Draft Aquatic Resources Inventory, Classification, and Function for East Contra Costa County HCP/NCCP Inventory Area

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Acronyms and Abbreviations

CCWD	Contra Costa Water District
County Flood District	Contra Costa County Flood Control and Water Conservation District
CRF	California red-legged frog
CTS	California tiger salamander
Delta	Sacramento–San Joaquin Delta
EBRPD	East Bay Regional Park District
Fm	Formation
HCP	Habitat Conservation Plan
NCCP	Natural Community Conservation Plan
PAB/UB	Palustrine aquatic bed/unconsolidated bottom
PNEM	Palustrine nonpersistent emergent
PPEM	Palustrine persistent emergent
RGPs	Regional General Permits
RPP	Regional Permit Program
USACE	U.S. Army Corps of Engineers
WoUS	waters of the United States
WPT	Western pond turtle

Chapter 1
Introduction and Goals

1.1 Introduction

This document provides an aquatic resource inventory, classification, and functional description for a 173,680-acre area of East Contra Costa County, California (Figure 1-1). This area, referred to herein as the "inventory area," corresponds to the planning boundaries of the East Contra Costa County Habitat Conservation Plan (HCP) and Natural Community Conservation Plan (NCCP). The proponents of the HCP/NCCP are Contra Costa County, the Contra Costa County Flood Control and Water Conservation District (County Flood District), Contra Costa Water District (CCWD), East Bay Regional Park District (EBRPD), and the Cities of Clayton, Pittsburg, Brentwood, and Oakley. These proponents formed a joint powers authority, referred to as the East Contra Costa County Habitat Conservation Plan Association (HCPA), to lead development of the HCP/NCCP. Although the City of Antioch is not participating in the HCP/NCCP, the HCP/NCCP inventory area includes Antioch.

This wetlands inventory and assessment was conducted in support of a regional planning, conservation, and permitting effort coordinated by the HCPA and the U.S. Army Corps of Engineers (USACE). The primary goal of this inventory is to provide a baseline record of waters of the United States (WoUS), including wetlands, on a regional scale throughout the inventory area. This report was specifically designed to support the HCPA's application to the USACE for a series of Regional General Permits (RGPs) in the inventory area that are expected to replace the existing Nationwide Permit Program. These RGPs will be bundled into a Regional Permit Program (RPP) that will provide a customized and streamlined wetlands permitting system for many projects in the inventory area, particularly those that receive coverage under the HCP/NCCP for impacts on listed species.

An important secondary goal of this inventory is to improve the HCP/NCCP by providing additional information on WoUS in the inventory area. Many WoUS in the inventory area provide important habitat for species proposed for coverage in the HCP/NCCP. Conservation measures in the HCP/NCCP will benefit from the information in this report on these key habitats.

This report describes the following in regard to WoUS.

- The locations of these features.
- The spatial extent of these features.
- The regional hydrogeomorphic context in which WoUS are formed and persist.
- The habitat, hydrology, and water quality functions that these WoUS provide.
- The overall functional value of WoUS in the study area.
- Management considerations to help promote conservation of these systems and minimize impacts on them.

The East Contra Costa County HCP/NCCP calls for preservation of approximately 30,000 acres of land in the inventory area to offset the impacts of expanding urban development in the participating cities. Data in this report will be used to predict the impact of this development on WoUS on a regional scale and to determine the level of conservation expected from assembly of the HCP/NCCP Preserve System. These data will also help to identify opportunities to mitigate potential future impacts on WoUS and their subbasins through comprehensive consideration of WoUS functioning on a landscape level.

It is important to note that this report presents the existing conditions of WoUS on a regional scale. As described later in this chapter, mapping of WoUS is based on coarse-level data and reconnaissance field verification. Data presented in this report are not based on site-specific wetland delineations according to approved USACE methodology. This report should not be used for project-level analysis and cannot be substituted for site-specific wetland delineations.

1.2 Organization of this Report

This report is organized into five chapters. Chapter 1 is this introductory chapter. Chapter 2 presents the methodology for the WoUS inventory and mapping. Chapter 2 also presents the approach to WoUS classification used in this report. That approach is based on a classification of physiographic regions in the inventory area. Individual subbasin drainages are identified according to the physiographic region that characterizes them most strongly (Figures 1-2 and 1-3). Chapter 3 presents the regional physical setting used to establish a context for the hydrologic conditions that support WoUS creation and introduces the following four physiographic regions identified in the inventory area.

- Montane region.
- Foothills/upper valley region.

- Lower valley/plain region.
- Sacramento–San Joaquin Delta region.

Chapter 4 describes the WoUS types found in the study region according to their general geomorphic requirements, location, extent, habitat functions, hydrologic functions, and water quality functions. Chapter 5 describes individual subbasins in greater detail. Subbasin assessments include specific discussions of subbasin physical conditions relevant for WoUS support; WoUS types found in the subbasin; WoUS functions in the subbasin; management consideration for WoUS conservation, impact avoidance, and enhancement in the subbasin; and WoUS valuation within the subbasin.

Appendices are included at the end of the inventory report. These are the waters of the U.S. Inventory Table (Appendix A) and the photo atlas for the inventory area (Appendix B). A separate document, the Regional Permit Program, contains a protocol for use of this inventory report for future assessments. The table in Appendix A lists and categorizes all WoUS mapped in the inventory area. The photo atlas displays the number, location, and surrounding area of each WoUS type mapped in the inventory area.

In sum, this effort seeks to conduct a regional approach to preservation, enhancement, and management of WoUS through two steps:

- establishing the baseline conditions of WoUS in an inventory, classification, and functional description at the subbasin scale; and
- providing an analysis of hydrogeomorphic conditions supporting WoUS by subbasin. This analysis is accompanied by a review of opportunities and constraints to preserve and restore WoUS and the physical processes that support their longer-term sustainability.

1.3 Terminology

Waters of the United States, or WoUS, is the encompassing term for areas that qualify for federal regulation under Section 404 of the Clean Water Act.

Wetlands are a subcategory of WoUS. For regulatory purposes, *wetlands* are defined as “areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (CFR 328.3, CFR 230.3). WoUS include features such as reservoirs and creeks that may not be vegetated and are therefore not defined as wetlands.

Isolated wetlands are those that are not bordering, contiguous with, or neighboring WoUS or other wetlands, and are not usually considered jurisdictional. Wetlands would probably be considered isolated if they were hydrologically isolated from both fluvial and tidal surface hydrology, were not part of a larger wetland or vernal pool complex, and occured in a closed basin that is not a headwater connected to a larger watershed. A USACE regulatory specialist will confirm final determination of adjacency or isolation.

A *watershed* is all of the upstream land (and subsurface groundwater) that drains to a particular point along a stream or river. *Subbasins* are considered "nested" watersheds within the larger principal watershed units (i.e., Sand Creek drainage is a subbasin of the Marsh Creek watershed). The term subbasin is also applied to smaller independent watersheds that may be isolated or adjacent to principal regional scale watersheds. This inventory does not attempt to determine whether individual wetlands within the inventory area are jurisdictional.

Hydrogeomorphic refers to water-related landform-shaping processes. For this study, these physical processes are typically the governing forces that influence the setting or capacity of WoUS to exist and persist.

Chapter 2
Methods

2.1 General Approach

Wetland types were mapped in the study area based primarily on the interpretation of black-and-white and color aerial photographs. Photointerpretation of wetland features was guided and verified with supplementary data sources, including National Wetland Inventory data, U.S. Geological Survey streams and roads data, and California Department of Water Resources land use data. These and other data sources are discussed below. The resulting draft wetland maps were ground-truthed through field reconnaissance surveys on public lands and from public roads during April and May 2004. Jones & Stokes ecologists and geomorphologists developed an understanding of WoUS types within their subbasin contexts through a functional analysis at the subbasin scale. WoUS functions were then described based on a qualitative analysis of physical characteristics, surrounding land use, and resulting biological characteristics. WoUS types were classified according to Cowardin et al. (1979) and assigned to a geomorphic unit according to Ferren et al. (1995).

2.2 Waters of the U.S. Mapping Methods

2.2.1 Data Sources

The following were the primary sources of information for WoUS mapping in the study area.

- Orthorectified black-and-white aerial photographs (provided by Contra Costa County, flown in May 2000) for the entire study area. (The scale in rural areas is 1 inch = 400 feet and in urban areas, 1 inch = 200 feet.)
- Color infrared photographs (scale 1:6,000) taken in June 1987 and 1988, which covered the study area except the southeastern corner (provided by Contra Costa Water District).
- National Wetlands Inventory Maps (scale 1:65,000) based on color-infrared photographs taken in 1985.

- U.S. Geological Survey (USGS) streams and roads data (USGS digital line graph data—various dates).
- California Department of Water Resources land use data (1995).

The ancillary data sources listed below were used to obtain information not available in the primary sources and to check the mapped information for accuracy.

- East Alameda–Contra Costa Biodiversity Study (Conservation opportunity mapping in eastern Contra Costa County) (Jones & Stokes Associates 1996).
- Habitat mapping within the Los Vaqueros Reservoir watershed (Jones & Stokes Associates 1994).
- Color aerial photographs (scale 1:6,000) taken in February 1987, which covered the southeastern corner of study area (Jones & Stokes file data).
- Soil survey mapping (Soil Conservation Service 1977).
- Vegetation maps of Contra Costa Water District (CCWD) interim service area (Contra Costa Water District 2000).
- Geologic maps of the San Francisco–San Jose Quadrangle (California Department of Conservation 1990).
- *Draft Environmental Impact Report for the Cowell Ranch Project General Plan Amendment and Related Actions* (Contra Costa County 1996a).
- Current residential development maps (provided by Contra Costa County).
- Recent WoUS delineations verified by USACE within the study area (Darwin Myers Associates 2003, US Army Corps of Engineers 2003).

2.2.2 Field Visits

In addition to using existing datasets, Jones & Stokes biologists conducted field visits. An initial field visit, December 7, 2001, was conducted to develop the land-cover classification and to perform preliminary verification of aerial photograph signatures. Two other field visits, January 10 and May 26, 2002, were conducted to verify WoUS types and consistency of mapping and to collect additional data for WoUS descriptions. Initial mapping was verified by visual inspection from locations accessible by public roads. Areas were selected for field verification on the basis of the WoUS types present and the accessibility of the area. Once field visits were conducted, WoUS mapping was revised on the basis of field findings. Intensive follow-up field surveys were conducted during April and May 2004, as described in detail below.

2.2.3 Mapping Procedures

WoUS maps were produced using the data sources listed above, according to methods outlined for the HCP/NCCP and summarized below. The East Contra Costa County HCP/NCCP provides more details on the methods used to create digital maps of WoUS in the project area (Jones and Stokes 2004).

Jones & Stokes biologists conducted extensive field surveys of the study area on February 17, 2004, and over 4 days between May 5 and June 2, 2004. The surveys were designed to substantially improve the land-cover data set used by the HCP/NCCP by locating

- additional alkali grasslands and alkali wetlands based on field conditions (rather than by soil type as mapped by SCS) and verifying the location of previously mapped alkali grasslands and wetlands;
- small WoUS (e.g., vernal pools, perennial wetlands, seasonal wetlands) and ponds that may have been missed during the original mapping; and
- additional riparian woodland/scrub in the field that may have been missed because of the difficulty of discerning that habitat type's signature in aerial photos.

It should be noted that much of the mapped riparian woodland/palustrine forest is unlikely to be considered jurisdictional wetlands because it may not be inundated with sufficient frequency or for sufficient duration. It was not possible to map the boundary between wetland and non-wetland in this land cover type from aerial photos.

Draft WoUS maps for the study area were compared with recent wetland delineations verified by the USACE (Darwin Myers Associates 2003; USACE 2003). This comparison allowed for further improvement of photointerpretation methods. In addition, it gave an indication of expected differences between landscape-level and site-level WoUS mapping, discussed further below.

2.2.4 Waters of the U.S. Mapping Limitations

This study involved mapping WoUS types on a landscape scale throughout the inventory area, based on photointerpretation and limited fieldwork. Project-related WoUS impacts and mitigation would take place on a smaller, site-specific scale. Some WoUS features in the inventory area, such as freshwater seeps, could not be mapped because they were too small or could not be visited during the limited fieldwork. As a result, landscape-level mapping may underestimate the area of WoUS compared to a site-specific delineation, as in the case of Alves Ranch (USACE 2003). In other cases, such as the case of the Bailey Estate, landscape-level mapping identified areas as wetlands that were not determined to be jurisdictional in a site-specific delineation (Darwin Myers Associates 2003).

In addition, WoUS are dynamic systems that change over time and from season to season, depending on rainfall and temperature.

Despite these limitations, data in this report are adequate to provide a regional picture of WoUS conditions and functions throughout the inventory area. Site-specific investigations can benefit from the regional context and classification provided in this document, but they cannot rely on the regional mapping. Field delineations of features will be required for any project proponent to receive a permit under the RPP that this regional WoUS inventory supports.

2.3 Valuation

In order to assist improve planning for aquatic resources conservation in the study area, a landscape-level assessment of WoUS quality was carried out. This assessment of WoUS quality can be helpful in evaluating landscape level scenarios for conservation and development, allowing planners to determine which patterns of development and conservation will conserve higher quality WoUS and impact lower quality WoUS. From a regulatory perspective, this valuation is designed to aid responsible agencies in determining whether conservation and development scenarios result in a net loss of WoUS function or area.

It is important to recognize the limitations of this valuation methodology. Because of the landscape scale of the data, WoUS valuation should be regarded as qualitative and approximate. Landscape-level valuation is a useful planning tool, but should not serve as a substitute for site-level WoUS valuation analysis conducted in conjunction with a site-level delineation.

To arrive at an overall wetland quality, WoUS were evaluated by wetland type, habitat type, water quality, hydrologic functioning, geomorphic region, and adjacent land use within each subbasin.

Landscape-level WoUS valuation was performed by assigning points to each WoUS based on the following five factors (Table 2-1 and 2-2):

- Area of wetland (not applied to streams);
- Geomorphic region (which served as a proxy for land use in the vicinity);
- Primary adjacent land cover;
- Secondary adjacent land cover (not applied to streams); and
- Subbasin or site-specific factors, such as the presence of abandoned mines or reservoirs.

Function scores were adjusted for each of these categories (Table 2-1 and 2-2) according to their ability to maintain or improve

- **Habitat.** Points were added if a given WoUS type has the potential to support wildlife and plant species.
- **Water Quality.** Points were added for a WoUS type with the ability to improve or maintain water quality through such processes as filtration of contaminants and prevention of erosion.
- **Hydrology.** Points were added for a WoUS type that can facilitate groundwater recharge and store floodwaters.

Taking this suite of functions into account, the total score for each WoUS type was assigned to one of three ranks: high, moderate, or low for current quality. (See Appendix A, and Tables 5-1 through 5-15 in Chapter 5.) A detailed discussion of the valuation process follows.

Area

Based on the rationale that wetlands with greater area are generally higher functioning, habitat, water quality, and hydrology functional scores were increased for each wetland that was greater than the median area for its wetland type. This factor was not considered in valuation of streams, because the area of a given stream reach was primarily determined by adjacent land use and/or geomorphic region, not by hydrologic or other factors that contribute to wetland quality. For example, the median area for alkali wetlands (PPEM-Alkali) in the inventory area is 3 acres, and the median area for seasonal wetlands (PPEM-Seasonal) is 0.8 acres. For alkali wetlands that are greater than 3 acres in extent and seasonal wetlands that are greater than 0.8 acres in extent, habitat, water quality, and hydrologic functional scores were increased (See Table 2-1). Median areas for other WoUS types in the inventory area are as follows. The median area of ponds (PAB/UB) is 0.2 acre. The median area of riparian woodland (Palustrine forest) is 2.1 acres. The median area of wetlands with undetermined inundation regimes (PPEM- Perennial or Seasonal) is 0.7 acre. The median area of sloughs/channels (riverine lower perennial) is 11 acres.

Geomorphic Region

The inventory area was classified into four geomorphic regions: 1) Montane, 2) Foothills/Upper Valley, 3) Lower Valley/Plain, and 4) Sacramento-San Joaquin Delta (Delta). They are described in Section 3.2. While information on land uses adjacent to each WoUS was considered in the valuation procedure, geomorphic regions served as a proxy for regional land use around each WoUS. Habitat, water quality, and hydrologic function scores were increased for each WoUS in the Montane region, because land cover in this region is the least altered from natural conditions in the inventory area (Tables 2-1 and 2-2).

Habitat, water quality, and hydrologic function scores were increased for each WoUS in the Foothills/Upper Valley region, but scores were increased less than for WoUS in the Montane Region (Tables 2-1 and 2-2). This region is dominated by rangeland. In some areas, negative impacts to WoUS from overgrazing are evident. The Foothills/Upper Valley region features more extensive alteration from natural conditions than the Montane region, because of its larger areas of residential, agricultural, and commercial land use.

The Lower Valley/Plain region is characterized by urban and industrial development. Habitat and hydrologic function scores for WoUS in this region were not increased, due to its relative scarcity of habitat and its extensive hydrologic modifications, such as increased impervious surface and channelized and/or undergrounded stream reaches. Water quality scores were slightly increased for WoUS in this region (Tables 2-1 and 2-2), because impacts to water quality from land uses in the region are less severe than impacts in the Delta region discussed below.

The Delta region is dominated by cropland. Habitat function scores were slightly increased for WoUS in this region (Tables 2-1 and 2-2), because cropland provides habitat for a greater number of species than the urban and residential areas that dominate the Lower Valley/Plain region. Water quality function scores were not increased for WoUS in this region, because sediment, nutrient, and pesticide inputs associated with agricultural use degrade water quality. Hydrologic function scores were not increased in this region, because streams in this region have been channelized and many WoUS have longer inundation or flow periods due to inputs from return irrigation flows.

Adjacent Land Cover

For the purposes of the valuation, adjacent land cover was assigned to one of three classes:

- Class I: Wetland or other native vegetation type (aquatic, aqueduct, alkali wetland, riparian, seasonal wetland, wetland, chaparral, oak woodland, oak savanna, grassland, alkali grassland);
- Class II: Agricultural/non-native open space (orchard, pasture, ruderal, turf, non-native woodland, cropland, vineyard); and
- Class III: Urban (developed, landfill).

In many cases, more than one land cover type is present adjacent to a WoUS. In these cases, the adjacent land cover with the greatest areal extent was recognized as the primary adjacent land cover. Other adjacent land covers were considered secondary adjacent land covers. Secondary land covers were considered to have the same type of effect on WoUS as primary land cover types, but to a lesser degree, so were scored lower (Tables 2-1 and 2-2). Where more than one class of secondary land covers was present, the secondary land cover type with the greatest areal extent was used in the valuation procedure. Data on secondary land cover were only available for wetlands, not for stream reaches.

Class I land covers were considered to enhance or have no negative impacts on WoUS functioning. Habitat, water quality, and hydrologic function scores were significantly increased for WoUS with Class I primary adjacent land covers (Tables 2-1 and 2-2). Habitat, water quality, and hydrologic function scores were moderately increased for WoUS with Class I secondary adjacent land covers.

Class II land cover types are characterized by open space with a moderate level of disturbance. While these land covers may be dominated by exotic invasive species, the open space associated with them provides some habitat value. Habitat function scores were slightly increased for WoUS with Class II primary adjacent land covers (Tables 2-1 and 2-2). The open space associated with these land cover types facilitates infiltration, reducing the flashiness of the local hydrograph. Therefore, the hydrologic function scores were slightly increased for WoUS with Class II primary adjacent land covers. Most land uses in this class are sources of sediment, nutrient, and pesticide inputs to WoUS. Water quality function scores were not increased for WoUS with Class II primary adjacent land cover. Habitat, water quality, and hydrologic function scores were not increased for WoUS with Class II secondary adjacent land cover.

Class III consists of urban land cover. This land cover type provides little habitat value and is characterized by extensive hydrologic modification. Habitat and hydrologic function scores were not increased for WoUS with Class III primary or secondary adjacent land cover types. However, urban areas are generally less significant sources of nutrients, sediment, and other contaminants relative to Class II agricultural areas. Therefore, water quality function scores were slightly increased for WoUS with Class III primary adjacent land cover. Water quality function scores were slightly increased for WoUS with Class III secondary adjacent land cover.

Scoring System

Habitat, water quality and hydrologic function scores based on the factors above were each summed separately. Total WoUS scores for each function ranged from 0 to 10 points for wetlands, and 0-6 points for streams. The three function scores were totaled to produce an overall WoUS quality score, ranging from 0 to 30 points for wetlands, and 0-18 points for streams. For each function, wetland scores of 8-10 and stream scores of 5-6 were assigned a rank of high, wetland scores of 4-7 and stream scores of 2-4 were assigned a rank of medium, and wetland scores of 0-3 and stream scores of 0-1 were assigned a rank of low. For overall quality, wetland scores of 24-30 and stream scores of 15-18 were assigned a rank of high, wetland scores of 8-23 and stream scores of 3-14 were assigned a rank of medium, and wetland scores of 1-7 and stream scores of 0-2 were assigned a rank of low. This system was used in order not to assign WoUS that may be moderate quality as low quality.

Subbasin or Local Factors

Important environmental factors exist in the inventory that affect WoUS functioning on a subbasin or local scale. A brief discussion of these factors and a description of their effects on the valuation follow.

Abandoned Mercury Mine

Mercury contamination from the abandoned Mt. Diablo Quicksilver Mine on Dunn Creek has contaminated areas downstream to the Marsh Creek Reservoir. Instream WoUS in affected areas of Upper Marsh Creek have therefore been given a water quality function ranking of low. Habitat function for these WoUS is reduced by one rank, to low or medium. Hydrologic functioning of these WoUS is unaffected. Lower Marsh Creek does not appear to be significantly affected by mercury contamination. Normal mercury levels in Lower Marsh Creek are due to two factors: 1) the Marsh Creek Reservoir traps mercury-containing sediment from sources upstream, 2) mercury-contaminated sediments that were present before the construction of the reservoir have been flushed out of the system, and are now located in the Big Break and the Delta.

Abandoned Coal Mine

An abandoned coal mine in the upper Kirker Creek subbasin has led to pH levels of 4-5 in the upper portions of the creek. The creek rapidly becomes neutral in pH downstream of the Black Diamond Mine Regional Park boundaries. WoUS within the affected area have been given a water quality and habitat function ranking of low.

Reservoirs

There are four reservoirs of significant size in the study area. These reservoirs have smoothed out the hydrographs of creek reaches downstream greatly, reducing peak flows and increasing base flows. Hydrologic functioning of instream WoUS downstream of Marsh Creek Reservoir, Los Vaqueros Reservoir, Contra Loma Reservoir, and Antioch Reservoir have therefore been ranked as low for hydrologic functioning regardless of their raw scores.

Intensive Grazing

Portions of Briones Creek and Deer Creek subbasins show evidence of intensive livestock grazing. Overgrazing in these subbasins has resulted in the loss of wetlands vegetation, increased inputs of fine sediment and nutrients, incised channels and unstable banks. WoUS in the affected areas of these subbasins have been ranked as low for habitat, water quality, and hydrologic functioning.

Potential Quality

Based on an evaluation of opportunities for restoration and enhancement, WoUS types within each subbasin were assigned a ranking of high, moderate, or low for potential quality. The factors responsible for degrading a given wetland were qualitatively evaluated to determine how amenable they are to change. For example, wetlands that are degraded due to intensive grazing have the potential to improve in quality with a modification to the grazing regime. A wetland with a low overall quality that is exposed to intensive grazing would thus be assigned a potential quality of moderate. However, a wetland with low overall quality due to its location in an urban area would have a low potential quality, as it is unreasonable to expect the adjacent land use to change.

Table 2-1. Effects of Area, Geomorphic Region and Adjacent Land Cover on WoUS Valuation

	Effect on Function Scores		
Factor	**Habitat**	**Water Quality**	**Hydrologic**
Area			
Greater than median area for WoUS type	+2	+2	+2
Less than median area for WoUS type	None	None	None
Geomorphic Region			
Montane	+3	+3	+3
Foothills/Upper Valley	+2	+2	+2
Lower Valley/Plain	None	+1	None
Sacramento-San Joaquin Delta	+1	None	None
Primary Adjacent Land Cover			
Class I*	+3	+3	+3
Class II*	+1	None	+1
Class III*	None	+1	None
Secondary Adjacent Land Cover			
Class I*	+2	+2	+2
Class II*	None	None	None
Class III*	None	None	None

*Class I: Wetland or other native vegetation type (aquatic, aqueduct, alkali wetland, riparian, seasonal wetland, wetland, chaparral, oak woodland, oak savanna, grassland, alkali grassland)
Class II: Agricultural/non-native open space (Orchard, pasture, ruderal, turf, non-native woodland, cropland)
Class III: Urban

Table 2-2. Effects of Area, Geomorphic Region and Adjacent Land Cover on Stream Valuation

	Effect on Function Scores		
Factor	**Habitat**	**Water Quality**	**Hydrologic**
Area			
Greater than median area for WoUS type	+2	+2	+2
Less than median area for WoUS type	None	None	None
Geomorphic Region			
Montane	+3	+3	+3
Foothills/Upper Valley	+2	+2	+2
Lower Valley/Plain	None	+1	None
Sacramento-San Joaquin Delta	+1	None	None
Primary Adjacent Land Cover			
Class I*	+3	+3	+3
Class II*	+1	None	+1
Class III*	None	+1	None
Secondary Adjacent Land Cover			
Class I*	+2	+2	+2
Class II*	None	None	None
Class III*	None	None	None

*Class I: Wetland or other native vegetation type (aquatic, aqueduct, alkali wetland, riparian, seasonal wetland, wetland, chaparral, oak woodland, oak savanna, grassland, alkali grassland)
Class II: Agricultural/non-native open space (Orchard, pasture, ruderal, turf, non-native woodland, cropland)
Class III: Urban

Chapter 3
Hydrogeomorphic Setting

This chapter describes the physical setting of the inventory area and the four physiographic regions used to categorize the geomorphology of the inventory area. The overview presented in this chapter of the geologic, soil, climate, hydrologic, and geomorphic characteristics of the inventory area is important in understanding the location, extent, and functioning of the region's wetlands and aquatic resources.

3.1 Regional Physical Setting

3.1.1 Regional Geology

Elevations in the inventory area range from at or below sea level (marshes adjacent to the Sacramento–San Joaquin Delta [Delta] near Brentwood and Oakley) to the 3,849-foot peak of Mount Diablo, the highest point in the inventory area. The physiography of the inventory area is dominated by Mount Diablo and its surrounding hillslopes/valleys (which generally trend northwest/southeast according to local structure/faulting), lower valleys, and plains transitioning to the Bay/Delta zones.

Figure 3-1 shows a simplification of the regional geology to portray general rock types in the inventory area. Descending in age, materials include currently active and older Holocene alluvial deposits (stream channels, floodplain deposits, bay muds, basin materials, dune sands, older fan deposits, etc.). Wetlands in the inventory area are typically found in alluvium occupying valley floors and floodplains. Understanding the distribution, texture, and depth of the wetlands soils is important in characterizing and evaluating wetland functioning.

Several Tertiary sedimentary formations, which are older in the stratigraphic column than the Holocene alluvial deposits mentioned above, are also found in the inventory area. These formations include the Tulare Formation (Fm.) (Pliocene non-marine sandstones/conglomerates); Markly Fm. (Eocene sandstones/siltstones); and Meganos Fm. (Paleocene siltstones, shales, conglomerates). Differences in granular texture of the submember units of individual formations become important in understanding soil distributions and wetland support opportunities. For example, certain shale members of sedimentary rock may be more likely to support more clay-dominant soils that offer greater water impoundment through reduced porosity/permeability (compared to sandier soils with better drainage). Older rocks in the inventory area include the sandstones, siltstones, and shale beds of the Great Valley Sequence and the basaltic/chert and sandstone mélange of the Franciscan Complex observed on the higher portions of Mount Diablo.

3.1.2 Regional Soils

Soils in the inventory area are highly variable because of the complex geology, climate, topography, and hydrology in the area (Figure 3-2). The Contra Costa County general soils map (Soil Conservation Service 1977) identifies 14 soil associations (distinctive patterns of soils in defined proportions) in the county. The inventory area contains all these soil associations except the Joice-Reyes association, which consists of saline mucks and silty clays in saltwater marshes and tidal flats. Most of the soils in the inventory area formed from alluvial, sedimentary, and meta-sedimentary sources and have been formed in concert with the complex geologic history of the area.

Many areas on the lower terraces have been urbanized and/or altered to produce crops. As mentioned above in relation to regional geology, the spatial distribution of sands, clays, clay loams, and mucks (as shown in Figure 3-2) is a key parameter in distinguishing the location and extent of wetlands, their cause, and their functioning. Figure 3-2 shows the banding of higher infiltrating sandy soils compared to clays in the Sand, Deer, Dry, and Briones Creek subbasins of the central inventory area.

3.1.3 Regional Climate

The inventory area is located in a transitional zone between the San Francisco Bay Area and the San Joaquin Valley in eastern Contra Costa County. The inventory area is characterized by a Mediterranean climate, with varying degrees of maritime influence depending on proximity to the Bay. Precipitation in the inventory area falls mostly as rain during the late fall, winter, and early spring months, although the higher elevations can receive infrequent snowfalls during the winter months, with snow sometimes lasting for 2–3 days on Mount Diablo (Soil Conservation Service 1977). Total precipitation is variable from an average of 13 inches per year at Antioch to almost 23 inches at Mount Diablo (Figure 3-3). Variability in precipitation reflects elevational and aspect differences in relation to the Bay and Mount Diablo. In particular, a rain shadow effect on the lee, or eastern, side of the Diablo Range increases aridity east of the mountains towards the Delta lowlands.

The climate in the inventory area is strongly influenced by its location and topography. In the summer, a steady marine wind blows through the Golden Gate and up the Carquinez Strait. The eastern portion of the inventory area is not influenced by marine air to the same extent as the western portion. Consequently, temperatures in the eastern part of the inventory area are generally warmer than in the western part. The alluvial dune sand geology and soils in the northern areas of lower Marsh Creek subbasin are a product of these historically strong winds and a sand source to the north in the Bay and Delta.

3.1.4 Regional Hydrology and Land Use

The inventory area contains several streams that drain to Suisun Bay and the Delta (Figure 1-2). For the purposes of this study, these watersheds have been subdivided into 15 subbasin units (Figure 1-3). Because of the Mediterranean climate and its characteristic lack of rainfall during the summer months, ephemeral and intermittent streams are the dominant hydrologic features in the inventory area.

Surface flow in ephemeral streams is generally supplied by rainfall; these streams flow only during and immediately following rain events. Surface flow in intermittent or seasonal streams is supplied by a combination of rainfall runoff and groundwater; these streams generally flow throughout the rainy season and into the late spring or early summer. Perennial streams in the inventory area are also supported by rainfall runoff and groundwater, but unlike seasonal streams, they run year-round with major dry-season input from both natural and artificial sources (e.g., upwelling springs or fault/geologic contacts, and surface/subsurface flows from local irrigation, respectively).

Major perennial streams in the inventory area include portions of Upper Mount Diablo Creek and its tributaries, Upper and Lower Marsh Creek, Lower Sand Creek and Deer Creek, and Kirker Creek. Evidence suggests that the perennial reaches of Lower Marsh, Sand, and Deer Creeks were not historically perennial and that current hydrological conditions have been influenced by increased discharges from agricultural and urban sources (Natural Heritage Institute and Delta Science Center 2002). Marsh Creek drains the largest area of any stream originating in the inventory area. Figure 1-2 (Figure 1-2) shows major perennial and ephemeral streams in the inventory area. Except for a few small streams that drain west into San Francisco and San Pablo Bays, most streams drain into the San Joaquin River and Suisun Bay to the north and east.

Land use (Figure 3-4 and Table 5-0 in Chapter 5) and hydrology are discussed separately below for the four physiographic regions in the inventory area.

3.2 Geomorphic Regions

To assist in the hydrologic and geomorphic assessment of individual subbasins and their wetland features (documented in Chapter 5), the inventory area has been classified into four geomorphic regions with similar physiographic conditions: montane region, foothills/upper valley region, lower plain/valley region, and Sacramento–San Joaquin Delta region (Figure 3-5). This classification was based on general elevational/structural conditions, whereby hillslope steepness and stream channel slopes are greatest in the montane zone and then decrease through the upper valleys, foothills, lower valleys, and plains, into the Delta zone.

The montane and foothills areas are source areas for sediment, groundwater, surface water, and water quality constituents to be transported downstream towards the upper valleys, lower valleys, and plains. However, while generally related to elevation and slope, this simple cascade of sediment/water downstream does not necessarily incorporate the opportunities for “sinks” (or storage) of water/sediment in several depositional areas throughout the system, such as floodplains, hollows, perches, terraces, mid-channel pools. These geomorphic features are often the most likely place for wetland occurrence. Thus, the classification of the four geomorphic regions was also based on a system that relates the basic physical processes of water/sediment transport to wetland occurrence/location.

Owing to topographic variability, individual subbasins in the inventory area cross more than one geomorphic region. For example, the Sand Creek subbasin is primarily characterized as a foothill/upper valley type of basin, but it originates in the montane region and continues downstream passing into the lower valley/plain region. For purposes of this report, individual subbasins are organized according to their principal geomorphic region as follows.

- Montane Region: Upper Mount Diablo Creek and Upper Marsh Creek.
- Foothills/Upper Valley Region: Willow Creek, Kirker Creek, West Antioch Creek, Deer Creek, Briones Creek, Sand Creek, Dry Creek, Brushy Creek, and Kellogg Creek.
- Lower Valley/Plain Region: East Antioch Creek, Oakley Creek, and Lower Marsh Creek.
- Sacramento–San Joaquin Delta Region: East County Delta Drainages (includes Indian, Rock, Sand Mound, Dutch, Piper, and Taylor Sloughs, as well as False River).

3.2.1 Montane Region

Most drainages in the montane region remain relatively natural and occupy at least a portion of their historic floodplains. This region plays an important role in providing high-quality habitat to riparian and wetlands species and is an important sediment source area for the rest of the inventory area. Most of the creeks in this area are ephemeral or intermittent and generally support narrow floodplains with limited riparian habitat. However, there are perennial, spring-fed reaches in this region as well. Stream gradients in this region are steep, and channels are frequently confined within narrow bedrock canyons.

3.2.2 Foothills/Upper Valley Region

Many of the drainages in the foothills/upper valley region have been affected by several decades of grazing. Under certain conditions and grazing regimes, livestock can be an effective means of controlling invasive species and maintaining a diverse native plant community. If stocking rates are too high, rotations are too long, and livestock access to aquatic resources is not properly regulated, grazing can reduce native plant cover, reduce overall vegetative cover, compact soils, contour hillslopes through the formation of terracettes, and destabilize streambanks.

In some areas, soil compaction and reduced vegetative cover due to overgrazing have increased storm runoff by reducing rainfall interception and soil infiltration. Increased surface runoff has led to increased stream flow in channels with unstable banks. These combined processes often result in eroded streams with severely incised reaches through valley bottom sections, higher sediment loads in the streams, and an increased alluviation/deposition at some point downstream where gradients are reduced. In general, channel erosion and incision has not been as severe in shallow hillslope tributaries as in valley bottoms, but native vegetation and overall vegetative cover has been severely reduced in these areas as well. Stream gradients in this geomorphic region are relatively steep in the foothills, and become much less steep on the valley floor.

3.2.3 Lower Valley/Plain Region

The lower valley/plain region of the inventory area has mostly been urbanized. In urban areas, hydrology and stream form has been altered for flood control or to convey irrigation water. Most streams have been disconnected from their historic floodplains by levees and channelization. Many of these streams are maintained as flood control channels that support little or no riparian vegetation. The terrain in this region is nearly level, with some low hills.

3.2.4 Sacramento–San Joaquin Delta Region

Most of the low-lying lands within the western Sacramento–San Joaquin Delta region (Delta region) have been reclaimed by protective dikes and converted to agricultural uses. As a result, little native vegetation remains in the area. The terrain in this region is nearly level, with very little topographic relief. Portions of the northeastern corner of the inventory area have substantially subsided and are currently at or below sea level. Sensitive channel systems have developed in this area because of blockage of natural flows by roads, culverts, and railroad lines. The drainages in the Delta region are treated here collectively as a single subbasin, the East County Delta Drainages. This subbasin includes Indian, Rock, Sand Mound, Dutch, Piper, and Taylor Sloughs, as well as False River.

Chapter 4
Regional Waters of the U.S. Types

Waters of the U.S. in the inventory area were classified into principal types according to Cowardin *et al*. (1979). The Cowardin classification is hierarchical, grouping WoUS into systems, subsystems, classes, and dominance types. Examples of systems include riverine, lacustrine, and palustrine. Examples of subsystems in the riverine system include upper perennial, lower perennial, intermittent, and tidal. Examples of classes in the riverine system include rocky bottom and unconsolidated bottom. Dominance types are based on the growth forms of the dominant vegetation in a wetland, such as forest or scrub. The system uses modifiers to further classify WoUS according to other criteria, such as duration of inundation and pH. The Cowardin classification is used here because it is helpful in assessing the functions and values of WoUS. For example, classifying a wetland as Palustrine Persistent Emergent informs us that this wetland is likely to provide habitat and improve water quality to a greater extent than a Palustrine Aquatic Bed WoUS, which is unvegetated. The Cowardin classification is used by the National Wetlands Inventory, as well as by numerous wetlands inventories and assessments.

The inventory area includes the following WoUS types (Cowardin et al. 1979).

- Palustrine Forest/Scrub/Shrub
- Palustrine Persistent Emergent
- Riverine Nontidal
- Riverine Tidal
- Riverine Excavated Artificial
- Impounded Lacustrine
- Palustrine Nonpersistent Emergent and Palustrine Aquatic Bed/Unconsolidated Bottom

These WoUS types and the acreage of each type in the inventory area are listed in Table 4-1. The aerial extent of specific WoUS types is based on data derived from the May 2000 aerial photographs. These data were updated by ground surveys conducted in spring 2003, spring 2004, and other data. Accordingly, data regarding WoUS should reflect current conditions in most of the inventory area as of spring 2004. In the following discussion, the following key characteristics of each WoUS type in the inventory area are described.

- Geomorphic units where found.
- Dominant vegetation.
- Hydrology.
- Location and extent in the inventory area.
- Mapping methods;
- Habitat, water quality, and hydrologic cycling functioning.

The goal of these discussions is to give the reader a familiarity with the landscape level WoUS inventory, as well as to describe the characteristics of WoUS types that are common to multiple subbasins, reducing redundancy in this report.

4.1 Palustrine Forest/Scrub/Shrub

Palustrine forest/scrub/shrub wetland is equivalent to riparian woodland/scrub in the HCP/NCCP (Table 4-1).

4.1.1 Geomorphic Units

These wetlands are found within montane and foothill geomorphic zones, along stream banks and overbank floodplain terraces.

4.1.2 Description

Palustrine forested or scrub/shrub wetlands are dominated by phreatophytic woody vegetation associated with streams and permanent water sources. Palustrine forest is dominated by trees and contains an understory of shrubs and forbs. Tree species include Fremont cottonwood (*Populus fremontii*), western sycamore (*Platanus racemosa*), and red willow (*Salix laevigata*). The understory may also include woody shrubs such as arroyo willow (*Salix lasiolepis*) and coyote brush (*Baccharis pilularis*). Palustrine scrub/shrub areas are dominated by young trees and shrubs that typically represent an early successional stage of riparian woodland. Coyote brush and arroyo willow are the dominant species in palustrine scrub. Palustrine forest/scrub areas are dominated by a mixture of trees and shrubs adapted to saturated and/or flooded soil conditions. The hydrologic regime in this type of wetlands is nontidal and saturated, with some areas that are temporarily or seasonally flooded. Generally, this wetland type occupies narrow corridors in the inventory area, with a canopy only several trees or shrubs wide. This wetland type forms a mosaic with the riverine nontidal wetland type, discussed in further detail below. As noted above, the boundary between palustrine forest/scrub that may be jurisdictional wetland and similar vegetation that is lacking hydric soils and wetland hydrology could not be mapped from aerial photos. Therefore, much of the mapped palustrine forest/scrub in the inventory area is most likely not jurisdictional wetland.

4.1.3 Location and Extent

Palustrine forest/scrub is rare in the inventory area, occurring on only 450 acres (<1%). The largest and longest stands of riparian vegetation are found in and near Pittsburg along Kirker Creek, and along Marsh Creek above and below Marsh Creek Reservoir. Riparian woodland and scrub is also present along Willow Creek, Upper Mount Diablo Creek, Kellogg Creek, Sand Creek, West Antioch Creek, East Antioch Creek and Brushy Creek, as well as along the East County Delta Drainages.

4.1.4 Mapping Methods Unique to Wetland Type

This wetland type was identified on the basis of its specific signature in the photographs and proximity to streams, drainages, and lakes or reservoirs. On infrared photographs, riparian areas were discernible by their light signatures. These light-colored signatures indicate areas of rapid vegetative growth. Riparian areas were mapped based on this signature type, topographic location, and canopy density. Because palustrine scrub/shrub is an early successional stage of palustrine forest, and because it was difficult to distinguish on aerial photos, the two categories were combined as palustrine forest/scrub. The minimum mapping unit for palustrine forest/scrub was 1 acre. It was not possible to distinguish between jurisdictional and non-jurisdictional wetland within the palustrine forest/scrub category. It is likely that the amount of palustrine forest/scrub mapped as wetlands overestimates the amount that is jurisdictional.

Some intermittent and ephemeral streams in the inventory area are dominated by a narrow corridor of oaks, California bay, or California buckeye (*Aesculus californica*), with only scattered riparian tree species (e.g., willows [*Salix* spp.] and cottonwoods [*Populus* spp.]) present. Stands in streams dominated by oaks were not mapped as palustrine forest/scrub. In some places (e.g., Contra Loma Reservoir), riparian trees such as cottonwoods have been planted as ornamentals with an understory of irrigated turf. These areas were mapped as turf, not as palustrine forest/scrub.

