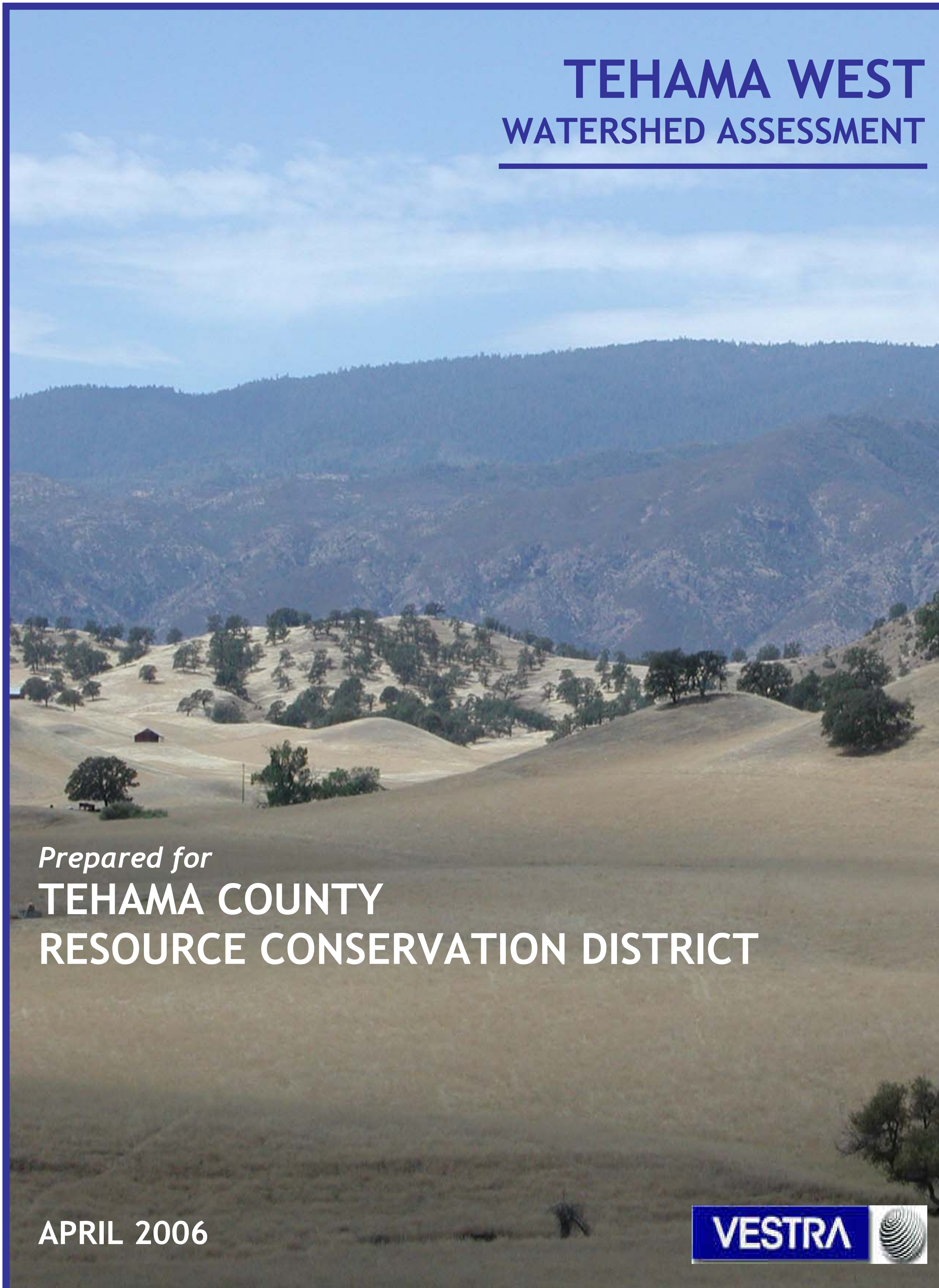

TEHAMA WEST

WATERSHED ASSESSMENT

Prepared for

TEHAMA COUNTY

RESOURCE CONSERVATION DISTRICT

APRIL 2006

VESTRA

TEHAMA WEST
WATERSHED ASSESSMENT

Prepared for

Tehama County Resource Conservation District

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APRIL 2006

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INTRODUCTION

SOURCES OF DATA

Data used to assemble the Tehama West Watershed Assessment comes from federal, state, and local sources. Data sources are based primarily on published material. However, whenever possible, data previously unavailable, such as academic theses, are incorporated into the document with concurrence from the Technical Advisory Committee (TAC). Agencies responsible for providing available data include but are not limited to:

- United States Forest Service (USFS)
- United States Department of Agriculture (USDA)
- Department of Transportation (DOT)
- Department of Water Resources (DWR)
- California State Water Resources Control Board (SWRCB)
- Bureau of Land Management (BLM)
- United States Geological Survey (USGS)
- National Oceanic and Atmospheric Administration (NOAA)
- California Department of Fish and Game (CDFG)
- Natural Resources Conservation Service (NRCS)
- California Department of Forestry and Fire Protection (CDF)

OBJECTIVES

The mission of the Tehama West Watershed Assessment is to gather and integrate existing information on the physical, cultural, and demographic variables that characterize the Tehama West Watershed at the present and in the past. The project is primarily an existing conditions report that will be used as an educational tool to help guide residents and stakeholders in prioritizing future watershed projects. This watershed assessment can be considered the initial step in developing our knowledge of existing conditions within the watershed ecosystem. It will be amended and extended as new information becomes available.

SCOPE

Information collected from previous studies has been organized according to a five-step process, consistent with the goal of the CalFed Watershed Program, promoting collaboration and integration among community-based watershed efforts. This watershed assessment is intended to assist the efforts of the Tehama County Resource Conservation District (TCRCD) in maintaining a viable stakeholder-driven means for assessing and implementing watershed-based projects and management. The basic approach to data collection and organization includes:

Step 1 – Characterization of the watershed
Step 2 – Description of current conditions
Step 3 – Description of reference (historical) conditions

Step 4 – Synthesis of information
Step 5 – Conclusions and recommendations

Information collected and organized in this watershed assessment has been developed in collaboration with the TCRCD Technical Advisory Committee (TAC).

FUNDING SOURCES

The watershed assessment project is funded through a grant from the State Water Resources Control Board through the CalFed Watershed Program. Many other contributions from state, federal, and private sources have made this assessment possible.

TECHNICAL ADVISORY COMMITTEE (TAC) MEMBERS

The TAC members are comprised of TCRCD staff and specialists from cooperating agencies. TAC members provided information and technical review for this project.

TAC Members include:

Frank Barron – Crane Mills
Larry Branham – United States Department of Agriculture
Bill Burrows – Sunflower CRMP
Andrea Carter – Bureau of Land Management
Guy Chetelat – Regional Water Quality Control Board, Central Valley Region
Vicky Dawley – Tehama County Resource Conservation District
Eda Eggeman – California Department of Fish and Game
Dennis Heiman – State Water Resources Control Board
Tom McCubbins – Tehama County Resource Conservation District, Project Manager
Harry McQuillen – United States Fish and Wildlife Service
John Merz – Sacramento River Trust
Ernie Ohlin - Tehama County Flood Control & Water Conservation District
Chuck Schoendienst – California Department of Forestry and Fire Prevention
Fraser Sime – California Department of Water Resources
Mike VanDame – United States Forest Service, Mendocino National Forest

WATERSHED INTRODUCTION

The TCRCD found the need to provide a comprehensive evaluation of environmental conditions within the Tehama West Watershed. The watershed is a Category I Watershed in the California Unified Watershed Assessment (NRCS 2005). Watersheds with Category I status meet one or more of the following criteria:

1. Contains water bodies listed as having impaired beneficial uses (State Water Resources Control Board's Clean Water Act Section 303(d) list) (SWRCB 2002 update)
2. Watersheds identified by local groups as needing improvements (United States Department of Agriculture Geographic Priority Areas [Environmental Quality Incentives Program] database)

3. Watersheds with very high wildfire or fuel hazards potential (California Department of Forestry and Fire Protection Wildfire Potential database)
4. Watersheds with proposed and listed criteria of aquatic, wetland-threatened, and endangered species (California Department of Fish and Game, Natural Heritage Division, Natural Diversity Database)
5. Watersheds with impairments in the quality of aquatic and riparian systems [California Rivers Assessment (CARA) professional judgment assessment (PJA)]
6. Watersheds with streams or riparian areas identified as not functioning or functioning at risk [from the Proper Functioning Condition Assessment (PFC) in CARA]

According to the California Unified Watershed Assessment, the Tehama West Watershed meets four of the above criteria (Criteria 3 through 6 from the above list) (NRCS, 2005).

The Tehama West Watershed is located in northern California along the western edge of the Sacramento Valley. It is bordered by the Cottonwood Creek Watershed to the north, Mendocino County to the west, Glenn County to the south, and the Sacramento River to the east. The general location of the watershed is shown in Figure 1-1. The Tehama West Watershed encompasses 668,168 acres and includes 11 sub-units. The watershed contains 11 major tributaries to the Sacramento River. The watershed boundary, its major tributaries, and general layout are included in Figure 1-2.

Rural lifestyles and a population density of approximately five persons per square mile generally characterize the watershed. The largest community in the watershed is Red Bluff, an incorporated city in Tehama County, with a current population of 13,147. Other incorporated towns in the watershed include Corning and Tehama. Unincorporated towns include Flournoy, Gerber, Paskenta, and Proberta. Ranching, farming, and timber are the primary resource activities throughout the watershed. Cattle, pasture and range, orchards, and grain hay dominate the agricultural activities.

Sub-Units

The Tehama West Watershed Assessment is comprised of 11 sub-units. The sub-units used for this report are summarized in Figure 1-3. These sub-units were delineated using USGS topographic maps. These watersheds vary from the standard Calwater units as the latter did not appear to present a reasonable picture of the true boundaries. Table 1-1 shows the sub-units along with tributary length, acreage, and percent of the watershed.

Ownership

General ownership within the watershed is shown in Figure 1-4. Land ownership in the Tehama West Watershed is approximately 15 percent public and 85 percent private (California Resources Agency, 2004). The number of acres in each ownership classification is shown in Table 1-2. Land ownership and other administrative boundaries are discussed in more detail in Section 3, "Demographics, Land Use, and Economic Activity."

Table 1-1 SUB-UNITS OF THE TEHAMA WEST WATERSHED			
Sub-unit	**Tributary Length (miles)**	**Acreage**	**Percent of Watershed**
Blue Tent Creek	10.0	15,142	2.3%
Burch Creek	24.1	94,199	14.1%
Dibble Creek	33.9	21,327	3.2%
Elder Creek	72.1	96,350	14.4%
Jewett Creek	21.4	35,902	5.4%
McClure Creek	22.4	29,761	4.5%
Oat Creek	22.4	44,612	6.7%
Red Bank Creek	56.2	74,450	11.1%
Reeds Creek	20.9	48,814	7.3%
Spring Creek	4.5	14,494	2.2%
Thomes Creek	70.0	193,117	28.9%
Total	**358.0**	**668,168**	**100%**

Table 1-2 LAND OWNERSHIP IN THE TEHAMA WEST WATERSHED		
Owner	**Total Acres**	**Percent of Watershed**
Bureau of Land Management	14,745	2.21%
California Department of Fish and Game	760	0.11%
California Department of Parks and Recreation	260	0.04%
Department of Defense	27	< 0.01%
State Lands Commission	410	0.01%
The Nature Conservancy	250	0.04%
US Fish and Wildlife Service	2,767	0.41%
US Forest Service	83,826	12.55%
Subtotal Government Acres	103,045	15.37%
Crane Mills	55,530	8.32%
Sierra Pacific Industries	1,001	0.15%
Unclassified Private Ownership	508,592	76.17%
Subtotal Other Acres	565,122	84.63%
Total	668,168	100.00%
Source: California Resources Agency		

Topography

The topography of the Tehama West Watershed varies significantly from the flat valley areas of the Sacramento Valley to the mountainous upper reaches to the west. Watershed topography is included as Figure 1-5. A summary of the USGS Quadrangle Maps within the watershed is shown in Table 1-3 and is included as Figure 1-6. The slope gradient and aspect of the watershed vary significantly, (as discussed in detail later in this report) but the valley floor is comparatively flat with a 0 to 5% slope.

A more detailed discussion of events leading to the topography of the watershed can be found in Sections 2 and 4, "General Watershed History" and "Geology, Geomorphology, and Soils."

Elevation

The average elevation of the watershed is approximately 1,000 feet above mean sea level (msl), with the lowest elevation of 150 feet msl at the Sacramento River, climbing steeply above 8,000 feet msl in the western mountains. South Yolla Bolly Mountain reaches the highest elevation in the watershed at 8,094 feet msl. The town with the highest elevation, Paskenta, sits at 743 feet msl (USGS, 1976). Watershed topography with elevation bands is included as Figure 1-7.

Table 1-3
USGS 7.5 MINUTE QUADRANGLES

Ball Mountain	Balls Ferry	Bend	Black Butte Dam
Blossom	Buck Rock	Cold Fork	Corning
Flournoy	Foster Island	Gerber	Hall Ridge
Henleyville	Hooker	Kirkwood	Log Spring
Los Molinos	Lowrey	Mendocino Pass	Mitchell Gulch
Newville	Oxbow Bridge	Paskenta	Raglin Ridge
Red Bank	Red Bluff East	Red Bluff West	Riley Ridge
Sehorn Creek	South Yolla Bolly	Vina	West of Gerber

Source: Bureau of Land Management

INTERVIEWS

Interviews of long time residents of the watershed were conducted by VESTRA Resources Inc. in November 2004. The goal of the interviews was to develop a historical perspective of western Tehama County watersheds and determine the important issues for the watershed assessment. Appendix 1-1 contains a list of the questions that were asked and a summary of the interviewee responses.

STREAM REACH PHOTOGRAPHIC ASSESSMENT

As part of the Tehama West Watershed Assessment, VESTRA Resources, Inc. (VESTRA) completed a review of historic air photos to evaluate historical changes to project area streams within the developed area of the Tehama West Watershed. For Reeds, Red Bank, Elder, and Thomes Creeks historic aerial photographs were reviewed and changes that have occurred during the time span of the photographic sequence. This review is included as Appendix 1-2.

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NRCS (National Resources Conservation Service). 2005. In *Clean Water Action Plan (CWAP) - California Unified Watershed Assessment (1998)*. Cited March 24, 2005. Available from World Wide Web: http://www.ca.nrcs.usda.gov/features/projects/cwap>.

SWRCB (State Water Resources Control Board). 2002 update. *Clean Water Act, Section 303(d) list*.

USGS (U.S. Geological Survey). 1976. 7.5 Minute Quadrangle Topographic Maps, 1968, Photorevised 1976.

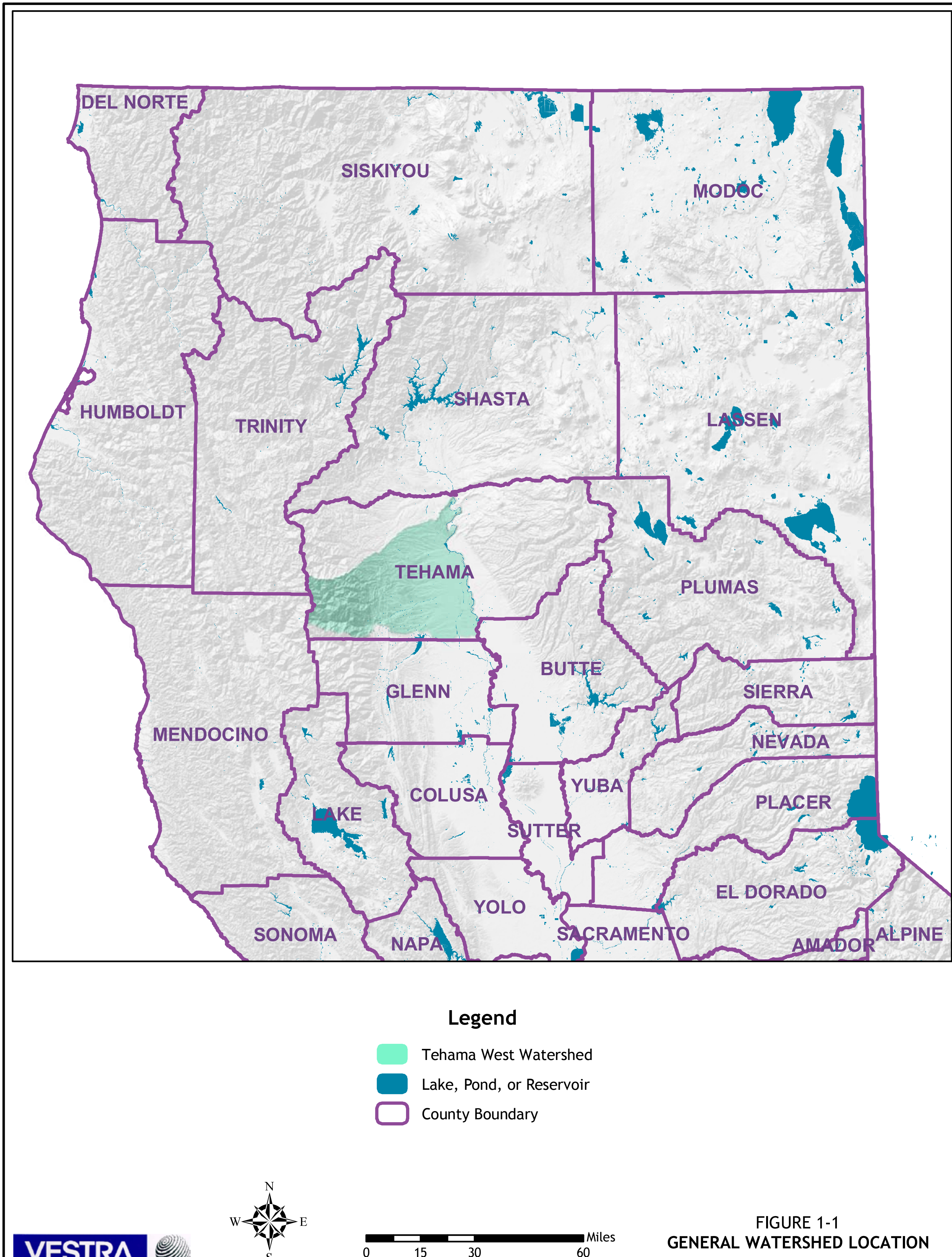
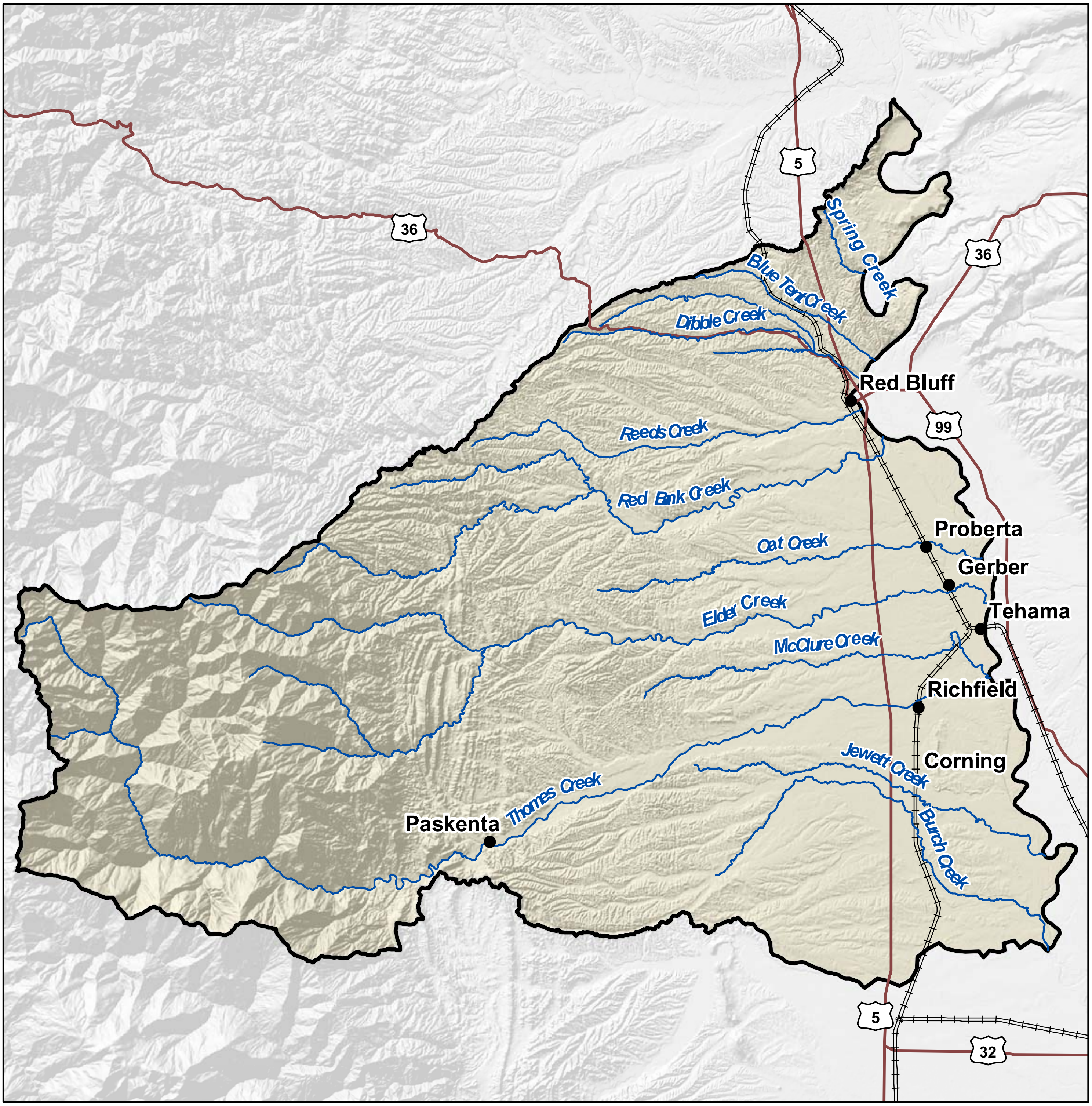


FIGURE 1-1
GENERAL WATERSHED LOCATION
TEHAMA WEST WATERSHED ASSESSMENT

VESTRA

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY



Legend

Railroad
Major Highway
Major Tributary
Tehama West Watershed

VESTRA

N W E S

0 2.5 5 10 Miles

FIGURE 1-2
WATERSHED BOUNDARY
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

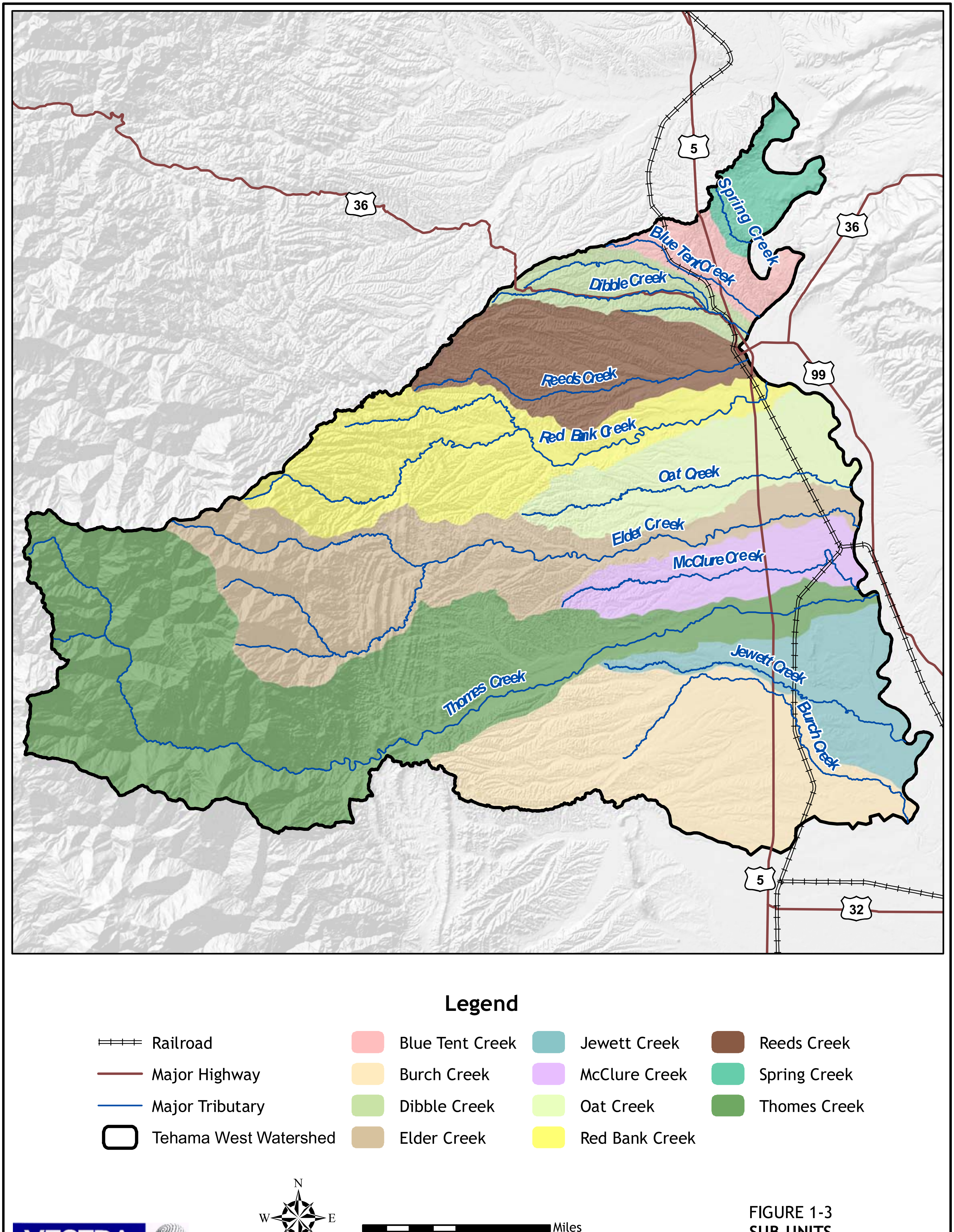
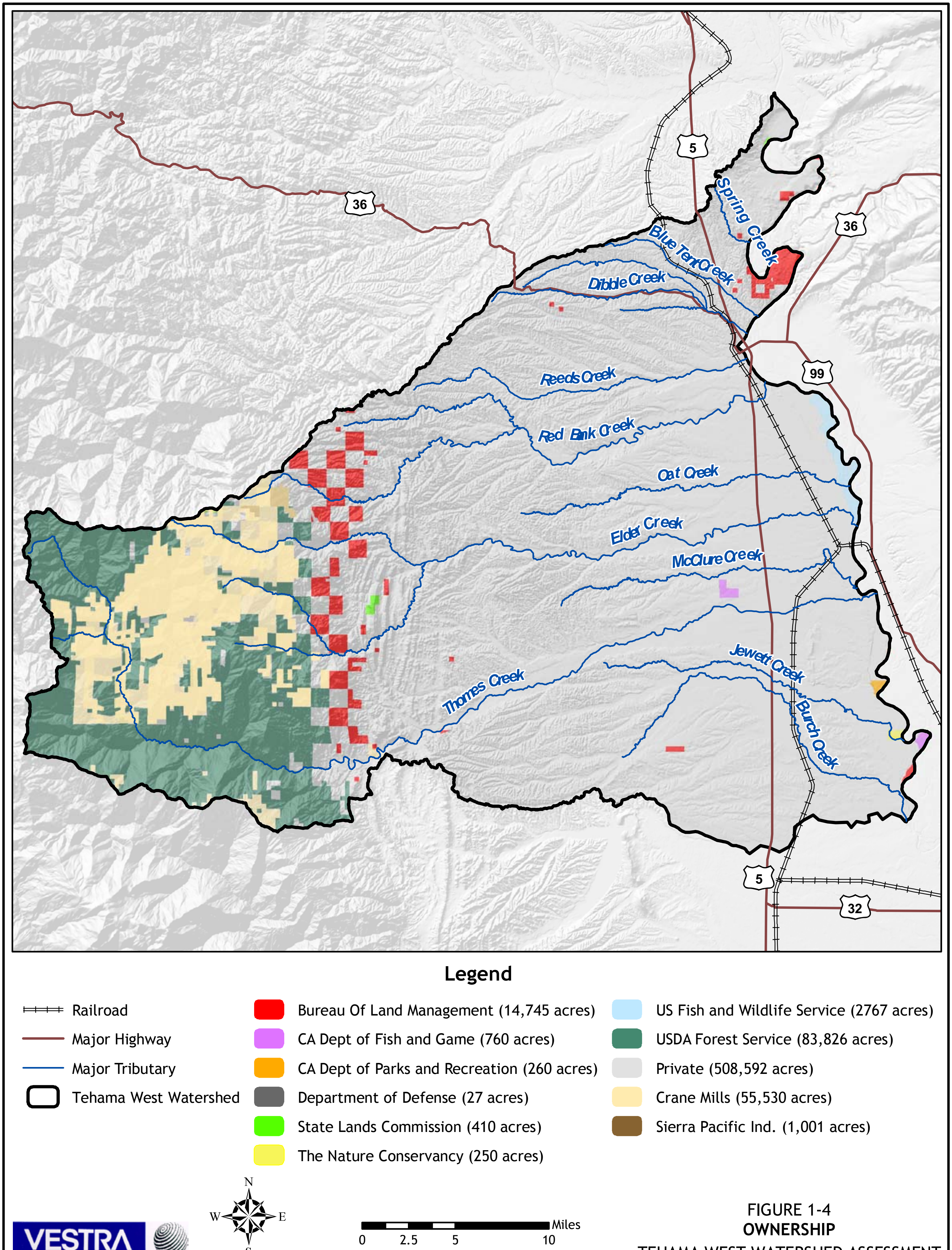


FIGURE 1-3
SUB-UNITS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY



VESTRA

FIGURE 1-4
OWNERSHIP
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

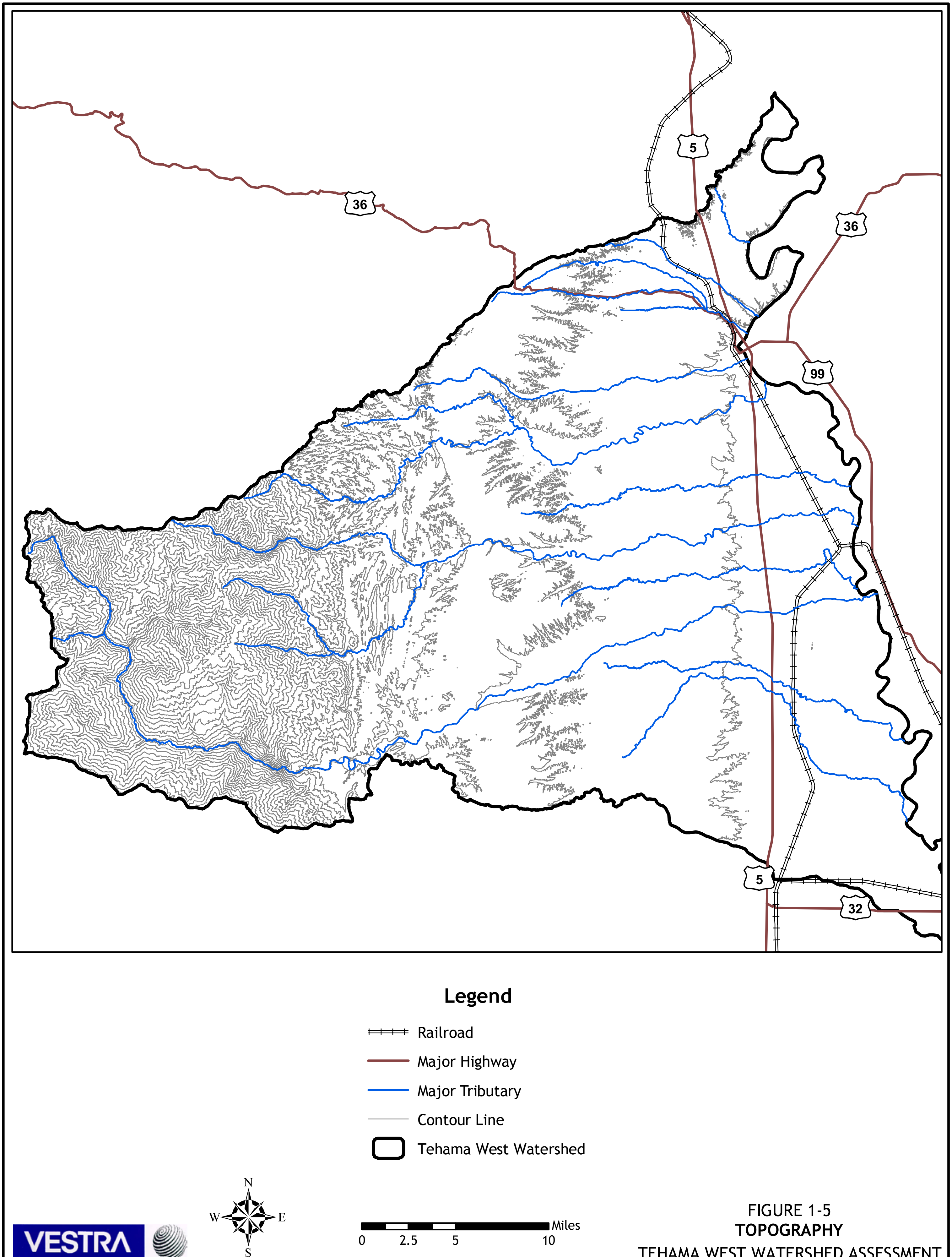


FIGURE 1-5
TOPOGRAPHY
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

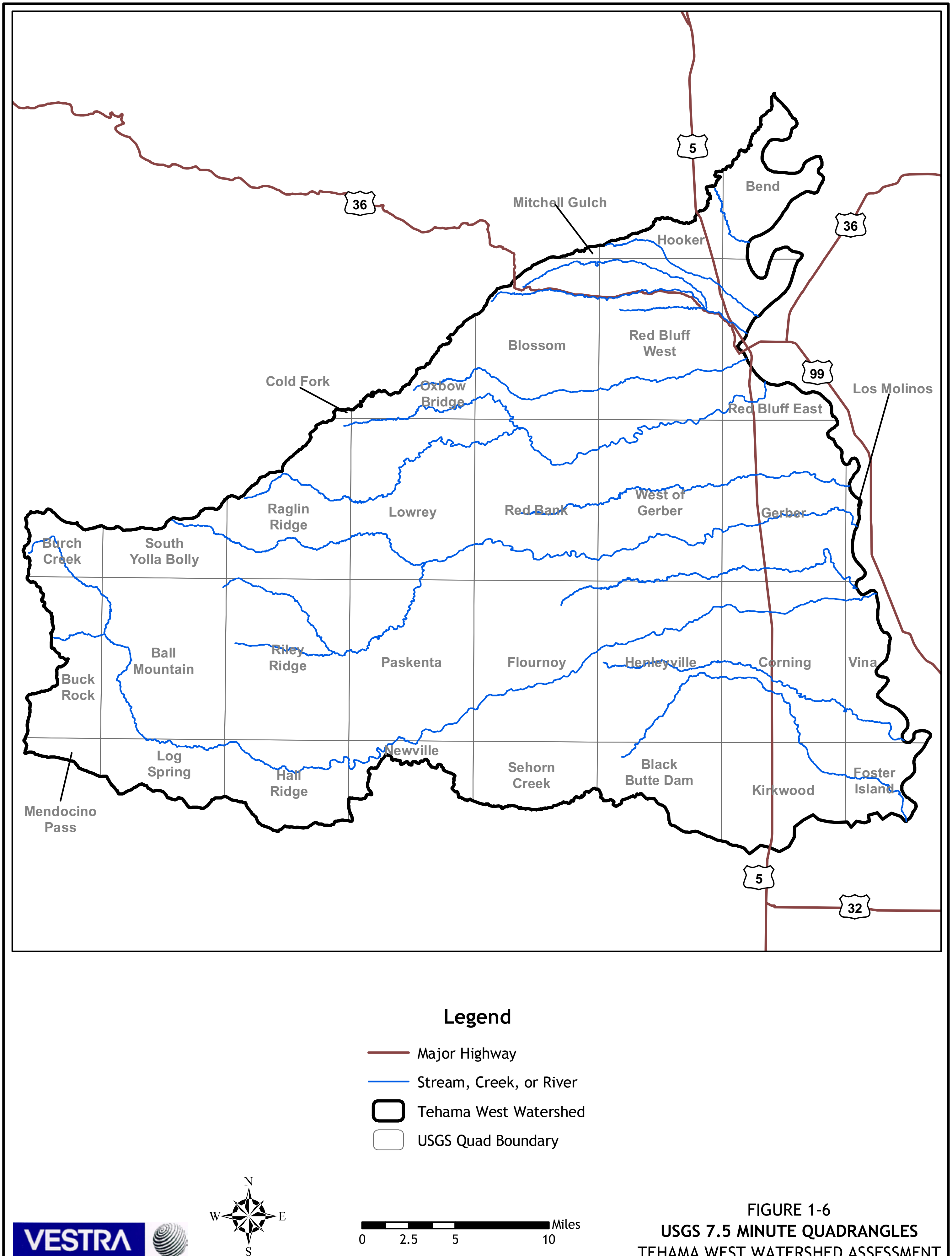


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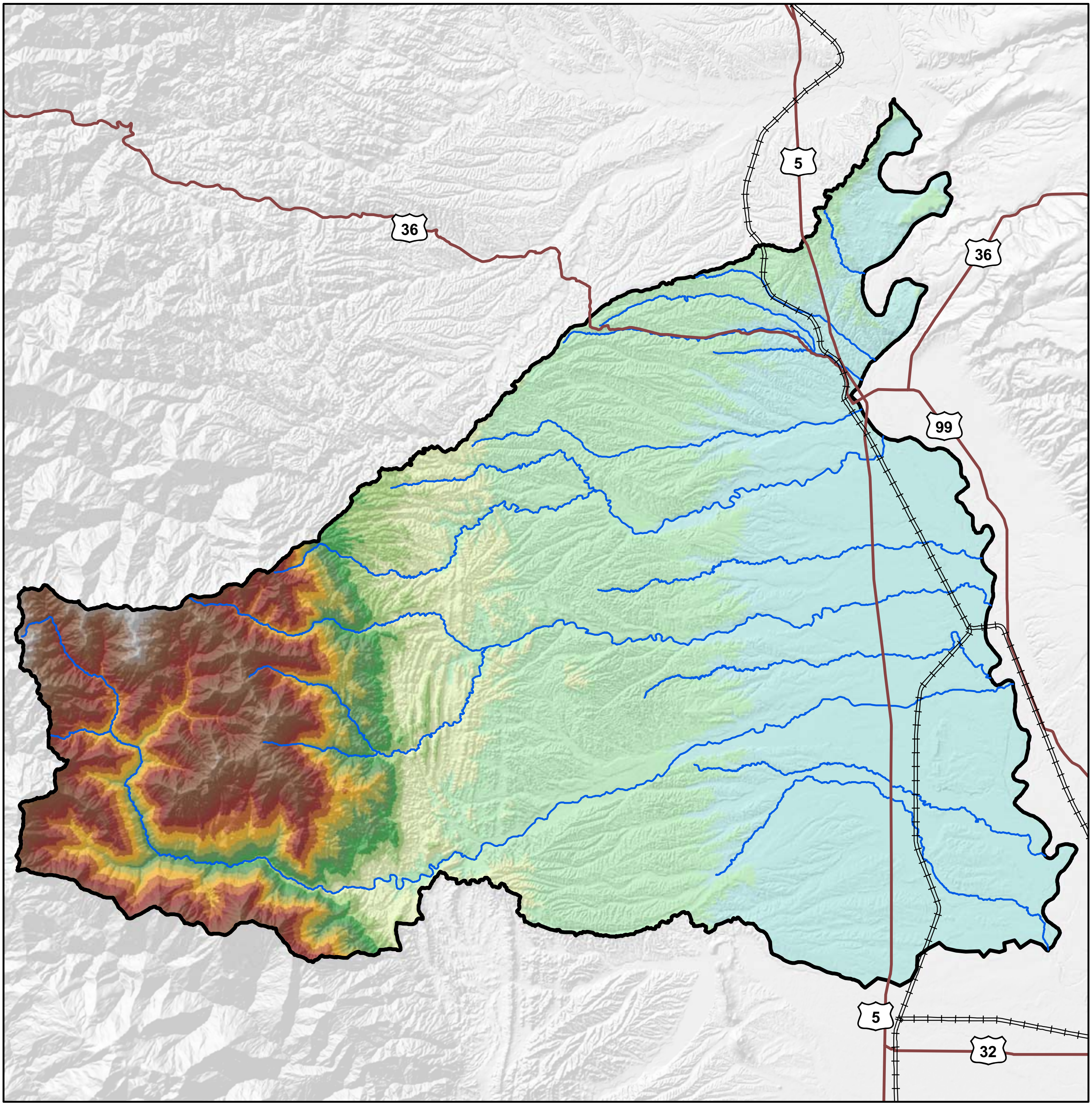
FIGURE 1-6
USGS 7.5 MINUTE QUADRANGLES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY



Legend

- Railroad
- Major Highway
- Major Tributary
- Tehama West Watershed

- 500 feet
- 501 - 1,000 feet
- 1,001 - 1,500 feet
- 1,501 - 2,000 feet
- 2,001 - 2,00 feet
- 2,501 - 3,000 feet
- 3,001 - 3,500 feet
- 3,501 - 4,000 feet
- 4,001 - 4,500 feet
- 4,501 - 5,000 feet
- 5,001 - 5,500 feet
- 5,501 - 6,000 feet
- 6,001 - 6,500 feet
- 6,501 - 7,000 feet
- 7,001 - 7,500 feet
- 7,501 - 8,000 feet
- 8,001 - 8,500 feet

N S W E

0 2.5 5 10 Miles

VESTRA

FIGURE 1-7
ELEVATION BANDS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

Appendix 1-1
RESIDENT INTERVIEWS

Interviewee No. 1
Landowner in Reeds Creek watershed

LAND USE:
- Landholdings in their area have decreased in size.
- Many 40-acre parcels exist, increasing the population and bringing an urban attitude.
- Their ranch now has many new neighbors from the 40-acre sites.
- Glad to see the BLM active with their property, but they do not manage it properly.
- There is not enough grazing on public lands and too much on some private lands.
- Feels conservation easements are great programs; glad to see landscapes protected.
- There is not enough education on conservation easements.
- There is an increased need for conservation easements.

