Petaluma Watershed Enhancement Plan

An owner's manual for
the residents and landowners of
the Petaluma Watershed

Prepared by:
The Southern Sonoma County
Resource Conservation District
in conjunction with the people
of the Petaluma Watershed

Funding provided by:
The State Water
Resources Control Board

July 1999

Petaluma Watershed Enhancement Plan

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Acknowledgements

The Petaluma Watershed Enhancement Plan is a collaborative effort of many individuals and organizations. The Plan is completed thanks to the valuable input from the Landowner Advisory Committee and concerned residents of the Petaluma Watershed. The USDA Natural Resources Conservation Service and the Southern Sonoma County Resource Conservation District provided project support and technical assistance throughout the planning process. Prunuske Chatham, Inc. was instrumental in providing consultation services, scientific studies and meeting facilitation, which effectively identified community concerns during the project.

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1.0 Executive Summary

The Petaluma Watershed Enhancement Plan was prepared through grant funding from the California Regional Water Quality Control Board (RWQCB). The Regional Board is currently focusing efforts on initiating watershed management planning for several counties, including Sonoma County. It is the RWQCB's belief that watershed planning and protection efforts will not be effective unless solutions are defined and implemented locally.

In compliance with the intent and purpose of the grant funding, the Southern Sonoma County Resource Conservation District (SSCRCD) issues this Watershed Enhancement Plan (Plan) in partnership with the many dedicated individuals from the AC established in 1997. During the Plan's two year planning process, the Advisory Committee determined the purpose, scope, and intent of the Enhancement Plan. The primary focus of the Enhancement Plan is the issues of concern of the agriculturists and landowners located outside of the Petaluma urban area.

The Advisory Committee met regularly to discuss their common issues and concerns and from these they identified goals for improving the watershed. One of the major issues for the landowners was the fact that the Petaluma River is not actually a river but is in fact a tidal slough or "tidewater estuary". This particular issue played an important part in the Committee's goal setting. See the History section 3.5 for more details. This particular issue played an important part in the Committee's establishment of future goals.

The majority of the landowners involved in this planning process are ranchers and farmers who care about the health of the watershed. They are interested in participating and contributing to the process of enhancing the watershed and sustaining agriculture in Sonoma County. The local landowners also realize that the criteria for water quality standards set for a river could be significantly more stringent than for a slough and could be unattainable. The main concern this created for landowners is the question of how to set water quality standards. With this in mind, the Advisory Committee realized that it would be prudent to remain involved in setting criteria for water quality standards within the watershed. Therefore, many of their goals reflect this interest.

At first, ten goals were identified and then through a process of strategizing and clarification, the Advisory Committee further refined and shortened the number of goals to four. These four goals and their accompanying objectives and recommended actions are described in detail with a time line for implementation in

Chapter 4.0. The four goals are listed as follows:

Goal A: *Establish a Local Watershed Council for Residents and Other Organizations to Fund and Coordinate Watershed Enhancement Activities and Keep One Another Informed.*

Goal B: *Improve Water Quality and Ground Water Recharge in the Petaluma Watershed with the Ultimate Purpose of Removing the Petaluma River from the RWQCB Impaired Waterbody List 303d*

Goal C: *Support the Viability of Agriculture in the Community*

Goal D: *Conserve and Enhance Existing Wildlife Habitat*

A fundamental assumption in attaining any of the goals in the Plan and/or following through with any of the recommended actions for enhancement in the watershed is the establishment of a Watershed Council. In turn, the success of the "Watershed Council" is directly related to the commitment and strength of the community and continuation of the existing Advisory Committee as it begins to evolve into a "Watershed Council." It is envisioned that the founding members of the Watershed Council would primarily consist of agriculturists and landowners from outside the urban community. Over time and with continued success, stakeholders from throughout the watershed would be invited to participate and work cooperatively on mutual goals.

Prunuske Chatham, Inc., an environmental consulting firm, specializing in ecological restoration and design, was hired to prepare supporting documentation on key technical subject areas such as erosion and sedimentation, land use, riparian enhancement, and marsh/bay habitats. These studies were originally entitled "summaries" and they are provided herein in their entirety and found as individual appendices of this document. Important information and analyses from these studies have been incorporated where appropriate, into the body of the Plan document.

2.0 Introduction

2.1 Purpose

The purpose of this document is two-fold: 1) to identify the existing conditions and issues from the perspective of the landowners and residents in the watershed, and 2) to state a set of goals, objectives and recommended actions that were collaboratively developed addressing specific issues and concerns. It is hoped that this Enhancement Plan for the Petaluma Watershed will serve as a guide for addressing the need for more information and outreach among stakeholders in the watershed and in identifying a focus of effort for a "Watershed Council" and it's recommended future actions.

The health of this watershed is affected by the many land use components making up our community. All activities within and beyond the City limits contribute to our watershed. This plan focuses primarily on the issues of concern related to the agricultural community of this watershed and lands beyond the Petaluma City limits. It is recognized, however, that urban land uses contribute significantly to water quality impacts such as erosion and sedimentation and the need for increased water supply and flood protection.

Representatives of the community and other entities came together to establish a collection of concerns for this watershed. In addition to issue identification, this group also established a number of actions and objectives to achieve major goals for the Petaluma Watershed. This plan was constructed primarily from the volunteer time and effort of the members of the AC. The issues and goals identified in this plan show the dedication and concern that members of the agricultural community have for the Petaluma Watershed.

2.2 Funding Source and Grant Objective

The funds to prepare the Petaluma Watershed Enhancement Plan were awarded to the Southern Sonoma County Resource Conservation District (SSCRCD) through a 205(j) grant from the California Regional Water Quality Control Board (RWQCB). The RWQCB's overall mission is to protect surface and ground waters of the San Francisco Bay Region. The RWCQB carries out this mission in many ways including regulation, enforcement, and pollution prevention. For example, RWQCB has administered a permit program for nearly two decades to control municipal sewage and industrial wastewater discharges. At the same time, urban and agricultural runoff discharges have continued mostly unchecked, and may contribute to the pollutant loading of rivers, streams, bays, lakes, and lagoons in the San Francisco Bay area. The RWQCB will be focusing much of their effort over the next few years on controlling pollution from these latter sources. The emphasis will be on preventing pollution before it occurs by managing resources more carefully, as opposed to cleaning up pollution "after the fact."

To help accomplish this, the RWQCB is focusing efforts on initiating watershed management planning for several counties, including Sonoma and Napa. In 1997, the SSCRCD prepared a similar Enhancement Plan for the Sonoma Creek Watershed. The RWQCB firmly believes that watershed planning and protection efforts will not be effective unless solutions are defined and implemented locally. An effective watershed management plan requires formulating water quality goals and objectives for watershed protection and enhancement, and committing to specific tasks that will eventually allow the objectives, and ultimately the goals, to be met. Broad, local consensus on what preventative and remedial actions are needed and how they should be applied, are crucial to success of this Plan.

2.3 Stakeholders in Watershed Planning

This plan serves as a vehicle and voice for the local watershed residents and landowners. In general planning terms, the "stakeholder" is an individual or group entity such as a resident/landowner/agency/or other group who has a business, or other interest, responsibility, or jurisdiction regarding the health and well being of the watershed. Each stakeholder comes to the table and typically works on a level playing field with others. In a local work group setting, such as a "Watershed Council", the stakeholders would come together to share information and to work cooperatively on common tasks where they are united by a shared vision of watershed planning goals.

2.4 How to Use the Enhancement Plan

The Petaluma Watershed Enhancement Plan is a working document and represents the consensus of over two year's work. The Plan has been written as a guide for future watershed enhancement efforts in the Petaluma watershed. The Plan is broken into sections beginning with a summary, introduction, description of the watershed, the plan goals and objectives, and numerous technical appendices.

The Petaluma Watershed Enhancement Plan is designed for readers to reference in several ways. Some readers may have limited time and want only to absorb the main points, while others will be able to read every appendix. The list below identifies the most essential portions of the Plan, which should not be missed. In order to get the most out of your time spent with the Plan you should use the list below in conjunction with the Table of Contents to read the sections most appropriately fitting your time and needs. Many acronyms are used throughout the document and they are defined on Table 1.

For those readers who have limited time:

- Read Section 1.0, Executive Summary
- Read Section 2.1, Purpose
- Read Section 4.3, Enhancement Plan Goals, Objectives and Recommended Actions
- Review Table 4, Enhancement Goals - Potential Source of Funding and Technical Support
- Review Section 4.4, Summary of Appendices

Table 1

List of Acronyms

AC	Advisory Committee
ACOE	United States Army Corps of Engineers (Corps)
ACP	Agricultural Conservation Program
AWC	Sonoma Marin Animal Waste Committee
CDF	California Department of Forestry
CDFG	California Department of Fish and Game
CIWMB	California Integrated Waste Management Board
EQIP	Environmental Quality Incentives Program
FSA	Farm Service Agency (USDA)
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmosphere Administration
NRCS	Natural Resources Conservation Service (USDA)
PCI	Prunuske Chatham, Inc.
RCD	Resource Conservation District
RWQCB	Regional Water Quality Control Board
SCWA	Sonoma County Water Agency
SSCRCD	Southern Sonoma County Resource Conservation District
TMDL	Total Maximum Daily Load
UCCE	University of California Co-operative Extension
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
WC	Watershed Council

2.5 Public Involvement

The Petaluma Watershed Enhancement Plan would not exist without public participation and it is the public's interest and active participation that will continue to be at the heart of the Plan's effective implementation. Public meetings were held throughout a two-year planning process (1997-1999). An Advisory Committee (AC) met periodically to discuss technical reports as well as establish the goals for the Watershed Enhancement Plan. A newsletter was published quarterly by the RCD to update residents of the Plan's progress as well as inform them of ongoing conservation efforts and workshops within the watershed.

The purpose of the first public meeting was to provide an overview of watershed issues, stimulate as well as discover landowner interests, and create a dynamic watershed group. This first public meeting formed the AC, consisting of landowners, residents, ranchers, farmers and community groups. From October 2, 1997 to February 10, 1999 the AC held 8 meetings at the Lucchesi Park Community Center to discuss technical studies, plan components, and goals. The group also attended two tours throughout the watershed and spent innumerable hours of their own time reviewing technical reports and scrutinizing proposed goals for the enhancement plan.

Five extended landowner outreach meetings were held by the RCD. These area meetings were established in order to discuss the enhancement plan, planning process and concerns of the landowners in these specific areas. These meetings were held in the Lakeville region, Denman Flat (Penngrove) region and two additional meetings took place in the San Antonio Creek subwatersheds.

The watershed tours were another form of outreach created to educate community members within the watershed and promote thought towards the Plan's development. The tours were part of an effort to identify ways of improving water quality through improved land management practices. Tour sites included a bayland farm, a dairy, a sheep ranch, and an olive orchard. Landowners demonstrated how they utilize best management practices to maintain and improve soil and water resources to comply with ever-increasing regulations.

The goals and recommendations of the Petaluma Watershed Enhancement Plan come directly from the AC and represent concerns voiced by residents throughout the watershed. During the process of identifying the goals and recommendations, three major themes emerged. The most important theme is that the local residents and community groups take the lead in watershed enhancement projects. Also vital to the Plan is that the community and all enhancement work support viable agriculture in the watershed. Another critical aspect of the Plan is to reduce erosion, improve water quality and enhance wildlife habitat. All of the goals and recommendations have these three main ideas interlaced into their "fabric".

All of the people listed in Table 2 attended either all or some of AC meetings that guided the creation of the Petaluma Watershed Enhancement Plan. Each person in the AC participated voluntarily in this process.

Table 2

Advisory Committee

Landowners & Residents:

Gloria Altenreuther	George Gambonini	Jeff Peters
Tom Altenreuther	Ray Gwendorf	Ray Peterson
Thomas Bachman	Michael Hart	Jim Riebli
Tom Baginski	Todd Horick	Herb Roche
Stan Brayton	Craig Jacobsen	William Roop
Vasco Brazil	Margaret Kullberg	Suzie Schlesinger
Rita Cardoza	Mimi Luebbermann	Joanne Scott
Elaine Carle	Iris Matson	Tom Scott
Pat Cheda	Jim Mendoza	Don Silacci
Jerry Corda	Lucy Mendoza	Liz Tabor
Hank Corda	Nita Miller	Tim Tamalantes
Cynthia Crane	Don Moreda	Dominga Tunzi
Katherine Flynn	Mike Morelli	Susan Tunzi
Frank Gambonini	Bruce Osterlye	Cheryl Witte

Contributors:

Agencies and Consultants

Jennifer Barrett - City of Petaluma
David Keller- City of Petaluma
Martha Neuman -
Prunuske Chatham, Inc.
Bill Hurley - RWQCB
Bill Cox - CDFG
Fred Botti- CDFG
Paul Jones - USEPA
Rick Wantuck- NMFS
Paul Olin- UCCE
Richard King- NRCS

Southern Sonoma County
Resource Conservation District

Board of Directors;
Tish Ward, President,
Paul Martin, Mitch Mulas,
Maxine Durney, James Ryan
RCD staff;
Leandra Swent, District Manager,
Paul Sheffer, Susan Haydon,
David Luther, Jennifer Allen,
Christine Molina

Others

Nancy Scolari, Executive Director,
Marin RCD
Robert Rand (former SSCRCD staff)

3.0 Description of the Watershed

3.1 Location

Located in southern Sonoma County, California, and a portion of northeastern Marin County, California, the Petaluma River Watershed encompasses a 146 square mile, pear-shaped basin (see the Vicinity Map, Figure 1). The watershed is approximately 19 miles long and 13 miles wide with the City of Petaluma near its center.

3.2 Description

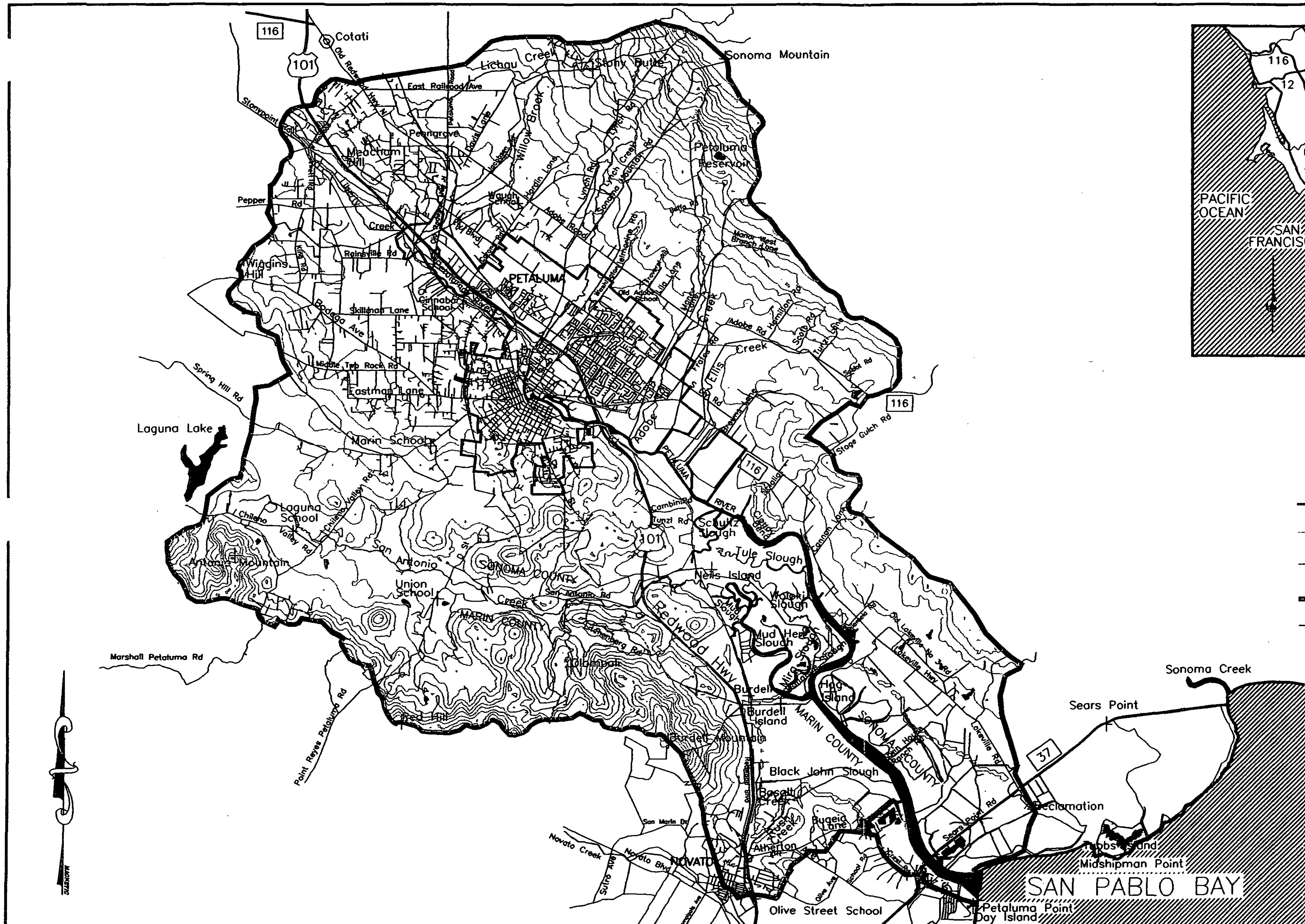
The headwaters and ephemeral tributaries of Petaluma River begin on the steep southwest slopes of Sonoma Mountain, the southern slopes of Mecham Hill, and the eastern slopes of Weigand's Hill and Mt. Burdell. The confluence of Willow Brook, Liberty Creek, and Weigand's Creek form the headwaters of the Petaluma Watershed just upstream of Rainsville Road and Stony Point Road. The Petaluma River itself flows across the Denman Flat area and through the City of Petaluma. Tidal influence extends upstream of the confluence with Lynch Creek (beyond the railroad crossing). See Figure 1, depicting the Petaluma Watershed.

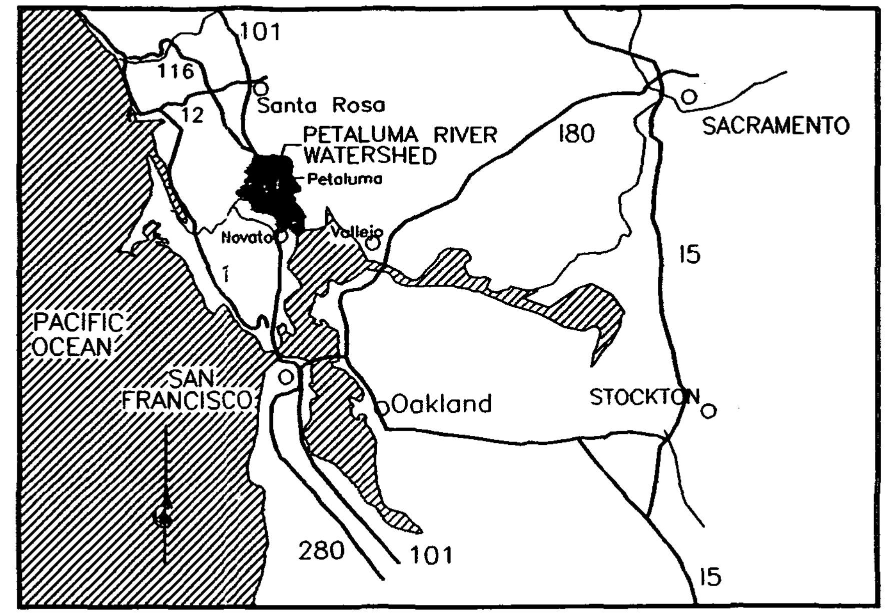
Mountainous or hilly upland areas comprise 56% of the watershed. Thirty-three percent of the watershed is valley, and the lower 11% are salt marshes. Sonoma Mountain at 2,295 feet is the highest point in the watershed. The Petaluma River empties into the northwest portion of San Pablo Bay.

The lower 12 miles of the Petaluma River flow through the Petaluma Marsh, the largest remaining salt marsh in San Pablo Bay. The marsh covers 5,000 acres and is surrounded by approximately 7,000 acres of reclaimed wetlands. Prior to reclamation, marshland elevations ranged from mean sea level to 3 feet above mean sea level.

Major tributaries in the eastern portion of the watershed include Lichau Creek, which flows into Willow Brook and feeds into Denman Flat area near Stony Point Road and Rainsville Road, Lynch Creek, Adobe Creek, and Ellis Creek. These tributaries flow through both unincorporated land and land within the City of Petaluma limits before joining the Petaluma River.

Three major creeks are located on the western side of the watershed. Weigand's Creek and Marin Creek flow into Liberty Creek, which also feeds into Denman Flat. The largest sub-watershed is San Antonio Creek located in the western portion of the watershed south of Petaluma. San Antonio Creek flows from near Laguna Lake in Chileno Valley to the Petaluma Marsh and divides Marin and Sonoma Counties. In the lower watershed, small tributaries drain into the river and marsh areas.





VICINITY MAP

LEGEND

CITY BOUNDARY

CONTOUR LINE @ 100' INTERVALS

HYDROGRAPHIC FEATURE

WATERSHED BOUNDARY

SUBWATERSHED BOUNDARY

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: November, 1997 SCALE: 1" = 5,000' CHECKED BY: MN DRAFTED BY: EA	REVISIONS / BY	PREPARED FOR: SOUTHERN SONOMA COUNTY RESOURCE CONSERVATION DISTRICT	PETALUMA RIVER WATERSHED	SHEET 1 OF 1

for family farms to compete with the new industry of poultrymen. From 1890 to 1960 chickens and eggs remained the primary source of income for the Petaluma vicinity.

In 1931 the Corps, again, widened the River to 100 feet wide and deepened it to eight feet at low tide. In 1959 the tidewater estuary of the Petaluma River was declared a river by an Act of Congress. Within a year, much of the poultry industry moved to southern California. By 1961 the major cargo moved via the Petaluma River was fuel.

After the chicken industry declined, dairies began to flourish with 46,000 cows and the largest cooperative creamery in the U.S. In 1972 the City Council of Petaluma passed a controversial ordinance limiting growth to 500 housing units per year. (Heig, 1982)

By 1997 there were only 15 dairies in the Petaluma watershed. These dairies are mostly in the San Antonio Creek and Adobe Creek regions.

Although vineyards were established in the Lakeville area before the prohibition era of the 1920's, the area was historically considered too cool for wine grapes. Recently, however, vineyard development has increased in the watershed, particularly in the Lakeville area. Vineyards are now competing with the dairy industry throughout the watershed and will impact the resources of the area. Urban development is concentrated within the city limits of Petaluma. Limited commercial and rural residential development is located in the community of Penngrove.

Figures 2 and 3 depict a historical view (Figure 2) and present-day view (Figure 3) of the watershed and provide a good comparison of the geography and land development between the days of a "creek" and those of a "river".

3.3 Climate

The climate of the Petaluma River basin is generally characterized as a marine west-coast type climate with cool, wet winters and warm, dry summers with some fog and wind. Localized climatic conditions are strongly affected by the topography, and it is not unusual to have wide variations in climate at locations separated by only a few miles.

Annual temperature means range from roughly 70.6° F maximum and 44.7° F minimum resulting in an average annual temperature of 57.7° F. Extreme recorded temperatures are 17° F and 109° F. Average annual rainfall over the basin ranges from about 20 inches at the mouth of the Petaluma River to about 50 inches at the highest elevations in the drainage basin. Rainfall and its resultant runoff, is the most significant factor in the planning and design of flood control drainage facilities and, in considering erosion and sedimentation control devices.

3.4 Geology

The Petaluma River Basin lies within the southern portion of the northern Coast Ranges of California. Basement rock is the Jurassic - Cretaceous Franciscan assemblage, overlain by thick, discontinuous sequences of Tertiary and Quaternary deposits. Prior to the general rise in sea level that occurred in recent geological time, Petaluma Valley was filled with older alluvium consisting of gravels, sands, and clays that were deposited by aggradation along the stream course traversing the area and by sheet wash and other colluvial processes in interstream areas. Well logs indicate these deposits are fairly thin in the upper Petaluma Valley but thicken to over 300 feet near the bay. The rise in sea level and the subsequent encroachment of the waters of San Pablo Bay resulted in the filling of the lower portion of the valley, extending inland as far as the City of Petaluma, with younger alluvium and soft marine silts and clays which are known as Bay Mud.

Folding and faulting which occurred in the basin during the late Pliocene and Quaternary periods produced the main structural and topographic features of the area. These processes have continued into recent time. Information on the geological units in the Petaluma Valley and their characteristics is contained in the State Department of Water Resources' Evaluation of Ground Water Resources in Petaluma Valley (Volume 3, Bulletin 118-4) published in June 1982.

The Rodgers Creek fault zone, which has been linked by some to the active Hayward fault, runs along the easterly ridge of the watershed. The Tolay fault extends along the valley easterly of the City of Petaluma, while the Bloomfield fault is located on the westerly side.

3.5 History

The following history of the Petaluma Creek is mainly taken from the *History of Petaluma, A California River Town* written in 1982 by Adair Heig. Because of its proximity to San Francisco, Petaluma Creek has had a colorful history and has gone through many changes both physically and legislatively. Because the creek was narrow and shallow, much work was done to dredge it, widen it and straighten it. By the 1860's

Chinese laborers began the work of straightening the more difficult segments of the creek. Work on the creek has continued ever since with more projects yet to be built. In the 1850's the Petaluma Creek was declared a navigable stream and a century later (1959) it was declared a "river" by an Act of Congress.

One version of the origin of the word Petaluma, from *pe'ta*, flat, and *luma*, back, was derived from the Miwok people who lived in Sonoma County for more than 2500 years. Petaluma was the name of a village on a low hill east of Petaluma creek and north east of the present day town of Petaluma (Figure 2). The Miwok were "hunters and gatherers" and thought to be especially adept at exploitation of the wetland resources. (Archeological Resource Service, 1997)

The first recorded exploration of the Petaluma River was by a Spaniard in 1776. While other members of his expedition prepared adobe and timber for new missions in the area, Fernando Quiros was accompanied by a number of sailors when entering the Petaluma Slough. They believed they might be able to sail from San Pablo Bay to Bodega Bay, but were unsuccessful.

Gold was discovered in California at the beginning of 1848. San Francisco Bay and its surrounding rivers and tributaries became the major source of transportation of goods. Petaluma Creek, even though it was narrow, shallow and difficult to navigate, became a vital way of transporting goods from the towns of the North Bay to San Francisco. Commercial use of the Petaluma Creek began in 1851 when a warehouse was built near the present Washington Street Bridge.

The town of Petaluma became one of the wealthiest towns in California. By 1852, schooners were a common sight on the creek as people began to find that it was cheaper to transport goods along the calm creek rather than go overland or sail from a coastal town.

By 1855, farming and other businesses along the creek's banks had contributed so much debris and mud that it became impossible for larger boats to go all the way to Petaluma. In 1859 laborers spent two months dredging the creek to remove the debris and mud. In spite of constant problems, the creek continued to be a steady source of revenue for the residents of Petaluma.

In 1879 Lyman Byce invented the Petaluma Incubator, greatly increasing the number of chickens and eggs hatched and bringing a new level of industry to Petaluma.

The Corps widened the creek in 1880 to fifty feet wide and deepened it to three feet at high tide. By 1915 the area was shipping out an estimated ten million eggs a year, most of them via the Petaluma Creek.

In 1918 Petaluma was declared the *Egg Basket of the World* and the world's richest city of its size. Spanning the next few decades the Petaluma poultry industry achieved world acclaim. The Petaluma Creek was used extensively for transporting chickens and eggs as well as many other products. Advancing technology made it more and more difficult

PETALUMA RIVER WATERSHED MASTER DRAINAGE PLAN

AREAS OF FLOODING - 100-YR FREQUENCY

PREPARED BY: SONOMA COUNTY WATER AGENCY

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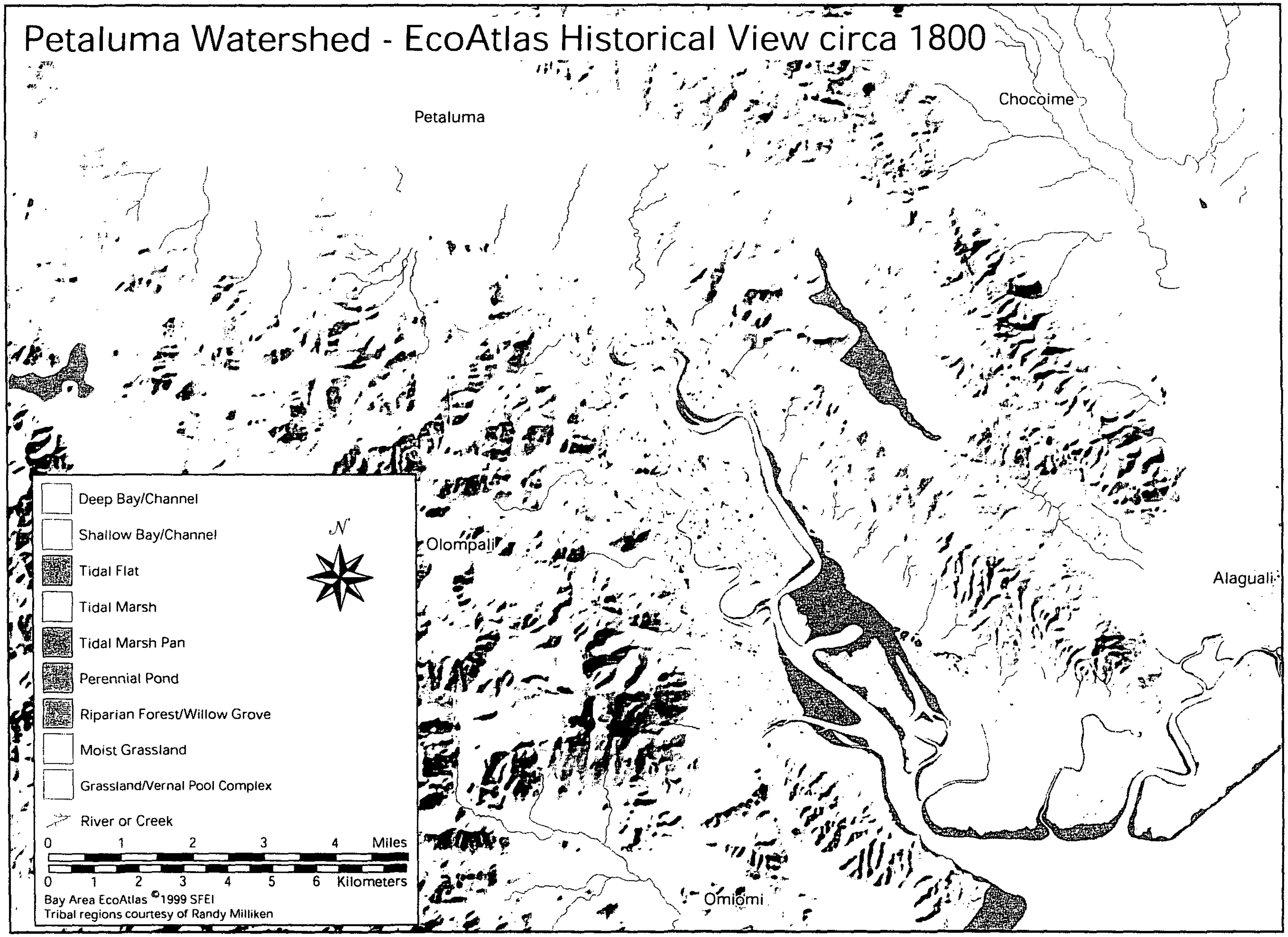
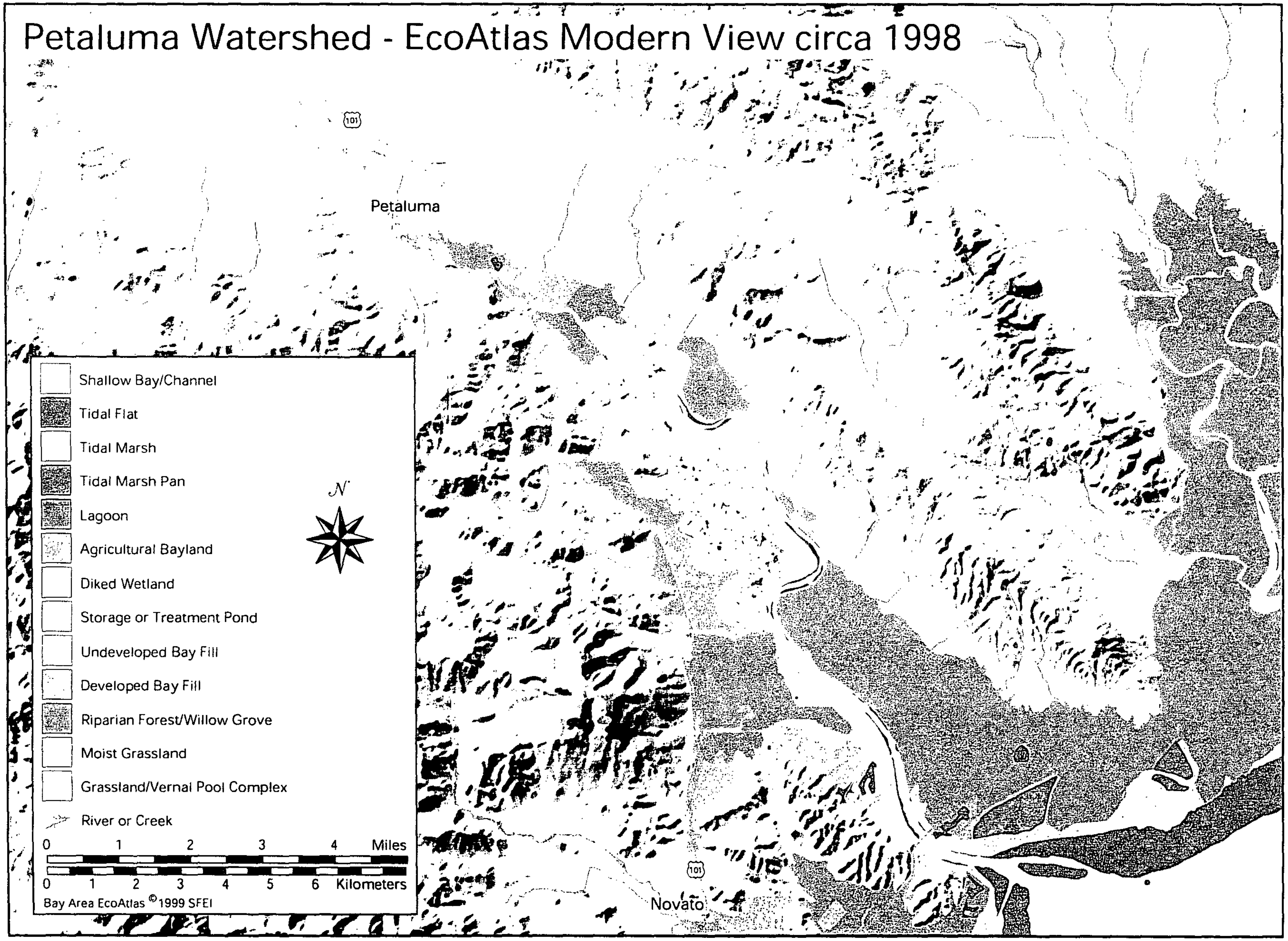
2B


Petaluma Watershed - EcoAtlas Historical View circa 1800
Petaluma
Chocoime
Olompali
Alaguali
Omiomi
Deep Bay/Channel
Shallow Bay/Channel
Tidal Flat
Tidal Marsh
Tidal Marsh Pan
Perennial Pond
Riparian Forest/Willow Grove
Moist Grassland
Grassland/Vernal Pool Complex
River or Creek
0 1 2 3 4 Miles
0 1 2 3 4 5 6 Kilometers
Bay Area EcoAtlas ©1999 SFEI
Tribal regions courtesy of Randy Milliken



Petaluma Watershed - EcoAtlas Modern View circa 1998
101
Petaluma
Shallow Bay/Channel
Tidal Flat
Tidal Marsh
Tidal Marsh Pan
Lagoon
Agricultural Bayland
Diked Wetland
Storage or Treatment Pond
Undeveloped Bay Fill
Developed Bay Fill
Riparian Forest/Willow Grove
Moist Grassland
Grassland/Vernal Pool Complex
River or Creek
N
0 1 2 3 4 Miles
0 1 2 3 4 5 6 Kilometers
Bay Area EcoAtlas ©1999 SFEI
101
Novato

3.6 Land Use

One component of the planning process was to develop an inventory of land uses in the Petaluma watershed. The purpose of preparing this land use appendix (Appendix A) was to assist SSCRCD's watershed advisory group in developing land use goals and recommendations for the watershed plan. This report summarizes available land use and watershed enhancement information from the City of Petaluma, Sonoma County, and other sources. It includes an overview of the historic relationship between the city and county regarding land use planning, as well as an identification of land use concerns related to: 1) agricultural sustainability, 2) natural resources, and 3) rural community quality of life.

Land uses in the watershed include intensive urban development, rural residential, agriculture, and open space. The urban development is concentrated within the city limits of Petaluma. Limited commercial and rural residential development is located in the community of Penngrove. This plan focuses primarily on non-urbanized land uses. Rural residential and open space land uses are described below, and agricultural land use is referred to in section 3.11 below.

Rural residential. Ranchettes or large lot, rural residential developments are found throughout the watershed. These rural properties typically range from one to 20 acres and are not usually part of development tracts. Many rural residents keep livestock such as sheep and horses. In Sonoma County, there are approximately 15,000 horses and each of these horses on average produces 50 pounds of waste per day, (*Agricultural Waste Management Field Handbook*, 1992). On the eastern side of the watershed, rural residential areas surround Penngrove and extend into the Lichau Creek and Lynch Creek areas. On the western side of the watershed, the rural residential areas outside Petaluma (Liberty Road, Rainsville Road, Skillman Lane, Middle Two Rock Road, and Eastman Lane) are expanding.

If not carefully managed, horse waste and sediment from horse facilities could enter waterways or infiltrate groundwater to create conditions detrimental to drinking water supplies, recreational activities and the environment. Though impacts from horses only compose a small fraction of total pollutants entering local waterways, horse owners and facility managers can take steps to lessen these impacts. Through responsible facility design, site planning, and waste management, stormwater runoff management, pasture and paddock care and protection of water bodies, the impacts can be minimized.

Open space. Open space land includes local and state parks, as well as preserves. The California Department of Fish and Game manages the 1,950 acre Petaluma Marsh Wildlife Area. It is located approximately six miles southeast of the City of Petaluma and bordered by the Petaluma River on the east, San Antonio Creek on the south, private property (Neils Island) on the west, and Schultz Slough on the north. The 300-acre Rush Creek Marsh managed by Marin County Open Space District is located south of Basalt Creek and north of Novato. The State Coastal Conservancy and U.S. Fish and Wildlife Service own and manage approximately 430 acres of marsh as part of the Baylands Project, located in the southwest corner of Lakeville Highway and Highway 37.

The Sonoma Land Trust owns and manages 472 acres of marshlands south of Petaluma on both sides of Highway 37. This land is currently leased as farmland. The Land Trust also has an agricultural preservation easement on an additional 528 acres, located northeast of the Highway 37 Petaluma River bridge.

Eight properties in the watershed, totaling 2,946 acres, have conservation easements with the Sonoma County Agricultural Preservation and Open Space District. Two of these properties have future potential for public access; the others are in agricultural production including hay, sheep, dairy, and grazing use. Two properties in Sonoma County adjacent to the watershed boundary also have conservation easements totaling 736 acres. Five ranches on the Marin County portion of the San Antonio Creek watershed have easements with Marin Agricultural Land Trust.

The City of Petaluma owns the 300-acre Petaluma River Marsh, Lafferty Ranch on Sonoma Mountain, small parcels related to water supply on Manor Road, Petaluma River Marina, oxidation ponds and related facilities near Lakeville, Schollenberger Park (a dredge disposal site), Rocky Memorial Dog Park (on an old landfill), the Alman Marsh near the marina, a portion of the McNear Peninsula near downtown, and 160 acres of marsh and oxidation ponds near Schollenberger Park.

Other open space land in the watershed includes: Helen Putnam Regional Park (Sonoma County Department of Parks and Recreation), the Burdell Ranch (CDFG), Petaluma Adobe State Historic Park, and Olompali State Historic Park (both owned by California Department of Parks and Recreation), and the Fairfield Osborn Preserve which is managed by Sonoma State University.

3.7 Flood Plain Delineation and River Navigability

The Sonoma County Water Agency's Master Drainage Plan describes in detail the climatic, hydrologic, and topographic factors, which contribute to the delineation of floodplains or flood prone areas. Specifically, the flood plain delineation closely approximates the base (100-year) flood elevation lines developed by the U. S. Army Corps of Engineers (ACOE) for the National Insurance Administration, Federal Emergency Management Agency's Flood Insurance Rate Maps for the City of Petaluma and Sonoma County.

The term 100-year flood is a measure of water level rather than rate of occurrence therefore can happen any time. The term "100-year flood" is often used inconsistently and misunderstood by many people. The misinterpretation can foster a belief that if a 100-year flood occurs in any one year, then it cannot occur for another 100 years. This belief is false because it implies that floods occur deterministically rather than randomly. Because periods of heavy rainfall and floods occur randomly and sometimes unpredictably, there is a finite probability that the 100-year flood could occur in any year.

Land use, specifically developed lands, is an important topographic factor influencing surface runoff of storm waters. The watershed's decrease in water quality, susceptibility to erosion and flooding is directly linked to the increased urbanization and accompanying pavement (SCWA, 1986). Sonoma County Water Agency's (SCWA) "Areas of Flooding - 100-Year Frequency" are depicted on Figure 4.

The navigability of the Petaluma River and its importance in the exploration, settlement and development of the watershed have been mentioned in several sections of this plan. Flooding along the banks of the river, and siltation of the streambed, affecting both navigation and water-carrying capacity, have been increasingly serious problems for more than a century. This is evident when one compares a depiction of the waterway from the late 1800's to the present. Some of the early recommendations for straightening the alignment of the Petaluma River throughout the City were subsequently implemented. The river today is no longer the "tortuous watercourse" described by Thompson in 1877 as "...winding through the green marsh, sometimes doubling back upon its course, (and) making in a distance of eight miles a direct progress of but two."

The problems of siltation and flooding recognized over a century ago still exist today. Since the 1880's the ACOE has improved and maintained the Petaluma Creek for navigation. The Corps' first dredging project, authorized in 1930 and completed in 1933, provided for a 200-foot wide, 8-foot deep channel for 33,000 feet across the mudflats in San Pablo Bay to the mouth of the Petaluma Creek. For the next 69,000 feet upstream to Western Avenue in the City of Petaluma, the channel was widened 100 feet and deepened 8 feet. Included in this part of the project was a 300' x 400' turning basin, 8 feet deep. From Western Avenue upstream to the Washington Street Bridge, the channel is now 50 feet wide and 4 feet deep. (SCWA, 1986)

Dredging is a continuing project and under present scheduling, the San Francisco District of the ACOE maintains the San Pablo Bay Channel on a 144-month cycle and the Upper River channel on a 48-month cycle. The Corps' dredging experience was also used as the basis for evaluating any impacts a proposed project might have on silt deposition in the Petaluma River. Based on the Corps' experience over the past 50 years, it appears that an average of 60,000 cubic yards of material is deposited in the river each year. (SCWA, 1986)

4.0 The Plan

4.1 Issues of Concern

4.1.1 River or Slough

One of the major issues for the landowners in the Petaluma Watershed is that the Petaluma River is not actually a river but is in fact a tidal slough or a tidewater estuary. This waterbody has been known as the Petaluma Creek, Petaluma Slough and Petaluma River. The lower reaches of the "slough" experience regular tidal exchange from San Pablo Bay. This tidal exchange, along with erosion problems throughout the watershed, cause sediment deposition that requires regular dredging to keep the creek navigable.

Landowners within the Petaluma Watershed are concerned about how water quality standards will be set for this waterbody. Standards for a river that have historically supported anadromous fish are likely to be more stringent than standards set for a tidewater slough. Southern Sonoma County RCD recommends that the landowners work with the Regional Water Quality Control Board (RWQCB) to set appropriate standards for different segments of the creek. For example, it is possible that the upper reaches, that may have higher quality habitat, could have higher standards applied. Conversely, those standards, which might apply to the lower reaches, may be lower, due to the lower reaches experiencing regular tidal influence. See section 2.2 of this Plan for more information regarding the RWQCB.

4.1.2 Fisheries

The Petaluma River has never been an outstanding salmonid stream such as its neighbor to the north, the Russian River. As part of the planning process, Prunuske Chatham, Inc., gathered and summarized existing information on the historical and current presence of salmonids in the Petaluma River watershed and identified opportunities to improve and expand anadromous fish habitat. This information is attached as Appendix I "Fisheries Enhancement".

The "Fisheries Enhancement" contains background information on the fishery resources in the Petaluma River, focusing on anadromous fish; it lists habitat needs for steelhead and identifies areas and actions for enhancement. A map showing current and estimated historic steelhead runs is attached to Appendix I.

The Petaluma River system supports a variety of marine, estuarine, and freshwater fish species. These species use the Petaluma River and its tributaries as habitat for spawning, rearing, and migration.

Of particular concern in the watershed is the status of salmonid fish such as steelhead, which are found in the Petaluma watershed. Steelhead trout populations have drastically declined throughout their range in California over the last 30 years. Under the federal Endangered Species Act, steelhead south of and including the Russian River have been listed as "threatened" by the National Marine Fisheries Service.

Although there is a steelhead presence in the Petaluma watershed the area is thought to have never been outstanding for salmonid such as the Russian River. According to representatives of both the Department of Fish and Game and National Marine Fisheries Service the Petaluma watershed is not the type of habitat that would have historically supported Coho or Chinook salmon.

Limited information is available about the current and historic numbers of steelhead in the Petaluma River watershed. The Department of Fish and Game (DFG) does not have records on historic or current populations of steelhead. Bill Cox, a biologist with the Department of Fish and Game, believes that historically steelhead were found in Lichau, Adobe, and San Antonio Creeks, and possibly in Lynch, Willow Brook, and Thompson Creeks. Other tributaries in the Petaluma River watershed were, and still are, too small and dry for steelhead.

Watershed residents have observed fish in Lichau, Adobe, and San Antonio Creeks. Since 1985, United Anglers of Casa Grande High School have conducted surveys of salmonids and their spawning and rearing habitat. The students have observed steelhead in Adobe Creek, redds (the salmonid fish egg nests) in Willow Brook Creek just above the Highway 101 crossing, and fish at several other locations including Payran Street bridge to Lynch Creek confluence, Washington Street Creek, and the confluence of Lynch Creek.

According to the California Department of Fish and Game and the National Marine Fisheries Service, the Petaluma River is a low gradient stream that would not have historically supported Coho or Chinook salmon. Chinook salmon are found in much bigger river systems such as the Sacramento River. The Chinook salmon found today are believed to be hatchery strays entering San Pablo Bay that become "lost" on their way to the Sacramento River.

The watershed enhancement plan tries to balance recognition of the fact that the Petaluma watershed has never been an outstanding salmonid stream and a commitment to enhance resources for all native species in the watershed. One of the biggest concerns of many residents in the watershed is that the Plan is being written for a "river" when in fact the lower portion of the Petaluma River is a tidal dead end slough. Watershed residents in the lower portion of the watershed (tidal area) might have to meet standards set for a river system as found in the tributaries of the upper watershed. To tackle this problem one of the first tasks for the Watershed Council should be to work with the RWQCB to set different standards tailored to specific portions of the watershed. Instead of generalized requirements, individualized standards could be set for the lower tidal portion that reflect attainable conditions for a tidal dead end slough. Another set of standards could be set for the tributaries in the upper watershed that could possibly support steelhead.

To read further about the status of fisheries in the Petaluma watershed refer to Appendix I.

4.1.3 Unique Considerations for Ranchette Owners

Ranchettes or large lot, rural homesites are found throughout the watershed. These rural properties typically range from one to 20 acres in size and are not usually part of development tracts. Many rural residents keep livestock such as sheep and horses. On the eastern side of the watershed, rural areas surround Penngrove and extend into the Lichau Creek and Lynch Creek areas. On the western side of the watershed, the rural areas outside Petaluma (Liberty Road, Rainsville Road, Skillman Lane, Middle Two Rock, and Eastman Lane) continue to be subdivided and expand. This particular type of residential density/land use has unique considerations for planning and several issues have been identified.

- Subdivision of land. The division of large parcels of agricultural land can decrease the amount of land available for productive and profitable agricultural operations. For example, while 200 acres could support a dairy operation, it is unlikely that ten 20-acre parcels could each support such a use.
- Concentration of animals and related facilities in small areas. Livestock trampling and heavy grazing can lead to accelerated erosion, soil compaction, and increased runoff of pollutants such as nutrients. This is particularly a concern in Liberty Valley, a major groundwater recharge area with sandy soils. Cumulatively, intense use of rural lots can contribute to an increase in runoff from roads and roofs resulting in erosion and degraded water quality.
- Improper drainage. Many rural residential landowners have developed their properties in ways that change natural drainage patterns and cut into hillsides. This also leads to accelerated erosion and drainage problems.
- Development of roads. Unpaved or improperly constructed roads are often a major source of erosion and sediment.
- Loss of contiguous wildlife habitat. A patchwork of differing land uses reduces the size of oak woodlands and fragments riparian forests, seasonal wetlands, and other important wildlife areas. Fences, cats, dogs, and increased human activity restrict wildlife access to those areas that remain. Domestic animals may prey on wildlife in natural areas. Replacing native vegetation with ornamental plants can also have a profound collective impact on the quality and quantity of wildlife habitat.

4.1.4 Manure Management

The streams and waterways within the watershed and throughout the County provide many miles of diverse aquatic and riparian habitats for a wide array of fish and wildlife species, some of which are classified as threatened or endangered. Streams, which once supported steelhead, are no longer able to support these species because of diversion and contamination of remaining flows. The birds and mammals that are dependent upon streams for food, water, and shelter to rear their young also suffer when animal wastes pollute streams. The quality of this water is critical for the health and welfare of the people and food-producing animals as well. Agricultural enterprises that generate animal wastes are encouraged to manage manure in order to maximize economic benefits, while reducing potential for pollution.

The health of the watershed depends on the diligence and continual improvement of waste management practices. Proper management will help the agricultural producer reduce the risk of penalties for substandard performance and maximize economic benefits from fertilizer application. California regulations require adequate pond size to contain manured area runoff expected from the wettest winter expected in 10 years as well as the one-day runoff from a 25-year storm. Locally, this amounts to a total of between three to four feet of water from all manured areas.

The California Regional Water Quality Control Board requires landowners and operators to have a Farm Plan and Annual Report for those dairy operations with over 700 cows or over 1,000 animal units. The RWQCB also requires adequate manure disposal and established nutrient budget levels to be maintained. The RCD, RWQCB, UCCE and AWC will work with producers to reach compliance with water quality standards set by regulating agencies. In cases of continual violations, abatement requirements or fines may be issued by the proper authorities.

Facilities with horses also must be aware of manure management. Horses contribute a small portion of total pollutants entering local waterways, but the impact is real. Voluntary compliance is the key issue and message of this plan. If all agricultural producers effectively manage their own operations and encourage others to do the same, the industry will benefit in the long term and the health of the watershed will be improved.

Best Management Practices (BMPs) have been developed through landowner and multi-agency cooperation. It is important to recognize that runoff water from clean and manured areas should be separated to the extent possible, maximizing benefits to the landowner and the environment. The 1997 Sonoma Marin Animal Waste Committee's ten recommendations and design guidelines for manure management are identified below:

- Facilities need to safely convey clean rainwater away from manured areas and ponds without creating erosion.
- Control all wastes and storm water runoff from confined animal facilities and manured areas.
- All liquid and solid manure should be managed in a manner that prevents the migration of manure and manure constituents into local waterways.
- Corrals or densely used portion of pastures need manure management.
- Manage pastures and fields for safe, effective manure utilization.
- Locate the animal feeding sites to protect waterways within high-use areas.
- Develop a short-term and long-term waste management plan.
- Develop an emergency plan.
- Manure and water testing will provide for better decision-making.
- Apply manure fertilizer appropriately.

4.1.5 Impacts from Urbanization in the Watershed

Urban land uses and the continued expansion of urbanization in the watershed have a pronounced influence on the health of the watershed. The AC felt strongly that the issue of existing and continued urbanization is a significant contributor to water quality impacts and degradation or loss of valuable riparian habitat. In summer months, it is quite common to view trash and unwanted household items filling the waterways and storm drains throughout the downtown river's segment.

Construction related impacts, such as topography changes (even subtle site grading) and increasing the amount of impervious cover associated with buildings and roads, alters and many times accelerates, natural processes or the rate of erosion and sedimentation in the waterway and refocuses the natural ecological change within a watershed. Urban development impacts ultimately effect all the stakeholders in a watershed and commit our non-renewable resources, such as water, forever. This is considered an irretrievable and irreversible commitment of resources.

The AC recommends that for the Plan "to be adopted", the Watershed Council may be interested in coordinating with the City of Petaluma.

4.1.6 Waste Tire Use

In the mid 1950's through the 1980's used tires were placed in gullies on ranches in the Petaluma Watershed and throughout Sonoma County for erosion control. Use of waste tires was a recommended practice by a number of agencies until the 1980s. Now these tires are considered a hazardous waste and the California Integrated Waste Management Board (CIWMB) is responsible for determining how these "legacy waste tire" piles will be remediated and at whose cost.

Landowners in the Petaluma Watershed have expressed concern about this issue and the burden that would be placed on the landowners if they were required to remove the tires. Not only is the actual removal of the tires extremely costly; there could be considerable erosion causing increased sedimentation of creeks. Other costly erosion control methods would need to be put into place where tires are removed.

The tire issue is a critical one that could eventually effect many landowners in and around Sonoma County. Removal by landowners could mean a severe financial burden for many dairies and ranchers and possibly the loss of their ranches. A significant financial burden attributable to landowner tire removal would cause or contribute to agriculture's inability to continue operation in this County.

Southern Sonoma County Resource Conservation District and landowners in the Petaluma Watershed have agreed to seek funding for a demonstration project to determine an economical and environmentally safe way to deal with the waste tire issue. The RCD, local landowners, the CIWMB and numerous regulatory agencies are working together to solve this problem in a new and innovative way.

4.1.7 Setting Standards for Water Quality

One of the major concerns for landowners in the Petaluma Watershed is the requirement to meet certain water quality standards that still need to be identified. Landowners are concerned that they will be required to meet standards that would be appropriate for a river. Since the lower portion of the watershed is actually a slough with tidal fluctuation, specific standards should be set for this portion of the watershed. Different standards could be set for the upper watershed tributaries that do not have tidal influence.

The AC has acknowledged that it is vital for them to work with the RWQCB to produce a "TMDL". TMDL stands for Total Maximum Daily Load, which simply put is an estimate of the maximum amount of a specific pollutant a body of water can receive and still meet water quality standards for its designated use. The Federal Clean Water Act of 1972 requires EPA to create a TMDL for every water body listed as an "impaired water body."

According to a Fact Sheet produced in 1997 by the RWQCB, TMDLs are developed to provide an analytical basis for planning and implementing pollution controls, land management practices, and restoration projects needed to protect water quality. States are required to include approved TMDLs and associated implementation measures in State water quality management plans or basin plans.

TMDLs are usually based on readily available information and studies. In some cases, complex studies or models are needed to understand how stressors are causing waterbody impairment. In many cases, simple analytical efforts provide an adequate basis for stressor assessment and implementation planning.

Where inadequate information is available to draw precise links between these factors, TMDLs may be developed through a *phased approach*. The *phased approach* enables states to use available information to establish interim targets, begin to implement needed controls and restoration actions, monitor waterbody response to these actions, and plan for TMDL review and revision in the future. Phased approach TMDLs are particularly appropriate to address nonpoint source issues.

TMDLs should address all significant stressors which cause or threaten to cause waterbody use impairment, including:

- *point sources* (e.g., sewage treatment plant discharges),
- *nonpoint sources* (e.g., runoff from fields, streets, range, or forest land) and
- *naturally occurring sources* (e.g., runoff from undisturbed lands).

A TMDL is the sum of the individual wasteload allocations for point sources, load allocations for nonpoint sources and natural background pollutants, and an appropriate margin of safety. TMDL Plans may address individual pollutants or groups of pollutants, as long as they clearly identify the links between:

- *the waterbody use impairment or threat of concern,*
- *the causes of the impairment or threat,* and
- *the load reductions or actions needed to remedy or prevent the impairment.*

4.1.8 Permits for Levee Landowners

Presently, the two sets of permit regulations that govern work in and around the levees in the Lakeville area (Section 404- Clean Water Act and Section 10- Rivers and Harbors Act) are issued from the U.S. Army Corps of Engineers (ACOE) as one combined, "blanket" permit. This particular permit covers the regulatory authority of eight local, state, and federal agencies. This permit allows landowners to: 1) clean existing drain ditches (on their land only), and 2) take bayside earthen material to cap the existing levee on the bayside only.

Another permit is issued by the San Francisco Bay Conservation & Development Commission (BCDC). See section 5.0 Guide to Federal, State and Local Agencies & Permitting Requirements for BCDC permit information. The permits are typically renewable and the existing permit was issued for five years and is due to expire in March 2000. The SSCRCD is currently working to assist the Lakeville area levee landowners in the renewal of these permits.

4.2 Other Planning Efforts in the Watershed

The Petaluma Watershed Enhancement Plan has been written as a planning tool to be used and referenced for the enhancement of the Petaluma watershed. The Plan is a working document, which can be amended as the issues within the watershed change over time. Below is a summary of current planning efforts in the Petaluma watershed. Work conducted by the City of Petaluma within the city limits is referenced in the context of how it fits into other watershed enhancement work.

City of Petaluma

The City of Petaluma has several watershed enhancement projects including:

Petaluma River Access and Enhancement Plan. Adopted in May 1996, the Petaluma River Access and Enhancement Plan establishes policies for preservation, enhancement, and restoration along a 7.8 mile stretch of river from the urban limit line near Old Redwood Highway, through downtown, and to the marina. The plan calls for creating a continuous riparian corridor or "greenway" along the river, identifies restoration and enhancement opportunities, and designates appropriate access points.

Petaluma River Marsh Enhancement Plan. In 1992, the City of Petaluma completed a plan for 300-acres of undeveloped disturbed wetland south of the City marina. The plan includes recommendations for water quality protection, habitat enhancement and restoration, endangered species protection, public access, and public recreational opportunities. Most of the land is in the City limits and owned by the City of Petaluma.

Petaluma Demonstration Marsh and Effluent Management Plan. In 1992, as part of the City's Long-Range Effluent Management Plan, the City approved acquisition of approximately 170 acres adjacent to the Petaluma Marsh to create a demonstration marsh. The plan includes restoration of approximately 100 acres of tidal marsh and creation of a mosaic of seasonal wetlands, riparian areas, and freshwater ponds.

The Ellis Creek Watershed Enhancement and Wetland Mitigation Plan. In 1996 this Plan was developed by the City as a mitigation project for a proposed reservoir on Higgins Creek. The Ellis Creek Plan includes fencing, installation of cattle crossings, bank stabilization, and enhancement planting of approximately 8,100 lineal feet along Ellis Creek. Additional freshwater wetlands and enhancement are also proposed on Higgins Creek (a tributary to Ellis Creek) as mitigation for the reservoir impacts. The

City is continuing to evaluate discharge options, which may eliminate the need for a reservoir.

County of Sonoma

Sonoma County has policies and programs to protect agriculture and natural resources. Most of these are contained in the County's General Plan, which was last updated in 1989.

Agriculture. The Sonoma County General Plan reflects the desire of residents to manage growth and protect agriculture. Agricultural land use policies include stabilizing agricultural land use at the urban fringe, limiting the intrusion of new residential areas into agricultural areas by maintaining parcels large enough for farmers to lease or buy for their operations, and minimizing conflicts between agricultural and non-agricultural uses.

Open Space. The Sonoma County General Plan identifies open space as a limited and valuable resource. Policies to protect open space include: maintaining community separators between Petaluma and both Novato and Rohnert Park and protecting scenic resources such as the Sonoma Mountains between Petaluma and Sonoma, the grassy hills and ridgelines south of Petaluma near the Marin County border, and views of San Pablo Bay along Highway 37.

Natural Resources. Policies were developed to protect critical wetland, marsh, and oak savanna habitat that are highly sensitive to change. For example, the riparian corridor policy states that agricultural cultivation and grazing should occur 100 feet from the top of the streambank in flatland areas and 50 feet in upland areas. Policies are identified to control soil erosion, protect agricultural and domestic water supplies, maintain Sonoma County's diverse plant and animal communities, and protect fishery resources while balancing needs for agriculture, development, and mining.

Other Policies. In addition to the General Plan, Sonoma County has several other natural resource-related policies. The County's Valley Oak Ordinance specifies that when oak trees on particular soil types are removed, landowners must notify the County and indicate that they will either plant new oaks or implement measures to protect existing trees. Sonoma County, several cities, public agencies, and various organizations (both environmental and agricultural) have also worked on a Vernal Pool Preservation Plan. A general permit has been requested from the ACOE to manage or restrict development-related activities on lands with vernal pools.

The County of Sonoma has recently adopted a Vineyard Planting and Replanting Ordinance restricting vineyard development on steep slopes in order to minimize soil erosion and water quality impacts. The new ordinance goes into effect on October 1, 1999 and will require farmers to first register with the County Agricultural Commissioner before planting grapes. The ordinance prohibits vineyards on steep hillsides (50-percent grade or more) and requires erosion control plans on lesser slopes. It also requires that vineyards near streams, creeks, and rivers provide a 50-foot setback to preserve riparian corridors.

4.3 Enhancement Plan Goals, Objectives, and Recommended Actions

The AC, in its first round, developed ten goals for the Petaluma Watershed Enhancement Plan. These goals were then further discussed and reshaped to form four comprehensive goals.

The intent of the goals is to provide direction for future enhancement efforts in the Petaluma watershed. The four goals listed below encompass and share common themes: support local control of future enhancement in the watershed, improve water quality in the Petaluma watershed, support the viability of agriculture and enhance existing wildlife habitat. Each goal is broken down into a number of objectives. The objectives are tangible extensions of the goals. Each objective is then assigned recommended actions. The recommended actions are given a probable timeline to complete of 2 years, 5 years, and ongoing.

GOAL A

Establish a local Watershed Council for residents and organizations to fund and coordinate watershed enhancement activities and keep one another informed.

Paramount to the goals of this plan, is the desire by the landowners to form a council or conservancy group to facilitate achievement of the other goals and objectives in this plan. The Advisory Committee members are committed to establishing a landowner Watershed Council for the purposes of addressing watershed-wide concerns and in increasing communication between all watershed stakeholders. The contributing authors of this plan feel that by establishing a strong and active council, a sense of oversight and coordination will occur and a collective voice will be able to effectively communicate the issues and objectives of this group. The formation of a Watershed Council is the first and most important step in achieving all the other goals developed by the Advisory Committee and future goals of the Council as described hereafter.

Objective: Form a local, citizen-based, Watershed Council to keep watershed residents informed of watershed planning and implementation efforts.

Recommended Actions

Two Year Actions

- Elect or appoint a Council chairperson, develop subcommittees. Establish a mission statement. Establish short and long term goals for the Watershed Council.
- Conduct regular one-on-one and "kitchen table" outreach meetings to let watershed residents know about how to participate in watershed enhancement efforts and to identify potential watershed enhancement projects.

- Keep landowners informed of watershed efforts, function as a clearinghouse for watershed and urban residents, sponsor enhancement efforts, and assist agencies and citizens in coordinating meetings.

Five Year Actions

- Develop and maintain an Internet website. Post information about upcoming meetings, available funding, enhancement efforts and monitoring results. Link to other websites with enhancement information and Petaluma Watershed data.
- Publish and distribute a watershed newsletter at least twice a year.

Ongoing Actions

- Inform landowners of monitoring methods and training through the Watershed Council.
- Keep landowners informed of upcoming agency plans and actions related to the Petaluma Watershed.
- Attend meetings of agencies and organizations (such as City of Petaluma, County Board of Supervisors, Farm Bureau, etc.) to keep them informed about landowner concerns and efforts.
- Support sub-watershed community efforts, (different areas have distinct issues and concerns).

Objective: Encourage local residents to take the lead in developing and implementing enhancement projects.

Recommended Actions

Two Year Actions

- Work with the Department of Fish and Game to determine the presence and occurrence of steelhead in the watershed.
- Encourage voluntary watershed activities including a student service learning component such as the Adopt-A-Watershed curriculum.
- Assist in developing a TMDL for Petaluma watershed (develop reasonable water quality standards for a tidal slough).

Ongoing Actions

- Encourage coordination of efforts for steelhead recovery where practical.
- Assist agencies and citizens in coordinating meetings.
- Set new short and long term goals for the Watershed Council.
- Work collaboratively with City of Petaluma and Sonoma County in rural watershed projects.
- Provide input to RCD planning and implementation efforts.

Objective: Encourage community involvement in developing flood hazard reduction measures that protect the local economy while conserving natural resources.

Recommended Actions

Two Year Actions
- Keep informed of the cumulative impact of proposed flood hazard reduction projects on overall watershed resources and comment on proposed plans.

Five Year Actions
- Coordinate with urban residents regarding common flooding issues.
- Develop restoration projects to reduce factors contributing to flooding.
- Inform community about impacts of upstream activity on flooding and habitat degradation.

Ongoing Actions
- Request a PL 566 Small Watershed Project from NRCS.
- Develop flood hazard reduction measures.
- Assess conditions of levees in the lower watershed.
- Recommend incorporating habitat enhancement measures into flood hazard reduction projects.

Objective: Seek funding and technical advice to attain Goals B, C and D in collaboration with all watershed stakeholders.

Recommended Actions

Two Year Actions
- Designate a member of the Watershed Council as grant writer.
- Identify where limited funding can most effectively be spent.
- Provide low-cost or free technical assistance to develop and implement conservation practices.
- Watershed Council creates a list of grantors and permit guidelines to assist agricultural landowners with conservation practices, planning, permitting, and funding to implement conservation projects.

Ongoing
- Seek funding for Watershed Council and enhancement implementation.
- Seek and provide technical assistance for all willing landowners.

GOAL B

Improve water quality and ground water recharge in the Petaluma Watershed with the ultimate purpose of removing the Petaluma River from the RWQCB Impaired Waterbody List 303d.

The Petaluma River is listed as an "Impaired Waterbody" under the California Regional Water Quality Control Board's 303d provisions. Decades of urbanization along the river corridor and continued erosion control and flooding problems significantly contribute to the river's impaired status. Ultimate reversal of the listing of the river is one of the primary goals of this enhancement plan. To this end, the Watershed Council's focus would be to work towards lowering the water temperature, reducing sedimentation and erosion, and increasing watershed education and landowner information on a variety of water quality topics. The health of groundwater and watercourse bodies in the watershed are fast becoming one of the most important national environmental concerns because of its direct correlation as an indicator of our environment as a whole.

Objective: Inform landowners of ways to prevent erosion, improve water quality and inform them of new and existing regulations.

Recommended Actions

Two Year Actions

- Produce and distribute a *Creek Care Guide*. Topics could include erosion control, riparian management, wildlife habitat, nutrient and waste management, road maintenance, and proper drainage.
- Make the *Handbook for Forest and Ranch Roads* published by the Mendocino County Resource Conservation District available to watershed residents, free of charge or for a nominal cost.
- Provide information about the sources and impacts of water pollutants including animal waste, fertilizers, household and ranch maintenance products and practices, etc.

Ongoing Actions

- Conduct research on the long-term water supply concerns for rural residents and agricultural operations especially in San Antonio Creek. Consider how increases in water supply or water use will affect natural resources and development.
- Keep landowners up-to-date with new water quality information.
- Assist residents in working with the Counties on well and septic installation and management to maintain or improve ground and surface water quality.

Objective: Continue and expand current voluntary surface and groundwater monitoring programs.

Recommended Actions

Two Year Actions
- Support local coordinator for monitoring outreach and coordination.
- Conduct outreach to landowners about water quality.
- Provide water quality monitoring kits to landowners.
- Encourage U.C. Cooperative Extension and/or the RCD to hold monitoring workshops in the watershed.

Five Year Actions
- Establish a watershed science team to evaluate, interpret, and make recommendations for further monitoring programs in the watershed.

Ongoing actions
- Assist landowners and organizations with volunteer water quality monitoring efforts.
- Keep watershed residents informed about water quality testing results and improvements.

Objective: Reduce accelerated soil erosion and manage sediment loads.

Recommended Actions

Two Year Actions
- Concentrate erosion control activities in the high priority sub-watersheds of Willow Brook, Lynch, Adobe, Ellis, and San Antonio Creeks.
- Seek funding and technical advice for landowners in the upper watershed for installation and maintenance of erosion control measures.

Five Year Actions
- Complete stream channel stability, upslope erosion, and geomorphological studies. The *Erosion and Sedimentation in the Petaluma Watershed* (see Appendix E) recommends that these studies be conducted in sub-watersheds with complicated system-wide erosion problems such as Lichau Creek, portions of Willow Brook Creek, upper Lynch Creek, upper Washington Creek, upper Adobe Creek, and San Antonio Creek.
- Manage livestock access to creeks and gullies, especially in the wet season.
- Provide workshops and conduct other outreach. Topics could include "do-it-yourself" erosion control, small farm and pasture management, and reducing rill and sheet erosion for pastures and corrals.

Ongoing Actions
- Maintain drainage ditches, spillways, culverts, etc. to avoid overtopping and delivery of sediment to the streams.
- Improve upstream waterways for flood and sediment control by planting native species.
- Maintain erosion control measures in the upper watershed.

Objective: Encourage natural stream morphology as a means of flood control and ground water recharge.

Recommended Actions

Ongoing Actions
- Collect information on ground water recharge and encourage recharge.
- Promote water conservation throughout the watershed.
- Reduce unnecessary diversions from creeks.
- Encourage maintenance of summer stream flow- for example, canopy cover.
- Maintain existing summer stream flow and avoid depleting instream pools of water in the summer.

GOAL C
Support the viability of agriculture in the community.

Past and present, the Petaluma community is founded on agriculture. Currently, the increasing land prices and stricter environmental regulations threaten the viability of the agricultural community. One of the most important factors contributing to the quality of life in the community is its history of and continued linkage, to agriculture. This goal seeks to support sustainability of agriculture in the watershed and work on improving its viability as an industry. Stewardship of the land is a significant hallmark of this plan and the sentiments of its contributors. With the formation of a Watershed Council, the agriculturists would have an opportunity to voice collective concerns and to work cooperatively with other stakeholders to promote broad public support for agricultural viability.

Objective: Support and seek funding for demonstration project to retain on-site and properly manage waste tires used historically for erosion control.

Recommended Actions

Two Year Actions
- Seek funding for abandoned tire demonstration project on rural lands.
- Begin demonstration project for abandoned tires on rural lands.

Five Year Actions
- Remove threat of violation from existing waste tires used for erosion by working with CIWMB to develop acceptable standards for legacy waste tire pile remediation.

Objective: Continue to provide information about technical and financial assistance for agriculture.

Recommended Actions

Two Year Actions
- Investigate financial incentives for landowners who plant trees along the riparian corridor or voluntarily take land out of production.
- Seek financial incentives to encourage landowners to leave buffer space along creeks on a voluntary basis.

Five Year Actions
- Provide assistance to property owners for self-diagnosing erosion problems, for developing possible solutions (especially those that are practical and stay away from regulatory concerns), and for identifying projects that residents can do themselves.
- Compile and distribute information on best management practices to ranchette owners.
- Compile and distribute information on best management practices to agriculture operations.

Ongoing Actions
- Provide information about upland grazing management.
- Encourage the use of best management practices for hillside vineyards.
- Support programs such as agriculture easements to protect farmlands on a voluntary basis.

Objective: Provide technical information to interested agriculture operators about the potential benefits and detriments of using reclaimed wastewater.

Recommended Actions

Five Year Actions
- Identify best management practices for using reclaimed water and biosolids.
- Provide information about obtaining reclaimed water and biosolids and uses for them.

Ongoing Actions
- Support users of reclaimed wastewater to develop irrigation management plans.
- Work with the City and County to provide more reclaimed water for agricultural use.
- Support the availability and responsible use of bio-solids and reclaimed water for interested agricultural users.

Objective: Support economic sustainability and stewardship activities of agricultural and rural residents.

Recommended Actions

Two Year Actions
- Hold ranch and vineyard planning workshops for both small and large landowners and managers.
- Assist rural residents with conservation practices, planning, permitting, and funding to implement conservation projects.
- Inform residents about the importance of agriculture to the local economy and about farming operations. Provide weekend tours and newsletters, and/or newspaper articles.

Five Year Actions
- Work cooperatively with regulatory agencies in streamlining permits for levee and ditch maintenance and agricultural operations.
- Develop a recognition program that acknowledges historical and current stewardship of the land by agriculture.
- Provide outreach to urban community about benefits of agriculture in the watershed.
- Develop a horse ranch management manual similar to the vineyard management manual.
- Hold conservation planning workshops for ranchette owners.

Ongoing Actions
- Support willing levee owners with stewardship practices that conserve or enhance wildlife habitat.
- Maintain long term landowner control of enhancement and implementation actions in the watershed.
- Support best management practices for manure disposal.

GOAL D

Conserve and enhance existing wildlife habitat.

This goal focuses on the protection, conservation, and restoration of riparian habitat along all waterways within the Petaluma watershed. Healthy vegetation within riparian corridors provides shade to help lower water temperatures and can also serve as a successful means of erosion control. These corridors provide excellent habitat and cover protection for a wide variety of terrestrial species including migratory songbirds.

Objective: Protect, preserve and restore riparian corridors in the watershed.

Recommended Actions

Two Year Actions

- Compile and distribute list of plants best suited for revegetation efforts.
- Begin to revegetate gullied areas with appropriate materials.

Five Year Actions

- Select enhancement projects that conserve or improve the habitat of endangered species. Follow any specific terms and conditions set by U.S. Fish and Wildlife Service and National Marine Fisheries Service.
- Devise a plan to try to control invasive exotic plant species.

Ongoing Actions

- Encourage the use of native plant species for riparian restoration.
- Protect intact sections of the riparian corridor.
- Revegetate high and medium priority sites identified in *Riparian Plant Community* (Appendix H). Work with willing landowners. High and medium priority sites include the opportunity to provide contiguous riparian forest habitat between an upper and lower reach of a stream, expand existing habitat, fill out areas of sparse cover, and provide cover in areas with a potential for high erosion. Inform community about local endangered species.
- Avoid depleting instream pools of water during the summer.

Objective: Encourage community pride in watershed's natural resources.

Recommended Actions

Two Year Actions

- Inform community about local wildlife enhancement potential with brochures and workshops.
- Conduct outreach regarding the importance and uniqueness of the Petaluma Marsh.

Five Year Actions

- Prepare and distribute information to the public about wildlife habitat needs, including steelhead and marsh species, and how residents can help enhance habitat. Include information on reducing summertime water diversions.
- Create manual on how residents can help enhance wildlife habitat.
- Provide workshops or written materials for residents about the importance of healthy riparian corridors to wildlife, erosion control, and water quality; do-it-yourself revegetation with native plants; how to maintain creek habitats; and available resources and technical assistance.

Ongoing Actions

- Get community involved with observing and preserving anadromous fish habitat.
- Support efforts to improve habitat for steelhead, songbirds, waterfowl, pond turtles, and other native wildlife species in the watershed. Concentrate on improving riparian habitat.
- Provide technical assistance to school and community groups working on revegetation projects.

Objective: Work with agencies to establish criteria for steelhead habitat.

Recommended Actions

Two Year Actions

- Incorporate steelhead habitat-related parameters into watershed monitoring (i.e., turbidity sampling, using aerial photographs to identify changes in riparian cover, etc.).

Five Year Actions

- Use the Department of Fish and Game protocol to evaluate the quality of steelhead spawning and rearing habitat. Focus on reaches being restored by watershed residents.
- Focus steelhead restoration efforts on tributaries that do, or potentially can, support steelhead, which include: Lichau Creek, Adobe Creek, San Antonio Creek, and possibly Lynch Creek and Willow Brook Creek.

3.8 Natural Resources

The Petaluma River is a tidal slough that has been reshaped and renamed many times to suit human purposes. Petaluma Creek has played an integral role in the human history within the Petaluma watershed. Before automobiles and the railroad, rivers were the main system of travel and transportation of goods. In 1852 the first wharf was constructed in town to accommodate the increasing river use. Petaluma Creek was being used so intensely that in 1880 ACOE spent $8,000 to widen the Petaluma Creek to 50ft wide and 3ft deep at low tide. By 1905 Petaluma Creek had the third highest commercial traffic of any river in California. Again in 1906 the ACOE began a project to create a river 50ft wide by 6ft deep from its mouth to the city border. Due to a growing population and increased usage for transportation of goods and materials in 1927 the river was widened to 100 feet and was made 8 feet deep. These new dimensions were from the mouth of the river all the way up to Washington Street in the city center.

In 1959 the United States Congress officially declared that Petaluma Creek was a River. In the process of making navigation channel improvements, many old river meanders were filled with dredged material. These old meanders are primarily located on the eastern banks of the river.

For over a century, agriculture has been the dominant land use throughout the Petaluma Watershed. Historically, the area has been a production center for poultry and dairy products. Although the poultry industry has declined, milk continues to be one of the watershed's leading agricultural commodities. Livestock and feed crops such as oat hay are also principal agricultural commodities in the area. Sonoma County's General Plan reflects the desire of residents to manage growth and protect agriculture. The county has reinforced its limited growth patterns with strong policies protecting agriculture.

More than 90% of California's original marshland has been degraded, destroyed or "reclaimed" by urbanization, agriculture, and commercial salt operations. In the San Francisco Bay, less than 15% of original tidal marshland remains-much of it highly fragmented or altered. Only 27% of the historic tidal marshes in San Pablo Bay remain. The North San Francisco Bay tidelands provide food and shelter for millions of shorebirds and hundreds of thousands of waterfowl that migrate through or winter every year.

The Petaluma Marsh is the largest remaining salt marsh in San Pablo Bay, totaling an estimated 5,000 acres. The marsh has three zones: low marsh of cordgrass or tules, which receives maximum submergence; a middle marsh of pickleweed, alkali bullrush, or cattails; and a high marsh, which is rarely, if ever, covered by tidal action. During extreme high tides, the surrounding uplands are a refuge for many marsh animals.

The Petaluma watershed provides habitat for a number of federally listed species. The California Clapper Rail, the California Black Rail and the Salt Marsh Harvest Mouse are completely dependent on marshes. The California Clapper Rail and the Salt Marsh Harvest Mouse are both dependent on tidal marshlands while the California Black Rail lives in freshwater and saltwater marshlands. Table 3 identifies all federally listed species and species of concern located in the watershed.

Table 3
Federally Threatened and Endangered Species in the Watershed

Listed Species - Threatened (T) and Endangered (E)

Mammals	Salt marsh harvest mouse, *Reithrodontomys raviventris* (E)
Birds	American Peregrine Falcon, *Falco peregrinus anatum* (E) California Clapper Rail, *Rallus longirostris obsoletus* (E) Western Snowy Plover, *Charadrius alexandrinus nivosus* (T) Bald Eagle, *Haliaeetus leucoccophalus* (T)
Amphibians	California Red-Legged Frog, *Rana aurora draytonii* (T)
Fish	Winter-Run Chinook Salmon, *Oncorhynchus tshawytscha* (E) Delta Smelt, *Hypomesus transpacificus* (T) Central California Steelhead, *Oncorhynchus mykiss* (T) Sacramento Splittail, *Pogonichthys macrolepidotus* (T)
Plants	Soft Bird's-Beak, *Cordylanthus mollis ssp. mollis* (E) Baker's Stickyseed, *Blennosperma bakeri* (E) Burke's Goldfields, *Lasthenia burkei* (E) Showy Indian Clover, *Trifolium amoenum* (E) Sebastopol Meadowfoam, *Limnanthes vinculans* (E)

Species of Concern

Mammals	Pacific Western Big-Eared Bat, *Corynorhinus townsenddii townsendii* Greater Western Mastiff-Bat, *Eumops perotis californicus* Long-Eared Myotis Bat, *Myotis evotis* Fringed Myotis Bat, *Myotis thysanodes* Fringed Myotis Bat, *Myotis thysanodes* Long-Legged Myotis Bat, *Myotis volans* Yuma Myotis Bat, *Myotis ymanensis* Point Reyes Jumping Mouse, *Zapus trinotatus orarius* Suisun Ornate Shrew, Sorex ornatus sinuisus
Birds	Tricolored Blackbird, *Agelaius tricolor* Western Burrowing Owl, *Athene cunicularia hypugea* Ferruginous Hawk, *Buteo regalis* Bell's Sage Sparrow, *Amphispiza belli belli* Saltmarsh Common Yellowthroat, *Geothlypis trichas sinuosa* San Pablo Song Sparrow, *Melospiza melodia samuelis* California Black Rail, *Laterallus jamaicensis coturniculus*
Reptiles	Northwestern Pond Turtle, *Clemmys marmorata marmorata*
Amphibians	Northern Red-Legged Frog, *Rana aurora aurora* Foothill Yellow-Legged Frog, *Rana boylii*
Fish	Pacific lamprey, *Lampetra tridentata* Longfin Smelt, *Spirinchus thaleichthys*
Invertebrates	Sonoma Arctic Skipper, *Carteerocephalus palaemon* ssp Ricksecker's Water Scavenger Beetle, *Hydrochara rickseckeri*
Plants	Fragrant Fritillary, *Frillaria lilacae* Marin Knotweed, *Polygonum marinense* Alkali Milk-Vetch, *Astragalus tener var. tener*

The Petaluma River's fish population is quite diverse providing habitat for 25 species of marine, estuarine, and freshwater fish. Twelve of the twenty-five species are native to California. The Petaluma River (Creek/Slough) has never had a run of steelhead trout, which are currently listed as "threatened" by the National Marine and Fisheries Service.

3.9 Water Quality

The tributaries of the Petaluma River begin in the surrounding hills and meander through areas of varying land uses, each of which contributes some level of pollution and impacts both natural and man-made waterways.

The Petaluma River is influenced by tidal action from the bay and receives little fresh water inflow from May to November when there is little or no rainfall. With insufficient fresh water to flush the river during the summer months, temperature and salinity increase and reduce the ability of the water to hold oxygen. Inadequate dissolved oxygen not only contributes to an unfavorable environment for fish and other aquatic life but can also result in objectionable odors from anaerobic decomposition.

Water quality in the Petaluma River Basin is under the jurisdiction of the State Water Resources Control Board and its San Francisco Bay Region Water Quality Control Board. A Water Quality Control Plan for the San Francisco Bay Basin was developed by the Regional Board and adopted by the State Board in 1975. Amendments to the Water Quality Control Plan were adopted in 1982, 1986, and 1995.

The Petaluma River has been designated as a "water quality limited" segment in the 1982 amended Water Quality Control Plan. In the Water Quality Control Plan, a segment of the River basin can be classified as "effluent limited" if water quality objectives are met after the application of effluent limitations. If water quality objectives are not met, even after application of effluent limitations on point sources, the segment is then classified as "water quality limited" and additional control of non-point sources of pollutants would be needed to meet water quality objectives.

Monitoring water quality of the Petaluma River was performed by the Regional Water Quality Control Board in the mid-1970's. Major concerns were dissolved oxygen (DO) readings below minimum standards, with coliform bacteria and unionized ammonia sometimes exceeding maximum standards. Additional field biological studies were conducted and a subsequent report was issued 1981 in conjunction with the City of Petaluma's Wastewater Management Plan. In 1982, the State Water Resources Control Board (SWRCB) reported that "dissolved oxygen and nutrient problems persist (in the Petaluma River) producing seasonal fish kills."

The City of Petaluma has upgraded its wastewater treatment facilities and is currently subject to the following order of the SWRCB:

> "the discharge of wastewater to the Petaluma River is prohibited from May 1 through October 20 of each year. The Executive Officer may authorize discharge prior to October 20 or subsequent to May 1 based

> upon a demonstration that rainfall has produced adequate flushing flow in the Petaluma River."

This reliance on freshwater flows for the dilution and flushing of effluent discharge has been taken into consideration in developing flood control measures for the Petaluma River.

An easily identifiable water quality problem, which directly affects stream capacity, is sedimentation, particularly in the Petaluma River and adjacent tidal areas. Although the precise causes of sedimentation are less readily identifiable than the effects, they can be separated into those attributable to the natural sediment load of the streams and those attributable to the additional loads created by current, ongoing human activities.

The effects of sedimentation appear to be aggravated and magnified by past construction of levees and land fills in the tidal areas. Confinement of the natural waterway by levees has accelerated sediment buildup in the remaining unleveed areas. As a result, the flood-carrying capacity of the remaining waterway area is gradually diminished by sedimentation and soon the levees begin to lose their effectiveness.

Sediment from erosion in the upper tributaries of the watershed decreases the capacity of downstream and tidal waterways. The ACOE in 1933 removed over half-a-million cubic yards of sediment from the Petaluma River to improve its navigability. Since 1937, ACOE has dredged over three million cubic yards of deposited material from the river to maintain the navigable channel.

Some tributaries to the Petaluma River northwest of Petaluma are over 50 percent filled with sediment, believed to be primarily from natural sources. Although adoption of erosion control ordinances, such as the City of Petaluma's Ordinance 1576, helps to limit sedimentation produced from human activities, public funds have been and will continue to be used to remove this material from critical reaches of the waterway. (SCWA, 1986)

3.10 Groundwater

Groundwater resources are important in serving the water supply needs of the Petaluma area citizens, commerce, industry, and agriculture. The state of the aquifers and the groundwater quality are vital to the health of the watershed. The following discussion provides an overview of the groundwater resources in the Petaluma Watershed and is summarized from the SCWA's Master Drainage Plan.

Several physical factors control natural recharge of groundwater in an area, including:

- Slope of the land surface
- Permeability of the soils
- Subsurface geology
- Amount of available storage space in the aquifer

The largest concentration of soils suitable for recharge is northwest of the city of Petaluma. These soils have formed on the sandy Merced Formation and cover 28 percent of the land surface in this area. Many soils in this area, not classified as recharge areas, were excluded because land slope exceeded 15 percent. The Merced Formation in this area is essentially one continuous aquifer averaging 450 feet in thickness. Because few creeks cross the recharge areas, the major source of natural recharge to the Merced Formation appears to be from rain falling on suitable soils.

Other recharge areas dot the western uplands and are scattered on the western flank of the Sonoma Mountains. In these areas, most recharge is from rainfall because few streams flow across the recharge areas.

Soils suitable for recharge underlie portions of the city of Petaluma, having formed on top of a thin deposit of alluvium and, to a lesser extent, alluvial fan deposits and the Tolay Volcanics. The Petaluma River flows across some of these recharge areas, however, because there is little storage available in aquifers beneath these recharge areas, the loss of surface water to the ground water body is probably small. Because the Petaluma River is tidal and brackish at the City limits, an increase in river recharge in this area would not be desirable.

Ground water levels near the city of Petaluma dropped from the mid-1950's until the early 1960's, allowing greater intrusion of salt water into the aquifers along the lower Petaluma River. Delivery of Russian River Project water to the City of Petaluma began in 1962 with completion of the Agency's Petaluma Aqueduct (SCWA). This allowed reduction in the volume of municipal groundwater pumped and recovery of ground water levels. Ground water levels have remained relatively steady since that time except during the drought of 1976-77, and no appreciable change appears to have occurred in the last 20 years in the volume of ground water affected by sea water intrusion. As long as ground water pumping near the tidal portion of the Petaluma River does not substantially increase, the volume of affected ground water should not increase.

State Department of Water Resources' computer analysis indicates that the total groundwater storage capacity of the Petaluma Valley is 1,697,000-acre feet. Based on fall 1980 ground water levels, total water in storage was 1,420,000-acre feet - about 84 percent of the total capacity. This figure includes water of all quality types, including brackish water caused by seawater intrusion. The report states that natural topographic constraints prevent the Petaluma Valley ground water basin from filling to more than the 84 percent as indicated by the DWR's computer program. If the basins are more than the 84 percent full, the additional ground water begins to leak out along roadcuts and into streams as "rejected recharge". The report concludes that "The Petaluma Valley basin is therefore, in effect, completely filled at the present time." (DWR, June 1982)

3.11 Agriculture in the Watershed

Since European settlement in the 19th century, agriculture has been the dominant land use in the Petaluma watershed. Although the historic poultry production has declined, dairy continues to be an important agricultural industry. Dairy operations are found throughout the watershed, particularly in the San Antonio Creek watershed and Adobe Creek watershed. By December of 1997, there were 15 dairies remaining in the watershed.

Although vineyards were established in the Lakeville area before the Prohibition Era, the area was historically considered too cool for wine grapes. Vineyard development has increased in the watershed, particularly near Lakeville, along Highway 101, and in the San Antonio Creek watershed. Wine grape production is expected to expand rapidly in the next five years. In December 1997, there were approximately a dozen vineyards in the Petaluma watershed.

Other agricultural uses include livestock (beef and sheep), horses (including about five boarding and training facilities), oats (for silage, hay, or straw and seed), olives, truck crops, Christmas trees, poultry production (turkeys, chickens, ducks, and eggs), emus, llamas, greenhouses, and floral nurseries.

Poor management techniques can profoundly impact natural resources. These impacts can include:

- degradation of water quality. Excess nutrients (especially nitrogen), high salt content, high sediment loads, low oxygen, and high water temperatures from lack of streamside cover can impact water quality. For this plan, water quality concerns are addressed in Appendix B.
- loss of streamside or riparian vegetation from grazing or farming practices. Streamside vegetation helps cool creek water, filters runoff from pastures and paddocks, protects banks from erosion and provides wildlife habitat. See Appendix H for the status of the riparian areas in the Petaluma Watershed.
- upland erosion from farming and grazing practices or vineyard management, as well as ranch roads. A separate overview of erosion has been prepared (Appendix E).
- loss of wildlife habitat (including those in upland, aquatic, and tidal areas) from farming practices. Loss of upland habitat and changes in upland vegetation is addressed in the riparian study (Appendix H).