4.1.5 Functions

Habitat

Palustrine forest/scrub provides habitat for a wide diversity of wildlife and plant species. The presence of flowing water associated with this wetland type attracts numerous mammals, amphibians, and reptiles. Riparian corridors are also important for deer migration. Common mammals found in this cover type include mule deer, raccoon, gray fox (*Urocyon cinereoargenteus*), striped skunk (*Mephitis mephitis*), deer mouse (*Peromyscus maniculatus*), harvest mouse (*Reithrodontus megalotis*), broad-handed mole (*Scapanus latimanus*), and dusky-footed woodrat (*Neotoma fuscipes*). Because of their proximity to rangelands, livestock graze many riparian areas in the inventory area. Numerous birds are also typical of this cover type, including Yellow Warbler (*Dendroica petechia*), Northern Flicker, Bewick's Wren, White-Tailed Kite, Cooper's Hawk (*Accipiter cooperii*), Red-Shouldered Hawk (*Buteo lineatus*), Song Sparrow (*Melospiza melodia*), and Black-Headed Grosbeak (*Pheucticus melanocephalus*) and migrants such as Pacific-Slope Flycatcher (*Empidonax difficilis*) and Wilson's Warbler (*Wilsonia pusilla*). In addition, palustrine forest/scrub provides a source of coarse woody debris in streams, which is an important habitat element for some riparian species.

Palustrine forest/scrub in the inventory area provides variable levels of habitat function. In the upper portions of the subbasins, palustrine scrub/forest provides a high level of habitat function. Riparian woodland, forest, and scrub in these areas are generally well developed, and surrounding lands are managed for grazing or conservation and recreation. In the lower portions of subbasins, palustrine forest/scrub provides a low level of habitat function because it is adjacent to developed areas, generally lacks a complex understory, and occupies a narrow area along streams.

Water Quality

Palustrine forest/scrub intercepts surface runoff, retains nutrients, contributes to groundwater supplies, and reduces suspended sediments, and therefore improves water quality. Because of the steep topography of the montane and foothill regions, these water features, commonly found at the base of slopes, are fed by surface sheet flow and shallow subsurface groundwater, and provide important flow retention. Shallow groundwater commonly contains high dissolved organic and inorganic nutrients leached from surrounding geology and saturated soils. These nutrients are removed, transformed, and exchanged by wetland vegetation.

Water quality is also improved through filtration of sediments and removal of associated nutrients and metals. Fine sediments are transported with surface sheet flows during storm events. An increased concentration of fine sediment in the water column will increase turbidity, making it difficult for aquatic species to locate food sources, and transport heavy metals and nutrients downstream. Depending on the surrounding geology, toxic heavy metals, such as mercury, can be transported with fine sediment. This phenomenon is especially true with clay sediments. One way to remove these metals from the watershed is through settling and consequent burial of these sediments. Vegetated wetlands serve this function because velocities are slowed and fine sediment is encouraged to settle out, thus removing metals from the water column.

Tall forest and shrub vegetation also provide shade, which maintains and reduces water temperature and improves water quality conditions.

Streambank Erosion Protection

Wetlands reduce streambank erosion because the roots of vegetation hold the soil in place. The root mass of large trees and shrubs, such as those found in this wetland type, are sometimes exposed to the surface. During storm events, these exposed roots help to slow flow velocity, which encourages sediment deposition. Recruitment of new sediment is important to encourage new vegetation growth and cycling of metals, nutrients, and carbon. Large trees and shrubs growing on streambanks in montane and foothill regions are important for streambank protection, particularly in highly erosive soil types.

Flood Storage

Palustrine forest and scrub wetlands sometimes occur in areas that are seasonally inundated by floodwaters. The flood storage function offers two main benefits to the surrounding environment: reduction of downstream erosion and reduction of suspended sediments. Wetlands, particularly those found in the montane and foothill regions, capture and slow surface and subsurface waters during storm events. During the peak of a storm hydrograph, flow velocities are the largest and the concentration of suspended sediments is the highest. High flow velocities can physically damage stream banks and residential areas downstream by causing erosion. The velocity reduction by in-stream vegetation and storage of floodwaters in upstream inundation areas or detention basins is important to prevent flood damage to downstream land users. High concentrations of suspended sediment can clog the streambed, therefore reducing groundwater infiltration and interfering with fish feeding. Inundation of wetlands by floodwaters encourages the settling of sediments, which in turn enhances the soil, promoting further vegetation growth. Growth of vegetation increases the cycling rate of nitrogen and phosphorus from the system, further enhancing water quality. Wetlands in the steep topography of the montane region store floodwaters for a shorter period of time because of the abundance of exposed bedrock and steep slopes.

4.2 Palustrine Persistent Emergent

Palustrine persistent emergent (PPEM) wetland corresponds to wetland and seasonal wetland in the HCP/NCCP (Table 4-1).

4.2.1 Geomorphic Units

These wetland features are found along stream floodplains/bottomlands, pond margins, montane or river-valley freshwater courses, lacustrine-reservoir shores, montane/plateau seeps, foothill seeps, and valley and plain seeps.

4.2.2 Description

PPEM wetlands are dominated by herbaceous species that grow in perennially or seasonally flooded, ponded, or saturated soil conditions. Hydrologic regimes are primarily nontidal, and range from seasonally flooded to temporarily flooded. Soil conditions are important in recognizing a subclass of PPEM wetlands that occur on alkali soils, described below.

Perennially flooded PPEM wetlands are characterized by a year-round water source. They are typically dominated by erect, rooted, herbaceous hydrophytic plant species adapted to growing in conditions of prolonged inundation. Common plant species present in this wetland type include cattails (*Typha* spp.) and tules (*Scirpus* spp.). Both tidal and nontidal perennial PPEM wetlands are found in the inventory area.

Seasonally flooded PPEM wetlands are freshwater wetlands that support ponded or saturated soil conditions during winter and spring and are dry through the summer and fall until the first substantial rainfall. The vegetation is composed of wetland generalists, such as hyssop loosestrife (*Lythrum hyssopifolia*), cocklebur (*Xanthium* spp.), and Italian ryegrass (*Lolium multiflorum*) that typically occur in frequently disturbed sites, such as along streams.

Vernal pools are temporarily flooded PPEM wetlands that pond water on the surface for extended durations during winter and spring and dry completely during late spring and summer.

Alkali wetlands support ponded or saturated soil conditions and occur as permanently to seasonally flooded features on alkali soils. The vegetation of alkali wetlands is composed of halophytic plant species adapted to both wetland conditions and high salinity levels. Typical species include those common to both seasonal and alkali wetlands, such as salt grass (*Distichlis spicata*), alkali heath (*Frankenia salina*), and common spikeweed (*Centromadia pungens*).

Freshwater seeps in the inventory area are also PPEM wetlands. Seeps generally occur at grade breaks or intersections of different subsurface strata where groundwater tends to rise to the surface. These features are small and isolated and therefore could not be distinguished from its surroundings on the aerial photographs. Thus, this wetland type was not mapped. Freshwater seeps generally occur in grasslands or meadows where water is permanently near the soil surface, supporting perennial grasses, rushes, sedges, and other wetland species (Holland 1986). Freshwater seeps are likely to be present along drainages and in other locations. Common species associated with freshwater seeps in the region include Baltic rush (*Juncus balticus*), toad rush (*Juncus bufonius*), creeping spikerush (*Eleocharis macrostachya*), annual rabbit's-foot grass (*Polypogon monspeliensis*), seep-spring monkeyflower (*Mimulus guttatus*), and bull clover (*Trifolium fucatum*).

4.2.3 Location and Extent

There are 683 acres of PPEM wetlands in the inventory area at 327 sites (i.e., distinct map units). Vernal pools could not be distinguished on the aerial photographs; they are included as PPEM wetlands.

A total of 18 acres of seasonally flooded PPEM wetlands were mapped at nine sites.

Vernal pools are expected to be very rare in the inventory area based on field surveys in large portions of the inventory area in which vernal pools could be found. In a comprehensive survey of land cover types in the Los Vaqueros watershed (19,600 acres), 15 acres of northern claypan vernal pools were mapped and field-verified (Jones & Stokes 1989). Most of these pools (10.5 acres) were low quality and found behind an artificial dam and were used at the time as a stock pond. In extensive planning surveys for the Cowell Ranch State Park (4,277 acres), 0.4 acres of northern claypan vernal pools were found in six natural and 12 artificial pools (see references in Wagstaff and Associates 1996). Most pools varied in size between 300 and 1,500 square feet; the largest pool was 5,000 square feet. Surveys of a large area around Sand Creek (2,708 acres) found no vernal pools (see references in Mundie and Associates and City of Antioch 2002). Small amounts of vernal pools (< 1 acre) are also found adjacent to the Byron Airport (Stromberg and Ford 2003). The Byron Airport pools include 0.06 acres of vernal pools that were created as mitigation for expansion of the airport in 1992.

Alkali wetlands are rare in the inventory area, occurring at 20 sites on 54 acres (<1%) in the southeastern portion of the inventory area in the Brushy Creek subbasin. Alkali wetlands are also found in the Dry Creek, Deer Creek, and Briones Creek subbasins.

No seeps were mapped in the course of this study. However, verified wetland delineations within the inventory area indicate that seeps are present.

4.2.4 Mapping Methods Unique to Wetland Type

Palustrine persistent emergent wetlands were identified on the basis of their aerial photograph signatures and landscape positions that would support wetland hydrology (e.g., wetlands generally have a dark-red signature on the infrared photographs because these areas are greener and are actively growing). The minimum mapping unit for all PPEM wetland types was 1 acre PPEM wetland subtypes were distinguished based on the darkness of the signature and the density of vegetation. If the type of wetland could not be determined (i.e., the duration of inundation could not be determined from aerial photography), the wetland was classified as the general wetland type. Seasonally flooded PPEM wetlands are likely underrepresented because of the small size, isolated locations, and difficulty in interpreting the photographic signature of individual features. Many seasonally flooded PPEM wetlands were not mapped because they were smaller than the minimum mapping unit of 1 acre or were not visible on the aerial photographs. In addition, many of the mapped seasonal wetlands were included in the general PPEM wetland land cover category because they could not be differentiated from permanently flooded PPEM wetlands. Vernal pool is a subtype of seasonally flooded PPEM wetlands that could not be mapped with available photography but is included in this wetland type. PPEM wetlands greater than 1 acre on alkali soils were mapped as alkali PPEM wetlands. Alkali PPEM wetlands were mapped where wetlands occurred within the alkali grassland land-cover type. Seeps remained unmapped because they lacked a clear signature on the aerial photographs and are smaller than the minimum mapping unit of 1 acre.

4.2.5 Functions

PPEM Habitat Functions

Perennially Flooded PPEM Wetlands

The perennially flooded PPEM wetland type is important for a wide variety of wildlife species. Representative waterbirds that forage and rest in these wetlands and associated open-water areas include Great Blue Heron (*Ardea herodias*), Great Egret (*Ardea alba*), Killdeer (*Charadrius vociferus*), American Coot (*Fulica americana*), and Greater Yellowlegs (*Tringa melanoleuca*), as well as various ducks, including Wood Ducks (*Aix sponsa*) and Mallards (*Anas platyrhynchos*). Typical amphibians and reptiles in this cover type include California red-legged frog (*Rana aurora draytonii*), western pond turtle (*Clemmys marmorata*), and garter snakes (*Thamnophis* spp.). Many of the larger mammals, such as mule deer (*Odocoileus hemionus*), may frequent these wetlands and use them as a source of drinking water.

Within the inventory area, the level of habitat function of this wetland type depends on adjacent land use, as well as the density and complexity of the vegetation. Examples of this wetland type include densely vegetated restored freshwater marshes along Kellogg Creek, as well as wetlands constructed for stormwater treatment in developed areas.

Seasonally Flooded PPEM Wetlands

Seasonally flooded PPEM wetlands provide habitat for different wildlife species depending on the season. During the wet season, these wetlands are commonly used by a variety of wildlife, including various amphibians such as western spadefoot (*Scaphiopus hammondii*), Pacific chorus frog (*Pseudacris regilla*), western toad (*Bufo boreas*), and California tiger salamander (*Ambystoma californiense*); shorebirds such as Killdeer, Black-Necked Stilt (*Himantopus mexicanus*), and American Avocet (*Recurvirostra americana*); and passerines such as Brewer's Blackbird (*Euphagus cyanocephalus*), Red-Winged Blackbird (*Agelaius phoeniceus*), Brownheaded Cowbird (*Molothrus ater*), and American Pipit (*Anthus rubescens*).

During the dry season, a variety of small mammals use the areas, including deer mouse, California vole (*Microtus californicus*), and long-tailed weasel (*Mustela frenata*). Raptors such White-Tailed Kites, Northern Harrier, and Red-Tailed Hawk may forage in this wetland type.

Alkali wetlands provide function and value for wildlife similar to those provided by non-alkaline wetlands. However, these wetlands provide habitat for a suite of alkali plant species, some of which are rare, threatened, or endangered.

Within the inventory area, the level of habitat function of this wetland type depends on adjacent land use, as well as the density and complexity of the vegetation. Examples of this wetland type include floodplain wetlands with native vegetation and surrounded by oak woodland along Upper Marsh Creek, as well as floodplain wetlands dominated by exotic plant species located along intermittent streams in the Willow Creek subbasin.

Vernal Pool Habitat

Because of their unique hydrology, vernal pools support specialized plants adapted to growing in these stressful conditions, such as coyote thistle (*Eryngium* spp.), goldfields (*Lasthenia* spp.), downingia (*Downingia* spp.), and navarretia (*Navarretia* spp.). These species are generally restricted or nearly restricted to vernal pools. A number of special-status invertebrates, including vernal pool fairy shrimp (*Brachinecta lynchi*), vernal pool tadpole shrimp (*Lepidurus packardi*), and longhorn fairy shrimp (*Brachinecta longiantenna*), may occur in vernal pools.

Seep Habitat

In the East Bay region, ten special-status plants are recorded in seep habitats, six of which are associated with alkali seeps, two with freshwater marsh, and two with freshwater seeps (California Natural Diversity Database 2003). As with other aquatic habitats, the freshwater seep communities are important because they provide wildlife species with a source of water for drinking, foraging, and breeding. Freshwater seeps in the inventory area may support reptiles and amphibians such as common garter snake and slender salamander (*Batrachoseps attenuatus*). California red-legged frog and California tiger salamander could also be supported by freshwater seeps. A variety of birds and mammals, such as deer and raccoon, also use seep habitat for drinking and foraging.

PPEM Water Quality Functions

Perennially Flooded PPEM Wetlands

Wetland areas inundated by water year-round improve water quality through sediment removal and cycling of nutrients. Vegetation found here is adapted to inundation by water, thus exhibits slow growth and has a long growing season. The continued presence of water encourages more vegetation growth and thus uses large quantities of nutrients. Most of the wetlands in this category in the inventory area are treatment wetlands and tidal marshes.

Treatment wetlands are often constructed to capture stormwater runoff from surrounding areas, such as residential subdivisions and golf courses. These wetlands provide a filter to remove suspended solids, metals, pollutants, and pathogens from stormwater runoff. The fringe vegetation growing around these ponds intercept the stormwater, slowing the velocity and encouraging sediments to settle out of the water column. Sediments contained in runoff from urban areas, including managed lands such as golf courses, can carry adsorbed nutrients, metals, and pathogens. These contaminants are removed from the water column along with the sediment. Treatment wetlands typically allow water to evaporate from their surfaces, thus adding to the hydrologic cycle.

Wetland vegetation has the unique capability of increasing the cycling and storage of nitrogen and phosphorus. The forms of nitrogen contained in stormwater are considered biostimulatory because they promote the growth of aquatic vegetation. In an anoxic wetland environment, nitrogen is removed from the water, transformed into a gaseous form, and released to the atmosphere to complete the nitrogen cycle. Phosphorus is also quickly used by vegetation and soil microbes. When these plants and microbes die, the phosphorus is released and adsorbed into the soil. Large amounts of phosphorus are stored in wetland soils in this manner. The phosphorus is re-released to surface water during winter storms, thus supplying downstream vegetation and water features with available phosphorus.

Seasonally Flooded PPEM Wetlands

Water quality functioning of seasonally flooded wetlands is similar to that described above, but at a reduced scale. Seasonal wetlands are so called because they receive and retain water flows for a limited amount of time, usually a few months after the rainy season. The shorter availability of water for vegetation allows for limited nutrient uptake and storage. However, sediment removal functions remain the same. Soil type and topography control the ability of seasonal wetlands to retain water during a storm. Like perennial wetlands, vegetation growing in these areas is adapted to capture nutrients contained in stormwater and adsorbed to sediments. However, short growing seasons result in a shorter period of active nutrient cycling. This implies that smaller quantities of nutrients, phosphorus in particular, are released and stored as part of the cycle. Nonetheless, cycling of nutrients is an important function of seasonal wetlands for the surrounding ecosystem.

Seasonal wetlands serve as important filters of suspended sediment from the water column. Although vegetation in these wetlands is typically of short stature, because of their location at topographic low points, flows are slowed and sediment is encouraged to deposit. Sediment deposition is important for vegetation growth, as described in the perennial wetland discussion above.

Seeps

Seeps are important for water quality because they are important sources of freshwater and mineral deposition. Seeps form when the groundwater table rises to the surface. Depending on the geology type in which the groundwater travels, different concentrations of minerals can be deposited where seeps daylight at the surface. For example, alkali seeps are formed by groundwater high in salts.

PPEM Erosion Protection Functions

Perennially Flooded PPEM Wetlands

Soils surrounding perennial wetlands are typically saturated, thus soil cohesion is high. Therefore, erosion of perennial wetlands does not occur at a rapid rate. Hillslope slumping can occur, however, where there is an increase in slope. Vegetated perennial wetlands are valuable to prevent adjacent land loss from erosion during storm conditions that increase soil moisture. Tidal marshes, in particular, protect the shoreline from eroding. As buffers, rooted vegetation helps to hold soils together and provides structure to the shoreline and adjacent land. The vegetation also encourages sediment deposition, which further stabilizes the bank and increases vegetation growth.

Seasonally Flooded PPEM Wetlands

Vegetation growing within and on the edge of seasonal wetland areas, such as riparian corridors in stream channels, provides important structure to the soils. Roots of established vegetation prevents erosion during storm events and reduces flow velocity. In the case of seasonal wetlands, vegetation dies out after the growth season, but its root structure remains within the soil for some time. This structure helps to prevent soil erosion, particularly when the first storm hits the area. Seasonal wetlands dry out during the summer, thus soil saturation and cohesion is sometimes reduced.

A large majority of seasonal wetlands in the project area are present in land heavily grazed by cattle. Properly managed, grazing can be compatible with the conservation of seasonal wetlands. For example, providing alternative water sources, keeping stocking rates low in the dry season, and/or fencing wetlands can protect them from negative grazing impacts. However, if not properly managed, cattle grazing can reduce wetland functioning because cattle may consume and trample wetland plants, leaving the wetland unvegetated. Removing vegetation from wetlands results in increased flood flow velocity and recruitment of sediment by floodwaters. If mismanaged, cattle may also trample and compact soils. Compacted soils absorb less moisture from flood flows and make it more difficult for vegetation to establish. The potential for streambank erosion increases with the presence of cattle on the land.

PPEM Hydrologic Cycling Functions

Perennially Flooded PPEM Wetlands

Perennial wetlands are commonly found at topographic low points or at downstream ends of the watershed. Waters held within this area year-round can provide an important source for groundwater recharge. Groundwater recharge occurs primarily through soils on the outside edges of the wetland because soils within the wetland are less permeable. Water percolating to the groundwater table supplies streams or other surface features down slope. This function is important to maintain the hydrologic cycling within the area. In addition, perennially flooded tidal marshes help to maintain the location of the fresh/saline groundwater interface.

Seasonally Flooded PPEM Wetlands

Seasonal wetlands are also found at topographic low points, which can be found throughout the watershed, not particularly at the downstream end. Hydrologic cycling functions of perennially flooded wetlands also apply to seasonally flooded wetlands, including vernal pools. Seasonally flooded wetlands may have a larger impact on groundwater recharge and hydrologic cycling than perennially flooded wetlands. This is due to their larger wetland perimeter-to-volume ratio. Seasonal wetlands tend to be large and shallow, which produces a large surface area and perimeter from which evaporation and groundwater percolation can occur. Evaporation and groundwater recharge are key functions to continue the hydrologic cycle of a watershed. These types of wetlands are invaluable for fostering cycling of water for plant growth, thus enhancing wildlife habitat.

Seeps

Like seasonal wetlands, seeps also play key functioning roles in hydrologic cycling of water. Seeps are features dependent on groundwater flow and a steady groundwater elevation. This illustrates again how important groundwater recharge is for the presence of surface water features. Seeps are also important sources of freshwater for wildlife.

PPEM Flood Storage and Conveyance Functions

Perennially Flooded PPEM Wetlands

Since perennial wetlands are commonly found at topographic low points or at the downstream end of the receiving watershed, these areas quickly swell with water during storms, causing floodwaters to back up and spread out over adjacent flood plain areas. Flood storage capacity has been reduced from historical levels to enable development of the floodplains for urban and agricultural uses. The lower portions of streams in the project area have been redirected through dikes to capture and convey floodwaters away from natural floodplains and to the Delta. Perennial wetland vegetation has developed within these channels. This vegetation helps to slow the velocity of floodwaters moving through the constructed channels. Though flood storage capacity has been reduced, the reduction in floodwater velocity provided by vegetated channels is important to reduce bank erosion and encourage settling of suspended sediments.

Seasonally Flooded PPEM Wetlands

Seasonal wetlands can retain water that would otherwise move downstream during storms. The majority of seasonal wetlands are dry before a storm of flood magnitude occurs. As the depressional area or pond fills with the storm flows, floodwaters rise and spread out over adjacent land, the floodplain. Inundation of the floodplain is important for sediment recruitment and plant growth, which stabilizes the stream bank.

Wetlands that provide flood storage can prevent erosion damage to land. This is particularly important in developed areas, such as residential housing subdivisions. Seasonal wetlands slow the velocity of stormwater, thus encouraging settling of sediments and debris carried by the waters.

4.3 Riverine Nontidal

Riverine nontidal is equivalent to streams in the HCP/NCCP (Table 4-1).

4.3.1 Geomorphic Units

Riverine nontidal features are found in montane stream channels, foothill/terrace stream channels, valley stream channels, and floodplain stream channels.

4.3.2 Description

Riverine nontidal WoUS in the inventory area includes intermittent, lower and upper perennial watercourses characterized by a defined bed and bank and/or ordinary high water mark. Bottom types represented include rock, unconsolidated, and aquatic bed. Most riverine nontidal WoUS in the inventory area are intermittent. Mount Diablo Creek and some of its tributaries, Marsh Creek, Kirker Creek, Delta sloughs, and lower Sand and Deer Creeks, are the only perennial streams within the inventory area. Of these, Upper Mount Diablo, Upper Marsh Creek and Kellogg Creek contain areas of upper perennial riverine nontidal WoUS, characterized by relatively narrow channels, steep gradients, and rocky bottoms. The remaining perennial riverine nontidal WoUS are lower perennial, characterized by wider channels, gentler gradients, and unconsolidated bottom or aquatic bed.

4.3.3 Location and Extent

Approximately 400 miles of riverine nontidal WoUS are known to exist in the inventory area based on existing data. Stream width in the montane and foothills/upper valley regions was assumed to be an average of 5 feet; stream width in the lower valley/plain and Delta regions was assumed to be an average of 10 feet. Based on these assumptions, it can be estimated that there are 308 acres of riverine nontidal WoUS in the inventory area. In some areas, these riverine nontidal WoUS are intermixed with palustrine forest/scrub and palustrine persistent emergent wetlands to form a mosaic of wetland types.

4.3.4 Mapping Methods Unique to WoUS Type

Streams in the inventory area, including riverine nontidal WoUS, were mapped by staff of the Contra Costa County Community Development and Public Works Departments. Mapping was done countywide to support the concurrent development of a county watershed atlas (Contra Costa County 2003). The stream layer was mapped by interpreting digital orthographic photographs (scale 1:200 where available, 1:400 elsewhere), 10-foot contours, and county storm drain data. USGS creek data (2003) were used to help determine the drainages that should be mapped, but substantial drainages absent from USGS maps were included. Draft data were ground-truthed by county staff and reviewed thoroughly by staff and members of the Contra Costa Watershed Forum who were knowledgeable about the specific conditions in individual subbasins. Creek centerlines were digitized when visible on aerial photos. Otherwise, riparian vegetation, slope breaks, and contour lines were used to locate creek centerlines approximately. Small tributaries were mapped only when a distinct bed and bank were visible on the air photos or sharp contour lines clearly defined a channel. Aerial photo signatures for small tributaries were ground-truthed in the field by county staff to calibrate the mapping. Small tributaries were mapped to a minimum length of 300 feet. Streams that are channelized and contained by levees were mapped as slough/channel, classed as riverine tidal.

4.3.4 Functions

Habitat

Like the palustrine forest/scrub and PPEM wetland types, riverine nontidal WoUS are important because they provide essential habitat for terrestrial and aquatic species. Many upland species rely on seasonal and perennial streams as water sources. In summer and early fall, perennial streams provide the only available water in an otherwise dry landscape. In addition, ephemeral, intermittent, and perennial streams provide habitat for aquatic macroinvertebrates, which are an important food source for local and downstream populations of fish, birds, and other animals.

Upper perennial stream reaches, found in portions of Upper Mount Diablo and Upper Marsh Creeks, retain riparian woodland vegetation in most areas, and are generally adjacent to open space managed primarily for conservation and recreation. They therefore provide a high level of habitat function for organisms such as the California red-legged frog and western pond turtle.

Lower perennial stream reaches in the inventory area are adjacent to grazing land (Lower Marsh), row crops (Lower Marsh)), or developed areas (Lower Marsh, and Deer, Sand, Kirker Creeks). Riparian vegetation, such as riparian woodland, is frequently present in a narrow corridor. Lower perennial streams in the inventory area therefore provide a low to moderate level of habitat function.

Intermittent streams in the inventory area provide a variable level of habitat function. In some cases, such as in Kellogg and Brushy Creeks, these stream reaches retain riparian vegetation and are adjacent to forest or woodland managed for conservation and recreation. These reaches provide a high level of habitat function. In other cases, such as Deer and Briones Creeks, these stream reaches are located in areas that appear to be heavily grazed. The banks of these reaches are frequently unvegetated, or vegetation consists of annual grasses and ruderal species. These reaches provide a low to moderate level of habitat function. Other intermittent reaches, such as East Antioch Creek, are located in developed areas. These reaches provide a low level of habitat function because only species tolerant of frequent human disturbance can utilize them as habitat.

Water Quality

Much like perennial wetlands, riverine nontidal WoUS improve water quality by fostering nutrient cycling. These channels receive waters from urban and agricultural runoff and are commonly found at lower elevations in the watershed. The channels hold water throughout the wet and dry season. During warm summer months, water within the channels will become stagnant, resulting in anoxic conditions. Any vegetation growing within the channel dies and falls to the channel bottom. Microbes facilitate the decomposition of this organic matter, resulting in increased biological oxygen demand and the release of nutrients. Objectionable odors are produced from the decomposing organic matter. The abundance of nutrients within the water provides desired conditions for growth of algae and aquatic macrophytes. Unattractive growth and odors do not appeal to residents, especially since insects like mosquitoes often reproduce in these environments. Particularly in developed areas, such as along Willow Creek, the increase of algae and macrophyte growth and the accompanying mosquitoes are unpopular with local residents. However, these processes are important to the cycling of nutrients, allowing for future vegetation growth and the delivery of nutrients downstream to the Delta.

Hydrologic Cycling

Riverine areas enhance hydrologic cycling in the watershed area by providing water vapor to the atmosphere through evaporation. The presence of water, either short or long term, increases the moisture content of the air, thus affecting the surrounding climate. Evaporation increases the concentration of water vapor in the air, which encourages precipitation, to a degree. Flood conveyance channels, such as lower Sand Creek, that fall under the riverine nontidal category are commonly impermeable and thus contribute little to groundwater recharge. However, some creeks, such as Dry and Willow Creeks, allow infiltration to surrounding soils. In permeable channels where water is held for long periods of time, water that is not transported downstream will percolate into the surrounding soils and the underlying groundwater aquifer. Replenishment of groundwater supplies maintains hydrology of groundwater-fed wetlands, as well as providing water for human and agricultural use. In the project area, riverine nontidal WoUS also provide a source of water for wildlife.

Flood Storage and Conveyance

Riverine nontidal WoUS help convey surface water to the Delta. In areas that have been developed for housing or industrial purposes, such as Sand and West Antioch Creeks, floodplain areas that once functioned for flood storage have been removed. Riverine features in these areas function for flood conveyance rather than flood storage. To handle increased flood flows from constructed impervious surfaces, these stream channels have been engineered to capture and convey the maximum amount of surface water runoff during storm events. The channels function to convey floodwaters to the Delta as quickly as possible, thereby reducing erosion and damage to structures. Flood conveyance channel bottoms are commonly impermeable and thus contribute little groundwater recharge. However, some channels in the project area allow infiltration to groundwater. Vegetation is sometimes allowed to grow within these channels to a limited extent, which does not hinder flood conveyance capacity.

4.4 Riverine Tidal

Riverine tidal WoUS are equivalent to sloughs/channels in the HCP/NCCP (Table 4-1).

4.4.1 Geomorphic unit

Riverine tidal features are found at the downstream distal ends of subbasin drainages where stream channels enter the tidal zone of the bay/straits region, or along Delta stream channels.

4.4.2 Description

Riverine tidal WoUS generally have perennial water and artificial banks (e.g., levees) constructed of natural soil materials and they may contain in-stream vegetation. Although the banks of sloughs are generally composed of soil, portions of sloughs may be lined with riprap, concrete, or rock gabions for bank stabilization. Sloughs are tidally influenced and may contain brackish waters. They may be lined with a narrow corridor of riparian forest or marsh species such as cattails and bulrushes, and may contain in-stream vegetation such as water hyacinth (*Eichhornia crassipes*), abundant in sloughs in the East County Delta Drainages subbasin. Channels include channelized urban streams such as the lower portion of Marsh Creek in Brentwood and Oakley.

4.4.3 Location and Extent

This cover type is relatively uncommon, occupying only 254 acres on the east and southeast sides of the inventory area near Discovery Bay and the Clifton Court Forebay.

4.4.4 Mapping Methods Unique to Wetland Type

Because levees were clearly visible on the aerial photographs, sloughs and channels could be mapped to the visible waterline. Large channels constructed to transport drinking water or agricultural water were mapped as riverine excavated artificial WoUS (aqueduct), not as riverine tidal WoUS (slough/channel).

4.4.5 Functions

Habitat

Sloughs and channels can be important to a variety of wildlife because they provide drinking water, foraging habitat, and resting habitat. Common wildlife found associated with this wetland type include garter snakes, a variety of ducks, both wading and shore birds, and large mammals that use these features for drinking water. In addition, the portion of Marsh Creek mapped as slough/channel provides habitat for western pond turtle, juvenile and spawning adult Chinook salmon (*Oncorhynchus tshawytscha*), and a variety of other aquatic species. Land uses surrounding sloughs and channels are generally intensive agriculture, residential, or commercial development. Because of these adjacent land uses, sloughs and channels in the inventory area provide a low to moderate level of habitat function.

Water Quality

Riverine tidal features transport runoff water from adjacent agricultural lands to the Delta. Return flows from irrigated lands often contain residual fertilizers, pesticides, and nutrients. High concentrations of these constituents can pollute the water, harming surrounding vegetation and wildlife. Incoming tidal waters dilute these constituents and then transport them to the Delta for further dilution. Within the channel, vegetation adapted to saline and brackish water thrives in the nutrient-rich water. This vegetation filters and removes nutrients and other contaminants through immobilization within the plant structure and soils. Thus, vegetated riverine tidal features potentially improve the quality of waters transported from agricultural lands to the Delta. However, continual delivery of sediment and nutrients from agricultural lands and urban runoff may exceed quantity that vegetation can remove from the system. Consequently, the U.S. Environmental Protection Agency has designated the San Joaquin River and many sloughs connecting the Delta as impaired by low dissolved oxygen and high concentrations of pesticides (USEPA 2003).

Hydrologic Cycling

Much like riverine nontidal features, riverine tidal features convey waters to the Delta. However the majority of the water consists of return flows from nearby irrigated agriculture lands. Because these channels have been constructed at or below sea level, tides influence water level and flow direction within the channel. The natural hydrologic cycle is interrupted by the surrounding land use. In agricultural areas, water transport is a necessary component of the hydrologic cycle. Water is pumped from groundwater aquifers, replenished by upstream recharge areas, and used to irrigate crops. Runoff waters from the crops are then discharged to the constructed channels and transported to the Delta. Compared to a natural hydrologic cycle, this cycle created by agricultural land use encourages increased evaporation and degrades water quality. However, the water still discharges to the Delta, just as it would in a natural system.

Flood Conveyance

During periods of high flows, these channels help to convey excess floodwaters to the Delta. However, once channel capacity is reached or exceeded, there is a potential for levees to be breached or overtopped, which could damage adjacent agricultural fields.

4.5 Riverine Excavated Artificial

Riverine excavated artificial WoUS are equivalent to aqueduct and to irrigation and drainage ditches in the HCP/NCCP (Table 4-1).

4.5.1 Geomorphic Unit

Riverine excavated artificial features are found along stationary artificial structures and in agricultural areas in the Delta and Plain regions.

4.5.2 Description

Riverine excavated artificial in the inventory area corresponds to the Contra Costa Canal and to agricultural drainage ditches. The primary purpose of the Contra Costa Canal is to deliver drinking water from the Delta via channels to treatment plants for distribution to consumers. These channels are completely impervious, and human contact with the water is prohibited. All vegetation is removed from the channel banks to reduce the threat of cracking the channel bed. Surrounding surface and groundwater is not allowed to influence the channels or the water they carry.

Agricultural drainage ditches carry water from agricultural fields into larger channels and to the Delta. In contrast to the Contra Costa Canal, these channels may contain abundant marsh vegetation.

4.5.3 Location and Extent

The Contra Costa Canal occupies an area of approximately 32 acres within the inventory area. Within the inventory area, the Contra Costa Canal runs primarily east to west through the Cities of Pittsburg and Bay Point. Agricultural drainage ditches are located primarily in the East County Delta Drainages subbasin, as well as in the Lower Marsh Creek and Brushy Creek subbasins. Drainage ditches and irrigation channels occupy approximately 76 acres.

4.5.4 Mapping Methods Unique to Wetland Type

All canals and larger drainage ditches that were visible on aerial photos were mapped. Canals and larger drainage ditches are clearly discernible in aerial photographs from adjacent agricultural areas as linear features with dark signatures.

4.5.5 Functions

The Contra Costa Canal provides breeding habitat for birds such as black phoebe (*Sayornis nigricans*). It also provides foraging and roosting habitat for waterfowl such as Mallard, which will use open water for loafing, while wading shorebirds such as Great Blue Heron (*Ardea herodias*) and Snowy Egret (*Egretta thula*) may use the canal for foraging. Amphibians such as Pacific chorus frog (*Pseudacris* [*Hyla*] *regilla*) and bullfrogs (*Rana catesbeiana*) may also occupy the canal. The canal does not provide suitable breeding habitat for any special-status amphibians because it lacks a vegetative cover and because of the highly disturbed nature of the surrounding area. The special-status western pond turtle might occupy the canal. However, because of the lack of riparian habitat in these channels, this species would only use them as movement corridors.

Agricultural drainage ditches lack open water habitat but do contain wetlands vegetation. They therefore provide foraging, movement, and breeding habitat for birds, amphibians, and reptiles that can tolerate the disturbed nature of surrounding agricultural land.

4.6 Impounded Lacustrine

Impounded lacustrine WoUS are equivalent to reservoirs in the HCP/NCCP (Table 4-1).

4.6.1 Geomorphic Unit

Impounded lacustrine features are found along lacustrine montane reservoirs and lacustrine river-valley reservoirs.

4.6.2 Description

Impounded lacustrine WoUS in the inventory area are those areas designated on USGS topographic maps as named reservoirs. Depending on depth, these WoUS may be limnetic or littoral. Lacustrine feastures in the inventory area generally have an unconsolidated bottom.

4.6.3 Location and Extent

Found in the Los Vaqueros, Contra Loma, Antioch, and Marsh Creek Reservoirs. Los Vaqueros and Marsh Creek reservoirs are fringed by palustrine persistent emergent wetlands. Reservoirs occupy approximately 1,800 acres in the inventory area.

4.6.4 Mapping Methods Unique to Wetland Type

Reservoirs were easily discernible on aerial photographs based on the smooth, uniform, dark signatures of open water. Reservoirs were mapped to the high water line, where discernible. The high water line was observed on the aerial photographs as either obvious rings of sparse vegetation or an open water signature (most of the reservoirs appeared to be full or nearly full when the aerial photographs were taken).

4.6.5 Function

Habitat

Reservoirs can provide breeding and foraging habitat to various ducks, including Mallard, Green-Winged Teal (*Anas crecca*), Cinnamon Teal (*Anas cyanoptera*), Gadwall (*A. strepera*), American Wigeon (*A. americana*), and American Coot. Shore and wading birds including Killdeer, Greater Yellowlegs, and several gull species can also be found in reservoirs. Large mammals can use reservoir habitat for drinking water. Western pond turtles have been documented in the vicinity of the Marsh Creek Reservoir.

Water Quality

Impounded lacustrine features in the project area include the Antioch, Contra Loma, Los Vaqueros, and Marsh Creek Reservoirs. The Antioch, Contra Loma, and Los Vaqueros Reservoirs were constructed to store drinking water for consumers in Contra Costa County. These reservoirs capture surface waters from their surrounding watershed areas. In addition, water is pumped from the Delta and transported to the Los Vaqueros Reservoir for storage. Retention of the Delta water in the reservoir improves water quality of the reservoir because sediments are allowed to settle out of the water column, along with metals and other contaminants adsorbed to the sediment.

The Marsh Creek Reservoir was created in the 1950s to protect against flooding. This reservoir is not used for drinking water primarily because of high levels of mercury whose primary source is an abandoned mine in Upper Marsh Creek. This reservoir retains mercury-contaminated sediments in the reservoir bottom. The removal of mercury from the system improves downstream water quality. However, water and sediments within the reservoir will become increasingly toxic as mercury accumulates.

The Contra Loma and Antioch Reservoirs provide additional water supply for Contra Costa County. The Contra Loma Reservoir is managed by the CCWD, while the Antioch Reservoir is managed by the City of Antioch. Both allow recreation activities, such as swimming and fishing, but are closely monitored to maintain good drinking water quality.

Hydrologic Cycling

As with perennial wetland features, large reservoirs provide important sources of water vapor for the atmosphere. This is particularly the case for Los Vaqueros, which is situated high in the Kellogg Creek watershed. Reservoirs also function to enhance groundwater recharge. Further discussion of evaporation and groundwater recharge can be found above in the PPEM section (Section 4.2).

Flood Storage and Conveyance

One of the many functions of reservoirs is flood control. Dams have been strategically constructed to capture storm flows behind a reservoir to prevent flooding of property and residences downstream. This is the case for the Marsh Creek Reservoir and, to some degree, the Contra Loma, Antioch, and Los Vaqueros Reservoirs. When storm flows fill a reservoir, water is released slowly over a long period of time to prevent damage downstream. This represents the alteration of the natural hydrograph, whereby peaks are attenuated and flow duration is typically increased. Lower peak flows minimize downstream erosion in the short term. However, in the longer term, sediment trapping behind dams prevents downstream sediment rejuvenation and sediment delivery to the coastal zone, and can increase erosion due to greater velocity and erosivity of water without sediment loads.

4.7 Palustrine Nonpersistent Emergent and Palustrine Aquatic Bed/Unconsolidated Bottom

Palustrine nonpersistent emergent and palustrine aquatic bed/unconsolidated bottom WoUS are equivalent to ponds in the HCP/NCCP (Table 4-1).

4.7.1 Geomorphic Unit

These features are found at agricultural and golf ponds.

4.7.2 Description

Palustrine nonpersistent emergent (PNEM) WoUS are small perennial or seasonal ponds dominated by submerged or floating vegetation. Palustrine aquatic bed/unconsolidated bottom (PAB/UB) WoUS are similar, but contain little or no vegetation. If vegetation is present, it is typically submerged or floating. Most PNEM and PAB/UB WoUS in the inventory area were created or expanded for livestock use (stock ponds), although some occur naturally, some were created as a part of golf courses, and others were created for water treatment.

4.7.3 Location and Extent

This wetland type is very common in the landscape of the inventory area but occupies a small overall area, a total of 161 acres (<1%) at 407 sites. Ponds are evenly distributed in the foothills/upper valley region of the inventory area, which is dominated by grazing. Ranchers have created ponds in this area to support cattle grazing operations. This pattern can be seen, for example, in the Kellogg, Brushy, Deer, and Briones Creek subbasins.

4.7.4 Mapping Methods Unique to WoUS Type

Ponds discernible on aerial photographs were mapped as PNEM or PAB/UB. Pond mapping generally included all open water occupying between 0.25 and 5 acres (including all stock ponds used by livestock). Ponds were easily discernible on the basis of two distinctive aerial photograph signatures. One signature—smooth, uniform, and dark black—indicates deeper and less turbid ponds. The other signature—light gray-brown—generally indicates a shallower or more turbid pond. The latter signature was more difficult to discern on the aerial photographs and in many cases required field verification. Where discernible, this WoUS type was mapped to the high water line. Some PPEM wetlands were likely included as PNEM WoUS.

4.7.5 Function

Habitat

Like lacustrine WoUS, PNEM and PAB/UB WoUS may support a variety of ducks and shore and wading birds. PNEM WoUS, together with PPEM WoUS, are of particular importance to native amphibians as breeding habitat.

Agricultural ponds are present because of grazing operations. They provide habitat for some species, even when unvegetated. However, heavy livestock use of these ponds reduces their habitat value for some species by causing the loss of emergent vegetation and eutrophication from increased nitrogen due to cattle urine.

Golf course ponds are mostly landscaped and offer little habitat function because they lack native vegetation and complex vegetative structure. Ponds created for water treatment generally offer little habitat function because they are isolated from other habitats that are suitable for wildlife.

Water Quality

Most stock ponds contain nutrient rich water that is high in suspended sediment and bacteria. While cattle trampling and consumption of wetland vegetation can reduce filtering and nutrient cycling functions in these ponds, the ponds continue to function as sediment traps, reducing the impact of rapidly eroding areas on downstream creeks.

Hydrologic Cycling

Groundwater infiltration varies in PNEM and PAB/UB WoUS in the study area. Where soil is protected from compaction by good grazing management, PNEM and PAB/UB WoUS soils remain uncompacted, allowing for a high rate of groundwater infiltration. In some areas, heavy trampling by cattle may lead to compaction, reducing the quantity of infiltration to groundwater and absorption in the surrounding area. Thus, compacted soils retain water within the pond for a longer period of time, which serves cattle well. Because these WoUS retain water, they contribute to the hydrologic cycle through evaporation and minor amounts of shallow groundwater recharge. However, these ponds tend to be small and located on clay-rich soils that do not allow much groundwater infiltration or evaporation. Stormwater retention ponds are commonly constructed to allow infiltration to groundwater supplies.

