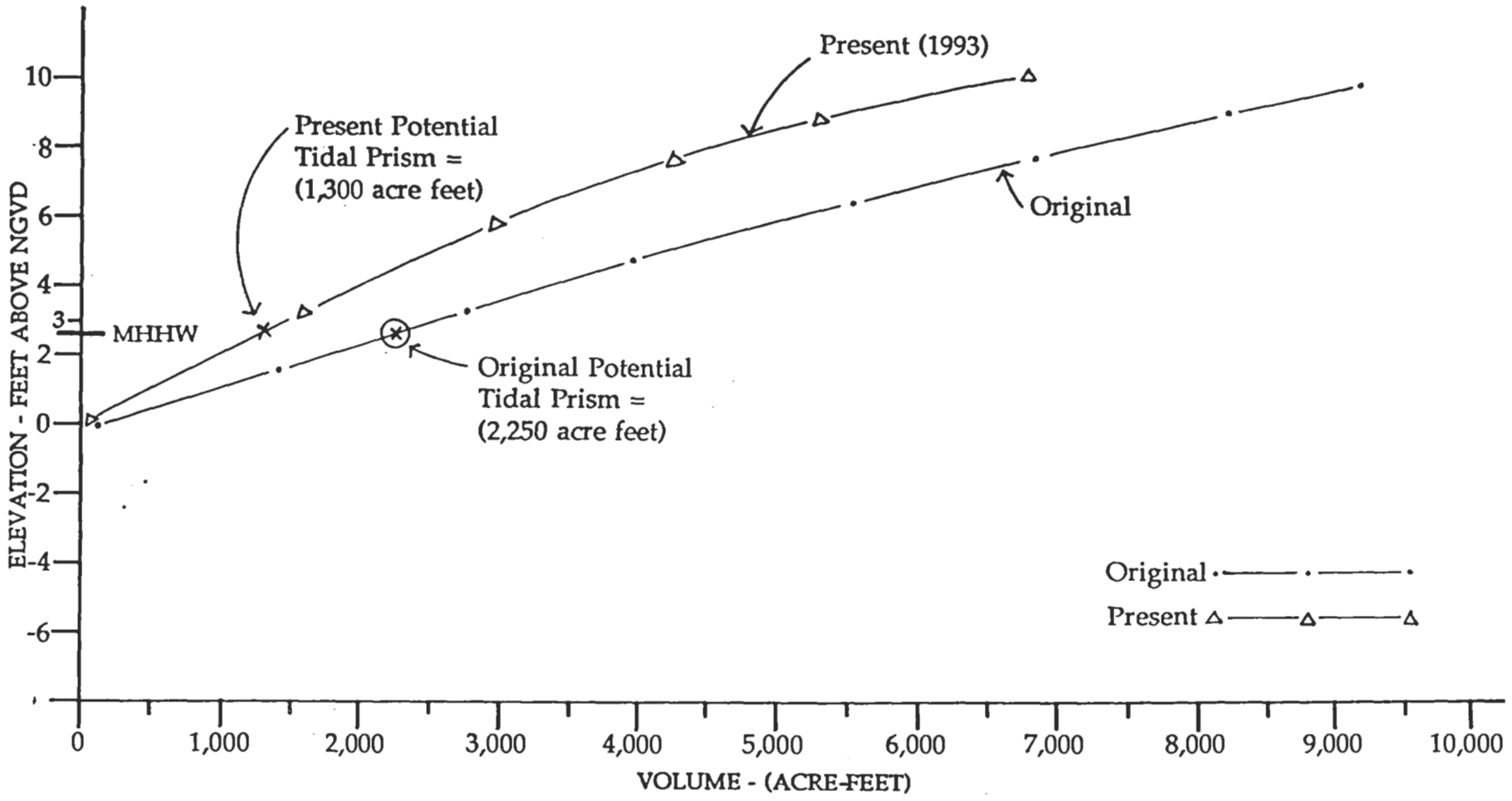
Figure 4-1



The Habitat Restoration Group Mitchell Swanson & Associates VB Agricultural Services Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Geologic Profile of the Area Underlying Moro Cojo Slough	Figure 4-2 2/96 705-01

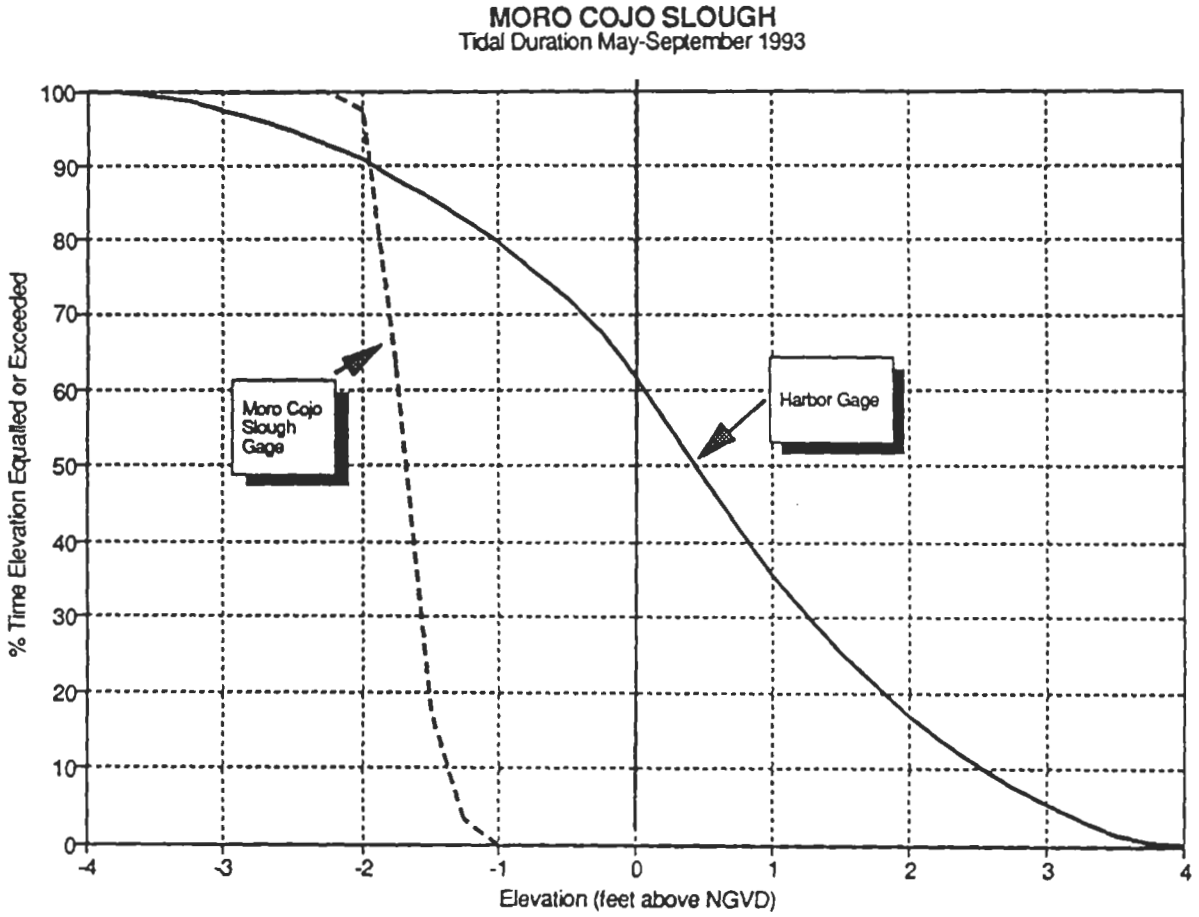


The Habitat Restoration Group Mitchell Swanson & Associates VB Agricultural Services Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Tidal Hydrographs for Moro Cojo Slough and Moss Landing Harbor Recorded in Summer of 1993	Figure 4-3 2/96 705-01



Source: Computed from survey data and calculations from Monterey County Water Agency and Mitchell Swanson & Associates

The Habitat Restoration Group Mitchell Swanson & Associates VB Agricultural Services Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Plot of Tidal Volume in Moro Cojo Slough - Past and Present	Figure 4-4 2/96 705-01



The Habitat Restoration Group Mitchell Swanson & Associates VB Agricultural Services Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Tidal Duration for Recording Stations in Moss Landing Harbor and Moro Cojo Slough	**Figure 4-5** 2/96 705-01

CHAPTER 5
BIOLOGICAL RESOURCES

VEGETATION RESOURCES

A reconnaissance-level botanical survey was conducted for the Moro Cojo Slough watershed. The survey documents the major native and non-native plant communities observed in the watershed. The survey was performed by walking portions of the lower watershed and driving public roads within the upper watershed east of Castroville Boulevard over five visits between June 1993 and March 1994. Both upland and wetland habitat types were observed during this time period, which spanned the blooming period for most species and various hydrological. The reconnaissance-level field survey provided only a cursory overview of much of the watershed. Most of the area is private property; therefore, portions of the survey area were not visible by car or foot. Plant communities within these areas were further documented through aerial photo interpretation.

Plant communities were designated utilizing the descriptions of the Preliminary Descriptions of the Terrestrial Natural Communities of California (Holland, 1986). The plant community designations of Holland were modified, where necessary, in order to best describe the communities observed on the project site. The plant communities are delineated on 1993 aerial-photograph base maps prepared by Aerial Photometrics, 1993, scale 1″=300′ (Figure 5-1). Aerial photographs at a scale of 1″=1,000′, provided by the MCWRA, 1993, were used to evaluate the extent of the plant communities east of Castroville Boulevard (Figure 5-2).

The potential for the presence of rare and endangered plant species or habitat for such species was evaluated through a literature review, personal communication with local experts and field survey observations. The California Natural Diversity Data Base (CNDDB) was accessed for known populations of State and Federal listed rare, threatened and endangered plant species within the watershed. The California Native Plant Society (CNPS) Inventory of Rare and Endangered Vascular Plants of California (CNPS, 1988) was used to evaluate the potential for the presence of plant species listed by CNPS. Vern Yadon, a native plant expert in Monterey County, was consulted on the distribution of listed plant species and potential for occurrence within the watershed. The Draft Environmental Impact Report for Manzanita Regional Park (Terra-Sol Ltd., 1980) was researched for information on known populations of species of special concern within the park boundaries.

Sensitive botanical resources are mapped on base maps at a scale of 1″=300′ and 1″=1,000′ (Figures 5-3 and 5-4). Wetland and riparian habitats are depicted on Figure 5-5.

Plant species were identified utilizing The Jepson Manual (Hickman, 1993) and A California Flora and Supplement (Munz and Keck, 1973) and are listed in Appendix C.

The extent of wetland habitat within the watershed was evaluated by mapping areas dominated by hydrophytic vegetation, conducting periodic soil samples tests, and evaluating the extent of wetland hydrology during field surveys and literature research. National Wetland Inventory (NWI) maps for the Moss Landing and Prunedale quadrangles (U.S. Department of Interior, 1972) were reviewed. Wetland designations from these maps, which are based on high altitude aerial photo interpretation, were refined based upon more detailed site reconnaissance (Figure 5-5). A preliminary jurisdictional wetland delineation meeting COE permitting requirements was not performed. A jurisdictional delineation would have to be conducted for any future project in wetlands (including restoration projects).

PLANT COMMUNITIES

There are 10 natural plant communities in the Moro Cojo watershed, and five non-native communities. The wetland communities include coastal salt marsh, freshwater marsh, and freshwater herbaceous wetlands. A riparian habitat, the central coast arroyo willow riparian forest, and a grassland, the coastal alkali grassland, may also be considered wetlands. Portions of the coastal alkali grassland that are considered wetlands are mapped as wet coastal alkali grassland (Figures 5-1 and 5-3). The grassland communities include coastal alkali grassland, non-native grassland, and mixed grassland. Plant communities in the upper watershed include maritime chaparral, coast live oak woodland and coyote brush scrub. The non-native plant communities are ruderal (roadside/weedy species), poison hemlock scrub, agricultural land, rural residential landscape vegetation, and non-native landscape trees. Representative locations of each mapped habitat are listed on Table 5-1; locations listed are considered representative of the habitat type and display both vegetative and salient environmental features typical for the habitat.

For inaccessible areas the vegetation was interpreted by aerial photographs and the plant communities are mapped as units with multiple plant communities represented.

Wetlands

Coastal Salt Marsh. The coastal salt marsh of Moro Cojo Slough extends from the Moss Landing Harbor to Castroville Boulevard The degree of salinity in this portion of the slough varies because, although salt water enters the slough at Moss Landing and freshwater drains into the slough at Castroville Boulevard, hypersaline water has been recorded. The hypersaline condition is, in part, due to flushing of salts which are present in the soil. It is also likely the result of summer evaporation in stagnant or slow moving waters. The high salt concentrations within the soil appear to be associated with reclaimed and/or drained land. Although portions of the slough have brackishwater under certain conditions, the coastal salt marsh vegetation persists due to the hypersaline conditions. Hypersaline water has been recorded from the lower slough at the east side of Highway 1 (ABA, 1990). Field estimates of salinity indicate hypersaline water, probably 40 ppt (*ibid.*).

The community is characterized by a dense cover of low-growing perennial herbaceous species. The salt-tolerant hydrophytic species in this community tend to be dormant in the winter. The width of the community varies in relation to topography such that the community widens where flat land borders the slough channel and will narrow where the adjacent slope steepens. The coastal salt marsh also occurs along the arms of the slough as well as the natural and man-made channels. There are large fields of coastal salt marsh vegetation containing natural drainage channels between the SPRR tracks and Castroville Boulevard.

The coastal salt marsh has been significantly disturbed by cattle grazing. In some areas where portions of the marsh are fenced, the marsh confined within the fenced area exhibits dense vegetation and the area outside the fence is nearly bare from grazing impacts. Portions of the slough have been cut off from the natural channel by berms resulting in the conversion of the dominant species from pickleweed to fat hen. In addition, the extent of the coastal salt marsh in these areas has been significantly reduced when compared to historical records of the marsh community in Moro Cojo Slough as depicted on an 1854 U.S. Coast Survey map (Figure 3-1).

Historic draining and ditching for agriculture has resulted in a significant loss of the coastal salt marsh of the slough. Although the flora and hydrology have been altered, many of these areas retain wetland characteristics and could be restored. In the Castroville Slough arm, the coastal salt marsh vegetation has been significantly reduced in recent years. Farming activities have encroached into the slough such

that the width of the slough has been reduced from 100 feet to less than 10 feet (Pamela Byrnes, Moss Landing Marine Laboratory, pers. comm., 1993).

The border of the slough channels and areas that experience frequent flooding are predominantly comprised of pickleweed (*Salicornia virginica*), a species adapted to periodic inundation. The remainder of this community is composed of alkali heath (*Frankenia salina*), jaumea (*Jaumea carnosa*), saltgrass (*Distichlis spicata*), alkali bulrush (*Scirpus robustus*), Pacific silverweed (*Potentilla anserina* ssp. *egedii*), fat hen (*Atriplex patula* var. *hastata*), creeping rye grass (*Leymus triticoides*), and rabbitsfoot grass (*Polypogon monspeliensis*). Alga was observed within the slough, both east and west of Highway 1 during the field surveys. The alga mats varied in density depending upon the season. *Ulva* and *Enteromorpha* have been recorded during monitoring studies performed by ABA (ABA, 1991). The alga appear to be an important component of the water ecosystem, providing habitat for the brackishwater snail and other invertebrates.

The agricultural land north of Dolan Road has farming activities in swales that support remnant coastal salt marsh vegetation. These disturbed areas also have vegetation representative of a seasonal wetland. Although flooded in winter, these areas are eventually farmed. The area is mapped as coastal salt marsh/ seasonal wetland.

Freshwater Marsh. The freshwater marsh occurs east of Castroville Boulevard, and in one arm of the slough west of Castroville Boulevard reaching northerly toward Dolan Road. Freshwater marsh has vegetation that is adapted to survival in ponded water. The community is dominated by herbaceous emergent species and associated hydrophytic species that border the aquatic areas and ponds within the watershed. Portions of this community exhibit a dense undisturbed association of plant species, although some areas of freshwater marsh have been significantly disturbed by cattle grazing activities and agriculture. The freshwater marsh intermixes with the willow riparian community in some areas; these areas are mapped as central coast arroyo willow riparian forest/freshwater marsh and include the freshwater arms of the slough near Castroville Boulevard, and smaller tributaries in the upper watershed. The mapping unit of central coast arroyo willow riparian forest/perennial wetland describes those areas with willows that are interspersed with perennial wetland areas where the overstory vegetation does not occur or has been removed, such as creeks in the upper watershed.

Species that occur in the freshwater marsh include smartweed (*Polygonum punctatum*), acute tule (*Scirpus acutus*), bog rush (*Juncus effusus*), burreed (*Sparganium eurycarpum*), California tule (*Scirpus californicus*), spike rush (*Eleocharis* sp.) and cattail (*Typha latifolia*).

Freshwater Herbaceous Wetland. The freshwater herbaceous wetland is associated with the upper watershed of Moro Cojo Slough. The community consists of perennial and seasonal wetlands that occur in depressions, swales, drainages, and along disturbed creek courses. This community is also associated with wet meadow areas. Where the community is interspersed between willow thickets, it is likely that the freshwater herbaceous wetland persists in wet areas, creek channels and drainages where the riparian overstory has been removed. The species composition consists of herbaceous annual and perennial hydrophytic species. Arroyo willow saplings and trees also occur within this community.

Seasonal wetlands were observed throughout the watershed. These areas include intermittent creeks, seeps, ponds and depressions. These areas are characterized by annual species and perennial vegetation adapted to survive the dry season. Examples are the seasonal ponds located along Dolan Road.

Perennial herbaceous wetlands have a constant source of water, but do not support emergent vegetation characteristic of the freshwater marsh. These areas are associated with springs and seeps that provide

surface and subsurface water, but do not have sufficient ponding to support significant emergent vegetation, such as the perennial seeps in the Paradise Road area.

One depression near Highway 1 supports seasonal wetlands that surround a ponded area with freshwater marsh vegetation that is mapped as freshwater marsh/seasonal wetland.

Dominant species observed in the freshwater herbaceous wetlands include bog rush (*Juncus effuses*), iris-leaved rush (*Juncus xiphioides*), toad rush (*Juncus bufonius*), willow herb (*Epilobium* sp.), smartweed (*Polygonum* sp.), rabbitsfoot grass, perennial rye grass, and loosestrife (*Lythrum hyssopifolia*).

Central Coast Arroyo Willow Riparian Forest

This riparian community is associated with the freshwater portions of the slough. The community can form dense thickets of willow trees and shrubs, or can be composed of isolated willow trees. The community intermixes with the freshwater marsh community. Characteristic understory species include California blackberry (*Rubus ursinus*), stinging nettles (*Urtica diocia* ssp. *holosericea*), and nut grass (*Cyperus esculentus*).

In the upper watershed, the channels of the tributaries have been impacted by residential development and agriculture such that the course of the original stream channel has been removed, culverted, or filled with sediment. Subsequently, the willow riparian forest vegetation along these tributaries consists of intermittent stands of arroyo willows interspersed with scattered arroyo willow trees. Along Blackie Road, the willow riparian community associated with a creek along the road has recently been significantly limbed and cleared. Willow saplings become established in natural drainages on farm land that have been converted into agriculture run-off drainages and ditches.

Grasslands

Coastal Alkali Grassland. The coastal alkali grassland occurs between the SPRR tracks and Highway 1. In some areas, the grassland is separated from the slough channel by a berm. These grassland areas can experience periodic inundation, saturation, ponding, and/or a high water table. Some of these coastal alkali grassland areas are historical wetlands that were drained for agriculture, but because these areas retain wetland characteristics unsuitable for farming, they are predominantly use for cattle grazing. Currently, these grassland areas have functional and abandoned channels, and ponded low areas. The soil in the coastal alkali grassland has hydric characteristics. The portions of this grassland community that exhibit wetland characteristics are mapped as the wet coastal alkali grassland.

The community is dominated by grass species such as saltgrass, rabbitsfoot grass, perennial ryegrass, foxtail (*Hordeum* sp.) and meadow barley (*Hordeum brachyantherum*). There are inclusions of coastal salt marsh vegetation such as alkali heath, fat hen and spikerush (*Eleocharis* sp.) within the grassland.

Much of the alkali grassland has been impacted by grazing activities. In addition, it is possible that long-term grazing impacts have resulted in the alteration of the species composition of this community such that the density of the native species has decreased, while the density of non-native species has increased. An area near Highway 1 that has undergone intensive grazing is mapped as coastal alkali grassland/non-native grassland.

Mixed Grassland. The mixed grassland was observed along the slopes bordering the slough in the vicinity of the mobile home park on Dolan Road. The community is characterized by native bunchgrasses, non-native grasses and wildflowers. The community includes species such as purple needlegrass

(*Nassella pulchra*), perennial rye grass, and creeping rye grass, and curly dock (*Rumex crispus*). Native wildflower species such as Mariposa lily (*Calochortus* sp.) and soaproot (*Chlorogalum pomeridianum*). A CNPS List 1B species, Gairdner's yampah (*Perideridia gairdneri* ssp. *gairdneri*) was also observed in this community. The mixed grassland community could occur in other portions of the watershed that were not surveyed on foot.

Non-native Grassland. The non-native grassland is associated with abandoned agricultural areas, hillsides bordering the slough, residential areas, and disturbed areas. The community is predominantly composed of non-native grasses and herbs. Non-native grassland becomes established in areas where the natural vegetation has been removed; thus, non-native grassland in common the rural areas within the watershed, either as an dominant community or as an understory component of other communities. Representative species include wild oat (*Avena barbata*), perennial ryegrass, ripgut brome (*Bromus diandrus*), English plantain (*Plantago lanceolata*), and wild radish (*Raphanus sativus*). Native species such as creeping rye grass and coyote brush shrubs (*Baccharis pilularis*) are also a component of this community.

Disturbed areas and large mapping units of the upper watershed are represented by a mixture of non-native grassland and non-native plant communities. These are named for the dominant components and include non-native grassland/ruderal, non-native grassland/non-native landscape trees, non-native grassland/rural residential vegetation, non-native grassland/rural residential vegetation/ruderal, and non-native grassland/rural residential vegetation/non-native landscape trees.

Maritime Chaparral

The maritime chaparral community occurs within upland areas in the upper watershed of Moro Cojo Slough. Maritime chaparral is associated with hillsides and south-facing slopes from the Paradise Canyon Road vicinity south to Manzanita Park (Figure 5-2). This community tends to intermix with the coast live oak woodland. The community is associated in sandy substrates on coastal hills influenced by the incursion of fog. The xeric conditions associated with sandy soils coupled with the temperate climate and summer fog results in a specialized environment that supports many special status plant species. Rural residential development occurs within this community.

The vegetation is characterized by manzanita species (*Arctostaphylos* spp.), chamise (*Adenostoma fasciculatum*), sticky monkey flower (*Mimulus aurantiacus*), poison oak, (*Toxicodendron diversilobum*), toyon (*Heteromeles arbutifolia*), and black sage (*Salvia mellifera*). The community is potential habitat for numerous protected plant species including (but not limited to) Pajaro manzanita, Hooker's manzanita (*Arctostaphylos hookeri*), and Monterey ceanothus (*Ceanothus cuneatus var. rigidus)*, which occur in Manzanita Regional Park.

This community intermixes with coast live oak woodland. Much of maritime chaparral occurs in the Paradise Road/Manzanita Regional Park area where access is limited; therefore, these areas were mapped as large cells with many plant communities including the maritime chaparral/coast live oak woodland, maritime chaparral/coast live oak woodland/rural residential vegetation/non-native landscape trees, and maritime chaparral/coast live oak woodland/non-native landscape tree associations.

Coast Live Oak Woodland

The coast live oak woodland occurs in the upper Moro Cojo Slough watershed. This community is typically associated with the mesic conditions of north-facing slopes, hillsides, and shaded ravines. The woodland intermixes with the maritime chaparral community on inland hills. This community is charac-

terized by an overstory of evergreen coast live oak trees (*Quercus agrifolia*) that reach a height of approximately 25 feet. The dense understory contains herbs and shrubs such as coffeeberry (*Rhamnus californica*), California blackberry, poison oak and bracken fern (*Pteridium aquilinum*). In rural areas, the understory has been disturbed such that non-native grassland has replaced, or intermixes with, native herbs and shrubs. This community has been fragmented by residential development, roads, and farming activities in this area. Rural residential land uses in the upper watershed area east of Castroville Boulevard result in disturbed coast live oak woodland associations that are mapped as non-native grassland/coast live oak woodland/rural residential vegetation/ruderal, coast live oak woodland/rural residential vegetation, or coast live oak woodland/rural residential vegetation/non-native landscape trees.

Coyote Brush Scrub

Coyote brush scrub occurs on hillsides in the upper watershed of Moro Cojo Slough. The density of the community can range from thickets of dense impenetrable shrubs to scattered shrubs interspersed with herbaceous species. The community is dominated by coyote brush shrubs and poison oak. Although coyote brush is a native shrub species, it tends to invade disturbed land; therefore, most areas of coyote brush scrub have resulted from previous land clearing practices. One large disturbed area is mapped as non-native grassland/coyote brush scrub. Other areas that are dominated by coyote brush scrub also have other non-native vegetation components such as the coyote brush scrub/ruderal, coyote brush scrub/poison hemlock scrub, and coyote brush scrub/non-native grassland/ruderal associations.

Non-native Plant Communities

Ruderal. Ruderal vegetation consists of native and non-native weed species that tend to invade disturbed areas such as roadsides. Ruderal vegetation can occur as understory vegetation or a component of another plant community (i.e., ruderal vegetation can be a component of non-native grasslands.

Ruderal vegetation is also associated with abandoned agricultural fields and vacant lots. In the Moro Cojo Slough watershed, ruderal vegetation consists of species such as wild radish, bristly ox-tongue (*Picris echioides*), wild geranium (*Malva parviflora*), horseweed (*Conyza canadensis*), and black mustard (*Brassica nigra*).

Poison Hemlock Scrub. The poison hemlock (*Conium maculatum*) scrub occurs on berms and hills bordering Moro Cojo Slough channels west of Castroville Boulevard. This non-native community is dominated by poison hemlock, although additional non-native species such a wild radish (*Raphanus sativus*) also occur (these areas are mapped as poison hemlock scrub/ruderal). The berms also support coastal salt marsh vegetation; therefore, the vegetation maps depict cells of coastal salt marsh/poison hemlock scrub and coastal salt marsh/poison hemlock scrub/ruderal vegetation.

Agricultural Land. The agricultural land consists of mono-cultures of agricultural crops such as strawberry, artichoke and herbs. These fields associated have ruderal and herbaceous hydrophytic species within drainage channels.

Rural Residential Vegetation. This mapping unit includes areas that have been landscaped with native or non-native species, residential gardens and orchards, and the ornamental vegetation that is associated with residential homes.

Non-native Landscape Trees. The non-native landscape trees in the Moro Cojo Slough watershed includes stands of eucalyptus, as well as Monterey cypress and Monterey pine trees that have been planted

as ornamental trees. Large areas of non-native trees often have an understory of ruderal vegetation and are mapped as non-native landscape trees/ruderal.

PLANT SPECIES OF CONCERN

There are 20 special status plant species with potential to occur within the Moro Cojo Slough watershed. Most of these species are associated with the upland habitat of the upper watershed. Table 5-2 outlines the scientific and common name of each species, the habitat(s) where it is known to occur, and the State, Federal and CNPS listings.

Eight plant species of special concern were observed or have been reported to occur within the watershed of Moro Cojo Slough. Three of these species were observed during the 1993 field surveys. Gairdner's yampah was observed within the mixed grassland on the hillside between the mobile home park on Dolan Road and the slough during the 1993 survey. Hooker's manzanita and Pajaro manzanita were observed in the maritime chaparral community of the upper watershed.

Seven of the plant species of special concern have been reported to occur in Manzanita Regional Park including Hooker's manzanita, Pajaro manzanita, Monterey ceanothus, Monterey spineflower, Eastwood's goldenbush, small-leaved lomatium, and Gairdner's yampah (CNPS, 1988). It is likely that these species occur in other portions of the watershed with the maritime chaparral community, such as the area north of Manzanita Regional Park.

It is expected that many populations of rare, threatened or endangered plant species occur within the watershed, predominantly in upland plant communities. Due to access, timing and budget constraints, focused surveys for these populations were not conducted for this plan. Because of the potential for these species in suitable habitat areas, focused surveys for these species are recommended.

WILDLIFE RESOURCES

Reconnaissance-level field surveys to assess existing wildlife habitat conditions were made during June, July, and September 1993, and January, February and March 1994. A literature review and consultation with knowledgeable people augmented the information base for wildlife resources in the study area. Although wildlife literature specific to the Moro Cojo Slough area is limited, research conducted in similar habitats (i.e., Salinas River environs, Elkhorn Slough) in the vicinity of the study area provided valuable reference.