Table 4 - Enhancement Goals - Potential Sources of Funding and Technical Support

Goal A - Watershed Council				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Establish a local Watershed Council for residents and organizations to fund and coordinate watershed enhancement activities and keep one another informed.	Form a citizen-based Watershed Council to keep watershed residents informed of watershed planning and implementation efforts.	2 years	Elect or appoint chairperson, develop subcommittees. Establish a mission statement. Establish short and long term goals for the Watershed Council.	WC
			Conduct regular one-on-one and "kitchen table" outreach meetings to let watershed residents know about how to participate in watershed enhancement efforts and to identify potential watershed enhancement projects.	WC, RCD
			Keep landowners informed of watershed efforts, function as a clearinghouse for watershed and urban residents, sponsor enhancement efforts, and assist agencies and citizens in coordinating meetings.	WC, RCD
		5 years	Develop and maintain an Internet website. Post information about upcoming meetings, available funding, enhancement efforts and monitoring results. Link to other websites with enhancement information or Petaluma Watershed data.	WC
			Publish and distribute a watershed newsletter at least twice a year.	WC
		Ongoing	Inform landowners of monitoring methods and training through the Watershed Council.	WC, RCD UC Extension Farm Bureau
			Keep landowners informed of upcoming agency plans and actions related to the Petaluma Watershed.	WC, RCD

Table 4 - Enhancement Goals - Potential Sources of Funding and Technical Support

Goal A - Watershed Council				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Establish a local Watershed Council for residents and organizations to fund and coordinate watershed enhancement activities and keep one another informed.	Form a citizen-based watershed council to keep watershed residents informed of watershed planning and implementation efforts.	ongoing	Attend meetings of agencies and organizations (such as City of Petaluma, County Board of Supervisors, Farm Bureau, etc.) to keep them informed about landowner efforts.	WC City of Petaluma County of Sonoma
			Support sub-watershed community efforts (different areas have distinct issues and concerns).	WC
	Encourage local residents to take the lead in developing and implementing enhancement projects.	2 years	Work with the Department of Fish and Game to determine the presence and occurrence of steelhead in the watershed.	WC
			Encourage voluntary watershed activities including a student service learning component such as the Adopt-A-Watershed curriculum.	WC
			Assist in developing a TMDL for Petaluma watershed (develop reasonable water quality standards for a tidal slough).	WC, RCD RWQCB
		Ongoing	Encourage coordination of efforts for steelhead recovery where practical.	WC, RCD, USF&WS, DFG, City of Petaluma
			Assist agencies and citizens in coordinating meetings.	WC
			Set new short and long term goals for the watershed council.	WC
			Work collaboratively with City of Petaluma and Sonoma County in rural watershed projects.	WC, RCD, City of Petaluma, County of Sonoma
			Provide input to RCD planning and implementation efforts.	WC

Table 4 - Enhancement Goals - Potential Sources of Funding and Technical Support

Goal A - Watershed Council				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Establish a local Watershed Council for residents and organizations to fund and coordinate watershed enhancement activities and keep one another informed.	Encourage community involvement in developing flood hazard reduction measures that protect the local economy while conserving natural resources.	2 years	Keep informed of the cumulative impact of proposed flood hazard reduction projects on overall watershed resources and comment on proposed plans.	WC
		5 years	Coordinate with urban residents regarding common flooding issues.	City of Petaluma, RCD ACOE, FEMA
			Develop restoration projects to reduce factors contributing to flooding.	WC, City of Petaluma, RCD
			Inform community about impacts of upstream activity on flooding and habitat degradation.	WC, RCD
		Ongoing	Request a PL 566 Small Watershed Project from NRCS.	RCD
			Develop flood hazard reduction measures.	WC, City of Petaluma, RCD, County of Sonoma
			Assess conditions of levees in the lower watershed.	RCD Env. Consultant
			Recommend incorporating habitat enhancement measures into flood hazard reduction projects.	WC, RCD
	Seek funding and technical advice to attain goals B,C and D in collaboration with all watershed stakeholders.	2 years	Designate a member of the Watershed Council as grant. writer.	WC
			Identify where limited funding can most effectively be spent	WC
			Provide low-cost or free technical assistance to develop and implement conservation practices.	RCD, NRCS

Table 4 - Enhancement Goals - Potential Sources of Funding and Technical Support

Goal A - Watershed Council

Goal	Objective	Time Line Target	Recommended Actions	Potential Resource
Establish a local Watershed Council for residents and organizations to fund and coordinate watershed enhancement activities and keep one another informed.	Seek funding and technical advice to attain goals B,C and D in collaboration with all watershed stakeholders.	2 years	Watershed Council creates a list of grantors and permit guidelines to assist agricultural landowners with conservation practices, planning, permitting, and funding to implement conservation projects.	WC
		Ongoing	Seek funding for Watershed Council and enhancement implementation.	WC, RCD
			Seek and provide technical assistance for all willing landowners.	WC, RCD

Goal B - Improve Water Quality

Goal	Objective	Time Line Target	Recommended Actions	Potential Resources
Improve water quality and ground water recharge in the Petaluma River and its tributaries with the ultimate purpose of removing the Petaluma River from the RWQCB Impaired Waterbody List 303d.	Inform landowners of ways to prevent erosion and improve water quality and inform them of new and existing regulations.	2 years	Produce and distribute a *Creek Care Guide*. Topics could include erosion control, riparian management, wildlife habitat, nutrient and waste management, road maintenance, and proper drainage.	RCD
			Make the *Handbook for Forest and Ranch Roads* published by the Mendocino County Resource Conservation District available to watershed residents, free of charge or for a nominal cost.	WC, RCD
			Provide information about the sources and impacts of water pollutants including animal waste, fertilizers, household and ranch maintenance products and practices, etc.	AWC, RCD

Table 4 - Enhancement Goals - Potential Sources of Funding and Technical Support

Goal B - Improve Water Quality				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Improve water quality and ground water recharge in the Petaluma River and its tributaries with the ultimate purpose of removing the Petaluma River from the RWQCB Impaired Waterbody List 303d.	Inform landowners of ways to prevent erosion and improve water quality and inform them of s new and existing regulations.	Ongoing	Conduct research on the long-term water supply concerns for rural residents and agricultural operations, especially in San Antonio Creek. Consider how increases in water supply or water use will affect natural resources and development.	WC, SCWA
			Keep landowners up to date with new water quality information.	WC, RCD, NRCS, RWQCB, UCCE
			Assist residents in working with the Counties on well and septic installation and management to maintain or improve ground and surface water quality.	WC County of Sonoma
	Continue and expand current voluntary surface and groundwater monitoring programs.	2 years	Support local coordinator for monitoring outreach and coordination.	WC, RCD
			Conduct outreach to landowners about water quality.	RCD, WC
			Provide water quality monitoring kits to landowners.	WC, RCD
			Encourage U.C. Cooperative Extension and/or the RCD to hold monitoring workshops in the watershed.	WC, RCD
		5 years	Establish a watershed science team to evaluate, interpret, and make recommendations for further monitoring programs in the watershed.	WC, SFEI

Table 4 – Enhancement Goals – Potential Sources of Funding and Technical Support

Goal B – Improve Water Quality				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Improve water quality and ground water recharge in the Petaluma River and its tributaries with the ultimate purpose of removing the Petaluma River from the RWQCB Impaired Waterbody List 303d.	Continue and expand current voluntary surface and groundwater monitoring programs.	Ongoing	Assist landowners and organizations with volunteer water quality monitoring efforts.	WC, RCD, UCCE, RWQCB
			Keep watershed residents informed about water quality testing results and improvements.	DFG
	Reduce accelerated soil erosion and manage sediment loads.	2 years	Concentrate erosion control activities in high priority sub-watersheds of Willow Brook, Lynch, Adobe, Ellis, and San Antonio Creeks.	RCD, WC NRCS
			Seek funding and technical advice for landowners in the upper watershed for installation and maintenance of erosion control measures.	WC, RCD NRCS
		5 years	Complete stream channel stability, upslope erosion, and geomorphological studies. The *Erosion and Sedimentation in the Petaluma River Watershed* (see Appendix E) recommends that these studies be conducted in sub-watersheds with complicated system- wide erosion problems—Lichau Creek, portions of Willow Brook Creek, upper Lynch Creek, upper Washington Creek, upper Adobe Creek, and San Antonio Creek.	WC, RCD Env. Consultant
			Manage livestock access to creeks and gullies, especially in the wet season.	LANDOWNERS
			Provide workshops and conduct other outreach. Topics could include "do-it-yourself" erosion control, small farm and pasture management, and reducing rill and sheet erosion for pastures and corrals.	UCCE, RCD NRCS

Table 4 - Enhancement Goals - Potential Sources of Funding and Technical Support

Goal B - Improve Water Quality				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Improve water quality and ground water recharge in the Petaluma River and its tributaries with the ultimate purpose of removing the Petaluma River from the Waterbody List 303d.	Reduce accelerated soil erosion and manage sediment loads.	Ongoing	Maintain drainage ditches, spillways, culverts, etc. to avoid overtopping and delivery of sediment to the streams.	Landowners
			Improve upstream waterways for flood and sediment control by planting native species.	Landowners Petaluma A-A-W WC, RCD
			Maintain erosion control measures in the upper watershed.	Landowners WC
	Encourage natural stream morphology as a means of flood control and ground water recharge.	Ongoing	Collect information on ground water recharge and encourage recharge.	WC, County of Sonoma SCWA
			Promote water conservation throughout the watershed.	City of Petaluma County of Sonoma
			Reduce unnecessary diversions from creeks.	Landowners County of Sonoma
			Encourage maintenance of summer stream flow - for example, canopy cover.	City of Petaluma SCWA
			Maintain existing summer stream flow and avoid depleting instream pools of water in the summer.	Landowners City of Petaluma SCWA

Goal C - Support Agricultural				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Support the viability of agriculture in the community.	Support and seek funding for demonstration project to retain on-site and properly manage waste tires used historically for erosion control.	2 years	Seek funding for tire demonstration project on rural lands.	RCD, County Health, CIWMB
			Begin demonstration project for tires on rural lands.	Landowners WC, RCD

Table 4 – Enhancement Goals – Potential Sources of Funding and Technical Support

Goal C - Support Agricultural				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Support the viability of agriculture in the community.	Support and seek funding for demonstration project to retain on-site and properly manage waste tires used historically for erosion control.	5 years	Remove threat of violation from existing waste tires used for erosion control by working with CIWMB to develop acceptable standards for legacy waste tire remediation.	RWQCB, EPA, CIWMB, RCD, WC
	Continue to provide information about technical and financial assistance for agriculture.	2 years	Investigate financial incentives for landowners who plant trees along the riparian corridor or voluntarily take land out of production.	WC, RCD
			Seek financial incentives to encourage stakeholders to leave buffer space along creeks on a voluntary basis.	WC, RCD
		5 years	Provide assistance to property owners for self-diagnosing erosion problems, for developing possible solutions (especially those that are practical and stay away from regulatory concerns), and identifying projects that residents can do themselves.	RCD, NRCS
			Compile and distribute information on best management practices to ranchette owners.	WC, RCD, NRCS
			Compile and distribute information on best management practices to agriculture operations.	WC, RCD, NRCS
		Ongoing	Provide information about upland grazing management.	RCD, NRCS
			Encourage the use of best management practices for hillside vineyards.	Ag. Commissioner RCD, SCGGA
			Support programs such as agriculture easements to protect farmlands on a voluntary basis.	Open Space District RCD

Table 4 - Enhancement Goals - Potential Sources of Funding and Technical Support

Goal C - Support Agricultural				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Support the viability of agriculture in the community.	Provide technical information to interested agriculture operators about the potential benefits and detriments of using reclaimed waste water.	5 years	Identify best management practices for using reclaimed water and biosolids.	SCWA, City of Petaluma
			Provide information about obtaining reclaimed water and biosolids and uses for them.	SCWA, City of Petaluma
		Ongoing	Support users of reclaimed wastewater to develop irrigation management plans.	SCWA, City of Petaluma
			Work with the City and County provide more reclaimed water for agricultural use.	SCWA, City of Petaluma
			Support the availability and responsible use of bio-solids and reclaimed water for interested agricultural users.	SCWA, City of Petaluma
	Support economic sustainability and stewardship activities of agricultural and rural residents.	2 years	Hold ranch and vineyard planning workshops for both small and large landowners and managers.	RCD, SCGGA
			Assist rural residents with conservation practices, planning, permitting, and funding to implement conservation projects.	WC, RCD
			Inform residents about importance of agriculture to the local economy and about farming operations. Provide weekend tours and newsletters, and/or newspaper articles.	WC, RCD
		5 years	Work cooperatively with regulatory agencies in streamlining permits for levee and ditch maintenance and agricultural operations.	WC, RCD
			Develop a recognition program that acknowledges historical and current stewardship of the land by agriculture.	WC, RCD, County of Sonoma

Table 4 - Enhancement Goals - Potential Sources of Funding and Technical Support

Goal C - Support Agricultural				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Support the viability of agriculture in the community.	Support economic sustainability and stewardship activities of agricultural and rural residents.	5 years	Provide outreach to urban community about benefits of agriculture in the watershed.	WC, City of Petaluma, RCD, County of Sonoma
			Develop a horse ranch management manual similar to the vineyard management manual.	RCD, NRCS, UCCE
			Hold conservation planning workshops for ranchette owners.	RCD, UCCE
		Ongoing	Support willing levee owners with stewardship practices that conserve or enhance wildlife habitat.	WC, RCD
			Maintain long term landowner control of enhancement and implementation actions in the watershed.	WC
			Support best management practices for manure disposal.	WC, RCD

Goal D - Wildlife Habitat				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Conserve and enhance existing wildlife habitat.	Protect, preserve and restore riparian corridors in the watershed.	2 years	Compile and distribute list of plants best for revegetation efforts.	RCD, UCCE Circuit Rider Productions
			Begin to revegetate gullied areas with appropriate materials.	Landowners RCD, AmeriCorps
		5 years	Select enhancement projects that conserve or improve the habitat of endangered species. Follow any specific terms and and conditions set by US Fish and Wildlife Service and National Marine Fisheries Service	Landowners RCD

Table 4 - Enhancement Goals - Potential Sources of Funding and Technical Support

Goal D - Wildlife Habitat				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Conserve and enhance existing wildlife habitat.	Protect, preserve and restore riparian corridors in the watershed.	5 years	Devise a plan to try to control invasive exotic plant species.	Ca. Exotic Pest Control
		Ongoing	Encourage the use of native species for riparian restoration.	WC, RCD
			Protect intact sections of the riparian corridor.	Landowners RCD
			Revegetate high and medium priority sites identified in *Riparian Plant Community* (Appendix H). Work with willing landowners. High and medium priority sites include the opportunity to provide contiguous riparian forest habitat between an upper and lower reach of a stream, expand existing habitat, fill out areas of sparse cover, and provide cover in areas with a potential for high erosion. Inform community about local endangered species.	NRCS, RCD AmeriCorps
			Avoid depleting instream pools of water during the summer.	Landowners SCWA
	Encourage community pride in watershed's natural resources.	2 years	Inform community about local wildlife enhancement potential with brochures and workshops.	WC, RCD, NRCS
			Conduct outreach about the importance and uniqueness of the Petaluma Marsh.	WC, RCD City of Petaluma
		5 years	Prepare and distribute information to the public about wildlife habitat needs, including steelhead and marsh species, and how residents can help enhance habitat. Include information on reducing summertime water diversions.	WC, RCD, NRCS USFWS
			Create manual on how residents can help enhance wildlife habitat.	RCD, NRCS, DFG, USFWS

Table 4 – Enhancement Goals – Potential Sources of Funding and Technical Support

Goal D - Wildlife Habitat				
Goal	**Objective**	**Time Line Target**	**Recommended Actions**	**Potential Resources**
Conserve and enhance existing wildlife habitat.	Encourage community pride in watershed's natural resources.	5 years	Provide workshops or other written materials for residents about the importance of healthy riparian corridors to, wildlife, erosion control, and water quality; do-it-yourself revegetation with native plants; how to maintain creek habitats; and available resources and technical assistance.	RCD, NRCS
		Ongoing	Get community involved with observing and preserving anadramous fish habitat.	RCD, USFWS DFG
			Support efforts to improve habitat for steelhead, songbirds, waterfowl, pond turtles, and other native wildlife species in the watershed. Concentrate on improving riparian habitat.	WC, RCD
			Provide technical assistance to school and community groups working on revegetation projects.	RCD Petaluma A-A-W
	Work with agencies to establish criteria for steelhead habitat.	2 years	Incorporate steelhead habitat-related parameters into watershed monitoring (i.e., turbidity sampling, using aerial photographs to identify changes in riparian cover, etc.)	DFG, USFWS
		5 years	Use the Department of Fish and Game protocol to evaluate the quality of steelhead spawning and rearing habitat. Focus on reaches being restored by watershed residents.	DFG, USFWS
			Focus steelhead restoration efforts on tributaries that do, or potentially can, support steelhead. These are Lichau Creek, Adobe Creek, San Antonio Creek, and possibly Lynch Creek and Willow Brook Creek.	WC, RCD DFG, USFWS

4.4 Summary of Appendices

Several technical studies were conducted in conjunction with the Petaluma Watershed Enhancement Plan. A summary of the technical appendices follows.

Appendix A Land Use in the Petaluma Watershed - Prunuske Chatham, Inc., 1997.

This report summarizes available land use and watershed enhancement information from the City of Petaluma, Sonoma County, and other sources. It includes an overview of the historic relationship between the city and county regarding land use planning, as well as an identification of land use concerns related to agricultural sustainability, natural resources, and rural community quality of life.

Appendix B Ground Water Quality in the Petaluma Watershed - Southern Sonoma County Resource Conservation District, 1998.

This report evaluates ground water quality and contamination in the Petaluma watershed. Cumulative data has shown that up until 1984, when the last study was completed, Petaluma's ground water quality had continually degraded. Historical problems have been identified with excessive nitrates, electrical conductivity (salts), coliform bacteria, and mineral constituents associated with seawater intrusion and connate water sources.

Appendix C Water Quality Monitoring Guidelines for the Petaluma Watershed - Southern Sonoma County Resource Conservation District, 1998.

This report is designed to provide landowners and residents with an introduction to existing monitoring data, data gaps, monitoring guidelines and recommendations for the Petaluma River watershed. These guidelines are designed to steer future monitoring projects. Further evaluation and assessment by the monitoring group is recommended before enacting a monitoring program.

Appendix D Flood Control Impacts in the Petaluma Watershed - Prunuske Chatham, Inc., 1998.

This summary is a compilation of existing information on flood control. It outlines proposed flood control projects within the watershed and describes potential habitat impacts from these projects. The summary also has an attached map of flood areas within the watershed. The ACOE and the City of Petaluma are beginning a channel widening project in the troubled Payran reach of Petaluma that will accommodate a 40-year flood event. Downstream of the City, large areas of agricultural land are dependent on a system of levees. In the winter of 1997/98 levees in the Lakeville area were overtopped by the high flows in the river.

Appendix E Erosion and Sedimentation in the Petaluma Watershed - Prunuske Chatham, Inc., 1998.

This report identifies priority sub-watersheds for erosion control work. It gives an overview of why erosion is of concern in the watershed, describes the methods used to prepare this summary, presents an overview of slope stability and landslides, and lists enhancement recommendations and opportunities. Beginning on page 14, each sub-watershed is characterized in terms of location, land use, soils, and erosion. Recommendations are listed for each sub-watershed. A base map delineating the sub-watersheds of the Petaluma River and showing their erosion repair priority is attached.

Appendix F PSIAC Model: Sediment Yields in Sub-watersheds of the Petaluma River - Southern Sonoma County Resource Conservation District, 1998.

The Pacific Southwest Inter-Agency Committee (PSIAC) study estimates average annual rates of sediment yield from five major tributaries into the Petaluma River. Sediment yield may be defined as the volume of sediment that reaches some arbitrary point in the watershed, for the Petaluma watershed that arbitrary point is the valley floor. The five sub-watersheds chosen were Lichau, Willow Brook, Lynch, Adobe and San Antonio. Each sub-watershed was chosen based on a number of factors including historical data available, accessibility and existing riparian habitat. Criteria should be developed to prioritize the sub-watersheds in terms of sediment reduction potential and/or technical feasibility. Elements of the criteria may include results of this sediment yield report, land ownership, potential cooperators, road network, feasibility of restoration, erosion control, and other pertinent factors.

Appendix G Marsh/Bay Habitat in the Petaluma Watershed - Prunuske Chatham, Inc., 1998.

The Marsh/Bay Habitat report illustrates overall marsh related habitat concerns. The three federally listed species that depend on the marsh habitat are the California Black Rail, the California Clapper Rail and the Salt Marsh Harvest Mouse. This summary describes the habitat of these species, their predators, historic and current range, the role of the U.S. Fish and Wildlife Service (USFWS) consultations and recommendations.

Appendix H Riparian Plant Community Enhancement in the Petaluma Watershed - Prunuske Chatham, Inc., 1998.

This study is an overview of riparian conditions outside the Petaluma urban boundary and is designed to identify recommendations for SSCRCD and the watershed advisory group to consider. The report describes the methods used in conducting the overview survey, the historic and current riparian communities and conditions in the watershed, and a list of recommendations to enhance the riparian corridor. A characterization of each of the creeks and sub-watersheds is included and contains enhancement opportunities. Watershed maps and references are also included.

Appendix I Fisheries Enhancement in the Petaluma Watershed - Prunuske Chatham, Inc., 1998.

This report contains background information on the fishery resources in the Petaluma River, focusing on anadromous fish; it lists habitat needs for steelhead and identifies areas and actions for enhancement. A map showing current and estimated historic steelhead runs is attached. This summary tries to balance recognition of the fact that the

Petaluma River has never been an outstanding salmonid stream and a commitment to enhance resources for all native species in the watershed.

Appendix J Monitoring California's Annual Rangeland Vegetation - University of California Cooperative Extension, 1990.

This report contains information about various methods of monitoring rangeland vegetation. Some of the many purposes of monitoring rangeland vegetation are to determine range grazing capacities, provide for better herd management, identify actual impacted resource areas, or to determine the effects of various levels of livestock use on plant succession.

Appendix K Record of Public Comment - Southern Sonoma County Resource Conservation District, 1999.

The public comment contained within this appendix includes comments that did not directly relate to specifics of the Plan, were not a consensus of opinion, or were submitted too late in the process to be incorporated into the document.

5.0 Agency Assistance and Permit Reference

This section describes the permits generally necessary for watershed restoration and enhancement work. These permits are required of agriculture and vineyard owners as well as individual landowners conducting work or sponsoring agencies such as SSCRCD. Local assistance is available to landowners in terms of financial support for qualifying projects and technical advice in ranch planning.

Cost Share Programs

The NRCS administers the Environmental Quality Incentives Program (EQIP). The 1996 Farm Bill replaced the Agricultural Conservation Program (ACP) cost-share program with the EQIP program. Many agencies are involved in determining eligibility and project development. Landowners are encouraged to contact the USDA Farm Service Agency for application and eligibility requirements as a first step in applying for EQIP funds.

SSCRCD convenes a local work group consisting of staff from the Natural Resources Conservation Service, Farm Service Agency, the Farm Service Agency County Committee, Farm Bureau, UC Cooperative Extension, Regional Water Quality Control Board, California Department of Fish and Game, California Department of Forestry, and others as appropriate. This local workgroup gives final approval for local individual projects that then must go to the state level for approval. The federal government's share of the cost is typically 70% with the landowner bearing 30%; this proportion is sometimes negotiable. The contract term is typically 5 to 10 years with a stipulation that a minimum term for structural work is during a one-year period and management practices would be completed during four years (or vice versa). The EQIP program requires a Conservation Plan be prepared that focuses on natural resource concerns.

Conservation, Ranch, Farm Planning

What is a Conservation Plan? A conservation plan is a voluntary effort involving the processes of setting goals, inventorying ranch resources, assessing water quality concerns and evaluating existing management practices. Once the plan is completed, implementing a monitoring program will help achieve set goals and evaluate the effectiveness of the management practices.

The purpose of a conservation plan is to develop a plan that will provide the landowner with a comprehensive integrated understanding of the past, present, and future management decisions and developments of their property. It follows a step by step process to meet the producer's goals and to assess the impact those goals may have on the natural resources in that watershed.

The role of a conservation plan in addressing water quality is becoming increasingly important as regulators look for landowners to demonstrate voluntary compliance with water quality laws. Writing a conservation plan will not exempt ranchers from water quality regulations, but both the CDFG and the RWQCB encourage cooperative conservation planning and recognize that conservation plans demonstrate an effort toward voluntary compliance. The RWQCB has stated that when accidental water quality violations occur, operators who are following conservation plans consistent with the appropriate Animal Waste Management Guidelines of the Sonoma Marin Animal Waste Committee (AWC) will receive additional consideration when the level of enforcement is determined.

Elements of a Conservation Plan. A conservation plan can be written many different ways. For range livestock operations, a plan can be fairly simple, but for dairies or confined animal facilities a conservation plan should be quite technical. All plans should involve the following components; introduction, facilities inventory, livestock and ranch operations, natural resources inventory, ranch condition assessment, planned management practices, and a monitoring program.

The introduction should identify the ranch location and ownership. It would also include the purpose of the plan and the operator's goals. Typically, ranch plan goals include production goals, quality of life goals, and landscape goals, though other categories can be added. Water quality goals would be included in landscape goals.

Facilities inventory should list and evaluate the condition of buildings, roads, corrals, feedlots and fences. This will help to identify capital improvements that may be needed. The pastures should be inventoried for size, forage type, and production. The inventory should also include improvements such as water developments, livestock crossings and erosion control structures.

The livestock and ranch operations section should describe current management practices that involve animal (both livestock and wildlife) and forage management. This section can include a calendar of ranch operations, grazing schemes, a pasture use calendar, and the calculated stocking rate and yearly forage demand.

The natural resources inventory describes the natural resources of the ranch. It should include the existing natural resources: vegetation, wildlife, soils, and the watershed and creeks.

A ranch condition assessment evaluates the condition of resources and facilities that have been inventoried. Conditions or problems that could prevent fulfillment of stated goals should be listed and described. Examples include overgrazed areas, gullies and other erosion sites, lack of streambank vegetation, brush encroachment, inadequate stock water, and weed and poisonous plant infestations. This section should also address nutrient sources (animal waste), quantities, and disposal methods.

A Planned Management Practices section should describe ways to address nonpoint source pollution from animal waste and sediment sources. It can include a discussion of the technical and economic feasibility of solving problems listed in the assessment section. A timetable for implementing selected practices can be included along with an assessment of long- and short-term impact of these practices. This section is the most critical in determining how to reach and maintain water quality goals.

A monitoring program should identify parameters to be monitored, locations and frequency of monitoring. Monitoring may be in the form of notes on observations of overall ranch operations, photographs, or actual measurements including residual dry matter (RDM), water testing, ranch condition and trend sampling. The purpose of monitoring is to determine if progress is made toward the goals established by the ranch operator. Monitoring provides information for timely management decisions and it documents the impacts of those decisions.

Essential plan components should include:

- an assessment of potential and existing water quality problems
- a description of and schedule for addressing these problems
- a nutrient budget (for dairies and confined animal facilities)
- a manure disposal plan (for dairies and confined animal facilities)
- a monitoring plan for ongoing work/testing.

<u>Where to go for Assistance</u>. Conservation planning assistance is available through the University of California Cooperative Extension and the Natural Resource Conservation Service (NRCS), an agency of the U.S. Department of Agriculture. NRCS provides free help through this voluntary participation program which is available to all land users through the Resource Conservation Districts. Resource Conservation Districts are local units of government (special districts under the State) which are guided by a governing board made up of local farmers, ranchers, other land users, and community leaders. Help from your local NRCS Soil Conservationist may be requested through the Southern Sonoma County Resource Conservation District.

Although most NRCS assistance is provided to farmers and ranchers on cropland, pasture, rangeland, and forest land, you can also get assistance with solving conservation problems on nonagricultural land uses, such as controlling erosion on construction sites or on public lands.

Conservation plans should be working documents that are revised as needed. Ranch plans and supporting data should be kept on-site at the ranch where it is available for easy reference and updating. Should a water quality problem occur, the conservation plan can be presented to regulatory agencies at that time.

Local Permits

The Sonoma County Public Works Division requires grading permits for streambank stabilization and similar projects.

Sonoma County Permit and Resource Management Department
(707) 527-1900
2550 Ventura Ave.
Santa Rosa, CA 95403

Regional Permits

The San Francisco Bay Conservation and Development Commission (BCDC) requires a permit for levee maintenance or work within 100 feet of the bay waters.

S.F Bay Conservation and Development Commission
(415) 557-8778
30 Van Ness Ave.
San Francisco, CA 94102

State Permits

The California Department of Fish and Game (DFG) requires Streambed Alteration Agreements for work that occurs in defined waterways. Under Streambed Alteration Agreements, repair projects must generally be completed by October 1st of each year.

California Department of Fish and Game
(707) 944-5525
Region 9
P.O. Box 47
Yountville, CA 94599

State Permits - (Cont.)

The San Francisco Bay Regional Water Quality Control Board (RWQCB) issues water quality certifications (401 certification) for all projects requiring permits from the ACOE (see below). This is to ensure that ACOE permits (including non-reporting Nationwide Permits) meet California's water quality standards. The application consists of a letter, description of the project, potential water quality impacts, proposed revegetation, and sketches.

Regional Water Quality Control Board
(510) 622-2300
1515 Clay Street, Suite 1400
Oakland, CA 94612

Federal Permits

The U.S. Army Corps of Engineers (ACOE) issues permits for work done in waters under their jurisdiction. As defined by ACOE, in non-tidal areas this extends up to the ordinary high water line or the upper limit of wetlands. For tidal waters, this extends up to the line of high tide (for dredge or fill), or up to the mean high water line. The ACOE and BCDC have issued a special Section 404 (of the Clean Water Act) blanket permit for levee maintenance in the Sonoma Creek and Petaluma Watershed drainages. The permit is administered by SSCRCD. The permit has been reissued since 1980, although not without review and input by several regulatory agencies. The SSCRCD anticipates that the current permit, which is good for five years, will be renewed for another five years.

SSCRCD is now working on an ACOE Section 10 permit renewal that would allow landowners to clean existing drainage ditches in the Petaluma River area.

Watershed restoration projects often come under ACOE nationwide Permit 27. Depending on the specific details of the repair, the ACOE may require advance notification of the work. There is no filing fee, but response can take up to one year.

The ACOE requires a permit for ripping ground in wetland areas.

U.S. Army Corps of Engineers
415) 977-8439
San Francisco District
33 Market St.
San Francisco, CA 94105

6.0 Glossary

Adopt-A-Watershed - An integrated K-12 science curriculum which uses a local watershed as a focal point for bringing theory into application. Students participate in hands on activities, making science directly applicable and relevant to their lives by allowing students to undertake field studies, restoration projects, and community action projects in which they apply these concepts.

Advisory Committee (AC) - A committee consisting of local landowners, residents, local interest groups and representatives from Local, State, Federal agencies whose role is to provide input and/or support toward watershed planning efforts.

Anadromous fish - Fish that live some or all of their adult lives in saltwater but migrate to freshwater to spawn.

Aquifer - A geologic layer of permeable rock, sand, or gravel that is water bearing and is often times a source for well water.

Baseline data - A selected set of data that forms a known starting point that will enable determining of system status and help determine trends as the system changes.

Bedrock - The solid rock underlying the soils of the earth's surface.

Best Management Practices (BMPs) - Accepted conservation practices used by land stewards that are designed to be the most effective and practicable way in addressing local watershed concerns.

Biodiversity - Biological diversity; variety of life forms in a given area.

Cover crop - A close-growing crop used primarily for the purpose of protecting or improving soil between periods of regular crop production or between trees and vines in orchards or vineyards.

Effluent – To flow out; an outflow of waste, as from a sewer; an outflow from a river out of a lake.

Endangered species - Wild species with so few individual survivors that the species could soon become extinct in all or most of its natural range.

Endemic - prevalent in or restricted to a particular locality.

Exotic species - A species of plant or animal that belongs by nature or origin to another part of the world.

Geographic Information System (GIS) - Technology that links traditional map information with computer database information about particular locations by allowing users to enter, manage, analyze, and output information.

Groundwater recharge - The process involved in the absorption and addition of water to the zone of saturation.

Habitat - An area in which an organism or population of organisms survive.

Land stewardship - A land ethic of cultural value set that promotes existing land use practices that protect the resources for succeeding generations.

Native species - Species that normally live and thrive in a particular ecosystem.

Natural resources - The soil, water, air, plants, animals, and geologic processes created by the earth's natural processes.

Nonpoint source pollution - Pollution that enters water from dispersed and uncontrolled sources, such as surface runoff, rather than through pipes. Nonpoint source (e.g., forest practices, agricultural practices, on-site sewage disposal, automobiles, and recreational boats) may contribute pathogens, suspended solids, and toxins. While individual sources may seem insignificant, the cumulative effects of nonpoint source pollution can be significant.

Point source pollution - A single identifiable source that discharges pollutants into the environment. Examples are the smokestack of a power plant or an industrial plant.

Rill erosion - An erosion process in which numerous small channels of only several centimeters in depth are formed; occurs mainly on recently cultivated soils.

Riparian - Pertaining to a river or stream.

Runoff - Rain water and melting ice that flows on the earth's surface into nearby streams, lakes, wetlands, and reservoirs.

Salmonid - Any species of a genus of Pacific Ocean fishes from the salmon or trout family that can breed in rivers and stream tributaries to the North Pacific.

Sheet erosion - The removal of a fairly uniform layer of soil from the land surface by surface runoff.

Spawn - To produce as spawn; deposit eggs or roe.

Stakeholder - an entity (individual/agency/group) who has an interest or responsibility or livelihood in the activities within the watershed and its health.

Water Rights - Specific policies governing rights to water.

Watershed – An entire drainage area that delivers water, sediment, and dissolved substances via streams and rivers.

Wetland - Land that: 1) has a predominance of hydric soils, 2) is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions, 3) does support a prevalence of such vegetation under normal circumstances.

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Appendix A

Land Use in the Petaluma River Watershed

Land Use in the Petaluma River Watershed

Prepared for
Southern Sonoma County Resource Conservation District
Petaluma River Watershed Enhancement Plan

Prepared by
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Southern Sonoma County Resource Conservation District has contracted with Prunuske Chatham, Inc., an environmental consulting firm located in Occidental, to produce this document entitled *Summary of Land Use in the Petaluma River Watershed.*

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SUMMARY OF LAND USE IN THE PETALUMA RIVER WATERSHED

1.0 Introduction

The Petaluma River and its receiving water, San Pablo Bay, are on California's Impaired Waterbody 303(d) list. [1] The San Francisco Bay Regional Water Quality Control Board (RWQCB) identifies the main pollutants as sedimentation, high nutrient levels, and animal waste, which causes the coliform standard to be exceeded. In response to this listing, the Southern Sonoma County Resource Conservation District (SSCRCD) applied for and received 205(j) grant funding from the RWQCB to develop a plan for the Petaluma River watershed. The planning area for SSCRCD's watershed plan includes all areas outside the limits of the City of Petaluma (City).

One component of the planning process is to develop a summary of land use in the Petaluma River watershed. The goal of the summary is to assist SSCRCD's watershed advisory group in developing land use goals and recommendations for the watershed plan. This report summarizes available land use and watershed enhancement information from the City, Sonoma County, and other sources. It includes an overview of the historic relationship between the City and Sonoma County regarding land use planning, as well as an identification of land use concerns related to 1) agricultural sustainability, 2) natural resources, and 3) rural community quality of life. Recommendations by the watershed advisory group are identified. Appendix A is a summary of permits required for watershed restoration work.

2.0 Watershed Overview

The Petaluma River watershed is located in southern Sonoma County and a portion of northeastern Marin County. It drains a 146 square mile, pear-shaped basin (see attached Map of the Petaluma River Watershed). It is approximately 19 miles long and 13 miles wide with the City near its center. U.S. Highway 101 bisects the watershed valley. Mountainous or hilly upland areas comprise 56% of the watershed, 33% percent of the watershed is valley, and the lower 11% is salt marsh. Sonoma Mountain at 2,295 feet is the highest point in the watershed. The Petaluma River empties into the northwest portion of San Pablo Bay.

The headwaters and ephemeral tributaries begin on the steep southwest slopes of Sonoma Mountain, the southern slopes of Meacham Hill, and the eastern slopes of Wiggins Hill and Mt. Burdell. The confluence of Willow Brook, Liberty, and Wiggins Creeks form the headwaters of the Petaluma River just upstream of Rainsville Road and Stony Point Road. The Petaluma

[1] Impaired refers to the limited capacity of the river to assimilate or flush waste.

River itself flows across the Denman Flat area and through the City. Tidal influence extends upstream of the confluence with Lynch Creek beyond the railroad crossing.

The lower 12 miles of the Petaluma River flow through the Petaluma Marsh, the largest remaining salt marsh in San Pablo Bay. The marsh covers 5,000 acres and is surrounded by approximately 7,000 acres of reclaimed wetlands. Prior to reclamation, marshland ranged from mean sea level to 3 feet above mean sea level.

Major tributaries in the eastern portion of the watershed include Lichau Creek, which flows into Willow Brook Creek and feeds into the Denman Flat area near Stony Point Road and Rainsville Road, Lynch Creek, Adobe Creek, and Ellis Creek. These tributaries flow through both unincorporated land and land within the City limits before joining the Petaluma River.

There are three major creeks on the western side of the watershed. Wiggins Creek and Marin Creek flow into Liberty Creek, which also feeds into Denman Flat. The largest subwatershed is San Antonio Creek located in the western portion of the watershed south of Petaluma. It flows from near Laguna Lake in Chileno Valley to the Petaluma Marsh and divides Marin and Sonoma counties. In the lower watershed, small tributaries drain into the river and marsh areas.

3.0 Watershed Land Uses

Land uses in the watershed include intensive urban development, rural residential, agriculture, and open space (see attached Map of the Petaluma River Watershed).[2] Urban development is concentrated within the City limits. Limited commercial and rural residential development is located in the community of Penngrove.

3.1 Rural residential.

Ranchettes or large lot, rural residential development are found throughout the watershed. These rural properties typically range from one to 20 acres and are not usually part of development tracts. Many rural residents keep livestock, such as sheep and horses. On the eastern side of the watershed, rural residential areas surround Penngrove and extend into the Lichau Creek and Lynch Creek areas. On the western side of the watershed, the rural residential areas outside the City (Liberty Road, Rainsville Road, Skillman Lane, Middle Two Rock Road, and Eastman Lane) are expanding.

[2] The land use map is from the 1989 Sonoma County General Plan. The County is in the process of updating the General Plan.

3.2 Agriculture.

Since European settlement in the 19th century, agriculture has been the dominant land use in the Petaluma River watershed. Although the historic poultry production has declined, dairy continues to be an important agricultural industry. Dairy operations are found throughout the watershed, particularly in the San Antonio Creek and Adobe Creek subwatersheds. In December, 1997, there were 15 dairies in the watershed.

Although vineyards were established in the Lakeville area before the prohibition era, the area was historically considered too cool for wine grapes. Vineyard development has increased, particularly near Lakeville, along Highway 101, and in the San Antonio Creek subwatershed. Wine grape production is expected to expand rapidly in the next five years. In December, 1997, there were approximately a dozen vineyards in the Petaluma River watershed.

Other agricultural uses include livestock (beef and sheep), horses (including about five boarding and training facilities), oats (for silage, hay, or straw and seed), olives, truck crops, Christmas trees, poultry production (chickens, ducks, and eggs), emus, llamas, greenhouses, and floral nurseries.

Eight properties in the watershed, totaling 2,946 acres, have conservation easements with the Sonoma County Agricultural Preservation and Open Space District. Two of these properties have future potential for public access; the others are in agricultural production, including hay, sheep, dairy, and grazing use. Two properties in Sonoma County adjacent to the watershed boundary also have conservation easements totaling 736 acres. Five ranches on the Marin County portion of the San Antonio Creek subwatershed have easements with Marin Agricultural Land Trust.

Agricultural activities can profoundly impact natural resources. These impacts are listed briefly here, and most will be addressed in other study components of SSCRCD's watershed enhancement plan. These impacts can include:

- **Degradation of water quality.**
  Excess nutrients (especially nitrogen), high salt content, high sediment loads, low oxygen, and high water temperatures from lack of streamside cover can impact water quality. For this plan, water quality concerns are addressed in a separate summary.

- **Loss of streamside or riparian vegetation from grazing or farming practices.**
  Streamside vegetation helps cool creek water, filters run-off from pastures and paddocks, protects banks from erosion and provides wildlife habitat.

For this plan, a separate report entitled *Summary of Riparian Community Enhancement in the Petaluma River Watershed* has been prepared.

- **Upland erosion.**
  Upland erosion can be caused by farming and grazing practices or vineyard management, as well as ranch roads. For this plan, a separate report entitled *Summary of Erosion and Sedimentation in the Petaluma River Watershed* has been prepared.

- **Loss of wildlife habitat from farming practices.**
  Wildlife habitat loss from farming practices can occur in upland, aquatic, and tidal areas. For this plan, habitat issues relating to salmon and steelhead, the federally-listed endangered California clapper rail, California black rail, and salt marsh harvest mouse are discussed in the *Summary of Fisheries Enhancement in the Petaluma River Watershed* and *Summary of Marsh/Bay Habitat in the Petaluma River Watershed.*

- **Loss of upland habitat and changes in upland vegetation are addressed in *Summary of Riparian Community Enhancement in the Petaluma River Watershed.***

3.3 Open space.

Open space land includes local and state parks, as well as preserves. The 1,950 acre Petaluma Marsh Wildlife Area is managed by the California Department of Fish and Game (CDFG). It is located approximately six miles southeast of the City and is bordered by the Petaluma River on the east, San Antonio Creek on the south, private property (Neils Island) on the west, and Schultz Slough on the north. The 300-acre Rush Creek Marsh, which is managed by Marin County Open Space District, is located south of Basalt Creek and north of Novato. The State Coastal Conservancy (SCC) and U.S. Fish and Wildlife Service (USFWS) own and manage approximately 430 acres of marsh as part of the Baylands Project.

The Sonoma Land Trust owns and manages 472 acres of marshlands south of Petaluma on both sides of Highway 37. This land is currently leased as farmland. The Land Trust also has an agricultural preservation easement on an additional 528 acres. They have a contract with State Lands Commission (SLC) to monitor an approximately 50-acre parcel that has been restored to tidal wetlands.

The City owns the 300-acre Petaluma River Marsh, Lafferty Ranch on Sonoma Mountain, small parcels related to water supply on Manor Road, the Petaluma River Marina, oxidation ponds and related facilities near Lakeville, Schollenberger Park (a dredge disposal site), Rocky Dog Memorial Park (on an old landfill), the Alman Marsh near the marina, a portion of the McNear

Peninsula near downtown, and 160 acres of marsh and oxidation ponds near Schollenberger Park.

On the eastern side of its boundaries, the City owns a municipal airport on East Washington Street, Prince Park, Wiseman Park, a golf course, and urban separator lands. The City is planning for two major open space acquisitions—the Gray property and floodplain areas for the Petaluma River Greenway.

Other open space land in the watershed includes Helen Putnam Regional Park (Sonoma County Department of Parks and Recreation), the Burdell Ranch (CDFG), Petaluma Adobe State Historic Park, and Olompali State Historic Park (both owned by California Department of Parks and Recreation), and the Fairfield Osborn Preserve (recently purchased by Sonoma State University).

3.4 Other land uses.

There is a small airport near the Marin County line just north of Novato and a privately-owned, inactive airstrip off Stony Point Road. A large, expanding quarry is located south of Petaluma and west of Highway 101. A privately-owned golf course is on Frates Road, and a KOA Campground is located on Stony Point Road. The Sonoma County landfill located off Meacham Hill Road drains to both the Stemple Creek and Petaluma River watersheds.

4.0 Summary of Current Planning Efforts

Below is a summary of current planning efforts in the Petaluma River watershed. Work conducted by the City within its urban limits is referenced in context to how it fits into other watershed enhancement work.

4.1 SSCRCD.

For many years, SSCRCD has participated in efforts to enhance the resources of the San Francisco Bay, which includes San Pablo Bay and bay wetland areas. This includes regular meetings with CDFG, USFWS, U.S. Army Corps of Engineers (ACOE), SLC, Bay Conservation and Development Commission (BCDC), and environmental groups. SSCRCD administers a landowner levee maintenance permit from ACOE and BCDC.

SSCRCD staff has designed dairy waste systems and responds to calls for assistance with erosion control. SSCRCD has received grants from the U.S. Environmental Protection Agency's North Bay Initiative for outreach to watershed landowners in the San Antonio Creek subwatershed and to coordinate with watershed landowners on levee permit issues. SSCRCD sponsors work by AmeriCorps and the Adopt-a-Watershed School Program for several schools in the watershed. More recently, SSCRCD received funding from a water quality violation fine for watershed restoration work in Lichau Creek. Their projects include conducting conservation planning workshops with local ranchers and streambank stabilization projects to reduce sediment delivery to the creek.

In 1997, SSCRCD received a contract from the State Water Resources Control Board (SWRCB) to develop a voluntary plan for the Petaluma River watershed. SSCRCD will continue to seek implementation funding for the project.

4.2 City of Petaluma.
The City has several watershed enhancement projects including:

- ***Petaluma River Access and Enhancement Plan.*** Adopted in May, 1996, the plan establishes policies for preservation, enhancement, and restoration along a 7.8 mile stretch of river from the urban limit line near Old Redwood Highway, through downtown to the marina. The plan calls for creating a continuous riparian corridor or "greenway" along the river, identifies restoration and enhancement opportunities, and designates appropriate access points.

- ***Petaluma River Marsh Enhancement Plan.*** In 1992, the City completed a plan for 300 acres of undeveloped, disturbed wetland south of the City marina. The plan includes recommendations for water quality protection, habitat enhancement and restoration, endangered species protection, public access, and public recreational opportunities. Most of the land is within the City limits and is owned by the City.

- ***Petaluma Demonstration Marsh and Effluent Management Plan.*** As part of the City's Long Range Effluent Management Plan, the City approved acquisition of approximately 170 acres adjacent to the Petaluma Marsh to create a demonstration marsh. The plan includes restoration of approximately 100 acres of tidal marsh and creation of a mosaic of seasonal wetlands, riparian areas, and freshwater ponds.

- ***The Ellis Creek Watershed Enhancement and Wetland Mitigation Plan*** was developed by the City as a mitigation project for a proposed reservoir on Higgins Creek. The Ellis Creek plan includes fencing, installation of cattle crossings, bank stabilization, and enhancement planting of approximately 8,100 linear feet along Ellis Creek. Additional freshwater wetlands and enhancement are also proposed on Higgins Creek, a tributary to Ellis Creek, as mitigation for the reservoir's impacts. The City is continuing to evaluate discharge options, which may eliminate the need for a reservoir. The enhancement plan could, however, be funded through other efforts.

- *Adobe Creek Restoration Project.* As part of the mitigation for widening Lakeville Highway, the City is restoring the lower portion of Adobe Creek to a brackish marsh, as well as enhancing public access and incorporating urban forestry into highway revegetation. Within the City limits, two upper reaches with constructed trapezoidal flood control channels are targeted as restoration projects to demonstrate reach-specific stream channel design and maintenance programs based on hydraulic analysis and the use of vegetation management standards. The goals for enhancing the upper portion of Adobe Creek include collecting and concentrating summer flows in a trained, low-flow channel; minimizing maintenance, dredging, and clearing; maintaining adequate flood protection; re-establishing a native riparian plant community above the channel and along the banks to provide shade and diversity for aquatic habitat; and providing on-going methods for removing sediment accumulation.

4.3 Sonoma County.
Sonoma County has policies and programs to protect agriculture and natural resources. Most of these are contained in the 1989 General Plan that was last revised in 1991.

4.3.1 Agriculture. The General Plan reflects the desire of residents to manage growth and protect agriculture. Agricultural land use policies include stabilizing agricultural land use at the urban fringe, limiting the intrusion of new residential areas into agricultural areas by maintaining parcels large enough for farmers to lease or buy for their operations, and minimizing conflicts between agricultural and non-agricultural uses.

4.3.2 Open space. The General Plan identifies open space as a limited and valuable resource. Policies to protect open space include maintaining community separators between Petaluma and both Novato and Rohnert Park and protecting scenic resources, such as the mountains between Petaluma and Sonoma, the grassy hills and ridgelines south of Petaluma near the Marin County border, and views of San Pablo Bay along Highway 37.

4.3.3 Natural resources. Policies were developed to protect critical wetland, marsh, and oak savanna habitat that are highly sensitive to change. For example, the riparian corridor policy states that agricultural cultivation and grazing should occur 100 feet from the top of the streambank in flatland areas and 50 feet in upland areas. Policies are identified to control soil erosion, protect agricultural and domestic water supplies, maintain Sonoma County's diverse plant and animal communities, and protect fishery resources while balancing needs for agriculture, development, and mining.

4.4.4 Other policies. In addition to the General Plan, Sonoma County has several other natural resource-related policies. The Valley Oak Ordinance specifies that when oak trees on particular soil types are removed, landowners must notify the County and indicate that they will either plant more oaks or implement measures to protect existing trees. Sonoma County, several cities, public agencies, and various organizations (both environmental and agricultural) have also worked on a Vernal Pool Preservation Plan. A general permit has been requested from the ACOE to cover development-related activities.

4.4 Relationship between City of Petaluma and Sonoma County.

The City and Sonoma County both have general plans and formal planning-related relationships. For example, annexation proposals are reviewed by the County both through LAFCO (Local Agency Formation Committee) and at a financial level. In addition, the City and County have a joint referral and review system. The County refers all projects within the Planning Referral Area to the City for comment. Likewise, City projects that may affect the County or are near the urban boundaries are referred to the County. Finally, the City has expressed a desire to review proposed projects in areas of interest that are beyond the City's formal sphere of influence. The City and County planning staff and public representatives also have working relationships and less formal means of cooperation, such as meetings on various topics related to planning.

The City has also adopted policies in the General Plan that support agricultural businesses located within Petaluma.

5.0 Land Use Areas of Concern

The following are concerns about agricultural land use in the Petaluma River watershed. Concerns were identified by the watershed advisory group, local residents, and public agencies regarding natural resources and long-term viability of agriculture in the region.

5.1 Rural residential development.

Large lot, rural residential parcels (ranchettes) ranging from one to 20-40 acres provide an opportunity for people to live in rural areas and have small agricultural operations, such as raising a few horses or other animals. Issues associated with expansion of rural residential areas include:

- **The division of large parcels of agricultural land** can decrease the amount of land available for productive and profitable agricultural operations. For example, while 200 acres could support a dairy operation, it is less likely that ten 20-acre parcels could each support such a use.

- **Concentration of animals and related facilities in small areas.** Livestock trampling and heavy grazing can lead to accelerated erosion, soil compaction, and increased run-off of pollutants such as nutrients. This is particularly a concern in Liberty Valley, a major groundwater recharge area with sandy soils. Cumulatively, the intensively used rural residential lots can contribute significantly to erosion and degradation of water quality.

- **Improper drainage.** Many rural residential landowners have developed their properties in ways that change natural drainage patterns and cut into hillsides. This also leads to accelerated erosion and drainage problems.

- **Development of roads.** Unpaved or improperly constructed roads are often a major source of erosion and sediment.

- **Loss of contiguous wildlife habitat.** A patchwork of differing land uses reduces the size of oak woodland and fragments riparian forests, seasonal wetlands, and other important wildlife areas. Fences, cats, dogs, and increased human activity restrict wildlife access to those areas that remain. Domestic animals also prey on wildlife in natural areas. Replacing native vegetation with ornamental plants can also have a profound collective impact on the quality and quantity of wildlife habitat.

5.2 Rural community quality of life.

Historically, life in the Petaluma River watershed revolved around agriculture. Development pressures, rising land prices, and the proliferation of rural residential areas are changing the character and community of the watershed. Threats to rural community quality of life include:

- **Rising land prices** that make it difficult for local ranchers to compete with wealthy investors for large tracts of land.

- **Tension** between long-established farming families and new rural residents who may not be aware of the economic vulnerability and complexity of farming operations.

- **Potential land use compatibility issues.**

5.3 Conversion to vineyards.

Vineyards and wineries are a key component of Sonoma County's economy. Vineyard expansion and development has begun in the Petaluma River watershed and is expected to increase rapidly, especially in the Lakeville area. Conversion of land to vineyards raises several issues of concern:

- **Sedimentation and water contamination.** Vineyards, especially those planted on steep hillsides, can contribute significant amounts of sediment and contaminants such as sulfides and other chemicals to creeks and tributaries.

- **Water development issues.** Additional water development is often needed for vineyards. New wells and stock ponds can draw down groundwater supplies and decrease the amount of water available for stream flows.

- **Loss of wildlife habitat.** Vineyard development replaces important wildlife habitat areas, such as grasslands, oak woodlands, and riparian forests.

- **Use of chemical pesticides and herbicides** can impact the surrounding ecology and water quality.

5.4 Agricultural impacts on natural resources.
The impact of agricultural activities on erosion, riparian habitat, fisheries, and water quality will be included in other summaries prepared for the *Petaluma River Watershed Enhancement Plan.*

5.5 Use of historic marshlands.
Approximately one-third of the historic marshlands have been reclaimed by a system of levees, drainage ditches, tide gates, and pumps. Many of these areas are used for hay and silage production. Landowners in this area have several concerns that include:

- **A burdensome regulatory process** to maintain levees along the river and conduct farming operations.

- **A lack of public awareness and understanding of the history and contribution of agriculture in this area.** The decisions to build levees were made at a time when public support for "taming the wilderness" was strong. As public opinion has changed, some of these landowners find themselves suddenly perceived as culprits.

- **A possible perceived decline in land values due to regulatory constraints.**

5.6 Water supply.
Domestic water for the cities of Petaluma and Penngrove is principally supplied by the Russian River Project administered by the Sonoma County Water Agency. The City maintains a group of municipal water wells as an auxiliary supply. Most rural residents and the agricultural community pump well water from the underlying aquifer. Under SSCRCD's planning process for the Petaluma River watershed, a summary of concerns related to groundwater is being prepared. Although SSCRCD's current project does not

include a component to review water supply issues, the watershed advisory group has expressed related concerns. These include:

- **The long-term viability of agriculture** in the area depends on available water, particularly for vineyard development and expansion.

- **Treated wastewater should be made available to agricultural operators.** The City currently supplies treated wastewater to approximately seven landowners for agricultural use in the Lakeville and Old Adobe areas.

6.0 Recommendations for Consideration

On December 2, 1997, the watershed advisory committee reviewed and discussed draft recommendations to address land use concerns in the watershed outside of Petaluma. The modified recommendations and those suggested by the committee are presented below. Specific recommendations for erosion control, riparian enhancement, water quality, and groundwater are being developed separately.

- **Support the viability of agricultural in the watershed**. Actions could include educating watershed residents about the importance of agriculture to the local economy and farming operations, as well as supporting programs to protect farmland, such as agricultural easements.

- **Support infill development within Petaluma's city limits.**

- **Conduct outreach to rural residential landowners**. Outreach activities could include information on erosion control, animal waste and nutrient management, Best Management Practices (BMPs), wildlife habitat, native plants, water quality, creek management, proper drainage, and road maintenance. Examples of outreach include easy to read creek care guides, step-by-step "how to" brochures, one page fact sheets, newsletters, as well as workshops.

- **Support ranch and vineyard conservation planning efforts.** Ranch and vineyard conservation plans assist land stewards in achieving both economic and natural resource goals. The plans are tailored to each operation and allow agricultural operators to prioritize projects that improve or maintain economic sustainability, enhance wildlife habitat, reduce critical erosion, implement on-farm water quality monitoring, and manage nutrients. So far, SSCRCD has assisted eight watershed landowners in developing these plans. The advisory committee recommended considering requiring vineyard plans for new vineyards and supporting conservation planning workshops for vineyard operators and ranchers; they also stressed the need to reach both small and large operations.

- **Compile and distribute information on BMPs for agricultural operators.** Actions could include working with the watershed advisory group to develop and review existing BMPs and distributing this information to watershed landowners. Information could be presented in creek care guides, "how to" brochures, one page fact sheets, and SSCRCD's sustainable vineyard manual. The advisory committee stressed including both small and large landowners when discussing management practices.

- **Compile and distribute information on BMPs to quarry operators.**

- **Work cooperatively with regulatory agencies in streamlining levee maintenance permits and other permits for agricultural operators in the bayland areas.**

- **Conduct research on the long-term water supply concerns for rural and agricultural residents, especially for agricultural operations.**

- **Support the availability of bio-solids for interested agricultural users.**

- **Assist residents' interface with the counties on well and septic regulations for groundwater and surface water to help maintain the rural quality of stream habitat.** This is especially important in the San Antonio Creek subwatershed.

- **Provide technical information to interested agricultural operators about the potential benefits and detriments of using treated wastewater and about BMPs for using treated wastewater.** The advisory committee also suggested that users of treated wastewater be required to follow a conservation plan and that BMPs or a management plan should be developed for using treated wastewater.

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APPENDIX A

Summary of Permits Required for Watershed Restoration Work

APPENDIX A

Summary of Permits Required for Watershed Restoration Work

Permitting Requirement Overview
This section describes the permits generally necessary for watershed restoration and enhancement work. These permits are required of either individual landowners conducting work or sponsoring agencies such as SSCRCD.

Local Permits. The Sonoma County Planning and Building Department requires grading permits for streambank stabilization and similar projects.

Regional Permits. The Bay Conservation and Development Commission's (BCDC) sphere of influence extends to near the Highway 101 bridge. BCDC requires a permit for levee maintenance (see Federal Permits below).

State Permits. The California Department of Fish Game (CDFG) requires Streambed Alteration Agreements for work that occurs on defined waterways. Streambed Alternation Agreements are also required for removal of log jams and fish passage barriers. Agreements can be issued by wardens and biologists. Under Streambed Alteration Agreements, repair projects must generally be completed by October 31 of each year. The application fee for projects under $25,000 is $132; for projects between $25,000-$500,000 the fee is $662, and for projects over $500,000 it is $1,191.

The San Francisco Bay Regional Water Quality Control Board (RWQCB) issues water quality certifications (401 Certifications) for all projects requiring permits from the U.S. Army Corps of Engineers (ACOE), which are discussed below. This is to insure that the ACOE permits (including non-reporting Nationwide Permits) meet California's water quality standards. The application consists of a letter, description of the project, potential water quality impacts, proposed revegetation, and any sketches. The filing fee is $500.

The RWQCB is considering regulations that would include spring development under wetland regulations.

Federal Permits. The ACOE issues permits for work done in waters under their jurisdiction. As defined by the ACOE, in non-tidal areas this extends up to the ordinary high water line or the upper limit of wetlands. For tidal waters, this extends up to the line of high tide (for dredge or fill), or up to the mean high water line (for work or structures). The ACOE and BCDC have issued a special Section 404 (of the federal Clean Water Act) blanket permit for levee maintenance in the Sonoma Creek and Petaluma River drainages. The permit is administered by SSCRCD. It has been reissued since 1980, although not without review and input by several regulatory agencies. The SSCRCD anticipates that the current permit, which is good for five years, will be renewed for another five years.

SSCRCD is now working on an ACOE Section 10 permit that would allow landowners to clean existing drainage ditches.

Watershed restoration projects often come under ACOE Nationwide Permit 27. Depending on the specific details of the repair, the ACOE may need advance notification of the work. There is no filing fee, but response can take up to one year.

An ACOE permit may be required for work in wetland areas.

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: November, 1997 SCALE: 1" = 5,000' CHECKED BY: MN DRAFTED BY: EA	REVISIONS	BY	PREPARED FOR: SOUTHERN SONOMA COUNTY RESOURCE CONSERVATION DISTRICT	PETALUMA RIVER WATERSHED	SHEET 1 OF 1

Appendix B

Ground Water Quality in the Petaluma Watershed

Ground Water Quality
in the
Petaluma Watershed

Prepared by:
Southern Sonoma County Resource Conservation District

June 1998

This Project has been funded wholly or in part by the United States Environmental Protection Agency Agreement No. C6999482-97-0 to the State Water Resources Control Board and by Contract No. 6-048-250-0 in the amount of $144,115. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency or the State Water Resources Control Board, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

Introduction

The goal of this study is to review and summarize published reports and data to evaluate ground water quality and contamination in the watershed. Research for this information has produced five documents pertaining to ground water quality in the Petaluma River watershed and contacts were made to agency personnel to identify available sources of information. (see appendix A)

Cumulative data has shown that up until 1984, when the last study was completed, Petaluma's ground water quality had continually degraded. Historical problems have been identified with excessive nitrates, electrical conductivity (salts), coliform bacteria, and mineral constituents associated with sea water intrusion and connate water sources. The following constituents present a general overview of ground water quality concerns in the Petaluma area.

Nitrates

The most pronounced ground water problem is nitrate contamination. All studies examined for this summary, have made reference to nitrate contamination specifically in the area northwest of Petaluma and west of Highway 101. (see Figure 1) The problem first surfaced in January, 1979 when a case of methemoglobinemia (blue baby syndrome) was reported to occur in the Gossage-Magnolia area. (Sonoma County, 1981) Blue baby syndrome is a temporary blood disorder which inhibits the transport of oxygen in the blood stream, resulting in oxygen deprivation and a consequential gray or blue like appearance in infants. Samples of ground water quality which were used for the infant's baby formula revealed high concentrations of nitrates.

The case prompted a study by the State of California Department of Water Resources which concluded that nitrates in the study area did not occur naturally and were "primarily the result of past agricultural practices (poultry and dairy operations)."(DWR, 1982) The study attributes much of the problem to poultry operations due to stockpiling of manure. The study also notes waste water systems as being a secondary source and that "the contribution of nitrates to ground water from individual waste water treatment systems (septic tank / leach lines) will become greater as rural development continues."

Electrical Conductivity

Electrical conductivity is sometimes associated with Total Dissolved Solids (TDS) and provides a measurement of the amount of minerals in ground water. Elevated readings can be attributed to connate water storage which is defined as sea or fresh water that is trapped in the earth's surface and isolated from the atmosphere for a considerable length of time. Connate water is stored near the base of the Merced formation, in the area northwest of Petaluma.

The Department of Water Resources identifies another source of contamination as being associated with land use activities such as animal agriculture. (DWR, 1982) Much of the study area containing nitrate contamination also has extensive electrical conductivity (EC) problems. (see Figure 1) The DWR nitrate study revealed that of the 52 wells that had high nitrates, 24 had EC values in excess of drinking water standards. Of the 50 low-nitrate wells, only four had excessive EC values.

Coliform Bacteria

According to the DWR nitrate study, 7 wells out of 81 sampled in 1981 were found to contain 20 or more colonies of coliform bacteria. One of the contaminated wells did not contain a surface seal which may have allowed small animals to fall into the well. The remaining wells were properly sealed indicating that contamination was occurring from the subsurface zone. "This is an indication of some localized waste water contamination of the supply.", concludes the study.

Sea Water Intrusion and Connate Water Influences

Sea water intrusion is a result of a gradual depletion of the freshwater ground aquifer which causes sea water to encroach upon and replenish the aquifer with saline water. Sea water and connate influences are combined in this summary since they possess resembling water quality characteristics and both have been found to occur in the southern part of the Petaluma River watershed, near San Pablo Bay. (DWR, 1982)

In the past, sea water intrusion has degraded the few aquifers present in the bay mud deposits and aquifers in the alluvial fan deposits in the Petaluma Valley. According to a 1958 study, Cardwell describes ground water quality as such:

> *"Southeast of Petaluma and downstream many wells tap water which seems to be contaminated by intrusion of brackish bay water or unflushed connate water of similar character."*

This proceeded to be a problem until 1962 at which time imported water was purchased from the Sonoma County Water Agency. Limited testing has shown no further deterioration in ground water quality since 1962. Water quality problems associated with these waters in the past have been sodium, salinity, total dissolved solids, boron, and hardness. (see Figures 2-5) (DWR, 1982) Of these constituents, sodium presents the greatest risk to humans, especially those with heart problems such as high blood pressure. Salinity and boron can be harmful to agricultural land uses in terms of crop health. Boron is specifically hazardous to crops such as apples and grapes. Hardness reduces the cleaning ability of most soaps. Water tanks and pipes are effected by reducing the available quantity and pressure of the water supply through build up of minerals. Iron and manganese impart a metallic taste to water and food and present a common problem to households by staining fixtures fabrics and utensils. (DWR, 1975)

Present Day Monitoring

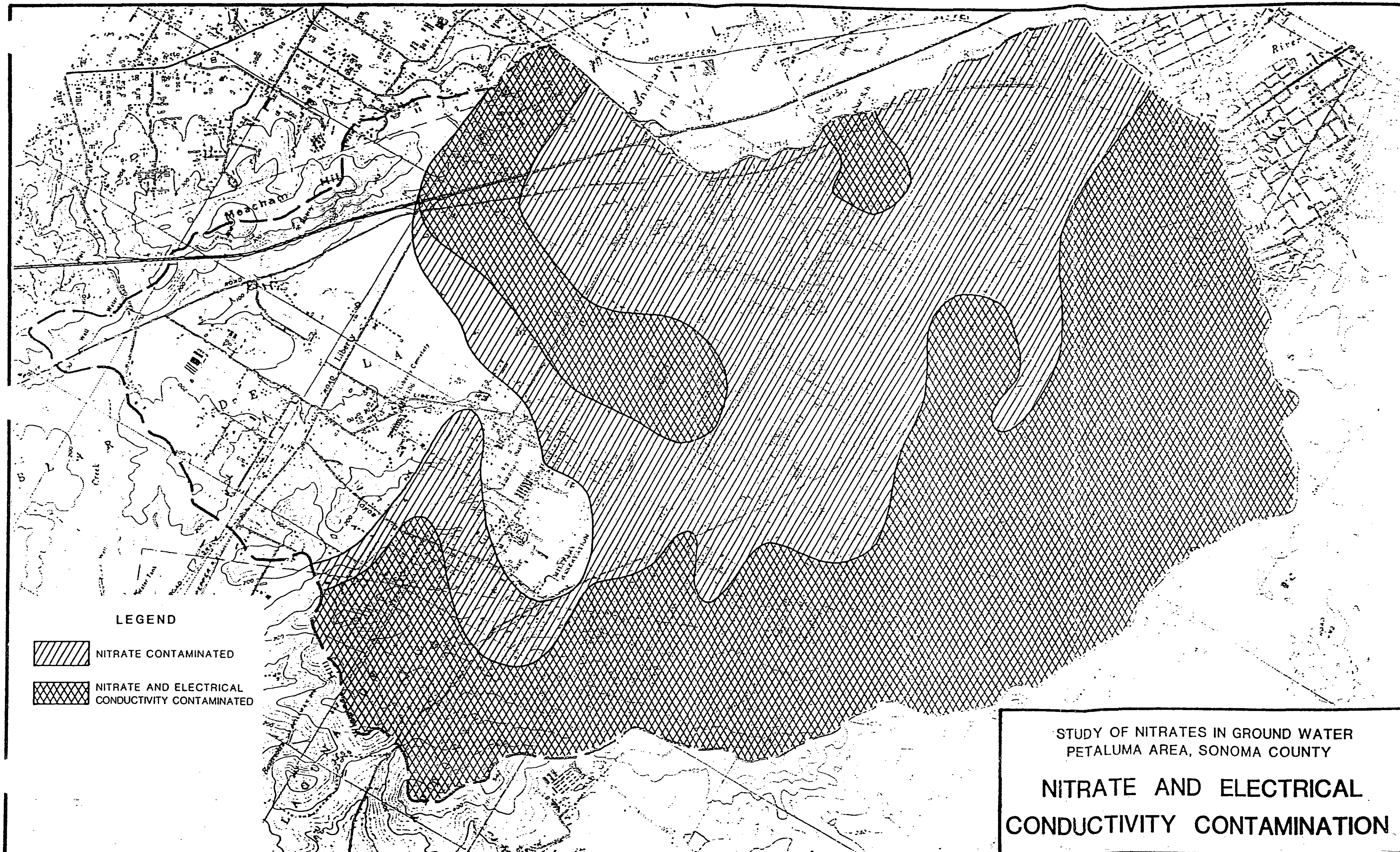
Recently, the City of Petaluma has instituted a testing program for seven wells located within the watershed. (personal communication, City of Petaluma, 1998) These wells will eventually be permitted for potable use under Title 22 of the California Administrative Code. The wells will be tested for general mineral, Physical, organic, inorganic, bacteriological, and radiological constituents. Nitrates will be tested yearly while chemical tests will be evaluated every three years. Wells are located as follows:

Well Name	**Location**
Luchessi Well	202 No. McDowell-Petaluma
Kingsmill Well	End of Castle Dr.-Petaluma
Prince Park Well No.	2301 E. Washington-Petaluma
Prince Park Well So.	2301 E. Washington-Petaluma
Airport Well	601 Sky Ranch Dr.-Petaluma
Frates Well	Frates Rd. @ Ely Blvd.-Petaluma

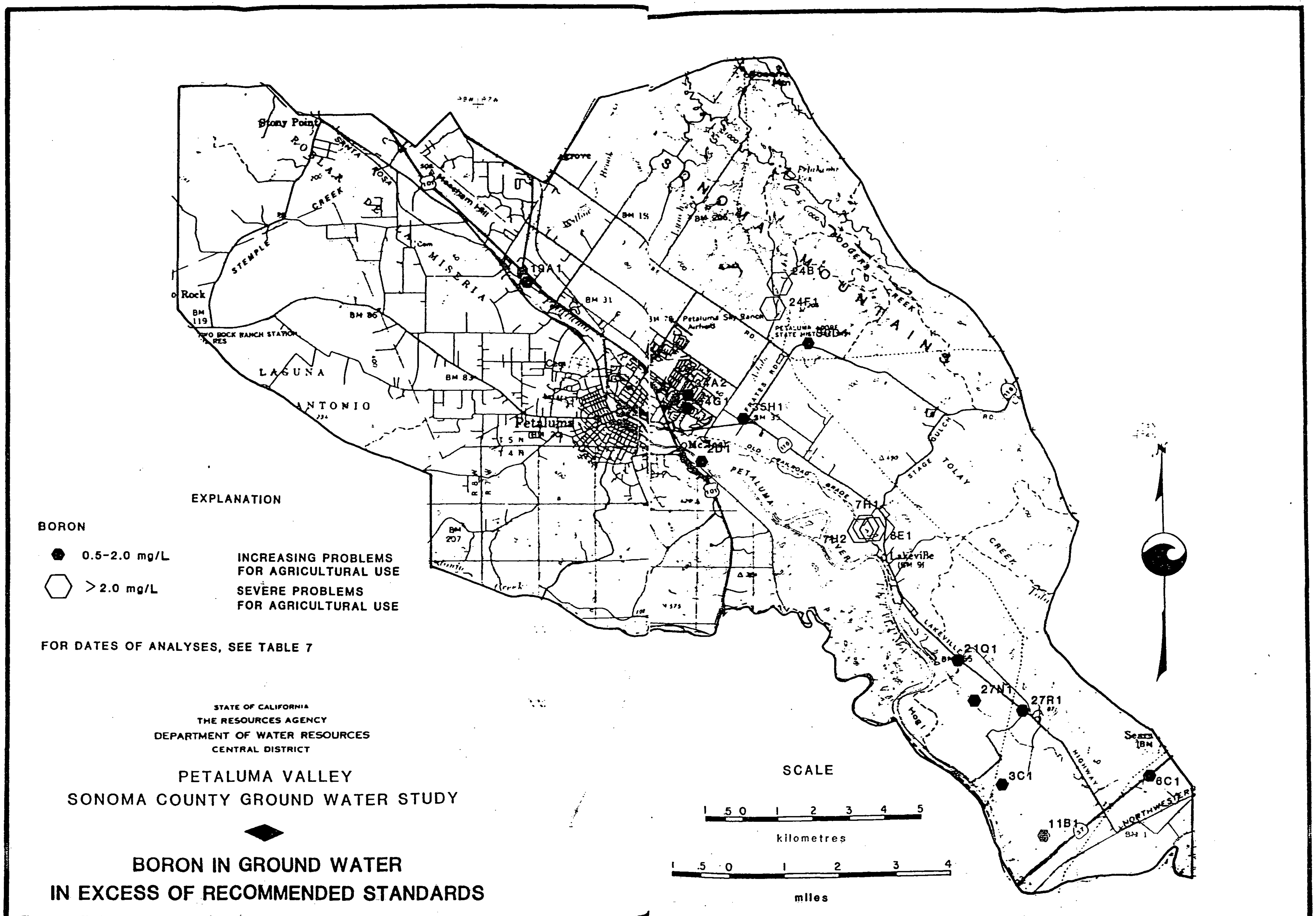
Conclusions

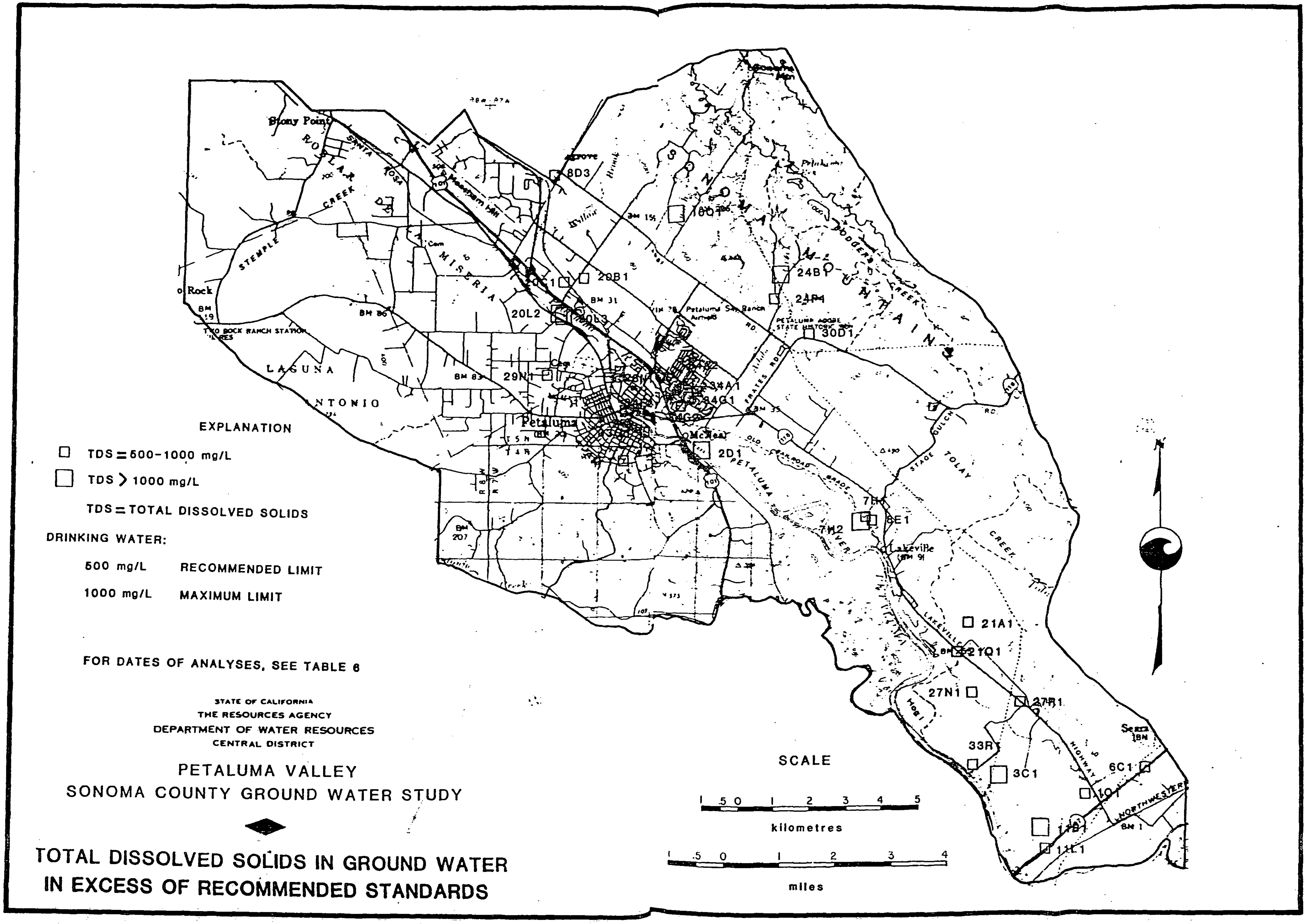
Past studies have shown nitrates and electrical conductivity to be of concern due to poultry and livestock agricultural land uses and secondary contamination due to septic and leach field systems. Today few poultry operations remain in existence, and water quality laws enforced by the Clean Water Act have deterred many livestock facilities from the practice of stockpiling of manure. Rural housing development has increased posing as a potential concern in terms of septic systems and leach lines.

Salt water intrusion in the lower Petaluma watershed has posed a problem in the past before water was imported into the area. The city of Petaluma is currently opening seven wells for drinking water use and wells will be monitored. The City of Petaluma's ground water monitoring program provides an excellent opportunity. Establishing an ongoing monitoring program will enable ground water quality to be evaluated on a regular basis providing water quality results to drinking water users.



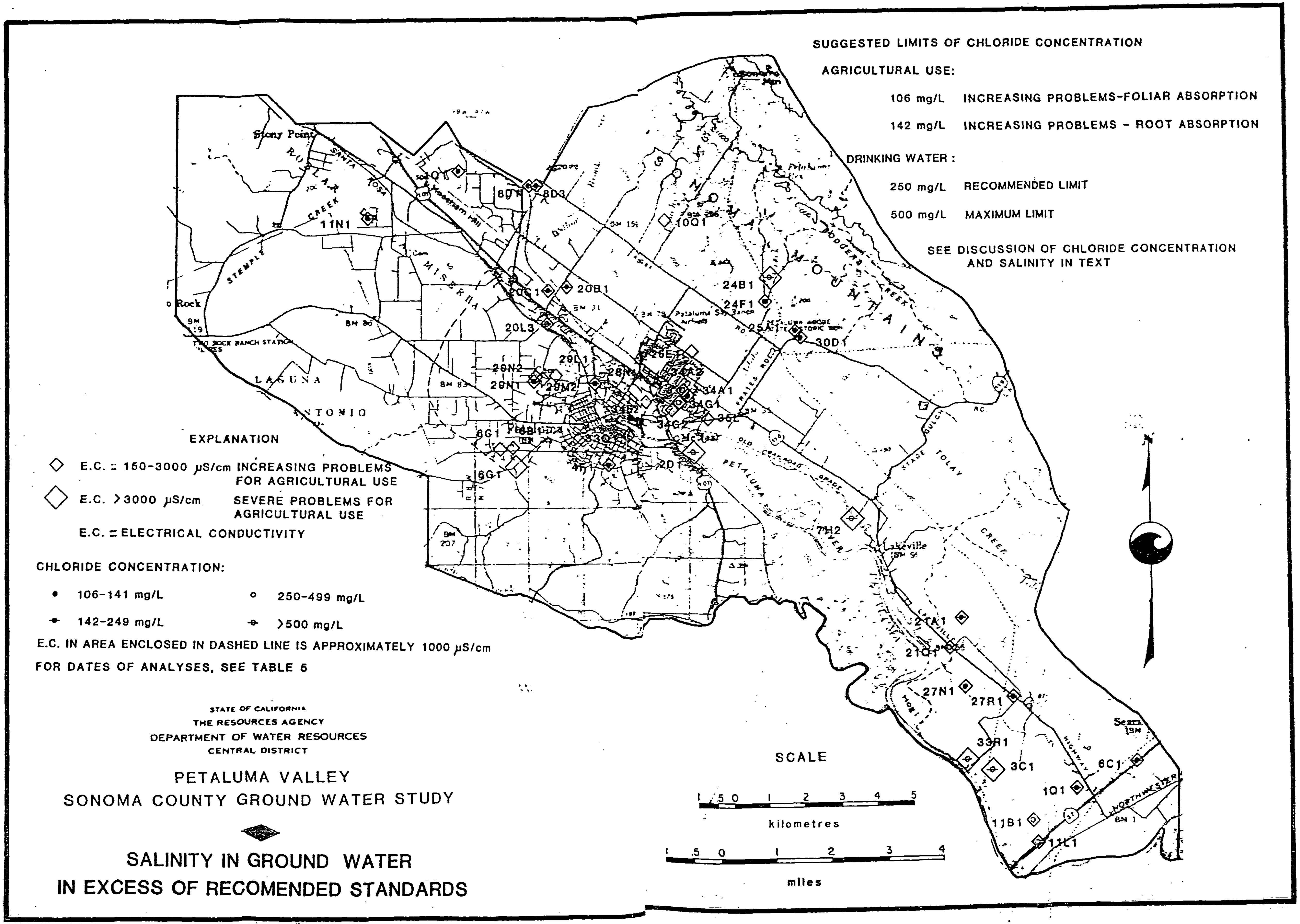
Source: DWR, 1982


EXPLANATION
BORON
0.5-2.0 mg/L
INCREASING PROBLEMS FOR AGRICULTURAL USE
> 2.0 mg/L
SEVERE PROBLEMS FOR AGRICULTURAL USE
FOR DATES OF ANALYSES, SEE TABLE 7
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
CENTRAL DISTRICT
PETALUMA VALLEY
SONOMA COUNTY GROUND WATER STUDY
BORON IN GROUND WATER
IN EXCESS OF RECOMMENDED STANDARDS
SCALE
kilometres
miles
Stony Point
Petaluma
Lakeville
Sears
SONOMA MOUNTAINS
LAGUNA
ANTONIO
STEMPLE CREEK
PETALUMA RIVER
TOLAY CREEK
19A1
24B1
24F1
34A2
34G1
35H1
2D1
7H1
7H2
8E1
21Q1
27N1
27R1
3C1
6C1
11B1

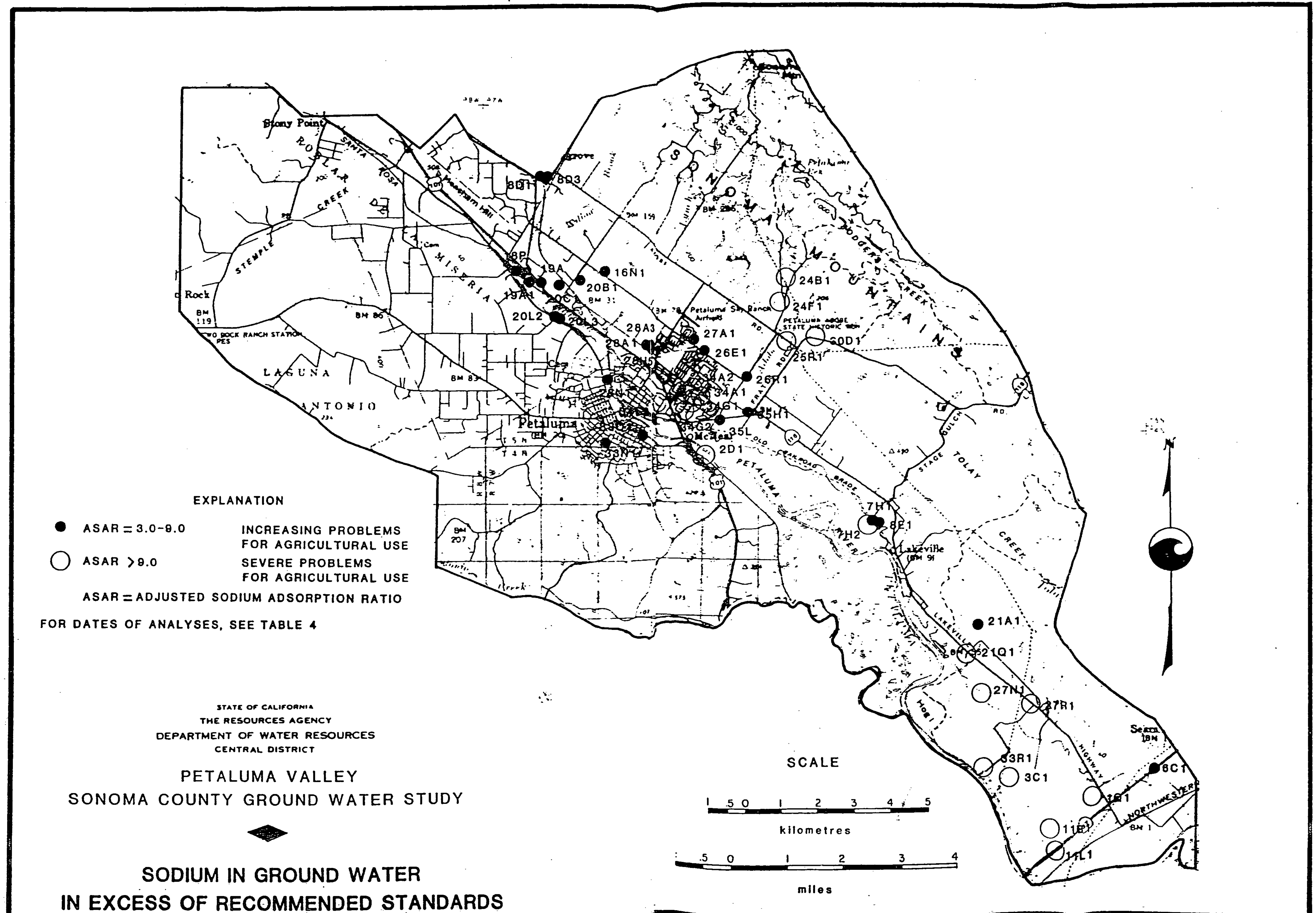


TOTAL DISSOLVED SOLIDS IN GROUND WATER IN EXCESS OF RECOMMENDED STANDARDS

Source: DWR, Bulletin 118-4, 1982



Source: DWR, Bulletin 118-4, 1982



SODIUM IN GROUND WATER IN EXCESS OF RECOMMENDED STANDARDS

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U.S. Geological Survey. "Map Showing Areas in the San Francisco Bay Region where Nitrate, Boron, and Dissolved Solids in Ground Water May Influence Local or Regional Development". Miscellaneous Field Studies Map MF-432. 1972

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Appendix A

Ground Water Contacts

Sonoma County Department of Health Services
Ron Anderson
3313 Chanate Road
Santa Rosa, CA
(707) 525-6565

Comments: No information other than Petaluma Nitrate study which he worked on. Referred to City of Petaluma, State Health Dept., and San Francisco Bay Regional Water Quality Control Board.

State of California Department of Health Services
Drinking Water Field Operations
Martin Ross
50 D, Suite 200
Santa Rosa, CA
(707) 576-2145

Comments: No data available, however City of Petaluma will be turning on new wells and has well monitoring data. In the past, all drinking water in Petaluma has been obtained through the Sonoma County Water Agency. Referred to Lou Hodge at City of Petaluma.

City of Petaluma
Water Department
Lou Hodge
11 English St.
Petaluma, CA 94952
(707) 778-4392

Date of Contact: 4/28/98
Comments: The City of Petaluma is in the process of acquiring a drinking water permit under Title 22 of the State Health Code. Monitoring is done at seven wells in the Petaluma area ranging from Frates/Ely Roads to King's Mill/Park Place Roads. Nitrate tests will be done every year and chemical tests every three years. Tests include general mineral content, organic (synthetics) and inorganic and radiological tests. One possible well was abandoned at Sola Optical in South Petaluma (superfund site). Mr. Hodge is also involved with environmental compliance at the Petaluma Landfill. A total of five wells are being monitored, two for leachates and three for groundwater quality. They are

sampled quarterly and results are given to the San Francisco Bay Regional Water Quality Control Board.

State Water Resources Control Board
San Francisco Bay Regional Water Quality Control Board
John Gin
2101 Webster, Suite 500
Oakland, CA 94612
(510) 286-1255

Date of Contact: 5/4/98
Comments: No information he is aware of.

Sonoma County Water Agency
Doris Anderson / Jim Flugen
2150 West College Avenue
Santa Rosa, CA
(707) 547-1961

Date of Contact: 4/28/98
Comments: Jim Flugen was not aware of any information other than the Department of Water Resources nitrate study. Doris Anderson was only aware of wells monitored near the Laguna de Santa Rosa.

Appendix C

Water Quality Monitoring Guidelines for the Petaluma Watershed

DRAFT

Water Quality Monitoring Guidelines for the Petaluma Watershed

Prepared By:
Southern Sonoma County Resource Conservation District

June 1998

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Table of Contents

Water Quality Monitoring Guidelines for the Petaluma Watershed

I. Introduction

The Petaluma River and its tributaries encompass a watershed of about 146 square miles and flows into the northwestern portion of San Pablo Bay. The pear-shaped basin located in both Sonoma and Marin Counties is approximately 19 miles long and about 13 miles wide. Normal annual rainfall over the watershed ranges from about 20 inches at the mouth of the Petaluma River to about 50 inches at the highest elevations, with the basin averaging about 26 inches (see attached Normal Annual Precipitation Map). Land use outside the City and rural residential areas is predominantly agriculture and open space.

Fifty-six percent of the watershed is mountainous and hilly, 33 percent is valley and 11 percent is salt marsh located along the lower 11 miles of the Petaluma River. The mountainous and hilly areas are covered with grass, shrubs, and groves of oak and California bay laurel. They are used for grazing and pasture with tracts of cultivated haylands scattered throughout. The marshlands are used for haylands and provide habitat to many plants and animals including rare and endangered species.

Sedimentation, high nutrient levels and animal waste, causing exceedance of water quality standards, have been identified as the main pollutants in the River. The receiving waters of San Pablo Bay are listed on the State's Impaired Waterbody 303(d) List. It is suspected that a combination of land use activities both urban and rural contributes to these impacts.

For purposes of the watershed enhancement plan, which focuses primarily on rural and rural residential areas, urban water quality impacts will not be addressed. It is important to note however, that urban areas impact water quality in a number of ways which include the contribution of sediments, nutrients, bacteria, and toxic heavy metals. Water runoff carries these pollutants over impervious areas which results in increased water volumes and velocities entering nearby streams.

The following monitoring guidelines are designed to provide landowners and residents with an introduction to existing monitoring data, data gaps, and recommendations for the Petaluma River Watershed. This report also includes a section addressing non-point source monitoring for private landowners, which may be used to steer future monitoring projects.

