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.
<table>
<thead>
<tr>
<th>Functional Type</th>
<th>Hydrogeomorphic Class (HGM)</th>
<th>Biological Functions</th>
<th>Biological Quality</th>
<th>Hydrologic Functions</th>
<th>Hydrologic Quality</th>
<th>Overall Quality</th>
<th>Potential Quality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine non tidal intermittent</td>
<td>Foothill/Terrace Stream channels;</td>
<td>Adjacent land cover varies from grassland and riparian forest to developed. CTS</td>
<td>Moderate</td>
<td>Wetland vegetation in some reaches filters pollutants. Groundwater recharge is greatest</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Valley Bottom Stream Channels</td>
<td>and CRF habitat in foothills.</td>
<td></td>
<td>at transition zone from foothills to valley. Some valley reaches are undeveloped and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>provide flood storage and groundwater recharge. Poorly installed culverts increase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>erosion.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine forest (riparian forest)</td>
<td>Foothill/Terrace Stream-Banks</td>
<td>Forest corridor is narrow and understory may be overgrazed in some areas.</td>
<td>Low</td>
<td>Reduce flow velocity and filter sediment. Maintain cool water temperatures.</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM)</td>
<td>Valley Bottom depressional wetlands, Stream Floodplains,</td>
<td>Fragments of tidal marsh may provide secondary habitat for some species. Seasonal</td>
<td>Low</td>
<td>Wetland vegetation, which is generally denser in upper subbasin, enhances filtration.</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Bottomlands or Pond Margins</td>
<td>wetlands provide CTS habitat.</td>
<td></td>
<td>Detention basins store flood flows and recharge groundwater.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverine excavated artificial</td>
<td>Aqueduct</td>
<td>Open water habitat for waterfowl, shorebirds and</td>
<td>Low</td>
<td>Human drinking water conveyance</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
Table 5-3. Continued

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

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

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
<td>28 miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine forest (riparian forest)</td>
<td>39</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)</td>
<td>56</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverine excavated artificial</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Available within Land Acquisition Analysis Zones with moderate or high acquisition priority.
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
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Chapter 5. Analysis and Results

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
<table>
<thead>
<tr>
<th>Functional Type</th>
<th>Hydrogeomorphic Class (HGM)</th>
<th>Biological Functions</th>
<th>Biological Quality</th>
<th>Hydrologic Functions</th>
<th>Hydrologic Quality</th>
<th>Overall Quality</th>
<th>Potential Quality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine nonidal intermittent</td>
<td>Foothill/Terrace Stream channels; Valley bottom stream channels</td>
<td>Adjacent grassland and woodland enhance riverine habitat in the foothills, where CRF and CTS have been documented. Adjacent development limits habitat function in valley.</td>
<td>Moderate</td>
<td>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.</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Riverine nonidal lower perennial</td>
<td>Valley bottom stream channels</td>
<td>Adjacent development limits habitat function.</td>
<td>Low</td>
<td>Restricted floodplain reduces flood storage and groundwater recharge. Problems with flooding in developed areas. Illegal dumping compromises water quality.</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Palustrine forest (riparian forest)</td>
<td>Foothill/Terrace Stream-Banks; Valley bottom stream banks</td>
<td>Forest corridor narrows from foothills to valley. Understory in foothills may be overgrazed.</td>
<td>Low</td>
<td>Reduce flow velocity and filter sediment. Maintain cool water temperatures.</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)</td>
<td>Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins</td>
<td>Floodplain wetlands with grassland adjacent provide habitat for CTS and other amphibians in the foothills.</td>
<td>Moderate</td>
<td>Wetlands in the foothills and vegetated detention basins in the valley filter contaminants and provide flood storage.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Riverine excavated</td>
<td>Aqueduct</td>
<td>Open water habitat</td>
<td>Low</td>
<td>Human drinking water</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
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</tbody>
</table>
**Table 5-4. Continued**