The occurrence of rare, threatened, endangered and State species of special concern was researched for all habitats within the study area. The CNDDB was accessed for information on the location of existing populations of sensitive wildlife species (CNDDB, 1989). Limited, focused surveys for sensitive wildlife species were conducted in winter 1993/1994 to further document potential presence of sensitive species. Sensitive wildlife resources are portrayed on base maps (Figures 5-3 and 5-4). Appendix D, Wildlife Species Observed or Predicted to Occur in the Moro Cojo Slough Watershed, identifies which species were observed during the study and which are predicted.

WILDLIFE HABITAT

The Moro Cojo Slough study area is a valuable resource to a great variety of wildlife species. The slough and its associated habitats, along with the Elkhorn Slough system, and the Pajaro and Salinas River mouth areas, are of regional importance to wildlife. Coastal sloughs and associated wetlands of the central California coast are well-known for their importance to migratory birds. Moro Cojo Slough

is one of the few remaining natural coastal wetlands in the Monterey Bay Area. Within the context of the Bay, much of the upper slough area serves as a focal point for wildlife activity. Much of the lower, more saline reaches of the slough have been reclaimed over the last 150 years, for agriculture and other human needs, yet still possess high wildlife value. In the local context, the slough is a focal point for wildlife activity (especially waterbirds), as the project area's natural habitats serve as a refuge for wildlife within the agricultural and urbanized environment of central Monterey Bay.

Studies focusing on the wildlife of Moro Cojo Slough are few and, for the most part, highly qualitative. Wildlife of the Elkhorn Slough, however, has been studied quite thoroughly for many decades and can serve as an important reference in predicting which wildlife species occur in the similar habitats of Moro Cojo Slough.

The Moro Cojo Slough study area is comprised of the following habitats: coastal salt/brackish-water marsh, coastal alkali grassland, non-native grassland, mixed grassland, central coast arroyo willow riparian forest, freshwater herbaceous wetland, coyote brush scrub, poison hemlock scrub, agricultural land, and maritime chaparral. The plant composition of these habitats is described in the vegetation section of this report.

Wildlife species diversity and abundance on the project site varies seasonally and annually, depending on the quantity and quality of resources present. While some wildlife species may be restricted to certain plant communities due to specific habitat requirements, many of them utilize several of the habitats present in the study area.

The slough's overall wildlife value results from its diversity of habitats, and location along the coast adjacent to the highly productive Monterey Bay. The wildlife value is also due to limited human disturbance resulting from limited access along much of the length of the slough. The slough is especially important for migratory waterbirds and shorebirds, and raptors. It may be assumed that of the more than 200 species of birds that may be seen at the Elkhorn Slough, many also make use of the resources in the Moro Cojo Slough area. Allen and Reilly (1980) observed a total of 14 shorebirds and three other bird species in a short survey. Hansen (1976) observed a similar number of species. The waterbird and shorebird total observed in the Elkhorn Slough represents approximately 56% of all the waterbird/shorebird species recorded in California (excluding oceanic species).

The wildlife value of Moro Cojo Slough is affected by intensive agricultural activities (past and present) which surround it, as well as urban development around much of the south and east sides of the upper reaches. Agricultural practices have impacted the wildlife value of the slough through removal of native upland habitat, limiting resources for wildlife.

Central Coast Arroyo Willow Riparian Forest

This habitat type includes the willow riparian forest which occurs along much of the upper reaches of the slough as well as along most of the tributaries flowing into the slough. The riparian habitat of the study area supports a high diversity of terrestrial wildlife species, due to the availability of numerous cover, roosting, nesting, and foraging sites provided by the abundant plant growth and the stratified nature of the vegetation. The riparian woodland is especially valuable as a wildlife refuge from the largely unsuitable habitat conditions of the adjacent agricultural fields. In addition, the riparian habitat functions as a movement corridor for wildlife species between different habitats. Much of the riparian habitat in the study area, however, is highly fragmented, interrupted by agricultural and residential developments, which tends to reduce the complexity of the vegetative layering and, thus, the overall wildlife value.

Amphibians. Amphibians are an important ecological component of riparian systems (Brode and Bury 1985). The presence of water, abundant dead and fallen woody material, and the high productivity of insects associated with deciduous vegetation makes this habitat highly suitable for several amphibian species. The adjacent aquatic environment offers an important resource to many frogs, toads, and salamanders that require standing water to complete their life cycles. Dead and downed woody material provides cover which moderates temperatures during the dry season, and creates suitable microclimates for amphibians. The high productivity of insects provides amphibians with an abundant food source.

Some of the amphibian species expected to use this habitat in the study area include California slender salamander, arboreal salamander, Santa Cruz long-toed salamander (SCLTS), California tiger salamander, Pacific treefrog, bullfrog, and western toad.

Reptiles. The mesic environment of this habitat is suitable for a variety of moisture dependent/tolerant reptile species, as well as those species which occur in more xeric situations. The abundance of dead and downed woody material offers suitable cover and rest sites, while the abundance of insects provide an important food source. Small mammals and amphibians occurring in this habitat are important food resources for snakes.

Reptiles known or expected to occur in this habitat include western fence lizard, northern alligator lizard, southern alligator lizard, sharp-tailed snake, ring-necked snake, western terrestrial garter snake, common garter snake, and common kingsnake.

Avifauna. Birds are the most numerous and diverse faunal group within the riparian habitat. The dense and diversified vegetation provides cover, forage, and nesting and roosting sites. The adjacent estuarine habitat provides various bird species opportunities for foraging, drinking, and bathing. Riparian habitat is an essential resource for migratory birds, offering a resting area where fat reserves can be replenished before continuing long distance flights between wintering and breeding grounds. As a result of migratory and local movements, reproduction, and seasonally changing habitat requirements, bird species richness and diversity in this habitat varies from season to season.

Some of the common representative birds occurring in this habitat include green-backed heron, belted kingfisher, Anna's hummingbird, downy woodpecker, black phoebe, Pacific-slope flycatcher, Swainson's thrush, Wilson's warbler, warbling vireo, black-headed grosbeak, chestnut-backed chickadee, Bewick's wren, bushtit, California towhee, ruby-crowned kinglet, yellow-rumped warbler, yellow warbler, and song sparrow. A large-shouldered kite aggregation has been reported in the vicinity of the Trails End Mobile Manor; over 100 birds have roosted in the willow trees in the late winter of 1987 (M. Silberstein, pers. comm. for Charlie Vierra).

Mammals. Most of the mammalian species using this habitat in the study area are largely year-round residents. While some of these are abundant in non-riparian areas, many are dependent on riparian habitat for food, water, dispersal corridors, and escape and thermal cover (Mayer and Laudenslayer 1988). The moist ground conditions and the large population of invertebrates within the soil and woodland litter are especially suitable for insectivorous mammals such as shrews and moles. The vegetated corridor functions as an important passage for the movement of predatory mammals such as gray fox, weasel, and skunk. The shade and presence of water throughout the year make this habitat suitable as refuge for many species occurring in the surrounding xeric habitats.

Some of the mammal species of known or potential occurrence in this habitat include Virginia opossum, ornate shrew, vagrant shrew, broad-footed mole, brush rabbit, raccoon, striped skunk, red fox, gray fox,

long-tailed weasel, muskrat, dusky-footed woodrat, and deer mouse. The red bat may roost in this habitat.

Coyote Brush/Poison Hemlock Scrub

This habitat supports a limited, but distinctive fauna. Coyote brush scrub is used by wildlife species that require dense, brushy habitats for cover and breeding. The interspersion of grassy patches within the scrub vegetation creates a diversified habitat structure and provides openings for species that forage in open areas adjacent to dense cover.

Avifauna. The dense vegetation is especially suitable for breeding bird species such as Bewick's wren, song sparrow, white-crowned sparrow, California towhee and wrentit. The resident bird population is supplemented by migrant wintering species, such as fox sparrow, Lincoln's sparrow, white-crowned sparrow (migratory *Z. l. gambelii*) and golden-crowned sparrow. The abundance of wintering birds in this habitat creates optimal foraging conditions for American kestrel, merlin, Cooper's hawk and sharp-shinned hawk.

Mammals. Small mammals typical of this habitat include brush rabbit, California pocket mouse, deer mouse, brush mouse and house mouse, all of which are prey for raptors, bobcat, gray fox, coyote and long-tailed weasel.

Mixed/Non-native/Coastal Alkali Grassland

The primary habitat type occurring on the project site is grassland vegetation. In the context of the project site, this vegetation type is an important component of the slough ecosystem. Grasslands provide an important buffer for the slough as well as habitat resources to wildlife of the slough.

The grasses and forbs typical of this community produce an abundance of seeds and attract numerous insects, thereby providing food for a variety of rodents, seed-eating birds and insectivores. These species form the prey base for large predators. Aerially-foraging species, such as bats and swallows occur in grassland habitats in search of flying insects.

Amphibians. Amphibian use of this habitat is limited due to its arid nature. A few species, such as SCLTS, California tiger salamander, Pacific treefrog and western toad may disperse into these habitats from nearby breeding sites and to forage, and use rodent burrows for shelter during the dry season.

Reptiles. Reptiles are common in non-native grassland habitats. The tall grasses and occasional scattered shrubs, provide excellent cover and support prey populations of insects and rodents. Rodent burrows provide additional refuge for snakes and lizards. The western fence lizard is the most common reptile in this habitat. Other species most likely to occur in this habitat include western skink, western yellow-bellied racer, gopher snake, common kingsnake, and western terrestrial garter snake.

Avifauna. Grassland habitats are used extensively by raptors, and granivorous and insectivorous birds. Commonly occurring raptors include northern harrier, red-tailed hawk, American kestrel, merlin and black-shouldered kite. Northern harriers are known to nest in grassland habitats throughout the region. Common passerine birds typical of this habitat include black phoebe, Say's phoebe, loggerhead shrike, barn swallow, savannah sparrow, house finch, lesser goldfinch, white-crowned sparrow and golden-crowned sparrow.

Mammals. The grasslands also provide food and cover for small rodents and rabbits. In turn, these mammals provide a prey base for larger predatory species. Representative mammals of this habitat include brush rabbit, black-tailed hare, Botta's pocket gopher, deer mouse, California meadow vole, western harvest mouse, striped skunk, gray fox, coyote and long-tailed weasel. Bats, such as little brown myotis and big brown bat, are expected to forage over this habitat.

Freshwater Herbaceous Wetland

Freshwater wetlands are considered one of the most productive wildlife habitat types in California (Mayer and Laudenslayer 1988). Wildlife species richness and abundance in wetlands are linked to the availability of water, thus wildlife use will vary as hydrologic conditions change. While many of the wildlife species frequenting wetland habitats are dependent upon their moisture regime and associated vegetation for survival, some species exploit the resources of these habitats without being intimately associated with the habitat. For example, bats and swallows forage over wetlands, but do not directly use the vegetation or aquatic habitat.

Amphibians. The freshwater herbaceous wetlands are especially suitable for amphibians due to their moist micro-climate and abundance of herbaceous plant growth, which provides cover and supports abundant invertebrate prey populations. These habitats may provide breeding habitat for aquatic-reproducing species, depending upon the availability of surface water. Representative amphibian species of these habitats include Pacific treefrog, western toad and California slender salamander, SCLTS, and California tiger salamander.

Reptiles. The moist micro-climate of these habitats is also suitable for a variety of reptiles. Small mammals, amphibians and invertebrates occurring in this habitat are important food resources for snakes such as western terrestrial garter snake, common garter snake, and common kingsnake.

Coastal Salt/Brackish-water Marsh

Coastal salt/brackish-water marsh habitat tends to be relatively uniform and simple, thus fewer niches for wildlife are available. Therefore, wildlife species richness (number of species) in this habitat is low. Moro Cojo Slough is unique among coastal estuarine systems in that full tidal influence has been largely eliminated by the construction of tide gates at the entrance to the slough at Moss Landing Road (Sandholdt Dam). This has severely limited the benthic communities typically found in tidally-influenced areas, and has allowed plant communities to grow closer to the water's edge, not restricted by limiting tidal influence (Hansen 1976). The salt/brackish-water marsh habitat, however, still plays an important role in the cycling of nutrients in the slough ecosystem. Thus the salt/brackish-water is integral to the ecology of the Moro Cojo Slough area.

Wildlife use of the salt marsh towards the mouth of the slough is limited due to the lack of tributary channels. The value of this habitat for wildlife varies depending upon local variation of the hydrologic regime and plant species composition. At high winter tides, salt water may intrude higher into the slough than is typical, creating brackish conditions in what is normally freshwater habitat. Low-lying areas adjacent to the slough become seasonally inundated, causing terrestrial wildlife to disperse to drier upland areas. Inundation, however, creates suitable conditions for waterbirds.

Amphibians. Amphibian use of this habitat tends to be limited due to the relatively high salinity. Amphibians do not breed in areas high in saline (Stebbins, 1985).

Reptiles. Reptile use of the coastal salt/brackish-water marsh is limited by the saline conditions. Reptiles from adjacent ruderal, grassland and riparian habitats may forage in the marsh. These species include common garter snake, western terrestrial garter snake, western aquatic garter snake, and gopher snake.

Avifauna. The vegetative structure of this habitat provides suitable cover and nest sites for a variety of birds, including shorebirds, raptors, waterbirds, and passerines. Northern harrier, mallard, cinnamon teal, gadwall, American avocet, black-necked stilt, song sparrow, and savannah sparrow are expected to breed in this habitat. American pipit and white-crowned sparrows are expected to occur in the brackish-water marsh during the non-breeding season. Barn owl, short-eared owl, and northern harrier forage in this habitat for small mammals and birds. During periods of inundation this habitat provides foraging sites for black-necked stilt, greater yellowlegs, marbled godwit, willet, long-billed curlew, whimbrel, herons, and egrets.

Mammals. The coastal salt/brackish-water marsh supports State Species of Special Concern mammals such as Monterey vagrant shrew, Monterey ornate shrew, and Salinas harvest mouse. These species are known to occur in wetland habitats in the Salinas River region (Williams 1986), and likely occur in the environs of Moro Cojo Slough. The vegetation of this habitat provides these species with seeds and vegetation for forage. Species which occur in the upland transition areas adjacent to marsh habitat include California vole, house mouse, and Norway rat. Gray fox, red fox, striped skunk, and raccoon forage in this habitat during low water periods.

Maritime Chaparral

Central coast maritime chaparral, consisting largely of dense stands of chamise, toyon, lilac and manzanita, provide suitable habitat for a high diversity of terrestrial wildlife species. Due to the availability of numerous cover, roosting, nesting, and foraging sites provided by the abundant plant growth and the stratified nature of the vegetation, this habitat is of high value to numerous species of birds, mammals, reptiles, and amphibians.

Seeds and berries typically produced by this community attract numerous insects, thereby providing food for a variety of rodents, seed-eating birds and insectivores. These species form the prey base for large predators. Many of the bird and mammal species found in riparian and coyote brush/hemlock scrub habitats may also be expected to occur in maritime chaparral. Its dense vegetative structure provides ideal habitat for passerine bird species seeking foraging, nesting, cover, and resting sites. In addition, raptors such as Cooper's hawk and sharp-shinned hawk, specially suited for hunting in dense, heavily wooded areas, are often found foraging on birds and reptiles associated with this habitat.

Amphibian species which may migrate to or through this habitat in the non-breeding season include California slender salamander, SCLTS, California tiger salamander, Pacific treefrog, and western toad.

Agricultural/Grazing Land

Much of the terrain surrounding Moro Cojo Slough has been reclaimed over the last two centuries for agricultural and/or cattle grazing purposes. This land use pattern is highly detrimental to the land's value to wildlife. Natural plant communities are replaced with row crops, providing limited seasonal use for a few insectivorous and granivorous species. Several of the previously farmed parcels within the study area, however, have lain fallow for a number of years, substantially increasing in value to wildlife over that time. Agricultural land may attract large numbers of granivorous birds during some parts of the year, while grazed parcels have substantially lower value to wildlife. Winter flooding is likely to occur on ag-land in parts of the study area, creating seasonal wetlands suitable as migration stopovers for water-

fowl and other birds. For the much of the year, however, growing season activities such as plowing, fertilizing, seeding, etc., greatly diminish its value to wildlife.

During periods of field rotation or other times of disuse, agricultural fields become highly suitable foraging habitat for a variety of insect and seed-eating birds, mammals and reptiles. Blackbirds, sparrows, starlings and finches and most commonly associated with fallow ag-lands, and raptors such as black-shouldered kite, American kestrel, northern harrier, and merlin are typically found foraging here as well. Mammal species commonly found in association with ag-lands include western harvest mouse, ornate shrew, broad-foot mole, and Botta's pocket gopher. Reptiles such as western fence lizard, western skink, western terrestrial garter snake and gopher snake may also be found foraging in these temporary habitats. Amphibian species such as California slender salamander, SCLTS, California tiger salamander, Pacific treefrog, and western toad may migrate to or through this habitat during non-breeding seasons to seek shelter in rodent burrows.

WILDLIFE SPECIES OF SPECIAL CONCERN

The study area supports use by an impressive array of sensitive wildlife species. Thirty-nine species classified as Federally or State endangered or threatened, candidates for endangered or threatened status, or State species of special concern have been recorded or are expected to occur in the study area. Ten of these have only occurred occasionally, but twenty three are known to make significant use of the study area (Table 5-3). Four additional species which make significant use of the study area do not have listed, candidate, of special concern status, but are still considered "sensitive" by the CDFG (denoted by "*" on Table 5-3). Of the species listed, the study area has regional importance for: California brackish-water snail, SCLTS, California tiger salamander, California red-legged frog, California brown pelican, osprey, northern harrier, peregrine falcon, snowy plover, elegant tern, Caspian tern, short-eared owl, Monterey ornate shrew, and Salinas harvest mouse.

The 14 sensitive species known to occur in the study area, but not listed on Table 5-3 are: (1) occasional, uncommon or rare migrants and winter visitors (e.g., ferruginous hawk, white-faced ibis); (2) species that utilize aerial habitat (e.g., black swift); or (3) have been recorded only 1-3 times (e.g., California clapper rail). These species do not utilize the study area significantly, and, as for the clapper rail, suitable habitat may not be present. Sensitive species in this category include common loon, white-faced ibis, southern bald eagle, golden eagle, prairie falcon, clapper rail, sandhill crane, mountain plover, California least tern, black skimmer, burrowing owl, black swift, purple martin, and tricolored blackbird.

A description of the status and pattern of occurrence for sensitive wildlife species known or expected to occur in the study area, not presented below, are depicted on Figures 5-5 through 5-8, and presented in Appendix E.

California Brackishwater Snail

The California brackishwater snail is a Federal Candidate 2 species for listing. In the study region it is known to occur toward the mouth of Moro Cojo Slough (Kellogg, 1980) on both sides of the Highway 1 bridge. Focused studies conducted for this plan documented the species occurrence in the lower slough. Please refer to the Aquatic Resources section of this document for detailed information on this species (pages 5-18 to 5-19).

Santa Cruz Long-toed Salamander (SCLTS)

The SCLTS is one of five subspecies of long-toed salamanders found in the western United States. It was discovered in 1954 (Russell and Anderson, 1956). Typical of salamanders in the family *Ambystomatidae*, SCLTS is thought to spend most of the year underground. Various terrestrial habitats are used, including riparian woodland, coastal scrub, and live oak woodland. Adult SCLTS migrate from upland refugia to temporary ponds during fall and winter rains (generally during November through February) in order to breed. Overland movements are generally limited to rainy nights. Individuals have been documented to travel about 0.8 miles, with vegetated drainages being favored as migration pathways (Reed, 1978). Males usually precede females to the breeding site. Additional adults may continue to immigrate while post-breeding adults are emigrating. In addition, juveniles typically emigrate from lowlands when rainfall allows.

Mating and egg-laying peak in January and February. Eggs mature and hatch in 30-45 days into gilled larva. Larva grow, develop legs, resorb gills, develop lungs, and transform into juveniles in May or June as the ponds are drying up. Adults are known to live at least five years (Bowler, 1977).

SCLTS was listed as endangered by the USFWS in 1967, one of the first species to be listed under this new legislation. In 1971 it was protected in the State of California by the California Species Preservation Act (subsequently the California Endangered Species Act). A Recovery Plan was published by the USFWS in 1977, followed by a revised Recovery Plan that was approved by the USFWS in 1986, but has not yet been published (Ruth 1988).

There are seven known breeding sites for this subspecies, all clustered in coastal areas of southern Santa Cruz and northern Monterey Counties. These sites are: Ellicott Pond, Valencia Lagoon, Seascape Pond, "Calabasas Pond", McClusky Slough, Bennett/Struve Slough, and upper Moro Cojo Slough. During a 1990 study, four individuals were captured by Dr. Stephen Ruth in several parts of the slough east of Castroville Boulevard.

The first specimen of the SCLTS in the area was identified on January 29, 1978 by Mr. Earnest Groves (Reed 1978). Subsequent field investigations further confirmed the presence of the species in a wetland swale at the end of Shaffi Lane, near the intersection of Castroville Boulevard and Meridian Road, and in several other locations in the headwater areas of Moro Cojo Slough. In 1990, Dr. Stephen Ruth conducted a drift fence study on a parcel north of the high school (ABA, 1990) in which he caught four long-toed salamanders. These may be representative of a much larger metapopulation occurring in the upper Moro Cojo watershed.

California Tiger Salamander

The California tiger salamander is a State species of special concern and a Category 2 candidate for Federal listing as threatened or endangered. Tiger salamanders primarily occur in valley floor and foothill grasslands, and open oak woodland and savannah. Adults utilize rodent burrows for refuge during the non-breeding season. They use aquatic habitat for reproduction, migrating to breeding sites during the rainy season from November to January (Stebbins, 1985). Tiger salamanders move overland up to one-half mile to quiet water of ponds, reservoirs, lakes, temporary rain pools, and occasionally streams. The larvae take 3-4 months to transform into adults, thus the species requires reliable sources of water. The reasons for this species' decline in California include loss of habitat, the introduction of predatory non-native fishes, and the use of larval forms as fishing bait (Stebbins, *ibid.*).

Potential breeding habitat for tiger salamanders exists in many of the freshwater areas of the slough east of Castroville Boulevard. The Arizona sub-species, considered a major competitor of the California tiger salamander, was documented in the study area in 1990 (ABA, 1990). Documentation of the California sub-species is largely limited to anecdotal accounts, which include observations along Meridian Road and near the intersection of Castroville Boulevard and Highway 156.

California Red-legged Frog

The California red-legged frog is a State species of special concern and was listed as threatened by the USFWS in 1996. The red-legged frog occurs west of the Sierra Nevada-Cascade crest and in the Coast Ranges along the entire length of the State. Red-legged frogs are found in quiet pools along streams, in marshes, and ponds. They are closely tied to an aquatic environment, and favor intermittent streams which include: areas with water >0.7 meters deep, emergent or shoreline vegetation, and a lack of introduced bullfrogs (*Rana catesbeiana*) and predatory non-native fishes. Red-legged frogs are generally found on streams having a small drainage area and low gradient (Hayes and Jennings, 1988). Ponds with suitable vegetative cover are also used by this species. This species' reproductive season spans January to March (Stebbins, 1962). Females deposit 2,000-4,000 eggs on submerged vegetation at or near the surface.

Much of this species' habitat has undergone significant alterations in recent years, leading to extirpation of many populations. Other factors contributing to its decline include its former exploitation as food, water pollution, and predation and competition by the introduced bullfrog and green sunfish (Moyle, 1973; Hayes and Jennings, *ibid.*).

Potentially suitable habitat for this species exists in much of the freshwater ponded habitat adjacent to the slough east of Castroville Boulevard and south of Meridian Road. Dr. Stephen Ruth (ABA, 1990) first documented the presence of this frog in the watershed. Although only one individual was observed, it is likely a larger metapopulation exists in the freshwater habitats of upper Moro Cojo Slough. One particularly noteworthy site was identified in February of this year, 1.1 miles east of the intersection of Meridian and Castroville Boulevard, a few meters south of Meridian Road. Many individuals, mostly yearlings, were observed in a seemingly perennial, levee-retained pond. This is potentially a major (>500 individuals) breeding location for this species in the bioregion.

Southwestern Pond Turtle

The southwestern pond turtle is a Federal Candidate 2 species for listing, and a State species of special concern. It occurs in permanent freshwater ponds, lakes, marshes, and rivers. Pond turtles are aquatic, but often bask in the sun on a partially submerged log or rock, or on the shoreline. During the breeding season, females leave the water to dig earthen cavities for deposition of eggs, usually along a sunny portion adjacent to the water's margin (Stebbins, 1954). Their populations are threatened with habitat alteration or loss due to urban and agricultural development. The southwestern pond turtle may occur in the freshwater ponds east and northeast of Castroville Boulevard.

California Linderiella

California supports 21 species of fairy shrimp, seven of which are unique to the state. USFWS has proposed four species of fairy shrimp for endangered status: the longhorn, Conservancy, vernal pool, and California linderiella fairy shrimp. The California linderiella is the only fair shrimp species known to occur in the Monterey Bay region.

Fairy shrimp live in ephemeral, freshwater aquatic habitats, such as vernal pools, rock outcrop pools, swales, and ponds. They are adapted to the temporary presence of water and to a species-specific set of environmental parameters (e.g., salinity, temperature, and alkalinity). Adult fairy shrimp typically occur between late October and late April.

The vernal pool near the junction of State Highway 156 and Castroville Boulevard is considered potential habitat for fairy shrimp (Jones & Stokes Associates, 1994). No fairy shrimp were found during the reconnaissance-level field survey; however, the survey was conducted outside the time when fairy shrimp are likely to occur. A complete survey during the appropriate period (from the first fall rains until the vernal pool is dry) using USFWS survey protocol would be required to conclusively determine the presence or absence of fairy shrimp at this site (Jones & Stokes Associates, 1994)

PROBLEM WILDLIFE SPECIES

Two mammal species which inhabit nearly all of the habitats in the watershed are the Norway rat (*Rattus norvegicus*) and the red fox (*Vulpes regalis*). Both are non-native, efficient predators. The red fox is known to be responsible for declines in California clapper rail populations in the San Francisco Bay (C. Striplen, pers. obs., 1992), and most likely played a large part in the extirpation of clapper rails in Elkhorn and Moro Cojo Sloughs. Other sensitive species known to suffer population declines in the presence of red foxes include the California least tern, Caspian tern, and western snowy plover. Recent predator management plans indicate that breeding bird populations can recover if predation by red foxes is controlled in nesting areas (USFWS, 1991). The red fox, a non-native species present within the Moro Cojo Slough watershed, has been reported to prey upon burrowing owls; red fox predation may be a factor in the distribution and abundance of burrowing owls within the watershed.

The Norway rat has long been known to depredate the eggs of ground-nesting birds, but has only recently been identified as a potentially significant threat to these birds' populations (Striplen 1992). Norway rats are known to be extremely destructive to avian populations in the San Francisco Bay and may have a strong presence in the Moro Cojo Slough watershed. These predators are extremely difficult to control, as they are numerous and widespread, and any use of poisons or rodenticides may jeopardize populations of sympatric special status small mammals, (i.e., Monterey ornate shrew, Monterey harvest mouse).

Feral dogs and cats are expected to occur within the watershed, but were not observed during the field surveys. Feral dogs, especially if formed into packs, can be efficient hunters of native wildlife. Feral cats are efficient hunters, especially of ground-nesting songbirds and amphibians. Domestic dogs and cats, if unsupervised and/or allowed to periodically roam, can impact native wildlife through predation and habitat disturbance. It is expected that the impact of feral/domesticated dogs and cats is highest in the upper watershed within/adjacent to rural residential development.

FISHERIES AND AQUATIC RESOURCES

The Habitat Restoration Group and Applied Marine Sciences reviewed existing data on the fisheries and brackishwater snail resources of Moro Cojo Slough. Field investigations were conducted for the brackishwater snail. Water chemistry measurements were not taken as part of this study.

FISHERIES RESOURCES

Anecdotal accounts indicate that large numbers of red-tailed sea perch (surfperch), steelhead and other fish populated Moro Cojo Slough from before the turn of the century until the 1930's (Hansen, 1976).

ABA Consultants (1988) relates the story of a local resident, Bill Lehman, who as a boy in 1910, had the task of removing from his father's hunting boats steelhead which jumped into the boats at night. Mr. Lehman also reported the presence of numerous steelhead, striped bass and salmon throughout the slough as late as the 1940's (ABA, 1988). On the basis of historical reports it is evident that Moro Cojo Slough once supported a diverse assemblage of fish including an important salmonid resource. Steelhead have apparently been extirpated from the Moro Cojo watershed within the past 50 years.