II. Summary of Existing Data

The Federal Clean Water Act requires the state to adopt water quality objectives for toxic pollutants. *California's Inland Surface Waters Plan* and the *Enclosed Bays and Estuaries Plan* were created in order to comply with federal water quality objectives. Both plans pertain to the Petaluma River and include objectives for 37 toxic substances or classes of pollutants and ambient toxicity for these waters. (Whyte, 1996)

Water quality objectives, which govern the concentration of pollutants in water, are outlined in the San Francisco Bay Regional Water Quality Control Board (RWQCB) Basin Plan and are designed "to protect present and potential beneficial uses...and to protect existing high quality waters of the state" (San Francisco Bay RWQCB, 1986). The Basin Plan outlines a variety of beneficial uses for the Petaluma River watershed, which include:

- cold fresh-water habitat
- warm fresh-water habitat
- preservation of areas of special biological significance
- marine habitat
- fish spawning habitat
- fish migration
- wildlife habitat
- preservation of rare & endangered species
- water contact recreation
- non-water contact recreation

Water quality impairments occur when the identified beneficial uses are threatened resulting in violations of prescribed water quality objectives. Pollutants and their effects on beneficial uses of water are exhibited in Table 1. The Regional Board has classified the Petaluma River as an impaired water body due to such violations based on past monitoring activities.

Past monitoring activities have been undertaken cooperatively with the Department of Water Resources, State Water Resources Control Board, and the San Francisco Bay Regional Water Quality Control Board. According to Bill Hurley, RWQCB, water samples were collected primarily in the mid 1970's at various locations and most recently in 1993 (see attached monitoring sites map). Their efforts were focused primarily on nutrients, dissolved oxygen, and coliform bacteria. In the upper portions of the watershed, tests revealed slightly elevated nutrient concentrations and high coliform counts. In the lower reaches, unacceptable levels of dissolved oxygen, turbidity, sedimentation, ammonia, coliform, algal blooms, eutrophication, and foul odors have been noted as problems (Questa, 1992). Mr. Hurley suggests the focus of additional sampling activities should be aimed at sediment

Table 1: Major Pollutants, Their Sources and Effects on Beneficial Uses of Water

Major Pollutant	Description	Common Sources or Causes of Pollutants	Some Effects of Pollutants
Organic Material	(Oxygen consuming substances)	Lumber, pulp, paper, and food processing waste discharges, animal and ag wastes; runoff from waste disposal sites	Produce foaming in industrial process waters; consume oxygen in water by decomposition
Dissolved Salts and Minerals	(chloride, carbonate, sulfate salts, and other chemical compounds)	Natural and man-induced soil erosion, sewage treatment plant and industrial waste discharges; storm sewer runoff; ag drainage water; sea water intrusion; and runoff from waste disposal sites	Cause disagreeable odor and taste; affect vital organs of humans, livestock, and fish; cause corrosion scaling, and foaming in industrial processes; toxic to many plants
Floating Debris	(paper, cans, bottles, plastic, lumber, and other materials)	Storm sewer runoff, runoff from waste disposal sites; ships, pleasure boats, picnickers, and campers	Interferes with the esthetic and recreational enjoyment of water; clogs ship channels, water supply intakes, and storm sewer intakes
Heat		Sewage treatment plant and industrial waste discharges, industrial cooling water discharges	Makes drinking water less palatable; reduces oxygen needed for fish; makes water less desirable for industrial processes; increases evaporation which tends to concentrate other pollutants
Nutrients	(compounds of nitrogen and phosphorous)	Sewage treatment plant and industrial waste discharges, runoff from waste disposal sites, ag drainage water; decomposition of organic matter; and detergents	Interfere with human digestive processes, and can be toxic to vital organs; toxic to some livestock and some wildlife species; promote growth of algae and other secondary pollutants
Oils & Greases	(animal, and vegetable oils, and petroleum products)	Storm sewer runoff, ships and pleasure boats; animal and ag wastes, and industrial waste discharges	Cause disagreeable odor and taste; clog water supply intakes and water distribution systems; interfere with the esthetic and recreational enjoyment of water; interfere with repiration in many forms of aquatic life; consume oxygen in water by decomposition
Pathogenic Organisms	(viruses, toxic bacteria, and parasites)	Human and animal wastes; seepage from septic tanks; runoff from waste disposal sites	Cause illnesses such as amoebiasis, hepatitis, poliomyelitis, and botulism in humans; toxic to many forms of life
Pesticides	(arsenicals, mercuricals, chlorinated hydrocarbons, organic phosphates, polychlorinated biophenyls)	Storm sewer runoff and ag drainage water	Cause illness of death in humans who consume contaminated water or food (fish and shellfish are known to concentrate certain pesticides in their flesh); toxic to fish and wildlife

Table 1: Major Pollutants, Their Sources and Effects on Beneficial Uses of Water- *Continued*			
Major Pollutant	**Description**	**Common Sources or Causes of Pollutants**	**Some Effects of Pollutants**
Secondary Pollutants	(algae, barnacles, aquatic weeds, and other organic growths)	Combined effect of nutrient materials present, warm temperatures, and sunshine	Cause disagreeable taste and odor; clog ship channels, and water supply intakes; consume excessive quantities or water; reduce oxygen in water when organisms and plants die and decompose; cause flooding by clogging drainage facilities
Suspended Sediment	(clay, silt, sand, and other inorganic matter)	Natural and man-induced soil erosion	Cause objectionable color in water, clog ship channels, and water supply intakes; cause flooding by clogging drainage facilities; interfere with penetration of light and decrease production of fish-food organisms
Toxic Heavy Metals	(cadmium, lead, mercury, selenium, and others)	Sewage treatment plant and industrial waste discharges; storm sewer runoff; and mining and refining heavy metals	Highly toxic to many forms of life with serious sublethal effects (some are cumulative poisons)
Toxic Chemical Materials	(acids, caustics, fluorides, borates, sulfides, and others)	Industrial and sewage treatment plant waste discharges; and decomposition of organic material	Toxic to many forms of life; interfere with industrial processes; corrode or attack wood and metal surfaces (wharves and ship hulls)
Toxic Organic Materials	(cyanides, alcohols, chloroform, organic acids, formaldehyde, and phenol)	Sewage treatment plant and industrial waste discharges; runoff from waste disposal sites; and citrus crop wastes	Toxic to many forms of life; interfere with industrial processes, especially processing of food products
Source: USGS, 1972.			

nation studies as well as pesticide and herbicide use. Water
nants will adhere to sand, silt, and clay particles based on their surface to
ratio and geochemistry. Samples are withdrawn from the stream
, usually where sediment deposition occurs. Table 2 shows identified
:ers of concern for the Petaluma River and associated land uses and/or
activities of concern as identified by the Regional Board.

The RWQCB will be analyzing baseline water quality data in an effort to establish water quality standards specific to the Petaluma River. The Total Maximum Daily Load (TMDL) and Attainment Strategy for the Petaluma River watershed will also identify sources of contamination by land use, establish target dates for water quality improvements, and make recommendations for corrective action. The TMDL process is slated to begin by the year 2000.

Table 2: Identified Water quality impairments for the Petaluma River and associated land uses/ activities of concern.

Water Quality Impairments	Land Use / Activites of Concern
Temperature	Dredging, agriculture, habitat alteration .
Ammonia	Agriculture
Dissolved Oxygen	Dredging, habitat alteration, agriculture
Sediment	Construction, dredging, habitat alteration, agriculture
Coliforms	Agriculture, Boat vessel discharges
Debris	Boat vessel discharges, industrial
Petroleum Distillates	Boat vessel discharges, industrial, urban runoff
Habitat	Construction activities, industrial
Herbicides	Urban runoff

Source: San Francisco Bay Regional Water Quality Control Board, 1989.

The California Department of Fish and Game (DFG) acts to protect water quality through management and enforcement of water quality laws. DFG Code 5650 states that "it is unlawful to deposit in, permit to pass into, or place where it can pass into the waters of this State ... any substance or material deleterious to fish, plant life, or bird life." DFG has been monitoring for agricultural runoff within the watershed since 1971, however a systematic program was not established until 1991 (Mike Rugg, Calif. Dept. Fish & Game, Pers. Comm.). During this time, eight stations have been monitored in the San Antonio Creek drainage followed by a more recent addition of two sites within the Ellis Creek watershed. All sites are monitored for pH, temperature, ammonia, percent saturation, electrical conductivity, dissolved oxygen, biochemical oxygen demand, and total dissolved solids.

Test results have consistently been distributed to the Sonoma Marin Animal Waste Committee, which acts to address animal waste issues. According to Mike Rugg, DFG Water Quality Biologist, water quality at the San Antonio Creek locations has improved considerably over the years with the exception of one station. In addition to the current monitoring program, Mr. Rugg suggests two additional stations as potential monitoring sites be included: 1) Old Adobe Rd. at Adobe Creek and 2) King Road at Wiggin's Creek.

The *Petaluma General Plan* and the *Petaluma River Access and Enhancement Plan* both direct the need to "improve the quality of the water in the Petaluma River." and to "protect and preserve streams and the river in their natural state." The City also has published reports concerning the *Ellis Creek Watershed Enhancement and Wetland Mitigation Plan and Monitoring Program for the Petaluma Wastewater Treatment and Storage Facilities Project* and an *Analysis of Historic and Current Hydrologic Conditions in the Petaluma River.*

The City is presently monitoring discharge effluent on a monthly basis during the non-discharge period from May 1 through October 20. Monitoring parameters include biochemical oxygen demand, total suspended solids, conductivity, pH, temperature, dissolved oxygen, and bacteria. Metals and pesticides are tested less frequently. Monitoring results are inconclusive at this time. Chris McAuliffe, EOS Environmental Inc., water quality consulting firm, has been working with the city's wastewater treatment program and recommends monitoring associated with nutrient and pesticide use adjacent to agricultural lands and diazinon and chlorpyrifos adjacent to residential properties.

The Army Corps of Engineers has recorded information on stream flows within the Petaluma River from 1941 to 1946 from a station located one mile upstream from the center of town (COE, 1971). In 1948, the US Geological Survey (USGS) relocated the gauge about 1,000 feet further upstream north of Corona Road, encompassing a 30.9 square mile area of the watershed. USGS continued to record data until 1963 at which time the gauge was removed (FEMA, 1991). During the period the gauge was active, flows ranged from 0-3,500 cubic feet per second and annual runoff was recorded between 1,600-32,800 acre feet (COE, 1971). Water temperatures were also recorded periodically at this station and ranged between 4 - 17 degrees Celsius (Blodgett, 1971).

Local schools, community groups, and organizations are also pursuing monitoring programs. They are listed as follows:

- **Grant Elementary School -** Third, fifth, and sixth graders at Grant School have been working with AmeriCorps members in order to establish a monitoring program for Thompson Creek. Preliminary samples have been collected, analyzed, and recorded for future reference. In addition to classroom activities related to wildlife populations and vegetation, students are monitoring for pH, temperature, ammonia, and dissolved oxygen (H. Jensen, Watershed Steward Project, personal communication).

- **Casa Grande High School -** The United Anglers of Casa Grande High School have been monitoring stream conditions within the watershed since 1983. Seven tributaries are monitored for water quality, fish conditions, and population studies (T. Furr, Casa Grande High School, personal communication). Students have restored stream reaches through the use of their fish hatchery, revegetation program, and debris clean up activities. Their efforts have proven successful with the presence of year around stream flows and increasing numbers of steelhead migrations.

- **Petaluma Tree Planters (PTP) -** PTP is a non-profit corporation founded in 1990 to "provide opportunities for citizens of southern Sonoma County to learn about and improve environmental conditions in the Petaluma River Watershed." The group has completed urban forestry, environmental education, and riparian restoration projects throughout the watershed. This year the Rose Foundation has granted the group funding to pursue diazinon testing at a minimum of eight major tributary confluences along the river and around the city of Petaluma (B. Abelli-Amen, Pet. Tree Planters, pers. comm.). Samples will be collected, analyzed and distributed for public information by July, 1999.

- **Sonoma and Marin County Farm Bureaus -** The Sonoma and Marin County Farm Bureaus have followed animal waste issues for the past twenty years through the development of the Sonoma Marin Animal Waste Committee. The committee is an informal group of agriculturalists, federal and state agency staff that meet on a regular basis to discuss waste management issues and solutions. Throughout the years, the committee has established informational materials and guidelines relating to animal waste in the form of Animal Waste Management Guidelines, Compliant Investigation Resolution Procedures, a Dairy Waste Pond Size Estimation Worksheet, Runoff and Pond Areas Calculation Worksheet, and Nutrient Budgeting Program. This year the committee established its first water monitoring program. The program includes monitoring at four sites within the watershed. Monitoring Parameters include pH, temperature, ammonia, and dissolved oxygen.

- **San Francisco Estuary Institute (SFEI) -** SFEI has been instrumental in creating a Regional Monitoring Program (RMP) for the San Francisco Bay. The RMP has been in effect since 1991, monitoring for trace elements such as arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. Trace organics such as diazinon, PAH's, DDT, Chlordane, PCBs, and chlorpyrifos are also examined (SFEI, 1997). The program includes one station located at the mouth of the Petaluma River. This station has consistently revealed elevated concentrations of trace elements and organics above water quality criteria. In comparison to other sites around the Bay, the

Petaluma station has the second highest number of water quality exceedences. One reason for the unusually high concentrations may be the location of the station at the opposite end of the Bay, and downstream of a major tributary, where contamination might expect to accumulate. The Petaluma station also has a shallow water depth which may result in a re-suspension of sediments. According to Dr. Rainer Hoenicke, SFEI Environmental Scientist, monitoring within the watershed could be enhanced through studies indicating the presence or absence of PCBs and mercury concentrations. An additional study examining sediment contamination and affiliated land use patterns would also enhance Petaluma's monitoring program.

III. Data Gaps

Baseline data will be essential in determining a Total Maximum Daily Load (TMDL) and Attainment Strategy for the watershed slated to begin in the year 2000. All existing data will be examined as well as data generated from current monitoring programs. Although existing programs may provide excellent data for baseline information, they cover limited portions of the watershed. An expansion of these programs could provide deeper insight into baseline conditions of the watershed as a whole.

Additional data pertaining to sediment contamination studies and associated land use practices would be of benefit although such studies are deemed costly. Participants of the Petaluma River watershed advisory group and water quality professionals have suggested pesticide, herbicide, and fungicide testing for urban, rural residential, and agricultural land uses. The watershed advisory group meetings held throughout the watershed have also revealed the need for information pertaining to sedimentation, water diversions and stream flows (SSCRCD, 1998).

IV. Water Quality Monitoring Plan

Previously identified non-point source pollutants associated with rural and rural residential areas include temperature, ammonia, dissolved oxygen, sediment, and coliform. Current rural water quality monitoring programs consistently monitor for these parameters with the exception of sediment and coliform levels. However, both of these parameters are being evaluated at this time to determine monitoring feasibility.

The USDA Natural Resources Conservation Service is now exploring coliform testing methods that may be utilized by landowners, and has recently published *Fecal Flash News*. The purpose of the newsletter is to inform and educate landowners and the general public about fecal coliforms and their associated impacts. A study of the watershed's sedimentation has also recently been completed entitled *Erosion and Sedimentation in the Petaluma Watershed,* appendix E. The information derived from both of these efforts should provide good baseline information that could expand current monitoring programs.

The current water quality monitoring program includes a monitoring plan developed by the University of California Cooperative Extension Service and the Sonoma and Marin County Farm Bureaus. The plan was developed for the Sonoma Marin Animal Waste Committee in order to address excessive nutrient loading in local streams. The following monitoring plan is now being used to curtail water quality impacts associated with animal waste.

Description of the Flow Chart

A. The flow chart will be initiated based on water testing results from Department of Fish & Game, Region,1 Water Quality Laguna Stations and Point Reyes National Seashore Stations. Trigger levels have been set that, if reached, initiate the process.

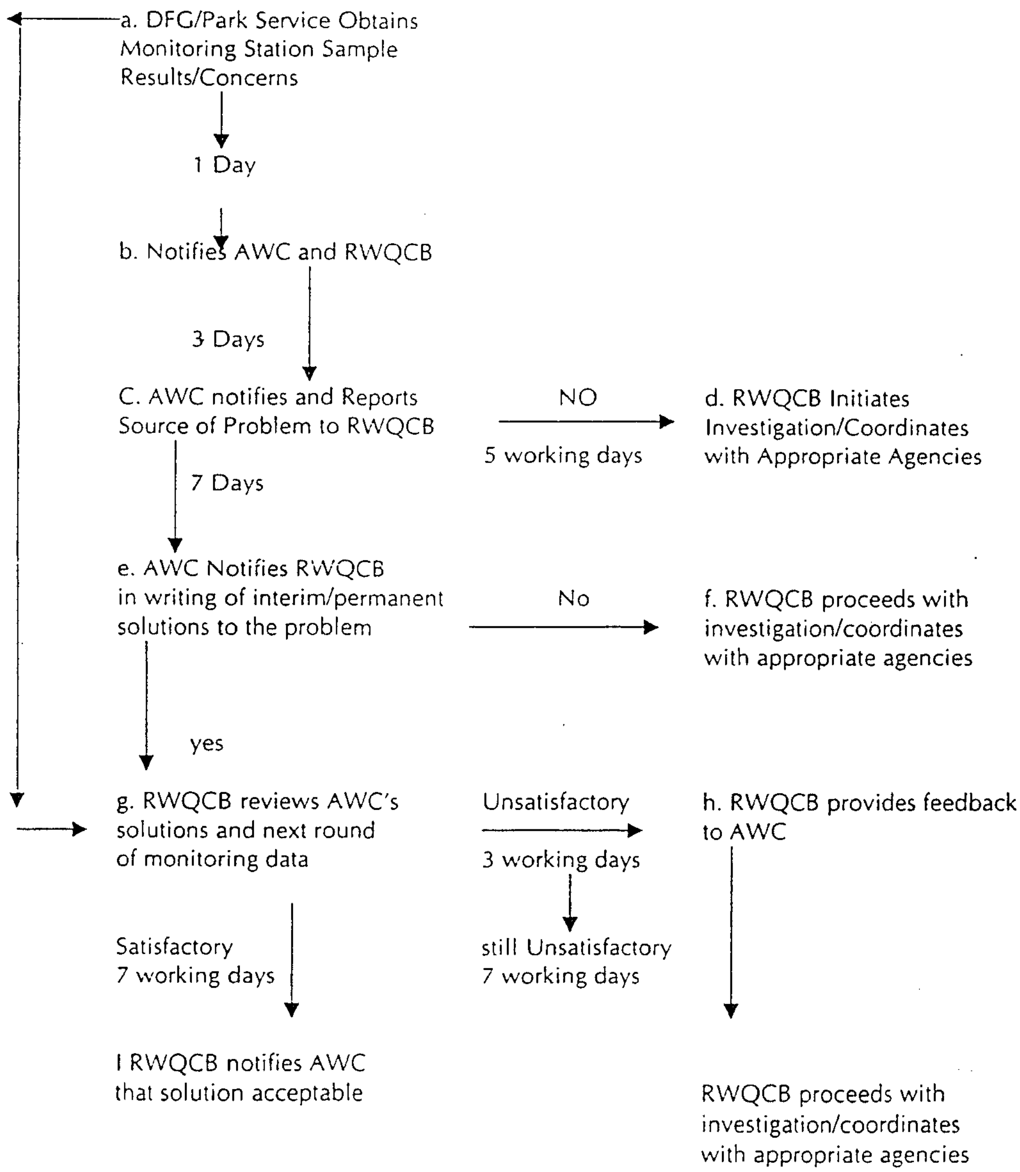
Levels	Standard Levels	Trigger
Total Ammonia	1.0 ppm	5.0 ppm
Unionized Ammonia	0.025 ppm	0.10 ppm
Dissolved Oxygen	>5.0	<5.0

The standard levels are those that reflect, on average, good water quality conditions. The trigger levels are those that are dangerous to aquatic life. Levels above the standards are not necessarily acceptable, but they are not as serous as the trigger levels. Test results between these two levels are an indication of a potential problem, and are also an indication to producers to identify possible sources before water quality reaches a toxic level. Once trigger levels are obtained, the response process begins. The monitoring party has one day to notify the Animal Waste Committee (AWC) (Judy James or Dayna Girardelli) and the respective regional water quality agency.

B. The AWC is notified and has three days to identify the source
C. No later than three days, the AWC is to contract the regional agency to report the source of the problem
D. If the AWC fails to report, water quality initiates its own investigation and the rest of the process is void
E. Seven days following the notification a written report is due to the regional agency, describing actions taken to reduce/eliminate the source
F. If a written report is not submitted, water quality initiates its own investigation and the remaining process is void
G. Water quality reviews the written report and takes into consideration the results of the next monitoring tests to determine if these actions are satisfactory
H. If actions are not deemed satisfactory the AWC is notified to take additional steps
I. The water quality board will notify the AWC that actions taken are satisfactory and the solution is acceptable
J. The AWC has seven days to make additional improvements. If they fail to do so, water quality will proceed with their own agenda

This process is initiated by using the trigger levels. There are, however, instances where regulatory agency involvement supercedes this process, such as deliberate discharge and or visually unacceptable circumstances. For the most part, regulating agencies will refer to this process to deal with poor water quality and concerns. With this process in place and regulatory cooperation, it is imperative that all landowners, regardless of industry, work together within each watershed to make the process work.

Agency Response Flow Chart



Source: University of California Cooperative Extension Service – Sonoma County, 1999

Recommendations

The water quality monitoring plan that is being implemented by the Animal Waste Committee has proven successful in its attempts to curtail water quality impacts associated with the dairy and livestock industries in the watershed. Monitoring programs such as these should continue and could be expanded to include additional monitoring parameters or monitoring sites. In addition to the continuation and expansion of existing programs, the establishment of a watershed science team, and the support of landowner water quality self-monitoring programs are recommended.

- **Continue and expand current monitoring efforts.** Current monitoring groups have done an exceptional job to date. Local schools, the Farm Bureau, Bay Area scientists, environmental organizations, and public agencies are all participating in an effort to determine water quality conditions for the Petaluma River. Efforts such as these have the ability to educate all facets of the community with an interest in water quality. These programs should continue and should be enhanced by funding opportunities whenever possible. Monitoring programs for the river could also be enhanced through the expansion of existing programs to include additional monitoring sites and parameters. Furthering these programs to include other areas of the watershed will aide in detecting the presence or absence of pollutants.

- **Establish a watershed science team consisting of local community groups and organizations, and local, state, and federal agency representatives focused on evaluating ongoing monitoring activities for the Petaluma River.** The creation of a watershed science team would help collectively organize groups and agencies to evaluate and refine ongoing monitoring activities by identifying gaps in data, making recommendations for improvement, and preventing duplication of studies. The riparian vegetation and erosion and sedimentation maps could be evaluated to determine additional monitoring sites. The watershed science team could also act to make this data available to the general public and provide direction for the purpose of furthering water quality improvement projects.

- **Support landowners to monitor water quality themselves** (*Recommendation of Landowner Advisory Committee).* Landowners have stressed the need for more outreach to let them know that monitoring kits/training/protocols are available (such as through the current Farm Bureau monitoring program). Monitoring workshops put on through the U.C. Cooperative Extension Service are encouraged. These workshops should stress standardized protocols to ensure that monitoring is done accurately. Landowners have also expressed the need for technical expertise, possibly through a local water monitoring coordinator.

V. Non-point Source Monitoring for Rural Landowners

Monitoring may be as simple as a visual observation or as complicated as performing a detailed laboratory analysis. It is often confusing to know which parameters may be of concern for a specific project or purpose. The following pages offer a set of guidelines to non-point source monitoring followed by a summary of water quality concerns and associated water quality parameters related to land use within the Petaluma River watershed. For purposes of the Petaluma River watershed study, these guidelines are focused on rural residential and agricultural areas of the watershed.

Non-point Source Monitoring. Sources of water pollution that require monitoring are divided into two categories: 1) point source and 2) non-point source pollution. The Regional Water Quality Control Board regulates both sources. Point source pollution is best described as any type of pollution that is released from a pipe such as wastewater and in certain cases, agricultural runoff. These are regulated by requiring National Pollution Discharge Elimination System (NPDES) permits for all point source discharges to waters of the state. In terms of agricultural practices, a NPDES permit is needed for dairies containing greater than 1000 animal units (the equivalent of 750 cows). Non-point source pollution is regulated in a different manner since it is difficult to assess an exact location that is contributing to a pollution problem. Polluted runoff from stormwater and agriculture are two examples of non-point source pollution. For purposes of the watershed study, these guidelines will focus on non-point source pollution.

Non-point source pollution can be addressed most effectively by instituting the following types of monitoring programs defined as:

> **Baseline monitoring** - Existing water quality conditions are characterized to establish a database for planning or future comparisons.
>
> **Effectiveness monitoring** - Evaluation is made to determine whether the specified activities (e.g., Best Management Practices, BMPs) have the desired effect (MacDonald, 1991).

The type of monitoring a project will adopt depends on the purpose of the project. Baseline monitoring can be used on a watershed basis and will reveal any existing concerns related to non-point or point source pollution. Once the watershed's problem areas are identified, the monitoring program can be refined to include trend monitoring which will evaluate any long term changes that are occurring in the watershed. This can be done on a regular basis of public access points.

Effectiveness monitoring would help evaluate a particular practice such as the effectiveness of planting a cover crop with a vineyard. This can be as simple as a visual observation but may include additional water quality monitoring measures. It is important to note that effective monitoring sites would most likely be located on private property and should be implemented by landowners unless permission for other monitors has been granted.

Monitoring programs can prove to be valuable for their desired purpose. The most important element to consider when developing a monitoring program is that the program produces quality data. Quality assurance and control will allow for better comparison and interpretation and ensure the data's validity for future endeavors. Once you have chosen the type of monitoring program you would like to pursue, the next step is identifying parameters of concern. Monitoring parameters outside urban areas can be identified most effectively through types of land use such as rural residential, animal agriculture, or vineyards and croplands.

Rural Residential Areas. Rural residential areas are often referred to as ranchettes and are found throughout the Petaluma River watershed. Ranchettes range from one to 20 acres and are usually not part of development tracts. These areas provide a direct impact on nearby stream systems carrying storm runoff and dry weather flows which include irrigation water and wash waters from impervious areas such as roads. The result is a lack of water infiltration into the soil (ground water recharge) and an increase in runoff. Compounding the effect is not only an increase in the volume of water but an added increase in the water velocity over impervious surfaces. Once the accelerated flow reaches the stream channel, the morphology of the stream may change, resulting in increased flooding, increased temperature, erosion, sedimentation, and habitat loss.

Aside from these factors, water quality is further degraded as runoff carries sediment, nutrients, bacteria, and toxic heavy metals into the stream. The sources of these pollutants are varied and can be traced to septic systems, residential and commercial landscaping, construction sites, motor vehicles (brake pads, tires, and oils), paints, cleaning products, fertilizers, pesticides, and herbicides. Ranchettes also harbor small-scale animal agriculture or crop operations. Please refer to the appropriate land use for monitoring parameters associated with such operations.

Rural residential areas within the Petaluma River watershed which may provide an impact to the river include the area on the eastern side of the watershed surrounding Penngrove extending into Lichau and Lynch Creeks. On the western side of the watershed, the rural residential areas impacting the river outside Petaluma are Liberty Road, Rainsville Road, Skillman Lane, Middle Two

Rock Road, and Eastman Lane. The following are water quality parameters that may be associated with rural residential areas (University of California, 1995:

- Visual evaluations/foam/color/odor
- Conductivity
- Flow
- Acute toxicity (visible mortality, odor, turbidity)
- Dissolved Oxygen (DO)
- Septic system failures (Coliform bacteria)
- Biomonitoring (monitoring instream fauna)
- Sediment/gravel
- Metals
- Ammonia/pH/temperature
- Biological oxygen demand (BOD)
- Habitat assessment
- Fertilizers/nutrients
- Pesticides
- Road oil, soap, surfactants, (visual)
- Paint/construction materials
- Garbage, (visual)

Animal Agriculture. Animal wastes such as those associated with horse, dairy, beef, sheep, poultry, and any other animal facility will contribute non-point source polluted runoff to nearby surface waters if managed incorrectly. Animals may contribute to non-point source pollution in a number of ways. The most direct effect is the presence of animals within the stream corridor. When managed incorrectly, these areas can become denuded of vegetation due to over grazing and/or hoof traffic. The result is the sloughing of streambanks, erosion, increased water temperature, sedimentation, and loss of wildlife habitat.

Animals will also contribute to non-point source pollution in the way of nutrients and bacteria from manure. This is caused by animals defecating in the stream or by runoff from manured areas such as confinement areas, feeding areas, watering areas, manure storage areas, silage pits, hoof trails, and manure application areas. The following are water quality parameters associated with confined animal facilities (University of California, 1995):

- Ammonia/pH/Temperature
- Conductivity
- Flow
- Dissolved Oxygen, (DO)
- Foam/color visual evaluation, odor turbidity
- Sediment/gravel
- Biological oxygen demand (BOD)

- Habitat assessment
- Pesticides

Agriculture - Vineyards/Croplands. The primary water quality concern related to vineyards and cropland is erosion and sedimentation. Sedimentation can be the result of new vineyard development and/or hillside vineyards that do not take the necessary precautionary steps for erosion control. The mismanagement of such sites can result in gullies, sheet and rill erosion, increased runoff, and increased water velocities. All of these factors ultimately affect the nearby streams by downcutting the stream channel, destroying wildlife habitat, increasing water temperatures, and/or destroying spawning beds.

Additionally, vineyards and croplands may contribute to non-point source pollution through the mismanaged use of pesticides, herbicides, fungicides, fertilizers, and pomace disposal. The following are water quality parameters associated with such practices (US Department of Agriculture, 1996):

- Sedimentation
- Flow
- Habitat assessment
- Pesticides
- Temperature
- Dissolved Oxygen
- Biological Oxygen Demand
- Fertilizers/nutrients

Other Considerations:
It may not be necessary to monitor for each of the parameters that is listed and to do so can prove to be expensive. For example, it is recommended that agricultural producers concerned with dairy waste monitor for pH, temperature, and ammonia. The cost to purchase test equipment for these parameters is substantially lower than if one were to purchase test kits for all parameters listed. Other considerations include identification of sites, and monitoring frequency. All these factors are important questions that should be answered by a local professional. Table 3 lists resource personnel available who can help answer these questions.

Table 3: List of Resources

Table 3 - List of Resources		
Agency	**Address**	**Phone Number**
Mike Rugg Department of Fish and Game	P.O.Box Yountville, CA 94599	(707) 944-5525
Bill Hurley Regional Water Quality Control Board	1515 Clay Street, Suite 1400 Oakland, CA 94612	(510)-622-2364
Dayna Ghirardelli / Paul Olin Univ.of California Cooperative Extension	2604 Ventura Ave., Rm. 100 Santa Rosa, CA	(707)-527-2621
Sonoma and Marin County Farm Bureau	970 Piner Road Santa Rosa, CA	(707) 544-5575
Josh Collins San Francisco Estuary Institute	1325 South 46th St. Richmond, CA 94804	(510) 231-9539
Paul Jones Environmental Protection Agency	75 Hawthorne Street San Francisco, CA 94105	(415) 744-1976
Mike Ban City of Petaluma	22 Bassett Street Petaluma, CA 94952-2610	(707) 778-4304
Southern Sonoma County Resource Conservation District	1301 Redwood Way Suite 170 Petaluma, CA 94954	(707) 794-1242x3
Natural Resources Conservation Service	1301 Redwood Way Suite 170 Petaluma, CA 94954	(707) 794-1242x3
Bruce Osterlye Trout Unlimited	727 Paula Lane Petaluma, CA 94952	(707) 765-9775
Paul Martin Western United Dairyman	5154 Linda Lane Santa Rosa, CA 95404	(209) 527-6453

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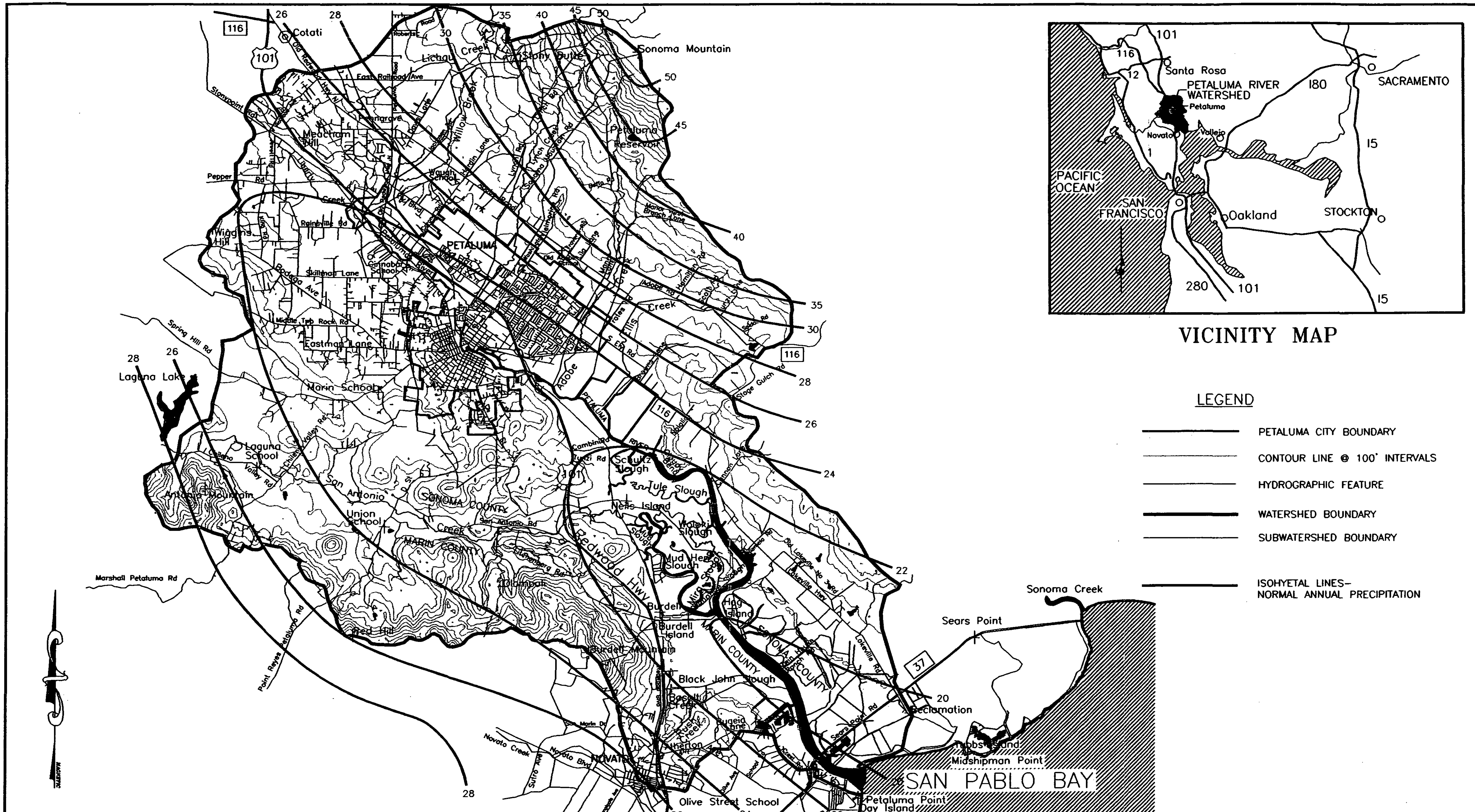
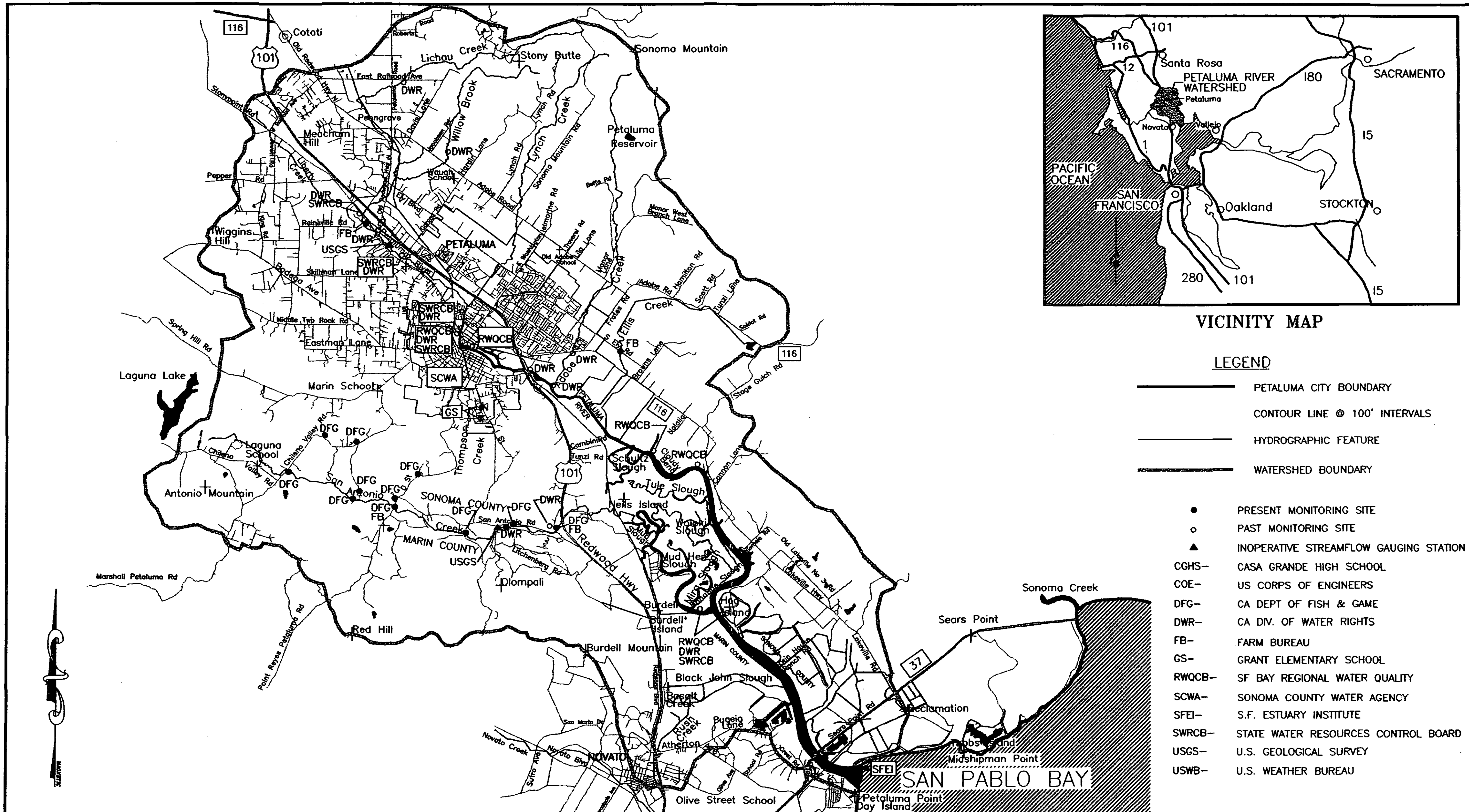


PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: March, 1998 SCALE: 1" = 10,000' CHECKED BY: MN DRAFTED BY: EA	REVISIONS	BY	PREPARED FOR: SOUTHERN SONOMA COUNTY RESOURCE CONSERVATION DISTRICT	NORMAL ANNUAL PRECIPITATION FOR PETALUMA RIVER WATERSHED	SHEET 1 OF 1



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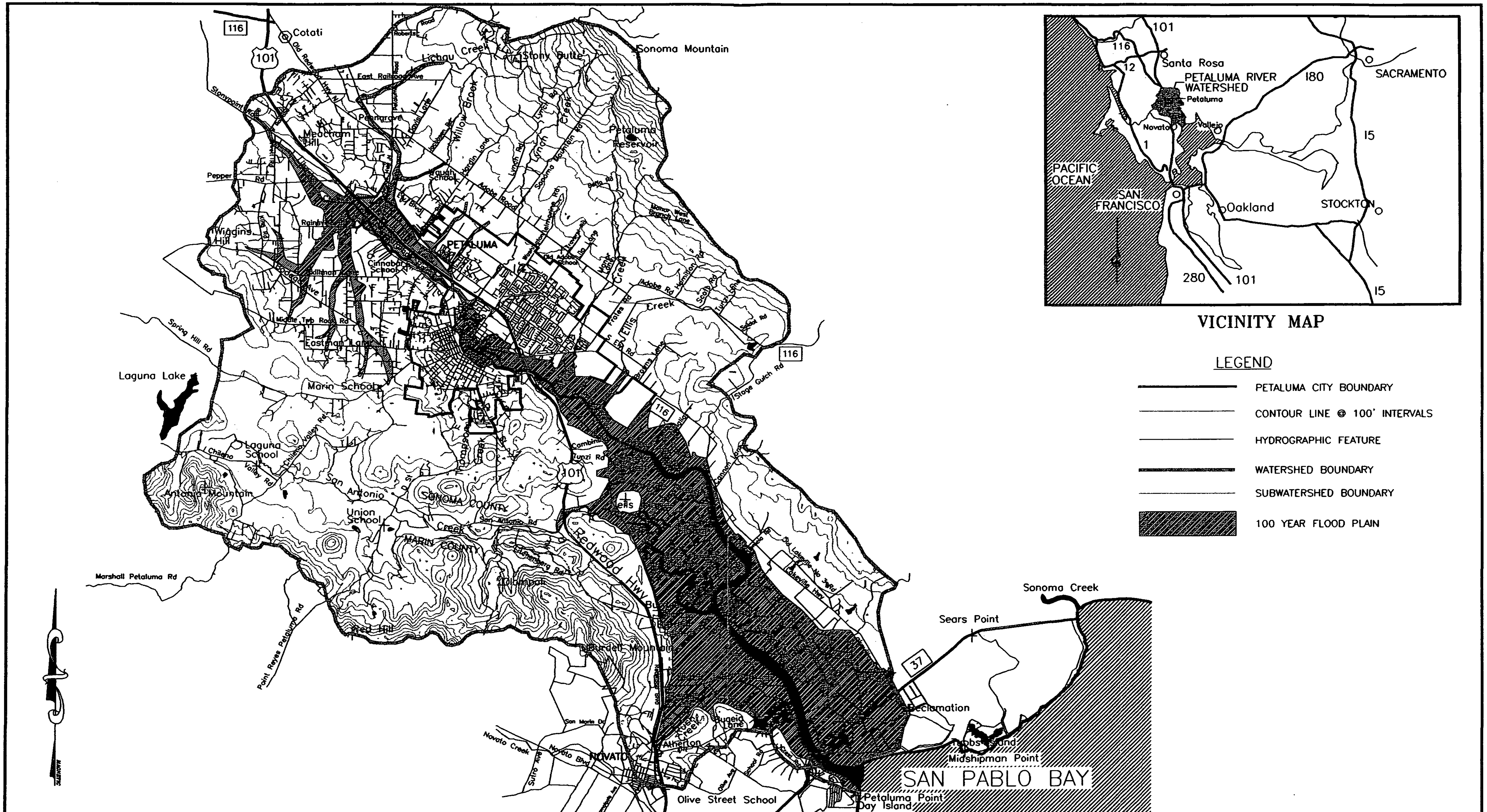
PREPARED FOR:
SOUTHERN SONOMA COUNTY
RESOURCE CONSERVATION DISTRICT

WATER QUALITY MONITORING IN THE PETALUMA RIVER WATERSHED

SHEET 1 OF 1



PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: May, 1998 SCALE: 1" = 5,000' CHECKED BY: MN DRAFTED BY: EA	REVISIONS	BY	PREPARED FOR: SOUTHERN SONOMA COUNTY RESOURCE CONSERVATION DISTRICT	100 YEAR FLOOD PLAIN IN THE PETALUMA RIVER WATERSHED	SHEET 1 OF 1

Appendix D

Flood Control Impacts in the Petaluma River Watershed

Flood Control Impacts in the Petaluma River Watershed

Prepared for
Southern Sonoma County Resource Conservation District
Petaluma River Watershed Enhancement Plan

Prepared by
Prunuske Chatham, Inc.
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July 1998

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Southern Sonoma County Resource Conservation District has contracted with Prunuske Chatham, Inc., an environmental consulting firm located in Occidental, to produce this document entitled *Summary of Flood Control Impacts in the Petaluma River Watershed.*

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SUMMARY OF FLOOD CONTROL IMPACTS IN THE PETALUMA RIVER WATERSHED

1.0 Introduction

Like most California rivers, the Petaluma River leaves its banks and spreads out into its floodplain on a regular basis. When the local human population was sparse, flooding was not considered a serious problem. Now, with lives and developed property at stake, it has become an urgent issue. Dramatic population growth, increases in paved and surfaced areas within the watershed, and ongoing erosion in tributary channels, combined with a recent spate of heavy storms, has galvanized the community and public agencies into action. The U.S. Army Corps of Engineers (ACOE) and the City of Petaluma (City) are beginning a channel widening project in the troubled Payran reach of the Petaluma River that will accommodate a 40-year flood event. The City and Sonoma County have also been considering flood control measures in the Denman Flats and Willow Brook Creek reaches.

Downstream of the City, large areas of agricultural land are dependent on a system of levees. Most were constructed by farmers and ranchers in the late 1800s when public policy championed the reclamation of salt marsh "wasteland" into productive use. The levee system is generally in good repair, but breaks do occur. Burrowing muskrats and wave action from boats and wind threaten levee integrity.

In the winter of 1997-98, levees in the Lakeville area were overtopped by the high flows in the river. Although flooding in this area does not have the impact on homes and other structures that flooding in the city has, it can have a profound effect on agricultural lands. The salt intrusion alone can seriously alter soil productivity. The Southern Sonoma County Resource Conservation District (SSCRCD) works with local landowners and the ACOE to secure blanket permits that allow ongoing levee maintenance.

As part of the *Petaluma River Watershed Enhancement Plan,* the SSCRCD has retained Prunuske Chatham, Inc. (PCI) to compile existing information on flood control, to prepare a brief summary of potential habitat impacts from proposed flood control projects, and to create a map of flood areas within the watershed. The map that delineates the 100-year flood zone as defined by the Federal Emergency Management Agency (FEMA) is attached.

2.0 Summary of Existing Information

Given the long interest in navigation and flood control on the Petaluma River, many studies, reports, and histories of the river exist. The chief players in flood control in the Petaluma River are the ACOE, the City, and the Sonoma County Water Agency (SCWA). The ACOE has maintained a channel for navigation from the mouth of the river to the Washington Street Bridge since the 1930s. SCWA is responsible for flood control throughout Sonoma County. The City, of course, maintains a vital interest in the safety and economic well-being of its citizens. The State Coastal Conservancy (SCC) and the City have also recently prepared an access and enhancement plan for a portion of the river corridor that addresses flood control as part of overall river management.

Below are brief summaries of several recent documents that address current flood issues. Each of these, in turn, contain extensive reference lists of additional information sources.

2.1 Sonoma County Water Agency. 1986. *Petaluma River Watershed Master Drainage Plan.* Prepared for the City of Petaluma.

The SCWA prepared the *Petaluma River Watershed Master Drainage Plan* at the request of the City and on the recommendation of the Zone 2A Flood Control Advisory Committee. Petaluma Basin Zone 2A encompasses 87 square miles and includes the Petaluma River watershed north of San Antonio Creek. A seven-member advisory committee meets at least once a year to recommend budget priorities to the SCWA Board of Directors (i.e., the Sonoma County Board of Supervisors). All of the members are residents of the District; six are appointed by the SCWA Board of Directors and one by the City. The *Petaluma River Watershed Master Drainage Plan* continues to guide the recommendations of the Zone 2A Flood Control Advisory Committee.

The master plan describes the hydrology of the watershed and identifies possible solutions to flooding problems. It includes brief sections on geology, climate, water quality, land use, and biotic and cultural resources. It also delineates areas of flooding for a 100-year frequency storm event.

The plan has a concise and interesting summary of previous studies of the Petaluma River going back to an ACOE report dated December, 1879, that recommends creating a 50-foot wide by 3-foot deep channel with three "cutoffs." The first flood control report in the list is dated 1896. It was prepared by the California Department of Public Works and recommended creation of a canal for navigation and the diversion of Lynch and Washington Creeks onto the salt marsh east of the town of Petaluma to reduce sedimentation in the main channel. The first ACOE report on flooding, dated August, 1942, concluded that "a plan could be developed to alleviate flooding and channel erosion on Petaluma River and its tributaries by construction of levees, channels, interceptor ditches and drop structures, along with implementation of proper grazing and land use practices."

The *Petaluma River Watershed Master Drainage Plan* identifies three areas that experience flooding that causes "serious damage to improved properties and structures." These are the Payran reach from the turning basin to the confluence with Lynch Creek, the Denman reach from Corona Road to the confluence of Liberty Creek and Willow Brook Creek, and the Willow Brook Creek reach, which begins just west of Stony Point Road and extends to Ely Road (see attached Map of Petaluma River Master Drainage Plan—Petaluma River Flood Mitigation Alternatives). After a brief discussion of non-structural flood control methods, such as public purchase of flood-prone property, the master plan describes three sets of structural flood control measures: 1) diversion and storage to slow and manage storm flows; 2) channel enlargement to allow storm flows to move faster through flood-prone areas; and 3) combinations of diversion and storage with channel modification. Hydrographs, which show the discharge over time, are provided for each alternative.

Diversion and storage alternatives include three elements: 1) the Petaluma bypass, which would collect water from Capri, Lynch, Washington, East Washington, and Adobe Creeks and divert it into Ellis Creek; 2) construction of a 12 to 15-foot high dam at Denman Flats, which would flood about 240 acres in a 100-year storm event; and 3) the Willow Brook Creek diversion, which would capture flow from Willow Brook Creek at Ely Road and divert it through an open channel to the reservoir created by the Denman dam. Hydrographs are also provided for the combination of the Petaluma bypass and the Denman reservoir and the combination of the bypass, the reservoir, and the Willow Brook Creek diversion.

Channel enlargement and modification alternatives are presented for three areas: 1) the Payran reach from just upstream of Lynch Creek to D Street; 2) the Denman reach from Willow Brook Creek to just downstream of Corona Road; and 3) the Willow Brook Creek reach from Ely Road to the Petaluma River. The channels proposed would be earthen with unspecified bank protection at "transitions, stress areas and bridges." Combinations of channel modification in two and in all three of the reaches are also presented, as is the combination of channel enlargement with diversion and storage elements. Table 3.2 on page 3-25 of the master drainage plan summarizes the costs, peak flows, and water surface elevations of all alternatives.

The plan also includes "34 Project Needs Reports" that summarize additional potential improvements to address street and property flooding throughout the watershed. Most involve construction of open channels or installation of concrete storm drains to move water out of flooded areas. Many follow natural waterways and could have a profound impact on riparian habitat.

The plan also includes a section on flood control financing and a very general Environmental Checklist, which concludes that environmental analysis would have to be conducted on a project-by-project basis to determine if the projects would have a significant impact on biotic or historic resources. The discussion on cumulative impact is amazingly given current environmental standards, and it is limited to the impacts of construction of the smaller projects on the hydrology of the Petaluma River.

2.2 WESCO (Western Ecological Services Company, Inc.). 1988. *Summary of interim reports and advisory statements on the proposed Petaluma River Watershed Master Drainage Plan.* Prepared for the City of Petaluma.

WESCO was retained by the City to provide an independent review of the SCWA's *Petaluma River Watershed Master Drainage Plan*. The interim reports include a hydrologic and hydraulic analysis by Philip Williams & Associates (PWA) and a fairly in-depth report on biological resources prepared by WESCO. PWA concluded that the Denman dam by itself would result in only a 4% decrease in peak flows at the Payran reach. The bypass channel as proposed by SCWA would reduce the peak discharge at the Payran reach by 24%, and extension of the bypass to include Willow Brook Creek would decrease the Payran discharge by 40%.

The biological resources report identified potential impacts of the proposed flood control measures. Construction of the Denman dam would impact three acres of vernal pools and two species of concern, the Petaluma popcorn flower and north coast semaphore grass. The combination of the dam with the Willow Brook Creek diversion would also affect passage of steelhead trout to and from Willow Brook Creek.

The report indicates that the bypass could have far reaching biological impacts. The bypass could substantially reduce in size 14 acres of coastal salt marsh at the mouth of Ellis Creek. This area is the uppermost extent of the Petaluma Marsh and provides suitable habitat for California clapper rail, California black rail, salt marsh yellowthroat, and other species of concern. Pool habitat in the reaches of the creeks cut off by the bypass would be reduced or eliminated. Salmonid passage would be profoundly affected as would instream habitat for rearing salmonids and resident fish. Changes in the volume and timing of stream flow would also impact the health and species composition of riparian plants. The channel modification alternatives proposed by SCWA would impact riparian habitat and fish passage, particularly during construction.

The report briefly identifies possible mitigation measures, including the re-establishment of riparian vegetation and avoidance of salt marsh and other critical habitats where possible. Where avoidance is not possible, the report suggests construction of additional wetlands. As for fish mitigation, the report suggests self-cleaning fish screens and maintenance of flows that meet the

U.S. Fish and Wildlife Service (USFWS) passage criteria for chinook salmon and steelhead trout.

2.3 JNRA (John Northmore Roberts and Associates, Berkeley, CA). 1992. *Alternatives Report, Petaluma River Access and Enhancement Plan.* Prepared for City of Petaluma and State Coastal Conservancy.

This is the second report from a team of consultants retained by the City with funding from the SCC to develop an access and enhancement plan for a 7.8 mile reach of the Petaluma River from Willow Brook Creek to the Highway 101 bridge. The consultants worked with a citizen River Advisory Committee and a Technical Advisory Committee to create goals and select alternatives. At this time (July, 1998), the City is still engaged in the design process for this reach; no projects are currently scheduled.

The report considers many aspects of river corridor use, including recreation, natural habitats, economic development, and flood control. Two of the River Advisory Committee's nine primary goals are to maintain navigability of the river and to improve flood control. All of the alternatives call for a greenway with varying lengths of trails and for preservation and enhancement of riparian and adjoining habitats. The importance of linking habitat areas and using biotechnical bank stabilization to maximize even marginal habitat is emphasized throughout the report.

The report divides the study reach into six areas. The authors make recommendations for flood control and bank protection for each. The section on the Upstream Area (Willow Brook Creek to Lynch Creek) contains a discussion of the SCWA's proposal of a grassed trapezoidal channel versus the flood terrace configuration proposed by WESCO and PWA. Both channels are designed to carry a 100-year storm flow as recommended in the report, but the flood terrace configuration would incorporate a low flow channel and a bench that could be restored to wet meadow and riparian forest. An interesting series of cross-sections illustrating how each alternative would look at various locations is included in the report.

Recommendations for the Payran reach include widening the channel to accommodate the 100-year flood and establishing a continuous native vegetation zone along the river. The report encourages the community to work with the ACOE to develop a plan that provides both flood control and habitat restoration. Channel widening to handle a 100-year flood is also recommended for the Lakeville Agri-Industrial Area (Edith Street to, and including, Dairyman's Feed).

Appendix A to the report includes a summary of public input from many sources, including neighborhood meetings, the two advisory committees, and a workshop.

2.4 U.S. Army Corps of Engineers and City of Petaluma. March, 1995. Petaluma River, California, detailed project report for flood control. ***Final Environmental Impact Statement/Environmental Impact Report.***

The City and ACOE investigated alternatives for reducing flood damage in the City from the Petaluma River. The specific study area extends from Lynch Creek to below Lakeville Street.

The Final Environmental Impact Statement (FEIS) addressed three alternatives: 1) no project; 2) channel improvements that would result in a 10-year level of flood protection, which is named the NED (National Economic Development) Plan because it was given the highest benefit-to-cost ratio of the plans considered; and 3) the Recommended Plan, which would result in a 40-year level of flood protection given the City's existing 2005 General Plan build-out scenario. The project designers assumed that full watershed development would occur by the year 2040 and that the natural upstream storage area of Denman Flat would remain in its present condition. Other alternatives, such as 100-year flood protection, flood-proofing, and flood control dams, were eliminated from in-depth analysis during the reconnaissance phase due largely to high costs and severe environmental impacts. Construction of the Recommended Plan is scheduled to begin in May of 1999, although at the time of the writing of this summary the ACOE has announced that they may be delayed by five months.

The Recommended Plan (see attached Map of Detailed Project Report—Petaluma River General Plan 40-Year Protection) includes approximately 3,700 feet of U-shaped and trapezoidal channel, replacement of two railroad bridges and two street bridges, 4,600 feet of concrete floodwalls, a weir at the upstream end of the project, and removal of two houses and one business. Unavoidable significant impacts identified are loss of 1.42 acres of riparian scrub-shrub, 0.17 acres of shaded aquatic habitat, 0.18 acres of emergent marsh, 2.13 acres of intertidal mud flats, 6.8 acres of grassland/ruderal habitat, 1.47 acres of exotic vegetation, and a gain of 4.04 acres of open water habitat. Mitigation measures for these impacts include revegetation of in-channel benches and the upper channel banks of the trapezoidal channel and revegetation of several areas totaling 9.28 acres with riparian scrub-shrub and grassland habitat. Proposed mitigation measures for the Sacramento splittail focus on planting riverside benches with emergent vegetation and riparian trees and piping freshwater flows around the construction zone to insure that downstream habitat would remain available.

The FEIS appendices contain the USFWS coordination report, which prescribes mitigation measures and advises the ACOE on the least environmentally damaging alternative. The recommendations include the statement that USFWS "maintain(s) that the Corps should adequately evaluate the cumulative effects to fish and wildlife . . . in combination with other proposed development projects along the Petaluma River." The appendices also contain agency and public comments to the FEIS, along with the ACOE's responses. The transcript of the NEPA/CEQA hearing before the Petaluma City Council on August 15, 1994, is of particular interest in that residents bring up many concerns, especially in the arena of cumulative impacts, that would apply to future flood control projects, as well as to the ACOE project.

3.0 Summary of Potential Habitat Impacts from Proposed Systems
Environmental impacts rarely exist as discrete elements. Each is tied to many others with the resulting web of impacts often greater than the predicted sum of the parts. The appendices to the ACOE's FEIS, particularly the input of the USFWS and concerned citizens, raise many pithy questions about the effects of that project. The fisheries and riparian sections of the WESCO review of SCWA's *Petaluma River Watershed Master Drainage Plan* also presents some thoughtful information on immediate and long-term impacts.

Without the funding to finance independent studies, the role of concerned citizens and small public agencies such as Resource Conservation Districts is often to ask questions during the environmental review process and to make sure that everything that could possibly be impacted is put on the table for discussion. Well documented citizen monitoring can also be a powerful information tool. Photographs of flooding or erosion, observations of fish and other wildlife, and cost estimates of damages incurred to agricultural products are all examples of important information contained within the local community that is often missing from the official environmental review process.

The following list sums up the major areas of impact to habitat that are associated with flood control projects. These are discussed in greater detail in the reports listed in Section 2 above and in other sources referenced within these reports.

3.1 Riparian habitat.
Riparian habitat is in the direct line of fire in many flood control projects. In order to access the channel and alter it, trees and shrubs have to be removed. Trapezoidal channels break the connection between established riparian habitat and open water, one of the most productive habitat zones. Even most modified channel designs, such as the current ACOE project, that incorporate low flow channels and benches rarely allow that direct interface, although they do bring the riparian habitat closer to the water surface. On the positive side, riparian habitat restoration has proven successful throughout the state. The technology is well developed and effective. In areas where non-native

plants dominate the riparian zone, flood control projects can present an opportunity to restore a native plant community.

Projects that alter the flow regime, such as the bypass, can indirectly affect riparian vegetation by changing the water table and/or the length of time that creekside plants receive water. Year-round flows in Walker Creek in neighboring Marin County, which began in the 1980s, appear to have encouraged willow and alder growth on the lower banks. Reduction or removal of these flows, such as is proposed for the bypass, would favor the return of grasses and woody plants that flourish in drier conditions. Aquatic life that takes shelter in willow roots growing into the water could be profoundly impacted over time by changes in species composition.

3.2 Other wetlands.

In addition to riparian areas, other wetlands may potentially be impacted by proposed projects. Some impacts are direct, such as the loss or significant alteration of the upper end of the Petaluma Marsh at Ellis Creek if the bypass is constructed. The Denman dam and reservoir would drown several acres of vernal pool habitat. Other effects are less readily visible. Subtle changes in upstream hydrology can alter the quantity and quality of water entering wetlands and can change the amount of sediment flowing into them.

Wetland reconstruction and management is far from a precise science at this time. The relationship between water, topography, soils, tidal influence, and the biotic community is immensely complex. Artificial wetlands created for mitigation frequently do not function as predicted, and rarely fully replace the lost natural habitat. Rigorous monitoring of impacted wetlands for long periods of time following project construction—at least ten years—is essential to adjust management strategies to achieve mitigation goals.

3.3 Instream habitat and fishery resources.

Flood control projects that modify the channel invariably disturb instream habitat. In some examples, such as the current ACOE project in Petaluma, project designers claim they can restore most of the habitat to its previous condition. In more complex reaches such as in the upper tributaries, restoring pools, riffles, overhanging logs, undercut banks, emergent wetlands, and other elements of vigorous instream habitat to previous conditions would be a challenging, if not impossible, task. The channel maintenance required for the continued functioning of most flood control projects also returns the channel bottom back to its disturbed condition on a regular basis.

Upstream or downstream projects that change the hydraulics of the channel also change the shape and function of the instream habitat. Slower water, for example, provides more suitable habitat for different insects and plants than the faster moving streams.

Resident fish are impacted by many changes to their homes. Warmer water can breed disease or attract fish predators. Loss of cover leaves them vulnerable. Channel maintenance can disrupt their reproductive cycles. Salmonids are impacted not only by these immediate effects, but also by diversions or changes in flow regimes. The bypass proposals could result in insufficient flows to attract fish upstream to spawn in Willow Brook and Lichau Creeks. Returning fish could be stranded in the bypass or in Denman reservoir if it were constructed as part of the flood control system.

The WESCO report discussed in Section 2.2 above also states that migrating salmonids could be impacted by channel modifications in the main stem of the Petaluma River. Although they don't spawn or rear there, they need adequate flows and resting habitat to pass through it.

3.4 Agricultural resources.

The ability of a landscape to support its population is a basic component of environmental health. Conserving the productivity of agricultural lands is a vital responsibility, particularly in Sonoma County with its rapidly growing population. Flood control projects affect agricultural lands in many ways. The proposed Denman reservoir, for example, would seasonally flood over 400 acres of land, thereby limiting its use to crops or grazing practices compatible with seasonal inundation. Projects that change the rate of water and sediment flowing through the system, such as the proposed bypass and channel modification, could affect groundwater recharge, downstream flooding, and/or erosion.

On the other hand, flood control projects can protect agricultural lands from the harmful impacts of floods. Reservoirs can provide water for irrigation and fire control.

Agriculture can also impact flooding. Concerted erosion control efforts can reduce downstream sedimentation and ultimately increase channel capacity over time. In the Petaluma River watershed, the impact of upstream erosion on City flooding is far outweighed by the impact of development in the floodplain and the covering of permeable surfaces with pavement and structures.

3.5 Stream function.

Many channel modifications profoundly affect the flow of sediment through a system. Although they may solve one problem, they can also create or exacerbate others that will require ongoing mitigation work. Channel straightening, for example, can increase flow velocities and lead to increased bank erosion downstream. Projects that decrease a stream's gradient can cause sediment deposition and require regular cleaning, which can be a profound disturbance to any habitat that does become established in the new channel.

Flood control projects can also change the quantity and timing of water flowing through the channel. The Denman dam, for example, would hold flows and release them slowly. The bypass proposals would reduce the volume of water flowing through each of the affected creeks downstream of the bypass. As was discussed above, these changes in water availability affect both the biotic habitat and agricultural production.

3.6 Economics.

Although not a direct habitat impact, economics are the engine driving many flood control projects. Since projects that take better care of the environment often cost more initially, cost is often used as the reason to choose other alternatives. Some questions that can help to clearly define the actual bottom line include:

- Are permit acquisition and public review costs realistically built into the budget? What, for example, does a three-year fight with the USFWS actually cost taxpayers?

- Is maintenance realistically included in the budget, including acquiring appropriate environmental permits?

- What is the long-term cost-to-benefit ratio for agricultural operations and small businesses impacted by the proposed project?

- Could there be long-term cost savings by incorporating community enhancement goals into flood control projects in one fell swoop, rather than constructing multiple projects? Would other funding sources become available if this were done?

3.7 Cumulative impact.

Cumulative impact is the orphan of many environmental reviews. Even with a rigorous scoping process, the decisions regarding what will be included in the cumulative impact analysis and to what extent is highly subjective. Limited budgets and official mandates further constrain the breadth of inquiry. Frequently, the local community needs to serve as the memory and voice of all the different projects and plans occurring within a watershed. Again, it is not always necessary or even possible to know the answers, just to articulate the community's questions and concerns.

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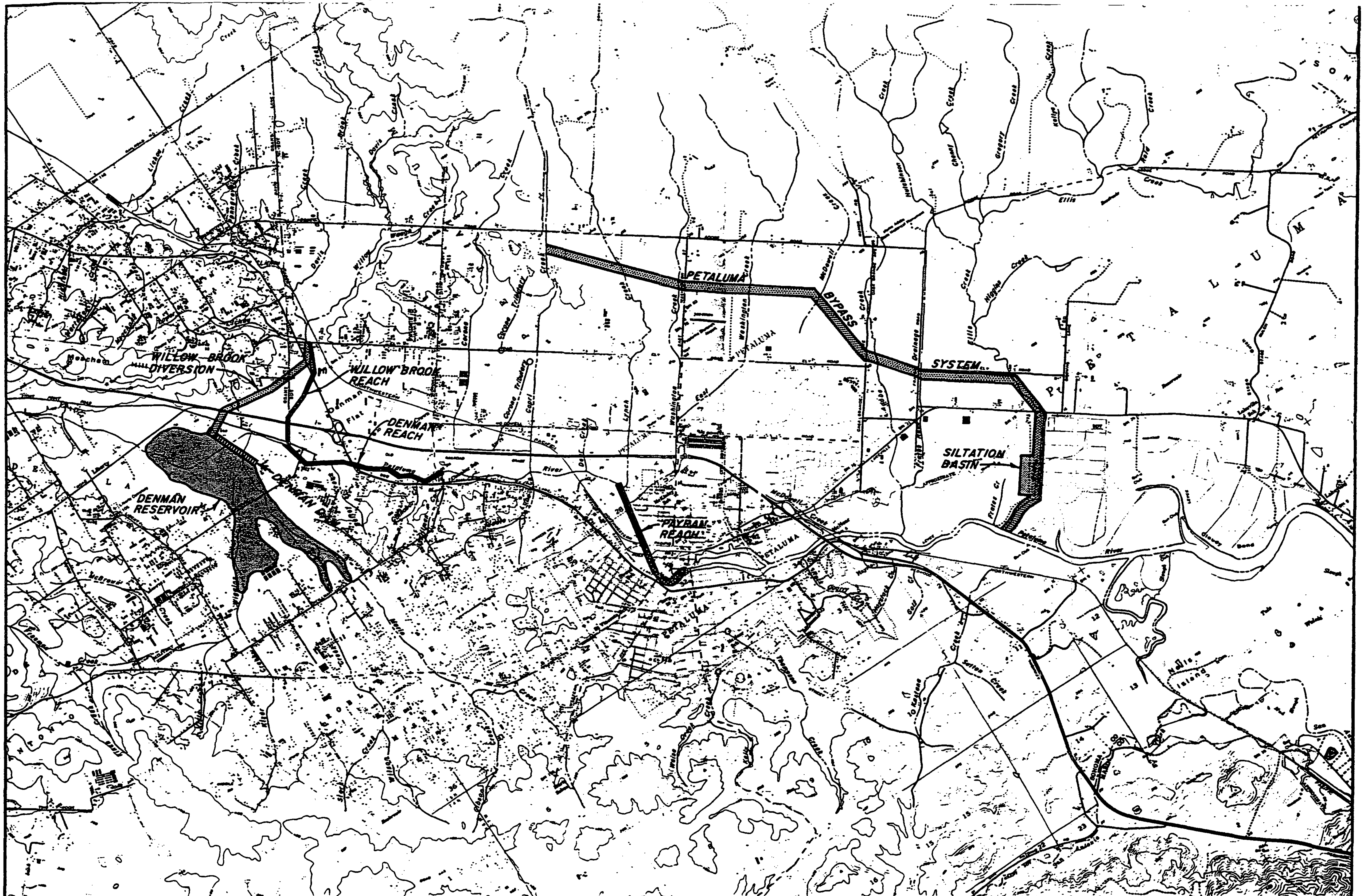

MAP NO.	PETALUMA RIVER WATERSHED MASTER DRAINAGE PLAN
3M	PETALUMA RIVER FLOOD MITIGATION ALTERNATES
	PREPARED BY: SONOMA COUNTY WATER AGENCY

Figure 1.

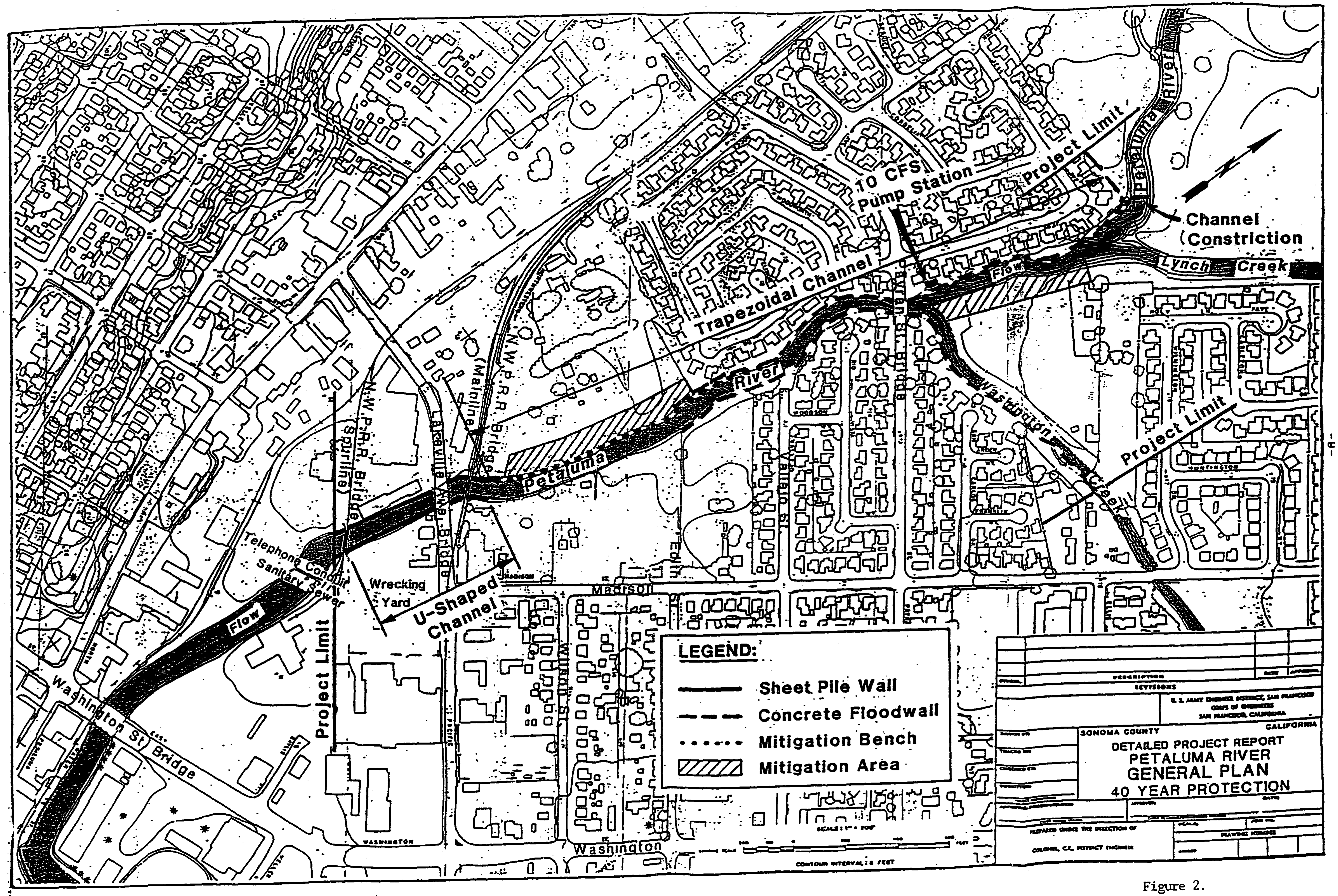
10 CFS
Pump Station
Project Limit
Petaluma River
Channel
Constriction
Lynch Creek
Flow
Trapezoidal Channel
Payran St. Bridge
River
Washington
Creek
Project Limit
N.W.P.R.R. Bridge
(Mainline)
N.W.P.R.R. Bridge
(Spurline)
Lakeville Ave. Bridge
Petaluma
Telephone Conduit
Sanitary Sewer
Wrecking
Yard
U-Shaped
Channel
Madison
Flow
Project Limit
Washington St Bridge
Washington
LEGEND:
Sheet Pile Wall
Concrete Floodwall
Mitigation Bench
Mitigation Area
SONOMA COUNTY
CALIFORNIA
DETAILED PROJECT REPORT
PETALUMA RIVER
GENERAL PLAN
40 YEAR PROTECTION

Figure 2.

Appendix E

Erosion and Sedimentation in the Petaluma River Watershed

Erosion and Sedimentation in the Petaluma River Watershed

Prepared for
Southern Sonoma County Resource Conservation District
Petaluma River Watershed Enhancement Plan

Prepared by
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August 1998

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Southern Sonoma County Resource Conservation District has contracted with Prunuske Chatham, Inc., an environmental consulting firm located in Occidental, to produce this document entitled *Summary of Erosion and Sedimentation in the Petaluma River Watershed.*

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SUMMARY OF EROSION AND SEDIMENTATION IN THE PETALUMA RIVER WATERSHED

1.0 Introduction

The focus of Southern Sonoma County Resource Conservation District's (SSCRCD) plan for the Petaluma River watershed is to improve water quality and enhance fish and wildlife resources. As part of the background preparation for the plan, Prunuske Chatham, Inc. (PCI) characterized erosion and sedimentation in the watershed. With this information, the SSCRCD, together with landowners, can discern opportunities for enhancement.

This report identifies priority subwatersheds for erosion control work. It gives an overview of why erosion is of concern in the watershed, describes the methods used to prepare this summary, presents an overview of slope stability and landslides, and lists enhancement recommendations and opportunities. In Section 2 below, each subwatershed is characterized in terms of location, land use, soils, and erosion. Recommendations are listed for each subwatershed. A base map delineating the subwatersheds of the Petaluma River and showing their erosion repair priority is attached.

1.1 Overview of Erosion

Soils vary widely in physical structure, fertility, mineral content, and the way they react to wind and water. Some soils drain slowly, making them poor choices for unsurfaced roads or septic systems. Others are highly erodible, and the smallest disturbance can lead to a gully or streambank washout.

Soil erosion is a natural process. When detached soil (sediment) enters a water system, it settles out—at a culvert inlet, in a stream channel, in a pond, or in an estuary. While some sediment is needed to bring nutrients and substrate materials to aquatic ecosystems, too much causes problems. It can reduce the capacity of watercourses to hold storm flows, thereby increasing flooding. Fine soil particles fill in wetlands and cement stream bottoms into uniform surfaces that no longer provide nooks and crannies to shelter young fish and the aquatic animals they eat. Erosion and sedimentation are a major cause of the decline of many animal species including salmon and steelhead trout. Increased sedimentation impacts downstream flooding, siltation, and water quality. Erosion problems mean loss of valuable agricultural land.

Erosion can be chronic and/or episodic. Chronic erosion is constant and occurs during significant rainfall. Common types of chronic erosion are sloughing, sheet erosion, rilling, and headcutting. Episodic erosion occurs occasionally, and sediment often moves in a big pulse, such as during a storm event or series of storm events. Landslides are an example of episodic erosion. Erosion problems can be both chronic and episodic, such as a landslide that continues to erode over time.

Sources of sediment can include natural background erosion in areas that are not intensively used, erosion from intensively used areas with sparse cover, and erosion from streambanks. Common areas of concern are sheet erosion from hillsides, gullies in rural areas, landslides, active streambank erosion that threatens property, and poorly designed or maintained roads. Each is briefly described below.

Background erosion. Background erosion occurs naturally by the action of wind and water on the landscape even in watersheds that have little or no human impact. In watersheds that have been intensively used, it can be difficult to assess how much erosion is caused by human activity and how much is independent of it.

Sheet and rill erosion. Sheet erosion is the loss of thin layers of soil from a slope. Rills are miniature gullies, less than one foot deep, that often occur in clusters along with sheet erosion. Slopes that have lost their vegetative cover through severe grazing, fire, or other disturbances are subject to sheet and rill erosion. A common place to see this type of erosion is on new fill slopes at a construction site after a heavy rain.

Gullies. Gullies are often the most visible sign of erosion. Gullies occur in natural drainages, ditches, and outflow areas from culverts. They move upslope with a headcut—a sharp break in slope gradient—at the top of the gully. Gully activity and size are dependent on soil type, cause, water flow into it, and rate of run-off from the surrounding watershed.

Landslides. Mass earth movement such as landslides usually occur naturally, although they can be exacerbated by human activities, such as road construction and removal of vegetation.

Streambank erosion. Streams are highly dynamic. Left to themselves, they continually adjust their length, width, and gradient to changes in weather patterns and in the landscape. We see these changes as erosion. For example, when sediment loads increase in some creeks, gravel bars grow larger and push the flow farther into the opposite bank, which cuts away soil and leads to more sediment in the creek. As this process repeats itself downstream, it can lead to a highly sinuous channel with great, sweeping curves and severe bank erosion.

Bank erosion can also be caused by downcutting, which lowers of the channel bottom. As the bottom drops, the banks are destabilized. Downcutting can occur throughout entire systems and can cause dramatic changes in the watershed as each tributary incises to bring its water down to the level of the main channel. Eventually, groundwater levels will also drop, which leads to drier soil conditions and changes in vegetation type. Causes of downcutting include geological uplifting, upstream dams that trap sediment, gravel removal, and changes in the watershed's hydrology—the rate at which rainfall enters the stream channels.

Local bank erosion can also occur from an obstruction, such as a fallen tree that pushs water into a streambank, or from excessive subsurface flow, such as an overly watered lawn or a poorly placed rain gutter.

Roads. Poorly designed roads are a chronic source of sediment. Typical road-related erosion problems include improper road sloping, inadequately armored culvert outlets, plugged or broken culverts, lack of cross drainage on the road surface, headcutting and downcutting along road drainage ditches, sheet and rill erosion on road surfaces, and rilling on cut slopes above roads.

1.2 Soil Erosion and Watershed Processes

In stable watersheds, rates of erosion are slow, and natural healing processes can keep up. But in many watersheds, human use of the land has accelerated the rate of change beyond nature's short-term healing capabilities. Today's problems are often a result of land uses and management that occurred 100 years ago.

Many erosion problems are complex and occur on a wide scale. A gully, for example, may be caused by channel downcutting within the entire subwatershed. Checkdams in such a gully would probably be undercut and rendered useless unless downstream incision is also addressed. A cut bank could be caused by road erosion in the upper watershed that dumped sediment downstream and led to increased meandering. Flooding is integrally tied to upstream activities, such as erosion and covering of permeable surfaces with pavement and structures. Understanding what is happening with a watershed-wide perspective is integral to selecting an effective repair. While stabilizing active erosion sites is important, long-term watershed health will ultimately depend upon land stewardship.

1.3 Sediment Source Investigation Methods

Erosion and sedimentation studies can range from highly detailed, scientific quantifications to qualitative assessments of erosion sources and sediment yields. For this stage of watershed planning in the Petaluma River watershed, a qualitative analysis was performed. Qualitative analysis can provide practical, cost-effective information on a more general scale. This type of study can identify priority areas for erosion control, subwatersheds with complex, chronic problems that may warrant more in-depth analysis, and where limited funding can most effectively be spent.

To develop a qualitative characterization of the watershed, PCI staff reviewed existing agency reports and literature for information about erosion and sedimentation in the Petaluma River watershed. These included USGS topographic maps; *Landslides and Relative Slope Stability Map for Southern Sonoma County,* (1974); the USGS/HUD document entitled *Relative Slope Stability and Land Use Planning in the San Francisco Bay Region, California* (1979); the U.S. Department of Agriculture Soil Conservation Service's March, 1985, *Soil Survey of Marin County, California,* and May, 1972, *Soil Survey of Sonoma County, California;* and studies for the Ellis Creek subwatershed and Lafferty Ranch. Staff reviewed the soil types and slopes in each subwatershed to estimate slope stability and erosion potential.

Aerial ortho-photos of the watershed taken in 1990 were reviewed and compared with present conditions. Although visibility is limited in many subwatersheds due to vegetation, particularly on the slopes of Sonoma Mountain, the ortho-photos were quite useful in locating ponds that collect substantial amounts of sediment that would otherwise be entering the Petaluma River, particularly in the Lakeville area subwatershed.

PCI staff interviewed Paul Sheffer of the SSCRCD and Bill Cox of the California Department of Fish and Game (CDFG) to ascertain their knowledge of erosion problem areas and other concerns regarding erosion, sediment, and their relationship to fish and wildlife habitat in the Petaluma River watershed. An announcement in the SSCRCD's Petaluma River newsletter, word-of-mouth communication, and landowner area meetings conducted as part of the planning process produced several requests from landowners that PCI and SSCRCD staff visit their erosion sites, which was done.

Limited field reconnaissance was conducted, including informal conversations with landowners about erosion conditions. Staff drove the public roads in each subwatershed looking for erosion and mapping it on a USGS topographic map. These site inventory sheets were collected for landowners who have expressed interest in working with the SSCRCD. They are on file at the SSCRCD office.

Using this information, subwatersheds were mapped and described in terms of general characterization, overview of soil types, a discussion of the erosion found in the watershed, and recommendations. Similar soils types are found throughout the watershed. Rather than repeat the entire soils description each time, the soil type and its erosion potential are simply identified in subsequent discussions of specific subwatersheds. Because many tributaries drain into land within the City limits, portions of Petaluma itself are included in the erosion and sedimentation map.

1.4 Landslide Activity in the Watershed

PCI reviewed existing studies for information on landslides throughout the watershed. The 1974 USGS *Landslides and Relative Slope Stability Map for Southern Sonoma County* indicates that most of the landslides mapped are located in areas of relatively unstable rock and soil on slopes greater then 15%. The slope stability map does not include slides that are too small to be delineated at a scale of one inch equals one mile.

The 1974 map indicates that most of the landslide activity occurs on the steep slopes of the San Antonio Creek subwatershed, the Ellis Creek subwatershed, and along the Lakeville area subwatershed tributaries. A moderate amount of landslide activity is shown for the upper slopes of Adobe Creek and Lynch Creek subwatersheds. Less significant landslide activity occurs on the steeper slopes of Willow Brook Creek, Lichau Creek, and Wiggins Creek (a tributary to Liberty Creek).

The study entitled *Relative Slope Stability and Land Use Planning in the San Francisco Bay Region, California* by the U.S. Geological Survey and the Department of Housing and Urban Development, 1979, mapped the slope stability using five categories (with Category 1 being stable and Category 5 being unstable). Although the lower one-third portions of Lichau, Lynch, Washington, and Adobe Creeks are generally mapped as Category 1, Stable, Liberty, Capri, and Corona Creeks are the most stable subwatersheds.

Category 5, Unstable, slopes include:

- The majority of the San Antonio Creek subwatershed.
- The hillsides of the Lakeville area and Rush Creek subwatersheds.
- The upper one-third of Lynch Creek, Washington Creek, and Adobe Creek subwatersheds.
- The upper headwaters of Lichau and Willow Brook Creeks.
- Isolated areas along the hillsides of Ellis Creek, the southwest hill of Petaluma, and some of the steeper slopes of the Liberty Creek subwatershed.

1.5 Summary of Erosion Activity and Potential in the Watershed

Subwatersheds were ranked as high, moderate, or low priority for repair based on the erosion potential and erosion activity (see Table 1). The rating system is highly subjective and intended to give a general picture of where erosion control could make the greatest difference in conserving the natural resources of the watershed.

Erosion Activity. A high erosion activity rating was given to subwatersheds that had chronic problems on numerous sites or a few very large sites with newly exposed, eroding soil. Vegetation has not yet had time to grow on these sites, and they contribute sediment during every major rainfall event.

ısion Potential. A high erosion potential was assigned watersheds where ...re is a strong possibility of significant erosion in the future. Current and future land use, land management, upslope stability, and the presence of downstream dams were factors considered in developing erosion potential ratings. For example, a steep watershed with highly erodible soils where rangeland is currently being converted to vineyard would receive a high erosion potential rating. A valley area of ranchettes with no foreseeable change in land use might be given a low erosion potential rating.

Repair Priority. The term "repair" includes addressing long-term land management, as well as restoring individual sites. The subwatershed repair priority rating was based on erosion activity, erosion potential, the impact of sedimentation on the resources of the overall watershed, and the feasibility of repairing erosion sites. A watershed with many active landslides, for example, might receive only a medium or low repair priority because of the extreme cost and difficulty of effectively repairing mass earth movements.

Adobe Creek, with only a moderate erosion activity rating, received a high repair priority because of its key role in supporting the remnants of the Petaluma River salmonid fishery. The Lakeville area tributaries, on the other hand, were assigned a moderate priority even with high ratings for both erosion potential and activity because roughly 50% of the sediment bedload is being deposited behind agricultural dams. From a landowner perspective, maintaining the capacity of small reservoirs might be extremely valuable, but from a watershed perspective, the dams are doing a great job keeping sediment from downstream channels and wetlands.

Table 1: Prioritization of Subwatersheds for Erosion Control

Subwatershed	Square Miles	Erosion Activity	Erosion Potential	Priority
Lichau Creek	9.7	Low	Moderate	Moderate
Willow Brook Creek	5.3	High	High	High
Corona & Capri Creeks	5.1	Low	Low	Low
Lynch Creek	4.0	High	High	High
Washington Creek	8.3	Moderate	Moderate	Low
Adobe Creek	4.9	Moderate	High	High
Ellis Creek	9.4	High	High	High
Lakeville Tributaries	19.8	High	High	Moderate
Rush Creek	9.2	Low	Low	Low
San Antonio Creek	36.5	High	High	High
Westside Tributaries	13.9	Low	Moderate	Low
Liberty Creek	15.3	Moderate	Moderate	Moderate

1.6 Summary of Enhancement Recommendations and Opportunities

A goal of the *Petaluma River Watershed Enhancement Plan* is to reduce accelerated erosion and manage sediment. Actions to achieve this goal include broad scale recommendations for entire subwatersheds and site-specific recommendations that individual landowners can implement.

For several subwatersheds, more detailed analysis of erosion, channel stability, and geomorphology is recommended. Conducting additional, limited studies can help determine the causes, the most effective course of action for restoration, and the downstream impacts of large-scale restoration projects. While additional investigations are being conducted, demonstration projects can be implemented.

Each subwatershed characterization includes a recommendation for riparian fencing and revegetation. In some places, riparian fencing could incorporate managed grazing once the desired plants are established. Such areas are called riparian pastures, and they have proven effective at several sites in Marin and Sonoma counties. Other recommendations include outreach activities to support land stewardship and land management activities, as well as repair of individual sites. All work undertaken by the Resource Conservation Districts is dependent on the voluntary cooperation of willing landowners.

A summary of enhancement recommendations follows. More detail can be found in Section 2.0 below.

- **Concentrate erosion control activities in high priority subwatersheds.** Priority subwatersheds include Willow Brook, Lynch, Adobe, Ellis, and San Antonio Creeks. Because these subwatersheds have complicated, system-wide erosion problems, the recommendations include conducting quantitative surveys, as well as implementing individual demonstration projects. Recommended actions include:

  <u>Willow Brook Creek:</u>

  ◊ Conduct a detailed stream channel stability and upslope field survey, particularly for the middle and upper reaches of Willow Brook and Davis Creeks.
  ◊ Install riparian fencing and revegetation.
  ◊ Stabilize the gully upslope of Hardin Lane.
  ◊ Stabilize the streambank and gully downstream of Hardin Lane.
  ◊ Repair other eroding streambanks.

  <u>Lynch Creek:</u>

  ◊ Stabilize upslope gullies.
  ◊ Use Best Management Practices (BMPs) for hillside vineyards.

- ◊ Leave buffers around creeks and minimize disturbance of remaining oak woodlands.
- ◊ Conduct a detailed stream channel stability and upslope erosion field survey for the upper subwatershed.
- ◊ Install riparian fencing and revegetation.
- ◊ Stabilize eroding streambanks.

Adobe Creek:

- ◊ Conduct a detailed erosion control and stream channel survey of upper Adobe Creek.
- ◊ Create a detailed sediment and riparian management plan with local community involvement.
- ◊ Address landslides that directly impact the creek.
- ◊ Install fencing and revegetation along the riparian corridor.
- ◊ Stabilize eroding streambanks.

Ellis Creek:

- ◊ Install riparian fencing and revegetation.
- ◊ Fence and revegetate large gullies.
- ◊ Stabilize gullies at key locations.
- ◊ Stabilize streambanks and large slumps.

San Antonio Creek:

- ◊ Work with local landowners to develop a subwatershed plan that includes detailed sediment and riparian management plans, a geomorphic analysis of the main channel, prioritization of erosion control sites, and a detailed inventory of the tributaries and upslope erosion.
- ◊ Install riparian fencing, revegetation, and bank stabilization on smaller tributaries.
- ◊ Stabilize banks at key locations.
- ◊ Fence and revegetate large gullies.
- ◊ Continue to provide conservation plan workshops for individual landowners.

- **Provide workshops and brochures for ranchette and ranch owners.** Topics could include "do-it-yourself" erosion control, small farm and pasture management, management and revegetation of the riparian corridor (including various fencing alternatives), how to reduce rill and sheet erosion for pastures and corrals, and other issues that landowners themselves identify. Related recommendations include working with U.C. Cooperative Extension and the Regional Water Quality Control Board to provide conservation plan workshops for dairy operators and ranchers and to distribute the *Handbook for Forest and Ranch Roads* published by the Mendocino County Resource Conservation District to watershed residents free of charge or for a nominal cost.