Flood Storage and Conveyance

PAB/UB functioning as cattle ponds tend to be small and shallow, offering little flood storage capacity. Surface flows from storms fill the majority of these ponds but contribute minutely to groundwater recharge and protection from downstream erosion.

On the contrary, the primary function of stormwater retention ponds is to store runoff from surrounding impervious surfaces. Many developed areas of the project are disconnected with a natural stream network. Developers build stormwater retention ponds to capture and store surface runoff to reduce modifications of the natural hydrograph that would otherwise be caused by an increase in impervious surface. This prevents damage to streets and structures and an opportunity to remove contaminants from the water before it is released to downstream areas. Vegetation is commonly encouraged to grow in these ponds to increase filtering functions. Vegetation and the large storage area reduce the velocity of incoming stormwater flows, thus encourage settling of sediment from the water column. To maintain the flood storage capacity of these ponds, accumulated sediment at the pond bottom is removed regularly.

Table 4-1. Wetland Types and Cross-walk with Other Wetland Classifications.

HCP/NCCP classification	Area occupied by type for the project area (acres)	Cowardin *et al.* (1979) classification				Ferren *et al.* 1995 Classification
		System	Subsystem	Class	Modifiers	Hydrogeomorphic (HGM) class
Wetlands						
Permanent or Seasonal (undetermined)	485	Palustrine		persistent emergent	nontidal saturated or seasonally flooded	Valley Bottom depressional wetlands with or without artificial structures (00.0.551) Stream Floodplains, Bottomlands or (00.0.395) Pond Margins
Seasonal	121	Palustrine		persistent emergent	nontidal temporarily or intermittently flooded	Valley Bottom depressional wetlands with or without artificial structures (00.0.551) Stream Floodplains, Bottomlands or (00.0.395) Pond Margins
Alkali	380	Palustrine		persistent emergent	nontidal temporarily or intermittently flooded, alkali soil	Valley Bottom depressional wetlands with or without artificial structures (00.0.551) Stream Floodplains, Bottomlands or (00.0.395) Pond Margins
Aquatic						
Reservoir	1807	Lacustrine	limnetic or littoral	unconsolidated bottom	Impounded	(00.0.154) Lacustrine Montane Reservoirs (00.0.155) Lacustrine River-Valley Reservoirs
Pond	162	Palustrine		nonpersistent emergent/aquatic bed or unconsolidated bottom	excavated or impounded	(00.0.147) Agricultural Ponds, Reservoirs
Slough/channel	213	Riverine	tidal or lower perennial	rock bottom	artificial	(00.0.214) Coastal Plain Stream Channels
Stream	532 total miles	Riverine	intermittent	rock or unconsolidated bottom or		(00.0.212) Foothill/Terrace Stream Channels (00.0.213) Valley Stream Channels
			lower perennial	aquatic bed or rocky shore or		(00.0.212) Foothill/Terrace Stream Channels (00.0.213) Valley Stream Channels
			upper perennial	unconsolidated shore		(00.0.212) Foothill/Terrace Stream Channels

HCP/NCCP classification	Area occupied by type for the project area (acres)	Cowardin *et al.* (1979) classification				Ferren *et al.* 1995 Classification
		System	**Subsystem**	**Class**	**Modifiers**	**Hydrogeomorphic (HGM) class**
Riparian woodland/scrub						
	449 total	Palustrine		forested or scrub/shrub	nontidal saturated or permanently,	(00.0.371) Montane Stream-Banks
					regularly, or seasonally flooded	(00.0.372) Foothill/Terrace Stream-Banks
						(00.0.373) Valley Stream-Banks
Developed						
Aqueduct	26 miles	Riverine			excavated artificial	(00.0.910.0000) Stationary Artificial Structures
Drainage ditches and irrigation canals	158 miles	Riverine			excavated artificial	(00.0.910.0000) Stationary Artificial Structures

Chapter 5
Subbasin Analysis and Results by Geomorphic Region

In this chapter, each major subbasin is described in detail. Subbasin descriptions are organized according to the following four subjects.

- Physical setting.
- Waters of the U.S. types.
- Waters of the U.S. functions.
- Management considerations for WoUS preservation and enhancement.

The physical setting discussions describe geology, soil, climate, hydrology, and land-use conditions to provide context for WoUS occurrence and hydrogeomorphic functioning. The discussions of WoUS types describe the types found in each subbasin. The discussions of WoUS function describe habitat, water quality, and hydrologic functioning of each WoUS type in the subbasin. The discussion of management considerations summarizes the opportunities and constraints for wetland protection, enhancement, or restoration. This chapter discusses WoUS types and functions on a subbasin level. Table 5-0 shows the approximate size of each subbasin, as well as the amount and number of each WoUS type mapped as being present. A list of each mapped WoUS in the inventory area, classified by Cowardin type and geomorphic class, and ranked according to overall functional value, is presented in Appendix A. Appendix B includes aerial photographs of each mapped WoUS.

5.1 Montane Region

The montane region supports a small portion of the Upper Mount Diablo Creek subbasin and the entire Upper Marsh Creek subbasin.

5.1.1 Upper Mount Diablo Creek

The Upper Mount Diablo Creek subbasin consists of the portion of the Mount Diablo Creek watershed from the headwaters downstream to approximately the northern boundary of the City of Clayton. The portion of the watershed downstream of Clayton is not included in the inventory area. This subbasin covers approximately 8,235 acres, representing approximately 5% of the inventory area. Figure 5-1a shows the location of WoUS types found in the Upper Mount Diablo Creek subbasin.

Physical Setting

Geology

Mount Diablo Creek flows off the northern slopes of Mount Diablo, draining narrow, steep canyons. In the lower portion of the subbasin, the stream transitions to a wider valley, where the City of Clayton is located. Much of the exposed bedrock in the upper portion of the watershed is classified as Oakland conglomerate, which is made up of silicic volcanic rocks and quartz sandstone. An interesting feature of the subbasin's geology is the presence of what appears to be an ancestral drainage, marked by patches of poorly sorted gravel, sand, silt and clay up to 164 feet thick. These formations are sediment sources for the creek downstream. Dense sand and gravel alluvial deposits are located along the channel of Mount Diablo Creek, particularly at the transition zone towards the base of the mountain. Most of the creek channel is occupied by alluvial deposits composed of less-dense sand and gravel.

Soils

The headwaters of the subbasin are located in the rock outcrop-xerorthents association, characterized by steep to very steep areas of rock outcrop and excessively drained, very shallow loamy soils that formed in material weathered from sedimentary rock and basic igneous rock on uplands. This area has low potential to form wide floodplains or offstream wetlands.

The lower portion of the subbasin is located within the Tierra-Antioch-Perkins association, characterized by nearly level to moderately steep, well-drained clays and well-drained loams and clay loams that formed in old alluvium on terraces. The Brentwood-Rincon-Zamora association, which is characterized by nearly level to gently sloping, well-drained clay loams and silty clay loams on valley fill, alluvial fans, and low terraces also occurs in this subbasin. The well-drained soils of this subbasin result in a relatively low potential to form wetlands.

Zamora silty clay loam deposits are found along the Mount Diablo Creek channel for much of its length, with adjoining areas of Perkins gravelly loam and Capay Clay. The creek's tributaries traverse areas of Los Osos clay loam and Lodo clay loam. Patches of Gilroy clay loam and rock outcrop-xerorthents associations comprise soils of the uppermost portions of the subbasin.

Climate

Precipitation in the subbasin averages 18 inches per year. Precipitation decreases from south to north down the mountain from a high of about 22 inches on the slopes of Mount Diablo to about 16 inches at the City of Clayton's northern boundary.

Hydrology and Land Use

Upper Mount Diablo Creek subbasin contains the following tributaries: Mitchell Creek, Deer Flat Creek, Back Creek, Donner Creek, Russellmann Creek, and Irish Creek. Portions of these creeks are spring-fed and perennial. Groundwater flows through fractured bedrock to supply water to these drainages. In addition to groundwater and storm flows from the upper watershed, diverted runoff from streets, houses, and parking lots in the lower urbanized area of the watershed are delivered to lower stream channels.

The upper portion of this subbasin is within Mount Diablo State Park; other upper areas are used for grazing. Upper portions of the subbasin are forested. Riparian forest along the stream channels provides wildlife habitat and shading. Minimal floodplain areas are present.

The lower portion of the subbasin, which constitutes the majority of the subbasin's area, is dominated by urban development. While Mount Diablo Creek remains in a natural channel throughout most of its length, several tributaries have been redirected underground through culverts in the City of Clayton.

Waters of the U.S. Types

WoUS types in the Upper Mount Diablo Creek subbasin include four of the general types described in Chapter 4.

- Riverine nontidal (upper perennial and intermittent streams).
- Palustrine forest (riparian forest).
- Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (golf course ponds and agricultural ponds).
- Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands).

Figure 5-1b shows representative photos of WoUS types commonly found in this subbasin. Table 5-1 summarizes the functions of each WoUS type found in the Upper Mount Diablo Creek subbasin.

Apart from the streams themselves, most other WoUS types in the subbasin are palustrine forest (riparian woodland) and PAB/UB (ponds). Most of the mapped

WoUS in the Upper Mount Diablo Creek subbasin are located in or adjacent to the creeks themselves. Ten WoUS, mostly agricultural ponds, were identified and mapped outside the creek channel and floodplain.

Waters of the U.S. Functions

Habitat

Riverine Nontidal (Upper Perennial Streams)/Palustrine Forest

The perennial stream reaches of the subbasin provide a high level of habitat function. These reaches are principally found near the headwaters of Mount Diablo Creek and its tributaries, where groundwater seeps provide year-round flow. Riparian woodland along upper perennial streams provides habitat for rare plant species such as Diablo helianthella (*Helianthella castanea*) and Mount Diablo fairy lantern (*Calochortus pulchellus*), both of which have been documented along streams in the subbasin (CNDDB 2003). These wetland types may also provide habitat for California red-legged frog (CRF), which has been documented in the subbasin (CNDDB 2003). Pools and riffles in these reaches provide prime habitat for wildlife, particularly juvenile fish species. Palustrine forest serves an important role in the subbasin in maintaining lower water temperatures, which is particularly important because Mount Diablo Creek historically supported a population of Central California Coast steelhead.

Intermittent Streams/Palustrine Forest

Intermittent streams in the subbasin provide variable levels of habitat function. Some intermittent stream reaches are located in Mount Diablo State Park or in grazing land, both of which enable moderate to high levels of habitat function. The stream corridor, which frequently retains riparian woodland in a narrow band along the channel, provides valuable habitat for wildlife in these areas. Rare plant species, such as Diablo helianthella, may be found along these reaches. Other intermittent stream reaches are located in residential areas. These stream reaches in residential areas have lower habitat value, but they may provide a movement corridor for a more diverse suite of species to the 8-mile reach of undeveloped floodplain in the Concord Naval Weapons Station.

Palustrine Aquatic Bed/Unconsolidated Bottom

General comments in Chapter 4 on habitat functions provided by PAB/UB apply to the Mount Diablo Creek subbasin. Seasonal ponds in the subbasin may provide breeding habitat for the California tiger salamander (CTS), which has been documented in the subbasin (CNDDB 2003), and other amphibians.

Palustrine Persistent Emergent (Seasonally or Temporarily Flooded)

All the mapped seasonal wetlands in the subbasin are surrounded by grassland or oak woodland, managed either for grazing or open space, enhancing their habitat function relative to seasonal wetlands in developed areas. No field visits were made to seasonal wetlands in this subbasin because access and budget were limited.

Water Quality

Riverine Nontidal/Palustrine Forest

A steep gradient stream, such as Upper Mount Diablo Creek, functions to supply sediment from upland sources to downstream depositional reaches. Streams of this type commonly form a step pool and riffle sequence. This channel form promotes channel bed scour and sediment transport, as well as increasing dissolved oxygen concentration and recruitment of large woody debris (fallen trees), which forms and stabilizes the pools and riffles. Coarse sediment transport from upstream areas is important to prevent erosion downstream becasue sediment-starved waters may have greater erosivity.

Palustrine Aquatic Bed/Unconsolidated Bottom (Ponds)

Ponds enhance water quality by reducing suspended sediments and removing phosphorus and nitrogen through adsorption to the aluminum and iron in the subbasin's clay soils. Ponds also function as important sources of groundwater recharge. Contaminants that could pollute a groundwater aquifer, such as mine drainage, pesticides, and organic matter, are retained in bottom sediments of ponds.

Palustrine Persistent Emergent (Seasonally or Temporarily Flooded)

Seasonal wetlands adjacent to streams enhance water quality by filtering fine sediments, nutrients, and heavy metals from surface flow entering streams. Isolated seasonal wetlands enhance groundwater quality through the same mechanism by filtering out nutrients and heavy metals that might otherwise enter the groundwater.

Hydrologic Cycling and Flood Storage

Riverine Nontidal

The well-drained alluvial soils of the subbasin allow groundwater recharge, reducing surface runoff and flooding. Flood storage and groundwater recharge would naturally be concentrated at the transition zone from steep to gentle gradients and in the lowland areas of the watershed. While Mount Diablo Creek and a narrow buffer have been conserved in most of the subbasin, much of the transition zone and lowland areas have been developed for residential and industrial use, which has reduced groundwater recharge and flood storage in this area. Partly to cope with the increased flooding that could result, several tributaries of Mount Diablo Creek have been routed underground to prevent damage to developed areas.

Palustrine Aquatic Bed/Unconsolidated Bottom

These WoUS types provide flood storage by collecting surface runoff and slowly releasing it into the groundwater, streams, and the atmosphere. Because most of the subbasin's ponds are in the higher elevation area of the subbasin, they collect surface runoff from a smaller area and provide less flood storage.

Palustrine Persistent Emergent (Seasonally Flooded)
The general discussion in Chapter 4 describing PPEM functions applies to PPEM wetlands present in this subbasin.

Management Considerations for WoUS Conservation and Enhancement

WoUS in the upper portion of this subbasin currently provide a high level of habitat function because of the presence of well-developed riparian woodland vegetation. Habitat, water quality, and hydrologic functioning of the lower portion of the watershed are constrained by development. Table 5-1 summarizes the overall quality of WoUS types.

Without large and impractical changes in land use, little potential exists to increase habitat, water quality, and hydrologic functioning in this subbasin. Residential development has encroached into the mountain transition zone, where steep gradients transition into gently sloping lowlands. This transition zone and gradient break is important for groundwater recharge because surface waters from higher elevations will flow subsurface to the underlying aquifer.

Some increase in WoUS function could result from the restoration of riparian woodland to intermittent stream reaches in the upper portion of the subbasin. The restoration of woodland vegetation to these reaches would result in better cover, increased food sources, and more complex structures for wildlife. Woodland vegetation would also reduce fine sediments in the creek and water temperature, thus improving habitat conditions for fish.

Restoring and enhancing emergent marsh vegetation surrounding ponds and streams would also improve habitat and water quality in this subbasin. Once vegetation regenerated, it would trap sediment, nutrients, and minerals, thus improving water quality downstream.

5.1.2 Upper Marsh Creek

Physical Setting

This subbasin covers approximately 28,375 acres, representing approximately 16% of the inventory area. Figure 5-2a shows the location of WoUS types found in the Upper Marsh Creek subbasin.

Geology

Like Upper Mount Diablo Creek, Upper Marsh Creek flows off the steep slopes of Mount Diablo. The subbasin can be divided into three geomorphic regions:

montane (44% of stream miles), foothills/upper valley (52%), and lower valley/plain regions (4%). Upper Marsh Creek is classified as a montane subbasin because its high percentage of montane area is unusual for the subbasins in the inventory.

Closest to their headwaters, Marsh Creek and many of its tributaries are confined to steep, bedrock canyons. The creek then enters a narrow valley bottom that cuts across several ranges of foothills before opening out into a wide valley. Marsh Creek flows through this valley to the Marsh Creek reservoir.

The Upper Marsh Creek subbasin comprises early and late Cretaceous sandstone and shale. The upper tributaries cut through cobble conglomerate overlaying conglomeratic sandstone and white rhyolite tuff. Bands of medium- to coarse-grained sandstones and shales are encountered throughout the basin. The creek channel cuts through these bedrock formations; thus large cobbles and boulders are transported throughout the upper basin.

Soils

Upper Marsh Creek, upstream from the confluence with Curry Canyon Creek and including Curry Canyon Creek, is overlain by soils of the Dibble series. These consist of shallow, well-drained silty clay loam soils interbedded with soft shale and sandstone. Exposed bedrock outcroppings are found along high-elevation ridgetops. The mid portion of this basin is located in the Los Osos-Millsholm-Los Gatos association, characterized by moderately steep to very steep, well-drained clay loams and loams that formed in material weathered from interbedded sedimentary rock on uplands. Soils of the lower reach of Upper Marsh Creek, from approximately 1.5 miles west of Deer Valley Road to the Marsh Creek Reservoir, are Brentwood clay loam. These soils are moderately alkaline, and well drained. The lowermost tributary, Round Valley Creek, flows through Altamont-Fontana silty clay loam and Cropley clay in its upper reaches and Los Osos clay loam in its lower reaches. These lower subbasin soils have slow infiltration rates and high runoff. Though the slopes in the area with Cropley clay are shallow, 2 to 5%, surface waters may runoff too quickly and in volumes too small for wetlands to form.

Climate

Average annual rainfall for the entire Marsh Creek watershed is approximately 17 inches. Rainfall decreases rapidly from west to east across the upper subbasin, from a high of approximately 25 inches at the headwaters to a low of approximately 14 inches at Marsh Creek Reservoir.

Hydrology and Land Use

Upper Marsh Creek drains the foothills to the southeast of Mount Diablo. The main channel runs in a narrow valley that widens as the creek turns to flow southeast. The Upper Marsh Creek subbasin includes the following large tributaries: Curry Canyon, Sycamore, and Round Valley. Portions of these tributaries, as well as parts of Marsh Creek itself, have valley foothill characteristics—wide functioning floodplain areas conveying upland flow and sediment in a narrow meandering channel. Steep topography in the upper canyon reaches lead to increased erosion of bedrock materials. Due to the steep topography, natural wetlands are lacking in the upper montane area. WoUS in this area consist of the stream channels themselves and stock watering ponds. Most reaches of Upper Marsh Creek are perennial, changing to seasonal downstream. The streambed contains small boulders and large cobbles. The channel carries high flows through narrow valleys that widen further downstream. As the topography flattens, flow gradients become gentler, the channel widens, and fine-grained sediments and gravels dominate the streambed. Increased grazing activities add nutrients, which encourages algae growth in slow moving waters and ponded areas.

Little development has occurred in this subbasin. Portions within Cowell Ranch State Park and land under EBRPD management are protected open space. Land use in this subbasin consists of grazing, residential, and recreational park use.

Waters of the U.S. Types

WoUS types in Upper Marsh Creek can be subdivided into the following five categories described in Chapter 4.

- Riverine nontidal (upper perennial, lower perennial, and intermittent stream).
- Palustrine forest/scrub.
- PAB/UB.
- Impounded lacustrine (Marsh Creek Reservoir).
- PPEM (perennially, seasonally, and temporarily flooded).

Figure 5-2b shows representative photos of WoUS types commonly found in this subbasin. Table 5-2 summarizes the functions of each WoUS type found in the Upper Marsh Creek subbasin.

Apart from the streams themselves, the majority of the WoUS types in the subbasin consist of palustrine forest (riparian woodland). Ponds and the Marsh Creek Reservoir make up most of the remaining WoUS types. The majority of the mapped WoUS in the Upper Marsh Creek subbasin are located in or adjacent to the creeks themselves. Approximately one third of the WoUS in the subbasin are off-channel WoUS, or are found outside the creek channels. These WoUS are mostly agricultural ponds, although there are a number of PPEM wetlands off the streams in this subbasin as well.

Waters of the U.S. Functions

Habitat

Riverine Nontidal (Upper Perennial)/Palustrine Forest

The perennial stream reaches of the subbasin provide a high level of habitat function. These reaches are principally found near the headwaters of Marsh Creek and its tributaries, where groundwater seeps maintain water in some pool and stream reaches year-round. Riparian forest and woodland lines the stream corridor, and in some places marshes or seasonal wetlands are found in the adjacent floodplain. Variation in the form of bedrock in the stream channels results in a diverse stream profile with deep pools and shallow riffles that provide a variety of habitat types.

This portion of the subbasin provides habitat for rare, threatened, and endangered wildlife species such as CRF and Western pond turtle (WPT) (CNDDB 2003). The combination of perennial pools and stream reaches for breeding with woodland and forest vegetation in adjacent areas provides good habitat for CRF. The intact riparian vegetation and open space adjoining the channels in these reaches provide foraging and breeding habitat for WPT. Sandy point bars provide basking habitat for WPT.

Riverine Nontidal (Lower Perennial)/Palustrine Forest

The lower perennial stream reaches in the subbasin provide a variable level of habitat functioning. Upstream of the point where Marsh Creek enters a broad valley and flows southeast (approximately 1.5 miles upstream of Deer Valley Road), the creek flows through a landscape with extensive riparian woodland and forest. Downstream, Marsh Creek enters a wide valley managed intensively for agriculture, primarily grazing. Although the creek maintains a corridor of riparian woodland vegetation, the surrounding land use is less suitable for some wildlife species than it is upstream. Occurrences of WPT and CRF have been documented throughout the lower perennial reaches of this subbasin (CNDDB 2003).

Riverine Nontidal (Intermittent)/Palustrine Forest

The intermittent streams in the subbasin provide high levels of habitat function. Most intermittent stream reaches are located in Cowell Ranch State Park, EBRPD lands, or in privately held woodland and forest, land uses which provide moderate to high levels of habitat function. The stream corridor retains riparian woodland and forest along the channel and provides valuable habitat for wildlife in these areas. Ephemeral stream reaches adjacent to natural vegetation may provide habitat for CTS. Occurrences of CTS have been documented in and adjacent to the intermittent stream reaches of the subbasin (CNDDB 2003).

Palustrine Aquatic Bed/Unconsolidated Bottom and Lacustrine Impounded

Seasonal ponds in the subbasin adjacent to grasslands may provide breeding habitat for the CTS and other amphibians. CTS have been documented in the subbasin. A band of woodland vegetation surrounds the Marsh Creek Reservoir. WPT has been documented in the reservoir (CNDDB 2003).

Palustrine Persistent Emergent (Perennially to Seasonally Flooded)

Perennial wetlands in the subbasin provide a variable level of habitat function. Intact freshwater marsh vegetation adjacent to grassland, woodland, and riparian forest provide access to a variety of habitats for foraging, breeding, movement, and aestivation for a diverse suite of wildlife. In some parts of the subbasin, marsh vegetation is found in and adjacent to the creek channel, but the surrounding floodplain is heavily grazed. Perennial wetlands in the subbasin may provide habitat for CRF and WPT.

Palustrine Persistent Emergent (Seasonally Flooded)

Seasonal wetlands in the subbasin provide a variable level of habitat function depending on their management and the surrounding land use. Some seasonal wetlands in the subbasin are relatively undisturbed, while others may be heavily grazed or mowed. While vernal pools were not mapped for this study, they are likely to be present in the subbasin, providing habitat for some rare, threatened, and endangered species.

Because seasonal wetlands in the subbasin are adjacent to natural grasslands and woodlands, they provide suitable habitat for CTS, which has been documented in the subbasin (CNDDB 2003).

Water Quality

Water quality of Marsh Creek is impaired by mercury contamination, originating primarily from the historic Mount Diablo Quicksilver Mine. The historic mine is drained by Dunn Creek, a tributary which joins Marsh Creek approximately 2 miles from the headwaters of Marsh Creek. Mercury-contaminated waters and sediments from the upper watershed mine site are distributed throughout the length of the downstream system.

Riverine Nontidal/Palustrine Forest

Water quality functioning is variable in the upper perennial stream in the subbasin. Some upper perennial reaches have steep gradients that generate sediment for delivery downstream. Other reaches have gentler gradients and contain a fringe of marsh vegetation that slows and filters water flow. Riparian woodland and forest along these reaches maintain cooler water temperatures.

The low stream gradient found in vegetated perennial reaches of the subbasin, combined with high clay content in the Brentwood soils, facilitate filtration of nutrients, heavy metals, and sediment.

Palustrine Aquatic Bed/Unconsolidated Bottom (Ponds and Reservoir)

Ponds and the reservoir have variable levels of water quality functioning. The stock ponds and reservoir in the subbasin enhance ground and surface water quality by reducing suspended sediments and removing phosphorus and nitrogen through adsorption of nutrients, trapping sediments and heavy metals (notably mercury) carried by the sediments. This function is at a higher level in the eastern portion of the subbasin where Brentwood soils with higher clay content are found.

Palustrine Persistent Emergent (Perennially to Seasonally Flooded)

Marshes in this subbasin filter nutrients, sediments, and heavy metals from surface water. Vegetation growing in these wetlands immobilizes heavy metals and other contaminants within the plants themselves and in the sediment. Perennial wetlands with well-developed marsh vegetation provide this function at a higher level than perennial wetlands where vegetation is severely impacted by grazing or other land uses. Perennial wetlands in and adjacent to streams are generally protected from grazing in this subbasin, while grazing has degraded isolated off-channel wetlands. The presence and continued functioning of these wetlands improve water quality.

Palustrine Persistent Emergent (Seasonally Flooded)

Seasonal wetlands in the subbasin adjacent to streams enhance water quality in streams by filtering fine sediments, nutrients, and heavy metals from surface flow entering streams. Isolated seasonal wetlands enhance surface water quality through the same mechanism by filtering out nutrients and heavy metals that might otherwise enter the groundwater. As is the case with perennial wetlands, seasonal wetlands provide a higher level of habitat function when they are located in Brentwood soils with high clay content and when they have well-developed vegetation (generally when they are adjacent to streams or in protected open space).

Hydrologic Cycling and Flood Storage

Riverine Nontidal (Upper Perennial)/Palustrine Forest

Headwater steep channel reaches with shallow soils do not provide significant flood storage or groundwater recharge. These reaches contribute to hydrologic cycling through cold water input from springs and sediment transport to downstream reaches.

Riverine Nontidal (Lower Perennial)/Palustrine Forest

Lower perennial streams have a high capacity to store floodwater and facilitate groundwater recharge due to their location in the subbasin. These streams lie in valleys at transitional zones in the topography between steep and gentle sloping gradients. Because of the gradient brakes, groundwater contributes to these streams during the late spring and early summer months. The Zamora and Brentwood soils found along these reaches have good water retention properties. The presence of a broad channel with a developed flood plain, supporting marsh and woodland vegetation, provides flood storage and some groundwater recharge.

Riverine Nontidal (Intermittent)/Palustrine Forest

Intermittent streams in the subbasin provide a variable level of hydrologic functioning. Some intermittent stream reaches in the subbasin, such as parts of Perkins and Curry Creeks, have steep gradients and thin soils. These reaches transport pulses of sediment and nutrients downstream during storm events. Intermittent stream reaches with gentler gradients and deeper soils, such as those found in Round Valley Creek, have wide channels that provide flood storage and groundwater recharge.

Palustrine Aquatic Bed/Unconsolidated Bottom (Ponds and Reservoir)

Ponds and the Marsh Creek Reservoir provide flood storage and groundwater recharge functions. They also serve as sediment traps, which is particularly important for improving water quality through the removal of mercury-contaminated sediments from the system.

Palustrine Persistent Emergent (Perennial and Seasonal Wetlands)

Perennial and seasonal wetlands in the subbasin provide variable levels of flood storage and groundwater recharge, depending on the degree to which natural vegetation has been removed by grazing.

Management Considerations for WoUS Conservation and Enhancement

Much of the WoUS in the subbasin provide high-level habitat functioning. The gradients and channel forms in the upper subbasin are functioning at the level expected based on the steep morphology of the region. The upper portion of the subbasin provides an important source for channel sediment and downstream water supply. This area should be monitored to ensure that a balance of sediment and flow quantity and velocity is maintained, in order to prevent negative downstream impacts. Table 5-2 summarizes the overall quality of WoUS types.

Mercury contamination from the historic Mt Diablo Quicksilver Mine on Dunn Creek continues to impair water quality. This contamination will continue to degrade water quality because of the complexity of remediating the mine.

Restoring woodland and emergent marsh vegetation in and adjacent to WoUS in the lower portion of the subbasin (valley-plain region) could increase wildlife habitat, water quality, and hydrologic functioning. One element in the restoration could involve a change in existing grazing regimes in the small portion of the subbasin downstream of where Marsh Creek enters a broad valley (about 1.5 miles upstream of Deer Valley Road). Restored woodland vegetation would provide better cover, increased food sources, and more complex structures for wildlife. Woodland vegetation would also reduce fine sediments in the creek and water temperature, thus improving habitat conditions for fish. Increased emergent marsh vegetation surrounding ponds and streams would also improve habitat and water quality in the lower portion of the subbasin.

5.2 Foothills/Upper Valley Region

The Foothills/Upper Valley region supports Willow Creek, Kirker Creek, West Antioch Creek, Deer Creek, Briones Creek, Sand Creek, Dry Creek, Brushy Creek, and Kellogg Creek.

5.2.1 Willow Creek

Physical Setting

This subbasin covers approximately 11,370 acres, representing approximately 7% of the inventory area. Figure 5-3a shows the location of WoUS found in the Willow Creek subbasin.

Geology

The Willow Creek subbasin drains a low range of foothills to the northeast of Mount Diablo. In its headwater areas to the south, the subbasin is largely underlain by sandstones and siltstones of the Markley Formation (Eocene) and the non-marine similar sediments of the Tulare Formation (Pliocene). These sandstone and siltstone materials of the upper basin are the sediment sources for the streams and alluvial deposits of the lower basin. Descending north down the subbasin towards its lower lands, areas are underlain by Pleistocene alluvial fan deposits, which then transition to Holocene bay mud deposits closer to San Pablo Bay, where tidal marsh and seasonal wetlands are found. Within the alluvial fan deposits of the lowland bay fringe area are a sequence of older Pleistocene and younger Holocene fan deposits. The active stream channel cuts through these older Quaternary deposits and locally supports its own sediments and floodplain of poorly to well-sorted sand, silt, or sandy gravels.

Soils

Willow Creek and unnamed streams in the subbasin exhibit varied deposits of clay and clay loam complexes of the Altamont, Antioch, and Diablo formations. Altamont and Fontana clay and shale are found at higher elevations, while Diablo clays are found mid-slope. The Altamont and Diablo series are well-drained and underlain by shale and sandstone. The flatlands comprise Antioch clay, clay loam, and loam, which is moderately well-drained and underlain by old alluvium. The potential for wetland formation is higher in the Fontana and Antioch series because of low permeability characteristics.

Climate

Average annual rainfall in the Willow Creek subbasin is 14 inches. The subbasin follows the regional pattern of precipitation decreasing as a result of the rain shadow of Mount Diablo. In the case of Willow Creek and neighboring subbasins to the north of Mount Diablo, there is only a small decrease in rainfall from the south to the north. The southern end of the subbasin averages approximately 15.25 inches of rain per year, while the northern end receives approximately 13.75 inches. The great majority of this rainfall comes in the late fall, winter, and early spring. The long dry season contributes to the absence of perennial streams in the subbasin. However, tidal marsh (PPEM) wetlands in the lower portion of the subbasin persist throughout the year because of the high groundwater levels close to the Bay.

Hydrology and Land Use

The Willow Creek subbasin contains many small streams, the largest of which is Willow Creek. All drainages in this subbasin are ephemeral and flow from south to north draining to San Pablo Bay during winter storm events. In addition to storm flows collected in the grassland areas of the upper watershed, these drainages also receive diverted runoff from streets, houses, and parking lots in the lower urbanized areas.

Upper Willow Creek is characterized by riparian forest (palustrine forest) vegetation, which provides wildlife habitat and shading. Minimal floodplain areas are present.

The majority of this subbasin is overlain by urban development. As such, large reaches of these creeks have been redirected underground through culverts. The upper portions of the subbasin are primarily used for grazing. Most of the upper unnamed streams within the subbasin to the west of Willow Creek have been modified and diverted by residential developments.

Waters of the U.S. Types

WoUS in the Willow Creek subbasin include six of the general types described in Chapter 4.

- Riverine tidal (intermittent streams).
- Riverine nontidal (intermittent streams).
- Palustrine forest.
- PAB/UB (golf course, agricultural, and industrial ponds).
- PPEM (stormwater detention basins/treatment marsh wetlands, tidal marsh, and seasonal wetlands).

- Riverine Excavated Artificial (Contra Costa Canal).

Apart from the aqueduct and canal, PPEM wetlands consisting of tidal marsh and seasonally flooded wetlands comprise the majority of the WoUS area in the subbasin. Palustrine forest (riparian woodland) is also relatively abundant in the subbasin.

Figure 5-3b shows representative photos of WoUS commonly found in this subbasin. Table 5-3 summarizes the functions of each WoUS type found in the Willow Creek subbasin.

Waters of the U.S. Functions

Habitat

Riverine Tidal and Nontidal/Palustrine Forest

Palustrine forest and adjacent grasslands in the foothills region of the subbasin provide habitat for a variety of species. CTS and CRF have been documented adjacent to streams in the subbasin (CNDDB 2003).

Palustrine Aquatic Bed/Unconsolidated Bottom

The subbasin's ponds generally lack vegetation, which reduces their habitat function. Seasonal ponds in the subbasin may provide habitat for CTS and other amphibians.

Palustrine Persistent Emergent (Tidal Perennially Flooded)

Tidal marsh in this subbasin is generally surrounded by development, reducing its habitat value for many species. However, the tidal marsh may provide secondary habitat for the many tidal marsh species that occur adjacent to the Delta itself. Note that tidal marshes adjacent to the Delta are located outside the study area.

Palustrine Persistent Emergent (Seasonally or Temporarily Flooded)

Seasonal wetlands in the foothills region of the subbasin are surrounded by grasslands. They may therefore provide habitat for CTS, which has been documented there (CNDDB 2003), as well as for other amphibians.

Palustrine Aquatic Bed/Unconsolidated Bottom and Palustrine Persistent Emergent (Stormwater Detention Basins/Treatment Wetlands)

Treatment wetlands contain marsh vegetation but are surrounded by development and are often small. They provide habitat for some waterfowl and other species tolerant of human disturbance.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Water Quality

Riverine Tidal and Nontidal/Palustrine Forest

Some of the downstream reaches of the subbasin's drainages contain marsh vegetation within their channels, although most of the subbasin's reaches lack marsh vegetation. Presence of riparian woodland or riparian forest vegetation along stream banks improves water quality by reducing flow velocity and trapping sediment and debris from entering the channel.

Palustrine Aquatic Bed/Unconsolidated Bottom

Ponds in Willow Creek generally lack vegetation, so water quality is not improved by filtration mechanisms provided by vegetation. The abundance of clay soils in Willow Creek assists in the removal of nutrients and metals, which bond to clay particles.

Palustrine Persistent Emergent (Tidal Perennially Flooded)

The general discussion on the previous page of water quality functioning of perennially flooded wetlands applies to this subbasin. Dense, tall stands of vegetation are found in tidal marshes, improving filtration of sediment and pollutants.

Palustrine Persistent Emergent (Seasonally or Temporarily Flooded)

Water quality function of seasonal wetlands is variable depending on the type and density of vegetation growing within the wetland. Seasonal wetlands are found in the downstream reaches of the Willow Creek subbasin. Most seasonal wetlands low in the watershed contain low-growing, relatively sparse ruderal species such as bristly ox-tongue (*Picris echioides*) and Italian wild rye (*Lolium multiflorum*). These species improve water quality through uptake and storage of nutrients and heavy metals within their plant and root structure. In upper reaches of the subbasin, denser stands of native vegetation, including common spikerush (*Eleocharis macrostachya*) and rushes (*Juncus* spp.), are found in seasonal wetlands. Dense, tall vegetation in the upstream reaches of the subbasin filter sediment and nutrients from flowing surface waters.

Palustrine Aquatic Bed/Unconsolidated Bottom and Palustrine Persistent Emergent (Stormwater Detention Basins/Treatment Wetlands)

The general discussion of water quality functioning by treatment wetlands in Chapter 4 applies to this type of wetland in the Willow Creek subbasin.

Riverine Excavated Artificial

No water quality function exists for this water feature in this subbasin.

Hydrologic Cycling and Flood Storage

Riverine Tidal and Nontidal (Intermittent)/Palustrine Forest

These WoUS generally provide a low level of flood storage and groundwater recharge. In the foothills region of the Willow Creek subbasin, steep gradients contribute sediment to the watershed. Groundwater infiltration and recharge occurs at the transition zone between steep and gentle gradients. In the valley and plain region of the lower subbasin, most stream reaches have been culverted to avoid flooding developed areas. The easternmost tributary of Willow Creek is located in a utility corridor that averages 0.2 miles wide. This tributary provides a moderate level of flood storage and groundwater recharge. The westernmost drainages in the subbasin are located in open space within the U.S. Naval Weapons Station at Port Chicago. These stream reaches provide a moderate level of flood storage and groundwater recharge.

Palustrine Aquatic Bed/Unconsolidated Bottom

Many of the ponds in this subbasin are detention basins in developed areas. These ponds are designed to detain and retain flows and often can recharge groundwater.

Palustrine Persistent Emergent (Tidal and Nontidal Perennially Flooded)

This wetland type provides a high to moderate level of flood storage and groundwater recharge in the subbasin. Vegetation is generally dense in these wetlands, slowing water flow and enhancing storage and infiltration.

Palustrine Persistent Emergent (Seasonally to Temporarily Flooded)

Flood storage and groundwater recharge function in these wetland types depends on vegetation type and condition. Mowed, low vegetation, found in seasonal wetlands along the easternmost tributary of Willow Creek, does not slow water flows or enhance infiltration as efficiently as dense, unmowed vegetation found in some seasonal wetlands in the foothills.

Riverine Excavated Artificial

No flood storage or groundwater recharge function exists for these WoUS in this subbasin.

Management Considerations for WoUS Conservation and Enhancement

Many of the wetlands in the Willow Creek subbasin are adjacent to developed areas, providing limited opportunities for enhancement of wetlands functioning. Two of Willow Creek's three tributaries, and four of the six drainages west of Willow Creek lie almost completely within developed areas. However, there are opportunities to improve the functioning of subbasin wetlands. Table 5-3 summarizes the overall quality of wetland types and opportunities for preservation and restoration.

Restoring and enhancing riparian vegetation, particularly in the understory of palustrine forest, in the upper foothills portion of the subbasin would increase habitat and water quality functioning. Regulating livestock access to some stream reaches may play a role in this restoration.

Habitat and water quality functions in the upper portion of the subbasin would also be enhanced by correcting problems with poorly installed culverts, which would allow riparian vegetation to establish on portions of the bank that are currently bare. This would reduce fine sediment in the channels downstream.

Altering land use and management in the middle and lower subbasin would improve habitat and water quality functioning. Day-lighting creeks by removing culverts and adjacent impervious surfaces would allow for development of a vegetated floodplain that would function as flood storage and improve water quality and groundwater recharge. In addition, reducing mowing frequency to allow dense growth of vegetation in the seasonal wetlands along the easternmost tributary of Willow Creek would enhance water quality functioning as well as flood storage and groundwater recharge in the lower portion of the subbasin. Urban creeks are often plagued by large amounts of trash, as is the case with neighboring Kirker Creek. Preventing illegal dumping and removing trash would further enhance water quality in the subbasin.

5.2.2 Kirker Creek

Physical Setting

This subbasin covers approximately 9,500 acres, representing approximately 5% of the inventory area. Figure 5-4a shows the location of WoUS found in the Kirker Creek subbasin.

Geology

Much like the Willow Creek subbasin, the headwater areas of the Kirker Creek basin are underlain by sandstones and siltstones of the Markley formation (Eocene). Descending north down the subbasin towards its lower lands, areas are underlain by Pleistocene alluvial fan deposits, which then transition to Holocene bay mud deposits closer to San Pablo Bay, where tidal marsh and seasonal wetlands are found. Within the alluvial fan deposits of the lowland bay fringe area are a sequence of older Pleistocene and younger Holocene fan deposits (near Highway 4) upstream of the point at which the creek is constrained in an earthen channel parallel to the railroad tracks.

Soils

The Kirker Creek subbasin is largely dominated by clay loam soils. Wetland habitat tends to occur in the Pescadero, Rincon, Brentwood, and Capay complexes due to their low permeability. Low elevation areas are dominated by the Rincon clay and silty clay loam formation, while upland areas have soils from the Altamont series. Areas of the Diablo series can be found along stream networks within the Altamont series. The Diablo series exhibits low permeability as well, and wetland habitats can be found in outcroppings of this soil type.

Climate

Average annual rainfall in the Kirker Creek subbasin is 16 inches. The subbasin follows the regional pattern of precipitation decreasing as a result of the rain shadow of Mount Diablo. In the case of Kirker Creek and neighboring subbasins to the north of Mount Diablo, there is only a small decrease in rainfall from the south to the north. The southern end of the subbasin averages approximately 18.75 inches of rain per year, and the northern end receives approximately 12.75 inches. The great majority of this rainfall comes in the late fall, winter, and early spring. The long dry season contributes to the scarcity of perennial stream reaches in the subbasin. Tidal marsh (PPEM) wetlands in the lower portion of the subbasin persist throughout the year due to the high groundwater levels close to the Bay. However, these tidal marshes, located within the Dow wetlands preserve, do not fall within the study area.

Hydrology and Land Use

Kirker Creek originates in Black Diamond Mines Regional Preserve, on the northeastern side of the subbasin. The Kirker Creek subbasin covers approximately 10,000 acres. Topography in the subbasin climbs from sea level at San Pablo Bay to 1,900 feet at the Kirker Hills watershed divide. The western side of the watershed contributes flow to one of the unnamed tributaries that can be seen from Kirker Pass Road. The western tributary joins Kirker Creek below the intersection of Nortonville and Kirker Pass Roads. The lower watershed appears to be bounded by Railroad Avenue and Somersville Road. (See Figures 1-1 and 1-2.) Adjacent watersheds are Markley Creek to the east and Willow Creek to the west. (Willow Creek is the area north of Highway 4, and Lawlor Ravine is defined south of Highway 4. The larger watershed assemblage is called Willow Creek.) As with many urban creeks, the channel of Kirker Creek has been altered. While most of the channel is open, culverts divert the creek underground at road crossings and along a few segments near the Pittsburg-Antioch Highway.