In 1976, sampling with a beach seine resulted in the capture of only two fish species, threespine stickleback and long-jaw mudsucker. According to ABA Consultants (1988) seven fish species were either known or could be expected to occur in Moro Cojo Slough as of 1981: yellowfin goby, jacksmelt, arrow goby, gambusia, threespine stickleback, long-jawed mudsucker and staghorn sculpin. The 1988 report also notes that the fish populations of the slough are "very poorly sampled and known."

ABA Consultants (1991) sampled Moro Cojo Slough by beach seine on April 7, 1990, resulting in the capture of three species, arrow goby, threespine stickleback and staghorn sculpin. The location of the sampling sites were from east and west of the Moss Landing Road tidegates. The predominant fish captured was the arrow goby (on both sides of the tides gates); one stickleback was captured on the east side and one sculpin on the west side (ABA, 1991).

The 1991 report by ABA Consultants also includes a brief discussion of water chemistry within the slough as measured on October 3, 1990. At that time, water temperature was "normal" throughout most of the slough, approximately 16-18°C. The report continues,

> *"However, on the east site of Highway 1 the bottom 10-20 cm of water was much warmer, around 25°C. This odd temperature inversion is probably the result of warm surface water warming, evaporating, becoming hypersaline and therefore heavier, then sinking to the bottom. Field estimates of salinity indicated hypersaline water, probably 40 ppt. The temperature inversion and hypersalinity are manifestations of the lack of mixing currents."*

Please refer to the water quality section for a more complete analysis of water quality data collected by the Elkhorn Slough Foundation.

The ABA report calls the finding of 25°C water temperature in the bottom 10-20 cm as an "odd temperature inversion". In fact, if a salt water lens was present on the bottom of the slough and no wind mixing had occurred, significantly higher temperatures within the lens would be the normal condition (Smith, 1990). The ABA report continues with the statement that the "estimates" of salinity indicated a hypersaline condition, probably 40 ppt. The method used to "estimate" salinity is not specified. It is unclear if salinity was actually measured. Based on the data provided, the temperature and salinity regime of Moro Cojo Slough cannot be reliably assessed.

Fish Species of Special Concern

The tidewater goby, a Federal endangered species, may potentially inhabit the lower slough. The species has been recorded from nearby Bennett Slough; suitable habitat may be present in the slow water areas of Moro Cojo Slough (areas downstream of SPRR). The species may have been present in the slough prior to the installation of the tidegates at Moss Landing Road and/or may have entered the slough through the tide gates (Smith, 1994, pers. comm.). Although not recorded in previous sampling efforts, additional sampling of the slough is necessary to determine presence or absence of the species. Depending upon results of the sampling and a more detailed analysis of suitable habitat conditions, introduction of the species into the slough may be possible (under consultation with USFWS).

AQUATIC RESOURCES

The California brackishwater snail, *Tyronia imitator*, the only aquatic resource addressed, was evaluated through a qualitative survey of Moro Cojo Slough and other locations in the Elkhorn Slough area, using a hand-held dip net to obtain samples of sediment and algae. The sediment and algae were gently washed in the net and discarded to obtain the snails.

The brackishwater snail has been reported in immergent portions of coastal lagoons, marshes, and sloughs from Sonoma County to San Diego County (Kellogg, 1980, 1985; Taylor, 1978). In these locations it is found associated with fine sediments (i.e., fine sand to mud, although this fine material may overlay gravel) and near-bottom algae, where it feeds on both sediment deposits and epiphytic material (Kellogg, 1985). The brackishwater snail is apparently tolerant to a wide range of salinities. For example, Kellogg (1980, 1985) found it occurring in salinities ranging from 4-32 ppt. Moreover, he found the snails at locations which experience large annual salinity ranges (e.g., $<10->50$ ppt, 4-44 ppt, and 0.10-0.35 ppt). Embryos are retained through direct development (Kellogg, 1980; Taylor 1978) which probably limits dispersal to the passive transport of juveniles and adults caught in the surface tension of water and on the feet and feathers of waterfowl (Kellogg, 1985).

The brackishwater snail was nominated for endangered status (Federal Register, Vol. 42, No. 8, January 12, 1977), although this status has not yet been approved. It is currently listed as a Category 2 taxon (Federal Register, Vol. 56, No. 225, November 21, 1991). Category 2 taxa are those for which listing as endangered is possibly appropriate, but for which conclusive data concerning vulnerability and threat are not available. The restriction of the brackishwater snail to coastal wetlands makes it vulnerable to habitat destruction associated with coastal development. Historically, it was reported from 34 locations in California, but by 1979 could be found at only 13 sites, including Bennett Slough, Parson's Slough, and Moro Cojo Slough (Kellogg, 1980, 1985). Although Parson's Slough was not surveyed during the present work, no living brackishwater snail could be found in Bennett Slough. Dead shells were, however, found in a tidal pond on the south side of Bennett Slough, west of Jetty Road. The disappearance of the snail from Bennett Slough was probably associated with changes in hydrodynamic conditions resulting from increased tidal exchange after installation of additional culverts under Jetty Road performed when damage from the Loma Prieta earthquake was repaired (M. Silberstein, pers. comm.).

Historically, the brackishwater snail has been reported in Moro Cojo Slough from both sides of Highway 1 (ABA Consultants, 1991; TAMS/Dames & Moore, 1991; Kellogg, 1980). ABA Consultants (1991) and Kellogg (1980) estimated densities of the snail to be at least 10,000/meter^2 in the vicinity of Highway 1.

The survey of Moro Cojo Slough in January 1994 revealed the brackishwater snail to be widespread. It was found from approximately half-way between Moss Landing Road and Highway 1, east to the point where tidal exchange ceases, just upstream of the mouth of Castroville Slough. Isolated ponds of brackishwater found upstream from this point did not contain any snails. Although no estimates of densities were made, the snails were most common just east of Highway 1, associated with a filamentous green alga that filled the water column and formed floating mats. The alga may be a species of *Enteromorpha* (M. Foster, pers. comm.).

At nearly all of the locations in Moro Cojo Slough where the brackishwater snails were found, it was associated with algae and depositional environments. Only in very shallow water at the eastern-most extent of its distribution in Moro Cojo Slough did the snail occur on a firm sediment bottom without nearby algae. At locations from just east of Highway 1 to the western-most site where it was observed, these algae consisted of *Ulva* and *Enteromorpha* that were in contact with the bottom. At several

locations, separate samples collected from the centers and outer edges (i.e., toward mid-channel) of algal clumps yielded different densities of snails, with very few being found on the outer edges, relative to the numbers found in the centers of clumps. These apparent differences in densities over spatial scales of < 1 meter may suggest predation effects on distribution of the snail, as proposed by Kellogg (1985). This spatial variation, when considered with the apparent disappearance of the brackishwater snail from Bennett Slough when tidal currents increased, as well as the presence of the snail in depositional environments, also substantiates the association of the brackishwater snail in Moro Cojo Slough with areas characterized by very low water velocities.

This study suggests that the distribution of the brackishwater snail in Moro Cojo Slough, although extensive in January 1994, may vary substantially according to seasonal freshwater flows into the slough and the presence of suitable algal substrata. The extent of migration between populations in Moro Cojo Slough and other possible populations in the region is presently unknown, so the importance of Moro Cojo Slough as a local habitat for this species can only be inferred from the snail's present widespread occurrence there and the historical reduction in living populations of the species along the California coast.

Aquatic Species of Management Concern

The Northern Salinas Valley Mosquito Abatement District has authority to treat wetlands within the Moro Cojo Slough Watershed in order to reduce mosquito populations and therefore, and vector-borne disease transmission. The District has treated the lower slough area for both saltwater and freshwater mosquitos. Treatment can occur from January through August (depending upon rainfall, salinity and level of water in the slough) and has included oil and organophosphate. Approximately 2,000 acres were treated in 1993 during 11 treatments (Northern Salinas Valley Mosquito Abatement District, pers. comm., 1993).

Table 5-1. Plant Communities within the Moro Cojo Slough Watershed

COMMUNITY TYPE	REPRESENTATIVE EXAMPLE
WETLANDS	
Coastal Salt Marsh	Moro Cojo Slough and Highway 1
Coastal Salt Marsh/Seasonal Wetland	North of Dolan Road
Coastal Salt Marsh/Poison Hemlock Scrub	Berms of Castroville Slough
Coastal Salt Marsh/Poison Hemlock Scrub/ Ruderal	Berm east of Southern Pacific railroad tracks
Freshwater Marsh	Upper slough east of Castroville Blvd.
Freshwater Marsh/Seasonal Wetland	North of Highway 1 and Molera Road junction
Freshwater Herbaceous Wetland - Seasonal Wetland	Ponds along Dolan Road
Freshwater Herbaceous Wetland - Perennial Wetland	Desmond Road area
RIPARIAN	
Central Coast Willow Riparian Forest	Ponds along Paradise Road
Central Coast Arroyo Willow Riparian Forest/ Perennial Wetland	Desmond Road area
Central Coast Arroyo Willow Riparian Forest/ Freshwater Marsh	Upper slough east of Castroville Blvd.
GRASSLANDS	
Coastal Alkali Grassland	Moro Cojo Slough east of Highway 1
Wet Coastal Alkali Grassland	East of Highway 1 along slough
Mixed Grassland	Near mobile home park off Dolan Road
Non-native Grassland	Dolan Road vicinity
Coastal Alkali Grassland/Non-native Grassland	East of Highway 1, south of slough
Non-native Grassland/Coyote Brush Scrub	North of Dolan Road
Non-native Grassland/Non-native Landscape Trees	Between Highway 1 and Harbor
Non-native Grassland/Rural Residential Vegetation	Along Dolan Road
Non-native Grassland/Rural Residential Vegetation/Ruderal	Along Dolan Road
Non-native Grassland/Rural Residential Vegetation/Non-native Landscape Trees	Junction of Castroville Blvd. and Elkhorn Road

Table 5-1. Plant Communities within the Moro Cojo Slough Watershed (Cont'd.)

COMMUNITY TYPE	REPRESENTATIVE EXAMPLE
Non-native Grassland/Coast Live Oak Woodland/ Rural Residential Vegetation/Ruderal	Between Meridian Road and Castroville Blvd.
MARITIME CHAPARRAL	
Maritime Chaparral/Coast Live Oak Woodland/ Rural Residential Vegetation/Non-native Landscape Trees	Between Paradise Road and Castroville Blvd.
Maritime Chaparral/Coast Live Oak Woodland/ Non-native Landscape Trees	North of Paradise Road
COAST LIVE OAK WOODLAND	
Coast Live Oak Woodland/Rural Residential Vegetation	Junction of Paradise Road and Castroville Blvd.
Coast Live Oak Woodland/Rural Residential Vegetation/Non-native Landscape Trees	Between Meridian Road and Highway 156
COYOTE BRUSH SCRUB	
Coyote Brush Scrub/Ruderal	Along Blackie Road
Coyote Brush Scrub/Poison Hemlock Scrub	By WaterTek facility
Coyote Brush Scrub/Non-native Grassland/ Ruderal	West of Paradise Road
NON-NATIVE PLANT COMMUNITIES	
Ruderal	Along Castroville Blvd.
Poison Hemlock Scrub/Ruderal	Ponds east of Castroville Blvd.
Agricultural Lands	North of Highway 1 and Molera Road junction
Rural Residential Vegetation	Homes along Moss Landing Road
Non-native Landscape Trees	Along Moss Landing Road

Table 5-2. Plant Species of Concern Known or Have Potential to Occur within the Moro Cojo Slough Watershed

Species Name Common Name	Habitat	State List	Federal List	CNPS List
Arctostaphylos hookeri ssp. *hookeri* Hooker's manzanita	Chaparral coastal scrub, closed-cone pine forests	-	-	1B
Arctostaphylos pajaroensis Pajaro manzanita	Chaparral	-	C2	1B
Arctostaphylos pumila sandmat manzanita	Chaparral, coastal dunes, closed-cone pine forest	-	C2	1B
Calyptridium parri var. *hesseae* Santa Cruz Mountains pussypaws	Chaparral	-	-	3
Ceanothus cuneatus var. *rigidis* Monterey ceanothus	Coastal scrub, closed cone pine forest	-	C2	4
Chorizanthe pungens var. *pungens* Monterey spineflower	Coastal dunes	-	FT	1B
Clarkia lewisii Lewis' clarkia	Chaparral, coastal scrub, woodland	-	-	4
Cordylanthus rigidus ssp. *littoralis* seaside bird's-beak	Chaparral, coastal scrub, closed-cone forest, woodland	CE	C1	1B
Ericameria fasciculata Eastwood's goldenbush	Maritime chaparral, coastal scrub, closed-cone forests	-	C2	1B
Fritillaria liliacea fragrant fritillary	Coastal scrub, grasslands	-	C2	1B
Holocarpha macradenia Santa Cruz tarplant	Coastal prairie, grasslands	CE	C1	1B
Lomatium parvifolium small-leaved lomatium	Closed-cone forests	-	-	4
Monardella undulata var. *undulata* curly-leaved monardella	Chaparral, coastal scrub, coastal dunes	-	-	4
Pedicularis dudleyi Dudley's lousewort	Maritime chaparral, grasslands	CR	C2	1B
Perideridia gairdneri spp. *gairdneri* Gairdner's yampah	Grasslands, chaparral	-	C2	4
Petunia parviflora wild petunia	Margins of ponds in many communities (chaparral, coastal scrub)	-	-	4
Piperia yadonii Yadon's piperia	Maritime chaparral, closed cone forests	-	C1	1B
Potentilla hickmanii Hickman's cinquefoil	Wet meadows, closed-cone forest	CE	C1	1B

Table 5-2. Plant Species of Concern Known or Have Potential to Occur within the Moro Cojo Slough Watershed (Cont'd.)

Species Name Common Name	Habitat	State List	Federal List	CNPS List
Psilocarphus tenellus var. *globiferus* round woolly marbles	Coastal dunes, vernal pools	-	-	4
Stebbinsoseris decipiens Santa Cruz microseris	Chaparral, coastal prairie, coastal scrub, broad-leaved upland forests	-	C2	1B

[1] State Listings: CE=Endangered, CR=Rare, CT=Threatened;

[2] Federal Listings: FE= Endangered, FT=Threatened, PE=taxa proposed to be listed as endangered, PT=taxa already proposed to listed as threatened, C1=Enough data on file to support listing, C1*=Enough data to support listing but plant presumed extinct, C2=threat and/or distribution data insufficient to support listing, C2*=threat and/or distribution data insufficient to support listing, presumed extinct, C3a=Extinct, C3b=Taxonomically invalid, C3c=Not threatened;

[3] CNPS Listing: List 1A=Plants presumed extinct, List 1B=Plants rare throughout their range and considered vulnerable due to limited habitat or low numbers individuals per population, List2=Rare, threatened or endangered in California, but common elsewhere, List3=Review list of species which may be rare, threatened or endangered but additional data is needed, List4=A watch list of species with a limited distribution which are not currently threatened.

[4] Species on CNPS Lists 1A, List 1B and List 2 are protected by Section 1901, Chapter 10 of the California Department of Fish and Game Code (Native Plant Protection).

Table 5-3. Sensitive Wildlife Species Known or Predicted to Occur in the Moro Cojo Slough Study Area

Species	Status	Occurrence	Habitat
California Brackishwater Snail	2	K	S
Santa Cruz Long-toed Salamander	FE,SE	K	FP,G,WR,C
California Tiger Salamander	2,CSC	P	FP,G,WR,C
California Red-legged Frog	FT,CSC	K	FP,WR,C
Southwestern Pond Turtle	1,CSC	K	FP
Common Loon	CSC	K	S,FP
American White Pelican	CSC	K	FP,S
California Brown Pelican	FE,SE	K	S
Double-crested Cormorant	CSC	K	S
Great Blue Heron	*	K	S,MF,M,SM
Great Egret	*	K	S,MF,M,SM
Snowy Egret	*	K	S,MF,M,SM
White-faced Ibis	2,CSC	K	S,M,SM
Bufflehead	CSC	K	S,FP
Golden Eagle	CSC	K	G,CS
Southern Bald Eagle	FE,SE	P	FP
Black-shouldered Kite	*	K	M,G,WR,C
Northern Harrier	CSC	K	M,G,WR,C
Sharp-shinned Hawk	CSC	K	WR,C,CS
Cooper's Hawk	CSC	K	WR,C,CS
Osprey	CSC	K	S,FP
Merlin	CSC	K	FP,M,G,C
Prairie Falcon	CSC	K	G,CS
American Peregrine Falcon	FE,SE	K	S,MF,G,C
Greater Sandhill Crane	ST	P	G,M
Long-billed Curlew	CSC	K	MF,SM
California Clapper Rail	FE,SE	P	S,SM
California Gull	CSC	K	S,MF,FP
Elegant Tern	2, CSC	K	S,FP
Caspian Tern	*	K	S,FP
Forster's Tern	*	K	S,FP
Black Skimmer	CSC	P	S,MF

Table 5-3. Sensitive Wildlife Species Known or Predicted to Occur in the Moro Cojo Slough Study Area (Cont'd.)

Species	Status	Occurrence	Habitat
Short-eared Owl	CSC	K	M,G
Black Swift	CSC	P,a	G,WR,CS
Purple Martin	CSC	P,a	G,WR,CS
Bank Swallow	ST	P,a	G,WR,CS
Yellow-breasted Chat	CSC	P	WR,C
Willow Flycatcher	FSS,SCE	K	WR,C
Tricolored Blackbird	2,CSC	K	G,FP,M
Yellow Warbler	CSC	K	WR,C
Monterey Ornate Shrew	2,CSC	P	M,G
Monterey Harvest Mouse	*	P	M,G
California Linderiella (fairy shrimp)	1	P	FP

STATUS KEY:

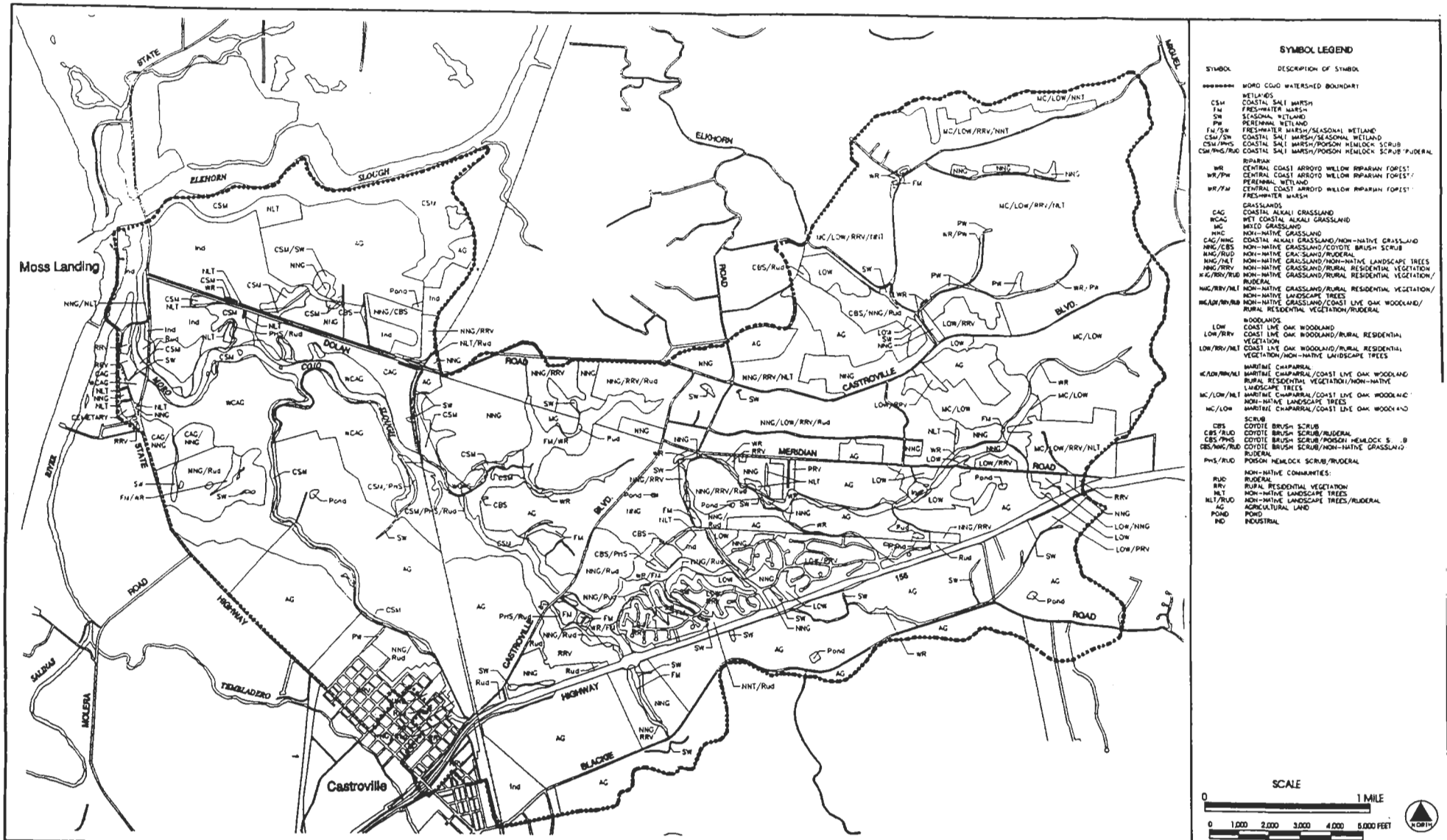
SE - Listed as Endangered by the State of California
ST - Listed as Threatened by the State of California
SCE - Candidate for listing as Endangered by the State
FE - Listed as Endangered by the Federal Government
1 - Category 1 candidate for Federal listing as per U.S. Fish and Wildlife Service
2 - Category 2 candidate for Federal listing as per the U.S. Fish and Wildlife Service
FSS - Federal Sensitive Species (U.S. Forest Service or Bureau of Land Management)
CSC - California Department of Fish and Game Species of Special Concern
* - "Sensitive" species as per CDFG Special Animals 1990
FT - Listed as Threatened by the Federal Government

OCCURRENCE KEY:

K - Species of known occurrence
P - Species of potential occurrence
a - Expected to occur primarily as an aerial transient

HABITAT KEY:

S - Slough/Aquatic Habitats
MF - Mudflats
FP - Freshwater Pond (open water and shoreline)
M - Marsh (brackish or freshwater)
SM - Salt Marsh (including shoreline)
G - Grasslands
WR - Willow Riparian
CS - Coyote Brush Scrub
C - Chaparral



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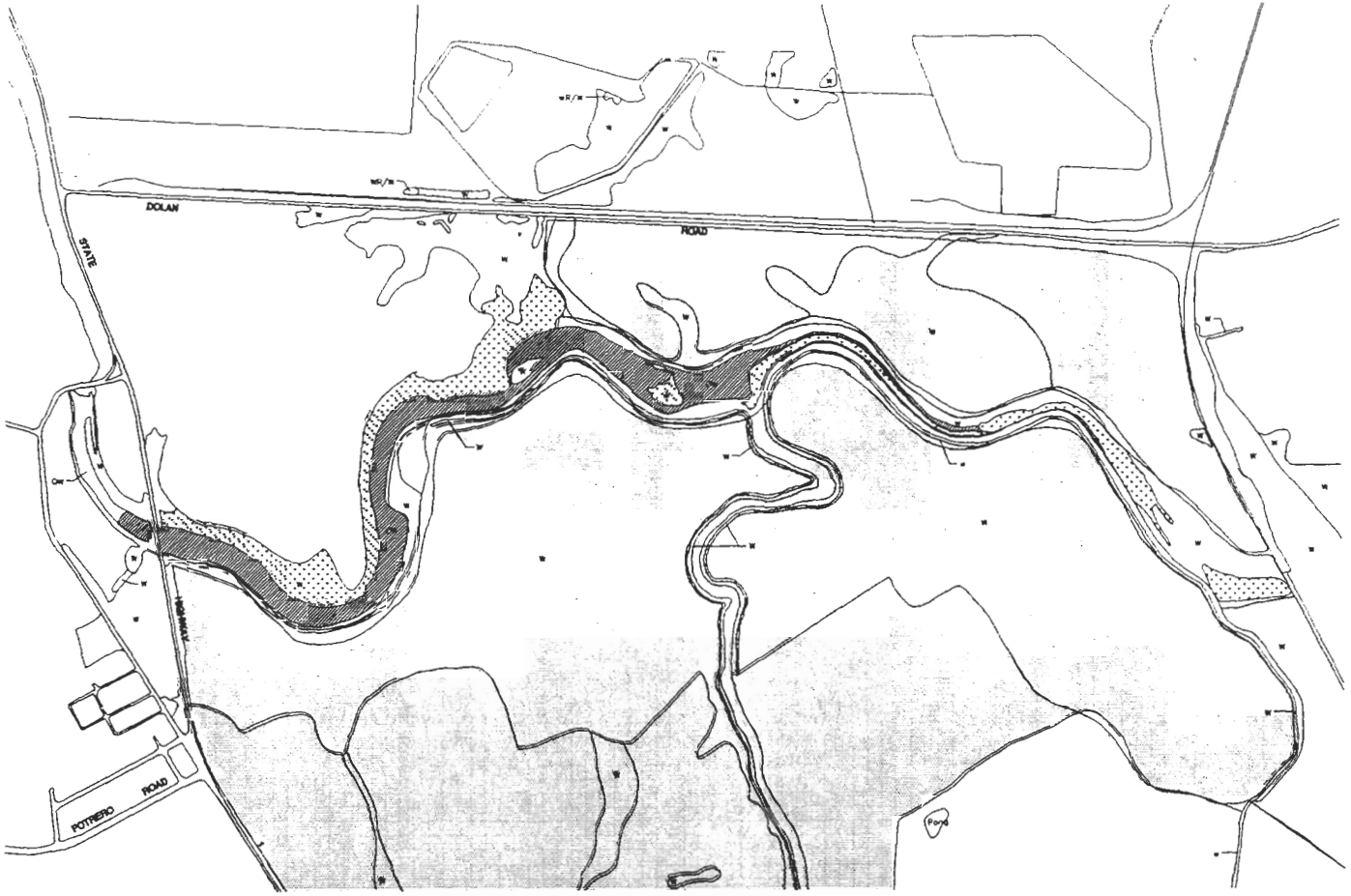
Moro Cojo Slough Management and Enhancement Plan
Plant Communities of Entire Watershed

2/96
705-01

Figure 5-2



SYMBOL LEGEND

SYMBOL	DESCRIPTION OF SYMBOL
W	WETLAND
WR/M	CENTRAL COAST ARROYO WILLOW RIPARIAN FOREST/ WETLAND
OW	OPEN WATER
	CALIFORNIA BRACKISHWATER SNAIL - DOCUMENTED
	SHOREBIRD & WATERFOWL NESTING/FORAGING AREA
	POTENTIAL UPLAND HABITAT FOR CALIFORNIA RED-LEGGED FROG, CALIFORNIA TIGER SALAMANDER, SANTA CRUZ LONG-TOED SALAMANDER

Note: Since this is not a jurisdictional map, its use for wetland identification is limited and site-specific wetland delineations will still be required pursuant to the Local Coastal Program and any other applicable state and federal laws.

SCALE

0 1 MILE

0 1,000 2,000 3,000 4,000 5,000 FEET

NORTH

The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Sensitive Biotic Resources of Lower Watershed	2/96 705-01	Figure 5-3

The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Sensitive Biotic Resources of Entire Watershed	2/96 705-01	Figure 5-4

The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Wetland and Riparian Habitat	2/96 705-01	Figure 5-5

CHAPTER 6
AGRICULTURAL RESOURCES

METHODOLOGY

The agricultural areas within the study area were examined by first field checking the watershed area both by car and foot. Maps used were County parcel maps. The study began in June 1993 and continued at least once every two weeks through October 1993 to observe production patterns. In June, letters were written to all agricultural landowners explaining the project and asking for interviews. Approximately one-third of the land owners responded positively to this request.

Interviews were held with landlords and lessees of the properties. Most growers and landlords were very cooperative and were informative as to operations by other growers in the area. Discussions were also held with farm advisors, Agricultural Commissioner's office personnel, and SCS employees who had worked in the region. Information from marketing boards and other pertinent literature was reviewed to prepare an overview of each crop. Existing agricultural uses are portrayed on Figure 6-1.

EXISTING CONDITIONS

The Moro Cojo Slough watershed area has approximately 5,000 acres in agriculture production, (i.e., artichokes, strawberries, flowers, vegetables and cattle operations). In the last 100 years this area has under gone major changes, allowing this type of production to occur. Diking, ditching and draining of lands occurred to allow the current row crops to be grown year-round. Before these land reclamation activities occurred, most of the ground was used for cattle, which could be moved to another location during the winter when water was present.

Land ownership has not greatly changed over the last 50 years; however, there have been changes in landowner involvement with agriculture. Most farmers are now working on leased land, with less participation by the landowners. This requires both landowners and lessees to be informed on both agricultural and environmental issues.