- **Identify cost-share programs for ranchette/small property owners.** Although cost-share programs exist for agricultural landowners, ranchette or non-production agricultural operations ususally do not qualify for these programs. Having cost-sharing available would help some small property owners address erosion problems.

- **Encourage the use of BMPs for hillside vineyards.** Vineyards are increasing in the Petaluma River watershed. New and existing vineyard owners should be encouraged through workshops, field days, and distribution of manuals and other educational materials to use BMPs, especially for production on hillsides and highly erodible slopes.

2.0 Subwatershed Characterizations

2.1 Lichau Creek Subwatershed

Erosion Activity:	LOW
Erosion Potential:	MODERATE
Repair Priority:	MODERATE

2.1.1 Characterization.

Lichau Creek, often referred to as Penngrove Creek by local residents, is the northernmost subwatershed to the Petaluma River with Willow Brook Creek located to the south. The subwatershed drains 9.7 square miles and includes Lichau, Cold Springs, Penngrove, and Davis Lane Creeks from the east and Highland, Martenoni, and Meacham Creeks from the west. Lichau Creek flows from Sonoma Mountain southwest then south through the town of Penngrove, where it converges with Willow Brook Creek. Davis Lane and Penngrove Creeks flow southwest from the base of Sonoma Mountain and join the main channel in Penngrove. Cold Springs Creek runs parallel to Copeland Creek along Lichau Road and then follows Petaluma Hill Road due south to Lichau Creek, while Highland, Martenoni, and Meacham Creeks flow northeast from Meacham Hill—locally referred to as A Thousand Acres—near the Highway 101 corridor.

Upper Lichau Creek consists of an entrenched, very steep gradient stream with bedrock falls, boulder cascades, and mixed cobble channel. The corridor is densely populated with an oak and bay woodland. The land use is primarily cattle grazing, along with a housing development consisting of ranchettes.

The middle reach is moderately entrenched with a moderate stream gradient and heavy cobble bedload. The channel has a moderately dense oak canopy, and the land is used for livestock grazing. Sonoma stone is collected from this area for use in local landscaping.

The valley floor reach east of Petaluma Hill Road has a moderately entrenched, low gradient channel with high gravel content mixed with cobble. The banks are vegetated with annual grasses and lack a riparian canopy. The creek meanders parallel to Old Redwood Highway through the urbanized and rural residential areas of Penngrove on a very low gradient floodplain. It has been channelized in portions of downtown Penngrove to protect roads and buildings. The channel has many deep perennial pools mixed with gravel and cobble riffles. The corridor has a mix of dense riparian canopy and open grasslands. According to Bill Cox of CDFG, Willow Brook Creek has historic spawning and salmonid habitat. Local residents occasionally see steelhead trout and "lost" Sacramento River-run chinook salmon in the channel.

Davis Lane Creek is a small, low gradient creek with sparse riparian vegetation adjacent to dairies. Penngrove Creek is also small with sparse native riparian vegetation; it flows through ranchettes into town. Cold Springs Creek is much like the middle to lower reaches of Lichau Creek on a smaller scale.

Highland, Martenoni, and Meacham Creeks all start on relatively steep slopes on Meacham Hill and then flow into an area dominated by small ranchettes. These three creeks are deeply entrenched, often cut to sandstone, and have been altered by culverts and roads. They have a mix of well vegetated native willow and oak canopies, eucalyptus groves, and grazed, bare banks.

2.1.2 Soils.

The lower reaches of Lichau Creek, including the east side of Meacham Hill, Penngrove, and the Petaluma Hill Road area, are comprised of Cotati fine sandy loams from the Goldridge-Cotati-Sebastopol association. According to the *Soil Survey of Sonoma County, California* (1972), these soils consist of well drained, fine sandy loams with a clay subsoil. They were formed from old marine terrace material consisting of weakly consolidated siltstone, shale, sands, clays, and gravels. Erosion potential is moderate. Steeper slopes (over 15%) with faster run-off have a high erosion potential. Sheet and rill erosion are common on heavily grazed pastures with slopes over 15%.

The midslopes upstream of Petaluma Hill Road have a variety of soils including the typical Diablo clays to the south of Lichau Creek and a scattering of Raynor clay, Goulding clay loam, Goulding-Toomes complex, and Goulding cobbly clay loam to the north. Also to the north, a narrow valley split by Lichau Road and shared by Copeland Creek is classified as Alluvial land, sandy, and Alluvial land, clayey. The Alluvial sandy soils consist of sand and gravel that have been deposited along the stream channel as water velocities are reduced. These soils are often subject to change and movement through bank erosion during large storm events. The Alluvial clayey soils are silty, clayey loams that deposit on the flat floodplains adjacent to the stream. Often these soil deposits have beneficial nutrients and minerals for crop production.

The Diablo clay found on most of the midslopes of Sonoma Mountain south to the Lakeville area consist of deep, well drained clay with a slight to high erosion potential. The steeper slopes (above 15%) have considerably higher erosion potential, and landslips are common. Diablo soils are underlain by calcareous sandstone, shale, and weathered siltstone that can be found at the bottom of most downcut gullies.

The hilly area between Roberts Road and East Railroad Avenue has a mix of Goulding clay loams and Raynor clays. These soils are typically found only in the upper elevations of Sonoma Mountain to the south along the ridge. Here, however, they are found in the lower elevation midslopes and in the upper reaches of Lichau Creek. The Goulding clay loams and Goulding cobbly clay loams are well drained, relatively shallow, and underlain with igneous and weathered basalt. The erosion hazard is moderate to very high, with slopes over 30% having the greatest potential. The Goulding cobbly loams have as much as 25% cobble mixed in the upper layers. The Goulding-Toomes complex has a mix of 45% Toomes rocky loam that is extremely shallow to underlain rock. These soils typically have 10% of the surface as rock land and have a moderate to high erosion potential. According to the *Soil Survey of Sonoma County, California* (1972), the Raynor soils consist of well drained clays underlain, at a depth of 20 to 60 inches, by volcanic and andestic rock. The erosion potential is moderate to high for soils above 15% slope.

The upper reaches of Lichau Creek also include Goulding and Raynor soils. Due to the steeper slopes in this area, the erosion potential is very high on slopes over 50%. The soils on these steep slopes tend to have a higher cobble content.

2.1.3 Erosion.
No major erosion sites were located while driving major roads in the Lichau Creek subwatershed. Several small gullies, headcuts, and scoured banks were located, along with additional isolated sheet and rill erosion sites.

Much like the upper subwatersheds of Willow Brook, Lynch, and Adobe Creeks, the major source of sediment is from Lichau Creek's upper subwatershed. The alluvial/cobble found in Lichau Creek's stream channel is likely from historic geomorphic processes of episodic events, which filled the creek with landslide sediments in a short period of time that were then followed by local seasonal flooding and additional floodplain deposition with long periods of channel downcutting through the landslide debris. New channels are formed as incisions take place through the landslide debris until the creek has cut back down to a stable channel bottom.

A small gully with headcuts is located in the upper subwatershed upstream of the fire house on Cold Springs Road. Further upstream, the creek is confined by several dammed ponds. The valley floor reach upstream of Petaluma Hill Road and directly downstream is unvegetated and has some oversteepened, scoured banks. The main channel downstream of the railroad crossing has steep, scoured, sparsely vegetated streambanks according to a longtime resident.

Sandy sediment deposits were sighted along Old Redwood Highway in the roadside ditches and stream crossings from the Meacham Hill area. Most likely the sediment is cumulative from sheet, rill, and small gully erosion off the ranchettes, specifically from small corrals, pastures, unpaved roads, culverts, diversion ditches, and construction sites. Many of the ranchettes are located on fine sandy loams that are susceptible to sheet and rill erosion when not well vegetated. Numerous small sheet and rill erosion sites were located on Railroad Avenue west of Old Redwood Highway. Upper Meacham Creek adjacent to Minnesota Avenue has bank sloughing and gully development threatening some mature oak trees. Residents have installed temporary straw bales and t-stake revetments to protect the oaks until a permanent repair can be installed. Downstream of Penngrove Avenue, an unvegetated portion of Meacham Creek has severe bank scour and has downcut to sandstone.

2.1.4 Recommendations.

A detailed stream channel stability and upslope erosion field survey should be undertaken to better understand the stability of the main channel of Lichau Creek. The reach from Davis Lane to Petaluma Hill Road and the lower reaches of Lichau Creek should be fenced and revegetated. These areas are ideal for management as riparian pastures. Due to flooding in these areas, seasonal electric fencing should be considered.

The cut banks can be stabilized by sloping them back with a 2:1 slope and armoring with traditionally engineered rock toe protection incorporated with bioengineering techniques to provide additional habitat enhancement. Fish-friendly boulder and log weir grade control structures can be used as needed upstream of Penngrove Avenue and Petaluma Hill Road.

Community outreach and workshops should be provided for ranchette and ranch owners. Funding should be made available for restoration cost-share programs for ranchettes. Classes on knowing your subwatershed and the values of a healthy riparian corridor, "do-it-yourself" erosion control, and small farm livestock and pasture management would be excellent community builders.

2.2 Willow Brook Creek Subwatershed

Erosion Activity: HIGH
Erosion Potential: HIGH
Repair Priority: HIGH

2.2.1 Characterization.

Willow Brook Creek subwatershed is located in the northeast part of the Petaluma River watershed. The subwatershed drains 5.3 square miles and includes Willow Brook, Davis, and Waugh Creeks from the northeast and Lower Lichau Creek from the northwest. Willow Brook Creek flows south from Sonoma Mountain to Adobe Road. The creek travels southwest from Adobe Road to the confluence with Lichau Creek just north of Ely Road. Davis and Waugh Creeks are small tributaries that drain into the main channel from Sonoma Mountain. Lower Lichau Creek flows from the northwest near Goodwin and Elysian Avenues and crosses under Old Redwood Highway just north of Ely Road.

Upper Willow Brook Creek and Davis Creek are entrenched, steep gradient streams with a combination of boulder cascades and cobble beds on lesser gradient slopes. The banks are well to moderately vegetated with mature oak and bay woodlands. The area's land use consists mostly of cattle ranching but also includes a hillside vineyard and housing development. The middle reach of Willow Brook Creek is moderately entrenched, with a moderate channel gradient consisting mostly of cobble and small boulders. The banks are vegetated with moderately dense oak and willow clusters mixed with open grasslands. This area is used primarily for livestock grazing, hay production, and horse boarding. Downstream of Adobe Road, the creek meanders through the valley floor and old marine terraces that have been cut into a deeply incised channel with a mixed bed of cobble, gravel, and sand. The cut streambanks have sparse to no woody riparian vegetation. The area is used for dairy and hay production. At the confluence of Lichau Creek near the urban boundary of Petaluma, the channel has moderate riparian canopy. According to Bill Cox of CDFG, Willow Brook Creek has potential for salmonid habitat and spawning. A concrete apron below the Jacobsen Lane stream crossing has scoured the channel bottom down approximately five feet creating a partial fish barrier.

2.2.2 Soils.

Soils in the lower reach of Willow Brook Creek are mostly Clear Lake clay, known locally as Adobe clay, that is found throughout the valley floor east of the Petaluma River. Clear Lake clays are characterized by high fertility, high water capacities, and low erosion potential. The high content of clay in these soils makes them subject to heavy compaction that will need to be considered when planning any revegetation project. Cotati fine sandy loams are also found in the lower reach between Ely Road and the main channel. Their erosion potential is moderate to high (when slopes are over 15%).

The main creek channel 2,000 feet downstream of Adobe Road and over a mile upstream from the road is classified as Gullied land. According to the *Soil Survey of Sonoma County, California* (1972), gullying has occurred in places where excess run-off has cut into natural watercourses on hillsides. Overgrazing by livestock has thinned or destroyed plant cover, which has resulted in increased run-off and aggravated headcutting of the gullies.

The middle to upper reaches of Willow Brook Creek consist of deep, well drained Diablo clay with an erosion potential of slight to high. The steeper slopes (above 15%) have considerably higher erosion potential, and landslips are common.

The upper reach of Willow Brook Creek consists of Goulding clay loams and Goulding cobbly clay loams with a moderate to very high erosion potential. The Goulding cobbly loams have as much as 25% cobble mixed in the upper layers. These eroded soils deposit sediments in the channel with a heavy cobble bedload. Small patches of Raynor clay are found among the Goulding soils. These well drained clays are underlain by volcanic rocks, often develop large cracks after drying, and have a moderate erosion potential. A few areas of Haire clay loam with moderate erosion potential are also found in the upper subwatershed.

2.2.3 Erosion.

Much like the upper subwatersheds of Lynch Creek and Adobe Creek, the major source of sediment is from Willow Brook Creek's upper subwatershed. The main source of erosion is most likely from large landslides and debris flows during intense rainfall or episodic storm events. These large debris flows can fill the valley floor and stream channel with several feet of poorly sorted sediments in one major storm event. As years go by, the stream flow scours and downcuts through the deposited sediments and creates a new channel. As the sediment is scoured out, the alluvium is sorted. The larger cobble begins to settle out along the middle reaches of the creek (Jacobsen Lane area) while the smaller gravels and sands migrate faster downstream (below Adobe Road). The Goulding soils in the upper subwatershed contribute to the cobble bedload found in the creek's middle reach. The main channel of Willow Brook Creek at the end of Davis Lane has a dammed pond, which retains a large portion of these sediments. (It is also a fish passage barrier). However, the main tributary of Davis Creek is not dammed.

Another major source of fine sediments is erosion from upland gullies. A large, active gully on a small tributary to Davis Creek has migrated up to

Hardin Lane. The downcut tributary has oversteepened the banks on outside meanders, causing a large amount of sloughing into the channel. Upstream of Hardin Lane towards Lynch Road, the gully seems to have active headcuts that are downcutting through a large pasture, thus inducing adjacent bank slumps.

The lower reach immediately upstream from Adobe Road and downstream to Lichau Creek has many scoured, vertical streambanks on outside meanders causing chronic sloughing. Where the meanders cut into adjacent hillsides, landslips have also occurred that deliver fine sediments to the stream system. Sheet and rill erosion are likely occurring where livestock holding facilities and corrals are located on sloped hills with fine sandy loams.

Lower Lichau Creek channel, a tributary to Willow Brook Creek, meanders through small ranchettes west of Old Redwood Highway. The small, seasonal creek is generally stable. Sheet, rill, and small gully erosion from adjacent ranchettes are the primary contributors of sediments.

2.2.4 Recommendations.

A detailed stream channel stability and upslope erosion field survey should be undertaken to better understand the stability (hydraulics and geomorphology) of the middle and upper reaches of Willow Brook and Davis Creeks. These areas will most likely benefit from riparian fencing and revegetation. The active gully upslope of Hardin Lane should be addressed with standard erosion control techniques while it is still of a manageable size. Small grade control structures and a grass-lined channel with biotechnical bank repairs may be adequate. Downstream of Hardin Lane, the scoured banks and downcutting gully may possibly be stabilized with grade control structures, fencing, and revegetation.

The main channel of Willow Brook Creek should also be fenced and revegetated with native riparian trees and shrubs. The flatter, lower reaches are ideal for management as riparian pastures. The cut banks can be stabilized by sloping them back with a 2:1 slope and armoring with traditionally engineered rock toe protection incorporated with bioengineering techniques to provide additional habitat enhancement. Fish-friendly boulder and log weir grade control structures can be used as needed.

Community outreach and workshops should be provided for ranchette and ranch owners.

2.3 Corona And Capri Creeks

Erosion Potential:	LOW
Erosion Activity:	LOW
Repair Priority:	LOW

2.3.1 Characterization.

Corona and Capri Creeks are located east of the Petaluma River with Willow Brook Creek to the northwest and Lynch Creek to the southeast. Combined, their drainage areas make up a 5.1 square mile subwatershed to the Petaluma River. The headwaters of Corona and Capri Creeks are at an elevation of 360 feet and are located on Lynch Road a little over half a mile northeast of Adobe Road. Capri is the smaller of the two and is southeast of Corona.

The creeks flow south, starting on dairy pastures, then cross Adobe Road where they pass adjacent small ranchettes. The lower half of the creeks south of Ely Road has been channelized through the new housing subdivisions and finally drains under Highway 101 to the Petaluma River. The majority of the creeks' channels are flanked by annual grasslands with a few isolated areas of native riparian vegetation. An urban revegetation effort is being implemented along the upper banks of Corona Creek in the new housing development.

2.3.2 Soils.

The soils in Corona Creek and Capri Creek subwatershed are very similar to those found in the Lichau Creek subwatershed to the northwest and Lynch Creek subwatershed to the southeast. The main difference in soil types is due to the length of the subwatersheds. Corona and Capri Creeks' headwaters are at the 360-foot elevation. This means that the majority of soils in these small drainages are common valley soils consisting of Clear Lake clay and Clear Lake clay loam. These soils, known locally as Adobe soil, have low erosion potential. The headwaters just reach the Diablo clay belt at the base of Sonoma Mountain. The steeper slopes (above 15%) have considerably higher erosion potential, and landslips are common. To the northwest of Corona Creek, the Cotati fine sandy loams begin; their erosion hazard is moderate to high on slopes greater than 15%.

2.3.3 Erosion.

No major erosion source was found during the road and aerial photo survey. However, sandy sediment deposits were sighted in the main channel of Corona Creek in the new housing development off of Ely Road. Most likely the sediment is cumulative from sheet, rill, and small gully erosion off the ranchettes, specifically from small corrals, pastures, unpaved roads, culverts, diversion ditches, and construction sites. Many of the ranchettes are located on fine sandy loams that are susceptible to sheet and rill erosion when not well vegetated. On Corona Creek, a small earthen dam just downstream of

Adobe Road acts as a sediment trap, capturing erosion from the upper subwatershed.

2.3.4 Recommendations.

Community outreach and workshops for ranchette owners and urban stream residents are again recommended. The creeks' riparian habitat value can be greatly enhanced through landowner education, fencing, and revegetation.

2.4 Lynch Creek Subwatershed

Erosion Activity:	HIGH
Erosion Potential:	HIGH
Repair Priority:	HIGH

2.4.1 Characterization.

Lynch Creek is located on the east side of the Petaluma River with Corona, Capri, and Willow Brook Creeks to the northwest and Washington Creek to the southeast. The narrow subwatershed drains a total of 4.0 square miles south to the Petaluma River. The headwaters are located at the top of Sonoma Mountain Ridge. Lynch Creek and its small tributaries flow south crossing Sonoma Mountain Road, Adobe Road, and Ely Road and enter the Petaluma River west of Highway 101. Lynch Road and Sonoma Mountain Road run parallel to the creek and the upper subwatershed's boundaries.

Upper Lynch Creek and its tributaries consist of an entrenched, steep gradient stream with a combination of boulder cascades and cobble beds on lesser gradient slopes. The banks are well vegetated with mature oak and bay woodlands. The area is used mostly for livestock grazing with the exception of a small vineyard. The middle reach of Lynch Creek is moderately entrenched with a moderate channel gradient consisting mostly of cobble and small boulders. The banks are vegetated with oak and willow clusters that become sparser downstream. This area down to Adobe Road is primarily in dairy production. The adjacent slope is annual grassland that is mostly used for grazing. As the creek flows south of Adobe Road and enters the urban boundary, it becomes channelized. It has a mix of riparian areas from dense riparian canopies to sparse vegetation. In general, it is well vegetated for an urban stream. According to Bill Cox of CDFG, Lynch Creek most likely was not historically used by salmonids because it lacks summer holding pools. Further investigation in the upper subwatershed would be needed to confirm this theory.

2.4.2 Soils.

Soils in the lower reach of Lynch Creek south of Adobe Road are primarily Clear Lake clay with low erosion potential. The main channel is classified as Gullied land with high erosion potential. Soils in the middle reach of Lynch Creek upstream of Adobe Road mostly consist of deep, well drained Diablo clay with an erosion potential of slight to high. The creek channel has downcut through the soil horizon to a layer of light gray siltstone in many areas along the middle reach.

Soils in the upper headwaters of Lynch Creek mostly consist of Goulding clay loams and Goulding cobbly clay loams with a moderate to very high erosion potential. The Goulding cobbly loams have as much as 25% cobble mixed in the upper layers. Small areas of Raynor clay are found on some gradually sloped flats with a low to moderate erosion potential.

2.4.3 Erosion.

The upper Lynch Creek subwatershed is likely a major source of sediment to the creek's total bedload. The main source of erosion is probably from large landslides and debris flows during intense rainfall or episodic storm events. The discussion in Section 2.2.3 above describes the process of sediment transport related to these debris flows. The Goulding soils in the upper reach of Lynch Creek contribute to the cobble bedload found in the creek's middle reach.

Shallow slides also occur during large rain events and are often triggered by human disturbances such as logging, grazing, water diversion, grading, and roads. These shallow landslides and slips are usually found on steep slopes where run-off is rapid and the clay subsoils swell during heavy rain events. Landslides often have the highest repair cost of all erosion control with limited long-term success.

A perennial tributary just upslope of where Hardin Road meets Lynch Road has an active, deep gully and a large, shallow-seated landslip. Most likely the gully has downcut the channel bottom, weakening the bank's toe and oversteepening the slope, thus causing a large slip and associated bank sloughing. Another large slip temporarily blew out Sonoma Mountain Road during the winter of 1997-98. The slip is not currently depositing sediment to any downslope tributaries.

The middle reach of Lynch Creek has many scoured, vertical streambanks on outside meanders. These banks consist of unsorted sediments with high cobble content from historic alluvial deposits. The area upstream of Adobe Road has been subjected to consistent lateral migration according to a longtime resident. He noted that the channel was historically several hundred feet to the west. An old bank stabilization project on his property using 24-inch riprap has failed, rolling the boulders several hundred feet downstream. He has had some success protecting streambanks with gabion wing deflectors. A side tributary east of Sonoma Mountain has active headcuts downcutting the upper drainage. The sediments are being deposited in his large pond immediately adjacent to Sonoma Mountain Road. Active headcuts are also downcutting the tributary below the dam and threaten the spillway. An upstream dairy has a large, 12-foot vertical concrete grade control structure at the property's boundary. Immediately above the structure, the creek is stable with good riparian canopy cover. Below the structure, the channel is deeply incised and unstable. This structure poses a major fish barrier to any fisheries restoration efforts.

According to Bill Cox of CDFG, a large amount of sediment has been deposited along the lower reach of Lynch Creek adjacent to the new Rooster Run Golf Course. The channel deposition occurred during a storm event on February 2, 1998, that filled the channel and left a 6 to 12-inch bank. Large amounts of sediment were reportedly deposited on the adjacent golf course.

2.4.4 Recommendations.

The upslope, advancing gullies should be controlled where feasible to protect valuable agricultural land and to reduce the amount of sedimentation to the creek. The upper slopes of the Lynch Creek area will likely be converted to hillside vineyards in the near future. Hillside vineyards should use BMPs for steep slopes and should consider the effects of concentrated run-off on downstream drainages. New vineyard developments should also leave adequate buffer space around creeks and minimize disturbance of the remaining oak woodlands. Additional, detailed stream channel stability studies (hydraulics and geomorphology) and upslope erosion field surveys should be completed to better understand the stability of the Lynch Creek upper subwatershed.

The middle reach of Lynch Creek would benefit from riparian fencing and revegetation. A well established riparian corridor will slow the rate of lateral migration and provide wildlife habitat enhancement. Because the middle reach is susceptible to lateral migration, the fencing should create a wide corridor in anticipation of channel movement, which can be managed as a riparian pasture for rotational livestock grazing while establishing riparian habitat values.

Traditionally engineered bank stabilization incorporated with bioengineering techniques can be used where moving banks threaten key areas to the landowners' operations. Due to the highly mobile bedload, deep toe protection below the predicted depth of scour will be essential to any bank stabilization effort.

2.5 Washington Creek Subwatershed

Erosion Activity: MODERATE
Erosion Potential: MODERATE
Repair Priority: LOW

2.5.1 Characterization.

Washington Creek subwatershed is located east of the Petaluma River between Lynch Creek to the northwest and Adobe Creek to the southeast. The 8.3 square mile subwatershed includes Washington, East Washington, and McDowell Creeks.

The main channel of Washington Creek flows southwest adjacent to Ielmorini Lane, crossing Adobe Road and following East Washington Blvd. to the Petaluma River. The upper channel is entrenched with a steep channel gradient and moderate riparian canopy. The middle reach has some perennial pools, is entrenched with moderate channel gradient, and has a dense, well vegetated canopy. The area above Adobe Road is used for livestock grazing, and the City has a water tank off of Ielmorini Lane.

The lower reach below Adobe Road is an entrenched, low gradient channel with sparse riparian canopy until it reaches the urban boundary where it becomes channelized. The new Rooster Run Golf Course and public park are adjacent to the creek before it enters the residential area. A newly planted, native riparian revegetation effort has been installed on the streambanks adjacent to the golf course.

East Washington Creek and its tributary, McDowell Creek, are much smaller and are located just east of Washington Creek and west of West Manor Lane. East Washington Creek is generally a moderate to low gradient stream with a narrow, continuous riparian canopy. The creek flows southwest, crossing Adobe Road where it straightens before becoming channelized at the urban boundary. The majority of the area is used for dairy and livestock grazing.

2.5.2 Soils.

The soils in the Washington Creek subwatershed are very similar to those of the Lynch Creek subwatershed to the northwest and the Adobe Creek subwatershed to the southeast. However, Washington Creek is not as long as the other two. Its headwaters are at the 1,200-foot elevation, about half of Sonoma Mountain's height. Thus, the majority of soils at the headwaters of Washington Creek are Diablo clay rather than the Goulding cobbly clay loams found at the higher elevation headwaters in the adjacent subwatersheds. The Diablo clay has slight to high erosion potential. The soils in the upper reaches of Washington Creek are characterized by 15 to 30% eroded slopes with small gullies visible and sheet erosion indicated by deposition at the lower end of the slopes.

The middle tributary of Washington Creek upstream of Adobe Road is classified as Gullied land. The lower reaches of Washington Creek below Adobe Road are Clear Lake clays with low erosion potential.

2.5.3 Erosion.

The upper third of Washington Creek adjacent to Sonoma Mountain Road is actively downcutting. Many small slips seen on the overly steepened banks are delivering fine sediments directly to the channel. These sediments from the two upper tributaries are being trapped in a stock pond east of Sonoma Mountain Road. The pond might be as much as one-third to one-half full with deposition from gravel and fine sediments. The channel gradient becomes moderate, and the banks are well vegetated below the dam, which can reduce the frequency of erosion. However, several small gullies are located on the small drainages of the west ridge as viewed on the aerial photograph. These gullies should be field-checked to determine if they are active or stable. A large slip was also spotted at the headwaters of McDowell Creek adjacent to West Manor Lane. According to the USGS & HUD Slope Stability and Land Use Planning Maps, the entire upper one-third of Washington Creek subwatershed is in Category 5, Unstable, condition due to the fact that the area is underlain by, or immediately adjacent to, landslide deposits.

Downstream at the new golf course, the creek channel has newly deposited sand and gravel on the bankfull (1.5 year storm) floodplain. It is likely that new slips, common with Diablo soils, have occurred on the steeper slopes. Minor streambank erosion was observed on the lower reach of Washington Creek, most likely due to lack of riparian vegetation.

2.5.4 Recommendations.

Despite limited access to the tributaries, a more detailed investigation of the stream channel stability (hydraulics and geomorphology) should be conducted above Adobe Road. The mature riparian canopies, rich in habitat value, should be protected by riparian corridor fencing. Riparian pastures can be developed to better protect these historic habitats while retaining grazing value. Sediment traps can be installed above the stock pond to protect it from deposition, or an on-site erosion control structure can be built. Community volunteers can be used to build biotechnical streambank repairs downstream of Adobe Road.

2.6 Adobe Creek Subwatershed

Erosion Activity: MODERATE
Erosion Potential: HIGH
Repair Priority: HIGH

2.6.1 Characterization.

Adobe Creek is northeast of the Petaluma River, southeast of Washington Creek, and northwest of Ellis Creek. Adobe Creek drains a narrow, 4.9 square mile subwatershed from the peak of Sonoma Mountain south to the Petaluma River. It enters the Petaluma River east of Highway 101 and south of Highway 116.

In the upper subwatershed above the Petaluma Reservoir, the creek has steep slopes and is well vegetated with mature oak woodlands. Below the reservoir to Adobe Road, it has moderate slopes with moderate to sparse riparian vegetation. The channel bottom is predominately large cobble with gravel and is lacking large woody debris. This middle reach of Adobe Creek along Manor Lane is used for dairy and cattle ranching. The lower reach below Adobe Road and adjacent to Casa Grande Road has a gradual channel gradient. The creek has a narrow riparian corridor and sparse vegetation where it runs through the golf course. It is channelized as it enters the residential neighborhoods of eastern Petaluma. This narrow corridor between houses is quite well vegetated considering its urban surroundings. The creek crosses Lakeville Highway into a business park with sparse riparian vegetation and then finally enters the Petaluma River.

2.6.2 Soils.

Soils in the lower reach of Adobe Creek southwest of Adobe Road are primarily Clear Lake clay with low erosion potential.

The area around the Old Adobe consist of Haire gravelly loams. These soils are moderately well drained, clay loams that have clay subsoil and are underlain by old marine terrace alluvium from mixed sedimentary and basic rock sources. The clay loam is mixed with up to 25% gravel throughout and has moderate erosion potential.

Soils in the middle reach of Adobe Creek upstream of Adobe Road mostly consist of deep, well drained Diablo clay with an erosion potential of slight to high. The main channel in this reach is classified as Gullied land with very high erosion potential. The creeks and drainages are subject to heavy channel downcutting and bank erosion.

Soils in the upper reaches of Adobe Creek mostly consist of Goulding cobbly clay loams and Sobrante loam. The erosion hazard is moderate to very high, with slopes over 30% having the greatest potential. The Sobrante loam soils consist of reddish brown, well drained loams that have a clay loam subsoil. They are found on steep slopes (over 30%), have a high erosion potential, and often contain gravel. Small areas of Raynor clay are found on gradual slopes; erosion potential is low to moderate.

2.6.3 Erosion.

The upper Adobe Creek subwatershed appears to be the major contributor of sediments to the creek channel. As in Willow Brook Creek, the main source of erosion is most likely from large landslides and debris flows during intense rainfall or episodic storm events.

Landslides often have the highest associated repair costs with limited long-term erosion control success. The most economical solution to landslide control is prevention, which can be achieved by reviewing slope stability maps and planning land use accordingly. In areas of low slope stability, slopes should be well vegetated, and concentrated water from road run-off should be addressed. House or vineyard development should be avoided or adequately armored.

According to Bill Cox of CDFG, the headwaters of Adobe Creek in the Lafferty Ranch area is a major source of sediment from landslides and gully erosion. A report done for the City indicates that near the top of Lafferty Ranch drainage areas have deep, eroded gullies. Heavy grazing is cited as having contributed to this erosion.

Along the middle reach of Adobe Creek, the primary erosion sources are bank erosion from scour and lack of well vegetated banks. Just upstream of the Manor Lane stream crossing, several large bank failures are located on the right bank looking downstream. From the road, it appears that scour along the bank's toe has weakened and oversteepened the slope, thus causing slumping. These eroded soils are Diablo clay underlain by sandstone; they are contributing nonbeneficial fine sediment to the channel. A combination of boulder, log, and biotechnical techniques could repair the banks and provide fish habitat. Another bank failure was located on the left bank just upstream of Adobe Road at the state park. This is an excellent site for a volunteer biotechnical streambank repair.

The lower reach of creek has some isolated bank erosion. It appears that heavy deposition may have occurred on the northwest side of Casa Grande Avenue upstream from the lower road crossing. It looks like approximately 1,000 feet of creek channel was excavated and placed on the top of banks in this area. Most likely the concrete box culvert is undersized or was plugged with debris, causing backwater that slowed velocities and led to upstream deposition. The creek is completely denuded of riparian vegetation in this area. A geomorphologic analysis and creek restoration project should be considered. Downstream of Lakeville Highway, a concrete grade control structure was installed that has trapped fine sediments and eliminated any low flow channel upstream of the weir.

2.6.4 Recommendations.

A sediment and riparian management plan should be created for subwatershed planning and enhancement. The school and local community should be an integral part of designing the plan. Detailed erosion control and stream channel surveys should be completed to better understand the stability of the upper Adobe Creek subwatershed. Landslides that directly impact the creek and are impairing downstream fisheries should be addressed.

Fencing and riparian corridor revegetation would greatly minimize the frequency of bank erosion. Some of the bank erosion sites with easy access could be repaired biotechnically by a volunteer effort. Fish-friendly boulder and log weir grade control structures can be used as needed to stabilize the channel and sort gravels.

Outreach to and participation of the upper subwatershed landowners will be the key to successful creek restoration. Workshops can be provided on subwatershed awareness and erosion control techniques. The SSCRCD can play a crucial role in facilitating workshops with the agricultural community, the high school, and other restoration efforts.

2.7 Ellis Creek Subwatershed

Erosion Activity: HIGH
Erosion Potential: HIGH
Repair Priority: HIGH

2.7.1 Characterization.

Ellis Creek subwatershed is located on the east side of the Petaluma River is southeast of Adobe Creek. The main channel (5.7 miles) meanders northwest following Adobe Road and then turns southwest towards the Petaluma River. Several small tributaries, including Hutchinson, Cherry, and Gregory Creeks, enter Ellis Creek and drain southwest from Sonoma Mountain. A fourth tributary, Higgens Creek, located north of South Ely Road, drains from the west near Browns Lane. The tributaries combined make up a 9.4 square mile subwatershed.

The upper subwatershed tributaries drain through steep gully systems with sparse riparian vegetation. Most of this land is used for cattle grazing. The moderate midslopes of the subwatershed down to the main channel are also used as irrigated pastures and for hay production, with water provided by effluent from the Petaluma wastewater facility. Most of the streambanks have no or sparse riparian vegetation. Upper Ellis and Higgens Creeks and lower Hutchinson and Cherry Creeks all have been dammed to provide water for agriculture.

The main channel meanders through the valley floor and adjacent hill terraces. The dominant vegetation is annual grasses. The lower reach of Ellis Creek has a low channel gradient, and the adjacent lands are flat. This low valley is used for livestock grazing and hay production. Directly north of Higgens Creek, the main channel is vegetated with a mature riparian canopy. The creek has been channelized downstream of Lakeville Highway and west of the Petaluma wastewater treatment ponds. This reach has sparse riparian vegetation. Past the wastewater ponds, the creek flows through adjacent marshlands before entering the Petaluma River.

2.7.2 Soils.

Soils along the main channel and all the tributary channels of Ellis Creek are classified as Gullied land with very high erosion potential. According to the *Soil Survey of Sonoma County, California* (1972), heavy livestock grazing has thinned or destroyed plant cover, which has resulted in increased run-off and aggravated headcutting of the gullies.

In the lower reaches of Ellis Creek where the slopes are minimal to flat, the soils consist of Clear Lake clay with low erosion potential. The hillslopes to the north and south of Adobe Road are mainly Diablo clay with an erosion potential of slight to high. Also included on these rolling hills are Haire clay loams with low to moderate erosion potential.

The higher elevation slopes to the north of the Ellis Creek subwatershed near Adobe Creek consist of Goulding cobbly clay loams with moderate to high erosion potential. The ridge of Sonoma Mountain to the southeast consists of Kidd stony loam. These well drained, gravelly loams have high erosion potential when slopes exceed 30%.

2.7.3 Erosion.

The tributaries that drain Sonoma Mountain to Ellis Creek are all active to partially active, deeply incised, downcutting gullies. The downstream portions of these gullies have generally cut down through Diablo clays to sandstone. The upstream portions are still actively downcutting, with many unstable headcuts present. As the channel bottom downcuts, the toes of the adjacent streambanks are destabilized. When the toe is scoured out, bank sloughing occurs that fills the channel with eroded sediments and widens the gully. The newly deposited sediment again goes through a downcutting phase or plugs the channel, diverting run-off toward adjacent streambanks, and thus causing more scour and sloughing. Many of the smaller, upper subwatershed gullies have been caused by roads with inboard ditches. Runoff is collected from the upslope hillside and road surface and is concentrated into culverts or outlet ditches at switchbacks. The concentrated discharge has caused existing downslope drainages to downcut or has scoured out new gullies.

Livestock have unlimited access to the majority of the oversteepened gullies. The livestock trails on these highly unstable slopes also concentrate run-off and lead to gully development. Grazing in these areas should be limited during the wet season when the ground is soft and susceptible to erosion. Sediment from several of these gullies does not reach Ellis Creek due to dammed stock ponds.

The main channel of Ellis Creek has many scoured, vertical streambanks on outside meanders that are causing chronic sloughing. Where the meanders cut into adjacent hillsides, small to large landslips have occurred that are delivering fine sediments to the stream system. Slumps can be seen along the south side of Adobe Road on the left bank. The incised channel's streambanks are susceptible to lateral migration due to the lack of woody riparian vegetation that would provide scour protection.

2.7.4 Recommendations.

The highest priorities for Ellis Creek and its tributaries are riparian fencing and revegetation of the streambanks. Many of the upland gullies are so large that it would be cost-prohibitive to install erosion control measures to stabilize them. Fencing and revegetation would be the most cost-effective solution to slowing the gully erosion to a more natural rate. More expensive erosion control measures (i.e., loose rock headcut repairs) should be used at key locations to protect against new gully advancement, access road failures, and facility damage. Low cost, biotechnical brush checkdams may be used in some gullies to help capture sediment and slow the rate of erosion.

The main channel of Ellis Creek should also be fenced and revegetated with native riparian trees and shrubs. The flatter, lower reaches are ideal for management as riparian pastures after the riparian corridor is reestablished. Traditionally engineered bank stabilization incorporated with bioengineering techniques can be used on vertical banks that are unsuitable for revegetation. Large slumps that deliver high quantities of fine sediment to the channel could also be addressed with biotechnical techniques. The slumps along Adobe Road are highly visible and can be used as demonstration projects for biotechnical repair methods.

Upper subwatershed road improvements should be made to reduce the chance of new gully development. Simple outsloping of the ranch roads and filling of inboard ditches would most likely result in a marked improvement.

2.8 Lakeville Subwatershed

Erosion Activity: HIGH
Erosion Potential: HIGH
Repair Priority: MODERATE

2.8.1 Characterization.

The Lakeville area is the southeastern-most subwatershed of the Petaluma River. It is located south of Ellis Creek and includes the drainage area from Stage Gulch Road to Highway 37. The many small, unnamed creeks draining from the hills flow southwest under Lakeville Highway to the Petaluma River. The creeks combined make up a 19.8 square mile subwatershed. The small Tolay Creek watershed is located directly to the east.

The majority of the land has traditionally been used for dairy operations, cattle ranching, and hay production. Land use has changed somewhat in recent years to include vineyards, ornamental flowers, and horse boarding facilities. The subwatershed will likely see more pasture lands converted to vineyards in the near future because the Lakeville area is considered part of the valuable Carneros appellation.

The small creeks drain through large gully systems with sparse or no woody riparian vegetation. The majority of the hillslopes are annual grasslands with isolated groves of eucalyptus trees once planted as wind breaks. Many of these tributaries have been dammed to provide water for local agriculture. As the creeks cross under Lakeville Highway, they enter marshlands or reclaimed marshlands, often in ditches with levees. The small creeks have not been known to support historic fisheries.

2.8.2 Soils.

Soils southwest of Lakeville Highway on the river side consist of Reyes silty clays and Clear Lake clay loams. The Reyes soils consist of poorly drained, silty clays that formed in mixed bay and stream alluvium. These soils are in salt water marshes adjacent to bodies of sea water and are often ponded if not protected by levees and drainage ditches. The erosion potential is low to none. The flats closer to Lakeville Highway that often have a little more slope are the Clear Lake clay loams with low erosion potential.

The soils in the gradual midslopes northeast of Lakeville Highway mainly consist of Haire gravelly loams with moderate erosion potential. On a few slopes over 30%, the soil has a high erosion potential. The upper slopes of the Lakeville area subwatershed consist mainly of the Diablo clay with an erosion potential of slight to high.

The small creeks that drain the Lakeville area are all classified as Gullied land with very high erosion potential. The creeks and drainages are subject to heavy channel downcutting and bank erosion.

2.8.3 Erosion.

The Lakeville area subwatershed has the most active gully erosion in the Petaluma River drainage basin, although the position of these small, seasonal creeks far downstream in the Petaluma River watershed may considerably lessen the impacts to the overall watershed. The entrenched gullies have cut down deep through Diablo clay soils and have reached a more stable sandstone and siltstone layer. However, the upper gullies are still highly active and are in a downcutting phase. Active headcuts in the upper drainages were observed in relatively unstable soils. The adjacent banks of the gullies are experiencing chronic slumping due to toe scour and oversteepened banks.

Uncontrolled livestock access to the gullies during the wet season is also adding to poor slope stability and chronic sloughing. In some cases, livestock trails have concentrated run-off along fences and have started new gullies 200 feet long by 4 feet deep by 2 feet wide. According to the USGS & HUD Relative Slope Stability and Land Use Planning Maps, the entire hillside along the Lakeville area is considered unstable. New hillside vineyard development on these highly unstable slopes could cause severe erosion if not adequately designed. A high percentage of the creeks in this area have dammed ponds on them that act as giant sediment traps. Review of the USGS topographic maps indicated that approximately 50% of the sediment bedload is being deposited behind dams.

2.8.4 Recommendations.

At this time, the Lakeville area subwatershed has been given a moderate repair rating due to the high proportion of sediment trapped in agricultural dams. On the other hand, the proximity to the Petaluma River's wetlands could lead the community to place a higher priority on this subwatershed. The highest priorities for the Lakeville area subwatershed and its small tributaries are riparian fencing and revegetation of the gullies. Many of the upland gullies are so large that it would be cost prohibitive to install erosion control measures to stabilize them. Fencing and revegetation would be the most cost effective solutions to slow the gully erosion to a more natural rate while improving the area's wildlife habitat. As with any fencing project, stable crossing areas and livestock water sources should be considered.

It is recommended that gully repairs be incorporated into ranch plans that utilize the fencing for rotational pastures to better manage grazing while increasing ranch productivity. More expensive erosion control measures (i.e., loose rock headcut repairs) should be used at key locations to protect against new gully advancement, access road failures, and facility damage. The gullies are generally too steep for grade control structures to be effective. Low cost, biotechnical brush checkdams may be used is some gullies to help capture sediment and slow the rate of erosion. Shallow sediment basins may be installed above stock ponds to retain sediments before filling the ponds with deposition. Hillside vineyard development should use BMPs for highly erodible slopes and consider the effects of concentrated run off on downstream drainages.

2.9 Rush Creek

Erosion Activity:	LOW
Erosion Potential:	LOW
Repair Priority:	LOW

2.9.1 Characterization.

The Rush Creek subwatershed is in the southwest portion of the Petaluma River watershed. It drains the southeast slopes of Burdell Mountain and the northern portion of Novato and totals 9.2 square miles. The major drainages are Rush Creek and Basalt Creek that converge east of Highway 101 and form Black John Slough. Most of the subwatershed is east of Highway 101 and is salt marsh. The majority of the marshes are owned and managed by CDFG.

The small, steep drainages are mostly located in dense oak and bay woodlands on the eastern slopes of Burdell Mountain. The Rush Creek tributary flows through an urban development and has been channelized. The creek has been revegetated throughout the development and near the Fireman's Fund building.

2.9.2 Soils.

The majority of the eastern slope of Burdell Mountain is the Tocaloma McMullin complex. The Tocaloma loam soils are moderately deep, formed from sandstone and shale, with rapid run off and a high erosion potential. The McMullin gravelly loam is shallow, well drained, derived from sandstone and shale, with rapid run-off and high erosion potential. Both soils are found on steep slopes of 30 to 50% and are associated with mixed evergreen forest and brush land.

The Los Osos-Bonnydoon complex is found in narrow bands on the eastern slope of Burdell Mountain. The complex is 60% Los Osos loam, a moderately deep, well drained loam derived from sandstone with a high erosion/slip potential when saturated. The Bonnydoon soils make up 20% of the complex. The soil is shallow and excessively drained; it is derived from sandstone and shale. Erosion potential is high.

The base of Burdell Mountain on the flatter slope adjacent to Highway 101 consists of Blucher-Cole complex. The Blucher soil is a fine sandy loam, and the Cole soil is a clay loam. These soils are associated with alluvial fans found on 2 to 5% slopes with a low erosion potential. The soils east of Highway 101 that are not in the tidal marsh are generally Reyes clay, a poorly drained soil found on reclaimed tidelands with an erosion potential of none to slight.

2.9.3 Erosion.

The slopes of Burdell Mountain have high erosion potential due to their steepness and erodible soil types. However, the dense oak and bay woodlands on the upper slopes most likely are minimizing erosion on the mountain. Any new development could greatly affect its current stability by concentrating run-off and removing vegetative cover. A new building development on the slopes of Burdell Mountain seems to be placed on a large cut and fill lot. The site should be further investigated for impacts on downstream drainages due to concentrated run-off.

In general, there was very little erosion sighted during the road survey. One downcutting gully with active headcuts and bare, scoured banks was seen just north of the Birkenstock building.

According to the USGS & HUD Relative Slope Stability and Land Use Planning Maps, the entire upper slope area of Burdell Mountain is listed as Category 5, Unstable, a listing indicating areas of any slope that are underlain by, or immediately adjacent to, landslide deposits.

2.9.4 Recommendations.

A detailed stream channel stability and upslope erosion field survey should be completed to better understand the stability of Burdell Mountain. The majority of the mountain is on private property and under a dense canopy, making erosion surveys from aerial photographs nearly useless. At a minimum, a phone survey should be conducted to the Burdell Mountain landowners to assess existing erosion. Downstream owners of the tidal marsh (CDFG) should be interviewed to examine historic sedimentation to the area, if any.

The gully behind the Birkenstock building most likely can be stabilized with loose rock headcut repairs, loose rock checkdams, and revegetation.

2.10 San Antonio Creek Subwatershed

Erosion Activity:	HIGH
Erosion Potential:	HIGH
Repair Priority:	HIGH

2.10.1 Characterization.

The San Antonio Creek subwatershed is located in the southwest portion of the Petaluma River watershed. The San Antonio Creek drainage basin is defined by Spring Hill (elev. 557′) to the north, Antonio Mountain (elev. 1,171′) to the west, Red Hill (elev. 1,257′) to the southwest, and Burdell Mountain (elev. 1,558′) to the southeast. The creek drains a 36.5 square mile subwatershed that makes up approximately 25% of the entire Petaluma River watershed. The main channel flows east from Antonio Mountain, crossing Chileno Valley Road and Point Reyes-Petaluma Road, then runs parallel to San Antonio Road. The channel finally crosses under San Antonio Road and Highway 101 and enters a slough with adjacent salt water marsh before entering into the Petaluma River.

The majority of tributaries to San Antonio Creek flowing from the west and south have steep gradients and incised channels that are moderately to densely vegetated with oak and bay woodlands. The slopes are used mostly for livestock grazing but also include an olive orchard.

The north side of the subwatershed near D Street, Chileno Valley Road, and Spring Hill Road has moderate slopes and channel gradients with moderate to heavy entrenchment. The vegetation is mostly open grassland with sparse riparian tree cover. Some of the tributaries do have moderately dense oak woodland cover. The area is used for livestock grazing, vineyards, and dairy production.

The main channel has cut through the valley floor and adjacent hill terraces as it meanders in a deeply entrenched, low gradient stream. The riparian corridor has a moderate to dense canopy with mature valley oaks and a mix of other riparian species. This low valley is used for livestock grazing, dairy production, and ranchettes.

2.10.2 Soils.
The soils adjacent to the main channel of San Antonio Creek mostly consist of deep, silty clay loams. These grayish brown soils are comprised of alluvial deposit from sedimentary rock found along valleys, creeks, and basins. Such soils are referred to as Blucher-Cole complex in the *Soil Survey of Marin County, California* (1985) and as Zamora silty clay loams in the *Soil Survey of Sonoma County, California* (1972). These fertile soils have high water-holding capacity, slow run-off, and slight to moderate erosion potential. They are subject to short duration, seasonal flooding. Along the channel in the Laguna School/Chileno Valley Road area, the soils include Ballard gravelly loams on 2 to 9% slopes. This is a well drained, alluvial soil derived from sedimentary and igneous rock. Erosion is generally low, although bank slough is common along entrenched channels.

On the ridge along Spring Hill Road that divides San Antonio Creek and Liberty Creek subwatersheds, the common soil types are Steinbeck loams, which consist of moderately well drained soils with a clay loam subsoil and underlain by weakly consolidated sandstone. These soils have a moderate erosion potential with sheet, rill, and small gully erosion found on steeper slopes.

The Los Osos soils are well drained clay loams with a clay subsoil and are underlain by fractured sandstone. These soils are the most abundant in the subwatershed and are found on the adjacent hillsides with slopes ranging from 2 to 50%. Many of the slopes over 15% are listed as eroded, shallow soils. According to the *Soil Survey of Sonoma County, California* (1972), sheet and gully erosion have resulted from overuse. Landslips are numerous on steep slopes.

The steep slope of Red Hill and the ridge running west to east consist mostly of Tocaloma-Saurin association soils, which are found on very steep slopes of 30 to 75%. The Tocaloma loams are well drained soils derived from sandstone or shale, with rapid run-off and high erosion potential. The Saurin clay loam is moderately deep and well drained, derived from sandstone and shales, with a high erosion potential. According to the *Soil Survey of Marin County, California* (1985), grazing should be delayed until the soil has drained sufficiently and is firm enough to withstand trampling by livestock. Slopes restrict access by livestock, resulting in overgrazing of less sloping areas. Also found on side slopes along the ridge are Gilroy-Gilroy-Variant–Bonnydoon Variant loams and Henneke stony clay loams. These loams are from igneous, metamorphic, and fractured andesite parent material with reddish brown to brown subsoils. They are found on slopes of 30 to 50%, and the potential for surface erosion is moderate to high. The Henneke stony clay loams have up to 50% of the surface covered with stones.

Many other isolated soils are found in the San Antonio Creek subwatershed, including Arbuckle gravelly loam, Clear Lake clay, Felton Variant loam–Soulajule complex clay loams, and tidal marsh soils.

2.10.3 Erosion.

Storms during the winter of 1997-98 caused numerous small landslides and bank erosion in the San Antonio Creek subwatershed, which has by far the worst streambank erosion in the entire Petaluma River basin. The upper subwatershed contributes a large amount of sediment to the lower channel during these large storm events from gully downcutting and from shallow slips as seen throughout the subwatershed during the winter of 1997-98. The lower reaches of San Antonio Creek have 2 to 3 feet of newly deposited fine, reddish brown sediments along the streambanks. The adjacent fields and floodplain near Highway 101 have up to several inches of deposition.

The alluvial soils found in San Antonio Creek's channel and streambanks are from historic geomorphic processes of episodic events that filled the creek with deposition. These large debris flows can fill the valley floor and stream channel with several feet of poorly sorted sediments in one major episodic event. During the following years, the stream flow scours and downcuts through the deposited sediments and valley floor, creating a new channel. These episodic events help explain the alluvial soils that historically created the San Antonio Creek valley. With only limited investigation, it seems the main channel has cut completely down to bedrock in many locations, thus ending the downcutting process. The deeply entrenched channel now seems to be in a process of lateral migration in these reaches.

Interviews with local landowners conducted in 1995 by PCI for the Southern Sonoma County and Marin County Resource Conservation Districts indicated that the most apparent problem in the San Antonio Creek subwatershed is severe streambank erosion, which cuts into pastures and mature riparian vegetation. Some of these cut banks are 15 to 20 feet high, and in some places they have cut to bedrock. A 200-foot long by approximately 25-foot vertical streambank on an outside meander at a cattle ranch near the Marin-Sonoma County line has cut into the left bank destroying livestock fencing and threatening several oak trees. The bank moved laterally 10 to 15 feet during the winter of 1997-98, and over 1,800 cubic yards of fine sediment were eroded into the creek. The channel bottom in this area has been cut down to bedrock and dense clays. A point bar on the opposite bank has accumulated some cobble and gravel. There are at least five other eroded streambanks on the ranch and on the opposite banks that equal this size in length.

Upstream, a sheep rancher is experiencing similar bank erosion problems with one bank being 125 feet long by 20 feet high with active sloughing. Repairs of these banks will most likely require 36 to 48-inch, engineered boulder toe protection or large revetments with pilings. The repairs can be incorporated with biotechnical repairs on the mid to upper banks. Standard biotechnical repairs cannot be built in this environment and will have to be modified due to dense clays and bedrock.

In some areas, slough materials from the top of the bank have deposited at the toe of the bank creating a low, unstable bench with good soils. These benches can be stabilized biotechnically and revegetated to create additional bank stability. It may be possible to use boulder weirs in various locations for grade control and to slow the migration of bed scour.

Following are brief descriptions of the numerous erosion sites located during the public road survey. An 18-inch deep by approximately 400-foot long rill is actively downcutting along the inboard road ditch at Helen Putnam Park. Downstream of the park, a gully is actively downcutting with associated bank slumps down to Chileno Valley Road. Driving west from the park on Chileno Valley Road, the tributary is unvegetated with numerous scoured banks and may still be in a downcutting phase. Further west, downstream of Chileno Valley Road below the horse boarding facility, the small, meandering tributary has vertically cut banks up to 15 feet high on outside curves.

Many new erosion sites were found after the February, 1998, storms along I Street. The small tributary and its upslope drainages adjacent to I Street had at least 9 active erosion sites, including gullies, landslips, headcuts, and scoured banks. A highly active, downcutting gully is located on San Antonio Road just a few hundred feet east of I Street. Many slips and slides were located along the north side of San Antonio Road on the south-facing hillslope east of I Street. In one location, a slump on an outside meander of San Antonio Creek threatens San Antonio Road.

Numerous cut banks with active sloughing were located on the tributary adjacent to Point Reyes-Petaluma Road upstream and northeast of San Antonio Road. Many small slips were located on the road cut of Point Reyes-Petaluma Road along the Red Hill grade. Other small gullies were spotted in the headwater drainages of Marshall-Petaluma Road.

2.10.4 Recommendations.
San Antonio Creek is a large, complex subwatershed that should have its own watershed plan, including detailed sediment and riparian management plans. All local landowners should be invited to participate in the planning process. The plan should provide practical guidelines for cost-effective solutions. A geomorphic analysis of the main channel of San Antonio Creek should be conducted to better understand the current channel geomorphology and stability. This element would be tremendously helpful in allocating resources effectively to reduce sedimentation. The plan should also address questions such as how to protect adjacent ranchlands from the lateral migration of streambanks. It should incorporate a detailed inventory of the tributaries and upslope erosion and provide recommendations for riparian habitat improvements and protection.

Individual landowners should be supported in their efforts to create conservation plans through workshops and one-on-one technical assistance.

Bank erosion in the lower subwatershed as discussed above will, for the most part, require technical and engineered planning. However, revegetation on the lower banks, where feasible, can add additional bank protection and habitat cover.

The upper subwatershed's smaller tributaries that have bank scour can be addressed by fencing, revegetation, and biotechnical repairs. Fencing and revegetation will be the most cost-effective solutions to slowing bank scour to a more natural rate. More expensive erosion control measures, including biotechnical and traditionally engineered bank repairs, should be used at key locations to protect against access road failures and facility damage. The many upland gullies in the upper subwatershed will also benefit from fencing and revegetation. In some of the smaller gullies, biotechnical brush checkdams can be used for grade control. This low tech, low cost method can be done by landowners and volunteers.

The geomorphic analysis of San Antonio Creek should be in place before large sums of money are sought for addressing upland erosion of large landslides and slips. There is a possibility that San Antonio Creek is actually starved of sediment in certain downstream reaches, which could lead to massive streambank erosion.

2.11 Petaluma River Westside Subwatershed

Erosion Activity:	LOW
Erosion Potential:	MODERATE
Repair Priority:	LOW

2.11.1 Characterization.

The Petaluma River Westside subwatershed consists of many small drainage areas with similar characteristics that drain the west side of Petaluma. They have been combined for planning purposes. They drain a total of 13.9 square miles and include (from north to south) Dailey, Cinnabar, Skillman, Jesse Lane, Magnolia, Kelly, Weise, Thompson, Rock Quarry, Haystack, Golf, Kastania, Sutton, and Shultz Creeks. The majority of the seasonal creeks flow through the urban boundary and are partially contained in channels and culverts. These small creeks often cause urban street flooding during large storm events. The more significant creeks that are outside of the urban boundary—or that have significant upstream tributaries unaffected by development—are Kelly, Thompson, Kastania, Sutton, and Shultz Creeks.

Kelly and Thompson Creeks have their headwaters along D Street in the hillslopes south of Petaluma. They have a moderate channel gradient with streambanks of annual grasses and limited oak and willow riparian canopy cover. The area is used for livestock grazing. As Thompson Creek enters the Westridge development, it becomes an urban stream corridor that has been partially channelized for flood control. The perennial creek has been recently revegetated with young native plants. Both of these creeks flow under the City through large underground storm drains to the Petaluma River.

Kastania Creek flows northeast from its headwaters near I Street under Highway 101 and the Northwestern Railroad track and enters a salt marsh before reaching the Petaluma River. Sutton Creek is a northwest-flowing tributary to Kastania Creek. Both creeks have a continuous, oak-dominated, riparian canopy and are used for livestock grazing.

Shultz Creek flows east to Highway 101 and then enters Shultz Slough, flowing northeast through an adjacent salt marsh. The drainage area is used for livestock grazing, and the riparian corridor has sparse to no woody vegetation.

2.11.2 Soils.
The small tributaries that drain the west side of Petaluma, including within the City limits, have a variety of soil types. The most common are Los Osos and Cotati loams with erosion potentials of low to moderate. It was noted that on slopes over 30% that have been heavily grazed, sheet and gully erosion are common. Natural slippage is also common on the steep slopes found in the headwaters of Thompson Creek. Los Osos soils are found to the west and south of Petaluma. Cotati fine sandy loams were formed from old marine terrace material consisting of weakly consolidated sands, clays, and gravels. Erosion potential is moderate. Steeper slopes (over 15%) with faster run-off have a high erosion potential. These soils are located to the northwest and west of Petaluma.

Clear Lake clays are located along the west side of the river and Petaluma Boulevard North. Again, the high content of clay in these soils makes them subject to heavy compaction that will need to be considered when planning any revegetation effort along the river.

Yolo clay loams are found on the west side of the river, mostly within the City limits in the D Street and I Street areas along Thompson and Kelly Creeks. These soils are well drained loams underlain by alluvium from sandstone; they have good fertility and water-holding capacities with low erosion potential.

Arbuckle gravelly loams are found in the Magnolia Avenue area of Petaluma. These well drained, gravelly sandy loams derived from sedimentary rock alluvium are found on terraces and small hills. The erosion potential is generally low to medium on gradual slopes. Pleasanton gravelly loams are similar to the Arbuckle gravelly loams and are found around the Westridge area along Thompson and Kastania Creeks.

Zamora silty clay loams are found in isolated areas south of Petaluma. They consist of well drained clay loams formed in recent alluvium from sedimentary sources. These soils are high in fertility, and erosion is slight.

2.11.3 Erosion.
No major erosion sites or sediment sources were identified in the Petaluma River Westside subwatershed. Small amounts of newly deposited fine sediments and gravels were located on the channel bottoms of nearly all the creeks along low gradient reaches entering town. More substantial amounts of sediment deposition were located in Westridge on Thompson Creek and along Shultz Creek. Most likely, small upslope gullies, slips, and sheet and rill erosion are the major contributors to downstream deposition. Many of the

soils in the area are fine sandy loams that are susceptible to sheet and rill erosion when located on slopes that are not well vegetated.

Upstream of the new Westridge development, large amounts of deposition can be seen, indicating upper subwatershed erosion from recent winter storms. A small, downcutting gully with active headcuts was located on the left bank of Thompson Creek approximately 1,000 feet upstream of the new development. Indications of historic landslides were seen on both banks above the new housing development. At the headwaters of Thompson Creek adjacent to D Street, a livestock trail has concentrated run-off, causing a 4-foot, active headcut to downcut.

Along I Street on the outskirts of the City limits, sheet and rill erosion were evident on some small corrals associated with the ranchettes. On D Street just outside the City limits, the driveway to a house built a few years ago has contributed to sediments entering Kelly Creek. The paved driveway was constructed with an inboard ditch and a 12-inch culvert road crossing. Within two years, the culvert has created a steep, approximately 100-foot long by 24-inch deep gully. This is a good example of outreach needed to inform contractors and landowners in rural areas about proper road development and erosion protection. Some additional landslips were seen from Highway 101 on the hillsides of Shultz and Kastania Creeks.

2.11.4 Recommendations.

Additional, detailed stream channel stability and upslope erosion field surveys should be completed to better understand the stability of Thompson, Sutton, Shultz, and Kastania Creeks. Some of the upper subwatershed areas would most likely benefit from riparian fencing and revegetation to help control erosion.

Community outreach and workshops should be provided for urban residents, as well as ranchette and ranch owners. Such workshops can also help bridge the gap between agriculture and the urban community.

2.12 Liberty Creek Subwatershed

Erosion Activity:	MODERATE
Erosion Potential:	MODERATE
Repair Priority:	MODERATE

2.12.1 Characterization.

The Liberty Creek subwatershed is located in the northwestern portion of the Petaluma River watershed. San Antonio Creek subwatershed is located to the south, Stemple Creek watershed to the west, and Lichau Creek subwatershed to the northeast. The Liberty Creek subwatershed drains approximately 15.3

square miles and includes Liberty, Wiggins, McBrown, Freeman, Finch, Vista, Kizer, Wilson, Marin, and Stork Creeks.

Liberty Creek drains run-off from the southwestern slopes of Meacham Hill, flowing northwest adjacent to Stony Point Road until reaching the confluence with Willow Brook Creek, where it becomes referred to as the Petaluma River. Freeman and McBrown Creeks drain the east side of Wiggens Hill, flowing west to Wiggens Creek. Finch, Vista, Kizer, Wilson, Marin, Stork, and Gibson Creeks flow south draining the ridge near Spring Hill Road and Middle Two Rock Road. The drainages join Wiggins Creek and then meet Liberty Creek downstream of Rainsville Road.

The main channel of Liberty Creek has cut through old marine terraces and alluvial deposits; it has a low channel gradient with areas of moderate to no woody riparian vegetation. The area is primarily used for dairy production and cattle grazing. The adjacent land is subject to seasonal flooding and has been channelized upstream and along Stony Point Road.

The characteristics of the remaining small creeks and tributaries are generally similar. Along the hillslopes, the creeks are deeply incised with a moderate channel gradient. Many of the streambanks are well vegetated with oak and willow, while others are vegetated with annual grasses and blackberry only. Ranchettes, cattle grazing, and dairy production dominate the land use. As the creeks enter the lower subwatershed, the channel gradient becomes very low; flooding and sedimentation are common. The subwatershed has been intensely altered from its original state. Many of the creeks have been channelized and cleared of vegetation for flood control to protect agricultural, ranchette, and road development. Historically, before the area was dewatered for agriculture, large seasonal wetlands with dense willow thickets existed.

2.12.2 Soils.
The southwest slope of Meacham Hill along the Highway 101 corridor consists of well drained Toomes rocky loams underlain by weathered basalt. The soil has a slight to moderate erosion potential on slopes below 30%. Steep slopes (above 30%), such as the cut slope from construction on Highway 101, have a high to very high erosion potential. The lower slopes and terraces along Stony Point Road and Highway 101 consist of the Sebastopol sandy loams with a moderate erosion potential.

The majority of the Liberty Creek subwatershed is comprised of loams and sandy loams on gently sloped lands. These include the Steinbeck loams, Cotati fine sandy loams, Blucher fine sandy loams, and Pajaro fine sandy loams along the main channel. The most common are the Steinbeck loams, consisting of moderately well drained soils with a clay loam subsoil and underlain by weakly consolidated sandstone. These soils have a moderate erosion potential with sheet, rill, and small gully erosion found on steeper slopes. The Cotati fine sandy loams have a moderate to high erosion potential.

The Blucher fine sandy loams are poorly drained loams underlain by mixed sedimentary alluvium typical along creek bottoms and alluvial floodplains. These soils have an overwash of fine sandy loam on the surface and tend to stay wet longer after the rainy season. Their potential for erosion is low. Also found along the creeks are the Pajaro fine sandy loams and Pajaro clay loams. These soils are poorly drained, fine sandy loams underlain by mixed sedimentary alluvial material; they have low erosion potential. The Pajaro clay loam soils have a surface layer of clay loam, contain a higher organic content, and tend to stay wet until late spring.

The southern ridge bordering the San Antonio Creek drainage has Los Osos clay loams and Goulding cobbly clay loams. The Los Osos erosion potential is low to moderate in the Liberty Creek subwatershed due to moderate slopes. The Goulding clay loams and Goulding cobbly clay loams have a moderate to very high erosion hazard, with slopes over 30% having the greatest potential.

2.12.3 Erosion.

The Liberty Creek subwatershed is generally stable due to its moderate to gradual slopes and does not have a high potential for major landslide activity. However, the signs of sedimentation are found near every creek, ditch, and culvert. The major threat to homes and property is flooding.

Several active gullies on Vista, Finch, and Freeman Creeks in the upper subwatershed near Wiggins Hill (Middle Two Rock Road and Petaluma Valley Ford Road) are contributing large amounts of sand deposition to the lower subwatershed. The banks of the gullies are oversteepened, scoured, and susceptible to sloughing. These gullies, however, do not contribute to the sedimentation occurring along the majority of other creeks in the subwatershed. A small pond downstream of Petaluma-Valley Ford Road has acted as a major sediment trap to one of the tributaries and is nearly full from deposition.

Sedimentation was spotted along King Road, Queen Road, Liberty Road, Skillman Lane, Thompson Lane, McBrown Avenue, Jewett Road, Pepper Road, and Rainsville Road, as well as in many other areas. Most likely the sediment is cumulative from sheet, rill, and small gully erosion off the many ranches and ranchettes in the subwatershed. More specifically the erosion is from small corrals, pastures, unpaved roads, culverts, diversion ditches, and construction sites. The majority of ranchettes are located on fine sandy loams that are susceptible to sheet and rill erosion when not well vegetated. Many small corrals are heavily stocked with livestock and horses, which contributes to the deposition found in the drainages.

There is evidence that severe sheet and rill erosion are occurring on the upper slopes of Middle Two Rock Road. Some creeks have been reported by local residents as having eroded streambanks, which is likely channel incision through newly deposited sediments. Creeks repeatedly go through a geomorphic process of filling, seasonal flooding, and downcutting. The creeks in this area most likely have had the same characteristics in the lower reaches for years. An example of this is a headcut on Jewett Road that is actively downcutting the adjacent tributary through recently deposited sediments.

2.12.4 Recommendations.

Sedimentation from the upper subwatershed gullies and small drainages can be controlled with grade control structures and sediment basins. The steep, vertical gully banks can be addressed with biotechnical bank stabilization structures. These gullies can be further stabilized by riparian fencing and revegetation. The main channel of Liberty Creek in the upper subwatershed (Stony Point Road) can be repaired with small grade control structures, fencing, and revegetation of the riparian corridor. In addition, small sediment basins can be installed downstream of eroded corrals and pastures to minimize downstream impacts from sediment.

Community outreach and workshops should be provided for ranchette and ranch owners. The SSCRCD should look for restoration cost-share programs for ranchettes. A focus on how to address sheet and rill erosion for pastures and corrals should be a priority topic.

3.0 References

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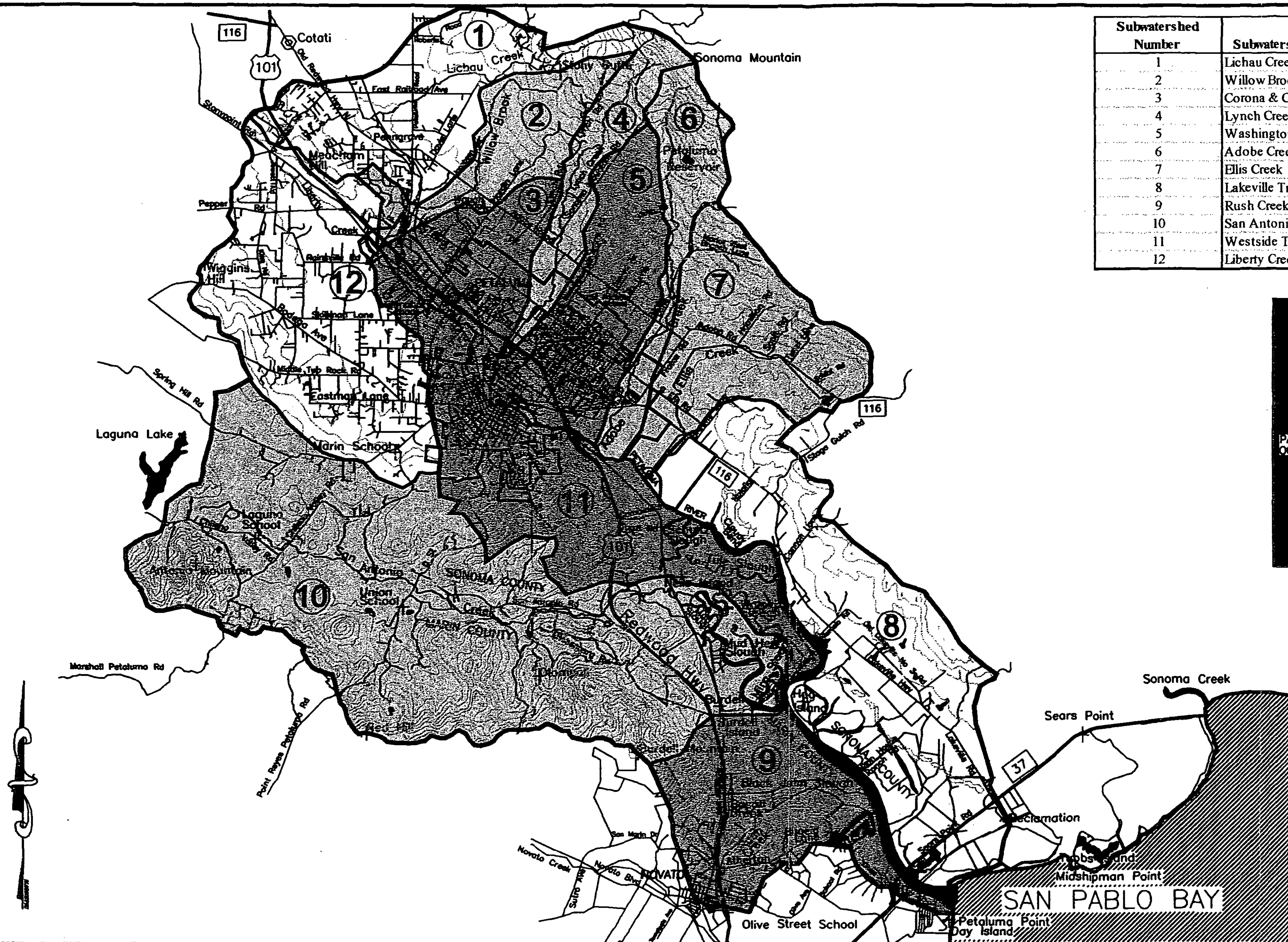
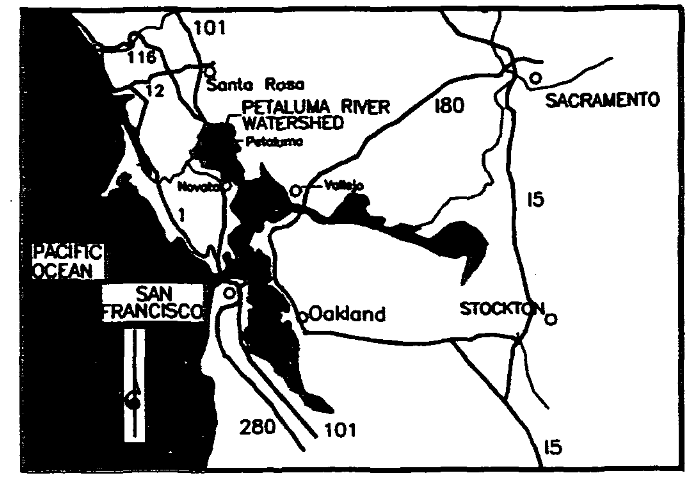
Subwatershed Number	Subwatershed Name	Square Miles	Erosion Activity	Erosion Potential	Priority
1	Lichau Creek	9.7	Low	Moderate	Moderate
2	Willow Brook Creek	5.3	High	High	High
3	Corona & Capri Creek	5.1	Low	Low	Low
4	Lynch Creek	4.0	High	High	High
5	Washington Creek	8.3	Moderate	Moderate	Low
6	Adobe Creek	4.9	Moderate	High	High
7	Ellis Creek	9.4	High	High	High
8	Lakeville Tributaries	19.8	High	High	Moderate
9	Rush Creek	9.20	Low	Low	Low
10	San Antonio Creek	36.5	High	High	High
11	Westside Tributaries	13.9	Low	Moderate	Low
12	Liberty Creek	15.3	Moderate	Moderate	Moderate





VICINITY MAP

LEGEND

- PETALUMA CITY BOUNDARY
- CONTOUR LINE @ 100' INTERVALS
- HYDROGRAPHIC FEATURE
- WATERSHED BOUNDARY
- SUBWATERSHED BOUNDARY
- HIGH PRIORITY
- MODERATE PRIORITY
- LOW PRIORITY

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: March, 1998 SCALE: 1" = 10,000' CHECKED BY: MJ DRAFTED BY: EL	REVISIONS	BY	PREPARED FOR: SOUTHERN SONOMA COUNTY RESOURCE CONSERVATION DISTRICT	EROSION AND SEDIMENTATION IN THE PETALUMA RIVER WATERSHED	SHEET 1 OF 1

Appendix F

PSIAC Model: Sediment Yields in Sub-watersheds of the Petaluma River

PSIAC Model: Sediment Yields in Sub-watersheds of the Petaluma River

Southern Sonoma County
Resource Conservation District
Petaluma, CA.
October, 1998

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Summary

The Pacific Southwest Inter-Agency Committee (PSIAC) is an empirical model that can be used as a watershed assessment tool to estimate average annual rates of sediment yield. Sediment yield may be defined as the volume of sediment that reaches some arbitrary point in the watershed. For the Petaluma watershed, that arbitrary point is the valley floor where the gradient of each creek levels out and the sediment drops out.

In the Petaluma watershed, Lichau, Willow Brook, Lynch, Adobe and San Antonio were evaluated using the PSIAC model. These five sub-watersheds were chosen based on a number of factors including historical data available, accessibility and existing riparian habitat. The primary factor was watershed size and its potential to deliver sediment into the Petaluma River.

In using the PSIAC model, nine factors were evaluated and assigned a rating. This assessment includes the surface geology, soils, climate runoff, topography, ground cover, land type, upland erosion and channel erosion/sediment transport in each sub-watershed. Each factor is evaluated independently and assigned a rating. The nine values are then summed up for a total rating. A rating sheet developed by PSIAC from empirical data correlates total rating values to average annual sediment yield. PSIAC results are initially reported in acre-feet per square mile per year. Conversion to tons per acre per year requires assuming a unit density of the sediment, which typically ranges from 70 - 110 pounds per cubic foot. We assumed average density for clay loam and soils of equal density which is representative of the area in this study.

In the course of using the PSIAC model in the Petaluma watershed, cross checks were performed to evaluate the model's effectiveness. An analysis, by the U.S. Geological Survey, of sediment transport and yield to the San Francisco Bay system between 1909 - 1966 was used to compare with values generated by the PSIAC model. Natural Resources Conservation Service TR-55 program was used to estimate runoff and peak discharge for Lynch Creek, which was then used to help assign ratings for the runoff subfactor for each of the subwatersheds.

The PSIAC model generated sediment yield values close to actual sediment yield data gathered from USGS. This cross-check adds confidence in the values from the PSIAC model. However, used as a watershed assessment planning tool, these values are best used to compare the sub-watersheds in terms of relative sediment contribution to valley floor and Petaluma River and not primarily used as data.

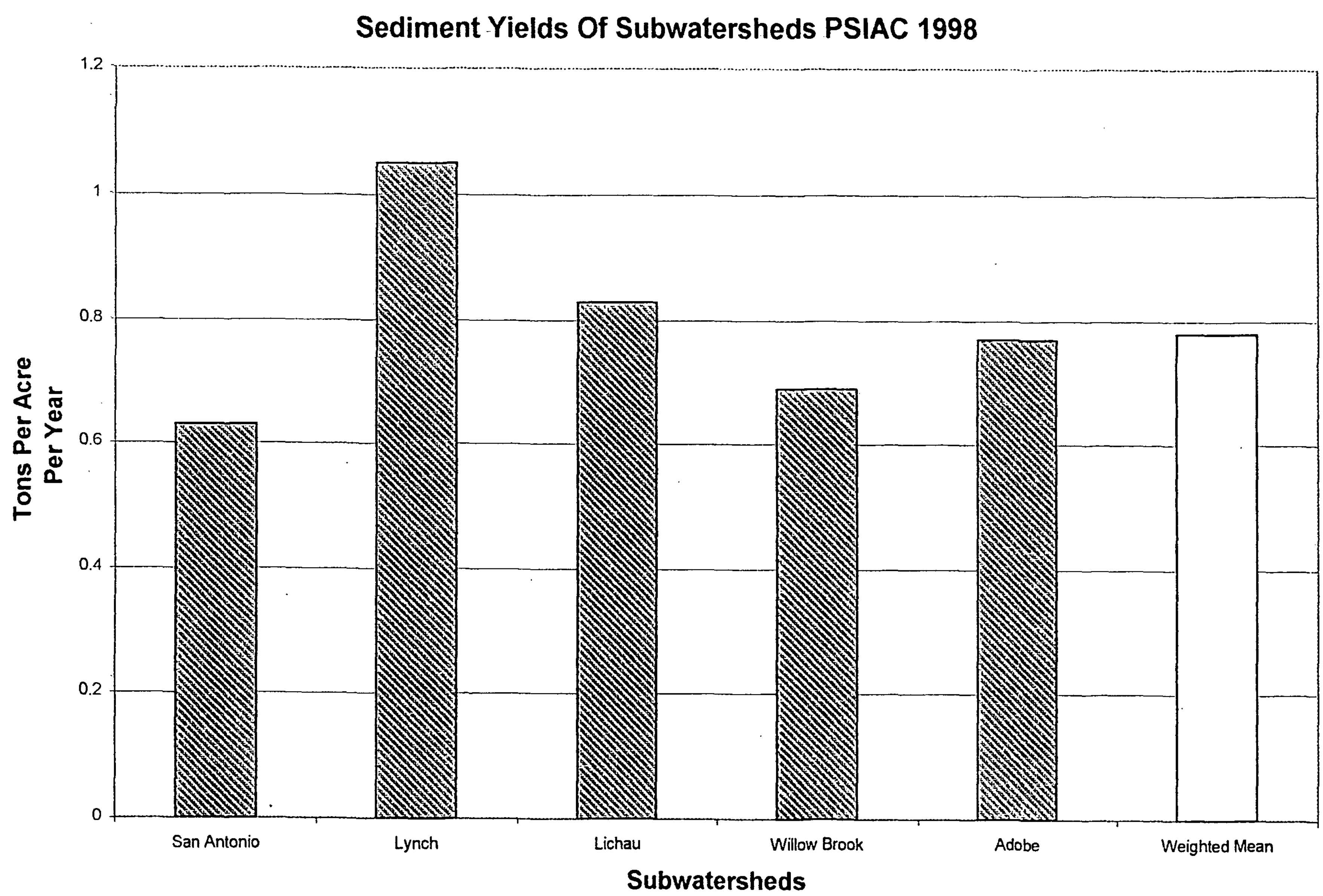
Recommendations:

A criteria should be developed to prioritize the sub-watershed in terms of sediment reduction potential and/or technical feasibility. Elements of the criteria may include results of this sediment yield report, land ownership, potential cooperators, road network, feasibility of restoration, erosion control (variety of treatment options, heavy equipment vs. hand work, impacts of work, accessibility), and other pertinent factors. Sub-watersheds determined to have higher potential or priority would require detailed erosion and sedimentation field studies to determine specific treatment options.

1998 PSIAC Sediment Yield Factors Table

Criteria (range)	Geology (0-5)	Soils (0-10)	Climate (0-10)	Runoff (0-10)	Topography (0-20)	Cover (-10-10)	Land Management (-10-10)	Upland Erosion (-10-10)	Channel Erosion & Sediment Transport (0-25)	Total (1-135)	Sediment Yield (tons per acre per year)	Sediment Yield (tons per square mile per year)	Density of Sediment (lbs per cubic foot) *	Approximate Area In (acres)	Approximate Area in (square miles)
San Antonio	3	6	5	5	6	-7	-6	3	12	27	0.63	403	84	22400	35
Lynch	3.3	5.1	5	7	8	-4	-5	8	15	42	1.05	677	84	2200	3.44
Lichau	2.5	5	5	7	7	-5	-2	5	10	35	0.83	531	84	2700	4.22
Willow Brook	2.7	4.9	5	7	5	-6	-5	4	12	30	0.69	439	84	2800	4.38
Adobe	1.5	5.9	5	6	8	-7.4	-5.9	7	13	33	0.77	494	84	3500	5.47
Weighted Mean											0.78	499	84		
Totals														33600	52.51

* Average density of clay type soil


Sediment Yields Of Subwatersheds PSIAC 1998
Tons Per Acre Per Year
1.2
1
0.8
0.6
0.4
0.2
0
San Antonio
Lynch
Lichau
Willow Brook
Adobe
Weighted Mean
Subwatersheds

Methods & References

Geology:
United States Geological Survey
Geology maps 1974

Soils:
Natural Resources Conservation Service
Climate data, 1965

Climate:
NOAA Atlas 2 Volume XI-California
Local Knowledge

Runoff:
Sonoma County Soil Survey
Hydrologic Soil Group
Estimated development using:
- USGS Topographical Maps
- Aerial Photography 1993

NRCS TR-55 program used on Lynch Creek

Topography:
Delineated sub-watersheds on USGS Quad sheets,
Estimated average slope for each watershed

Field observation

Effective Ground Cover:
Aerial photography
Field observation

Land Use and Management Quality:
Field observation
Local Knowledge

Upland Erosion:
Aerial Photography
Field observation

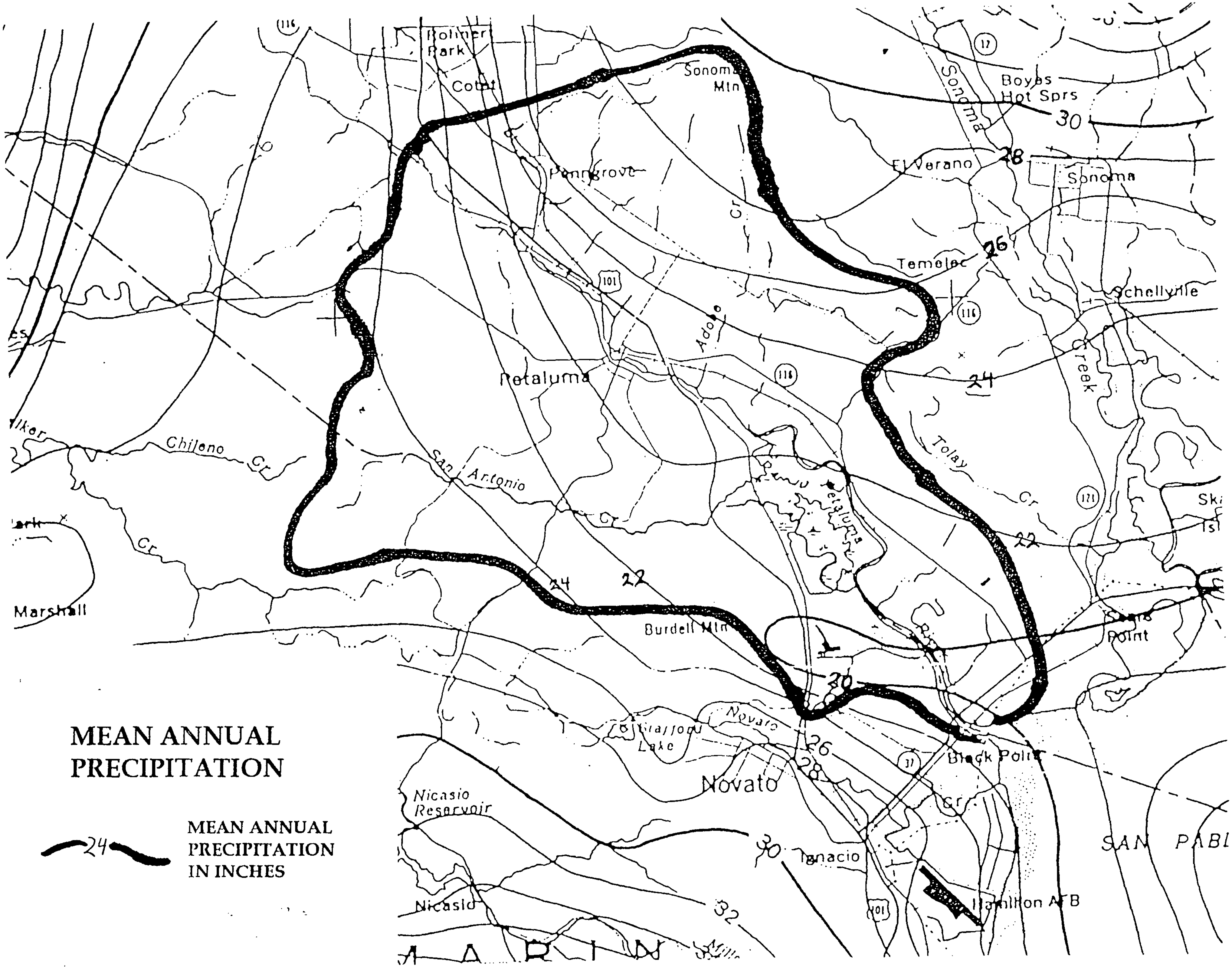
Channel Erosion and Sediment Transport:
Field observation

Petaluma Watershed Soils

Soils listed for each sub-watershed from most prominent to least prominent
All soils except those with an * are in the Soil Survey of Sonoma County

	Creek	Lichau	Willow Brook	Lynch	Adobe	San Antonio
Tons/Acre-Year		0.83	0.69	1.05	0.77	0.63
	(Average Annual sediment yield estimated using PSIAC)					
Most Prominent Soils	GoF, RaC, CfA DbD, CtC, SoF	CeA, DbC, GID CtC, HcD, RaD	CeA, DbC, GIE RcD, ShF	GgE,DbD, ShF LaF	LsF2, 184* ZaB, 105* 163*	

* These soils are from the Soil Survey of Marin County
105 Bluchar
163 Saurin
184 Tocaloma



MEAN ANNUAL PRECIPITATION

Major Tributaries of Petaluma Watershed

Creek	Estimated Slope Percent Length/Area=Slope	Length in Feet For each creek	Estimated Area Acres
Lichau	14	35,980	2,700
Willow Brook	11.6	24,430	2,800
Lynch	15.5	21,490	2,200
Adobe	16.7	24,500	3,500
San Antonio	13	53,970	22,400
Total		160,370	33,600

* List arranged clockwise starting at headwaters.

The equation used to determine the estimated slope percent was $S=hL/A$

S = slope of the subwatershed

h = contour interval

L = length of the watercourse in the subwatershed

A = Area

GRAPHICAL PEAK DISCHARGE METHOD Version 2.00

?roject : psiac User: dl Date: 11-12-98
:ounty : sonoma State: ca Checked: ____ Date: ________
;ubtitle: petaluma sub-watersheds

Data: Drainage Area : 2200 * Acres
Runoff Curve Number : 83 *
Time of Concentration: 0.04 * Hours
Rainfall Type : IA
Pond and Swamp Area : NONE

Storm Number	1	2	3	4	5	6
Frequency (yrs)	2	5	10	25	50	100
24-Hr Rainfall (in)	3.5	4.5	5.0	5.5	6.0	7.0
Ia/P Ratio	0.12	0.09	0.08	0.07	0.07	0.06
Used	0.12	0.10	0.10	0.10	0.10	0.10
Runoff (in)	1.86	2.73	3.17	3.63	4.09	5.03
Unit Peak Discharge (cfs/acre/in)	0.248	0.251	0.251	0.251	0.251	0.251
Pond and Swamp Factor 0.0% Ponds Used	1.00	1.00	1.00	1.00	1.00	1.00
Peak Discharge (cfs)	1014	1503	1751	2002	2257	2773

- Value(s) provided from TR-55 system routines

RUNOFF CURVE NUMBER COMPUTATION Version 2.00

'roject : psiac User: dl Date: 11-12-98
'ounty : sonoma State: ca Checked: ____ Date: ________
ıbtitle: petaluma sub-watersheds
ubarea : 2200

COVER DESCRIPTION		Hydrologic Soil Group A	B	C	D
			Acres (CN)		
HER AGRICULTURAL LANDS					
'asture, grassland or range	fair	-	-	-	1650(84)
ıods - grass combination	good	-	-	-	550(79)
ıtal Area (by Hydrologic Soil Group)					2200

UBAREA: 2200 TOTAL DRAINAGE AREA: 2200 Acres WEIGHTED CURVE NUMBER: 83*

- Generated for use by GRAPHIC method

TIME OF CONCENTRATION AND TRAVEL TIME Version 2.00

'roject : psiac User: dl Date: 11-12-98
:ounty : sonoma State: ca Checked: ____ Date: ________
ubtitle: petaluma sub-watersheds

'low Type	2 year rain	Length (ft)	Slope (ft/ft)	Surface code	n	Area (sq/ft)	Wp (ft)	Velocity (ft/sec)	Time (hr)
heet	3.5	300	10	e					0.031
hallow Concent'd		300	7.5	u					0.002
pen Channel		21490	15.5		.035280		53		0.012

Time of Concentration = 0.04*
=====

--- Sheet Flow Surface Codes ---

A Smooth Surface
B Fallow (No Res.)
C Cultivated < 20 % Res.
D Cultivated > 20 % Res.
E Grass-Range, Short
F Grass, Dense
G Grass, Burmuda
H Woods, Light
I Woods, Dense
J Range, Natural

--- Shallow Concentrated ---
--- Surface Codes ---

P Paved
U Unpaved

- Generated for use by GRAPHIC method

Total Yield Comparison: 1998 PSIAC vs. USGS Water-Resources Investigations 80-64 "Sediment Transport of streams tributary to San Francisco, San Pablo, and Suisun bays, California, 1909-1966"

1998 PSIAC Results:

499 Tons per square mile per year X 52.51 Square Miles (Estimated Area) =

26,202 Tons per Year

USGS Water-Resources Investigations Sediment Yield:

517 Tons per Square Mile per year X 52.51 Square Miles =

27, 148 Tons per Year

PSIAC Sediment Yield Factor Rating Sheet 1991 Rev.