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

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.
<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverine nontidal lower perennial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine forest (riparian forest)</td>
<td>41 miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)</td>
<td>43</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverine excavated artificial</td>
<td>0.4</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)</td>
<td>3</td>
<td></td>
<td></td>
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</tbody>
</table>

* Available within Land Acquisition Analysis Zones with moderate or high acquisition priority
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, siltstones, 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.
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- 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.
<table>
<thead>
<tr>
<th>Functional Type</th>
<th>Hydrogeomorphic Class (HGM)</th>
<th>Biological Functions</th>
<th>Biological Quality</th>
<th>Hydrologic Functions</th>
<th>Hydrologic Quality</th>
<th>Overall Quality</th>
<th>Potential Quality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
<td>Foothill/Terrace Stream channels; Valley bottom stream channels</td>
<td>Adjacent protected forest and grasslands in foothills enhance habitat quality for species including CTS and CRF.</td>
<td>Moderate</td>
<td>Vegetated reaches filter contaminants. Stream reaches in the transition zone may provide groundwater recharge.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Riverine nontidal lower perennial</td>
<td>Valley bottom stream channels</td>
<td>Low habitat quality due to adjacent developed land and culverted reaches</td>
<td>Low</td>
<td>Sediment sink. Contaminants from urban runoff may be trapped in bottom sediments. Naturally lined channels provide groundwater recharge.</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Palustrine forest (riparian forest)</td>
<td>Foothill/Terrace Stream-Banks</td>
<td>Protected forest areas provide habitat for species including Diablo helianthella.</td>
<td>High</td>
<td>Reduce flow velocity and filter sediment. Maintain cool water temperatures.</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM)</td>
<td>Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins</td>
<td>Wetlands in the foothills provide habitat for CTS and CRF. Wetlands in the Lower Valley/Plain are small and isolated.</td>
<td>Moderate</td>
<td>Wetlands in the foothills filter contaminants and provide flood storage.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Riverine excavated artificial</td>
<td>Aqueduct</td>
<td>Open water habitat for waterfowl, shorebirds and some amphibians.</td>
<td>Low</td>
<td>Human drinking water conveyance</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Palustrine aquatic bed/unconsolidated</td>
<td>Agricultural Ponds</td>
<td>Stock ponds provide habitat for CTS.</td>
<td>Moderate</td>
<td>Stock ponds provide a low level of flood storage and</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
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</table>
### Table 5.5. Continued

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<tr>
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<th>Biological Functions</th>
<th>Biological Quality</th>
<th>Hydrologic Functions</th>
<th>Hydrologic Quality</th>
<th>Overall Quality</th>
<th>Potential Quality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ponds)</td>
<td></td>
<td>Where adjacent land has not been developed or landscaped for recreation, habitat value is enhanced.</td>
<td>Low</td>
<td>Groundwater recharge.</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
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<tr>
<td>Lacustrine impounded</td>
<td>Reservoir</td>
<td></td>
<td></td>
<td>Sediment sink. Flood storage and groundwater recharge.</td>
<td></td>
<td></td>
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</table>

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

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<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
<td>25 miles</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Riverine nontidal lower perennial</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine forest (riparian forest)</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverine excavated artificial</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lacustrine impounded</td>
<td>126</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

\(^a\) Available within Land Acquisition Analysis Zones with moderate or high acquisition priority
(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.