In the past 30 years, in the Salinas/Watsonville area, strawberry acreage has more then doubled. In 1965, the area had 4,470 acres in strawberries and in 1993 the acreage was 10,445. Thirty years ago this area had very few strawberries mainly due to the fact that in the 1960's strawberries were flood irrigated, which is not possible on the rolling hills found in the slough. Drip irrigation allowed the strawberry production to occur here and become the predominant crop.

Artichokes

Crop Production. The only company farming artichokes in this area is Sea Mist farms, also known as Cal-Choke. Currently they are farming approximately 875 acres of artichokes surrounding the slough area. These ranches are referred to by the names Blackie Road Ranch, Desante Ranch and the Salla Ranch.

Artichokes are a very labor-intensive crop with 40-50% of the costs going to labor for planting, harvesting, weeding, etc. Artichokes are available throughout the year with peak season occurring between March through May and again in October.

Artichokes are grown ideally in frost-free areas with cool foggy summers. Plantings usually last seven years. Plants are normally spaced 4 feet × 9 feet, amounting to about 1,450 plants/acre. Rows are placed according to natural land drainage to prevent plant loss in the winter.

Before planting, lime, fertilizer, and manure is added to achieve proper crop conditions. Artichokes are not a crop that heavy pre-plant fertilizers are needed. Planting occurs June-August, then plants are stumped (i.e., tops cut off) three times a year (December, January, and March), with first harvest occurring in March. Ditching occurs in the fields before the rains come, usually in October.

Irrigation normally occurs by sprinklers, but Sea Mist farms has begun experimenting with drip irrigation. The use of drip irrigation reduces the overall amount of water used and thereby may reduce the amount of salt delivered to each plant. The main reason for trying this is that the high salt content in water from wells less than 180 feet deep. Seawater intrusion has occurred in past years due to groundwater over-pumping. Salty water can burn the new roots, adversely affecting plant growth and production. Irrigations occur roughly twice a month in July and August, then once a month in the remaining months of the year. Each irrigation lasts about 12 hours. Agricultural users are still obtaining waters from wells within the 180-foot aquifer, however, salt water intrusion has occurred (see Chapter 4 for a discussion on the effect of sea water intrusion into the 180-foot, 400-foot, and 800-foot aquifers). A study in 1987 estimated that between 1998 and 2003, the 180-foot aquifer will no longer be usable. The MCWRA plans to deliver reclaimed water for irrigation to the Castroville area by 1997. A detailed description of the Castroville Seawater Intrusion Program is contained in Chapter 4.

Soil Fertility and Pest Control. Fertilization can occur through irrigation water or by broadcast. Usually three fertilizations occur from July - October. Common materials used are 10-5.5-.8 and 32% N. (N refers to actual amount of nitrogen in percentage, with the other two materials being phosphorous and potassium.) The first fertilization is the heaviest, at approximately 80 gallons/acre; the other two are relatively small at 20 gallons/acre. These fertilizations are used along with stumping to try to manipulate the plant to produce at different times.

Herbicides (weed killers) are used primarily after planting; then again to keep ditches clear in the winter time, so the water will drain off properly. Common materials used are Kerb and Princep pre-emergents (pre-emergent means "before the intended crop is planted"); they are used to kill grasses and weeds such as lambsquarters and purslane. Poast is a post-emergence (after planting) herbicide selectively used to kill grasses in November. Goal may also be applied at this time for weeds such as lambsquarter, malva, mustards and groundsel. Roundup™ is used in the winter time only in the drainage ditches with the use of quad runners.

The main problem insect is the Artichoke Plume Moth. The damage occurs to the buds when the newly hatched larvae bore into the developing buds. If no control measures are taken, the larvae can destroy 60% of the yearly crop. A normal field is treated 10-12 times. Even with these treatments 5-10% damage is common. One percent damage in a field results in a loss of at least $35/acre.

When treating for the artichoke plume moth, sprays are designed to obtain maximum foliage coverage. Once the worm is inside the bud it can not be controlled. Control difficulty occurs also because generations (life cycles, egg-to-adult) overlap between July-February, with about four generations. Sprays will target both adults during egg-laying and newly emerged worms before they have a chance to bore into the buds.

Growers are beginning to use biological control agents in the field with a material called Biovector. Biovector is actually nematodes suspended in a solution that attack the artichoke plume moth larvae.

Field sprays with this have not worked well because the nematodes need moisture to move and stay alive, but a pre-plant dip (before the plant is put in the soil) shows good results. The crowns (center of plant with minimal roots and no top growth) are soaked in the Biovector with a cellulose solution to keep the nematodes alive longer. This can keep a newly planted field clean from the plume moth larvae for almost two months.

Other pesticides used for control include Supricide, Phosdrin, Furadan and Guthion used in the vegetative state, and Asana and Ambush used during bud production. Supricide and Asana are the most commonly used insecticides. These chemicals are broad-spectrum insecticides that will also kill aphids, leaf miners and thrips, other common insects in artichokes. None of these pesticides are known to leach into soil or water bodies. Also these pesticides may be fairly toxic when first sprayed, but break down quickly in sunlight. When snails and slugs become problems in wet years, a Sevin bait is used for control. A new pest, the Cribate weevil has become a problem with no real control measures available.

In recent years field mice and voles have also become a major problem. The main reason for the increase in activity is the removal from use of a material called Rozol. The main ingredient in this rodenticide is an anticoagulant in a bait form. In other words the animal has to ingest the material in sufficient amounts to cause death. This keeps it very target-specific. EPA is currently working on re-registration.

Other problems exist, such as the fungus called powdery mildew. Bayleton, a very effective fungicide, has just received registration for artichokes. If a particular market is targeted, Pro-Gibb 4%, a growth regulator, can be sprayed to accelerate maturity. This would be applied at bud initiation, approximately six weeks prior to harvest.

All pesticides are applied by an outside contracted company, Kleen-Globe. Kleen-Globe recommends the pesticides, does the actual application, and keeps records.

All the artichoke fields surrounding the slough had good planning before production occurred. Eighteen-foot drive roads are next to all the slough waterways. This would prevent irrigation runoff, fertilizer runoff, or pesticide over-spray from entering the slough. Also, no soil erosion problems were noted during the field surveys; however, the surveys were not conducted during the rainy season.

For artichoke growers to stay in production, the salt intrusion problem will have to be addressed. Concerns have also been raised as to the proper width of the ditches surrounding the fields leading to the slough. This will have to be addressed so cultivation practices do not encroach into the wetlands, causing drainage problems to the Moro Cojo Slough.

Strawberries

Crop Production. Strawberries are, by far, the largest crop in production on the Moro Cojo Slough watershed. The berries are farmed off Elkhorn Road, Castroville Boulevard, Highway 156, and Blackie Road, for a total of approximately 2000 acres. All the ground is farmed by lessees, and not the property owners. Leases tend to be renewed on a yearly basis. Most farms are roughly 10-50 acres in size.

The area contains many varied soil conditions. However, the majority of strawberries in the watershed are farmed on fine sandy loams (Elkhorn and Santa Ynez soil types). These soils provide the best soil conditions for strawberry production since they fumigate well, accumulate less salt over the production year, make land preparation (i.e., beds drawn-up and cultivation) easier, and adapts better to frequent harvest and irrigation patterns. These soils are shallow (less than 36 inches) and are underlain by a soft sandstone which restricts drainage. The rolling hills also complicate tractor work, irrigation, and

harvesting and can accelerate runoff of winter rains if not managed properly. The average lease is $700/acre.

Three varieties of strawberries are planted in this area. These are named Pajaro, Selva, and Seascape. Planting of Pajaro is in late August or September, and the Selva and Seascape are planted in October to December. Harvest begins in March, continuing until November, depending on variety and weather conditions.

Production differs greatly by grower but, in this area, 4,500 fresh market crates of strawberries per acre would by considered good. A grower may also pick freezer berries or juice berries that are used in processing. The same field will be picked an average of twice a week for the entire season.

Fields are normally only one year old because after one year, berry size and production falls drastically. If the grower keeps the same field for two years, the berries are small, and 80% will go to freezer or processing. About 40% of the strawberry fields in this area are second-year, a higher percentage than in most of California. Growers keep second-year fields only because they do not have the money to replant.

Soil Fertility and Pest Control. Before planting, many things occur to the soil. The soil must be worked well, disked to remove clods, and ripped to 18 inches in both directions for good drainage. Soil amendments such as manure, lime, gypsum, and formulated fertilizer like 6-20-20, may be spread at this time. Soil will then be irrigated to achieve proper soil moisture before fumigation.

Fumigation is necessary for high-yielding annual strawberry production. Currently in the industry the only material used is a combination of Methyl Bromide and Chloropicrin. This will kill weed seeds, nematodes, and plant diseases. After at least two weeks, the beds will be drawn up. Pre-plant fertilizer may be added. This is a slow release fertilizer which will carry the plant until the beginning of harvest, usually formulated at 20-7-12 and applied at 300-600 pounds/acre, depending on how much the grower wants. This is very expensive and the only reason a grower doesn't use this is due to the fact he may not be able to afford it. At this time the drip irrigation tape may be put in the field.

Planting occurs by hand placement in grooves dug by a tractor. Transplants come from northern California nurseries, so the plant has the proper number of cold hours to add vigor to the plant. Spacing differs by grower, but 10 inches across the bed and 12 inches down is common. The density per acre is roughly 20,000 plants/acre, depending on how many beds the grower can fit in one acre. Sprinklers are used at this point for initial root establishment. No more cultivation will occur in the field except maybe once to run bottoms in the furrows to break up the soil and kill weeds.

After the plants have established, irrigation is accomplished by drip irrigation methods. A thin plastic hose placed down the center of the bed with small holes every 8 inches. Frequency and amounts differ by water quality, soil type, and climate. Amounts for the entire year from planting to last harvest vary from 2.2-4.0 acre feet/acre.

In late winter or early spring the plants are mulched. Mulching is a placement of a clear or white plastic over the soil of the beds and between the plants. This warms the soil and keeps the temperature more consistent. Consistent temperature helps the fruit ripen more evenly. The plastic also keeps the fruit off the wet soil reducing rotten and dirty fruit. Mulching can be done just down the middle covering the irrigation tape, or can cover the entire bed. The entire-bed method is preferred but much more expensive.

Throughout the year fertilization will occur by liquid feed through the drip tape. Common materials used are AN 20, CAN 17, and mixes such as 15-10-30. This fertilization will occur once every week or 10 days until harvest ends. Less of this liquid fertilizer needs to be used if pre-plant was used during planting. Foliar fertilizers may also be applied for micro-nutrients added with pesticides in the spray tanks.

Strawberries are a heavily sprayed crop with over 20 regularly used pesticides. Most fields will be sprayed once or twice after planting and before the rains, then continually every 10-14 days when picking season begins. All spraying is done by the farmer himself to coincide with picking schedules. This large amount of spraying has greatly increased the resistance to pesticides by most diseases and insects found in strawberry fields.

Major insects found in strawberries are snails and slugs, aphids, lygus bugs, thrips, cyclamen mites, two-spotted spider mites, cutworms, leaf rolling caterpillars, and weevils. All of these can cause major problems but the most sprayed for are two-spotted spider mites and lygus bugs.

Mites are found under the leaf sucking out plant juices. Heavy mite populations can devastate a field lowering production and leaving leaves red. Four pesticides are commonly used to control mites. These are Omite, Vendex, Avid, and Kelthane. Vendex and Kelthane are not used much due to pest resistance. Omite can only be used under cool conditions or it will burn the plant. Avid is under a special registration, only allowing four sprays a year but resistance is still occurring. Avid is the safest material because the insect must ingest it to die, making it specific to mites.

Biological control is available to kill mites. These are called persimmillis mites, which are mass-produced for releases, and work well if the grower does not spray pesticides or fungicides for two weeks. The cost for biological control is expensive, and therefore not greatly used in this area. Cost for the average Avid spray is $50/acre and for a persimmillis release, $120/acre.

Lygus bugs feed on newly formed seeds causing deformed fruit. A type of tractor-mounted vacuum has been used for control of these but agreement is not reached on whether it works well. No other types of control exist except for pesticides. No grower in this area uses a bug vacuum. Depending on the year, a field may be sprayed as much as 10 times in the growing year. All pesticides used are broad spectrum, meaning they kill lots of insects in the field. This can sometimes create a problem because other insects such as mites can get out of control when predators are exterminated.

Pesticides used to kill lygus bugs include: Dibrom, Malathion, Phosdrin, and Lannate. Phosdrin and Lannate are dangerous materials, as they are very strong and can kill all insects in the field. Dibrom and Malathion can be used effectively in the field only on young lygus bugs. Heavy resistance occurs with all these pesticides.

Many plant diseases occur in strawberry fields. Gray mold or Botrytis and powdery mildew are the most important. Others include Phytophora root rot, Bacterial leaf spot, and Anthracnose. Good, safe fungicides are available for control if the grower begins his sprays early. These include sulfur, Benlate, Captan, Dyrene, Rally, Rovral, and Thiram.

Due to the large number of lessee growers, many are not adequately informed by the landowners as to where the slough wetlands begin and how close to the slough they should be cultivating. Plants are often placed right next to waterways, resulting in sprays and fertilizers drifting into the slough. The growers may also not be capable of better growing techniques, due to lack of knowledge or money. Soil erosion is occurring from improper field layout and management. Due to varied terrain, some furrows run down

the slope rather than along the contour of the hill. However, the major source of erosion is from access roads on strawberry ranches. These roads receive the runoff from contoured furrows and severe gullying can occur if the road surface is not adequately prepared in the fall prior to the winter rains (SCS, 1984a; SCS, 1984b; SCS, 1994; Mountjoy, 1993). Relatively impervious sandstone underlying the fields contributes to accelerated runoff and erosion and can cause saturation of the soil and resulting pathogen growth. Most strawberry lands are replanted annually with no crop rotation or cover cropping to rest the soil. In the absence of soil improvements, uncontrolled erosion is expected to destroy the productivity of these lands within 20 years.

Interviews with five landlords and over 20 growers revealed that there is very little communication between the two groups. Over 90% of the strawberry farmers are Hispanic and speak little English. Some growers were actually subleasing from someone else and actually did not even know who owned the property.

Vegetable Production

Crop Production. Vegetables are grown in many areas of the slough by different companies off of Highway 1 and Dolan Road. All of these companies farming vegetables have been farming in this area for decades and are excellent growers. Vegetables grown include brussel sprouts, broccoli, lettuce, spinach and cauliflower.

Chemicals used are similar to the ones used in the artichokes. The main concern with vegetable production is the high use of nitrogen fertilizers used. Sometimes amounts can be as high as 500 pounds/acre/year.

The current growers appear interested in protecting their water and soil quality. All growers employ the same techniques used by the artichoke growers, in that 18-foot roads surround the slough, and soil erosion is not a problem. One brussel sprout grower does not even farm about 20% of his ground because the ground tends to be too heavy and retain too much moisture.

All irrigation is by overhead sprinklers, or furrow irrigation on one flat piece. No major irrigation runoff was observed. All these growers cover-crop their fields once every two or three years to help build the soil back up to a good fertile level.

Off of Highway 1 on Washington Street in Castroville is a vegetable transplant nursery. This nursery grows vegetable plants for transplantation into fields. A ditch exists directly behind this nursery which feeds in to the slough. The irrigation water comes directly off the 4 inches of soil where the plants are grown. Irrigation is done a few times a day in small increments to avoid run off. Even though plants are highly fertilized and sprayed, excessive runoff has not been noted.

Cut Flower Production

Production. Nurseries farming flowers occur near Amaral and Elkhorn Roads. Pesticides are seldom sprayed on flowers for two reasons: few pesticides are registered for use, and they are expensive considering the financial return of the product. Both growers stated they just plant different varieties if possible. All fields and greenhouses will be fumigated with Methyl Bromide and Chloropicrin before new plants are introduced to fight off nematodes and root rot. The pesticides that are used are safe materials with low toxicity such as Cycocel, Daconil, Diazinon, Dipel, Kelthane, Avid, Sulfur, Vendex, and Thiodan.

Erosion. Irrigations occur by sprinklers and drip tape. Fertilizers are placed in the water with the same concept as the strawberries but at small rates. Soil erosion problems were noted on the Amaral Road hillside. Topsoil runs off in large amounts in the winter time because proper ditching had not been done. This actually affected lower strawberry fields. The SCS has recently assisted with the problem, and it should be resolved.

The Amaral Road area has been farmed for many years and a hardpan exists approximately 3-4 feet below the surface.

Cattle: Feedlots and Dairies

Cattle operations are located off Highway 1, Highway 156, Dolan Road, and Castroville Boulevard. No person operating cattle operations was willing to talk about their operations for this study. The few people who did expressed the belief that all that would come of this study was a government agency stealing their land. All observations were made from adjoining properties; no trespassing occurred.

Two dairies are located in the watershed area, Moon Glow Dairy and Glen Dolan's dairy, both located off Dolan Road. Glen Dolan's dairy actually touches one arm of the slough, with no fence line separating it from water. Moon Glow Dairy is across the street; no direct drain activity or access to above-ground water in the slough was observed.

Basic dairy operations require barns where the cows will enter the facility 2 or 3 times a day to be milked. Other barns are used for holding and feeding. The milking barns are extremely clean areas constantly sprayed down with water to remove feces and urine. This area directly outside barns has been studied intensively to determine if leaching of nitrates occur. In both these dairies, manure was observed being taken off and spread to discourage this type of over-accumulation. Also these dairies were not overly crowded with cows.

Surrounding the barns, the cattle have pasture land to roam. Requirements per cow are roughly 500 square feet per animal as recommended by the University of California. All animals had well over this requirement.

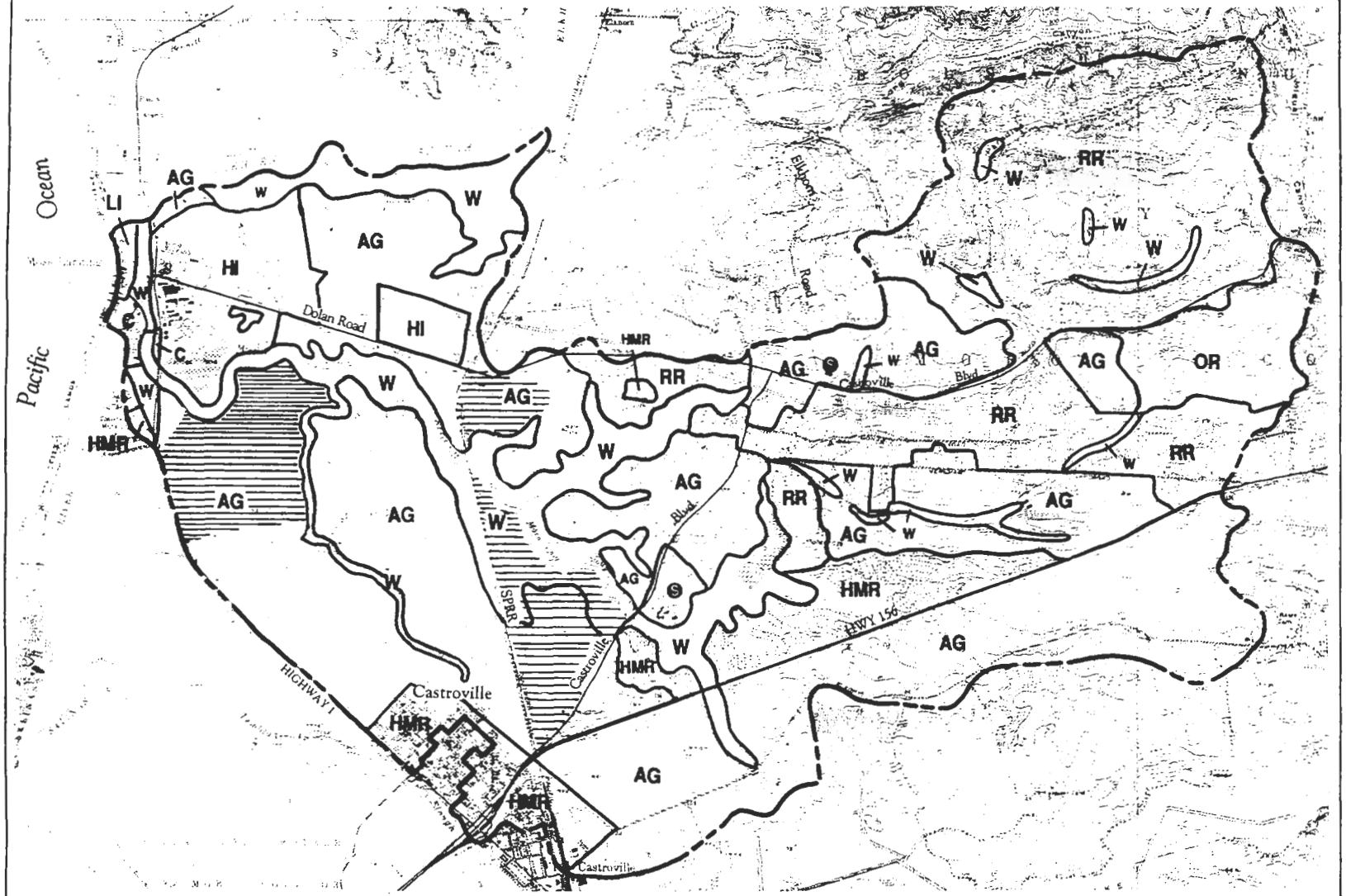
Other observances noted are dumping of feed, such as hay or carrots on the pasture surrounding the dairies. These feeding areas were always rotated.

Overall these dairies are clean, well-managed operations. Due to rising costs of operations and no significant rise in milk prices over the past 15 years, it is surprising that these two are still in business. One reason may be that both dairy operations are also the landowners.

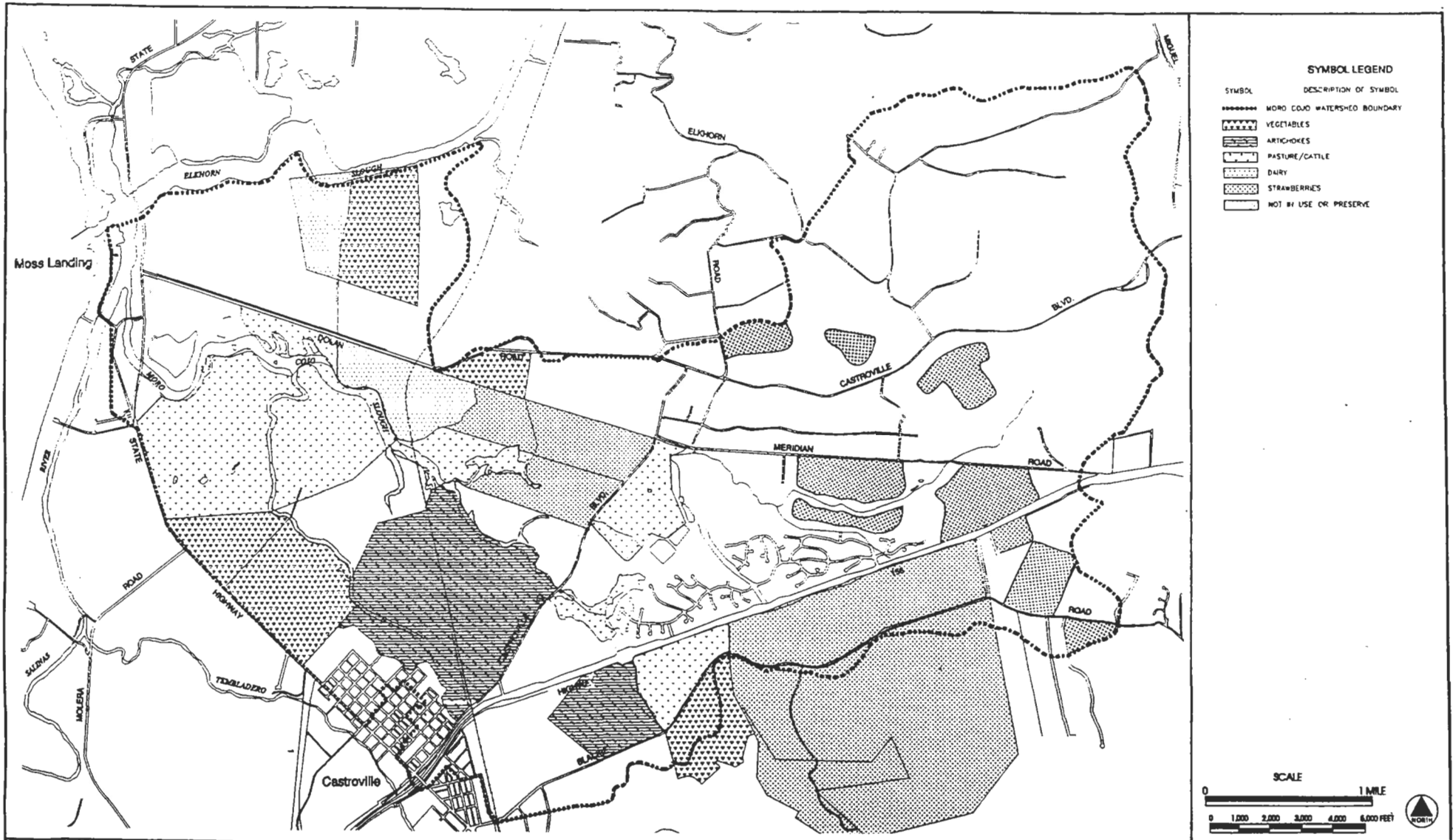
The other cattle operation is a feed lot and grazing operation, run by Pete Dennis. Mr. Dennis leases land that would not be suitable for growing row crops. Most of this land will flood in winter, so the cattle are moved to higher ground. Mr. Dennis only grazes a few hundred head of cattle.

Land problems from grazing were not observed. Less desirable weed species and brush have resulted from the lack of freshwater on the land.

Smaller grazing operations exist throughout the slough. These include homes on large acreages where a person may have livestock (i.e., horses, pigs, chickens, and cattle). This land is zoned for rural development. Although water quality problems could exist from some operations, this was not able to be addressed within the scope of the project.



The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Existing Land Uses	2/96 705-01	Figure 7-1



The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Existing Agricultural Land Uses	2/96 705-01	Figure 6-1

CHAPTER 7
LAND USE

EXISTING LAND USE

The Moro Cojo Slough study area is under the primary jurisdiction of Monterey County, although the Monterey County School District and other special purpose districts, including MLHD, have limited jurisdiction in different portions of the area. A number of other jurisdictions also potentially affect land use within and adjacent to the study area. These agencies include the CCC, COE, USFWS, the California State Lands Commission and CDFG.

Ten land use categories exist within the Moro Cojo Slough study area: high/moderate density residential, rural residential, agricultural, wetlands, heavy industrial, light industrial, commercial and outdoor recreation (Figure 7-1). Most of the acreage within the study area is rural residential, agriculture and wetlands (Moro Cojo Slough), and with the exception of the Highway 1 corridor, the region in general reflects a rural low density and agricultural character. Along the Highway 1 corridor are enclaves of residential, roadside commercial and heavy industrial land uses (Figure 7-1).

Access to the study area is provided by Highway 1 and Moss Landing Road on the west, Dolan Road on the north, Castroville Boulevard to the east, and Highway 156 to the south and east.

Rural residences are scattered throughout the upland areas at densities ranging from 2.5-40+ acres per unit. Many residences on larger parcels are associated with commercial agricultural operations, while some on smaller parcels include small scale "weekend farms" with limited livestock grazing. More densely developed residential areas include the Oak Hills/Monte Del Lago Mobilehome Community north of Highway 156, Trails End Mobile Manor off Dolan Road, and portions of the urbanized Castroville community.

Wetlands within the study area include the salt/brackish-water wetlands and freshwater aquatic areas of Moro Cojo Slough, as well as upper watershed stream channels that drain into the slough. Environmental characteristics of the slough and upper drainages are described in other sections of this report.

Outdoor Recreation Areas

Manzanita Regional Park, a County park, encompasses approximately 464 acres in the northeastern portion of the Moro Cojo study area. The park provides picnic areas, active recreation (baseball complex), and equestrian complex and passive recreational uses (hiking and nature study). Limited passive recreational activities (i.e., bird-watching) also occur within the Moro Cojo Slough complex, primarily on private lands. Moss Landing Harbor has created a deep-water channel with berthing facilities at the mouth of Moro Cojo Slough thereby providing outdoor recreation facilities.

Agricultural Lands

Agricultural lands occur on flatter terraces in the westerly portion of the study area, as well as in the sandy hill areas to the east. Artichokes are the major crop grown on larger parcels near Highway 1, while strawberries and flowers predominate in the more erodible sloping lands to the east. Cattle grazing and dairy farms also occurs on lands with marginal soil conditions. A more detailed discussion of the agricultural uses in the study area is contained in Chapter 6.