Kirker Creek is mostly ephemeral, flowing from November through April, although some of the lower reaches of the creek are perennial due to artificial inputs such as irrigation return water and urban runoff. The lower reaches of the creek and its tributaries have been culverted, concreted, and redirected in reaches to accommodate residential and industrial uses. The most drastic alteration occurred in the 1940s, when the creek was diverted away from the property of U.S. Steel (now USS-POSCO), where it once flowed, directly north into New York Slough (Kirker Creek Watershed Planning Group [KCWPG] 2004). Today, the channel turns 90-degrees just north of Highway 4, flows eastward adjacent to the highway, and then flows into the New York Slough through two channels, the Dowest Slough and the Los Medanos Wasteway (KCWPG 2004).

The upper reaches of Kirker Creek support open grasslands with patches of oak-woodlands. The upper channel is deeply incised in some reaches where the creek is restricted by Kirker Pass and Somersville Road. Poorly installed culverts are causing bank erosion in some reaches. Because of the steepness and road restrictions, floodplain features in upper Kirker Creek are minimal.

Land use in this subbasin transitions from protected lands to urban and industrial use. The headwaters of Kirker Creek lie in Black Diamond Mines Regional Park. Most of the upper portion of the subbasin is used for grazing land. The lower Kirker Creek watershed is overlain by residential and industrial developments. As the creek enters the developed valley region, its gradient becomes gentler and is slightly influenced by tidal action.

Waters of the U.S. Types

WoUS in the Kirker Creek subbasin include five of the general types described in Chapter 4.

- Riverine nontidal (lower perennial and intermittent).
- Palustrine forest.
- PAB/UB (agricultural and industrial ponds).
- PPEM (stormwater detention basins/treatment marsh wetlands, perennial, and seasonal wetlands).
- Riverine excavated artificial (Contra Costa Canal).

Apart from the aqueduct, palustrine forest WoUS occupy most of the WoUS acreage in this subbasin, followed by PPEM wetlands.

Figure 5-4b shows representative photos of WoUS commonly found in this subbasin. Table 5-4 summarizes the functions of each WoUS type found in the Kirker Creek subbasin.

Waters of the U.S. Functions

Habitat

Riverine Nontidal (Perennial and Intermittent)/Palustrine Forest

Streams and adjacent riparian woodland provide variable levels of habitat function in this subbasin. In the upper portion of the subbasin, within the foothills geomorphic region, riparian woodland occupies a wider buffer along the creek than it does in the valley portion, and the adjacent land is grassland, which can provide foraging and aestivation habitat. The greater width of the riparian woodland buffer in the foothills region is probably due to lower development pressure in this area. However, understory development and tree regeneration is limited in much of the foothills region, probably because of grazing (KCWPG 2004). Riparian woodland in the subbasin includes species such as valley oak (*Quercus lobata*), black walnut (*Juglans californica* var. *hindsii*), Fremont cottonwood, California buckeye, Oregon ash (*Fraxinus latifolia*), arroyo willow, and red willow (KCWPG 2004). CRF and CTS have been documented along the upper reaches of drainages in this subbasin (CNDDB 2003). In the valley portion of the subbasin, riparian woodland is confined to a narrow corridor with an understory of ruderal vegetation. Adjacent land is developed or landscaped.

Palustrine Aquatic Bed/Unconsolidated Bottom

See general discussion of agricultural ponds in Section 4.7. Seasonal ponds in the subbasin may provide breeding habitat for CTS, which has been documented there (CNDDB 2003), as well as for other amphibians.

Palustrine Persistent Emergent

PPEM wetlands are primarily found in the stream floodplains in the foothills region of the subbasin. Approximately 21 acres of PPEM wetland were identified in this subbasin. Most PPEM wetlands within the subbasin are seasonal, although some artificial PPEM wetlands in the valley portion of the subbasin are perennial due to contributions from artificial water sources. In general, the areas surrounding these wetlands consist of grassland. Therefore, these seasonal wetlands may provide valuable habitat for CTS and other amphibians. In the valley region, developed areas surround these wetlands, reducing habitat functioning.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Water Quality

Kirker Creek suffers from illegal dumping of trash, which can cause bank erosion and release toxic substances into the water from debris such as batteries (KCWPG 2004). Within the Black Diamond Mine Regional Preserve, Kirker Creek is naturally acidic, with typical pH levels of 4 to 5, from historical coal mining in the upper watershed. The San Francisco Regional Water Quality Control Board and East Bay Regional Parks District have determined that rainwater soaking through the coal mining waste piles becomes acidic before it enters Kirker Creek. Downstream of the park boundaries, the creek’s water rapidly becomes neutral, presumably because of the neutralizing effects of soil and vegetation (KCWPG 2004).

Riverine Nontidal (Perennial and Intermittent)/Palustrine Forest

In the foothills portion of the subbasin, water flows rapidly because of steep gradients, preventing substantial filtration or settling out of sediments, nutrients and other pollutants. In the valley portion, a restricted floodplain limits the amount of filtration the creek can provide.

Palustrine Aquatic Bed/Unconsolidated Bottom

The majority of agricultural ponds in this subbasin lack vegetation, thus contributing little to water quality improvement.

Palustrine Persistent Emergent

Several large PPEM wetlands in the foothills region of the watershed enhance water quality by filtration of sediment and contaminants. Vegetated detention basins in the valley region, such as the one located at Los Medanos College, function at a high level to enhance water quality through filtration.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Hydrologic Cycling and Flood Storage

Riverine Nontidal (Perennial and Intermittent)/Palustrine Forest

WoUS in Kirker Creek function at a low to moderate level for flood storage and groundwater recharge. In the foothills region, steep gradients supply water and sediment to the creek. In the valley region, the undeveloped floodplain area is narrow and thus provides low flood storage and groundwater recharge functions. Flooding is a recurring problem in the developed portions of this subbasin near Kirker Creek (KCPWG 2004). Riverine wetlands function to store and convey floodwaters downstream while enhancing growth of riparian vegetation from accumulated nutrients.

Palustrine Aquatic Bed/Unconsolidated Bottom

Flood storage is the primary function of detention basins throughout the watershed, particularly in areas that have been covered by impervious surfaces. Agricultural ponds provide little flood storage capacity because they are small and shallow.

Palustrine Persistent Emergent

Large seasonal wetlands in the foothills region of the subbasin function at a moderate level for flood storage because of the presence of riparian vegetation. Vegetated treatment wetlands in the plain region provide a moderate level of flood storage.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Management Considerations for WoUS Conservation and Enhancement

The upper portions of Kirker Creek subbasin provide habitat for a diverse suite of wildlife, because riparian woodland vegetation and adjacent grasslands are present. This portion of the subbasin, located in the foothills region, delivers flows and sediments to the plain region. Development in the plain region has resulted in limited provision of habitat, water quality, and hydrologic functioning. Table 5-4 summarizes the overall quality of wetland types and opportunities for preservation and restoration.

Habitat and water quality functioning in the foothills region of the subbasin could be increased by correcting poorly installed culverts. If these culverts were improved, vegetation would stabilize banks and decrease erosion. Restored sections along Kirker Pass Road could potentially provide a wider riparian corridor, improving flood storage and habitat conditions. Restoration of a riparian woodland understory and enhancement of regeneration by riparian tree species would increase habitat and water quality functioning.

Better management of developed areas in the lower watershed could increase water quality and hydrologic functioning. Culverts in this area are commonly undersized, causing channel erosion and flooding. Prevention of illegal trash dumping and removal of debris in the channel would improve water quality within urban reaches of Kirker Creek (KCWPG 2004). A detention wetland planned on Dowest Slough will also improve flood storage and water quality.

Proper disposal or isolation of coal mining waste piles in the Black Diamond Mine Regional Preserve would benefit water quality and habitat conditions in portions of the subbasin within and adjacent to the park.

5.2.3 West Antioch Creek

Physical Setting

This subbasin covers approximately 8,000 acres, representing approximately 5% of the inventory area. Figure 5-5a shows the location of WoUS found in the West Antioch Creek subbasin.

Geology

Much like the Willow and Kirker Creek subbasins, West Antioch Creek is largely underlain by sandstones, siltsones, and mudstones of the Markley and Tulare formations in its headwaters and then transitions to Quaternary alluvial deposits down basin towards the Bay fringe.

Soils

The West Antioch Creek subbasin is largely dominated by clay loam soils. Wetland habitat tends to occur in Altamont-Fontana and Brentwood complexes due to their low permeability. Low elevation areas are dominated by the Rincon clay and silty clay loam formation, while upland areas have soils from the

Altamont-Fontana series. The majority of wetland habitats are found in the upper subbasin in the Altamont-Fontana series. The upper channel of the easternmost tributary of the subbasin is underlain by the Cropley series. The Cropley series exhibits low permeability as well, and wetland habitats are found in outcroppings of this soil type.

Climate

Average annual rainfall in the West Antioch Creek subbasin is approximately 15 inches. This subbasin receives more rainfall than East Antioch Creek, which receives approximately 13 inches of rainfall on an annual basis. The difference in rainfall is perhaps due to the rain shadow effect of the higher elevation of West Antioch Creek compared to the lower elevation of East Antioch Creek.

Hydrology and Land Use

The West Antioch Creek subbasin covers approximately 8,180 acres and contains several tributaries in the foothills region of the subbasin, including Markley Canyon Creek. The stream network in the foothills region is dendritic. Most stream reaches in this subbasin are ephemeral and flow from south to north draining to San Pablo Bay during winter storm events. In addition to storm flows collected in the grassland areas of the upper watershed, these drainages also receive diverted runoff from streets, houses, and parking lots in the lower urbanized areas. Some of the reaches in the plain region may therefore be perennial. The hydrology of West Antioch Creek has been altered by the creation of the Antioch Reservoir near the transition from the foothills region to the plain region. The Contra Loma Reservoir captures virtually all flows from the tributary immediately to the west of West Antioch Creek.

Land use in the subbasin follows the typical pattern of dense urban development in the plain region of the subbasin and open space in the foothills and montane regions. Streams are routed underground through much of the developed portion of the subbasin. These underground reaches represent 20% of total stream channel length in the subbasin (Contra Costa County 2003). In this subbasin, the foothills and montane regions are almost completely protected open space, located within Contra Loma and Black Diamond Mine Regional Parks. While grasslands within the parks may be grazed, grazing in these areas is not heavy.

Waters of the U.S. Types

WoUS in the West Antioch Creek subbasin include six of the general types described in Chapter 4.

- Riverine nontidal (lower perennial and intermittent).
- Palustrine forest.

- PAB/UB (agricultural and industrial ponds).
- PPEM (stormwater detention basins/treatment marsh wetlands, perennial, and seasonal wetlands).
- Riverine excavated artificial (Contra Costa Canal).
- Impounded lacustrine (Contra Loma and Antioch Reservoirs).

Apart from the reservoirs and the aqueduct, palustrine forest wetlands occupy most of the WoUS acreage in this subbasin, followed by PPEM wetlands.

Figure 5-5b shows representative photos of WoUS commonly found in this subbasin. Table 5-5 summarizes the functions of each WoUS type found in the West Antioch Creek subbasin.

Waters of the U.S. Functions

Habitat

Riverine Nontidal (Lower Perennial)

The lower perennial reaches of West Antioch Creek are surrounded by development. Significant portions of these reaches have been routed underground. Aboveground reaches surrounded by development provide habitat for a limited group of species that can tolerate high levels of disturbance, such as raccoons (*Procyon lotor*), Black Phoebes (*Sayornis nigricans*), and bullfrogs (*Rana catesbeiana*).

Riverine Nontidal (Intermittent)

The portions of West Antioch Creek in the foothills region are largely within protected open space and provide habitat for a diverse group of wildlife species, including CTS and CRF, which have been documented in the subbasin (CNDDB 2003). Some reaches are characterized by palustrine forest vegetation. Palustrine forest provides habitat for riparian plant species, including the rare Diablo Helianthella, which has been documented along Markley Canyon Creek (CNDDB 2003). Other reaches are characterized by grassland vegetation, which may provide habitat for Burrowing Owl (*Athene cunicularia*), a special-status species that has been documented in the subbasin near the Antioch Reservoir.

Palustrine Aquatic Bed/Unconsolidated Bottom

Stock ponds in the foothills region provide habitat for some amphibians, including CTS, which has been documented in the subbasin (CNDDB 2003).

Industrial PAB/UB WoUS in the plain region of the subbasin provide a very low level of habitat function.

Palustrine Persistent Emergent

PPEM wetlands in the foothills region provide habitat for a diverse group of species, including CRF and CTS, which have been documented in the subbasin

(CNDDB 2003). In the plain region, PPEM wetlands are small, isolated, and surrounded by development, providing habitat only for those species that can tolerate high levels of disturbance.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Impounded Lacustrine

The Contra Loma and Antioch Reservoirs are used for recreation but retain woodland and grassland vegetation in the vicinity of their shorelines. San Joaquin kit fox (*Vulpes macrotis mutica*), an endangered species, has been documented near the shoreline of the Contra Loma Reservoir.

Water Quality

Riverine Nontidal (Lower Perennial)

Riverine perennial wetlands in the West Antioch Creek subbasin function modestly to improve water quality. Perennial channels capture and retain contaminants transported in urban runoff from surrounding developments. Accumulation of urban runoff contaminants within the channel bottom can further degrade water quality.

Riverine Nontidal (Intermittent)

Vegetation found in intermittent stream reaches filters sediments and nutrients from stormwater. Intermittent stream reaches occur in the transition zone from grazing and protected parklands to urban and residential areas. Water quality functioning in this transition zone is important to maintain water quality further downstream. Sediments washing down from uplands can be captured by vegetation in the channel. Vegetation will also lower water temperature by shading the channel from the sun.

Palustrine Aquatic Bed/Unconsolidated Bottom

Stock ponds and treatment WoUS found in the subbasin improve water quality by removing sediment and contaminants while cycling nutrients. Treatment wetlands found in the lower subbasin were constructed to filter discharge waters from industrial processing. Vegetation growing in these wetlands immobilizes heavy metals and other contaminants within their plant structure and sediment. This water quality function is important to prevent degradation of the quality of water discharging to the Delta.

Palustrine Persistent Emergent

Vegetated wetlands in upper West Antioch Creek filter sediments carried in surface flows from upland areas. In addition, these wetlands improve water quality by encouraging generation of dissolved oxygen and are an important source for groundwater recharge.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Impounded Lacustrine

The Contra Loma and Antioch Reservoirs capture waters from the upland areas to prevent flooding of the developed area downstream. The Antioch Reservoir captures sediments, nutrients, and perhaps residual pesticides from management of the adjacent golf course. Nutrients and residual contaminants are held within sediments that settle to the reservoir bottom. The capture of sediment within the reservoirs prevents sedimentation of downstream channels and culverts that could increase flooding. Water quality in reservoirs may be degraded by warm water temperature, which encourages algae and bacterial growth. Maintenance of good water quality is imperative because both these reservoirs store drinking water.

Hydrologic Cycling and Flood Storage

Riverine Nontidal (Lower Perennial)

Lower perennial reaches of West Antioch Creek that are naturally lined may contribute to recharge of the underlying groundwater aquifer. These and underground reaches offer little flood storage capacity; however they function to convey floodwaters quickly downstream.

Riverine Nontidal (Intermittent)

Intermittent stream channels in West Antioch Creek provide flood storage in some reaches where they are connected to a floodplain area. Reaches of Markley Canyon Creek are connected to a small area of floodplain. However, the land adjacent to the creek is rapidly being developed for residential housing. Groundwater recharge also occurs from this WoUS type.

Palustrine Aquatic Bed/Unconsolidated Bottom

Stock ponds and treatment WoUS contribute limited groundwater recharge.

Palustrine Persistent Emergent

These wetlands also contribute to hydrologic cycling through groundwater recharge.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Impounded Lacustrine

The main function of these reservoirs is to provide flood storage and protection against flooding downstream.

Management Considerations for WoUS Conservation and Enhancement

Most of the West Antioch Creek subbasin is either managed for conservation and recreation or is developed. Limited improvements in WoUS functioning are possible without major changes in land use. Markley Canyon could expand the area of regularly flooded riparian vegetation along its banks if portions of Somersville Road were moved further west. Habitat downstream of the reservoirs could improve somewhat if releases were managed to imitate natural flow patterns. However, most of the area downstream of the reservoirs is developed, so increases in habitat functioning would be limited. Table 5-5 summarizes the overall quality of wetland types and opportunities for preservation and restoration.

5.2.4 Sand Creek

Physical Setting

This subbasin covers approximately 9,600 acres, representing approximately 6% of the inventory area. Figure 5-6a shows the location of WoUS found in the Sand Creek subbasin.

Geology

Bedrock geology of Sand Creek consists of alternating beds of Meganos Paleocene sandstone, shale, and conglomerate in the upper basin. As the sandstones erode in the main channel, underlying Quarternary Pleistocene and Holocene surficial deposits are exposed, particularly in the reach passing through the city boundary of Antioch. This same bedrock type occupies the majority of the lower portion of the Sand Creek drainage.

Soils

Soils in upper Sand Creek consist of Los Gatos Loam at higher elevations. At lower elevations, a mixture of Altamont Clay-Fontana silty clay loam mingled with patches of Briones loamy sand and various clay loam formations are found. The creek flows through Rincon clay loam soils, which overlie Quarternary sedimentary deposits, within the city limits of Antioch. Soils in the lower reach of Sand Creek are Sycamore silty clay loam. Soils on either side of the lower creek channel are Capay clay. The lower reaches of Sand Creek are likely to be a major source of sediment for lower Marsh Creek (Robins and Cain 2002).

Soils in the majority of the Sand Creek watershed are not very permeable due to their high clay content. These soil types are not very suitable for wetland formation; thus, water features found in the majority of this basin are artificial stock watering ponds. The two lower tributaries to Sand Creek pass through highly alkali soils of the Pescadero clay loam formation, which contains seasonal wetlands along the creek channel. The reach from the border of the Cities of Antioch and Brentwood through the confluence with Marsh Creek cuts through poorly drained soils of the Sycamore series. Soil in this reach is underlain by clay at a depth of 40 to 60 inches. This soil type is favorable for wetland habitat.

Climate

Average annual rainfall in the Sand Creek subbasin varies from approximately 22 inches at its headwaters to approximately 14 inches at its confluence with Marsh Creek.

Hydrology and Land Use

Sand Creek is the lowermost tributary to Marsh Creek and flows in a west-east direction. The majority of the creek flows through relatively flat topography, increasing the sinuosity of the channel. Three small tributaries flow into Sand Creek from the south side of the basin: Oil Canyon Creek in the upper basin and two unnamed drainages in the lower basin. The sandier soil type in the mid basin zone is highly erosive, thus increasing the sinuosity of the channel. Slumps and gullies are common at transition zones in the topography combined with the erosive soils. Channel incision of up to 10 feet was observed near the Deer Valley Road crossing. The Sand Creek subbasin crosses three geomorphic regions: montane, foothills/upper valley, and lower valley/plain.

Water features found in upper Sand Creek tend to be artificial stock watering ponds because the well-drained soils do not support natural wetlands. However, perennial pools have been reported along the creek in the upper portion of the subbasin (Robins and Cain 2002). Limited seasonal wetland areas that retain water for only short periods are found in the creek channel. The wetlands persist longer where the creek, or tributaries, crosses soil boundaries with lower permeability, such as Briones clay loam, or where runoff is received as a constant supply, such as from golf courses. Seasonal wetlands found near the two unnamed tributaries receive surface runoff waters as well as groundwater seeps in some areas.

Sand Creek has been modified to a trapezoidal channel to accommodate agriculture and residential housing from the Highway 4 bypass to its confluence with Marsh Creek. The creek is perennial in most of this reach because of runoff waters from agriculture and residential developments.

Land use in the upper montane region of the subbasin is dominated by grazing. The foothills/upper valley portion of the subbasin includes grazing land, the Roddy Ranch golf course, and portions of Black Diamond Mine Regional Park. The lower valley/plain region contains row crops and residential development.

Waters of the U.S. Types

WoUS in the Sand Creek subbasin include four of the general types described in Chapter 4.

- Riverine nontidal (intermittent and lower perennial).
- Palustrine forest.
- PAB/UB (agricultural and golf course ponds).
- PPEM (perennial treatment, seasonally flooded, and alkali).

PPEM wetlands account for most of the WoUS acreage in the subbasin, with palustrine forest also making up a significant amount of the WoUS acreage. Mapped WoUS in the Sand Creek subbasin are generally located in or adjacent to the creek itself, with the exception of agricultural and golf course ponds. Palustrine forest is found along a single reach of the creek in the lower subbasin. The reaches of Oil Canyon Creek in the montane region are bordered by palustrine forest vegetation as well.

Figure 5-6b shows representative photos of WoUS commonly found in this subbasin. Table 5-6 summarizes the functions of each WoUS type found in the Sand Creek subbasin.

Waters of the U.S. Functions

Habitat

Riverine Nontidal (Intermittent and Lower Perennial) /Palustrine Forest

In the montane region of this subbasin, well-developed palustrine forest vegetation is found along the Oil Canyon creek channel, providing a high level of habitat function. Perennial pools in the creek channel in this region are important habitat features for fish and for amphibians such as CRF, which has been documented in the montane and foothills/upper valley portions of the subbasin (CNDDB 2003). In the foothills/upper valley region, the creek is bordered by ruderal vegetation and appears to suffer from overgrazing. Burrowing Owl, which has been documented in the Deer Creek subbasin to the south (CNDDB 2003), may use the creek banks for nesting in this region.

Palustrine Aquatic Bed/Unconsolidated Bottom (Agricultural and Golf Course Ponds)

Agricultural ponds in the Sand Creek subbasin may provide drinking water, foraging habitat, breeding habitat, and resting habitat for a variety of wildlife. Livestock use of agricultural ponds in the subbasin has led to the loss of emergent vegetation and eutrophication from increased nitrogen due to cattle urine, decreasing their habitat value for wildlife. Seasonal ponds in the subbasin may provide habitat for salamanders such as CTS, which has been documented in the subbasin (CNDDB 2003).

Golf course ponds in the subbasin are landscaped and offer little habitat function because they lack native vegetation and complex vegetative structure.

Palustrine Persistent Emergent (Perennial Treatment, Seasonally Flooded, and Alkali)

Perennial treatment

The treatment wetland associated with the Roddy Ranch golf course has well-developed emergent marsh vegetation. It is dominated by cattails (*Typha* spp.) and surrounded by annual grassland. Although it is small and artificial, it may provide habitat for a diverse group of species.

Seasonal

Seasonal wetlands in the subbasin provide variable levels of habitat function. Several large seasonal wetlands in the lower valley/plain region appear to be regularly mowed to maintain short stature. They are surrounded by agricultural row crops and residential development, reducing their habitat value for species that cannot tolerate frequent disturbance. Seasonal wetlands within Black Diamond Mines Regional Park are likely to have better-developed wetlands vegetation and are surrounded by oak woodland and grassland. These wetlands provide a higher level of habitat function. Seasonal wetlands in heavily grazed portions of the subbasin are unvegetated or dominated by ruderal species. They may also be trampled by cattle, reducing their habitat value for many species. However, these wetlands may still provide habitat for CTS and fairy shrimp, which have been documented in the Briones Creek subbasin to the south (CNDDB 2003).

Alkali

Alkali wetlands along the creek channel in the foothills/upper valley region provide potential habitat for special-status plant species. These wetlands are dominated by saltgrass (*Distichlis spicata*) and rabbitsfoot grass (*Polypogon monspeliensis*). Alkali heath (*Frankenia salina*) and alkali mallow (*Malvella leprosa*) are found in the uplands near these wetlands, indicating the presence of alkaline soils. San Joaquin spearscale (*Atriplex joaquiniana*), a rare alkali plant species, has been documented in the subbasin. While much of this region is grazed, grazing pressure has not removed all vegetation from alkali wetlands.

Water Quality

Riverine Nontidal (Intermittent and Lower Perennial)

Channel water features improve water quality in the upper subbasin through contributions of cold temperature water produced from seeps and tall vegetation shading the channel. Established vegetation prevents channel erosion, and therefore reduces sediment transport downstream. Water quality of the lower perennial reaches of Sand Creek is degraded by agricultural return flow and urban runoff from residential housing.

Palustrine Aquatic Bed/Unconsolidated Bottom (Agricultural ponds)

Agricultural ponds capture nutrients and sediment generated by cattle grazing. These ponds tend to have poor water quality due to high water temperatures and nutrients.

Palustrine Persistent Emergent (Perennial Treatment, Seasonally Flooded, and Alkali)

Vegetation surrounding seasonal and perennial wetlands maintains high water quality functioning. The vegetation protects against erosion and filters sediment from stormwater. Perennial treatment wetlands remove contaminants, such as residual herbicides, from urban runoff.

Hydrologic Cycling and Flood Storage

Riverine Nontidal (Intermittent and Lower Perennial)

The majority of intermittent reaches in Sand Creek allow for flood storage in the valley bottom area because of gentle sloping topography. The lower channel has been modified for flood control and conveyance to protect against damage to developments and farmland.

Palustrine Aquatic Bed/Unconsolidated Bottom (Agricultural ponds)

The majority of agricultural ponds in the subbasin are located at the base of small drainages. Storage of these waters may contribute modest amounts to subsurface groundwater.

Palustrine Persistent Emergent (Perennial Treatment, Seasonally Flooded, and Alkali)

Seasonal wetlands found in Sand Creek function as flood storage during storm events. Storage of water in depressional areas encourages modest contributions to subsurface groundwater and water vapor.

Management Considerations for WoUS Conservation and Enhancement

Regulating livestock access to WoUS in the foothills/upper valley region of the Sand Creek subbasin would increase habitat and water quality functioning by allowing vegetation to return to the creek channel. While the channel may remain highly mobile, and continue to be a sediment source, well-developed vegetation may prevent unwanted levels of sediment downstream. Table 5-6 summarizes the overall quality of wetland types and opportunities for preservation and restoration.

Residential development is being considered in some of the subbasin's remaining open space, which would reduce habitat value and potentially introduce more pollutants into the streams.

A restoration priority for the Sand Creek subbasin would be to enhance the alkali habitat along Deer Valley Road and develop a riparian corridor along the lower channelized reach of Sand Creek east of Highway 4 and south of Sand Creek Road.

5.2.5 Deer Creek

Physical Setting

This subbasin covers approximately 4,000 acres, representing approximately 2% of the inventory area. Figure 5-7a shows the location of WoUS found in the Deer Creek subbasin.

Geology

The geology of the Deer Creek watershed influences the stream network and WoUS distribution within the subbasin. Deer Valley is underlain primarily by sandstones from the Meganos Formation dating from the Paleocene and Late Cretaceous. Siltstone and shale are also found here. Upper Deer Creek's floodplain is composed of relatively dense Pleistocene alluvial fan deposits. As Deer Creek reaches the eastern half of Deer Valley, its floodplain changes, becoming dominated by less dense Holocene alluvial fan deposits made up of sand and sandy gravels. These Holocene alluvial deposits are among the best developed in Contra Costa County. The shift from denser, Pleistocene deposits to Holocene deposits results in a greater tendency of the creek to incise.

The location and orientation of geological faults in the Deer Creek subbasin contributes to an unusual stream network. Rather than a dendritic network, with tributaries entering at acute angles to the mainstem, Deer Creek's four major tributaries enter from the south at nearly right angles to the Creek. This pattern is driven partly by north-south faults traversing the foothills of Mount Diablo. These faults create depressions at right angles to Deer Creek that drain the surrounding hillsides. This structural alignment and drainage pattern are also seen in the Briones, Sand, and Upper Marsh Creek subbasins.

Soils

The soils of the Deer Creek subbasin are primarily clays and clay loams, with the exception of several areas of Briones loamy sand primarily located south of the creek after it leaves Deer Valley and enters the plain region. Los Gatos loams comprise the soils on the foothills to the south of the creek, while Altamont and

Capay clays and Rincon and Pescadero clay-loams are found adjacent to the creek itself. The subbasin's low permeability clay soils provide the potential for wetland formation.

Deer Creek's major tributaries flow exclusively from the south side of the creek. This pattern can be explained by the distribution of soil types in the subbasin. The soil types found in the hills north of Deer Valley contain an area of Briones loamy sand and an area of Altamont Clay-Fontana silty clay loam complex soils, rather than the less permeable Altamont and Rincon clays directly to the south of the creek. The more permeable northern soils allow water from the north side of the valley to infiltrate through the soil and join the creek as shallow subsurface flow through swales, rather than forming well-defined tributaries. In addition, the south-facing slopes on the north side of the valley are less steep than the north-facing slopes across the valley. The gentler, south-facing slopes allow more time for surface water to infiltrate into the soil.

Climate

Deer Creek subbasin follows the regional pattern of precipitation decreasing from west to east as a result of the rain shadow of Mount Diablo. The western end of the subbasin averages approximately 18 inches of rain per year, and the eastern end receives approximately 12.5 inches. The great majority of this rainfall comes in the late fall, winter, and early spring. The long dry season contributes to the absence of perennial streams in the subbasin. Like the streams, many of the depressional wetlands in the subbasin hold water on a seasonal basis and are dry for much of the year.

Hydrology and Land Use

Deer Creek and its tributaries are intermittent or ephemeral streams, with the exception of a perennial reach that begins near the Brentwood Golf Club and continues until its confluence with Marsh Creek. For most of its length, the creek receives little sustained contribution from groundwater during the dry season. Water inputs to Deer Creek and associated WoUS are primarily from precipitation and surface runoff. Compared to Sand Creek to the north and Briones Creek to the south, Deer Creek receives less precipitation because the subbasin does not extend as far west as neighboring subbasins. It is therefore in the more arid zone of Mount Diablo's rain shadow. Irrigation water from agriculture and landscaping makes a significant contribution to lower Deer Creek. The perennial reach of the creek might be intermittent were it not for these artificial contributions.

Deer Creek subbasin has been subject to the effects of overgrazing discussed above for foothill/upper valley subbasins generally. Surface runoff into the stream is more rapid and carries more sediment than it would in a less intensively grazed landscape. Portions of Deer Creek are severely incised, and its streambanks are degraded, unstable, and devoid of vegetation. The clay soils in the Deer Creek channel are a significant source of fine sediments and probably result in increases in turbidity downstream. Deer Creek has less sinuosity than neighboring Briones and Sand Creeks. This may be a result of creek incision, as it is typically associated with reduced sinuosity (Riedel et al. 2002). Deer Creek tributaries appear to be better vegetated and less incised, especially in the upper slopes of the foothills.

Land-use has contributed to the formation of some depressional wetlands in the subbasin. For example, road berms at the intersection of Deer Valley Road and Chadbourne Road help retain road runoff and floodwater from a tributary of Deer Creek. A berm that crosses Deer Creek south of Balfour Road retains water in a small reservoir. A headcut has formed upstream of the point where Deer Creek crosses Deer Valley Road, probably due to the lower elevation of the culverted road crossing. The plunge pool downstream of the headcut is fringed by a PPEM wetland with freshwater marsh vegetation dominated by cattails.

Waters of the U.S. Types

WoUS in the Deer Creek subbasin include four of the general types described in Chapter 4.

- Riverine nontidal (lower perennial and intermittent).
- Lacustrine excavated artificial.
- PAB/UB (golf course and agricultural ponds).
- PPEM (seasonally flooded. depressional with artificial structures, and alkali).

PPEM wetlands account for most of the WoUS acreage in the subbasin. Mapped WoUS in the Deer Creek subbasin are generally located in or adjacent to the creek itself, with the exception of golf course ponds. In addition, three small WoUS that are not located on the creek or its tributaries were mapped in the foothills in the western half of the watershed. It was not possible to access these areas for this study, so these WoUS could not be classified. Nevertheless, their position in the landscape suggests that they are likely seasonal depressional wetlands or swales fed by surface runoff.

Figure 5-7b shows representative photos of WoUS commonly found in this subbasin. Table 5-7 summarizes the functions of each WoUS type found in the Deer Creek subbasin.

Waters of the U.S. Functions

Habitat

Riverine Nontidal (Lower Perennial)

The perennial stream reach of Deer Creek provides only a low level of habitat function. This reach traverses a developed area, and a portion of it has been straightened, channelized, and riprapped. Natural vegetation remains in a small portion of the reach, adjacent to a soccer field/detention basin near Fairview Avenue. There is a barrier to fish passage just upstream of the detention basin, where a cement and rock structure was built to stabilize the elevation drop into the detention basin.

Riverine Nontidal (Intermittent)

Most of the intermittent streams in the Deer Creek subbasin provide only a low level of habitat function. Because vegetation is lacking, there is little cover or structure in the streams to provide habitat for a diversity of wildlife species. The lack of vegetation also contributes to higher water temperature and a greater sediment load, which decreases the value of the streams as fish habitat. However, the unvegetated banks of Deer Creek, together with the adjacent grassland, may provide nesting habitat for Burrowing Owls, a federal species of concern and California species of special concern. Burrowing owls typically occupy burrows excavated by other animals, such as the ground squirrels observed in the subbasin. Burrowing Owl presence in the subbasin is documented in the CNDDB (2003).

Some areas along the banks of Deer Creek retain natural vegetation, such as cattails. These wetlands are classified as stream floodplain palustrine persistent emergent wetland but are treated here together with the streams. One such wetland is found along a short reach of the creek just south of the point at which Deer Creek crosses Deer Valley Road. These wetlands provide habitat for a greater diversity of wildlife than other WoUS in the Deer Creek subbasin, although their small size and lack of connectivity with other habitat limit their function. Although these wetlands are marginal habitat, waterbirds such as Mallards, Great Blue Heron, American Coot, and Great Egret may forage or rest in them. Various amphibians such as western spadefoot, Pacific chorus frog, and western toad may use these wetlands. CRF have been documented nearby in the Sand Creek subbasin (CNDDB 2003). This species may use wetlands in the Deer Creek subbasin for foraging, although none of the seasonal wetlands would provide appropriate breeding habitat.

Lacustrine Excavated Artificial and Palustrine Aquatic Bed/ Unconsolidated Bottom

The reservoir and ponds in the Deer Creek subbasin may provide drinking water, foraging habitat, breeding habitat, and resting habitat for a variety of wildlife. The loss of emergent vegetation and increased nitrogen inputs due to livestock use decrease ponds' habitat value for wildlife. The reservoir and agricultural ponds are dry for part of the year. These seasonal ponds may provide breeding habitat for the CTS and other amphibians. CTS has been documented in Sand

Creek and Briones Creek, adjoining the Deer Creek subbasin. Golf course ponds are mostly landscaped, and offer little habitat function because they lack native vegetation and complex vegetative structure.

Palustrine Persistent Emergent (Seasonal Depressional)

Most seasonal wetlands in the subbasin lack vegetation. Although many of these wetlands are surrounded by grasslands, they provide low habitat value for most species. However, they may provide habitat for two species of rare fairy shrimp (*Branchinecto lynchi* and *Linderiella occidentalis*), which have been documented in the Briones Creek subbasin to the south. CTS may also use these wetlands for breeding.

Palustrine Persistent Emergent (Alkali)

Alkali wetlands in the subbasin also lack vegetation. These wetlands provide potential habitat for rare plant species such as San Joaquin saltbush (*Atriplex joaquiniana*). San Joaquin saltbush has been documented in Briones Creek subbasin and Sand Creek subbasins, which lie adjacent to the Deer Creek subbasin to the north and south. However, it is unlikely that these plant species could use alkali wetlands in the Deer Creek subbasin under the current grazing regime.

Water Quality

Riverine Nontidal (Perennial and Intermittent)

Perennial and intermittent streams trap nutrients in channel sediments and vegetation. The subbasin's streams enhance water quality through the removal of nutrients and metals released from naturally occurring deposits or fertilizers applied to agricultural lands. The ability of streams to filter contaminants is largely a function of the amount and type of vegetation growing in and adjacent to the channel. Many of the streams in Deer Creek contain little or no vegetation, or are dominated by annual grasses of short stature. Therefore, streams in the subbasin provide limited benefits to water quality. However, the subbasin's alluvial clay soils enhance their filtration abilities, because aluminum and iron found in these soils readily bind phosphorus and nitrogen. Once bound to clay soils, the phosphorus and nitrogen are unavailable for biological uptake. While stream channels in this subbasin generally lack well-developed vegetation, there are small patches of PPEM seasonal wetlands adjacent to the streams at several locations. These wetlands improve water quality by trapping suspended sediments and removing nitrogen and phosphorus.

Lacustrine Excavated Artificial and Palustrine Aquatic Bed/ Unconsolidated Bottom

These WoUS types enhance water quality by reducing suspended sediments and removing phosphorus and nitrogen through adsorption to the aluminum and iron in the subbasin's clay soils. Reservoirs and ponds, such as those constructed at golf courses, function as important sources of groundwater recharge and water quality treatment.

Palustrine Persistent Emergent

The lack of emergent vegetation in most PPEM wetlands in the subbasin has degraded their water quality functioning. Under natural conditions, vegetation growing within seasonal depressional and alkali wetlands would provide filtration of sediments and infiltration of water to subsurface soils and groundwater supplies. Without vegetation and its underground root structure, sediment is scoured and transported downstream during storm events. This degrades water quality of downstream water features. In addition, nutrient inputs from livestock can result in nutrient levels in excess of water quality standards.

Alkali wetlands are an important source of minerals and salt in the subbasin. Presence of water within these wetlands helps flush these minerals from the soils and transport it downstream. An overabundance of salt dissolved in the water can degrade water quality to a level unfit for human consumption. However, concentrations of salt compared to the volume of runoff water from alkali wetlands do not exceed standards for potable water use.

Hydrologic Cycling and Flood Storage

Riverine Nontidal (Perennial and Intermittent)

The clay soils adjoining Deer Creek and its tributaries have a high capacity for water retention, enhancing their flood storage capability and allowing for groundwater recharge to take place. The small patches of PPEM seasonal wetlands in the subbasin provide flood storage by slowing the flow of water and thereby increasing infiltration into the soil and groundwater.

Lacustrine Excavated Artificial and Palustrine Aquatic Bed/ Unconsolidated Bottom

These wetland types provide flood storage by collecting surface runoff and slowly releasing it into the groundwater, streams, and the atmosphere. Because most of the subbasin's ponds are on the valley floor rather than in the foothills, they collect surface runoff from a greater area and provide increased flood storage.

Palustrine Persistent Emergent

PPEM wetlands provide some temporary flood storage and contribute modestly to groundwater recharge.

Management Considerations for WoUS Conservation and Enhancement

Wetland functioning would increase in the middle and upper portions of the Deer Creek subbasin if the grazing regime were altered. Grazing can play an important role in enhancing biodiversity in this subbasin, particularly in grassland areas. Regulating livestock access to WoUS, in particular alkali wetlands and Deer Creek, would facilitate the restoration of wetland and riparian vegetation. Increased riparian vegetation would provide increased food sources and diverse habitat for wildlife. Vegetation would reduce fine sediments and water temperature, improving habitat conditions for fish and downstream water quality, and potentially allowing rare plant species to colonize alkali wetlands in the subbasin. Creek incision and streambank erosion would be reduced by increased growth of vegetation and channel sinuosity would therefore increase. If sinuosity returned to the system, Deer Creek would have a more diverse velocity profile, improving habitat for species that flourish in a range of stream velocities at different life history stages. Increased sinuosity and reduced grazing would also improve flood storage and groundwater recharge functions. Table 5-7 summarizes the overall quality of wetland types and opportunities for preservation and restoration.

5.2.6 Dry Creek

Physical Setting

This subbasin covers approximately 2,700 acres, representing approximately 1.5% of the inventory area. Figure 5-8a shows the location of WoUS found in the Dry Creek subbasin.

Geology

The upper portions of Dry Creek are underlain primarily by shale and sandstone members of the Meganos Formation (Paleocene). Downstream, towards the confluence with Marsh Creek, Quaternary alluvial fan deposits comprising sands and shales are found.

Soils

The Dry Creek subbasin is unique because, unlike Briones and Deer Creeks, Dry creek cuts through the east-west running ridgelines. The subbasin is crossed by alternating bands of Altamont clay, Briones loamy sand, and Pescadero clay loam. Rincon and Capay clays are found in the lower subbasin. Briones loamy sand is the most permeable of the three types, thus wetland features are not found in this soil type. The Altamont and Pescadero series have medium to low permeability, suitable for wetland formation. Pescadero soils tend to be slightly alkaline.

Climate

Average annual rainfall for the subbasin is approximately 14 inches.

Hydrology and Land Use

Dry Creek is an ephemeral stream with two major tributaries that drain from southwest to northeast to the confluence with Marsh Creek. The subbasin is small, draining approximately 3.5 square miles, and there are approximately 5.8 miles of stream channel (CCCo watershed atlas 2003). The lower subbasin has been modified to protect developed areas from flood damage. The lower portions of the two tributaries were relocated underground in culverts. The creek has been reinforced with riprap at the confluence with Marsh Creek. The creek passes through a golf course in the middle of the subbasin. Though portions of the creek pass through underground culverts, the channel may receive year-round runoff flows from maintenance of the golf course.

Land use of upper areas of the watershed consists of agricultural and park land, and the lower subbasin is developed for residential use including a golf course. A wide road and rural houses have been constructed in the upper watershed. In addition, many unpaved roads and long driveways appear to be associated for agricultural activities.

Waters of the U.S. Types

WoUS in the Dry Creek subbasin include three of the general types described in Chapter 4.

- Riverine nontidal (intermittent).
- PAB/UB (golf course, stock ponds, Dry Creek Reservoir and Detention Basin).
- PPEM (seasonal, alkali).

PPEM wetlands account for most of the WoUS acreage in the subbasin. A significant proportion of these are alkali wetlands found in the Pescadero clay loam soils. PAB/UB WoUS also make up a significant amount of the WoUS acreage. Most of the ponds in the subbasin are golf course ponds in the lower valley-plain region.

Figure 5-8b shows representative photos of WoUS commonly found in this subbasin. Table 5-8 summarizes the functions of each WoUS type found in the Dry Creek subbasin.

Waters of the U.S. Functions

Habitat

Riverine Nontidal (Intermittent)

Habitat function of stream channels in the subbasin varies by geomorphic region. In most of the foothills/valley region, the stream channel is surrounded by a corridor of grassland vegetation 100 feet wide or wider. Vegetation characteristic of seasonal wetlands and alkali wetlands (saltgrass [*Distichlis spicata*], alkali heath [*Frankenia salina*], brass buttons [*Cotula coronopifolia*]) is found in patches in and along the stream channel. These areas provide habitat for wetland plant species, including rare halophytes such as San Joaquin spearscale and brittlescale (*Atriplex depressa*), which have been documented in adjacent Briones Creek subbasin (CNDDB 2003). Unvegetated creek banks in the subbasin may provide habitat for Burrowing Owl, which has been documented in the adjacent Deer Creek subbasin (CNDDB 2003).