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
<table>
<thead>
<tr>
<th>Functional Type</th>
<th>Hydrogeomorphic Class (HGM)</th>
<th>Biological Functions</th>
<th>Biological Quality</th>
<th>Hydrologic Functions</th>
<th>Hydrologic Quality</th>
<th>Overall Quality</th>
<th>Potential Quality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
<td>Foothill/Terrace Stream channels; Valley bottom stream channels</td>
<td>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.</td>
<td>Moderate</td>
<td>Sandy soils are important sediment source for Marsh Creek. Gentle gradients and adjacent grassland allow flood storage.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Riverine nontidal lower perennial</td>
<td>Valley bottom stream channels</td>
<td>Engineered trapezoidal channel adjacent to development provides low habitat function.</td>
<td>Low</td>
<td>Flood water conveyance.</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Palustrine forest (riparian forest)</td>
<td>Foothill/Terrace Stream-Banks</td>
<td>Riparian forest along perennial reaches of Oil Canyon Creek provides high-quality habitat.</td>
<td>High</td>
<td>Reduce flow velocity and filter sediment. Maintain cool water temperatures.</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)</td>
<td>Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins</td>
<td>Wetlands within preserve offer high quality habitat. Wetlands in overgrazed and mowed areas provide habitat for disturbance-tolerant species.</td>
<td>Low</td>
<td>Filter contaminants and provide flood storage and limited groundwater recharge.</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>PPEM Alkali</td>
<td>Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins</td>
<td>Alkali wetlands in foothills provide potential habitat for rare species such as San Joaquin spearscale if livestock access is regulated.</td>
<td>Moderate</td>
<td>Filter contaminants and provide flood storage and limited groundwater recharge.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
</tbody>
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Table 5-6. Continued

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

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

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<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
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<tr>
<td>Riverine nontidal lower perennial</td>
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<tr>
<td>Palustrine forest (riparian forest)</td>
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<tr>
<td>Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)</td>
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<tr>
<td>PPEM Alkali</td>
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<tr>
<td>Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)</td>
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* Available within Land Acquisition Analysis Zones with moderate or high acquisition priority
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.
<table>
<thead>
<tr>
<th>Functional Type</th>
<th>Hydrogeomorphic Class (HGM)</th>
<th>Biological Functions</th>
<th>Biological Quality</th>
<th>Hydrologic Functions</th>
<th>Hydrologic Quality</th>
<th>Overall Quality</th>
<th>Potential Quality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
<td>Foothill/Terrace Stream channels; Valley bottom stream channels</td>
<td>Riparian vegetation lacking due to overgrazing. Streambanks may provide burrowing owl habitat.</td>
<td>Low</td>
<td>Erosion results in abundant fine sediment. Gentle gradient and clay soils with high water retention allow flood storage.</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Riverine nontidal lower perennial</td>
<td>Valley bottom stream channels</td>
<td>Adjacent development compromises habitat quality. Portions have been riprapped.</td>
<td>Low</td>
<td>Flood water conveyance.</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)</td>
<td>Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins</td>
<td>Lack of vegetation compromises habitat quality. Some wetlands retain marsh vegetation. May provide fairy shrimp and CTSA habitat.</td>
<td>Low</td>
<td>Lack of vegetation due to livestock impacts limits filtration capacity. Provide flood storage and limited groundwater recharge.</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>PPEM Alkali</td>
<td>Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins</td>
<td>Potential special status species habitat if livestock access is regulated.</td>
<td>Low</td>
<td>Heavy grazing reduces vegetation, limiting filtration capacity. Provide flood storage and limited groundwater recharge.</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Palustrine aquatic bed/unconsolidated</td>
<td>Agricultural Ponds, Stock ponds provide potential</td>
<td>Moderate</td>
<td>Low level of flood storage and</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Functional Type</td>
<td>Hydrogeomorphic Class (HGM)</td>
<td>Biological Functions</td>
<td>Biological Quality</td>
<td>Hydrologic Functions</td>
<td>Hydrologic Quality</td>
<td>Overall Quality</td>
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<tr>
<td>bottom (PAB/UB) (ponds)</td>
<td>Recreational Ponds</td>
<td>habitat for CTS.</td>
<td></td>
<td>groundwater recharge.</td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Lacustrine impounded</td>
<td>Reservoir</td>
<td>Potential CTS habitat</td>
<td>Low</td>
<td>Flood storage and groundwater recharge</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
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* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