AGRICULTURE:
- Irrigated lands have gone down due to the high increase of power.
- They had sprinklers, but they were too labor intensive and cost too much.
- They had a lot of deer when they had irrigated pastures.
- They used to irrigate and then wait for their well to recharge at night.
- They also pumped a lot of sand, and it was hard on the sprinklers.
- Now they just do a few acres of dryland oats and sudan grass hay.
- Their ranch was historically farmed by another family.
- The family could cross the creek to the fields over the gulley, now the gulley is incised making travel impossible.

FIRE AND FUELS:
- Historically, there were big burns, but didn't hurt the trees.
- Now there is too much brush, making a big fire risk.
- The Moonshadow subdivision has a lot of brush.

VEGETATION:
- Noticed oaks dying in their area. There is not much regeneration, either.
- Most of their ranch was cleared of oaks in the early 1960s.
- Vernal pools must be grazed for proper diversity. Grazing is intrinsic.

REEDS CREEK:
- They own two miles of Reeds Creek, and have noticed changes in the creek.
- The creek erodes down to the hardpan, and then it will erode through the hardpan, moving upstream.
- The creek has dropped at least 5 feet since they have been there.
- They have done some fencing, this improves habitat for black oaks and blackberries.
- All of the tributary gulches drop in erosion to meet the creek.
- The creek is dry upstream, but recharges through their area.
- They have an artesian well and some springs.

WILDLIFE:
- Wild pigs are out of control. At one time it seemed they were wiped out 10-15 years ago, but suddenly there was a huge population explosion.
- The pigs are tearing up the hillsides like never before.
- They have always had deer on their ranch.
- The deer follow the green pastures.
- A lot of turkeys around. Some quail.
- A decrease in squirrel populations.
- Also not seeing as many magpies and blue jays.
- They have six house cats controlling the rattlesnakes around the house, usually get four a year.
- They do not commercially hunt on ranch.
- Have never seen any mountain lions or bears.
- A lot of mountain lions just south of there reported by neighbors.
- In the 1960s there was an extreme drought and the water would recharge at night in the creek, but bone dry upstream.

GRAZING/RANGELAND:
- Used to be grazed primarily for sheep, now it is for cattle.
- Last grazed sheep in 1983, now only cattle.
- They used to have thousands of sheep that heavily grazed the ranch.
- Not much poison oak in sheep pastures, more poison oak on cattle pastures.
- They have pockets of perennial grasses all over their ranch, which they planted.
- Have rose and some sub-clovers.

(Interview No. 1 Continued)

- Range productivity has stayed about the same overall. Gets better with better management.

RESERVOIRS:
- Built in the 60's. They had 4 built total, two on each ranch they own. There were two more built in the 50s.
- Some designs are not good, lost one to erosion.
- Would like to fence and pipe out the water.
- Now doing more water troughs to distribute.
- Would like to put in a solar trough, but vandalism is a big problem.

FISH:
- Reeds Creek has a few minnows and maybe a sucker or two.

Largest threat to area:
1. Urbanization
2. Creekbed dropping
3. Land Clearing

Interviewee No. 2
Red Bank Creek Area

LAND USE:
- Land holding sizes have been decreasing.
- Very little change in public vs. private ownership. BLM has been trying to sell some of their property in western Tehama County and/or exchange it for other property.
- The property is in a Williamson Act contract and many large landowners would have to give up their property if it were not for the tax break involved in being a contract holder.
- Conservation easements are a good way to preserve agriculture and also be able to pass the land down to the next generation.
- We used to do some dryland farming; however with the use of a reservoir constructed in the 1970s we are able to do a limited amount of irrigated agriculture.
- The current gravity flow irrigation system, which can irrigate a maximum of 100 acres, currently irrigates 40 acres.
- Urban sprawl and land development are on the rise in western Tehama County.

FIRE AND FUELS:
- The goal of the Coordinated Resource Management Plan (CRMP), which governs 40,000 acres and 65 landowners, is to improve fire safety and wildlife habitat in the Elder Creek/Red Bank Creek Area. Tree and brush removal has been implemented in many areas, with plans in place to use goats for brush maintenance.

VEGETATION:
- Many landowners have clear-cut the oak woodlands for a profit before subdividing and selling the land. Other landowners have been doing selective cutting to help reduce fire hazards, control brush, improve grazing, and improve wildlife habitat.
- Star thistle on the property is kept under control by the sheep and goats. The other invasive plant in the area is Tamarisk.
- Riparian plant growth has increased over time.

GRAZING:
- Sheep are nearly absent from the county.
- Range Productivity – Better animal management has led to increased range productivity on our ranch.

WATER:
- There are a couple of stock ponds and one very large reservoir used for irrigation on the ranch.
- Water transfers out of the county should not be allowed.
- There are no fish in the creeks only in the reservoirs.
- Sheet erosion is probably the biggest contributor to sediment in the creeks.

Most Important Change: Urban sprawl.

Most Important Resource Change: Water use, capture, and quality.

Interviewee No. 3
Flournoy Area

LAND USE:

- Individual land holdings have decreased in size. One or two places may be getting bigger but everybody else is getting smaller.
- Would like to see property put into conservation easements remain available for agriculture.
- Dryland farming has decreased because the costs are too expensive and the return is too small. The Flournoy area used to have lots of dryland farming including dryland orchards. Some of the orchards were irrigated out of Thomes Creek.
- Urban sprawl is increasing.

FIRE AND FUELS:

- There are more prescribed burns now.
- The land in the mountains and upper foothills used to be burned every year. The trees were healthier and made better wood if they were exposed to fire. The fires killed insects and rattlesnakes.

VEGETATION:

- The oak trees are diseased and dying.
- The riparian corridor is overgrazed.

WILDLIFE:

- Pig populations are increasing; most pigs are west and north of Flournoy.
- Deer populations have decreased dramatically.
- Coyotes, bobcats, and mountain lions. There are a lot of predators that are diminishing the deer, quail, and jackrabbit populations.

GRAZING:

- Sheep numbers started declining rapidly in the 1930s and 1940s. As sheep numbers diminished, cattle grazing and farming took the place sheep had vacated.
- An open range policy is okay in the mountains, but not in the valley because there is too much traffic.
- Range productivity has diminished. When the family first came to the area, the bunch grasses and wild oats were tall enough to grab and wrap around the saddle horn while riding horseback.
- The ground is being overused, it needs more fertilizer or more rest. People are raising too many animals for what the land can support.

WATER:

- There used to be six diversions on Thomes Creek. There is water in Thomes Creek all year, but not enough to irrigate with.
- Gravel mining is okay if it is done correctly.
- There are fish in the streams. He has seen salmon in Thomes Creek downstream from Flournoy.

Most Important Change: Ease of transportation.

Other: Land was overgrazed 30 years after man first made contact with the area and has remained overgrazed since then.

Interviewee No. 4
Proberta Area, Reeds Creek

LAND USE:

- Individual land holdings have decreased in size.
- Williamson Act-Contract holders that believe the Williamson Act is good for preserving agricultural ventures and open space.
- Dryland farming has decreased and irrigated crops have increased.
- Almond orchards and rice fields have increased in the area.
- Drip irrigation systems are a good system for irrigated agricultural ventures.
- Urban sprawl is increasing.

FIRE AND FUELS:

- The interviewees have noticed more frequent controlled burns in the last few years.
- Landowners are starting to clean brush up a little bit.

VEGETATION:

- Clear-cutting oak trees has become very popular for firewood sales. Clear-cutting is not good for the terrain of western Tehama County.
- Star Thistle and Medusahead are the invasive plants they deal with on their pastures and rangeland.
- Reeds Creek is choked with willows and arundo.

WILDLIFE:

- Starting to see more pigs in the Lowry/Johnson Road area.
- The wild turkey numbers have increased.
- Deer populations have increased.
- There are a lot of coyotes in the valley but not as many to the west.
- Jackrabbit numbers have decreased but squirrel numbers have increased.

GRAZING:

- Sheep numbers have declined over time.
- Rangelands-absentee owners own the nicest rangeland in western Tehama County.
- An open range policy is good for ranchers, but it would create too much county liability.
- Range productivity depends on the operator. Larger landholdings tend to not be overgrazed. Overgrazing is more common on the smaller landholdings.
- They wait until the grass is two inches high or December 1st to bring cattle back to winter pasture.
- They take the livestock to summer range by May 15th.

WATER:

- They have a tailwater pond on the valley piece and no reservoirs on the rangeland.
- They pump water from the ground and use flood irrigation on the valley piece. There is no irrigation on the range piece.
- There has been an increase in domestic water use in western Tehama County. Agricultural water has possibly stayed the same, with a slight increase from an increase in rice production.
- Water should not be transferred out of the county. The Proberta Water District has already sold water to be transferred out of the county for a million dollars.
- Gravel mining is okay as long as the area is returned to as natural a state as possible when the mining activities are ended. Grass does not grow where the gravel operations are located anyway.
- Fisheries-Reeds Creek and Pine Creek both dry up so there are no fish in either one of those streams. There are sucker fish, bass, and catfish in the tailwater pond.
- Water quality has diminished as the amount of roads, houses, and ditches has increased. Water quantity has decreased. The artesian well located on the range piece used to run all year long, but it currently dries up from the month of June to October. There used to be a lot of springs on the west side of Tehama County.
- Most erosion is a natural occurrence in the kind of terrain found in western Tehama County. The increase of impermeable surfaces, including housing rooftops and roads, has led to higher runoff volumes. The higher runoff volumes contribute to the formation of gullies and increased streambank erosion. Recreational vehicle tracks have also contributed to gully and sheet erosion.

(Interview No. 4 Continued)

Most Important Change: Urban sprawl.

Most Important Resource Concerns: Preservation of open space and the oak woodlands. More stringent restrictions on land development should be implemented.

Interviewee No. 5

LAND USE:
- Land holding sizes have gone down.
- Would like to see the Williamson Act held up.
- Positive with public land ownership as long as it is properly managed.
- Conservation easements probably a good thing.
- In 1980s, all their neighbors were farmers. Now, it's pretty well gone.
- Collective bargaining.
- Block commodities together.
- Farms not producing enough to keep people on farms.

VEGETATION:
- Control weeds in barley.
- Wild oats and Italian Rye – grass in barley spray to get it out.
- Oaks are changing, dying, not sure why.
- Planting trees on ranch to promote wildlife, shade for cattle, etc…
- In the 1980s, some ranchers bought a ranch, clear-cut the oaks and sold firewood.
- Riparian changes – more vegetation now than he remembers. Used to be a sheep ranch and sheep hammered the creeks, now vegetation is coming back.

WILDLIFE:
- Wild pigs love his grain – Asiatic boars (Ruskies) crossed with Hampshires.
- Come back in the spring, rototill all over in the grain and make a mess.
- Mountain lions drove him out of the sheep business, used to lose one a night for a while.
- Deer, dramatic decrease in populations. Barely any around. Something is going on … abortion? Brucellosis? Used to see at least 6-10 at all times, now none.
- Rattlesnakes are going way up. In the 80s, there were very few. Last year they killed a lot by the house, a lot of little ones. Coming down the creek…. Maybe due to more creek riparian vegetation, more cover.

GRAZING:
- His barley stubble makes good cattle feed.
- In favor of open range.
- Range production is going down. Pastures not growing like they used to. Even grain not as productive as it used to. Planting perla grass to improve range conditions.
- The area grows good sudan grass, and he plants that during the summer.
- No vernal pools out there.

FISHERIES:
- Thomas creek used to have salmon.
- The creek by the house used to have suckers in the 80s, haven't seen them since.

WATER:
- Water levels going down. Well pumped 40 gpm in the 80s, now down to 15 gpm.
- Weird stuff going on with the aquifer.
- In 1995, they got 54" of rain at the ranch.
- Springs are variable, wet year and they dry up. Dry year and they run.
- People like the Metropolitan Water District drying up the country. Put in wells, pump out the water and it dries out the country.
- Flournoy school area has some serious issues. The people building houses out there better get used to bottled water.

Most Important Resource Concern: Low prices to farmers, leads to farmers selling land, subdividing… a snowball effect.

Interviewee No. 6
Red Bank Creek Area

LAND USE:
- Public lands not managed properly.
- Private land use can be wonderful or hideous. Best is an enlightened private user.
- Conservation easements generally a valuable tool with many long-reaching effects.
- Irrigated agriculture decrease. Increase in energy costs takes out the irrigation.
- Dryland farming way down.
- Urban sprawl a huge threat.

FIRE AND FUELS:
- Sunflower CRMP – slight increase in prescribed burns.
- Increase in fuels management for their area.

VEGETATION:
- Oak harvesting a huge threat to the area.
- Properties raped for their wood. Some neighbors in their area clear-cut 8,000 acres for firewood.
- Some oak is regenerating, especially on their ranch, but in other places in county it is not.
- Yellow starthistle, saltcedar. Not big issues, symptom of problem, alter grazing to help control noxious weeds.
- Increase in adobe lilies and diamorphic snapdragons.
- Riparian – dramatic increase. Positive effects.
- Creek used to go dry by 4th of July. Now it goes year-round for nearly 1 mile on their ranch.
- Sedges, rushes, mulefat, cottonwoods. All about grazing management.

WILDLIFE:
- Wild pigs
- Not a long-term program… they will eradicate themselves over time.
- Mountain lions are an expression of the landscape.
- Have 2 resident bears on property.
- Porcupines have gone away.
- Badgers, gone.
- Coyotes, gone.
- Buzzards, down.
- Rattlesnakes, same.
- Ground squirrel, down.
- Skunks, way down.

GRAZING:
- Bands pretty well gone
- Cattle populations have gone down, too.

RANGELAND:
- Annual Mediterranean climate should not be grazed all at once.
- Runs cattle on their ranch year-round.
- Vernal pools need to be grazed.

Most Important Resource Concerns:
1. Shift from owner/producers to investment owners with renters… they don't care about the property, just run it into the ground.
2. Urbanization
3. Overall decline in productivity, decrease in wildlife, increased erosion.

Interviewee No. 7
Historic Tehama County Resident/west of Red Bluff

LAND USE:
- Threat to ranches is when they fall apart and nobody owns it.
- Family ranches go down the chain until it hits a spot where the family isn't interested in it anymore.
- Then it sells, and it goes to a developer because the land value is too high now. This happens more on the cattle ground than the farm ground.
- Conservation easements are not good. They have strings attached. They own the ground, and you can only do certain things on the ranch.
- Impossible to have two different groups own the land. They will kick off the cattle any day to help an endangered species.
- What happens when TNC dries up like everything did during the depression. During the 20s and 30s, rich people committed suicide because things were so bad. What happens if it happens again?

VEGETATION:
- Oaks are cut and there is no problem with regeneration.
- They always grow back. Their ranch was cut twice for wood. Ranch was cut back hard during the depression. They had probably 85% re-growth of the oaks afterward.
- Have medusahead and starthistle. No sheep anymore to keep the starthistle back.
- Vegetation in the streams have gone up. They used to clear the streams with dozers to keep them flowing well. Worked for the county for 30 years clearing out streams.

WILDLIFE:
- Wild hogs have stayed the same overall. There were always hogs around; that's how people lived back then. Wildlife really responded to the installation of reservoirs in the area during the 40s and 50s. Before that, there wasn't as much.
- Now there are a lot of poachers.
- A lot of mountain lions, lost three calves last week.

AGRICULTURE:
- Used to irrigate their property. Had 10 acres, and sprinkled it. Eventually cost too much to maintain.
- Agriculture is doomed in the county. Decrease in irrigated ground. Not enough water to go around. It's a big threat for the county. Can't make it in farming anymore.
- Prunes used to be a big crop, but not as much anymore. Ripping out fields.
- Water is the biggest issue.
- No dryland farming anymore because expenses have risen and the price you get for the barley has stayed the same.

GRAZING:
- Maybe staying the same with rangeland AUMS, maybe increasing, though.
- Go out and graze a Forest Service permit on the 1st of June near Lassen.
- Has some other range and then back down by the 1st of November.
- Sheep were good at keeping the starthistle down. No more sheep grazing.

Biggest threat to area: Urbanization.

Interviewee No. 8
Elder Creek Area

LAND USE:

- Individual land holdings have decreased in size. Many large holdings are being clear-cut to harvest oak firewood, then divided into 160-acre parcels. The parcels are bought by people that do not have the financial standing to take care of a property or by absentee landowners. Often these vacant lots become homes for low income squatters.
- The Ranch and 62 of the neighbors have a great working relationship with government agencies and publicly held lands. The group has created a Coordinated Resource Management Plan with several government agencies and managers of two publicly held lands with the goal of creating fire safety and wildlife habitat.
- Williamson Act is a great program to be used to save agricultural lands, specifically large land holdings.
- Private Lands entering in Conservation Easements is a great concept to help marginal operations retain the land without selling it to a developer.
- Dryland farming used to be very profitable and there is no irrigated farming in the area.

FIRE AND FUELS MANAGEMENT:

- The Ranch has being using the ball and chain method for brush reduction in conjunction with selective oak tree removal. The Burrows ranch intends to use goats for brush maintenance in the future.

VEGETATION:

- Brush has severely encroached on the oak woodlands from decades of fire suppression efforts. The last rancher out of the foothills used to set fire to the landscape thereby reducing the fuel load and rejuvenating grasslands.
- Starthistle and Medusahead have come to the Ranch; however the Ranch uses rotational grazing to minimize the recurrent growth and spread of the noxious plants with descent control. There is a possibility that the noxious plant problem would not be as severe if the land was grazed on a rotational basis for the entire year instead of allowing the noxious plants to grow ungrazed all summer long.
- The riparian corridor on the Ranch is improving because the livestock are not allowed to camp in the riparian corridors.

WILDLIFE:

- The wild pig herds have increased in size.
- The wild turkey numbers have increased.
- Deer populations have decreased due to:
    1. Urbanization, increased road kills and higher numbers of trespassers and poachers.
    2. Increased predators – mountain lion and bear populations are on the rise.
    3. Disease – Blue Tongue
    4. High population of does, need an occasional doe hunt.

GRAZING:

- Sheep and goat numbers have declined over time; however sheep and goats are making a small comeback. Cattle numbers have increased as sheep numbers have decreased.
- Most large landowners are pushing for the county to become an open range county due to the increased costs to fence off county roads.
- Overall the range productivity in western Tehama County has declined dramatically. There are increased amounts of grasses and forbs with poor nutrient contents or low palatability. One belief is that range productivity would be improved if landowners utilized the ground all year with a rotational grazing program.

WATER:

- The ranch reservoirs are used for stock water and fishing. Reservoirs were built in the 1950s with most built in the last 15 years. Permitting and regulatory fees (taxes) limit the amount of new impoundments.
- There has been an increase in domestic water use in both the valley floor and the western foothills of Tehama County. Agricultural water use has also increased on the valley floor; however agricultural use of water has decreased in the foothills.
- Water should not be transferred out of the county.
- In order to maintain roads and with continued urbanization of the area, gravel has to come from someplace. If the mining is done in accordance with regulations and is a well-managed operation, continued gravel mining is okay and a necessity.

(Interview No. 8 Continued)

- Fisheries on individual land holdings are better because fish populations are managed in water impoundments. The fisheries in the streams are worse. The fish most often found in the streams are trout. Trout used to be planted from 1950 to approximately 1985 in the local streams. Planned grazing on the Ranch has improved the trout populations in the streams running through the ranch.
- Water quality has not changed much over time, however water quantity is decreasing. The climate is changing, as both rainfall and snowfall have decreased. The Ranch used to have to winter feed every other year and have not had to winter feed for 20 years.
- Erosion overall in western Tehama County has increased due to poor management practices. Overgrazing has led to a decrease in perennial grasses and forbs and an increase in annual grasses and forbs. The Burrows Ranch does not allow cow camping on riparian corridors and the animals are restricted completely in the spring and early fall.

Most Important Change: Small parcels ranging in size from 5 to 160 acres have had the biggest impact on the watershed.

1. Dust and nitrate contamination and general people pollution works against a healthy watershed.
2. Stewards of the land are being driven out due to increased land values, increased taxes, increased insurance, and increased operating taxes.

Most Important Resource Concerns:

1. Maintain largest land units possible under one manager.
2. Reduce brush encroachment.
3. Promote perennial grasses.
4. Promote planned grazing.
5. Promote agri-tourism.

Fundamental Truth:
In the last 1000 years 21 civilizations have collapsed.
The civilizations collapsed because the watersheds supporting them were abused.
The indicators of eventual collapse in order of occurrence are:

1. Wildlife diminishes.
2. Small towns disappear.
3. Big cities collapse.

Interviewee No. 9

LAND USE:

- Watershed area protects very little. If it weren't for that, ranches would be gone already.
- Illegal parcels created with lot line adjustments, etc…
- Ordinance – open range now closed, rural people fence their own property to keep cows out.
- County falls under requirements, increase county costs, taxpayers probably not for it.
- Public ownership is better than a subdivision.
- Better to be in private hands than the government, though.
- Large land holdings are getting smaller through illegal parcel divisions. Lot line adjustments and four by four splits are the most common methods.
- A lot of the smaller parcels are owned by absentee land owners or retired people.
- Against taking land out of private ownership unless it will prevent the subdivision of lands.
- 95% of the rural land in Tehama County is in a Williamson Act contract.
- Dryland farming has diminished as operating costs have increased.
- Dryland farming – all economics, why not much left.
- Detrimental to grasslands, worst thing you could do is to lose the humus layer topsoil.
- Sheep caused trails on hills, overgrazed it.
- Economics and predators. Need to balance nature.

FIRE AND FUELS:

- There should be more controlled burns.
- In the 1960s the popular way to control brush encroachment was to bulldoze or kill trees and come in 3 years later and burn the area. Our family would also set fire to a different section of the upper foothills when they came down out of the hills in the fall, this would help to clear brush and rejuvenate grasslands.

VEGETATION:

- Blue Oaks and Valley Oaks are not rejuvenating. Overgrazing and hog rootings may be the cause of the problem.
- Medusahead and starthistle continue to increase. In the 1970s many people planted arrundo for streambank stabilization, now it is an invasive plant that is spreading out of control. Biological control of starthistle (beetles) works until there is nothing left for the beetles to eat.
- Vegetation has decreased along the streams.
- Weeds – starthistle, medusahead, and lupin, worst weeds.
- Wild oats not as good anymore.
- Overgrazing is the problem.
- Drastic reduction in feed. Key is to get them out 1st of June.
- Put cattle on range 3 weeks after 100% germination. Usually Nov 15-25. Get off 1st of May, earlier the better. Many people go April 25-May 5. Most go May 5-June 1.
- In the 1960s, there were major clear-cuts of oaks for firewood. On average, there were maybe 20,000 acres a summer. This increased the rangeland for cattle.
- Need more rangeland fires to control medusa and starthistle.
- Biocontrol – beetle on starthistle three years ago and it worked very well.
- Banks hurting from erosion. The water gushes out too fast, with nothing to hold it back. More trees are needed on the banks.
- Arundo is not that bad, holds back banks. Less plant life from too much erosion.
- Dams – check into Red Bank dam site. Doesn't impact people. Stock ponds in area were created primarily in the 1950s.
- Scorched Earth Policy – graze every last blade of grass on the property... resembling a devastating fire had just gone through the ranch. Too many ranchers do it.

WILDLIFE:

- Coyotes and other predators were affecting the deer. Eating fawns.
- Deer populations drastically down. Mountain lions take down mature bucks and does.
- Reservoirs – bullfrog situation, not big ones anymore.
- Rattlesnakes are down.
- King snakes down; bull snakes fine.
- Field mice okay. Bald eagles doing fine.
- Possums down.
- Crows a problem.
- Magpies a problem.
- Blue Jay populations are down.

(Interview No. 9 Continued)

- Hogs – came from Owens ranch. Not feral pigs, Hampshire breeds, few wild boars introduced. Was a commercial operation that went awry, put them on the dry farmed fields.

GRAZING:

- Sheep numbers have declined due to the economics of the industry. Sheep and cattle have both contributed to overgrazed rangeland.
- An open range policy is going to increase county costs.
- 60% of rangeland is overgrazed. Wild Oats have diminished due to overgrazing. One theory is that dryland farming has destroyed the fragile humus layer so vital to grassland health.
- A good rule-of-thumb for grazing management is to take livestock to winter grazing three weeks after 100% germination of grass seed (around mid-November). Take livestock back to summer grazing ground as early as possible (end of April, start of May). Most people take livestock to summer grazing as late as the end of May.

WATER:

- Water impoundments, built from the 1940s through to the 1960s, are strictly used for stock water.
- Surface water transfers to the south would be okay.
- Gravel mining adds to erosion in the streams. Gravel mining can continue but upstream effects need to be assessed and addressed.
- Thomes Creek and Elder Creek have had salmon; the only fish in Reeds Creek are sucker fish.

Most Important Change: Overgrazing has created an erosion problem and diminished water retention situation. When the land is overgrazed there is not enough residual matter to capture and retain water to percolate into the aquifers. Additionally, increased water runoff leads to increased erosion.

Most Important Resource Concern: Rangeland productivity.

Biggest issue: Overgrazing. Big factor with increased erosion. Not enough residues in spring. Maybe 60% of ranches are abused. Getting a little better. Absentee owners don't run their ranches as hard. Mid/early 1980s, ranches hit very hard.

Gravel mining: Adds to erosion. Increased velocity. It's a good practice, but needs to be selective and address upstream effects. Needs to be done right.

Interviewee No. 10
Landowner south of Red Bluff

HISTORY:

- Tehama County was established in farm districts, Flournoy, Paskenta, Henleyville…
- 1870s – first major development in the county.
- Sir Ranches. First grain bulk storage in the county.
- Clover seed, alfalfa seed, recycled all things.
- Clover threshings were used as feed.
- Toss a match on the range when they leave. Improves range.
- Good dates to turn cows on summer range: May 10th
- Old drives, used to go 10 miles a day during cattle drive.
- Sheep drink ½ gallon water per day, so they are more practical for lower valley without water.
- Over time, water is developed, so not as much needed for sheep.
- Sheep get shorn twice, once in September and once in April.
- No fences in county until around the turn of century.
- Drive the hogs by sewing eyes shut, and somebody leading saying "oink!"

LAND USE:

- All of the small communities of western Tehama County are remnants of former farming districts formed in relation to the Grange Association and the Farm Bureau.
- Dryland farming controlled medusahead and increased erosion hazards.
- Urbanization has decreased the amount of land farmed and has altered land values.
- Urbanization, can't make a go of it anymore… Land costs too much.
- 1970s probably last time you could actually make a go of it.
- Williamson Act is good for now, but the economics forces development.
- If agriculture was more profitable, you wouldn't have the development pressure.

FIRE AND FUELS MANAGEMENT:

- Fuels Management – historically the last man out of the mountains and foothills in the fall would set fire to a different section of the landscape every year to clear brush and rejuvenate grasslands.
- Fuels Management – some landowners would allow livestock to graze around homes as a way of controlling vegetative fire hazards.

VEGETATION:

- Farming kept the medusa out. Either farm it or burn it.
- Lot of erosion with the old dryland farming.

WILDLIFE:

- Wild pigs are becoming a nuisance, destroying fencing and drip irrigation systems. Raise hell, tear up fences, and chew up drip line in new orchards, poachers going out after them with guns.
- Mountain lion and bobcat populations have both increased.
- Coyotes a number one predator to sheep.
- Coyotes and mountain lions decimate deer populations.

GRAZING:

- Sheep were used on dryland farming fields to clear grain stubble. Sudan grass and clover were often planted in the grain fields to encourage the sheep to graze the fields.
- Historically, during the winter, the sheep would graze in the valley and the cattle would graze in the foothills, this arrangement was based on the water needs of the two species. In the summer everything was moved to the mountains for grazing and returned to the valley in the fall.
- Some landowners would run turkeys in the fields after the sheep had vacated them to control bugs.

WATER:

- The property has reservoirs for stock water that were built in the 1940s.
- Some earthquakes have taken out springs, and some springs have started from earthquakes.

Interviewee No. 11
Landowner in Flournoy Area

LAND USE:

- Existing ranches are staying the same size.
- Increasing amounts of leapfrog developments. Recent subdivision in Flournoy has been poorly planned - area aquifer is not large enough to support any additional draw on the supply.
- Large land holdings are starting to be split up.
- Non-profit conservation easements take property out of the tax base.
- Williamson Act is a good deal for agriculturalist gives them a tax break and keeps land from being developed.
- Dryland farming and rotational cropping has decreased over time. Depressed grain prices and rising operating costs have caused the decline in dryland farming practices. Dryland farming on their ranch went out 20-30 years ago. Costs came up and the price of grain stayed the same. Not economical anymore.
- Sheep populations have gone down drastically. They once had 1200 ewes and then dropped it down to about 100, they have none today.
- Reasons: Predators, lack of extra range, depressed prices. Would rather run sheep, but predators are too bad. Coyote worst, then mountain lion.
- His family used to drive stock over the mountains to the Eel River country.
- Range productivity – sub clover plantings have helped out a lot. Thistle reduces it, so he's maybe even. Bur clover was present in the area, but alfalfa weevils knocked that back 30 years ago and wiped it out. Bur clover only grows on good ground. Sub clover only on the red bad ground. Medusahead has increased over time. Keeps stock on ranch year round. Used to go to irrigated pasture, but its too expensive.
- Flournoy Ranch bought by developer, has riparian wildlife corridor easement.
- Does not foresee much expansion on the west side for The Nature Conservancy or other groups. Not too fond of it due to tax base, land off tax roll. Government has too much land already.
- Williamson Act is on the right track.
- Neutral to conservation easements.
- Open grazing – better for rancher. Open range keeps liability off rancher when cow gets hit. His ranch is set up that he couldn't fence off the road very well, without leaving some very funky triangular pastures without water.

FIRE AND FUELS:

- Frequencies of prescribed burns have stayed at the same rate for some time.

VEGETATION:

- Historically trees have been cleared from the property to increase the amount of rangeland available for feed.
- Invasive plants found on the property include: Italian Thistle, Medusahead, and Bull Thistle.
- Thistle control methods have included both herbicidal sprays and weevil biological control.
- Riparian corridor vegetation has stayed the same along the smaller creeks and increased along the larger creeks.

WILDLIFE:

- Few wild pigs found on their property, the wild pig population increases the further west you go. During drier years, the pigs move east out of the western foothills in search of water. Wild pigs tend to tear up the ground and water gap fences.
- Deer populations have decreased from higher predator populations.
- Coyote and Mountain Lion populations have increased.

GRAZING:

- Sheep numbers have decreased dramatically in the last 20 years. There is less land available to lease for grazing ground and predators (coyotes) have increased.
- Cattle numbers have increased as the sheep populations have decreased.
- Ranchers will have less liability. Impractical fencing could be removed.
- Family has planted clover to increase range use. Weed species have increased (Medusahead). Dryland farming used to moderate weed species and rejuvenate clover species.
- Historically the family used to summer livestock in the eastern mountains until around 1940. From that time to the very recent past the animals were grazed on rented,

irrigated pastures.

(Interview No. 11 Continued)

WATER:
- Not much water from Henleyville to Flournoy.
- Limited water. Crane orchards put in some walnuts.
- At Thomas Creek the increase of riparian vegetation has led to too much vegetation, causing blockage in the creek and then the creek goes sideways and erodes.
- Six ponds on ranch. Built during 40s and 50s. One has fish because water is in year-round.
- Canal water is getting too expensive.
- Impoundments – the property has five major reservoirs and one smaller one, all constructed in the 1940s and 1950s. Impoundments strictly used for livestock water. Now must pay a $100.00 fee for water rights per impoundment.
- Gravel mining in the Flournoy area has decreased over time.
- Fish can be found in the streams in the mountains but not in the foothills.
- Erosion is a natural occurrence in the western Tehama County landscape.

Most Important Change: Urban sprawl has had the biggest impact on the watershed. Nonsensical isolated housing developments create an unsupportable draw on the watershed resources. Land use, urban sprawl, and development.

Most Important Resource Concern: Management of future housing developments to infill undeveloped areas between those areas of higher population densities.

Interviewee No. 12
Proberta Area

LAND USE:
- Land is being subdivided in the Red Bank area.
- The family has a good working relationship with government agencies.
- Conservation easements are okay as long as the land can be utilized for agricultural endeavors.
- Dryland farming has decreased and irrigated crops have increased.
- Urban sprawl is increasing.
- Much of the red land has been ripped and planted to Eucalyptus groves. Price of wood is down now, so it's pretty worthless.
- Used to gather cattle in the Rancho Tehama area 40 years ago. The rancher retired and sold his 4,000 acres for $100/acre. It was developed and now has 3,500 people.
- Proberta Water District gets water from Sacramento River. Used to be $18/acre foot now water is $30/acre foot.
- In favor of working with non-profit groups. Work with the U.S. Fish & Wildlife Service and TNC. Have a good relationship with the groups.
- Williamson Act is not a very well written document.
- Dryland farming – can't afford it anymore. Price of grain has stayed the same for the last 50 years.