Other Land Uses

Other less prevalent land uses in the Moro Cojo Study area include commercial uses in Moss Landing, Castroville, and in scattered locations along major roadways. Industrial uses are concentrated primarily in the Moss Landing area. Light industrial activities include fish processing and harbor support facilities on Sandholdt Road, as well as agricultural packing plants and greenhouses throughout the study area. National Refractories and Minerals, just north of the slough; the adjacent PG&E power plant; and an assembly plant on Meridian Road are the major heavy industrial facilities in the study area.

NORTH COUNTY LOCAL COASTAL PROGRAM

Monterey County's North County Land Use Plan (LUP, 1982) and Coastal Implementation Plan - Part 1 & 2 (1988) establish the framework for future development and land use changes within the study area. The LUP and County implementation regulations were mandated by the California Coastal Act (1976) as the mechanisms to carry out various policies of the State Coastal Act at the local level. The Coastal Act contains a number of provisions which need to be incorporated into each LUP. The significant policy provisions relating to this management plan involve protection of environmentally sensitive habitats, protection of viable agricultural lands, designation of development priorities on other lands, and providing public access to the coast.

The North County LUP contains a number of policies and recommended actions to carry out requirements of the Coastal Act. The LUP is divided into the following major sections: resource management, public service systems, land use and development, public access, and implementation, with a separate discussion on the Moss Landing Community Plan. The reader should refer to the LUP (1982, amended) for the complete text.

RESOURCE MANAGEMENT

The plan defines environmentally sensitive habitats as "areas in which plant or animal life or their habitats are rare or especially valuable because of their special nature or role in an ecosystem, and which could be easily disturbed by developments." These areas include wetlands (Moro Cojo Slough) and endangered species' habitat. A number of policies establish protection measures, limitations on diking, dredging, and filling, setbacks and further detailed resource management planning in order to preserve and enhance these resources. This plan is a recommended action of the LUP (Section 2.3.4.2).

The LUP also recognizes the problem of rapid soil erosion in the Upper Moro Cojo Slough watersheds, and the resulting impacts from siltation causing, among other things, biotic impacts and loss of wetlands. LUP policies suggest Land Disturbance Targets (LDT), or limits on the cumulative amount of bare ground in each subwatershed. These limits would allow development and agricultural conversion only on non-critical erosion land as a way to return erosion/siltation to historic (pre-development) rates.

Agriculture is recognized as an important land use which make a substantial contribution to the area's economy. Protection of agricultural land is a key LUP and Coastal Act policy. However, several economic and environmental management issues are involved in the long-term viability of agriculture in Moro Cojo watershed. One is encroaching urbanization and rural residential development, particularly in Castroville and smaller communities like Moss Landing and Oak Hills. Residential development raises property values and taxes for nearby farmlands. One method for combating high taxes and land speculation was the Williamson Act passed by the State in 1965. The Act offers significant property tax reductions for owners signing contracts to maintain land in agricultural use for 20 years. There are Williamson Act contracts in effect in the study area, covering approximately 200 acres. The County,

Coastal Commission and willing property owners have used other types of easements to restrict development on agricultural or non-agricultural lands. These easements include scenic, open space, public access, flood control and agricultural conservation easements. These easements generally restrict development on or use of property to preserve the particular value sought by the easement. In some cases a single easement can be used to protect multiple values (e.g., open space easement). As an example, an offer of dedication from public access and open space easement were made in 1989 for a 100-foot strip on the easterly side of Moro Cojo Slough between Moss landing Road and Highway 1.

LAND USE AND DEVELOPMENT

The LUP future land use plan (Figure 7-2) reflects existing land uses throughout the Moro Cojo Slough watershed. New development is designated only where compatible with agriculture and sensitive resource protection. Buildout of undeveloped residential area parcels of Castroville Boulevard is allowed at low rural densities (2.5-40 acre/dwelling unit). High density residential use is allowed on two sites adjacent to Castroville Boulevard with site-specific review for resource and public facility constraints. Small-scale commercial uses are encouraged in specific areas to serve local neighborhoods. Industry is limited to coastal-dependent uses in areas where they presently exist, although some build-out of harbor-related light industry is recognized in the Sandholdt Road area.

Development and new agricultural operations in Moro Cojo and Elkhorn Slough watersheds are subject to a permit process to ensure compliance with slope, erosion and development density policies in the LUP. In addition, Watershed Restoration Areas were established to monitor LDT and implement land restoration measures for particular sub-watersheds subject to high erosion levels. Five watersheds (#28-33) cover the Moro Cojo Slough Watershed (see North County, LCP Resource Map Book). Watersheds #31 and #32 are designated watershed restoration Areas pursuant to North County Land Use Plan policy 2.5.2.4.

PUBLIC SERVICES

The LUP indicates the need to improve Highway 1, Highway 156, and local roads consistent with resource and agricultural protection. The Plan also notes that septic system failures have caused water quality problems in Moro Cojo Slough; as well as local public health hazards. Plans are underway to service high-density residential areas with sewers. North County High School, for example, has been sewered. On-site wastewater management systems are recommended for lower density rural areas.

PUBLIC ACCESS

The Plan recognizes the need to provide public access to shoreline and public recreational areas in the coastal zone. In the study area, new access locations or access improvements are shown in the Moss Landing-Sandholdt Road beach area, and a circular trail system from Castroville Boulevard to Moro Cojo Slough in the vicinity of the high school. A more detailed description of public access is contained in Chapter 9.

WATER SUPPLY AND QUALITY

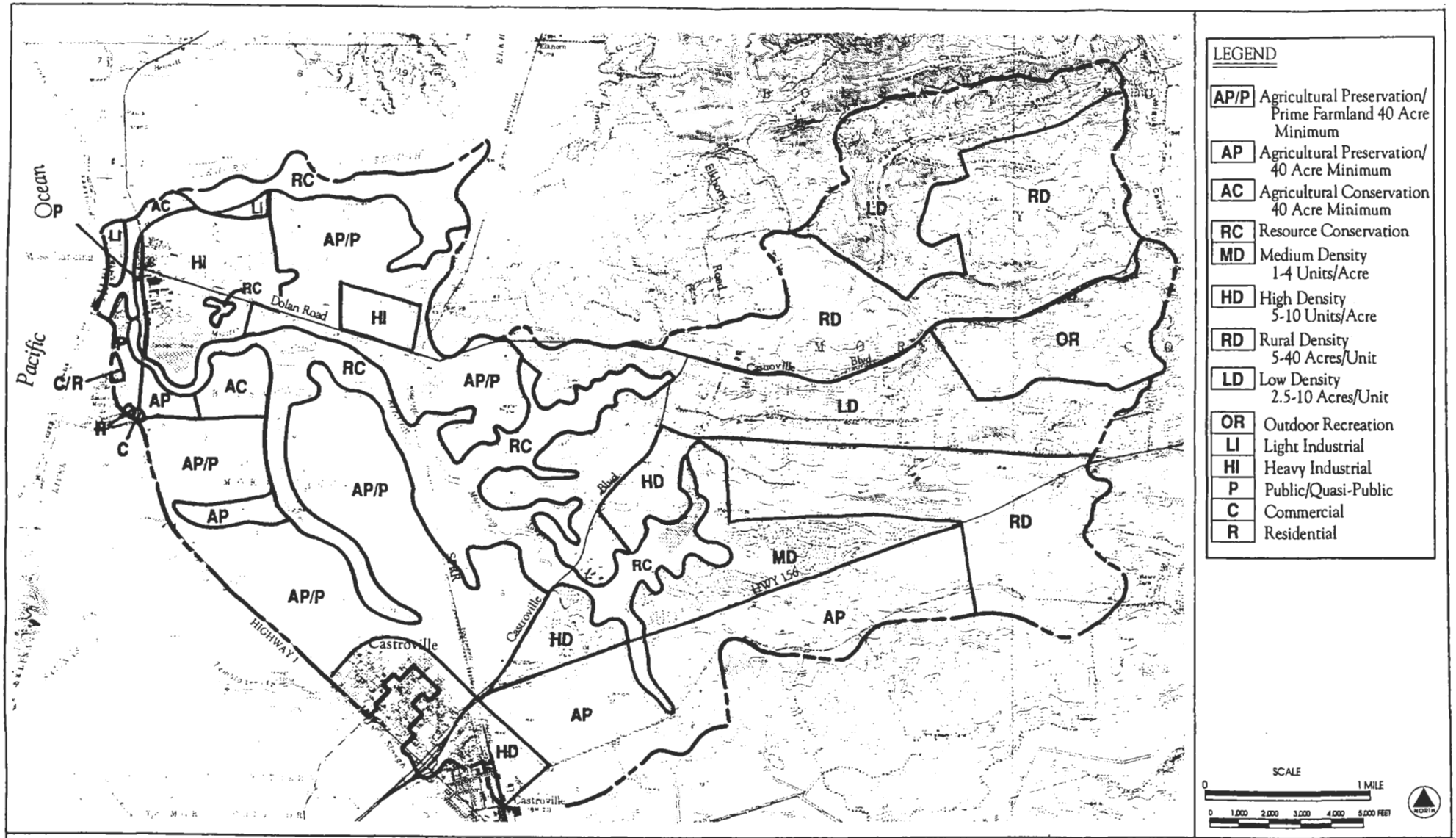
The LUP also addresses water supply for future development and agriculture. The LUP recognizes groundwater overdraft problems and indicates "managing the demand for water generated by agricultural... residential and commercial development will be a major challenge for the [North County] in coming years." A key policy of the plan is to protect water quality and control new development at levels that can be served by identifiable, available, long-term water supplies. Potential water sources

include the San Felipe project or construction of a dam on the Arroyo Seco River (North County Local Coastal Program, 1982). Recently, treated wastewater injection wells have been suggested as a method to reduce seawater water intrusion and provide water for agricultural irrigation. A detailed description of the Castroville Seawater Intrusion Program is contained in Chapter 4.

Nonpoint source pollution (NPSP) is considered a problem for the Moro Cojo Slough watershed, resulting in the degradation of wetland and riparian resource values. Section 6217 of the Coastal Zone Reauthorization Amendments of 1990 (CZARA) requires the development and implementation of a Coastal Nonpoint Pollution Control Program to ensure the protection and restoration of coastal waters. This is consistent with LUP policies and the County has participated in proposals to prepare a more comprehensive NPS Pollution program for the region, and to implement projects to reduce NPSP and facilitate groundwater recharge.

IMPLEMENTATION

The Monterey County Coastal Implementation Plan documents (Parts 1 and 2, 1988) provide a series of zoning ordinances and permit regulations to implement the LUP. Part 2 contains a series of regulations for development in the LUP area.



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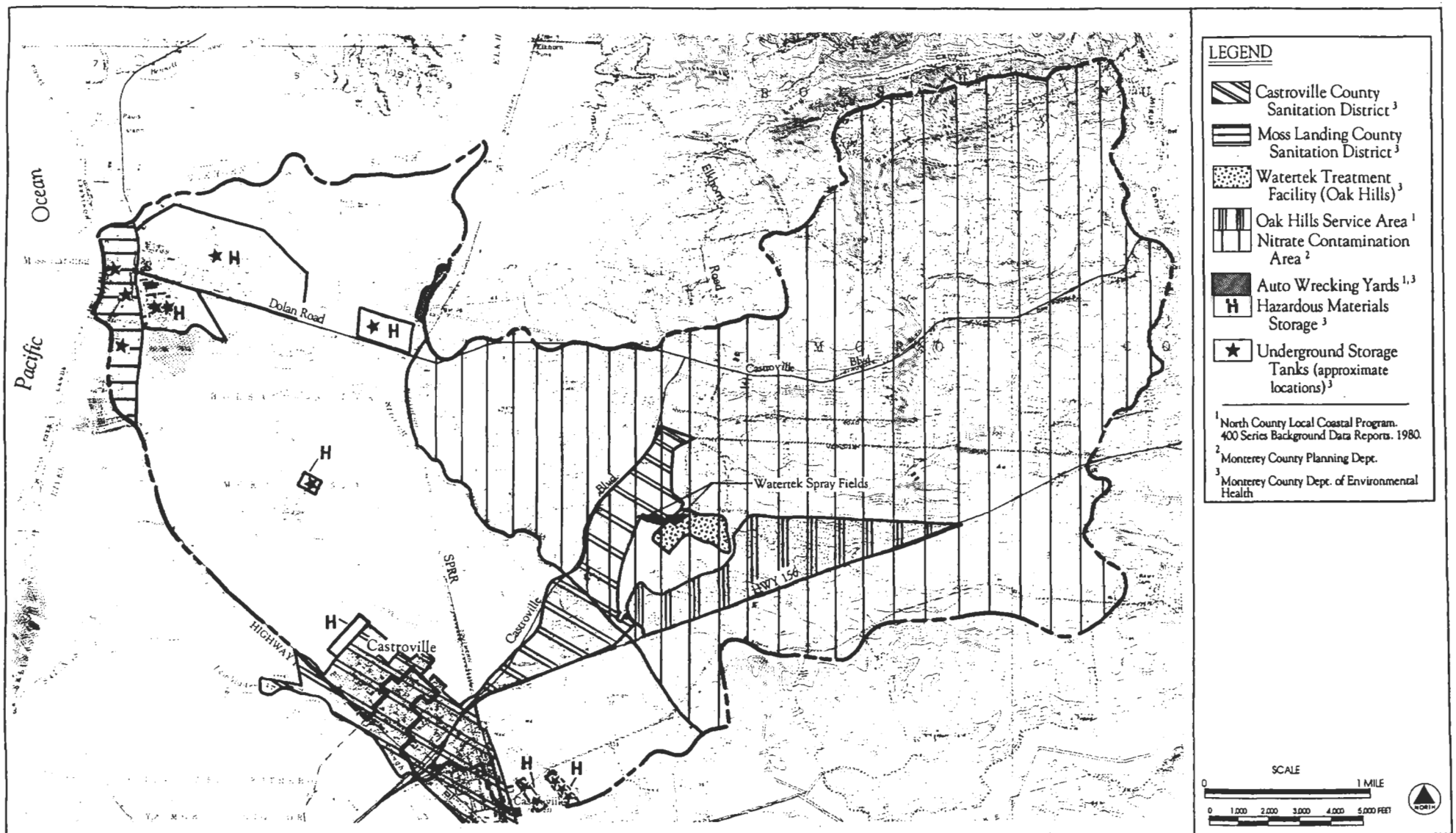
Moro Cojo Slough Management and Enhancement Plan
North County Land Use Plan

2/96
705-01

Figure 7-2



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Moro Cojo Slough Management and Enhancement Plan
Existing Wastewater Facilities

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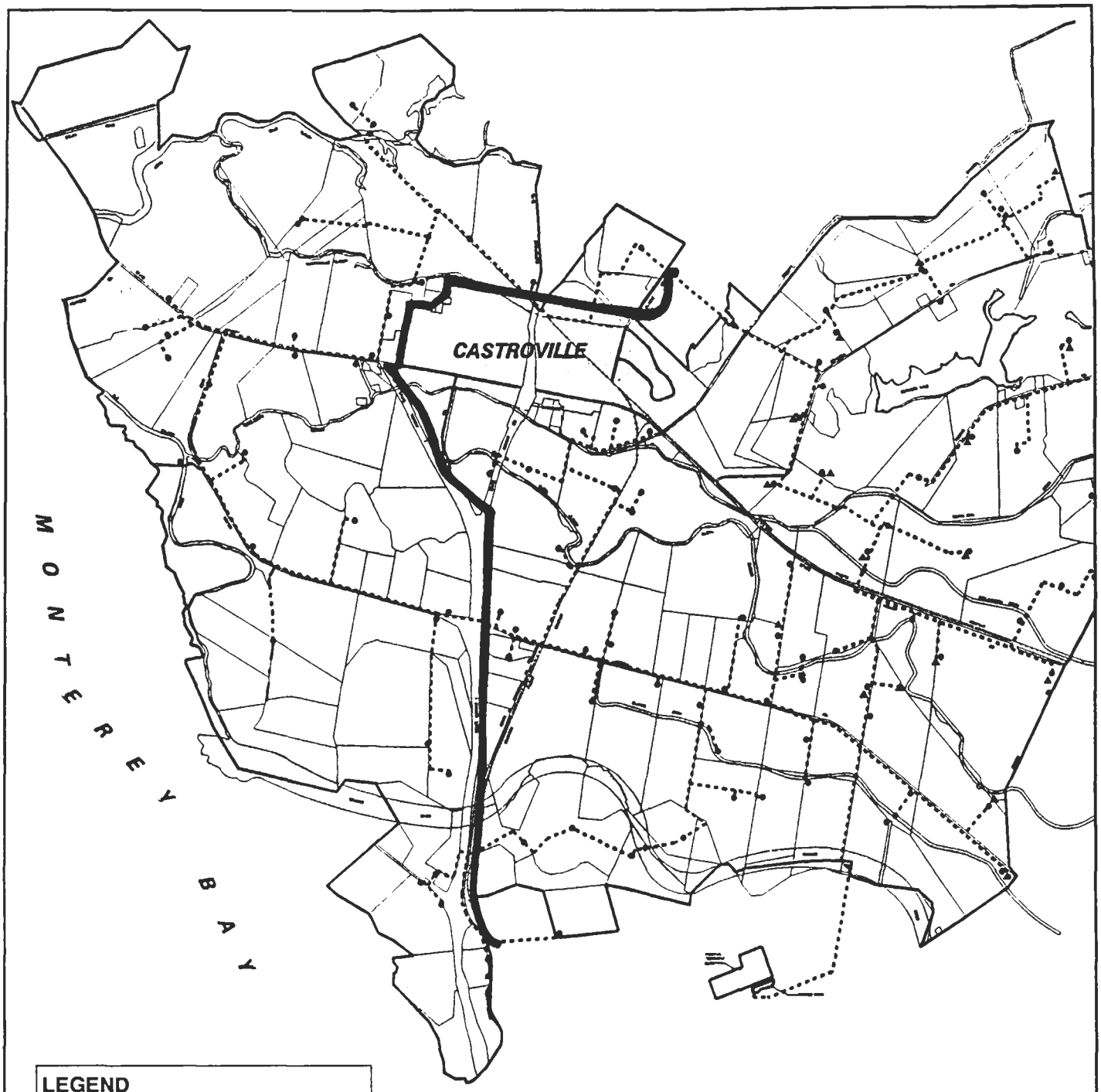
Figure 8-1



Source: Monterey County Water Resources Agency

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Moro Cojo Slough Management
and Enhancement Plan
Castroville Seawater Intrusion Project
Proposed Facilities

Figure 7-3
2/96
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CHAPTER 8
WASTEWATER

INTRODUCTION

Municipal and domestic wastewater in the Moro Cojo Slough watershed is managed through a combination of regional treatment facilities, local treatment facilities, and dispersed septic systems.

WASTEWATER FACILITIES

Two sanitation districts handle and process wastewater in the Moro Cojo slough watershed: Castroville County Sanitation District and Moss Landing County Sanitation District (Figure 8-1). These districts collect wastewater effluent that is transported out of the basin and treated at the Monterey Regional County Sanitation District facility, in Marina.

Within the Moro Cojo Slough watershed boundaries, one local package treatment plant is currently operating, one facility has been abandoned, and one new facility has been proposed. The WaterTek wastewater treatment currently serves the Oak Hills community near Castroville Boulevard. This treatment plant consists of two percolation ponds and a spray field. A sod farm utilizing the treated wastewater has been proposed for this facility; in addition, WaterTek is also proposing to raise the berms surrounding the percolation ponds. The now-abandoned wastewater system for the Monte del Lago Mobilehome Community was in use from 1975 to 1985. The abandoned treatment ponds are still in place along the border of the slough, and the wetlands within them have been restored. The restored wetlands are now managed by CDFG. There is a proposal for a local package treatment plant that will service 10-15 residential units on Trails End Road (off Dolan Road). The proposed facility will dispose of effluent through a leach field.

Most of the development within the Moro Cojo Slough watershed are on septic systems (e.g., farms and rural residential land uses). The Monterey County Department of Environmental Health (MCDEH) has about 30 years of records on septic system permits and septic repair permits; however, because the information has not been synthesized, data regarding failed septic systems along Moro Cojo slough could not be provided (B. First, MCDEH, pers. comm., 1994). A former North County inspector for MCDEH can recall only one septic repair within 100 yards of the slough (M. Jorvina, MCDEH, pers. comm., 1994). Overall there are no specific trends of septic failures along the slough (M. Dias, MCDEH, pers. comm., 1994).

Although the potential for wastewater seepage to the slough exists. Septic systems can fail, especially under wet winter conditions, as well as in areas with clay soils, sandy soils, or a high water table. Before the implementation of a 1968 ban on septic systems and the formation of the Moss Landing County Sanitation District, numerous septic systems problems reportedly occurred in the Moss Landing area; this is likely due to high groundwater and shallow, sandy soils.

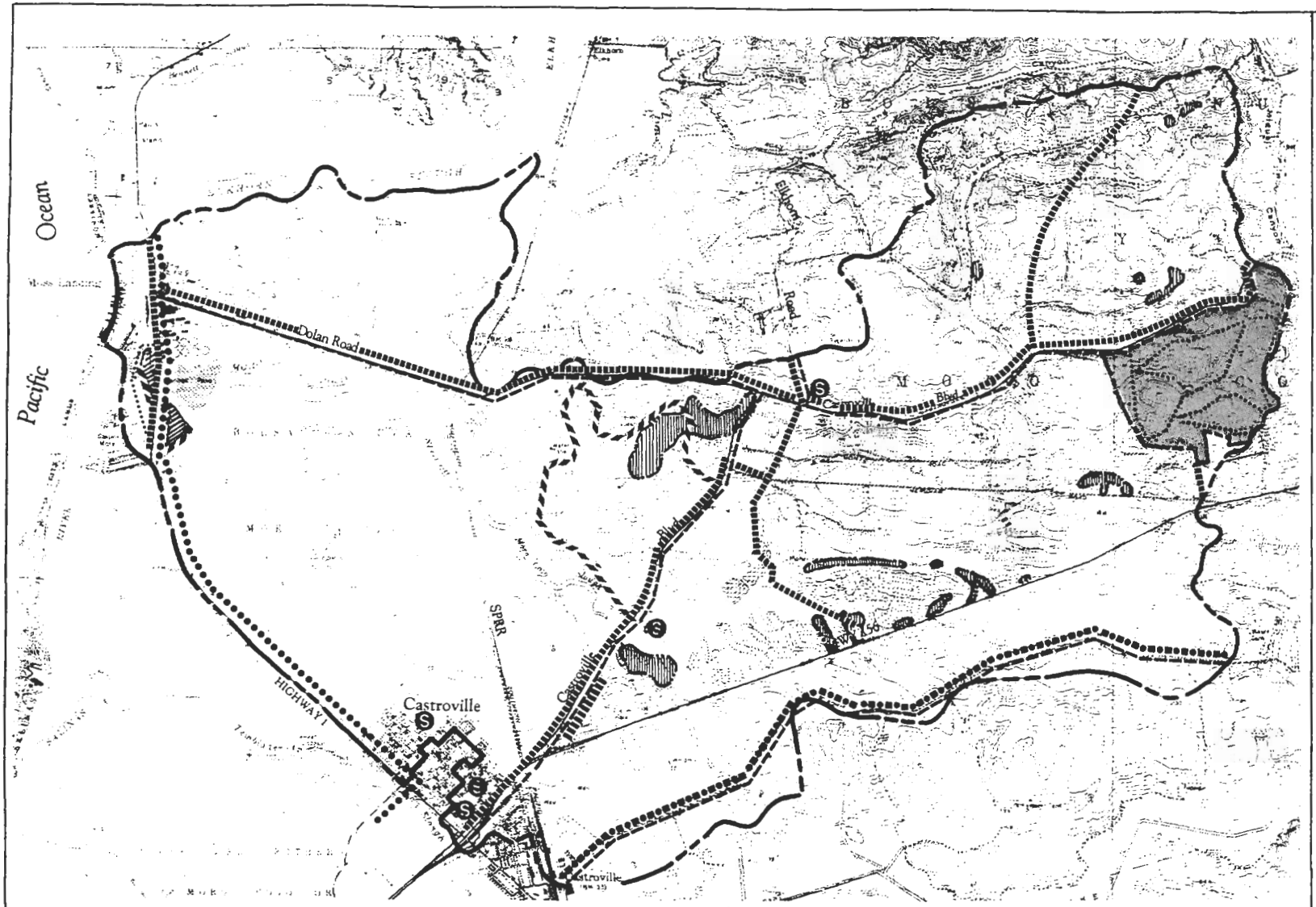
The contamination problems associated with the slough include nitrate, chlorine, and heavy metals (Monterey County Planning and Building Inspection Department, 1980). Agriculture practices can result in increased levels of salts including sodium, sulfates and chlorine. In addition, fertilizer and pesticide run-off into the slough can result in an increase in the levels of nitrates and phosphates in the water. Much of the phosphates are absorbed by clay soils; however, nitrates can create a water quality problems in the soil. Septic tank failures can result in increased levels of nitrates and soluble organic residue in groundwater (*ibid.*). Run-off from the dairy farm and pig farm along Dolan Road flows into the wetlands of

the slough, resulting in increased nitrate concentrations from the animal wastes. Cattle are also allowed to graze in the slough. Most of the grazing occurs west of the Southern Pacific railroad tracks along the north and south banks of the slough; however, cattle have been observed in the slough in the area adjacent to North Monterey County High School (M. Jorvina, pers. comm., 1994). Individual rural residences within the watershed also have farm animals that encroach into the slough or its tributaries. Some heavy metals may be present in wells that occur in the upper watershed areas; heavy metals have been documented in wells west of San Miguel Canyon Road (Monterey County Planning and Building Inspection Department, 1980).

Surface water in the slough is contaminated with excessive sodium concentrations. Sources of the sodium include leachage of salts from the soil during the wet season, run-off of agricultural irrigation, and seepage from the holding ponds at the National Refractories facility. Poor water circulation and drainage contribute to the high levels.

Registered underground storage tanks and hazardous material storage sites are sparsely distributed throughout the watershed; however, they are concentrated in the commercial industrial areas of Castroville and Moss Landing (Figure 8-1). Registered hazardous material storage sites are also associated with farms.

Groundwater degradation from solid waste facilities has not been documented for the Moro Cojo Slough area. There are no solid waste facilities within the watershed boundaries.



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Moro Cojo Slough Management and Enhancement Plan
Existing and Approved Public Access and Educational Facilities

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705-01

Figure 9-1

CHAPTER 9
PUBLIC ACCESS AND EDUCATION

EXISTING PUBLIC ACCESS

Within the Moro Cojo Slough study area, access to the slough is limited for all modes of transportation. Private property limits public access to the slough, except for intersections of public roads and some public facilities (i.e., schools).

Vehicular Access

Vehicular access is supplied by intersections of the slough with county roads and State Highway 1, in addition to intersections with private driveways and farm roads. Major county roads that intersect the slough include Castroville Boulevard, Elkhorn Road, Blackie Road, Dolan Road and Meridian Road.

At present vehicular access is limited to private land uses, most notably farming activities and residential uses. The North County High School property provides for limited vehicular access along the perimeter of the school site.

Public parking is limited to on-street turnouts from local roadways, roadside businesses along State Highway 1 and some parking at the High School during non-school hours. An unpaved Park-and-Ride facility abuts State Highway 1 near Dolan Road.

Pedestrians and Bicyclists

Little pedestrian activity occurs within the slough area because of the rural character of the study area, except for students travelling to and from Castroville to North County High School. No sidewalks, crosswalks or pedestrian signals currently exist along the county roads or State Highway 1. The SPRR tracks traverse the study area; while not currently designated as a public thoroughfare, the Transportation Agency for Monterey County has discussed potential acquisition of the railway for pedestrian and/or light rail service.

Existing and proposed trails associated with Moro Cojo Slough are outlined in the North County Trails Plan (Monterey County Planning and Building Inspection Department, 1989). The only existing trails in the watershed are the hiking/equestrian trails of Manzanita Regional Park and the Pacific Coast Bicycle Route (formerly the Bicentennial Bicycle Route) that predominantly follows Highway 1 (Figure 9-1). Most local bicyclists prefer to use Elkhorn Road and Castroville Boulevard. Hikers and equestrians using the California State Park trails of Salinas River State Beach can access these trails from Moss Landing Road or Potrero Road. An unpaved parking lot exists at the end of Potrero Road. Ad hoc trails occur in scenic easements associated with the Oak Hills Development.

The Trails Plan (*ibid.*) also proposes numerous new trails in the Moro Cojo Slough watershed (Figure 9-1). These trails predominantly follow existing roadways such as Dolan Road and Castroville Boulevard, or are associated with scenic easements. The trails connect major recreational features such as Manzanita Regional Park, Elkhorn Slough, and Moss Landing. The proposed trails focus on bicycle and equestrian use groups, although a multi-use trail is proposed along Blackie Road, and a hiking trail is proposed for a scenic easement area along the slough.