Watershed:________________ State:______ Condition: Present, FWOP, FWP, Fire

Geomorphic Unit______________________ Names:____________ Date

Map________________ Location: T____R____, S____, ____1/4____1/4____1/4

(a) Surface Geology Geologist	(b) Soils Soil Scientist	(c) Climate Local Knowledge	(d) Runoff Hydrologist	(e) Topography Map & Field
(5) a. Marine shales and related mudstones and siltstones	(10) a. Fine textured; easily dispersed; saline-alkaline; high shrink-swell characteristics b. Single grain silt and fine sands	(10) a. Storms of several days' duration with short periods of intense rainfall b. Frequent intense convective storms c. Freeze-thaw occurrences	(10) a. High peak flows per unit area b. Large volume of flow per unit area	(20) a. Steep upland slopes (in excess of 30%) b. High relief; little or no floodplain development
(3) a. Rocks of medium hardness b. Moderately weathered c. Moderately fractured	(5) a. Medium textured soil b. Occasional rock fragments c. Caliche layers	(5) a. Storms of moderate duration and intensity b. Infrequent convective storms	(5) a. Moderate peak flows per unit area b. Moderate volume of flow per unit area	(10) a. Moderate upland slopes (less than 20%) b. Moderate fan or floodplain development
(0) a. Massive, hard formations	(0) a. High percentage of rock fragments b. Aggregated clays c. High in organic matter	(0) a. Humid climate with rainfall of low intensity b. Precipitation in form of snow c. Arid climate, low intensity storms d. Arid climate; rare convective storms	(0) a. Low peak flows per unit area b. Low volume of runoff per unit area c. Rare runoff events	(0) a. Gentle upland slopes (less than 5%) b. Extensive alluvial plains % Slope %Area = ____ x ____ = ____ ____ x ____ = ____ ____ x ____ = ____ ____ x ____ = ____ ____ x ____ = ____ Weighted Slope %______ Rating Chart (e) on back
Factor Value				

(f) Effective Ground Cover Land Use Planner Range Conservationist	(g) Land Type and Management Quality Land Planner	(h) Upland Erosion Geologist	(i) Channel Erosion and Sediment Transport Geologist
(10) Ground cover does not exceed 20% a. Vegetation sparse; little or no litter b. No rock in surface soil cover	(10) a. Almost all of area overgrazed or historic overgrazing impacts still active b. All of area recently burned c. Roads in need of O & M or improved design d. Almost all of area is badlands with minimal armor	(25) a. More than 50% of the area characterized by concentrated flow erosion with increasing gully development	(25) a. Eroding banks, continuously or at frequent intervals, with deep flows of long duration. b. Active headcuts and degradation in tributary channels
(0) Cover not exceeding 40% a. Noticeable litter b. If trees present, understory not well developed	(0) a. <50% of area overgrazed or with historic overgrazing impacts still active b. <50 % area recently logged c. Ordinary road and other construction d. Almost all of area is badlands with 50% of area covered with armor	(10) a. About 25 % of the area characterized by concentrated flow erosion with increasing gully development	(10) a. Moderate flow depths, medium flow duration with occasionally eroding banks or bed
(-10) a. Area completely protected by vegetation, rock fragments, litter b. Little opportunity for rainfall to reach erodible material	(-10) a. No recent logging b. Good grazing management or historic overgrazing impact under control c. Badland are totally armored	(0) a. No apparent signs of erosion Rating Chart (h) on back	(0) a. Wide shallow channels with flat gradients and short flow duration b. Channels in massive rock, large boulders, or well vegetated c. Artificially controlled channels
Rating Chart (f) on back Veg.____% Litter____% Rock___% Total Cover____________%			
Factor Value			

	Subtotal (a) - (g)	Subtotal (h) - (i)	Total Rating____ = _____ ac.ft./sq.mi./yr.

(instructions on reverse side)

(AcFt/mi ^{2}) X (3) Conversion Factor = ____Tons/acre

Sheet _____of _____

Instructions: Interpolation between sediment yield levels in each factor may be made. High values for columns (a) through (g) should correspond to high values for (h) and (i). If the difference between the total (a) through (g) and the total of (h) and (i) is greater than 10 points, then either a field related justification is necessary or the factor ratings should be revaluated. The total rating should be reviewed from a field perspective with this question: "Does this rating reflect field observations of erosion and sediment yield for the geomorphic unit?"

Factor (e) Chart
Topography

%	Pts	%	Pts
>30	20	18 - 20	10
29	19	17 - 18	9
28	18	15 - 17	8
27	17	14 - 15	7
26	16	12 - 14	6
25	15	11 - 12	5
24	14	9 - 11	4
23	13	8 - 9	3
22	12	6 - 8	2
21	11	5 - 6	1
		<5	0

Factor (f) Chart
Effective Ground Cover

%	Pts
<20--	10
25--	8
30--	5
35--	3
40--	0
45--	-1
50--	-2
55--	-2
60--	-3
65--	-4
70--	-5
75--	-6
80--	-7
85--	-7
90--	-8
95--	-9
100--	-10

Factor (h) Chart
Upland Erosion

%	Pts
50--	25
45--	22
40--	19
35--	16
30--	13
25--	10
20--	8
15--	6
10--	4
5--	2
0--	0

Total Rating vs Annual Sediment Yield Chart

Pts	ac-ft/sq mi	Pts	ac-ft/sq mi	Pts	ac-ft/sq mi	Pts	ac-ft/sq mi
1	<0.10	41	0.36	81	1.52	121	6.44
2	<0.10	42	0.37	82	1.58	122	6.67
3	<0.10	43	0.39	83	1.64	123	6.92
4	<0.10	44	0.40	84	1.70	124	7.17
5	0.10	45	0.42	85	1.76	125	7.44
6	0.10	46	0.43	86	1.82	126	7.71
7	0.11	47	0.45	87	1.89	127	8.00
8	0.11	48	0.45	88	1.96	128	8.29
9	0.11	49	0.48	89	2.03	129	8.59
10	0.12	50	0.50	90	2.11	130	8.90
11	0.12	51	0.52	91	2.18	131	9.23
12	0.13	52	0.54	92	2.26	132	9.57
13	0.13	53	0.56	93	2.35	133	9.92
14	0.14	54	0.58	94	2.43	134	10.29
15	0.14	55	0.60	95	2.52	135	10.66
16	0.15	56	0.62	96	2.61		
17	0.15	57	0.64	97	2.71		
18	0.16	58	0.66	98	2.81		
19	0.16	59	0.69	99	2.91		
20	0.17	60	0.72	100	3.02		
21	0.18	61	0.74	101	3.13		
22	0.18	62	0.77	102	3.25		
23	0.19	63	0.80	103	3.36		
24	0.20	64	0.82	104	3.49		
25	0.20	65	0.86	105	3.62		
26	0.21	66	0.89	106	3.75		
27	0.22	67	0.92	107	3.89		
28	0.23	68	0.95	108	4.03		
29	0.23	69	0.99	109	4.18		
30	0.24	70	1.02	110	4.33		
31	0.25	71	1.06	111	4.49		
32	0.26	72	1.10	112	4.65		
33	0.27	73	1.14	113	4.82		
34	0.28	74	1.18	114	5.00		
35	0.29	75	1.23	115	5.19		
36	0.30	76	1.27	116	5.38		
37	0.31	77	1.32	117	5.57		
38	0.32	78	1.37	118	5.78		
39	0.33	79	1.42	119	6.00		
40	0.34	80	1.47	120	6.21		

Notes:

Appendix G

Marsh/Bay Habitat in the Petaluma River Watershed

Marsh/Bay Habitat in the Petaluma River Watershed

Prepared for

Southern Sonoma County Resource Conservation District
Petaluma River Watershed Enhancement Plan

Prepared by

Prunuske Chatham, Inc.
P.O. Box 828
Occidental, CA 95465
(707) 874-0100

April 1998

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Southern Sonoma County Resource Conservation District has contracted with Prunuske Chatham, Inc., an environmental consulting firm located in Occidental, to produce this document entitled *Summary of Marsh/Bay Habitat in the Petaluma River Watershed.*

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SUMMARY OF MARSH/BAY HABITAT IN THE PETALUMA RIVER WATERSHED

1.0 Introduction

More than 90% of California's original marshland has been degraded, destroyed, or reclaimed (drained and/or filled for agricultural use) by agriculture, urbanization, and commercial salt operations. In the San Francisco Bay, less than 15% of original tidal marshland remains—much of it highly fragmented or altered. Only 23% of the historic tidal marshes in the North Bay remain.

The Petaluma Marsh is the largest remaining salt marsh in San Pablo Bay. Its 5,000 acres are surrounded by approximately 7,000 acres of reclaimed wetlands. The marsh has three zones: low marsh of cordgrass or tules, which receives maximum submergence; a middle marsh of pickleweed, alkali bulrush, or cattails; and a high marsh, which is rarely, if ever, covered by tidal action. During extreme high tides, the surrounding uplands are a refuge for many marsh animals.

As part of the planning process for the Petaluma River watershed, the Southern Sonoma County Resource Conservation District (SSCRCD) is summarizing information about three endangered species that depend on the remaining marsh habitat. These are the California black rail, the California clapper rail, and the salt marsh harvest mouse. This summary describes the habitat of each of these species, their predators, historic and current range, the role of the U.S. Fish and Wildlife Service (USFWS) consultations, and examples of mitigation measures for species preservation. (Two other endangered species that rely on the marsh are the salt marsh yellowthroat and the Sacramento splittail. These species are not addressed in this summary.) Recommended actions for the SSCRCD are also listed.

Two of the SSCRCD's tasks in preparing this summary were 1) to reproduce an historic map of the San Pablo Bay's boundaries near the Petaluma River and 2) to produce a map of the nesting areas for the two birds and of habitat for the salt marsh harvest mouse. The San Francisco Estuary Institute (SFEI) is in the process of finalizing maps of the current and historical North Bay marsh boundaries. These are considered the most current and accurate marsh maps available. Rather than replicate SFEI's efforts, SSCRCD will purchase copies of SFEI's maps as part of this planning process.

Information about nesting and habitat areas is not readily available from public agencies and, therefore, no map has been prepared at this time. The 1994 Endangered Species Formal Consultation for SSCRCD-sponsored levee maintenance activities marks some of these areas. The San Francisco Estuary Goals Project is in the process of preparing status information on the endangered species that will include narrative accounts, species distribution, management concerns, and, where possible, habitat maps. It is anticipated that this information will be available within the next six months. It is PCI's recommendation that SSCRCD stay informed about the Goals Project and make pertinent information available to landowners as appropriate, for example, through a newsletter or the advisory committee.

2.0 Overview of Special Status Species

2.1 California black rail.

The California black rail *(Laterallus jamaicensis coturniculus)* is a scarce, rarely seen, year-round resident of saline, brackish, and freshwater emergent wetlands. California black rails are most commonly found in tidal emergent wetlands dominated by pickleweed *(Salicornia virginica)* or in brackish marshes that support bulrushes *(Scirpus robustus)* and pickleweed. In freshwater, they are usually found in bulrush, cattail (*Typha* spp.), and salt grass *(Distichlis spicata)* areas.

They prefer high marsh regions that have shallow, stable water levels and that seldom flood. This type of marshland features dense stands of low growing, semi-aquatic plants interspersed with areas of open water and drier upland habitat; it provides materials for nest building and cover for nests. Nests are built at ground level or elevated several inches and are concealed in dense vegetation near the upper limits of tidal flooding. Rails eat insects, crustaceans, and other arthropods, as well as aquatic plant seeds.

Information on the historical range of the California black rail is scarce. Limited numbers are known to have bred along the coast from Tomales Bay to northern Baja California in Mexico. The bird also bred inland at freshwater marshes including the Sacramento-San Joaquin River Delta. Today California black rails are found in San Francisco Bay, in Bodega Bay in Sonoma County, in Tomales Bay and Bolinas Lagoon in Marin County, and in Morro Bay in San Luis Obispo County. The black rail no longer breeds in coastal southern California. Population numbers have continued to decline since the 1970s. More than 80% of the remaining California black rails are estimated to be concentrated in the marshes of northern San Francisco Bay.

The major cause of decline and principal barrier to recovery of the California clapper rail is the loss and degradation of the wetland habitat in northern and southern California. This includes coastal and estuarine salt marshes, inland freshwater marshes, and Colorado River marshlands. Of crucial concern for the rail is loss of high marsh habitat that provides refuge areas from high tides. Lack of refuge areas has left rails exposed as easy prey for domestic and feral cats, herons, egrets, and other birds, as well as red foxes and rats.

The California black rail is designated as a threatened subspecies in California. Under the federal Endangered Species Act (ESA), it is designated as a Candidate Species (C-1).

2.2 California clapper rail.

The California clapper rail *(Rallus longirostris obsoletus)* lives in coastal salt and brackish marshes and tidal sloughs. A year-round resident, the California clapper rail lives mostly in the upper to lower zones of coastal salt marshes dominated by pickleweed and cordgrass *(Spartina foliosa)*; some birds live in coastal brackish marshes. The California clapper rail forages in the shallow water along the mudflat interface and along tidal creeks. They require adjacent higher vegetation for cover during high water. The clapper rail mostly preys on crabs, mussels, clams, snails, insects, spiders, and worms. Nesting activity occurs from mid-March through July. The birds most often nest near tidal sloughs where cordgrass is abundant. They build a nesting platform concealed by a canopy of woven cordgrass stems or pickleweed and gumweed.

Historically, California clapper rails were found in tidal salt marshes and brackish marshes from Humboldt Bay in Humboldt County to Morro Bay in San Luis Obispo County. The bird is now found in San Francisco Bay and Suisun Bay. South San Francisco Bay marshes continue to support the largest number of these rails in the state. In the Petaluma River watershed, clapper rails are resident and breed along the river as far north as Schultz Creek.

In the early 1980s, more than a decade after the California clapper rail was first listed as endangered, an estimated 1,500 birds remained, with at least 80% of the surviving population confined to the southern part of San Francisco Bay. In the mid-1980s, the population was estimated to have declined steeply. In 1992, nineteen pairs of clapper rails were estimated to be in the Petaluma Marsh, primarily found at the mouth of the Petaluma River and in nearby large portions of tidal salt marsh.

Destruction of marsh habitat for industrial, municipal, agricultural, and salt pond use, as well as over-hunting, have depleted the California clapper rail population. Habitat loss also resulted from the dying out of marsh vegetation. Rail eggs have been found to harbor elevated levels of mercury, selenium, and other contaminants, probably because sewage effluent, industrial discharges, and urban run-off have contaminated the bird's food supply. Predators to both clapper rails and their eggs include raptors (northern harrier, red-tailed hawk, and peregrine falcon) and mammals (red foxes, rats, and cats). Predators are a serious threat to clapper rail populations, and predator management is not being regularly practiced in the North Bay. The introduced horse mussel may also inadvertently kill clapper rails by trapping the bills or feet of birds that have stepped on or probed into the shell.

The California clapper rail was listed as endangered by the state of California and under the federal ESA in 1970.

2.3 Salt marsh harvest mouse

Two subspecies of salt marsh harvest mouse (*Reithrodontomys raviventris)* are endemic to the San Francisco Bay area. The mice inhabit the middle to upper levels of dense pickleweed stands in tidal and diked coastal salt marshes. They rely on escape cover formed by dense vegetation in the higher zones of the marsh to shelter them during high tides. Grasslands adjacent to pickleweed saline emergent wetlands are used when new grass growth provides suitable cover in spring and summer months. The mice's diet is comprised of seeds and green vegetation, and they can drink water with a relatively high salt content. Reproduction generally occurs from April through September. Salt marsh harvest mice build nests of grass and sedge on the ground; they do not burrow. Predators include hawks, owls, gulls, weasels, and other mammals.

Historically, the salt marsh harvest mouse was found throughout the extensive marshes that once bordered San Francisco, San Pablo, and Suisun Bays. It is now restricted to scattered, discontinuous, coastal salt marshes within its original range. The northern subspecies *(R. r. haliocoetes)* is found in the salt marshes of San Pablo and Suisun Bays in Contra Costa, Solano, Napa, and Sonoma counties. Most populations of the southern subspecies *(R. r. raviventris)* inhabit the southern half of San Francisco Bay in Alameda, Santa Clara, and San Mateo counties, and few occur along the eastern portion of the Marin Peninsula in Marin County and at Point Richmond in Contra Costa County.

Decline in salt marsh harvest mouse populations is linked to habitat loss, especially of escape cover, fragmentation of the remaining marshes, widespread loss of the high marsh zone as a result of backfilling, land subsidence from excessive groundwater pumping, and vegetational changes from freshwater sewage discharge, especially in the South Bay. Most of the remaining marshes are too small and too widely separated to support viable populations.

Excessive pumping of groundwater in some regions has triggered subsidence of land along the bays' edges. This and backfilling have eliminated important escape cover in the marshland's higher zones, making these marshes unsuited to the mice's needs. Fragmentation of remaining marshes, as well as filling and diking of marshes for commercial salt production and urbanization, have also eliminated habitat throughout the species' range.

Both the state and federal governments listed the salt marsh harvest mouse as an endangered species in 1970. Since populations of the mice cannot be supported for the long term on the small, widely separated marshes that remain, the USFWS recovery plan for the species focuses on restoring and preserving existing habitat and acquiring additional habitat. Specific objectives include acquiring privately owned marshes and restoring former baylands that have been diked. The plan also calls for creating vegetative cover in the upper portions of marshes. Further objectives include studying the effects of such factors as sewage effluents, pollution, flood control, and marsh erosion on existing populations and habitat.

3.0 Role of U.S. Fish and Wildlife Service Consultations

The role of the USFWS is to protect endangered and threatened species and to restore them to a secure status in the wild. Under the federal endangered species program, the responsibilities of USFWS include to:

- List, reclassify, and delist species under the federal ESA.
- Provide biological opinions to federal agencies regarding the possible effects of their activities on listed species.
- Oversee recovery activities for listed species.
- Provide for the protection of important habitat areas.
- Provide grants to states to assist with their endangered species conservation efforts.

The federal ESA prohibits "take" of a federally listed wildlife species. Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect" any such species. Take may include significant habitat modification or degradation, where wildlife are actually killed or injured by significantly impairing essential behavioral patterns such as breeding, feeding, or shelter.

An incidental take occurs when a threatened or endangered species is unintentionally harmed in the course of a lawful activity. The USFWS may authorize an incidental take in advance by one of two procedures, depending on the agencies involved.

If a federal agency is involved in permitting, funding, or carrying out a project that might result in take, that agency must engage in a Formal Consultation with USFWS. The consultation will result in a biological opinion that addresses anticipated effects of the project to listed and proposed species; it may authorize a limited level of incidental take. For projects within the Petaluma River watershed, consultation would be required for projects with federal funding, such as 319(h) grants, or federal permitting, such as U.S. Army Corps of Engineers (ACOE) Nationwide Permits.

If no federal agency is involved, the applicant—the RCD, state, city, county, landowner, etc.—should apply for an "incidental take permit." USFWS may issue this type of permit if a satisfactory conservation plan for the species affected by the project is submitted.

For projects in the San Francisco Bay Area, including the Petaluma River watershed, the Sacramento USFWS office administers the federal ESA. The phone number is (916) 979-2725.

4.0 Examples of Mitigation Measures

The USFWS provides mitigation guidelines in two forms. On a large scale, they provide recovery plans for species within a region. They also provide mitigation recommendations on a project-specific basis.

4.1 Recovery plans.

In 1984, the USFWS completed a recovery plan for the salt marsh harvest mouse and California clapper rail. This plan identifies steps that USFWS believes are necessary in order for the species to no longer need protection under the federal ESA. It describes areas that require restoration and outlines management steps, such as controlling public access, managing predators, and reducing human disturbance during breeding season. The recovery plan is currently under revision, and the USFWS is assessing the effectiveness of the 1984 plan.

The California clapper rail and salt marsh harvest mouse are endangered due to destruction of marsh habitat. Survival of these species requires protecting and enhancing existing marshes, restoring former habitat, and undertaking additional research on their habitat requirements and population trends. The objectives of the recovery plan are to:

- Secure and manage about 3,900 hectares of essential habitat under the jurisdiction of federal, state, and local governments.
- Secure and manage about 3,200 hectares of occupied, unsecured, essential habitat (largely private lands).
- Restore and/or enhance an additional 7,000 hectares of tidal marsh and diked historic baylands.

Recovery actions include habitat areas in the Petaluma Marsh and are anticipated to be expensive and to occur over a long period of time.

Appendix B of the recovery plan for the salt marsh harvest mouse and California clapper rail describes marsh management guidelines. These include:

- Areas should have 100% cover.
- Vegetation should be 30-50 cm deep at summer maximum.
- A high percentage of pickleweed should be present.
- Few or no areas of salt grass, brass buttons, alkali bulrush, other *Scirpus* species, or *Typha*.
- No barriers of open ground or water dissecting the vegetation.
- Each marsh area should be large (at least 20 meters wide) and a considerable portion should be habitable throughout the year.
- Area should receive minimal disruptive manipulations (only those needed to provide and maintain mouse habitat); plowing, mowing, and/or burning should not be allowed.

General guidelines for marshes include:

- Marshes should have an upper zone where possible and include native plant species typical of that zone. Islands of higher vegetation should be created within marshes where possible.
- Human impact on the upper zone of marshes and adjacent upland vegetation should be minimized. This includes land filling, discing, grazing, burning, and placement of trails and roads.
- There should be a buffer zone of upland vegetation adjacent to the upper edge of each tidal marsh where possible.
- Restored tidal marshes should be large enough to allow tidal channels to develop, which will provide foraging areas for rails. Narrow strip marshes are not desirable except to connect adjacent larger parcels as corridors for rail and mouse movement.
- Restored tidal salt marshes should support the three zones of habitat typical of pristine bay marshes, including upper, middle, and lower zones. Brackish tidal marshes should have high species diversity (both

plant and animal). Both types of marshes should have a wide, relatively undisturbed band of upland vegetation adjacent to their upper zone.

4.2 Project-specific examples.

Project-specific recommendations are tailored to site-specific needs. An example of project-specific mitigation measures are the terms and conditions listed in the Biological Opinion for Levee Maintenance Activities and Dredging. The following descriptions are condensed portions of these conditions:

- To avoid possible disruption of clapper rail breeding activities, levee maintenance work shall not occur during the period from February 1 through August 31 within any given year on identified levee segments.

- Levee maintenance near identified clapper rail nesting areas shall not occur during high winter tide events to avoid disturbance of clapper rails using refuge habitat within these areas.

- The applicant (SSCRCD) shall prepare and implement a detailed tidal salt marsh habitat restoration plan that compensates for the permanent and temporary loss of 71 acres of salt marsh harvest mouse and clapper rail habitat associated with the proposed action. Suitable areas are identified by the USFWS opinion.

5.0 Recommended Actions for the SSCRCD

The following actions are recommended for SSCRCD as part of the *Petaluma River Watershed Enhancement Plan:*

- Inform landowners of upcoming agency plans and actions related to the Petaluma Marsh.

- Prepare and distribute information to the public about the habitat needs of these species and how watershed residents can help with recovery efforts.

- Select enhancement projects that do not adversely impact the habitat of these endangered species. If this is unavoidable, follow up and insure that the specific terms and conditions identified by USFWS are implemented.

6.0 References

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Mayer, Kenneth, and William Laudenslayer, editors. 1988. *A Guide to Wildlife Habitats of California.* California Department of Forestry and Fire Protection, Sacramento, California.

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Mossman, Harry. U.S. Fish and Wildlife Service. April 2, 1998. Personal communication with Martha Neuman, PCI.

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White, Wayne, Field Supervisor, U.S. Fish and Wildlife Service. December 23, 1997. Letter to Calvin Fong, U.S. Army Corps of Engineers. *Endangered Species Formal Consultation on the proposed Bahia Master Plan Residential Development, Novato.*

White, Wayne, Field Supervisor, U.S. Fish and Wildlife Service. July 7, 1997. Letter to David H. Densmore, U.S. Department of Transpiration. *Endangered Species Formal Consultation on the Proposed State Route 37 Improvements Project.*

APPENDIX A

Examples of U.S. Fish and Wildlife Service Consultations

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Sacramento Field Office
2800 Cottage Way, Room E-1803
Sacramento, California 95825

In Reply Refer To:
1-1-94-F-41

September 9, 1994

Lt. Colonel Michael J. Walsh
U.S. Army Corps of Engineers
Regulatory Branch (Attn: Bob Smith)
211 Main Street
San Francisco, California 94105-1905

Subject: Endangered Species Formal Consultation on the Proposed Levee Maintenance Activities and Dredging in the Sonoma Creek, Petaluma River, and San Antonio Creek Drainages, Marin and Sonoma Counties, California (PN 19989N46, PN 19990N54, and PN 19991N39)

Dear Lt. Colonel Walsh:

This responds to your request for formal consultation on issuance of a permit to the Southern Sonoma County Resource Conservation District (SSCRCD) to maintain levees through dredging of material from waterways in the Sonoma Creek, Petaluma River, and San Antonio Creek drainages in Marin and Sonoma Counties. Your request for formal consultation and conferencing, dated June 3, 1994, was received by the U.S. Fish and Wildlife Service (Service) on June 6, 1994.

This biological opinion addresses the effects of levee maintenance and dredging on the endangered California clapper rail (*Rallus longirostris obsoletus*), endangered salt marsh harvest mouse (*Reithrodontomys raviventris halicoetes*), and proposed threatened Sacramento splittail (*Pogonichthys macrolepidotus*).

This biological opinion is based on (1) U.S. Army Corps of Engineers (Corps) Public Notices 19989N46, 19990N54, and 19991N39, dated February 14, 1994; (2) information in Service files; and (3) additional communications between the Corps, the SSCRCD, and the Service.

Biological Opinion

It is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the endangered California clapper rail, endangered salt marsh harvest mouse, or proposed threatened Sacramento splittail. Critical habitat for these species has not been designated or proposed; therefore, none will be adversely modified or destroyed.

Description of the Proposed Action

Participating members of the SSCRCD propose to dredge material from the channels and/or wetlands adjacent to existing levees on their property to obtain material for levee maintenance. These levees lie adjacent to Sonoma Creek, Tolay Creek, the north and east branch of Tolay Creek, Napa Slough, Second Napa Slough, Third Napa Slough, Hudeman Slough, Steamboat Slough, Schell Slough, Railroad Slough, Rainbow Slough, and San Pablo Bay in the Sonoma Creek drainage; and San Antonio Creek, Petaluma River, and San Pablo Bay in the Petaluma River drainage.

Material would be dredged using a dragline from the water side of the levee and placed directly on top of the levee. The borrow areas are typically 25 feet out from the base of the levee and 15 feet wide, although the width varies. Borrow areas are excavated about 3 feet in depth.

In the Petaluma River drainage, most of the levees along the east bank of the river and some along San Antonio Creek support emergent vegetation 25 feet or less in width. Along these stretches, material for levee repair would be dredged directly from the river or creek bed. Along the remaining levees, material would be dredged from borrow areas in adjacent sloughs (Mud, Mud Hen, Black John, and Basalt Creek) with emergent tidal vegetation. According to the Public Notice (19989N46, 19991N39), the borrow areas along most of these levees are well defined, but for some, particularly along Black John Slough, the borrow areas are less visible because of regrowth of emergent vegetation.

In the Sonoma Creek drainage, many of the levees along Sonoma Creek above Second Napa Slough, along Lower Tolay Creek, and portions of remaining sloughs support emergent vegetation 25 feet or less in width. Material in these areas would be dredged directly out of the slough or creek bed. Along other levees, material would be dredged from borrow areas in adjacent marsh. According to the Public Notice (19990N54), the borrow areas along upper Tolay Creek, the north and east branches of Tolay Creek, the south side of Tubbs Island (San Pablo Bay), the south side of Steamboat Slough, upper Hudeman Slough, Second Napa Slough, and Napa Slough east of the Gonzales property, are less visible because of regrowth of emergent vegetation.

The permit application includes 242,000 linear feet of levee in the Sonoma Creek drainage and 83,500 linear feet (excludes Redwood Sanitary Landfill proper) in the Petaluma River drainage. The Corps Regional Permit for this activity, however, would authorize the dredging of up to 4 cubic yards of material per foot of levee, not to exceed 10,000 cubic yards per property owner per year (approximately 2,500 feet of levee/property owner/year). The Regional Permit would be in effect for 5 years.

Species Account/Environmental Baseline

California Clapper Rail

Please refer to U.S. Fish and Wildlife Service (1984) for biological information on the California clapper rail. Additional information is taken from a previous biological opinion prepared by the Service, dated August 31, 1990, on Department of the Army permit application no. 15283E49, however, certain sections on the distribution, abundance, and status of the rail contained in that opinion are updated below to reflect current information.

Of the 193,800 acres of tidal marsh that bordered San Francisco Bay in 1850, about 30,100 acres currently remain (Dedrick, 1993). This represents an 84 percent reduction from historical conditions. In the north Bay alone, 59,000 acres of tidal marsh occurred historically. Only 13,670 acres or 23 percent remain today. A number of factors influencing remaining tidal marshes limit habitat values for clapper rails. In the north Bay as well as other portions of the Bay, habitat suitability of many marshes for clapper rails is limited or precluded by small size, fragmentation, and lack of tidal channel systems and other microhabitat features. Much of the tidal marsh habitat in the project area is comprised of narrow strips adjacent to levees. Although much is unsuitable for nesting, these narrow strips of marsh may also provide movement corridors for rails dispersing from existing nesting areas. In addition, marshes in the upstream portions of the Sonoma Creek drainage are comprised of primarily freshwater vegetation which is unsuitable for the clapper rail. In other portions of the Bay, marsh erosion and conversion to freshwater habitat are eliminating or limiting available habitat for clapper rails. These limitations render much of the remaining tidal marsh acreage in San Francisco Bay unsuitable or of low value for the species.

Throughout the Bay, the remaining California clapper rail population is besieged by a suite of mammalian and avian predators. At least twelve native and three non-native predator species are known to prey on various life stages of the rail in the south Bay (Albertson *et al.*, in prep.). Albertson *et al.* (in prep.) reported nest predation as high as 64 percent in some south Bay marshes. Red fox, Norway rats, and various raptors are the most common predators of clapper rails in the south Bay. These predators also may commonly prey on clapper rails in the north Bay. No studies, however, have been done in the north Bay on the effects of predators on clapper rails. Red fox, however, have been sighted at several locations in the north Bay in recent years.

Mercury accumulation in eggs is perhaps the most significant contaminant affecting clapper rails in San Francisco Bay, with the south Bay containing the highest mercury levels. Mercury is extremely embryo toxic and has a long biological half-life. The Service collected data from 1991 and 1992 on mercury concentrations in rail eggs in the southern portion of the estuary and found that the current accumulation of mercury in rail eggs occurs at potentially harmful levels. The percentage of non-viable eggs ranged from 25 to 38 percent (mean = 29 percent). No similar studies of contaminants and their effects on clapper rails have been done in the north Bay.

Gill (1979) estimated the total California clapper rail population in San Francisco Bay in the mid-1970's at 4,200 to 6,000 birds. Surveys conducted by the California Department of Fish and Game and the Service estimated that the clapper rail population approximated 1,500 birds in the mid-1980's (Harvey 1988). In 1988, the total San Francisco Bay clapper rail population was estimated to be 700 individuals with 200-300 rails in the north Bay and Suisun

Marsh (Foerster 1989). The total rail population reached an estimated all-time historical low of about 500 birds in 1991 with the greatest recorded declines occurring in the south Bay (USFWS unpubl. data; E. Harding-Smith, pers. comm., 1993). In response to predator management, the south Bay rail population has since rebounded and is now estimated to be approximately 600 individuals (USFWS unpubl. data). A preliminary estimate of the north Bay and Suisun Marsh population is 195-422 pairs (Evens and Collins 1992).

In the Petaluma River drainage, Evens and Collins (1992) estimated 19 pairs of clapper rails. Clapper rails were found primarily at the mouth of Petaluma River, in Petaluma Marsh, and in nearby large blocks of tidal salt marsh habitat. In the Sonoma Creek drainage, Evens and Collins (1992) estimated 13 pairs of rails with Second Napa Slough, Hudeman Slough, and the mouth of Sonoma Creek being the primary locations of breeding pairs.

In a north Bay marsh, Evens and Page (1983) concluded that the clapper rail breeding season, including pair bonding and nest construction, may begin as early as February. Field observations in south Bay marshes suggest that pair formation also may occur in February in some areas (J. Takekawa, pers. comm., 1993). Similar observations have been made in Suisun Marsh (B. Grewell, pers. comm., 1993). The end of the breeding season is typically defined as the end of August, which corresponds with the time when eggs laid during renesting attempts have hatched and young are mobile. Young may fledge as late as mid-September (J. Takekawa, pers. comm., 1993).

Upland cover for escape during flood tides is essential for the species (Evens and Page 1983). In the project area, upland refugial cover is confined to the slopes of the levees.

Salt Marsh Harvest Mouse

Please refer to U.S. Fish and Wildlife Service (1984) for a summary of the status, distribution, and habitat requirements of the salt marsh harvest mouse. The information included in the Service's August 31, 1990, biological opinion on Department of Army permit application no. 15283E49 is still current and, therefore, thereby incorporated by reference.

Preferred habitat of the salt marsh harvest mouse in the project area is tidal salt marsh dominated by pickleweed. Salt marsh harvest mice share similar habitat with the California clapper rail, and therefore have experienced similar historic loss of habitat, particularly in the north Bay.

No comprehensive salt marsh harvest mouse surveys have been conducted in either the Petaluma River or Sonoma Creek drainage basins. The most recent trapping studies in the project area occurred in the late 1970's and early 1980's in preferred habitat in Sonoma Creek, Tolay Creek, at the mouth of Petaluma River, and just south of the Highway 101 bridge over Petaluma River. Mice are presumed to inhabit other similar habitat in the drainage basins.

Sacramento Splittail

Please refer to the proposed rule to list the Sacramento splittail as a threatened species (59 FR 862) for a more detailed account of the biology of the species. The Sacramento splittail (*Pogonichthys macrolepidotus*) is a large cyprinid that can reach greater than 12 inches in length (Moyle 1976). Adults are characterized by an elongated body, distinct nuchal hump, and a small blunt head with barbels usually present at the corners of the slightly subterminal mouth. This species can be distinguished from other minnows in the Central Valley of California by the enlarged dorsal lobe of the caudal fin. Splittail are dull, silvery-gold on the sides and olive-grey dorsally. During the spawning season, the pectoral, pelvic and caudal fins are tinged with an orange-red color. Males develop small white nuptial tubercles on the head.

Splittail are endemic to California's Central Valley where they were once widely distributed (Moyle 1976). Historically, splittail were found as far north as Redding on the Sacramento River and as far south as the site of Friant Dam on the San Joaquin River (Rutter 1908). Rutter (1908) also found splittail as far upstream as the Oroville Dam site on the Feather River and Folsom Dam site on the American River. Anglers in Sacramento reported catches of 50 or more splittail per day prior to damming of these rivers (Caywood 1974).

In recent times, dams and diversions have increasingly prevented upstream access to large rivers and the species is restricted to a small portion of its former range (Moyle and Yoshiyama 1992). Splittail enter the lower reaches of the Feather (Jones and Stokes 1993) and American Rivers (Charles Hanson, State Water Contractors, in litt., 1993) on occasion, but the species now largely is confined to the Delta, Suisun Bay, Suisun Marsh, and Napa Marsh.

Splittail are long lived, frequently reaching five to seven years of age. Females are highly fecund and each produces over 100,000 eggs. Populations fluctuate annually depending on spawning success. Spawning success is highly correlated with fresh water outflow and the availability of shallow-water habitat with submerged vegetation (Daniels and Moyle 1983). Splittail usually reach sexual maturity by the end of their second year. There is some variability in the reproductive period since older fish reproduce before younger individuals (Caywood 1974). Splittail migrate upstream to spawn, similar to delta and longfin smelt. The onset of spawning is associated with rising temperature and peaks from the months of March through May, although there are records of spawning from late January to early July (Wang 1986). Spawning occurs over flooded vegetation in tidal freshwater and euryhaline habitats of estuarine marshes and sloughs and slow-moving reaches of large rivers. Larvae remain in shallow, weedy areas close to spawning sites and move into deeper water as they mature (Wang 1986).

Splittail are benthic foragers that feed on opossum shrimp, although detrital material makes up a large percentage of their stomach contents (Daniels and Moyle 1983). Earthworms, clams, insect larvae, and other invertebrates are also found in the diet. Predators include striped bass and other piscivores. Splittail are sometimes used as bait for striped bass. Although this occurs, it is not a common practice.

Splittail can tolerate salinities as high as 10-18 ppt (Moyle 1976, Moyle and Yoshiyama 1992). Splittail are found throughout the Delta, Suisun Bay and Suisun and Napa marshes. They migrate upstream from brackish areas to spawn in freshwater. Because they require flooded vegetation for spawning and rearing, splittail are frequently found in areas subject to flooding.

The 1983-1992 decline in splittail abundance is concurrent with hydrologic changes to the Sacramento-San Joaquin Estuary. These changes include increases in water diversions during the spawning period of January through July and dams that limit upstream migration. Diversions, entrainment due to CVP/SWP pumping, dams and reduced outflow, coupled with severe drought years, introduced aquatic species, and loss of wetlands and shallow-water habitat (California Department of Fish and Game 1992) appear to have reduced the species' capacity to reverse its decline.

The existing environmental baseline for the Sacramento splittail includes Central Valley Project (CVP) and State Water Project (SWP) operations modified by D-1485, the February 12, 1993, winter-run chinook salmon biological opinion, and the Service's February 4, 1994, delta smelt biological opinion.

The Sacramento splittail is adapted to living in rivers of the Central Valley where salinity varies spatially and temporally according to tidal cycles and the amount of freshwater inflow. Despite this tremendously variable environment, historical conditions probably offered relatively consistent spring flows that provided the Sacramento splittail with desired spawning and rearing grounds. Since the 1850's, however, the amount and extent of suitable habitat for the Sacramento splittail has declined dramatically. The advent in 1853, of hydraulic mining in the Sacramento and San Joaquin Rivers, led to increased siltation and alteration of the circulation patterns of the estuary (Nichols *et al.* 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94 percent of the Estuary's tidal marshes (Nichols *et al.* 1986, Monroe and Kelly 1992).

In addition to this degradation and loss of habitat, the Sacramento splittail has been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of desired flooded vegetative habitat. These adverse conditions are primarily a result of the steadily increasing proportion of water diverted from the Delta by the Federal and State water projects (Monroe and Kelly 1992). Water delivery through the CVP began in 1940. The SWP began delivering water in 1968. However, the proportion of freshwater being diverted has increased since 1983, and has remained at extremely high levels ever since (Moyle *et al.* 1992). The high proportion of fresh water exported has exacerbated the already harsh environmental conditions experienced by the Sacramento splittail during the last six drought years.

There are over 1,800 screened and unscreened diversions within the delta; most of which adversely impact the Sacramento splittail. Entrainment caused by these diversions is likely the greatest source of mortality to Sacramento splittail. No fish screens can protect all Sacramento splittail from being entrained or impinged, and larval Sacramento splittail are particularly susceptible to entrainment, even with the best screening.

During the Sacramento splittail critical rearing interval from March 1 to May 31, adequate outflows of sufficient magnitude and duration are beneficial to provide the conditions necessary for spawning. For Sacramento splittail, these flows also provide transport away from the influence of the CVP/SWP pumps, and provides the necessary rearing habitat areas.

Effects of the Action

Disturbance to Clapper Rail Breeding Territories

Proposed levee maintenance activities could disrupt clapper rail breeding where territories lie adjacent to levees to be maintained. The degree of this disturbance likely would depend upon the proximity of individual rails and nests and the timing within the breeding season, and could result in increased competitive interactions, territory boundary shifts, or territory abandonment.

During a recent telemetry study of clapper rails in south San Francisco Bay, researchers observed an individual rail leaving an established territory in the Laumeister Marsh during the breeding season when apparently disturbed by a PG&E work crew in April 1992. The rail disturbed in Laumeister Marsh left a small, well-defined territory and subsequently moved throughout a large 37-acre area within the marsh and was unable to establish a new territory within the breeding period (USFWS, unpub. data). As a result of this territorial abandonment, the opportunity for successful reproduction during the breeding season was eliminated (J. Takekawa, pers. comm., 1993). Data from this telemetered rail suggest that increased human activity and associated noise within a rail's established territory can significantly alter the normal behavioral patterns of rails during the breeding season, possibly resulting in extensive movements, lack of reproductive success, or territory abandonment.

Levee maintenance activities conducted during the breeding season could cause rails to shift or abandon their territories. The ability of rails to reestablish new breeding territories could be severely hampered by limited habitat available in the vicinity to establish a new territory and the fact that rails tenaciously defend established breeding territories from intrusions by other rails. Furthermore, suitable tidal marsh habitat along remaining portions of the Sonoma Creek and Petaluma River drainages also is limited and disturbed rails could be forced to move considerable distances across marginal habitat in search of suitable unoccupied habitat. Such movement by a pair of rails from its established territory could significantly increase the risk of predation and mortality. Survival of displaced rails likely would be less than survival of rails that remain in established territories. In a telemetry study of light-footed clapper rails in southern California, Zembal and Massey (1988) found that three out of six telemetered rails that moved extensively were preyed upon within a relatively short period of time. By comparison, seven other rails that remained sedentary within established territories were not preyed upon during the telemetry period. Loss of one female rail also would constitute the loss of potential progeny to the north Bay population into the future.

Loss of Marsh Habitat

In the Petaluma and Sonoma Creek drainages there are 14 and 16 property owners, respectively, potentially needing to do levee repair in any given year. Because the permit would restrict the amount of dredging per land owner per year to 10,000 cubic yards, a maximum of 140,000 cubic yards/year or 3.2 acres/year in the Petaluma River drainage and 160,000 cubic yards/year or 3.7 acres/year in the Sonoma Creek drainage could be dredged. According to calculations in the Public Notice, which are based on SSCRCD previous work from 1978 to 1990 under a separate permit and SSCRCD data, the total average borrow area dredged per year was estimated to be 210,000 square feet or 4.8 acres. The SSCRCD believes that only 1/3 to 1/2 of property owners that apply in any given year to repair levee segments actually do the work in that year.

Although the SSCRCD has applied for a five year permit which allows limited dredging by each property owner, this dredging activity is likely to continue into the future. Past levee maintenance activities have resulted in primarily permanent and some temporary loss of tidal salt marsh habitat as evidenced by the permanency of the majority of borrow ditches in both the Petaluma and Sonoma Creek drainages. This activity has resulted in a permanent and temporary loss of nesting habitat and cover for the clapper rail and habitat for the salt marsh harvest mouse.

The Service has calculated the acreage of tidal salt marsh habitat that has in the past or in the future will be affected by dredging operations in the Petaluma River drainage. The area affected was calculated by multiplying the linear feet of levees of each property in the application by a borrow area 15 feet in width. Subtracted from this calculation were levee areas not lying adjacent to salt marsh habitat and levee segments that have tidal marsh vegetation less than 25 feet wide adjacent to the levee. In these latter areas, it was assumed that the dredge reaches into the slough for material and does not disturb tidal marsh vegetation. For the purposes of this calculation, we also assumed that vegetation lying between the borrow area and the crest of the levee would not be impacted by the dredging operation. The total area of wetland impact was calculated to be 15 acres in the Petaluma River drainage and 56 acres in the Sonoma Creek drainage.

Excavation of borrow ditches, however, could benefit clapper rails and salt marsh harvest mice in several ways. Creation of borrow ditches might increase tidal circulation in the marsh where the ditches are connected to tidal sloughs. Increased tidal circulation in the marsh could increase overall marsh productivity, thereby indirectly benefiting the clapper rail and salt marsh harvest mouse. The number of ditches connected to tidal sloughs in the project area, however, has not been quantified and, therefore, the extent of this potential benefit to the rail and mouse is unknown. These borrow ditches also may provide travel lanes or foraging areas for clapper rails, although no studies have been done to estimate the extent of their use by clapper rails.

Where borrow ditches have revegetated, plant species diversity could increase marsh productivity by providing alternate nesting habitat.

Interruption of Access by Salt Marsh Harvest Mice to Refugial Habitat

Temporary and permanent creation of 15-foot wide borrow ditches between the levee slope and the tidal salt marsh interrupt access to high tide refugial habitat for the salt marsh harvest mouse. During high tide events at the locations of borrow ditches, salt marsh harvest mice would be forced to leave vegetative cover and cross a 15-foot wide expanse of water to reach upland cover on the levee slope. Exposure of salt marsh harvest mice to predation would be significantly increased.

Disturbance to Refugial Habitat for Clapper Rails

Noise associated with levee maintenance particularly if these activities occur during high tides could reduce availability of high tide refugial habitat that lies along the outboard levee face. The level of impact would be exacerbated if levee maintenance activities occur during a winter high tide series, which typically occurs from November through February each year. High tide series during these months also can be augmented substantially with changes in local weather patterns, including the presence of low pressure systems, heavy precipitation, and extraordinary tidal heights associated with storm surges (J. Takekawa, pers. comm., 1993). Although no studies have been done of the availability or extent use of refugial cover in the project area, it is likely that during high tide series, suitable refugial habitat becomes limited and any available vegetative cover becomes critical to the survival of clapper rails in the project area.

Rail mortality could occur if rails are displaced by levee maintenance activities during a high tide and are preyed upon while attempting to seek alternative refugial habitat along the levee or within the adjacent marsh. DeGroot (1927) noted that rails were extremely vulnerable to predation by raptors during high tide events when they were forced to seek refuge in exposed locations. Foerster *et al.* (1990) observed red foxes and raccoons foraging in one south Bay marsh during extreme winter high tides. Additional observations of red foxes foraging in south Bay marshes during high tides have been made by Refuge staff (E. Harding-Smith, pers. comm., 1993). Furthermore, of 7 rails lost to raptor predation during a telemetry study, all were lost during tidal cycles of 5.5 NGVD or higher (USFWS, unpub. data). Although lacking comparative data, Evens and Page (1986) suspected that avian predator success on black rails to be much lower during tidal events below winter high tides, and suggested initiation of a study on avian and possibly mammalian predatory behavior to determine if these predators keyed into high tide events and thus increased their foraging activities.

Loss of Subtidal Habitat

The dredging and/or excavation of bottom material from tidal sloughs or borrows for the purposes of providing material for levee maintenance has the potential to effect Sacramento splittail directly and indirectly. First, because Sacramento splittail are known to utilize flooded vegetation in shallow slow moving sloughs and back water channel habitat for spawning, they, or the eggs they may have laid, may be directly taken as a result of the dredging and/or excavation of existing substrate if such activity disrupts or removes any existing emergent vegetation. The placement of dredged materials on the tops of levees could further effect emergent vegetation if measures, such as temporary fences or walls, are not constructed to prevent such material from falling back into the water. Eggs laid that are not directly taken by the dredging activities could remain unfertilized as adults are "chased" from the nesting sites by the proposed dredging activities. Eggs could also become covered with silt stirred up from the dredging operations and suffocated. Further, because the dredging activities will subsequently change the water depth and circulation in these areas, Sacramento splittail may be forced to seek alternative, less desirable, spawning sites.

Dredging operations resulting in the creation of standing pools that are not tidally influenced at low tide could result in the stranding of Sacramento splittail and other species. Stranding could make these species more susceptible to predation by predatory fish that are also stranded in the pool or piscivorous birds in and around the area. Therefore, any pools created during dredging must be provided with escape channels to allow free movement of any stranded species. These escape channels must also be accessible at low tides.

Summary

1) Disturbances from levee maintenance work during the breeding season from February through August creates the likelihood for rails to abandon up to an estimated 8 breeding territories within adjacent tidal marshes. The Service assumes this could result in the loss of reproductive success during the breeding season, and/or possible mortality of displaced individual birds. Any combination of the above would result in a net reduction in the long-term reproductive contribution to the population.

2) Long term levee maintenance work would result in the permanent and temporary loss of about 15 acres of tidal salt marsh in the Petaluma River Drainage and 56 acres of tidal salt marsh in the Sonoma Creek drainage which provides cover for both the salt marsh harvest mouse and clapper rail, and possibly nesting habitat for the clapper rail.

3) Levee maintenance work which creates permanent borrow ditches interrupts access for the salt marsh harvest mouse to the levee slope during high tide events, thereby increasing the risk of predation.

4) Levee maintenance work conducted during high tide events would reduce availability of high tide refugial habitat for clapper rails in the project area, thereby increasing the risk of predation.

5) Levee maintenance work conducted within areas of emergent vegetation may disrupt the normal behavioral patterns of Sacramento splittail including, but not limited to, breeding, feeding, and sheltering, and may also mobilize sediments containing contaminants.

Based on our analyses above, the increased probability of adverse effects to a low number of individuals, including progeny, and temporary loss of a small area of habitat from the proposed project, would not appreciably reduce the likelihood of survival and recovery of the endangered salt marsh harvest mouse and California clapper rail or the proposed Sacramento splittail in the wild.

Cumulative Effects

Cumulative effects are those impacts of future non-Federal actions affecting listed species that are reasonably certain to occur in the action area. Future Federal actions are subject to the consultation requirements under section 7 of the Act and, therefore, are not considered cumulative to the proposed action.

Cumulative effects on the clapper rail include ongoing habitat conversion from salt to brackish conditions by fresh water effluent from the San Jose/Santa Clara Water Pollution Control Plant. The San Francisco Bay Regional Water Quality Control Board routinely renews discharge permits that allow marsh conversion to continue. Although the most recent permit renewal contained a mitigation measure to replace about 275 acres of former salt marsh that has converted to largely unsuitable brackish marsh conditions, it has yet to be implemented. Other cumulative effects include chemical contamination from point and non-point discharges that may adversely affect survival rates and reproductive success.

One of the most serious cumulative effects on the salt marsh harvest mouse has been the degradation of diked wetlands, typically by the elimination of wetland vegetation through grazing, discing, grubbing, and plowing, and/or the elimination of appropriate hydrologic conditions by installing drains, ditches, and pumps. The extensive conversion of south Bay salt marshes to brackish and freshwater habitat also has appreciably reduced available tidal habitat for the species. Approval of urban developments without maintaining adequate upland habitat adjacent to wetlands also represents a major cumulative effect by likely increasing mortality rates and lowering harvest mouse carrying capacity in affected areas.

Cumulative effects on the Sacramento splittail include any continuing or future diversions of water that may entrain adult or larval fish or that may decrease outflows incrementally. Water diversions through intakes serving numerous small, private agricultural lands and duck clubs in the Delta, upstream of the Delta, and in Suisun Bay contribute to these cumulative effects. These diversions also include municipal and industrial uses, and provide cooling water for power plants. State or local levee maintenance and channel dredging activities also disturb spawning or rearing habitat. Sacramento splittail adults seek flooded vegetation in shallow, tidally-influenced sloughs and channel edges for spawning. To assure egg hatching and larval viability, spawning areas also must provide suitable water quality (i.e., low concentrations of pollutants) and substrates for egg attachment (e.g., submerged tree roots and branches and emergent vegetation). Suitable water quality must be provided by addressing point sources of contaminants so that maturation is not impaired by pollutant concentrations. Levee maintenance and channel dredging disturbs spawning and rearing habitat, and re-suspends contaminants into these waters.

Cumulative effects also include point and non-point source chemical contaminant discharges. These contaminants include selenium and numerous pesticides and herbicides associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality in Sacramento splittail, these contaminants may adversely affect splittail reproductive success and survival rates.

Cumulative effects, operating together with those of the proposed action, are not likely to appreciably reduce the likelihood of survival and recovery of the salt marsh harvest mouse, California clapper rail, or Sacramento splittail.

Incidental Take

Sections 4(d) and 9 of the Act, as amended, prohibit taking (i.e., to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Under the terms of 7(b)(4) and 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement. The measures described below are nondiscretionary, and must be undertaken by the agency so that they become binding conditions of any authorization granted to the applicant for the exemption under 7(o)(2) to apply.

The Federal agency has a continuing duty to regulate the activity that is covered by this incidental take statement. If the agency fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the authorization, the protective coverage of 7(o)(2) may lapse.

For the California clapper rail, we anticipate that harassment and/or harm of up to 8 pairs of rails would result from the proposed action. Reduced availability of refugial habitat would subject rails to increased risk of predation. Territorial abandonment by rails could result in harassment and/or harm of individual rails and breeding failure. Levee maintenance activities over the long term would directly impact about 71 acres of rail cover and possibly nesting habitat.

The Service anticipates that an unquantifiable number of harvest mice may be killed during levee maintenance activities over the long term. This area of impact is estimated to be 71 acres in the two drainages combined. An additional unquantifiable number of harvest mice not directly impacted by levee maintenance activities may be exposed to higher levels of predation because of the loss of continuous habitat adjacent to the levees. The harvest mouse population, however, is expected to rebound in those areas where the borrow ditches revegetate.

The Service anticipates that an unquantifiable number of Sacramento splittail may be taken as a result of the proposed maintenance activities. Project implementation would reduce the availability of approximately 13.5 acres of spawning and rearing habitat for Sacramento splittail. In this area contaminants would also be mobilized and could also adversely affect Sacramento splittail over an unknown period of time as these substances bio-accumulate.

The Service establishes the following reasonable and prudent measures to minimize the impact of incidental take. The measures described below are nondiscretionary, and must be implemented by the Department of the Army.

1) The potential for harassment, harm (including habitat modification), or mortality to California clapper rails shall be minimized.

2) Impacts to California clapper rail and salt marsh harvest mouse resulting from habitat modification shall be minimized.

3) Harm and harassment to Sacramento splittail resulting from the proposed dredging operations shall be minimized.

To be exempt from the prohibitions of Section 9 of the Act, the following terms and conditions, which implement the reasonable and prudent measures described above, must be complied with, and included as special conditions in any permit granted by the Department of the Army for this project.

The following terms and conditions implement reasonable and prudent measure #1:

(a) To avoid possible disruption of clapper rail breeding activities, levee maintenance work in the Petaluma River and Sonoma Creek drainages shall not occur during the period from February 1 through August 31 within any given year on the levee segments shown in the enclosed maps (cross-hatched areas) of the drainage basins. These areas are: in the Petaluma River drainage - 2,500 linear feet of levee (California Department of Fish and Game) adjacent to Black John Slough; and for the Sonoma Creek drainage - (1) 4,000 linear feet of levee (Kiser Brothers) that lies adjacent to Second Napa Slough; (2) 2,900 linear feet of levee and 800 linear feet of levee (J. Leveroni), both adjacent to Hudeman Slough; (3) 3,400 linear feet of levee (W. Haire) adjacent to Hudeman and Second Napa Sloughs; and (4) 8,000 linear feet of levee (N. Yanni) at the mouth of Sonoma Creek. All levee segments lie adjacent to established clapper rail breeding territories. Future surveying for rails in either drainage may result in expansion or contraction of seasonal restrictions to protect nesting rails. The Service shall provide the Corps with any revision to rail seasonal restrictions during annual review of work proposed under the permit.

(b) Levee maintenance adjacent to the above clapper rail nesting areas shall not occur during high winter tide events to avoid disturbance of clapper rails using refugial habitat within these areas.

The following term and condition implements reasonable and prudent measure #2:

(a) The applicant shall prepare and implement a detailed tidal salt marsh habitat restoration plan which compensates for the permanent and temporary loss of 71 acres of salt march harvest mouse and clapper rail habitat associated with the proposed action. The enclosed maps identify several areas within the Petaluma River and Sonoma Creek drainages that could be suitable restoration sites (outlined areas). These are: in the Petaluma River drainage - (1) a 98-acre piece of agricultural land owned by the Redwood Sanitary landfill, (2) a 48-acre portion of agricultural land owned by A. Anolik on the Petaluma River, and (3) a 20-acre portion of agricultural land owned by M. Kullberg on the Petaluma River; and in the Sonoma Creek drainage - (1) a 16-acre piece of agricultural land owned by D. Reinecker, which was formerly the bed of the North Branch of Tolay Creek, and 62 acres of native vegetation upstream of the 16-acre parcel on Tolay Creek that could be enhanced; and (2) a 74-acre portion of agricultural land owned by G. Kiser near Wingo. The restoration plan shall be submitted to the Service and Corps for review and approval within one year of permit issuance and implemented within two years of permit issuance. The plan shall include habitat enhancement, monitoring for compliance and effectiveness, and management in perpetuity of the habitat for salt marsh harvest mouse and California clapper rail. Upon completion of appropriate salt marsh mitigation, no consultation for future regional permits will be required on the effects of the temporary and permanent loss of tidal salt marsh habitat on the salt marsh harvest mouse and California clapper rail provided there are no changes in the scope and extent of levee maintenance work which is currently proposed.

The following terms and conditions implement reasonable and prudent measure #3:

(a) To minimize take of Sacramento splittail, no dredging shall be conducted between January 1 and July 31. Because Sacramento splittail utilize the proposed areas for spawning and rearing during this time, habitat during this season must remain undisturbed.

(b) To minimize the impacts to the normal behavioral patterns of Sacramento splittail including, but not limited to, breeding, feeding, and sheltering, dredging shall occur away from the edge waters so that the shorelines are minimally disturbed. Dredging not shall disturb any emergent vegetation or create pools that are not tidally influenced at low tide. Furthermore, no dredged materials shall be placed on any existing emergent vegetation during levee repairs or fall into the water where emergent vegetation exists.

If, while maintaining levees in the project areas, the amount or extent of incidental take of the California clapper rail, salt marsh harvest mouse or Sacramento splittail, as described above, is exceeded, the causative action shall cease and consultation shall be reinitiated immediately.

The Service shall be notified within twenty-four (24) hours of the finding of any injured or dead California clapper rail or their eggs, or salt marsh harvest mouse, or any unanticipated damage to clapper rail or salt marsh harvest mouse habitat associated with levee maintenance. Notification must include the date, time, and precise location of the specimen/incident, and any other pertinent information. The Service contact person is Karen Miller (916/978-4866). Any dead or injured specimens shall be reposited with the Service's Division of Law Enforcement, 2800 Cottage Way, Sacramento, California 95825-1846 (916/978-4860).

This concludes formal consultation on the proposed work described above. Reinitiation of formal consultation is required if (1) the amount or extent of incidental take is exceeded, as previously described; (2) new information reveals effects of the actions that may affect listed species or critical habitat in a manner that was not considered in this opinion; (3) if the project is substantially modified in a manner that causes an effect to listed species that was not considered in this opinion; and/or (4) if a new species is listed or critical habitat is designated that may be affected by the action. If you have any questions regarding this opinion, please contact Karen Miller (mouse/rail) or Matt Vandenberg (splittail) of my staff at (916) 978-4866.

Sincerely,

Joel A. Medlin

Joel A. Medlin
Field Supervisor

Enclosures

cc: RD (ARD-ES), FWS, Portland, OR
FS (ES), FWS, Wetlands Branch, Sacramento, CA
DHC, Washington, D.C.
CDFG, Region III, Yountville, CA
CDFG, Environmental Services, Sacramento, CA

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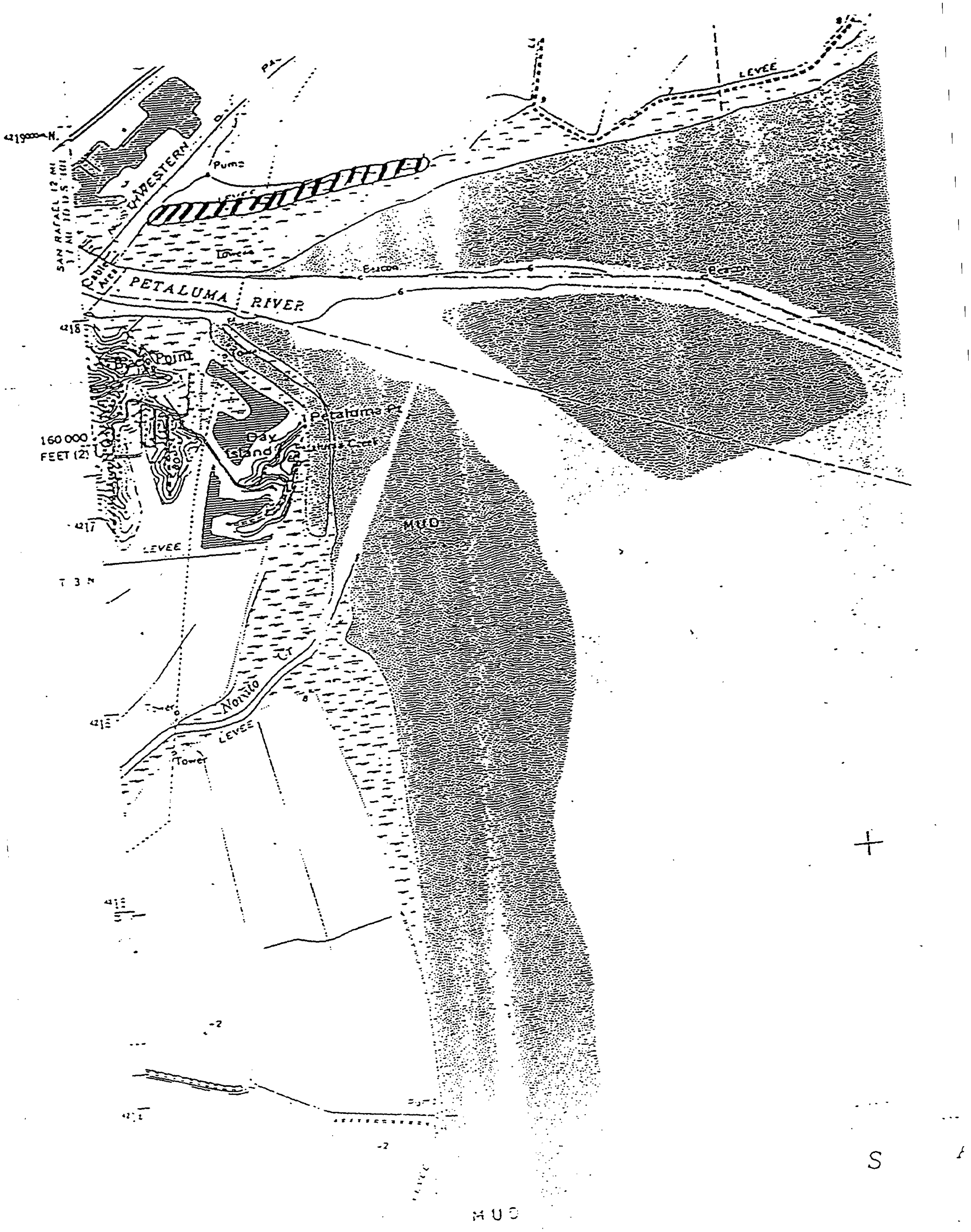
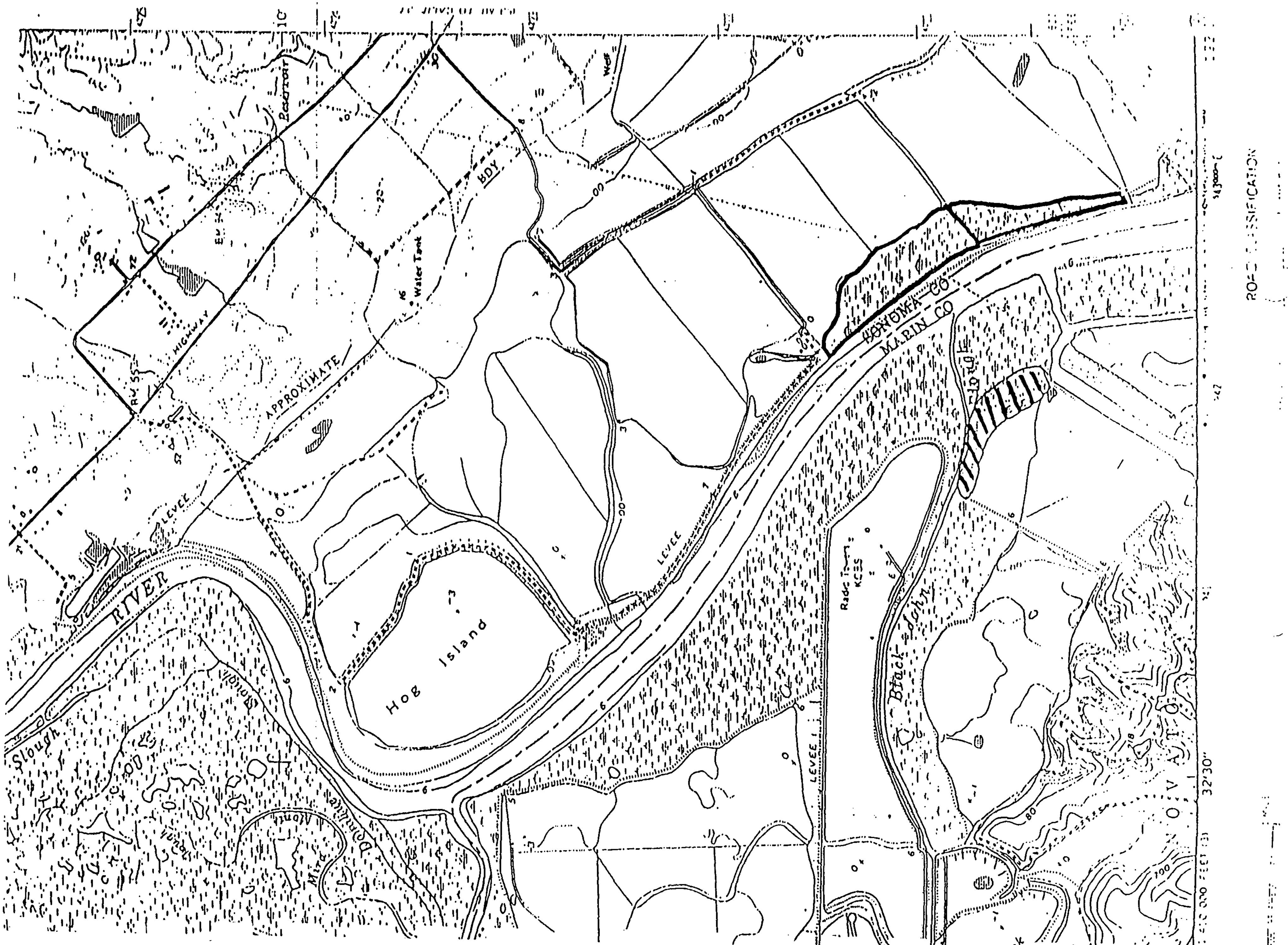
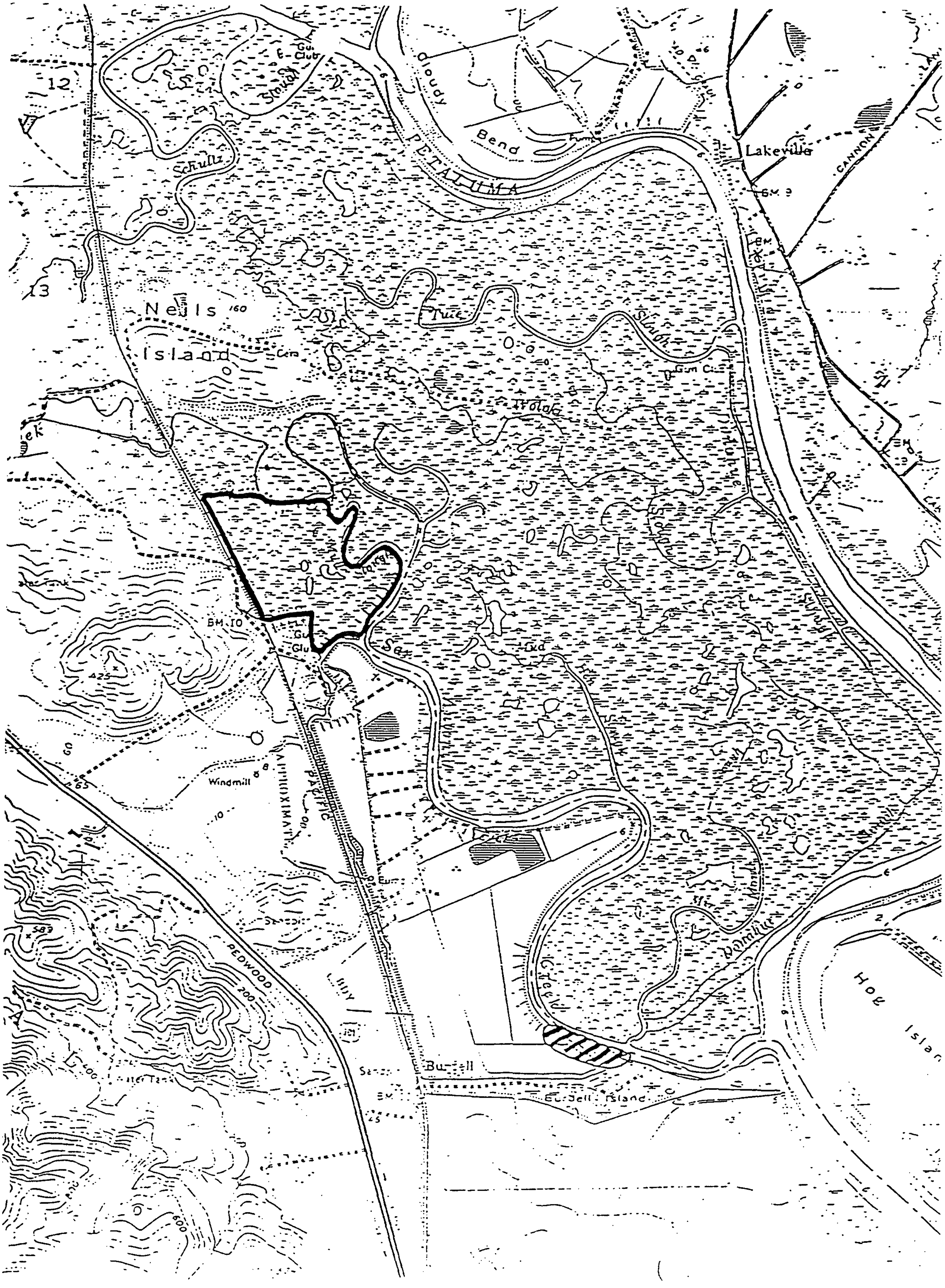


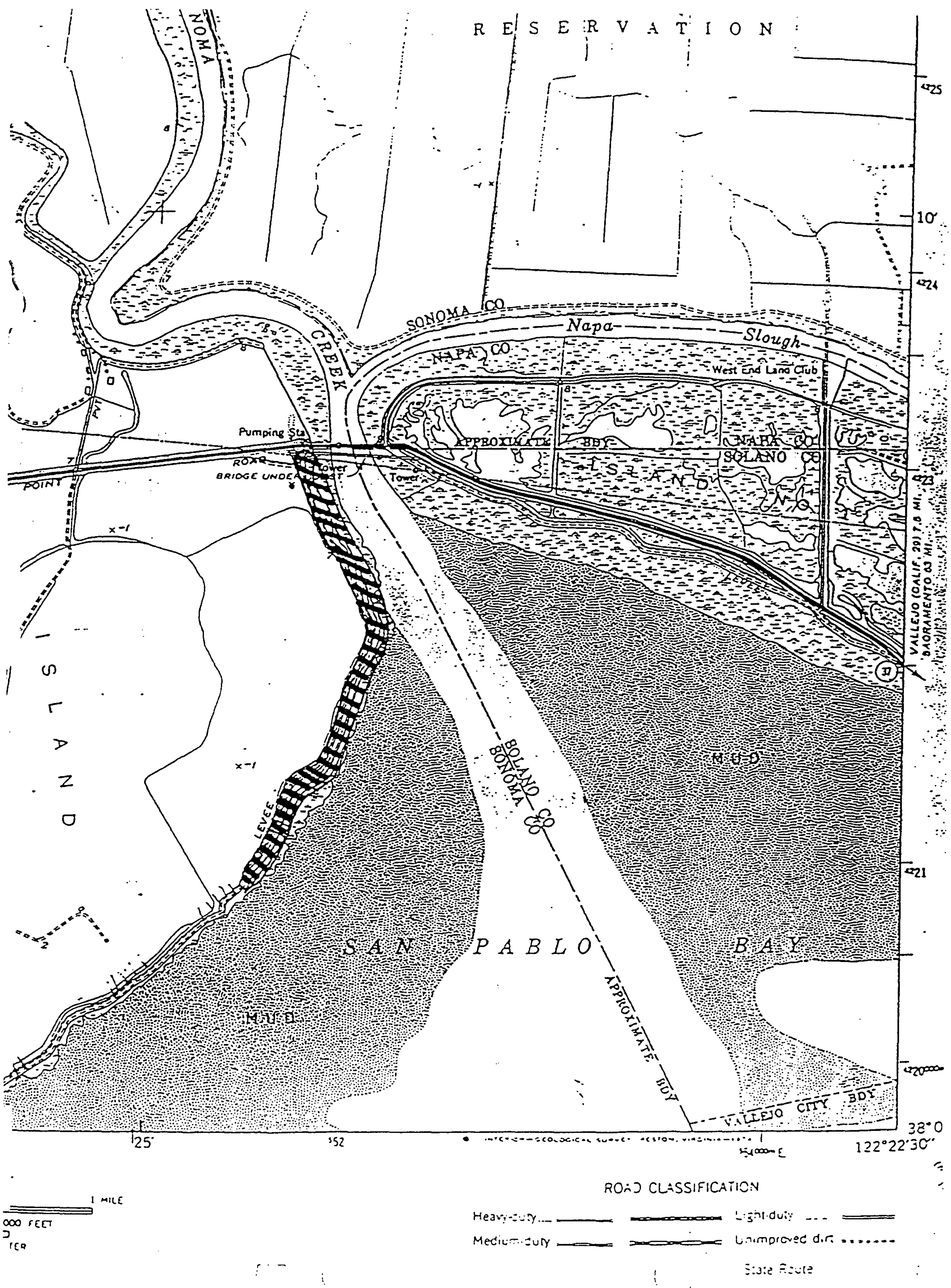
PETALUMA RIVER
LEVEE
Pump
Beacon
Petaluma Pt
Day Island
160 000
FEET (2)
MUD
LEVEE
T 3 N
Tower
LEVEE
S



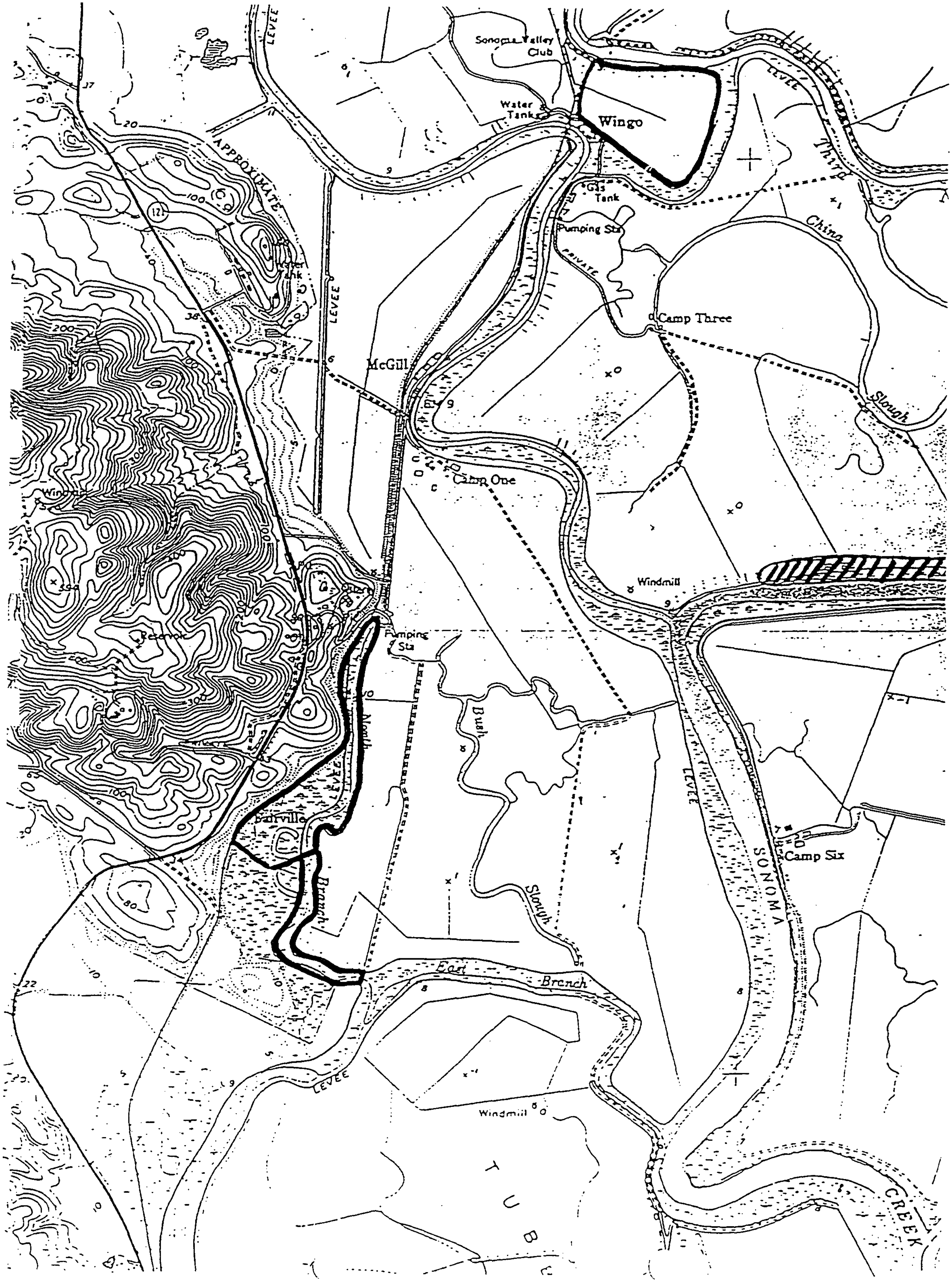
Hog Island
RIVER
Slough
SONOMA CO
MARIN CO
APPROXIMATE
BDY
HIGHWAY
LEVEE
LEVEE
LEVEE
Water Tank
Black John Slough
NOVATO
32'30"
ROAD CLASSIFICATION



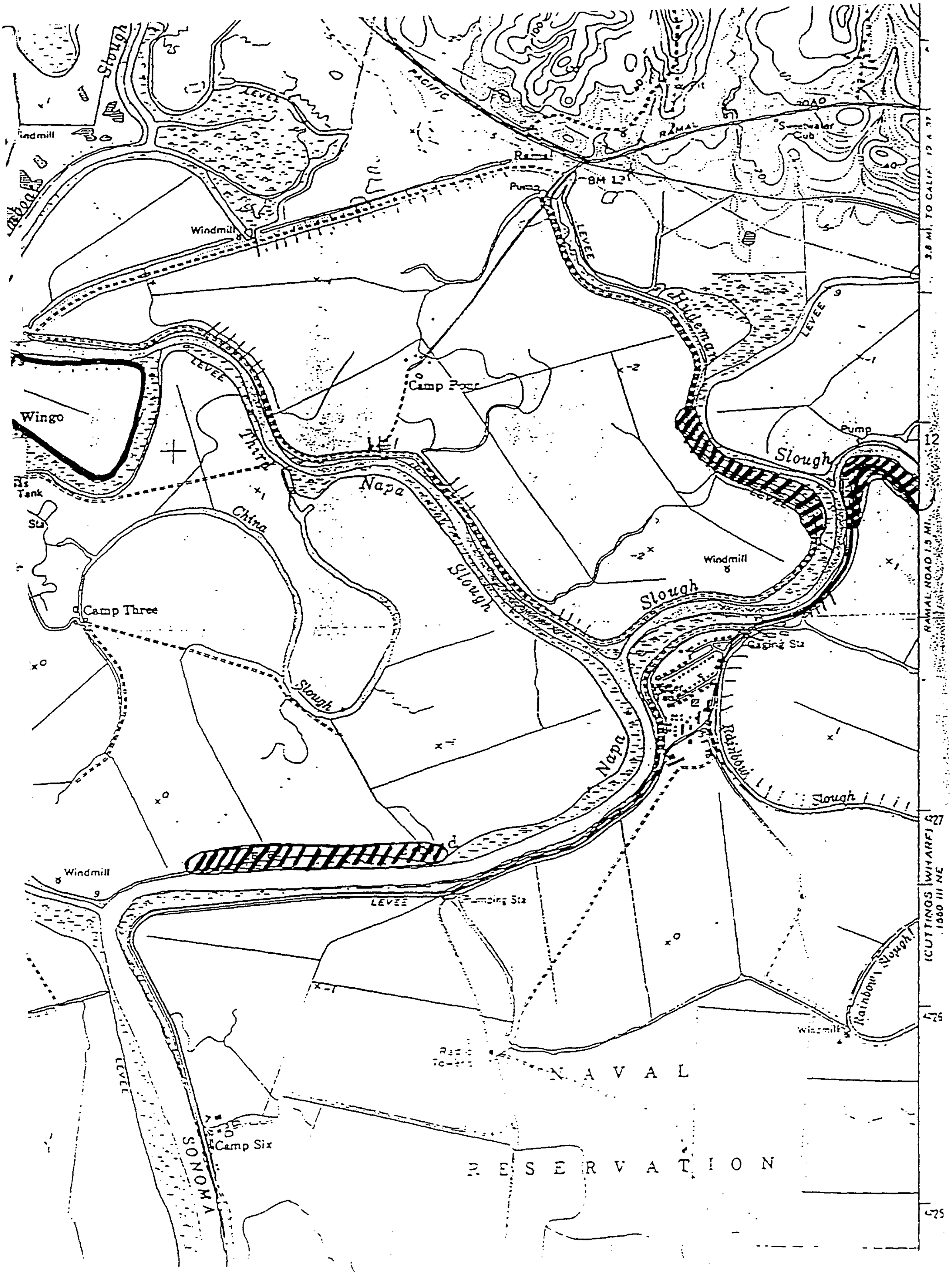
Petaluma
Cloudy
Bend
Lakeville
Schultz
Slough
Tule
Slough
Neils
Island
BM 10
Gu
Windmill
Pacific
Redwood
Burdell
Burdell Island
Hog
Island
Cannon
Creek
425
589
200



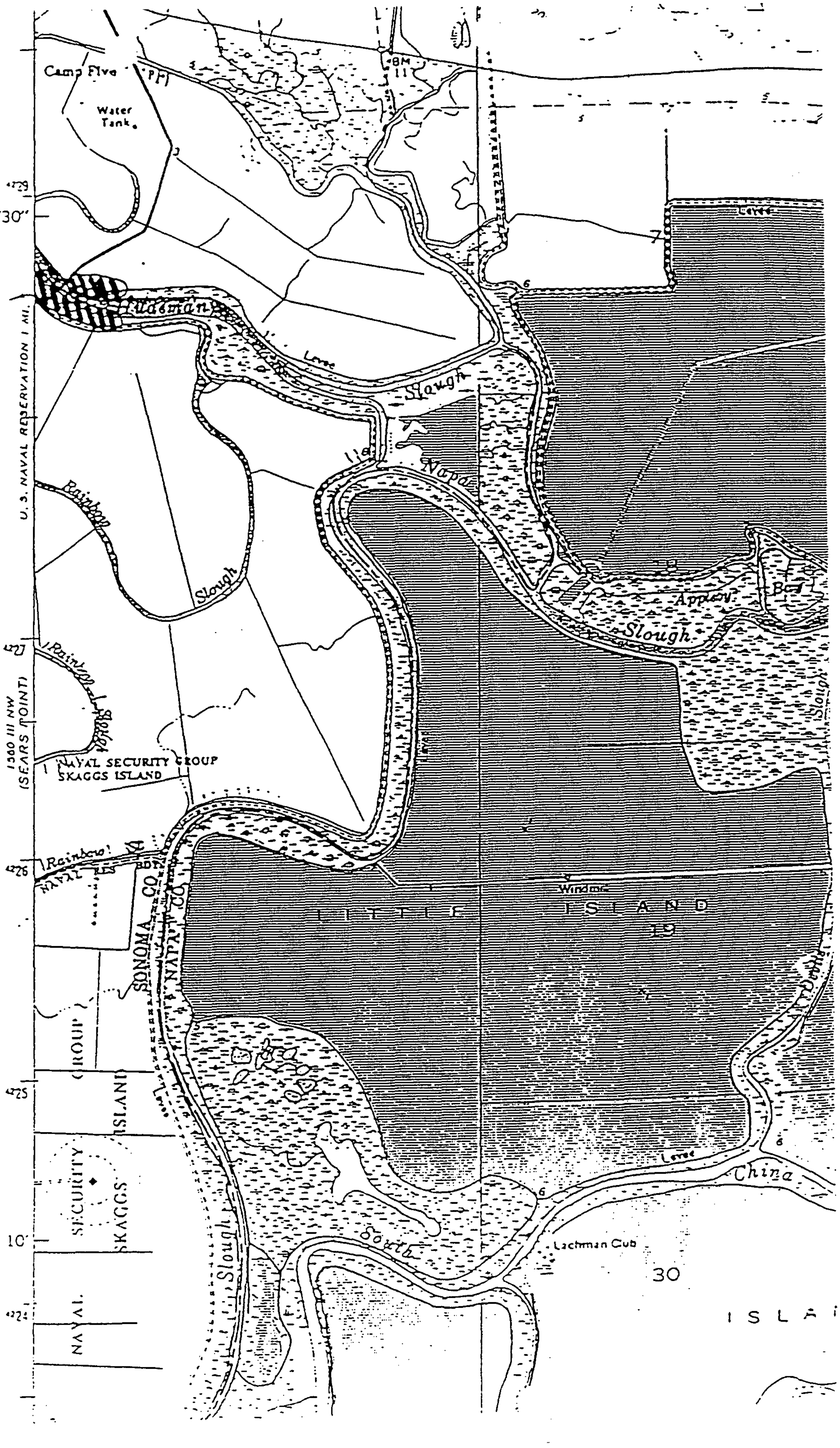
RESERVATION
SONOMA
SONOMA CO
Napa Slough
NAPA CO
CREEK
West End Land Club
Pumping Sta
ROAD
BRIDGE UNDER
POINT
Tower
APPROXIMATE BDY
NAPA CO
SOLANO CO
ISLAND
LEVEE
SOLANO CO
SONOMA CO
MUD
SAN PABLO BAY
APPROXIMATE BDY
VALLEJO CITY BDY
ISLAND
VALLEJO (CALIF. 29) 7.8 MI.
SACRAMENTO 63 MI.
10'
38°0
122°22'30"
25'
552
554000 E
1 MILE
ROAD CLASSIFICATION
Heavy-duty
Light-duty
Medium-duty
Unimproved dirt
State Route



Sonoma Valley Club
Water Tank
Wingo
Gas Tank
Pumping Sta
PRIVATE
Camp Three
China
Slough
Third
LEVEE
APPROXIMATE
Water Tank
McGill
Camp One
Windmill
Pumping Sta
North
Branch
Bush
Slough
East
Branch
Fairville
Camp Six
SONOMA
CREEK
TUB
Windmill
Reservoir



Slough
Levee
Pacific
Ramal
Road
Sweetwater Club
Windmill
Pump
BM 13
Levee
Hudeman
Slough
Levee
9.8 MI. TO CALIF. 12
Wingo
Camp Four
Third
Napa
Tank
Sta
China
Slough
Windmill
Camp Three
Slough
Napa
Slough
Pump
Slough
Levee
Windmill
Gaging Sta
Rainbow
Slough
RAMAL ROAD 1.5 MI.
Napa
Windmill
Levee
Pumping Sta
(CUTTINGS WHARF) 1560 III NE
Rainbow Slough
Windmill
Radio Towers
NAVAL
Levee
Sonoma
Camp Six
RESERVATION



Camp Five
Water Tank
BM 11
12'30"
Levee
Slough
Napa
Rainbow Slough
U.S. NAVAL RESERVATION 1 MI.
Appley
Slough
NAVAL SECURITY GROUP
SKAGGS ISLAND
1560 III NW (SEARS POINT)
Rainbow
NAVAL RES BDY
SONOMA CO
NAPA CO
Windmill
LITTLE ISLAND
19
NAVAL SECURITY GROUP SKAGGS ISLAND
Levee
China
South
Slough
Lachman Cub
30
10'
ISLA

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
3310 El Camino Avenue, Suite 130
Sacramento, California 95821-6340

APR 06 1998

IN REPLY REFER TO:
1-1-97-F-180

December 23, 1997

Mr. Calvin Fong
Chief, Regulatory Branch
U.S. Army Corps of Engineers
San Francisco District
333 Market Street
San Francisco, CA 94105-2197

Subject: Endangered species Formal Consultation on the proposed Bahia Master Plan Residential Development, Novato, Marin County, California

Dear Mr. Fong:

This is in response to your June 3, 1997, request for formal consultation with the U.S. Fish and Wildlife Service (Service) on the Bahia residential development project (1995 Bahia Master Plan Revision Project) proposed by Debra Investment Corporation. Your request was received in our office on June 4, 1997. This document represents the Service's biological opinion on the effects of the action on the endangered California clapper rail (*Rallus longirostris obsoletus*) and the endangered salt marsh harvest mouse (*Reithrodontomys raviventris halicoetes*), in accordance with section 7 of the Endangered Species Act of 1973, as amended (Act).

This biological opinion is based on information provided in the following documents: (1) the Department of the Army Permit Application and attached documents dated August 1997, prepared by Huffman & Associates, Larkspur, California; (2) the U.S. Army Corps of Engineers, San Francisco District (Corps), Regulatory Branch Public Notice 148831N, dated August 18, 1997; (3) the 1995 *Master Plan Revision*, dated March 24, 1995, submitted by Debra Investment Corporation to the City of Novato; (4) the Final Environmental Impact Report for the 1990 *Bahia Master Plan Revision* (in relevant part), prepared by Earth Metrics for the City of Novato, dated November 1992; (5) the Service's biological opinion for the previous Bahia Master Plan (1-1-89-F-46), dated September 13, 1989. This opinion also is based on field assessments of the Bahia project and adjacent marsh site by Service staff and on other relevant published and unpublished studies on the distribution and abundance of clapper rails in San Pablo Bay and the Petaluma Marsh. A complete administrative record of this consultation is on file in this office.