In the lower valley/plain region, the creek is surrounded by residential development and a golf course, with only a narrow corridor of open space remaining.

Palustrine Aquatic Bed/Unconsolidated Bottom (Golf Course and Stock Ponds, Reservoir and Detention Basin)

PAB/UB wetlands in the subbasin provide varying levels of habitat function. Stock ponds in the foothills/upper valley region are surrounded by grassland. If these stock ponds are seasonal, they may provide habitat for salamanders such as CTS, which has been documented in the subbasin (CNDDB 2003). Golf course ponds, Dry Creek Reservoir (which is too small to be classified as lacustrine impounded), and Dry Creek Detention Basin are landscaped and lack complex vegetation structure, limiting their habitat function. None of the PAB/UB WoUS in the Dry Creek subbasin retain well-developed marsh vegetation on their fringes.

Palustrine Persistent Emergent (Seasonal, Alkali)

PPEM wetlands in the subbasin are mostly found in two areas. A cluster of PPEM wetlands is found at the headwaters of Dry Creek. This cluster is surrounded by grassland and may provide valuable habitat for salamanders such as CTS and for fairy shrimp. Molestan blister beetle (*Lytta molesta*), which is associated with vernal pool vegetation, has also been documented in the vicinity. A second cluster of PPEM wetlands is found along the southern branch of Dry Creek just upstream of the point where the creek is channelized and turns due north. These wetlands are characterized by alkali vegetation. They adjoin residential development and a golf course to the north, and grasslands to the south. These wetlands provide habitat for halophytes, potentially including rare species such as San Joaquin spearscale, documented in Briones Creek, the adjacent subbasin to the west.

Both clusters of wetlands are located in areas of Pescadero clay loam soil, a soil map unit that contains 10 to 20% alkaline soils (Welch 1977). Both clusters of wetlands are alkaline.

Water Quality

Riverine Nontidal (Intermittent)

Channel vegetation found in Dry Creek captures and filters sediments and nutrients from upstream rural residences and agricultural activities, such as grazing. In addition, sediment generated from use of unpaved roads is trapped by channel vegetation. Development has restricted the water quality functioning by reducing the width of vegetated corridors alongside the channel and modifications to the channel shape, particularly in the lower subbasin.

Palustrine Aquatic Bed/Unconsolidated Bottom (Golf course and Stock Ponds, Reservoir and Detention Basin)

Stock ponds in the upper subbasin and golf course ponds in the lower subbasin affect water quality by encouraging nutrients cycling. These ponds commonly contain high amounts of nutrients from animal waste and high temperature water. This combination encourages the creation of bioavailable forms of nitrogen and phosphorus. Growth of algae and aquatic macrophytes are accelerated in nutrient-rich waters such as these. Golf course ponds also help to trap and store residual fertilizer and herbicides contained in runoff from lawn maintenance activities.

The Dry Creek Reservoir and Detention Basin allow suspended sediment to settle out of the water column. Metals and other contaminants adsorbed to the sediment particles would also be removed in this manner. This would improve water quality downstream when the water is released from the reservoir.

Palustrine Persistent Emergent (Seasonal, Alkali)

Urbanization in this subbasin has degraded the water quality functioning of PPEM wetlands in lower Dry Creek. Under natural conditions, vegetation growing within seasonal depressional and alkali wetlands would provide filtration of sediments and infiltration of water to subsurface soils. Without vegetation and its underground root structure, sediment is scoured and transported downstream during storm events where impacts to residences may be felt.

Alkali wetlands are an important mineral sink for the subbasin. Depressional wetland areas within the landscape capture and retain minerals flushed from surrounding soils. These wetland soils build up high concentrations of salts, thus creating unique habitat for halphytic plants. High flows through these wetlands will transport the salts downstream to creeks or other depressional areas.

Hydrologic Cycling and Flood Storage

Riverine Nontidal (Intermittent)

The stream channel in the lower subbasin has been altered to attain control of flooding. To do this, the channel has been straightened and forced into culverts to direct floodwaters quickly through the system. Unfortunately, flood plain areas have been reduced to small corridors or removed from functional use by residential developments. This interruption to the natural hydraulic pathway of the creek has reduced development of a riparian corridor, which in turn reduces water quality functioning and wildlife habitat.

Palustrine Aquatic Bed/Unconsolidated Bottom (Golf Course and Stock Ponds, Reservoir and Detention Basin)

Stock and golf course ponds contribute minor amounts of water to underlying groundwater supplies. Because of their location in depressional areas, these ponds can function to store floodwaters. They also contribute water vapor to the atmosphere through evaporation.

The Dry Creek Reservoir and Detention Basin are connected to the larger flood control network that was developed to store, divert, and move floodwaters away from urban development areas. The Dry Creek Reservoir remains dry until floodwaters exceed a defined level and are diverted to the reservoir. Once filled, the reservoir holds the floodwater until flows within the channel have declined before releasing the water downstream.

Palustrine Persistent Emergent (Seasonal, Alkali)

Similarly to PAB/UB ponds, PPEM wetlands contribute to groundwater, the atmosphere, and flood storage. However, the addition of vegetation growing within and around PPEM wetlands increases the effectiveness of these functions.

Management Considerations for WoUS Conservation and Enhancement

There is limited potential for improvement of wetland function in Dry Creek. Table 5-8 summarizes the overall quality of wetland types and opportunities for preservation and restoration. The following measures would help maintain and enhance WoUS functioning in this subbasin.

- Protect alkaline wetlands from adjoining residential development, particularly in the upper and southernmost areas of the subbasin.
- Improve riparian corridor in downstream reaches where the creek runs through residential neighborhoods (opportunities to develop community parks, educational programs, etc). Improving the lower creek would help water quality by encouraging filtration and enhancing flood storage capabilities.

- Protect the upper subbasin from overgrazing and residential development.
- Maintain dirt roads to reduce sediment inputs to the channel.

5.2.7 Briones Creek

Physical Setting

This subbasin covers approximately 4,500 acres, representing approximately 3% of the inventory area. Figure 5-9a shows the location of WoUS found in the Briones Creek subbasin.

Geology

The northwest/southeast alignment of the Briones Creek subbasin (similar to the alignment of Deer, Sand, and Upper Marsh Creeks) is a structural feature according to regional compression and faulting around the Mount Diablo complex. In the Briones Creek drainage, bedrock beneath the hills to the north and south of the valley bottom consists of sediments from the Great Valley sequence (Cretaceous), including sandstone and siltstone members. Towards the base of the hillslopes transitioning to the valley bottom are found Quarternary alluvial fans and fluvial fan deposits from the Pleistocene and younger Holocene alluvial fan deposits in the lower half of the subbasin. The Pleistocene deposits are less permeable than the Holocene deposits.

Soils

Altamont-Fontana silty clay loam soils are found on the north and south ridges of the Briones Creek subbasin. The valley cuts through Rincon clay loam and Capay clay as it flows from northwest to southeast. These soils have slow permeability but a high runoff potential. Vernal pool wetlands form in depressions within the topography of these clay soils.

Climate

Due to the influence of Mount Diablo's rain shadow, annual average rainfall for the Briones Creek watershed ranges from approximately 19 inches at the headwaters to approximately 14 inches at its confluence with Marsh Creek. The great majority of this rainfall comes in the late fall, winter, and early spring. The long dry season contributes to the absence of perennial streams in the subbasin. Like the other subbasins, many of the depressional wetlands in the Briones Creek subbasin hold water on a seasonal basis and are dry for much of the year.

Hydrology and Land Use

Briones Creek flows from northwest to southeast for approximately 13 miles from its headwaters to the confluence with Marsh Creek near the Marsh Creek Reservoir. Streams in the subbasin are mostly ephemeral, with flashy, short duration surface flows. The channel is highly sinuous and mobile, probably owning to the shallow, highly erodable alluvial soils through which it runs. The channel is extremely incised in most reaches of the creek. Channel incision of 15 feet or greater was noted at a few locations. Existing channel incision and predominant soil type provide few favorable areas for in-channel wetland formation and flood plain development in this basin. Water features are commonly stock watering ponds in this basin. Alkali wetlands can be found in the lower reaches of the creek.

Cattle grazing with patches of residential and agricultural use are the common land use in this basin. Grazing activities in this basin likely increase sediment loading downstream and possibly increase sinuosity. East of Deer Valley Road, much of the subbasin is managed for conservation and recreation as part of the John Marsh State Historic Park.

Waters of the U.S. Types

WoUS in the Briones Creek subbasin include three of the general types described in Chapter 4.

- Riverine nontidal (intermittent).
- PAB/UB (agricultural ponds).
- PPEM (seasonally flooded, vernal pools, and alkali).

PPEM wetlands account for most of the WoUS acreage in the subbasin, with the PAB/UB category also making up a significant amount of the WoUS acreage. Mapped WoUS in the Briones Creek subbasin are generally located in or adjacent to the creek itself, with the exception of agricultural ponds. Clusters of northern claypan vernal pools and a large alkali wetland are found southeast of the intersection of Deer Valley Road and Briones Valley Road (Contra Costa County 1996). Vernal pools and alkali wetland were also mapped in the western part of Briones Valley (Contra Costa County 1996).

Figure 5-9b shows representative photos of WoUS commonly found in this subbasin. Table 5-9 summarizes the functions of each WoUS type found in the Briones Creek subbasin.

Waters of the U.S. Functions

Habitat

Riverine Nontidal (Intermittent)

Much of the channel and banks of Briones Creek are generally unvegetated, providing habitat for a limited group of species. Portions of the channel bottom show signs of compaction by cattle. Ground squirrel activity is high in this subbasin, providing potential habitat for burrowing owls who may nest in the creek banks and forage in the surrounding grasslands. Burrowing owls have been documented in the Deer Creek subbasin to the north (CNDDB 2003). The incised channel and eroding banks lead to high water temperatures and fine sediment loads, degrading the creek's habitat quality for fish.

Scattered trees are found along the creek channel. Small patches of marsh vegetation are found in some incised portions of the creek channel where pools have formed. Although these patches of marsh vegetation are small, they provide potential habitat for species that cannot use other portions of the creek.

Palustrine Aquatic Bed/Unconsolidated Bottom(Agricultural Ponds)

Ponds in the Briones Creek subbasin may provide drinking water, foraging habitat, breeding habitat, and resting habitat for a variety of wildlife. Agricultural ponds in the subbasin generally lack emergent vegetation and suffer from eutrophication due to nutrient inputs from livestock, decreasing their habitat value for wildlife. Ruderal species such as cocklebur (*Xanthium* spp.) dominate the shoreline vegetation around some ponds (Contra Costa County 1996), while the shorelines of other ponds are unvegetated. Amphibians such as CTS, which has been documented in the subbasin (CNDDB 2003), may use seasonal stock ponds for breeding habitat.

Palustrine Persistent Emergent (Seasonally Flooded, Vernal Pools, and Alkali)

Seasonal

Seasonal wetlands in the upper portion of the subbasin lack vegetation, although many of these wetlands are surrounded by grasslands and provide some habitat value for most species. Seasonal wetlands in the lower portion of the subbasin are located within a state park and managed for conservation. CTS, which has been documented in the subbasin within the state park (CNDDB 2003), may use these wetlands for breeding. Some seasonal wetlands in this subbasin may function like vernal pools, providing habitat for species discussed below.

Vernal pools

Vernal pools in the subbasin are found in shallow depressions in impervious clay soils and are dominated by common vernal pool plant species, such as Vasey's coyote thistle (*Eryngium vaseyi*) and slender popcorn flower (*Plagiobothrys stipitatus* var. *micranthus*) (Contra Costa County 1996). Vernal pools in this area provide habitat for two species of rare fairy shrimp (*Branchinecta lynchi* and

Linderiella occidentalis), which have been documented in the subbasin (CNDDB 2003). Molestan blister beetle, a rare species that is found in vernal pool vegetation, has been documented in the vicinity (CNDDB 2003), and may use vernal pool habitat in the subbasin.

Alkali

Alkali wetlands in the subbasin are a mixture of valley sink scrub, dominated by iodine bush (*Allenrolfea occidentalis*), alkali heath (*Frankenia salina*), saltgrass (*Distichlis spicata*), as well as unvegetated alkali scalds. These wetlands provide habitat for rare plant species such as the San Joaquin saltbush. San Joaquin saltbush has been documented in this subbasin, as well as to the north in the Sand Creek subbasin.

Water Quality

Riverine Nontidal (Intermittent)

Limited vegetation on the banks and within intermittent reaches of Briones Creek causes sediment to erode from the banks and transport to downstream reaches. The lack of riparian vegetation along streambanks, together with livestock use of the banks and channel, further encourages channel erosion and downcutting. The vegetation that does thrive within and immediately adjacent the channel helps capture sediment. This vegetation does little to lower or maintain water temperature through shading.

Palustrine Aquatic Bed/Unconsolidated Bottom (Agricultural Ponds)

Agricultural ponds scattered throughout the basin function to contain nutrients deposited from nearby sources, such as cattle. These shallow, unvegetated ponds often hold warm water, which encourages growth of bacteria and algae.

Palustrine Persistent Emergent (Seasonally Flooded, Vernal Pools, and Alkali)

Seasonal wetland features in the Briones Creek subbasin have reduced water quality functioning because they lack vegetation, and consequently have a low capacity for sediment filtration and nutrient cycling. Due to the fine grain size of the clay soils and overgrazing in this subbasin, water quality within these seasonal pools tends to be turbid and high in nutrients.

Hydrologic Cycling and Flood Storage

Riverine Nontidal (Intermittent)

Tributary stream channels of Briones Creek appear to have small floodplain areas. During storm events, water is forced quickly to the mainstem channel and downstream. High water velocity due to low permeability and high runoff potential of the soils cause the stream channel to downcut, as opposed to developing a floodplain. Only modest contributions to groundwater recharge are made through this water feature.

Palustrine Aquatic Bed/Unconsolidated Bottom (Agricultural Ponds)
The majority of agricultural ponds in the subbasin are located at the base of small drainages. Storage of these waters may contribute modest amounts of water and subsurface groundwater.

Palustrine Persistent Emergent (Perennial Treatment, Seasonally Flooded, and Alkali)
Seasonal wetlands found in Sand Creek function as flood storage during storm events. Storage of water in depressional areas encourages modest contributions to subsurface groundwater and water vapor.

Management Considerations for WoUS Conservation and Enhancement

Wetland functioning would increase in the middle and upper portions of the Briones Creek subbasin if livestock access to the creek and selected wetlands were restricted, at least seasonally. Native vegetation would return to the creek, providing increased food sources, diverse habitat for wildlife, and improving water quality. Vegetation would reduce fine sediments and water temperature, improving habitat conditions for fish and downstream water quality, and potentially allowing rare plant species to colonize alkali wetlands in the subbasin. Creek incision and streambank erosion would be reduced by increased growth of vegetation. Reduced grazing pressure on aquatic resources would also improve flood storage and groundwater recharge functions. Table 5-9 summarizes the overall quality of wetland types and opportunities for preservation and restoration.

A restoration priority for the Briones Creek subbasin would be to restrict cattle from the creek channel by using fencing.

5.2.8 Kellogg Creek

Physical Setting

This subbasin covers approximately 20,700 acres, representing approximately 12% of the inventory area. Figure 5-10a shows the location of WoUS found in the Kellogg Creek subbasin.

Geology

Bedrock in the Kellogg Creek drainage basin consists of Late Cretaceous sandstone interbedded with shale and siltstone. Sandstone beds can be 33 feet thick with approximately 3 to 6.5 feet of interbedded siltstone and mudstone. Undivided surficial Pleistocene and Holocene deposits are found southeast towards the delta. Alluvial fan deposits are found close to the creek's outlet to the delta.

Soils

Wetlands tend to be found in areas of poorly drained valley fill soils such as Brentwood clay loam, Pescadero clay loam, and Rincon clay loam. The majority of wetlands in Kellogg Creek are found in Altamont clay and Rincon clay loam soils. However, the majority of the basin is made up of bands of Los Osos clay loam and the Altamont-Fontana complex and small patches of other soil types. Los Osos clay loam occupies the highest elevations of the basin. This soil type is found on 15% to 30% slopes and roots can penetrate to 25 to 40 inches.

Climate

Average annual rainfall in the Kellogg Creek drainage is 16 inches.

Hydrology and Land Use

The Kellogg Creek drainage basin encompasses 20,863 acres largely owned and managed by the Contra Costa Water District. The Los Vaqueros Reservoir occupies a large portion of the upper watershed. This reservoir can store up to 100,000 acre-feet of drinking water. Major tributaries draining to the reservoir are Horseshoe, Upper Kellogg, Mallory, Adobe Creeks and Fig Pig Gulch. Tributaries draining to Kellogg creek downstream of Los Vaqueros are Mariposa, Buckeye, Kit Fox, and Eagle Creeks. These tributaries are ephemeral. However, there are some reaches that hold water for long periods of time perhaps because of year-round agricultural return flows.

This drainage basin crosses three geomorphic regions: montane, foothill/upper valley, and the Sacramento–San Joaquin Delta region. Wetland types and distribution differ between regions. The area surrounding and draining to the reservoir lies in the montane region. Apart from the Los Vaqueros Reservoir, wetlands in this region are mostly stock ponds located along stream channels.

The area from the dam downstream to the crossing of Vasco Road falls in the foothills/upper valley region. The wetlands in this region largely consist of riparian woodland, stock ponds, and seasonal depressional wetlands. Downstream of Vasco Road, the subbasin is located in the Delta region. The creek channel in the Delta region has been modified for flood conveyance and irrigation. WoUS in this area are riparian woodland, irrigation ditches and ponds, and seasonal wetlands.

Most of the Kellogg Creek subbasin is managed to protect water quality of waters stored by the Los Vaqueros Reservoir. Watershed protection lands are also used for grazing. The Delta portion of the subbasin is used principally for crop production. Less than 5% of the land is covered by impervious surfaces.

Waters of the U.S. Types

WoUS in the Kellogg Creek subbasin include five of the general types described in Chapter 4.

- Riverine nontidal (intermittent and lower perennial).
- Palustrine forest and scrub.
- PAB/UB (ponds).
- Lacustrine impounded.
- PPEM (perennial, seasonally flooded, and alkali).

Apart from the Los Vaqueros reservoir, PPEM wetlands account for most of the WoUS acreage in the subbasin, with palustrine forest also making up a significant amount of the WoUS acreage. Mapped WoUS in the Kellogg Creek subbasin are generally located in or adjacent to the creek itself. Palustrine forest is principally found at the transition from the foothills/upper valley region to the Delta region. Alkali wetlands are mapped in Pescadero clay loam soils in the foothills/upper valley region adjacent to Eagle and Kit Fox Creeks.

Figure 5-10b shows representative photos of WoUS commonly found in this subbasin. Table 5-10 summarizes the functions of each WoUS type found in the Kellogg Creek subbasin.

Waters of the U.S. Functions

Habitat

Riverine Nontidal (Intermittent)

Intermittent streams in the subbasin are surrounded by grasslands and woodland vegetation. In some reaches, riparian woodland and emergent marsh vegetation are well developed adjacent to the stream channel. These reaches are located in the montane and foothills/upper valley regions, which are protected from development in order to protect water quality in the Los Vaqueros Reservoir. They provide habitat for a diverse group of wildlife species. In the downstream portion of the foothills/upper valley region, grazing pressure is higher, but the banks of intermittent streams retain seasonal wetland vegetation and appear to be stable.

Riverine Nontidal (Lower Perennial)

Perennial streams in the subbasin are located in the foothills/upper valley region downstream of the reservoir and in the Delta region. These streams are supplied by agricultural return flows year round. In the foothills/upper valley region, these streams are surrounded by grassland and have well-developed woodland and marsh vegetation along their channels. They provide habitat for a diverse group of species, including rare species such as the WPT and CRF, which have been documented in the montane and foothills/upper valley regions of the subbasin (CNDDB 2003).

In the Delta region, Kellogg Creek has been channelized and is surrounded by orchards and annual cropland. While the creek channel and adjacent drainage ditches may retain marsh vegetation, only species that can tolerate the disturbance and lack of native vegetation in the surrounding cropland can use this habitat.

Palustrine Forest and Scrub

Palustrine scrub in this subbasin consists of dense thickets of willow and alders in the montane region and in the upper portion of the foothills/upper valley region. The complex structure and dense cover that these areas provide serve important habitat functions for a variety of species. Palustrine forest is also found at the transition from the foothills/upper valley region to the Delta region, where it consists of less dense woodland vegetation dominated by valley oak, surrounded by grassland. These areas provide habitat for fewer species than denser palustrine forest and scrub upstream.

Palustrine Aquatic Bed/Unconsolidated Bottom (Ponds)

Grazing intensity within watershed lands is relatively low, allowing for the development of marsh vegetation around some ponds. Ponds in the montane and foothills/upper valley region are surrounded by grassland. Seasonal ponds provide potential habitat for CTS, which has been documented in the montane and foothills/upper valley regions of the subbasin (CNDDB 2003). Ponds in the Delta region are surrounded by annual cropland and orchards. These ponds provide a lower level of habitat function.

Lacustrine Impounded

Los Vaqueros Reservoir is surrounded by grassland and woodland vegetation. It provides habitat for species such as Great Blue Heron, Mallards, Snowy Egret, and Double-crested Cormorant (*Phalacrocorax auritus*).

Palustrine Persistent Emergent (Perennially Flooded, Seasonally Flooded, Alkali)

Perennially flooded

Perennial wetlands in the subbasin are located along perennial stream reaches. The dominant plant species are bulrushes (*Scirpus* spp.) and cattails. These wetlands are surrounded by grasslands. They provide cover, foraging and nesting habitat for a variety of species, including CRF, which has been documented in the subbasin (CNDDB 2003).

Seasonally flooded

Seasonally flooded wetlands in the foothills/upper valley region are surrounded by grassland. They therefore provide potential breeding habitat for amphibians such as CTS, which can aestivate in adjacent uplands and has been documented in the subbasin (CNDDB 2003). Seasonal wetlands were also mapped in the Delta region adjacent to annual cropland. These wetlands appear to be mowed or plowed, and provide a low level of habitat function.

Alkali

Alkali wetlands in the subbasin provide habitat for halophytes, including rare species such as brittlescale and San Joaquin spearscale, which have both been documented in the subbasin.

Water Quality

Riverine Nontidal (Intermittent and Lower Perennial)

Riverine water features improve water quality in upper Kellogg Creek through contributions of cold temperature water produced from seeps and tall vegetation shading the channel. Water quality of the lower perennial reaches of Kellogg Creek is degraded by agricultural return flows.

Palustrine Forest and Scrub

Established vegetation found in this wetland type prevents streambank erosion, and therefore reduces sediment transport downstream and prevents degradation of downstream water quality.

Palustrine Aquatic Bed/Unconsolidated Bottom (Agricultural ponds)

Agricultural ponds capture nutrients and sediment generated by cattle grazing. These ponds tend to have poor water quality due to high water temperatures and nutrients.

Lacustrine Impounded

The Los Vaqueros Reservoir functions as drinking water storage and is maintained to prevent degradation of water quality. The surrounding upper watershed is also managed and protected. The management program in place ensures water quality of the reservoir is protected from degradation and contamination.

Palustrine Persistent Emergent (Perennial Flooded, Seasonally Flooded, and Alkali)

Vegetation surrounding seasonal and perennial wetlands maintains high water quality functioning. The vegetation protects against erosion and filters sediment from stormwater. Perennial wetlands remove contaminants, such as residual herbicides, from agricultural runoff.

Hydrologic Cycling and Flood Storage

Riverine Nontidal (Intermittent and Lower Perennial)

The majority of intermittent reaches in Kellogg Creek allow for limited flood storage in the valley bottom area where the topography gently slopes and a floodplain area is present. The lower channel has been modified for flood control and conveyance to protect against damage to developments and farmland and to capture agricultural return flows.

Palustrine Forest and Scrub

This type of wetland is commonly found in upper Kellogg Creek and thus conveys, rather than stores, stormwater.

Palustrine Aquatic Bed/Unconsolidated Bottom (Ponds)

The majority of agricultural ponds in the subbasin are located at the base of small tributary drainages. Storage of these waters may contribute modest amounts of water and subsurface groundwater.

Lacustrine impounded

Because of the large surface area of the Los Vaqueros Reservoir, a considerable amount of water may evaporate to the atmosphere thus increasing local humidity and influencing the climate via a “lake effect.”

Palustrine Persistent Emergent (Perennial Flooded, Seasonally Flooded, and Alkali)

Seasonal wetlands found in Kellogg Creek function as flood storage during storm events. Storage of water in depressional areas encourages modest contributions to subsurface groundwater and water vapor.

Management Considerations for WoUS Conservation and Enhancement

Habitat could be improved by restoring portions of the channel in the Delta region but at the loss of adjacent agricultural land. Table 5-10 summarizes the overall quality of wetland types and opportunities for preservation and restoration.

Water quality would be enhanced by a sediment removal restoration project that has been proposed and is seeking funding (Contra Costa County 2003).

5.2.9 Brushy Creek

Physical Setting

This subbasin covers approximately 24,500 acres, representing approximately 14% of the inventory area. Figure 5-11a shows the location of WoUS found in the Brushy Creek subbasin.

Geology

Bedrock geology in the upper Brushy Creek drainage basin consists of Late Cretaceous sandstone interbedded with shale and siltstone. Sandstone beds can be 33 feet thick with approximately 3 to 6 feet of interbedded siltstone and mudstone. Undivided surficial Pleistocene and Holocene deposits comprise Lower Brushy Creek bedrock. Alluvial fan deposits are found close to the Clifton Court Forebay and Delta.

Soils

Soils in the Brushy Creek drainage are strongly alkali, especially in the lower portion of the basin. Soils in this basin have slow to very slow permeability rates, which is conducive to wetland formation. The majority of the water features in the upper basin are found in the Altamont Clay-Fontana silty clay loam complex (AcF) and the Pescadero formation. The AcF complex is found on 30% to 50% slopes. Altamont soils are found on lower and north-facing slopes, while Fontana soils are found along ridge crests and south-facing slopes. This complex has a low potential for runoff and a high infiltration rate. The Pescadero soils are formed from sedimentary rock and found in small inland valleys and on basin rims in 0% to 2% slopes. Pescadero clay loam is found in stream channels in the northwest area of the basin and has high alkali content. This soil is subject to ponding and slow surface water runoff.

Water features in the lower basin are found in Marcuse and Solano soils. The Marcuse series are found on slopes less than 2% and are typically saturated from mid-December to March unless artificially drained. Marcuse clays, such as those found in this basin, have strong alkali content and are poorly drained. Solano soils are found in the southeastern portion of the basin and are somewhat poorly drained. The soils retain water from November to June and dry out during the summer. Similar to Marcuse soils, Solano soils are strongly alkali.

Climate

Average annual rainfall in this basin is 13 inches.

Hydrology and Land Use

The Brushy Creek drainage area covers 24,422 acres of mostly agricultural lands primarily used for grazing. Surface waters drain from an elevation of 1,220 feet in the southwest to sea level in the northeast. This drainage basin crosses four geomorphic regions: montane, foothills/upper valley region, lower valley/plain region, and Sacramento–San Joaquin Delta region. Approximately 99.7% of the stream channels in this watershed have not been structurally reinforced. Streams are located in steep v-shaped meandering valleys. Wetlands found in the upper basin are located in depressional areas within stream channels. The majority of the water features in the upper basin are grazing ponds. Water features of the lower basin consist of alkali wetland areas and agricultural ditches.

Land use consists of grazing lands in the upper basin and agricultural croplands in the lower basin. Some areas in the western portion of the subbasin are protected open space, part of Vasco Caves Regional State Park or Contra Costa Water District land managed as part of the Los Vaqueros watershed. Approximately 800 acres of Byron Airport have been set aside as a wildlife preserve targeting San Joaquin kit fox (Williams et al. 1998). Lands covered by impervious surfaces, such as residential or urbanized areas, comprise 5% of the watershed, mostly in the lower basin. Channel incision, as much as 7 feet, was noted in some portions of the watershed. Incision in this basin may be caused by grazing pressure or poorly designed culverts.

Waters of the U.S. Types

WoUS in the Brushy Creek subbasin include five of the general types described in Chapter 4.

- Riverine nontidal (intermittent and lower perennial).
- Palustrine forest and scrub.
- Riverine excavated artificial.
- PPEM (seasonal, alkali, vernal pools).
- PAB/UB (stock ponds, detention ponds).

Most WoUS in the subbasin are PPEM alkali wetlands. PPEM seasonal wetlands also account for a significant amount of WoUS acreage. Most of the PPEM alkali wetlands are located in the foothills region on areas of Pescadero clay and Solano loam. Many alkali wetlands have been mapped in the vicinity of the Byron Airport.

Figure 5-11b shows representative photos of WoUS commonly found in this subbasin. Table 5-11 summarizes the functions of each WoUS type found in the Brushy Creek subbasin.

Waters of the U.S. Functions

Habitat

Riverine Nontidal (Intermittent and Lower Perennial)/Palustrine Forest and Scrub

Nontidal Intermittent/Palustrine Forest and Scrub

Riverine nontidal intermittent WoUS in the subbasin are principally located in the foothills region. The creek channel contains many patches of palustrine scrub dominated by willows, particularly in the upper reaches, as well as emergent marsh vegetation dominated by bulrushes (*Scirpus* spp.). These reaches of creek are surrounded by grasslands. These WoUS provide habitat for numerous species, including curved foot hygrotus diving beetle (*Hygrotus curvipes*) which may use seasonal pools in the creek channel and which has been documented in the subbasin. CRF has also been documented in the subbasin.

Creek reaches at the transition from the foothills to the lower valley/plain region lack vegetation and appear more heavily grazed. These reaches may provide habitat for Burrowing Owl, which has been documented in the subbasin.

Nontidal Lower Perennial

Lower perennial reaches of the creek in this area occur within the Delta and lower valley/plain regions. Many of these portions of the creek channel have been diverted and channelized to facilitate agriculture (Contra Costa County 2003). Invasive vegetation, such as water hyacinth (*Eichhornia crassipes*), is found in these portions of the creek. Creek banks in these reaches may provide habitat for the special-status plant rose mallow (*Hibiscus lasiocarpus*), which has been documented along sloughs in this area.

Riverine Excavated Artificial

Drainage ditches in the subbasin may contain marsh vegetation but are narrow and surrounded by intensive agriculture. They provide habitat for species able to tolerate frequent human disturbance.

Portions of the Delta-Mendota Canal are present in this subbasin, but provide little habitat function.

Palustrine Persistent Emergent (Seasonal, Alkali, Vernal Pools)

PPEM wetlands in the foothills region are surrounded by grassland. Some of these wetlands are in areas managed for conservation goals by the EBRPD and CCWD. Freshwater wetlands provide habitat for a variety of species, including special-status species such as CTS, which has been documented in the subbasin. PPEM alkali wetlands provide similar habitat function to wildlife species. Alkali wetlands are crucial habitat for some special-status plant species, such as San Joaquin saltbush and brittlescale, which have both been documented in the subbasin.

Large areas of PPEM wetlands are also found in the lower valley-plain and Delta regions of the subbasin. In these areas, wetlands are surrounded by intensive agriculture, and therefore only provide habitat for species that can tolerate human disturbance. The extensive alkali wetlands in these areas still provide suitable habitat for special-status plant species.

While vernal pools have not been mapped for this inventory, they are known to be present in this subbasin, and provide important habitat for species such as Contra Costa goldfields (*Lasthenia conjugens*) and fairy shrimp, which have both been documented in the subbasin.

Palustrine Aquatic Bed/Unconsolidated Bottom (Stock Ponds, Detention Ponds)

Numerous stock ponds are located in the foothills and montane regions of the subbasin. While grazing pressure reduces the amount of vegetation present around these ponds, they can still provide habitat for amphibians such as CTS and CRF, which have been documented in the subbasin.

Detention ponds in the lower valley/plain region provide little habitat value.

Water Quality

Riverine Nontidal (Intermittent and Lower Perennial)/Palustrine Forest

In the foothills portion of the subbasin, water flows rapidly due to steep gradients, preventing substantial filtration or settling out of sediments, nutrients and other pollutants. In the valley portion, a restricted floodplain and high grazing pressure limits the amount of filtration the creek can provide. Grazing activities increase the amount of sediment moving downstream through the watershed. Perennial reaches convey agricultural return flows to the Delta. Waters within these reaches often contain high concentrations of nutrients and other contaminants from agriculture and urban land use.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Palustrine Persistent Emergent (Seasonal, Alkali)

See discussion of PPEM wetlands in Section 4.2. Several large PPEM wetlands in the foothills region of the Brushy Creek subbasin enhance water quality by filtering sediment and associated contaminants. Vegetated detention basins in the valley region, function at a high level to enhance water quality through filtration. Alkali wetlands serve as important sinks for minerals and salts dissolved in surface waters.

Palustrine Aquatic Bed/Unconsolidated Bottom (Stock Ponds, Detention Ponds)

See discussion of PAB/UB WoUS in Section 4.7. The majority of agricultural stock ponds in this subbasin lack vegetation and thus function poorly to remove sediment and improve water quality. Stormwater detention ponds improve water quality by allowing sediment to settle out of the water column.

Hydrologic Cycling and Flood Storage

Riverine Nontidal (Perennial and Intermittent)/Palustrine Forest

These reaches of Brushy Creek function for flood storage and groundwater recharge at a low to moderate level. In the foothills region, steep gradients transport sediment to the creek. In the valley region, a confined floodplain provides low potential for flood storage and groundwater recharge. Perennial channels in the lower Delta region convey return flows to the Delta.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Palustrine Persistent Emergent (Seasonal, alkali)

Large seasonal wetlands in the foothills region of the subbasin function at a moderate level for flood storage due to the presence of riparian vegetation. Seasonal and alkali wetlands contribute minor amounts to groundwater. These wetlands provide little in terms of flood storage functions.

Palustrine Aquatic Bed/Unconsolidated Bottom (Stock Ponds, Detention Ponds)

Stormwater detention basins function at a moderate to high level for flood storage. Agricultural and wastewater treatment ponds function at a low to moderate level for flood storage. Wastewater treatment ponds are not connected to surrounding surface water features, such as creek channels or wetlands.

Management Considerations for WoUS Conservation and Enhancement

Protection of sensitive alkali habitat is imperative in the Brushy Creek subbasin. Modifying the grazing regime by reducing stocking rates and restricting access to creek channels, especially in the dry season, would lessen sediment loading to the creek, thus improving water quality. This would also allow development of a riparian corridor, which would improve wildlife habitat. Water quality of sloughs and the Delta can be enhanced through minimizing use of fertilizers and pesticides on agricultural lands. Table 5-11 summarizes the overall quality of wetland types.

5.3 Lower Valley/Plain Region

East Antioch Creek, Oakley, and Lower Marsh Creek subbasins are located primarily in the lower valley/plain region.

5.3.1 East Antioch Creek

Physical Setting

This subbasin covers approximately 7,261 acres, representing approximately 4% of the inventory area. Figure 5-12a shows the location of wetland types found in the East Antioch Creek subbasin.

Geology

Much like West Antioch Creek, East Antioch Creek is largely underlain by Tertiary bedrock in its upland areas. Pleistocene alluvial fan deposits underlie the lower flatland areas. These deposits also extend upland along tributaries adjacent to channels. The Younger Holocene alluvial fan deposits can be found within stream channels in the lower plains region.

Soils

The East Antioch Creek subbasin is largely dominated by clay loam soils. Wetland habitat tends to occur in Rincon clay and clay loam complexes because these complexes have low permeability. Low-elevation areas are dominated by the Rincon clay and silty clay loam formation, while upland areas are dominated by clay soils. Patches of alkali clay and clay loam are found in the upper subbasin.

Climate

Average annual rainfall in the East Antioch Creek subbasin is approximately 13 to 14.5 inches. This subbasin receives less rainfall than West Antioch Creek, which receives approximately 15 to 18 inches of rainfall annually. The difference in rainfall is due to the rain shadow effect of the higher elevation of West Antioch Creek compared to the lower elevation of East Antioch Creek.

Hydrology and Land Use

The East Antioch Creek subbasin contains one major tributary originating in the foothills region of the subbasin. East Antioch Creek is ephemeral and flows from east to northwest, draining to the Delta during winter storm events. In addition to storm flows collected in the grassland areas of the upper watershed, the creek receives diverted runoff from streets, houses, and parking lots from urbanized areas, the dominant land cover. Detention basins and levees have been built along the creek to promote infiltration and prevent the floodwaters from moving into adjacent subbasins (Contra Costa County 2003). Approximately 87% of the main East Antioch Creek channel lies above ground (Contra Costa County 2003). A 1-mile reach of the creek upstream of Highway 4 is underground.

Land use in the subbasin follows the typical pattern of dense urban development, with small patches of parkland scattered throughout the subbasin. Sixty percent of the watershed is impervious (Contra Costa County 2003). Restoration projects in the lower subbasin are underway just upstream of Alhambra Lake and in the tidal marsh areas close to the Delta, outside the inventory area.

WoUS Types

WoUS types in the East Antioch Creek subbasin include six of the general types described in Chapter 4.

- Riverine nontidal (intermittent and lower perennial).
- Riverine excavated artificial.
- Lacustrine impounded.
- Palustrine forest.
- PAB/UB (detention basins).
- PPEM (seasonal).

Figure 5-12b shows representative photos of WoUS types commonly found in this subbasin. Table 5-12 summarizes the functions of each WoUS type found in the East Antioch Creek subbasin.

Apart from the Alhambra Lake reservoir and the Contra Costa Canal, about 60% of the WoUS types in this subbasin are palustrine forest/scrub, while the remaining 40% are PPEM wetlands. Most of these WoUS are concentrated in an open space corridor north of Highway 4. South of Highway 4, only riverine nontidal intermittent WoUS are found in this subbasin.

Wetland Functions

Habitat

Riverine Nontidal (Intermittent and Lower Perennial)

Much of East Antioch Creek has been culverted or is surrounded by dense residential development. However, the reach of creek between Highway 4 and Calaveras Circle is surrounded by grassland. In this area, some reaches of the channel contain marsh vegetation and others are lined with palustrine forest. This area provides habitat to a diverse group of wildlife species, including CRF, which has been documented in the neighboring subbasin (CNDDB 2003).

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Lacustrine Impounded

Lake Alhambra is surrounded by dense development and therefore provides habitat only to species that use open water and tolerate high levels of human disturbance.

Palustrine Forest

Two areas of palustrine forest are present in this subbasin. One of these is located adjacent to the Bidwell School, southeast of Hillcrest Street and East 18th Street. This area is surrounded by dense development and thus provides habitat only for species that can tolerate high levels of human disturbance. The second area is located in an open space corridor between Highway 4 and Calaveras Circle. This area of palustrine forest is larger and is surrounded by grassland and PPEM wetland, providing habitat for a greater number of more sensitive species.

Palustrine Aquatic Bed/Unconsolidated Bottom (Detention Basins)

Only two small areas totaling 0.6 acres of PAB/UB WoUS are mapped in the subbasin. These areas are surrounded by dense residential development and therefore provide habitat for few species.

Palustrine Persistent Emergent (Seasonal and Perennial)

PPEM wetlands in the open space corridor between Highway 4 and Calaveras Circle contain well-developed wetlands vegetation surrounded by or adjacent to grassland, palustrine forest, and the creek channel. These wetlands may provide habitat for a diverse group of species, including CTS and CRF, which have been documented in this subbasin or in adjacent subbasins.

Water Quality

Riverine Nontidal (Intermittent and Lower Perennial)

Long reaches of East Antioch Creek exist as an open vegetated channel. A section of the channel southwest of Highway 4 is located in an underground culvert. However, the majority of the creek has been modified and relocated to accommodate residential housing and vehicle transportation. The vegetated channels slow flows during high precipitation events and filter sediment and contaminants from the water column.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Lacustrine Impounded

Reservoirs, such as Lake Alhambra, improve water quality by settling sediment and associated contaminants from urban runoff. Sediment and contaminants are collected on the reservoir bottom and made unavailable to plants and wildlife through the decomposition process. Because Lake Alhambra is near the most downstream end of the watershed, it perhaps serves as the last filtration mechanism to improve water quality of East Antioch Creek.

Palustrine Aquatic Bed/Unconsolidated Bottom (Detention Basins)

Stormwater detention basins function to improve water quality through filtration of sediment and removal of urban contaminants adsorbed to sediment particles. After the stormwater is held for a period, gates are lifted and the filtered and settled water is allowed to pass along downstream channels or through the storm drain network. Detention basins are particularly important at the lower end of the watershed area because contaminants and sediment have a chance to be removed before flowing to downstream areas and the Delta.

Palustrine Persistent Emergent (Seasonal and Perennial)/Palustrine Forest

The riparian areas in the middle of the watershed north of Highway 4 function to improve water quality by filtering sediments associated with new residential construction and runoff from vehicle use on the highway. This large riparian area is one of the few places in the watershed where contaminants contained in surface waters have an opportunity to be removed.

Hydrologic Cycling and Flood Storage

Riverine Nontidal (Intermittent and Lower Perennial)

Flood storage in the channel has been reduced by urban development. The watershed has been modified to accommodate storm flows in storm drain networks leading to detention basins and reservoirs.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Lacustrine Impounded

In addition to serving recreational functions, Lake Alhambra absorbs flood flows from storm events. Incoming storm flows are held in the lake then slowly released to the marsh area below the reservoir and to the Delta. Lake Alhambra protects the residences in this flat and downstream area of the watershed from flooding.

Palustrine Aquatic Bed/Unconsolidated Bottom (Detention Basins)

Water held in these basins prevents storm runoff from flooding developed areas. Detention basins are particularly important to protect developments at the bottom of the watershed area from flooding.

Palustrine Persistent Emergent (Seasonal and Perennial)/Palustrine Forest

The large open space area north of Highway 4 provides ample flood storage capacity for surface waters from upper areas of the watershed. There is little flood storage capacity in the upper subbasin because of residential developments and relocated stream channels in culverts. The flood plain area north of Highway 4 is large compared to other subbasins in the inventory area.

Management Considerations for WoUS Conservation and Enhancement

The East Antioch Creek subbasin is dominated by dense residential and commercial development. Wetland functioning can be maintained by preventing development along the channel downstream of Highway 4 to encourage riparian corridor development and improve wildlife habitat in the lower channel. This will also provide flood storage and improve water quality. Table 5-12 summarizes the overall quality of wetland types and opportunities for preservation and restoration.