FIRE AND FUELS:
- Not enough range fires. Starting to do controlled burns a little more now. Still nowhere near enough prescribed burns.
- The Proberta Volunteer Fire Department has been shut down.
- Fire hazards are increasing as the population increases.

VEGETATION:
- The family used to poison trees and clear-cut trees to increase rangeland. Oak firewood sales are often used to subsidize bad years in the cattle industry.
- Starthistle and Klamath weed are the invasive plants the family deals with. They have used biological controls to eliminate the Klamath Weed. The streams and reservoirs are being invaded with *Hydrilla* as well.
- Riparian corridors have increasing amount of plant life leading to more flooding.
- Too much oak clear-cutting.
- They had Klamath weed, and the biocontrol agent wiped it out. They have some starthistle, but know how to graze it at the right times and its not as bad as it was.
- Too much vegetation now. CDF used to clear Oat Creek. There is an aquatic weed problem in Coyote Creek, *Hydrilla*.

WILDLIFE:
- Pig populations have increased.
- The wild turkey numbers have increased.
- Deer populations have decreased in numbers, except for along the river.
- The coyote populations have increased tremendously.
- Mountain lions are a problem and they lose about one head of cattle per year to mountain lion predation.
- Jackrabbit, pheasant, and rattlesnake numbers have decreased.
- Not too many pigs on the place. Pigs in the Eucalyptus systems tear up the drip irrigation lines. They sometimes follow the creek past Flores Avenue. Pig hunts are very popular with the local hunters.
- Populations are way down, especially at their spot down along the river. Not enough habitat, too many orchards.
- Pheasants are in decline due to increased predation.
- Rattlesnakes decreased. Some bull snakes in fields. King snakes around the house.
- Voles controlled by egrets, cranes, herons.

GRAZING:
- Sheep numbers have declined over time and the cattlemen have taken over where the sheep have left off. Economy brought the major decline of that industry. Cattle took over sheep ranges. Used to be huge sheep drives, over two miles long. There were a lot of sheep in the Flournoy area.
- An open range policy is good for ranchers.
- Range productivity has stayed about the same. Urban sprawl has diminished the amount of available rangelands.

(Interview No. 12 Continued)

- They move livestock to the higher elevations in June and return to the lower elevations in November.

GRAVEL MINING:
- It is necessary. Just need to do it right.
- A lot in Red Bank, some in Oat Creek.
- Restrictions by Fish and Game make it compatible with wildlife.

FISHERIES:
- Catfish in the reservoirs.
- Used to fish in the Sacramento River for steelhead, their populations are down.
- Four years ago, there was salmon spawning in Coyote Creek.

WATER QUALITY:
- Better quality. The Sacramento River has improved a lot, used to smell the river at the house, but you can't anymore.

EROSION:
- Major bank conditions have remained largely the same since they can remember. It has always been that way… not a new thing.

WATER:
- They have reservoirs for stock water in the higher elevations and tail water catch ponds on the lower elevation cropland.
- The Ohm family use flood irrigation to irrigate the crop land.
- The Ohm family have some vernal pools; the areas of vernal pools are not managed any differently than those areas without the vernal pools.
- There has been an increase in domestic water use in western Tehama County. Agricultural water has possibly stayed the same, with a slight increase from an increase in rice production.
- The Proberta Water District has already sold water to be transferred out of the county for a million dollars.
- Gravel mining is okay if it is done responsibly. Gravel mining is actually good at keeping the choking vegetation out of the streams.
- Fisheries – Steelhead in the river has diminished and the salmon populations are increasing.
- Water Quality – water quality has improved as people have become more conscientious about what goes into the water system.
- Erosion – The Ohm family used to fill in gullies and plant grass seed to increase rangeland. Most sediment found in the creek is from bank erosion.

Most Important Change: Leveled land and irrigated pastures have had the biggest impact on the watershed.

Appendix 1-2

STREAM REACH PHOTOGRAPHIC ASSESSMENT

TEHAMA WEST STREAM REACH PHOTOGRAPHIC ASSESSMENT
REEDS, RED BANK, ELDER, AND THOMES CREEKS

As part of the Tehama West Watershed Assessment, VESTRA Resources, Inc. (VESTRA) completed a review of historic air photos to evaluate historical changes to project area streams within the developed area of the Tehama West Watershed. For Reeds, Red Bank, Elder, and Thomes Creeks historic aerial photographs were reviewed and changes that have occurred during the time span of the photographic sequence. This is the summary of findings.

Large format aerial photography covering lower portions of the four assessment streams were reviewed. Natural Resource Conservation Service (NRCS) aerial photographs from 1938 and 1952 were used as a base condition. U.S. Geological Survey (USGS) photography from 1994 and 2004 were used to display current conditions. However, not all stream reaches had full coverage for each of these years.

The assessment considered the following stream segments:

- **Reeds Creek** from the Sacramento River upstream 2.75 miles to Red Bank Road

- **Red Bank Creek** from the Sacramento River upstream approximately 1.5 miles to the Interstate 5 crossing

- **Elder Creek** from the Sacramento River to the Interstate 5 crossing, 6 miles upstream

- **Thomes Creek** from the Sacramento River to the Interstate 5 crossing, 5.7 miles upstream

For each stream segment the available photographs were chronologically compared and summaries were made regarding:

- Existing infrastructure
- Physical features within and adjacent to the stream
- Riparian vegetation quantity and patterns
- Miscellaneous observations

Locations on each stream showing interesting features or examples of characteristic changes were scanned from a chrono-sequence of photographs, so as to visually document the changes. In addition, several upland areas were compared using historic and 2004 photographs. Changes in vegetation, stream and gully erosion patterns, etc. were noted.

REGIONAL EVENTS WITH THE POTENTIAL TO AFFECT STREAM SEGMENTS

A number of regional events have occurred that have the potential to affect one or more of the streams in the Tehama West Watershed. A summary of these events follows to provide a base of knowledge from which to view photo "snaps of time'.

1. The highest recorded stream flows for Thomes and Elder Creeks are shown in Table 1. It is assumed that these events also represent floods for adjacent drainages. The two recorded events occurring prior to the earliest aerial photographs used in the assessment (1938) are highlighted in grey:

2. Shasta Dam was constructed in the early 1940s and began to have control over downstream river flows by 1944.

3. The Corning Canal was constructed between 1954 and 1959.

4. The Red Bluff Diversion Dam was constructed in the mid-1960s.

5. Interstate 5 was constructed through Tehama County in the mid- to late-1960s.

6. The Tehama/Colusa Canal was constructed between 1965 and 1979.

7. Most levees existing along assessed streams were likely constructed in the 1960s.

Table 1
ANNUAL PEAK FLOWS: RETURN PERIOD > 5 YEARS

Thomes Creek (1921-1996)			Elder Creek (1949-2004)		
Date	**Flow (cfs)**	**Gage Height (feet)**	**Date**	**Flow (cfs)**	**Gage Height (feet)**
Dec. 22, 1964	37,800	12.7	Feb. 28, 1983	17,700	12.1
Feb. 17, 1986	32,900	12.11	Feb. 14, 1986	15,300	11.62
Jan. 16, 1974	29,400	12.3	Mar. 04, 2001	15,100	11.58
Dec. 21, 1955	23,500	12.14	Dec. 11, 1983	13,200	11.17
Mar. 09, 1995	20,100	10.54	Dec. 16, 2002	13,100	12.11
Mar. 26, 1928	19,600	10.5	Feb. 24, 1958	11,700	13.9
Jan. 26, 1983	19,500	10.19	Dec. 31, 1996	11,500	10.75
Jan. 31, 1963	19,200	12.63	Dec. 22, 1964	10,300	13.23
Jan. 13, 1980	18,800	10.1	Mar. 09, 1995	9,740	10.3
Feb. 08, 1960	18,700	12.32	Mar. 07, 1975	9,000	11.22
Jan. 21, 1943	18,600	10.92	Jan. 16, 1974	8,850	11.14
Jan. 23, 1970	18,000	12	Dec. 21, 1955	8,840	12.52
Feb. 28, 1940	17,000	14.3	Jan. 23, 1970	8,690	11.05
Dec. 10, 1937	16,500	16.8	Feb. 17, 2004	8,340	10.41
Feb. 15, 1982	16,400	9.57	---	---	---
Feb. 24, 1958	14,300	9.78	---	---	---

Source: Taken from Table 6.4 of Tehama West Watershed Assessment (2005)

RESULTS

Reeds Creek

An evaluation was made from Red Bank Road downstream to the Sacramento River (approximately 2.75 miles in length). Photographs used in the assessment were taken in 1938, 1952, 1994, and 2004.

1938 Photos

The 1938 image was taken prior to the construction of Shasta and Red Bluff Diversion Dams. A number of interesting features in the Red Bluff vicinity give perspective regarding pre-Shasta Dam conditions and how water flow management likely affected the vicinity:

- Virtually all of the community of Red Bluff in 1938 existed west of the Sacramento River, north of Reeds Creek, and south of Dog Island Park. The city was densely in-filled and covered a total of only 0.63 square miles.

- Reeds Creek crossings included Highway 99 (stream mile 0.15), Southern Pacific Railroad (stream mile 0.35), Rawson Road bridge (stream mile 0.65), a low-water crossing at Paskenta Road (stream mile 1.75), and the Red Bank Road bridge (stream mile 2.75).

- Two large islands existed within the Sacramento River at the northeastern tip of Red Bluff. Both showed evidence of recent bed material movement and had modest amounts of short and moderate-height vegetation. River flow was split relatively equally between the three channels around and between the islands (see Image Comparison 1a).

- Little development existed in the Antelope Blvd. area east of the Sacramento River. Nearly all of the land from the Oak Street Bridge east more than 1.25 miles showed evidence of bed-load movement, some recent. Some agriculture was occurring immediately east of Paynes Creek Slough.

- During high river flows the Sacramento River's progress appeared to be slowed by the sharp bend at Red Bluff. This resulted in water spilling out into overflow channels known as (from west to east) East Sand, Sampson, and Paynes Creek Sloughs. These sloughs flowed through most of today's eastern Red Bluff.

Evidence of scour, cut-bank formation, and possible riparian vegetation clearing was noted along Reeds Creek and its tributary Brickyard Creek. This suggests that sometime shortly before 1938 one or more significant floods occurred. It is possible that the 1928 or 1937 flood events (see Table 1) may have been responsible for the stream conditions noted. Graphic down-cutting and bank-cutting occurred in the lower 1,000 feet of Brickyard Creek, as well as its tributary immediately west of Red Bluff (see Image Comparisons 1b and 1c).

Image Comparison 1a. Red Bluff and the Sacramento River in 1938 (top) and 2004 (bottom). Note the two large islands at the bend of the river and the large overflow area to the east of Red Bluff in 1938 and compare the 2004 situation. These changes are likely due to Shasta Dam's moderation of river flows during floods.

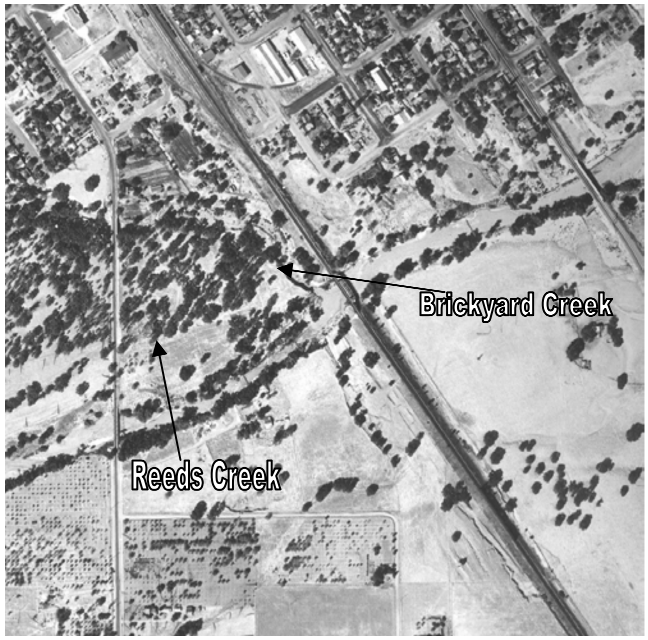


Image Comparison 1b. Red Bluff, Reeds Creek, and Brickyard Creek in 1938 (top) and 1994 (bottom). Note vegetation and stream channel changes at Brickyard Creek's confluence with Reeds Creek, immediately west of the railroad bridge; the density of riparian cover along Reeds Creek; and the degree of urban sprawl to the south of the stream.

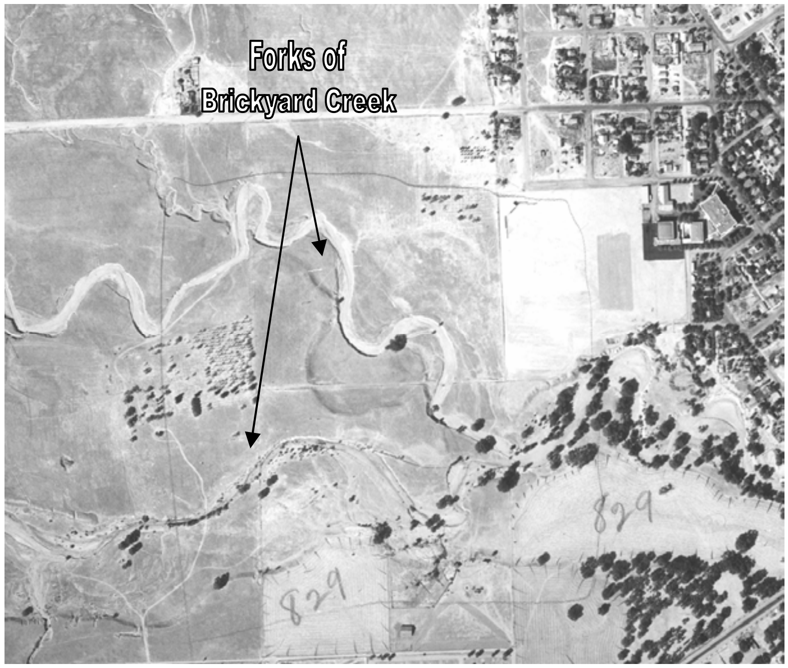


Image Comparison 1c. North and South Forks of Brickyard Creek and western Red Bluff in 1938 (top) and 1994 (bottom). Note evidence of stream bank cutting on both forks of the stream and the lack of riparian cover in 1938, along with changes in 1994.

Reeds Creek was broken into the following three segments and estimates were made of stream bank riparian foliar cover (see Table 2):

- Segment 1—Sacramento River upstream to Southern Pacific Railroad
- Segment 2—Southern Pacific Railroad upstream to Rawston Bridge
- Segment 3—Rawston Road upstream to Paskenta Road

Table 2
ESTIMATED PERCENT STREAM BANK RIPARIAN FOLIAR COVER, LOWER REEDS CREEK, 1938-2004

Year	Stream Segment		
	1	2	3
1938	30	65	30
1952	40	70	35
1994	70	90	70
2004	70	90	70

The Paskenta Road crossed Reeds Creek with a low-water ford. The crossing location was approximately 650 feet wide and the stream was highly braided at this point. Little if any riparian vegetation existed within several hundred yards either side of the crossing.

1952 Photos
Between 1938 and 1952 both Reeds and Brickyard stream banks appear to have increasing riparian cover, particularly from Rawson Road to the Sacramento River. In 1952 the Paskenta Road crossing was upgraded to a concrete low-water ford, which had a falls on its downstream side that caused some localized scour. Scattered riparian growth is coming in along the edges of the braided streambed along Segment 3.

1994 Photos
A bridge now exists at the Paskenta Road crossing. The stream channel at this point has been narrowed to less than one-half of its original width. Vegetation along Reeds Creek stream banks appears greater than in earlier photographs (see Table 2).

2004 Photos
The lower 1,000 feet of Brickyard Creek is densely covered by riparian vegetation (see Image Comparison 1b). West of Red Bluff, Brickyard Creek's tributaries have riparian vegetation becoming established and the sharp bank cuts, apparent in the 1938 photograph, are much more muted (see Image 2c).

Riparian growth appears to be much greater along Reeds Creek than in 1938 but very similar to what it was in 1994 (see Table 2). The lower portion of Reeds Creek, from the old Highway 99 Bridge to the Sacramento River has changed considerably from 1938, as it is now Lake Red Bluff's summer-time bay. Short to mid-height riparian growth extends densely along the sides of this stream section except adjacent to the Sacramento River, where construction and maintenance of a boat ramp facility may have reduced vegetation.

By 2004 urban uses cover most of the southern banks of Reeds Creek downstream of the Rawson Road and from the eastern abutment of the Oak Street Bridge east on Antelope Blvd.

Also, there is only one island on the bend of the Sacramento River (see Image 2a) and it is heavily covered by riparian vegetation.

Between 1938 and 2004 there were infrastructure changes adjacent to Reeds Creek. Most apparent is the construction of a bridge and narrowing of the stream channel at the Paskenta Road crossing site at stream mile 2.75 and urban sprawl along the southern bank of the stream, extending at least 1.2 miles up from the Sacramento River.

Construction of Shasta and Red Bluff Diversion Dams has a variety of effects on the Sacramento River and adjacent areas, including:

- Floods to the Antelope Blvd. area have been reduced, allowing for the eastern portion of Red Bluff to develop.

- The two islands evident in the Sacramento River in 1938 have been reduced to one and it has become heavily vegetated.

- The Red Bluff Diversion Dam backs up water during the summer to the Southern Pacific Railroad Bridge.

Red Bank Creek

Red Bank Creek was evaluated from the Sacramento River upstream approximately 2.1 miles, to a point 0.5 miles west of the Interstate 5 crossing site. Photographs from 1938, 1952, 1994, and 2004 were used to compare stream and near-stream conditions.

1938 Photos
Conditions in 1938 included:

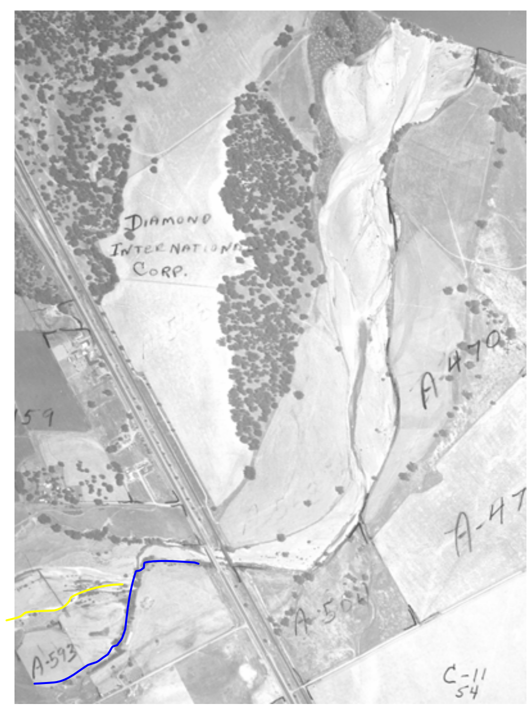
- Red Bank Creek throughout the entire assessment area is a braided stream showing evidence of recent high stream flows and bank cutting. Very little riparian growth exists along the outer stream banks or on island features within the banks, except for small stringers at the stream's confluence with the Sacramento River (see Image Comparisons 2a).

- A sharp stream bank feature exists upstream from the Highway 99/Southern Pacific Railroad Bridges (see Image Comparison 2a).

- Red Bank Creek stream crossings consist of the adjacent Southern Pacific Railroad and Highway 99 bridges.

- Adjacent lands consist of dry land agriculture and oak woodlands. Scattered home sites with outbuildings exist south of the stream.

Image Comparisons 2a—Lower Red Bank Creek in 1938 (above) and 1952 (below). Note braided stream conditions and scarcity of riparian growth both above and below the Highway 99 and Southern Pacific Railroad Bridges. Also, note the stream bank feature lined by scattered hardwoods in the extreme southwest portion of the images (blue line). The area bound by blue and yellow lines has been reclaimed for agricultural uses.



The assessment area was broken into three segments to estimate stream bank foliar cover, including:

- Segment 1—the Sacramento River to Highway 99 Bridge
- Segment 2—Highway 99 Bridge west to the future location of Interstate 5 crossing
- Segment 3—the Interstate 5 crossing site to 0.5 miles west. Estimates of percent foliar cover are shown on Table 3.

Table 3
ESTIMATED PERCENT STREAM BANK RIPARIAN FOLIAR COVER--LOWER RED BANK CREEK (1938-2004)

Year	Stream Segment 1	Stream Segment 2	Stream Segment 3
1938	<5	<5	15[a]
1952	<5	5	20[a]
1994	Not Available	20	25[a]
2004	75[b]	20	25[a]

Notes: [a]-Most foliar cover is provided by large scattered trees, likely blue or valley oaks.
[b]Entire stream segment is a bay of Red Bluff Diversion Dam during summer-time.

1952 Photos
The stream channel conditions appear to be similar as in 1938; however, there may be slightly more riparian growth within the stream channel upstream from the Highway 99/Railroad Bridges (Segments 2 and 3).

Infrastructure changed little from 1938 to 1952 in the stream's vicinity; however, agriculture encroached upon the stream channel site located slightly upstream from the Highway 99/Railroad bridges, as shown in the Image Comparison 2a

2004 Photos
In the mid-1960s Interstate 5 and the Red Bluff Diversion Dam/Pumping facilities were completed. Interstate 5 crossed Red Bank Creek approximately 0.5 miles west of the Highway 99/Railroad bridges while the Red Bluff Diversion Dam was placed several hundred yards below the mouth of the Red Bank Creek. Following the placement of the Red Bluff Diversion Dam, Red Bank Creek held water nearly to Highway 99. In addition, the Diamond International mill facility was constructed on the north bank of Red Bank Creek, between Highway 99 and the Sacramento River. Construction of this facility eliminated hardwood habitat adjacent to Red Bank Creek. Finally, small residential developments were constructed between Interstate 5 and Highway 99, immediately south of Red Bank Creek.

During this period of time there were changes to the stream and near-stream habitats, including:

- Heavy streamside vegetation (species unknown) increased along the stream banks from the Sacramento River up to Highway 99. This is in marked contrast to 1938 and 1952 when there was very little streamside vegetation in this segment (see Table 3). The cause is likely the construction of the Red Bluff Diversion Dam that backs water up through this reach (similar to the lowest reach of Reeds Creek).

- Additional stream channel portions have been reclaimed to agricultural uses, both between Interstate 5 and Highway 99 crossings and immediately upstream from Interstate 5 (see Image Comparisons 2b).

- Stream bank and within-channel vegetation appears to have increased modestly in Segments 2 and 3 above Highway 99 (see Table 3).

Very little change was noted when comparing the 1994 and 2004 photographs regarding the stream or riparian vegetation.

Elder Creek

Elder Creek was evaluated along its lower 6 miles, from the Interstate 5 crossing downstream to the Sacramento River. Photos were reviewed for the lowest 1.5 miles of the stream for 1952, 1994, and 2004, while from that point upstream to the Interstate 5 crossing photos were reviewed for 1938, 1952, 1994, and 2004.

1938 Photos
Due to the lack of 1938 images of the lower stream segment, no assessment could be made for this period of time. The following are observations about conditions from stream mile 1.5 up to the future Interstate 5 crossing site:

- Stream crossings consisted of the Tehama Road low-water ford; Highway 99 and Southern Pacific Railroad bridges at Gerber; and Rawson Road Bridge approximately 1 mile west of Gerber.

- Irrigated agriculture crops were adjacent to Elder Creek upstream to about 0.5 miles east of the Interstate 5 crossing site. From that point west the land is either rangeland or dry land farmed.

- The community of Gerber exists close to the stream's northern banks but only about one-quarter of the lots support buildings.

- The Elder Creek stream channel tends to be relatively narrow (<200 feet wide) upstream to about 1.3 miles east of the future Interstate 5 crossing. (It is possible that levees extend along the stream banks along this portion of Elder Creek.) Upstream from that point the stream channel noticeably widens and varies from 400-1,000 feet in width.

- Riparian vegetation cover values are shown on Table 4, broken down in the following segments:

    - Segment 1—the Sacramento River to Tehama Road crossing
    - Segment 2—Tehama Road crossing to Highway 99
    - Segment 3—Highway 99 to Rawson Road
    - Segment 4—Rawson Road to 1.3 miles east of Interstate 5
    - Segment 5—1.3 miles east of Interstate 5 to Interstate 5

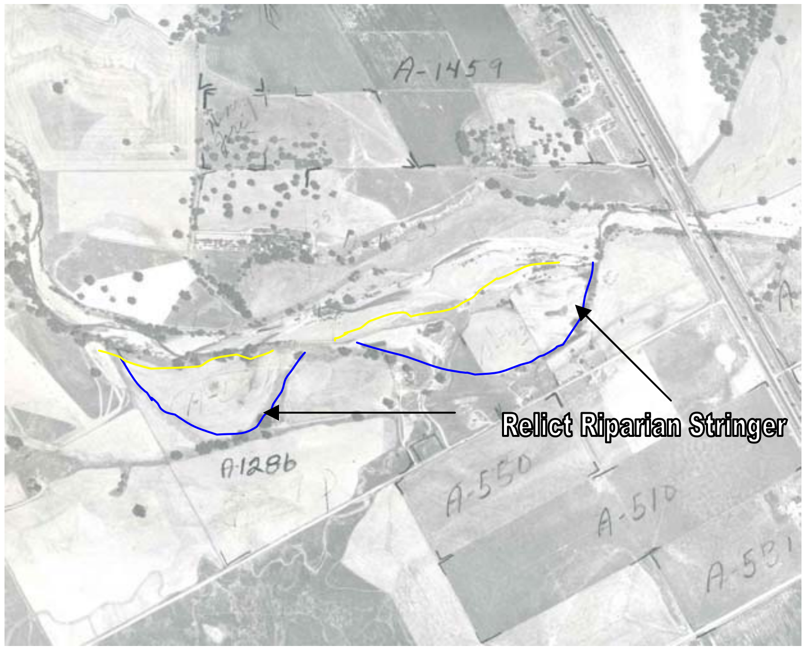


Image Comparison 2b. Red Bank Creek in 1952 (top) and 1994 (below). Highway 99 crosses the stream near the right edge of both images and I-5 crosses in the center of the 1994 image. Note wide stream channel features between Highway 99 and the I-5 crossing site that has been converted to agricultural land in 1994. (Stream cut bank shown with blue line and reclaimed land bound by yellow and blue lines.) Also note the "riparian" hardwood stringers that line the historic stream banks that are now distant from the stream.

Table 4 ESTIMATED PERCENT STREAM BANK RIPARIAN FOLIAR COVER LOWER ELDER CREEK (1938-2004)					
	Stream Segment				
Year	1	2	3	4	5
1938	Not Available	20	30[a]	50[a]	15
1952	35	15	Not Available	Not Available	20
1994	25	5	Not Available	15	10
2004	35	5	10	30	15
Notes: [a]Most foliar cover provided by large scattered trees, likely blue or valley oaks.					

1952 Photos

The earliest view of the mouth of Elder Creek was from a 1952 photograph. At this date the stream's lowest reach (Segment 1) is relatively narrow (<200 feet wide) with moderate amounts of riparian cover, primarily provided by hardwoods with large crown diameters. It is possible that small levees extend along the stream's banks.

1938–2004 Photos

Between 1938 and 1994 marked changes have occurred along the entire assessment segment, including:

- Interstate 5 and the Tehama-Colusa Canal have been constructed and cross Elder Creek.
- The Tehama-Colusa Canal crosses the stream approximately 0.6 miles west of Highway 99.
- Large levees now extend along both south and north sides of the stream from the Sacramento River upstream at least to Interstate 5.
- Irrigated agricultural fields exist on both sides of the stream and west at least as far as Interstate 5.
- Several portions of stream overflow channels have been converted to agricultural use.
- Most city lots have been built upon in Gerber.
- Changes from 1994 to 2004 appear to be slight.

The degree and variety of 1938-2004 changes appear much more pronounced along Elder Creek than in either the Reeds or Red Bank Creeks situation. Construction of large levees, likely in the 1960s, and their constraining effects on the stream is probably responsible for these changes. Some of the effects or results of levee construction or enlargement include:

- Stream bank cover in the lowest portion of Elder Creek (Segment 1) is similar to what it was in 1952 but the riparian corridor width is much reduced with nearly all trees outside the levees having been removed (see Image Comparison 3b).

- In Segments 3 and 4 the hardwood canopy cover is much reduced in 1994 and 2004 relative to 1938. This reduction may be due to enlargement of levees (see Image Comparison 3c).

- Large areas of stream overflow channel have been converted to farmland (see Image Comparison 3a).

By 1994 Elder Creek's channel width is relatively consistent throughout the assessed swath, except for portions of Segment 3 (immediately above Highway 99) and Segment 5. Construction of the Interstate 5 crossings, the Tehama-Colusa Canal, and a concrete slab dam constructed immediately below the Tehama-Colusa Canal (to protect the canal siphon from stream scour) have all constricted the stream flow from its 1938 pattern (see Image Comparison 3a for changes at the Interstate 5 crossing site). In each of these locations the stream's total overflow channel width was constricted to less than one-half of its 1938 width. This constriction has allowed conversion of portions of the flood overflow channels into agricultural fields (see Image Comparison 3a). Stream constriction caused by levee construction deepens and speeds water discharge during floods and creates a homogeneous stream profile.

Elder Creek differs from the other assessed streams because it may have had levees much earlier. The relatively narrow condition of the stream shown in the 1938 image may be due to early directing efforts, which allowed agriculture to extend to the levee walls. Image Comparison 3c shows a portion of Segment 3 that is tightly constrained in 1938, with a narrow stringer of hardwoods within the old levees. When the levees were enlarged (possibly in the 1960s) much of the residual hardwood cover was removed.

Thomes Creek

Thomes Creek historical changes were assessed using 1952, 1994, and 2004 photographs. The stream's assessment reach extends from the Sacramento River west to the Interstate 5 crossing, a distance of approximately 5.7 miles.

1952 Photos

The Thomes Creek confluence at the Sacramento River produces a pronounced debris fan (see Image Comparison 4a). The Sacramento River appears to form a wide eastward bend to flow around the fan. Topographic maps of this delta show overflow channels radiating both north and south from Thomes Creek to the Sacramento River, along the lower 0.8 miles of the tributary.

Due to the size of the Thomes Creek delta and its relationship with the Sacramento River, it may be possible to use the fan to assess changes to address management effects in the Thomes Creek drainage. If sediment discharge from the drainage changes, one would expect that the delta will change. Specifically, if sediment discharge (through increased man-caused erosion) increases and all other factors remain stable, the delta may push further to the east and build in size. If sediment production is reduced, perhaps by gravel mining, the Sacramento River may show

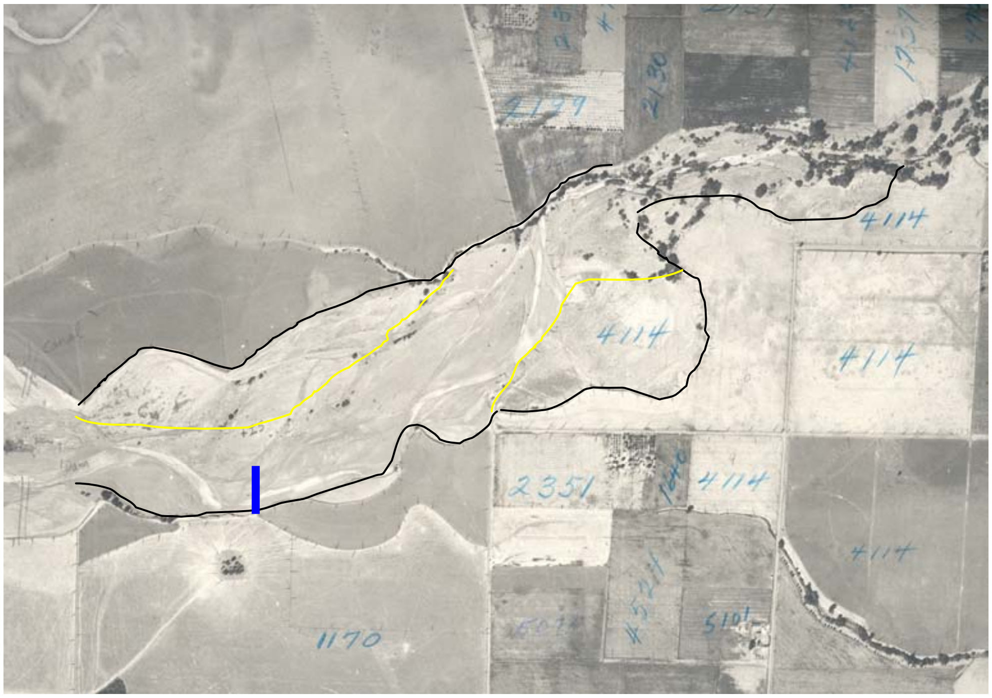


Image Comparison 3a. Elder Creek at the I-5 crossing in 1938 (top) and 1994 (bottom). The 1938 stream channel extent is shown with black lines and the site and length of the Interstate 5 crossing is shown as a blue bar. The areas between black and yellow lines are reclaimed farmland following Interstate 5 and levee construction, resulting in much more constrained stream. Also, note the vegetation changes either side of the I-5 crossing between the two images. Much of the 1994 vegetation is likely *Arundo* or Tamarisk.

Image Comparison 3b. The lowest reach of Elder Creek in 1952 (top) and 1994 (bottom). Note the distinctive levee system along the stream in 1994, along with the reduction in hardwood cover along the stream and adjacent areas compared with 1952. This area is stream "Segment 1".

Image Comparison 3c. Elder Creek's Segment 4 in 1938 (top) and 1994 (bottom). The constrained nature of this segment in 1938 is likely due to early levees which allowed the surrounding land to be used for agricultural purposes. The large hardwoods along the stream may be residual oaks, from woodlands that pre-dated agricultural development. The 1994 image shows the enhanced levee system, possibly built in the 1960s, and the elimination of nearly all large hardwoods.

signs of reducing the delta's size. Related changes may also be noticed in the Sacramento River immediately up and downstream of the mouth of Thomes Creek.

The 1952 stream conditions and adjacent land use along Thomes Creek include:

- The stream's crossings consist of a wide low-water ford at Hall Road, at approximately stream mile 1.5, and Highway 99 and Southern Pacific Railroad bridges at Richfield (stream mile 4.3).

- Land uses were primarily rangeland or dry land crops north of Thomes Creek and irrigated crops and orchards south of the stream. Scattered farm homes are located south of the stream, with a concentration in the Richfield area. The Richfield Mill exists immediately east of the railroad, on the south banks of Thomes Creek.

- Thomes Creek is wide and has a highly braided character through the entire assessment area. Total stream channel width was often in excess of 1,000 feet, while at both the Hall Creek low-water crossing (see Image Comparison 4b) and Interstate 5 crossing site (see Image Comparison 4c) total stream width was about 3,000 feet.

- Streamside vegetation is very sparse and only exists as small "islands" of short-statured growth within the channel boundaries and as stringers of moderate to large canopied trees along the external edges of the stream channel. Frequently these stringers of hardwood trees are associated with cut bank features (see Image Comparison 4b).

1994 Photos

Between 1952 and 1994 significant changes have occurred throughout the Thomes Creek segment, including:

- Additional stream crossings have been built and now include: a wide low water at the Hall Road; the Tehama-Colusa Canal crossing at stream mile 2.0; Highway 99 and Southern Pacific bridges at Richfield; and Interstate 5 bridges at stream mile 5.7. (The Corning Canal crossing was placed approximately 0.6 miles west of Interstate 5.)

- Thomes Creek continues to be highly braided throughout its reach; however, in many locations its 1952 width has been constricted. Examples include: the Hall Creek crossing (see Image Comparison 4b); levees constructed to protect the Tehama-Colusa Canal; and the Interstate 5 crossing (see Image Comparison 4c). In the latter case the original width was narrowed from 0.6 miles to less than 0.3 miles.

- Land use has changed now so that both north and south sides of the stream have irrigated crops or orchards.

- More farm buildings and structures exist through the area, almost all occurring on the south side of Thomes Creek. The Richfield Mill appears inoperable and assorted buildings and open areas take up the site. The community of Richfield is more developed than in 1952.

Image Comparison 4a. Thomes Creek confluence with the Sacramento River (delta) in 1952 (top) and 2004 (bottom). Note that Thomes Creek's mouth may be migrating further to the north, eliminating riparian forest along the Sacramento River and cutting off the 1952 river channel. In the late 1990s a new river channel formed by cutting through the large point bar and it is possible that the island created will become attached to the western land mass.