Consultation history

The proposed Bahia project has undergone many changes since the 1960s. In 1964, the City of Novato approved a Master Plan for a 2200-unit residential development at the Bahia site, including extensive development in diked non-tidal salt marsh. Development of the project proceeded over portions of the Master Plan area. Some residential areas were completely developed, some were graded but not developed (*e.g.*, "peninsulas" and lagoons), and some areas were entirely undeveloped. By 1979, Debra Investment Corporation (the current permit applicant) purchased the remaining potentially developable area within the 900-acre Bahia Master Plan area and initiated the permit and approval process for complete build-out of the Master Plan. This resulted in revisions of the project in the 1980s. The Corps initiated formal Section 7 consultation on June 7, 1989, for a permit request to fill and excavate approximately 39 acres of seasonal freshwater wetlands, non-tidal salt marsh, and tidal salt marsh. The Service issued a no-jeopardy biological opinion for that version of the project on September 13, 1989, which addressed impacts to the harvest mouse. At that time, the Service did not anticipate effects on the clapper rail, based on available information of its distribution near the Petaluma River in the 1980s. Since the 1980s, the Service has reviewed additional information on the distribution and abundance of clapper rails in the project vicinity and has re-evaluated indirect effects of development on habitat suitability for harvest mice and clapper rails.

Following the issuance of the 1989 biological opinion and the decisions of other State and Federal resource and regulatory agencies, the Bahia Master Plan was revised in 1990 and 1995. The project proposal in the 1995 Master Plan revision is the subject of the current Corps permit request.

BIOLOGICAL OPINION

Description of the Proposed Action

The current project entails construction of 304 single family homes, 120 multi-family homes, roads and amenities, and a community center. A total of 424 new homes would be added to the existing 288 homes for a full build-out of 712 homes. Approximately 18.2 acres of seasonal fresh to brackish marsh are proposed to be impacted by excavation or fill. No tidal salt marsh or non-tidal salt marsh is proposed to be filled in this project revision. Excavation of approximately 4 acres of fresh to brackish seasonal wetland swales and depressions on the Albatross Peninsula would be associated with the proposed use of these areas as a borrow pit and would result in reclamation of the pit as tidal open water (eventually intertidal habitat). Fill of the remaining peninsulas (4.85 acres of seasonal wetlands distributed throughout their length) and the abandoned dredge disposal site along the landward margin of the Central lowlands (9.3 acres seasonal wetland, distributed over almost the entire former dredge disposal site) would be associated with site preparation for residential development. In addition, approximately 0.01 acres of jurisdictional freshwater drainages in the adjacent hillsides would be filled for development of residences and roads. The new residential development would be located within oak woodland and grassland adjacent to non-tidal salt marsh and tidal marsh and within abandoned dredge disposal sites located on historic tidal marshland. A detailed description of the residential development project is found in the Bahia Master Plan permit application to the Corps (August 1997) and the March 1997 Master Plan Revision for 1995.

Two areas of the proposed development are closely adjacent to wetlands which are occupied by endangered species. The development from the Townhomes area (proposed for the abandoned dredge disposal site) to the south end of Bahia Drive is directly adjacent to non-tidal salt marsh of the Central Lowlands, which is occupied habitat of the harvest mouse. The Topaz (Orient) Peninsula is directly adjacent to an approximately 80-acre tidal salt/brackish marsh owned by the California State Lands Commission (SLC; hereafter termed the SLC Marsh). The SLC Marsh is an approximately 1200-foot-wide strip, which is part of the continuous tidal marsh corridor fringing the west bank of the Petaluma River, linking San Pablo Bay tidal marsh with the Petaluma Marsh. The SLC Marsh is occupied habitat of the clapper rail and is contiguous with marsh identified as essential habitat (recovery priority designation 2) for the recovery of the clapper rail in the 1984 California Clapper Rail/Salt Marsh Harvest Mouse Recovery Plan (Service 1984). This 80-acre marsh is also occupied habitat for the Black Rail, and portions of it are known to have been occupied by harvest mice (see species accounts, below).

Proposed Mitigation

The applicant proposes to mitigate for direct impacts to seasonal wetlands (not occupied by endangered species) by creating approximately 22 acres of seasonal wetlands at Twin House Ranch, an oat hayfield across the Petaluma River. The applicant has proposed a mitigation plan for project impacts to salt marsh harvest mice, prepared by H.T. Harvey and Associates, dated February 24, 1997 (Harvey Plan). The Harvey Plan entails conceptual measures to reduce impacts of human and domestic pet intrusion into adjacent marshes, including fencing, signage, education, and feral cat control. The mitigation plan also proposes future protection and enhancement of the Western Marsh and Central Lowlands (occupied harvest mouse habitat) and potential transfer to the California Department of Fish and Game (CDFG) as mitigation. It is asserted in the Corps permit application (Huffman and Associates 1997; p. 15) that the project would not be expected to have impacts to clapper rails, while acknowledging that the "marsh area east of the Orient [Topaz] peninsula is also considered possible habitat for this species." The Harvey Plan does not address any potential adverse impacts to clapper rails, yet it claims (p. 14) that the proposed Topaz Peninsula levee slope revegetation would provide escape cover for clapper rails.

The Harvey and Associates mitigation plan also proposes measures to enhance habitat quality for harvest mice in existing non-tidal diked salt marsh of the Central Lowlands and Western Marsh. The goals of the proposed mitigation are to enable future wetlands managers to control flooding and drainage of the marsh for optimal harvest mouse habitat conditions. New pumps and water control structures would be installed to enable controlled and timed flooding and salinization of the marsh to maintain optimal pickleweed vegetation, and drainage of excess impounded rainwater or tidal water from overtopped levees. The applicant proposes to provide funding for a managing agency (presumably the CDFG) to maintain the marsh in perpetuity, and to transfer the marsh in fee title to the managing agency.

Status of the Species and Environmental Baseline

California Clapper Rail

The clapper rail was federally listed as endangered in 1970 (35 **FR** 1604). A detailed account of the taxonomy, ecology, and biology of the California clapper rail is presented in the approved 1984 Recovery Plan for this species (Service 1984). Supplemental information on the status of the clapper rail, particularly information regarding its status in its northern range, is presented below.

The clapper rail is endangered primarily as a result of habitat loss, and degradation of existing habitat quality. Decline in habitat quality is due to fragmentation, salinity reduction from dry-season wastewater discharges, artificial augmentation of non-native and native predator activity in remaining habitat, and contamination of prey by toxic substances such as mercury and other heavy metals. Clapper rail populations in San Francisco Bay and San Pablo Bay have been unstable since the 1984 Recovery Plan was approved. In the southern reaches of San Francisco Bay (south bay), where the highest densities and largest populations occurred historically, rapid and extreme fluctuations of clapper rail population size occurred as a result of sharp increases in non-native predators (primarily red fox), and subsequent implementation of predator control (Albertson 1995, J. Takekawa pers. comm.). South bay population size diminished to about 300 rails in the early 1990s, and rebounded from this low to approximately 500-600 individuals after intensive predator control in the mid-1990s (Service unpublished data). In the San Pablo Bay and the Petaluma and Napa marshes (North Bay), clapper rail population size has been estimated to be on the order of 200-425 pairs (estimates include Suisun Marsh; Evens *et al.* 1992, Collins *et al.* 1993). In the north bay, clapper rail density is positively related to the extent of salt marsh habitat (dominated by pickleweed/cordgrass), and is highest in salt marsh parcels larger than 250 acres (100 hectares) in area (Evens *et al.* 1992). These habitat characteristics correspond with the mouths of major creek and river tributaries to San Pablo Bay. There are fewer than 15 large marsh parcels that appear to be able to support long-term viable clapper rail subpopulations in the north Bay (Evens *et al.* 1992). Clapper rail nesting in the north bay corresponds with the upper ends of small tidal creeks with tall (>50 cm) grasslike vegetation, remote from the bayward edge of tidal marsh (Evens *et al.* 1992). Precipitation cycles (drought/high rainfall) have caused cyclic changes in clapper rail habitat quality, related to contraction and expansion of salt and brackish marsh habitats of the clapper rail in the north bay. Years of high rainfall cause expansion of alkali bulrush and tules, dominants of brackish marsh vegetation which encroaches on cordgrass-dominated marsh which is preferred by clapper rails.

Many factors contribute to the degradation of habitat quality for clapper rails in the North Bay, and diminish the viability of clapper rail sub-populations in discrete tidal marsh parcels. Red fox activity and sign have been detected in tidal marshes and adjacent land on both sides of the Petaluma River (J. Evens, pers. comm; Service staff observations). Predator management is not being practiced regularly in the north bay, and clapper rail populations there remain highly susceptible to fox predation. Habitat loss and habitat fragmentation are also significant threats to the long-term viability of rail populations in the north bay. With the exception of the Petaluma marsh and China Camp marshes, virtually all historic tidal salt marsh with high densities of small tidal creeks (optimal habitat for clapper rails) have been diked and reclaimed for agriculture and subsequently other land uses. Most tidal marsh which has accreted outside of dikes supports relatively low densities of tidal creeks, and often occurs in relatively narrow strips. The integrity of fringing marshes as nesting and foraging habitat for clapper rails, and as dispersal corridors, is threatened by loss of high tide refugial habitat in upland transition zones. Nearly all natural high marsh-upland edges have been replaced by steep-sided and narrow dikes which provide inferior tidal refugia.

Of equal or greater importance to the integrity of fringing tidal marshes as clapper rail habitat is disturbance by humans, domestic pets, feral animals, and native predators which are artificially supported by human habitation (raccoons, rats, skunks), as well as non-native red fox. An artificially high density of avian predator perches (*e.g.*, utility poles, power lines and towers, pilings, hunting blinds, fences, derelict boats, non-native trees in unnatural locations, etc.) can also degrade the habitat quality of some marshes for clapper rails by increasing predation pressures in suitable habitat. Tidal marshes which are subject to periodic intrusion by humans, domestic pets, and feral and native predators from urban or suburban corridors may cause disturbance of nesting, breeding, and foraging activities of clapper rails, and may diminish the viability of refugia from tidal flooding in the high marsh transition zone. This is particularly likely where the absence of large tidal channels or deep, wide borrow ditches enables extensive access into tidal marsh areas (*e.g.*, fringing tidal marsh or pocket marshes). Abandonment of clapper rail territories in the Corte Madera Ecological Reserve (Marin County) has been attributed to human and dog disturbances by local marsh managers.

Few diked baylands in the north bay have been restored to tidal marsh (CDFG Toy marsh, immediately south of Bahia; "Carl's Marsh," immediately north of Petaluma River bridge; Sonoma Baylands, east of Port Sonoma Marina; north White Slough, Vallejo; pond 2A, Napa marshes; American Canyon marshes), and only two of these restored marshes are mature enough to provide substantial nesting and foraging habitat for clapper rails (White Slough, Toy Marsh). Of these, the accidentally "restored" White Slough marsh (unrepaired levee breach now approximately 20 years old) now supports relatively high densities of clapper rails (Evens *et al* 1992; Collins *et al.* 1993). Many restored tidal marshes in the North Bay are subject to varying degrees of artificially high predation pressures from red foxes, raccoons, and skunks, and many have artificially high densities of raptor perches. Tidal marsh restoration in the north bay has not yet substantially compensated for the historic decline in rail habitat or population size in the area, but restoration of large tidal marshes of high quality habitat is the most essential long-term measure for recovery of the species in the long term.

The Recovery Plan identifies the tidal marsh immediately south of the Bahia Topaz peninsula (the fringing marsh bayward of Toy Marsh) as essential habitat (priority 2) for the recovery of the clapper rail. This approved essential habitat is linked to the SLC Marsh by a ditch which is now dominated by cordgrass. The SLC Marsh contains numerous small tidal channels, relict artificial mosquito ditches, and vegetated old sidecast spoil berms supporting marsh gumplant (*Grindelia stricta* var. *angustifolia*) and coyote brush (*Baccharis pilularis*), creating a mix of nesting, foraging, and tidal refugial habitat for clapper rails. The SLC Marsh vegetation structure has varied between mixed alkali bulrush-cordgrass domination in creeks during high rainfall periods (early 1980s, mid-late 1990s) to cordgrass-dominated (most favorable for clapper rails) during droughts (early 1990s) (J. Evens, pers. comm. and Service staff observations).

The 1989 biological opinion on the earlier version of the Bahia development project concluded that the "endangered California clapper rail apparently does not occur in the immediate vicinity of the proposed project" (Service 1989). The Bahia permit application to the Corps (Huffman and Associates 1997) states that the marsh east of the Orient [Topaz] peninsula is "possible" clapper rail habitat, according to a 1990 reference. Subsequent data have demonstrated that the SLC marsh and adjacent tidal marshes are in fact occupied by clapper rails, as well as black rails. The marsh immediately north of the SLC marsh (between the mouths of Black John Slough and the Bahia channel) has been surveyed during their breeding season and has been determined to be occupied by clapper and black rails at moderately high densities (Evens *et al.* 1992, Collins *et al.* 1993, and Evens pers. comm.). The SLC marsh itself has not been quantitatively surveyed for rails, but calls have been detected in the north end of the SLC marsh from the north side of the Bahia channel (J. Evens, pers. comm.). All other clapper rail survey sites from the mouth of the Petaluma River to the Petaluma Marsh have resulted in detection of clapper rails in suitable tidal marsh habitat (Evens *et al.* 1992, Collins *et al.* 1993). Relevant site-specific information on the distribution of rails has developed since the issuance of the 1989 biological opinion for the previous Bahia project. Based on survey results, and the compositional and structural features of the tidal marshes north and south of the Bahia channel, the Service concludes that all suitable tidal marshes adjacent to Bahia peninsulas are occupied by clapper rails and are continuous with and ecologically indistinguishable from the adjacent area mapped as essential habitat in 1984. The Preliminary draft California Tidal Marsh Ecosystem Recovery Plan (to supersede the Recovery Plan) recognizes the ecological and biological values of these areas for the clapper rail and currently identifies all tidal marshes fringing the lower Petaluma River as essential habitat, including the SLC marsh.

Evens *et al.* (1992) concluded that all tidal marshes upstream from the mouth of the Petaluma River supported an estimated 19 pairs of clapper rails. Collins *et al.* (1993) estimated clapper rail densities in the vicinity of Black John Slough and the Petaluma River mouth (between which the SLC Marsh lies) to range between 0.057-0.093 pairs per acre (0.14 - 0.23 pairs per hectare). The average value of their surveys in the vicinity of Black John Slough based on Evens' data is 0.075 pairs per acre (0.186 pairs per hectare). Based on this density, the SLC Marsh (approximately 80 acres, or 32.4 hectares) is likely to support an estimated 6 pairs of clapper rails. The marsh area within 400-500 feet south of the SLC Marsh and flushing lagoon levee/road (approximately 10 acres) could be expected to support approximately 1 additional rail pair. Actual annual numbers of breeding pairs would fluctuate naturally.

There is direct field evidence of ongoing disturbance of the SLC Marsh by humans and dogs. Dog tracks and footprints are evident in muddy depressions at the marsh edge and unpaved roads and trails around the undeveloped Topaz Peninsula and flushing lagoon, and recent trash lacking sediment films (expected if deposited by tides) has been found near the tracks. Service staff have also directly observed joggers using perimeter trails adjacent to the marshlands at Bahia. Raccoon tracks are also evident in muddy depressions at some locations. It is likely that a host of domestic, feral and native predators access the SLC marsh from the developed Bahia area, which provides a base of shelter and food for their populations. No quantitative data on the level of human and predator pressures on the marsh are currently available for this site or other Bay area tidal marshes. Predator pressures are conventionally assessed subjectively based on indirect indicators (tracks, scat, direct observations, and population changes in prey species).

Salt marsh harvest mouse

The harvest mouse was federally listed as endangered in 1970 (35 **FR** 1604). A detailed account of the taxonomy, ecology, and biology of the harvest mouse is presented in the approved Recovery Plan for this species (Service 1984). Supplemental information on the status of the harvest mouse is provided below.

Harvest mice are endangered by loss of habitat and degradation of habitat quality. Primary habitat for the harvest mouse in the north bay historically was tidal pickleweed-dominated salt marsh and brackish marsh in the middle tidal marsh zone, complemented by natural creek levee vegetation (including tall, shrubby gumplants) and upland transition zones supporting vegetation cover which remains emergent even during extreme high tides. Diking for agricultural reclamation eliminated the majority of both habitat components in the San Francisco Bay estuary during the 19th and early 20th century. Substantial populations of harvest mice often occupy diked salt marshes which undergo infrequent episodes of tidal flooding, and irregular periods of inundation from impounded rainwater and runoff from adjacent uplands. These diked salt marshes are subject to large population fluctuations of harvest mice, with "crashes" following periods of prolonged, deep flooding. (H. Shellhammer, San Jose State University, pers. comm.) They provide, however, important refugial populations for the species because most existing salt marsh in the San Francisco Bay estuary is geomorphically young (formed after widespread marsh diking and reclamation), and often lacks the features of mature tidal marsh that supply ample refugia from tidal flooding, such as high densities of natural channel levees and dense, tall gumplant vegetation.

The northern subspecies of salt marsh harvest mouse *(R. raviventris halicoetes)* has only two extensive, continuous blocks of high quality natural tidal marsh habitat in the North Bay: the wide, prograded salt marsh along the north shore of San Pablo Bay from Marin County to Mare Island, Solano County, and the Petaluma Marsh (a natural remnant brackish-salt tidal marsh). The north San Pablo Bay fringing marsh is mostly a monodominant stand of pickleweed, and has recently been modified in Solano County to reduce artificially persistent and deep impoundment of tidal flood waters and rainwater, and improve the quality and stability of harvest mouse habitat there. Other harvest mouse habitat in the North bay consists of relatively small fringing marshes along diked tidal creeks, and diked salt marsh. Virtually all other habitat has been reclaimed for agriculture.

Most recent tidal marsh restoration in the North Bay (see clapper rail account, above) has produced either low marsh and mudflat, or low-elevation middle marsh (all unsuitable for viable harvest mouse populations), and has contributed relatively little toward the recovery of this species to date. Because of the substantial risk of local extinction associated with infrequent deep, persistent flooding in diked salt marsh, harvest mouse populations are considered to remain at risk in these potential refugial sites. Thus, for most of its range in the North Bay outside the northern San Pablo Bay fringing marshes, the viability of most harvest mouse populations remains at a precariously low and uncertain level.

The diked salt marshes of the Bahia project site are known to support substantial populations of salt marsh harvest mice, and harvest mice have also been detected in tidal marsh adjacent to the Topaz peninsula. The large diked salt marsh areas in the Central Lowlands and Western Marsh were surveyed for harvest mice in 1984 and 1987 by Harvey and Stanley Associates (Dr. Howard Shellhammer, principal investigator; Harvey and Stanley 1984, 1988) and confirmed the abundance of harvest mice there in pickleweed-dominated marsh and mixed pickleweed-grassland marsh. Harvey and Stanley (1988) also confirmed the presence of harvest mice along the high marsh strip contiguous and parallel with the Topaz Peninsula. The dredge disposal site (proposed Townhomes area) and peninsula interiors, which support seasonal wetlands with mixed halophytes and grassland (ryegrass, rabbit's-foot grass, spearscale, brass-buttons), were surveyed for harvest mice in 1996 (McGinnis 1996; Harvey and Stanley 1996). The mice trapped in these marginally suitable habitat were initially found to be ambiguous taxonomically, but were eventually considered to be predominantly or wholly assignable to western harvest mouse (*Reithrodontomys megalotis*). The Service concurs that *Reithrodontomys* individuals recently trapped on the dredge disposal site (Townhomes site) and peninsula basins are western harvest mice (*Reithrodontomys megalotis*), and that the endangered harvest mice are presumably absent from these habitats under current conditions. In contrast, the habitat quality of the diked salt marsh of the Central Lowlands and Western Marsh has been either stable or increased since the 1980s surveys, and the Service presumes that all suitable habitat in these areas (including peripheral flooding refugia) remains abundantly occupied by endangered harvest mice. Harvest mouse trapping data available from the Bahia site provide only relative density data and do not permit estimates of absolute density of harvest mice.

Effects of the Proposed Action

California Clapper Rail

The proposed project is likely to have indirect adverse effects on the clapper rail. Short-term effects would result primarily from construction-related disturbances along the Topaz (Orient) Peninsula, affecting the adjacent tidal marsh and rail population. Long-term effects would result from a permanent increase in intrusion into the tidal marsh by residents, their dogs and cats, feral cats, and the artificially augmented populations of raccoons, rats, mice, and skunks associated with suburban dwellings. Development of the Topaz Peninsula is expected to preclude effective predator management in the long term. These impacts would not be mitigated effectively by proposed actions.

One element of the project, the excavation of the Albatross peninsula and its conversion to deepwater tidal habitat, could have some beneficial impacts to rail habitat in the remote future, after it reverts to tidal marsh. This would probably take well over 30 years, based on the initial deepwater condition proposed. Much of the potential benefit of distant future habitat gains would likely be offset by indirect adverse impacts associated with residential build-out of the area.

Short-term adverse effects on clapper rails would result from noise associated with heavy construction and earth-moving equipment. High noise levels interfere with the ability of clapper rails to detect predators by sound, and background noise is known to have detrimental effects on predator avoidance by other bird species (Sherzinger 1979, Shen 1983).

Long-term adverse effects on clapper rails would result from increased intrusion into the SLC Marsh by residents, pets, and predators. Local residents have established use of the marshes and adjacent trails, and unimproved roads around the Bahia site, for recreational use. Low-lying levee roads between Toy marsh and the marsh flushing lagoon provide access. The existing vacant peninsulas contain vehicle tracks and pedestrian trails which lead down to the SLC Marsh and the adjacent CDFG Toy marsh. After rains, these tracks exhibit numerous tracks of dogs, off-road bicycles, and pedestrians, despite signs prohibiting entry to the area. The trails are well-established, and strongly suggest that a number of local residents have become accustomed to using the marsh and peninsulas as open-space recreational areas for off-leash dog exercise areas and other activities. Similar unimproved roads in the vicinity of the proposed Townhomes area (dredge disposal site) are used by local residents as jogging trails and dog exercise areas, as indicated by direct observation and tracks. The proposed residential project would add a total of 424 new homes for a cumulative residential total of 712 homes, approximately a 250% increase above the current number of residences, which implies commensurate increase in residential population size. The development proposal and Master Plan do not identify non-wetland open space dedicated to off-leash dog exercise and recreation. In the absence of available alternative open space for recreation and exercise, it is highly likely that new residents (particularly children and young adults) would seek open spaces within and around the marshes and follow established precedent of local residents who use the marshes or marsh edges for recreational uses including off-leash dog exercise, fishing, wildlife-watching, jogging, and off-road bicycle use.

Harvey and Stanley Associates (1997) and the 1995 Bahia Master Plan Revision suggests enforcement of dog leash laws, educational signage and fencing (symbolic and physically restrictive) as the mainstay of mitigation measures to prevent intrusion into marshes by pets and residents. The Service agrees that proposed measures to reduce intrusion and disturbance of marsh habitats (signs, fences, and local pet "rules," leash law enforcement) are necessary and prudent. These measures alone, however, would not, be sufficient to prevent (or adequately minimize) a highly significant detrimental increase in intrusion into the marshes by new residents and their pets. For example, there have been numerous occasions of unrestrained dogs causing disturbance to clapper rails at the Corte Madera Ecological Reserve, also in Marin County, despite signs informing visitors that they are entering sensitive wildlife areas and pets must be under restraint while in the preserve (J. Garcia, pers. comm.). Similarly, the Service has generally found insufficient compliance with symbolic fencing intended to discourage entry to sensitive wildlife areas, where attractive open space with recreation potential and physically suitable access occurs. The Service has also observed unacceptably low levels of compliance with local and Federal leash laws, even with substantial enforcement efforts, in areas managed for a mix of public access, recreation, and wildlife habitat for listed species. For example, recent enforcement of leash laws at Ocean Beach and Presidio (Golden Gate National Recreation Area, San Francisco), has met with opposition and substantial non-compliance by dog owners who feel entitled to "grandfathered" rights for off-leash dog exercise where leash laws apply.

Even with implementation of proposed restrictions, it is very likely that a 250% increase in the local general population at Bahia (particularly near the peninsulas) would still result in a significant increase in intrusion into marsh areas supporting clapper rails near the Topaz Peninsula, despite proposed restrictions. Most of these impacts are expected to occur in the western half of the SLC Marsh and adjacent north end of the Toy marsh, where clapper rail territories and nest densities would be expected to be highest near the upper ends of small tidal creeks, and near tidal refugia on low old berms, levee edges, and tall high marsh vegetation. Occasional disturbances of this area during pair bonding, mating and nesting seasons could cause failure of nest establishment or territory abandonment. Clapper rails displaced from home ranges would be expected to suffer increased intraspecific competition and risk of predation. Occasional disturbance of this area during high tides could cause loss of effective tidal refugia for clapper rails, and could result in increased predation during high tides. Frequent disturbance of this area could cause persistent abandonment of the habitat by clapper rails. Thus, by impacting critical portions of the SLC Marsh which are essential to successful nesting and tidal refugia, the viability of the entire SLC marsh as clapper rail habitat is likely to be impaired or eliminated. This systemic effect of habitat fragmentation in tidal salt marshes has been indicated for both clapper rails and harvest mice in the south bay, where hundreds of acres of otherwise suitable habitat are unoccupied or occupied at very low densities for lack of adequate tidal refugia (Shellhammer *in prep.*), nesting habitat, or because of excessive predation (Foerster *et al.* 1990; J. Takekawa, pers. comm.; unpublished data; USFWS San Francisco Bay National Wildlife Refuge).

The residential build-out on the Topaz Peninsula would also have adverse effects on clapper rails by increasing predation by mammalian species other than dogs, including domestic and feral cats, and raccoons, skunks, and rats. Populations of these species are typically supported and augmented by suburban dwellings in semi-rural settings. Raccoons, rats, and cats in particular are known to prey on nests (eggs) and juvenile and adult clapper rails. (De Groot 1927, Harvey 1988, Foerster *et al.* 1990). New residences at this location would establish permanently increased predator pressures on the adjacent tidal marsh. Furthermore, residential occupancy of the area would cause substantial interference with, or completely eliminate, the potential for predator management in the area. Areas open to pets (even unauthorized entry) or open to view by residents are extremely difficult areas in which to implement effective predator control measures. To conduct predator management in such areas, predator management personnel must take additional burdensome and time-consuming measures to minimize contact with the public (*e.g.*, night work, placement of traps away from visible areas), and these adjustments significantly reduce the efficacy of predator management while increasing its cost. Vandalism of traps, and local political opposition of animal population control efforts (a long-established issue in Marin County) is also important impediments to predator management in areas which become highly visible and known to residents. Future control of expanding red fox populations in the project area probably would be severely impeded and could preclude local viability of clapper rail populations in the long term. The collective impact of increased disturbance to the marsh, increased predator pressures, and decreased potential for predator control is therefore likely to significantly reduce or eliminate the viability of clapper rail habitat in the SLC marsh and northern portions of the adjacent Toy marsh.

The potential to physically restrict the movement of predators, dogs, and people into the marsh is subject to several constraints. The Topaz Peninsula is contiguous with tidal marsh habitat for clapper rails (indeed the foot of the Peninsula levee itself is suitable clapper rail tidal refugium), and residential development is proposed to the edge of the peninsula levee. The full build-out of the narrow peninsula and lack of potential buffer area between the peninsula and habitat precludes the feasibility of converting a wide area to a deepwater "moat" to serve as a barrier to marsh access by residents. The only potential for physical restriction of access lies with the steepness and cover of the peninsula levee slope, fence design along the periphery of the peninsula and flushing lagoon, and altering the configuration of roads/levees around the flushing lagoon. The potential feasibility and effectiveness of physical restriction of access to this area is doubtful. To mitigate for similar impacts of other residential build-outs into tidal marshes, the Service has relied on a combination of extensive buffer areas and intensive barriers to access, coupled with rigorous predator control programs and compensatory mitigation (Service 1996).

The applicant has proposed no mitigation for indirect effects on the clapper rail resulting from the residential build-out of the Topaz peninsula. In the absence of reliable, relatively certain mitigation measures to minimize take of clapper rails in the SLC Marsh, the only feasible alternative to minimize take would be replacement of degraded habitat, equivalent to the estimated carrying capacity of the SLC Marsh for clapper rails (compensatory habitat mitigation). The western portion of the SLC Marsh, which would be most strongly affected by indirect impacts of development, includes the majority of tidal refugia and potential breeding habitat (heads of small tidal creeks). The viability of the clapper rail sub-population of the SLC Marsh as a whole, and the potential for foraging habitat value nearer the Petaluma River, depends on the integrity of the western portion of the SLC Marsh. The systemic, interdependent relation between marsh sub-habitats requires that compensatory mitigation consist of a restored whole, structurally balanced marsh system of equivalent carrying capacity (estimated by area and habitat structure). The location of a compensatory habitat mitigation site would need to be in the lower Petaluma River, where potential rail density is high, and where there is need to maintain continuity of clapper rail movement and consolidated large blocks of habitat. The location would also need to be in an area where future predator management would not conflict with existing or future (zoned) land uses. Because of the time-lag in establishing restored clapper rail habitat (approximately 7-10 years for foraging habitat, 15-25 years for middle marsh and high marsh zones, unless artificially engineered), it is likely that even compensatory mitigation of the SLC marsh as a whole (approximately 80 acres; 90+ acres including the affected northern CDFG Toy Marsh) would result in temporary net reduction of rail habitat and population in the lower Petaluma River.

Other indirect effects of the project on clapper rails include increased contaminant loads in the SLC Marsh. The applicant proposes installation of a new outfall structure to the flushing lagoon which would serve as a water quality treatment detention basin adjacent to the south end of the Topaz Peninsula. The outfall drains into the SLC marsh. The substantial increase in residential population would result in proportional increases in contaminant loads in runoff. The flushing lagoon is likely to trap a substantial portion of the contaminant load as it is designed to do, but significant episodes of contaminant discharges to the marsh may occur during periods of high rainfall and high contaminant loading. Increases in contaminants in intertidal muds in which clapper rails feed could result in increased body burdens of contaminants, causing decreases in reproductive fitness.

Salt marsh harvest mouse

The proposed project would have some moderately strong adverse indirect effects, but no significant direct adverse effects, on the harvest mouse. The habitat enhancement components of the mitigation proposal would have some important beneficial effects on harvest mouse habitat. Most of the adverse effects on the harvest mouse would occur in the Central Lowlands (diked salt marsh), and to a lesser extent in the Western Marsh (diked salt marsh) as well. The indirect effects on harvest mice would result primarily from increased intrusion into pickleweed-dominated wetlands by domestic and feral cats, competitor species (house mice, *Mus musculus*), and predator species (rats, *Rattus norvegicus*) supported by expanded residential development. Residential development would occur directly adjacent to harvest mouse habitat from the Townhomes site to the end of Bahia Drive (proposed Community Center), and adjacent to the Topaz Peninsula (SLC Marsh). New residences in the Bahia Highlands northwest of the Townhomes site would be mostly set back from the marsh along ridge crests, but would provide similar levels of indirect human recreational pressure and predator pressure on harvest mouse habitat, particularly from roaming feral and domestic cats. Human intrusion into diked pickleweed marsh is also likely to degrade habitat quality for harvest mice. Human intrusion (including off-leash dog exercise) into harvest mouse habitat is likely to increase most strongly along both the developed area between the Townhomes site and Community Center (Central Lowlands), and along the improved fire access road (Western Marsh), which would likely be used as a recreational trail by the increased Bahia residential population.

The Draft Mitigation Plan (Harvey and Associates 1997) for harvest mice impacts proposes measures to limit access to sensitive harvest mouse marsh habitats, and proposes environmental education and "homeowner pet rules" to foster compliance with access restrictions.
These measures would not reduce an increased influx of domestic and feral cats and rats (predators), or house mice (competitors) into harvest mouse habitat and are unlikely to sufficiently deter human intrusion significantly. The sufficiency of these proposals to achieve their objectives is evaluated in detail under the discussion of clapper rail impacts (see above). The acreage of harvest mouse habitat affected by this diffuse impact is difficult to estimate.

Assuming that predation and disturbance derives primarily from the upland edge, and not along levee travel corridors, the estimated area of impact would range between 55 and 140 acres (based on 400 foot and 1000 foot wide impact zones). If perimeter levees of diked salt marsh become sources of predation and disturbance, the estimated acreage impacted would more than double.

The proposed mitigation of enhancing salt marsh habitat is technically sound and appropriate. If incorporated, it would compensate for adverse indirect impacts to harvest mice caused by the project. Reduction in the frequency and duration of deep inundation of the diked marsh, and enhancement of pickleweed vegetation would increase carrying capacity of the site for harvest mice, and could compensate for diffuse indirect effects of predation and disturbance on harvest mice caused by the residential build-out. The proposed habitat enhancements, if effective, could cause a net increase in the viability and size of the resident harvest mouse population, despite indirect residential impacts.

The watersheds adjacent to the Central Lowlands and Western Marsh drain into harvest mouse habitat. The increase in residential runoff from the new development, and the loss of seasonal wetlands in the proposed Townhomes area (which act as natural filters to improve water quality), would probably cause some increase in the contaminant loads in harvest mouse habitats, particularly near discharge points. According to the 1995 Master Plan (p. 14), stormwater runoff would be filtered at various points through the hillside, where sediment traps would filter particulates before effluent is discharged into wetlands. This conceptual design has the potential to substantially mitigate contaminant loading of marshes, but sites-specific designs and empirical verification through monitoring would be necessary to determine whether the system is adequately preventing incremental net increases of contaminants in harvest mouse habitat.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion.
Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Cumulative impacts to clapper rails occur through increased public access to marshes (often mandated by State or local agencies), interference with or deficiency of non-native predator management programs, and development in diked historic baylands which are essential sites for salt marsh habitat restoration. Discharges of contaminants such as mercury in the bay may also cause adverse cumulative effects on clapper rails. Progressive invasion of San Francisco Bay salt marshes by invasive non-native smooth cordgrass (*Spartina alterniflora*), in the absence of regional control programs, is likely to adversely impact clapper rails by reducing the density of small tidal creeks in salt marsh, choking them with sediment.

The degradation of diked, non-tidal salt marsh habitat, caused by unplanned flooding, managed flooding (as waterfowl habitat or flood detention), drainage, certain mosquito control practices, and alternation of vegetation by discing or invasion by exotic plants is the most significant cumulative effect on harvest mice. To a lesser extent, the conversion of diked non-tidal pickleweed vegetation to other habitat types (such as tidal mudflat and low marsh), either through planned restoration or spontaneous dike breaches (a consequence inaction to maintain levees or pumps), is a cumulative impact on large remaining patches of high-quality harvest mouse habitat.

Conclusion

After reviewing the current status of the harvest mouse and clapper rail, the environmental baseline for the action area, the effects of the proposed action and cumulative effects, it is the Service's biological opinion that the Bahia residential development as proposed is not likely to jeopardize the continued existence of the California clapper rail or salt marsh harvest mouse. No critical habitat has been designated for these species, therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the agency so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take

The Service expects that the incidental take of clapper rails will be difficult to detect because of the reclusive nature of the species. Based on rail densities in the vicinity of the project area, and the acreage of marsh indirectly affected, the Service estimates that up to approximately 7 breeding pairs of clapper rails would be subject to increased mortality, harm and/or harassment. However, in instances such as this, the Service estimates take in terms of acres of habitat impacted by the proposed action. Because take of clapper rails caused by residential impacts would be ongoing, not a single instantaneous event, it is reasonable to estimate take in terms of acreage and breeding population density. Clapper rails in up to approximately 90 acres of habitat may be killed, harmed, or harassed because of this project.

The Service expects that the incidental take of harvest mice will be difficult to detect because of the variable, unknown size of the resident population over time, and the difficulty of finding killed or injured small mammals. However, the following level of take of this species can be expected. The Service expects that an unquantifiable number of harvest mice maybe killed, harmed or harassed on approximately 65 acres of non-tidal salt marsh and transitional grassland habitat. Successful implementation of proposed mitigation measures, designed as part of the proposed action, to minimize take of this species will offset this amount of take. The harvest mouse population is expected to stabilize or increase in size and viability in the long term after successful implementation of proposed mitigation measures.

Effect of the Take

In the accompanying biological opinion, the Service determined that the level of anticipated take is not likely to result in jeopardy to the California clapper rail, salt marsh harvest mouse, or destruction or adverse modification of critical habitat.

Reasonable and Prudent Measures

The Service believes that the following reasonable and prudent measures are necessary and appropriate to minimize the impact of incidental take on California clapper rails and salt marsh harvest mice:

1. The potential for harm, harassment, and mortality to the California clapper rail and salt marsh harvest mouse shall be minimized.

2. Impacts to the California clapper rail and salt marsh harvest mouse resulting from habitat modification shall be minimized.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of ESA, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary.

1. The following terms and conditions implement reasonable and prudent measure #1:

   a. To minimize breeding season disturbances to clapper rails, the following construction conditions shall be implemented:

      i. All construction activities on the Topaz Peninsula shall be prohibited between February 1 and August 31 each year. This prohibition may be reduced or eliminated at the Service's discretion, if Service-approved breeding season surveys performed by a qualified biologist detect no clapper rail breeding territories within 200 feet of the Topaz Peninsula. The location of all breeding territories determined by these surveys must be reviewed by the Service. Any construction, filling, or grading activities on the project site between February 1 and August 31 shall be subject to approval by the Service.

      ii. No temporary staging areas, stockpiling of equipment or construction materials, placement of any dredge or fill material, or artificial lighting shall occur in or impinge upon the tidal marsh adjacent to the Topaz peninsula during construction.

   b. To minimize the impacts of new residential development on management programs for predators of the clapper rail in the project vicinity, the applicant shall prepare and implement a predator management plan (PMP). The PMP shall be submitted to the Service and be subject to review and approval by the Service. The PMP shall be completed at least three months prior to initiation of any project construction, filling, or grading activities on the Topaz Peninsula or Townhomes site. The PMP shall include, but not be limited to, adequate funding for U.S. Department of Agriculture Wildlife Service personnel to conduct predator management for a minimum of 20 hours per week in perpetuity, beginning at the time of the initial occupancy of residences on the Topaz Peninsula.

   c. The applicant shall prepare (in coordination with the Service) and implement a plan to re-design fences, barriers, and signs designed to reduce, to the maximum extent feasible, human and pet intrusion into marshes supporting habitat of clapper rails and harvest mice. The plan shall consider the feasibility and effectiveness of slope adjustments on the peninsulas (near-vertical engineered upper slopes, gentle lower slopes) and fence modifications (double fencing, higher fencing, fences with recurved tops, fine wire or fabric mesh). The plan may include a public viewing area with restrictive trails. The plan must be reviewed and approved by the Service prior to any construction, filling, or grading activities on the Topaz Peninsula or Townhomes site.

d. To minimize harassment or harm of clapper rails caused by people and pets in clapper rail habitat, public access shall be prohibited in marshlands and adjacent upland areas in the vicinity of the Topaz Peninsula (including the flushing lagoon area). Public access to this marshland area shall be physically restricted around the residential development by construction of adequate physical barriers to access into the marsh. Physical barriers shall include either chain-link fence with recurved tops and no cross-bars, or structures which are equally effective at restricting access, subject to review and approval by the Service. Informational signs explaining the sensitivity of endangered wildlife in the marsh area shall be posted, and redesigned fences (subject to Service review and approval) shall be erected and maintained in perpetuity along the border between the Topaz peninsula residential area and the adjacent marshlands, particularly near potentially suitable access points. Fencing plans must be reviewed and approved by the Service prior to any construction, filling, or grading activities on the Topaz Peninsula or Townhomes site.

e. The applicant shall provide, to the maximum extent consistent with the Master Plan, alternative open space off-leash dog exercise areas. This measure is intended to reduce recreational pressures on, and intrusion into, tidal and non-tidal salt marshes.

f. The Covenants Codes and Restrictions for the Topaz Peninsula development and Townhomes sites shall at a minimum include:

i. a description of the importance of protecting the listed species in the surrounding marshes;

ii. a list of prohibited activities that are inconsistent with the maintenance of the suitability of the remaining habitat including, but not limited to:

(1) alteration of existing topography or any other alteration for any purposes; (2) placement of any new structure in the protected habitat; (3) dumping or burning of any garbage, waste, or fill materials; (4) building of any new roads or trails; (5) killing, removal, alteration, or replacement of any existing native vegetation; and (6) use of pesticides or herbicides in the protected habitat.

2. The following terms and conditions implement reasonable and prudent measure #2:

a. The applicant shall prepare and implement a mitigation plan to compensate for long-term degradation of rail habitat, by initiating restoration of at least 80 acres of tidal marsh habitat suitable for colonization by California clapper rails within diked baylands of the lower Petaluma River. The site shall be located in a setting where residential development is permanently precluded, and where predator management programs would not be impeded by prevailing adjacent land uses. The plan shall be prepared in coordination with the Service, and shall be subject to Service review and approval before implementation. The habitat restoration plan shall include provisions for passive tidal sedimentation (to maximize final channel density), adequate initial tidal circulation, gentle high marsh to upland topographic gradients, and management of non-native vegetation and predators. Superfluous design features of the engineered marsh shall be avoided. The plan shall establish an adequate endowment for monitoring and perpetual management and maintenance of the mitigation area. The plan shall also include a monitoring and reporting component, including objective performance criteria and contingency measures. The final plan must be submitted to the Service no later than 1 year after the Corps permit decision date for review and approval. Final approval of the plan by the Service shall be required before the initiation of construction, filling, or grading activities on the Topaz Peninsula or Townhomes site.

b. The applicant shall, as proposed in the Harvey mitigation plan, transfer in fee title the Central Lowlands and Western Marsh to the State trustee agency, the California Department of Fish and Game (CDFG), and endow the site with sufficient capital (acceptable to CDFG) for maintenance in perpetuity for harvest mice. The transfer must be accompanied with a legal restriction requiring management to benefit the clapper rail and harvest mouse, as determined by the Service. All documents relevant to the land transfer and endowment shall be reviewed and approved by the Service prior to any construction, filling, or grading activities. The transfer of the title must be preceded by the successful and complete implementation of the Harvey mitigation plan at (C) below.

c. The applicant shall implement all other improvement and mitigation measures as described in the Harvey mitigation plan (Harvey and Associates 1997). A plan which includes (1) implementation guidelines for the measures and (2) methods of funding the projects (including any endowments for perpetual maintenance of created or restored areas), shall be submitted to the Service no later than 1 year after the Corps' permit decision date for review and approval. Final approval of the plan by the Service shall be required before initiation of construction, filling, or grading activities on the Topaz Peninsula or Townhomes site.

Reporting Requirements

The Service shall be notified by the Corps or its permit applicant(s) within twenty four (24) hours of the finding of any injured or dead California clapper rails or their eggs, or salt marsh harvest mouse, or any unanticipated damage to clapper rail or harvest mouse habitat associated with project implementation. Notification must include the date, time, and precise location of any specimen/incident, and any other pertinent information. The Service contact person is the Assistant Field Supervisor for Endangered Species in the Sacramento Fish and Wildlife Office at (916) 979-2710. Any dead or injured specimens shall be reposited with the Service's Division of Law Enforcement, telephone (916) 979-2987.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Endangered Species Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases.

The Service has the following recommendation:

> The San Francisco District of the Corps should pursue opportunities to utilize potentially available programs or funds to implement tidal wetland restoration projects, designed in coordination with the Service, in San Pablo Bay and San Francisco Bay, within areas determined to be essential habitat for the conservation of the California clapper rail and salt marsh harvest mice.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION--CLOSING STATEMENT

This concludes formal consultation on the action(s) outlined in your June 4, 1997, request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Please contact Dr. Peter Baye of this office at (707) 562-3003 or (916) 979-2725, if you have any questions. If you have any questions regarding wetlands, contact Mark Littlefield at (916) 979-2113.

Sincerely,

Wayne S. White
Field Supervisor

Enclosures/Attachments

cc: Gary Deghi, Huffman and Associates
John Briscoe, Esq., Washburn, Briscoe and McCarthy
Charles Linthicum, Debra Investment Co.
Carl Wilcox, CDFG, Yountville, CA
Michael Monroe, EPA, San Francisco, CA
Regional Water Quality Control Board, Oakland, CA
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PERSONAL COMMUNICATIONS

Mr. Michael Monroe, U.S. Environmental Protection Agency, San Francisco, CA.

Mr. Carl Wilcox, California Department of Fish and Game, Yountville, CA.

Mr. Jules Evens, Point Reyes Bird Observatory, Bolinas, CA.

Appendix H

Riparian Plant Community Enhancement in the Petaluma River Watershed

Riparian Plant Community Enhancement in the Petaluma River Watershed

Prepared for
Southern Sonoma County Resource Conservation District
Petaluma River Watershed Enhancement Plan

Prepared by
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March 1998

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Southern Sonoma County Resource Conservation District has contracted with Prunuske Chatham, Inc., an environmental consulting firm located in Occidental, to produce this document entitled *Summary of Riparian Plant Community Enhancement in the Petaluma River Watershed.*

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Summary of Riparian Plant Community Enhancement in the Petaluma River Watershed

1.0 Introduction

One purpose of Southern Sonoma County Resource Conservation District's (SSCRCD) *Petaluma River Watershed Enhancement Plan* is to characterize the riparian plant community and identify opportunities for enhancement. This study is intended to be an overview of riparian conditions outside the Petaluma urban boundary and to identify recommendations for the SSCRCD and the watershed advisory group to consider. The *Summary of Riparian Plant Community Enhancement in the Petaluma River Watershed* is one of several layers of investigations and activities that contribute to the overall *Petaluma River Watershed Enhancement Plan.*

Before European settlement, California's landscape was described as a sea of rolling hills traversed by clear, rushing rivers with contiguous, dense forest corridors. Today the corridors have become fragmented and tapered, and the water is often mixed with silt and sand from eroding hillsides and streambanks. In many areas, the riparian plant community has been converted into annual grassland dominated by European species. Biological diversity has declined as a result of this conversion and loss of riparian habitat.

The riparian plant community is a complex association of canopy and understory trees, shrubs, vines, and herbs. Each layer plays a dynamic role in providing shelter and food for hundreds of species of insects and other invertebrates, birds, fish, amphibians, reptiles, and mammals. The extensively layered root systems have co-evolved with micro and macro organisms, such as bacteria and fungi, that enhance soil fertility and nutrient accessibility. This fibrous subsoil network is the living rebar that helps to sustain hillside and streambank integrity, thus maintaining water quality.

This report describes the methods used in conducting the overview survey, the historic and current riparian communities and conditions in the watershed, and a list of recommendations to enhance the riparian corridors. A characterization of each of the creeks and subwatersheds follows, including specific enhancement opportunities. Appendix A is a summary table of the riparian enhancement opportunities. Appendix B contains a summary of comments from the Landowner Advisory Committee (LAC) on the draft enhancement recommendations. Appendix C includes a description of Valley Foothill Riparian and an explanation of the California Wildlife Habitat Relationships (WHR) System, and Appendix D is a list of plant species for the Petaluma River watershed. Watershed maps and references are also included.

2.0 Survey Methods

An overview of riparian conditions was developed through a review of existing literature, inspection of photographs and maps, and field reconnaissance. Literature reviewed included the *Restoration Design and Management Guidelines for the Petaluma River Watershed* (Questa Engineering Corporation, et al., July, 1996) and historical and recent aerial photographs. Soil maps in the *Soil Survey of Sonoma County, California* (1972) and *Soil Survey of Marin County, Califoria* (1985) were consulted to assist in analyzing potential or existing erosion hazards and to assess historical plant community conditions. To help identify changes in plant community boundaries and composition, aerial photographs from 1942 were compared to 1990 aerial ortho-photos from the Sonoma County Planning Department. Such comparisons are useful for evaluating the extent of floristic changes in natural habitat through time and to assist in predicting long-term trends and consequences from land use.

Boundaries of historic riparian forests were estimated by using 1990 ortho-photos along with historic photos, maps, and limited field reconnaissance. Stream lengths and widths were scaled off the ortho-photos using a map measure. Acreages were derived from various stream lengths and widths ranging from 100 to 300 feet. In the field, plant communities were described by identifying dominant plant species, tree size and density, understory conditions, streambank stability, and the presence or absence of exotic plant species. Much of the information about soil types, vegetation, and associated wildlife habitat was published in *Restoration Design and Management Guidelines for the Petaluma River Watershed* (Questa Engineering Corporation, et al., July, 1996).

Specific subwatershed reaches were characterized using the California Wildlife Habitat Relationships (WHR) system (Mayer and Laudenslayer, 1988). This system allows for a broadly based characterization of vegetation types, which include dominant species, size or age of the vegetation, and percent of vegetative canopy closure. The WHR vegetation classification system is intended to provide an umbrella classification for more detailed analysis and also allows for prediction of potential wildlife habitat, as well as access to wildlife and habitat information through a computerized database that is maintained by the Wildlife Management Division of the California Department of Fish and Game (CDFG). More information on the WHR system is contained in Appendix C.

For the purpose of this report, vegetation was characterized as either Valley Foothill Riparian (VRI) or Annual Grassland (AGS) depending on the presence or absence of trees and shrubs (see Table 1 on page 3). This system allowed us to identify specific areas on the accompanying Riparian Area Maps that could potentially be enhanced. For example, areas identified as VRI 4S or

4P on the maps are generally accompanied by recommendations for enhancement. Areas identified as Annual Grassland (AGS) are likely to have been Valley Foothill Riparian (VRI) historically, and they too are accompanied by specific recommendations for enhancement (see Section 6 below, Creek and Subwatershed Characterizations and Enhancement Opportunities).

Table 1: Summary of WHR Habitat Classifications

WHR Classification	Size (for trees) Height (for grasses)	Canopy Cover Density (trees) Cover Density (grasses)
Valley Foothill Riparian (VRI) Found in valleys bordered by low foothills and coastal plains. (See Appendix C for more information).	**4**: small trees (hardwood crown diameter of 30′ - 45′) **5 or 6**: Large or medium trees or a two-storied forest (hardwood crown diameter greater than 45′)	**D**: Dense (60-100% of canopy is closed) **M**: Moderate (40-59% of canopy is closed) **P**: Open (25-39% of canopy is closed) **S**: Sparse (10-24% of canopy is closed)
Annual Grassland (AGS)	**1**: short herb (less than 12″ when mature) **2**: tall herb (more than 12″ when mature)	**D**: Dense (60-100% of ground is covered **M**: Moderate (40-59% of ground is covered) **P**: Open (10-39% of ground is covered) **S**: Sparse (2-9% of ground is covered)
Examples: VRI 4M means that the site is classified as Valley Foothill Riparian with small trees and a moderate canopy cover. AGS 1D means that the site is classified as Annual Grassland and is densely covered with short grasses.		

The Petaluma River watershed has been divided into five riparian vegetation areas for the purpose of mapping. Riparian Vegetation Area Map R1 includes Lichau Creek and Willow Brook Creek subwatersheds; Riparian Vegetation Area Map R2 includes Lynch Creek, Adobe Creek, and Ellis Creek subwatersheds; Riparian Vegetation Area Map R3 is the Liberty Creek subwatershed; Riparian Vegetation Area Map R4 includes San Antonio, Kelly, Thompson, Kastania, Sutton, and Schultz Creeks; and Riparian Vegetation Area Map R5 is the Lakeville subwatershed.

3.0 Historic Riparian Plant Communities

The Petaluma River watershed is approximately 146 square miles or 93,440 acres (Sonoma County Water Agency, 1986). Of this area, 77% lies within Sonoma County, and 23% is located in Marin County. In general, the riparian corridors were historically of various widths (approximately 100 to 300 feet) and consisted of willows (*Salix* sp.), ash (*Fraxinus latifolia*), and alder (*Alnus rhombifolia*) in the wettest areas with a mixture of buckeye (*Aesculus californica*), California bay (*Umbellularia californica*), and coast live oak (*Quercus agrifolia*) along the banks of the lower reaches of the main tributaries. The riparian forests gradually changed in composition going up towards the headwaters where valley oaks (*Q. lobata*) were replaced by black oaks (*Q. kelloggii*), and California bay and live oaks became the dominant species. Oak and bay woodlands emanated from the upper banks at these higher elevations, increasing the value of the corridor for a multitude of wildlife. Remnant vegetation along the upper reaches hints at these historically dense, two-storied forests that grew to over 300 feet in width.

The character of the landscape began to significantly change in the early 1800s with the establishment of the missions and introduction of European agricultural practices. By 1866, Marin County accounted for about 75% of California's dairy production (Kashiwagi, 1985). By the 1870s, it was estimated that about 50% of the hardwood acreage in Sonoma County had been logged. Half of this was due to agricultural clearing (California State Agricultural Society, 1870). The other half of the hardwood harvesting supplied fuels for heating and cooking into the early part of the twentieth century. Starting in the 1940s, significant rangeland clearing was practiced throughout California with assistance from government subsidies, technical help from the University of California Cooperative Extension and Soil Conservation Service, and the advent of bulldozers and herbicides. Clearing and channelizing streams within the Petaluma River watershed were practiced by agencies and individuals for flood control.

Soil maps dating back to 1917 indicate areas of historic riparian forest corridors along many of the creeks and tributaries within the watershed (Swiecki and Bernhardt, 1998). The 1942 aerial photos indicate a thinning of many of these riparian forest corridors—most noticeably in areas within small side tributaries where the slopes are gentle and there is good access for livestock to congregate for shade and water (as well as access for woodcutters). Soil compaction and browsing have impacted riparian vegetation and impeded natural regeneration.

There are still suggestions of the width of historic riparian forests on the 1990 aerial ortho-photos. For example, along portions of streams that are deeply incised, making access difficult (i.e., San Antonio Creek), an average forest canopy width of 150 feet has been used as an estimate. On hillslopes that are extremely steep, preventing almost all access on adjacent slopes (i.e., upper Willow Brook Creek), forest canopy widths are in excess of 300 feet.

4.0 Present Riparian Plant Communities

Today the major portion of the Petaluma River watershed outside of the urban boundary and marshes is largely used for livestock grazing, rural residences, and, most recently, viticulture. Approximately 26 miles of dense Valley Foothill Riparian (VRI) habitat remain, most of which is located in the steep, uppermost reaches of large creeks. Here the historically dense, two-storied corridors with adjacent oak and bay woodlands remain. The wide, 300-foot corridors are characterized by an overstory of large live oak, black oak, and California bay trees. The understory consists of buckeye and big leaf maple (*Acer macrophyllum*) on the upper banks with willow instream. Dense thickets of native and non-native blackberry (*Rubus ursinus* and *R. discolor*) with snowberry (*Symphoricarpos alba*), honeysuckle (*Lonicera sp.*), and poison oak (*Toxicodenron diversilobum*) are characteristic of the shrub layer along the streambanks. California bee plant (*Scrophularia californica*), a tall and spreading herbaceous plant, is commonly found below the shrub layer. Groundcovers and small herbs are sparse, either being shaded out by the dense canopy or displaced by rambling vines. Streambank stability in these uppermost reaches is usually high due to extensive root systems and only minor grazing.

For the most part, the middle and lower reaches of creeks have been converted to areas of moderate to open riparian canopy cover and annual grassland. In contrast to the dense, contiguous corridors of pre-settlement times, the corridors have become fragmented and narrow with widths reduced to well under 150 feet. Remnant stretches of moderately dense forest remain along portions of the middle reaches, reminding us of the landscape potential. (San Antonio Creek has several miles of moderately dense forest remaining along its main channel.) These forests are commonly dominated by shrub willow thickets in the lower, wetter reaches with occasional large, two-storied willow trees towering over. Small clusters of willow or live oak remain in pockets that have survived overgrazing and turn-of-the-century reclamation when low-lying creeks and marshes were filled or drained for agricultural use.

Moving upstream, live oak begins to dominate the vegetation, with buckeye and bay on the upper banks. The shrub layer is similar to that in the dense upper reaches, although usually less dense and often compromised by invading exotic species such as fennel (*Foeniculum vulgare*), poison hemlock (*Conium maculatum*), and non-native blackberry. In many lower reaches, where streambank slopes are slight and accessible to livestock, the vegetation has been mostly converted to annual grassland dominated by introduced grasses such as annual ryegrass (*Lolium multiflorum*), Mediterranean barley (*Hordeum marinum*), and oats (*Avena* sp.). In some cases, all that remains to suggest a history of riparian vegetation is a single, aged willow that is unable to regenerate because of livestock impacts.

Along the main channels and tributaries, the removal of woody plant cover has left streambanks open and unprotected. Bank slumping and headcuts are common along many of the creeks (especially those associated with gullied land soils such as Willow Brook, Ellis, Hutchinson, and Cherry Creeks), causing significant sedimentation in the lower reaches and ultimately into the Petaluma River. Vigorous exotic plants are displacing native species in the most disturbed areas. Some of these introduced species are toxic to livestock and wildlife.

5.0 Enhancement Recommendations and Opportunities

A recommended goal of the *Petaluma River Watershed Enhancement Plan* is to restore the riparian corridor. Several steps to achieve this goal are listed below and summarized in Appendix A, Summary of Riparian Enhancement Opportunities. Erosion control measures described in a separate report, *Summary of Erosion and Sedimentation in the Petaluma River Watershed,* will also help to restore riparian areas.

- **Revegetate high and medium priority riparian sites with cooperative landowners.** Fifty-one sites have been given a tentative medium to high priority for a total of 1,029 acres of potential restoration. Criteria for prioritizing enhancement sites include the opportunity to provide contiguous riparian forest habitat between a lower and upper reach of the watercourse, to expand existing habitat, to fill out areas of sparse cover, and to provide cover in areas of higher erosion potential. Benefits would include reduction in erosion hazard, increased water quality, wildlife expansion, and aesthetic improvement.

  Only native riparian species should be used. Native plants are adapted to the conditions that exist within the watershed, such as soil type, water regime, and weather. Many indigenous animals and insects are dependent on their association with native plants. When native plant species are diminished or displaced by exotic varieties, the delicate ecological balance of the riparian system is disrupted and often destroyed.

- **Manage livestock access to the creeks, especially during the wet season.** Livestock can have a serious effect on riparian vegetation and streambank stability. Controlling livestock access to creeks during times of the year when the ground is saturated and compactible can help reduce damage. Installing livestock control fencing with livestock crossings and off-stream water development is one way to protect the riparian habitat. Riparian pastures can allow regulated grazing in riparian areas by excluding livestock until creekside vegetation is well established. Carefully managed grazing in riparian areas can be successful. Cross-fencing can allow rest periods for sections of corridor while livestock have access to others. Developing off-stream water and shade sources can help reduce the time livestock spend in and near streams.

Livestock fencing design and floodgates for livestock crossings can be obtained from local ranch suppliers, the Natural Resources Conservation Service, or consultants.

- **Develop and distribute a creek care guide to rural landowners and agricultural operators.** Topics to include are 1) the importance of healthy riparian corridors to wildlife and the community, 2) landowner stewardship and ways to protect the riparian corridor (i.e., take care to avoid run-off of hazardous waste, soaps, chemicals, and pollutants into the watercourse—don't use the streambed for a dump, minimize erosion, plant native species), and 3) available resources and technical assistance.

- **Control invasive exotic species.** Exotic plant species have displaced native species in disturbed areas within the watershed. German ivy (*Senecio mikanioides*), an invasive vine, is growing in the lower reach of Washington Creek near Ielmorini Lane. This plant is suspected to contain chemical substances that are toxic to fish. Other species, such as giant reed (*Arundo donax*), are common along creeks and rivers in Sonoma County. This plant was identified during field surveys along Willow Brook Creek at Old Redwood Highway and Ely Road. If this tall, bamboo-like grass is observed, it should be removed immediately.

- **Protect intact sections of the riparian corridor.** Healthy riparian vegetation remains in areas along several of the creeks within the Petaluma River watershed. Installation of livestock control fencing along these stretches will help to preserve existing vegetation, allow regeneration, and increase streambank stability, thus reducing potential and existing erosion problems. Undisturbed vegetation is less susceptible to invasion by exotic plant species and has high wildlife value.

- **Maintain drainage structures** such as culverts and ditches to avoid overtopping and erosion of soils into the streams. Other erosion prevention recommendations are included in a separate report entitled *Summary of Erosion and Sedimentation in the Petaluma River Watershed.*

- **Avoid depleting instream pools of water during the summer** that may be needed to sustain aquatic life until the winter rains resume. Fisheries are discussed in detail in a separate report entitled *Summary of Fisheries Enhancement Opportunities in the Petaluma River Watershed.*

6.0 Creek and Subwatershed Characterizations and Enhancement Opportunities

Appendix A summarizes the enhancement opportunities for each subwatershed. Table 1 on page 3 provides a key to the abbreviations from the WHR stages that are used throughout the following descriptions.

6.1 Lichau Creek Subwatershed

6.1.1 Characterization.

Lichau Creek is located in the northern portion of the Petaluma River watershed east of Sonoma Mountain (see Riparian Vegetation Area Map R1). The main channel flows southeast for about 7.5 miles through the town of Penngrove until it joins Willow Brook Creek. The subwatershed contains several small creeks that flow east and west into the main channel. They include Highland, Martenoni, Meacham, Penngrove, and Davis Lane Creeks. Together they comprise approximately 4.5 miles of riparian corridor. The entire subwatershed drains an area of approximately 9.7 square miles, which is 7% of the Petaluma River watershed.

Soils in the lower reach of Lichau Creek are Cotati fine sandy loam with a moderate erosion hazard rating according to the *Soil Survey of Sonoma County, California* (1972). Moving upstream, the soils turn to Diablo clay and then to Goulding cobbly clay loams. These soils are associated with rapid run-off and high erosion hazard.

Riparian vegetation along the middle and lower reaches of Lichau Creek shows a high degree of impact from development and agriculture since historical times when a contiguous forest of dense trees and shrubs (VRI 4-6D) characterized the corridor. Today the lower reach of creek, east of Petaluma Hill Road and south along the Northwestern Pacific Railroad to its confluence with Willow Brook Creek, drains through areas that have been converted for municipal and residential use. Here the vegetation varies from areas of moderate woody growth dominated by willow and live oak (VRI 4-5M) to open areas lacking substantial woody vegetation (VRI 4P). Groves of eucalyptus and Lombardi poplar are interspersed with the native vegetation. East of Petaluma Hill Road, a 2-mile stretch of creek has been converted to annual grassland habitat (AGS 2D). Upstream, the corridor graduates into a moderately dense canopy of live oak, California bay, and willow (VRI 4M). Still further upstream in the uppermost reach, the riparian corridor deepens, reflecting its historical character. The dense, two-storied forest (VRI 4-6D) covers about 88 acres (just under 3 linear miles) and is dominated by oak and California bay. It is flanked by oak/bay woodlands to the north and south, increasing its value to wildlife and decreasing erosion problems along the hillsides and streambanks.

Highland, Martenoni, and Meacham Creeks are located west of the Northwestern Pacific Railroad and north of the Highway 101 corridor. They flow east into Lichau Creek. Penngrove Creek and Davis Lane Creek are east of the railroad, flowing southwest into the main channel. The riparian vegetation that remains is dominated by live oak interspersed with groves of eucalyptus. Although the corridor has been fragmented and split by division of land into small, rural residential estates, small intact sections of moderately dense (VRI 4M) vegetation persist along portions of Meacham Creek and Penngrove Creek (see Riparian Vegetation Area Map R1). Davis Lane Creek is the most degraded of all six, with less than a quarter of a mile of riparian vegetation (VRI 4M) remaining.

Also included in the Lichau Creek subwatershed is a large, unnamed creek located north of Lichau Creek. For ease of description, it is referred to as Cold Springs Creek. This is the northernmost creek in the Petaluma River watershed. The lower reach flows along Roberts Road where it is highly impacted by cattle grazing, horse pasture, and rural residential use. Here the vegetation is primarily annual grassland (AGS 1D) with an occasional live oak. The riparian vegetation graduates into willow and alder where the creek turns and follows Lichau Road. As elevations increase, the riparian corridor widens and becomes dominated by large oak and bay trees with big leaf maple and buckeye (VRI 4-5M). Where it nears Cold Springs Road, the tree density increases, and the two-storied riparian forest is dominated by live oak and bay (VRI 5D).

6.1.2 Enhancement opportunities.

Enhancing the two miles of converted annual grassland along the riparian corridor of Lichau Creek east of Petaluma Hill Road was given high priority (see AGS 1D site on Riparian Vegetation Area Map R1). Enhancement would include installation of livestock control fencing and planting willow and oak. The corridor east of the annual grassland (AGS 1D) site and west of the dense forest (VRI 4, 5 & 6D) would also benefit from fencing and scattered planting of oak and California bay in the sparse (VRI 4S) areas; this was given medium priority. The reach between Highland Creek and Penngrove Creek (VRI 4-5M) is accessed by cattle and has erosion problems. Fencing and planting are recommended and given high priority. High priority was also given to fencing and planting oak and California bay in all the open (VRI 4P) sites.

Enhancing the riparian corridor along Highland, Martenoni, Meacham, and Penngrove Creeks is worth pursuing. Because the area has numerous landowners, it may be difficult to coordinate their involvement. For this reason, this area was given a medium priority rating for riparian enhancement. Public outreach in the form of community meetings and education and/or a publicized and distributed creek care guide could bring important information to people with interests in the area. Enhancement would include control of exotic plant species in the area, installation of fencing, and planting willow and oak in areas where woody vegetation is minimal (VRI 4P). Fencing and planting the annual grassland sites (AGS 1D) along Davis Lane Creek was given high priority.

Enhancement along the lower reaches of Cold Springs Creek was given high priority. Enhancing areas that have been converted to annual grassland (AGS 1D & VRI 4P)) by installing livestock control fencing and planting would help to substantially extend the existing corridor. Managing livestock access to the upper reaches will help to preserve the health and aesthetics of the existing corridor; this was given medium enhancement priority. The upper reaches of Cold Springs Creek are relatively healthy and intact.

6.2 Willow Brook Creek Subwatershed

6.2.1 Characterization.

Willow Brook Creek subwatershed is located in the northeast portion of the Petaluma River watershed and drains an area of about 5.3 square miles, which is 4% of the watershed. It includes Willow Brook, Davis, Waugh, and Lower Lichau Creeks.

The headwaters of Willow Brook Creek are located on Sonoma Mountain south of Lichau Creek. The main channel flows south past its confluence with Lichau Creek and into the urban boundary, entering the Petaluma River west of the Highway 101 corridor. The main channel and riparian corridor are approximately 6 miles long. The upper reaches of the riparian corridor are utilized by a wide variety of wildlife, including waterfowl and other bird species, coyote, deer, mountain lion, raccoon, and skunk.

Soils along the main channel are mostly Clear Lake clay in the lower reaches and Gullied land in the upper reaches. The clay soils are the poorly drained soils of floodplains. The slow run-off characteristic of these soils keeps erosion potential low. Gullied land, occurring within the upper reaches of the Willow Brook Creek corridor, is unique to certain areas east of Petaluma. Here, where livestock impacts have diminished protective plant cover, excess run-off cuts into the natural watercourses resulting in very high erosion hazard.

Most of the length of Willow Brook Creek has a seasonal rather than perennial water regime with water flow occurring only during the wet season. South of Ely Road and into the urban boundary, the riparian vegetation is composed of moderately dense trees (VRI 4M) dominated by willow and oak. Riparian vegetation has been reduced to an occasional tree in the portion of creek north of Ely Road and south of Adobe Road. Years of agricultural use and municipal expansion have converted the vegetation to annual grassland (AGS 1D) dominated by introduced grasses such as annual rye and wild oat. One can assume that historically this portion of the creek was once dominated by willow thickets and blackberries. From the unwooded lower reach, the vegetation develops upstream into moderately dense, small trees (VRI 4M) dominated by live oak and California bay. Moving farther upstream, cattle access for grazing has developed a mosaic pattern to the corridor with alternate areas of dense vegetation and open grassland. This portion of the creek was given a WHR rating of VRI 4P. Within the uppermost reach of Willow Brook Creek, deep steep slopes and occasional fencing have hindered access to the corridor, thus protecting the riparian habitat from livestock. The vegetative corridor here extends to widths up to 300 feet. The habitat stage is dense, small and large trees (VRI 4-5D) dominated by black oak, coast live oak, and California bay, with an understory of buckeye.

Davis and Waugh Creeks are tributaries flowing southwest into the main channel of Willow Brook Creek. Lower Lichau Creek is located on the east side of Willow Brook Creek and flows eastward into the main channel east of the Highway 101 corridor. Davis Creek has approximately 0.5 mile of VRI 4M vegetation remaining and about 8.5 acres (less than 0.25 mile) of VRI 4-6D forest within its uppermost reach. Waugh Creek is characterized primarily by sparse to open riparian vegetation (VRI 4S & 4P).

Historically, the overall streamside vegetation was likely a continuous, dense forest similar to the present upper reach, with medium to large riparian trees (VRI 4-6D).

6.2.2 Enhancement opportunities.

About 21 acres of annual grassland habitat (AGS 1D) located in the lower reach of Willow Brook Creek, just north of Adobe Road and running south to Ely Road, was identified as having high enhancement opportunity (see Riparian Vegetation Area Map R2). This would include installing livestock control fencing and planting willows. Landslips are common along this stretch of creek, and revegetation would help to decrease erosion hazards and increase water quality.

Along the middle reach of the creek, an area of approximately 43.5 acres north of Adobe Road (including the eastern tributary) is comprised of a mixture of moderately dense to open tree canopy (VRI 4M, 4S & 4P) and annual grassland (AGS 1D). This area was rated as having medium enhancement priority. The riparian corridor here could be considerably enhanced by limiting cattle access with fencing. Areas where woody vegetation is scarce or absent (VRI 4S & 4P and AGS 1D) could be planted with live oak and California bay (see Riparian Vegetation Area Map R2).

The uppermost reach, an area of about 68 acres (about 2 linear miles), has been protected by its unique gullied topography and management practices. This area, which resembles historic riparian conditions (VRI 4-6D), was given a low priority rating for enhancement.

Enhancement along Waugh Creek and Davis Creek would increase wildlife values in areas nearer the urban boundary and help to minimize erosion problems along the streambanks. These areas were given high enhancement priority due to their degraded condition. Enhancement would include fencing and planting willow and oak along the annual grassland (AGS 1D) sites and areas with sparse to open woody vegetation (VRI 4S & 4P) (see Riparian Vegetation Area Map R2). Lower Lichau Creek is located within small, rural residential properties. Enhancement by fencing and planting open areas with willow and oak (VRI 4P) was given medium priority.

6.3 Corona and Capri Creeks

6.3.1 Characterization.

Corona and Capri Creeks are small creeks located southeast of Willow Brook Creek and northwest of Lynch Creek. Their headwaters are located on Sonoma Mountain and flow south across Adobe Road into the urban boundary, entering the Petaluma River just west of the Highway 101 corridor. They drain an area of approximately 5.1 square miles, which is 3% of the Petaluma River watershed.

Riparian habitat along these creeks has been almost entirely converted into annual grassland (AGS 1D). Corona Creek has a small patch (less than 0.25 mile) of moderately dense (VRI 4M) riparian vegetation remaining, and Capri Creek is characterized entirely by annual grassland (AGS 1D).

6.3.2 Enhancement opportunities.

Enhancement along both creeks would increase wildlife value in areas nearer the urban boundary and help to minimize erosion problems along the streambanks. These areas were given high enhancement priority due to their degraded condition. Enhancement would include fencing and planting willow and oak among the annual grassland (AGS 1D) sites and areas with sparse woody vegetation (VRI 4S) (see Riparian Vegetation Area Map R2).

6.4 Lynch Creek Subwatershed

6.4.1 Characterization.

Lynch Creek is situated in the northeast portion of the Petaluma River watershed, draining approximately 4.0 square miles and comprising 3% of the watershed. The headwaters are located in steep hillsides along Sonoma Mountain Ridge near Sonoma Mountain Road. The main channel drains south 6.8 miles (4 miles are outside the urban boundary) with 3.5 miles of tributary and enters the Petaluma River west of Highway 101 at the confluence of what is locally-known as Petaluma Creek.

Soils of the lower half of Lynch Creek are primarily Gullied land and Diablo clay with Clear Lake loam appearing in the floodplain where the channel nears the Petaluma River. Both Gullied land and Diablo clay soils have high erosion potential and land slippage associated with excess run-off. Moving upstream into the upper reaches, the soils become Goulding cobbly clay loam. These shallow soils are also associated with rapid run-off and high erosion hazard.

Inside the urban boundary south of Adobe Road, about 13 acres (approximately 0.75 linear miles) of densely vegetated stream still exist. Outside the boundary, the riparian corridor is generally open in the middle reach. Cattle access to the creek and other agricultural practices have reduced the historically dense corridor to scattered individual trees and small groupings (VRI 4P). Willow is the dominant species with alder and oak. Upstream the vegetation graduates into a section of moderately dense, small trees (VRI 4M). Still further upstream in the upper reach, approximately 83 acres (about 2.25 linear miles) of the corridor remain reminiscent of what existed historically, reaching widths over 300 feet. The riparian forest in this section is dense and two-storied (VRI 5-6D), dominated by oak and California bay. Oak/bay woodlands inhabit the hillsides directly adjacent to the corridor, increasing the wildlife values of these upper areas.

6.4.2 Enhancement opportunities.

Enhancement opportunity exists for the riparian corridor south of the dense riparian forest (VRI 5-6D) in the upper watershed (see the VRI 4P sites on Riparian Vegetation Area Map R2). The presence of mature, relatively intact forest in the upper watershed gives value to remnant areas downstream. Connecting the corridor south into the City boundary will increase water quality, wildlife usage, and aesthetics throughout the subwatershed.

Enhancement would include installing livestock control fencing along the moderately dense (VRI 4M) portion of the corridor (medium priority), as well as fencing and planting willow, oak, and California bay (high priority) along the open (VRI 4P) portions of the riparian corridor.

6.5. Washington Creek Subwatershed

6.5.1 Characterization.

Washington and East Washington Creeks are located in the northern portion of the Petaluma River watershed between Lynch Creek to the northwest and Adobe Creek to the southeast. Together they drain an area of approximately 8.3 square miles, which is 6% of the entire watershed.

The main channel of Washington Creek flows south adjacent to Ielmorini Lane, crossing Adobe Road and following East Washington Blvd. and finally draining into the Petaluma River north of Petaluma Blvd. The riparian corridor is approximately 7 miles long with about 2 miles of tributary, nearly 3 miles of which are located outside the urban boundary. The upper reaches of the riparian corridor are utilized by a wide variety of wildlife.

Soils along the main channel are Diablo clay. Storm run-off is moderate to rapid, resulting in medium to high erosion hazard. Landslips are characteristic of these soils.

Portions of Washington Creek north of Adobe Road have a perennial water regime with water running all year round. Cattle graze the rural hillsides and have access to the creek, although steeply incised banks have helped to protect the integrity of the riparian vegetation. The Valley Foothill Riparian vegetation characteristic of the channel north of Adobe Road is a dense, two-story riparian forest (VRI 5-6D) dominated on the upper banks by a canopy of live oak, black oak, and California bay with buckeye in the understory. A shrub layer, including snowberry, honeysuckle, and poison oak, occurs in dense to moderate patches throughout. Big leaf maples share instream portions of the banks with willow and blackberries. This portion of creek is probably reminiscent of historical conditions, although historical riparian forest widths of greater than 300 feet are reduced to widths closer to 100 to 150 feet.

Upstream, tree and shrub density thin to a habitat stage of 6M with oak and bay remaining dominants, and willow becoming less abundant. Density increases again in the very upper reach of creek with approximately 27.5 acres (just over 1 mile) of two-storied, dense (VRI 5-6D) forest. South of Adobe Road, just before it enters the urban boundary, the creek corridor has been dramatically impacted by agriculture and development practices. Here the riparian vegetation thins into a single-story, sparsely populated riparian corridor (VRI 4S) with willow in the creekbed and exotic Lombardi poplars along the streambanks.

East Washington Creek is a small creek located east of Washington Creek and west of Adobe Creek. The main channel is approximately 3.5 miles long with just over 3 miles of significant tributary. Nearly 2 miles of the lower reach have been channelized as it enters the urban boundary. The creek flows southwest, crossing Adobe Road, and is channelized until it drains into Washington Creek east of the Highway 101 corridor within the urban boundary.

Soils in the lower reach are Clear Lake clay with a slight to moderate erosion hazard. Upstream, the soils turn to Diablo clay in the main channel and Gullied land in the western tributary. Erosion hazard increases in the tributary with increased slope steepness.

North of Adobe Road, the main riparian corridor is a relatively narrow but contiguous forest of moderately dense woody vegetation (VRI 4M) dominated by willow with oak and alder. A very small patch (less than 0.25 mile) of dense forest (VRI 4D) occurs just north of Adobe Road. Riparian vegetation in the western tributary becomes fragmented and open with a habitat stage of VRI 4S-4P.

6.5.2 Enhancement opportunities.

The majority of the Washington Creek riparian plant community north of Adobe Road constitutes a contiguous corridor of moderate to densely populated large trees and shrubs. This portion of creek was given low enhancement priority due to its relatively good condition. This should not underrate the value of landowners seeking ways to preserve the integrity of this habitat. Installing livestock control fencing to limit access to the creek will help to insure creek protection and limit existing or potential erosion hazards.

An exotic plant problem is developing in a portion of the creek directly adjacent to Ielmorini Lane (see site WA-1 on Riparian Vegetation Area Map R2). A thick layer of introduced German ivy is displacing the natural creekside groundcovers and shrubs. Poison hemlock is well established and expanding its territory. Indigenous wildlife is adapted to the native flora for food and cover. Displacement of these natives can have serious impact on wildlife inhabiting the area. Certain exotic plant species, such as German ivy, are suspected to contain chemical substances that can be poisonous to native fishes. Removal of these exotic species was given a medium priority rating.

South of Adobe Road and north of the urban boundary is an area of approximately 14 acres that has high enhancement potential (see VRI 4P site on Riparian Vegetation Area Map R2). The existence of a contiguous riparian corridor to the north increases the potential wildlife values of this portion of creek. Enhancement would include fencing and planting willow.

Enhancement opportunity along the upper reaches of East Washington Creek north of Adobe Road was given a medium priority. Fencing the entire channel would promote natural revegetation with occasional planting in areas where woody vegetation is absent (VRI 4S & 4P sites). Fencing and planting in the sparse and open sites (VRI 4S & 4P) along the western tributary would speed the natural recovery of the creek. Revegetation will reduce erosion hazards that may be a problem due to the patchy habit of the streamside vegetation.

6.6 Adobe Creek Subwatershed

6.6.1 Characterization.

Adobe Creek is located in the northeastern portion of the Petaluma River watershed. The seasonal creek meanders south from the steep slopes of

Sonoma Mountain, draining an area of approximately 4.9 square miles, which is 3% of the watershed. The main channel flows southward approximately 7.5 miles, crossing Manor Lane, Adobe Road, and Casa Grande Avenue and entering the low-lying areas within the urban boundary. Adobe Creek enters the Petaluma River south of Highway 116 and east of Highway 101. Tributaries account for another 2 miles of riparian corridor.

Soils in the lower reach of Adobe Creek are Clear Lake clay and have a slight erosion hazard due to slow run-off according to the *Soil Survey of Sonoma County, California* (1972). Moving upstream, soils turn to Diablo clay with increasing erosion potential and land slippage. The upper reaches are characterized by Goulding cobbly clay loam and Sobrante loam soils. Goulding soils are shallow soils with cobblestones; run-off is rapid, and erosion hazard is high.

The riparian vegetation in the low-lying areas south of Adobe Road and adjacent to Adobe Creek Golf Course has been almost entirely eliminated. A sparsely-populated remnant patch of riparian forest (VRI 4S) remains in a 1,000-foot stretch of creek in the northeast corner of the golf course. Above Adobe Road the riparian habitat remains sparse (VRI 4S) until it approaches the intersection with Manor Lane. Here an approximately 500-foot stretch of creek is characterized by moderately dense small trees dominated by willow with oak and alder (VRI 4M). The understory consists of dense thickets of non-native blackberry with significant populations of poison hemlock, yellow starthistle (*Centaurea solstitialis*), and fennel along the roadside where the creek crosses Manor Lane. West of Manor Lane the riparian vegetation thins again to sparse and open habitat stages (VRI 4S & 4P) with only small portions having moderate density (VRI 4M). The willow dominating the wetter areas becomes less common, and live oak increases with California bay.

Upstream, Adobe Creek forks downstream of the old Petaluma Reservoir. This upper reach of creek, which includes north and south forks, contains approximately 180 acres (approximately 5 linear miles) of two-storied, dense riparian vegetation (VRI 5-6D) dominated by oak and willow. This remnant, historical corridor reaches widths over 300 feet and is joined by oak and bay woodlands above its banks. This area has been preserved by steep hillsides and management practices.

6.6.2 Enhancement opportunities.

Overall, the riparian vegetation along the middle and lower reaches of Adobe Creek has been significantly degraded through many years of agriculture and development. North of Adobe Road, approximately 33 acres including tributaries (nearly 2 linear miles) were identified as having high enhancement opportunities (see VRI 4S & 4P sites on Riparian Vegetation Area Map R3). South of Adobe Road and east of the Adobe Creek Golf Course, a stretch of creek approximately 0.5 miles long (approximately 9 acres) that has no riparian vegetation (see AGS 1D site on Riparian Vegetation Area Map R3) was also given a high enhancement rating. These areas could be enhanced by fencing and planting. Streambank stability is low to moderately low in several places along the main channel. Re-establishing the riparian vegetation in these areas would have a significant effect on reducing existing and potential erosion problems. Control of exotic plant species that are displacing native species (see site AD-1 on Riparian Vegetation Area Map R3) is important for overall wildlife values and is a medium priority enhancement opportunity.

Enhancement along the upper, dense corridor has been given low priority. The naturally steep topography has limited access. The dense, natural vegetation lowers erosion potential and maintains high water quality and wildlife values.

6.7 Ellis Creek Subwatershed

6.7.1 Characterization.

Ellis Creek and its tributaries are located in the western Petaluma River watershed, draining an area of approximately 9.4 square miles, which is 6% of the watershed. The main channel meanders east and south approximately 5.7 miles, traveling through flat agricultural and marshland and entering the Petaluma River at a great bend just south of Petaluma's wastewater ponds. Hutchinson, Cherry, and Gregory Creeks are northern tributaries of Ellis Creek, flowing south into Ellis Creek before it changes course and journeys southward. Together they comprise approximately 12 miles (including their tributaries) of stream. Higgins Creek is a more southerly tributary, located north of South Ely Road between Frates Road and Browns Lane; it flows westward about 1 mile into Ellis Creek.

Soils along Ellis Creek and its tributaries are primarily Gullied land with very high erosion hazard.

In the lower reach of Ellis Creek south of the confluence of Higgins Creek, the main channel has been severely depleted of natural vegetation with only occasional willow and oak remaining (VRI 4P). The corridor south of Lakeville Highway and west of the Petaluma wastewater ponds (approximately 0.75 miles) has been channelized for flood control. A sparse canopy of woody vegetation remains in this portion and is characterized by a habitat stage of VRI 4S.

North of Higgins Creek, the main channel develops into a dense canopy of willow and oak (VRI 4D). Although the corridor is much narrower here (approximately 75 feet) than what likely occurred historically (greater than 300 feet), the vegetation is contiguous. The eastern and upper reaches of Ellis Creek become open once again just east of its confluence with Gregory Creek. This portion of the corridor is characterized by an open canopy of willow and live oak (VRI 4P).

All of the tributaries that flow into Ellis Creek have been significantly altered by land use during the past two hundred years. Historical corridor conditions, which likely included riparian forest widths over 200 feet, have been reduced to narrow bands of trees dominated by oak and open grassland. Hutchinson Creek remains the most floristically intact of the four tributaries, receiving a habitat rating of VRI 4M throughout a significant portion. Approximately 5 acres (less than 0.5 mile) of dense forest (VRI 4D) occurs just north of Adobe Road (see Riparian Vegetation Area Map R3). Tree canopy in Cherry and Gregory Creeks is primarily open (VRI 4P), and riparian vegetation along Higgins Creek has been converted to annual grassland (AGS 1D).

6.7.2 Enhancement opportunities.

With the exception of the channelized area of Ellis Creek west of the Petaluma wastewater ponds, most of the main channel and its tributaries were rated with a high enhancement priority. Above Lakeville Highway, the riparian corridor would benefit from livestock control fencing and planting. Large landslips are common along Ellis Creek and all four tributaries. Limiting streamside access would help to promote natural revegetation while reducing erosion hazards. Planting along the sparse and open areas (VRI 4S & 4P; see Riparian Vegetation Area Map R3) would hasten recovery time and increase water quality, wildlife, and aesthetic values.

The dense forest (VRI 4D) north of Higgins Creek and south of Adobe Road to the confluence with Cherry Creek received a medium enhancement priority, which would include installing livestock control fencing.

6.8 Liberty Creek

6.8.1 Characterization.

The Liberty Creek subwatershed drains the upper northwest portion of the Petaluma River watershed. The area is approximately 15.3 square miles, which is 10% of the entire watershed. The main channel of Liberty Creek outside the urban boundary is approximately 3 miles long. Liberty Creek drains into the Petaluma River just inside the urban border where Stony Point Road meets Petaluma Blvd. North. The surrounding land use has been agricultural since the 1800s (mostly range and pasture) and is characterized by European annual grasses.

Soils along the main channel are mostly Pajaro fine sandy loams with a low erosion hazard rating due to moderate streambank sloping. Soils along the lower reach of the creek turn to sandy Alluvial soils, sandy, in which streambank cutting and erosion have occurred.

Liberty Creek has a seasonal water regime. The land use surrounding it is primarily dairy. Cattle access to the creek has maintained a predominantly grassland habitat (with occasional remnant willows) along the majority of the creek that can be characterized as Annual Grassland (AGS 1D) dominated by species such as annual rye, soft chess broom, Mediterranean barley, and wild oat. The riparian vegetation, which occurs only occasionally along the main channel west of Jewett Road and north of Pepper Road (approximately 0.5 miles long), is characterized by mostly moderate cover of small trees (VRI 4M) dominated by willow and live oak with patches of non-native eucalyptus.

Beginning at the confluence of Liberty Creek and the Petaluma River, which occurs within the urban boundary, and following north along Petaluma Blvd., the riparian corridor becomes relatively dense and contiguous. Although municipal development has impacted species composition and the natural regime of the creek, the riparian corridor is more intact than in upstream areas. The habitat value of this portion of creek is important when assessing enhancement opportunities along the creek corridor outside of the City. Establishing a contiguous riparian corridor from within the urban boundary to the outlying rural areas can increase wildlife and water quality values considerably.

Historically, the riparian corridor was probably dense willow thickets with live oak reaching widths over 200 feet. The lowest-lying areas may have fanned out into extensive seasonal wetlands dominated by sedges and rushes.

Wiggins, Wilson, and Marin Creeks are small creeks within the Liberty Creek subwatershed that drain a low-lying area of the Petaluma River watershed. The main channels and riparian corridors outside the urban boundary total 15 miles in length. Most of the length of the creeks are within the 100-year flood zone. Extensive channelizing, clearing, development, and grazing have changed the character of these creeks from what may have been predominantly willow and oak with wetlands to European annual grasses (AGS 1D). Only about 12% of the length of these creeks has a narrow width of riparian habitat classified as VRI 4P or 4M.

Except in the uppermost reaches, soils along the creek corridors are Blucher fine sandy loam, overwash on 0 to 2% slopes, according to the *Soil Survey of Sonoma County, California* (1972). These soils are poorly to moderately drained and are subject to frequent flooding. Soils in the uppermost reaches are Pajaro fine sandy loam, clay loam, Cotati fine sandy loam, and Steinbeck loam. Erosion hazard for these soils is mostly slight with moderate hazard on steeper slopes.

6.8.2 Enhancement opportunities.

Nearly all of the riparian corridor along Liberty Creek has high potential for enhancement except the vegetated portions near Jewett and Pepper Roads (see Riparian Vegetation Area Map R3). Enhancement could include installation of fencing and planting willows and coast live oak along 2 miles of creek (see AGS 1D sites on Riparian Vegetation Map R3), thus connecting and integrating the now fragmented riparian habitat. Increasing the riparian vegetation along the creek will help reduce any existing or potential erosion and sedimentation problems along the streambank while providing new and extended habitat for wildlife.

Enhancement along Wiggins, Wilson and Marin Creeks was given low priority. These creeks have had a history of being cleared and dewatered due to intense agricultural use. Enhancement would be a formidable task because of development pressures, multiple landownership, and the disturbed nature of the area from a wildlife habitat perspective. There is probably little habitat value to be gained without a major restoration of the entire stream corridor. Restoration would involve fencing, regrading, and planting of wetland plants, as well as riparian woody species.

6.9 Kelly, Thompson, Kastania, Sutton, and Schultz Creeks in the Petaluma Westside Subwatershed

6.9.1 Characterization.

Kelly, Thompson, Kastania, Sutton, and Schultz Creeks are small creeks draining a low-lying area of 6.8 square miles (not including areas within the urban boundary), which is 4.6% of the Petaluma River watershed. This area is west of the Petaluma River and Highway 101 north of the San Antonio Creek subwatershed.

Kelly and Thompson Creeks have their headwaters in the hilly agricultural land south of the City and run through the town before their confluence with the Petaluma River. Soils in the upper reaches are Los Osos clay loams with moderate to high erosion hazard rating. The lower reaches are Pleasanton loams with slight to moderate erosion hazard rating. These creeks were probably moderate to dense forests historically (VRI 4M & 4D) with willows and oaks. The riparian corridor has largely been converted to annual grasses (AGS 1D) with a few areas of open remnant woody cover (VRI 4P).

Kastania and Sutton Creeks enter the Petaluma River in the marshlands to the south. They still have good, continuous riparian cover (VRI 4M) on Los Osos clay loams with Zamora silty clay loams downstream. Both soils have a slight to moderate erosion hazard rating. Historically these creeks may have had a wider riparian cover zone.