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<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
<td>12 miles</td>
<td></td>
<td>Preservation</td>
<td>Restoration</td>
<td>Wetland Preservation Needed (acres)</td>
<td>Wetland Needed for Restoration (acres)</td>
</tr>
<tr>
<td>Riverine nontidal lower perennial</td>
<td>8</td>
<td></td>
<td>Preservation</td>
<td>Restoration</td>
<td>Wetland Preservation Needed (acres)</td>
<td>Wetland Needed for Restoration (acres)</td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM)</td>
<td>8</td>
<td></td>
<td>Preservation</td>
<td>Restoration</td>
<td>Wetland Preservation Needed (acres)</td>
<td>Wetland Needed for Restoration (acres)</td>
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<tr>
<td>(seasonally or temporarily flooded wetlands)</td>
<td></td>
<td></td>
<td>Preservation</td>
<td>Restoration</td>
<td>Wetland Preservation Needed (acres)</td>
<td>Wetland Needed for Restoration (acres)</td>
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<tr>
<td>PPEM Alkali</td>
<td>6</td>
<td></td>
<td>Preservation</td>
<td>Restoration</td>
<td>Wetland Preservation Needed (acres)</td>
<td>Wetland Needed for Restoration (acres)</td>
</tr>
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<td>11</td>
<td></td>
<td>Preservation</td>
<td>Restoration</td>
<td>Wetland Preservation Needed (acres)</td>
<td>Wetland Needed for Restoration (acres)</td>
</tr>
<tr>
<td>Lacustrine impounded</td>
<td>7</td>
<td></td>
<td>Preservation</td>
<td>Restoration</td>
<td>Wetland Preservation Needed (acres)</td>
<td>Wetland Needed for Restoration (acres)</td>
</tr>
</tbody>
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* Available within Land Acquisition Analysis Zones with moderate or high acquisition priority
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.
<table>
<thead>
<tr>
<th>Functional Type</th>
<th>Hydrogeomorphic Class (HGM)</th>
<th>Biological Functions</th>
<th>Biological Quality</th>
<th>Hydrologic Functions</th>
<th>Hydrologic Quality</th>
<th>Overall Quality</th>
<th>Potential Quality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
<td>Foothill/Terrace Stream Channels; Valley Bottom Stream Channels</td>
<td>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.</td>
<td>Moderate</td>
<td>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.</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands, mostly Alkali)</td>
<td>Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins</td>
<td>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.</td>
<td>Moderate</td>
<td>Short stature wetlands vegetation limits the extent of filtration. Some flood storage and groundwater recharge.</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)</td>
<td>Agricultural ponds, recreational ponds,</td>
<td>Stock ponds provide potential CTS habitat. Golf course ponds and detention basins provide little habitat</td>
<td>Low</td>
<td>Sediment traps. Some flood storage and groundwater recharge.</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Riverine Excavated Artificial Aqueduct</td>
<td>Open water habitat for waterfowl, shorebirds, and some amphibians.</td>
<td>Low</td>
<td>Human drinking water conveyance</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.
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<td>Preservation</td>
<td>Restoration</td>
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<td>PPEM Alkali</td>
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<td>Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)</td>
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<td>Riverine Excavated Artifical</td>
<td>0.3</td>
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</table>