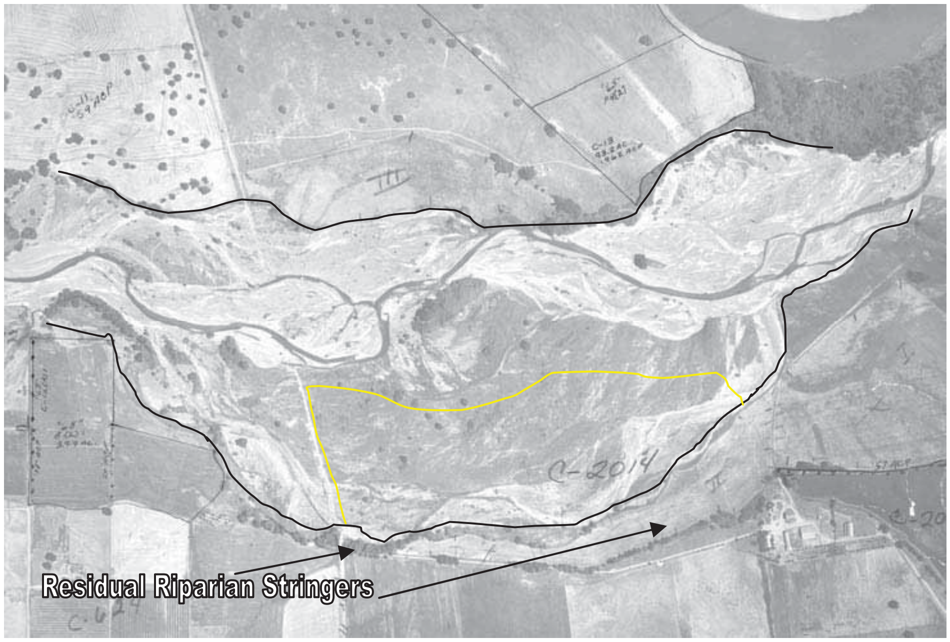


Image Comparison 4b. Thomes Creek at the Hall Road crossing in 1952 (top) and 1994 (bottom). Note the extent of the stream's overflow patterns in 1952 (black lines) and the rows of riparian trees along the outer stream banks. By 1994 significant portions of the overflow channels have been converted to agricultural land (area encircled by yellow line), which is orchard. Note the row of hardwoods still existing along the stream bank feature south of the orchard.

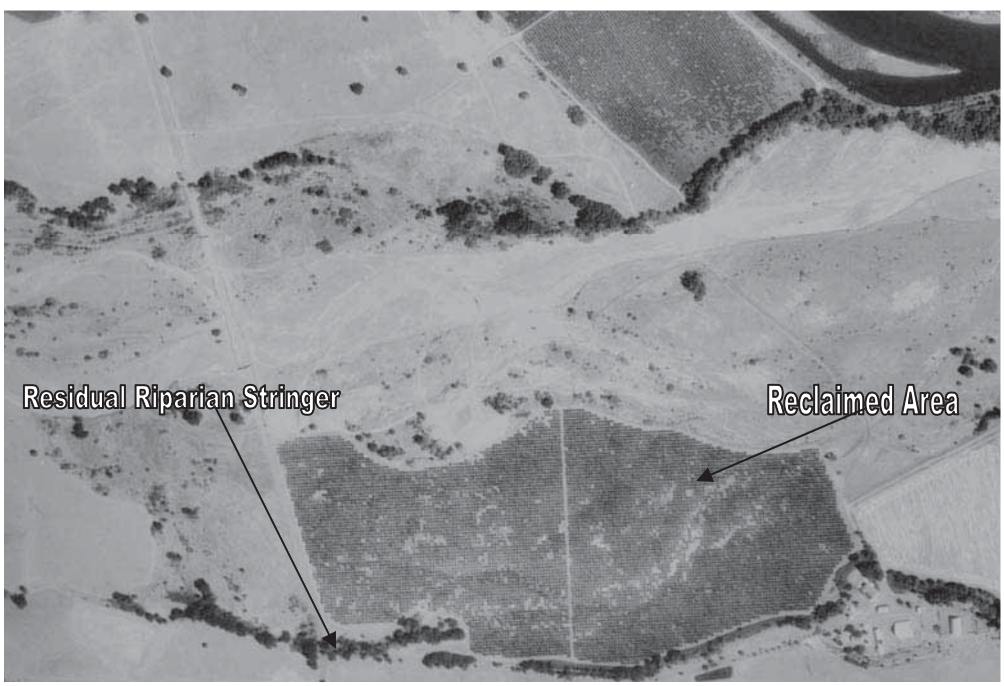


Image Comparison 4c. Thomes Creek at the Interstate 5 crossing site in 1952 (above) and 1994 (bottom). Note the braided stream condition in both images. The Interstate 5 Bridge locations and lengths are shown as a blue bar. The extent of overflow patterns in 1952 are shown by the black lines and the 1994 extent of stream constriction is shown by the yellow line. Comparing these images show the extent of channel constriction. (The feature to the west of Interstate 5 is the Corning Canal crossing.)

- Many levees have also been constructed between Interstate 5 and the Sacramento River.

- Riparian vegetation has changed. At the stream's confluence with the Sacramento River the riparian forest along the northern portion of the delta has narrowed. Riparian vegetation continues to be scant and patchy in 1994; however, dense growth occurs within some reaches (particularly immediately upstream from Richfield and immediately upstream from Interstate 5; see Image 4d). It is likely that most of this vegetation is comprised of invasive species.

- Historical outermost stream channel banks can still be identified by their residual hardwood stringers of moderate to large size trees; however, these features are often a distance from the current stream channel (see Image Comparison 4b).

Estimates of stream bank riparian foliar cover were made for various segments of Thomes Creek for the period 1952-2004 and are shown on Table 5. The segments include:

- Segment 1—Sacramento River upstream to Hall Road crossing

- Segment 2—Hall Road crossing to 0.5 miles west of the Tehama-Colusa Canal crossing

- Segment 3—0.5 miles west of the Tehama-Colusa Canal crossing to Highway 99

- Segment 4—Highway 99 to the Interstate 5 crossing site

Although estimating stream foliar cover was different with all assessment streams, the historical changes in stream flow characteristics and invasion of weeds complicates the issue for Thomes Creek. In both 1994 and 2004 images vegetation, likely *Arundo* and Tamarisk, appear to grow in dense mats within the stream channel (see Image 4d). The estimations shown in Table 5 continue to follow the same logic used in Tables 2-4 for the other assessment streams, with only shrub or tree growth <u>along the stream banks</u> being considered. Therefore, mid-channel invasive vegetation contributed by alien species is <u>not</u> considered by the estimates.

Table 5
ESTIMATED PERCENT STREAM BANK RIPARIAN FOLIAR COVER
LOWER THOMES CREEK (1952-2004)

Year	Stream Segment 1	Stream Segment 2	Stream Segment 3	Stream Segment 4
1952	5	5	5	<5
1994	<5	5	10[a]	15[a]
2004	5	10[a]	15[a]	20[a]

Notes: [a]—These increase in foliar cover is primarily provided by low-statured vegetation which may be *Arundo* or Tamarisk.

Stream bank cover appeared to increase modestly for each stream segment between 1952 and 2004; however, it is possible that invasive plants contribute some or much of that increase.

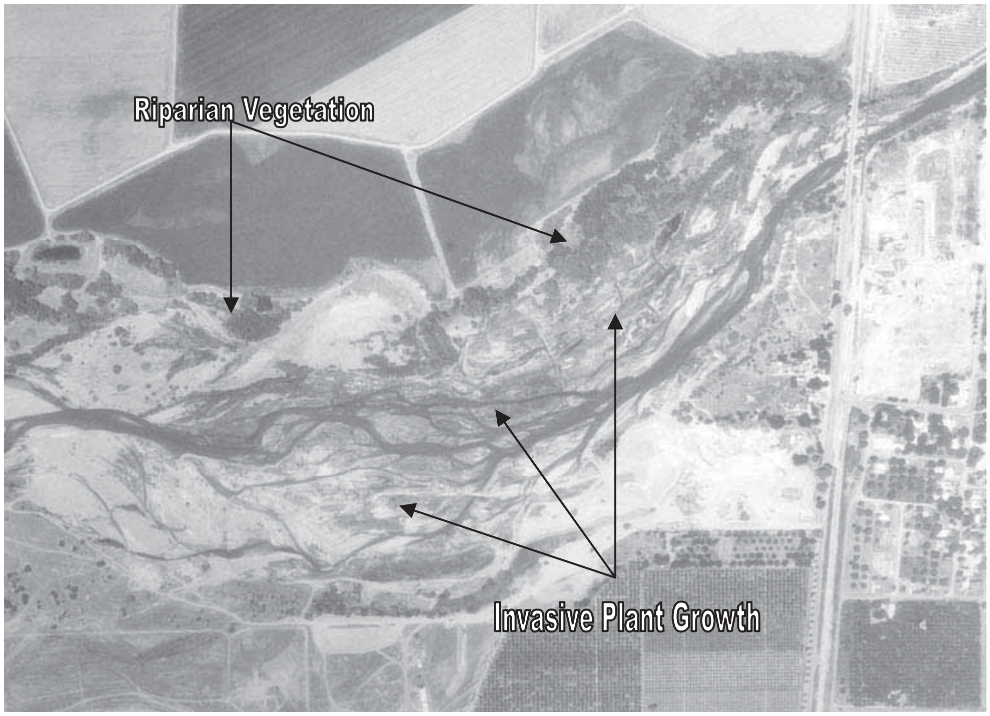


Image 4d. Thomes Creek immediately west of Richfield, in 1994. Note the vegetation occurring within the stream braids, likely *Arundo*, and larger-statured vegetation along the sides of the channel.

There are many locations where the stream's 1952 flood overflow channels have been reclaimed to agriculture. Examples include locations at the Hall Road crossing (see Image Comparison 4b) and the Interstate 5 crossing (see Image Comparison 4c). Similarly as described for the Red Bank and Elder Creek cases, the reclaimed sites retain the old stream bank cut features with narrow stringers of hardwood trees. These features are now often quite distant from the stream channel.

As in the case of Elder Creek and to a lesser extent Red Bank Creek, the narrowing of Thomes Creek channel has likely resulted in a deepening and speeding of flood waters passage through the lower system. Consequently, less sediment deposition can occur in side channels.

UPLAND HABITAT COMPARISON

Six separate upland areas were selected in the Tehama West Watershed assessment area for comparison of old and recent photographs. These specific upland sites were selected because they showed evidence of recent stream bank cutting or gullying in the earliest available photograph. Comparing the oldest available photograph with 2004 images showed how the erosion features had changed, as well as differences in riparian and upland vegetation and land use patterns.

The sites include:

- Site 1—Brickyard Creek. The site is located approximately 2 air-miles west of Red Bluff. Brickyard Creek is a tributary of Reeds Creek. The terrain is rolling grasslands with very few trees.

- Site 2—Brewery Creek. This site is located approximately 0.5 miles northwest of Red Bluff. The terrain is gently rolling grasslands with steeper gullies.

- Site 3—Oat Creek. This site is located approximately 10 air-miles southwest of Red Bluff. The terrain is rolling grasslands with adjacent steeper hills having gray pine and blue oak stands.

- Site 4—Thomes Creek/Flournoy. This site is located approximately 1 air-mile west of Flournoy. The site is centered on Thomes Creek and includes adjacent flat to rolling terrain.

- Site 5—Elder Creek. This site is located along Elder Creek, approximately 1 mile west of the Paskenta Road. The site includes rolling terrain with steeper slopes on the north bank of Elder Creek. There are scattered gray pine and blue oaks on the steeper slopes.

- Site 6—Thomes Creek/Paskenta—This site is approximately 1 mile southwest of Paskenta. Most of the site is rolling terrain, with steeper hills along the area's southern fringe. Scattered gray pine and blue oak grow on the steeper hills.

Comparisons of the photographic chrono-sequence include the following observations.

Site 1

The 1938 photograph of this portion of the Brickyard Creek drainage shows a large number of sharp erosion features, apparently recent in origin. These include steep and raw cutbanks in minor gullies draining into Brickyard Creek. Many of these erosion features are dendritic, suggesting downcutting in the main channels, leading to downcutting in the feeder channels.

Riparian growth is scant, only occurring along Brickyard Creek's main channel in a few scattered locations. The land use is rangeland in the north of the image with some dry land agriculture south of Brickyard Creek.

In the 2004 photograph (Image 5b) several features are immediately apparent—a 2004 rangeland fire has burned through the western portion of the assessment area and urban sprawl has pushed in from the east (suburbs of Red Bluff). In addition, several dams have been constructed in small draws, creating slender ponds.

The sharp erosion features noted in the 1938 photograph appear muted in the 2004 image. Although the resolution of the 1938 image is greater than the 2004 photograph, this change appears to be a product of gradual healing of the eroded gullies and suggests that the distinctive features seen in 1938 were created only shortly prior to when the photograph was taken.

Riparian vegetation appears to have changed little in extent or density between 1938 and 2004. Very little if any riparian growth is seen in 2004 adjacent to draws or gullies leading to Brickyard Creek and Brickyard Creek has only insignificant amounts of growth in small patches.

Site 2

In 1938 this assessment area is laced with sharp, down-cut gullies. No urban development has occurred in the area and vegetation appears to be grassland/rangeland. No riparian vegetation exists in any of the gullies leading into Brewery Creek or along the main creek itself.

In 2004 residential areas have extended westerly from the City of Red Bluff along both Park and Waldbridge Streets. Waldbridge Street has been extended through the southern portion of the assessment area but the central portion of the assessment area has been avoided by new development, likely due to the eroded and broken terrain. As in the case of Site 1, the sharp erosion gully features are much less apparent in 2004 than in 1938, suggesting that they have rounded and begun to heal. As in 1938, there is no riparian vegetation along the gullies or Brewery Creek. Also, the assessment area continues to exist as a grassland/rangeland.

Site 3

As shown by Figure 6a, in 1952 this assessment area is composed primarily of gently sloping and rounded terrain. Dry land agriculture is used on most of the land, except for the draws with steeper slopes and the hills to the northwest. The hills have moderately-heavy growth of gray pine and blue oak.

Sharp erosion features exist at Site 3, in a similar manner to Sites 1 and 2. Riparian growth is very restricted, only occurring in narrow, disconnected patches directly adjacent to Oat Creek and its larger tributaries. Riparian growth does not exist along any of the smaller gullies.

By 2004 (Figure 6b) some changes are apparent, relative to 1952. First, the oak/pine woodland north and south of the pond has been significantly thinned but not eliminated. Second, the erosion features sharply seen in 1952 appear to be more rounded and blend in with the adjacent uplands. Third, dense vegetation has encircled the pond, with some of the growth being emergent. It is possible that the pond's size has declined, due to sediment deposition, or that the emergent vegetation contributes to this perception. Riparian growth along Oat Creek is even more limited in 2004 than 1952. Riparian stringers do not exist in 2004, merely scattered individual shrubs or shrub-clusters.

Site 4

The vicinity southwest of Paskenta, shown in Figures 7a and 7b show similar erosion features in small headwater gullies and along bends of stream channels, in a manner similar to Sites 1-3. However, the gullying is less severe and less wide-spread than in the previous assessment areas.

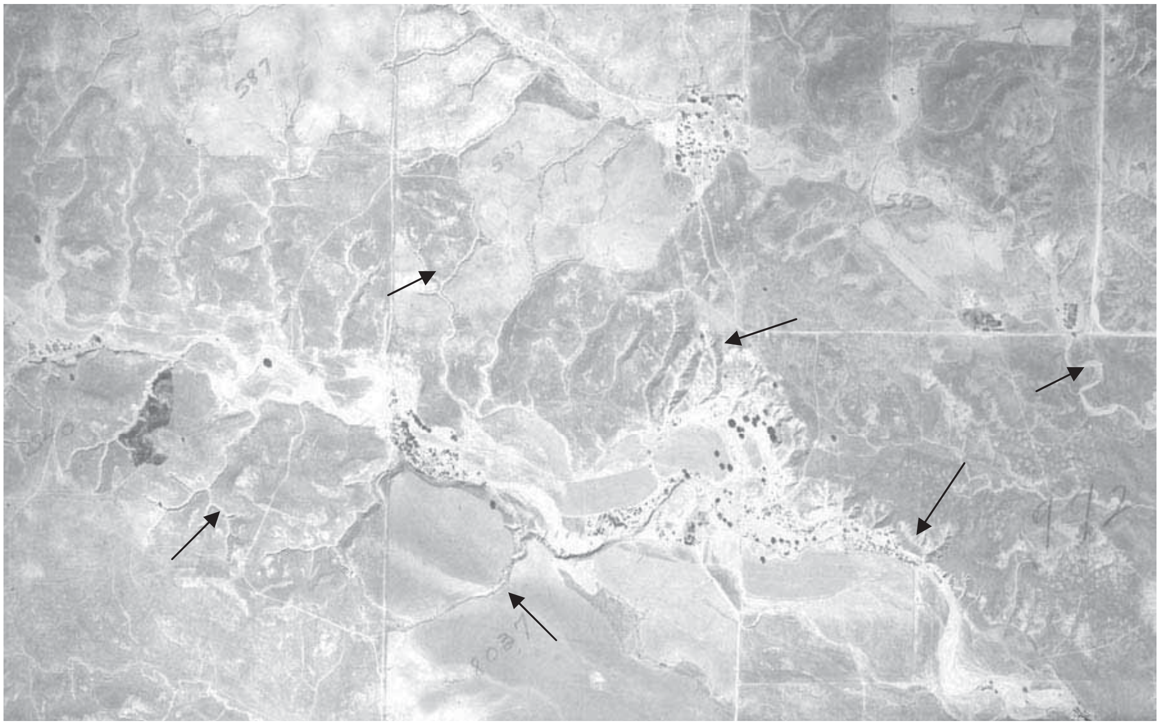


Image 5a (1938, above) and 5b (2004, below). Upland Site 1, Brickyard Creek, West of Red Bluff. Examples of sharp erosion features are pointed at by the arrows.

Image 5b (top, 1938) and 5b (bottom, 2004). Brewery Creek Drainage, immediately northwest of Red Bluff (Site 2). Examples of sharp erosion features are pointed at by the arrows. For reference, the bend of Baker Road is shown as a black line in both images.

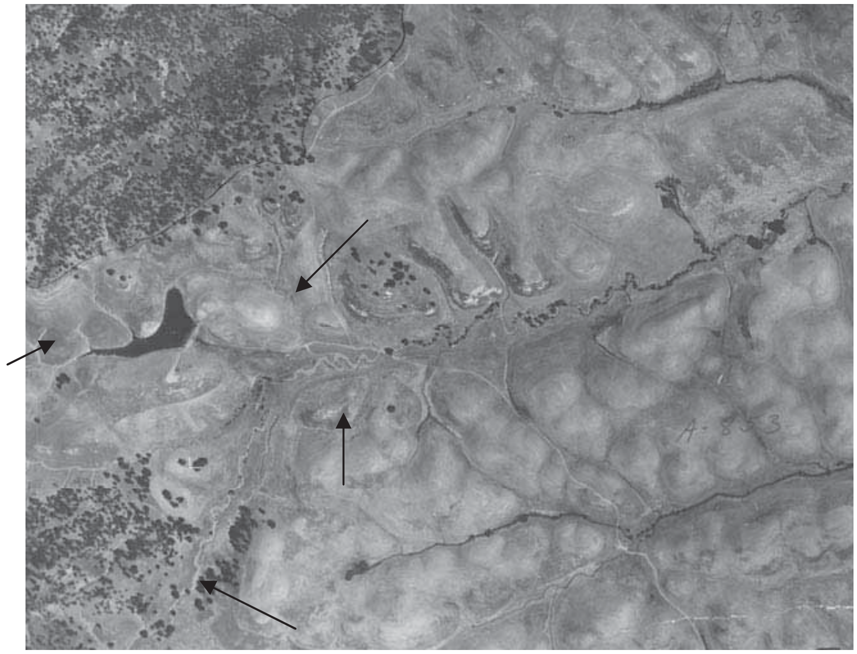


Figure 6a (top, 1952) and 6b (bottom, 2004). This assessment area (Site 3) is located along Oat Creek, approximately 2 miles south of the location called Red Banks. Significant erosion features are shown by arrows.

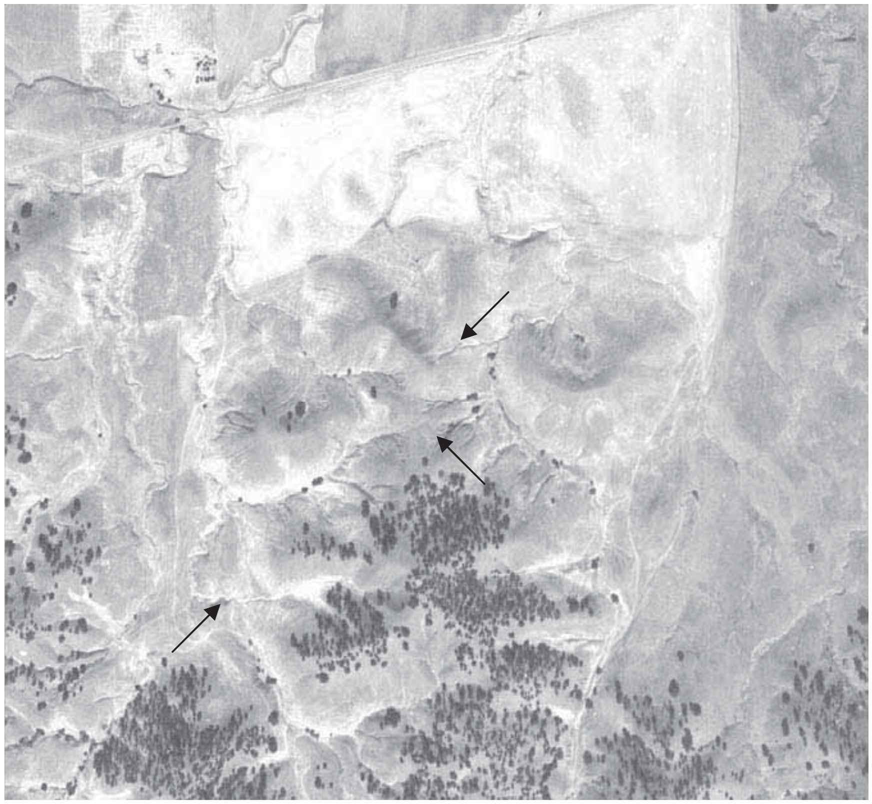


Figure 7a (top, 1938) and 7b (bottom, 2004). This area (Site 4) is located only 1 mile southwest of Paskenta. Sharp erosion features are shown by the arrows.

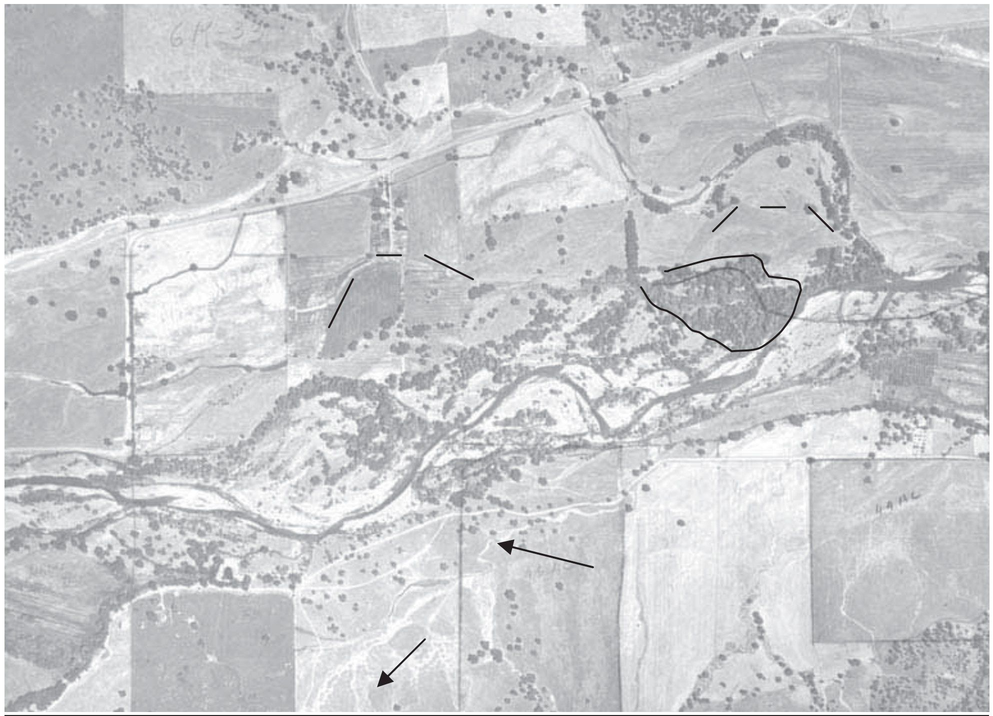


Figure 8a (top, 1952) and 8b (bottom, 2004). Significant areas of riparian growth that have been affected are circled by black lines. Gully erosion features are shown with arrows. Note old stream bend features shown with broken lines. This is Site 5.

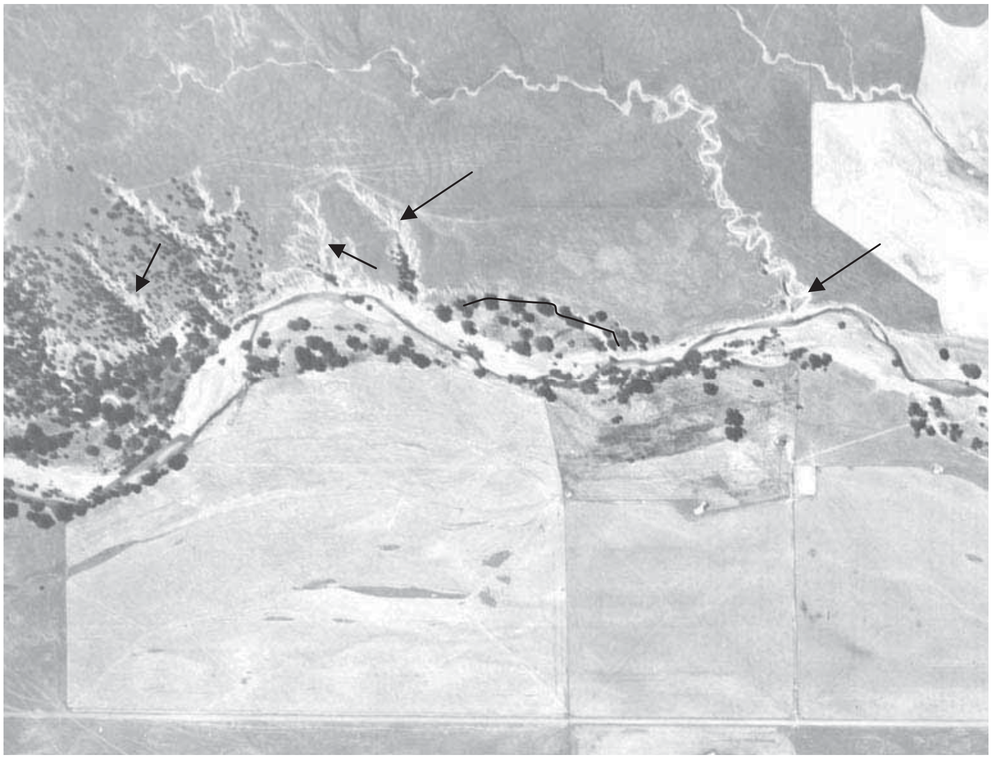
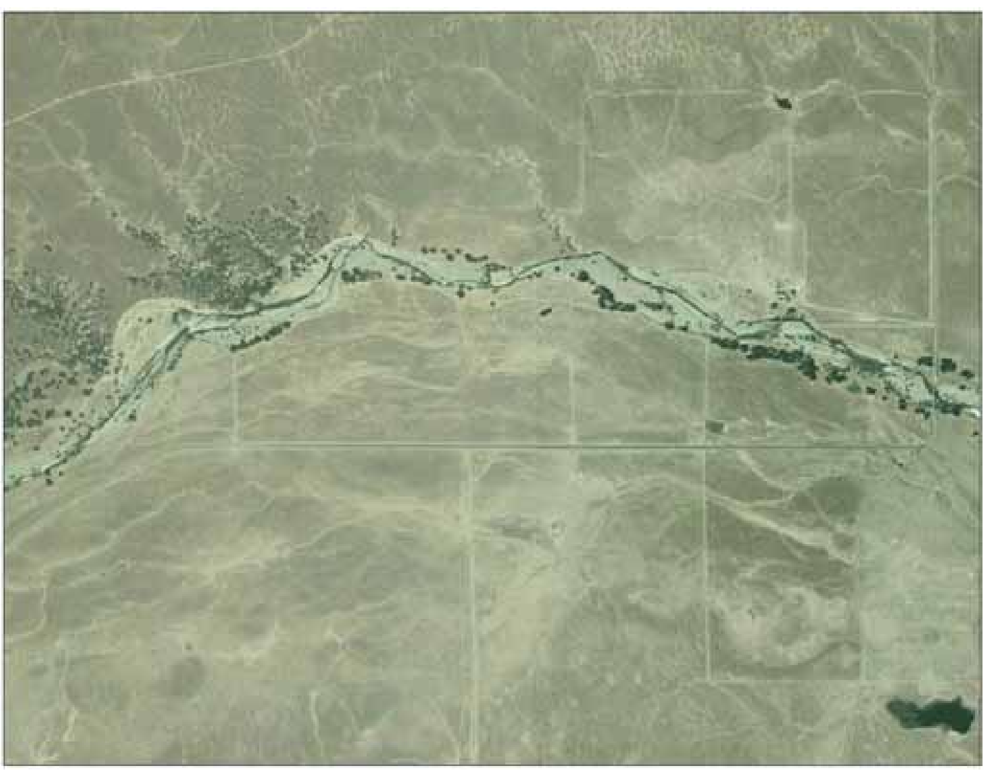


Figure 9a (top, 1947) and 9b (bottom, 2004). This is Site 6, along Elder Creek and approximately 1 mile west of the Paskenta Road. Note significant erosion features shown by the arrows. An old stream erosion feature is shown with the wavy line.



In 1938 the area was a combination of grassland/rangeland on the flats and gentle slopes with stands of gray pine and blue oaks on the steeper, adjacent hills. Riparian vegetation does not exist on any of the gullies. In 2004 the gully erosion is less pronounced but riparian growth still is totally lacking. The pine and oak woodlands are similar in extend and density, with no evidence of thinning.

Site 5

Figures 8a and 8b compare a location along Thomes Creek approximately 1 mile west of Flournoy. Fields adjacent to Thomes Creek were irrigated in both 1952 and 2004 but further away from the stream the lands are grasslands. Several small ponds were constructed prior to 1952 in the hills immediately south of the assessment area, no doubt to help in irrigating adjacent fields.

Some gully erosion can be seen in Figure 8a; however, the degree of upland erosion is less than in Sites 1-3.

Riparian vegetation shows significant change between 1952 and 2004. Specifically, Thomes Creek has eaten away at large portions of the riparian habitats that existed in 1952. Evidence of past stream bends, extending hundreds of feet to the north of the existing Thomes Creek channel, can be seen on both photographs. This suggests that the stream has varied in width and path in the past. Even so, the amount of riparian cover along the lower portion of McCarthy Creek, in the northeast quadrant of the 1952 image, is very similar in both years. In both 1952 and 2004 riparian vegetation and other shrub or tree cover is very sparse along gullies feeding into Thomes Creek.

Site 6

This assessment area along a small canyon surrounding Elder Creek is compared from 1947 and 2004 photographs. In 1947 the land north of Elder Creek is grassland/rangeland and most of the area to the south is dryland agriculture. There are scattered oaks and gray pine from Elder Creek north, on steep hills that climb away from the stream.

Along the northern bank of Elder Creek there are a number of significant erosion features, similar to what was seen in Sites 1-3. Sharp cut banks exist in the 1947 photograph, along with dendritic gully erosion patterns (as shown on Figure 9a). Riparian growth is very scant along Elder Creek and not present in side gullies.

In 2004 the erosion features appear less noticeable than in 1947, with the possible exception of the gully shown by the furthest east arrow on Figure 9a. Riparian growth - all of which exists directly along Elder Creek - appears mostly unchanged between 1947 and 2004.. Finally, agricultural efforts appear to have been curtailed south of Elder Creek between 1947 and 2004, with only grasslands/rangelands south of Elder Creek during more recent years.

SUMMARY

Aerial photographs from 1938 to 2004 were used to develop a chrono-sequence of stream changes to Reeds, Red Bank, Elder, and Thomes Creeks. Land use, infrastructure, stream characteristics, and riparian growth were compared for the period covered by the photographic record.

The earliest photographs available showed that each of the four streams had either segments or their entire assessed length that were highly braided and aggraded, with only scant to moderate amounts of riparian cover along their banks. This suggests that wide and braided conditions may represent "natural" condition for these streams. If so, riparian growth would tend to be sparse, as it would frequently be either disturbed or abandoned by stream flow.

Reeds Creek and its tributary Brickyard Creek, along with Red Bank Creek, show evidence of a recent flood event prior to 1938, with heavy stream bank cutting and possibly riparian cover reduction.

As time progressed in the photographic review, significant changes occurred for all four streams. There were improvements of existing or installations of new stream crossings. Each of these crossings resulted in constraining the stream's ability to widen or change channel and each crossing also was accompanied by levees or other structures that protected the crossing from channel deviation and damage. Other changes noted included increased rural and urban development, increased use of irrigation, and changes in land use from agriculture to commercial or residential or from dry land to irrigated uses.

During the period covered by the photographic record the streams have responded in a wide variety of manners to management activities and adjacent land uses. Reeds Creek, a relatively short stream, had significant evidence of severe flooding prior to 1938 and since that time stream and riparian conditions (including the tributary Brickyard Creek) appear to be stabilizing and improving. Changes in water relations at its mouth, including both control of flow of the Sacramento River since the mid-1940s and construction of the Red Bluff Diversion Dam in the mid-1960s, has resulted in considerably different conditions in the stream's lowest reach. Today it serves as primarily a bay for Lake Red Bluff.

Red Bank Creek also showed indications of severe flooding prior to 1938. Very little change has occurred since that time to the lower reach unaffected by the Red Bluff Diversion Dam. The stream has continued to be highly braided and with very little riparian growth. Below Highway 99 the stream becomes a summer-time arm of Lake Red Bluff.

In contrast to the other three streams, Elder Creek is highly braided east of Interstate 5; however, it narrows considerably closer to the river. The narrowness through most of the assessed portion of this stream is likely due to early-day levees, which allowed agricultural development to the structures. In more recent times the levees have been improved upon, allowing additional land to be placed into agriculture and a reduction in near-stream hardwood cover. The extent of levee construction on Elder Creek and the extent of channel narrowing that has occurred are much greater than that of the other three streams assessed.

Thomes Creek is the largest assessed stream and well-known for its prodigious sediment discharge potential. The stream channel with flood plains was as wide as 3,000 feet in several

segments. Very little riparian growth existed in the active stream channel in the earliest photographs but in some areas it appears to be increasing significantly. A large portion of that growth may be introduced weed species.

Recent highway and canal crossings have constricted the Thomes Creek stream channel to less than one-half of its previous width in several locations and agricultural development has encroached upon the pre-1952 stream channel boundaries; however, not to the same extent as with Elder Creek. Outer stream cut bank erosional features are often lined with larger riparian trees but these features are now isolated and separated from the existing stream channel and appear incongruous.

Levee construction in Elder and Thomes Creeks has resulted in the stream channels acting as ditches. Stream gradient, width, and flow rates are homogeneous and riparian growth development is not favorable.

It is possible that the mouth of Thomes Creek, a large depositional delta, may be changing at its entry point into the Sacramento River. The author suggests that continued assessments of the lower mile of Thomes Creek may present an opportunity to evaluate management and bed load changes upstream. Any significant change to sediment discharge rates may alter the existing conditions at the stream's mouth. An increase in sediment discharge may increase the delta size and push the Sacramento River further to the east, while a decrease in sediment discharge may allow the river to cut away at the delta. Any change at the delta mouth of Thomes Creek is also likely to impact segments of the Sacramento River both above and below the delta. Many confounding issues likely exist with regards to sediment discharge and river dynamics and attempts at making cause-and-effect linkages need to be made with care.

Six upland sites were also considered to compare land changes between the time of the earliest available aerial photograph and the 2004 photographic images. These sites extend from immediately west of Red Bluff to a mile southwest of Paskenta.

Land use changes tended to be very subtle in the past 50+ years, with the exception of the Brewery Creek site, west of Red Bluff. Roads and subdivisions have been placed through parts of that site. Several small ponds have been constructed in several assessment areas, possibly for livestock or to provide small-scale irrigation. In some cases, such as along Elder Creek west of the Paskenta Road, it appears that dry land agriculture had been abandoned.

Gullying and stream downcutting was very pronounced in earliest photographs of the three upland assessment areas furthest to the north (Sites 1-3). Gullying was also noted in the remaining Sites 4-6 but to a lesser extent. Between the time of the earliest photographs (1938-1952) and 2004 all sites appeared to have muting of the severity and sharpness of the erosion features—suggesting that a degree of healing has occurred during the 52-66 year period. This also suggests that a significant erosion event occurred shortly prior to 1938, which may have been more severe than any floods since that time.

Riparian vegetation is very scant in all upland sites, with the exception of the immediate periphery of perennial streams. In most cases riparian growth was similar in the older and 2004 images, with two exceptions. Along Thomes Creek, just west of Flournoy (Site 5) the stream has cut away significant amounts of mature riparian growth. Also, adjacent to Oat Creek, at Site 3, there appears to be a decrease in riparian cover during the assessment period. Upland vegetation has changed slightly in at least one assessment area, Site 3. Blue oaks have been thinned through portions of that assessment area.

Section 2

Section 2
GENERAL HISTORY

TABLES

FIGURES

Section 2

GENERAL HISTORY

The Tehama West Watershed has been influenced and changed by both man and nature. The arrival of Europeans in the middle of the nineteenth century has most recently influenced and changed the watershed. In the last 150 years Europeans have molded the watershed environment to fit their needs. The most significant impacts are related to the exclusion of fire, introduction of non-native grasses and brush species, as well as development and urbanization. Prior to the arrival of Europeans, native peoples also managed the landscape to meet their specific needs.