Schultz Creek enters the marshlands further to the south and overall has less riparian cover, ranging from none (AGS 1D) to sparse (VRI 4S) to dense (VRI 4D). The area is active rangeland with houses and a barn adjacent to the creek. Soils are Zamora silty clay loams and Los Osos clay loam with moderate to high erosion hazard.

6.9.2 Enhancement opportunities.

The upper reaches of Kelly and Thompson Creeks could be enhanced with fencing and planting. Within the urban boundary on Thompson Creek, there has been a streamside planting program with good community involvement that could be carried farther upstream. The isolated nature of the habitat from a wildlife perspective lowers the value of enhancement projects. However, the higher erosion hazard, low woody cover, and social values argue for rating this as a medium priority enhancement site.

Fencing and planting the 5,000 feet of open area within the Schultz Creek stream zone could connect upper and lower habitat areas in this drainage and potentially reduce erosion. This area is rated high priority for enhancement.

6.10 San Antonio Creek Subwatershed

6.10.1 Characterization.

San Antonio Creek drains most of the southwest portion of the Petaluma River watershed encompassing approximately 36.5 square miles, which is 24% of the entire watershed. The main channel and riparian corridor are approximately 11 miles long with 13 miles of significant tributary on the north side and another 26 miles of significant tributary on the south. ("Significant tributary" in this case is a "blueline" stream as found on the USGS 7.5 minute topo map.) The confluence of San Antonio Creek and the Petaluma River is in marshland west of Highway 101 at the Marin-Sonoma county line. The surrounding land use has been agricultural since the early 1800s. The majority of the watershed is now characterized by European annual grasses with scattered oak woodlands and narrow bands of riparian forest. The riparian corridor is utilized by a wide variety of wildlife including resident and migratory bird species, coyote, deer, mountain lion, raccoon, and skunk. A more complete species list is included in the *Restoration Design and Management Guidelines for the Petaluma River Watershed* by Questa Engineering Corporation, et al., July, 1996 (see Appendix D).

Most of the length of San Antonio Creek has a seasonal rather than perennial water regime. Soils along the riparian corridors are Zamora silty loams, Clear Lake clay, and Los Osos clay loam with a slight to moderate erosion hazard rating. On the Marin County side, soils are Ballard gravely loam, Blucher silt loam, Cole clay loam, and Clear Lake clays (*Soil Survey of Marin County, California,* 1985). The erosion potential increases in the tributaries with increased slope steepness.

The riparian vegetation in lower reaches follows the main channel in a roughly 150-foot wide corridor. The habitat stage is mostly dense, small trees (VRI 4D) dominated by willow, live oak, buckeye, and California bay. There are patches of non-native eucalyptus as well. This vegetation type graduates into a dense, two-story (VRI 6D) riparian forest of valley oak and buckeye with willows downstream of D Street.

West of D Street, the character of the riparian corridor changes to a more open to sparse canopy cover (VRI 5S & 5P) with valley oaks as the dominant riparian woody species. As the land elevation increases in the tributaries and headwaters, the species composition changes to black oak with coast live oak, bay, ash, and willow. These upper riparian corridors west of D Street appear to be the most heavily impacted by agricultural practices.

Historically, the 50 miles of streamside vegetation was most likely a continuous, dense canopy of medium to large riparian trees (VRI 4-6D). Today the riparian corridor has thinned out in many areas with one-third the length of the corridor exhibiting sparse and open canopy cover and some areas converted to annual grassland with no woody canopy.

Also included in the San Antonio Creek subwatershed are the north and south forks of Olompali Creek. These creeks are located within Olompali State Park and are under the jurisdiction of the California Department of Parks and Recreation (DPR).

6.10.2 Enhancement opportunities.

In the lower reach of San Antonio Creek east of Highway 101, an area of about 11 acres was identified as a potential enhancement opportunity (see site SA-1 on Riparian Vegetation Area Map R4). Enhancement would consist of installing livestock control fencing and planting willows, coast live oak, buckeye, and California bay. This area was given a medium priority rating.

Between Highway 101 and D Street, there are stretches that could be fenced (or fences repaired) to limit livestock from the riparian corridor. In so doing, natural regeneration of oaks, which is currently low to moderate, would be enhanced along with streambank stability and reduced water pollution. One of the northern tributaries in this reach (site SA-9 on Riparian Vegetation Area Map R4) has a lower canopy cover on approximately 2.5 acres with a moderate to high erosion hazard rating. Again, fencing and planting are recommended.

Most of the medium to high priority sites for riparian enhancement, which would include both fencing and tree planting, are located west of D Street along San Antonio Creek and in side tributaries. In some cases, livestock crossings and alternate water sources, such as stock tanks, may need to be developed. Some areas would also be enhanced by the control of exotic species such as starthistle and broom. (See Sites SA-2 to SA-8, which total 112 acres, as noted on the Riparian Vegetation Area Map R4.)

6.11 Lakeville Subwatershed

6.11.1 Characterization.

Several small creeks are located in the lower southeastern portion of the watershed east of the Petaluma River. Positioned south of Ellis Creek, these small tributaries drain into the extensive marshlands that surround the southern portion of the river. This entire subwatershed, which includes the marshland east of the river, comprises an area of 19.8 square miles, 14% of the Petaluma River watershed.

Soils characteristic of these creeks are primarily Gullied land with high erosion potential due to rapid run-off according to the *Soil Survey of Sonoma County, California* (1972).

The riparian vegetation in this area has been dramatically altered by agriculture and livestock grazing. Approximately 1.7 miles (20 acres) of moderately dense forest and less than 0.25 miles (8 acres) of dense forest remain in the subwatershed. Primarily woody vegetation has been converted to annual grassland (AGS 1D) with occasional tall willows remaining in small clusters along some of the creeks with rushes and sedges in seasonally saturated areas. Groves of planted eucalyptus occur in several areas within the subwatershed.

6.11.2 Enhancement opportunities.

Enhancement along all of the tributaries in this southern subwatershed has been given high priority. Several gullies and landslips are present in the area where riparian vegetation has been removed by years of overgrazing and farming.

Enhancement would include installing livestock control fencing and planting along approximately 7.5 miles (82 acres) of Wheat Creek, the tributary adjacent to Stage Gulch Road, and the several unnamed creeks located south to Highway 37 (see AGS 1D & VRI 4P sites on Riparian Vegetation Area Map R5). Generally, willow is the dominant riparian tree species in this area. Vineyards occupy portions of the hills surrounding some of these creeks, and willow is an undesirable species to be planted near grapes. To prevent any problems, willow should be planted discriminantly in areas distant from local vineyards. Alder or ash with live oak could substitute for willows in areas of concern.

6.12 Rush Creek

6.12.1 Characterization and enhancement opportunities.

Rush Creek is located west of the Petaluma River and south of San Antonio Creek in Marin County. It drains an area of approximately 9.2 square miles. The *Enhancement and Public Access Plan for the Petaluma River Area Marin County, California* prepared by Questa Engineering Corporation includes pertinent information on Rush Creek.

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APPENDIX A

Summary of Riparian Enhancement Opportunities

Appendix A
Summary of Riparian Enhancement Opportunities

Name of Tributary	WHR Habitat Stage/Site	Ortho-photo Number	Length* (feet)	Area* (acres)	Enhancement Priority Rating	Enhancement Recommendations	Riparian Area Map #
Lichau Creek	VRI 4D	33D, 34C	25555	88	Low	None	1
	VRI 4-5M	33D	11000	38	High	Fencing & planting	
	AGS 1D	33D	6000	21	High	Fencing & planting	
	VRI 4P	33D	4750	16.4	High	Fencing & planting	
	VRI 4S	33D	2250	7.8	Medium	Fencing & planting	
Highland, Martenoni, Meacham, Penngrove Creeks	AGS 1D	33D	3250	7.46	Medium	Fencing & planting	1
	VRI 4P	33D	11000	25	Medium	Creek Care Guide Control exotics	
Davis Lane Creek	AGS 1D	33D	6250	14.4	High	Fencing & planting	1
Cold Springs Creek	AGS 1D	33D	9750	22.4	High	Fencing & planting	1
	VRI 4P	33D	1250	4.3	High	Fencing & planting	
	VRI 4D	33D, 34C	6500	37	Low	None	
Willow Brook Creek	AGS 1D	33F	6098	21	High	Fencing & planting	1
	VRI 4M	33D	3500	12	Medium	Fencing	
	VRI 4S, 4P, AGS 1D	33D	18250	63	Medium	Fencing & planting	
	VRI 4D	33D	2000	07	Low	None	
	VRI 4-6D	34C	10560	68	Low	None	
Waugh Creek	AGS 1D	33F	6750	15.5	High	Fencing & planting	1
	AGS 1D	33D	750	1.7	High	Fencing & planting	
Davis Creek	VRI 4P	33D	6250	14.4	High	Fencing & planting	1
	AGS 1D	33D, 34C	4000	9.2	High	Fencing & planting	
Lower Lichau Creek	VRI 4P	33F	4250	9.8	Medium	Fencing & planting Control exotics	1
Corona Creek	AGS 1D	33F	5750	13	High	Fencing & planting	1
	VRI 4S	33F	500	1.1	High	Fencing & planting	
Capri Creek	AGS 1D	33F	4500	10.3	High	Fencing & planting	1

* Length and acreage measurements are approximate.

Appendix A
Summary of Riparian Enhancement Opportunities

Name of Tributary	WHR Habitat Stage/Site	Ortho-photo Number	Length* (feet)	Area* (acres)	Enhancement Priority Rating	Enhancement Recommendations	Riparian Area Map #
Lynch Creek	VRI 4P	34C	4500	15.5	High	Fencing	2
	VRI 4M	34C	7250	25	High	Fencing	
	VRI 4P	34E	9750	34	High	Fencing	
	VRI 4M	34E	4000	14	High	Fencing	
	VRI 5-6D	34E	11880	83	Low	None	
Washington Creek	WA-1	34E	4066	14	High	Fencing & planting	2
	WA-2	34E	35	0.02	Medium	Control exotics	
	VRI 4-6D	34C	5600	27.5	Low	None	
East Washington Creek	VRI 4M, 4D	34E	4250	15	Medium	Fencing	2
	VRI 4S, 4P	34E	17500	60.3	Medium	Fencing & planting	
Adobe Creek	VRI 5-6D	34C	26136	180	Low	None	2
	AD-1	34E	50	0.03	Medium	Control exotics	
	VRI 4S, 4P	34E	9600	33	High	Fencing & planting	
	AGS 1D	34E	2640	9.1	High	Fencing & planting	
Ellis Creek	VRI 4P	34E	4500	15.5	High	Fencing & planting	3
	VRI 4P	38A	5750	20	High	Fencing & planting	
	VRI 4D	38A	4500	15.5	Low	None	
	VRI 4P	34F	18000	41.32	High	Fencing & planting	
Hutchinson Creek	VRI 4M, 4S, 4P	34E	14500	50	High	Fencing	3
	VRI 4S, 4P	34E	9500	32.7	High	Fencing & planting	
Cherry Creek	VRI 4P	34E	8250	28.4	High	Fencing & planting	3
Gregory Creek	VRI 4P	34E	3000	10	High	Fencing & planting	3
Liberty Creek	AGS 1D	33E	10560	24.2	High	Fencing & planting	3

* Length and acreage measurements are approximate.

Appendix A
Summary of Riparian Enhancement Opportunities

Name of Tributary	WHR Habitat Stage/Site	Ortho-photo Number	Length* (feet)	Area* (acres)	Enhancement Priority Rating	Enhancement Recommendations	Riparian Area Map #
Wiggins, Wilson & Marin Creeks	AGS 1D	33E, 33F, 37B	60000	137.7	Low	None	3
Kelly & Thompson Creeks	AGS 1D	37B, 37D	6000	13.8	Medium	Fencing & planting	3
Schultz Creek	AGS 1D, VRI 4S	38C	5000	11.5	High	Fencing & planting	3
San Antonio Creek	SAC-1/AGS 2D	38C	3200	11	Medium	Fencing & planting	4
	SAC-2/VRI 5S	37D	8250	28	Medium	Fencing & planting	4
	SAC-3/AGS 1D	37D	9750	22	High	Fencing & planting	4
	SAC-4/VRI 4P, AGS 1D	37D	5000	11	High	Fencing & planting	4
	SAC-5/AGS 1D	37C	3100	7	High	Fencing & planting	4
	SAC-6/VRI 4P	37C	5350	12	Medium	Fencing & planting	4
	SAC-7/VRI 4-5S,AGS 1D	37D	8650	19	High	Fencing & planting	4
	SAC-8/VRI 4S	37C	5600	12.8	High	Fencing & planting	4
	SAC-9/VRI 4P	37D	726	2.5	High	Fencing & planting	4
	VRI 4-6D	38C, 37D, 37C	44250	174	Low	None	4
Lakeville Subwatershed	AGS 1D, VRI 4P VRI 4M VRI 4P	38B, 38D, 39C 38B, 38D	39916 8750 1250	82 20 8	High Medium Low	Fencing & planting Fencing None	5
TOTALS			567322	1860.6	1,029 acres = Medium & High priority		

* Length and acreage measurements are approximate.

APPENDIX B

Summary of February 10, 1998, Landowner Advisory Committee Meeting

PETALUMA RIVER WATERSHED ENHANCEMENT PLAN
SUMMARY OF RIPARIAN COMMUNITY ENHANCEMENT IN THE PETALUMA RIVER WATERSHED

APPENDIX B

SUMMARY OF LANDOWNER ADVISORY COMMITTEE MEETING
February 10, 1998

Agenda Topics

- Updates about SSCRCD's Petaluma River Enhancement Project and other SSCRCD projects
- Overview of the Riparian Plant Community Enhancement Survey
- Discussion of goals and actions to enhance the riparian corridor

SSCRCD's Petaluma River Enhancement Project Update

- Project schedule was reviewed.
- The RCD mailed over 3000 newsletters to watershed residents. Next newsletter is scheduled to be mailed March 20, 1998.
- Three advisory committee meetings have been held. The RCD needs to solidify the committee so that a consistent, core group of landowners are making recommendations for the watershed. The RCD would like to make the names of the participants available to watershed residents.
- As part of the project, the RCD has a Technical Advisory Committee comprised of public agency representatives. These agencies can provide input to the landowners about their concerns and recommendations. The RCD can invite the agency representatives to provide technical information at the meetings.
- Four area meetings are being held with watershed residents to discuss the plan, planning process, and concerns that landowners may have. The first meeting was held on February 3 in Lakeville and attended by over 20 landowners. Meetings are scheduled for the Denman and Penngrove areas, as well as in the San Antonio Creek watershed.
- The RCD has received a grant for $300,000 from the Cal-Fed program (for improving resources in the Bay-Delta area). The RCD funding is earmarked for the Sonoma Creek watershed, specifically for projects. RCD will share the grant with the Sonoma Ecology Center, the San Francisco Estuary Institute, and the Sonoma Valley Vintners & Growers Alliance.

Riparian Plant Community Enhancement Survey
One purpose of the Petaluma River Watershed Enhancement Plan is to characterize the riparian plant community and identify opportunities for enhancement. The study is an overview of riparian conditions outside the Petaluma urban boundary and identifies recommendations for SSCRCD and the watershed advisory group to consider.

The Riparian Plant Community Survey is available from Robert Rand at the RCD. Robert will mail the survey to interested landowners. Comments about the study and recommendations are welcome.

A recommended goal of the Petaluma River Watershed Enhancement Plan is to restore the riparian corridor. The following recommended actions can help achieve this goal. (More detail on the recommendations is presented in the survey). Comments from the meeting are presented in italics.

- **Revegetate high and medium priority riparian sites with willing landowners.** Fifty-one sites have been given a tentative medium to high priority for a total of 1030.5 acres of potential restoration. Criteria for prioritizing enhancement sites include the opportunity to provide contiguous riparian forest habitat between a lower and upper reach of the watercourse, to expand existing habitat, to fill out areas of sparse cover, and to provide cover in areas of higher erosion potential. Benefits would include reduction in erosion hazard, increased water quality, wildlife expansion, and aesthetic improvement.
  √ Use only native riparian species for revegetation.

  - *Most riparian enhancement sites will fall into a medium or high category. Need to add ways to prioritizing sites other than "open and sparse" and "with willing landowners". Water quality issues in individual creeks should be considered. Riparian habitat can provide cover in areas of nutrient loading.*
  - *Another prioritization criteria could include having an adjacent link to other valuable habitat areas such as seasonal wetlands.*
  - *One person (bad actor) can do more damage in a small watershed than everyone combined in a large watershed.*
  - *Need to conduct outreach to all landowners to identify a bigger pool of landowners willing to participate in RCD-sponsored projects.*

- **Manage livestock access to the creeks, especially during the wet season.** Livestock can have a serious effect on riparian vegetation and streambank stability. Controlling livestock access to creeks during times of the year when the ground is saturated and compactible can help reduce damage.

- √ Installing livestock control fencing with livestock crossings and off-stream water development is one way to protect the riparian habitat.
- √ Riparian pastures, cross-fencing, and shade sources are other ways to manage livestock access.

- *Economic considerations. Where do the cows go if they are restricted from creeks in the rainy season?*
- *Need to balance the needs of ranchers and regulatory agencies.*
- *What about fire hazard in areas where livestock are restricted?* Response: Controlled livestock grazing has many benefits, including reducing fire hazard.
- *Are there financial incentives for landowners who plant trees/restore riparian corridors/take land out of production? These incentives could help landowners participate in restoration efforts.*
- *Would conducting a restoration project raise the property value?*
- *Do riparian buffers serve as nutrient filters?* Response: Yes, they can.

- **Develop and distribute a creek care guide to rural landowners and agricultural operators.** Topics should include:
  - √ The importance of healthy riparian corridors to wildlife and the community.
  - √ Landowner stewardship and ways to protect the riparian corridor
  - √ Available resources and technical assistance.

- **Control invasive exotic species.** Plants to especially watch for and remove include German ivy and giant reed.

- **Protect intact sections of the riparian corridor.** Healthy riparian vegetation remains in areas along several of the creeks within the Petaluma River watershed. Installation of livestock control fencing along these stretches will help preserve existing vegetation and streambank stability, thus reducing potential and existing erosion problems.

- **Maintain drainage structures** such as culverts and ditches to avoid overtopping and erosion of soils into the streams.
  - *Can flood gates be included?*

- **Avoid depleting instream pools of water during the summer** that may be needed to sustain aquatic life until the winter rains resume.

General concerns and discussion about the riparian recommendations
Comments in italics are responses by RCD staff.

- How much money will be available to landowners for projects? *This isn't known. Having a plan in place will help the RCD compete for state and federal grants.*
- Are federal cost-share programs available and used in the watershed? Do ranchers know about the availability of these programs? *This was followed by a discussion of the EQIP program. The EQIP cost share programs are administered by the federal Farm Services agency and with technical assistance by NRCS. Information on EQIP is mailed by the Farm Services Agency to all agricultural landowners in Marin and Sonoma Counties. Most EQIP funds in the area are allocated to dairies. The RCD receives funding through grants and the County general fund.*
- Other possible funding options could be mitigation money from freeway expansion and from county road and flood control agencies.
- Why isn't the City of Petaluma here? City has more runoff than rural areas? What is their stormwater program? How do we know that the City will participate in this planning effort and the implementation of the plan?
- City of Petaluma has an erosion control ordinance.
- Sonoma County has a requirement that driveways be paved. This leads to more impervious surfaces in the watershed.

Other general comments from the meeting:
- Look into the condition of the levees, especially after this years rains.

APPENDIX C

Description of Valley Foothill Riparian and WHR Habitat Stages

Valley Foothill Riparian

William E. Grenfell Jr.

Vegetation

Structure.—Canopy height is approximately 30 m (98 ft) in a mature riparian forest, with a canopy cover of 20 to 80 percent. Most trees are winter deciduous. There is a subcanopy tree layer and an understory shrub layer. Lianas (usually wild grape) frequently provide 30 to 50 percent of the ground cover and festoon trees to heights of 20 to 30 m (65 to 98 ft). Herbaceous vegetation constitutes about one percent of the cover, except in openings where tall forbs and shade-tolerant grasses occur (Conard et al. 1977). Generally, the understory is impenetrable and includes fallen limbs and other debris.

Composition.—Dominant species in the canopy layer are cottonwood, California sycamore and valley oak. Subcanopy trees are white alder, boxelder and Oregon ash. Typical understory shrub layer plants include wild grape, wild rose, California blackberry, blue elderberry, poison oak, buttonbrush, and willows. The herbaceous layer consists of sedges, rushes, grasses, miner's lettuce, Douglas sagewort, poison-hemlock, and hoary nettle.

Other Classifications.—Other classification schemes that describe VRI habitats are Cottonwood and California Sycamore (Parker and Matyas 1981), Central Valley Bottomland Woodland - 6.11, Southern Alluvial Woodland - 6.31 (Cheatham and Haller 1975), Wild Rose, Alder, Cottonwood, Sycamore, Willow (Paysen et al. 1980), Riparian Forest - 28 (Küchler 1977) and Forested Wetland - 61 (Anderson et al. 1976).

Habitat Stages

Vegetation Changes 1;2-5:S-D.—Cottonwoods grow rapidly and can reach WHR size/age class 5 in about 20 to 25 years. One specimen measuring 92 cm (36 in) (inside the bark) showed an age of 29 years (Sudworth 1908). This secondary succession to climax could occur as rapidly as 25 to 30 years in VRI habitats dominated by cottonwood. One valley oak tree 54 cm (21 in) in diameter (WHR size/age class 4) showed an age of 57 years. Valley oak dominated riparian systems would probably take 75+ years to reach climax/maturity. Some VRI types consisting of only a shrub layer (VRI 1;2: S-D) (willows, wild rose, blackberry) may persist indefinitely.

Duration of Stages.—Shrubby riparian willow thickets may last 15-20 years before being overtopped and shaded out by cottonwoods. Cottonwood or willow tree habitats close to river channels that receive a good silt infusion, without major disruptive flows, tend to be self perpetuating (R. Holland pers. comm.).

Biological Setting

Habitat.—Transition to adjacent nonriparian vegetation is usually abrupt, especially near agriculture (Cheatham and Haller 1975). The Valley-Foothill Riparian habitat is found in association with Riverine (RIV), Grassland (AGS, PGS), Oak Woodland (VFH) and Agriculture (PAS, CRP). It may intergrade upstream with Montane Riparian.

Wildlife Considerations.—Valley-foothill riparian habitats provide food, water, migration and dispersal corridors, and escape, nesting, and thermal cover for an abundance of wildlife. At least 50 amphibians and reptiles occur in lowland riparian systems. Many are permanent residents, others are transient or temporal visitors (Brode and Bury 1985). In one study conducted on the Sacramento River, 147 bird species were recorded as nesters or winter visitants (Laymon 1985). Additionally, 55 species of mammals are known to use California's Central Valley riparian communities (Trapp et al. 1985).

Physical Setting

Valley-foothill riparian habitats are found in valleys bordered by sloping alluvial fans, slightly dissected terraces, lower foothills, and coastal plains. They are generally associated with low velocity flows, flood plains, and gentle topography. Valleys provide deep alluvial soils and a high water table. The substrate is coarse, gravelly or rocky soils more or less permanantly moist, but probably well aerated (Cheatham and Haller 1975). Average precipitation ranges from 15 to 76 cm (6-30 in), with little or no snow. The growing season is 7 to 11 months. Frost and short periods of freezing occur in winter (200 to 350 frost-free days). Mean summer maximum temperatures are 24 to 39°C (75 to 102°F), mean winter minima are −2 to 7°C (29 to 44°F) (Munz and Keck 1973). VRI habitats are characterized by hot, dry summers, mild and wet winters. Coastal areas have a more moderate climate than the interior and receive some summer moisture from fog (Bailey 1980). Potential evaporation during the warmest months is often greater than precipitation. Low rainfall and streamflow result in water scarcity in many parts of the area.

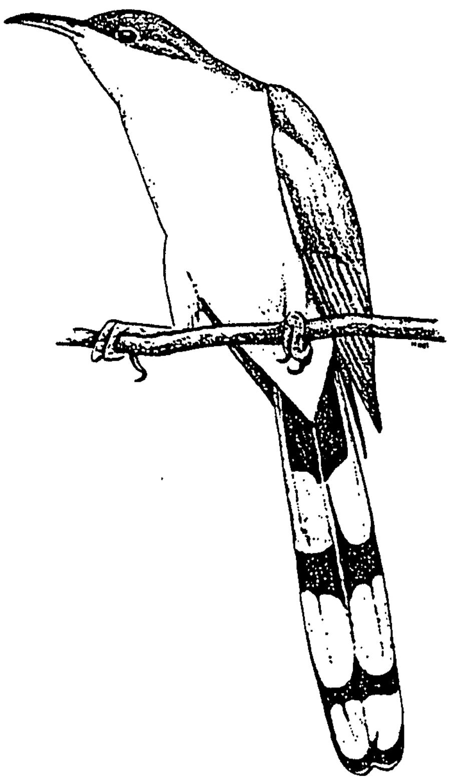
Distribution

Valley-foothill riparian habitats occur in the Central Valley and the lower foothills of the Cascade, Sierra Nevada and Coast ranges. They are also found in lower slopes at the bases of the Peninsular and Transverse ranges. A few lower elevation locations are on the desert side of the southern California mountains. VRI habitats range from sea level to 1000 m (3000 ft), fingering upward to 1550 m (5000 ft) on south-facing slopes.

Mayer, et al, eds, 1988.
A Guide to Wildlife
Habitats of California.

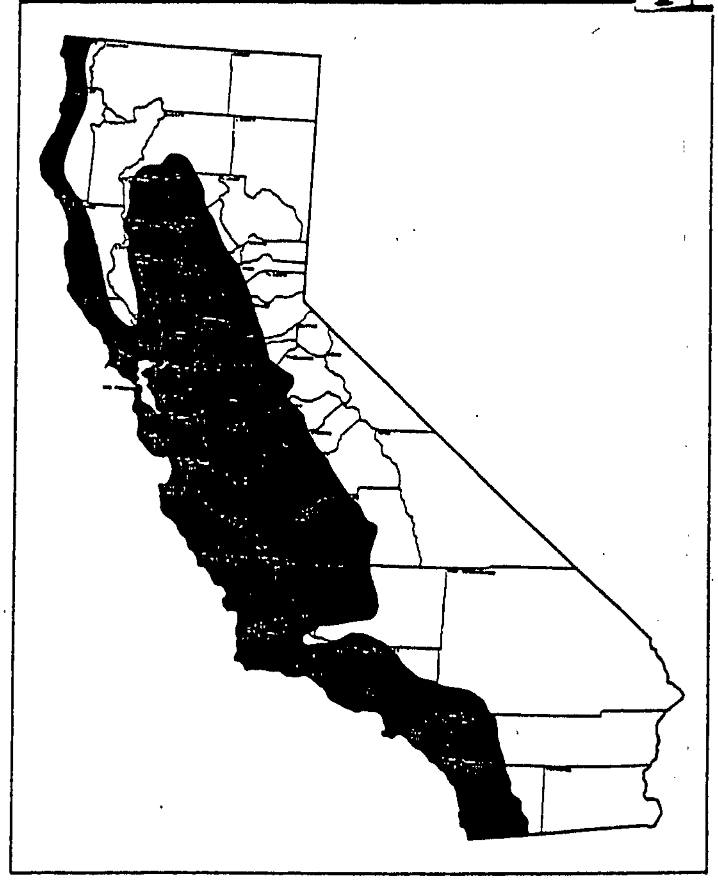
Ringtail *(Bassariscus astutus)*

VRI
Valley Foothill Riparian habitat, Sacramento River, California (photo by Robert F. Holland)



Western Yellow-billed Cuckoo
(Coccyzus americanus)

Valley Foothill Riparian



The map depicts general habitat distribution. Green represents an area of the state that the habitat can be found when the proper environmental conditions exist.

Table 1. Available Habitat Stages For Tree Dominated Habitats

Tree Habitat		Habitat Stage																	
		1	2S	2P	2M	2D	3S	3P	3M	3D	4S	4P	4M	4D	5S	5P	5M	5D	6
SCN	Subalpine Conifer	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
RFR	Red Fir	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
LPN	Lodgepole Pine	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
SMC	Sierran Mixed Conifer	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
WFR	White Fir	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
KMC	Klamath Mixed Conifer	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
DFR	Douglas-Fir	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
JPN	Jeffrey Pine	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
PPN	Ponderosa Pine	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
EPN	Eastside Pine	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
RDW	Redwood	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
PJN	Pinyon-Juniper	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
JUN	Juniper	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
CPC	Closed-Cone Pine-Cypress	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
ASP	Aspen	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
MHC	Montane Hardwood-Conifer	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
MHW	Montane Hardwood	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
BOW	Blue Oak Woodland	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
BOP	Blue Oak—Digger Pine	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
VOW	Valley Oak Woodland	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
COW	Coastal Oak Woodland	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
MRI	Montane Riparian	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
VRI	Valley Foothill Riparian	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	

Standards For Tree Size

WHR	WHR Size Class	Conifer Crown Diameter	Hardwood Crown Diameter	dbh
1	Seedling Tree	n/a	n/a	‹1"
2	Sapling Tree	n/a	‹15"	1"-6"
3	Pole Tree	‹12'	15'-30'	6"-11"
4	Small Tree	12'-24'	30'-45'	11"-24"
5	Medium/Large Tree	›24'	›45'	›24"
6	Multi-Layered Tree	Size class 5 trees over a distinct layer of size class 4 or 3 trees, total tree canopy exceeds 60% closure		

Standards For Canopy Closure

WHR	WHR Closure Class	Ground Cover (Canopy Closure)
S	Sparse Cover	10-24%
P	Open Cover	25-39%
M	Moderate Cover	40-59%
D	Dense Cover	60-100%

Table 2. Available Habitat Stages For Shrub Dominated Habitats

Shrub Habitat		Habitat Stage												
		1	2S	2P	2M	2D	3S	3P	3M	3D	4S	4P	4M	4D
ADS	Alpine-Dwarf Shrub	•	•	•	•		•	•	•		•	•	•	
LSG	Low Sage	•	•	•	•		•	•	•		•	•	•	
BBR	Bitterbrush	•	•	•	•	•	•	•	•	•	•	•	•	•
SGB	Sagebrush	•	•	•	•	•	•	•	•	•	•	•	•	•
MCP	Montane Chaparral	•	•	•	•	•	•	•	•	•	•	•	•	•
MCH	Mixed Chaparral	•	•	•	•	•	•	•	•	•	•	•	•	•
CRC	Chamise-Redshank Chaparral	•	•	•	•	•	•	•	•	•	•	•	•	•
CSC	Coastal Scrub	•	•	•	•	•	•	•	•	•	•	•	•	•
DSS	Desert Succulent Shrub	•	•	•	•		•	•	•		•	•	•	
DSC	Desert Scrub	•	•	•	•		•	•	•		•	•	•	
ASC	Alkai Desert Scrub	•	•	•	•		•	•	•		•	•	•	

Standards For Shrub Size

WHR	WHR Size Class	Crown Decadence
1	Seedling Shrub	(seedlings or sprouts ‹3 years)
2	Young Shrub	None
3	Mature Shrub	1-25%
4	Decadent Shrub	›25%

Standards For Canopy Closure

WHR	WHR Closure Class	Ground Cover (Canopy Closure)
S	Sparse Cover	10-24%
P	Open Cover	25-39%
M	Moderate Cover	40-59%
D	Dense Cover	60-100%

Table 3. Available Habitat Stages For Herbaceous Dominated Habitats

Herbaceous Habitat		Habitat Stage							
		1S	1P	1M	1D	2S	2P	2M	2D
AGS	Annual Grassland	•	•	•	•	•	•	•	•
PGS	Perennial Grassland	•	•	•	•	•	•	•	•
WTM	Wet Meadow	•	•	•	•	•	•	•	•
FEW	Freshwater Emergent Wetland	•	•	•	•	•	•	•	•
SEW	Saline Emergent Wetland	•	•	•	•	•	•	•	•

Standards For Height Classes

WHR	WHR Height Class	Plant Height at Maturity
1	Short Herb	‹12"
2	Tall Herb	›12"

Standards For Canopy Closure

WHR	WHR Closure Class	Ground Cover (Canopy Closure)
S	Sparse Cover	2-9%
P	Open Cover	10-39%
M	Moderate Cover	40-59%
D	Dense Cover	60-100%

GUIDE TO THE CALIFORNIA WILDLIFE HABITAT RELATIONSHIPS SYSTEM

Prepared for:

State of California Resources Agency
Department of Fish and Game
1701 Nimbus Road
Rancho Cordova, CA 95670

Governor George Deukmejian
Gordon K. Van Vleck, Secretary, Resources Agency
Peter Bonadelli, Director,
Department of Fish and Game

Prepared by:

Daniel A. Airola
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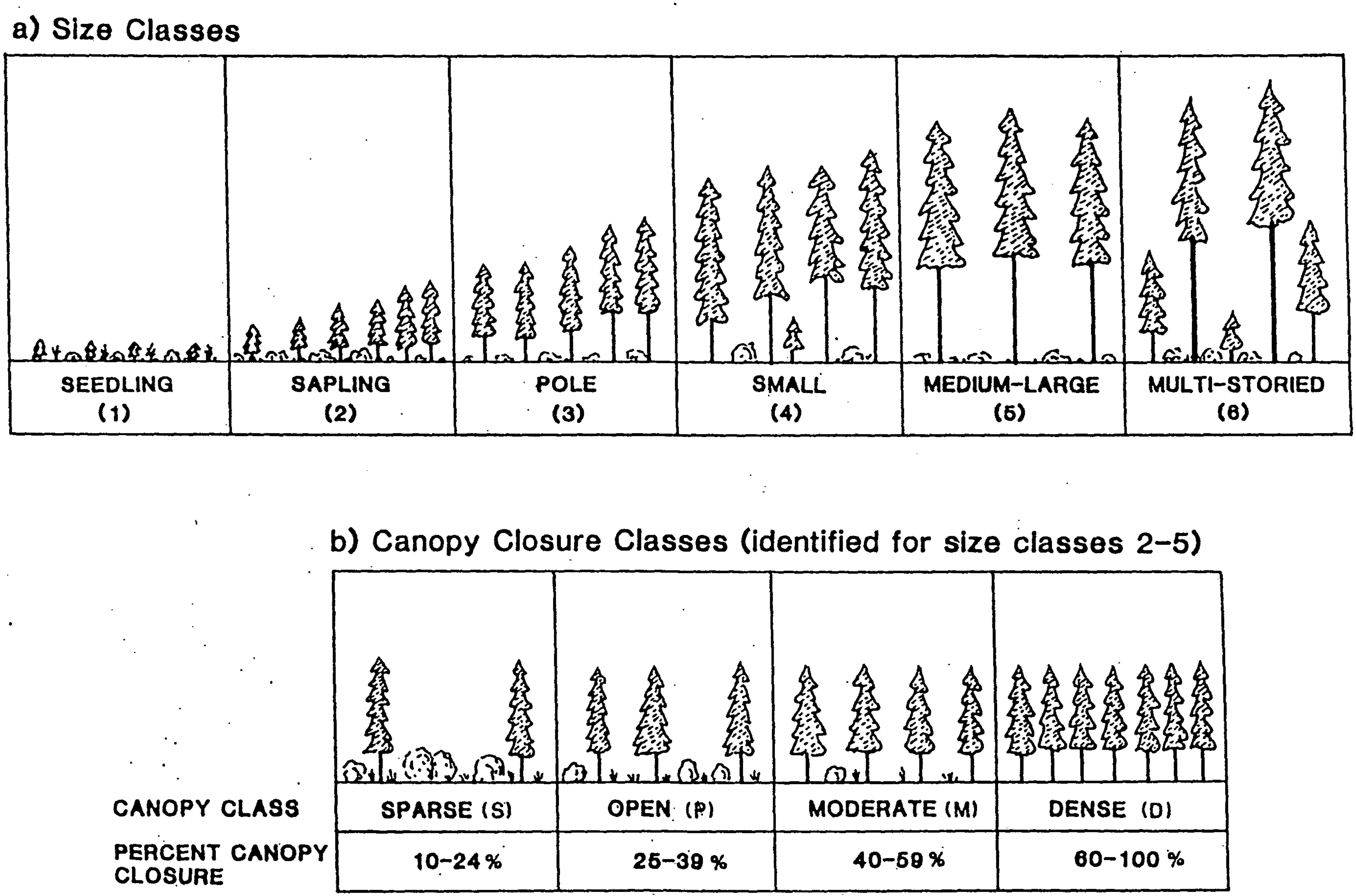
March 1988



Diagramatic Representation of the Habitat Stages Identified for Forest and Woodland Habitats in the Statewide Wildlife Habitat Relationships Program. Habitat Stages are Based on Tree Size Classes Alone for Stages 1 and 6, and for Combinations of Size Classes and Canopy Closures for Size Classes 2 through 5.

APPENDIX D

Plant Species List from *Restoration Design and Management Guidelines for the Petaluma River Watershed*

Questa Engineering Corporation and
Waxman Environmental Consulting & Services,
July, 1996

Waxman Environmental &
Questa Engineering, 1996.
Restoration Design &
Management Guidelines for
the Petaluma River Watershed.

APPENDIX A
PLANT SPECIES FOUND IN WETLAND ENVIRONMENTS IN THE PETALUMA VALLEY

Riparian Plant Species (channel banks & floodplains)

Trees

California Buckeye	*Aesculus californica*	all
Bigleaf Maple	*Acer macrophyllum*	Ly+ Wa Ad-
California Box Elder	*Acer negundo ssp. californicum*	Ly- Th
White Alder	*Alnus rhombifolia*	Ly Wa-
Oregon Ash	*Fraxinus latifolia*	El+ Ly+ Ad Wa
California Black Walnut	*Juglans hindsii*	Th- Ly--
Fremont Cottonwood	*Populus fremontii*	El+ Ly--
Coast Live Oak	*Quercus agrifolia*	all
Valley Oak	*Quercus lobata*	all+-
Red Tree Willow	*Salix laevigata*	all
Pacific Willow	*Salix lasiandra*	Ly Ad
California Bay	*Umbellularia californica*	all+-

Woody Shrubs

Coyote Bush	*Baccharis pilularis var. consanguinea*	Ad Ly
Toyon	*Heteromeles arbutifolia*	Ly- Ad-
California Wild Rose	*Rosa californica*	all+-
Poison Oak	*Toxicodendron diversilobum*	all+-
Himalaya Berry	*Rubus procerus* *	all +-
California Blackberry	*Rubus vitifolius*	El+ Ly
Arroyo Willow	*Salix lasiolepis*	all
Common Snowberry	*Symphoricarpos rivularis*	El+ Ly+

Perennial Subshrubs & Vines

Milkweed	*Asclepias fasicularis*	El-
Mugwort	*Artemisia douglasiana*	all+-

---

all = found on all reference creeks
Ly = Lynch Creek, Ad = Adobe Creek, Th = Thompson Creek, El = Ellis Creek, Wa = Washington Creek, PR = Pet. River
+ = occurs frequently   - = occurs infrequently
all+- = occurs frequently on some creeks and infrequently on others
* = not native to the Petaluma River Valley

Bee Balm	*Scrophularia californica*	Ly El
Vervain	*Verbena lasiostachys*	Ad--
Periwinkle	*Vinca major* *	Ad PR El Lu Wa
Nettle	*Urtica dioica ssp. holosericea*	EL Ad Ly

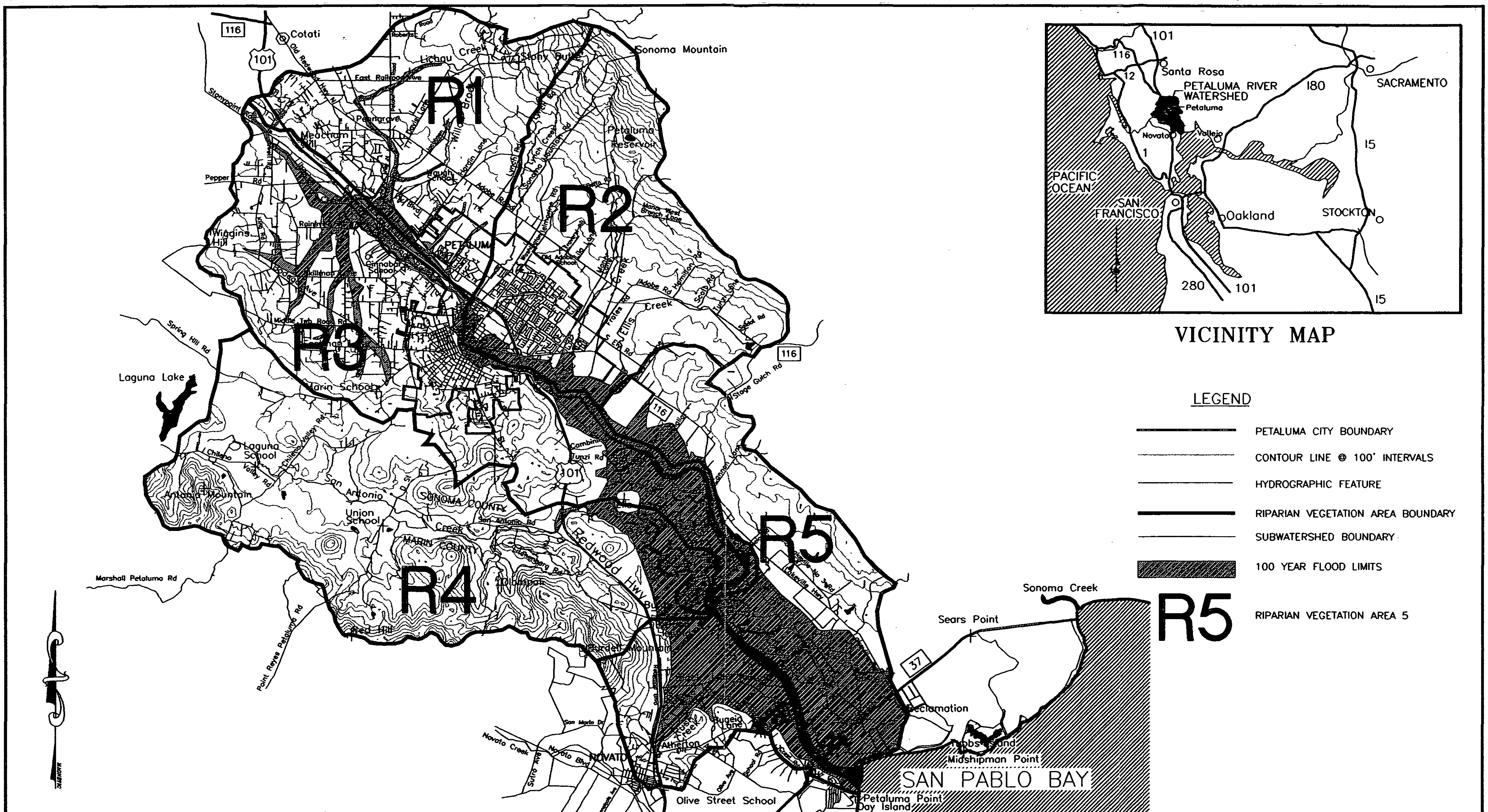
Grasses & Herbs
(channel banks, floodplains & adjacent agricultural fields)

Blow Wives	*Achyrachaena mollis*	PR El
Hair Grass	*Aira caryophyllea* *	PR
Red Maids	*Calandrinia ciliata*	PR El Ly
Blue Wildrye	*Elymus glaucus*	PR
Intermediate Wheatgrass	*Elytrigia intermedia* *	Ad -
California Poppy	*Eschscholzia californica*	all+-
California Fescue	*Festuca californica*	Ad-
Sneezeweed	*Helenium puberulum*	El -
Tarweed	*Hemizonia sp.*	PR Ad El Ly Wa
Meadow Barley	*Hordeum brachyantherum*	PR Ly
Wild Pea	*Lathyrus sp.*	PR Ly -*
Creeping Wild Rye	*Leymus triticoides*	all+-
Dwarf Lupine	*Lupinus nanus*	PR El
Knot Grass	*Paspalum dilatatum* *	Ad Ly
Hardinggrass	*Phalaris tuberosa* *	All+-
Canadian Bluegrass	*Poa compressa*	Ad--
Blue-eyed Grass	*Sisyrinchium bellum*	PR Ly El
Horsemint/Hedge Nettle	*Stachys sp.*	PR EL Ad Ly Th
Vetch	*Vicia americana* *	PR Ly El Ad Wa

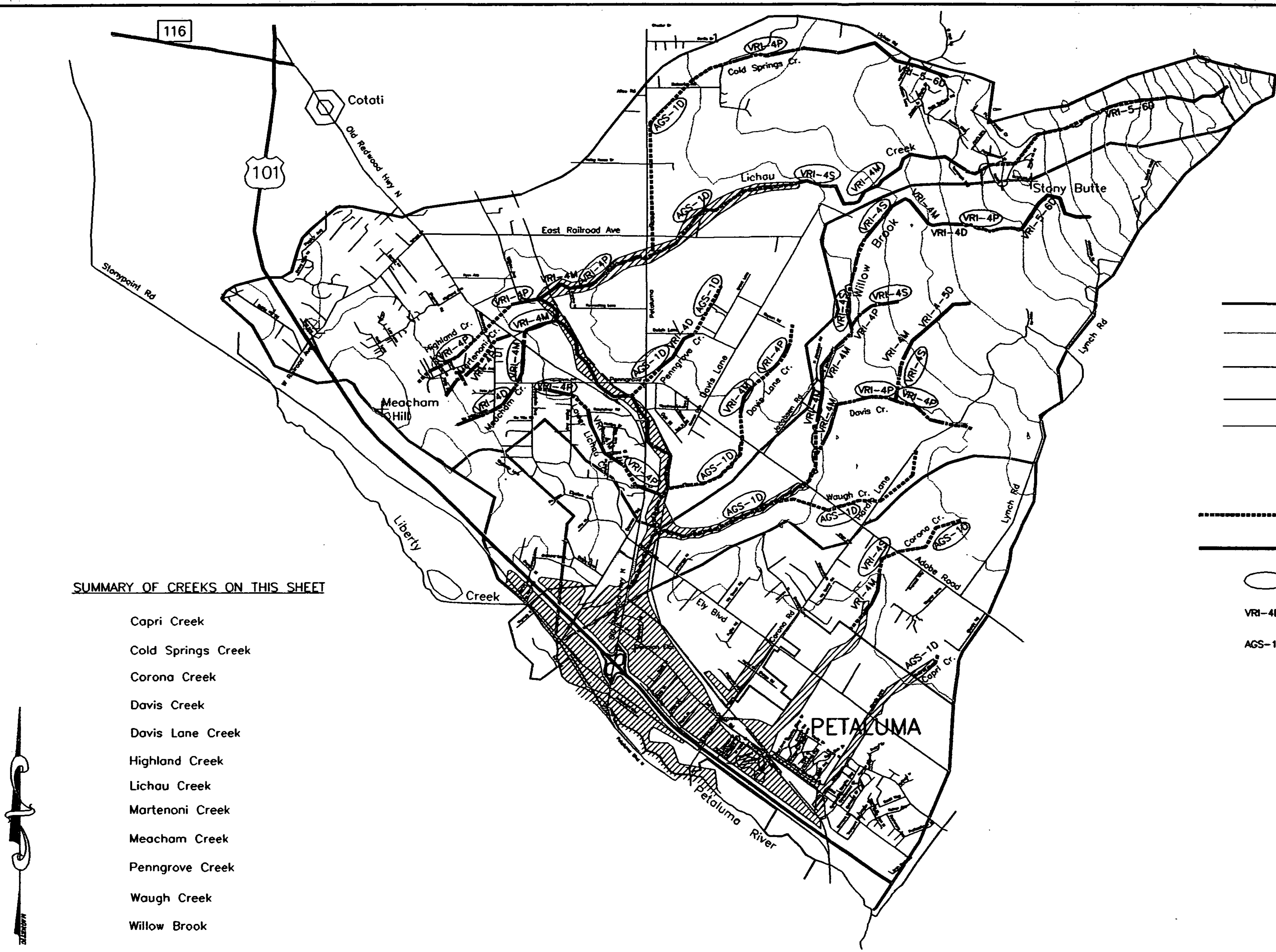
Grasses & Herbs found in shallow drainages, swales & vernal pools in floodplains & adjacent agricultural fields

Brodiaea	*Brodiaea coronaria*	PR
Downingia	*Downingia pulchella*	PR
Spike Rush	*Eleocharis macrostachya*	PR
Coyote Thistle	*Eryngium armatum*	PR
Goldfields	*Lasthenia glabrata*	PR
Tidy Tips	*Layia platyglossa*	PR
Pennyroyal	*Mentha pulegium*	PR El Ad Ly Wa
Owlsclover	*Orthocarpus sp.*	PR

all = found on all reference creeks
Ly = Lynch Creek, Ad = Adobe Creek, Th = Thompson Creek, El = Ellis Creek, Wa = Washington Creek, PR = Pet. River
+ = occurs frequently - = occurs infrequently
all+- = occurs frequently on some creeks and infrequently on others
* = not native to the Petaluma River Valley



PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: April, 1998 SCALE: 1" = 10,000' CHECKED BY: MN DRAFTED BY: EA	REVISIONS	BY	PREPARED FOR: SOUTHERN SONOMA COUNTY RESOURCE CONSERVATION DISTRICT	PETALUMA RIVER WATERSHED RIPARIAN VEGETATION KEY MAP	SHEET 1 OF 6



SUMMARY OF CREEKS ON THIS SHEET

Capri Creek
Cold Springs Creek
Corona Creek
Davis Creek
Davis Lane Creek
Highland Creek
Lichau Creek
Martenoni Creek
Meacham Creek
Penngrove Creek
Waugh Creek
Willow Brook

LEGEND

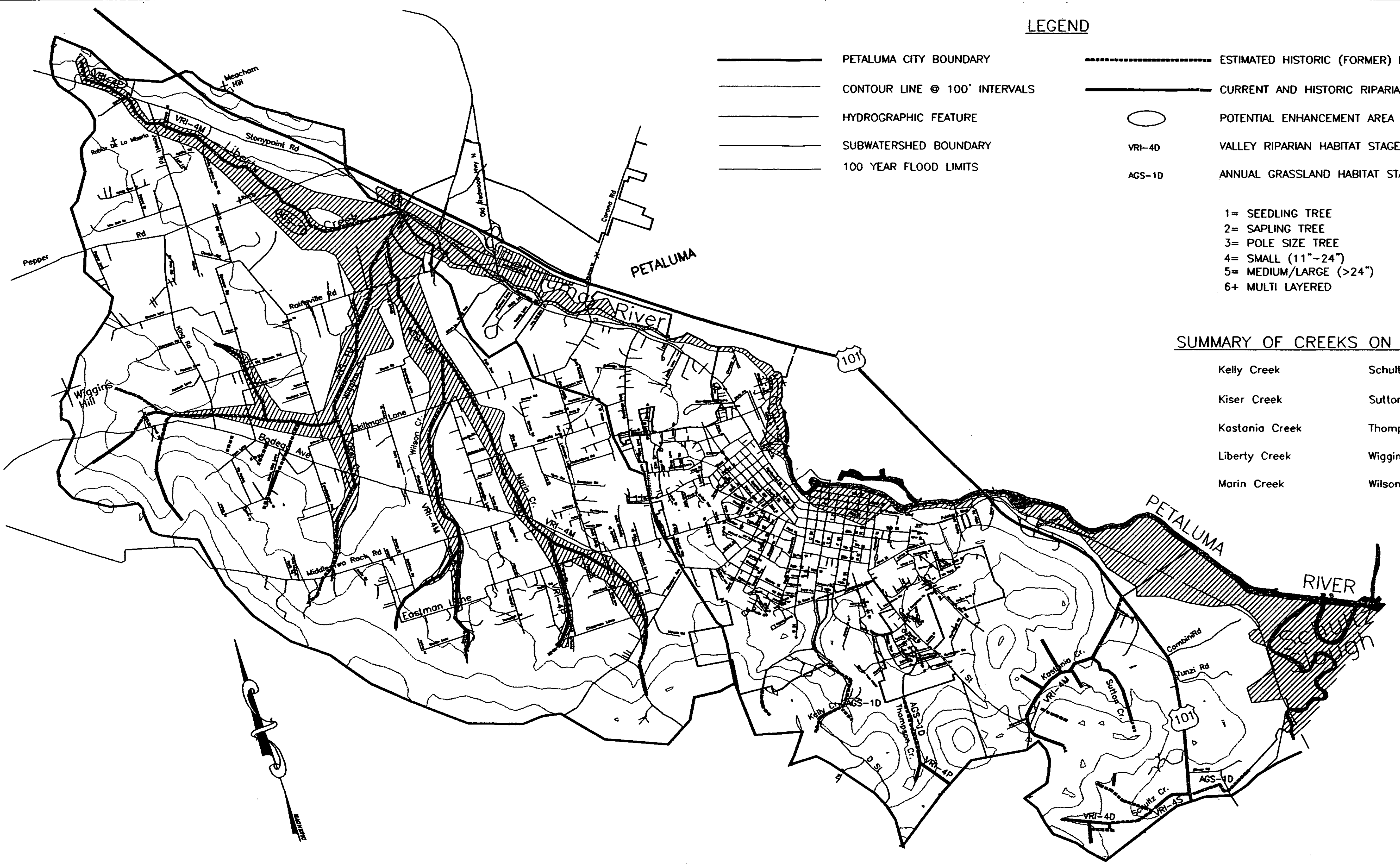
PETALUMA CITY BOUNDARY
CONTOUR LINE @ 100' INTERVALS
HYDROGRAPHIC FEATURE
SUBWATERSHED BOUNDARY
100 YEAR FLOOD LIMITS

HISTORIC (FORMER) RIPARIAN VEGETATION (ESTIMATED)
CURRENT AND HISTORIC RIPARIAN VEGETATION
POTENTIAL ENHANCEMENT AREA
VRI-4D VALLEY RIPARIAN HABITAT STAGE (AT PRESENT TIME)
AGS-1D ANNUAL GRASSLAND HABITAT STAGE (AT PRESENT TIME)

1= SEEDLING TREE
2= SAPLING TREE
3= POLE SIZE TREE
4= SMALL (11"-24")
5= MEDIUM/LARGE (>24")
6+ MULTI LAYERED

S= SPACE
P= OPEN
M= MODERATE
D= DENSE

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: January 30, 1998 SCALE: 1" = 4,000' CHECKED BY: SH DRAFTED BY: EA	REVISIONS	BY	PREPARED FOR: SOUTHERN SONOMA COUNTY RESOURCE CONSERVATION DISTRICT	PETALUMA RIVER WATERSHED RIPARIAN VEGETATION AREA R1	SHEET 2 OF 6



LEGEND

PETALUMA CITY BOUNDARY	ESTIMATED HISTORIC (FORMER) RIPARIAN VEGETATION
CONTOUR LINE @ 100' INTERVALS	CURRENT AND HISTORIC RIPARIAN VEGETATION
HYDROGRAPHIC FEATURE	POTENTIAL ENHANCEMENT AREA
SUBWATERSHED BOUNDARY	VRI-4D VALLEY RIPARIAN HABITAT STAGE (AT PRESENT TIME)
100 YEAR FLOOD LIMITS	AGS-1D ANNUAL GRASSLAND HABITAT STAGE (AT PRESENT TIME)

1= SEEDLING TREE
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5= MEDIUM/LARGE (>24")
6+ MULTI LAYERED

S= SPACE
P= OPEN
M= MODERATE
D= DENSE

SUMMARY OF CREEKS ON THIS SHEET

Kelly Creek	Schultz Creek
Kiser Creek	Sutton Creek
Kastania Creek	Thompson Creek
Liberty Creek	Wiggins Creek
Marin Creek	Wilson Creek

PRUNUSKE CHATHAM, INC.
P.O. BOX 828
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(707) 874-0100

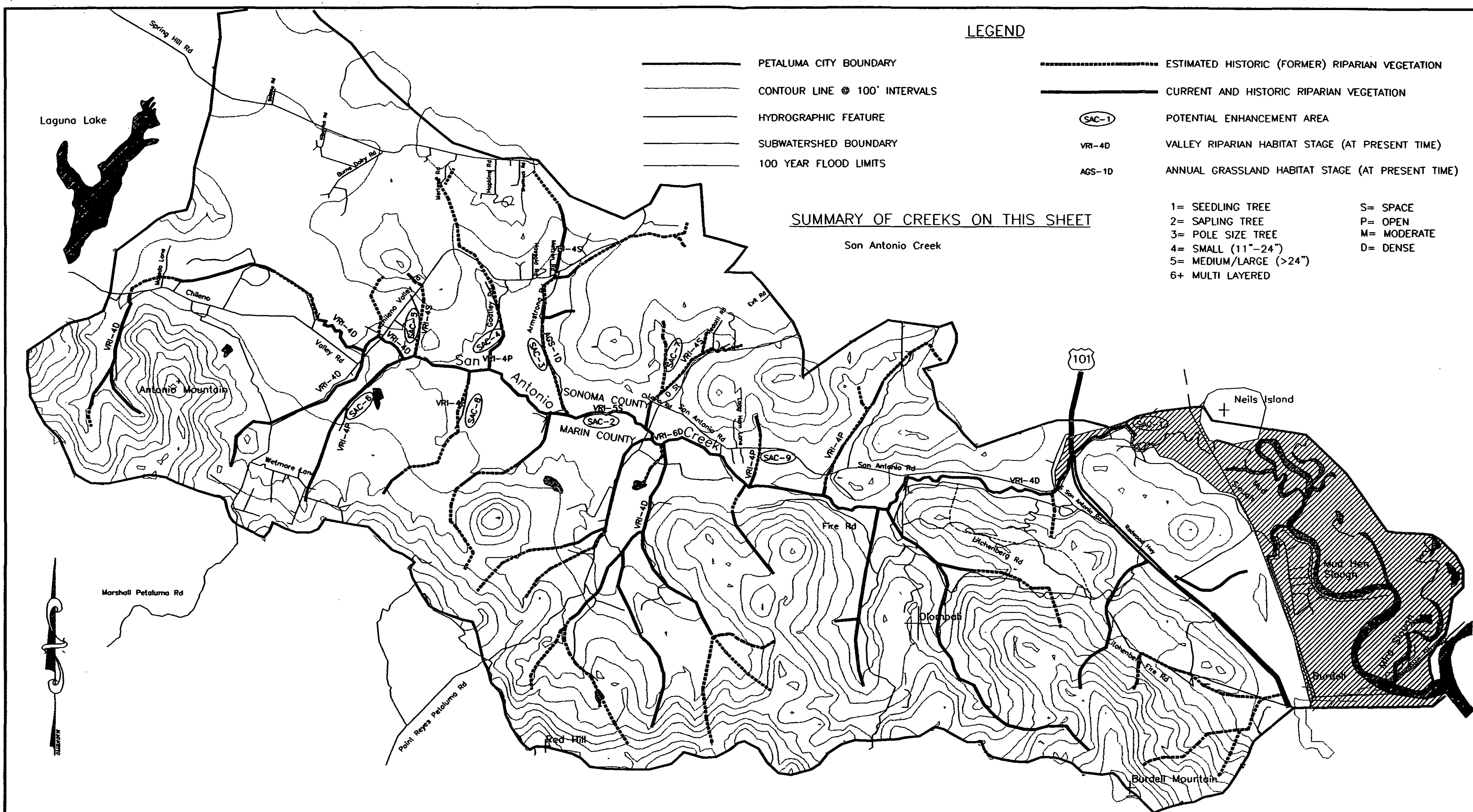
DATE: January 29, 1998
SCALE: 1" = 4,000'
CHECKED BY: HA
DRAFTED BY: EA

REVISIONS	BY	

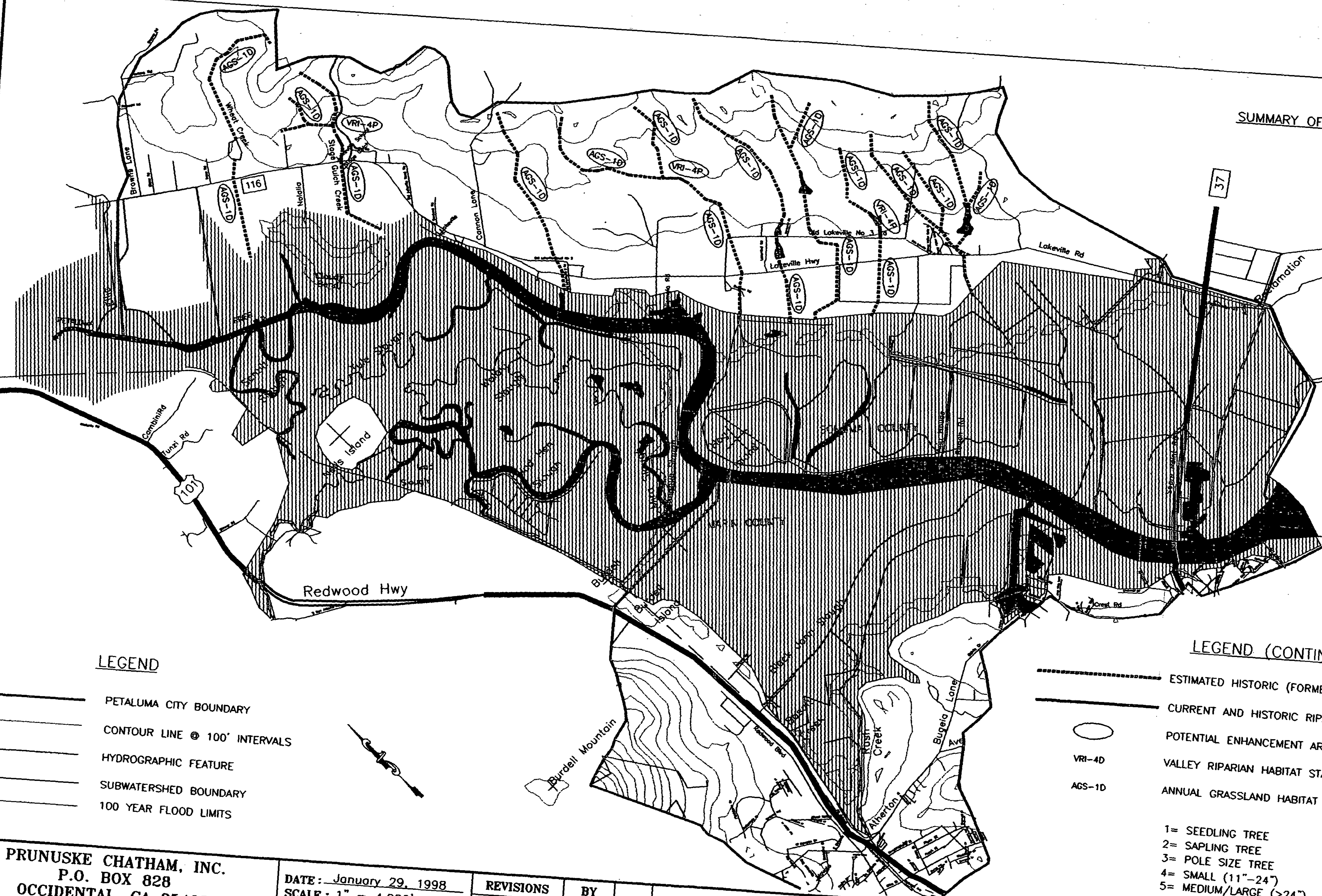
PREPARED FOR:
SOUTHERN SONOMA COUNTY
RESOURCE CONSERVATION DISTRICT

PETALUMA RIVER WATERSHED
RIPARIAN VEGETATION AREA R3

SHEET 4 OF 6



PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: January 28, 1998 SCALE: 1" = 4,000' CHECKED BY: HA DRAFTED BY: EA	REVISIONS	BY	PREPARED FOR: SOUTHERN SONOMA COUNTY RESOURCE CONSERVATION DISTRICT	PETALUMA RIVER WATERSHED RIPARIAN VEGETATION AREA R4	SHEET 5 OF 6



SUMMARY OF CREEKS ON THIS SHEET

Stage Gulch Creek
Wheat Creek

LEGEND

PETALUMA CITY BOUNDARY
CONTOUR LINE @ 100' INTERVALS
HYDROGRAPHIC FEATURE
SUBWATERSHED BOUNDARY
100 YEAR FLOOD LIMITS

LEGEND (CONTINUED)

ESTIMATED HISTORIC (FORMER) RIPARIAN VEGETATION
CURRENT AND HISTORIC RIPARIAN VEGETATION
POTENTIAL ENHANCEMENT AREA
VRI-4D VALLEY RIPARIAN HABITAT STAGE (AT PRESENT TIME)
AGS-1D ANNUAL GRASSLAND HABITAT STAGE (AT PRESENT TIME)

1= SEEDLING TREE
2= SAPLING TREE
3= POLE SIZE TREE
4= SMALL (11"-24")
5= MEDIUM/LARGE (>24")
6+ MULTI LAYERED

S= SPACE
P= OPEN
M= MODERATE
D= DENSE

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DATE: January 29, 1998
SCALE: 1" = 4,000'
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DRAFTED BY: EA

REVISIONS	BY	

PREPARED FOR:
SOUTHERN SONOMA COUNTY
RESOURCE CONSERVATION DISTRICT

PETALUMA RIVER WATERSHED
RIPARIAN VEGETATION AREA R5

SHEET 6 OF 6

Appendix I

Fisheries Enhancement in the Petaluma River Watershed

Fisheries Enhancement in the Petaluma River Watershed

Prepared for
Southern Sonoma County Resource Conservation District
Petaluma River Watershed Enhancement Plan

Prepared by
Prunuske Chatham, Inc.
P.O. Box 828
Occidental, CA 95465
(707) 874-0100

February 1999

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Southern Sonoma County Resource Conservation District has contracted with Prunuske Chatham, Inc., environmental consultants, to produce this document entitled *Summary of Fisheries Enhancement in the Petaluma River Watershed.*

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TABLE OF CONTENTS

SUMMARY OF FISHERIES ENHANCEMENT OPPORTUNITIES IN THE PETALUMA RIVER WATERSHED

1.0 Introduction

The Petaluma River watershed is home to many species of resident (year-round) and anadromous (spawn in fresh water and mature at sea) fish. Of particular interest is the status of the anadromous salmonids, such as steelhead trout and salmon, both of which are found in the Petaluma River system. These fish runs have drastically declined in California over the last 30 years.

One focus of Southern Sonoma Resource Conservation District's (SSCRCD) plan for the Petaluma River watershed is to identify opportunities to enhance salmonid habitat. As part of the planning process, Prunuske Chatham, Inc. (PCI) gathered and summarized existing information on the current and estimated historical presence of salmonids in the Petaluma River watershed and identified opportunities to improve and expand anadromous fish habitat.

This report contains background information on the fishery resources in the Petaluma River watershed with a focus on anadromous fish. It lists habitat requirements for steelhead trout and identifies areas and actions for enhancement. A map showing current and estimated historic steelhead runs is attached. This summary tries to balance recognition of the fact that the Petaluma River has never been an outstanding salmonid stream (unlike its neighbor to the north, the Russian River) and a commitment to enhance resources for all native species in the watershed.

2.0 Fishery Resources in the Petaluma River Watershed

The Petaluma River system supports a variety of marine, estuarine, and freshwater fish species. These species use the Petaluma River and its tributaries as habitat for spawning, rearing, and migration. Fishery populations are described below.

2.1 Steelhead trout.

Steelhead trout populations have declined throughout their range in California, especially south of Monterey Bay. Under the federal Endangered Species Act (ESA), steelhead south of and including the Russian River have been listed as threatened by the National Marine Fisheries Service (NMFS).

Limited information is available about the current or historic numbers of steelhead in the Petaluma River watershed, even from the California Department of Fish and Game (CDFG). Bill Cox, a biologist with the CDFG, believes that historically steelhead were found in Lichau, Adobe, and San Antonio Creeks, and possibly in Lynch, Willow Brook, and Thompson Creeks. Other tributaries in the Petaluma River watershed were, and still are, too small and dry for steelhead. The United Anglers of Casa Grande High School have collected fishery habitat information and conducted fish counts in the watershed. These data are available in the 1994 *U.S. Fish and Wildlife Coordination Act Report: Petaluma River Section 205 Flood Control Study.*

Stream survey records for 1968 from CDFG indicate that Lichau, Lynch, Adobe, and San Antonio Creeks should be managed as steelhead streams. The records also identify habitat limitations, which include lack of summer flows and large amounts of sand and silt in Lichau Creek, lack of stream flow in Lynch Creek, fish passage barriers in Adobe Creek, and lack of summer flow, a high percentage of sand, and water pollution in San Antonio Creek.

The steelhead that spawn and rear in the Petaluma River watershed are wild, not hatchery, stock. Watershed residents have observed fish in Lichau, Adobe, and San Antonio Creeks. Since 1985, surveys of salmonids and their spawning and rearing habitat have been conducted by the United Anglers of Casa Grande High School. The students have observed steelhead in Adobe Creek, redds (the salmonid fish egg nests) in Willow Brook Creek just above the Highway 101 crossing, and fish at several other locations, including in the reach from the Payran Street bridge to the Lynch Creek confluence and from Washington Street Creek to the confluence of Lynch Creek.

2.2 Coho and chinook salmon.

According to CDFG and NMFS, the Petaluma River is a low gradient stream that would not have historically supported coho or chinook salmon. Chinook salmon are found in much bigger river systems, such as the Sacramento River. The chinook salmon found today are believed to be hatchery strays entering San Pablo Bay that become "lost" on their way to the Sacramento River. Chinook are seen in the main stem of the Petaluma River. The United Anglers of Casa Grande High School have seen chinook at the turning basin and near the Lynch Creek confluence.

2.3 Other fish species.

In 1993, as part of the U.S. Army Corps of Engineers (ACOE) proposed flood control improvements within the City of Petaluma (City), the U.S. Fish and Wildlife Service (USFWS) conducted a fishery survey in the watershed. Fish were collected from two stations, one at the confluence of Lynch and Washington Creeks and the other at the Northwestern Pacific Railroad crossing next to the Lakeville Avenue bridge. The twenty-five species collected included marine, estuarine, and freshwater fish. The most numerous species (totaling 75% of the fish) included the inland silverside and Pacific staghorn sculpin.

Of the species caught for this study, twelve are native to California. These included bay pipefish, California roach, chinook salmon, Pacific herring, Pacific staghorn sculpin, prickly sculpin, Sacramento splittail, Shiner surfperch, steelhead, threespine stickleback, tule perch, and yellowfin goby. The introduced species included American shad, black crappie, brown bullhead, chameleon goby, yellowfin goby, common carp, *Gambusia*, goldfish, inland silverside, largemouth bass, *Lepomis* spp., rainwater killifish, and striped bass. Of the the native species found, the Sacramento splittail is proposed for federal listing as threatened. It migrates up the Petaluma River in the spring and spawns over aquatic vegetation.

3.0 Overview of Steelhead Life Cycle and Habitat Needs

Steelhead trout (*Oncorhynchus mykiss)* are an anadromous form of rainbow trout. They usually spend one to two years in the ocean before returning to spawn. Steelhead may survive spawning, return to the ocean, and spawn again in a later year. Adults typically migrate upstream between January and March. In California, juvenile steelhead generally spend one to three years in freshwater before migrating back to the ocean, usually between March and June. Steelhead, like other salmonids, require:

- **A year-round supply of cool, high quality water**. Steelhead need year-round water in the stream. Their preferred water temperatures range from 12.8° to 15.6° C (55.0° to 60.1° F). For steelhead, the critical thermal maximum (the temperature at which a fish loses equilibrium and dies) is 29.4° C (84.9° F). Riparian vegetation can shade the creek to moderate summer stream temperatures. In many western streams, increased summer temperatures caused by the removal of shading cover have changed historical salmonid streams into warm water streams that support only non-native fish.

- **Good water quality.** Common threats to aquatic life include suspended sediments; ammonia (especially un-ionized ammonia that can be lethal to fish); low levels of dissolved oxygen; excessive levels of nutrients from animal waste, decaying vegetation, and fertilizer; biological contamination such as pathogens; and heavy metals. Pollutants are concentrated in low stream flows.

- **Diverse habitat with deep, quiet pools and shallow, rocky areas (riffles).** Steelhead use different parts of the stream during their life cycle. For example, young-of-the-year steelhead often use riffle and run habitat during the summer months and move to deeper, slower water habitat during the high flow months. Larger juveniles (yearlings or older) will feed near the heads of pools. Steelhead spawn at the head of riffles. Fine sediment from erosion can fill in pools that are important resting and rearing areas for fish. As the volume of pools decreases, fish become crowded, and competition increases for food and shelter from predators.

- **Clean gravels for spawning and incubation.** Excessive sedimentation can be detrimental to salmonids. When large quantities of sand and fine gravel are deposited in the spaces between gravel and cobble, these "fines" reduce circulation of water, oxygen, nutrients, and the removal of waste products through the coarser material. This can stress and kill fish eggs. Fines reduce the spaces between large cobbles and boulders that are available to young fish for refuge and for aquatic insects. They can destabilize the gravel in which redds are made, making them more susceptible to scour during high flows.

- **Relatively stable streambanks.** Thickets of streamside vegetation can help support stable streambanks, while at the same time provide critical aquatic habitat from fallen logs, undercut banks, and leaf drop.

- **Dense shade canopy from streamside vegetation.** In addition to shading the creek, low growing, overhanging vegetation provides cover for young fish. Vegetation that becomes inundated during high flows provides high flow refuge habitat. Dense vegetation is an important source of insects and nutrients.

- **Lots of woody debris from fallen trees and branches.** Woody debris is made up of branches, root wads, brush, and leaves from dead or down trees. It is a crucial part of salmonid habitat. Woody debris helps create and maintain the deep, quiet pools where young fish seek shelter and rest. It also creates the cover needed for rearing habitat, refuge from predators and heavy storm flows, and "holding habitat" for fish before they spawn. Woody debris provides foraging sites for fish. It contributes nutrients and insect habitat to the creek, forming the base of the food chain. It also helps diversify habitat by varying water velocity and depth. When woody debris has been removed from streams, salmonid populations have declined.

- **Adequate food supply, primarily insects.** Native riparian vegetation provides habitat for terrestrial insects that are an important food source for salmonids and other aquatic species. This vegetation also provides organic materials, an important source of the nutrient energy for streams.

- **Abundance of cover.** Undercut banks, rocks, tree roots, surface turbulence, overhanging streamside vegetation, deep quiet pools, and woody debris all provide refuge from predators and high water flows.

4.0 Potential to Expand Current Salmonid Populations

Habitat improvements, such as erosion control, water quality improvement, and riparian corridor enhancement, can help to expand steelhead populations. CDFG recommends focusing restoration on areas with good habitat and a reasonable potential to provide steelhead habitat. These are Lichau, Adobe, San Antonio, and possibly Willow Brook and Lynch Creeks. The following descriptions summarize the recommendations for each of these creeks as they pertain to fishery habitat improvement from the *Summary of Riparian Plant Community Enhancement in the Petaluma River Watershed, Summary of Erosion and Sedimentation in the Petaluma River Watershed,* and a water quality information summary prepared for the SSCRCD.

In addition to the information presented about each subwatershed, there is overall information about water quality in the watershed. The San Francisco Estuary Institute (SFEI) collects tissue samples from bi-value organisms (mussels, clams, and oysters) at the mouth of the Petaluma River. Data from 1996 indicates contaminants including PAHs and PCBs (pesticides and other chemicals) were accumulated in their tissues. Metals and pesticides can accumulate in the food chain.

4.1 Lichau Creek Subwatershed

Lichau Creek is the northernmost subwatershed in the Petaluma River watershed. According to CDFG, Lichau Creek has the greatest potential to provide steelhead habitat. Much of the streambed is cobble and gravel. There are deep, perennial pools mixed with riffles in the lower reach. Within the town of Penngrove, portions of the creek have been channelized.

4.1.1 Erosion. In the *Summary of Erosion and Sedimentation in the Petaluma River Watershed* prepared for this plan, Lichau Creek is described as having low erosion activity and moderate erosion potential. The repair priority is also moderate based on erosion activity, erosion potential, the impact of sedimentation on the resources of the overall watershed, and the feasibility of repairs. The main source of sediment is from the upper subwatershed, much of it probably from ranchettes, specifically from small corrals, pastures, unpaved roads, culverts, diversion ditches, and construction sites. The *Summary of Erosion and Sedimentation in the Petaluma River Watershed* recommends fencing and revegetation in the middle and lower reaches, biotechnical erosion control for eroding streambanks, and community outreach and workshops for ranchette and ranch owners. Although the tributaries may not support a fishery, controlling erosion in the tributaries will improve steelhead habitat in Lichau Creek.

4.1.2 Water quality. Water quality data is not available for Lichau Creek.

4.1.3 Riparian habitat. The riparian corridor in the upper reach is largely a dense forest of oak and bay. In the middle reach, there is a moderately dense oak canopy. In the lower reaches, most of the riparian forest is gone, and the area is mainly annual grasses. Along the tributaries to Lichau Creek, there are moderate stands of riparian vegetation. The *Summary of Riparian Plant Community Enhancement in the Petaluma River Watershed* identifies four high and medium priority sites for riparian revegetation and fencing for livestock control, which total 24,000 linear feet. This would help reduce erosion and develop a shade canopy, as well as provide other benefits of a riparian corridor.

4.2 Adobe Creek Subwatershed

Threats to steelhead habitat in Adobe Creek are lack of riparian vegetation and sedimentation. The United Anglers of Casa Grande High School have focused their restoration efforts on Adobe Creek. The Sonoma County Water Agency (SCWA) and NMFS recently repaired a fish ladder in the low reaches of the creek.

4.2.1 Erosion. The upper subwatershed appears to contribute the majority of sediment to the creek channel. The main sources of erosion are likely from large landslides and debris flows. Along the middle reach of Adobe Creek, the primary sediment source is bank erosion from scour and poorly vegetated banks. The lower reach has isolated areas of bank erosion. The *Summary of Erosion and Sedimentation in the Petaluma River Watershed* recommends conducting detailed erosion control and stream channel surveys to better understand the stability of the upper Adobe Creek subwatershed, addressing landslides that directly impact the creek, fencing and revegetation of the riparian corridor, and conducting outreach to watershed landowners.

4.2.2 Water quality. Water quality information is not available for Adobe Creek.

4.2.3 Riparian habitat. Some of the upper reaches of the creek are well vegetated. In the middle and lower reaches, the riparian vegetation has been significantly degraded. The *Summary of Riparian Plant Community Enhancement in the Petaluma River Watershed* identifies two high priority sites for riparian fencing and revegetation, which total 12,240 linear feet. The United Anglers of Casa Grande High School have planted willows along Willow Brook and Adobe Creeks to help restore riparian habitat.

4.3 San Antonio Creek Subwatershed

Although limited information is available about the historic runs of steelhead in San Antonio Creek, this subwatershed may have had the largest fishery in the Petaluma River watershed. Sedimentation and water quality are two important steelhead habitat limitations in San Antonio Creek.

4.3.1 Erosion. The stream channel is deeply entrenched and extremely active. In many places it has cut down to bedrock and is now undergoing a lateral migration. As a result, the upper subwatershed contributes a large amount of sediment to the lower, primarily from severe streambank erosion. The lower reaches of San Antonio Creek have two to three feet of newly deposited fine sediment along the streambanks. Recommendations in the *Summary of Erosion and Sedimentation in the Petaluma River Watershed* include developing a detailed sediment and riparian management plan that includes information on channel geomorphology and stability. Addressing the bank erosion in the lower subwatershed will, for the most part, require technical and engineered plans. Where feasible, revegetation will provide bank protection. Bank scour in the tributaries to the upper subwatershed can be addressed through livestock control fencing, revegetation, and biotechnical repairs in key locations. Fencing gullies and installing biotechnical repairs will also help control sediment delivery to San Antonio Creek.

4.3.2 Water quality. The creek has seasonal water flows. Water quality data collected by CDFG for San Antonio Creek indicates high levels of ammonia and conductivity (a measure of salts in the water and an indicator of animal waste in freshwater). In April, 1998, water temperatures ranged from 11° to 28° C. Summer water measurements typically include temperatures ranging from 22° to 26° C—much higher than is optimal for steelhead.

4.3.3 Riparian habitat. The riparian corridor on both the main stem and tributaries of San Antonio Creek has moderate to dense canopy with mature valley oaks and a mix of other riparian species. Managing livestock access to the creek, replanting riparian vegetation, and installing biotechnical streambank repairs would help restore denuded portions of the riparian corridor. Riparian vegetation will be a key component in lowering the creek's water temperatures and reducing the toxic levels of ammonia. The *Riparian Plant Community Enhancement Summary for the Petaluma River Watershed* identifies nine medium and high priority sites for fencing and planting, which total 93,876 linear feet.

4.4 Lynch Creek Subwatershed

Lynch Creek may provide potential habitat for steelhead. Fish passage to the upper watershed is blocked. CDFG recommends conducting fish surveys to determine whether or not steelhead are present and how they are distributed in the creek.

4.4.1 Erosion. In the *Summary of Erosion and Sedimentation in the Petaluma River Watershed,* Lynch Creek is rated as high in terms of erosion activity, erosion potential, and repair priority. Erosion is primarily from the upper watershed, particularly landslides and debris flows. The middle reach has many scoured, vertical streambanks. Recommendations include controlling upslope gullies, using Best Management Practices (BMPs) for new vineyard development (including leaving creek buffers and remaining oak woodlands), fencing, revegetation in the middle reaches, and biotechnical repairs where appropriate.

4.4.2 Water quality. Water quality data is not available for Lynch Creek.

4.4.3 Riparian habitat. In the upper reaches of the creek, riparian vegetation is dense. In the middle and lower reaches outside the City limits, the riparian corridor has portions with moderate vegetation and other areas with sparse vegetation. The portion of Lynch Creek that flows within the City limits is densely vegetated. Enhancement opportunities identified in the *Summary of Riparian Plant Community Enchancement in the Petaluma River Watershed* include connecting the upper and lower reaches of riparian forest by fencing to control livestock access and revegetation. Four high priority sites are identified, which total 25,500 linear feet.

4.5 Willow Brook Creek Subwatershed

Willow Brook Creek may support steelhead trout. Much of the channel is comprised of cobble and small boulders. As in Lynch Creek, fish passage to the upper watershed is blocked. A concrete apron at Jacobsen Lane may be a passage barrier. CDFG recommends conducting fish surveys to determine whether or not steelhead are present and how they are distributed in the creek.

4.5.1 Erosion. In the *Summary of Erosion and Sedimentation in the Petaluma River Watershed,* Willow Brook Creek is rated as high in terms of erosion activity, erosion potential, and repair priority. The major source of sediment is from the upper watershed, primarily from landslides, debris flows, and gullies. The lower reach has many scoured, vertical streambanks with chronic sloughing. Rill and sheet erosion are likely to occur where livestock facilities are located on sloped hills and from ranchettes near the creek. Recommendations include conducting a detailed stream channel stability and upslope erosion survey, particularly in the middle and upper reaches of the creek, fencing and riparian restoration, and possibly grade control structures where necessary. Controlling erosion in the tributaries is important for enhancing habitat in the main reach of Willow Brook Creek.

4.5.2 Water quality. Water quality data is not available for Willow Brook Creek.

4.5.3 Riparian habitat. The uppermost portions of the subwatershed are densely vegetated. The middle reach has areas of dense vegetation, as well as open areas. Much of the lower reach is denuded. The *Summary of Riparian Plant Community Enhancement in the Petaluma River Watershed* identifies three medium and high priority sites for livestock control fencing and revegetation, which total 27,848 linear feet. These sites are located in the middle and lower reaches of the subwatershed.

5.0 Recommendations

Recommendations focus on enhancing the ecological functions in the watershed. For example, restoring the riparian corridor in the Lichau Creek subwatershed will help control streambank erosion, cool water temperatures, and provide habitat for steelhead and other species of concern, such as western pond turtles and the yellow-legged frog. These recommendations include:

- **Focus riparian restoration and erosion control efforts on tributaries that do, or potentially can, support steelhead.** These tributaries are Lichau, Adobe, San Antonio, and possibly Lynch and Willow Brook Creeks. Controlling erosion in the upper reaches of the watershed will benefit the portions of the stream where steelhead spawn and rear.

- **Conduct outreach about steelhead and aquatic habitat to ranch and ranchette owners.** Topics for a creek care guide or workshops could include disposal of yard and garden waste, erosion control, disposal of hazardous materials, enhancement of native riparian corridors, and curtailing summertime water diversions.

- **Conduct outreach about minimizing the impact of animal waste.** Topics could include managing run-off from confined livestock areas near waterways, manure and fertilizer application, and silage storage.

- **Work with CDFG to determine the presence and distribution of steelhead in the watershed.** CDFG conducts fish surveys in the late summer/early fall. Surveys can determine the presence or absence of steelhead, the distribution of steelhead (how far upstream they live), and any passage problems. CDFG recommends that these surveys be conducted in Lichau, Lynch, Willow Brook, Adobe, and San Antonio Creeks. The results of the survey should be made available to watershed residents.

- **Use the CDFG protocol to evaluate the quality of salmonid spawning and rearing habitat.** CDFG recommends that habitat typing only be conducted in specific reaches of streams that watershed residents are working to restore. This information can serve as a baseline to evaluate changes.

- **Incorporate steelhead habitat-related parameters into watershed monitoring.** Include monitoring that focuses on steelhead habitat when evaluating watershed conditions. These parameters could include evaluating long-term changes to the riparian corridor and turbidity sampling for water quality.

- **Provide technical assistance to school and community groups working on revegetation projects.** This could include proper planting techniques for willow and other riparian plants, assistance with water quality monitoring, and related projects.

- **Assist landowners with self-monitoring of water quality.** Water monitoring kits for ammonia, temperature, and dissolved oxygen are inexpensive and relatively simple to use. In neighboring watersheds, the SSCRCD and U.C. Cooperative Extension have provided free instructional workshops for landowners.