*a Available within Land Acquisition Analysis Zones with moderate or high acquisition priority*
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 \textit{[Distichlis spicata]}, alkali heath \textit{[Frankenia salina]}, brass buttons \textit{[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 \textit{[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 \textit{[Lyttia 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 Quaternary alluvial fans and fluvioglacial 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.
<table>
<thead>
<tr>
<th>Functional Type</th>
<th>Hydrogeomorphic Class (HGM)</th>
<th>Biological Functions</th>
<th>Biological Quality</th>
<th>Hydrologic Functions</th>
<th>Hydrologic Quality</th>
<th>Overall Quality</th>
<th>Potential Quality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
<td>Foothill/Terrace Stream Channels; Valley Bottom Stream Channels</td>
<td>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.</td>
<td>Low</td>
<td>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.</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Palustrine forest/scrub</td>
<td>Foothill/Terrace Stream Banks; Valley Bottom Stream Banks</td>
<td>Small patches of woodland vegetation provide limited habitat quality</td>
<td>Low</td>
<td>Sediment filtration and water cooling limited by small size of patches</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)</td>
<td>Foothill/Terrace Stream Channels; Valley Bottom Stream Channels; Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins</td>
<td>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.</td>
<td>Moderate</td>
<td>Lack of vegetation reduces filtration capacity in upper subbasin. Greater filtration capacity in lower subbasin. Flood storage and small amounts of groundwater recharge.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>PPEM Alkali</td>
<td>Same as above</td>
<td>Mostly within state park. Provide habitat for halophytic species such as San Joaquin spearscale.</td>
<td>High</td>
<td>Short stature of vegetation limits filtration capacity. Flood storage and small amounts of groundwater recharge.</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)</td>
<td>Agricultural ponds</td>
<td>Potential habitat for CTS</td>
<td>Low</td>
<td>Sediment and nutrient traps. Modest amounts of flood storage and groundwater recharge.</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
Table 5-9. Continued

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

<table>
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<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
<td>19 miles</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Palustrine forest/scrub</td>
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<td>Palustrine persistent emergent (PPEM)</td>
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<td>(seasonally or temporarily flooded wetlands)</td>
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<td>5</td>
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<td>10</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>(ponds)</td>
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</table>