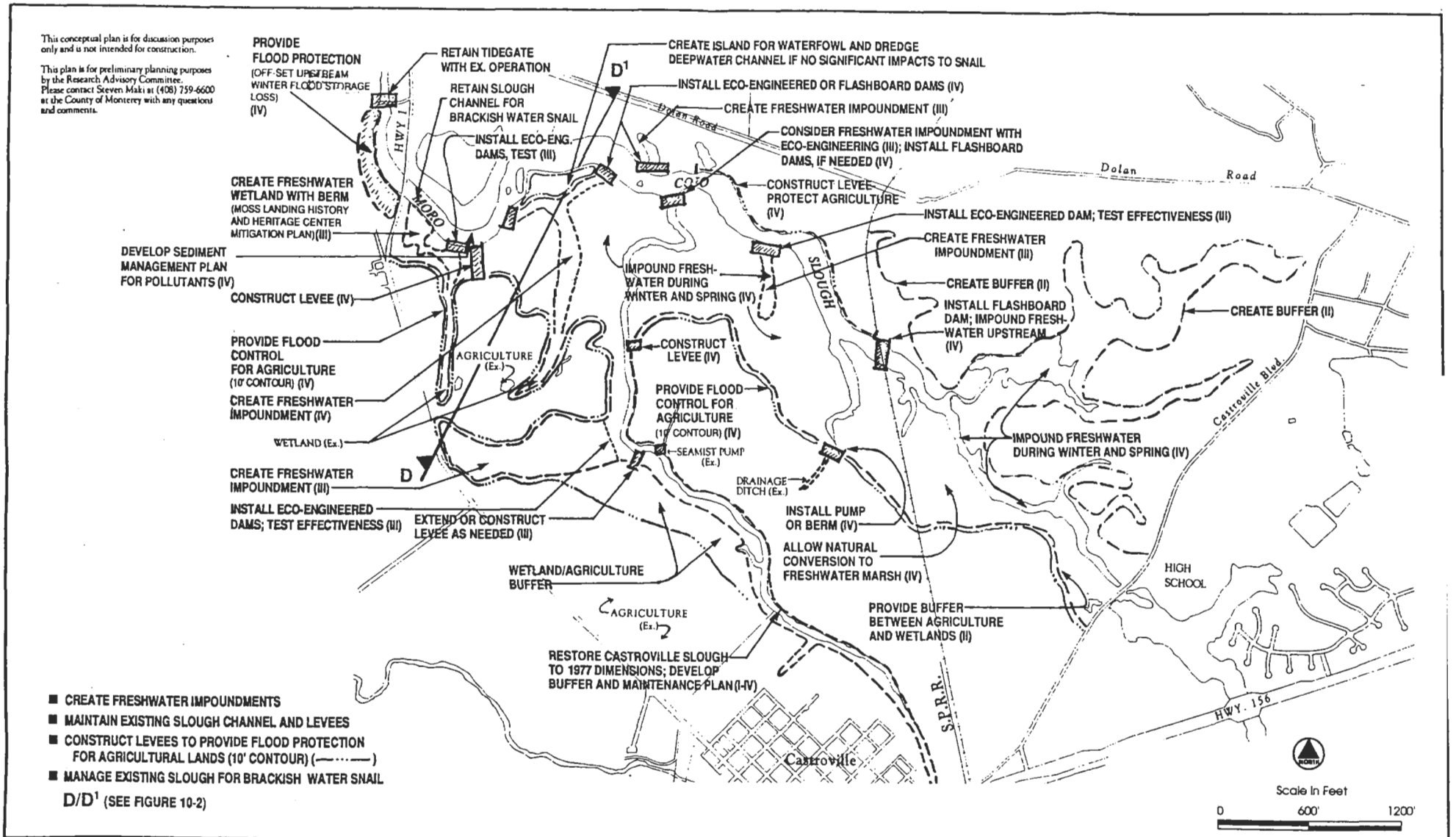
Manzanita Regional Park provides equestrian and hiking trail facilities within the 464-acre park. Providing access to the slough is a component of the Moss Landing Wetland Park proposed by the Elkhorn Slough Foundation. Trails are proposed near the mouth of the slough on parcels that are either currently dedicated as a scenic conservation easement or owned by the Elkhorn Slough Foundation (Figure 9-1). The Foundation intends to restore and enhance the wetland habitat of Moro Cojo Slough in conjunction with the development of this park.

A trail along the entire coast of California has been proposed since the late 1970's (Willard, pers. comm., 1994). A coastal trail, managed by the Monterey Peninsula Regional Park District (MPRPD), currently exists in Monterey County. The trail, named the Monterey Bay Coastal Trail, will be incorporated into the state-wide coastal trail network. This 35-mile long trail extends south from the City of Marina to Point Lobos, although numerous gaps in the trail currently occur. The MPRPD has recently received a grant to install a bicycle/hiking trail that will run from Marina to Elkhorn Slough, passing through the community of Castroville. The purpose of the trail is to service bicycle commuters and recreational users (G. Tate, MPRPD, pers. comm., 1994).

EDUCATION

There are five public schools within the boundaries of Moro Cojo Slough watershed, including North Monterey High School; Joseph Gambetta, Castroville and Elkhorn elementary schools; and the Geil Street Headstart and Adult Education schools. These schools are part of the North County School District. The close proximity of the schools to the slough provides excellent educational opportunities and a potential for the involvement of school-age children with the enhancement and long-term protection of the slough's biotic resources. One agreement made prior to the construction of North Monterey County High School indicates that the school provide educational programs focusing on the wetland habitat of Moro Cojo Slough, although the school has not yet implemented this program.

Manzanita Regional Park provides an opportunity for educational programs. The park occurs in the upper (eastern) portion of the watershed and currently functions as a sports complex. The park currently has a volunteer program that utilizes individuals for park maintenance activities. The volunteer program could be expanded to include a team of people interested in wetland enhancement and restoration.



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CHAPTER 10
PREFERRED LOWER WATERSHED PLAN

INTRODUCTION

Five alternatives to enhance resources within the lower watershed of Moro Cojo Slough (e.g., Moss Landing Road to Castroville Boulevard) were developed. These alternatives were evaluated by the RAC, who then selected the preferred resource management alternative for the lower watershed. The five alternatives reviewed were; Alternative A, Tidal Regime; Alternative B, Partially Tidal Regime; Alternative C, Enhanced Existing Conditions; Alternative D, Winter/Spring Freshwater Conditions; and Alternative E, No Project.

Each of the five alternatives evaluated suggest actions to protect existing significant biotic resources, increase overall habitat values within the slough environs, resolve existing resource problems and land use conflicts and provide passive recreational/educational uses. Each action was analyzed as to its potential benefits (i.e., ability to meet stated goals and objectives of the plan) and potential impacts. Measures to reduce impacts were also identified. A general description of each alternative and why they were not selected by the RAC is presented below; a full description and analysis of each alternative is in Volume II - Resource Enhancement and Alternatives Report on file at Monterey County Planning and Building Inspection Department. The reader is directed to the Resource Enhancement and Alternatives Report for representative cross-sections and conceptual features of the alternatives not selected by the RAC.

Selection of the Preferred Plan

The RAC reviewed each of the alternatives presented in the Resource Enhancement Alternatives report and, through consensus, selected a preferred alternative. The RAC, in addition to the goals and objectives developed for the watershed-wide plan, identified several habitat and/or land use criteria that they felt were necessary for the preferred lower slough watershed plan. Each of the alternatives were evaluated by these criteria:

RAC criteria for lower slough:

1) retain both saltwater and freshwater habitats within the lower slough,
2) maintain known habitat for rare and endangered species (i.e., brackishwater snail and SCLTS),
3) maintain existing saltwater flow in the lower slough below SPRR bridge,
4) utilize treated, reclaimed water to recharge aquifers,
5) create freshwater conditions in lower slough (east if Highway 1),
6) retain water in the lower slough through the creation of impoundments,
7) maximize freshwater in lower slough through increased run-off and use of reclaimed water,
8) utilize eco-engineering,
9) recognize the need for maintenance and monitoring, and
10) maximize buffers between wetlands and adjacent land uses.

Based on these criteria, the RAC selected Alternative D, Winter/Spring Freshwater Conditions as the Preferred Plan.

The preferred plan, as presented in this report, is conceptual; additional analysis, design, and agreements with willing landowners will be required prior to implementation or construction. The actions proposed to occur under the preferred alternative are listed on Table 10-1. The ability of a proposed action to meet

the objectives of the management and enhancement plan are identified below; please refer to Chapter 2 for the list (and codes) of the various objectives. The potential impacts of implementing the Preferred Plan, and recommended mitigation measures to mitigate such impacts, are described below and summarized in Table 10-2. (Note: Nothing in this plan shall be construed as legitimizing any violations of nor superseding any required remediation pursuant to the Coastal Act, Local Coastal Program, or other agency requirements.)

The RAC has recommended phasing the implementation of the management actions into four phases (I-IV), estimated years of 1995 through 2005 (Table 10-2).

Phase I - Education and Enforcement through Existing Programs
(Year 1 and on-going)

- Develop Moro Cojo Management and Enhancement Plan framework.
- Identify management plan objectives and develop management plan monitoring program and success criteria.
- Formulate and implement a broad, watershed-wide education program.
- Initiate wetland restoration of previously converted wetland areas and easements through cooperation of landowners.
- Initiate regulatory permitting with applicable agencies and Monterey County.
- Identify potential funding sources and secure monies for implementation of the management plan actions.
- Provide for pilot projects on public, and/or non-profit agency owned lands in Years 1 through 10 to test the effectiveness of the management actions and to evaluate any impacts they may have on adjacent agricultural activities; thereby offering modifications to correct any deficiencies to remaining management actions through the remaining phases.

Phase II - Establish Buffers between Wetlands and Other Lands with Willing Landowners
(May be modified after the implementation and evaluation of a pilot project in Phase I)

- Create buffers with willing landowners.
- Initiate land management (e.g., move fences/cattle, install signs).

Phase III - Ecological Engineering
(May be modified after the implementation and evaluation of a pilot project in Phase I)

- Obtain necessary permits from regulatory agencies and Monterey County.
- For Highway 1/Dolan Road/Castroville Triangle, design and implement educational and demonstration projects.
- Design eco-engineered structures for freshwater impoundments, evaluate effectiveness, and initiate construction of the impoundments utilizing chosen techniques.
- Investigate placement of flashboard dam at Castroville Slough, conduct design studies.
- Design selected BMP features, such as retention ponds and filter swales with willing landowners.

Phase IV - Design and Implement Structural Engineering Actions
(May be modified after the implementation and evaluation of a pilot project in Phase I)

- Install flashboard dam at SPRR and Castroville Slough.
- Design and construct waterfowl island.
- Design and construct levees, install agricultural drainage pumps.

- Design and construct other plan features to protect structures and/or agricultural lands from flooding.
- Install selected BMP features on applicable lands.

PREFERRED PLAN - WINTER/SPRING FRESHWATER CONDITIONS

General Description of the Preferred Plan

The Preferred Plan — Winter/Spring Freshwater Conditions creates areas for freshwater impoundments within the lower slough watershed between Moss Landing Road and Castroville Boulevard. The plan does not modify the existing tidal environment below the SPRR. The tide gates at Moss Landing Road will be retained and operated in the same manner as the existing operation. A flashboard dam will be installed at SPRR to restrict tidal movement and to allow upstream impoundment of freshwater during the winter and spring. Freshwater impoundments would also be created in existing alkali grasslands, and/or excavated into the grassland, between Highway 1 and the SPRR. The RAC has recommended the use of "eco-engineering" (e.g., hay bales) to create barriers between the freshwater impoundments and the main slough channel. The hay bale barriers will need to be constructed so they are effective in impounding water, to create the desired freshwater "lakes", as well as preventing excessive leakage of freshwater into the adjacent salt/brackish main slough channel, to protect habitat for the brackishwater snail. Existing brackishwater areas above the SPRR would convert to more freshwater conditions due to the construction of a flashboard dam at the SPRR overcrossing. Areas currently freshwater near Castroville Boulevard would persist. Most areas below the 10-foot contour between Highway 1 and SPRR would be subject to freshwater inundation during the winter and spring, depending upon rainfall. The RAC has recommended the use of reclaimed water to maintain the freshwater impoundments during the winter and spring, if rainfall and/or runoff from the watershed is not sufficient to keep the impoundments inundated. The preferred plan incorporates agriculture and/or grazing on lands above the 10-foot contour.

Benefits and Constraints of the Preferred Plan

The preferred plan offers several features that meet the project goals and objectives (see pages 2-2 and 2-3) and the RAC's 10 criteria (see page 10-1). The plan also poses several constraints, including hydrologic, biological, and agricultural land use issues. The preferred plan will also require several permits from regulatory agencies and a program for maintenance and monitoring. An analysis of the key actions and the anticipated impacts and mitigations of this alternative are described below and summarized on Table 10-2.

Creation of Freshwater Impoundment Areas. The plan proposes the creation of winter/early spring freshwater impoundment areas within the marsh plain of the lower slough (below SPRR) and retainment of freshwater within the main slough upstream of SPRR. An "eco-dam" or a flashboard dam would be installed at the confluence of Castroville Slough and Moro Cojo Slough (Action H-3). These actions will not result in any modification of the tide gates at Moss Landing Road or saltwater flow below SPRR (RAC criteria 3). The freshwater impoundments are expected to enhance the existing grassland areas for waterfowl nesting and foraging (Action B-7), thus addressing plan Objectives G-1, B-1, B-5, B-6, W-4, W-5, A-2 (see pages 2-2 and 2-3), and the RAC criteria 1, 5, 6, 7, and 8 (see page 10-1).

The creation of the freshwater impoundments may result in partial or full inundation of approximately 375 acres below the 10-foot contour between the SPRR and Highway 1; these areas will require purchase or conservation easements from willing landowners (Actions L-1, L-2, A-1 [see Table 10-1]). Additionally, adjacent agricultural lands will require protection from flooding. Inundation of the alkali grassland

west of SPRR may cause a gradual conversion of the area to freshwater plant species (Action B-1). Likewise, freshwater impoundments east of SPRR may convert the brackishwater marsh areas to a more freshwater habitat (Action B-2). Mitigation would include the construction of earthen berms at the 10-foot contour and management/upgrade of existing agricultural drainage pump systems (Actions F-1 and F-2). These actions will increase habitat values of the slough system, addressing Objectives G-1, B-2, B-5, B-6, A-3, L-1 (see pages 2-2 and 2-3), and the RAC criteria 5, 6, 7, and 8 (see page 10-1). The impoundments may utilize treated, reclaimed water runoff to recharge aquifers (RAC criteria 4). Additionally, the plan would allow some public access and citizen involvement in implementing the plan (Objectives P-1 and P-2).

The operation of the freshwater impoundments could impact 65 acres of known habitat for the brackish-water snail and potential habitat for the tidewater goby in the main slough channel downstream of the SPRR. As mitigation, the plan incorporates measures to control the release of freshwater into the main slough channel. The RAC has proposed the use of "eco-engineering" to create the impoundments (Action H-6), such as the use of hay bales (Objective G-2 and RAC criteria 2 and 8). This methodology is less costly than more traditional methods, such as the installation of flashboard dams. As discussed above, the use of a method such as hay bales, should be tested as to their effectiveness in preventing excessive leakage of freshwater into the main slough. The integrity of the impoundments will need to be periodically checked, and repairs made as necessary, throughout the winter and spring, particularly after storm events (RAC criteria 9 and Objective W-7). If hay bales are not deemed effective, it is recommended that flashboard dams be installed. With either of the methods, some leakage of fresh water is expected and there may be some loss of habitat immediately adjacent to the dam outlets. More detailed design of the dams, coupled with sampling of snail populations and sampling to determine the presence of tidewater goby is required to determine the significance of the potential impacts. Consultation and/or permitting with regulatory agencies will be required.

If the freshwater impoundments are to be excavated in the alkali grassland, rather that allowing inundation of the existing grasslands, there will be disturbance of existing wetland and/or removal of some contaminants from the slough area. The feasibility of excavation and deposition of this material within receiving waters (i.e., Monterey Bay) or onto adjacent lands will require a more detailed analysis and consultation/ permitting with appropriate regulatory agencies (i.e., NOAA, COE, RWQCB). A sediment management plan for pollutants will be prepared (Action H-5).

The plan proposes to maintain the existing tidal activity within the main slough channel between Highway 1 and SPRR (Action H-4, Table 10-1, and RAC criteria 3). This is not expected to result in significant changes in existing saltmarsh mosquito management. The creation of freshwater impoundments during the winter and early spring, however, is expected to result in an increase in the freshwater winter mosquito population (P. Ghormely, North Salinas Valley Mosquito Abatement District, pers. comm., 1994) (Action B-5, Table 10-1). The freshwater winter mosquito has increased its presence in the region over the last nine years and is considered a serious public health and resource management concern (*ibid.*). The life cycle begins in November-December and lasts through the spring. The species produces one brood per year and they are vicious biters. The mosquito population is difficult to manage through conventional means, as treatments such as oil and Bt have little effect (*ibid.*). A cooperative research project is currently underway to determine suitable treatments for this species of mosquito. The preferred management action to control this species is to drain seasonal wetlands or to have impoundments of constant water level with little/no vegetative breeding habitat. This management action, however, is contrary to the intent of the preferred plan. It is expected that freshwater winter mosquito populations will be a management concern in the impoundment areas both upstream and downstream of the SPRR. If aerial spraying of oil is utilized as a management action, for example, it is estimated to cost

approximately $6,000 per application. Implementation of the preferred plan will be coordinated with the mosquito abatement district (Objective W-6).

Creation of Island for Waterfowl Breeding. The plan includes the opportunity to create an island within the slough to facilitate breeding by shorebirds or waterfowl (Action B-6, Table 10-1). As proposed, the island would include a deep water channel to discourage predation by mammals. Of particular concern are red fox and feral dogs; the deep water channel may discourage their access to the breeding island (addresses Objective B-4). A more detailed sediment transport study is needed to determine whether the creation of the deep water channel would significantly impact existing brackishwater snail habitat. Additional study is needed to determine if sediments will accumulate in the channel over time and if periodic dredging would be necessary (Action H-5). Permits from regulatory agencies would need to be acquired prior to implementation of this action.

Erosion and Flooding. The preferred plan is not expected to cause erosion of the marsh plain, since the grade control structure at Highway 1 will be maintained (Action H-1, Table 10-1). This action addresses Objective W-2.

Flood flows may result in flooding of existing properties between Highway 1 and Moss Landing Road; however, the extent of flooding may be reduced by the capture of runoff in the freshwater impoundments. It is expected that floodwalls or purchase of property would still be required (Action F-2).

Modification of the SPRR Track Overcrossing to Install a Flashboard Dam. The installation of a flashboard dam at SPRR (Action H-2) will require the modification to the SPRR overcrossing. The installation of the dam is expected to gradually convert the existing brackish marsh areas upstream of SPRR to a more freshwater habitat (Action S-2, Table 10-1). This may affect approximately 200 acres. This action addresses Objective B-2 (see page 2-2) and the RAC criteria 5, 6, and 7 (see page 10-1).

The installation of the flashboard dam at SPRR is not anticipated to impact existing breeding areas of the SCLTS, tiger salamander and red-legged frog, unless inundation levels occur within the breeding areas. Proper maintenance and management of the flashboard dam is expected to prevent impacts to the breeding areas. The need for maintenance and monitoring is recognized in RAC criteria 9 and Objective W-7.

Creation of Buffers between Existing Agriculture and Wetland Resources. The plan includes the creation of buffers between existing wetlands and agricultural land uses (Actions L-1, A-2, B-3 [Table 10-1]). These buffers are for two general areas: 1) areas downstream of the SPRR, and 2) areas upstream of SPRR. The buffer areas downstream of SPRR are proposed to be situated along the 10-foot contour adjacent to the flood control berms/levees (Action F-1). The buffers are intended to provide area for the construction of retention basins, filter swales or other features to reduce impacts to the adjacent wetlands from agricultural and/or grazing land uses (Action A-3). Buffer areas upstream of SPRR will be established between wetland areas and agricultural and/or grazing lands. The establishment of buffer areas would be pursuant to purchasing land or obtaining conservation easements from willing landowners. Assuming a 50-foot-wide buffer zone, approximately 75 acres of agricultural land would be affected above the SPRR; below the SPRR, approximately 375 acres may be affected. The establishment of buffer and water quality management features addresses Objectives B-5, B-6, W-1, W-2, W-3, A-1, A-2, A-4 and RAC criteria 10. If needed, the buffer areas could be revegetated with native species and invasive plants removed (Objectives B-3 and B-8).

Widening Castroville Slough to 1977 Dimensions. This proposed action (Action B-4, Table 10-1) is intended to restore habitat values within portions of Castroville Slough through the re-establishment of wetland habitat. Working with willing landowners, there may be opportunities to improve agricultural

drainage and other drainage/flooding problems through a re-design of the slough (Action A-4, Table 10-1). Suggested designs include a one-bank widening with a lowered berm upon which native wetland habitat can be established. A more detailed investigation of 1977 conditions, identification of wetland-agricultural conflicts, an analysis of design opportunities, and cooperation with landowners is required for implementation of this action. Based on a preliminary analysis of aerial photos, over 10 acres of agricultural land may be affected. Addressing these land use conflicts and restoring habitat along Castroville Slough addresses Objectives A-5, B-5, B-7 and RAC criteria 5.

According to available information, there are no known official violations with the COE for actions along Castroville Slough. Previous activities may have resulted in the fill of wetlands, however they have not been cited as violations by State or Federal regulatory agencies. Recent filling of apparent wetlands within the Castroville area occurred through an adjustment of the coastal zone boundary by CCC. Violations to the County's riparian setback policy have been addressed by the County and a restoration plan has been prepared. If filling occurs in the future and the COE assumes jurisdictional authority, they may require re-establishment of impacted areas. In similar instances within the region, the COE has required re-establishment of habitat based on conditions five years previous to the citation (i.e., 1989). The RAC, as part of the preferred plan, has recommended restoration of Castroville Slough to its dimensions as of January 1, 1977, the date Section 404(f) of the Clean Water Act was enacted (see Chapter 2, U.S. Army Corps of Engineers). The RAC wants to use this as the baseline date for management and enhancement; however, the date should not restrict enhancement objectives (RAC, August 1994).

OTHER ALTERNATIVES CONSIDERED BY THE RAC

The following alternatives for the lower watershed were considered by the RAC, but were rejected. A brief description of each alternative and the rationale for its rejection is presented below.

Alternative A - Tidal Regime

Alternative A, The Tidal Regime, is an alternative that would create an open tidally-influenced system from Moss Landing Road to Castroville Boulevard. The alternative is modeled after the conditions believed to be present within the lower watershed in the 1850's, prior to the installation of tide gates at Moss Landing Road. The alternative incorporates agriculture and/or grazing on lands above the 10-foot contour (believed to be the condition in the 1850's), and periodic tidal inundation of lands currently being grazed below the 10-foot contour.

Benefits and Constraints of Alternative A. This alternative offers several features that meet the project goals and objectives. The alternative also poses several constraints, including hydrologic, biological, and agricultural land use issues. The alternative would also require several permits from regulatory agencies. The removal of tide gates at Moss Landing Road (Sandholdt Dam) is one of the key actions of this alternative. Removal of the tide gates will allow tidal circulation within the slough. In conjunction with the installation of tide gates at SPRR, a fully tidal saltmarsh environment, including mudflats, marsh habitat and adjacent habitat is expected between Highway 1 and SPRR. In addition to the removal of the tide gates at Moss Landing Road, several breaks will be made in the existing levee system to allow inundation of grassland below the 10-foot contour. These habitats are expected to increase the areas value to tidal marsh-dependent wildlife.

As proposed in the Preferred Plan, an island, with a deep water channel to discourage predation by mammals, would be created. Tidal activity is expected to maintain the deep water channel, however if sediments accumulate, periodic dredging may be necessary. Restoring tidal activity in the lower slough

may cause erosion of the marsh plain. As mitigation a new grade control structure would need to be installed at Highway 1.

Increased tidal flows may result in partial or full inundation of approximately 375 acres below the 10-foot contour between the SPRR and Highway 1; as with the Preferred Plan, these areas will require purchase or conservation easements from willing landowners and protection from flooding and/or tidal flows. This alternative includes the creation of buffers between existing wetlands and agricultural land uses as proposed in the Preferred Plan. The increased tidal action may affect adjacent agricultural lands (i.e., artichokes) below SPRR if salts rise within the root zone ($\pm$3 feet below surface) by capillary action.

The increased tidal activity could impact approximately 65 acres of known populations of brackishwater snail, a species of special concern. The tidewater goby, a Federally endangered species, which may inhabit the slough, would potentially be impacted by this alternative. Mitigation would include the construction of shallow tidal channels to create compensation habitat for these species. More detailed sampling of snail populations and sampling to determine the presence of tidewater goby and consultation with regulatory agencies is required. The creation of shallow channels would require dredging of marsh sediments; this may result in the disturbance and/or removal of some contaminants from the slough area. The feasibility of deposition of this material within receiving waters (i.e., Monterey Bay) onto adjacent lands will require a more detailed analysis (Action H-7) and consultation/permitting with appropriate regulatory agencies (i.e., NOAA, COE, RWQCB).

Increased tidal activity between Highway 1 and Castroville Boulevard is expected to create conditions unsuitable for mosquitos. The daily tidal activity is expected to reduce potential breeding habitat for saltmarsh mosquitos. Mosquitos may remain a management concern in upper reaches of the slough where areas are more brackish-fresh. Mitigation measures could include the construction of runnels (i.e., channels) or other drainage features in coordination with the Mosquito Abatement District.

The increased tidal activity to Castroville Boulevard will require the modification to the SPRR overcrossing. The crossing will need to be enlarged to allow additional flow. The increased flows are expected to gradually convert existing freshwater marsh areas upstream of SPRR to a more tidally-influenced habitat. This may affect approximately 225 acres. The increased tidal activity upstream of the SPRR may impact existing breeding areas of the SCLTS, tiger salamander and red-legged frog, encompassing three known sites over approximately 90 acres. Mitigation would include the construction of berms/levees around breeding ponds to preserve the habitat. A more detailed analysis of this action would need to be explored with regulatory agencies in order to evaluate its effectiveness.

Increased tidal activity above the SPRR has the potential to affect seawater percolation into groundwater where the upper and lower aquifers may be connected. This potential impact requires a more detailed investigation of groundwater movement and tidal activity.

This alternative recommends restoring habitat values within portion of Castroville Slough through the re-establishment of wetland habitat to 1989 conditions. Based on a preliminary analysis of aerial photos, approximately 10 acres of agricultural land may be affected.

Reason for Rejection of Alternative A. The RAC rejected this alternative due to the potential impacts (and recommended mitigation measures) to endangered species (i.e., brackishwater snail below the SPRR, and SCLTS above SPRR) and the numerous structural changes that would be required (i.e., modification to Moss Landing Road culverts, construction of tidal channels). The RAC also was concerned that regulatory permitting for this alternative would be extensive.

Alternative B - Partially Tidal Regime

Alternative B - Partially Tidal Regime creates a tidal environment upstream to SPRR. As in Alternative A, the tide gates at Moss Landing Road will be removed; however, tidal influence will be prevented past the SPRR. Existing brackishwater conditions (a short distance upstream of SPRR) and freshwater conditions upstream of SPRR to above Castroville Boulevard would persist. Similar to Alternative A, existing areas below the 10-foot contour between Highway 1 and SPRR would be subject to tidal inundation. The alternative incorporates agriculture and/or grazing on lands above the 10-foot contour.

Benefits and Constraints of Alternative B. As in Alternative A, one of the key actions of this alternative is the removal of the tide gates at Moss Landing Road to allow full tidal circulation within the slough. The removal of the tide gates and several breaks in the existing levee system would allow inundation of grassland below the 10-foot contour.

As proposed in Alternative A, Alternative B includes the opportunity to create an island within the slough to facilitate breeding by shorebirds, partial or full inundation of lands below the 10-foot contour between the SPRR and Highway 1. The increased tidal activity is expected to adversely impact a portion of the known populations of brackishwater snail, a species of special concern. Approximately 3,000 linear feet (24 acres) of snail habitat may be affected. Increased tidal activity between Highway 1 and SPRR is expected to create conditions unsuitable for mosquitos. The daily tidal activity is expected to reduce potential breeding habitat for saltmarsh mosquitos. Mosquitos are expected to remain a management concern in the slough above SPRR where areas will be dominated by freshwater. This alternative includes the creation of buffers between existing wetlands and agricultural land uses, as described in Alternative A. Please refer to the discussion in Alternative A regarding the benefits and constraints of these actions.