SOURCES OF DATA

The following data sources were used to develop the information presented in this section:

- National Agricultural Statistics Service
- Tehama County Museum
- Tehama County Agricultural Crop Reports
- United States Department of Agriculture Soil Survey of Tehama County
- California Department of Conservation Division of Land Resource Protection
- Tehama County Parcel Data

The National Agricultural Statistics Service (NASS) is responsible for collecting and analyzing agricultural statistical data. The first crop reports were released in July 1863. Subsequent crop reports have been released to provide farmers with detailed market information on a variety of commodities. Agricultural statistical data was available for Tehama County from 1880 to the present. Initially, reports were released in 10-year intervals and have been released in 5-year intervals since 1910. Tehama County Agricultural Crop Reports were analyzed for each of the years between 1950 and 2003. Crop Reports contain reports of acreage, as well as production and value of the agricultural crops produced in Tehama County. The information in these reports is derived directly from growers, processors, and government agencies. Primary soils data for Tehama County was extracted from the United States Department of Agriculture's Soil Survey of Tehama County from 1967. The California Department of Conservation's Division of Land Resource Protection was also an essential source of information regarding historic Williamson Act acreage and farmland protection and conservation. Data was compiled from the California Department of Conservation from 1992 to 2002 to monitor agricultural lands in Tehama County. An in-depth look at the 1998 to 2000 Tehama County Field Report and the 2000 to 2002 Tehama County Field Report were analyzed for this report. Data from the 2002 to 2004 report is not yet available and is not included in this report. Historical books and other documents were used to interpret historical agricultural conditions. Interviews with various farmers and ranchers in the county were also used to provide a source of local information.

NATIVE PEOPLE

The Nomlaki people, a division of the Wintu, were the first inhabitants of the watershed. Their territory extended from the crest of the Coast Range to the west, beyond the Sacramento River to the east, about Cottonwood Creek to the north, and into Glenn County to the south (Goldschmidt, 1951). There were two distinct Nomlaki divisions, the River Nomlaki and the Hill Nomlaki. The River Nomlaki occupied the area adjacent to the Sacramento River. The Hill Nomlaki occupied the areas to the west in the foothills. Much of the recorded information regarding the Nomlaki is sourced from the Hill Nomlaki (Goldschmidt, 1951).

The Nomlaki subsisted upon the natural landscape. Acorns, grass seeds, and tubers were primary vegetative products. Deer, elk, rabbit, misc. small game, birds and fish were primary staples. Fish were taken by hand, net, trap or by harpoons. Salmon were harpooned within shallow pools from the Sacramento River. At least eight varieties of acorns were consumed. Clover was an important food because it was the first fresh green food in the spring (Goldschmidt, 1951).

Only the men of the tribe did hunting. Although all men hunted, certain men specialized in hunting. The Nomlaki used bow and arrows, knotted mahogany clubs, nets, snares, slings, and traps. Slings were used to kill birds. Nets were used to trap deer, rabbits and quail. Deer and elk were run down in relays. Only the hunting specialists hunted bears, as the work was difficult and dangerous.

The Nomlaki selectively altered the natural landscape in settlement areas. It is believed that they recognized "fire weather," the optimal conditions in which a ground fire could be lit and controlled by natural weather conditions and physiology. Burning specific plant species may have been practiced to improve and/or maintain plant diversity, or to promote the capture of insects or game animals. It is believed that fire was utilized by the Nomlaki in the forested area of the watershed on a small scale. Burning and other plant culture practices were passed from generation to generation, and required a sensitivity and knowledge of the landscape that today exists only with a handful of elders.

The Nomlaki were divided into numerous local groups, and not a unified tribe. Each group had a varied population, ranging from 25 to over 200 residents. Each local group had a central village and associated surrounding land. Each village had from five to fifty family houses. A typical Nomlaki village would contain a chief's house, multiple family dwellings, a dance house, and a menstrual hut. The villages would commonly be adjacent to springs or creeks. These groups commonly had a second area of land in the higher elevations that they would move to during the summer (Goldschmidt, 1951).

The Nomlaki were hunter-gatherers that lived off the abundant resources. Trade within the Nomlaki was widespread and integral to their survival. The River Nomlaki traded fish to the Hill Nomlaki in exchange for seeds and animals. Trading outside of the tribe was primarily with the Yuki for salt. The pelt of the black bear was probably the most valuable economic item within the Nomlaki. Other hides, such as the otter and foxes, were valuable as quivers to store arrows. Feathers were also very important within the Nomlaki.

At first contact with early settlers, the Nomlaki most likely had a population of approximately 2,000 individuals (Goldschmidt, 1951). During the first decade of contact, their numbers were greatly reduced. During the 1830s, an epidemic decimated the population of the Nomlaki. A tribal fortuneteller tells of the coming settlers, "There are some people from across the ocean who are going to come to this country…They have some kind of boat with which they can cross, and they will make it. They are on the way…they have five fingers and toes; they are built like we are, only they are light" (Goldschmidt, 1951).

In September 1854, the Nome Lackee Indian Military Post was established near Paskenta. The reservation encompassed 23,000 acres. The post contained 600 fruit trees and had 1,000 acres of grain under production (Goldschmidt, 1951). There were five wells on the land and many domestic animals. The Nome Lackee Military Post existed for 7 years (Dutschke, 2004).

Life at Nome Lackee was difficult in the early days. An observation made in October 1854 showed 200 Indians lived on the post with little food or clothing (Goldschmidt, 1951). Conditions changed, and by August 1855, it was reported that about 1,000 well-fed and clothed Indians resided at Nome Lackee. By April 1856 records show between 1,500 and 2,000 Indians in residency. In September 1857 it was reported that between 2,500 and 3,000 Indians resided at the reservation. The Secretary of Interior called for the abandonment of Nome Lackee in 1859. Under the Appropriation Act of 1863, reservation lands were sold by the US government.

EUROPEAN EXPLORATION

The first European to enter the area was probably Hudson Bay trapper Louis Pickett. Pickett headed south in 1820 from the Hudson's Bay company headquarters at Fort Vancouver on the Columbia River in Oregon. It is possible that Pickett ventured as far south as Tehama County. In 1821 a Spanish expedition entered Tehama County. The explorers used the Sacramento River as a guide and followed the path of the meandering river past Red Bluff.

The first known American to enter Tehama County was explorer Jedediah Smith. Smith passed through present-day Tehama County in April of 1828. Smith and his exploration party of 18 men and 300 horses and mules stopped along the Sacramento River near Red Bluff to construct a skin canoe to cross the river. Smith chronicled his adventures as he passed through California seeking a route to Oregon.

The Hudson Bay Company was responsible for sending fur trappers to Northern California throughout the early 1800s. The company had a headquarters at Fort Vancouver, located on the banks of the Columbia River in Oregon. The trappers were responsible for some of the earliest trails, maps, and charts of the area. Beaver was the most prized species for the fur trade. Both beaver and otter were heavily trapped in the region. The unrestricted trapping eventually led to the drastic reductions in beaver and other populations in the local streams. This led to the decline of the fur trade in the region. In 1845 the Hudson Bay Company withdrew their trappers from the region.

In 1833 Hudson Bay Company trapper John Work and his expedition accidentally infected Native Americans with either malaria, influenza, smallpox, or cholera. This initial contact is believed to have spread throughout the entire Native American population in the northern Sacramento Valley. This led to a severe depopulation of the Native Americans in this region (Goldschmidt, 1951).

In 1844 General John Bidwell, William Chard, A.G. Toomes, R.H. Thomes, J.F. Dye, and Pierson B. Reading traveled to the area. These men made notes that the area was occupied only by Indians, large herds of elk and antelope, and an occasional grizzly bear. Wild oats were growing on the soils and grew as high as the skirt of a saddle. These men decided this was the "Promised Land" and immediately put petitions in for a rancho location. These petitions were eventually granted, and became the first Mexican Land Grants established in Tehama County.

Mexican Land Grants

Mexican land grants were the first attempts at permanent settlement in Tehama County. Tehama County had 131,379 acres awarded in seven land grants. The land grants averaged 20,000 acres each. In the Tehama West Watershed, a few large land grants helped pave the way for establishment of Tehama County.

Rancho de Los Saucos (Ranch of the Elder Trees) was granted to Robert Hasty Thomes in 1844. This grant was approximately 6,800 acres and was situated between Thomes Creek on the south and Elder Creek on the north. Rancho de las Flores (Ranch of the Flowers) was granted to William Chard in 1844. This was the smallest of the land grants and included land between Elder Creek and Oat Creek. It contained approximately 13,300 acres and included the present towns of Gerber and Proberta. Rancho Barranca Colorada (Ranch of the Red Banks) was granted to Josiah Belden in 1844. This land grant included land immediately north of Las Flores. This rancho was bounded on the north by Red Bank Creek. This property later became the property of William B. Ide. An area was settled by William C. Moon, Ezekiel Merritt, and Henry L. Ford. These men never received grants for the land nor did they buy it. This land was situated south of Thomes Creek and to the west of the Sacramento River. This land contains the present town of Corning (Tehama County Museum 2005).

Gold Rush Era

In 1848 California was forever changed with the discovery of gold by John Marshall at Coloma. Later that year, Pierson Reading discovered gold at Reading's Bar in Shasta County. Soon, Euro-Americans swarmed to California from all other states. Although gold was not heavily mined in the Tehama West Watershed, the gold rush era played a significant role in the development of early Tehama County.

Originally, Tehama County was a portion of Shasta County (see Figure 2-1). As the southern communities of Shasta County grew, county residents felt the county seat, Shasta City, was too far away. In 1852 the first steps to form a new county were taken, but to no avail. In December of 1855, another attempt to create a new county was made. On February 23, 1856, E.J. Lewis introduced a bill to the state legislature to create Tehama County. On April 9, 1856, Tehama County was created from the neighboring counties of Shasta, Butte, and Colusi (the original name of Colusa County). Initially, the town of Tehama was to be the county seat. On May 17, 1856, the first Board of Supervisors meeting was held at the county seat in Tehama. Many citizens felt the flood-prone location of Tehama was a poor choice and the county seat was eventually moved to Red Bluff.

HISTORY OF TRANSPORTATION

In 1849 the first-known steamboat, the "Washington," owned by Peter Lassen, brought supplies up the Sacramento River. Mr. Lassen had a land grant at Deer Creek, and arrived at his rancho on the mouth of Deer Creek. The steamboat soon sank after the trip. In 1850 the second steamboat to enter the area was the "Jack Hayes." This steamer arrived at the town of Tehama, which, at the time, was the farthest upstream a steamboat had ever been on the Sacramento River. For more than a year Tehama was the head of river navigation for the Sacramento River.

The town of Red Bluff was soon established as the primary location for navigation on the Sacramento River. Steamboats traveling up the Sacramento River brought essential supplies for the mining camps in the northern portion of the region. In 1852 Red Bluff was receiving many smaller steamers, better equipped to traverse the Sacramento River.

By 1853 Red Bluff had become a bustling community. Warehouses sprouted up along the banks of the river to handle the incoming supply cargoes and the outgoing cargoes of wool, wheat and other farm goods. The supplies were unloaded in Red Bluff and transported by ground to the various mining camps in the area. Although Red Bluff was a critical location for navigation on the river, the variable Sacramento River made river travel unreliable. Due to sand bars, shallow summer depths and snags, the river passage to Red Bluff was only accessible eight months out of the year. By 1854 the California Steam Navigation Company was in control of river traffic on the Sacramento River.

The arrival of the railroad in Tehama County was critical during the early stages of development of the area. Reliable transportation was critical in the development of the county's infrastructure. In December 1872 the Central Pacific Railroad was completed to Red Bluff. Soon, large warehouses were built along the tracks in Red Bluff to store the agricultural commodities of wool, sheep and cattle, which were being shipped out of the area. This reliable distribution center for agricultural commodities helped shape the area as an agricultural crossroads.

The railroad was granted land by the federal government as a way to defray costs. In addition to the right-of-way, the railroad was granted alternate sections of non-mineral land for each mile of rail constructed. The railroad had the responsibility of selling this land to help defray the construction costs. In 1879 the railroad had received title to the land and immediately established a campaign to liquidate the properties. This land was selling from between 5 and 25 dollars an acre in the 1880s, with the creek land being the most expensive.

SETTLEMENT HISTORY

The settlement of Tehama County was largely based on small communities. Each community played an integral role in the development of the county, especially those of Corning and Red Bluff.

Corning

Corning has probably the most unique history of any town in the Tehama West Watershed. In the 1840s, William Moon and his partners, Henry L. Ford and Ezekial Merritt, settled on land approximately one mile south from the present day Woodson Bridge. A house was constructed that served the purposes of an inn, tavern, and stage station along the California-Oregon Trail. A ferry was also installed to carry travelers across the Sacramento River during the early 1850s.

In the mid 1850s, a cousin of Henry Ford, Nathaniel Merrill, purchased 640 acres south of Moon's place. Merrill was allowed to buy the land due to the Preemption Act of 1853, which enabled squatters to buy public land at $1.25 an acre. The first reported commercial wheat crop in Tehama County was produced on this land. George Hoag, a native of Scotland, also played a role in the early settlement of Corning. Hoag was the first settler in Tehama County to raise both sheep and grain, and had a ranch that encompassed 4,560 acres. The railroad drew settlers, many of who were squatters, and by 1872 most of the land surrounding present-day Corning had been settled. These scattered dwellings became known as Scatterville.

In 1872 Charles Rice settled on 160 acres west of present-day Corning and built a general store. He is responsible for changing the name from Scatterville to Farmington. Soon, his general store and hotel attracted 14 other businesses. Many farmers were attracted to the area by the very successful farming of rye, barley and wheat. In 1876 Rice applied for a post office. The application was denied because an existing post office was already established at another Farmington. The Post Office suggested a name change, so Farmington became Riceville. On April 5, 1881, the post office was established.

In 1881 and 1882 the Central Pacific Railroad was expanding through the area. The railroad was situated one mile to the east of Riceville. The residents decided that the future of the town would be with the railroad, so it was decided to move the entire town. In September, 1882, the houses, stores, and workshops were pulled on huge logs to the new location.

Now, with the settlement of Riceville adjacent to the Central Pacific Railroad, the town flourished. The Pacific Improvement Company, a development firm and subsidiary of the Central Pacific Railroad, named the new settlement after John Corning, an executive of the Central Pacific Railroad. Soon, Corning was approximately 161 acres in size and was the shipping center for the area.

As the town of Corning was bustling, two entrepreneurial men, Charles Foster and Warren Woodson, had a dream that would forever change the destiny of Corning. In the early 1890s, 3,107 acres east of Corning were purchased for $77,675.00 ($25/acre) to be developed as the Maywood Colony. This land was subdivided into 10-acre plots. The lots were sold with the intent that a family could make a living off the land and afford the mortgage. The intent was for the family to sell fruit as a revenue source.

Extensive advertising in newspapers throughout the nation told the story of the Maywood Colonies, and fueled the development of the town of Corning. Gimmicks were created to entice potential parcel buyers. Ministers were given discounts on the purchase price of their own parcels for each new buyer they could find. They even had a rebate system of $45 cash to every person who bought a 10-acre parcel before Jananuary 7, 1893. The Maywood Colony was also promoted at the Chicago World's Fair in 1893. Over $500,000 was spent on advertising throughout the years to turn the Maywood Colony dream into reality.

Although there was a large investment in advertising, a large investment was also made in developing the infrastructure of the Maywood Colony. Extensive fruit trees were planted, with 900 trees as the average planting on a 10-acre site. Orchardist George H. Flournoy was hired to assist with planting and developing the orchards. Almonds, apples, black walnuts, cherries, figs, grapes, lemons, olives, oranges, peaches, pears, pecans, and plums were planted extensively. The olives produced the best out of any of the fruit trees. Men were hired to care for the orchards, and by 1893 a crew of 70 men was tending to the newly planted orchards.

In 1893 the Maywood Addition was established 160 acres east of the railroad. This was laid out with the intent to build a cooperative cannery and packing house, and to provide space for a central park, now designated as Woodson Park. In 1895 Maywood Colonies Nursery was established and many trees were planted around the town of Corning, including many of the palm trees that line the streets today. The palm trees were planted to demonstrate the unique climate of Corning.

In 1899 the Maywood Colonies Fruit Association was established to assist in the processing of fruit. Soon many of the orchards were in full production, and the capacity of the processing facilities soon were increased. In the winter months of 1899 and 1900, the Maywood Colonies Fruit Association was responsible for planting more than 2,000 acres of fruit trees in the Corning area.

Red Bluff

The town of Red Bluff was primarily shaped by the Gold Rush. Once gold was found in 1848, many prospectors headed to California. Once the southern gold fields were inundated with miners, many miners headed to the northern gold fields. The best mode of transportation was steamboats up the Sacramento. For a while, the town of Tehama was the head of navigation on the river. The seasonal flooding at Tehama was not conducive to the establishment of a large-scale community. Looking farther upstream, Red Bluff was chosen as an ideal location for a commercial center that would fit the needs of the northern Sacramento Valley.

The exact location for Red Bluff was chosen by two investors, Colonel Sachell Woods, a Presbyterian Minister, and Colonel Charles Wilson, a partner of Peter Lassen. The site was chosen because of a plateau high above the floodplain. The first survey of the area was completed in 1850.

William Myers was the earliest settler in the area and he established a homestead. This homestead was soon recognized as the Red Bluff House, which served as an inn for travelers through the Sacramento Valley. Additional settlements followed in the area.

The settlement at this time did not have an established name. The names that were associated with this settlement included Reedsburgh, Cavertsburgh, Bulltown, Red Cliff, and Frogtown. Red Bluffs was referred to as the general area of the settlement. By 1856, the town took the name of Red Bluffs and dropped the "s" at the end.

During this formative period for Red Bluff, a devastating fire in Shasta City, the Shasta County seat to the north, established Red Bluff as a permanent settlement. The fire in Shasta City burned nearly everything to the ground, and the settlers soon started re-building the town. Cargo necessary to the development of the town had to be sourced from Red Bluff. This dramatic boom in trade secured the future of Red Bluff.

Over the next few decades Red Bluff prospered. The census in 1870 indicated that the town's population had swelled to approximately 2,000 residents. During the 1870s, many events helped pave the way for additional development in Red Bluff. The most important event that occurred was the Central Pacific Railroad coming to town in 1871. In 1876 the Sierra Flume and Lumber Company established one of the most complex lumber operations in the world, building a new factory on the east bank of the Sacramento River across from Red Bluff. Also during the 1870s, a water service, gas lights, and a fire company were all established in Red Bluff. The Centennial Free Bridge was completed in 1876, allowing lumber to be transported by rail across the Sacramento River to the Central Pacific Railroad tracks.

FARMING

Number of Farms

The number of farms in Tehama County has fluctuated dramatically over the years. Early in Tehama County history Mexican Land Grants helped pave the way for settlement of the area. These large tracts of land were soon subdivided into smaller farms in the late 1800s and early 1900s (Phillips & Miller, 1915). In the late 1800s, the number of farms reported in Tehama County ranged between 600 and 800. By 1910 over 1,000 farms were in existence, and by 1945 there were 1,890 farms reported, the largest number in county history. Since the 1940s, the number of farms have steadily decreased until the early 1970s, where in 1974, 1,160 farms existed. The reduction in farm numbers most likely was the consolidation of existing farms, creating a larger average farm size. In 2002 Tehama County reported a total of 1,573 farms, down 6 percent from 1,679 farms reported in 1997.

Average farm sizes in Tehama County can be traced back to the late 1800s. In 1880 the average farm size was 820 acres. Since that time, average farm sizes fluctuated between 600 and 1,000 acres. During the 1930s and the 1970s average farm size increased. During the 1920s and between the 1940s and 1950s, the average farm size has decreased. Average farm sizes are depicted on Figure 2-2. More recently, average farm sizes in the county has decreased substantially. In 1974 the average farm size was reported at 1,083 acres. In 2002 the average farm size was reported at 548 acres, the lowest ever recorded for Tehama County. The average farm size in California is 346 acres (National Agricultural Statistics Service, 1987, 1992, 1997, 2002).

Total acreage in farms increased from the 1880s until the mid 1970s. During this time total acreage peaked at nearly 1.3 million acres. From 1970 to the late 1980s, total acreage exhibited a slight decline. Between 1987 and 1997, it was reported that total farm acreage dropped from 1,104,584 acres to 885,426 acres (NASS 2004). Total farm acreage is depicted on both Table 2-1 and Figure 2-3.

Table 2-1
AGRICULTURAL ACREAGE COMPARISON, 1950–2000

Year	Orchard	Cropland	Total Farm Acres
1950	10,673	281,710	1,131,660
1954	11,338	186,859	1,161,699
1959	15,203	N/A	1,254,707
1964	14,620	N/A	1,168,133
1969	21,948	147,752	1,101,562
1974	20,093	138,669	1,256,010
1978	26,985	156,827	1,165,043
1982	32,497	160,359	1,168,247
1987	32,908	131,869	1,104,584
1992	35,422	120,902	1,016,851
1997	36,956	127,019	885,426
2002	45,236	140,987	862,440

Source: National Agricultural Statistics Service

Cropland

Land used for crop production has fluctuated much over the years. Data indicates that at its peak in 1950, over 280,000 acres in Tehama County was designated as cropland (NASS, 2004). Many lands were farmed without irrigation, producing dryland grain hay and other crops. This trend has slowly decreased over the years, with a low in the 1990s around 120,000 acres. In 2002 total cropland was estimated at 140,000 acres. Cropland acreage trends are summarized on Table 2-1 and Figure 2-4. Major crop types over time are included in Figure 2-5.

Grain Production
Grain production in Tehama County has decreased significantly in recent years. Barley, oat, and wheat were widely produced and were very important economic crops. Many areas in the lower rolling foothills on the west side of the county were used historically for dryland grain farming (Smith, 1997). Other than a few remnant producers, dryland grain crops have been nearly eliminated from production in Tehama County. The low prices for grain and the increased costs of production are largely responsible for the decline in grain production. Grain production is depicted on Figure 2-6. Hay production is included on Figure 2-7.

Rice Production
Rice production has also seen a major decline in the past 2 decades. Plantings of rice date back to the early 1980s, when nearly 3,000 acres were produced (NASS 2004). In 2003 only 600 acres were reported (Tehama County 2003). Increases in the cost of water have nearly eliminated water-intensive crops such as rice from agricultural production in Tehama County. Rice production is depicted on Figure 2-8.

Orchard Production
Orchard production in Tehama County was initially reported by the NASS in 1930. During the 1930s to the mid 1960s, orchard production remained stagnant with an approximate 10,000 to 15,000 acres in production. By the late 1960s total orchard production jumped to over 20,000 acres. Since this time, total orchard production has experienced a steady increase to 45,236 acres reportedly in orchards in 2002 (NASS, 2004). Tehama County orchards are predominantly walnuts, prunes, almonds, or olives. Total orchard acreage trends are summarized on Table 2-1 and Figure 2-4. Specific orchard crop production trends are depicted on Figure 2-9.

The combination of the availability of irrigation water, advances in irrigation technologies, relatively good commodity prices for orchard crops, in addition to the availability of processing facilities have been mainly responsible for the drastic increase in the acreage planted in orchards. Many orchards have been established in western Tehama County on clay soils with drip irrigation. Earlier in Tehama County history, other factors that led to the increase in orchard plantings were the construction of Shasta Dam in 1945, which drastically minimized the flood risk of prime agricultural lands adjacent to the Sacramento River; the development of the Red Bluff Diversion Dam combined with the Tehama/Colusa Canal and the Corning Canal; and the reduction in copper mine pollution from lower Shasta County in the early 1900s (Kristofors, 1973).

Walnuts are the most widely planted crop in the county, with a steep increase in plantings occurring in the 1990s. Walnut acreage in the watershed is currently estimated at 14,057 acres (Tehama County 2003).

Almonds have seen a tremendous increase in plantings in the early 1980s and somewhat stagnant growth in the early 1990s. Since the early 1990s, almond acreage has increased gradually, with a reported 7,268 acres in production in 2003 (Tehama County, 2003).

Dried plums have been a steadily high-valued crop in the county for decades. Dried plums were produced on 8,848 acres in 2003 (Tehama County 2003). More recently, overproduction has led to the U.S. Department of Agriculture's (USDA) voluntary tree removal program in Tehama County.

Olives have remained the most stable orchard crop in Tehama County. In 1978 Bell-Carter Foods Inc. purchased the Maywood Olive Company, the only major olive processing facility in the county. The facility, located in Corning, was renovated and opened in 1980. Since that time, Bell-Carter Foods has been the primary olive processing facility in the county, selling olives under the Lindsay Olives brand name (Bell-Carter, 2004). Olives are currently produced on 5,560 acres in Tehama County (Tehama County, 2003). Olives are planted primarily around the Corning area.

Other crops, such as peaches, historically were a large orchard crop in Tehama County. In 1909 it was reported that 2,891 acres were planted to peach production (Grimes, 1983). In 1975 peaches were reportedly produced on 884 acres, and by 1985, the acreage dramatically dropped to 83 acres. The reduction in prices and marketing outlets are a few of the many reasons for the decline of the production of this crop.

Livestock Production

Tehama County serves as winter grazing ground for many northern California and southern Oregon cattlemen. Historically and to the present, cattle are wintered in the lower foothills of Tehama County and summered in the mountain meadows in Tehama County and other surrounding counties (Briggs, 1956). Some livestock producers keep cattle on irrigated pasture on the valley floor during the summer months. Most of the early settlers in Tehama County depended primarily on livestock for their livelihood. In the late 1800s, of the farms reporting inventories, sheep production was much more prolific than cattle or hog production. The large sheep herds of the past are gone, and now beef cattle production is the largest livestock industry in the county. Livestock populations are depicted on Figure 2-10.

General Cattle

Cattle inventories in Tehama County have drastically increased over the years. In the late 1800s cattle numbers ranged near 10,000 head (NASS 2004). Over the next century cattle numbers steadily increased to a peak in the 1970s with around 100,000 head. In 2002 total cattle inventories for Tehama County indicate approximately 68,000 cattle in the county. Two reasons for the drastic increase in cattle numbers was an increase in cattle commodity prices and the reduction of sheep populations in the county (Briggs, 1956).

Urban developments threaten the winter ranges in the foothills. Irrigated pastures serve as a location for cattle in the summer months, and have been slowly reduced over the years. The increasing cost of water and the high land values are challenges to a low-value crop such as irrigated pasture.

Hogs
Hog production was widespread in the late 1800s and the early 1900s, with the average hog population around 20,000 head residing in the county in any given year. Over the years this number has experienced a steady decline. In 2003 only 1,000 domestic hogs were reported in the county (Tehama County 2003). It should be noted that wild pigs have been introduced into certain portions of the county over the years. The lower foothills on the west contain wild pig populations.

Sheep
Sheep were historically the largest livestock commodity in Tehama County. The first reported estimate of sheep populations occurred in 1880, when 121,963 sheep were reported. Sheep production was much more common than cattle production during the early settlement of the county because they were primarily nomadic (Wentworth, 1948). Sheep production in Tehama County peaked in 1930, with nearly 350,000 head. This number has steadily declined since then, and in 2003 only 5,800 head reportedly resided in the county (Tehama County 2003). Reasons for sheep numbers declining include the dramatic increase of predators, reduction in mountain summer ranges available to grazing, low commodity prices, and the availability of labor for sheep-herders (Briggs, 1996).

Poultry
Chickens and turkeys historically were a large commodity in Tehama County. Over the years, these populations have drastically declined. Chickens especially have declined over the years. In 1939 nearly 135,000 chickens were reported in the county. Poultry populations have been declining for many years now. Population estimates are not calculated by the local Ag Commissioner's office due to the low number of poultry in the county.

Grazing

By the late 1800s, most of the agricultural land within what is today the Mendocino National Forest had been used for grazing, preempted, or homesteaded. Congressional authority in the 1850s and 1860s allowed legal land acquisition by Euro-American settlers. Passage of the Homestead Act in 1864 allowed settlers to gain legal title to lands squatted in the 1850s. The general pattern of Euro-American settlement within and around the forest was clearly established by the 1870s.

Range grazing and ranching were California's first major industry. The rangelands of California were rapidly stocked after the Gold Rush, with an increase from 300,000 animals (cattle and sheep) in 1850 to nearly 5 million in 1880. After 1850 and reaching a peak in 1910 to 1920, much grazing occurred in open conifer types and mountain meadows.

Moving sheep into the high country was in large part a response to drought in the 1860s affecting herds in the Central Valley. Following the Civil War, a high tariff was placed on wool to keep out foreign competition. Wool production became one of the country's major industries. Ranching communities began to take on a more gentrified appearance.

Grazing pressures increased due to rapid population growth and demand for meat in the San Francisco Bay Area. There was also a demand for beef in the lumber camps along the coast, and mutton was shipped as an inexpensive substitute for beef. Due to increasing demand and coyote predation, by 1900 many sheep ranchers had switched to cattle.

Grazing caused multiple, cumulative effects and native grasslands were greatly altered by livestock use. Records in diaries, early botanical collections, interviews, and vegetation studies suggest that the replacement of the largely perennial California prairie by annual grassland with few perennials occurred from 1850 to 1880. Sheep introduced from other areas spread non-native plant species, carrying seed on their wool and hooves, and in their manure. These hardy, non-native annual species became abundant, and native grassland vegetation was further reduced by later cultivation, road building, severe droughts, urbanization, and other causes.

Range burning was a major grazing-related impact which altered the ecology and productive capacity of the forest. Sheep herders allowed overgrazing of open grass areas, and as these areas became depleted, began to burn timber and thickets to open them up for browse production. Repeated burning caused permanent soil loss in open areas, and thinning and increased fuel loads in timber. Early officials, likely concerned about the viability of tree seedlings, noted that in the late nineteenth century "it was possible to count over 100 fires from one high point." Hunters, lumbermen, and others also set fires.

In 1907, Theodore Roosevelt created the Stony Creek Forest Reserve, renamed the California National Forest and finally the Mendocino National Forest in 1932. The Stony Creek Forest Reserve was created to "protect the headwaters of streams that will some day be developed for irrigation". At the time of its creation, overgrazing, damage due to stockman's fires, and moving management toward silviculture were the immediate concerns of early Forest Service officials. For over 75 years there was an integral relationship between grazing and wildland fires on the lands that became part of the forest. Early forest officials were torn between allowing grazing-related burning to continue to help in reducing fuel loading for fire protection, and concern over the other effects of fire. Early forest policy focused on the establishment of individual ranges or grazing allotments based on accessibility and the carrying capacity of the land. Between 1910 and 1920, forest officers surveyed and defined specific grazing allotments within the forest. Due to extensive resource damage, the Forest Service undertook gradual reductions in grazing levels, reducing sheep and goat grazing across the forest while increasing cattle grazing, then eventually removing sheep altogether.

Despite efforts to systematize grazing management, a 1924 inventory found that over 100,000 acres across the forest may have been impacted enough to injure forage and affect forage reproduction. Without protection, the A-horizon of the soil in many areas was eroded by winter rains, creating large barren areas devoid of vegetation that still exist today. The intense grazing of the nineteenth century had also degraded riparian and water resources in the forest, despite the numerous, small-scale, early water developments such as log troughs created to preserve local water sources. Despite these impacts, in 1925 grazing was still the largest source of revenue on the forest, exceeding other resource-related industries. Figure 2-11 shows vegetation change over time in the watershed from 1977 to 2002.

In the 1920s and 1930s, massive poisoning programs conducted by the U.S. Biological Survey to reduce livestock predators and rodents on federal lands decimated the targeted species, but also had major impacts on other furbearers, birds, and domestic animals. According to reports filed in the 1920s, U.S. Biological Survey crews had eliminated almost all the ground squirrels on the forest. In addition, the report noted that many "egg-eating animals" were also reduced or eliminated. Ranchers also used poison to eliminate species thought to be a threat to livestock. Coyote, mountain lion, bear, and other predators were affected.

Timber

It was not until the 1920s that the Pacific Southwest Region of the Forest Service began to exploit the timber resources of the Mendocino National Forest. Logging is tied to forest road access. Prior to 1920, timber within the forest was usually harvested by small operators. Mills were established just above the valley floor and moved farther into the forest in the late 1800s when wagon roads were built. In 1925 most of the forest's timber was still considered inaccessible. It was not until after World War II that virgin stands of timber at the higher elevations were harvested.

Timber production in the area of the forest during the nineteenth century was directed almost entirely to markets within the state, but following the development of transcontinental railroads and the opening of the Panama Canal, markets in other regions of the United States and even export markets became important to California mills.

Due to market collapse in the Depression (1930s), logging was not an important activity at that time. However, this period was the greatest episode of trail and road building on the forest. The Civilian Conservation Corp built many roads and trails between 1933 and 1941. Their activities had three important results: establishment of a basic road system within the forest, access to more timber stands, and employment of otherwise jobless workers from throughout the country. During and after World War II large trucks were available to haul timber made accessible by the new road system. Major congressional appropriations for road construction to support timber harvest occurred in the late 1950s and 1960s.

Forest timber outputs remained relatively constant in the early to mid 1980s, but have declined significantly during the 1990s. Although average annual timber sale volumes from the forest during 1978 through 1987 were 84 million board feet (MMBF), the volume sold in 1989 was 54 MMBF. By 1991, 27 MMBF of timber were sold. Current projections are that timber supply levels from the forest during the 1990s will be 65-75 percent below those of the 1980s. Timber prices have meanwhile trended upward.

Starting in the 1960s, as timber harvest became increasingly important on national forest lands, a series of public land management compliance measures came into effect, all of which have affected management of the Mendocino National Forest. The Multiple-Use/Sustained Yield Act of 1960 and the National Forest Management Act (NFMA) of 1976 established a process for managing National Forests including the development of forest plans. In 1969 the National Environmental Policy Act (NEPA) was passed, and in 1994 the Record of Decision for the Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old Growth Forest Related Species within the Range of the Northern Spotted Owl (NWROD) was signed. This decision established late-successional reserves and is incorporated into the Mendocino National Forest Land and Resource Management Plan (LRMP), signed in 1995.

The Wilderness Act was passed in 1964. In 1977 the Forest Service started a second Roadless Area Review and Evaluation (RARE II) to determine additional backcountry areas meeting the criteria for wilderness. In 1984 the California Wilderness Act was passed, designating some RARE II lands as wilderness. Those areas not designated were officially released to multiple-use management upon Forest Plan signature. However, management such as timber harvest within released RARE II lands remains controversial due to the continued roadless nature of many of the areas.

Timber has always played a large role in the economy of Tehama County. Timber harvesting zones in the county are located on the eastern and western mountain slopes. Timber harvesting over the years has faced an overall decline. Throughout the 1980s timber harvesting in Tehama County extracted an average of 140 million harvested board feet annually. In the 1990s the average timber harvested dropped to below 100 million harvested board feet annually. In the 2000s timber harvesting continues to drop below historical numbers. In 2003 approximately 74 million board feet of timber were harvested. This indicates nearly a 50 percent decrease in production compared to timber harvesting levels from the 1980s. In 2003 the gross value for timber production in the county was estimated at $17 million. Timber production is shown on Figure 2-12.

HISTORY OF WATER DEVELOPMENT

Throughout the historical past, water was a deciding factor in settlement and land use in and around the forest. Alternating periods of drought and flooding caused California Indians to move their settlements, caused early settlers to move their livestock to the Coast Range to escape high water or diminishing forage, and destroyed valuable crops on the valley floor. Water was a major issue for early settlement and homesteading in and around the forest area of the watershed. Homesteads were frequently abandoned when wells went dry. Drought, rainfall, and flooding affected agricultural and industrial growth and development. Agriculture-related irrigations systems and water impoundments were introduced in the Sacramento Valley as early as the 1850s.

Irrigation has led to the intensification and development of agriculture in Tehama County. The first irrigated field was supposedly located in Rancho Bosque, a Spanish land grant. A gristmill operated by waterpower was supposedly the first water extraction device for irrigation purposes somewhere between 1847 and 1852 (Gowans, 1967). In 1855 an irrigation ditch was created off of Elder Creek, supplying water to a fork of Mill Creek, which provided water to a ranch near Paskenta (Bedford, 1991). Since that time, ditches were commonly constructed adjacent to streams to provide water for irrigation.

The livestock industry has played a significant role in the development of stock ponds and reservoirs. Between 1938 and 1954, 554 stock ponds and reservoirs were constructed in the county, with an estimated storage capacity of 3,349 acre-feet (Gowans, 1967). These stock ponds were primarily constructed in the lower foothills of western Tehama County, and many have the ability to hold water year-round. On the east side of the county, stock ponds were constructed by digging out small basins down to the bedrock. These smaller basins hold water for livestock during the winter and spring months, but soon dry out during the summer.

In 1935 the authorization of the Central Valley Project helped paved the way for the construction of Shasta Dam (United States Bureau of Reclamation, 2004). The construction of Shasta Dam in 1945 was significant to water availability in Tehama County. An extension of the Central Valley Project that directly benefited the Sacramento Valley included the Sacramento Canals Unit, which was designed to provide irrigation water for Tehama, Glenn, and Colusa Counties. The Sacramento Canals Unit was authorized on September 29, 1950. This unit included the construction of the Red Bluff Diversion Dam, Corning Pumping Plant, Tehama-Colusa Canal, and the Corning Canal. The Red Bluff Diversion Dam diverts water from the Sacramento River to the Corning and Tehama-Colusa Canals. This project was completed in August 1964. Central Valley projects are shown on Figure 2-13.

The Tehama-Colusa canal serves water to Tehama, Glenn, Colusa, and Yolo counties. The canal is 110.9 miles long with eight different canal reaches. Reaches six and seven were completed in 1979, and the last reach, reach eight, was complete in May 1980. The Tehama-Colusa Canal has a capacity of 2,530 cubic feet per second (cfs) (USBR, 2004).