In addition, storm drains need to be better maintained to prevent migration of garbage and other contaminants to the stream channel. Stencilling storm drains in this subbasin with signs indicating that they drain to the creek and the Delta may be helpful in reducing dumping of pollutants.

5.3.2 Oakley

Physical Setting

This subbasin covers approximately 3,892 acres, representing approximately 2% of the inventory area. Figure 5-13a shows the location of wetland types found in the Oakley subbasin.

Geology

Brentwood dune sands, deposited in the Pleistocene and Holocene, dominate the geology of the Oakley subbasin.

Soils

Soils of the Oakley subbasin can be characterized as nearly level and are dominated by Delhi sands with patches of clay loam. The Delhi sands are ancient dune deposits. Aside from the sands, these clay loams have low permeability and are highly alkaline. These soils will hold water for long periods unless intentionally drained.

Climate

Average annual rainfall in the Oakley subbasin ranges from 12 to 13 inches.

Hydrology and Land Use

This subbasin lacks a naturally defined channel network. Runoff from impervious surfaces are collected in underground storm drain networks and conveyed to stormwater detention and retention basins, or discharged northwards to the Delta. There are several industrial wastewater treatment ponds in this subbasin. These ponds do not discharge to the Delta or groundwater supplies. The tidal marshes in this subbasin are located outside the inventory area.

Land use in the Oakley subbasin is a mixture of intensive agriculture, residential, and industrial development. However, residential developments are quickly becoming the dominant land use in the subbasin. An active railroad line runs through this subbasin. Maintenance and operation of rail lines involve lubrication of the tracks and wheels with oils and greases. These contaminants can be transported to drainage channels and ultimately to the Delta, further degrading water quality.

WoUS Types

WoUS types in the Oakley subbasin include four of the general types described in Chapter 4.

- Riverine excavated artificial.
- Palustrine scrub/shrub.
- PPEM (perennial, seasonal).
- PAB/UB (stormwater and industrial wastewater treatment ponds).

Figure 5-13b shows representative photos of WoUS types commonly found in this subbasin. Table 5-13 summarizes the functions of each WoUS type found in the Oakley subbasin.

Ponds (PAB/UB) associated with industry and water treatment make up the majority of the WoUS types in this subbasin, followed by PPEM wetlands. PPEM wetlands are located in agricultural areas and adjacent to the Suisun Bay salt marshes. Tidal wetlands with palustrine scrub/shrub vegetation are found adjacent to the Suisun Bay salt marshes.

Wetland Functions

Habitat

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4. In some cases, drainage ditches in this subbasin contain freshwater marsh vegetation and may provide habitat for species that can use marsh vegetation surrounded by intensive agriculture.

Palustrine Scrub/Shrub

Two patches of palustrine scrub/shrub in the subbasin are located adjacent to tidal marshes on Suisun Bay. Although commercial and industrial development is present nearby, these wetlands may provide habitat for a diverse group of sensitive species. Antioch Dunes evening primrose (*Oenothera deltoides* ssp. *howellii*) has been documented in the subbasin and may be present on remnant river bluffs in the area. A third area of palustrine scrub/shrub is located adjacent to intensive agriculture and industrial development. This area provides habitat for species able to tolerate frequent human disturbance.

Palustrine Persistent Emergent (Perennial, Seasonal)

A few PPEM wetlands in the subbasin are located adjacent to the Suisun Bay tidal marshes and provide habitat for a diverse group of species. Antioch Dunes evening primrose has been documented in the subbasin and may be present on remnant river bluffs in the area.

Most of the PPEM wetlands in the subbasin are surrounded by intensive agriculture or residential development. These wetlands provide habitat for species able to tolerate frequent human disturbance.

Palustrine Aquatic Bed/Unconsolidated Bottom (Stormwater and Industrial Wastewater Treatment Ponds)

PAB/UB features in the subbasin are surrounded by industrial development and provide little habitat value.

Water Quality

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Palustrine Aquatic Bed/Unconsolidated Bottom (Stormwater and Industrial Wastewater Treatment Ponds)

Wastewater treatment ponds capture industrial discharge and urban stormwater runoff function to improve water quality through filtration and settling of sediment, thus removing urban contaminants adsorbed to sediment particles. Water from these ponds is not released to nearby stream channels or the Delta; thus, water quality of the surrounding environment is not affected unless the treatment pond is not maintained and contaminants leach to the surrounding area and underlying groundwater.

Palustrine Persistent Emergent (Perennial, Seasonal)

There is a group of perennial and seasonal wetlands on the northeast boarder of the Oakley subbasin. These wetlands function to filter out sediment and associated nutrients and urban runoff contaminants contained in surface runoff flows from the surrounding area. The wetlands serve as the last surface water filtering mechanism for that area before the water reaches the Delta.

Hydrologic Cycling and Flood Storage

Riverine excavated artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Palustrine Aquatic Bed/Unconsolidated Bottom (Industrial Wastewater and Stormwater Treatment Ponds) and Palustrine Persistent Emergent (Perennial and Seasonal)

Industrial wastewater ponds and seasonal wetlands provide little flood storage capacity. Stormwater treatment ponds function to capture and retain runoff waters from surrounding impervious surfaces. The perennial and seasonal wetlands near the Delta help stabilize the shoreline from wave erosion during high winds.

Management Considerations for WoUS Conservation and Enhancement

The following measures are advisable to maintain and enhance WoUS functioning in this subbasin.

- Protect perennial and seasonal wetlands adjacent to Suisun Bay tidal marshes on the northeast portion of the subbasin.
- Maintain industrial wastewater treatment ponds to prevent contamination of the Delta.
- Limit the increase in impervious surfaces within the subbasin to prevent impacts on adjacent tidal wetlands.

Table 5-13 summarizes the overall quality of wetland types.

5.3.3 Lower Marsh Creek

Physical Setting

This subbasin covers approximately 10,454 acres, representing approximately 6% of the inventory area. Figure 5-14a shows the location of wetland types found in the Lower Marsh Creek subbasin.

Geology

Lower Marsh Creek is underlain by a variety of Quaternary deposits that have been recently mapped in detail by Helley & Graymer (1977). Downstream of the confluence with Briones Creek, the Lower Marsh subbasin consists of Holocene levee-overbank deposits (Qhl), which are generally porous and permeable; alluvial fan deposits (Qhaf), which are generally more gravelly; and finer Holocene basin deposits (Qhb) comprising silty clay and clays. To the north toward the San Joaquin river channel are found Quaternary dune sands (Qds) that originate from the lower sea levels of the Last Glacial Maximum (LGM) and provide very well-draining soils.

Soils

Soil in and adjacent to the Marsh Creek channel from the Marsh Creek Reservoir to just downstream of the confluence with Sand Creek is Sorrento silty clay loam. The creek cuts through a band of Rincon clay loam, and then through alternating patches of Delhi sand, Sorrento silty clay loam with a sandy substrate, and Sycamore silty clay loam.

Climate

Annual average rainfall in the entire Marsh Creek watershed is 17 inches.

Hydrology and Land Use

Marsh Creek becomes perennial at its confluence with Dry Creek. From its confluence with Sand Creek to its mouth in the Delta, the creek is confined to a trapezoidal channel that functions to quickly convey floodwater downstream. Vegetation in the Lower Marsh Creek channel is not chemically managed. Riparian vegetation growing along the channel banks, including areas of freshwater marsh, is dominated by cattails and hardstem bulrush (*Scirpus acutus*) and areas of seasonal wetland dominated by rabbit’s root grass (*Polypogon monspeliensis*) and dotted smartweed (*Polygonum punctatum*). However, marsh and riparian vegetation is cleared regularly, and the channel is periodically dredged (Robins and Cain 2002). The southernmost portion of the subbasin is located at the transition between the foothills/upper valley and lower valley/plain regions. A portion of this area west of the Marsh Creek channel consists of rangeland containing several stock ponds and seasonal wetlands. The reach from the Marsh Creek Reservoir to the confluence with Dry Creek runs through a corridor of palustrine forest surrounded by agricultural fields. The reach from Dry Creek to the confluence with Sand Creek is surrounded by residential housing and is therefore restricted from meandering or floodplain inundation.

Land use in this portion of Marsh Creek is largely residential and industrial with patches of agricultural farmland. The southernmost portion of the subbasin, between Concord Avenue and the reservoir, is located within John Marsh State Historic Park. Creekside Park, a small municipal park, surrounds a short reach of Marsh Creek between Arlington Way and Balfour Road. There are two active railroad lines that run through this subbasin. Maintenance and operation of rail lines involve lubrication of the tracks and wheels with oils and greases. These contaminants can be transported to drainage channels and ultimately to the Delta, further degrading water quality.

WoUS Types

WoUS types in the Lower Marsh Creek subbasin include six of the general types described in Chapter 4.

- Riverine nontidal (intermittent and lower perennial).
- Riverine tidal (lower perennial).
- Riverine excavated artificial.
- Palustrine forest.
- PAB/UB (stock ponds, wastewater treatment ponds).
- PPEM (seasonal).

Figure 5-14b shows representative photos of WoUS types commonly found in this subbasin. Table 5-14 summarizes the functions of each WoUS type found in the Lower Marsh Creek subbasin.

Apart from the aqueduct and wastewater treatment plant, riverine lower perennial areas make up most of the WoUS acreage in this subbasin, with significant areas of PPEM as well. Outside of the creek channel itself, nearly all of the WoUS in the subbasin are located south of the confluence with Dry Creek and consist of palustrine forest along the channel and stock ponds and seasonal wetlands in rangeland.

Wetland Functions

Habitat

Riverine Nontidal (Intermittent and Lower Perennial)/Palustrine Forest

South of Creekside Park, most of the creek channel is surrounded by palustrine forest or grasslands. This reach of the creek is likely to be somewhat sediment starved because of its location just downstream of Marsh Creek Reservoir. However, the reach provides habitat for a variety of wildlife.

Downstream of Creekside Park, the channel is frequently disturbed and is surrounded by development or intensive agriculture, limiting its habitat value.

Riverine Tidal (Lower Perennial)

These features are formed near the mouth of Marsh Creek. The portion of the creek closest to the mouth provides important riverine mudflat and tidal marsh habitat for many species, but it is outside the inventory area. The portion in the inventory area is surrounded by intensive agriculture and consists of a trapezoidal flood control channel, providing limited habitat value.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Palustrine Aquatic Bed/Unconsolidated Bottom (Stock Ponds)

Seasonal stock ponds in the southern portion of the subbasin may provide habitat for amphibians such as CTS, which has been documented in this area of the subbasin (CNDDB 2003).

Palustrine Persistent Emergent (Seasonal)

Seasonal PPEM wetlands in the Lower Marsh Creek subbasin are located principally in the grazing land in the southern portion of the subbasin. These wetlands, while largely unvegetated, still provide potential habitat for amphibians such as CTS and invertebrates such as fairy shrimp (*Branchinecta lynchi*) and molestan blister beetles (*Lytta molesta*), all of which have been documented in this area of the subbasin (CNDDB 2003).

Water quality

Riverine Nontidal (intermittent and lower perennial)

Lower Marsh Creek downstream of Marsh Creek Reservoir captures contaminants contained in urban runoff from surrounding residential housing and agricultural fields. Contaminants such as oils and grease, carbon particulates, and nutrients from fertilizers are washed to the channel and conveyed downstream. These contaminants are adsorbed to fine sediments and transported into the channel. Although reaches of the channel within residential neighborhoods have been planted with grass, shrubs, and trees to provide filtering of runoff waters, the primary function of the channel in this area is to convey floodwaters; thus, the majority of these sediments are transported downstream where water quality is further degraded. Sediments within Lower Marsh Creek also contain high concentrations of mercury washed from mines and soils higher in the watershed.

The lower perennial reach of Marsh Creek has been modified to support agriculture and urban development. This reach carries agriculture return and runoff flows from the surrounding developed land. Maintenance and operation activities for active railroads can deposit oils and grease to nearby channels. Contaminants carried from these sources, in addition to contaminants from upland sources, degrade water quality.

Riverine Tidal (Lower Perennial)

Tidal reaches of Lower Marsh Creek mix and dilute with surface waters carried from the upper watershed with brackish Delta water. Stable vegetation grows in the channel in this reach. The vegetation helps to filter and remove excessive nutrients and metals from surface and Delta waters.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Palustrine Aquatic Bed/Unconsolidated Bottom (Stock Ponds, Wastewater Treatment Ponds)

Wastewater treatment ponds found in the Lower Marsh Creek subbasin are part of the treatment process for the City of Brentwood Sunset Wastewater Treatment Plant. Wastewater treatment ponds function to improve water quality through filtration and settling of sediment, thus removing urban contaminants adsorbed to sediment particles. Water from these ponds is not commonly released to nearby stream channels, so water quality of the surrounding environment is not degraded. Similarly, stock ponds remove sediment from the water column. However, use of these ponds by cattle degrades water quality through high concentrations of nutrients and high turbidity from trampling of the soils.

Palustrine Persistent Emergent (Seasonal)

Seasonal wetlands found on grazed lands function to filter out sediment and associated nutrients and urban runoff contaminants contained in surface runoff flows from the surrounding area. These wetlands can serve as the last surface water filtering mechanism before the water reaches the Delta.

Hydrologic Cycling and Flood Storage

Riverine Nontidal (Intermittent and Lower Perennial)

Because of residential developments in the flatland areas low in the watershed, creek channels have been modified to convey floodwaters quickly to the Delta. Floodwaters from this subbasin are carried to the Delta through these engineered channels, as well as culverts and storm drain networks.

Riverine Tidal (Lower Perennial)

Vegetation growing in tidally influenced reaches of Lower Marsh Creek provides structure against bank erosion due to wave action. This is particularly important during storm events when waves become large and more forceful.

Riverine Excavated Artificial

See discussion of the Contra Costa Canal in Section 4.5 of Chapter 4.

Palustrine Aquatic Bed/Unconsolidated Bottom (Stock Ponds, Wastewater Treatment Ponds) and Palustrine Persistent Emergent (Seasonal)

Ponds and seasonal wetlands provide little flood storage capacity.

Management Considerations for WoUS Conservation and Enhancement

There are many opportunities for restoration in the Lower Marsh Creek subbasin to improve habitat and water quality. Table 5-14 summarizes the overall quality of wetland types and opportunities for preservation and restoration. Listed below are a few potential opportunities for this subbasin.

- Restore vegetative and wildlife habitat to upper reaches of the channel. Restore channel sinuosity and create step pool habitat (also works for flood control).
- Ensure wastewater treatment ponds are being properly maintained so contaminants are not leaching to surface or groundwater supplies.
- Maintain grates to stormwater drains in residential neighborhoods to reduce recruitment of garbage and debris to the channel.
- Post notices to prevent local residents from depositing oil, grease, paint, and other chemicals down storm drains, which ultimately transport to Lower Marsh Creek.
- Enforce prevention of illegal dumping of garbage and chemicals to the stream channels and drainage ditches.

5.4 Sacramento–San Joaquin Delta

The Sacramento–San Joaquin Delta region supports numerous drainages, which are treated here collectively as a single subbasin, the East County Delta Drainages subbasin. The East County Delta Drainages include Indian, Rock, Sand Mound, Dutch, Piper, and Taylor Sloughs, as well as False River.

5.4.1 East County Delta Drainages

Physical Setting

This subbasin covers approximately 20,385 acres, representing approximately 12% of the inventory area. Figure 5-15a shows the location of WoUS found in the East County Delta Drainages subbasin.

Geology

Brentwood dune sands, deposited in the Pleistocene and Holocene, underlie the East County Delta Drainages. This deposit type extends through the northern portion of the region. These sands are being buried by Basin Deposits found in the surrounding areas of this region. The Basin Deposits are very fine silty clay and clay deposits at alluvial fan edges and adjacent to bay mud.

Soils

Soils of the East County Delta Drainages can be characterized as nearly level silty clay and clay loams. These comprise Capay clay, Brentwood clay loam, Marcuse clay, alkali Sacramento clay, with patches of Sycamore clay, Marcuse sand, and Rincon clay loam. A band of Delhi sands crosses the area from the northwest towards the southwest. Aside from the sands, these soils have low permeability and high alkali content. These soils hold water for long periods of time unless intentionally drained.

Climate

Average annual rainfall in this subbasin is 11 inches.

Hydrology and Land Use

Elevation in the subbasin ranges from 100 feet above sea level, towards the south, to 20 feet below sea level, in the northeast. Water originating in the subbasin from pumped groundwater and agricultural return flows generally flows northeast towards the San Joaquin River and ultimately to the Delta. Additional water for agricultural use is pumped from the Delta. Channels in this basin consist of constructed irrigation and flood control channels, including the Contra Costa Canal, as well as channelized sloughs. Channelized reaches of Indian, Rock, Sand Mound, Dutch, Piper, and Taylor Sloughs are found in this subbasin, as well as False River. These channels are perennial due to return flows from agriculture and the conveyance of potable water. Some of these channels are vegetated, while others are formed by impervious concrete. PPEM wetlands are found in depressional areas along the northern and eastern edges of the subbasin boundary. Many of these wetlands are adjacent to sloughs or drainage channels, particularly along Old River, on the eastern edge of the subbasin.

Land use in this subbasin is dominated by agriculture, though portions are rapidly being developed for residential use. Row crops, such as corn, are grown in fields irrigated by groundwater and captured surface water. There are two active railroad lines that run through this subbasin. Maintenance and operation of rail lines involve lubrication of the tracks and wheels with oils and greases. These contaminants can be transported to drainage channels and thence to the Delta.

Waters of the U.S. Types

WoUS in the East County Delta Drainages subbasin include three of the general types described in Chapter 4.

- PPEM (perennial, seasonal).
- Riverine (tidal and nontidal lower perennial).
- Riverine excavated artificial.

PPEM wetlands make up about 40% of WoUS acreage in the subbasin. Riverine lower perennial areas account for about 20% of WoUS acreage in the subbasin.

Figure 5-15b shows representative photos of WoUS commonly found in this East County Delta Drainages subbasin. Table 5-15 summarizes the functions of each WoUS type found in the subbasin.

Waters of the U.S. Functions

Habitat

Palustrine Persistent Emergent (Perennial, Seasonal)

PPEM wetlands in the subbasin are surrounded by intensive agriculture. Some of these wetlands are themselves farmed and therefore provide habitat only for those species that can tolerate frequent human disturbance. These PPEM wetlands do provide habitat for plant species associated with emergent marshes and seasonal wetlands. However, large populations of exotic ruderal species are associated with agricultural land adjacent to these wetlands, and these exotic species may compete aggressively with some native wetlands species. Seasonal wetlands in the subbasin may provide habitat for vernal pool fairy shrimp, which have been documented in the subbasin (CNDDB 2003).

Riverine Tidal and Nontidal (Lower Perennial)

Riverine WoUS in the subbasin include tidal portions of Old River and an unnamed tributary of False River along the eastern and north edges of the subbasin, as well as nontidal drainages in the center of the subbasin. Some of these sloughs, particularly on the northern edge of the subbasin, flow into tidal marsh along the Suisun Bay. While these sloughs are adjacent to agricultural areas, their proximity to tidal marsh implies that they may provide secondary habitat for marsh species. Slough banks may provide habitat for rose mallow, which has been documented in the area.

Riverine Excavated Artificial

The Contra Costa Canal provides very limited habitat functions, as described above. Some artificial drainage ditches in the subbasin contain abundant marsh vegetation and provide habitat for species able to tolerate the frequent human disturbance associated with adjacent agricultural areas and periodic maintenance of the ditches themselves. Larger drainage channels contain dense populations of water hyacinth (*Eichhornia crassipes*), an invasive exotic plant species.

Water Quality

Riverine Tidal and Nontidal (Lower Perennial)

The lower perennial drainages have been modified to support agriculture and urban development. These drainages carry agriculture return and runoff flows from the surrounding developed land. Water within these channels is degraded by fertilizers, pesticides, and heavy metals from machinery, all contributing to reduced water quality for aquatic life. Maintenance and operation activities for active railroads can deposit oils and grease to nearby channels. Contaminants carried from these sources, in addition to contaminants from upland sources, degrade water quality.

Stable vegetation grows in the channel in this reach. The vegetation helps to filter and remove excessive nutrients and metals from surface and Delta waters.

Tidal reaches help dilute surface waters carried from upland areas with brackish water of the Delta.

Palustrine Persistent Emergent (Alkali)

Alkali wetlands are an important source of minerals and salts in the subbasin. Presence of these wetlands flushes minerals from the soils; the minerals are transported downstream and made available for uptake by aquatic life. An overabundance of salts dissolved in the water can degrade water quality to a level unfit for human consumption. However, concentrations of salt deposited in alkali wetlands in this subbasin have a minimal impact on the quality of potable water supplies.

Hydrologic Cycling and Flood Storage

Riverine Tidal and Nontidal (Lower Perennial)

Channels of the East Delta Drainages function to capture and convey agricultural irrigation and return flows to and from the Delta. These channels function to convey, rather than store, flood flows. Vegetation growing in these perennial reaches provides structure against bank erosion due to wave action. This is particularly important during storm events when waves become larger and more forceful.

Palustrine Persistent Emergent (Alkali)

Seasonal wetlands provide little flood storage capacity.

Management Considerations for WoUS Conservation and Enhancement

Table 5-15 summarizes the overall quality of WoUS types. Listed below are a few potential opportunities to improve habitat and water quality for this subbasin.

- Encourage farmers to reduce quantity of fertilizers and herbicides used on fields to improve water quality of marsh areas and ultimately the Delta.
- Discourage illegal dumping of garbage and chemical waste near and into sloughs and drainage channels.
- Reduce or remove invasive plant species growing within drainage channels to encourage establishment of native plant species and ultimately native wildlife species.

Table 5-1. Upper Mount Diablo Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic (HGM) Class	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal (upper perennial and intermittent streams)	Montane Stream Channels	Pool and riffle formations within the channel provide unique habitat for rare wildlife species, such as CRF and juvenile fish.	High	Steep topography and transport of sediment and large woody debris to the channel creates step-pools, thus providing high quality in-channel habitat for fish and wildlife. Cold water inputs to the channel reduces water temperature thus improving water quality.	High	High	High
Riverine nontidal (upper perennial and intermittent streams) continued	Foothill/Terrace Stream Channels Valley Stream Channels	Areas protected by state parks provide moderate to high quality plant and wildlife habitat. Where adjacent land is grazed or occupied by residential use the channel contains less species diversity.	Moderate	Residential use in the lower subbasin has reduced groundwater recharge and flood storage functions. Many reaches of stream channels have been routed underground to prevent flood damage to property, thus reducing hydrologic functions.	Low	Moderate in protected areas Low in residential areas	High in nonresidential areas Low in residential areas
Palustrine forest (riparian forest)	Montane Stream-Banks	Rare plant and wildlife species found in the high quality habitat provided by upper riparian woodlands	High	Riparian vegetation, particularly tall trees, contributes to the formation of step-pools when branches or tree trunks fall and become lodged in the channel. This improves water quality and hydrologic functioning.	High	High	High
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Adjacent land is occupied by grassland or oak woodland habitat that is managed for cattle grazing or open space. High quality habitat for foothill and valley species is found here.	High	These wetlands function to improve water quality through filtration of sediment and nutrients from surface flows.	High	High	High

Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Agricultural Ponds and Reservoirs	Breeding habitat for CTS and other amphibians are provided by these ponds	Moderate	Ponds function to provide small quantities of flood storage and groundwater recharge.	Low	Moderate	Moderate

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio		Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
			Preservation	Restoration			
Riverine nontidal (upper perennial and intermittent streams)	36						
Palustrine forest (riparian forest)	13						
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	3.3						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	6						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-2. Upper Marsh Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal upper perennial	Montane stream channels	Pool and riffle formations, sandy point bars, within the channel provide a variety of habitats. Habitat for rare wildlife species, such as CRF and WPT.	High	Mercury contamination downstream of Dunn Creek. Sediment sources.	Moderate (most upper perennial reaches are upstream of Dunn Creek)	High	High
Riverine nontidal lower perennial	Valley Stream Channels	Habitat quality varies depending on adjacent land cover (riparian forest or grassland). CRF and WPT occurrences documented.	Moderate	Mercury contamination. Filtration capacity higher in eastern portion of subbasin where high clay soils are found. High flood storage and groundwater recharge function, especially at transition from steep to gentle gradients.	Low	Low	Moderate
Riverine nontidal intermittent	Montane stream channels, Foothill/Terrace Stream Channels	Intact riparian forest adjacent to channel provides high quality habitat for species such as CTS.	High	Mercury contamination downstream of Dunn Creek. High clay content in the Brentwood soils, concentrated in eastern part of subbasin, facilitate filtration.	Low	Moderate	Moderate
Palustrine forest (riparian forest)	Montane Stream-Banks	Rare plant and wildlife species found in the high quality habitat provided by upper riparian woodlands	High	Generates coarse woody debris, increasing channel variability. Maintains cool water temperatures.	High	High	High
Palustrine persistent	Valley Bottom	Habitat quality varies	Moderate	Filtration capacity	Moderate	Moderate	High

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
emergent (PPEM) (seasonally or temporarily flooded wetlands)	depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	with adjacent land use. Adjacent land is occupied by grassland or oak woodland habitat, sometimes overgrazed.		higher in eastern part of subbasin because of high clay soils. Wetlands in and adjacent to streams provide greater water quality functioning because of lower livestock impacts.			
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Agricultural ponds	Breeding habitat for CTS and other amphibians are provided by these ponds	Moderate	Ponds function to provide small quantities of flood storage and groundwater recharge. In-stream ponds store mercury in trapped sediments.	Low	Moderate	Moderate
Impounded lacustrine	Reservoir	Woodland surrounding reservoir enhances habitat. WPT occurrences documented.	Low	Stores mercury in sediments on reservoir bottom. Sediment sink results in sediment starved waters downstream, increasing erosivity of creek flows. Provides flood storage and groundwater recharge.	Low	Low	Low

* "Potential" as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio: Preservation	Mitigation Ratio: Restoration	Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
Riverine nontidal upper perennial	90 miles						
Riverine nontidal lower perennial							
Riverine nontidal intermittent							
Palustrine forest (riparian forest)	171						
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	20						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	35						
Impounded lacustrine	31						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-3. Willow Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal intermittent	Foothill/Terrace Stream channels; Valley Bottom Stream Channels	Adjacent land cover varies from grassland and riparian forest to developed. CTS and CRF habitat in foothills.	Moderate	Wetland vegetation in some reaches filters pollutants. Groundwater recharge is greatest at transition zone from foothills to valley. Some valley reaches are undeveloped and provide flood storage and groundwater recharge. Poorly installed culverts increase erosion.	Low	Low	Moderate
Palustrine forest (riparian forest)	Foothill/Terrace Stream-Banks	Forest corridor is narrow and understory may be overgrazed in some areas.	Low	Reduce flow velocity and filter sediment. Maintain cool water temperatures.	Moderate	Low	Moderate
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Fragments of tidal marsh may provide secondary habitat for some species. Seasonal wetlands provide CTS habitat.	Low	Wetland vegetation, which is generally denser in upper subbasin, enhances filtration. Detention basins store flood flows and recharge groundwater.	Moderate	Low	Moderate
Riverine excavated artificial	Aqueduct	Open water habitat for waterfowl, shorebirds and	Low	Human drinking water conveyance	Low	Low	Low

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
		some amphibians.					
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Agricultural Ponds, Recreational Ponds	Vegetation generally lacking. Stock ponds may provide CTS habitat.	Moderate	Some pollutants adsorb to the abundant clay soils in subbasin. Small amount of flood storage and groundwater recharge.	Low	Low	Low

* "Potential" as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio: Preservation	Mitigation Ratio: Restoration	Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
Riverine nontidal intermittent	28 miles						
Palustrine forest (riparian forest)	39						
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	56						
Riverine excavated artificial	1						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	11						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-4. Kirker Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal intermittent	Foothill/Terrace Stream channels; Valley bottom stream channels	Adjacent grassland and woodland enhance riverine habitat in the foothills, where CRF and CTS have been documented. Adjacent development limits habitat function in valley.	Moderate	Foothills provide sediment source. Poorly installed culverts increase erosion. Restricted floodplain reduces flood storage and groundwater recharge. Low pH in headwaters area due to historic coal mines.	Low	Low	Moderate
Riverine nontidal lower perennial	Valley bottom stream channels	Adjacent development limits habitat function.	Low	Restricted floodplain reduces flood storage and groundwater recharge. Problems with flooding in developed areas. Illegal dumping compromises water quality.	Low	Low	Moderate
Palustrine forest (riparian forest)	Foothill/Terrace Stream-Banks; Valley bottom stream banks	Forest corridor narrows from foothills to valley. Understory in foothills may be overgrazed.	Low	Reduce flow velocity and filter sediment. Maintain cool water temperatures.	Moderate	Low	Moderate
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Floodplain wetlands with grassland adjacent provide habitat for CTS and other amphibians in the foothills.	Moderate	Wetlands in the foothills and vegetated detention basins in the valley filter contaminants and provide flood storage.	Moderate	Moderate	Moderate
Riverine excavated	Aqueduct	Open water habitat	Low	Human drinking water	Low	Low	Low

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
artificial		for waterfowl, shorebirds and some amphibians.		conveyance			
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Agricultural Ponds, Recreational Ponds	Vegetation generally lacking. Stock ponds may provide CTS habitat.	Moderate	Unvegetated detention basins provide flood storage and groundwater recharge. Stock ponds provide these services at low levels.	Low	Low	Low

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio: Preservation	Mitigation Ratio: Restoration	Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
Riverine nontidal intermittent	41 miles						
Riverine nontidal lower perennial							
Palustrine forest (riparian forest)	43						
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	19						
Riverine excavated artificial	0.4						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	3						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-5. West Antioch Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal intermittent	Foothill/Terrace Stream channels; Valley bottom stream channels	Adjacent protected forest and grasslands in foothills enhance habitat quality for species including CTS and CRF.	Moderate	Vegetated reaches filter contaminants. Stream reaches in the transition zone may provide groundwater recharge.	Moderate	Moderate	Moderate
Riverine nontidal lower perennial	Valley bottom stream channels	Low habitat quality due to adjacent developed land and culverted reaches	Low	Sediment sink. Contaminants from urban runoff may be trapped in bottom sediments. Naturally lined channels provide groundwater recharge.	Low	Low	Low
Palustrine forest (riparian forest)	Foothill/Terrace Stream-Banks	Protected forest areas provide habitat for species including Diablo helianthella.	High	Reduce flow velocity and filter sediment. Maintain cool water temperatures.	High	High	High
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Wetlands in the foothills provide habitat for CTS and CRF. Wetlands in the Lower Valley/Plain are small and isolated.	Moderate	Wetlands in the foothills filter contaminants and provide flood storage.	Moderate	Moderate	Moderate
Riverine excavated artificial	Aqueduct	Open water habitat for waterfowl, shorebirds and some amphibians.	Low	Human drinking water conveyance	Low	Low	Low
Palustrine aquatic bed/unconsolidated bottom (PAB/UB)	Agricultural Ponds	Stock ponds provide habitat for CTS.	Moderate	Stock ponds provide a low level of flood storage and	Low	Moderate	Moderate

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
(ponds)				groundwater recharge.			
Lacustrine impounded	Reservoir	Where adjacent land has not been developed or landscaped for recreation, habitat value is enhanced.	Low	Sediment sink. Flood storage and groundwater recharge.	Low	Low	Low

* "Potential" as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio: Preservation	Mitigation Ratio: Restoration	Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
Riverine nontidal intermittent	25 miles						
Riverine nontidal lower perennial							
Palustrine forest (riparian forest)	45						
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	21						
Riverine excavated artificial	0.1						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	3						
Lacustrine impounded	126						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-6. Sand Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal intermittent	Foothill/Terrace Stream channels; Valley bottom stream channels	Riparian forest along some reaches enhances habitat quality for species such as CRF and fish. Lack of riparian vegetation compromises habitat quality in overgrazed areas.	Moderate	Sandy soils are important sediment source for Marsh Creek. Gentle gradients and adjacent grassland allow flood storage.	Moderate	Moderate	High
Riverine nontidal lower perennial	Valley bottom stream channels	Engineered trapezoidal channel adjacent to development provides low habitat function.	Low	Flood water conveyance.	Low	Low	Moderate
Palustrine forest (riparian forest)	Foothill/Terrace Stream-Banks	Riparian forest along perennial reaches of Oil Canyon Creek provides high-quality habitat.	High	Reduce flow velocity and filter sediment. Maintain cool water temperatures.	High	High	High
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Wetlands within preserve offer high quality habitat. Wetlands in overgrazed and mowed areas provide habitat for disturbance-tolerant species.	Low	Filter contaminants and provide flood storage and limited groundwater recharge.	Moderate	Low	Moderate
PPEM Alkali	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Alkali wetlands in foothills provide potential habitat for rare species such as San Joaquin spearscale if livestock access is regulated.	Moderate	Filter contaminants and provide flood storage and limited groundwater recharge.	Moderate	Moderate	High

Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Agricultural Ponds, Recreational Ponds	Stock ponds provide potential habitat for CTS.	Moderate	Low level of flood storage and groundwater recharge.	Low	Low	Low

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio: Preservation	Mitigation Ratio: Restoration	Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
Riverine nontidal intermittent	29 miles						
Riverine nontidal lower perennial							
Palustrine forest (riparian forest)	20						
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	27						
PPEM Alkali	11						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	17						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-7. Deer Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal intermittent	Foothill/Terrace Stream channels; Valley bottom stream channels	Riparian vegetation lacking due to overgrazing. Streambanks may provide burrowing owl habitat.	Low	Erosion results in abundant fine sediment. Gentle gradient and clay soils with high water retention allow flood storage.	Low	Low	Moderate
Riverine nontidal lower perennial	Valley bottom stream channels	Adjacent development compromises habitat quality. Portions have been riprapped.	Low	Flood water conveyance.	Low	Low	Low
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Lack of vegetation compromises habitat quality. Some wetlands retain marsh vegetation. May provide fairy shrimp and CTSA habitat.	Low	Lac of vegetation due to livestock impacts limits filtration capacity. Provide flood storage and limited groundwater recharge.	Low	Low	Moderate
PPEM Alkali	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Potential special status species habitat if livestock access is regulated.	Low	Heavy grazing reduces vegetation, limiting filtration capacity. Provide flood storage and limited groundwater recharge.	Low	Low	Moderate
Palustrine aquatic bed/unconsolidated	Agricultural Ponds,	Stock ponds provide potential	Moderate	Low level of flood storage and	Low	Low	Low

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
bottom (PAB/UB) (ponds)	Recreational Ponds	habitat for CTS.		groundwater recharge.			
Lacustrine impounded	Reservoir	Potential CTS habitat	Low	Flood storage and groundwater recharge	Moderate	Low	Low

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

			Mitigation Ratio				
Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Preservation	Restoration	Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
Riverine nontidal intermittent	12 miles						
Riverine nontidal lower perennial							
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	8						
PPEM Alkali	6						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	11						
Lacustrine impounded	7						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-8. Dry Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal intermittent	Foothill/Terrace Stream Channels; Valley Bottom Stream Channels	Adjacent grassland in foothills region enhances habitat quality for burrowing owl and other species. Some reaches provide habitat for halophytic plant species such as San Joaquin spearscale. Adjacent development in lower valley/plain region reduces habitat quality.	Moderate	Unpaved roads contribute fine sediment to channel. Filtration is limited because of narrow vegetated riparian buffers. Floodplain areas are narrow in lower subbasin. Channel functions for flood water conveyance.	Low	Low	Moderate
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands, mostly Alkali)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Adjacent grassland at Dry Creek's headwaters enhance PPEM habitat for CTS, fairy shrimp and other species. Other PPEM wetlands provide habitat for halophytes such as San Joaquin spearscale but quality is limited by adjacent development.	Moderate	Short stature wetlands vegetation limits the extent of filtration. Some flood storage and groundwater recharge.	Low	Moderate	Moderate
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Agricultural ponds, recreational ponds,	Stock ponds provide potential CTS habitat. Golf course ponds and detention basins provide little habitat	Low	Sediment traps. Some flood storage and groundwater recharge.	Low	Low	Low
Riverine Excavated Artificial	Aqueduct	Open water habitat for waterfowl, shorebirds, and some amphibians.	Low	Human drinking water conveyance	Low	Low	Low

* "Potential" as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio: Preservation	Mitigation Ratio: Restoration	Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
Riverine nontidal intermittent	7 miles						
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	4						
PPEM Alkali	17						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	8						
Riverine Excavated Artifical	0.3						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-9. Briones Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal intermittent	Foothill/Terrace Stream Channels; Valley Bottom Stream Channels	Overgrazing in foothills region limits the development of riparian vegetation and thus limits habitat quality. Stream banks provide potential burrowing owl habitat. Lower subbasin is in state park.	Low	Incised channel and eroding banks lead to high sediment loads and water temperatures. Limited floodplain development due to downcutting results in limited flood storage. Soils with low permeability reduce groundwater recharge potential.	Low	Low	Moderate
Palustrine forest/scrub	Foothill/Terrace Stream Banks; Valley Bottom Stream Banks	Small patches of woodland vegetation provide limited habitat quality	Low	Sediment filtration and water cooling limited by small size of patches	Low	Low	Moderate
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	Foothill/Terrace Stream Channels; Valley Bottom Stream Channels; Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Overgrazing in upper subbasin reduces habitat quality. Most PPEM wetlands are in lower subbasin within state park and provide habitat for fairy shrimp and CTS.	Moderate	Lack of vegetation reduces filtration capacity in upper subbasin. Greater filtration capacity in lower subbasin. Flood storage and small amounts of groundwater recharge.	Moderate	Moderate	High
PPEM Alkali	Same as above	Mostly within state park. Provide habitat for halophytic species such as San Joaquin spearscale.	High	Short stature of vegetation limits filtration capacity. Flood storage and small amounts of groundwater recharge.	Low	Moderate	Moderate
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Agricultural ponds	Potential habitat for CTS	Low	Sediment and nutrient traps. Modest amounts of flood storage and groundwater recharge.	Low	Low	Low

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio		Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
			Preservation	Restoration			
Riverine nontidal intermittent	19 miles						
Palustrine forest/scrub	0.1						
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	11						
PPEM Alkali	5						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	10						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-10. Kellogg Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal intermittent	Foothill/Terrace Stream channels; Valley Bottom Stream channels	Adjacent grasslands provide good habitat for a variety of species, including CRF.	High	Outside the protected watershed area, the floodplain is restricted and livestock access to the channel increases erosion and nutrient delivery downstream.	Moderate	Moderate	High
Riverine nontidal lower perennial	Foothill/Terrace and Valley Stream channels	Agricultural land use has degraded the quality of habitat in these reaches. Species found here are accustomed to human disturbance.	Low	Poor water quality due to high nutrients and other contaminants from agricultural return flows in the lower subbasin. Low flood storage due to confinement of the adjacent floodplain.	Low	Low	Moderate
Palustrine forest and scrub	Foothill/Terrace Stream-Banks	Willow, alders, oaks, and grassland provide habitat for a wide variety of species. Fewer species are found closer to the Delta.	High	Improved water quality through sediment removal. Patches of forest and scrub locally reduce water temperature.	Moderate	Moderate	High
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Intensive agriculture surrounds wetlands and vernal pools in the lower subbasin. Special status plants and wildlife have been documented throughout the subbasin.	Moderate	Removal of sediments and associated contaminants improves water quality. However, grazing pressure may reduce this function in some areas.	Moderate	Moderate	High
PPEM Alkali	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond	Many special status plant species. Many alkali wetlands are stressed by adjacent	Moderate	Important sink for minerals and salts dissolved in surface waters.	Moderate	Moderate	High

	Margins	agricultural uses.					
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Agricultural Ponds	Numerous stock ponds are found throughout the subbasin. The ponds provide habitat for CTS and CRF.	Moderate	Some pollutants adsorb to the abundant clay soils in subbasin. Little flood storage and groundwater recharge.	Low	Low	Low
Lacustrine impounded	Reservoir	Habitat for bird species is provided by the Los Vaqueros reservoir.	High	Human drinking water supply. Sediment and associated contaminants settle out of the water column here.	High	High	High
Riverine excavated artificial	Aqueduct	Open water habitat for waterfowl, shorebirds and some amphibians.	Low	Human drinking water conveyance	Low	Low	Low

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio		Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
Functional Type			Preservation	Restoration			
Riverine nontidal intermittent and perennial	56 miles						
Riverine tidal	11.5 miles						
Palustrine forest and scrub	25						
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	55						
PPEM Alkali	15						
Lacustrine impounded	1434						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	20						
Riverine excavated artificial	4 miles						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-11. Brushy Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal intermittent	Foothill/Terrace Stream channels; Valley bottom stream channels	Adjacent grasslands provide good habitat for a variety of species, including CRF.	High	Restricted floodplain and livestock access to the channel in the valley reduce water quality filtration mechanisms and flood storage capacity	Low	Moderate	High
Riverine nontidal lower perennial	Valley bottom stream channels	Agricultural land use has degraded the quality of habitat in these reaches. Invasive aquatic plants dominate the channels.	Low	Poor water quality due to high nutrients and other contaminants from agricultural return flows. Low flood storage due to confinement from agricultural use.	Low	Low	Moderate
Palustrine forest and scrub	Foothill/Terrace Stream-Banks	Scrub habitat, found in the upper subbasin, is often degraded by livestock.	Moderate	Improved water quality through sediment removal. Patches of forest and scrub locally reduce water temperature.	Moderate	Moderate	High
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Intensive agriculture surrounds wetlands and vernal pools. Special status plants and wildlife have been documented here.	Moderate	Removal of sediments and associated contaminants improves water quality. However, this function is reduced where begetation cover is impacted by livestock.	Moderate	Moderate	High
PPEM Alkali	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Many special status plant species. Many alkali wetlands are stressed by adjacent	Moderate	Important sink for minerals and salts dissolved in surface waters.	Moderate	Moderate	High

		agricultural uses.					
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Agricultural Ponds	Numerous stock ponds are found in the upper subbasin. The ponds provide habitat for CTS and CRF.	Moderate	Some pollutants adsorb to the abundant clay soils in subbasin. Little flood storage and groundwater recharge.	Low	Low	Low
Riverine excavated artificial	Aqueduct	Open water habitat for waterfowl, shorebirds and some amphibians.	Low	Human drinking water conveyance	Low	Low	Low

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio: Preservation	Mitigation Ratio: Restoration	Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
Riverine nontidal intermittent and perennial	47 miles						
Palustrine forest and scrub	15						
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	190 [b]						
PPEM Alkali	326[b]						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	29						
Riverine excavated artificial	48.5 miles						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

[b] Acreage represent wetland complexes, not all of which are jurisdictional wetlands.