6.0 References

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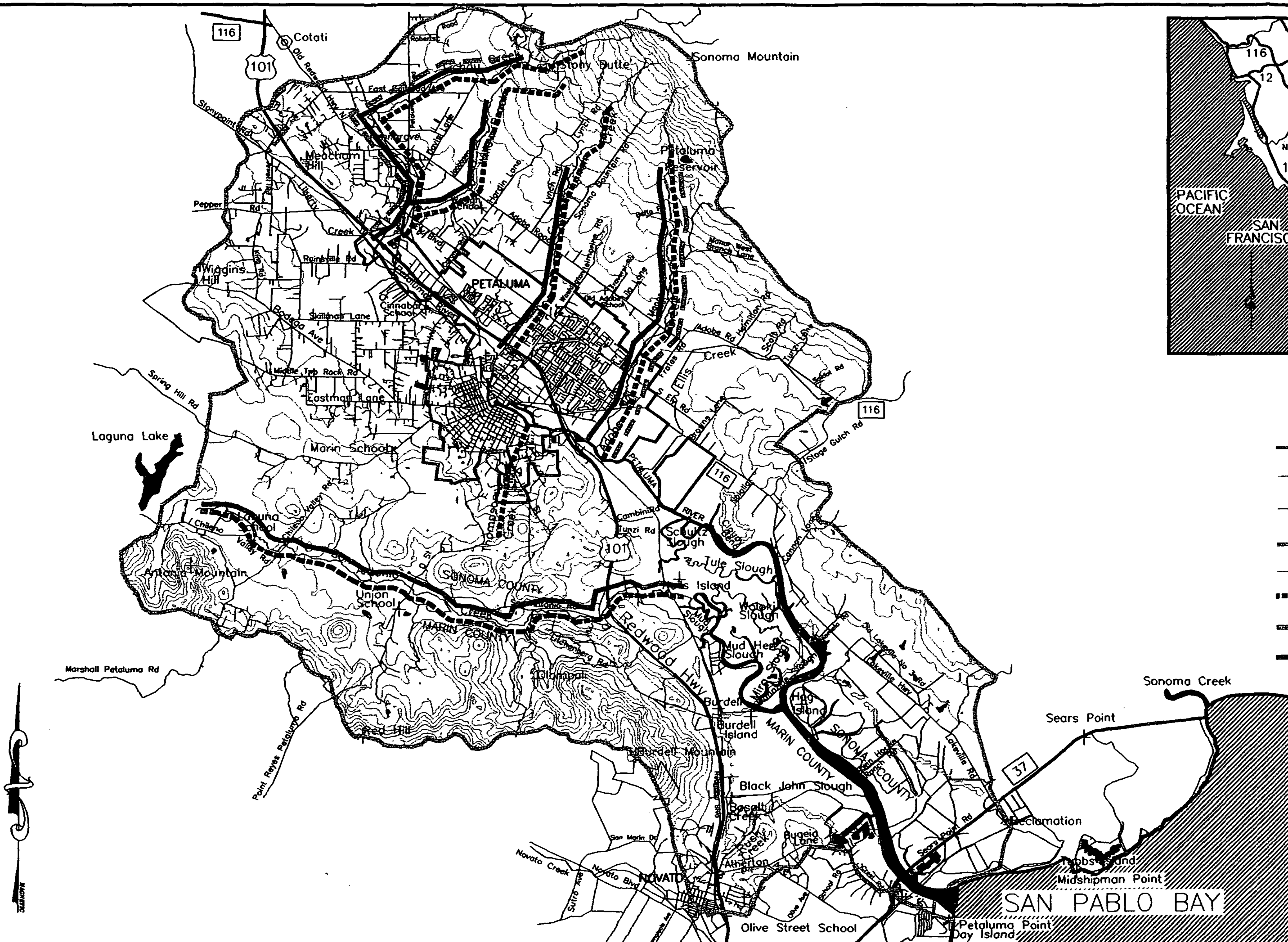
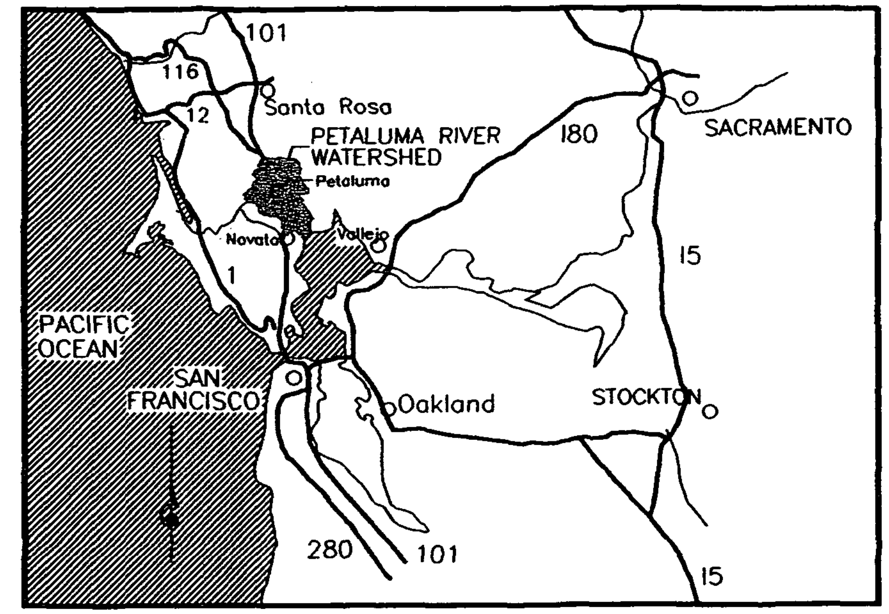




VICINITY MAP

LEGEND

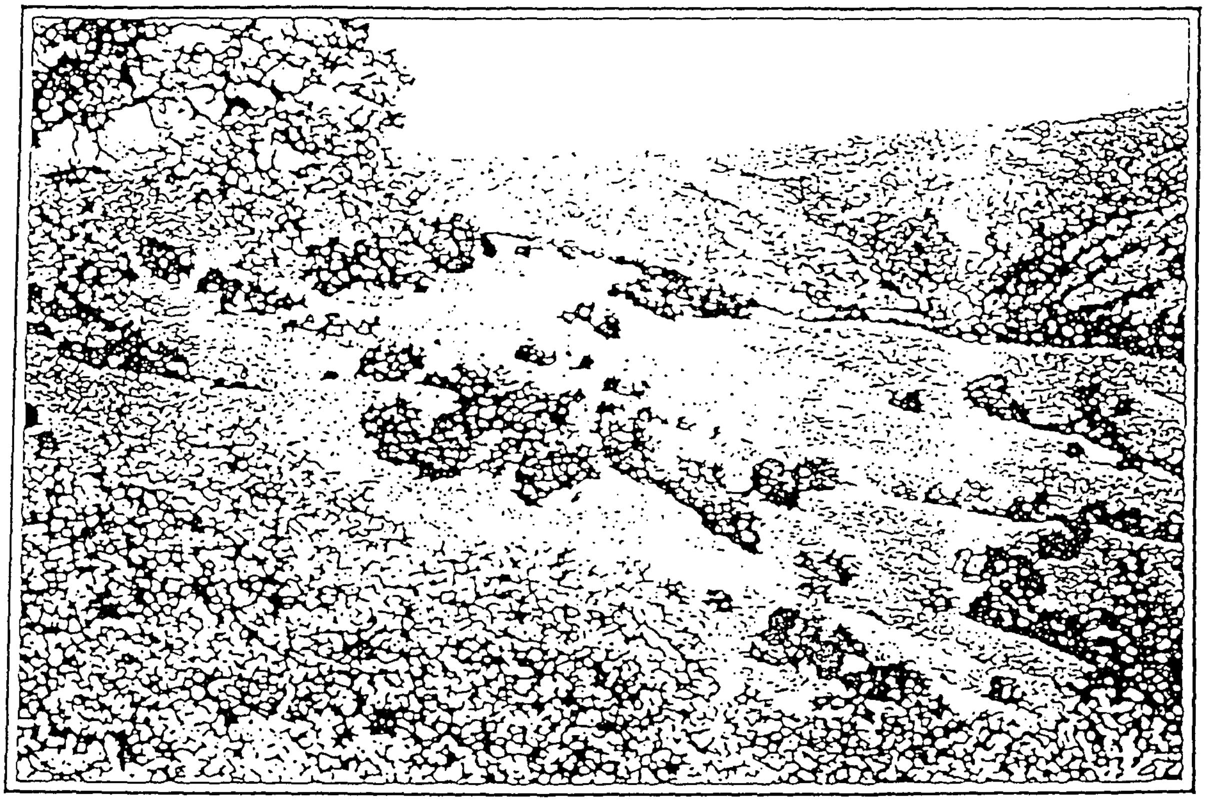
- PETALUMA CITY BOUNDARY
- CONTOUR LINE @ 100' INTERVALS
- HYDROGRAPHIC FEATURE
- WATERSHED BOUNDARY
- SUBWATERSHED BOUNDARY
- ESTIMATED HISTORIC STEELHEAD RUN
- PRESENT (KNOWN) STEELHEAD RUN
- POTENTIAL STEELHEAD RUN

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: May, 1998 SCALE: 1" = 10,000' CHECKED BY: MN DRAFTED BY: EA	REVISIONS / BY	PREPARED FOR: SOUTHERN SONOMA COUNTY RESOURCE CONSERVATION DISTRICT	STEELHEAD FISHERY IN THE PETALUMA RIVER WATERSHED	SHEET 1 OF 1

Appendix J

Monitoring California's Annual Rangeland Vegetation

Monitoring California's Annual Rangeland Vegetation



Cooperative Extension University of California
Division of Agriculture and Natural Resources

Leaflet 21486

Herbaceous Plant Measurements

William E. Frost, Neil K. McDougald, and Melvin R. George

Residual Dry Matter

The amount of old plant material left on the ground at the beginning of a new growing season, residual dry matter (RDM), indicates the previous season's use and can be used to describe the health or condition of annual rangelands. An RDM evaluation is made before the first effective fall rains, usually in late September or in early October.

RDM estimates are obtained by direct clipping and weighing, comparative yields, or visually using photo standards or the following descriptions (Clawson, McDougald, and Duncan 1982):

- Light grazing leaves little or no patchy appearance. Unused plant matter averages 3 or more inches in height and small objects are masked.
- Moderate grazing leaves an average of 2 inches of unused plant matter, a patchy appearance, and little bare soil. Small objects will not show at a distance of 20 feet or more.
- Heavy grazing leaves less than 2 inches of unused plant matter. Small objects and areas of bare soil are visible at 20 feet or more.

Mapping of RDM provides a means of recording the total pool of herbage remaining, as well as its distribution (Frost, McDougald, and Clawson 1988).

Cover

Vegetation and ground cover are monitored often. Vegetation cover indicates the ecological importance of a species in a community. Ground cover provides a good measure of site protection. Measuring cover is relatively easy and can be done consistently.

Step-point

The step-point method (Evans and Love 1957) provides an objective way to determine species composition and total ground cover. The method records bare soil, rock, gravel, litter, and plant species encountered under certain points selected by pacing a range site. The technique has been used to monitor the effects of grazing treatments, prescribed burns, fertilizer, and seeding projects, etc. The method allows large areas to be sampled quickly for analysis of range practices.

The procedure involves selecting a random transect through a representative part of a range site. A transect often consists of 100 paces, resulting in 100 points sampled. The observer establishes a step-point by lowering a sampling pin to the ground, guided by a definite notch in the toe of the boot. At each step-point the observer places the boot at a 30° angle to the ground to avoid disturbing plants in the immediate area and lowers the pin perpendicularly to the sole of the boot until it either hits a herbaceous plant or the ground. The first plant hit by the point of the pin near the ground is recorded. If no plant is hit, the pin is pushed to the ground and a hit on bare soil, rock, gravel, or litter is recorded. In addition, if no plant is hit, the nearest plant to the pin is recorded. Nearest plants are determined in a forward direction (180° arc) going from left to right.

Total plant cover, species composition, percentage bare soil, rock, gravel, and litter are determined by dividing the number of hits on each by the total number of points sampled. Relative species composition can also be calculated from this information. For relative species composition the number of hits plus the number of nearest plant occurrences for a particular species or species group are divided by the total number of points sampled. Form 1-1 (page 19) provides sample data collection sheets for step-point.

Biomass or Yield

Land managers are interested in measuring biomass or herbage yield to indicate site productivity, carrying capacity, or to determine the current standing crop for forage allocation. At the end of the grazing season, determining the amount of residual dry matter in the area is of interest to learn whether the level of grazing was proper.

Clipped plot

A straightforward method for measuring standing crop or residual dry matter is to clip and weigh the herbaceous material. Different species may be separated if desired. Samples may be weighed moist in the field, and subsamples taken, dried, and weighed for moisture correction or the whole sample taken in and dried before weighing.

Clipping plots is time consuming and the variability of rangeland vegetation often requires a large sample size (about 15 to 20 plots per pasture) for reasonable precision. A large number of samples may require days or weeks to collect, and may introduce error into the sampling process as vegetation matures or disappears over the sampling period. In these cases, one way of increasing sampling efficiency is to decrease the time spent per sampling unit, even if at the expense of some precision on each observation. To increase the sample size possible for a given amount of time and money, the following technique is recommended.

Comparative yield

The comparative yield method (Haydock and Shaw 1975) is a variation on the clipped plot estimate. In comparative yield, five standard plots, generally square-foot plots in annual vegetation, are set up representing the range of weight likely to be encountered in the sample area.

The initial step is to walk through the unit noting the range of residual dry matter or standing crop present. Once this reconnaissance is completed, five standards are constructed by semipermanent placement of square-foot frames. Standard 1 is set up to represent the least amount of biomass present on the area, standard 5 to represent the largest amount of biomass. Standards 2, 3, and 4 are set up in a stepwise progression between standards 1 and 5. When setting up each standard plot, a similar plot is clipped and weighed to ensure that the standard plots selected represent the proper amount of standing crop or residual dry matter.

For example:

- Range Unit 31 of the San Joaquin Experimental Range was walked through and standards 1 and 5 selected.
- A plot identical to standard 1 was clipped and weighed. The weight of the vegetation was 5 g.
- A plot identical to standard 5 was clipped and weighed. The weight of the vegetation was 105 g.
- Standard 3 is the middle standard which should contain vegetation weighing approximately 55 g = (5 + 105) ÷ 2.
- Standard 4 should contain vegetation whose weight falls in the middle of standards 3 and 5, approximately 80 g = (55 + 105) ÷ 2.

These standards will be used to rank plots in the sample area.

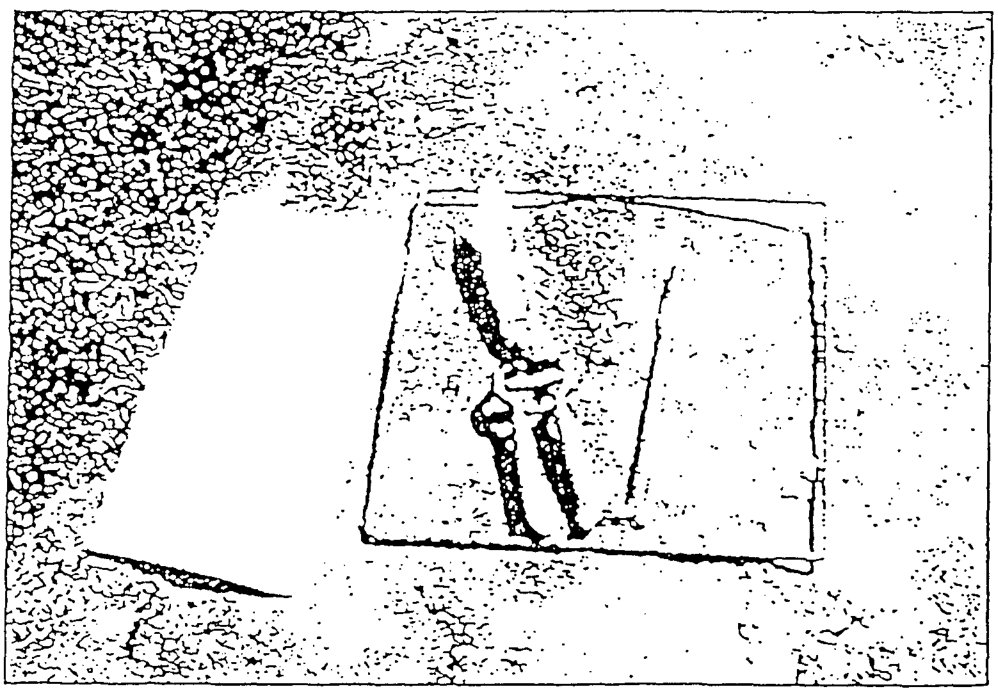
With the standards established, observers inspect them one last time. Actual sampling then begins. Sample plots are located according to a desired sampling scheme. Each sample plot is simply ranked, as it corresponds to the five standards (1-5). If a plot does not appear to fit one of the five standards, an intermediate ranking (i.e., 2.5) is given. Once observers begin ranking plots, they never go back to check the five standards.

When sampling is completed, an additional 15 plots are ranked and clipped. This sample of 15 plots should represent the range of biomass present in the sample area. These clipped samples are dried and weighed. Clipped sample weights, with their associated rankings, are used to calculate a linear regression equation with a separate regression equation calculated for each observer.

To determine the amount of standing crop or residual dry matter present, the average ranking from all plots is inserted into the regression equation. For more complex statistics (variance, confidence intervals, etc.) each observation is put into the regression equation, or more commonly, sampling is conducted along 5 to 10 transects in the field, with the average ranking from each transect used in the regression equation to produce 5 to 10 weight estimates, which are then used for additional statistical analysis. Form 1-2 (page 20) provides a sample data sheet.

Capacitance Meter

Many indirect dry matter assessment devices have been developed, including various capacitance meters, such as the Heterodyne Vegetation Meter and the New Zealand Pasture Probe. Since the 1930s the principle of measuring capacitance, the ability to store electrical energy, has been used as an index to moisture content (Neal and Neal 1973). Since the 1950s this principle has been used to measure herbage yield (Fletcher and Robinson 1956). Capacitance meters have proved useful in rapidly estimating standing crops under a variety of conditions. Even with the limitations during periods of low amounts of green forage and during the dry forage season, the pasture probe is a useful grazing management tool (George et al. 1989).



Sampling equipment for weighing clipped herbaceous plant material includes, left to right, paper bag, square-foot (or 1/10 meter) frame, clippers, and scale.

Range Monitoring Handbook

Point Reyes
National Seashore

December 1990
National Park Service—U.S. Department of Interior

- Photo plate, 1 ft. square, black and white quadrants
- Zip-lock plastic collection bags for plant specimens
- "Cruiser" vest for carrying equipment

Compiling, Summarizing, and Storing Data

- Transect data are entered into a dBase III database using a menu driven data entry and analysis program. This program module is a component of the Resource Information Management System residing on the Resource Management Computer System.

- The Transect module of the Range program uses the transect data to calculate percent cover summaries for 1) native vs. exotic, 2) life cycle (annual, biennial, perennial), 3) life form, 4) cattle forage value, and 5) response to grazing. These printouts can then be compared from year to year to detect trends.

- Step by step instructions for using the Transect Module of the RIMS are contained in Appendix A.

- Field forms are stored in a Range file folder labeled "Condition/Trend Data, Spring 19__". There is a folder for each year.

IV. Residual Dry Matter (RDM) Surveys

Purpose

- To determine range grazing capacities,

- To provide for better herd management on rangelands by identifying overgrazed areas and underutilized areas,

- To identify actual or potentially impacted resource areas, and

- To determine the effects of various levels of livestock use on plant succession.

RDM Definition

Residual Dry Matter is defined as the above-ground remains of the current year's herbage production. It consists mostly of dry palatable grass and forb stubble. Excluded from estimation or clipping are the following: shrubs, vines, ferns, rushes, tree leaves, sticks, manure, and hay. Also excluded are such unpalatable plant species as iris, blackberry, thistles, poison hemlock, cocklebur, eryngium and other noxious weeds

Types of RDM Surveys

1. Double-Sampling

RDM is both clipped and estimated in 50 plots along the same baselines used for the Condition/Trend transects. The resulting total RDM lb/acre is used as a reference to aid in Zone Mapping. It is also used along with the transect data in evaluating range condition and trend.

2. Zone Mapping

RDM is estimated for entire pastures and ranch units in broad classes or zones of utilization. The zones are defined as: Severe, Heavy, Moderate or Light. This method zone-mapping depicts livestock utilization patterns on the range, and overgrazed areas can be identified and quantified.

V. RDM Double-Sampling Procedure

Photo Points

Before sampling, photograph the Key/Critical Area as described in above for the Condition/Trend Transects.

Double-Sampling Procedure

1. Locating Sample Plots

Use a systematic random method for selecting 50 sample plots. Select two random distances parallel to the baseline. Locate 25 plots along these lines by walking straight down the line, eyes fixed on a distant point of reference, and placing the plot frame on the ground at the toe of your boot every fourth step.

Estimate the RDM for all 50 plots. Clip the first plot, and every fifth one thereafter, for a total of 10 clipped plots.

2. Estimate RDM

Estimate the grams of RDM within the plot. Only the RDM contained within the plot frame is counted. Record the estimated weight (in grams) in the "Estimated Weight" column of the form "RDM Double Sampling Estimates" (Fig. 5).

3. Clipping Procedure

Begin by sorting out sticks, dried manure and other excluded material from the plot. Clip around the perimeter of the plot on a vertical plane. This clipped line defines the boundary between vegetation inside and outside of the sample plot. Collect vegetation within the plot down to 1/2" stubble height. Include above-ground stolons or tillers of perennial grasses down to the 1/2" stubble height. Clip forbs such as plantain only above the woody stem base. Gather loose materials on the surface with your fingers or coarse comb. Be careful to avoid gathering dirt, gravel or earthworm castings. Gather the clippings into a wide-mouth 1 pint plastic container. This procedure should take about 10 minutes per plot.

4. Weighing Sample

After clipping, empty the RDM from the plastic container into a small (9 gram) bag for weighing. Use a 50 gram Pesola spring scale to suspend the sample inside the 10" x 6" x 15" box while weighing. The box reduces the effects of wind on weighing. Record the weight to the nearest 1/2 gram, subtract the bag weight, and record the net RDM in the "Clipped Weight" column of the form.

Transfer the sample RDM from the weighing bag to a larger collection bag, in which the 10 clipped samples will be pooled for later air-drying. Record the transect number, date and sampler's initials on the bottom of the bag.

After sampling, field forms should be proofread before filing for computer entry.

Drying Samples

Air dry the bags of clippings for 24 hours inside a heated building (approximately 70 degrees). Reweigh the pooled sample and record the Dry Weight on the appropriate sample form.

Sampling Period

Sampling should be done on an annual basis, from September 1 to 30th. Two persons, working independently, are required to sample the 45 Key/Critical Areas during this time. One person can sample 2 - 3 areas each day, but moisture from fog or light rain precludes field work and causes unpredictable delays. It is desirable to compress the sampling period into as short a time as possible so that results are comparable. Also, sufficient time must be left so that the RDM mapping survey can be completed by October 20, the average date of the first germinating fall rains.

If time or personnel constraints make it infeasible to sample all Key/Critical Areas, sampling should be prioritized on fewer areas. Those areas which appear to have over 1800 lb/acre RDM, by visual estimate, may be excluded from intensive sampling, since it is less important to have precise measurements of lightly used areas. In high RDM areas, 1 to 3 clippings from representative sites, subjectively selected, should suffice. The estimated total RDM value for these areas should be entered on the field sampling form on the first data entry line.

Sampling Equipment

- Grass shears
- Pesola 50 g spring scale
- 0.96 sq. ft. plot frame (square or circular)
- Box (approximately 10" x 6" x 15") for weighing and carrying samples
- 50 small (9 grams) paper bags, for weighing samples
- 50 grocery bags (9" x 13") for storing clipped samples
- Plastic, 1 pint, wide-mouth containers for gathering clippings
- Clipboard, pen or pencil
- RDM field forms (Fig. 5)
- 100 m Kesan fiberglass tape
- Compass
- Key/Critical Area description sheet and map
- 35 mm camera with color print film
- Photo plate (1 ft. square) with black and white quadrants

Compiling, Summarizing, and Storing Data

- RDM data are entered into a dBase III database using a menu driven data entry and analysis program. This program module is a component of the Resource Information Management System residing on the Resource Management Computer System.

- The RDM module of the Range program will compile the entered data and perform a statistical analysis. Hard copy printouts are provided summarizing the data for each sample site. The resulting printouts, "RDM Summary" (Table 1), will list the Key/Critical Area by number, average the dry weight-adjusted RDM in lb/acre, and calculate 95% confidence interval, "r" value and coefficient of variation.

- Step by step instructions for using the RDM Module of the RIMS are contained in Appendix B.

- Field forms are stored in a Range file folder labeled "Key Area RDM, 19__". There is a folder for each year.

Appendix K

Public Comment

Dominga Tunzi
P.O. Box 731
Petaluma, CA 94953
(707) 762-7446

September 14, 1998

Maxine Durney
198 Ely Road
Petaluma, CA 94952

Dear Maxine,

Here is a copy of the Land Use Summary that we (SSCRCD'S Advisory Committee) have reorganized and corrected. Please note that the highlighted sections are portions that still need to be corrected or filled in. You can compare this copy with the original draft from PCI. Mostly I have reorganized their work. We have added the Urban Impacts category and are requesting additions to the agriculture category (please see attached summary).

Also, please find attached a letter that I sent, for and at the request of the Advisory Committee, to SSCRCD Leahandra Swent which outlines some of the corrections needed for the Land Use Summary.

Thank you for your help and time. Please call me if you have any questions. Take care.

Best Wishes,

Dominga Tunzi

Dominga M. Turel
P.O. Box 731
Petaluma, CA 94953
◆
Phone (707) [illegible]

August 23, 1998

Leahandra Swent
c/o Southern Sonoma County
Resource Conservation District
1301 Redwood Way, Suite 170
Petaluma, CA 94954

Dear Leahandra Swent,

I am writing this letter on behalf and at the request of the Petaluma Advisory Committee for the following information to be included in the Summary of Land Use in the Petaluma River Watershed. We have noticed, through the rearrangement of the contents of the Land Use Summary written by PCI (Prunuske Chatham, Inc.), that there are large amounts of data missing. Below we have listed them in the parallel forms and structures, established by PCI, to make it easier for you to follow. We are writing to ask you to please acquire the necessary information. The structures are listed by category and use "(have)" for what is already in the report and "(need)" for the information needed:

Sonoma County

(have)	Sonoma County 1989 General Plan's policies and programs to protect agriculture and natural resources.
(need)	**Sonoma County's current Watershed enhancement plans and projects (if any) --to be comparable to the City of Petaluma's information.**

Marin County
(need entire section)

(need)	**Marin County's General Plan's policies and programs to protect agriculture and natural resources.**
(need)	**Marin County's current Watershed enhancement plans and projects (if any) --to be comparable to the City of Petaluma's information.**

City of Petaluma

(need)	**City of Petaluma's General Plan's policies and programs to protect agriculture (businesses) and natural resources.**
(have)	City of Petaluma's current Watershed enhancement projects and plans.

Sincerely,

Dominga M. Turel
Member of PRWAC

cc: Bill Hurley, RWQCB
Jeffery Peters, Member of PRWAC

*PRWAC is an acronym for the Petaluma River Watershed Advisory Committee

Summary of Land Use
in the Petaluma River Watershed

1.0 INTRODUCTION

This report summarizes available land use and watershed enhancement information from Sonoma County, the City of Petaluma, and other sources. It also includes a brief overview of the relationship between the city and county regarding land use planning, a summary of the role of Southern Sonoma County Resource Conservation District (SSCRCD), and a brief summary of land use areas of concern. Appendix A is a summary of permits required for watershed restoration work.

2.0 WATERSHED OVERVIEW

Located in southern Sonoma County and a portion of northeastern Marin County, the Petaluma River watershed drains a 146 square mile, pear-shaped basin (see Figure 1)[1]. It is approximately 19 miles long and 13 miles wide with the City of Petaluma near the center of the watershed. U.S. Highway 101 bisects the watershed valley. Mountainous or hilly upland areas comprise 56% of the watershed. Thirty-three percent of the watershed is valley, and the lower 11% is salt marsh. Sonoma Mountain at 2,295 feet is the highest point in the watershed. The Petaluma River empties into the northwest portion of San Pablo Bay.

The headwaters of the Petaluma River and it's ephemeral tributaries begin on the steep southwest slopes of Sonoma Mountain, the southern slopes of Meacham Hill, and the eastern slopes of Wiggins Hill and Mt. Burdell. The confluence of Willow Brook, Liberty Creek, and Wiggins Creek form the headwaters of the Petaluma River just upstream of Rainsville Road and Stony Point Road. The Petaluma River itself flows across the Denman Flat area and through the City of Petaluma. Tidal influence extends upstream of the confluence with Lynch Creek (beyond the railroad crossing).

The lower 12 miles of the Petaluma River flow through the Petaluma Marsh the largest remaining salt marsh in San Pablo Bay and the San Francisco Bay Area. The marsh covers 5,000 acres and is surrounded by approximately 7,000 acres of reclaimed wetlands; reclamation of the wetlands began in 1860.[2] Prior to reclamation, marshland ranged from mean sea level to 3 feet above mean sea level.

Major tributaries in the eastern portion of the watershed include Lichau Creek, which flows into Willow Brook and feeds into Denman Flat area near Stony Point Road and Rainsville Road; Lynch Creek; Adobe Creek; and Ellis Creek. These tributaries flow through both unincorporated land and land within the city limits before joining the Petaluma River. On the western side of the watershed Wiggins Creek and Marin Creek flow into Liberty Creek which also feeds into Denman Flat. The largest subwatershed is San Antonio Creek located in the western portion of the watershed south of Petaluma. San Antonio Creek flows from near Laguna Lake in Chileno Valley to the Petaluma Marsh and divides Marin and Sonoma Counties. In the lower watershed, small tributaries drain into the river and marsh areas.

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[1] The land use map is from the 1989 Sonoma County General Plan. The County is in the process of updating the General Plan.

[2] A Few Historical Facts About Petaluma and Its River *A Work In Progress* with additions made up to January 1998; Compiled by William Roop and Katherine Flynn, Archaelological Resource Service pg. 8.

3.0 WATERSHED LAND USES

Land uses in the watershed include intensive urban development, rural residential, agriculture, parks and preserves, city lands outside the city limits of Petaluma, recreational facilities, and other land uses (see Figure 1).

3.1 Urban Development. Urban development is concentrated within the city limits of Petaluma (the City of Petaluma's urban growth boundaries are currently under revision). There is also limited commercial and rural residential development located in the community of Penngrove.

3.2 Rural residential. Ranchettes or large lot, rural residential developments are found throughout the watershed. These rural properties typically range from one (1) to twenty to forty (20-40) acres and are not usually part of development tracts. These ranchettes provide an opportunity for people to live in rural areas and have small agricultural operations. On the eastern side of the watershed, rural residential areas surround Penngrove and extend into the Lichau Creek and Lynch Creek areas. On the western side of the watershed, the rural residential areas outside Petaluma (Liberty Road, Rainsville Road, Skillman Lane, Middle Two Rock Road, and Eastman Lane) are expanding.

3.3 Agriculture. *Since European settlement in the 19th century, agriculture has been the dominant land use in the Petaluma River watershed. Although the historic poultry production has declined, dairy continues to be an important agricultural industry (need more history here).** Dairy operations are found throughout the watershed in August 1998 there were approximately 30 dairies in the watershed.[4]

Although vineyards were established in the Lakeville area before the prohibition era, the area was historically considered too cool for wine grapes. Vineyard development has increased in the watershed, particularly near Lakeville, along Highway 101, and in the San Antonio Creek watershed. Wine grape production is expected to expand rapidly in the next five years. In December 1997, there were approximately a dozen vineyards in the Petaluma River watershed.

Other agricultural uses include:

livestock (beef and sheep); horses (breeding and about five boarding and training facilities); poultry production-- chickens, turkeys, ducks, and eggs; oats, silage, hay, straw and seed; truck crops; greenhouses and floral nurseries; olives; Christmas tree farms; exotics-- emus and llamas.

Eight properties in the watershed, totaling 2,946 acres, have conservation easements with the Sonoma County Agricultural Preservation and Open Space District. Six of these properties are in agricultural production including hay, sheep, dairy, and grazing use. The other two properties may have future potential for public access. Five ranches on the Marin County portion of the San Antonio Creek watershed have easements with Marin Agricultural Land Trust *(need acreage numbers).*

3.4 Parks (Local and State) and Preserves. Parks and Preserves in the Petaluma River Watershed are as follows: Helen Putnam Regional Park (Sonoma County Department of Parks and Recreation), the Burdell Ranch (Department of Fish and Game), Petaluma Adobe State Historic Park, and Olompali State Historic Park (both

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* *see last page for some poultry ranching history; need some history of dairies.*
[4] UC Ag. Extension, August 1998.

owned by California Department of Parks and Recreation), and the Fairfield Osborn Preserve (recently purchased by Sonoma State University).

3.5 Marsh Lands In Preserves: The 1,950 acre Petaluma Marsh Wildlife Area is managed by the Department of Fish and Game. It is located approximately six miles southeast of the City of Petaluma and bordered by the Petaluma River on the east, San Antonio Creek on the south, private property (Neil's Island) on the west, and Schultz Slough on the north. The 300-acre Rush Creek Marsh managed by Marin County Open Space District is located south of Basalt Creek and north of Novato. The State Coastal Conservancy and U.S. Fish and Wildlife Service own and manage approximately 430 acres of marsh as part of the Baylands Project.

The Sonoma Land Trust owns and manages 472 acres of marsh lands south of Petaluma on both sides of Highway 37 (this land is currently leased as farmland). The Land Trust also has an agricultural preservation easement on an additional 528 acres. They have a contract with State Lands to monitor an approximately 50-acre parcel that has been restored to tidal wetlands.

The City of Petaluma owns the 300-acre Petaluma River Marsh, the Alman Marsh near the Marina, a portion of the McNear Peninsula near downtown, and 160 acres of marsh and oxidation ponds near Schollenberger Park. The city is planning for two major open space acquisitions-the Gray property and floodplain areas for the Petaluma River Greenway.

3.6 Other Petaluma City Lands Outside the City Limits. Lafferty Ranch on Sonoma Mountain, small parcels related to water supply on Manor Road, oxidation ponds and related facilities near Lakeville, and urban separator lands.

3.7 Recreational Facilities. On the eastern side of the Petaluma's boundaries, the city owns a municipal airport on East Washington, Prince Park, Wiseman Park, and a golf course. On the south side of Petaluma is the Petaluma River Marina, Schollenberger Park (a dredge disposal site), and Rocky Dog Memorial Park (on an old landfill). There is a small airport near the Marin County line, just north of Novato. A privately-owned golf course is on Frates Road, and a KOA Campground is located on Stony Point Road.

3.8 Other land uses. A large, expanding quarry is located south of Petaluma and west of Highway 101. The Sonoma County landfill located off Meacham Hill Road drains to both the Stemple Creek and Petaluma River watersheds.

4.0 SONOMA COUNTY.

Sonoma County has policies and programs to protect agriculture and natural resources. Most of these are contained in the 1989 General Plan (which is currently under revision).

4.1 Agriculture. The plan reflects the desire of residents to manage growth and protect agriculture. Agricultural land use policies include: stabilizing agricultural land use at the urban fringe, limiting the intrusion of new residential areas into agricultural areas by maintaining parcels large enough for farmers to lease or buy for their operations, and minimizing conflicts between agricultural and non-agricultural uses.

4.2 Open space. The General Plan identifies open space as a limited and valuable resource. Policies to protect open space include maintaining community separators between Petaluma and both Novato and Rohnert Park and protecting scenic resources such as the Sonoma Mountains between Petaluma and Sonoma, the grassy hills and ridgelines south of Petaluma near the Marin County border, and views of San Pablo Bay along Highway 37. *(Need Open Space District Statement Here.)*

4.3 Natural resources. Policies were developed to protect critical wetland, marsh, and oak savanna habitat that are highly sensitive to change. For example, the riparian corridor policy states that agricultural cultivation and grazing should occur 100 feet from the top of the streambank in flatland areas and 50 feet in upland areas. Policies are identified to control soil erosion, protect agricultural and domestic water supplies, maintain Sonoma County's diverse plant and animal communities, and protect fishery resources while balancing needs for agriculture, development, and mining.

4.4 Other policies. In addition to the General Plan, Sonoma County has several other natural resource-related policies. The Valley Oak Ordinance specifies that when oak trees on particular soil types are removed, landowners must notify the County and indicate that they will either plant more oaks or implement measures to protect existing trees. *Sonoma County, several cities, public agencies, and various organizations (both environmental and agricultural) have also worked on a Vernal Pool Preservation Plan. A general permit has been requested from the ACOE to cover development-related activities (This is for Sonoma County-does not pertain to Petaluma River Watershed).*

NEED MARIN COUNTY

5.0 CITY OF PETALUMA

The City has also adopted policies in the General Plan in support of agricultural businesses located within Petaluma (General Plan Policies need to be stated here).

The City of Petaluma has several watershed enhancement and mitigation projects including:

- Petaluma River Access and Enhancement Plan. Adopted in May 1996, the Plan establishes policies for preservation, enhancement, and restoration along a 7.8 mile stretch of river from the urban limit line near Old Redwood Highway, through downtown, and to the marina. The plan calls for creating a continuous riparian corridor or "greenway" along the river, identifies restoration and enhancement opportunities, and designates appropriate access points.

- Petaluma River Marsh Enhancement Plan. In 1992, the City of Petaluma completed a plan for 300-acres of undeveloped disturbed wetland south of the City marina. The plan includes recommendations for water quality, habitat enhancement and restoration, endangered species protection, public access, and public recreational opportunities. Most of the land is in the City limits and owned by the City of Petaluma.

- Petaluma Demonstration Marsh and Effluent Management Plan. As part of the City's Long Range Effluent Management Plan, the City approved acquisition of approximately 170 acres adjacent to the Petaluma Marsh to create a demonstration marsh. The plan includes restoration of approximately 100 acres of tidal marsh and creation of a mosaic of seasonal wetlands, riparian areas, and freshwater ponds.

- Adobe Creek Restoration Project. As part of the mitigation for widening Lakeville Highway, the City is restoring the lower portion of Adobe Creek to a brackish marsh, as well as enhancing public access and incorporating urban forestry into highway revegetation. Within the city limits, two upper reaches with constructed trapezoidal flood control channels are targeted as restoration projects to demonstrate reach-specific stream channel design and maintenance programs based on hydraulic analysis and the use of vegetation management standards. The goals for enhancing the upper portion of Adobe Creek include collecting and concentrating summer flows in a trained, low-flow channel; minimizing maintenance, dredging and clearing; maintaining adequate flood protection; re-establishing native riparian plant community above the channel and along the banks to provide shade and diversity for aquatic habitat; and providing on-going methods for removing sediment accumulation.

5.1 Relationship between City of Petaluma and Sonoma County. The City of Petaluma and Sonoma County both have general plans and formal planning related relationships. For example, annexation proposals are reviewed by the County both through LAFCO (Local Agency Formation Committee) and at a financial level.

In addition, the City and County have a joint referral and review system. The County refers all projects within the Planning Referral Area to the City for comment. Likewise, City projects that may affect the County or are near the urban boundaries are referred to the County. The City and County planning staff and public representatives also have working relationships and less formal means of cooperation such as meetings on various topics related to planning.

The City has also adopted policies in the General Plan in support of agricultural businesses located within Petaluma (Put under City of Petaluma section).

6.0 SOUTHERN SONOMA COUNTY RESOURCE CONSERVATION DISTRICT (SSCRCD).

Below is a summary of the role of the Southern Sonoma County Resource Conservation District.

For many years, SSCRCD has participated in efforts to enhance the resources of San Francisco Bay and Estuary, which includes San Pablo Bay and bay wetland areas. This includes regular meetings with Department of Fish and Game, U.S. Fish and Wildlife Service, Army Corps of Engineers (ACOE), State Lands Commission, Bay Conservation and Development Commission (BCDC), and environmental groups. SSCRCD administers a landowner levee maintenance permit from ACOE and BCDC.

SSCRCD staff has designed dairy waste systems and responds to calls for assistance with erosion control. SSCRCD has received grants from U.S. Environmental Protection Agency's North Bay Initiative for outreach to watershed landowners in the San Antonio Creek watershed and to coordinate with watershed landowners on levee permit issues. SSCRCD sponsors work by AmeriCorps and the Adopt-a-Watershed School Program for several schools in the watershed. Their projects include conducting conservation planning workshops with local ranchers and streambank stabilization projects to reduce sediment delivery to the creek.

In 1997, SSCRCD received a contract from the State Water Resources Control Board to assist in developing a voluntary stakeholder written plan for the Petaluma River Watershed. SSCRCD will continue to seek implementation funding for the project.

7.0 LAND USE AREAS OF CONCERN

The following are concerns about land use in the Petaluma River watershed. Concerns were identified by the watershed advisory group, local residents, and public agencies concerned with natural resources and the long term viability of agriculture in the region.

CREEK AND SUBWATERSHED CHARACTERIZATIONS AND ENHANCEMENT OPPORTUNITIES

Table 2 summarizes the enhancement opportunities for each subwatershed (see Appendix A). Table 1 provides the key to the abbreviations from the California Habitat Relationships System that are used throughout the following descriptions.

1.0 Lichau Creek Subwatershed

1.1 Characterization

Lichau Creek is located in the northern portion of the Petaluma River Watershed east *(west?)* of Sonoma Mountain. The main channel flows southeast for about 7.5 miles, through the town of Penngrove, until it joins Willow Brook Creek. The subwatershed contains several small creeks that flow east and west into the main channel. They include Highland Creek, Martenoni Creek, Meacham Creek, Penngrove Creek, and Davis Lane Creek. Together they comprise approximately 4.5 miles of riparian corridor. The entire subwatershed drains an area of approximately 9.68 square miles, which is 7% of the Petaluma River watershed.

Soils of the lower reach of Lichau Creek are Cotati fine sandy loam with moderate erosion hazard rating according to the 1972 Sonoma County Soil Survey. Moving upstream, the soils turn to Diablo clay and then to Goulding cobbly clay loams. These soils are associated with rapid runoff and high erosion hazard.

Riparian vegetation along the middle and lower reaches of Lichau Creek shows a high degree of impact from development and agriculture. The lower reaches of the creek, east of Petaluma Hill Road, flows south along the Northwestern Pacific Railroad to its confluence with Willow Brook Creek, draining through areas that have been converted to municipal and residential use. Here the vegetation varies from areas of moderate woody growth dominated by willow and live oak (VRI 4M) to open areas lacking substantial woody vegetation (VRI 4P). Groves of eucalyptus and Lombardi poplar are interspersed with the native vegetation. East of Petaluma Hill Road, a 2 mile stretch of creek has perennial grassland habitat (PGS 2D). Upstream, the corridor graduates into a moderately dense canopy of live, oak, California bay, and willow (VRI 4M). Still further upstream, in the uppermost reach, the riparian corridor deepens with a dense two-storied forest (VRI 4-6D) covering about 88 acres (just under 3 miles) and is dominated by oak and California bay. The riparian corridor is flanked by oak/bay woodlands to the north and south, decreasing erosion problems along the hillsides and streambanks, and increasing valuable habitat to wildlife.

Highland, Martenoni, and Meacham Creeks flow east into Lichau Creek and are located west of the Northwestern Pacific Railroad and north of the Highway 101 corridor. Penngrove Creek and Davis Lane Creek flow southwest into the main channel and are east of the railroad. The riparian vegetation in these areas are dominated by live oak interspersed with groves of eucalyptus. Although these riparian corridors have been fragmented and split by the division of land into small, rural residential parcels, there are sections of moderately dense (VRI 4M) vegetation along portions of Meacham Creek and Penngrove Creek (see Riparian Vegetation Area Map #1). Davis Lane Creek has the least riparian habitat of the six creeks, with less than a quarter of a mile of riparian vegetation (VRI 4M).

Also included in the Lichau Creek subwaterhed is a large, unnamed creek located north of Lichau Creek. (For ease of description we will call it Cold Springs Creek.) This is the northernmost creek in the Petaluma watershed. The lower reach flows along Roberts Road, passing through agriculture and rural residential lands. Here the vegetation is primarily perennial grassland (PGS 1D) with occasional live oaks. The riparian vegetation graduates into willow and alder where the creek turns and follows Lichau Road. As elevations increase, the riparian corridor widens and becomes dominated by large coast live oak and California bay trees with big leaf maple and California buckeye (VRI 4-5M). Where it nears Cold Springs Road the tree density increases, and the two-storied riparian forest is dominated by coast live oak and California bay (VRI 5D).

1.2 Enhancement Opportunities

Enhancing the 2 miles of riparian corridor, that consists mostly of grasses (PGS 1D), along Lichau Creek east of Petaluma Road was given high priority. Enhancement could include installation of livestock control fencing and plantings. The corridor east of the perennial grassland (PGS 1D) site and west of the dense forest (VRI 4, 5 & 6D) may also benefit from fencing and scattered plantings (of oak and California bay) in the sparse (VRI 4S) areas. Enhancement opportunities for these portions of creek were given medium priority. Fencing moderately dense areas (VFI 4M) were also give medium priority. High priority was given to fencing and plantings along all the open (VRI 4P) sites.

Enhancing the riparian corridor along Highland, Martenoni, Meacham, and Penngrove Creeks is worth pursuing (given a medium priority rating). Public outreach in the form of community meetings and education and/or a publicized and distributed Creek Care Guide could bring important information to people with interests in the area. Enhancement would include control of exotic plant species in the area, installation of fencing, and plantings (willow and oak) in areas where woody vegetation is minimal (VRI 4P). Fencing and planting the perennial grassland sites (PGS 1D) along Davis Lane Creek was given high priority.

Enhancement opportunity along the lower reaches of Cold Springs Creek was given high priority. Enhancing riparian areas, that are mostly perennial grassland sites (PGS 1D & VRI 4P)), by installing livestock control fencing and planting which may help to connect the existing riparian corridors. Continued management of livestock access to the upper reaches will help to continue to preserve the health and aesthetics of the existing corridor. (This was given a medium enhancement priority if fencing is needed.) The upper reaches of this creek are healthy and intact.

2.0 Willow Brook Creek Subwatershed

2.1 Characterization

The Willow Brook Creek subwatershed is located in the northwest portion of the Petaluma River watershed, draining an area of about 5.3 square miles, which is 4% of the watershed. The subwatershed includes Willow Brook, Davis, Waugh, and Lower Lichau Creeks. The headwaters of Willow Brook Creek are located on Sonoma Mountain south of Lichau Creek. The main channel flows south past its confluence with Lichau Creek and into the urban boundary, entering Petaluma Creek west of the Highway 101 corridor. The main channel and riparian corridor are approximately 6 miles long. The riparian corridors are utilized by a wide variety of wildlife which includes waterfowl and other bird species, coyote, deer, mountain lion, raccoon, and skunk.

Soils along the main channel are mostly Clear lake clay in the lower reaches and Gullied land in the upper reaches according to the 1972 Sonoma County Soil Survey. The clay soils are poorly drained soils of floodplains. The slow runoff characteristic of these soils keeps erosion potential low. Gullied land, occurring within the upper reaches of the Willow Brook corridor, is unique to certain areas east of Petaluma. Here, where there is sparse protective woody plant cover, accelerated runoff cuts into the water courses resulting in very high erosion hazard.

Most of the length of Willow Brook has a seasonal rather than perennial water regime with water flow occurring only during the wet season. South of Ely Road and into the urban boundary, the riparian vegetation is composed of moderately dense trees (VRI 4M) dominated by willow and oak. Riparian vegetation is open to sparse in the portion of creek north of Ely Road and south of Adobe Road. Agricultural use and municipal expansion have converted some of the vegetation to perennial grassland (PGS 1D) dominated by introduced grasses such as perennial and annual rye with wild oat. From the sparsely wooded lower reach, the vegetation develops upstream into moderately dense, small trees (VRI 4M) dominated by coast live oak and California bay. Farther upstream shows the mosaic pattern of the corridor with alternate areas of dense vegetation and open grassland. This portion of creek was given a WHR rating of VRI 4P. Within the uppermost reach of Willow Brook, which has deep steep slopes and occasional fencing, the habitat is dense with small and large trees (VRI 4-5D) dominated by California black oak, coast live oak, and California bay, with an understory of California buckeye. The vegetative corridor here reaches widths up to 300 feet.

Davis and Waugh Creeks are tributaries flowing southwest into the main channel of Willow Brook Creek. Lower Lichau Creek is located on the east side of Willow Brook and flows eastward into the main channel east of the Highway 101 corridor. Davis Creek has approximately 0.5 mile of VRI 4M vegetation and about 8.5 acres (less than 0.25 mile) of VRI 4-6D forest within its uppermost reach. Waugh Creek is characterized primarily by sparse to open riparian vegetation (VRI 4S & 4P).

2.2 Enhancement Opportunities

About 21 acres of perennial grassland habitat (PGS 1D) located in the lower reach of Willow Brook, just north of Adobe Road and running south to Ely Road, was identified as having high enhancement opportunity.

This would include installing livestock control fencing and plantings. Landslides are common along this stretch of creek, and woody vegetation may help to decrease erosion hazards and increase water quality.

Along the middle reach of the creek, an area of approximately 43.5 acres, north of Adobe Road (including the eastern tributary), is comprised of a mixture of moderately dense to open tree canopy (VRI 4M, 4S & 4P) and perennial grassland (PGS ID). This area was rated as having medium enhancement priority. The riparian corridor here may be enhanced by limiting cattle access with fencing. Areas where woody vegetation is sparse or absent (VRI 4S & 4P and PGS 1D) could be planted with live oak and willow (or other plantings).

The uppermost reach of Willow Brook, an area of about 68 acres (about 2 miles), with its unique gullied topography, has been protected by management practices. This area, (VRI 4-6D), was given a low priority rating for enhancement. Enhancement along Waugh Creek and Davis Creek may increase wildlife value in areas nearer the urban boundary and help to minimize erosion problems along the streambanks. These areas were given high enhancement priority due to their sparse to open conditions. Enhancement could include fencing and plantings along the riparian sites with perennial grasses (PGS 1D) and areas with sparse to open woody vegetation (VRI 4S & 4P). Lower Lichau Creek is located within small rural residential parcels, enhancement by fencing and planting open areas (VRI 4P) was given medium priority.

4.0 Lynch Creek

4.1 Characterization

Lynch Creek is situated in the northeast portion of the Petaluma River watershed, draining approximately 4.0 square miles and comprising 3% of the watershed. The headwaters are located in steep hillsides along Sonoma Mountain Ridge near Sonoma Mountain Road. The main channel drains south 6.8 miles (4 miles are outside the urban boundary) with 3.5 miles of tributary and enters the Petaluma River west of Highway 101 at the confluence of Petaluma Creek.

For soils see Erosion Control Summary.

Inside the urban boundary south of Adobe Road, there are about 13 acres (approximately 0.75 mile) of densely populated woody stream vegetation. Outside the boundary, the riparian corridor is generally open in the middle reach, with occasional individual trees, and small groupings (VRI 4P). Willow is the dominant species with alder and oak. Upstream the vegetation graduates into a section of moderately dense small trees (VRI 4M). In the upper reach, approximately 83 acres (about 2.25 miles) of the corridor is a dense and two-storied riparian corridor (VRI 5- 6D), dominated by oak and California bay. Oak/bay woodlands inhabiting the hillsides, reaching widths over 300', are directly adjacent to the corridor which increases the wildlife value of these upper areas.

4.2 Enhancement Opportunities

Enhancement opportunity exists for the riparian corridor (VRI 4P) south of the dense riparian forest (VRI 5-6D) in the upper watershed. The presence of the mature forest in the upper watershed gives value to remnant areas downstream. Connecting the corridor south into the city boundary may help decrease erosion, increase water quality, wildlife habitat, and aesthetics throughout the subwatershed.

Enhancement could include fencing and planting along the open (VRI 4P) portions of the riparian corridor (high priority), as well as installation, if necessary, of livestock control fencing along the moderately dense (VRI 4M) portion of the corridor (medium priority) .

3.0 Corona and Capri Creeks

3.1 Characterization

Corona and Capri Creeks are small creeks located southeast of Willow Brook Creek and northwest of Lynch Creek. Their headwaters are located on Sonoma Mountain and flow south across Adobe Road into the urban boundary, entering Petaluma Creek just west of the Highway 101 corridor. They drain an area of approximately 5.1 square miles, which is 3% of the Petaluma River watershed.

Riparian habitat along these creeks is almost entirely perennial grasslands (ACS 1D). Corona Creek has a small site (less than 0.25 mile) of moderately dense (VRI 4M) riparian vegetation, and Capri Creek is characterized entirely by perennial grasslands (PGS 1D).

3.2 Enhancement Opportunities

Enhancement Opportunities Enhancement along both creeks may help to minimize erosion problems along the streambanks and increase wildlife value in areas nearer the urban boundary. These areas were given high enhancement priority. Enhancement would include fencing and plantings along the perennial grassland (PGS 1D) sites and areas with sparse woody vegetation (VRI 4S).

From Restoration Design & Management Guidelines for the Petaluma River Watershed (Appendix F) Volume I

CALIFORNIA BLACK OAK

Quercus kelloggii

APPEARANCE

Form/shape- A medium-sized, upright tree with a broad, rounded crown.

Foliage- Deciduous. Leaves are 4-8 inches (10-20 cm) long, deeply lobed with bristly points at tips, and bright, rich glossy green. They turn yellow and orange in the fall.

Height at Maturity- 30-80 feet (9-25 m).

Spread at Maturity- 20-50 feet (6-15 m).

Flower- Catkins appear in April and May. Acorn matures second year.

GROWTH RATE/MAXIMUM AGE

The growth rate is slow to moderate. The maximum age is about 300 years.

ECOLOGICAL RELATIONSHIPS

Native Range- The Sierra Nevada and Coast Ranges from San Diego County north.

Climate Zones- 5-7, 15, 16.

Plant Communities- Mixed Evergreen Forest, Yellow Pine Forest, North Oak Woodland.

Plant Associations- *Umbellularia californica*, *Arbutus Menziesii*, *Quercus* spp.

WILDLIFE HABITAT VALUE

The acorns are an excellent food source for mallards, pintails, woodducks, clapper rails, pheasant, pigeons, quail, blackbirds, crows, jays, meadowlarks, mice, thrushes, foxes, woodpeckers, titmice, starlings, thrashers, rabbits, muskrats, raccoons, squirrels and woodrats. Herbage and acorns provide excellent browse for deer. Flowers and young leaves eaten by pigeons.

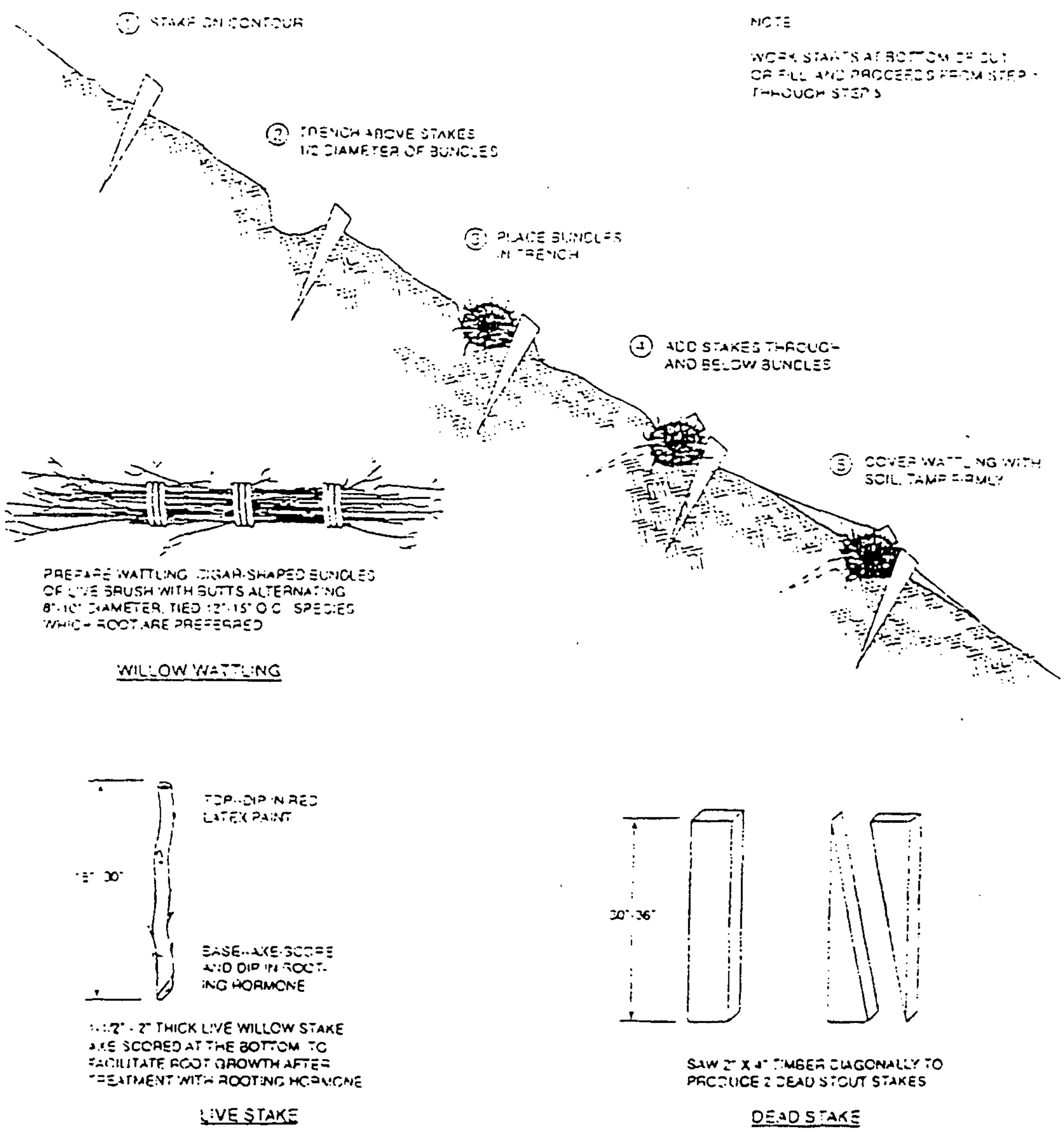
EROSION CONTROL VALUE

The roots are deep and provide good erosion control.

DESIGN/LANDSCAPING VALUE

The young leaves are a bright pink to rose color in spring. Fall color is also attractive. This is our best and only oak for fall color.

from Volume II



Questa Engineering Corporation Point Richmond, California	**Willow Wattling and Live Staking**	Figure 9-1

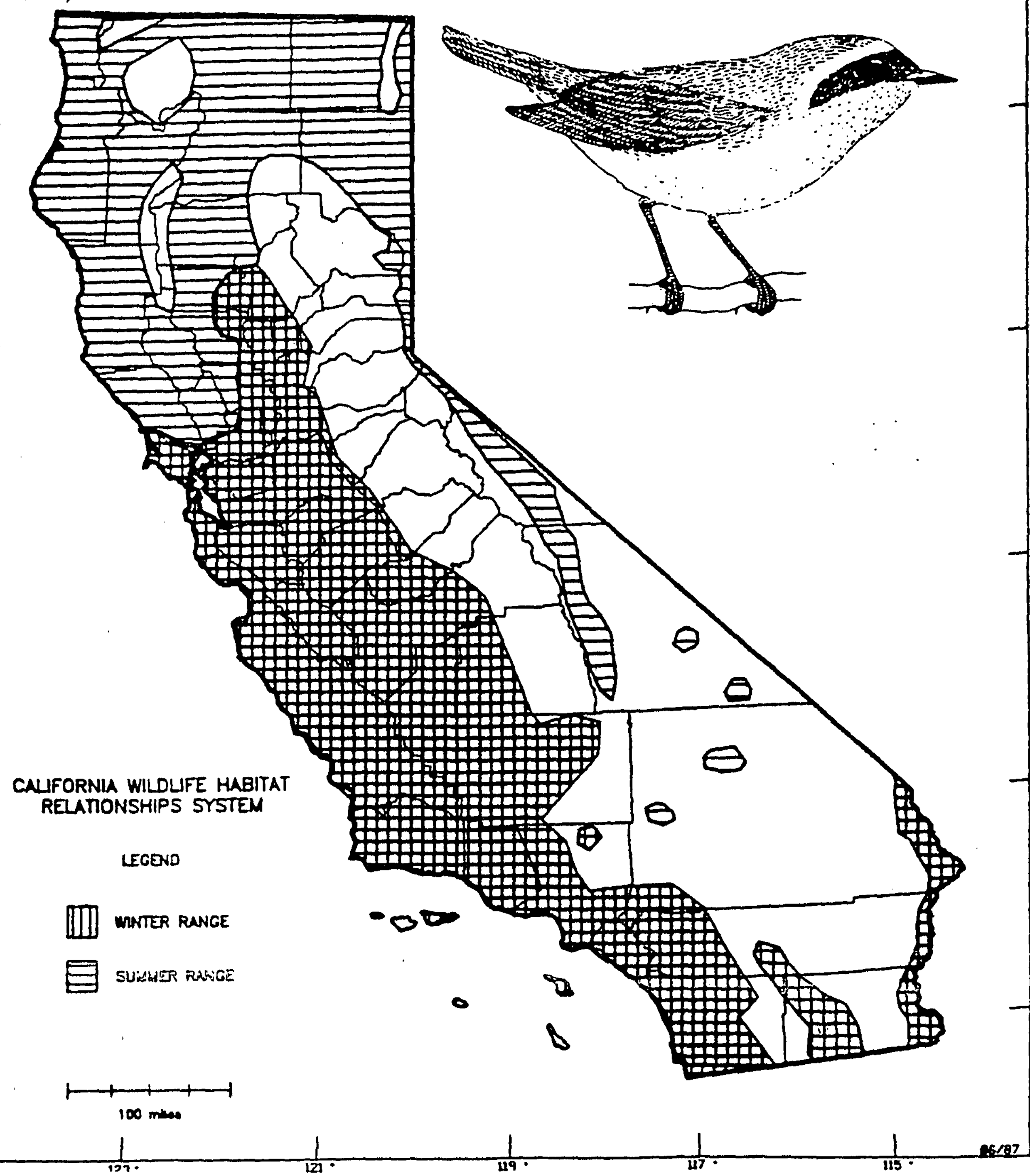
This is the bird that was left out of our plan. Why?

APPENDIX C

COMMON YELLOWTHROAT

AUTHORSHIP

Species Note Prepared By: M. Green
Species Note Edited By: D. Winkler, R. Duke
Species Note Reviewed By: L. R. Mewaldt



Dear Mr. Luther,	1-7-99

Received draft copy of Pet. Watershed Enhancement plan on 2-3-99. Find the short timeframe given process non-involved landowners to prepare comments and ideas Re: Plan draft, for the 2-10-99 meeting as short sighted, down right rude and insulting to them. They should have a minimum of 3 weeks from date of receiving notification for date of meeting. 1 month would be preferred. You must think we do draft plan review 9 to 5, five days a week and run our ranches on weekends. Insulting and a hardship is your method for viewing the appendices. Copies cost a quarter a pop at library. Have you ever tried to concentrate in the "quiet" of the library with young and older students. Most landowners would/sha the library study experience as being unsatisfactory and not review the Plan or the appendices. Which may be your intent. The RCD should spring for 30 cps of all appendices and 30 draft plan copies, made available for landowner pickup at RCD office, considering the numerous claims of the importance of involving watershed residents with the process. Put your money where your mouth is. Those residents of the watershed not involved with the process are being ignored by not being given ample time to review the Plan draft and all appendices. They should all receive notification. I recall 3,000 watershed newsletters being mailed to watershed residents. Your cover letter indicated that I am a member of the PWLAC, when I am not. I have not attended any meetings of the PWLAC. Who are the members of the PWLAC? How many times did they meet? The Plan draft is the product of which committee? Was the $114,115.- grant for a PRWEP or a PWEP? At the last meeting I attended, I raised the issue of the project being a waste of taxpayers money since the socalled Petaluma River is not a river but a tidal dead end slough. So why a river enhancement study on a tidal dead end slough by the RCD and PCI for $114,115.- This issue has many ramifications to watershed residents and they should be discussed in great detail before a private club-committee makes recomendations for a river that is not a river. Watershed landowners may be put in a position of goals for the slough that will not be attaynable. Until this issue is settled the watershed process should be put on hold. VB

Presented to LAC on February 10, 1999

Vasco Brazil

Susan Tunzi & Domingo Tunzi 2/10/99

Rewrite entire Plan and include the following:

1. Reorganize goals & recommendations into coherent timeline.
2. Need "20 yr." or "Ongoing" timeline for the long-term goals.
3. Separate RCD goals from Watershed Council goals & show how they work together.
4. Use "stakeholder" not "landowner".
5. Research & rewrite history.
6. Conservation Plan--put it in Appendix and write an introduction.
7. Include all agency people that contributed (*see attachment*).

Please call or write if we can help you write this plan or if you need any additional information. Thank you.

Petaluma ~~Landowner~~ *Stakeholder* Advisory Committee

Watershed Advisory Group

Landowners/Residents

Add these names to list

Tom Altenreuther
Lucy Mendoza (Farm Bureau Rep.)
Jim Mendoza (Farm Bureau Rep.)
Jan Riebli
Paul Martin (SSCRCD Board)

Agencies and Consultants

Paul Jones-EPA (*When* did he come?)

Add names to this list

Jennifer Barrett - formerly City of Petaluma; now City of Novato (*Who is her replacement as contact for the City of Petaluma?* Please add name)

David Keller - City of Petaluma Council (on list)

Mike Jensen - PCI (wrote & did field work for Erosion and Sedimentation Summary; gave presentation on Erosion & Sedimentation at Ad. Committee meeting.)

Rick Wantuck - National Marine Fisheries Service (came to give presentation and answer questions, but was not given the opportunity due to meeting's time limits and SSCRCD did not have anyone from Nat'l Marine Fisheries to come to another meeting despite the request from the Ad. Committee to please have another meeting for Nat'l Marine to speak!)

Fred Botti - DFG (gave presentation on Petaluma Marsh)

Nancy Scolari - Marin Resource Conservation District (formerly SSCRCD- wrote summaries of and gave presentation on Surface and Groundwater Quality Data and Surface Water Quality Monitoring Guidelines Summaries); As Marin RCD she has supplied information and assistance for both the Marin and Petaluma parts of the *Petaluma River Watershed.*

Paul Olin - UCCE (gave presentation on salmonid habitats)

Southern Sonoma County Resource Conservation District

Tish Ward
Paul Martin
Maxine Durney
Mitch Mulas
James Ryan
Assoc. Susan Bianchi, Clarence Jenkins, Becky Jenkins,
Bruce Osterlye, Craig Jacobsen (new member?)

Nancy Scolari (Marin RCD; formerly SSCRCD)
Robert Rand (formerly SSCRCD Project Manager)
Paul Scheffer (SSCRCD)
Jennifer Allen (SSCRCD)
David Luther (SSCRCD)
Leandra Swent (SSCRCD)

RAYMOND H PETERSON
636 Gossage Ave
Petaluma, Ca 94952
707- 765-4582
FAX 765-9907

February 11, 1999

David Luther
So. Sonoma County RCD
1301Redwood Way Suite 170
Petaluma, Ca 94952

Re; Comments on draft watershed plan

The Sonoma County Flood Control and Water Conservation District (AKA Water agency) is working on flood midigation midation plans for the Petaluma River watershed. Suggest that you obtain a draft copy of the Hydrology Study of the Marin Creek and Wiggins Creek Watershed from John R Rainwater, PE at the agency, 526-5370. There are some differences; for example they discuss foliage in creeks on private lands as a cause of flooding. The RCD plan refers to foliage as a stream improvement.

The draft plan is very difficult to follow or reference comments, no page numbers or identification of section numbers refereed to in the "How to use the plan section". Next version should be numbered. Without the appendices the draft is only a summary. Request that copies of the appendixes be made available.

Page 6, 1 numbered beginning with the 1st page after the Table of contents, indicates that sedimentation and nutrient loading are the major problems. No indication is given as to the causes. The entire draft is aimed at the agricultural landowner, however, a review indicates that the major causes of erosion are suburban landowners. The city of Petaluma Grading and Erosion Control ordnance 17.31 of the municipal code restricts activity that allows soil to erode beyond property boundaries or into streams. The County of Sonoma does not have such an ordinance. Land developers outside the city limits make little, if any attempt to control erosion. This is the major problem and should be addressed in the watershed improvement plan.
Page 12.
An early goal should be a recommendation to Sonoma County that they adopt an ordinance and enforce it. The Petaluma ordinance and their enforcement actions could be a good model. Correcting behavior that is a major contributor is the least costly approach. Suggest this be included as a first year objective.

An area of major erosion, the Marin and Wiggins creeks do not appear to be addressed. I pointed out at the first advisory committee meeting the significant problems there.

The 10 year objective 3. Establish a buffer zone between all land uses and creeks, makes no sense. Is a modifier prior to "land use" intended?? Open space and reparian corridor are land uses. Goal must be to buffer land uses that cause erosion.

Objective 2, Maintain summer flows does not seem to be obtainable. Much of the watershed has been paved over. Sonoma County now requires paved driveways to rural homes. This reduces the ability to replenish the aquifer. That coupled with the increased pumping for new homes has reduced that water table. There do not appear to be any recommendations to increase percolation. What steps are intendentedintendented to return summer flows?

Page15 5-year objectives should be accelerated. Identification and enhance land most susceptible to flooding can be done within the first year. Moving to identify land in the flood zone is most pressing. Every day additional flood zone is being developed. No mitigation can keep up with the current level of development.

Page 17, reduce accelerated soil erosion and manage sediment. Again Wiggins and Marin creeks are only included as sub-watersheds of Willow Brook. They should be emphasized.

Page 19 under 10 year objectives has the development of groundwater recharge program. That should be accelerated to provide input to the Sonoma County water Agency in its flood control projects on Wiggins and Marin Creeks.

Thank you for the opportunity to comment on the draft Petaluma Watershed Enhancement plan.

Sincerely,

cc: water agency Zone 2A

RAYMOND H PETERSON
636 Gossage Ave
Petaluma, Ca 94952
707- 765-4582
FAX 765-9907

February 18, 1999

John R Rainwater, PE
Water Agency engineer
PO BOX 11628 Santa Rosa, CA 95406

RE: Marin Creek and Wiggins Creek Hydrology study

At the same time as you are preparing this study the Southern Sonoma County Resource Conservation District has prepared a draft Petaluma Watershed Enhancement Plan. The two plans have overlap as to area, look for solutions to detrimental effects of storm water, but come to different conclusions as to mitigation. Whereas the hydrology study is suggests moving water through projects to the Petaluma River, the enhancement plan is aimed at reducing the erosion and its introduction into the Petaluma River as an increase in turbidity and silting of the river.

I suggest that you obtain a copy of the watershed plan from David Luther at 794-1242.

Comments on the Draft Hydrology study;
Page 5 indicates that.."*the land use is an important topographic factor influencing surface runoff of storm waters.*" The Resource Conservation district has suggested an objective to identify the flood zone areas and take steps to prevent further development in the flood zone. Why is that not a similar goal in the hydrology study?

The 3rd par of page 7 indicates that floodwater in ravines and channel in the upper hilly parts of the watershed is not a problem. However, that is where the erosion is occurring that silts in the lower areas causing streams to disappear and water to sheet over the land.

The last par of page 8 suggests that cumulative water flow increases could cause further flooding downstream. What is the proposed mitigation to the increased flows caused by any of the proposed flood control projects? What is proposed to reduce the erosion and increased silting of the Petaluma River? (Note the dredging requirements for the river are increasing)

Page 9, 2nd Par states.. "*The upper reaches of Marin creek...are steep.. The creek location, as a result, is stable and keeps itself and the structures it passes through clean for the most part. ...all of the sand and silt that comes down off the steeper slopes deposits in this area* (Denman Flats). Doesn't the floodwater also carry a significant amount of this silt into the Petaluma River? Causing the river to silt and reducing the rivers ability to carry flood water and the need for dredging? Are there mitigation measures that could reduce the upper reach erosion? The study points out that the Denman flats is a natural "detention basin", could that area not be enhanced to reduce the silt flowing out and increase its retention of peak periods offsetting the increases do to projects and further development?

Project needs reports: figure 1 shows the unnatural 90 bend forced into Marin creek at Skillman Lane. The projects do not indicate its removal? Isn't that necessary to eliminate the flooding?

Will project (file no. 2-1186/018-1) upstream of Skillman Lane eliminate the erosion for the upper reaches of Marin creek? The description seems to fall short of the length to western Ave and only riprap the "toe of the banks".

Thank you for the opportunity to comment on the draft plan.

Member Zone 2a Advisory Committee

cc: RCD, Zone 2A

To SSCRCD
Herein is my testamony Re: Your Petaluma Tidal Dead End Slough Watershed Enhancement Plan. The Summary Draft on Erosion and Sedimentation of the Petaluma Dead End Slough Watershed, Watershed Land Use, Watershed Riparion Plant Community, Fisheries Enhancement and the Petaluma Marsh/Bay Habitat.

This watershed plan to enhance water quality and enhance aquatic fish and wildlife resources is a product of the U S EPA that is funding the grant through the SWRCB. The SSCRCD has a SWRCB contract that lists the scope of work to be covered in this watershed plan. Thus this RCD is being paid by a regulatory agency to preform this project on us, making this RCD an agent of regulatory agencys. According to an article on this watershed plan that appeared in the Argus Courier on 2-13-98. This RCD is a non regulatory agency and does not create or enforce regulations and was given the grant funds. not so, this RCD requested the grant funds from the SWRCB and is promoting enhancement project sites and specific material for project use. This RCD has miss stated the source of pollution problems in the Petaluma Tidal Dead End Slough as ag related. When in fact the actual cause has not yet been discovered. A stated recommended action for the RCD in the Marsh/Bay Habitat Summary on pg 11 states "Select enhancement projects that do not adversely impact the habitat of these endangered species. (Calif. Black Rail - Calif. Clapper Rail and the Salt Marsh Mouse) If this is unavoidable, follow up and ensure that specific terms and conditions identified by USFWS are implemented." This RCD hired PCI to produce a number of watershed inventory studies. The information for these inventory studies mostly came from self interest agencys. Therefore the views as stated in the studies by PCI reflect the biased and self interest views of these self interest sources

This RCD is taking sides with the regulatory agencys as it was paid to do. This biased information may or shall be used by regulatory agencys to formulate mandatory regulations on this watershed. The National Marine Fisheries Service held a public forum in Ukiah on 4-6-98 to explain a proposed critical habitat protection zone along all Northern coast waterway. Source EIR 5-98 issue story.

I believe this RCD has been remiss to this point with informing watershed landowners of what this is really all about. We should have already been told of what will or will not occur to us if and when a watershed plan is implemented by regulatory agencys. Are you leading us to mandatory agency regulations? Are mandatory regulations or voluntary regulations really necessary for a tidal dead end slough? Is there a hidden agenda here? How much grant funding is available for projects for FY99-00 + 00-01. What is the funding status for Stemple Creek and the Estero for the next 3 years? What is the role of the City of Petaluma in this? Are they in line for funding City watershed projects. I question spending taxpayers money for the stated purpose of this project. That of improving water quality and enhance fish and wildlife, using only fish friendly projects and materials. In a watershed that is not a river, therefore would not have the same capacity of increasing fish and fish speci population such as a river with year round water would. Would it not make more sense to spend taxpayers money were your goal has a better chance to succeed? In your cover letter for todays meeting you mention receiving written comments Re: this watershed plan. These letters should be made available to all Advisory Committee members and the public. Have you also notified all watershed landowners with a high project priority rating of these meetings?

Testamony Re: Erosion and Sedimentation Petaluma Tidal dead end Slough. The PCI views in this summary reflect the bias and self interest views of the sources used and information given by these same self interest sources. What amount of information in this summary came from watershed landowners? Such as there own ongoing farm plan or BMP being practiced. I most certainly do not agree with the stated repair rating system. Repair priority would be equal for all subwatersheds large or small. Large repair costs should not be an excuse for a low repair rating. The presence of reservoirs in watersheds with high erosion and erosion activity potential, such as Lakeville tributaries, should have a high repair rating not a moderate rating. Especially if Petaluma City effluent is used for summer irrigation of these watersheds. The use of city effluent in the Wheat Creek and the Ellis Creek watersheds was acknowleged by PCI. Why was the added winter runoff effect on these watershed not addressed by PCI? These reservoirs were made with taxpayer and landowner funds in the 50's and 60's. There primary purpose was to store water in water short areas of this county for ag purposes. The reduction of any silting of these reservoirs should be encouraged not ignored. There construction was highly promoted by the RCD and the SCS at that time. My how time has changed this RCD, you used to be on our side, now you follow the money trail. The repair cost for watersheds could be reduced if some landfill materials would be directed for watershed erosion repair. Such as tree stumps, brush, used lumber some rip rap and soil. If done properly rip rap is perment, requires next to no maintenance and will refrain cattle from walking in creeks. Its use should be encouraged by the RCD and the NRCS as being landowner friendly. On the other hand this fish only funded watershed projects will only prevent most watershed landowners from making watershed repairs right after last winters very heavy rainfall damage. The cost to change land from ag use to a resource should not be at the expense of the willing watershed ag only landowner. The benefitting agency should bear all the conversion costs and pay the landowner a fee equal to its resource value or its ag value whichever is highest on a yearly basis.

[illegible]

To SSCRCD,

Herein is my testamony Re: Your Draft Petaluma Watershed Plan, Dated March 1999, I reserve the right to add more written comments before 5 PM of April 21, 1999 at RCD office.

During the summer of 1997 some 18 months ago I started attending Petaluma River Watershed Enhancement Plan meetings as a volunteer member of the Landowner Advisory Committee, [illegible] incentives because it would most likely affect me since my ranch is in this watershed. Secondly to see if this regulatory agency governed process was fair to the watershed landowners. Now that the process is nearing its end it is quite evident that the process is indeed not fair to watershed landowner. The process is being held in the regulatory agency arena where decisions are made arbitarily with no accountability. Goals and objectives will be made by some 30 people that will adversely effect all watershed landowners of 146 square miles. This indicates a lack of notification to motivate watershed land owners to attend the LAC meetings in greater numbers by the SSCRCD project manager. The services for process procedure is totaly funded with funds from the agency that will accept and approve the submitted watershed plan. [illegible] made by LAC members at the meetings to the PC | staff person for consideration by the members were not voted on to establish member approval or disapproval of the comment. There is no accountability of projects cost to taxpayers, or landowners, of project failure and or success potential, of benefit to cost evaluation, or adverse land use or fininacial impacts to watershed landowners.

The LAC is deemed a vital part of this stakeholder driven enhancement plan formulation by all regulatory agencys, for it justifys there involvement due to the publics concern for the environment. In this case the clean water act (impaired status) of the so called Petaluma river, which is really a tidal dead end slough, and the threatned speci act (salmonid speci which, the Petaluma tidal dead end slough has never been an outstanding water body for salmonid speci as the Russian river is. Thus the need for watershed enhancement plans and projects that are fish friendly and for involved stakeholder goals and objectives with recommended actions. All of which will later become mandatory agency regulations upon there approval of the watershed plan. The so called Petaluma river was declared impaired in 1994, without a river status the clean water act and the endangered speci act are mute poi for agency implementation of this watershed plan. The endang ered speci (salmonid) is not endimic to tidal dead end sloughs and labeling a tidal dead end slough as a river is c ice. "Notwithstanding the above, the contract for the Petaluma River Watershed Plan between the SSCRCD the SWRCB and the US PA was signed on 11-5-96. This contract binds the Contractor - SSCRCD and all subcontractors such as Prunuske Chatham Inc. and Questa Engineering to render there services for the development of a watershed plan for the Petaluma River Watershed which focuse on 3 areas." 1- A technical data study and compilation of informatio be produced, (the appendices) 2- Public participation and outreach occur, (LAC meetings and newsletter) 3- Preparation of a watersh plan including recomendations for specific treatment prioritie target best management practices and an implementation strategy. (goals and objectives) The contractors and subcontracto in following contract instructions of regulatory agencys act a there agents, to impose goals and objectives for our watershed that eventually will be mandatory. That will restrict our choices to specific aquatic specie friendly watershed projects nly, to specific aquatic species friendly vegetation only. The will then cause the watershed landowners to lose manage- ment control of his watershed property, with no compensatio The watershed landowners will be subject to suits and fines or both from regulatory agencys or environmental groups, under the clean water act or the endangered speci act. None of the LAC member watershed owners were informed of these adverse effects to them by the Contractor SSCRCD or subcon tractor PCI at the start of the meetings. I consider this deceitfu by all involved agencys. All are promoting an impaired river status for a non river. Are promoting watershed plans and projects for salmonid specie recovery in a dead end slough. Have no agency recorded historic or current salmoni numbers to justify the spending of $150,000.- on this proposed project and plan using taxpayer money. "Know that most sub tributaries of the Petaluma dead in slough were and ar still too small and dry for salmonids. The 4 sub tributarie erceived to have some salmonid potential, have sand and silt, lack of stream flow, fish barriers water pollution plus all of the above. Those salmonids found in the Petal- uma River are lost strays going for the Sacramento River." Source PCI Fisheries Enhancement Summary

In Summary, I wrote a three page letter to Bill Hurley of SFRW QCB, dated 8-16-98, Re: the Petaluma River classification for a tidal dead end slough. I referred to the PCI Fisheries Enhancement Summary, which plainly states the Petaluma River has never been an outstanding salmonid water body. I am still waiting for his response. At the last meeting that PCI staff person presided over the LAC here at the Community Center, I stated that this enhancement plan was a waste of taxpayer money, some agreed with me. However the process and plan continue forward for final approval. Reminants of the LAC continued having meetings with the approval of the regulatory agencys and the SSCRCD. I would request a list of these members? How many times did they meet? Which draft plan did they work for. Is the draft plan dated March 1999 a product of there meetings. Is this what is referred to as public participation with public outreach or due process?? I wrote a letter to Dave Luther on his 3X5 card. My main issues were short time for non LAC members to study Plan Draft for the 2-16-99 meeting, Shortage of document copies for more landowners with easier access, and the river that is a dead end slough issue. I have yet to receive his response. It is my belief that all agencys involved with this enhancement plan and process are using the clean water act and the endangered specie act as the tool to force its implementation with so called stakeholder assistance. Lacking a river that an endangered specie could use the endangered specie is mute. I am not against reducing soil erosion or improving water quality of this watershed. I do not like it being done in a deceitful way. This SSRCD should try harder to educate the stewards of the watersheds to do a better were needed and let the schools teach the 3 rs. I feel the involved agencys all of them are acting overzealous with attempting to force watershed landowners, without good reason, to produce a spawning and rearing site for salmonid speci in our watershed that has not occurred historically. This in my opinion is the very unreasonable use of the environmental laws by these agencys and subject to challenge. As for the enhancement plans and the process on the table for this watershed stating a tidal dead end slough is a river that is impaired so as to make it an endangered speci habitat, We throw this plan out. We discuss a new plan without the endangered spece and clean water acts adverse impacts to us. We have to do this now.

Herein is my testamony Re: your Draft Petaluma Watershed Plan, Dated April 1999. The SSCRCD [illegible] acting as an agent for regulatory agencys (by requesting [illegible] funds [illegible] State Water Control Board to produce Petaluma River Watershed Enhancement Plan) [illegible] RCD [illegible] as the [illegible] regulatory agencys are [illegible] promoting the [illegible] of tax [illegible] money for a watershed plan to create habitat for a salmonid [illegible] (the steelhead trout), without a cost-benefit analysis [illegible] the [illegible] rate of the objective (of salmonid [illegible]) [illegible] a watershed [illegible] a economic analysis for property [illegible] or potential threat to private property rights [illegible] regulatory [illegible] regulations for control of the watershed [illegible] compensation [illegible] the taking of private property.

This RCD has [illegible] (with [illegible]) to assist the rural watershed landowners [illegible] the regulatory agencys admit the Petaluma River [illegible] Tidal [illegible] End [illegible] That this [illegible] salmonid species spawning [illegible], That [illegible] Dead End Slough [illegible] standard [illegible] that the RCD will [illegible] all [illegible] the proper [illegible] for [illegible] waste [illegible] plan [illegible], before submitting the Environmental [illegible] agency approval. Rather than help settle the river/slough [illegible] when this issue was raised at the [illegible] 98 LAC [illegible] meeting, the LAC meeting process was urged to continue [illegible] LAC [illegible] a LAC [illegible] chairperson and with RCD approval. The reason given for this change was that PCI could [illegible] chair the LAC meetings. While it is unclear to me, how many LAC members meetings occurred in this [illegible] fashion? This does indeed raise questions as to the public process at this stage. I did attend a LAC member meeting chaired by L Brent on 2-10-99, which had a standing [illegible] of 5 landowners with 2 owners from the same property. [illegible] the [illegible]. [illegible] and [illegible] Dead [illegible] made [illegible] the river [illegible] with no response [illegible] then I indicated my disapproval of the [illegible] process by not participating in it and left the meeting. The last LAC member meeting of the process was held on [illegible] It was [illegible] by PCI. The 15 people present included RCD, PCI and regulatory vendors and regulatory agency staff personel. The main topic was for a

group review and discussion of goals A, B, C, and D. review and
..ee in potential resources (meeting participants) no time was
..en for general comments from the public.
This so called Landowner, Stakeholder process is flawed simply
because it does not involve adequate numbers of effected water-
shed landowners to participate in the process due to inadequate
disclosure of this watershed enhancement plans adverse affects
on watershed landowners at its onset by the RCD. The small
number of landowner/residents listed in the April draft, is not
inadequate due process representation for a land use change
from ag production, to resource habitat enhancement for 146 sq
miles of watershed. Another flaw in the process is the fact
that the regulatory agency, making the final decision is lack
ing the need for accountability for any of enhancement projects
[illegible] actions to no one. We are in the arena where they will at
times treat landowners very unreasonable, with the help of
the RCD. Deceit of watershed landowners by all involved agency
is apparant since they all attempted to implement an enhance-
ment plan for an impaired river that should support an en-
[illegible] species. All agencys not knowing its real status of Tidal
[illegible] End Slough, with no historic proof of small fry population
numbers in the watershed tributarys [illegible] steelhead trout, and lack
for year round supply of water as the cause for no historical popula-
tion count.
The biggest change that has occurred in the Enhancement Plan
drafts is the removal of Petaluma River from the title. The same
is basically true of the Water Quality monitoring Guidelines for
the Petaluma River Watershed and [illegible] the Petaluma Water-
shed, the removal of the Petaluma River from the title was the
biggest change. The odd thing is they both, have the same
[illegible] 6-98. I acquired the Petaluma River version on 7-28-98 the
Petaluma Watershed version on 4-5-99. The guidelines are the
same for both. With a description of the flow chart with
standard Levels and Trigger Levels defined and the process that
occurs once a trigger level is reached in the watershed version.
Supposedly this water quality plan is being implemented by the
Animal Waste Committee in Sonoma County. Then it states that
many groups and agencys are participating in an effort to deter-
[illegible] water quality conditions for the Petaluma River, not the
Petaluma Tidal Dead End Slough. More RCD public outreach
is needed to correct this misconception before a watershed plan
is implemented for the Petaluma Tidal [illegible] and Slough. Since
[illegible] agree with the process as being reflective of the majority
of the rural watershed landowners [illegible] not involved

with the formation of the Enhancement Plan as stated earlier n therefore rejecting all goals, recomended actions with time [illegible]es made in the Petaluma Watershed Enhancement Plan dated -99. Further dilution of the process was this RCD acting as an agent of the regulatory agencys and promoting the enhancement [p]lan for the agencys benefit. While claiming to be a neutral agency. This RCD was not the watershed owners friend for [illegible] levee permit negociations. It was not the watershed landowners friend in the Tolay Creek Enhancement Plan. It is certainly not our friend now. During maybe the past 10 years all RCD's have developed a close working relationships with regulatory agencys. By promoting regulatory agency project that produce grant funds that benefit the RCD and the NRCS this is an insidious arrangement that does adversely effect ag landowners. I don't believe that a watershed conservency board is the right thing for this enhancement plan, due to possible unequal representation of a board composed of watershed landowners. As an example the pre 9-29-98 LAC member did not address the buried tires issue. The post 9-29-98 LAC members did address the buried tires issue as an erosion hazard affecting watershed water quality if tire removal occurs. The issue of additional erosion in watersheds from added winter rain runoff in watersheds that summer irrigation occurs was not addressed. This was an issue raised early in the process. Could the neutral [illegible] be a reason for this omission or is the reason biased?

When one rejects a plan one must propose one to replace the one rejected. The regulatory agencys [illegible] upon [illegible] Dead End Slough being a river. They must [illegible] drop the [illegible] endangered speci habitat in watershed [illegible] that are historically dry in summer. They should encourage and assist financially all erosion control projects in this watershed, fish friendly or not. Watershed water quality testing is already being implemented in certain locations, other watershed landowners may agree to start on a voluntary basis. Should the RWQCB implement water quality testing of watersheds it should be on a voluntary basis, with no threat to private property rights. The regulatory agencys should acknowledge that the Petaluma Tidal Dead End Slough is part of a [illegible] system of which the water changes direction [illegible] times, which means the water quality will reflect the natural occurrence.

[illegible]

Table 3 - Enhancement Goals - Potential Sources of Funding and Technical Support

Goal A - Watershed Council

Goal	Objective	Priority	Recommended Actions	Potential Resources
Establish a watershed council for residents and other organizations to fund and coordinate watershed enhancement activities and keep one another informed.	Form a citizen-based watershed council to keep watershed residents informed of watershed planning and implementation efforts.	2 years	Elect or appoint chairperson, develop subcommittees.	WC
			Establish mission statement.	WC
			Establish short and long term goals for the watershed council.	WC
			Conduct regular one-on-one and "kitchen table" outreach meetings to let watershed residents know about how to participate in watershed enhancement efforts and to identify potential watershed enhancement projects.	WC, RCD
			Keep landowners informed of watershed efforts, function as a clearinghouse for watershed residents, sponsor enhancement efforts, and assist agencies and citizens in coordinating meetings.	WC
		5 years	Develop and maintain an internet website. Post information about upcoming meetings, available funding, enhancement efforts and monitoring results. Link to other websites with enhancement information or Petaluma Watershed data.	WC
			Publish and distribute a watershed newsletter at least twice a year.	WC
		Ongoing	Inform landowners of monitoring methods and training through the Watershed Council.	WC
			Keep landowners informed of upcoming agency plans and actions related to the Petaluma Marsh.	WC, RCD

THIS MIGHT WORK

I OBJECT TO A WATERSHED COUNCIL FOR RESIDENTS. ACTUALLY 3 OUT OF 4 PEOPLE PRESENT AT THIS MEETING OBJECTED TO IT. THE OVERALL FEELING WAS IT WAS BEING SHOVED DOWN OUR THROAT BY HIRED FACILITATORS.

THE MAIN GOAL EXPLAINED TO ME WAS TO USE THIS TO GET GRANT MONEY FROM CALFED. THIS MONEY IS WASTED ON FACILITATORS AND TO PAY RCD AGENTS.

SOME OF THESE FOLKS ARE THE SAME PEOPLE THAT LIED ABOUT TOLAY CREEK, WHICH IS A BIG FIASCO AND WILL COST UNKOWN MILLION OF DOLLARS.

Sincerely
Harvey Goldberg

PLEASE STOP FUNDS TO RCD WHICH IS WORKING WITHOUT PROPERTY OWNERS INVOLVEMENT.

TRY REPAIRING LEVEE'S

Pg 1 of 3

TO:

4-9-99

BOARD of Directors
Sonoma Petaluma Resources Conservation Dist.
N. McDOWELL BLVD.
PETALUMA, CALIF.

Bill Bisso
25800 Arnold Dr.
SONOMA, CALF.
707 996-0956 Ph.
707 935-8901 FAX

Dear Friends

• THIS IS CONSTRUCTIVE NOTICE AND COMPLAINTS THAT ARE DIRECTED TO ALL PARTIES DIRECTLY OR INDIRECTLY LOCAL OR REGIONAL AGENCIES OF ANY GOV. OR POLITICAL ENTITY AND MOST SPICIFICALLY Pet. Son. R.C. Dist. who HAS PROMOTED THE PETALUMA WATERSHED PLAN AND STUDY ETC.

• STUDIES + PLANS HAVE ALREADY BEEN DONE BY QCMLW — ESTURIES THE GOALS + POLICIES ETC, ALL OF WHICH ARE ONLY TOOLS TO END THE AGRICULTURE FREEDOM AND SPECIFICALLY TERMINATE FARMING IN SONOMA + MARIN CO'S AS IT WAS IN PAST. TODAY, REMAINING FEW ARE SUBJECT TO CONFISCATION REGULATORY EASEMENTS ETC. ALL IN EFFORT TO CONTROL LANDS AND OPERATIONS ALL FOR BENEFITS OF PUBLIC ENVIRNMENTALISTS BY USE OF "TOOLS". IE: OPEN SPACE — ENDANGERED SPECIES — ESTURARY

Pg 2 of 3 / Cont'd - R.C.D. - B. Brosso 4-9-99

ESTUARY RESORATIONS - EVEN WHEN IMPOSSIBLE — SIMPLY A TITLE + CONTROLS ARE THE 'AGENDA' — Recently 3-17/18/19-99 SYMPOSIUM OF SCIENTISTS OVER U.S.A.; (850) CAME TO S.F. AND OUR LOCAL B.C.D.C. VOICE OF MIKE MONROE ANNOUNCED — "THIS MEETING IS NOT FOR THE LANDOWERS, OR FARMER."

• THERE, YOU HAVE IT DOCUMENTED BY ONE OF THE HUNDREDS OF AGENCIES CORRORBORATEING TO COMMAND CONTROL + REGULATE ALL LANDS — THE 10 COMMANDS OF THE MARXIST MANEFESTO IS A DUPLICATE!

• IT WAS ALSO SAID: "LANDOWNERS NOT OUR PROBLEM; SINCE WE SET THE RULES BY WHICH APPRAISALS ARE GENERATED, AS THAT TIME APPEARS

• NOT (1%) one percent of COMMUNITY KNOWS OR IS AWARE OF THE UN-NECESSARY "PLAN" AND BY THE LATCHES SYSTEM A NON-PARTICIPANT IS CREDITED AS "AGREEING" TO THE SOCIALIZEING OF THEIR RIGHTS TO AN ADMINSISTRATIVE POLITICAL RULE; PLANNED TO BE USED NEGATIVELY TO LANDOWNER