The Corning Canal diverts water from the Tehama-Colusa Canal. This canal is 21 miles long and terminates 4 miles southwest of Corning. Construction of the canal started in November 1954 and was primarily completed in May 1957. The entire project was completed in July 1959. The Corning Pumping Plant diverts water at the Red Bluff Diversion Dam from the Sacramento River. The pumping plant was completed in November 1960. The Corning Canal has a capacity of 500 cfs (USBR, 2004).

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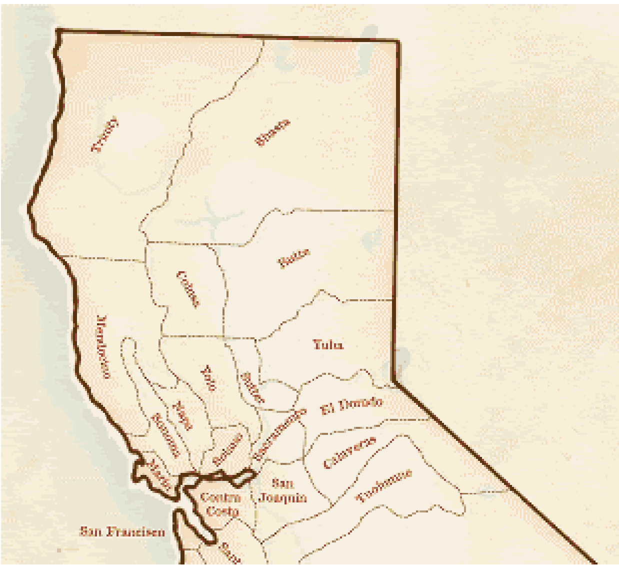
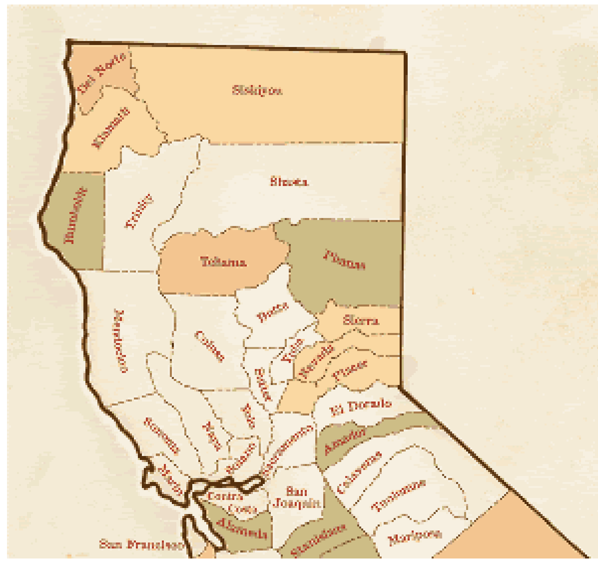


1850



1860

1870

FIGURE 2-1
EARLY COUNTY BOUNDARY CHANGES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA ASSOCIATION OF COUNTIES, 2003

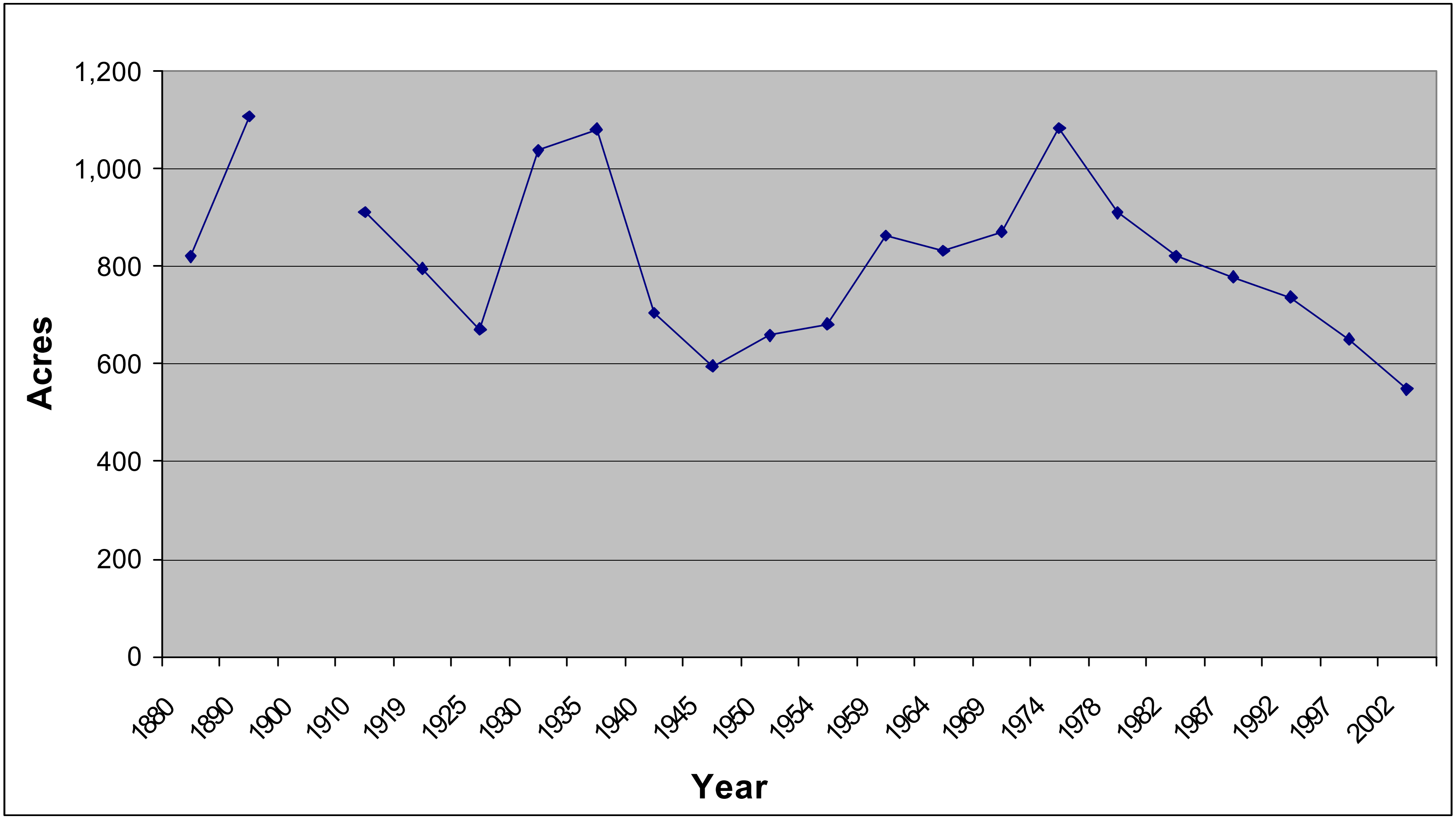


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FIGURE 2-2
AVERAGE FARM SIZE, 1880-2002
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: NATIONAL AGRICULTURAL STATISTICS SERVICE

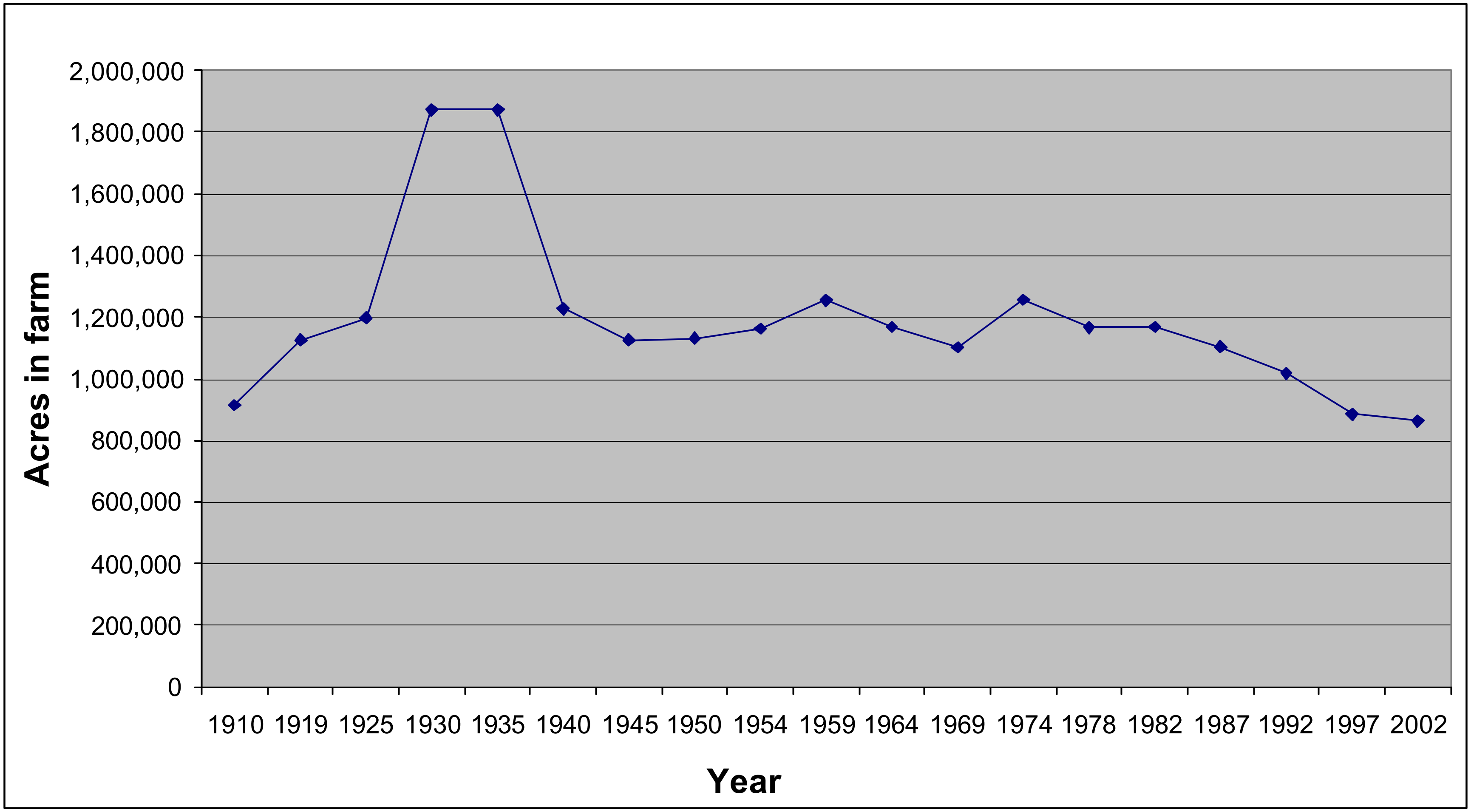

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FIGURE 2-3
TOTAL FARM ACREAGE, 1910-2002
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: NATIONAL AGRICULTURAL STATISTICS SERVICE

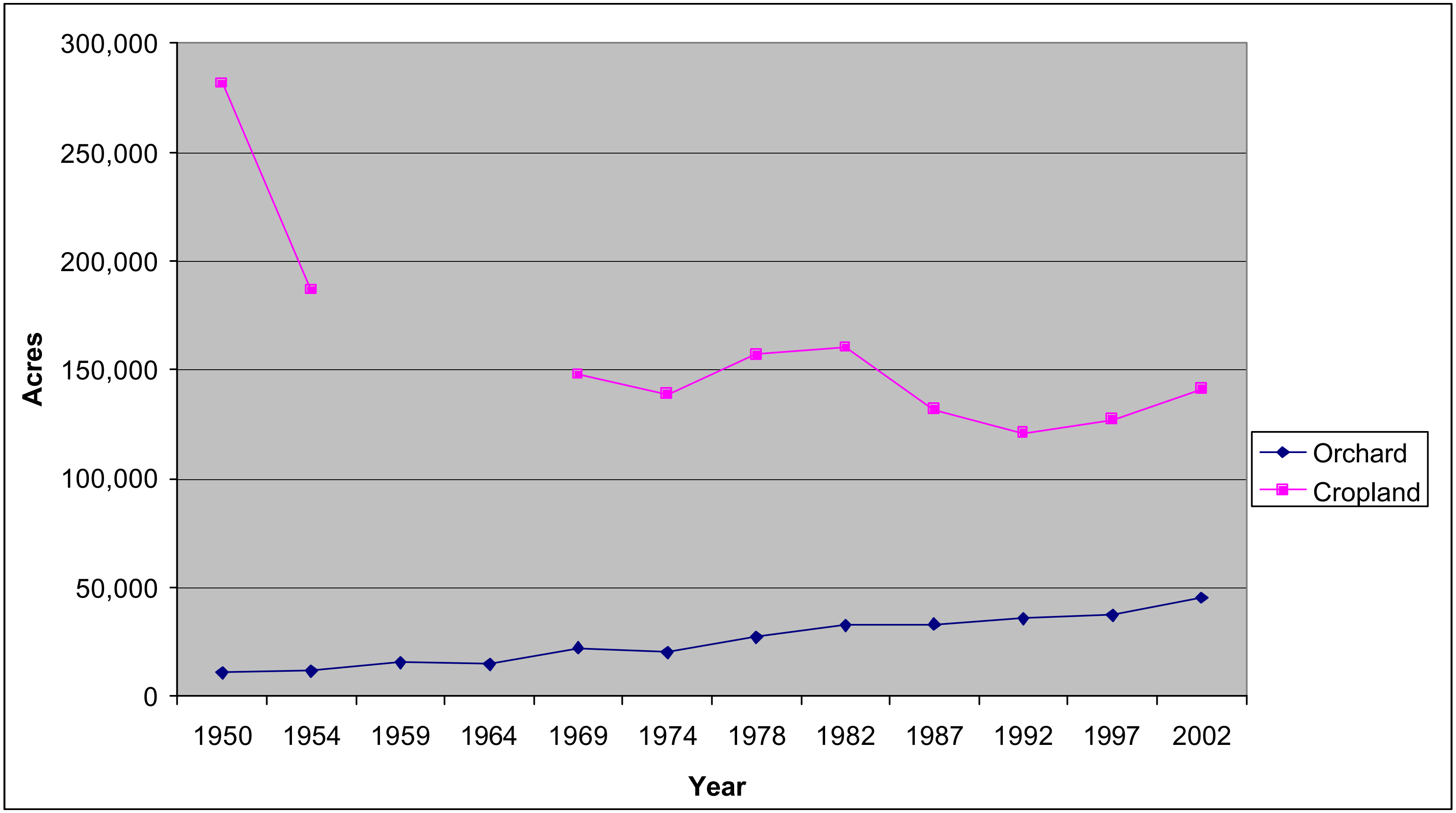

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FIGURE 2-4
ORCHARD AND CROPLAND ACREAGE TRENDS, 1950-2002
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: NATIONAL AGRICULTURAL STATISTICS SERVICE

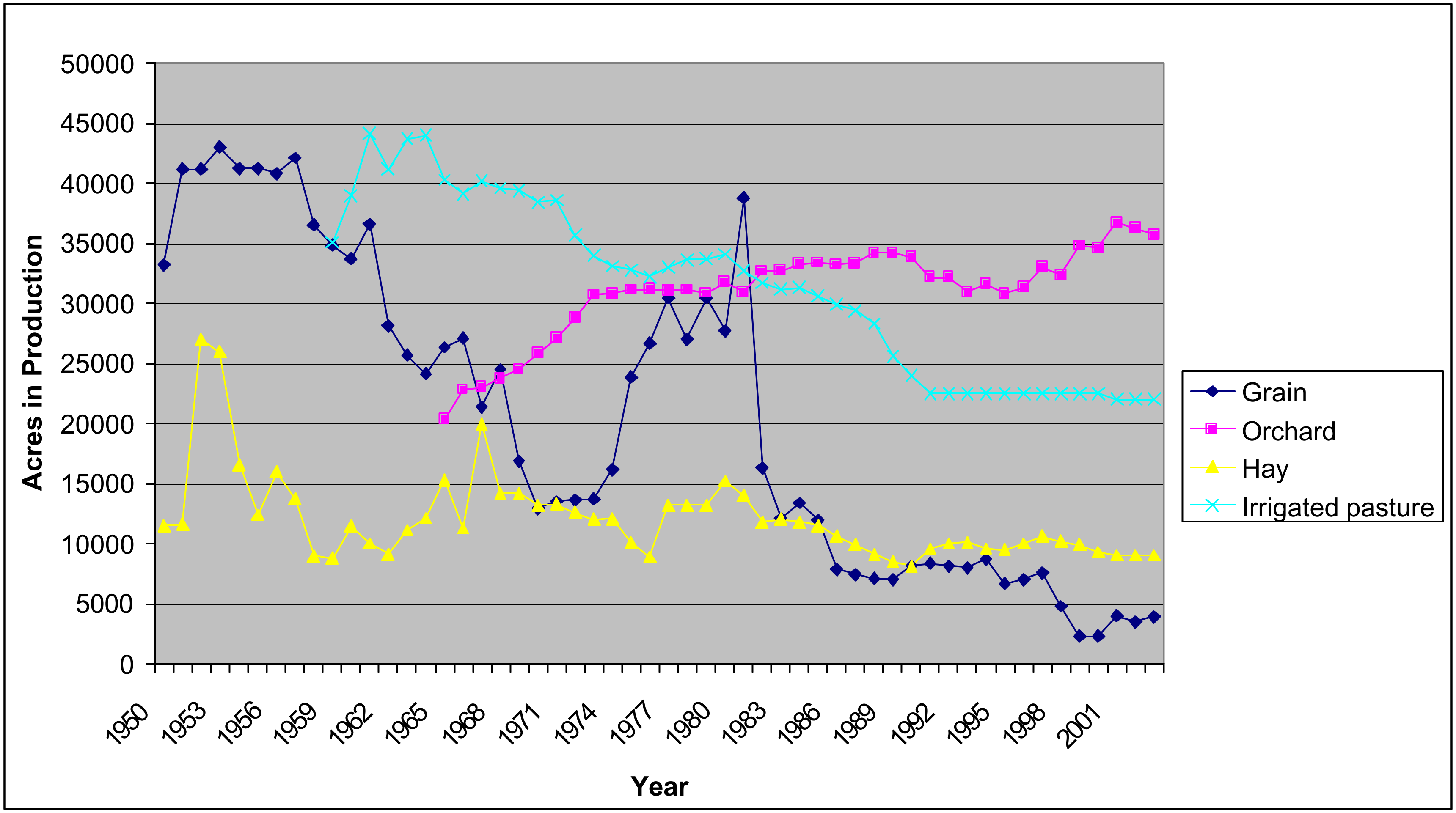

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FIGURE 2-5
MAJOR CROP TYPES, 1950-2003
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS

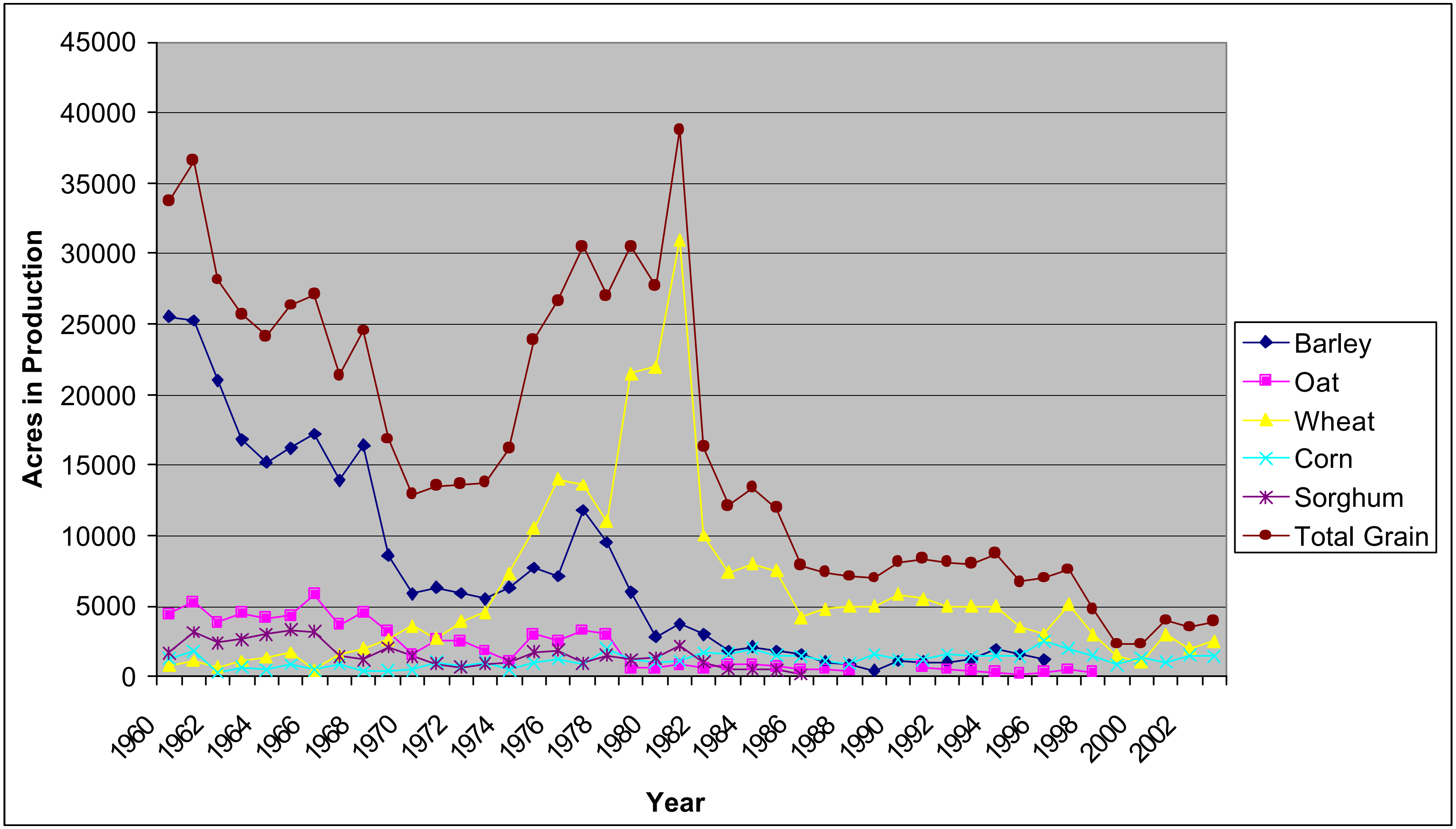

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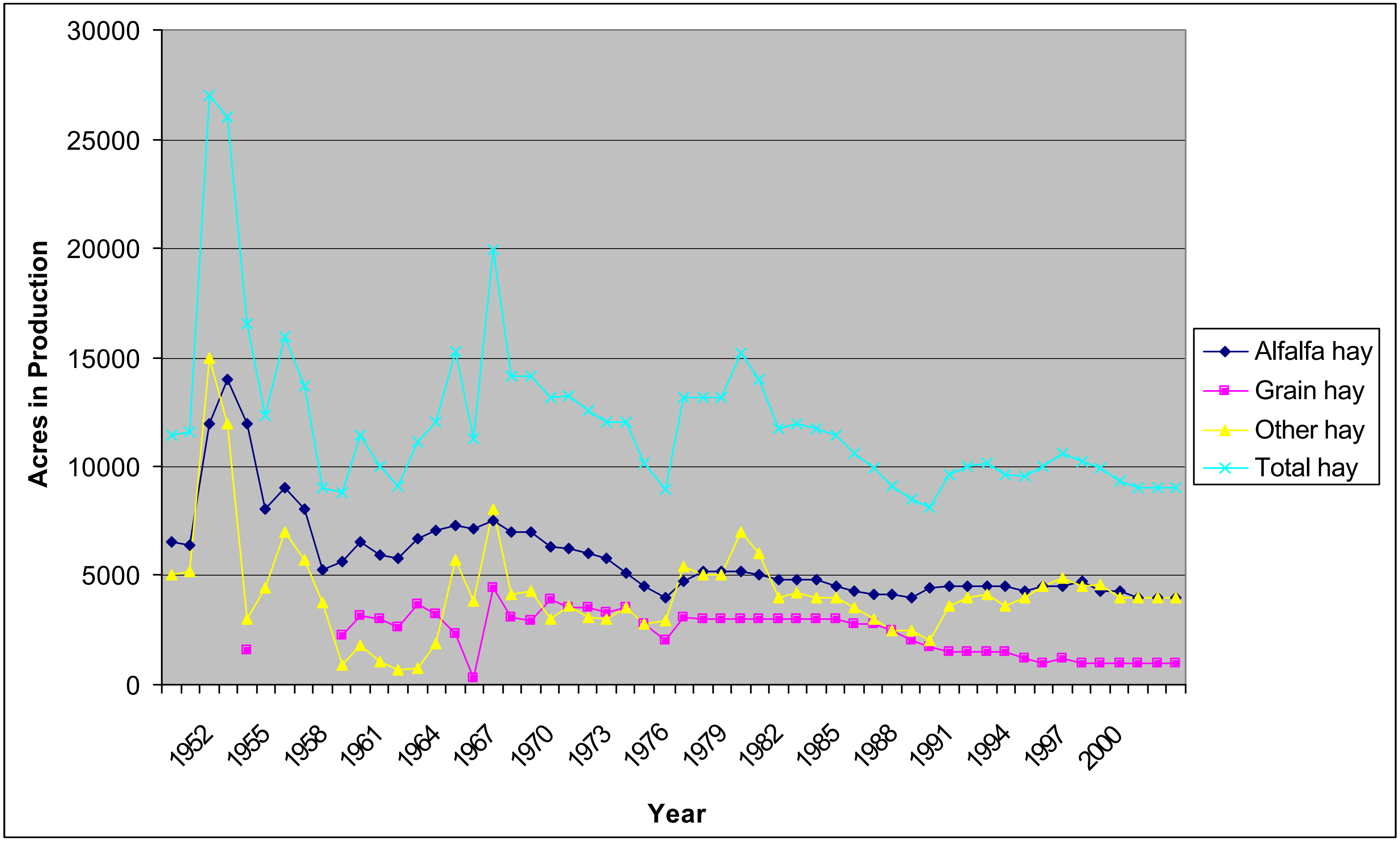
FIGURE 2-6
GRAIN PRODUCTION, 1960-2002
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS



VESTRA

FIGURE 2-7
HAY PRODUCTION, 1950-2003
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS

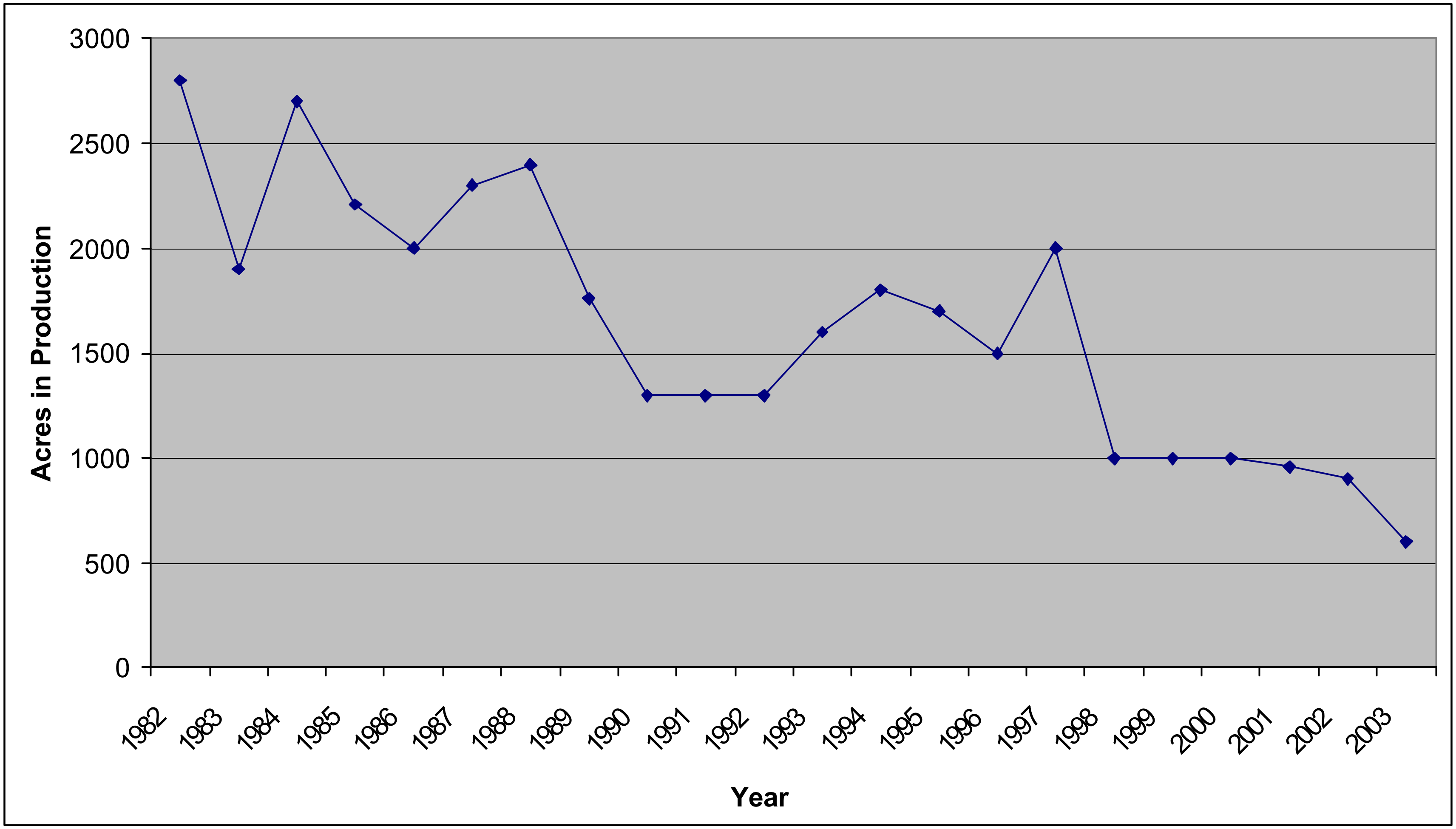


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FIGURE 2-8
RICE PRODUCTION, 1982-2003
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS

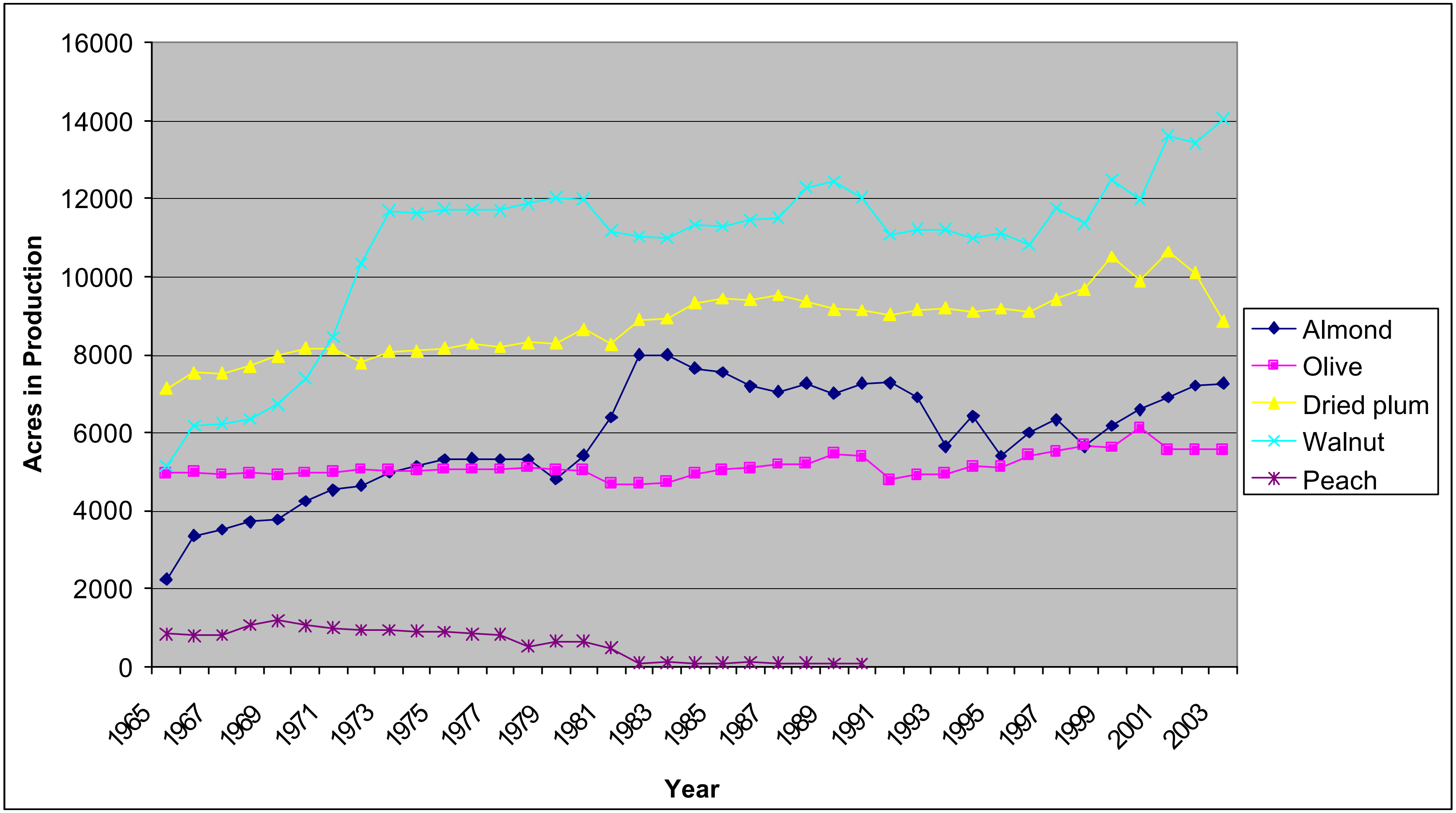

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FIGURE 2-9
ORCHARD PRODUCTION, 1965-2003
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS

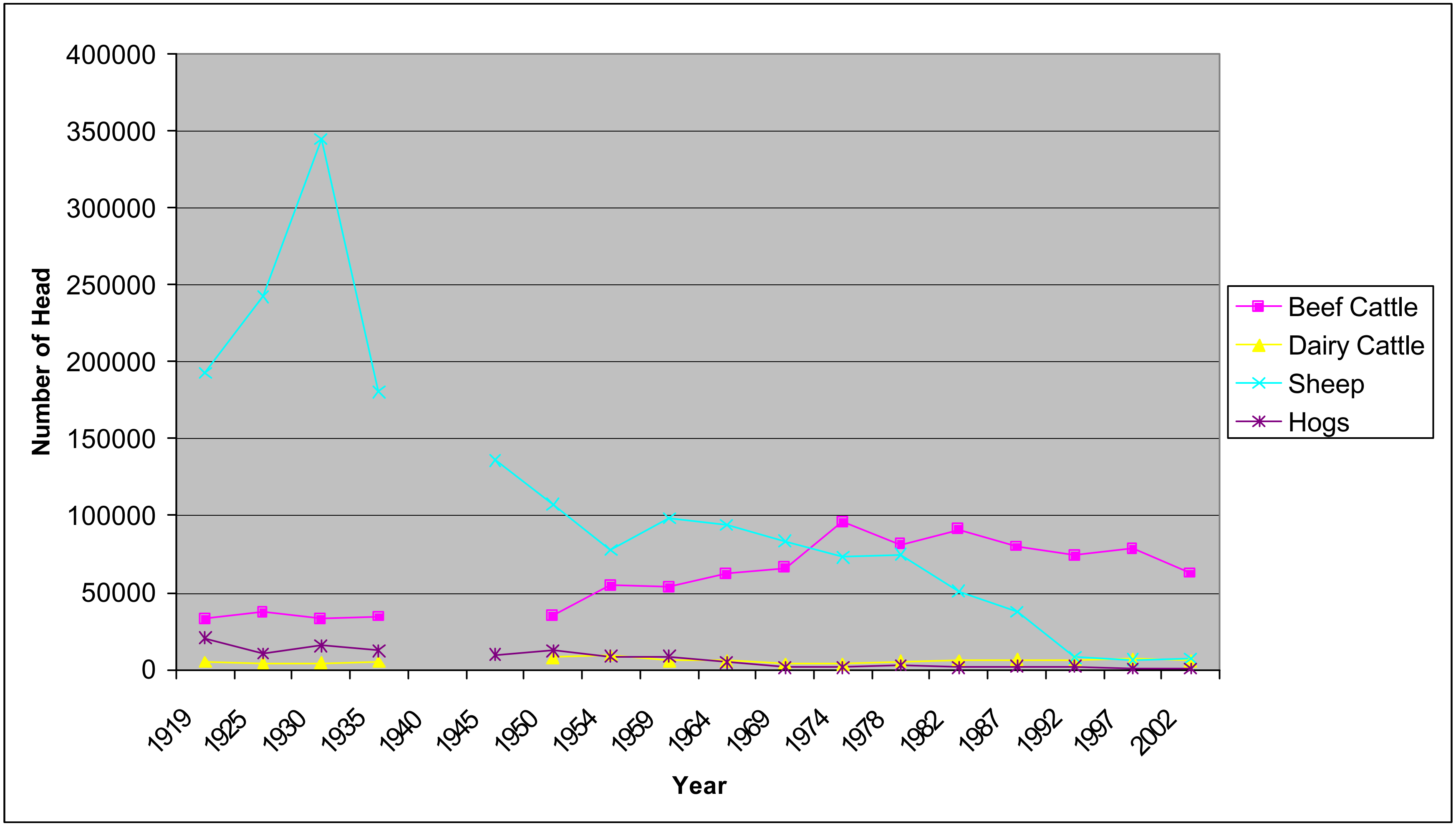

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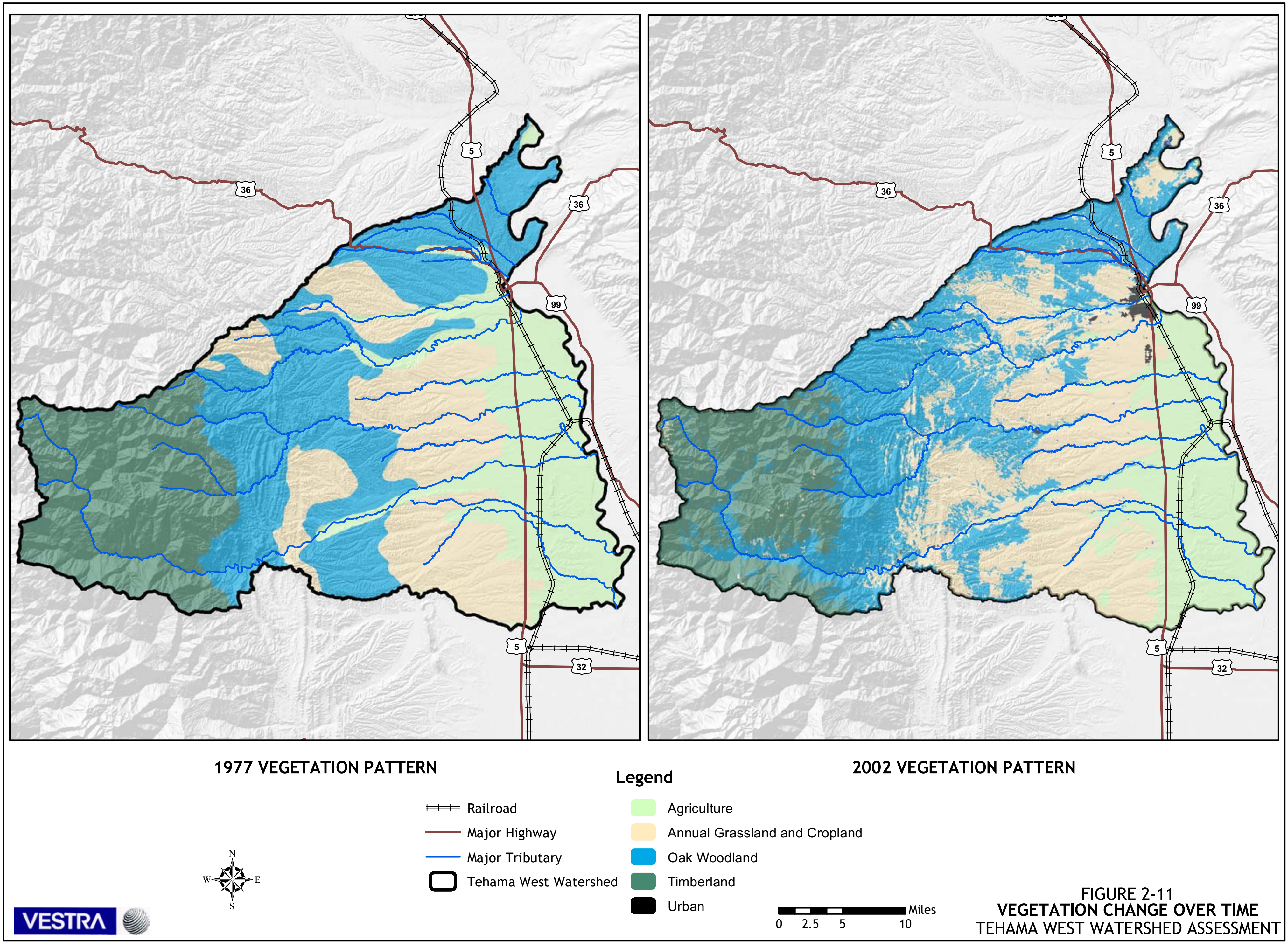
FIGURE 2-10
LIVESTOCK TRENDS, 1919-2002
TEHAMA WEST WATERSHED ASSESSMENT

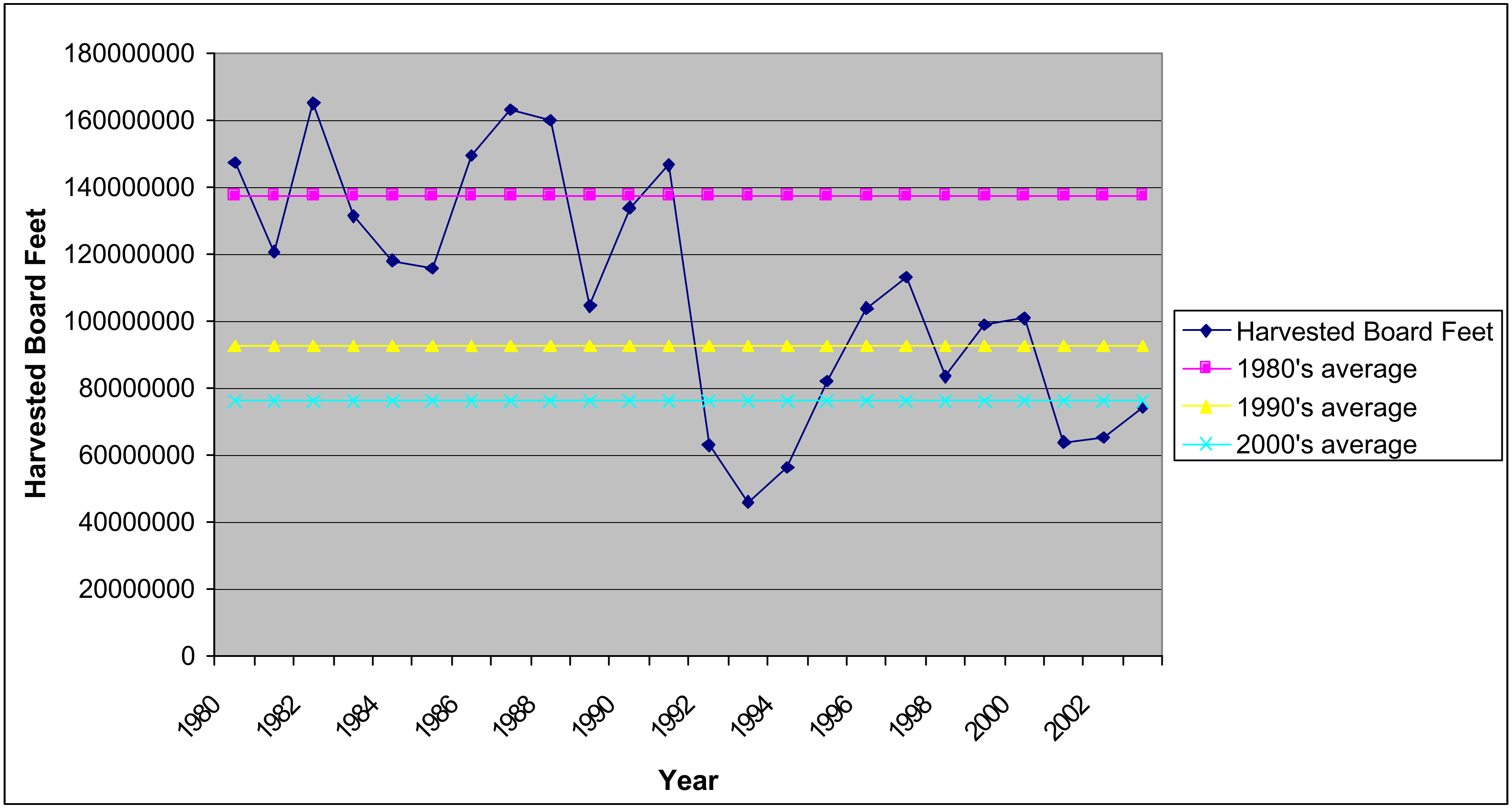
SOURCE: NATIONAL AGRICULTURAL STATISTICS SERVICE



VESTRA

FIGURE 2-11
VEGETATION CHANGE OVER TIME
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: UNITED STATES FOREST SERVICE, REMOTE SENSING LAB



VESTRA

FIGURE 2-12
TIMBER PRODUCTION, 1980-2003
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS

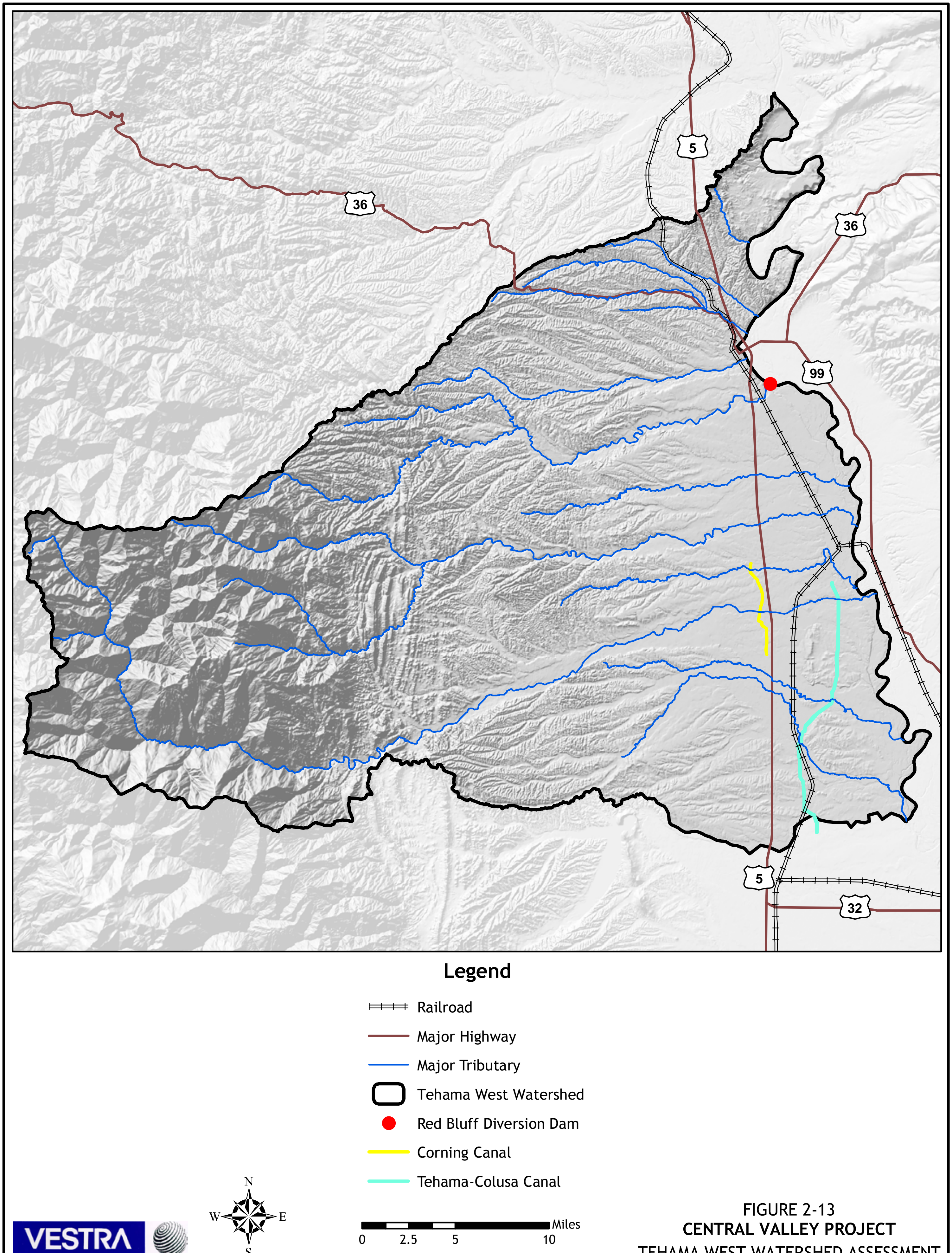


FIGURE 2-13
CENTRAL VALLEY PROJECT
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

Section 3

Section 3

DEMOGRAPHICS, LAND USE, AND ECONOMIC ACTIVITY

TABLES

FIGURES

Section 3
DEMOGRAPHICS, LAND USE, AND ECONOMIC ACTIVITY

This section includes discussion of changes in demographics and land use in the Tehama West Watershed over time. It should be noted at the time of this writing that the Tehama County General Plan is being revised. Information obtained for this section was taken from the draft plan and may change prior to final General Plan approval. Much of the data used for this section was summarized “by county” and smaller sub-unit data was not available. Where delineation of data in to sub-units was not possible the discussions address the county as a whole. Where sub-unit definition was practical the discussion addresses the applicable sub-unit.

SOURCES OF DATA

Primary sources of data used to construct this section of the report include:

- Tehama County General Plan (Draft)
- Files and records obtained from Tehama County Planning Department
- Agricultural Commissioner and Assessors offices
- Digital and non-digital data obtained from the California Department of Conservation

Reports and other documents reviewed and used to construct this section are included in the references section at the end of this section. Census data was used for population projections, however because census blocks vary by census within the county changes over time by area within the watershed were not available.

CITIES

The Tehama West Watershed is located in Tehama County. The county was created out of parts of Butte, Colusa, and Shasta Counties in 1856. The county is made up of 2,951 square miles and is located approximately 120 miles north of the City of Sacramento and roughly midway between Sacramento and the Oregon state border. There are three incorporated cities within the watershed. Included are the cities of Red Bluff, Corning, and the City of Tehama. Incorporated cities are included on Figure 3-1.

Red Bluff

Red Bluff, the county seat, was established in 1856. Its strategic location along the Sacramento River, connecting it to both Sacramento and San Francisco, enabled it to serve as a transportation hub, exporting agricultural and lumber products by steamships up and down the river. Steamships also imported freight to Red Bluff where it was unloaded and distributed to the Trinity mining camps to the northwest. The Central Pacific Railroad connected through to Red Bluff in the 1870s and soon replaced the steamships as the primary mode of transportation and commerce. Red Bluff’s downtown reflects the Victorian architectural style popular during the

1870s due both to its connection to the cities of Sacramento and San Francisco as well lumber made available by the Sierra Lumber Company Flume.

Corning

Corning, the watershed's second-largest city, was incorporated in 1907. It originally served as an agricultural hub for Tehama County, producing olives, plums, almonds, walnuts, and peaches, as well as cattle and sheep. Corning is home to Bell Carter Foods (which includes the Lindsey Olive Company).

City of Tehama

The City of Tehama, which was established in 1846, is both the watershed's oldest and smallest incorporated city (approximately 0.8 square miles). The city was originally established as a trading hub due to its proximity to the Sacramento River. Today, Tehama is almost entirely residential, with residents fulfilling commercial needs in the unincorporated, but larger town of Los Molinos, which is located approximately 1 mile to the east.

CURRENT LAND OWNERSHIP

The Tehama West Watershed is largely rural in nature, with isolated pockets of population primarily concentrated along the watershed's major transportation corridor along Interstate 5. As the watershed extends westward from these populated areas and into the watershed's margins, large ranches, forest products industry, and government land holdings dominate the terrain.

The existing land use pattern within the watershed primarily consists of a combination of upland agricultural, exclusive agricultural, and public lands. A majority of the major incorporated (city) and unincorporated developed (town) areas within the watershed are located adjacent to Interstate 5.

Commercial land uses also primarily occur along the Interstate 5 transportation corridor, mainly in Red Bluff and Corning. Residential land uses within the developed portions of the county often tend to be located behind or beyond the commercial and service uses directly adjacent to the major street network.

Based on the available data summarized in Table 3-1, the watershed has a large area of land in private ownership (85 percent). This leaves approximately 15 percent in federal and state ownership. General ownership within the watershed is shown in Figure 3-2.

GENERAL PLAN

The General Plan is the guiding document from which zoning and other development approval on private property emanates. Viewed as the constitution for the community, the General Plan includes broad principles and goals designed to forward a vision for the community. While all of the components of the General Plan are equal in stature, two elements, Land Use and Circulation, are used more in the day-to-day review of development proposals. The Land Use element contains a listing of uses allowed by type. Low Density Residential for example, typically provides for traditional housing subdivisions. Commercial designations can allow for a variety of retail, professional office, and light industrial types of use. Table 3-2 and Figure 3-3 contain the draft general plan designations found in the Tehama West Watershed.

Table 3-1
LAND OWNERSHIP IN THE TEHAMA WEST WATERSHED

Owner	Total Acres	Percent of Watershed
Bureau of Land Management	14,745	2.21
California Department of Fish and Game	760	0.11
California Department of Parks and Recreation	260	0.04
Department of Defense	27	< 0.01
State Lands Commission	410	0.01
The Nature Conservancy	250	0.04
US Fish and Wildlife Service	2,767	0.41
US Forest Service	83,826	12.55
Subtotal Government Acres	103,045	15.37
Crane Mills	55,530	8.32
Sierra Pacific Industries	1,001	0.15
Unclassified Private Ownership	508,592	76.17
Subtotal Other Acres	565,122	84.63
Total	668,168	100.00
Source: California Resources Agency		

Table 3-2
DRAFT GENERAL PLAN DESIGNATIONS

General Plan Designation	Description	Acres
C	Cropland	143,255
CC	Composite Cropland	9,232
CR	Commercial Recreation	316
CTY	City	7,356
G	Grazing	285,504
GC	General Commercial	469
GOV	Government Lands	97,721
IG	General Industrial	3,161
NH	Habitat Resource	4,951
NR	Resource Lands	451
OS	Open Space	744
P	Public Facility	45
RL	Rural Large Lot	14,609
RS	Rural Small Lot	21,327
SE	Scenic Easement	671
SP	Special Plan	4,355
SR	Suburban	10,948
T	Timber	57,743
TR	Native American Lands	1,985
U	Urban	1,986
W	Water	114

Just because a property has a land use designation, there is no assurance that the land will be developed. In many instances, the land will remain vacant for years, often outlasting several General Plan revisions. The General Plan designation provides an opportunity for development, not a guarantee to develop. It is also possible that property may contain a land use designation that cannot be developed because of some site constraint unknown to the county at the time the General Plan was adopted. General Plans seldom provide sufficient information to enable development at the individual property level, which is why area plans and watershed plans are so important. Wetlands, biological resources, limited access, mineral rights, and agricultural preserves are only some of the things that can restrict a property owner's ability to implement the underlying general plan designation.

The Circulation Element is important because it dictates how connectivity will occur between parcels. The Circulation Element also assures that new owners can in fact gain access to their land, and establishes minimum roadway widths and location. Policies within the circulation element govern the extension of utilities including power, water, phone, etc. Obviously the placement and size of a roadway can create an opportunity to build where one may not currently exist, or restrict development due to a lack of access. Because of this, circulation issues are frequently discussed with, or ahead of, land development proposals.

The General Plan is so important that state law limits amendments to four times per year. Most communities allow one per quarter and keep one in reserve for special projects. Tehama County is about to conclude the complete revision and update of its General Plan and looks to adopt the General Plan early in 2006. Unlike many other counties and cities, most of Tehama County is organized along a 10-mile wide strip on either side of Interstate 5. Lands to the far west and east of this strip are usually in larger agricultural use, or owned by state and federal agencies. Large tracts of land are also in conservation or agricultural preserve trusts. The County is focusing its development pressure on lands along the Interstate 5 corridor to both make use of this transportation improvement, and to help preserve larger agricultural uses outside of this central core. During the update process, the County met with numerous land owners, members of the public and held community meetings in several regions of the County. The land use map proposed with this update reflects very little change from the current land use map, which is both normal, and desired by the County and the members of the update committee. Large changes in land use patterns are typically addressed through specific plans, like Lake California or the Sun City Tehama project, which can address both the broad policy issues as well as site specific development concerns. The Specific Plan process is typically accompanied by its own environmental impact report (EIR).

Key to implementation of any General Plan designation is the zone district adopted by the County for specific properties. By state law, a zoning district must be consistent with the underlying General Plan designation. By zoning a property, the County identifies a list of permitted uses that can occur with little or no review or governmental discretion. These uses are typically consistent with the title of the zoning district. For example, a residential zone district will typically allow a single family dwelling as a permitted use. Conditional uses are those that the County might allow, but that need additional review to ensure that the use is compatible with the surrounding area(s) affected by the proposal. Other laws, such as the subdivision map act, County health codes, etc, also govern how a property can be developed, and must be consistent with both the General Plan designation and the Zoning District.

EXISTING ZONING

The Tehama County Board of Supervisors adopted the current Zoning Ordinance in 1983, pursuant to Ordinance No. 3787 (Zoning Enabling Plan for Tehama County). The purpose of the zoning ordinance was to protect and promote public health, safety, morals, peace, comfort, convenience, prosperity, and general welfare, including prescribing land use regulations that promote forestry and agriculture. The Zoning Ordinance establishes Zoning Districts based upon the General Plan land use designations, summarized in Table 3-3. Figure 3-4 shows the zoning districts within the watershed.

Table 3-3
ZONING DISTRICTS

District	Zoning District	General Plan Land Use Designation
Agricultural		
U-A	Upland Agricultural District	**Agricultural Lands:** The primary land use in this district is for the grazing of livestock. Secondary uses include tree, row, and field crops, farming, animal husbandry, dairies, nurseries, etc. Minimum lot area in a U-A district shall be forty to one hundred sixty acres.
E-A	Agricultural Exclusive District	**Agricultural Lands:** The primary land use in this district shall be the production of crops. Secondary uses for lands in this district include the grazing of livestock. Minimum lot area in an E-A district shall be ten acres to forty acres.
Residential		
RE	Residential Estate District	**Rural Large Lot:** Uses permitted in an RE district include one-family dwellings, crop and tree farming, private stables, and publicly owned parks. The minimum lot area is ten thousand five hundred square feet.
R-1	One-Family Residential District	**Rural Small Lot:** Uses permitted in an R-1 district shall be one-family dwellings, including private garages, accessory buildings, and home occupations. Crop and tree farming is also permitted, but not including commercial nurseries, or the railing of any animals other than ordinary household pets. Minimum lot area is five thousand square feet.
R-2	Two-Family Residential District	**Suburban Residential:** Uses permitted in an R-2 district shall include all uses permitted in an R-1 district with the addition of two-family dwellings. Minimum lot area is six thousand square feet.
R-3	Neighborhood Apartment District	**Suburban Residential:** Uses permitted in an R-3 district shall include all uses permitted in the R-1 and R-2 districts with the addition of parks and playgrounds, group buildings, multiple-family dwellings, apartments, boardinghouses and private garages/parking lots. Minimum lot area is six thousand square feet, but not less than one thousand five hundred square feet of lot area for each unit in multiple or apartment dwellings, and not less than two thousand square feet for each unit in group dwellings.
R-4	General Apartment District	**Suburban Residential**: Uses permitted in an R-4 district shall include all uses permitted in the R-1, R-2, and R-3 districts with the addition of hotels, hospitals, mortuaries, rest homes, churches, private schools, sanitariums, nursery schools, daycare centers, professional offices, clubs, lodges and fraternities. Minimum lot area is six thousand square feet.

Table 3-3 (cont.) ZONING DISTRICTS		
District	**Zoning District**	**General Plan Land Use Designation**
C-1	Neighborhood Commercial District	**Commercial:** Uses in a C-1 district shall include all uses permitted in R districts, as well as the retail businesses such as foodstores, bookstores, drugstores, laundry agencies, barbershops, small-scale repair shops, professional offices, gas stations, and self-operated laundries. There are no minimum lot requirements in the district.
C-2	Community Commercial District	**Commercial:** Uses in a C-2 district shall include all uses permitted in R and C-1 districts, with the addition of retail stores such as banks, bowling alleys, drugstores, clothing stores, restaurants, pawnshops, hotels, theaters, print shops, mortuaries, and bakeries. Professional offices and public utility offices are also permitted. There are no minimum lot requirements in the district.
C-3	General Commercial District	**Commercial**: Uses permitted in a C-3 district shall include uses permitted in R, C-1 and C-2 districts, with the addition of commercial repair garages, automobile sales, construction and building material sales, transient lodging, funeral and interment services and plumbing and electrical services. There are no minimum lot requirements in the district.
C-4	Local Convenience Center Commercial District	**Commercial**: Uses permitted in a C-4 district shall include uses permitted in R districts, with the addition of foodstores, gas stations, small restaurants and bars, and commercial uses that provide a needed service to the community. There are no minimum lot requirements in the district.
Recreation		
G-R	General Recreation District	**Recreation:** Uses permitted in a G-R district shall include public parks, playgrounds, and recreation areas, crop and tree farming, grazing and animal husbandry, one-family dwellings, and noncommercial picnic, boating, swimming, fishing, riding and hunting facilities and structures. Lot requirements in a G-R district shall follow minimum regulations provided for R-1 districts, and otherwise provided in use permit conditions.
NR	Natural Resource Lands and Recreation District	**Recreation:** Uses permitted in an NR district include fire trails, riding and hiking trails, nonprofit riding stables, parks and picnic sites, crop and tree farming, grazing, noncommercial boat launching and docking facilities, and other uses that the Planning Commission determines are similar to the above. Minimum parcel size in an NR district is forty acres.
Industrial		
M-1	Light Industrial District	**Industrial**: Uses permitted in an M-1 district shall include uses permitted in C-3 districts, with the addition of assembly and storage of goods, wholesale and storage warehouses, feed yards, manufacturing, dry-cleaning plants, laundries, veterinary hospitals, retail lumberyards, and similar uses. There are no minimum lot requirements in the district.
M-2	General Industrial District	**Industrial:** Uses permitted in an M-2 district shall include uses permitted in M-1 districts with the addition of wholesale lumberyards, lumber mills, pottery kilns, concrete batching plants, blacksmith shops and casting foundries. There are no minimum lot requirements in the district.
PD	Planned Development District	**Development:** Uses permitted in a PD district shall include all uses permitted in R, C & M districts, subject to the securing of a use permit. Lot requirements are specified in the use permits.

Table 3-3 (cont.) ZONING DISTRICTS		
District	**Zoning District**	**General Plan Land Use Designation**
Miscellaneous		
AV	Airport District	**Airport:** Uses permitted in an AV district shall include paved runways, aircraft storage, repair hangers, aircraft refueling facilities, passenger and freight terminal facilities, lighting radio and radar facilities, and accessory structures and facilities, including aircraft and aviation accessory sales, caretaker dwelling and related uses. There are no minimum lot requirements in the district.
PA	Public Agency District	**Public Agency:** Uses permitted in a PA district include public schools, parks and recreation areas, fairgrounds, civic centers, public forest and reservoir areas, historical sites, public utility facilities for local services, and other sites which the Planning Commission determines are similar to above. There are no minimum lot requirements in the district.
TPZ	Timber Preserve District	**Forest Lands:** Uses permitted in a TPZ zone include those integrally related to the growing, harvesting, and processing of forest products; management for watershed; fire and erosion control; and management for fish and wildlife habitat. A TPZ district must consist of contiguous parcels, and parcels zoned TPZ may not be divided into parcels less than one hundred sixty acres.

POPULATION

Between 1960 and 1990, Tehama County's population increased from 25,305 to 49,625 people, an average annual growth rate of 1.68 percent. Between 1990 and 2000 the county's population increased from 49,625 to 55,700 people, or an average 1.18 percent annual growth rate for the decade. The growth rate was around 3 percent early in the decade (1990 to 1992) and declined to less than 1 percent in the latter part of the decade (CED, 2004). Figure 3-5 shows a comparison of population density for 1990 and 2000. Table 3-4 and Figure 3-6 show historical population data for Tehama County.

Table 3-4
TEHAMA COUNTY POPULATION CHANGE

Year	Total	Change	Percent Change
1860	4,044	---	---
1870	3,587	(457)	-11.30%
1880	9,301	5,714	159.30%
1890	9,916	615	6.61%
1900	10,996	1,080	10.89%
1910	11,401	405	3.68%
1920	12,882	1,481	12.99%
1930	13,866	984	7.64%
1940	14,316	450	3.25%
1950	19,276	4,960	34.65%
1960	25,305	6,029	31.28%
1970	29,517	4,212	16.64%
1980	38,888	9,371	31.75%
1990	49,625	10,737	27.61%
2000	56,039	6,414	12.92%

Source: University of Virginia Library, 2005

Tehama County's population ranks 41st among the 58 counties in California. The majority of the population is located along the central valley area of the county, primarily adjacent to the north-south running Interstate 5 and Highway 99, a roughly parallel facility. The State Department of Finance Demographic Research Unit estimated Tehama County's population at 58,700 people in 2005, representing a 1.1 percent annual growth rate over the last 10 years. It further projected the county population to reach 61,200 people in 2010, representing a 0.8 percent annual growth rate through the year 2010 (CED, 2004). Based on recent proposed development in the Interstate 5 corridor, this number may increase significantly.

Between 2000 and 2003, the Tehama County's population rose to 57,700 people, averaging a 1.16 percent annual growth rate for the 3-year period, which is lower than the growth rate for the State of California within that same time period (4.8 percent). Reflecting its rural character, Tehama County's population density (persons per square mile) remains dramatically below the State average, with just 19 persons per square mile in 2000 compared to the state average of 217.2 persons per square mile.

Table 3-5 below provides a historical perspective of dwelling unit construction in the county and the number of units constructed in 3- to 10-year intervals throughout history.

Table 3-5
HISTORIC CONSTRUCTION OF DWELLING UNITS, TEHAMA COUNTY

Year Built	Number
1939 or earlier	2,233
1940 to 1949	2,098
1950 to 1959	2,110
1960 to 1969	2,666
1970 to 1979	5,981
1980 to 1989	4,623
1990 to 2000	3,836

Source: U.S. Bureau of the Census, Census 2000

Table 3-6 provides a perspective as to the total number of dwelling units (by type) in the county, based on the 2000 census.

According to the 2000 Census, the county contained 90 units (0.4 percent) that lack complete plumbing facilities, 159 units (0.8 percent) that lack complete kitchen facilities, and 483 units (2.3 percent) that have no telephone service.

Table 3-6 TOTAL HOUSING UNITS (BY TYPE), TEHAMA COUNTY		
Units in Structure	**Number**	**Percent**
1-unit, detached	14,186	60.2
1-unit, attached	486	2.1
2 units	435	1.8
3 or 4 units	778	3.3
5 to 9 units	612	2.6
10 to 19 units	308	1.3
20 or more units	670	2.8
Mobile Home	5,773	24.5
Boat, RV, Van, etc.	299	1.3
Total Units	**23,547**	**100.0**
Source: U.S. Bureau of the Census, Census 2000		

The population of Tehama County is almost evenly divided between men and women. Women account for 50.6 percent of the population, according to 2000 census figures. Approximately 58.4 percent of the population age 15 years and older is married, while 23.7 percent have never married. Approximately 17.9 percent of the 15-and-over population is divorced or separated.

The percentage of county residents below the age of 18 is 27.4 percent, an increase from 26.9 percent in 1990. Residents 65 years of age or older comprise 15.9 percent of the county population, which is a decrease from 16.9 percent in 1990.

Table 3-7 shows the racial composition of the County population in 1990 and 2000. As indicated by the table, little change has occurred in the racial composition of the county population, except for a significant decline in the percentage of white residents. Although speculative, the decline may be explained in part by residents who changed their racial categorization from “white” to another category, particularly “other” or “two or more races,” the latter category not having been established prior to the 2000 Census.

Table 3-7 COUNTY POPULATION BY RACE			
Race	**Percent of Population, 1990**	**Percent of Population, 2000**	**Percentage Change**
White	91.6	84.8	-6.8
Black	0.7	0.6	-0.1
American Indian/Alaska Native	1.8	2.1	+0.3
Asian/Pacific Islander	.04	0.8	+0.76
Other	4.8	5.0	+0.2
Two or more races	[1]	3.4	[1]
[1] Category not established in 1990 U.S. Census. Figures may not add up to 100 % due to rounding. Source: U.S. Census Bureau			

Hispanics/Latinos are considered an ethnic group rather than a race. The Hispanic population in the county increased from 10.3 percent of the total county population in 1990 to 15.8 percent in

2000. The 5.5 percent increase is greater than that for any racial group, and is slightly lower than the percentage increase in the state population during the same time period (6.6 percent).
There are 23,547 households in the county, which is 0.11 percent higher than the 1990 figure of 20,403. Approximately 63.5 percent of Tehama County's households are considered family households, which is less than the 1990 percentage of 67.2 percent. Approximately 9.6 percent of county households are family households headed by females. Of the total non-family households, approximately 70.5 percent have householders that live alone. Approximately 10.4 percent of total County households have householders 65 years of age or older who live alone, which is slightly above the 1990 percentage of 10.0 percent and above the statewide percentage of 7.8 percent. The average household size in the county in 2000 was 2.62, a slight decrease from the 1990 average size of 2.68.

Approximately 72.2 percent of the County population age 25 and older has graduated from high school. The percentage of 25-and-over residents with a bachelor's degree or higher is 10.2 percent. By comparison, approximately 76.8 percent of California residents graduated from high school, and approximately 26.6 percent hold a bachelor's degree or higher.

Median household income in Tehama County in 1999 was $31,206. This was below the statewide median household income of $47,493. Approximately 17.3 percent of families in the County were below the poverty level established in 1999. This percentage is higher than that of California families who are below the poverty level (10.6 percent).

LAND USE

Land use based on Department of Water Resources data is included as Figure 3-7. Land use based on Tehama County parcel information is included as Figure 3-8. General plan designations based on the Draft 2005 General Plan are included as Figure 3-3. General Plan Designations are included on Table 3-2. Proposed areas of future development based on the Draft Tehama County General Plan are included on Figure 3-9.

This section addresses specific land use issues determined at scoping meetings to be important to watershed residents. These include:

- Agricultural Land Use
- Grazing Land Use
- Timber
- Conservation Easements
- Mining
- Recreation
- Development

Agricultural Resources

Agriculture has long been the backbone of the Tehama West Watershed economy. The favorable growing season, arid climate, fertile soils, and abundance of water contribute to make the watershed an agricultural cornucopia in the northern Sacramento Valley. The lands that surround the Sacramento River are prime agricultural lands for irrigated crops. The foothills provide critical grazing land and production of dryland grain. The mountains provide timber and meadows for summer grazing. All of these factors contribute to shaping the agricultural evolution of the watershed.

The Tehama West Watershed is rich with an interesting agricultural history. Since the early settlement of the county with the Mexican Land Grants, agriculture has intensified with the development of new technologies, fertilization, and irrigation systems. The watershed was the home to one of the world's largest planned agricultural communities, the Maywood Colonies, near Corning.

Agriculture, historically and currently, is the area's highest income producing industry. Agriculture provides the watershed with its rural character, open space, and lifestyle that are highly valued by its residents. The portion of the watershed dedicated to agricultural uses including timber and livestock is included on Figure 3-10.

Preservation or loss of agricultural land value and social values remain controversial issues with the county. The history of agriculture was included in Section 2, "General Watershed History." The discussion is summarized in this section because of the importance of agricultural land use issues. As in Section 2, available data was not digital and could not be broken down by watershed sub-unit. The data presented is for Tehama County as a whole.

Farm Numbers

The number of farms in Tehama West Watershed has fluctuated dramatically over the years. In the late 1800s, the number of farms reported in Tehama County ranged between 600 and 800. By 1910, over 1,000 farms were in existence, and by 1945 there were 1,890 farms reported, the largest number in county history. The number of farms steadily decreased until the early 1970s, where in 1974, 1,160 farms existed. In 2002, Tehama County reported a total of 1,573 farms, down 6 percent from 1,679 farms reported in 1997.

Farm Size

In 1880, the average farm size was 820 acres. Since that time, average farm sizes have fluctuated between 600 and 1,000 acres. More recently, average farm sizes in the county have decreased substantially. In 1974, the average farm size was reported at 1,083 acres. In 2002, the average farm size was reported at 548 acres, the lowest ever recorded for Tehama County. The continued decrease in farm size is reflected across California and is documented as a potential statewide problem (DCD 2004). The average farm size in California is now 346 acres. The reduction in farm size is due to increases in "hobby" farm properties. Although some "hobby" farms produce farm income, most do not. The expansion of "hobby" farm properties and ensuing loss of agricultural income has prompted additional legislation to protect farm land uses. Table 3-8 shows size data for farms between the years 1987 and 2002.

Commodity Changes

Commodity types have changed much since 1950. While orchard and other specialty crops have increased, dryland grain crops have decreased significantly. Crop type acreages are included on Table 3-8 and specific commodity production is shown on Figure 3-11.

Table 3-8 CROP TYPE ACREAGES	
Crop Type	**Acres**
Field Crops	10,569
Field Crops (Irrigated)	10,513
Irrigated Almond Orchard	7,053
Irrigated Misc. Orchard	1,346
Irrigated Olive Orchard	7,686
Irrigated Prune Orchard	9,140
Irrigated Walnut Orchard	7,265
Misc. Orchard	20
Pasture	2,128
Pasture (Irrigated)	23,980
Pasture (Dry Grazing)	320,040
Row Crops (Irrigated)	3,301
Vine and Bush Fruits (Irrigated)	53

Farm Acreage

Total farm acreage peaked at nearly 1.3 million acres in 1974. Between 1987 and 1997, it was reported that total farm acreage dropped from 1,104,584 acres to 885,426 acres (NASS, 2004). Table 3-9 shows the agricultural acreage comparison from 1950 to 2000.