Table 5-12. East Antioch Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal intermittent	Foothill/Terrace Stream channels; Valley bottom stream channels	Adjacent development along most of creek degrades habitat quality. Adjacent protected forest and grasslands in creek reach northwest of Hwy 4 enhance habitat quality for species including CTS and CRF	Low	Vegetated reaches filter contaminants. Stream reaches in the transition zone may provide groundwater recharge.	Moderate	Low	Low
Riverine nontidal lower perennial	Valley bottom stream channels	Low habitat quality due to adjacent developed land and culverted reaches	Low	Sediment sink. Contaminants from urban runoff may be trapped in bottom sediments. Naturally lined channels provide groundwater recharge.	Low	Low	Low
Palustrine forest (riparian forest)	Foothill/Terrace Stream-Banks	Small patches of forest, some surrounded by development, provide habitat for limited number of species.	Moderate	Reduce flow velocity and filter sediment. Maintain cool water temperatures.	High	Moderate	Moderate
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Wetlands in the Lower Valley/Plain are adjacent to an open space corridor, and mayprovide habitat for CTS and CRF.	Moderate	Well-developed wetlands vegetation filters contaminants and provide flood storage.	Moderate	Moderate	Moderate

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine excavated artificial	Aqueduct	Open water habitat for waterfowl, shorebirds and some amphibians	Low	Human drinking water conveyance	Low	Low	Low
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Recreational Ponds	Recreational ponds are surrounded by development and provide little habitat function.	Low	Highly disturbed ponds increase sediment mobility, thus degrading water quality. Some flood storage and groundwater recharge.	Low	Low	Low
Lacustrine impounded	Reservoir	Lake Alhambra is surrounded by development and provides little habitat function.	Low	Provides a sediment sink and flood storage.	Low	Low	Low

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio		Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
			Preservation	Restoration			
Riverine nontidal (intermittent and lower perennial)	7 miles						
Palustrine forest (riparian forest)	13						
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	10						
Riverine excavated artificial	0.3						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	1						
Lacustrine impounded	21						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-13. Oakley Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Palustrine scrub	Valley Stream Banks	May provides habitat for a variety of sensitive species, particularly in areas adjacent to tidal marshes.	Moderate	Scrub vegetation removes sediment and associated contaminants through filtration of surface waters. Vegetation at tidal fringes helps to stabilize banks from erosion.	High	High	High
Palustrine persistent emergent (PPEM) (seasonal and perennial)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Habitat quality varies with adjacent land use. Adjacent land is occupied by intensive agriculture, mostly grazing and row crops, or by development.	Low	Filtration capacity of vegetation improves water quality of surface runoff waters. Little flood storage functioning.	Moderate	Low	Low
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Industrial Ponds	Adjacent development limits habitat function.	Low	Lined ponds do not provide flood storage and groundwater recharge.	Low	Low	Low
Riverine excavated artificial	Aqueduct	Open water habitat for waterfowl, shorebirds and some amphibians.	Low	Human drinking water conveyance	Low	Low	Low

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio: Preservation	Mitigation Ratio: Restoration	Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
Palustrine scrub	7						
PPEM (seasonal and perennial)	30						
PAB/UB) (ponds)	3						
Riverine excavated artificial	0.07 miles						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-14. Lower Marsh Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Palustrine persistent emergent (PPEM) (seasonal)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Habitat quality varies with adjacent land use. Adjacent land is occupied by intensive agriculture, mostly grazing and row crops. CTS and fairy shrimp have been documented.	Moderate	Filtration capacity of vegetation improves water quality of surface runoff waters. Little flood storage functioning.	Moderate	Moderate	Moderate
Palustrine forest (riparian forest)	Foothill/Terrace Stream-Banks	Forest areas, found surrounding the Marsh Creek Reservoir and upstream, provide habitat for a variety of species.	Moderate	Reduce flow velocity and encourages sediment removal from the water column. Maintains cool water temperatures.	High	Moderate	Moderate
Riverine tidal and nontidal (lower perennial)	Coastal Plain Stream Channels	Limited habitat in tidal reaches due to modification of channel banks for flood conveyance. Frequent disturbance and surrounding development and intensive agriculture limits habitat value.	Low	Riverine channels function to capture and convey agricultural waters. The filtration capacity of vegetated channels is important to improve degraded water quality of agricultural return waters.	Moderate	Moderate	Moderate
Riverine nontidal (intermittent)	Foothill/Terrace and Valley Stream Channels	Adjacent land use consists of palustrine forest and grasslands or residential and agricultural use. Forests and grasslands found in the upper subbasin provides a better variety of habitat than land use of the lower subbasin.	Moderate	Primary use of the stream channel is to convey floodwaters away from developed areas. Water quality is degraded by residential, industrial, and agricultural use.	Low	Moderate	Moderate

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Agricultural Ponds	Stock ponds provide habitat for CTS.	Moderate	Stock ponds provide a low level of flood storage and groundwater recharge. Frequently disturbed ponds increase sediment delivery to downstream habitats.	Low	Low	Moderate
Riverine excavated artificial	Aqueduct	Open water habitat for waterfowl, shorebirds and some amphibians.	Low	Human drinking water conveyance	Low	Low	Low

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

			Mitigation Ratio				
Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Preservation	Restoration	Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
PPEM (seasonal or perennial)	18						
Palustrine forest	47						
Riverine tidal and nontidal (lower perennial)	6 miles						
Riverine nontidal (intermittent and lower perennial)	4 miles						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	1						
Riverine excavated artificial	10						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Table 5-15. East County Delta Drainages Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Habitat quality varies with adjacent land use. Adjacent land is occupied by intensive agriculture, mostly row crops. Exotic aggressive ruderal species dominate. Vernal pool fairy shrimp have been documented.	Low	Filtration capacity of vegetation improves water quality of surface runoff waters. However, surrounding land uses degrades water quality. Little flood storage functioning.	Low	Low	Moderate
Riverine tidal	Coastal Plain Stream Channels	Marsh vegetation present in sloughs adjacent to agricultural lands provides habitat for a variety of species including rose mallow, documented in the area.	Moderate	The filtration capacity of vegetated channels improves degraded water quality of agricultural return waters. Vegetation prevents erosion from tidal action.	Moderate	Moderate	Moderate
Palustrine forest	Valley Stream Banks	Habitat quality limited by adjacent intensive agriculture.	Low	Filters sediment and cools water.	Moderate	Low	Low
Riverine excavated artificial	Aqueduct, Drainage channels	Open water habitat for waterfowl, shorebirds and some amphibians. Drainage channels may have PPEM vegetation.	Low	Human drinking water conveyance. Flood water conveyance.	Low	Low	Low

* "Potential" as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio: Preservation	Mitigation Ratio: Restoration	Wetland Preservation Needed (acres)	Wetland Available for Preservation[a] (acres)	Wetland Needed for Restoration (acres)
Palustrine persistent emergent (PPEM) (seasonal)	13						
Palustrine persistent emergent (PPEM) (undetermined inundation period)	110						
Riverine tidal	3						
Palustrine forest	11						
Lacustrine impounded	34						
Riverine excavated artificial	93						

[a] Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

Chapter 6
Evaluation of Planning Scenario

This chapter illustrates the potential application of the aquatic resources inventory to regional planning in the study area. The following analysis utilizes information about aquatic resources in the study area to assess the regional implications of a planning scenario currently under consideration in the HCP/NCCP. This planning scenario identifies particular portions of the study area as development areas and other portions as high, medium, or low priority for conservation (conservation areas).

Development areas are defined in the Draft HCP/NCCP as proposed development within the cities of Clayton, Pittsburg, Oakley, and Brentwood excluding tidally-influenced areas along the Delta. Small areas in Contra Costa County surrounding Byron and the Byron Airport are also included, as are selected rural infrastructure projects outside the Urban Limit Line such as roads and detention basins. The City of Antioch is not participating in the HCP/NCCP so its development is not included. Up to 14,502 acres of development is proposed in the Draft HCP/NCCP (see the Draft HCP/NCCP for details).

Not all wetlands within the development area would be lost under this scenario. Avoidance and minimization measures would reduce wetland losses considerably. In particular, no more than 0.6 miles of perennial and intermittent streams and 4.0 miles of ephemeral streams are expected to be lost or degraded under this development scenario, out of the 532 miles of streams within the inventory area. A much greater length of stream would be protected within the conservation area than the length lost or degraded in the development area, and an equivalent or greater length of streams would be restored or enhanced in the conservation area. Up to 250 acres of wetlands or wetland complexes are expected to be lost within the development area. This loss would be balanced by the conservation, enhancement and creation of wetlands within the conservation areas. Wetland types and valuation rankings were compared between wetlands in the development area and the conservation areas. The conservation area is divided into areas of high acquisition priority, medium acquisition priority, and low acquisition priority, based on the value of biological resources in these areas, proximity to existing open space, and other factors (see Chapter 5 of the HCP/NCCP for details). The wetland valuation methodology used is described in Chapter 2. This comparison aids in understanding the overall implications of wetland loss, conservation, enhancement and creation under this planning scenario.

Wetlands in the development area tend to be ranked lower in overall quality than wetlands in the conservation area (Table 6-1). For example, approximately 44% of the wetlands in the development area were ranked as having low overall quality, while only 10% of the wetlands in the conservation area are ranked low. Conversely, only 7% of the wetlands in the development area are ranked as having high overall quality, while 15% of the wetlands in the conservation area are ranked high. Almost a third of wetlands in the high priority acquisition portions of the conservation area are ranked as having high quality. The difference in wetland rankings between the development and conservation area is due to the influence of surrounding land use, which is primarily urban and agricultural in the development area. Wetlands were ranked lower if adjacent land use was urban or intensive agriculture. Urban land use and intensive agriculture in the study area is concentrated in the downstream portions of subbasins (Figure 3-4). The development area is located in the downstream portion of the subbasins, as well. Thus, the current planning scenario would result in the loss of predominantly lower-ranked wetlands, and the protection of predominantly higher-ranked wetlands.

Table 6-1. Distribution of High, Medium, and Low Ranked* Wetlands by HCP/NCCP Planning Designation (Acres)

HCP/NCCP Planning Designation	**Total Extent of Wetlands****	**Extent of Wetlands by Value Rank (Percentage of Total in Each Area)**		
		High	**Medium**	**Low**
Development Area	159	11 (7%)	78 (49%)	70 (44%)
Conservation Area				
High Acquisition Priority	182	56 (31%)	112 (62%)	13 (7%)
Medium Acquisition Priority	141	22 (16%)	119 (84%)	0 (0%)
Low Acquisition Priority	448	38 (9%)	366 (81%)	44 (10%)
Conservation Area Overall	751	116 (15%)	597 (77%)	58 (7%)
Total in Study Area***	1,568	277 (18%)	1,066 (68%)	225 (14%)

*See Chapter 2 for Ranking Methodology.

** Wetland acreages do not include the Contra Costa Canal.

***The Study Area includes the Development Area, the Conservation Area, and other areas with neither designation. Therefore, the total wetland areas in the Development and Conservation Areas combined are less than the wetland area in the Study Area.

Chapter 7
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Chapter 8
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Appendix A
Waters of the United States Inventory Tables

Appendix A

Table 1. Valuation for Wetlands in the Study Area

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
Briones Creek Subbasin										
326	Wetland	0.26	Foothills	grassland	grassland	Low	Low	Low	Low	High
332	Wetland	0.27	Foothills	grassland	grassland	Low	Low	Low	Low	High
338	Pond	0.19	Foothills	grassland	grassland	Low	Low	Low	Low	Medium
341	Pond	0.17	Montane	oak savannah	oak savannah	High	High	High	High	High
344	pond	0.12	Foothills	grassland	grassland	Low	Low	Low	Low	Medium
358	pond	0.24	Montane	grassland	grassland	High	High	High	High	High
359	pond	0.08	Montane	oak woodland	oak woodland	High	High	High	High	High
361	pond	0.18	Foothills	grassland	grassland	Low	Low	Low	Low	Medium
365	pond	0.12	Foothills	oak woodland	oak savannah	Medium	Medium	Medium	Medium	Medium
370	pond	0.14	Montane	grassland	grassland	High	High	High	High	Medium
371	pond	0.28	Foothills	grassland	grassland	Low	Low	Low	Low	Medium
372	wetland	0.10	Foothills	grassland	grassland	Low	Low	Low	Low	High
374	pond	0.43	Montane	grassland	grassland	High	High	High	High	High
383	wetland	0.67	Foothills	grassland	grassland	Low	Low	Low	Low	High
389	pond	0.09	Foothills	grassland	grassland	Low	Low	Low	Low	Medium
390	pond	0.11	Montane	oak savanna	oak savanna	High	High	High	High	High
394	seasonal wetland	0.22	Foothills	grassland	grassland	Low	Low	Low	Low	High
395	pond	0.11	Montane	oak savannah	oak savannah	Medium	Medium	Medium	Medium	Medium
398	pond	0.03	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
399	pond	1.10	Montane	grassland	oak savannah/ oak woodland	High	High	High	High	High
401	pond	0.36	Foothills	oak woodland	oak savannah/ grassland	High	High	High	High	High
403	pond	0.13	Montane	grassland	oak woodland	High	High	High	High	High
405	pond	0.12	Foothills	grassland	grassland	Low	Low	Low	Low	Low
406	pond	0.15	Foothills	grassland	grassland	Low	Low	Low	Low	Low

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
407	wetland	0.09	Foothills	grassland	grassland	Low	Low	Low	Low	High
408	pond	0.10	Foothills	grassland	grassland	Low	Low	Low	Low	Medium
415	pond	0.11	Foothills	oak woodland	grassland	Medium	Medium	Medium	Medium	Medium
418	pond	0.18	Montane	grassland	grassland	High	High	High	High	Medium
422	pond	0.30	Foothills	grassland	oak woodland	High	High	High	High	Medium
423	wetland	0.39	Foothills	grassland	grassland	Low	Low	Low	Low	High
426	pond	0.13	Foothills	grassland	grassland	Low	Low	Low	Low	Medium
429	wetland	0.57	Foothills	grassland	grassland	Low	Low	Low	Low	High
430	seasonal wetland	0.03	Foothills	grassland	grassland	Low	Low	Low	Low	High
443	wetland	0.28	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
451	pond	0.09	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
459	seasonal wetland	6.28	Foothills	grassland	grassland	High	High	High	High	High
461	pond	0.16	Foothills	urban	urban	Low	Low	Low	Low	Low
472	alkali wetland	1.04	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
476	pond	0.49	Foothills	grassland	grassland	High	High	High	High	High
478	alkali wetland	4.44	Foothills	grassland	grassland	High	High	High	High	High
481	pond	0.18	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
491	pond	0.04	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
496	wetland	0.17	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
504	wetland	0.32	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
510	pond	0.12	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
515	wetland	0.10	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
519	pond	0.05	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
520	pond	2.17	Foothills	grassland	grassland	High	High	High	High	High
522	wetland	0.09	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
524	wetland	0.83	Foothills	grassland	grassland	High	High	High	High	High
528	pond	0.05	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
Brushy Creek Subbasin										
500	wetland	5.16	Delta	cropland	pasture	Medium	Low	Low	Medium	Medium
555	wetland	3.52	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium
566	pond	1.45	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
575	alkali wetland	13.20	Delta	alkali grassland	croplad/ urban/ wetland	Medium	Medium	Medium	Medium	High
582	wetland	5.89	Delta	cropland	alkali grassland	Medium	Medium	Medium	Medium	High
585	wetland	29.69	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium
588	pond	0.12	Delta	cropland	cropland	Low	Low	Low	Low	Low
590	wetland	1.91	Delta	urban	cropland	Low	Low	Low	Low	Medium
591	wetland	0.58	Delta	urban	urban	Low	Low	Low	Low	Medium
593	seasonal wetland	14.66	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium
595	pond	0.88	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
598	alkali wetland	7.61	Delta	urban	pasture	Low	Low	Low	Low	Medium
599	pond	3.24	Delta	urban	urban	Low	Low	Low	Low	Low
602	wetland	0.62	Lowland	ruderal	ruderal	Low	Low	Low	Low	Medium
605	wetland	6.93	Delta	cropland	urban	Medium	Low	Low	Medium	Medium
606	pond	4.01	Delta	urban	urban	Low	Low	Low	Low	Low
608	pond	1.88	Delta	wetland	cropland	Medium	Medium	Medium	Medium	Medium
617	pond	0.31	Foothills	urban	urban	Medium	Medium	Medium	Medium	Medium
619	alkali wetland	16.74	Delta	alkali grassland	cropland	Medium	Medium	Medium	Medium	High
620	pond	1.10	Foothills	grassland	ruderal	Medium	Medium	Medium	Medium	Medium
622	wetland	28.24	Delta	alkali grassland	cropland	Medium	Medium	Medium	Medium	High
623	riparian	5.50	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
624	riparian	5.12	Foothills	ruderal	ruderal	Medium	Medium	Medium	Medium	High
629	pond	0.47	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
630	alkali wetland	9.51	Delta	alkali grassland	alkali grassland	High	Medium	Medium	Medium	High
633	wetland	5.68	Foothills	ruderal	ruderal	Medium	Medium	Medium	Medium	High
635	seasonal wetland	0.96	Foothills	ruderal	ruderal	Medium	Medium	Medium	Medium	High
636	seasonal wetland	10.27	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium
638	alkali wetland	0.95	Delta	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
640	pond	0.22	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
644	seasonal wetland	0.38	Delta	cropland	cropland	Low	Low	Low	Low	Medium
645	pond	0.55	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
646	pond	0.08	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
647	alkali wetland	17.36	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
649	alkali wetland	1.65	Foothills	alkali grassland	grassland	Medium	Medium	Medium	Medium	High
652	alkali wetland	18.95	Delta	alkali grassland	alkali grassland	High	Medium	Medium	Medium	High
653	pond	0.56	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	Medium
654	alkali wetland	0.61	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
658	alkali wetland	0.81	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
660	riparian	0.84	Delta	crop	aqueduct	Medium	Low	Low	Medium	Medium
661	pond	0.29	Foothills	alkali grassland	alkali grassland	High	High	High	High	High
667	wetland	7.89	Delta	ruderal	alkali grass/ pasture	Medium	Low	Low	Medium	Medium
670	wetland	5.99	Delta	alkali grassland	ruderal	Medium	Medium	Medium	Medium	High
675	pond	0.13	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	Medium
677	alkali wetland	11.80	Delta	alkali grassland	pasture	Medium	Medium	Medium	Medium	High
681	alkali wetland	0.38	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
682	alkali wetland	4.10	Delta	alkali grassland	pasture	Medium	Medium	Medium	Medium	High
689	alkali wetland	1.71	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
690	alkali wetland	18.86	Foothills	grassland	alkali grassland	High	High	High	High	High
691	wetland	0.11	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
692	wetland	1.26	Delta	alkali grassland	alkali wetland	High	Medium	Medium	Medium	High
693	alkali wetland	0.96	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
694	pond	0.13	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	Medium
695	alkali wetland	3.79	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
697	alkali wetland	0.76	Lowland	grassland	alkali grassland	Medium	Medium	Medium	Medium	High
698	alkali wetland	3.22	Foothills	alkali grassland	alkali grassland	High	High	High	High	High
699	pond	0.09	Foothills	grassland	alkali grassland	Medium	Medium	Medium	Medium	Medium
700	pond	0.05	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
701	alkali wetland	30.42	Lowland	alkali grassland	grassland/ wetland	Medium	Medium	Medium	Medium	High
702	alkali wetland	1.35	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
703	wetland	0.21	Delta	alkali grassland	urban	Medium	Low	Low	Medium	Medium
704	alkali wetland	1.80	Foothills	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
705	alkali wetland	5.18	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
706	alkali wetland	3.24	Delta	alkali grassland	alkali grassland	High	Medium	Medium	Medium	High
707	pond	0.13	Delta	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	Medium
709	pond	0.16	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
710	wetland	0.80	Lowland	alkali grassland	grassland	Medium	Medium	Medium	Medium	High
713	pond	0.10	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	Medium
714	pond	0.33	Foothills	grassland	grassland	High	High	High	High	High
715	alkali wetland	0.79	Delta	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
716	wetland	1.65	Foothills	grassland	grassland	High	High	High	High	High
717	wetland	0.25	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
718	pond	0.13	Lowland	alkali wetland	alkali wetland	Medium	Medium	Medium	Medium	Medium
719	wetland	0.43	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
722	alkali wetland	1.54	Delta	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
724	pond	0.19	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
725	wetland	1.23	Foothills	grassland	grassland	High	High	High	High	High
726	wetland	3.08	Foothills	grassland	grassland	High	High	High	High	High
727	alkali wetland	2.23	Delta	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
728	alkali wetland	45.79	Lowland	alkali grassland	grassland	Medium	Medium	Medium	Medium	High
729	wetland	1.43	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
731	wetland	0.60	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
732	alkali wetland	4.43	Foothills	grassland	alkali grassland	High	High	High	High	High
735	wetland	0.23	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
737	wetland	0.77	Delta	grassland	pasture	Medium	Medium	Medium	Medium	High
738	pond	0.50	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
739	wetland	0.18	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
741	wetland	0.30	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
742	wetland	0.62	Delta	ruderal	ruderal	Low	Low	Low	Low	Medium
743	wetland	1.62	Foothills	grassland	grassland	High	High	High	High	High
744	pond	0.43	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
745	pond	0.15	Delta	ruderal	ruderal	Low	Low	Low	Low	Low
746	alkali wetland	0.61	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
747	wetland	1.58	Delta	ruderal	ruderal	Medium	Low	Low	Medium	Medium
748	alkali wetland	55.15	Lowland	alkali grassland	grassland	Medium	Medium	Medium	Medium	High
750	alkali wetland	0.18	Lowland	alkali wetland	alkali wetland	Medium	Medium	Medium	Medium	High
753	wetland	0.95	Lowland	grassland	urban	Medium	Medium	Medium	Medium	High
754	alkali wetland	3.39	Lowland	alkali grassland	grassland	Medium	Medium	Medium	Medium	High
758	pond	3.17	Delta	cropland	alkali grassland	Medium	Medium	Medium	Medium	Medium
760	wetland	2.97	Delta	ruderal	ruderal	Medium	Low	Low	Medium	Medium
765	pond	0.06	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
766	pond	0.09	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
767	pond	0.96	Lowland	alkali grassland	grassland	Medium	Medium	Medium	Medium	Medium
768	wetland	3.92	Delta	ruderal	ruderal	Medium	Low	Low	Medium	Medium
769	wetland	0.58	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
770	pond	0.05	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
773	alkali wetland	8.24	Lowland	alkali grassland	grassland	Medium	Medium	Medium	Medium	High
777	seasonal wetland	15.34	Lowland	grassland	alkali grassland	Medium	Medium	Medium	Medium	High
778	alkali wetland	1.10	Foothills	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
779	wetland	0.67	Delta	ruderal	ruderal	Low	Low	Low	Low	Medium
780	pond	0.26	Foothills	grassland	grassland	High	High	High	High	High
781	alkali wetland	8.11	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
786	pond	0.82	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	Medium
787	alkali wetland	4.43	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
788	alkali wetland	2.59	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
789	wetland	3.44	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
790	pond	1.28	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
791	pond	0.14	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
792	alkali wetland	1.50	Lowland	alkali grassland	grassland	Medium	Medium	Medium	Medium	High
793	wetland	5.45	Foothills	grassland	grassland	High	High	High	High	High
794	wetland	0.10	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
798	pond	1.21	Foothills	alkali grassland	alkali grassland	High	High	High	High	High
799	wetland	7.44	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
800	wetland	1.19	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
802	pond	0.41	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
803	pond	0.53	Foothills	grassland	grassland	High	High	High	High	High
804	pond	0.27	Foothills	alkali grassland	alkali grassland	High	High	High	High	High
805	alkali wetland	1.44	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
807	wetland	0.31	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
810	pond	0.15	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
811	alkali wetland	0.96	Lowland	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	High
814	wetland	0.42	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
815	riparian	2.42	Foothills	grassland	grassland	High	High	High	High	High
816	pond	0.08	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
817	riparian	0.79	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
818	pond	0.16	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
819	pond	0.09	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
823	wetland	0.31	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
825	pond	0.53	Foothills	grassland	grassland	High	High	High	High	High
827	wetland	0.28	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
828	pond	0.88	Foothills	grassland	grassland	High	High	High	High	High
829	wetland	1.97	Foothills	grassland	grassland	High	High	High	High	High
830	pond	0.10	Montane	grassland	grassland	High	High	High	High	High
835	pond	0.47	Foothills	grassland	grassland	High	High	High	High	High
838	wetland	0.21	Montane	grassland	grassland	High	High	High	High	High
883	slough/channel	2.25076902	Delta	alkali grassland	ruderal	Low	Low	Low	Low	Medium
911	slough/channel	11.6991298	Delta	cropland	alkali grassland	Medium	Low	Medium	Medium	High
919	slough/channel	28.1834995	Delta	alkali grassland	ruderal	Medium	Medium	Medium	Medium	High
929	alkali wetland	8.54	Lowland	alkali grassland	urban grassland	Medium	Medium	Medium	Medium	High
Deer Creek Subbasin										
292	pond	0.84	Foothills	grassland	grassland	Low	Low	Low	Low	Low
296	pond	0.60	Lowland	turf	turf	Low	Low	Low	Medium	Medium
299	wetland	0.13	Foothills	grassland	grassland	Low	Low	Low	Low	High
303	wetland	0.15	Foothills	grassland	grassland	Low	Low	Low	Low	High
307	pond	0.93	Foothills	grassland	grassland	Low	Low	Low	Low	Low

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
309	pond	0.15	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
312	pond	0.17	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
313	pond	0.33	Lowland	turf	turf	Low	Low	Low	Medium	Medium
315	pond	0.43	Foothills	grassland	grassland	Low	Low	Low	Low	Low
317	seasonal wetland	0.10	Foothills	grassland	grassland	Low	Low	Low	Low	High
319	wetland	0.20	Foothills	grassland	grassland	Low	Low	Low	Low	High
320	pond	1.23	Lowland	turf	turf	Low	Low	Low	Medium	Medium
321	pond	1.67	Lowland	turf	turf	Low	Low	Low	Medium	Medium
325	seasonal wetland	0.54	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
327	pond	0.59	Lowland	turf	turf	Low	Low	Low	Medium	Medium
328	seasonal wetland	0.92	Lowland	urban	urban	Low	Low	Low	Low	Low
329	pond	0.78	Lowland	turf	turf	Low	Low	Low	Medium	Medium
331	wetland	6.00	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
333	pond	0.88	Lowland	urban	urban	Low	Low	Low	Low	Low
334	pond	0.80	Lowland	turf	turf	Low	Low	Low	Medium	Medium
336	pond	0.69	Lowland	urban	urban	Low	Low	Low	Low	Low
337	pond	0.52	Lowland	turf	turf	Low	Low	Low	Medium	Medium
345	pond	0.07	Foothills	grassland	oak woodland	Medium	Medium	Medium	Medium	Medium
347	wetland	0.15	Foothills	grassland	grassland	Low	Low	Low	Low	High
351	pond	0.08	Foothills	grassland	grassland	Low	Low	Low	Low	Low
352	wetland	0.19	Foothills	grassland	grassland	Low	Low	Low	Low	High
356	pond	0.07	Foothills	chaparral	chaparral	Medium	Medium	Medium	Medium	Medium
357	alkali wetland	0.77	Foothills	alkali grassland	alkali grassland	Low	Low	Low	Low	High
362	alkali wetland	5.66	Foothills	grassland	alkali grassland	Low	Low	Low	Low	High
392	pond	0.16	Foothills	oak woodland	oak woodland	Medium	Medium	Medium	Medium	Medium
Dry Creek Subbasin										
335	pond	0.70	Lowland	turf	turf	Low	Low	Low	Medium	Medium
339	pond	1.59	Lowland	turf	turf	Low	Low	Low	Medium	Medium
343	pond	0.94	Lowland	turf	turf	Low	Low	Low	Medium	Medium
348	wetland	0.76	Lowland	urban	urban	Low	Low	Low	Low	Low
349	pond	0.42	Lowland	turf	turf	Low	Low	Low	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
350	pond	0.28	Lowland	turf	turf	Low	Low	Low	Medium	Medium
355	pond	0.50	Lowland	turf	turf	Low	Low	Low	Medium	Medium
364	seasonal wetland	0.89	Lowland	urban	urban	Low	Low	Low	Low	Low
366	alkali wetland	0.44	Lowland	urban	urban	Low	Low	Low	Low	Low
367	wetland	0.47	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
369	pond	0.29	Foothills	grassland	grassland	High	High	High	High	High
373	pond	0.64	Lowland	turf	turf	Low	Low	Low	Medium	Medium
376	wetland	1.23	Foothills	grassland	grassland	High	High	High	High	High
377	alkali wetland	3.91	Foothills	grassland	grassland	High	High	High	High	High
378	pond	0.54	Lowland	turf	turf	Low	Low	Low	Medium	Medium
381	pond	0.38	Lowland	turf	turf	Low	Low	Low	Medium	Medium
384	wetland	0.13	Lowland	urban	urban	Low	Low	Low	Low	Low
385	pond	0.05	Lowland	turf	turf	Low	Low	Low	Low	Low
386	pond	0.27	Lowland	turf	turf	Low	Low	Low	Medium	Medium
387	wetland	0.14	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
388	alkali wetland	12.87	Lowland	grassland	urban/ turf	Medium	Medium	Medium	Medium	Medium
391	pond	0.14	Lowland	alkali wetland	alkali wetland	Medium	Medium	Medium	Medium	Medium
396	pond	0.09	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
400	wetland	0.47	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
402	pond	0.07	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
409	pond	0.12	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
410	pond	0.06	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
414	pond	0.40	Foothills	grassland	grassland	High	High	High	High	High
417	pond	0.40	Foothills	grassland	grassland	High	High	High	High	High
419	pond	0.09	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
424	pond	0.22	Foothills	grassland	grassland	High	High	High	High	High
435	pond	0.09	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
439	pond	0.01	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
450	pond	0.09	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
East Antioch Creek Subbasin										
48	wetland	0.87	Lowland	urban	urban	Low	Low	Low	Low	Low

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
61	pond	0.49	Lowland	urban	urban	Low	Low	Low	Low	Low
84	wetland	2.86	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
92	wetland	2.34	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
93	riparian	2.97	Lowland	urban	urban	Low	Low	Low	Low	Low
105	riparian	8.28	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
109	wetland	0.75	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
110	wetland	3.17	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
114	riparian	2.06	Lowland	ruderal	ruderal	Low	Low	Low	Low	Low
174	pond	0.12	Lowland	orchard	orchard	Low	Low	Low	Low	Low
East County Delta Drainages										
69	pond	0.18	Delta	urban	urban	Low	Low	Low	Low	Low
70	pond	0.97	Delta	urban	urban	Low	Low	Low	Low	Low
75	pond	0.13	Delta	urban	urban	Low	Low	Low	Low	Low
76	pond	2.72	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
83	pond	0.46	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
86	pond	1.03	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
88	riparian	11.05	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
99	seasonal wetland	0.42	Delta	cropland	cropland	Low	Low	Low	Low	Medium
104	seasonal wetland	7.13	Delta	pasture	wetland	Medium	Medium	Medium	Medium	High
107	seasonal wetland	1.27	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium
124	seasonal wetland	1.63	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium
132	seasonal wetland	2.89	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium
160	slough/channel	2.8408833	Delta	cropland	pasture	Low	Low	Low	Low	Low
177	slough/channel	5.04425012	Delta	cropland	urban_pasture	Low	Low	Low	Low	Low
178	slough/channel	2.7628164	Delta	urban	cropland	Low	Low	Low	Low	Low
179	slough/channel	3.79719926	Delta	urban	cropland	Low	Low	Low	Low	Low
183	slough/channel	8.39747086	Delta	pasture	wetland_cropland	Medium	Low	Low	Medium	Medium
187	slough/channel	28.9065806	Delta	pasture	cropland	Medium	Low	Low	Medium	Medium
208	slough/channel	19.1663752	Delta	cropland	pasture_wetland	Medium	Low	Low	Medium	Medium
211	slough/channel	12.617575	Delta	pasture	wetland_cropland	Medium	Medium	Medium	Medium	Medium
212	wetland	3.46	Delta	urban	wetland/ pasture	Low	Low	Low	Low	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
215	wetland	26.41	Delta	urban	pasture/ slough	Low	Low	Low	Low	Medium
219	wetland	3.79	Delta	urban	pasture	Low	Low	Low	Low	Medium
220	wetland	1.84	Delta	urban	urban	Low	Low	Low	Low	Medium
224	wetland	0.93	Delta	urban	pasture	Low	Low	Low	Low	Medium
245	wetland	3.36	Delta	urban	cropland	Low	Low	Low	Low	Medium
251	wetland	3.99	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
257	wetland	0.78	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
268	wetland	0.77	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
310	wetland	11.54	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium
346	wetland	6.68	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium
855	wetland	4.82	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
856	wetland	6.78	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
868	wetland	2.38	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
891	wetland	1.60	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
892	wetland	17.29	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
899	wetland	7.26	Delta	pasture	pasture	Medium	Low	Low	Medium	Medium
902	wetland	1.62	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium
903	wetland	4.02	Delta	ruderal	cropland	Medium	Low	Low	Medium	Medium
Kellogg Creek Subbasin										
457	riparian	6.96	Delta	cropland	pasture/ grassland	Medium	Low	Low	Medium	Medium
466	riparian	7.91	Delta	grassland	cropland	Medium	Medium	Low	Medium	High
474	wetland	1.11	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
492	pond	0.18	Delta	orchard	orchard	Low	Low	Low	Low	Low
493	pond	0.08	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
494	wetland	0.10	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
499	wetland	0.71	Lowland	grassland	grassland	Medium	Medium	Low	Medium	Medium
505	wetland	3.17	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
508	riparian	0.26	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
509	seasonal wetland	3.38	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium
513	seasonal wetland	7.19	Delta	cropland	cropland	Medium	Low	Low	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
516	pond	0.37	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
517	pond	0.13	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
521	pond	0.29	Foothills	grassland	grassland	High	High	High	High	High
523	riparian	0.60	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
526	wetland	2.37	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
527	pond	0.23	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
532	pond	0.72	Delta	orchard	orchard	Medium	Low	Low	Medium	Medium
533	riparian	0.83	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
541	pond	0.21	Lowland	grassland	grassland	Medium	Medium	Low	Medium	Medium
542	pond	0.16	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
549	wetland	0.99	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
552	seasonal wetland	1.40	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
558	riparian	0.36	Lowland	ruderal	grassland	Low	Low	Low	Medium	Medium
563	riparian	0.50	Lowland	grassland	ruderal	Low	Low	Low	Medium	Medium
571	riparian	0.87	Lowland	ruderal	ruderal	Low	Low	Low	Low	Medium
573	riparian	2.05	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
587	pond	0.51	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
600	pond	0.04	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
607	wetland	0.84	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
609	wetland	0.73	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
614	alkali wetland	8.26	Foothills	alkali grassland	alkali grassland	High	High	High	High	High
615	pond	0.08	Foothills	alkali grassland	alkali grassland	Medium	Medium	Medium	Medium	Medium
625	pond	0.69	Foothills	grassland	grassland	High	High	High	High	High
626	pond	0.07	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
632	alkali wetland	0.88	Foothills	alkali grassland	grassland	Medium	Medium	Medium	Medium	High
637	alkali wetland	5.69	Foothills	alkali grassland	grassland	High	High	High	High	High
641	pond	1.40	Foothills	grassland	grassland	High	High	High	High	High
648	wetland	0.12	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
650	pond	0.04	Foothills	grassland	grassland	Medium	Medium	Low	Medium	Medium
655	pond	0.15	Foothills	oak woodland	oak woodland	Medium	Medium	Medium	Medium	Medium
656	wetland	0.63	Foothills	grassland	oak savannah	Medium	Medium	Low	Medium	High

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
659	wetland	0.74	Foothills	grassland	grassland	High	High	Low	High	High
662	wetland	1.39	Foothills	grassland	grassland	High	High	High	High	High
663	wetland	1.13	Foothills	grassland	grassland	High	High	High	High	High
664	riparian	3.35	Foothills	grassland	grassland	High	High	High	High	High
665	wetland	0.31	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
669	wetland	0.44	Foothills	grassland	grassland	Medium	Medium	Low	Medium	High
671	pond	0.21	Foothills	grassland	grassland	High	High	Low	High	High
673	wetland	0.82	Foothills	grassland	grassland	High	High	Low	High	High
674	pond	0.33	Foothills	grassland	grassland	High	High	Low	High	High
676	wetland	0.05	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
678	wetland	0.07	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
679	wetland	0.22	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
680	pond	0.16	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
683	wetland	0.27	Foothills	grassland	grassland	Medium	Medium	Low	Medium	High
684	pond	0.18	Foothills	grassland	grassland	Medium	Medium	Low	Medium	Medium
687	wetland	0.46	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
688	pond	0.17	Foothills	grassland	grassland	Medium	Medium	Low	Medium	Medium
696	pond	0.33	Foothills	grassland	grassland	High	High	High	High	High
708	wetland	1.39	Foothills	grassland	oak savanna	High	High	High	High	High
711	pond	0.08	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
712	pond	2.40	Foothills	oak savannah	oak woodland	High	High	High	High	High
721	wetland	2.57	Foothills	grassland	grassland	High	High	High	High	High
723	riparian	1.62	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
730	pond	0.72	Foothills	grassland	grassland	High	High	High	High	High
734	wetland	0.34	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
736	wetland	0.35	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
740	wetland	0.12	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
749	pond	0.53	Montane	grassland	grassland	High	High	High	High	High
759	pond	0.21	Foothills	grassland	grassland	High	High	High	High	High
761	pond	0.11	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
762	pond	1.51	Montane	grassland	oak woodland	High	High	High	High	High

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
764	pond	0.16	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
771	pond	0.60	Montane	oak woodland	grassland	High	High	High	High	High
775	pond	0.08	Montane	grassland	grassland	High	High	High	High	High
776	pond	0.33	Foothills	oak savanna	grassland	High	High	High	High	High
782	pond	0.22	Montane	grassland	oak woodland	High	High	High	High	High
783	wetland	0.17	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
785	pond	0.06	Foothills	oak savanna	oak savanna	Medium	Medium	Medium	Medium	Medium
795	pond	0.14	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
796	pond	0.19	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
797	pond	0.27	Montane	urban	urban	Medium	Medium	Medium	Medium	Medium
801	pond	0.19	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
806	wetland	0.82	Foothills	grassland	grassland	High	High	High	High	High
808	wetland	0.83	Foothills	grassland	grassland	High	High	High	High	High
809	pond	0.80	Foothills	grassland	grassland	High	High	High	High	High
812	wetland	0.48	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
813	pond	0.26	Foothills	grassland	grassland	High	High	High	High	High
820	pond	0.64	Montane	grassland	grassland	High	High	High	High	High
821	pond	0.14	Montane	grassland	grassland	High	High	High	High	High
822	pond	0.26	Montane	grassland	grassland	High	High	High	High	High
824	pond	0.55	Montane	grassland	grassland	High	High	High	High	High
826	pond	0.74	Montane	grassland	oak woodland	High	High	High	High	High
831	wetland	17.03	Foothills	grassland	grassland	High	High	High	High	High
832	pond	0.33	Montane	grassland	grassland	High	High	High	High	High
833	pond	0.20	Foothills	grassland	grassland	High	High	High	High	High
834	pond	0.31	Foothills	grassland	grassland	High	High	High	High	High
836	pond	0.11	Montane	grassland	grassland	High	High	High	High	High
837	pond	0.09	Montane	grassland	grassland	High	High	High	High	High
839	pond	0.15	Montane	grassland	grassland	High	High	High	High	High
840	pond	0.46	Montane	grassland	grassland	High	High	High	High	High
841	wetland	0.18	Montane	grassland	oak woodland	High	High	High	High	Medium
842	pond	0.40	Foothills	grassland	grassland	High	High	High	High	High