The installation of tide gates at SPRR will require the modification to the SPRR overcrossing. The installation of tide gates is expected to gradually convert the existing brackish marsh areas upstream of SPRR to a more freshwater habitat. This may affect approximately 200 acres. The management of the tide gates at SPRR is not anticipated to impact existing breeding areas of the SCLTS, tiger salamander and red-legged frog. Although tide gates may leak, the influence of the leakage is not expected to extent upstream to the breeding areas. Increased tidal activity to the SPRR has the potential to affect seawater percolation into groundwater where the upper and lower aquifers may be connected. This potential impact requires a more detailed investigation of groundwater movement and tidal activity; however, the impact is less likely than in Alternative A since the tidal exchange will stop short of the potential recharge areas. This action, if deemed a significant impact, would be contrary to Objective W-5.

Reason for Rejection of Alternative B. The RAC rejected this alternative due to the potential impacts to endangered species (i.e., brackishwater snail) and the numerous structural changes that would be required (i.e., modification to Moss Landing Road culverts, construction of tidal channels). The RAC was also concerned that regulatory permitting for this alternative would be extensive.

Alternative C - Enhanced Existing Conditions

Alternative C - Enhanced Existing Conditions creates a modified tidal environment upstream to SPRR. The tide gates at Moss Landing Road will be retained, but modified to allow greater the tidal influence to the SPRR. Existing brackish (for a short distance upstream of SPRR) and freshwater conditions upstream of SPRR to above Castroville Boulevard would persist. Similar to Alternative A, existing areas below the 10-foot contour between Highway 1 and SPRR would be subject to tidal inundation. The alternative incorporates agriculture and/or grazing on lands above the 10-foot contour.

Benefits and Constraints of Alternative C. This alternative proposes a modification of the tide gates to allow tidal circulation within the slough to SPRR. This is expected to enhance the existing tidal saltmarsh environment, including creating some additional channels for mudflat and pickleweed marsh habitat. These habitats are expected to enhance the value of the lower slough to tidal marsh-dependent wildlife. The alternative includes several breaks in the existing levee system to allow inundation of grassland below the 10-foot contour.

This alternative includes the opportunity to create an island within the slough to facilitate breeding by shorebirds. The increased tidal flows may result in flooding (tidal and flood-related) of existing properties between Highway 1 and Moss Landing Road. Increased tidal activity between Highway 1 and SPRR is expected to create conditions unsuitable for mosquitos. The daily tidal activity is expected to reduce potential breeding habitat for saltmarsh mosquitos. This alternative includes the creation of buffers between existing wetlands and agricultural land uses. Please refer to the discussion in Alternative A regarding the benefits and constraints of these actions.

Modification of the tide gates, while retaining the culverts at Highway 1, is not expected to cause erosion of the marsh plain. This action addresses Objective W-2. Increased tidal flows may result in partial or full inundation of approximately 375 acres below the 10-foot contour between the SPRR and Highway 1. These areas will require purchase or conservation easements from willing landowners (Action L-1). Additionally, adjacent agricultural lands will require protection from flooding and/or tidal flows. Mitigation would include the construction of earthen berms at the 10-foot contour and management/ upgrade of existing agricultural drainage pump systems (Action F-1). This action will increase habitat values of the slough system.

The increased tidal activity is expected to adversely impact a portion of the known populations of brackishwater snail, a species of special concern. Approximately 1,200 linear feet (8 acres) of snail habitat may be affected. The tidewater goby, a Federally endangered species, which may inhabit the slough, would potentially be impacted by this alternative. Mitigation would be similar to Alternative A, where shallow tidal channels will be constructed to create compensation habitat for these species. The installation of tide gates at SPRR will require the modification to the SPRR overcrossing. The installation of tide gates is expected to gradually convert the existing brackish marsh areas upstream of SPRR to a more freshwater habitat. This may affect approximately 200 acres.

The small modification of tidal activity has the potential to affect seawater percolation into groundwater where the upper and lower aquifers may be connected. This potential impact requires a more detailed investigation of groundwater movement and tidal activity; however, the impact is considered low since the tidal exchange will stop short of the potential recharge areas, as described in Alternative A.

Reason for Rejection of Alternative C. The RAC rejected this alternative due to the potential impacts to endangered species (i.e., brackishwater snail). The RAC also was concerned that regulatory permitting for this alternative would be extensive.

Table 10-1. Summary of Lower Watershed Preferred Alternative Plan Actions, Moro Cojo Slough Management and Enhancement Plan, By Phase

Action	Phase
PHASE I	
Hydrologic Actions	
H-4. Maintain existing operation of tide gate at Moss Landing Road (Sandholdt Dam) to allow for tidal action and storms. (Addresses RAC criteria 1, 2 and 3; Plan Objectives B-2, B-5, W-4 and A-2.)	I
Agricultural Actions	
A-4. Through willing landowners, obtain conservation easement, purchase or land exchange to restore Castroville Slough to its 1977 dimensions. Investigate various designs, such as a lowered berm on one bank, to allow wetland restoration, compatible with adjacent agricultural land use and water quality protection. (Addresses RAC criteria 5; Plan Objectives B-2, B-5, B-7, W-2, A-5, P-2 and P-3.) Conduct pilot projects on public and/or non-profit agency-owned lands to test effectiveness of the management actions and to evaluate any impacts they may have on adjacent agricultural activities; thereby offering modifications to correct any deficiencies to remaining management actions through the remaining phases.	I
Biotic Resource Actions	
B-4. Begin to restore wetland habitat along Castroville Slough to 1977 dimensions. (See A-4, above.)	I
PHASE II	
Land Use Actions	
L-1. Through voluntary landowner involvement, obtain conservation easements, purchase or land exchange for pasture and/or agricultural lands below the 10-foot contour between SPRR and Castroville Boulevard to provide buffer between agricultural lands and wetlands. (Addresses RAC criteria 10; Plan Objectives B-6 and A-5.)	II
Agricultural Actions	
A-2. Through willing landowners, obtain conservation easement, purchase or land exchanges for the conversion of marginal agricultural land adjacent to the slough between SPRR and Castroville Boulevard to wetland/agricultural buffer area. (Addresses RAC criteria 5 and 6; Plan Objectives B-5, B-7, B-8, W-2, W-3, A-5, L-1 and P-2.)	II

Table 10-1. Summary of Lower Watershed Preferred Alternative Plan Actions, Moro Cojo Slough Management and Enhancement Plan (Cont'd.)

Action	Phase
A-3. Through willing landowners, obtain conservation easement, purchase or land exchange to minimize potential conflicts between agricultural land practices and habitat protection by constructing grass-lined swales, sediment control structures, and perimeter ditches. (Addresses RAC criteria 8, 9 and 10; Plan Objectives G-2, B-5, W-1, W-2, W-3, W-7, A-3, A-4, P-2 and P-3.)	II
A-4. Through willing landowners, obtain conservation easement, purchase or land exchange to restore Castroville Slough to its 1977 dimensions. Investigate various designs, such as a lowered berm on one bank, to allow wetland restoration, compatible with adjacent agricultural land use and water quality protection. (Addresses RAC criteria 5; Plan Objectives B-2, B-5, B-7, W-2, A-5, P-2 and P-3.)	II
Biotic Resource Actions	
B-3. Protect existing wetlands and riparian habitat through creation of wetland/agricultural buffers. (Addresses RAC criteria 10; Plan Objectives B-6 and A-5.)	II
B-4. Continue to restore wetland habitat along Castroville Slough to 1977 dimensions. (See A-4, above.)	II
PHASE III	
Hydrologic Actions	
H-3. Install "eco-dam" or a flashboard dam at the confluence of Castroville Slough and Moro Cojo Slough to limit/control tidal movement in Castroville Slough and control releases of freshwater into Moro Cojo Slough. (Addresses RAC criteria 1, 2 and 8; Plan Objectives G-1, B-1, B-5, W-4, W-5, W-6 and A-2.)	III (eco dam)
H-6. Install barriers (e.g., eco-engineered hay bales or flashboard dams) between freshwater impoundments and main slough channel to create impoundments. Preserve brackishwater character of main slough. (Addresses RAC criteria 2, 3, 5 and 6; Plan Objectives G-1, B-1, B-5, W-6 and A-2.)	III
Flood Control Action	
F-1. Provide tidal/flood water protection for agricultural lands west of SPRR through construction of levees, berms, pump systems, as needed. (Addresses Plan Objectives W-4, W-7, A-2, A-5 and P-2.)	III

Table 10-1. Summary of Lower Watershed Preferred Alternative Plan Actions, Moro Cojo Slough Management and Enhancement Plan (Cont'd.)

Action	Phase
Agricultural Actions	
A-3. Through willing landowners, obtain conservation easement, purchase or land exchange to minimize potential conflicts between agricultural land practices and habitat protection by constructing grass-lined swales, sediment control structures, and perimeter ditches. (Addresses RAC criteria 8, 9 and 10; Plan Objectives G-2, B-5, W-1, W-2, W-3, W-7, A-3, A-4, P-2 and P-3.)	III
A-4. Through willing landowners, obtain conservation easement, purchase or land exchange to restore Castroville Slough to its 1977 dimensions. Investigate various designs, such as a lowered berm on one bank, to allow wetland restoration, compatible with adjacent agricultural land use and water quality protection. (Addresses RAC criteria 5; Plan Objectives B-2, B-5, B-7, W-2, A-5, P-2 and P-3.)	III
Surface Water Actions	
S-2. Impound available freshwater in impoundments during spring and summer. (Addresses RAC criteria 5 and 6; Plan Objectives G-1, B-1, B-5, W-4, W-5 and A-2.)	III
Biotic Resource Actions	
B-1. Gradually convert alkali grassland to freshwater plant species west of SPRR. (Addresses RAC criteria 5 and 7; Plan Objective G-1.)	III
B-3. Protect existing wetlands and riparian habitat through creation of wetland/agricultural buffers. (Addresses RAC criteria 10; Plan Objectives B-6 and A-5.)	III
B-4. Restore wetland habitat along Castroville Slough to 1977 dimensions. (See A-4, above.)	III
B-5. Potential change in species composition and abundance of mosquito populations. (Addresses RAC criteria 5; Plan Objective W-6.)	III
B-7. Create freshwater impoundment areas for waterfowl habitat. (Addresses RAC criteria 2, 5 and 6; Plan Objectives B-1 and B-5.)	III
PHASE IV	
Land Use Actions	
L-2. Through voluntary landowner involvement, obtain conservation easements, purchase or land exchange for pasture and/or agricultural lands below 10-foot contour west of SPRR for construction of freshwater impoundments. (Addresses RAC criteria 5 and 6; Plan Objectives G-1 and B-1.)	IV

Table 10-1. Summary of Lower Watershed Preferred Alternative Plan Actions, Moro Cojo Slough Management and Enhancement Plan (Cont'd.)

Action	Phase
Hydrologic Actions	
H-1. Replace Highway 1 crossing with a spanning bridge to allow additional flows; maintain grade control structure. (Addresses RAC criteria 1 and 3; Plan Objectives W-2.)	IV
H-2. Modify the SPRR track overcrossing to accommodate additional flows, and install flashboard dam to impound water. (Addresses RAC criteria 2, 5 and 6; Plan Objectives G-1, B-1, B-5, W-4, W-5, W-6 and A-2.)	IV
H-3. Install "eco-dam" or a flashboard dam at the confluence of Castroville Slough and Moro Cojo Slough to limit/control tidal movement in Castroville Slough and control releases of freshwater into Moro Cojo Slough. (Addresses RAC criteria 1, 2 and 8; Plan Objectives G-1, B-1, B-5, W-4, W-5, W-6 and A-2.)	IV (flashboard dam)
H-5. Develop sediment management plan for pollutants. (Addresses Plan Objectives W-2 and W-3.)	IV
H-6. Install barriers (e.g., eco-engineered hay bales or flashboard dams) between freshwater impoundments and main slough channel to create impoundments. Preserve brackishwater character of main slough. (Addresses RAC criteria 2, 3, 5 and 6; Plan Objectives G-1, B-1, B-5, W-6 and A-2.)	IV
Flood Control Actions	
F-1. Provide tidal/flood water protection for agricultural lands west of SPRR through construction of levees, berms, pump systems, as needed. (Addresses Plan Objectives W-4, W-7, A-2, A-5 and P-2.)	IV
F-2. Provide protection of private property/structures in Moss Landing from flood water inundation (7 parcels). (Addresses Plan Objective A-5.)	IV
Agricultural Actions	
A-1. Through willing landowners, obtain conservation easement, purchase or land exchange for the conversion of existing pasture and/or agricultural lands west of SPRR to managed wetland habitat (i.e., remove or limit cattle activities). (Addresses RAC criteria 5 and 6; Plan Objectives B-5, B-7, B-8, W-2, W-3, A-5, L-1 and P-2.)	IV

Table 10-1. Summary of Lower Watershed Preferred Alternative Plan Actions, Moro Cojo Slough Management and Enhancement Plan (Cont'd.)

Action	Phase
A-3. Through willing landowners, obtain conservation easement, purchase or land exchange to minimize potential conflicts between agricultural land practices and habitat protection by constructing grass-lined swales, sediment control structures, and perimeter ditches. (Addresses RAC criteria 8, 9 and 10; Plan Objectives G-2, B-5, W-1, W-2, W-3, W-7, A-3, A-4, P-2 and P-3.)	IV
A-4. Through willing landowners, obtain conservation easement, purchase or land exchange to restore Castroville Slough to its 1977 dimensions. Investigate various designs, such as a lowered berm on one bank, to allow wetland restoration, compatible with adjacent agricultural land use and water quality protection. (Addresses RAC criteria 5; Plan Objectives B-2, B-5, B-7, W-2, A-5, P-2 and P-3.)	IV
Surface Water Actions	
S-2. Impound available freshwater in impoundments during spring and summer. (Addresses RAC criteria 5 and 6; Plan Objectives G-1, B-1, B-5, W-4, W-5 and A-2.)	IV
Biotic Resource Actions	
B-1. Gradually convert alkali grassland to freshwater plant species west of SPRR. (Addresses RAC criteria 5 and 7; Plan Objective G-1.)	IV
B-2. Allow natural conversion of brackishwater marsh areas east of SPRR to a more freshwater plant association. (Addresses RAC criteria 5 and 7; Plan Objective G-1.)	IV
B-3. Protect existing wetlands and riparian habitat through creation of wetland/agricultural buffers. (Addresses RAC criteria 10; Plan Objectives B-6 and A-5.)	IV
B-4. Restore wetland habitat along Castroville Slough to 1977 dimensions. (See A-4, above.)	IV
B-5. Potential change in species composition and abundance of mosquito populations. (Addresses RAC criteria 5; Plan Objective W-6.)	IV
B-6. Provide island along main slough to facilitate waterfowl breeding. (Addresses Plan Objective B-4.)	IV
B-7. Create freshwater impoundment areas for waterfowl habitat. (Addresses RAC criteria 2, 5 and 6; Plan Objectives B-1 and B-5.)	IV

Table 10-2. Analysis of Lower Watershed Preferred Alternative Plan - Winter/Spring Freshwater Conditions, Moro Cojo Slough Management and Enhancement Plan

Issues and Concerns	Winter/Spring Freshwater Conditions	
Project Costs		
Easements/Land Purchase	$3.7 million	($8,000/acre)
Construction/Planning	$2.0 million	
Mitigation/Revegetation	$1.0 million	
Maintenance (5 yrs)	$1.0 million	
Mosquito Abatement (5 yrs)	$0.1 million	
Total Cost	$7.8 million	
General Description	Creation of impoundments between Highway 1 and Castroville Blvd. to hold freshwater during winter/early spring. Install flashboard dam at SPRR. Widen portions of Castroville Slough to 1977 dimensions. Utilize "eco-engineering" in early phases and test effectiveness.	
Benefits of Plan	Creates areas for freshwater impoundments for waterfowl nesting and foraging. "Eco-engineered" barriers (i.e., hay bales) or flashboard dams installed between impoundments and main slough to protect existing habitat of brackish-water snail and potential tidewater goby habitat. Creation of island to facilitate breeding by waterfowl. Converts brackish/freshwater habitat upstream of SPRR to predominantly freshwater habitat; retains existing endangered species habitat (i.e., salamander). Enhancement of habitat values within Castroville Slough by widening portions of the marsh plain.	
Hydrology: Impacts, Mitigations and Enhancements		
Tidal Inundation	**Impact:** Action H-1. Replace Highway 1 crossing with spanning bridge will inundate agriculture. **Mitigation:** See F-1 and F-2.	
	Impact: Action H-2. Modifying SPRR track overcrossing with flashboard dam will inundate agriculture. **Mitigation:** See F-1 and H-3.	
	Impact: Creation of freshwater impoundments may affect salinity of slough **Mitigation:** Action H-6. RAC proposes to utilize "eco-engineered" hay bales between impoundment and slough. If not effective, install flashboard dams between freshwater impoundments and main slough channel to keep slough brackish. Action H-3. Install tide gate at confluence of Castroville and Moro Cojo Sloughs.	
Flood Control	**Impact:** Potential flooding of existing agricultural lands below SPRR. **Mitigation:** Action F-1. Construct earthen berms at 10-foot contour between Highway 1 and SPRR; inundate 375 acres with freshwater.	

Table 10-2. Analysis of Lower Watershed Preferred Alternative Plan - Winter/Spring Freshwater Conditions, Moro Cojo Slough Management and Enhancement Plan (Cont'd.)

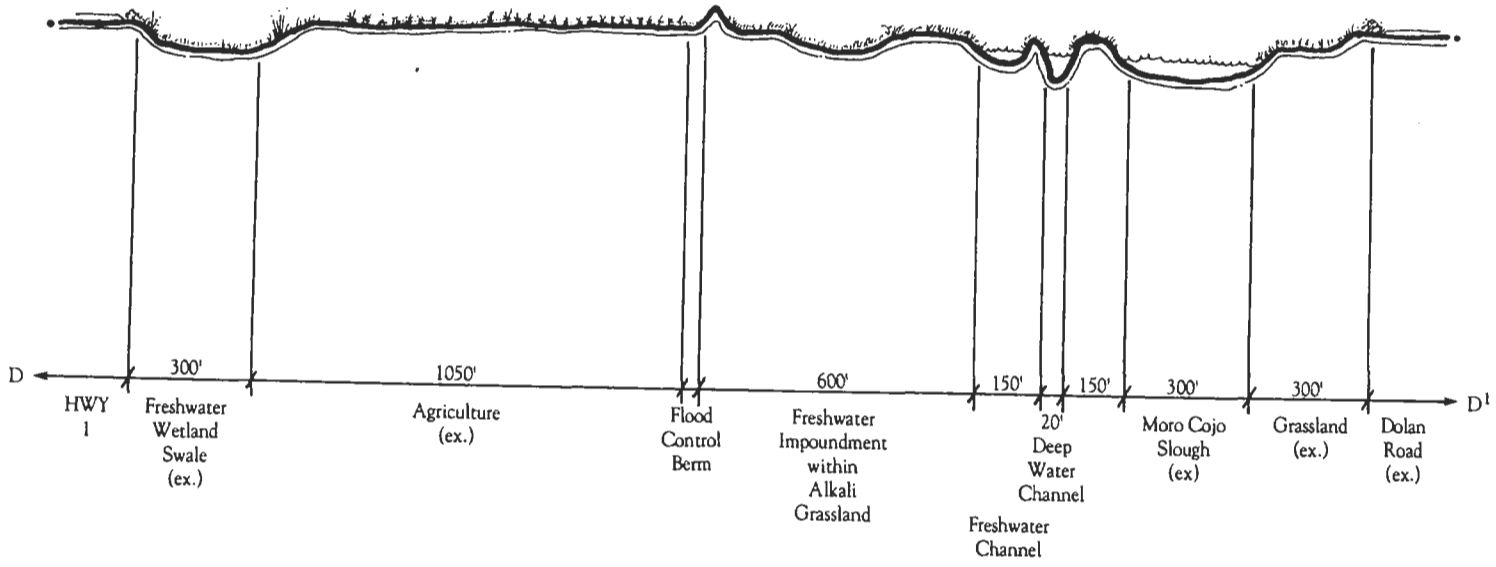
ISSUES AND CONCERNS	WINTER/SPRING FRESHWATER CONDITIONS
Flood Control (Cont'd.)	**Impact:** Potential flooding impacts (flood related) to properties between Highway 1 and Moss Landing Road. **Mitigation:** Action F-2. Construct floodwalls below Highway 1; acquire selected parcels below Highway 1.
	Impact: Potential flooding impacts to structures and properties upstream of Castroville Blvd. **Mitigation:** Requires more detailed topography and analysis.
Surface Water/ Groundwater	**Impact:** The volume of freshwater stored will be highly dependent upon rainfall. Based upon an initial water balance analysis, it appears that this alternative will create only seasonal wetlands in some years. **Mitigation:** Action S-2. Release freshwater during spring and summer from flashboard dams, if water is available to release. RAC recommends use of reclaimed water to supplement freshwater impoundments.
WATER QUALITY	
Deposition of Fill	**Impact:** Removal of some contaminants from slough, and deposition of contaminated dredge material into receiving waters or adjacent lands for construction of impoundment; detailed sediment analysis and dispersal study required. **Mitigation:** Action H-5. Sediment management plan for pollutants.
BIOTIC RESOURCES: IMPACTS, MITIGATIONS AND ENHANCEMENTS	
Vegetation	**Impact:** Action B-1 will inundate existing alkali grassland below 10-foot contour with freshwater during winter and spring; may result in gradual conversion of alkali grassland to freshwater plant species (375 acres). **Mitigation:** see Land Use
	Impact: Installation of flashboard dam at SPRR will prevent tidal inundation above SPRR and allow for gradual conversion of brackishwater marsh areas east of SPRR to more fresh water plant association (200 acres). **Mitigation:** None
	Impact: Freshwater impoundments will be created above and below the SPRR, totalling 250 acres. **Mitigation:** see Land Use
	Impact: Action B-3. Protects existing habitat via creation of wetland/agricultural buffers. **Mitigation:** see Land Use
	Impact: Action B-4. Create wetland habitat along portions of Castroville Slough to 1977 dimensions.

Table 10-2. Analysis of Lower Watershed Preferred Alternative Plan - Winter/Spring Freshwater Conditions, Moro Cojo Slough Management and Enhancement Plan (Cont'd.)

ISSUES AND CONCERNS	WINTER/SPRING FRESHWATER CONDITIONS
Wildlife	**Impact:** Action B-6. Provide island along slough to facilitate waterfowl breeding. **Mitigation:** Requires permit from COE to alter existing wetland and deposition of dredged material. Investigate if this would significantly impact brackishwater snail or tidewater goby.
	Impact: Inundation of additional lands with freshwater may result in an increase in freshwater winter mosquito populations. Treatment may affect wildlife resources depending on the method employed (e.g., use of mosquito fish).
Fisheries and Aquatic	**Impact:** Modification of the water regime (i.e., increase in storage/release of freshwater) may result in loss of 8,000 linear feet (65 acres) of brackishwater snail habitat. **Mitigation:** Action B-5 will install "eco-engineered" hay bale dams between the freshwater impoundments and the main slough to protect existing brackishwater snail habitat. Monitoring is needed to test effectiveness of hay bales to prevent excessive release of freshwater into the slough in order to prevent impact to the snail. If not effective, flashboard dams should be utilized.
	Impact: Inundation of additional lands with freshwater may result in an increase in freshwater winter mosquito populations within the lower watershed. **Mitigation:** It is not known if the "eco-engineered" hay bales will allow sufficient manipulation of water levels to reduce breeding habitat for mosquitos and minimize mosquito abatement operations. The winter/spring freshwater regime will be very favorable for mosquitos; mosquitos may be of significant management concern. Runnels and other drainage features could be used to reduce standing water but may be contrary to design plan. Cost of mosquito abatement may be high. Treatment may affect aquatic resources, depending on method.
Agricultural Resources	**Impact:** Increased inundation of lands below 10-foot contour will remove 375 acres from existing grazing and/or other agricultural use. **Mitigation:** Action A-1; obtain conservation easement to convert pasture and/or agricultural lands west of SPRR to managed wetland habitat.
	Impact: Creation of buffers between agriculture and wetlands will remove 75 acres from agriculture. **Mitigation:** Action A-2 will purchase or obtain conservation easement to convert pasture and/or agricultural land between SPRR and Castroville Blvd. to wetland/agricultural buffer.

Table 10-2. Analysis of Lower Watershed Preferred Alternative Plan - Winter/Spring Freshwater Conditions, Moro Cojo Slough Management and Enhancement Plan (Cont'd.)

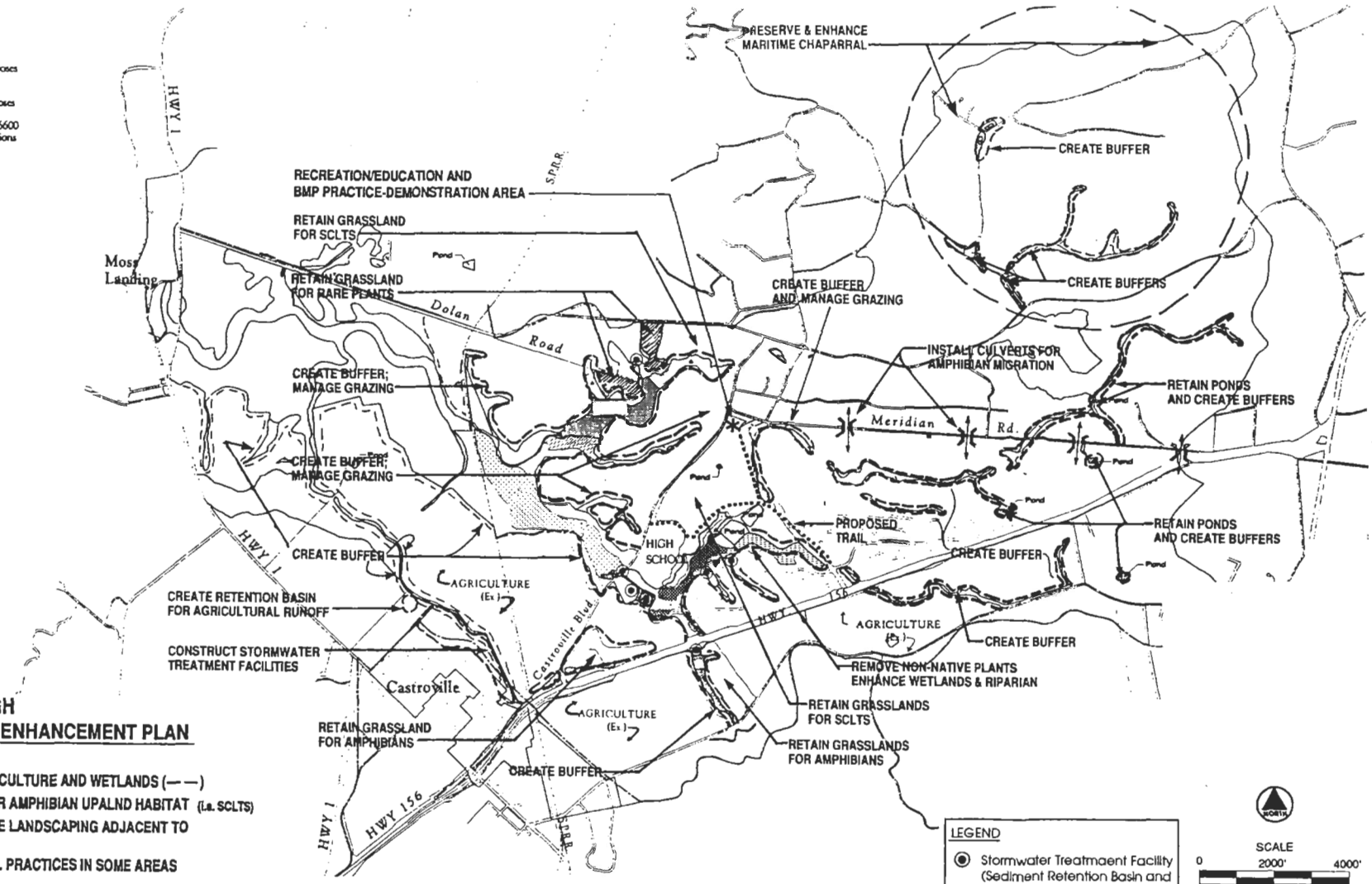
ISSUES AND CONCERNS	WINTER/SPRING FRESHWATER CONDITIONS
Agricultural Resources (Cont'd.)	**Impact:** Creation of retention basins, grassland swales and perimeter ditches in buffer between agriculture and wetlands upstream of SPRR will remove 75 acres from agriculture. **Mitigation:** Actions A-2 and A-3 will purchase or obtain conservation easement to create a wetland/agricultural buffer to minimize conflicts between agricultural land practices and habitat protection (i.e., grass-lined swale, sediment control, perimeter ditches).
	Impact: Widening of portions of Castroville Slough to restore wetlands along Castroville Slough to 1977 dimensions will remove more than 10 acres of existing agriculture. **Mitigation:** Action A-4 would encourage landowners that have filled wetlands without COE permits to re-establish wetlands along the slough.
LAND USE	
Land Ownership/ Property Rights	**Impact:** Conversion of agricultural land to wetland habitat. **Mitigation:** Action L-2. Obtain conservation easements for pasture and/or agricultural lands below the 10-foot contour west of SPRR to construct freshwater impoundments (375 acres). Some landowners may be reluctant to give conservation easement and may make action unfeasible.
	Impact: Opportunity to redesign Highway 1 with CalTrans project. **Mitigation:** None.
REGULATORY PERMITS	
Monterey County	M-1. Environmental Impact Report.
	M-2. Development permit for construction/grading.
CDFG	C-1. Streambed alteration agreement for work in channel.
U.S. Army Corps of Engineers	COE-1. Section 404 permit required for excavation of slough channels and deposition of materials onto wetlands for levee construction; probable mitigation of wetlands at minimum 1:1 acreage. COE-2. Federal environmental review FONSI/EIS.
CA Regional Water Quality Control Board	RB-1. Certification of water quality compliance.
NOAA	N-1. Permit for deposition of fill into National Marine Sanctuary and possible migration of contaminants into Elkhorn Slough, if deposition utilized.
USFWS	U-1. Section 7 consultation for potential impacts to endangered species; tidewater goby, long-toed salamander, red-legged frog, brackishwater snail, if listed.
Moss Landing Harbor District	HD-1. Permit required for activity within slough.