* Available within Land Acquisition Analysis Zones with moderate or high acquisition priority
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 lynchii 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
<table>
<thead>
<tr>
<th>Functional Type</th>
<th>Hydrogeomorphic Class (HGM)</th>
<th>Biological Functions</th>
<th>Biological Quality</th>
<th>Hydrologic Functions</th>
<th>Hydrologic Quality</th>
<th>Overall Quality</th>
<th>Potential Quality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
<td>Foothill/Terrace Stream channels; Valley Bottom Stream channels</td>
<td>Adjacent grasslands provide good habitat for a variety of species, including CRF.</td>
<td>High</td>
<td>Outside the protected watershed area, the floodplain is restricted and livestock access to the channel increases erosion and nutrient delivery downstream.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Riverine nontidal lower perennial</td>
<td>Foothill/Terrace and Valley Stream channels</td>
<td>Agricultural land use has degraded the quality of habitat in these reaches. Species found here are accustomed to human disturbance.</td>
<td>Low</td>
<td>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.</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Palustrine forest and scrub</td>
<td>Foothill/Terrace Stream-Banks</td>
<td>Willow, alders, oaks, and grassland provide habitat for a wide variety of species. Fewer species are found closer to the Delta.</td>
<td>High</td>
<td>Improved water quality through sediment removal. Patches of forest and scrub locally reduce water temperature.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)</td>
<td>Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins</td>
<td>Intensive agriculture surrounds wetlands and vernal pools in the lower subbasin. Special status plants and wildlife have been documented throughout the subbasin.</td>
<td>Moderate</td>
<td>Removal of sediments and associated contaminants improves water quality. However, grazing pressure may reduce this function in some areas.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>PPEM Alkali</td>
<td>Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond</td>
<td>Many special status plant species. Many alkali wetlands are stressed by adjacent</td>
<td>Moderate</td>
<td>Important sink for minerals and salts dissolved in surface waters.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Environment</td>
<td>Margins</td>
<td>Agricultural Ponds</td>
<td>Moderation</td>
<td>Agricultural uses.</td>
<td>Recharge</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>-----------------------------------</td>
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<td>------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>------------</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)</td>
<td></td>
<td></td>
<td></td>
<td>Numerous stock ponds are found throughout the subbasin. The ponds provide habitat for CTS and CRF.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lacustrine impounded</td>
<td>Reservoir</td>
<td></td>
<td>High</td>
<td>Habitat for bird species is provided by the Los Vaqueros reservoir.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverine excavated artificial</td>
<td>Aqueduct</td>
<td></td>
<td>Low</td>
<td>Open water habitat for waterfowl, shorebirds and some amphibians.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.
<table>
<thead>
<tr>
<th>Functional Type</th>
<th>Est. Total in Inventory Area (acres)</th>
<th>Est. Impact (acres)</th>
<th>Mitigation Ratio</th>
<th>Wetland Preservation Needed (acres)</th>
<th>Wetland Available for Preservation(^a) (acres)</th>
<th>Wetland Needed for Restoration (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine nontidal intermittent and perennial</td>
<td>56 miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverine tidal</td>
<td>11.5 miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine forest and scrub</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM)</td>
<td>55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine persistent emergent (seasonally or temporarily flooded wetlands)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPEM Alkali</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lacustrine impounded</td>
<td>1434</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverine excavated artificial</td>
<td>4 miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Available within Land Acquisition Analysis Zones with moderate or high acquisition priority.
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.
<table>
<thead>
<tr>
<th>Functional Type</th>
<th>Hydrogeomorphic Class (HGM)</th>
<th>Biological Functions</th>
<th>Biological Quality</th>
<th>Hydrologic Functions</th>
<th>Hydrologic Quality</th>
<th>Overall Quality</th>
<th>Potential Quality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine nontidal intermittent</td>
<td>Foothill/Terrace Stream channels; Valley bottom stream channels</td>
<td>Adjacent grasslands provide good habitat for a variety of species, including CRF.</td>
<td>High</td>
<td>Restricted floodplain and livestock access to the channel in the valley reduce water quality filtration mechanisms and flood storage capacity</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Riverine nontidal lower perennial</td>
<td>Valley bottom stream channels</td>
<td>Agricultural land use has degraded the quality of habitat in these reaches. Invasive aquatic plants dominate the channels.</td>
<td>Low</td>
<td>Poor water quality due to high nutrients and other contaminants from agricultural return flows. Low flood storage due to confinement from agricultural use.</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Palustrine forest and scrub</td>
<td>Foothill/Terrace Stream-Banks</td>
<td>Scrub habitat, found in the upper subbasin, is often degraded by livestock.</td>
<td>Moderate</td>
<td>Improved water quality through sediment removal. Patches of forest and scrub locally reduce water temperature.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)</td>
<td>Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins</td>
<td>Intensive agriculture surrounds wetlands and vernal pools. Special status plants and wildlife have been documented here.</td>
<td>Moderate</td>
<td>Removal of sediments and associated contaminants improves water quality. However, this function is reduced where vegetation cover is impacted by livestock.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>PPEM Alkali</td>
<td>Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins</td>
<td>Many special status plant species. Many alkali wetlands are stressed by adjacent</td>
<td>Moderate</td>
<td>Important sink for minerals and salts dissolved in surface waters.</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Habitat Type</td>
<td>Characteristics</td>
<td>Potential 1</td>
<td>Potential 2</td>
<td>Potential 3</td>
<td>Potential 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)</td>
<td>Numerous stock ponds are found in the upper subbasin. The ponds provide habitat for CTS and CRF.</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural Ponds</td>
<td>Some pollutants adsorb to the abundant clay soils in subbasin. Little flood storage and groundwater recharge.</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverine excavated artificial</td>
<td>Open water habitat for waterfowl, shorebirds and some amphibians.</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aqueduct</td>
<td>Human drinking water conveyance</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.
<table>
<thead>
<tr>
<th>Functional Type</th>
<th>Est. Total in Inventory Area (acres)</th>
<th>Est. Impact (acres)</th>
<th>Mitigation Ratio</th>
<th>Wetland Preservation Needed (acres)</th>
<th>Wetland Available for Preservation&lt;sup&gt;a&lt;/sup&gt; (acres)</th>
<th>Wetland Needed for Restoration (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine non-tidal intermittent and perennial</td>
<td>47 miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine forest and scrub</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)</td>
<td>190&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPEM Alkali</td>
<td>326&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverine excavated artificial</td>
<td>48.5 miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

<sup>b</sup> Acreage represent wetland complexes, not all of which are jurisdictional wetlands.
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.