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
843	pond	0.17	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
844	wetland	2.52	Foothills	grassland	oak savannah	High	High	High	High	High
845	pond	0.16	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
906	slough/channel	4.31	Delta	grassland	orchard	Low	Low	Low	Low	Medium
Kirker Creek Subbasin										
38	seasonal wetland	2.42	Lowland	ruderal	urban	Low	Low	Low	Medium	Medium
42	wetland	0.39	Lowland	urban	urban	Low	Low	Low	Low	Low
54	riparian	4.22	Lowland	urban	ruderal	Low	Low	Low	Low	Low
57	wetland	0.28	Lowland	ruderal	ruderal	Low	Low	Low	Low	Low
58	seasonal wetland	0.81	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
65	riparian	1.58	Lowland	urban	ruderal	Low	Low	Low	Low	Low
78	riparian	3.32	Lowland	urban	ruderal	Low	Low	Low	Low	Low
87	pond	0.20	Lowland	non-native woodland	non-native woodland	Low	Low	Low	Medium	Medium
89	riparian	20.11	Lowland	urban	urban	Low	Low	Low	Low	Low
95	pond	0.58	Lowland	urban	urban	Low	Low	Low	Low	Low
101	wetland	0.21	Lowland	ruderal	ruderal	Low	Low	Low	Low	Low
102	seasonal wetland	0.08	Lowland	ruderal	urban	Low	Low	Low	Low	Low
103	seasonal wetland	0.47	Lowland	urban	urban	Low	Low	Low	Low	Low
112	pond	0.15	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
116	wetland	0.16	Lowland	ruderal	ruderal	Low	Low	Low	Low	Low
117	wetland	0.11	Foothills	grassland	oak woodland	Medium	Medium	Medium	Medium	Medium
120	riparian	5.04	Foothills	grassland	grassland	High	High	High	High	High
122	wetland	0.09	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
123	wetland	0.10	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
126	pond	0.19	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
128	riparian	4.84	Foothills	grassland	grassland	High	High	High	High	High
130	wetland	0.80	Foothills	grassland	urban	Medium	Medium	Medium	Medium	Medium
133	wetland	0.11	Foothills	grassland	oak woodland	Medium	Medium	Medium	Medium	Medium
134	pond	0.16	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
136	seasonal wetland	7.21	Foothills	grassland	urban	Medium	Medium	Medium	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
139	pond	0.08	Foothills	seasonal wetland	grassland	Medium	Medium	Medium	Medium	Medium
140	pond	0.06	Montane	grassland	grassland	High	High	High	High	High
141	wetland	0.05	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
142	wetland	1.98	Foothills	grassland	grassland	High	High	High	High	High
145	wetland	0.07	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
152	riparian	2.66	Foothills	grassland	urban	Medium	Medium	Medium	Medium	High
154	pond	0.04	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
157	seasonal wetland	1.31	Foothills	grassland	grassland	High	High	High	High	High
158	riparian	1.23	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
159	wetland	0.17	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
164	pond	0.20	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
167	wetland	0.28	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
168	pond	0.19	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
169	wetland	1.26	Foothills	grassland	grassland	High	High	High	High	High
176	pond	0.18	Foothills	oak savannah	oak savannah	Medium	Medium	Medium	Medium	Medium
192	pond	0.29	Montane	grassland	grassland	High	High	High	High	High
195	wetland	0.03	Montane	grassland	grassland	High	High	High	High	High
197	wetland	0.10	Foothills	oak savannah	oak savannah	Medium	Medium	Medium	Medium	Medium
198	wetland	0.34	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
199	wetland	0.05	Montane	grassland	grassland	High	High	High	High	High
201	wetland	0.39	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
218	seasonal wetland	0.29	Montane	oak savannah	oak woodland	Low	Low	High	Medium	Medium
227	pond	0.10	Montane	oak woodland	oak woodland	Low	Low	High	Medium	Medium
241	pond	0.23	Montane	grassland	grassland	Low	Low	High	Medium	Medium
243	pond	0.24	Montane	grassland	oak woodland	High	High	High	High	High
Lower Marsh Creek Subbasin										
97	wetland	2.60	Delta	urban	urban	Low	Low	Low	Low	Low
100	riparian	1.59	Delta	urban	cropland	Low	Low	Low	Low	Low
113	riparian	0.94	Delta	pasture	pasture	Low	Low	Low	Low	Low
166	wetland	1.06	Lowland	ruderal	urban	Low	Low	Low	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
207	wetland	1.52	Lowland	urban	urban	Low	Low	Low	Low	Low
213	riparian	1.07	Lowland	urban	urban	Low	Low	Low	Low	Low
255	wetland	1.45	Lowland	urban	urban	Low	Low	Low	Low	Low
324	wetland	0.57	Lowland	urban	urban	Low	Low	Low	Low	Low
342	riparian	37.57	Delta	orchard	urban grassland	Medium	Low	Low	Medium	Medium
368	wetland	0.48	Delta	orchard	orchard	Low	Low	Low	Low	Low
411	wetland	0.96	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
428	wetland	7.14	Foothills	grassland	grassland	High	High	High	High	High
431	pond	0.46	Foothills	grassland	grassland	High	High	High	High	High
432	wetland	0.87	Foothills	grassland	grassland	High	High	High	High	High
437	wetland	0.63	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
449	pond	0.19	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
455	pond	0.03	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
458	riparian	6.12	Delta	grassland	orchard	Medium	Medium	Low	Medium	Medium
857	slough/channel	13.3781939	Delta	pasture	cropland_urban	Medium	Low	Low	Medium	Medium
861	slough/channel	28.2550655	Delta	urban	crop_orch_past_ruderal	Low	Low	Low	Low	Low
888	slough/channel	41.7124594	Lowland	urban	crop_orch_past_ruderal	Low	Low	Low	Low	Low
Oakley Subbasin										
49	wetland	0.85	Lowland	urban	urban	Low	Low	Low	Low	Low
55	seasonal wetland	0.80	Lowland	urban	urban	Low	Low	Low	Low	Low
56	wetland	0.86	Lowland	urban	urban	Low	Low	Low	Low	Low
59	wetland	0.67	Lowland	urban	urban	Low	Low	Low	Low	Low
60	riparian	2.95	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
62	riparian	1.57	Lowland	urban	wetland	Low	Low	Low	Low	Low
63	wetland	0.81	Lowland	riparian	vineyard	Medium	Medium	Medium	Medium	Medium
64	wetland	1.13	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
67	riparian	2.12	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
68	wetland	2.40	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
73	pond	2.74	Lowland	orchard	orchard	Low	Low	Low	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
106	wetland	16.89	Lowland	urban	ruderal	Low	Low	Low	Low	Low
111	wetland	3.00	Lowland	urban	urban	Low	Low	Low	Low	Low
118	wetland	0.41	Lowland	urban	urban	Low	Low	Low	Low	Low
119	wetland	1.91	Lowland	urban	urban	Low	Low	Low	Low	Low
Sand Creek Subbasin										
209	pond	0.42	Foothills	grassland	grassland	High	High	High	High	High
214	wetland	2.56	Foothills	grassland	grassland	High	High	High	High	High
216	seasonal wetland	0.47	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
217	pond	0.24	Foothills	grassland	grassland	High	High	High	High	High
221	pond	0.17	Montane	oak woodland	oak woodland	High	High	High	High	High
222	pond	2.39	Foothills	grassland	grassland	High	High	High	High	High
225	pond	0.02	Foothills	grassland	grassland	Low	Low	Medium	Medium	Medium
226	wetland	0.32	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
229	pond	0.01	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
230	pond	0.07	Foothills	grassland	oak woodland	Medium	Medium	Medium	Medium	Medium
231	pond	0.07	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
234	pond	0.02	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
236	pond	0.13	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
238	pond	0.14	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
239	riparian	2.11	Foothills	grassland	oak woodland	High	High	High	Medium	Medium
240	riparian	15.96	Lowland	grassland	cropland/ urban	Medium	Medium	Medium	Medium	Medium
244	wetland	0.29	Foothills	grassland	oak woodland	Medium	Medium	Medium	Medium	High
246	pond	0.35	Foothills	grassland	grassland	High	High	High	High	High
247	pond	0.24	Foothills	grassland	oak woodland	High	High	High	High	High
248	wetland	4.90	Foothills	grassland	grassland	High	High	High	High	High
249	riparian	1.71	Foothills	grassland	oak savannah/ oak woodland	Medium	Medium	Medium	Medium	Medium
250	wetland	3.31	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
252	wetland	0.47	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
253	pond	0.15	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
254	pond	0.12	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
259	wetland	0.27	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
260	pond	0.14	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
262	wetland	0.92	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
263	pond	0.07	Montane	grassland	grassland	High	High	High	High	High
264	pond	0.46	Lowland	urban	urban	Low	Low	Low	Low	Low
266	pond	0.24	Foothills	grassland	grassland	High	High	High	High	High
269	pond	0.50	Foothills	grassland	grassland	High	High	High	High	High
270	pond	0.03	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
271	seasonal wetland	0.11	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
273	alkali wetland	2.02	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
274	seasonal wetland	8.10	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
275	seasonal wetland	0.57	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
276	pond	0.23	Foothills	grassland	grassland	High	High	High	High	High
277	seasonal wetland	4.06	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
281	pond	0.26	Foothills	grassland	grassland	High	High	High	High	High
282	pond	1.06	Foothills	grassland	grassland	High	High	High	High	High
283	pond	1.38	Lowland	turf	turf	Low	Low	Low	Medium	Medium
284	seasonal wetland	0.68	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
285	pond	0.37	Foothills	grassland	grassland	High	High	High	High	High
286	pond	0.54	Lowland	turf	turf	Low	Low	Low	Medium	Medium
287	pond	0.85	Foothills	grassland	grassland	High	High	High	High	High
288	pond	1.12	Lowland	turf	turf	Low	Low	Low	Medium	Medium
289	pond	0.32	Foothills	oak savanna	grassland	High	High	High	High	High
291	alkali wetland	0.69	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
294	seasonal wetland	0.25	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
297	pond	0.08	Montane	grassland	grassland	High	High	High	High	High
298	alkali wetland	7.77	Foothills	grassland	grassland	High	High	High	High	High
300	pond	0.90	Foothills	turf	grassland	Medium	Medium	Medium	Medium	Medium
302	pond	0.54	Foothills	grassland	grassland	High	High	High	High	High
304	pond	0.66	Foothills	turf	grassland	Medium	Medium	Medium	Medium	Medium
305	pond	0.10	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
306	pond	0.76	Foothills	grassland	grassland	High	High	High	High	High
308	wetland	0.08	Foothills	oak woodland	grassland	Medium	Medium	Medium	Medium	High
311	pond	0.44	Foothills	grassland	grassland	High	High	High	High	High
314	pond	0.07	Montane	grassland	grassland	High	High	High	High	High
316	pond	0.04	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
318	pond	0.58	Foothills	turf	grassland	Medium	Medium	Medium	Medium	Medium
322	pond	0.09	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
323	pond	0.16	Montane	oak savannah	oak woodland	High	High	High	High	High
330	pond	0.44	Montane	grassland	grassland	High	High	High	High	High
Upper Marsh Creek Subbasin										
375	pond	0.40	Montane	oak savannah	oak savannah	High	High	High	High	High
379	wetland	2.18	Montane	oak savannah	oak savannah	High	High	High	High	High
380	pond	0.12	Montane	oak savannah	oak savannah	Medium	Medium	Medium	Medium	Medium
382	pond	0.15	Foothills	oak savannah	oak woodland	Medium	Medium	Medium	Medium	Medium
393	pond	0.47	Montane	grassland	grassland	High	High	High	High	High
397	pond	0.37	Montane	grassland	grassland	High	High	High	High	High
404	wetland	0.43	Foothills	oak woodland	oak woodland	Low	Low	Medium	Medium	Medium
412	pond	0.47	Foothills	oak savannah	oak savannah	High	High	High	High	High
413	pond	0.88	Foothills	oak savannah	grassland	High	High	High	High	High
416	pond	0.60	Montane	oak savannah	oak woodland	High	High	High	High	High
420	pond	0.72	Montane	oak savannah	oak savannah	Medium	Medium	Medium	Medium	Medium
421	pond	0.07	Montane	oak savanna	oak woodland	High	High	High	High	High
425	wetland	0.69	Foothills	oak woodland	oak woodland	Low	Low	Medium	Medium	Medium
427	pond	0.11	Foothills	oak woodland	oak woodland	Low	Low	Medium	Medium	Medium
433	pond	1.47	Foothills	oak woodland	ruderal	Low	Low	Medium	Medium	Medium
434	pond	2.17	Montane	grassland	grassland	High	High	High	High	High
436	wetland	0.58	Montane	grassland	grassland	High	High	High	High	High
438	wetland	0.24	Foothills	grassland	oak woodland	Low	Low	Medium	Medium	Medium
440	wetland	0.37	Foothills	urban	grassland	Medium	Medium	Medium	Medium	Medium
441	pond	0.10	Foothills	wetland	urban	Low	Low	Medium	Medium	Medium
442	wetland	0.65	Foothills	grassland	oak savanna	Low	Low	Medium	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
444	pond	0.42	Montane	oak savannah	grassland	High	High	High	High	High
445	pond	0.14	Foothills	oak woodland	grassland/ urban	Low	Low	Medium	Medium	Medium
446	pond	0.05	Foothills	urban	urban	Low	Low	Low	Low	Low
447	pond	0.05	Foothills	oak savanna	oak savanna	Medium	Medium	Medium	Medium	Medium
448	pond	1.31	Foothills	grassland	grassland	High	High	High	High	High
452	wetland	0.39	Foothills	urban	urban	Low	Low	Low	Low	Low
453	wetland	0.41	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
454	pond	0.11	Montane	oak savannah	oak savannah	High	High	High	High	High
456	riparian	22.07	Foothills	grassland	urban	Low	Low	Medium	Medium	Medium
460	seasonal wetland	0.41	Foothills	grassland	oak woodland	Low	Low	Medium	Medium	Medium
462	pond	0.27	Foothills	grassland	grassland	High	High	High	High	High
463	riparian	8.03	Foothills	oak woodland	grassland	High	High	High	High	High
464	pond	0.81	Foothills	oak woodland	oak woodland	High	High	High	High	High
465	pond	0.19	Foothills	ruderal	ruderal	Low	Low	Low	Medium	Medium
467	riparian	9.39	Foothills	grassland	oak woodland	Medium	Low	High	Medium	Medium
468	pond	0.24	Foothills	ruderal	ruderal	Low	Low	Medium	Medium	Medium
469	pond	0.05	Montane	oak woodland	oak savanna	High	High	High	High	High
470	pond	0.12	Foothills	oak savannah	oak savannah	Low	Low	Medium	Medium	Medium
471	pond	0.24	Foothills	grassland	urban	Medium	Medium	Medium	Medium	Medium
473	wetland	0.39	Foothills	oak woodland	oak savannah	Medium	Medium	Medium	Medium	Medium
475	wetland	0.36	Foothills	grassland	urban	Medium	Medium	Medium	Medium	Medium
477	seasonal wetland	0.60	Foothills	oak woodland	grassland	Medium	Medium	Medium	Medium	High
479	pond	0.87	Foothills	grassland	oak woodland	High	High	High	High	High
480	pond	0.03	Montane	oak savannah	oak savannah	High	High	High	High	High
482	pond	0.07	Montane	oak savannah	oak woodland	High	High	High	High	High
483	riparian	3.23	Foothills	oak woodland	grassland	Medium	Low	High	Medium	Medium
484	riparian	44.04	Lowland	grassland	ruderal	Medium	Medium	Medium	Medium	Medium
485	pond	0.31	Foothills	oak woodland	oak woodland	High	High	High	High	High
486	pond	0.23	Foothills	oak woodland	oak woodland	High	High	High	High	High
487	pond	0.26	Foothills	oak woodland	oak woodland	High	High	High	High	High
489	wetland	1.09	Lowland	grassland	riparian	Medium	Medium	Medium	Medium	High

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
490	pond	0.46	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
495	riparian	9.80	Foothills	grassland	oak savannah/ oak woodland/ urban/ orchard	Medium	Medium	Medium	Medium	Medium
497	pond	0.20	Foothills	grassland	oak savannah	Medium	Medium	Medium	Medium	Medium
498	riparian	1.95	Foothills	grassland	oak savannah	Low	Low	Medium	Medium	Medium
501	riparian	6.46	Foothills	oak woodland	oak woodland	Medium	Low	High	Medium	Medium
502	riparian	9.27	Foothills	oak woodland	urban	Low	Low	Medium	Medium	Medium
503	wetland	0.19	Foothills	oak savannah	oak savannah	Medium	Medium	Medium	Medium	High
506	pond	2.07	Foothills	oak savannah	oak savannah	High	High	High	High	High
507	pond	0.10	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
511	pond	0.30	Foothills	oak woodland	oak woodland	Medium	Low	High	Medium	Medium
512	pond	0.21	Foothills	oak woodland	oak woodland	High	High	High	High	High
514	pond	0.44	Foothills	grassland	grassland	High	High	High	High	High
518	pond	0.13	Foothills	urban	urban	Low	Low	Low	Low	Low
525	pond	0.69	Foothills	oak woodland	oak woodland	High	High	High	High	High
529	pond	0.78	Foothills	oak woodland	oak woodland	High	High	High	High	High
530	wetland	0.08	Foothills	oak woodland	grassland	Medium	Medium	Medium	Medium	Medium
531	pond	0.15	Montane	oak savannah	oak savannah	High	High	High	High	High
534	pond	0.17	Montane	oak savannah	grassland	High	High	High	High	High
535	wetland	2.24	Lowland	grassland	riparian	Medium	Medium	Medium	Medium	High
536	pond	0.18	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
537	pond	0.11	Foothills	grassland	urban	Medium	Medium	Medium	Medium	Medium
538	wetland	1.83	Foothills	grassland	grassland	High	High	High	High	High
539	pond	0.78	Foothills	grassland	oak woodland	High	High	High	High	High
540	pond	0.06	Foothills	oak savannah	oak savannah	Medium	Medium	Medium	Medium	Medium
543	pond	0.13	Montane	grassland	grassland	High	High	High	High	High
544	riparian	1.71	Foothills	grassland	oak savannah/ oak woodland	Medium	Medium	Medium	Medium	Medium
545	wetland	0.10	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
546	pond	0.33	Foothills	oak woodland	oak woodland	High	High	High	High	High

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
547	pond	0.20	Foothills	grassland	oak woodland	Medium	Medium	Medium	Medium	Medium
548	pond	0.24	Montane	oak savannah	oak savannah	High	High	High	High	High
550	riparian	1.73	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
551	pond	0.09	Foothills	oak savannah	oak woodland	Medium	Medium	Medium	Medium	Medium
553	pond	0.04	Montane	oak woodland	oak savannah	High	High	High	High	High
554	wetland	0.16	Foothills	urban	oak savannah	Medium	Medium	Medium	Medium	Medium
556	pond	0.07	Montane	oak woodland	oak savannah	High	High	High	High	High
557	pond	0.17	Montane	oak woodland	oak woodland	High	High	High	High	High
559	pond	0.36	Foothills	oak woodland	oak woodland	High	High	High	High	High
560	pond	0.16	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
561	riparian	29.40	Foothills	grassland	ruderal/ oak woodland/ oak savannah/ cropland/ orchard	Low	Low	Medium	Medium	Medium
562	pond	0.51	Foothills	grassland	grassland	High	High	High	High	High
564	pond	0.03	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
565	pond	0.05	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
567	wetland	0.45	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
568	pond	0.05	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
569	wetland	0.14	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
570	pond	0.74	Montane	oak savannah	oak savannah	Medium	Medium	Medium	Medium	Medium
572	pond	0.09	Montane	oak savannah	oak savannah	Medium	Medium	Medium	Medium	Medium
574	pond	0.08	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
576	pond	0.46	Montane	grassland	oak woodland	High	High	High	High	High
577	wetland	0.27	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
578	pond	0.05	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
579	riparian	23.55	Foothills	grassland	orchard/ ruderal	Low	Low	Medium	Medium	Medium
580	pond	0.25	Montane	grassland	grassland	High	High	High	High	High
581	pond	0.27	Foothills	grassland	urban	Medium	Medium	Medium	Medium	Medium
583	wetland	0.29	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
584	pond	0.17	Montane	grassland	grassland	High	High	High	High	High

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
586	pond	0.68	Foothills	grassland	oak woodland	High	High	High	High	High
589	pond	0.25	Foothills	oak woodland	grassland	High	High	High	High	High
592	pond	0.45	Foothills	oak savannah	oak savannah	Medium	Medium	Medium	Medium	Medium
594	pond	0.17	Montane	oak woodland	oak woodland	High	High	High	High	High
596	pond	0.06	Foothills	oak savannah	oak woodland	Medium	Medium	Medium	Medium	Medium
597	wetland	0.21	Foothills	oak savannah	oak savannah	Medium	Medium	Medium	Medium	Medium
601	wetland	0.56	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
603	wetland	3.65	Foothills	oak savannah	oak woodland	High	High	High	High	High
604	pond	0.49	Montane	oak savanna	oak woodland	High	High	High	High	High
610	pond	0.38	Montane	oak woodland	oak savannah/ grassland	High	High	High	High	High
611	pond	0.30	Montane	oak savannah	oak woodland	High	High	High	High	High
612	pond	0.07	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
613	pond	0.13	Montane	oak savannah	oak savannah	Medium	Medium	Medium	Medium	Medium
616	pond	0.12	Foothills	oak savanna	grassland	Medium	Medium	Medium	Medium	Medium
618	wetland	0.11	Foothills	oak woodland	oak woodland	Medium	Medium	Medium	Medium	Medium
621	pond	0.77	Foothills	oak woodland	grassland	High	High	High	High	High
627	pond	0.04	Montane	oak savanna	oak savanna	High	High	High	High	High
628	pond	1.39	Montane	grassland	grassland	High	High	High	High	High
631	pond	0.15	Montane	grassland	grassland	High	High	High	High	High
634	pond	0.26	Foothills	grassland	oak woodland	High	High	High	High	High
639	pond	0.11	Montane	grassland	grassland	High	High	High	High	High
642	pond	0.50	Montane	oak woodland	grassland	High	High	High	High	High
651	pond	0.15	Foothills	grassland	oak woodland	Medium	Medium	Medium	Medium	Medium
657	pond	0.34	Foothills	oak savannah	oak savannah	High	High	High	High	High
666	pond	0.04	Montane	oak woodland	oak woodland	High	High	High	High	High
668	pond	0.10	Montane	oak woodland	oak woodland	High	High	High	High	High
672	wetland	0.07	Montane	oak savannah	oak savannah	High	High	High	High	High
685	wetland	0.73	Montane	grassland	grassland	High	High	High	High	High
686	pond	0.15	Montane	grassland	grassland	High	High	High	High	High
720	pond	0.22	Montane	oak woodland	oak woodland	High	High	High	High	High

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
733	pond	0.21	Montane	grassland	grassland	High	High	High	High	High
752	pond	1.19	Montane	grassland	grassland	High	High	High	High	High
757	pond	0.25	Montane	grassland	grassland	High	High	High	High	High
763	pond	0.60	Montane	grassland	grassland	High	High	High	High	High
772	pond	0.14	Montane	grassland	grassland	High	High	High	High	High
774	pond	0.13	Montane	grassland	grassland	High	High	High	High	High
784	pond	0.29	Montane	grassland	grassland	High	High	High	High	High
Upper Mt. Diable Creek Subbasin										
162	riparian	4.61	Foothills	grassland	grassland	High	High	High	High	High
170	pond	0.05	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
204	pond	0.86	Foothills	turf	turf	Medium	Medium	Medium	Medium	Medium
205	pond	0.42	Foothills	turf	turf	Medium	Medium	Medium	Medium	Medium
206	pond	0.89	Foothills	turf	turf	Medium	Medium	Medium	Medium	Medium
223	wetland	0.63	Montane	grassland	grassland	High	High	High	High	High
228	pond	0.25	Foothills	grassland	grassland	High	High	High	High	High
232	pond	0.10	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
233	seasonal wetland	0.31	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
235	wetland	0.07	Montane	grassland	grassland	High	High	High	High	High
237	pond	0.06	Montane	grassland	grassland	High	High	High	High	High
242	wetland	0.26	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
256	pond	0.21	Foothills	grassland	grassland	High	High	High	High	High
258	wetland	0.13	Montane	grassland	grassland	High	High	High	High	High
261	pond	0.12	Montane	grassland	grassland	High	High	High	High	High
265	pond	0.13	Foothills	oak woodland	grassland	Medium	Medium	Medium	Medium	Medium
267	pond	0.28	Montane	grassland	grassland	High	High	High	High	High
272	pond	0.06	Montane	grassland	grassland	High	High	High	High	High
278	riparian	2.15	Foothills	urban	urban	Medium	Medium	Medium	Medium	Medium
279	wetland	0.97	Montane	grassland	grassland	High	High	High	High	High
280	riparian	5.19	Foothills	urban	grassland/ oak woodland	Medium	Medium	Medium	Medium	Medium
290	wetland	0.37	Foothills	grassland	urban	Medium	Medium	Medium	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
293	pond	0.23	Foothills	wetland	urban	Medium	Medium	Medium	Medium	Medium
295	pond	0.50	Montane	grassland	oak woodland	High	High	High	High	High
301	riparian	1.46	Foothills	urban	orchard/ oak woodland	Low	Low	Low	Low	Low
340	pond	0.46	Foothills	urban	oak savannah	Medium	Medium	Medium	Medium	Medium
353	pond	0.69	Foothills	oak woodland	grassland	High	High	High	High	High
354	pond	0.15	Foothills	oak woodland	oak woodland	Medium	Medium	Medium	Medium	Medium
360	pond	0.13	Montane	grassland	grassland	High	High	High	High	High
363	wetland	0.51	Foothills	oak woodland	oak woodland	Medium	Medium	Medium	Medium	Medium
West Antioch Creek Subbasin										
108	riparian	22.25	Lowland	urban	ruderal/ grassland	Low	Low	Low	Low	Low
115	pond	0.59	Lowland	urban	urban	Low	Low	Low	Low	Low
129	pond	0.05	Foothills	riparian	ruderal/ grassland	Medium	Medium	Medium	Medium	Medium
131	riparian	0.98	Foothills	grassland	oak woodland	Medium	Medium	Medium	Medium	Medium
135	wetland	0.16	Foothills	ruderal	ruderal	Low	Low	Low	Medium	Medium
137	riparian	5.77	Lowland	urban	ruderal/ grassland/ turf	Low	Low	Low	Low	Low
143	riparian	9.05	Foothills	grassland	urban	Medium	Medium	Medium	Medium	Medium
144	riparian	1.03	Lowland	aquatic	ruderal/ urban	Low	Low	Low	Medium	Medium
146	riparian	0.73	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
147	pond	0.07	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
148	riparian	1.17	Lowland	aquatic	ruderal	Low	Low	Low	Medium	Medium
149	wetland	3.63	Foothills	riparian	grassland	High	High	High	High	High
150	riparian	1.21	Foothills	aquatic	grassland	Medium	Medium	Low	Medium	Medium
151	riparian	0.42	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
153	wetland	1.41	Foothills	aquatic	turf	Medium	Medium	Low	Medium	Medium
155	wetland	2.91	Foothills	aquatic	turf	Medium	Medium	Low	Medium	Medium
156	wetland	1.73	Foothills	aquatic	turf	Medium	Medium	Low	Medium	Medium
161	wetland	1.82	Foothills	grassland	grassland	High	High	High	High	High
163	riparian	0.18	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
165	pond	0.09	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
171	pond	0.16	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
172	pond	0.45	Foothills	grassland	grassland	High	High	High	High	High
173	pond	0.49	Foothills	grassland	turf/ wetland	Medium	Medium	Medium	Medium	Medium
175	wetland	1.72	Foothills	grassland	grassland	High	High	High	High	High
180	pond	0.10	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
181	wetland	0.82	Foothills	grassland	grassland	High	High	High	High	High
182	pond	0.29	Foothills	grassland	grassland	High	High	High	High	High
184	riparian	1.83	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
185	wetland	0.34	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
186	pond	0.11	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
188	wetland	1.39	Foothills	grassland	grassland	High	High	High	High	High
189	seasonal wetland	2.36	Foothills	grassland	grassland	High	High	High	High	High
190	pond	0.18	Montane	grassland	grassland	High	High	High	High	High
191	wetland	0.28	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
193	pond	0.29	Foothills	grassland	grassland	High	High	High	High	High
194	wetland	0.16	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
196	wetland	0.52	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
200	wetland	1.48	Foothills	grassland	grassland	High	High	High	High	High
202	wetland	0.44	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
203	pond	0.12	Foothills	oak woodland	oak savannah	Medium	Medium	Medium	Medium	Medium
210	pond	0.23	Foothills	oak woodland	oak woodland	High	High	High	High	High
Willow Creek Subbasin										
1	wetland	5.79	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
2	wetland	2.30	Lowland	ruderal	ruderal	Low	Low	Low	Medium	Medium
3	wetland	1.08	Lowland	urban	urban	Low	Low	Low	Low	Low
4	wetland	3.77	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
5	wetland	0.59	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
6	wetland	0.64	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
7	pond	0.31	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
8	pond	0.46	Lowland	urban	urban	Low	Low	Low	Low	Low
9	pond	0.95	Lowland	urban	urban	Low	Low	Low	Low	Low

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
10	riparian	0.74	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
11	wetland	1.25	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
12	riparian	1.40	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	Medium
13	wetland	1.60	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
14	wetland	0.75	Lowland	grassland	grassland	Medium	Medium	Medium	Medium	High
15	wetland	0.44	Lowland	grassland	urban	Low	Low	Low	Medium	Medium
16	wetland	0.30	Lowland	grassland	urban	Low	Low	Low	Medium	Medium
17	pond	0.25	Lowland	urban	urban	Low	Low	Low	Low	Low
18	riparian	1.21	Lowland	urban	ruderal	Low	Low	Low	Low	Low
19	wetland	0.56	Lowland	urban	urban	Low	Low	Low	Low	Low
20	wetland	0.37	Lowland	urban	ruderal	Low	Low	Low	Low	Low
21	riparian	1.43	Lowland	urban	ruderal	Low	Low	Low	Low	Low
22	wetland	0.62	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
23	wetland	1.18	Lowland	urban	urban	Low	Low	Low	Low	Low
24	riparian	0.71	Lowland	urban	urban	Low	Low	Low	Low	Low
25	riparian	0.87	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
26	wetland	0.53	Lowland	ruderal	ruderal	Low	Low	Low	Low	Low
27	wetland	12.13	Lowland	ruderal	ruderal	Low	Low	Low	Medium	High
28	riparian	5.96	Lowland	urban	urban	Low	Low	Low	Low	Low
29	wetland	0.16	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
30	pond	0.12	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
31	riparian	0.83	Lowland	urban	urban	Low	Low	Low	Low	Low
32	wetland	2.36	Lowland	urban	ruderal	Low	Low	Low	Low	Low
33	pond	0.10	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
34	wetland	0.46	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
35	wetland	4.21	Lowland	ruderal	urban	Low	Low	Low	Medium	Low
36	riparian	0.42	Lowland	urban	urban	Low	Low	Low	Low	Low
37	wetland	1.04	Foothills	grassland	grassland	High	High	High	High	Medium
39	pond	0.50	Lowland	grassland	urban	Medium	Medium	Medium	Medium	Medium
40	riparian	2.52	Lowland	ruderal	urban	Low	Low	Low	Medium	Low
41	seasonal wetland	0.38	Lowland	grassland	urban	Low	Low	Low	Medium	Medium

						Level of Function				
ID	Wetland Type	Acreage	Geomorphic Region	Primary Land Cover	Secondary Land Cover	Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential
43	wetland	0.81	Lowland	urban	ruderal	Low	Low	Low	Low	Low
44	seasonal wetland	4.38	Lowland	grassland	aqueduct	Medium	Medium	Medium	Medium	Medium
45	seasonal wetland	0.34	Lowland	grassland	aqueduct	Medium	Medium	Medium	Medium	Medium
46	riparian	7.34	Lowland	ruderal	urban	Low	Low	Low	Medium	Low
47	riparian	6.18	Lowland	grassland	ruderal	Medium	Medium	Medium	Medium	High
50	pond	0.84	Lowland	turf	turf	Low	Low	Low	Medium	Medium
51	pond	0.79	Lowland	turf	turf	Low	Low	Low	Medium	Medium
52	pond	0.85	Lowland	turf	turf	Low	Low	Low	Medium	Medium
53	pond	0.84	Lowland	turf	turf	Low	Low	Low	Medium	Medium
66	riparian	7.44	Foothills	grassland	grassland	High	High	High	High	High
71	riparian	0.64	Lowland	aqueduct	urban/ grassland	Low	Low	Low	Medium	Low
72	wetland	0.36	Lowland	grassland	ruderal	Low	Low	Low	Medium	Low
74	pond	1.28	Lowland	turf	turf	Low	Low	Low	Medium	Medium
77	pond	2.51	Lowland	urban	urban	Low	Low	Low	Low	Low
79	wetland	0.34	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
80	wetland	0.45	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
81	pond	0.21	Lowland	urban	urban	Low	Low	Low	Low	Low
82	wetland	0.28	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
85	wetland	0.97	Foothills	grassland	grassland	High	High	High	High	Medium
90	wetland	6.93	Foothills	grassland	grassland	High	High	High	High	High
91	seasonal wetland	0.31	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
94	seasonal wetland	8.14	Foothills	grassland	grassland	High	High	High	High	High
96	riparian	1.21	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	High
98	pond	0.19	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
121	pond	0.17	Foothills	grassland	grassland	Medium	Medium	Medium	Medium	Medium
127	pond	0.39	Foothills	grassland	grassland	High	High	High	High	High

Appendix A
Table 2. Valuation for Streams in the Study Area

Reach Code	Miles	Geomorphic Region	Adjacent land cover	Level of Function						Subbasin
				Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential	Overall Existing score (0-18)	
Willow Creek Subbasin										
1A	1.85	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Willow
1B	1.31	Foothills	Natural	High	High	High	High	High	15	Willow
2A	0.33	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Willow
3A	1.55	Lowland	Urban	Low	Low	Low	Low	Low	1	Willow
4A	0.04	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Willow
4B	0.19	Foothills	Natural	High	High	High	High	High	15	Willow
5A	1.61	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Willow
6A	0.43	Lowland	Urban	Low	Low	Low	Low	Low	1	Willow
7A	0.32	Lowland	Urban	Low	Low	Low	Low	Low	1	Willow
8A	0.91	Lowland	Urban	Low	Low	Low	Low	Low	1	Willow
8B	0.31	Foothills	Urban	Medium	Medium	Medium	Medium	Medium	7	Willow
9A	0.83	Foothills	Natural	High	High	High	High	High	15	Willow
10A	0.04	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Willow
10B	0.28	Foothills	Natural	High	High	High	High	High	15	Willow
11A	0.82	Foothills	Urban	Medium	Medium	Medium	Medium	Medium	7	Willow
12A	1.20	Foothills	Natural	High	High	High	High	High	15	Willow
13A	0.49	Lowland	Urban	Low	Low	Low	Low	Low	1	Willow
14A	1.76	Lowland	Urban	Low	Low	Low	Low	Low	1	Willow
14B	0.70	Foothills	Urban	Medium	Medium	Medium	Medium	Medium	7	Willow
15A	0.40	Foothills	Natural	High	High	High	High	High	15	Willow
16A	1.40	Lowland	Urban	Low	Low	Low	Low	Low	1	Willow
17A	2.40	Foothills	Natural	High	High	High	High	High	15	Willow
17B	0.28	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Willow
17C	0.10	Montane	Natural	High	High	High	High	High	18	Willow
18A	1.39	Lowland	Urban	Low	Low	Low	Low	Low	1	Willow

Reach Code	Miles	Geomorphic Region	Adjacent land cover	Level of Function						Subbasin
				Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential	Overall Existing score (0-18)	
18B	0.24	Foothills	Urban	Medium	Medium	Medium	Medium	Medium	7	Willow
19A	0.15	Foothills	Natural	High	High	High	High	High	15	Willow
20A	1.86	Lowland	Urban	Low	Low	Low	Low	Low	1	Willow
21A	2.16	Foothills	Natural	High	High	High	High	High	15	Willow
21B	0.59	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Willow
22A	2.20	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Willow
22B	0.10	Foothills	Natural	High	High	High	High	High	15	Willow
Kirker Creek Subbasin										
23A	10.43	Lowland	Urban	Low	Low	Low	Low	Low	1	Kirker
23B	1.40	Foothills	Urban	Medium	Medium	Medium	Medium	Medium	7	Kirker
24A	21.67	Foothills	Natural	Low	Low	High	Medium	Medium	15	Kirker
24B	0.14	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Kirker
24C	5.91	Montane	Natural	Low	Low	High	Medium	Medium	18	Kirker
25A	0.23	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Kirker
26A	0.77	Lowland	Urban	Low	Low	Low	Low	Low	1	Kirker
27A	0.13	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Kirker
West Antioch Creek Subbasin										
28A	9.23	Lowland	Urban	Low	Low	Low	Low	Low	1	West Antioch
28B	1.58	Foothills	Urban	Medium	Medium	Medium	Medium	Medium	7	West Antioch
29A	3.38	Foothills	Natural	High	High	High	High	High	15	West Antioch
29B	0.66	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	West Antioch
29C	0.47	Montane	Natural	High	High	High	High	High	18	West Antioch
30A	0.59	Foothills	Natural	High	High	High	High	High	15	West Antioch
31A	3.63	Foothills	Natural	High	High	High	High	High	15	West Antioch
31B	0.02	Montane	Natural	High	High	High	High	High	18	West Antioch
32A	2.51	Foothills	Natural	High	High	High	High	High	15	West Antioch
33A	0.14	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	West Antioch
33B	2.57	Foothills	Natural	High	High	High	High	High	15	West Antioch
East Antioch Creek Subbasin										
34A	0.64	Lowland	Urban	Low	Low	Low	Low	Low	1	East Antioch

Reach Code	Miles	Geomorphic Region	Adjacent land cover	Level of Function						Subbasin
				Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential	Overall Existing score (0-18)	
35A	4.23	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	East Antioch
36A	2.29	Lowland	Urban	Low	Low	Low	Low	Low	1	East Antioch
37A	0.29	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	East Antioch
Upper Mt Diablo Creek Subbasin										
38A	9.71	Foothills	Urban	Medium	Medium	Medium	Medium	Medium	7	Upper Mt Diablo
39A	0.20	Foothills	Natural	High	High	High	High	High	15	Upper Mt Diablo
40A	0.28	Foothills	Natural	High	High	High	High	High	15	Upper Mt Diablo
41A	0.28	Foothills	Natural	High	High	High	High	High	15	Upper Mt Diablo
41B	0.00	Montane	Natural	High	High	High	High	High	18	Upper Mt Diablo
42A	0.41	Montane	Natural	High	High	High	High	High	18	Upper Mt Diablo
42B	0.09	Foothills	Natural	High	High	High	High	High	15	Upper Mt Diablo
43A	5.68	Foothills	Natural	High	High	High	High	High	15	Upper Mt Diablo
43B	5.46	Montane	Natural	High	High	High	High	High	18	Upper Mt Diablo
44A	0.43	Foothills	Natural	High	High	High	High	High	15	Upper Mt Diablo
45A	3.52	Foothills	Natural	High	High	High	High	High	15	Upper Mt Diablo
45B	0.81	Montane	Natural	High	High	High	High	High	18	Upper Mt Diablo
46A	0.36	Foothills	Natural	High	High	High	High	High	15	Upper Mt Diablo
47A	0.82	Foothills	Natural	High	High	High	High	High	15	Upper Mt Diablo
47B	0.03	Montane	Natural	High	High	High	High	High	18	Upper Mt Diablo
48A	4.94	Foothills	Natural	High	High	High	High	High	15	Upper Mt Diablo
48B	3.00	Montane	Natural	High	High	High	High	High	18	Upper Mt Diablo
Sand Creek Subbasin										
49A	19.77	Foothills	Natural	High	High	High	High	High	15	Sand
49B	2.49	Montane	Natural	High	High	High	High	High	18	Sand
49C	5.37	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Sand
50A	0.13	Lowland	Urban	Low	Low	Low	Low	Low	1	Sand
51A	0.45	Lowland	Agriculture	Low	Low	Low	Low	Low	2	Sand
52A	0.22	Lowland	Urban	Low	Low	Low	Low	Low	1	Sand
53A	0.46	Lowland	Agriculture	Low	Low	Low	Low	Low	2	Sand
54A	1.09	Lowland	Urban	Low	Low	Low	Low	Low	1	Sand

Reach Code	Miles	Geomorphic Region	Adjacent land cover	Level of Function						Subbasin
				Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential	Overall Existing score (0-18)	
Lower Marsh Creek Subbasin										
55A	0.96	Delta	Agriculture	Medium	Low	Low	Medium	Medium	3	Lower Marsh
55B	0.02	Lowland	Agriculture	Low	Low	Low	Low	Low	2	Lower Marsh
56A	0.69	Lowland	Urban	Low	Low	Low	Low	Low	1	Lower Marsh
57A	0.30	Lowland	Agriculture	Low	Low	Low	Low	Low	2	Lower Marsh
57B	0.09	Delta	Agriculture	Medium	Low	Low	Medium	Medium	3	Lower Marsh
58A	0.40	Delta	Urban	Low	Low	Low	Low	Low	2	Lower Marsh
58B	0.34	Lowland	Urban	Low	Low	Low	Low	Low	1	Lower Marsh
59A	1.04	Lowland	Agriculture	Low	Low	Low	Low	Low	2	Lower Marsh
60A	1.31	Lowland	Urban	Low	Low	Low	Low	Low	1	Lower Marsh
61A	0.31	Lowland	Agriculture	Low	Low	Low	Low	Low	2	Lower Marsh
62A	1.82	Lowland	Urban	Low	Low	Low	Low	Low	1	Lower Marsh
63A	1.56	Lowland	Natural	Medium	Medium	Low	Medium	Medium	9	Lower Marsh
63B	0.92	Delta	Natural	Medium	Medium	Low	Medium	Medium	10	Lower Marsh
63C	0.01	Foothills	Natural	High	High	High	High	High	15	Lower Marsh
Deer Creek Subbasin										
64A	3.71	Lowland	Urban	Low	Low	Low	Low	Low	1	Deer
65A	7.64	Foothills	Natural	Low	Low	Low	Low	Medium	15	Deer
65B	1.02	Lowland	Natural	Low	Low	Low	Low	Medium	9	Deer
Dry Creek Subbasin										
66A	2.97	Lowland	Urban	Low	Low	Low	Low	Low	1	Dry
67A	0.59	Foothills	Natural	High	High	High	High	High	15	Dry
67B	0.16	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Dry
68A	1.80	Foothills	Natural	High	High	High	High	High	15	Dry
68B	0.98	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Dry
Briones Creek Subbasin										
69A	1.80	Lowland	Natural	Low	Low	Low	Low	Medium	9	Briones
69B	16.05	Foothills	Natural	Low	Low	Low	Low	Medium	15	Briones
69C	0.97	Montane	Natural	High	High	High	High	High	18	Briones

Reach Code	Miles	Geomorphic Region	Adjacent land cover	Level of Function						Subbasin
				Habitat	Water Quality	Hydrologic	Overall Existing	Overall Potential	Overall Existing score (0-18)	
Upper Marsh Creek Subbasin										
70A	3.05	Lowland	Natural	Low	Low	Medium	Low	Low	9	Upper Marsh
70B	46.55	Foothills	Natural	Medium	Low	High	Medium	Medium	15	Upper Marsh
70C	39.70	Montane	Natural	High	High	High	High	High	18	Upper Marsh
Kellogg Creek Subbasin										
71A	0.04	Lowland	Natural	Medium	Medium	Low	Medium	Medium	9	Kellogg
71B	30.34	Delta	Natural	Medium	Medium	Low	Medium	Medium	10	Kellogg
71C	7.53	Foothills	Natural	High	High	Low	Medium	Medium	15	Kellogg
71D	11.19	Montane	Natural	High	High	High	High	High	18	Kellogg
72A	6.41	Lowland	Agriculture	Low	Low	Low	Low	Low	2	Kellogg
72B	0.63	Delta	Agriculture	Medium	Low	Low	Medium	Medium	3	Kellogg
Brushy Creek Subbasin										
73A	2.27	Lowland	Natural	Medium	Medium	Medium	Medium	Medium	9	Brushy
73B	21.01	Delta	Natural	Medium	Medium	Medium	Medium	Medium	10	Brushy
73C	21.21	Foothills	Natural	High	High	High	High	High	15	Brushy
73D	0.96	Montane	Natural	High	High	High	High	High	18	Brushy
74A	6.20	Delta	Agriculture	Medium	Low	Low	Medium	Medium	3	Brushy

Appendix B
Photo Atlas for the Inventory Area