The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Cross-section Showing Design of Lower Watershed Preferred Plan-Winter/Spring Freshwater Conditions (D/D¹)	2/96 705-01	Figure 10-2

This conceptual plan is for discussion purposes only and is not intended for construction.

This plan is for preliminary planning purposes by the Research Advisory Committee. Please contact Steven Maki at (408) 759-6600 at the County of Monterey with any questions and comments.



MORO COJO SLOUGH MANAGEMENT AND ENHANCEMENT PLAN

Best Management Practices

- BUFFERS BETWEEN AGRICULTURE AND WETLANDS (— —)
- RETAIN GRASSLANDS FOR AMPHIBIAN UPALND HABITAT (i.e. SCLTS)
- ENCOURAGE COMPATIBLE LANDSCAPING ADJACENT TO SENSTITIVE HABITATS
- UPGRADE AGRICULTURAL PRACTICES IN SOME AREAS OF THE WATERSHED

The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Project-Wide Best Management Practices	2/96 705-01	Figure 11-1

CHAPTER 11
PROJECT-WIDE BEST MANAGEMENT PRACTICES

Best management practices (BMP's) are recommended for the entire watershed to provide resource protection and enhancement (Figure 11-1). The BMP's are consistent with guidance documents developed as part of Section 6217 of the Coastal Zone Reauthorization Amendments of 1990 (CZARA). This act requires states with Federally approved coastal zone management programs, such as California, to develop and implement Coastal Nonpoint Pollution Control Programs to ensure the protection and restoration of coastal waters. A funding request, to prepare a more comprehensive NPS Pollution program for the Natividad/Gabilan Creek watershed (which includes the Moro Cojo Slough drainage), was submitted to the EPA under Section 205(j)(2) of the Clean Water Act (AMBAG, 1994). The project was funded and the report is expected to be completed by August 1996 (AMBAG, pers. comm., 1996). A companion project, under Section 319(h) of the Clean Water Act, proposes to implement several wetland restoration projects to demonstrate their value as natural filters for reducing nonpoint source pollution and facilitating groundwater recharge (*ibid.*; this project has also been approved for funding). The State programs must include management measures in conformity with those specified in EPA's management measures. The state will have some flexibility in that they may adopt either the measures specified in the EPA's guidance or alternative measures, provided the alternative measures are as effective as EPA's measures in controlling coastal nonpoint pollution (EPA, 1993).

Another water quality program of note is the planning effort begin led by the Monterey Bay National Marine Sanctuary office. The Water Quality Protection Program (WQPP) implements a key provision of a Memorandum of Agreement adopted by eight federal, state, and local agencies in September 1992 when Congress and the President established the Sanctuary. This program, using a watershed approach to address coastal water quality, is investigating a broad range of problems including toxic pollutants in sediments, fish and shellfish, human health problems, sedimentation and low flows in rivers and streams, wetlands alteration and habitat loss. The Protection Program will develop and carry out a plan containing specific strategies and actions that address these problems while sustaining the region's economic viability. Strategies might include public education, technical assistance, research and monitoring, and regulations and enforcement, where necessary. One major component of the WQPP will be the development of a Model Urban Runoff Program. Two Model Urban Runoff Ordinances will be drafted. Another component of the WQPP will be the development of an Agricultural Runoff Management Program.

Nonpoint source pollution (NPSP) is a problem for the Moro Cojo Slough watershed, resulting in the degradation of wetland and riparian resource values. The BMP's address sediment/erosion, confined animal facilities, nutrient management, pesticide management, livestock grazing, new development, sewage systems, pollution prevention, stormwater runoff, protection and restoration of wetland and riparian areas, and public education. The BMP's also recommend actions to protect and manage rare, threatened, endangered and locally unique plant and animal species and their habitats. The California Coastal Commission has a federal grant to produce a linked GIS, Database, and Modeling methodology for applying BMPs within critical Moro Cojo Slough subwatersheds. For a fuller discussion on how to implement BMPs see California Coastal Commission, Procedural Guidance Manual: Addressing Polluted runoff in the California Coastal Zone, San Francisco, forthcoming.

The locations for each action are depicted in Figure 11-1 and described below. Plan objectives, listed in Chapter 2 (pages 2-2 and 2-3), that are achieved through implementation of each action are also identified. For additional information on these actions, please refer to the following sections of the Technical Appendix:

G: Best Management Practices for Water Resources
H: Best Management Practices for Agriculture
I: Best Management Practices for Control of Selected Invasive Non-native Plant Species
J: Plant Species Suitable for Development Activities Adjacent to Oak Trees

Landowners are encouraged to voluntarily implement these actions in order to meet the overall project goal of enhancement and resource values of the Moro Cojo Slough watershed. Each action is intended to be implemented by/with willing landowners. Funding mechanisms for implementation are discussed in Chapter 2, Implementation Program.

HYDROLOGY, WATER QUALITY, AND WASTEWATER

BMP-1. To enhance water quality of the slough, construct grass-lined swales between the slough and adjacent agricultural operations to filter runoff (see Agriculture Resources).

Implementation of this measure will primarily address objective A-4, but will also contribute to meeting project objectives B-5, B-6, W-1, W-2, W-4, A-1, A-2, A-4, P-2, and P-3.

BMP-2. To enhance water quality within the slough, construct sediment retention basins adjacent to medium to high-density development areas within the watershed. The basins will filter runoff and collect sediment.

Implementation of this measure will primarily address objective W-3, but will also contribute to meeting project objectives B-5, W-1, W-2, W-3, P-2, and P-3.

BMP-3. To enhance water quality within the slough, conduct periodic maintenance in retention basins.

Implementation of this measure will primarily address objective W-3, but will also contribute to meeting project objectives B-5, W-1, W-2, W-3, A-1, A-2, A-4, P-2, and P-3.

BMP-4. Encourage Monterey County to install and maintain stormwater treatment facilities for new and existing developments that drain into Castroville Slough.

Implementation of this measure will primarily address objective W-3, but will also contribute to meeting project objectives B-5, W-1, W-2, W-7, P-3.

BMP-5. To assess the effect of the retention basins and stormwater treatments facilities, monitor water quality within the slough on a regular, on-going basis during high and low water levels.

Implementation of this measure will primarily address objective W-7, but will also contribute to meeting project objectives B-5, W-1, W-2, W-3, and P-3.

Wastewater

BMP-6. Encourage Monterey County Department of Health to compile data on septic tank failures within the watershed to evaluate the potential threat to both surface and groundwater.

Implementation of this measure will primarily address objective W-1, but will also contribute to meeting project objectives B-5, B-6, W-1, W-2, and W-7.

BIOTIC RESOURCES

BMP-7. To enhance/preserve existing locally unique grassland plant species, implement management program for selected alkali grassland and native/mixed grassland areas (i.e., prescribed burning, mowing, grazing management, removal on invasive, non-native plant species).

Implementation of this measure will primarily address objective G-2, but will also contribute to meeting project objectives B-3, B-5, B-6, W-2, L-1, and P-2.

BMP-8. To enhance habitat values of riparian corridors, implement revegetation program for selected degraded riparian habitat areas and remove invasive, non-native plant species. Develop planting list of appropriate plant species, and planting techniques, for dissemination to affected landowners. Encourage voluntary revegetation of degraded areas. Develop list and description of invasive, non-native plants to be removed; see Appendix I for management techniques. Where necessary, fence riparian area to exclude domestic animal access. Establish buffers between riparian habitat and confined animal facilities and other developments.

Implementation of this measure will primarily address objective B-7, but will also contribute to meeting project objectives B-3, B-5, B-6, B-8, W-2, L-1, and P-2.

BMP-9. To enhance/preserve existing habitat for endangered wildlife species, implement management program for selected amphibian habitat areas (i.e., preserve pasture/grassland, agricultural ponds, grazing management, control of feral animals). Encourage landowners in area to preserve breeding/potential breeding ponds. Conduct education program with affected landowners on land use activities compatible with habitat protection.

Implementation of this measure will primarily address objective G-2, but will also contribute to meeting project objectives B-3, B-5, B-6, W-2, L-1, and P-2.

BMP-10. To enhance/preserve existing habitat for endangered wildlife species, install culverts under Meridian Road to facilitate amphibian migration (Figure 4-4).

Implementation of this measure will primarily address objective G-2, but will also contribute to meeting project objectives B-5, B-6, P-2, and P-3.

BMP-11. To enhance/preserve existing habitat for wildlife species utilizing the slough, establish program to resource agencies to control feral animals, including red fox. Consult with USFWS on measures utilized at Salinas River NWR.

Implementation of this measure will primarily address objective G-2, but will also contribute to meeting project objectives B-3, B-5, B-6, W-2, L-1, and P-2.

BMP-12. To preserve existing maritime chaparral and oak woodland habitats, encourage residents within these areas to utilize compatible plant species in residential landscaping and remove invasive, non-native plant species (Appendix J). Disseminate information to affected landowners. For new development, this practice is in effect through the County's review of landscaping plans.

Implementation of this measure will primarily address objective B-7, but will also contribute to meeting project objectives B-3, B-5, B-6, B-8, W-2, L-1, and P-2.

BMP-13. To preserve existing grasslands for rare and endangered plant and amphibian species, encourage residents within mixed grassland and selected non-native grassland habitats to maintain these areas as open space. Conduct education program with affected landowners on land use activities compatible with grasslands.

Implementation of this measure will primarily address objective B-5, but will also contribute to meeting project objectives G-2, W-2, L-1, and P-2.

AGRICULTURAL RESOURCES

BMP-14. To minimize impacts to wetland and riparian resources adjacent to the slough, manage agricultural uses (including grazing activities) through the creation of buffers and seasonal closures (i.e., winter closures for grazing below the 10-foot contour). Obtain conservation easements with willing landowners for land to at least the 10-foot contour and compensate landowners for the cost of removing existing agriculture or cattle grazing operations from selected areas. Erect fencing to separate grazing lands from wetlands; place fencing at least 3 feet back from grazing edge to accommodate grazing activity that occur through the fence (i.e., cattle put their heads through the fence to graze).

Implementation of this measure will primarily address objective B-5, but will also contribute to meeting project objectives G-2, B-6, W-1, A-1, L-1, P-2, and P-3.

BMP-15. To enhance water quality within the slough, construct sediment and wastewater retention ponds adjacent to nurseries and confined animal facilities. The ponds will filter runoff and collect sediment.

Implementation of this measure will primarily address objective W-3, but will also contribute to meeting project objectives B-5, W-1, W-2, W-3, A-1, A-2, A-4, P-2, and P-3.

BMP-16. To minimize soil erosion and transport of fertilizers and pesticides from strawberry fields and other crops, implement resource management systems which encourage on-site soil and water conservation. Examples of systems which reduce overland flow of rainfall include conservation tillage, contour farming, grassed waterways, and mulching. Examples of systems which reduce erosion and sediment transport include diversion channels, lined waterways, underground outlets, and corrugated plastic pipe furrow pickup lines. Design specifications and technical assistance for the installation of these and other systems are available from the SCS.

Implementation of these measures will primarily address objectives A-3 and A-4, but will also contribute to meeting project objectives A-1, A-2, G-1, W-1, and W-2.

BMP-17. To minimize introduction of agricultural nutrients and pesticides into slough and upstream wetlands, reduce application of agricultural chemicals through use of nutrient management plans and integrated pest management (IPM). Nutrient plans allow for reduced nutrient inputs on farms by monitoring soil conditions, assessing crop yield expectations, and considering environmental hazards of the site. Pesticide management also reduces chemical use in the watershed by improving the timing and efficiency of application in accordance with pest economic thresholds.

Implementation of these measures will primarily address objectives A-1 and A-3, but will also contribute to meeting project objectives A-2, A-4, and W-1.

BMP-18. To remove sediments and associated farm chemicals from agricultural runoff before entering the slough, construct sediment basins to settle out eroded material, or establish biological filter strips at base of cropped fields. These systems should be used in combination with systems which prevent in-field erosion and runoff (BMP-16).

Implementation of these measures will address objectives A-2, A-3, A-4, W-2, B-6, and W-3.

BMP-19. To encourage proper agricultural practices that benefit agricultural and wetland resources (i.e., contour plowing, use of sediment retention basins, buffer zones) for lands within the watershed, establish an "agriculture best management practices" awareness program. Program could be conducted through local soil conservation service office. Conduct outreach program with both landowners and growers. Implement BMP "practice demonstration projects" at one or more locations with willing landowners.

Implementation of this measure will primarily address objective A-3, but will also contribute to meeting project objectives G-2, B-5, B-6, W-1, W-3, W-4, W-5, A-1, A-2, A-4, L-1, P-2, and P-3.

BMP-20. To increase wetland resource values and minimize impacts to sensitive biotic resources, convert marginal agricultural lands to managed wetland habitat. Obtain conservation easements or purchase marginal agricultural lands from willing landowners, providing compensation for removal of agriculture. Implement wetland restoration and management actions.

Implementation of this measure addresses objective B-5, G-2, B-6, W-1, A-1, L-1, P-2, and P-3.

LAND USE

BMP-21. To reflect the existence of high/moderate density residential development near Dolan Road, amend the North County LUP to depict this development.

Implementation of this measure does not address a specific plan objective.

BMP-22. To preserve existing grasslands for rare and endangered plant and amphibian species (upland refugia), evaluate revision to North County Land Use Plan to retain existing pasture land along Castroville Boulevard (northeast of high school and south of Monte Del Lago Mobilehome Community).

Implementation of this measure will primarily address objective G-2, but will also contribute to meeting project objectives B-3, B-5, B-6, W-2, L-1, and P-2.

BMP-23. To oversee restoration and management actions in the watershed, establish a private non-profit organization. Conduct community outreach programs (residents and growers) and seek grants, funding, and private donations to implement management plan actions. Encourage the development of watershed-wide and/or neighborhood public education/watershed stewardship program. Develop BMP practice demonstration area at the Castroville Boulevard/Highway 156/Meridian Road triangle.

Implementation of this measure will primarily address objective P-2, but will also contribute to meeting project objectives G-2, B-3, B-5, B-6, B-7, B-8, W-1, W-2, W-3, W-4, W-5, W-6, W-7, A-1, A-2, A-3, A-4, L-1, P-1, and P-3.

PUBLIC ACCESS AND EDUCATION

BMP-24. To provide passive recreational needs, encourage implementation of trails within the watershed as adopted in the North County Trails Plan.

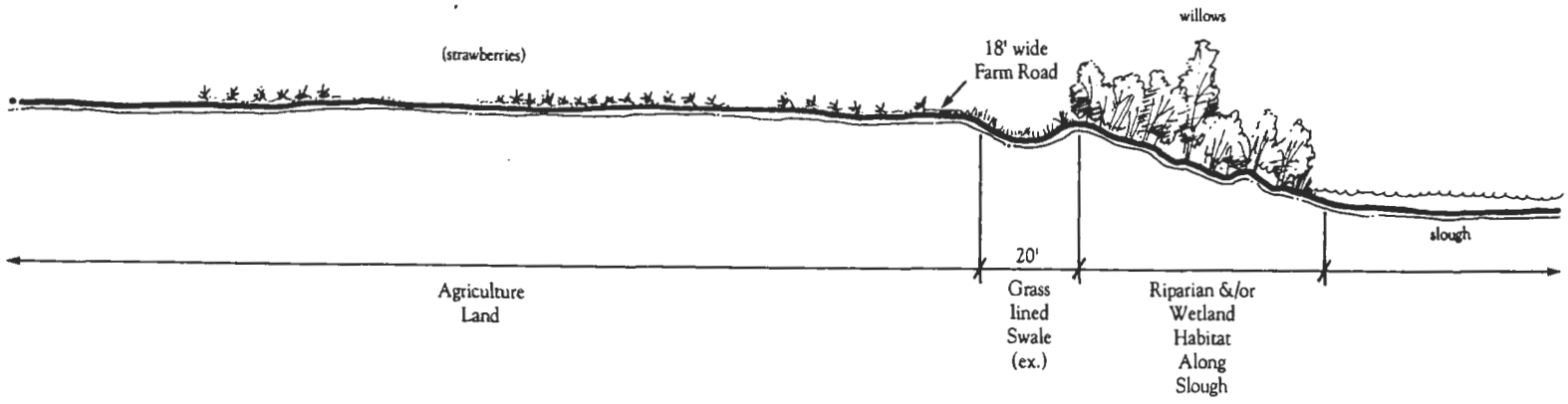
Implementation of this measure will primarily address objective P-1, but will also contribute to meeting project objectives P-2, and P-3.

BMP-25. To provide passive recreational and alternative transportation link, create a pedestrian trail linkage between the high school and Oak Hills residential development, perhaps utilizing land adjacent to the WaterTek Treatment Facility.

Implementation of this measure will primarily address objective P-1, but will also contribute to meeting project objectives P-2, and P-3.

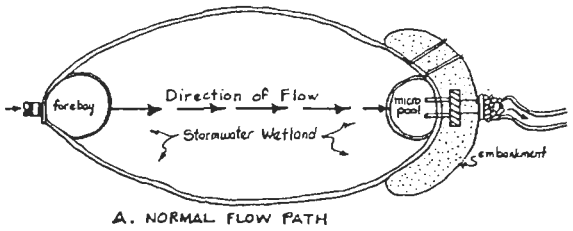
BMP-26. To provide an interpretation on the natural and agricultural resources within the watershed and concurrent with implementation of trails, as proposed in the North County Trails Plan and BMP-23, above, install interpretive signs describing natural resources and management of the Moro Cojo Slough watershed. Develop a recreation and education area at the Castroville Boulevard/Highway 156/Meridian Road triangle area.

Implementation of this measure will primarily address objective P-1, but will also contribute to meeting project objectives P-2, and P-3.

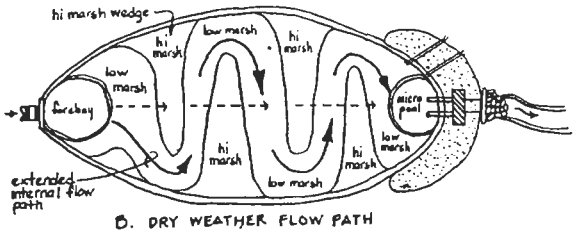


The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Cross-section Showing Project-wide Best Management Practices: Agricultural Buffer Area and Grass-lined Swale	2/96 705-01	Figure 11-2

Stormwater Wetland in Upper Watershed:

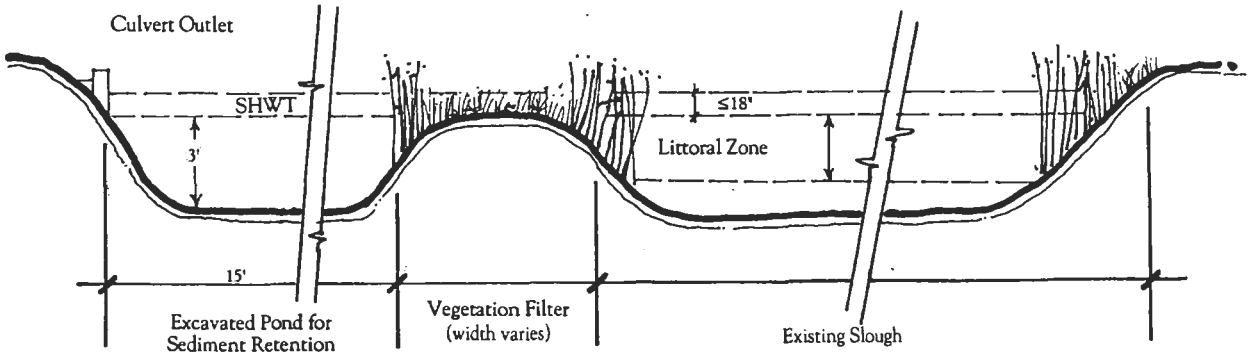


A. NORMAL FLOW PATH

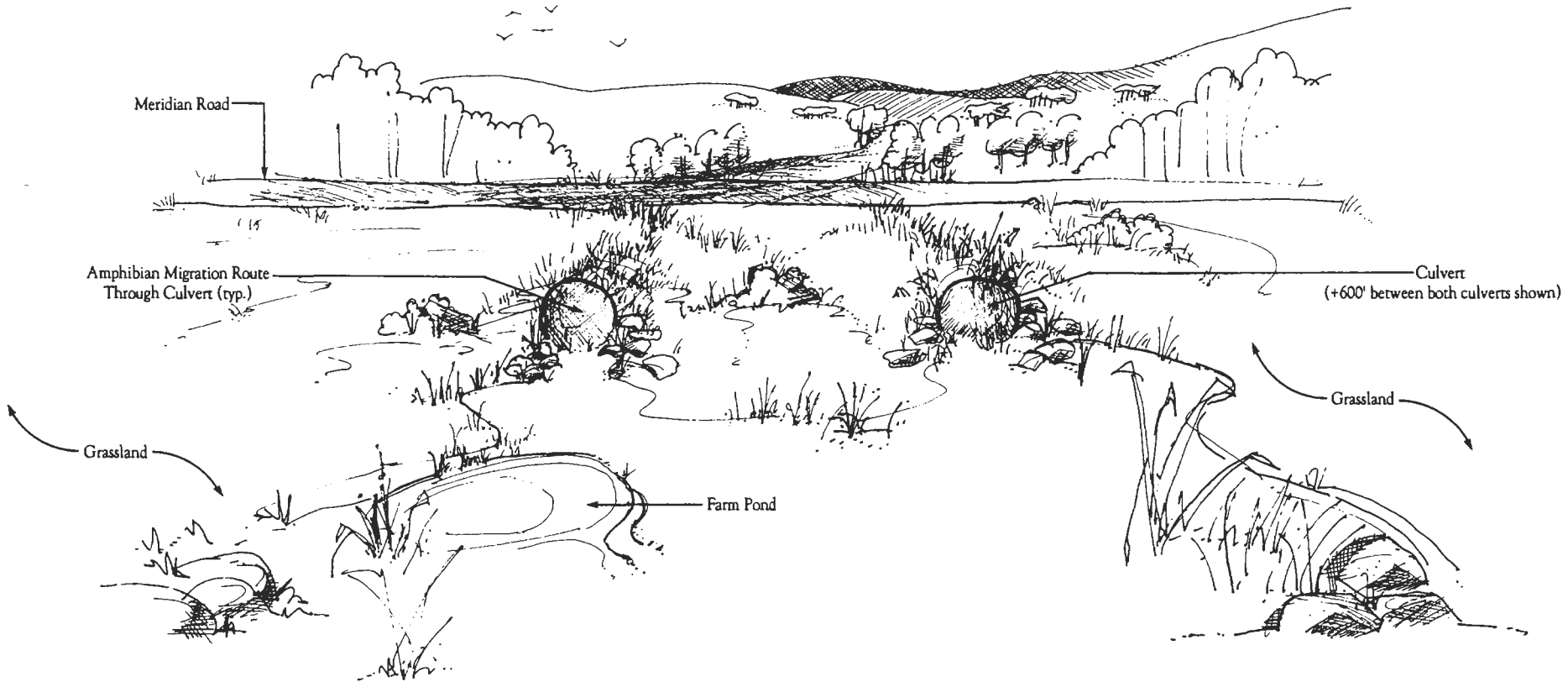


B. DRY WEATHER FLOW PATH

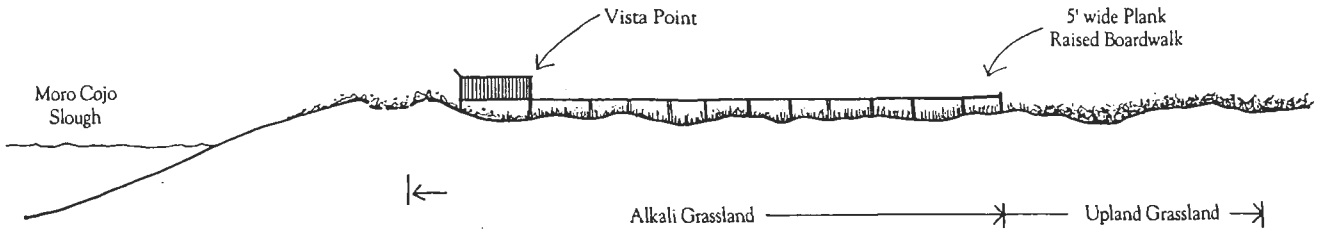
Sediment Retention Basin Adjacent to Slough



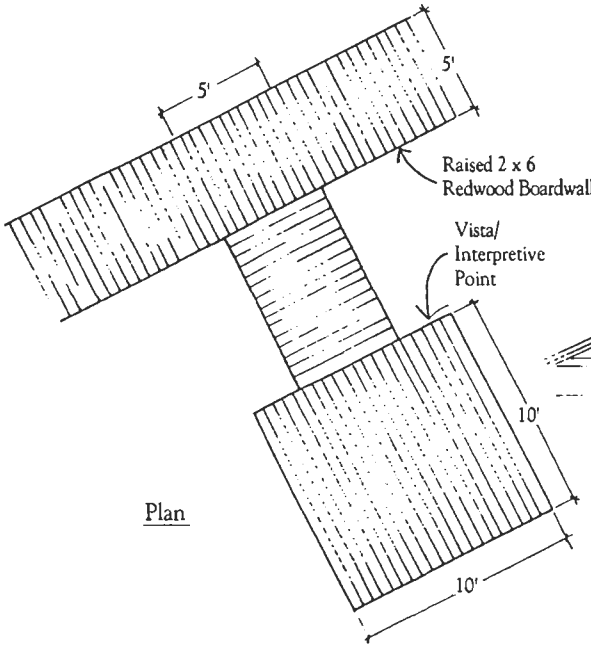
The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Schematic Design of Project-wide Best Management Practices: Sediment Retention Basin	2/96 705-01	Figure 11-3



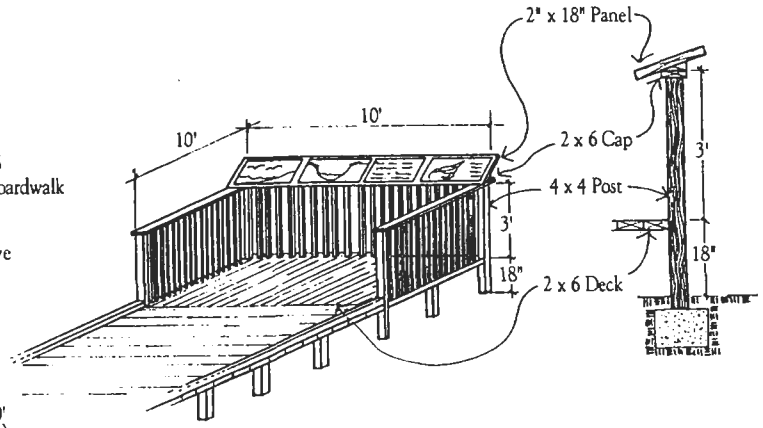
The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Schematic Design of Project-wide Best Management Practices: Culvert Crossings for Amphibian Migration	2/96 705-01	Figure 11-4



Raised Boardwalk Section



Plan



NOTE: All dimensions shown are subject to verification by a structural engineer and are shown for schematic purposes only.

The Habitat Restoration Group • Mitchell Swanson & Associates • VB Agricultural Services • Applied Marine Sciences	Moro Cojo Slough Management and Enhancement Plan Schematic Design of Project-wide Best Management Practices: Raised Boardwalk within Wetland Areas and Interpretive Signs	2/96 705-01	Figure 11-5

CHAPTER 12
REFERENCES AND LITERATURE CITED

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