Table 3-9 FARMS BY SIZE, 1987-2002				
Farm Size	**1987**	**1992**	**1997**	**2002**
1 to 9 acres	237	240	251	212
10 to 49 acres	574	556	529	413
50 to 179 acres	274	249	259	323
180 to 499 acres	146	142	144	271
500 to 999 acres	59	70	67	91
1,000 acres or more	130	124	112	81
Source: National Agricultural Statistics Service, 1987, 1992, 1997, 2002				

Crops

Land that has been used for producing crops has fluctuated much over the years. Data indicates that at its peak in 1950, over 280,000 acres in Tehama County was designated as cropland (NASS, 2004). Many lands were farmed without irrigation, producing dryland grain hay and other crops. This trend has slowly decreased over the years, with a low in the 1990s around 120,000 acres. In 2002, total cropland was estimated at 140,000 acres. Agricultural acreage comparisons from 1950 to 2000 are included in Table 3-10.

Table 3-10 AGRICULTURAL ACREAGE COMPARISON, 1950-2000			
Year	**Orchard**	**Cropland**	**Total Farm Acres**
1950	10,673	281,710	1,131,660
1954	11,338	186,859	1,161,699
1959	15,203	N/A	1,254,707
1964	14,620	N/A	1,168,133
1969	21,948	147,752	1,101,562
1974	20,093	138,669	1,256,010
1978	26,985	156,827	1,165,043
1982	32,497	160,359	1,168,247
1987	32,908	131,869	1,104,584
1992	35,422	120,902	1,016,851
1997	36,956	127,019	885,426
2002	45,236	140,987	862,440
Source: National Agricultural Statistics Service			

Grain production in Tehama County has decreased significantly in recent years. Historical grain production by type is included on Figure 3-12. Barley, oat, and wheat were widely produced historically and were very important economic crops. Many areas in the lower rolling foothills on the west side of the county were used historically for dryland grain farming (Smith, 1997). Other than a few remnant producers, dryland grain crops have been nearly eliminated from production in Tehama County. The low prices for grain and the increased costs of production are largely responsible for the decline in grain production. There are 10,475 acres of grain crops in the watershed.

Rice production has also seen a major decline in the past 2 decades. Plantings of rice date back to the early 1980s, when nearly 3,000 acres were produced (NASS 2004). In 2003, only 600 acres were reported (Tehama County 2003). Increases in the cost of water have nearly eliminated water-intensive crops such as rice from agricultural production in Tehama County. Historical rice production is included on Figure 3-13.

Orchard Production

Orchard production in Tehama County was initially reported by the National Agricultural Statistics Service (NASS) in 1930. During the 1930s to the mid 1960s, orchard production remained stagnant with an approximate 10,000 to 15,000 acres in production. By the late 1960s, total orchard production jumped to over 20,000 acres. Since this time, total orchard production has experienced a steady increase to 45,236 acres reportedly in orchards in 2002 (NASS, 2004). Tehama County orchards are predominantly walnuts, prunes, almonds, or olives. This is due in great part to availability of irrigation water and higher dollar value for orchard commodities. Acres in orchard production for 1965 to 2003 are shown on Figure 3-14.

The combination of the availability of irrigation water, advances in irrigation technologies, relatively good commodity prices for orchard crops, and the availability of processing facilities are responsible for the drastic increase in orchard acreage. Many orchards have been established in western Tehama County on clay soils with drip irrigation. Earlier in Tehama County history, other factors that have led to the increase of orchard plantings were the construction of Shasta Dam in 1945, which drastically minimized the flood risk of prime agricultural lands adjacent to the Sacramento River; the development of the Red Bluff Diversion Dam combined with the Tehama/Colusa Canal and the Corning Canal; and the reduction in copper mine pollution from lower Shasta County in the early 1900s (Kristofors, 1973).

Walnuts are the most widely planted crop in the county, with a steep increase in plantings occurring in the 1990s. Walnut acreage is currently estimated at 7,160 acres in the watershed.

Almonds have seen a tremendous increase in plantings in the early 1980s and somewhat stagnant growth in the early 1990s. Since the early 1990s, almond acreage has increased gradually, with a reported 7,268 acres in production in 2003 (Tehama County, 2003). There are 7,053 acres of almond orchards in the watershed.

Dried plums have been a high-valued crop in the county for decades and are presently produced on 8,848 acres (Tehama County, 2003). More recently, overproduction has led to the U.S. Department of Agriculture's (USDA) voluntary tree removal program in Tehama County. There are 9,140 acres of dried plum orchards in the watershed.

Olives have remained the most stable orchard crop in Tehama County. A large processing facility is located in Corning at the Bell Carter processing facility. The Maywood Cannery in Corning was the only major olive processing facility in the county. In 1978, Bell-Carter Foods Inc. purchased the Maywood Olive Company and the facility was renovated and opened in 1980. Since that time, Bell-Carter Foods has been the primary olive processing facility in the county, selling olives under the Lindsay Olives brand name (Bell-Carter, 2004). Olives are currently produced on 5,560 acres in Tehama County (Tehama County, 2003). Olives are planted primarily around the Corning area. There are 7,665 acres of olive orchards in the watershed.

Peaches have historically been large orchard crops in Tehama County. In 1909, it was reported that 2,891 acres were planted for peach production (Grimes, 1983). In 1975, peaches were reportedly produced on 884 acres, and by 1985, the acreage dramatically dropped to 83 acres. The reduction in prices and marketing outlets is one of the many reasons for the decline of the production of this crop. There are 36 acres of peach orchards in the watershed.

Crop types in the watershed are included on Figure 3-15 (Tehama County 2005).

Grazing and Livestock

Livestock has been a valuable commodity since the turn of the century. Both historically and today, cattle are wintered in the lower foothills of Tehama County and summered in the mountain meadows of Tehama County and other surrounding counties (Briggs, 1956). Some livestock producers keep cattle on irrigated pasture on the valley floor during the summer months. Historical irrigation acreages for Tehama County are shown on Figure 3-16.

Most of the early settlers in Tehama County depended primarily on livestock for their livelihood. In the late 1800s, of the farms reporting inventories, sheep production was much more prolific than cattle or hog production. The large sheep herds of the past are now gone, passing beef production the title of the largest livestock industry in the county. Livestock population trends are included on Figure 3-17.

Cattle inventories in Tehama County have drastically increased over the years. In the late 1800s, cattle numbers ranged near 10,000 head (NASS, 2004). Over the next century, cattle numbers steadily increased to a peak of approximately 100,000 head in the 1970s. In 2002, total cattle inventories for Tehama County indicate approximately 68,000 cattle in the county. Two of the reasons for the drastic increase in cattle numbers were an increase in cattle commodity prices and the reduction of sheep populations in the county (Briggs, 1956).

Urban developments threaten the winter ranges in the foothills. Irrigated pastures serve as a location for cattle in the summer months, and have been slowly reduced over the years. The increasing cost of water and the high land values are challenges to a low-value crop such as irrigated pasture.

Hog production was widespread in the late 1800s and the early 1900s, with the average hog population around 20,000 head residing in the county in any given year. Over the years, this number has experienced a steady decline. In 2003, only 1,000 domestic hogs were reported in the county (Tehama County, 2003). It should be noted that wild pigs have been introduced into certain portions of the county over the years. The lower foothills on both the west and east side of the county contain wild pig populations.

Sheep were historically the largest livestock commodity in Tehama County. The first reported estimate of sheep populations occurred in 1880, when 121,963 sheep were reported. Sheep production was much more common than cattle production during the early settlement of the county because they were primarily nomadic (Wentworth, 1948). Sheep production in Tehama County peaked in 1930, with nearly 350,000 head. This number has steadily declined since this time, and in 2003, only 5,800 head reportedly resided in the county (Tehama County, 2003). Reasons for sheep numbers declining include the dramatic increase of predators, reduction in mountain summer ranges available to grazing, low commodity prices, and the unavailability of labor for sheep-herders (Briggs, 1996).

Timber

Timber has always played a large role in the economy of Tehama County. Timber harvesting zones in the county are located on the eastern and western mountain slopes. Timber harvesting over the years has faced an overall decline. Throughout the 1980s, timber harvesting in Tehama County extracted an average of 140 million harvested board feet annually. In the 1990s, the average timber harvested dropped to below 100 million harvested board feet annually. In the 2000s, timber harvesting continues to drop below historical numbers. In 2003, approximately 74 million board feet of timber were harvested. This indicates nearly a 50 percent decrease in production compared to timber harvesting levels from the 1980s. In 2003, the gross value for timber production in the county was estimated at $17 million. Timber production from 1980 to 2003 is included on Figure 3-18.

Economic Agricultural Conditions

Gross Sales of Farms

Farms in Tehama County range from small "hobby farms" to large-scale agribusiness operations. Hobby farms are generally defined as a farm with under $10,000 in sales annually and are typically subsidized by the owner's income from other sources. The majority of farms, though not the majority of acreage, are designated hobby farms. Eight hundred seventy-one farms reported gross sales below $10,000 and 324 farms reported gross sales of over $50,000 in 2002. Farms by value of sales are summarized in Table 3-11.

Table 3-11 ECONOMIC CHARACTERISTICS OF FARMS, 1987-2002				
Farms by Value of Sales	Number of Farms			
	1987	1992	1997	2002
$0-$9,999	809	746	693	871
$10,000 to $49,999	346	349	366	378
$50,000 or more	265	286	303	324
Total	1420	1381	1362	1573
Source: National Agricultural Statistics Service, 2002				

Agricultural Contribution to Economy

The total value for Tehama County agricultural commodities in 2003 was an estimated $125 million (Tehama County, 2003). Orchard crops are the highest value crops in the county, with an estimated $68 million in gross revenue in 2003. Livestock and poultry were the next highest valued commodity with a total value of approximately $22 million. Commodity value trends from 1999 to 2003 are included on Table 3-12. Commodity trends from 1994 to 2003 are included on Figure 3-19.

Table 3-12 AGRICULTURAL COMMODITY VALUE COMPARISON SUMMARY ($), 1999-2003					
Commodity	1999	2000	2001	2002	2003
Fruit and Nut Crops	47,655,250	58,914,500	58,525,470	71,377,000	68,112,790
Livestock & Poultry	19,195,500	21,170,250	24,205,560	21,500,000	21,808,520
Field Crops	6,356,750	5,867,250	6,813,050	6,187,770	5,970,320
Pasture & Range	9,020,000	9,020,000	8,965,000	9,295,000	10,225,000
Livestock & Poultry Prod.	11,491,000	12,079,500	15,475,120	12,147,300	13,797,500
Seed Crops	774,250	730,000	640,630	593,360	542,770
Nursery Crops	1,367,000	1,308,500	1,991,000	2,102,000	1,600,000
Apiary Products	941,500	1,453,000	1,173,000	3,009,630	2,921,800
Vegetable Crops	156,000	160,250	162,240	160,000	160,000
TOTAL	**96,957,250**	**110,703,250**	**117,951,070**	**126,372,130**	**125,138,700**
Source: Tehama County Agricultural Crop Reports					

Of the orchard crops, walnuts created the highest revenue of any commodity, nearly $28 million in 2003. Walnuts accounted for roughly 41 percent of the total values of orchard crop production. Almonds were the next highest value, with just over $16 million in value, accounting for approximately 24 percent of the total value of orchard crops in 2003. Dried plums accounted for roughly $13 million and olives accounted for just over $7 million.

Field crops play a relatively minor role in Tehama County agriculture. Alfalfa hay was valued at approximately $2 million in 2003. Nursery crops, such as strawberry plants, had a value of $1.6

million. Other crops, such as grain hay, silage, corn, and rice are also important field crops for the county. Cultivated agricultural commodities are summarized in Table 3-13.

Table 3-13
TOP TEN CULTIVATED AGRICULTURAL COMMODITIES, 2003

Rank	Crop	Value in $
1	Walnuts	27,987,490
2	Almonds	16,280,230
3	Dried plums	13,130,430
4	Olives	7,005,600
5	Alfalfa hay	2,090,000
6	Nursery crops*	1,600,000
7	Grain hay	736,000
8	Silage	660,000
9	Corn	630,000
10	Rice	540,000
Total		**70,659,750**

Source: 2003 Tehama County Agricultural Crop Report
* Orchard trees, Christmas trees, strawberry plants

Agricultural commodities were grouped to estimate the value of each industry and/or specific crops to the economy. Walnut production remains the highest value crop or industry in Tehama County in 2003. The beef industry, with a total of approximately $26 million was the second highest-ranking industry behind walnuts. Timber production was the third highest grossing industry in Tehama County for 2003. The top 10 agricultural commodities are summarized on Table 3-14.

Table 3-14
TOP TEN AGRICULTURAL COMMODITIES, 2003

Rank	Crop	Value in $
1	Walnuts	27,987,490
2	Beef industry[1]	26,694,265
3	Timber	17,137,043
4	Dairy industry[2]	16,496,000
5	Almonds	16,280,230
6	Dried plums	13,130,430
7	Olives	7,005,600
8	Apiary products[3]	2,921,800
9	Alfalfa hay	2,090,000
10	Fish[4]	2,000,000

Source: 2003 Tehama County Agricultural Crop Report
Note: (1) Feeders, bulls, calves, range, rental, etc. (2) Milk and cattle (3) Honey, queens, packaged bees, etc. (4) Sturgeons, trout, catfish, fishing, etc.

Market Value of Production

In 2002, total agricultural production was valued at $126,372,130. Assuming there were 1,573 farms in existence in 2002, each farm received estimated gross revenue of $80,338. Also assuming the average farm size is 548 acres, the estimated gross revenue per farm acre in Tehama County is roughly $146 per acre.

Conservation Easements and Programs

Over the past few years, a significant amount of farmland has been protected under permanent conservation easements. A conservation easement compensates the landowner for the fair market value of their property less than the restricted value, determined by an accredited appraiser. The Sacramento River Corridor is an area where permanent agricultural conservation easements are occurring. The Natural Resources Conservation Service (NRCS) has five easements in the watershed totaling approximately 85 acres. The City of Red Bluff also has a 1-acre easement in the watershed for the Red Bluff River Park. Figure 3-20 shows the conservation easements in the watershed area.

Farmland Mapping Program

In 1980, the California Department of Conservation, Division of Land Resource Protection, began work to supplement the Soil Conservation Service (SCS) conservation programs through a Farmland Mapping and Monitoring Program (CDC, 2001). This program, designed to inventory important farm and grazing lands in the form of important Farmland Series maps, became California Law in 1982. Its purpose is to monitor conversion of the state's agricultural land to and from agricultural use, and report concerns to the Legislature, local government, and the public. A map of the types of farmland within the watershed is shown on Figure 3-21.

The guidelines identified five categories of farmlands: prime farmland, farmland of statewide importance, unique farmland, farmland of local importance, and grazing land. All five designations of land use are found throughout the Tehama West Watershed. According to the California Department of Conservation, the state's total agricultural land use acreage has grown by approximately 9 percent. Change by area of land use is shown in Table 3-15 and Figure 3-22. The Department of Conservation defines these five categories as described in the sections below.

Prime Farmland

Prime Farmland is land, which has the best combination of physical and chemical characteristics for the production of crops. It has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops when treated and managed, including water management, according to current farming methods. "Prime Farmland" must have been used for the production of irrigated crops within the last three years. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use.

Table 3-15 CHANGE BY LAND USE COUNTY ONLY						
Land Use Category	**Total Acreage Inventoried**					
	1992	**1994**	**1996**	**1998**	**2000**	**2002**
Prime Farmland	83,716	79,698	77,153	77,463	73,770	74,126
Farmland of Statewide Importance	21,560	20,004	18,651	19,431	19,762	19,871
Unique Farmland	11,117	12,787	19,088	19,447	18,487	18,468
Farmland of Local Importance	122,705	127,719	131,226	129,633	132,763	132,980
Important Farmland Subtotal	**239,098**	**240,208**	**246,118**	**245,974**	**244,782**	**245,445**
Grazing Land	714,049	712,634	706,585	706,309	706,027	705,674
Agricultural Land Subtotal	**953,147**	**952,842**	**952,703**	**952,283**	**950,809**	**951,119**
Urban and Built-Up Land	10,165	10,696	10,758	10,784	11,458	11,544
Other Land	871,910	869,802	869,907	870,206	871,006	870,610
Water Area	6,214	6,155	6,133	6,221	6,221	6,221
Total Area Inventoried	**1,841,436**	**1,839,495**	**1,839,495**	**1,839,494**	**1,839,494**	**1,839,494**

Farmland of Statewide Importance
Farmland of Statewide Importance is land other than "Prime Farmland" that has a good combination of physical and chemical characteristics for the production of crops. It must have been used for the production of irrigated crops within the last three years. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use.

Unique Farmland
Unique Farmland is land that does not meet the criteria for "Prime Farmland" or "Farmland of Statewide Importance" and that is currently used for the production of specific high economic value crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to produce sustained high quality or yields of a specific crop when treated and managed according to current farming methods. Examples of such crops may include oranges, olives, avocados, rice, grapes, and cut flowers. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use.

Farmland of Local Importance
Farmland of Local Importance is land currently producing crops, or having the capability of production. "Farmland of Local Importance" is land other than "Prime Farmland," "Farmland of Statewide Importance," and "Unique Farmland." This land may be important to the local economy due to its productivity. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use.

Grazing Land
Land defined in Section 65570(b)(2) of the Government Code as "land on which the existing vegetation, whether grown naturally or through management, is suitable for grazing or browsing of livestock." The minimum mapping unit for "Grazing Land" is 40 acres.

Mineral and Aggregate Resources

In 1975, the California Legislature enacted the Surface Mining and Reclamation Act to prevent adverse environmental impacts of mining operations, reclaim mined lands, encourage production and conservation of minerals, consider the value and potential uses of mineral areas for recreation, watershed, wildlife habitat and scenic enjoyment and eliminate public health and safety hazards associated with mining activities (Public Resources Code 2712).

The majority of Tehama County's mineral wealth is derived from the extraction of non-metallic sand, gravel, and limited volcanic cinder, which are used primarily by local paving and construction industries. Because of their bulky, heavy character, aggregate resources are expensive to transport, and given increasing transportation costs, the sand and gravel deposits located close to the developing areas of Tehama County are valuable assets. As of September 2005, there are 32 mineral extraction operation permits granted in Tehama County and 15 in the Tehama West Watershed. The locations of these operations are shown on Figure 3-23.

Aggregate mining is necessary to supply base materials needed to construct roads and projects within the county. As development increases, the demand for materials will also increase. Aggregate mining is targeted for many negative impacts to stream and aquatic and riparian habitats. If conducted using best management practices, impacts can be greatly lessened. Numerous sources address the impacts of gravel extraction on the ecological systems. Significant work has been compiled to address gravel extraction, sediment loading, and gravel impacts (USFS 1997) to Thomes Creek. The following general discussion of impacts was summarized from the National Marine Fisheries Service National Gravel Extraction Policy (1996).

Channel hydraulics, sediment transport, and morphology are directly affected by human activities such as gravel mining and bank erosion control. Direct effects reshape the boundary, either by removing or adding materials. Subsequently, flow hydraulics are altered when water levels rise and inundate the altered features. This can lead to shifts in flow patterns and patterns of sediment transport. Local effects also lead to upstream and downstream effects.

Altering any habitat parameters can lead to deleterious impacts on instream biota and the associated riparian habitat (NMFS 1996). This can include shifts in species, invasion, and colonization by non-native plants from an alteration of the flow patterns resulting from modification of the river bed or an excess of suspended sediment

The potential effects of gravel extraction activities on stream morphology, riparian habitat, and anadromous fishes and their habitats may include:

1. Extraction of bed material in excess of natural replenishment by upstream transport may cause bed degradation. This is partly because gravel "armors" the bed, stabilizing banks and bars, whereas removing this gravel causes excessive scour and sediment movement. Degradation can extend upstream and downstream of an individual extraction operation, often at great distances, and can result from bed mining either in or above the low-water channel (NMFS 1996).

2. Gravel extraction may increase suspended sediment, sediment transport, water turbidity and gravel siltation. The most significant change in the sediment size distribution resulting from gravel removal is a decrease in sediment size caused by fine material deposition into the site. Siltation, substrate disturbances and increased turbidity also affect the invertebrate food sources of anadromous fishes (NMFS 1996).

3. Bed degradation can change the morphology and dynamics of flow within the channel (NMFS 1996).

4. Gravel bar "skimming" significantly impacts aquatic habitat. Bar skimming creates a wide flat cross section, then eliminates confinement of the low flow channel, and results in a thin sheet of water at baseflow. Bar skimming can also remove the gravel "pavement," leaving the finer subsurface particles vulnerable to entrainment (erosion) at lower flows (NMFS 1996).

5. Operation of heavy equipment in the channel bed can directly destroy spawning habitat, and produce increased turbidity and suspended sediment downstream (NMFS 1996).

6. Stockpiles and overburden left in the floodplain can alter channel hydraulics during high flows. During high water, the presence of stock piles and overburden can cause fish blockage or entrapment, and fine material and organic debris may be introduced into the water, resulting in downstream sedimentation (NMFS 1996).

7. Removal or disturbance of instream roughness elements (down debris) during gravel extraction activities negatively affects both quality and quantity of anadromous fish habitat. Instream roughness elements, particularly large woody debris, play a major role in providing structural integrity to the stream ecosystem and providing critical habitat for salmonids. These elements are important in controlling channel morphology and stream hydraulics, in regulating the storage of sediments, gravel and particulate organic matter, and in creating and maintaining habitat diversity and complexity (NMFS 1996).

8. Destruction of the riparian zone during gravel extraction operations can have multiple deleterious effects on anadromous fish habitat. The importance of riparian habitat to anadromous fishes should not be underestimated. The riparian zone includes stream banks, riparian vegetation and vegetative cover. Damaging any one of these elements can cause stream bank destabilization, resulting in increased erosion, sediment and nutrient inputs, and reduced shading and bank cover leading to increased stream temperatures. Destruction of riparian trees also means a decrease in the supply of large woody debris (NMFS 1996).

In addition, disturbances caused by mining activities have been accused of increasing the likelihood of colonization of non-native invaders such as tamarisk and arundo. Mining is also blamed for increased braiding of both Thomes and Elder Creeks.

Other mineral resources found in the county include aragonite, borax, chalcopyrite, chromite, copper, cristobalite, galena, garnet, opal, pectolite, penninite, sassolite, and Wallstonite. Of these, chromite offers the best possibilities for development. Chromite is an important metal used in steel production, yet almost all of the nation's demand for this metal is currently met by import rather than domestic production. In future years, domestic production of chromite may become a necessity due to rising importation costs and/or decreasing foreign supplies. At such a time, the demand for chromite deposits in Tehama County may increase, resulting in future development of chromite mining operations. The Raglin Ridge area along the North Fork of Elder Creek in the Western Planning Area contains the most significant deposits of this metal.

The earliest record of production of chromite was in 1886 when the Tehama Consolidated Chrome Company located deposits and mined lenses of high-grade ore from open cuts. Shipments were made by rail to San Francisco and then by boat to Philadelphia. The properties were then closed and remained idle until World War I in 1915. From 1915 until the collapse of the market in 1918, the Noble Electric Steel Co., the American Refractories, and several other operators produced 3,800 long tons of chromite ore. Significant production was resumed in 1942 (CDMG 1996).

Tertiary continental deposits cover a majority of the older rocks in which chromite occurs in the Sacramento Valley. Eastward-dipping sedimentary rocks of late Jurassic to Cretaceous age border the Klamath Mountains. Separated from the southern Klamath Mountains by a long, tabular, north-trending body of peridotite is the Elder Creek mass, which in some places attains a thickness of more than 2 miles. The Elder Creek mass terminates to the north at the South Fork of Cottonwood Creek.

Another large body of peridotite, the Beegum Creek body, crops out in the northwest corner of the county and extends more than 6 miles in a northwesterly direction into Trinity County. It lies within Paleozoic and Triassic metasedimentary and metavolcanic rocks. It is irregular in shape, and much of it has been sheared to slickentite. Many thousands of long tons of lump ore and concentrates have been mined from the Elder Creek and Beegum Creek peridotite masses over the last 125 years.

Natural gas and geothermal resources are also located in Tehama County. Natural gas fields are found in the South Interstate 5 Planning Area to the northeast and to the south of the City of Corning.

Construction and mining constitute only four percent of Tehama County employment, reflecting the relatively low intensity of mineral development in the county today. Though this figure is small, mining should not be considered an insignificant contribution to the County's economy and is worthy of protection under General Plan policies and programs.

RECREATION

The Tehama West Watershed is rich in recreational resources and lands. Hiking, fishing, and boating opportunities abound, as well as the opportunity for more passive recreation. The valleys and mountains have diverse and unique scenic resources including rivers, lakes, wetlands, large expanses of grassland, spectacular forests and high mountains. The Sacramento River provides numerous recreational opportunities to residents and visitors. California State University, in association with other agencies, has created The Sacramento River Recreational and Public Access Guide.

Included in this inventory are USDA Forest Service (USDAFS) lands, National Park Service lands (under the US Department of the Interior), Bureau of Land Management (BLM) properties, California State Parks facilities and areas, US Army Corps of Engineers lakes and parks, and County regional parks – each of which are described in more detail below.

The Mendocino National Forest straddles the eastern spur of the Coastal Mountain Range in northwestern California, covering 894,399 acres that span portions of seven counties: Butte, Colusa, Glenn, Lake, Mendocino, Tehama, and Trinity. The Mendocino National Forest extends from the Yolla Bolly Mountains in the north (just west of Red Bluff), to Clear Lake in the south. This includes 137,787 acres of designated wilderness and over 40 campgrounds, with a total of 514 recreation sites. Elevations range from about 1,000 feet to over 8,000 feet, providing a variety of vegetation and wildlife.

The Mendocino National Forest offers an array of recreation opportunities to the visitor, including fishing in lakes and streams, camping, picnicking, boating, hiking, horseback riding, wildlife viewing, hang-gliding, a large off-road vehicle trail system, winter snow play, hunting, wilderness experiences and mountain biking. The Mendocino National Forest is divided into three ranger districts: Grindstone (formerly Corning and Stonyford), Covelo, and Upper Lake.

The Mendocino National Forest Red Bluff Recreation Area encompasses 488 acres of diversified habitat adjacent to the Sacramento River, 2 miles south of Red Bluff. The Recreation Area includes the Sacramento River Discovery Center, Lake Red Bluff, two campgrounds, boat launches, a salmon viewing area, interpretive opportunities and a unique birding experience.

LAND USE REGULATIONS

Many laws and regulations govern the manner in which both public and private lands are managed on the federal, state and county level. This section will discuss some of the laws most relevant to the watershed and its citizens. This is not an all-inclusive list and the reader is cautioned to not use the following as legal or regulatory advice.

Federal

National Environmental Policy Act (NEPA) of 1969

The purposes of this Act are to declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere; and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

Clean Water Act (Federal Water Pollution Control Act Amendment) of 1972

The primary purpose of the 1972 Clean Water Act was to “restore and maintain the chemical, physical and biological integrity of the nation’s waters.” To achieve that goal, the law prohibits the discharge of pollutants into "navigable waters," defined in the act as "waters of the United States," without a permit. The law has historically been understood to protect traditionally navigable waters, tributaries of navigable waters, wetlands adjacent to these waters, and other wetlands, streams, and ponds that, if destroyed or degraded, could affect interstate commerce.

Endangered Species Act of 1973

The Endangered Species Act recognizes that various species of fish, wildlife, and plants in the United States have been rendered extinct because of economic growth and development, and that other species of fish, wildlife and plants have been so depleted in numbers that they are in danger of, or threatened with, extinction. The Unites States has pledged to conserve to the extent practicable the various species of fish or wildlife and plants facing extinction.

Forest and Rangeland Renewable Resources Planning Act (1974)

The Forest and Rangeland Renewable Resources Planning Act of 1974 provided authority to the United States Forest Service (USFS) to prepare and update an assessment every 10 years to inventory and monitor the status and trends of the forest lands and range lands in the National Forest System, and to prepare a long-range plan every 5 years to guide USFS policies. The act authorizes the Secretary of Agriculture to conduct, support, and cooperate in investigations, experiments, tests, and other activities deemed necessary to obtain, analyze, develop, demonstrate, and disseminate scientific information about protecting, managing, and utilizing forest and rangeland renewable resources in rural, suburban, and urban areas. It also requires a comprehensive assessment of present and anticipated uses, demand for, and supply of renewable resources from the nation's public and private forests and rangelands, as well as coordinated public and private research programs.

National Forest Management Act (1976)

The National Forest Management Act of 1976 established standards and guidelines for managing the national forests, including directives for national forest land management planning, and public participation. The act requires the Secretary of Agriculture to assess forest lands, develop a management program based on multiple-use, sustained-yield principles, and implement a resource management plan for each unit of the national forest system. It is the primary statute governing the administration of national forests.

State

California Environmental Quality Act (CEQA) of 1970

CEQA is closely modeled on the National Environmental Policy Act (NEPA). Unlike NEPA, CEQA imposes an obligation to implement mitigation measures, or project alternatives to mitigate significant adverse environmental effects, if these measures or alternatives are feasible. Thus, CEQA establishes both a procedural obligation to analyze and make public adverse physical environmental effects, and a substantive obligation to mitigate significant impacts.

California Endangered Species Act (CESA) of 1984

CESA generally parallels the main provisions of the federal Endangered Species Act, which is administered by the California Department of Fish and Game (CDFG). Under CESA, the term "endangered species" is defined as a species of plant, fish or wildlife which is "in serious danger of becoming extinct throughout all, or a significant portion of its range," and is limited to species or subspecies native to California.

California Forest Practices Act (1973)

The California Forest Practices Act was enacted in 1973 to regulate all timber harvesting in California on all non-federal land, including private land, with the intent to restore, enhance, and maintain forest productivity and to sustain high-quality timber products while taking into account recreation, watershed, wildlife, range and forage, fisheries, regional economic vitality, employment, and aesthetic enjoyment. This is an all-encompassing law enacted to involve timber owners, loggers, and environmentalists alike in forest management decisions.

Farmland Protection

Farmland and rangeland are precious commodities in Tehama County. Temporary and permanent programs help provide landowners with incentives to keep their agricultural lands in production and prevent conversion to urban uses. Temporary programs, such as the Williamson Act, help provide property tax reductions to landowners for enrolled properties. Permanent protection can be found through conservation easements. An agricultural conservation easement maintains a property's agricultural focus by restricting residential or commercial development.

California Land Conservation Act of 1965 (Williamson Act)

The California Land Conservation Act of 1965, also known as the Williamson Act, is the primary program for the conservation of agricultural lands in California. The Williamson Act creates an arrangement between the private landowner and the county to preserve agricultural lands. Terms are established under 10 year contracts. The Williamson Act is a voluntary program that helps reduce property tax rates for private lands enrolled in the program. The benefits of the Williamson Act provide an estimated 20 to 75 percent savings in property taxes annually (Department of Conservation, 2004).

The Williamson Act is only eligible to landowners within a designated agricultural preserve. A local government, such as a city or a county, establishes an agricultural preserve. In Tehama County, the Board of Supervisors establishes agricultural preserves. Agricultural preserves are regulated by strict rules to provide guidelines that ensure the land within the preserve is maintained for agricultural or open space use. Agricultural preserves have a minimum of 100 acres. Smaller agricultural preserves may be established. Contiguous neighbors may team up to combine their properties to enter them into the Williamson Act. A minimum term for a Williamson Act contract is 10 years. A contract is renewed automatically each year. The Williamson Act contract is tied to the land and is transferred upon sale of the property. The Williamson Act is enforced by the California Department of Conservation.

To remove land from the Williamson Act, a notice of non-renewal must be established. During the non-renewal process, the annual tax assessments increase. Once the 9-year non-renewal period is complete, the Williamson Act contract is terminated. Another removal process is to cancel the contract. Only the private landowner can petition to cancel a contract. The city or county must approve the contract cancellation.

Farmland Security Zone

In 1998, another option within the Williamson Act Program was established to provide additional property tax incentives for agricultural properties. The Farmland Security Zone (FSZ) was created to provide additional tax incentives for property owners to protect agricultural lands. Land restricted by a FSZ contract is valued for property assessment purposes at 65 percent of its Williamson Act valuation or 65 percent of its Proposition 13 valuation, whichever one is lower (Department of Conservation, 2004).

A FSZ contract is nearly identical to a Williamson Act contract. Farmland Security Zone contracts are established for a 20-year minimum term. Similar to a Williamson Act contract, these contracts renew annually unless a “notice of non-renewal” is filed. Lands within a FSZ are prohibited from being annexed from cities and special districts that provide non-agricultural services. School districts are also prohibited from acquiring FSZ lands for school facilities. For land to be eligible for the FSZ, the land must be designated as Prime Farmland, Farmland of Statewide Importance, Unique Farmland, or Farmland of Local Importance.

Williamson Act and FSZ contracts are not intended to be cancelled. Cancellation is typically reserved for unusual, “emergency” situations. Therefore, the 9-year non-renewal process has been identified as the legally preferred method for terminating a Williamson Act contract.

Criteria for Williamson Act Land Classification

The Williamson Act classifies land under different categories, Prime Agricultural Land, Non-Prime Agricultural Land, Land in Non-Renewal, Farmland Security Zone Land, Urban and Built-Up Land, and Non-Enrolled Land.

Prime Agricultural Land

- Land which is Class I or Class II in the NRCS Land Use Capability Classification System
- Land which rates 80 to 100 in the Storie Index Rating System
- Grazing lands with an annual carrying capacity equivalent to at least one Animal Unit per Acre (AUM) as defined by USDA
- Land planted to orchards or vineyards which have a nonbearing period of less than 5 years and will bring a normal return not less than two hundred dollars per acre
- Land which has agricultural returns producing an annual gross value of not less than two hundred dollars per acre for 3 of the previous 5 years

Non-Prime Agricultural Land

- Land which does not meet any of the criteria for classification as Prime Agricultural Land
- Land is defined as Open Space Land of Statewide Significance
- Typically this type of land is used agriculturally for grazing or non-irrigated crops

Land in Non-Renewal

- Land which is in the process of non-renewal

- Annual tax assessment gradually increases

Farmland Security Zone Land

- Land created within an agricultural preserve identified by the County Board of Supervisors upon request of landowner(s)

Urban and Built-Up Land

- Land occupied by structures with a density of at least 1 unit to 1.5 acres
- Data is provided by the California Department of Conservation's Farmland Mapping and Monitoring Program (FMMP)

Non-Enrolled Land

- Land not enrolled in the Williamson Act Program

Lands in Tehama County protected under the Williamson Act total 747,396 acres (Department of Conservation, 2004). Farm Security Zones are established on 11,364 acres. Currently, there are 8,763 acres that are placed into the Notice of Non-Renewal for Williamson Act contacts.

Conservation Easements

Over the past few years, a significant amount of farmland and other habitats, such as riparian, have been protected under permanent conservation easements. A conservation easement compensates the landowner for the fair market value of their property less than the restricted value, determined by an accredited appraiser.

California Department of Conservation's Farmland Mapping and Monitoring

The California Department of Conservation has established a FMMP in 1982. The primary goal of this program was to assess the location, quality, and quantity of agricultural lands and their conversion to other uses over time. Currently, the FMMP maps both agricultural and urban land use on over 90 percent of the state's private lands. Reports are compiled every 2 years. For a listing of categories, see page 19.

The Surface Mining and Reclamation Act

Requirements of the Surface Mining and Reclamation Act of 1975 (hereinafter the "Act") state that cities and counties must adopt an ordinance(s) "…which establishes procedures for the review and approval of reclamation plans and the issuance of a permit to conduct surface mining operations" (Public Resources Code Section 2774). The intent of this legislation is to ensure the prevention or mitigation of the adverse environmental impacts of mining, the reclamation of mined lands, and the production and conservation of mineral resources are consistent with recreation, watershed, wildlife, and public safety objectives (Public Resources Code 2712).

The Tehama County Zoning Code complies with the requirements of the Act by permitting "the commercial excavation of natural materials…in any (zoning) district upon the securing of use permits in each case. The excavation of natural materials shall be in conformance with all provisions of the Surface Mining and Reclamation Act of 1975 and future amendments thereto."

Also according to the Act, in association with regulations of the State Board of Mines and Geology, the State Geologist must identify mineral areas of the state, which are threatened by incompatible land uses that would preclude mining activities. These areas are to be classified as one of four Mineral Resource Zones (MRZ) or as a Scientific Zone. This classification system must be incorporated into the General Plan of cities and counties supporting mining operations, including dredging and quarrying, and is intended to ensure that mineral resources will be available when their development is necessary or economically feasible.

AGENCIES WITH PERMITTING AUTHORITY

Many agencies have permitting or review authority over projects in the Tehama West Watershed. These are summarized on Table 3-16.

DATA GAPS

No major data gaps were identified in the area of land use. However, almost all data presented was for Tehama County with no mechanism for isolation of sub-units within the watershed.

CONCLUSIONS AND RECOMMENDATIONS

- Support monitoring of watershed health that provides information regarding agricultural viability, water quality, and habitat conditions

- Assess aquatic and riparian habitat and reaches that have undergone gravel extraction. If warranted, make recommendations to mitigation impacts from gravel extraction

- Evaluate aggregate mining to ensure compliance with current policies and best management practices

- Modify extraction activities as necessary to reduce impacts on salmonid habitat and other aquatic resources

- Initiate education programs for wise grazing management and reduce year round use of foothill uplands

- Work with local land owners to limit farmland conversion where possible

- Encourage retention of large ownerships to enhance stewardship and management efficiency for agricultural resources, fuels management, and preservation of open space

- Work with Tehama County to develop erosion control guidelines to minimize sediment input associated with construction and development activities. Encourage practical protective construction techniques that encourage enlightened self interest among road builders

- Continue to employ the most ecologically sound timber harvesting practices by following the Forest Plan (USFS) and Resource Management Plan (BLM) on federal lands and THP rules on private lands within the watershed

- Modify and employ the most ecologically sound grazing practices by following the Forest Plan and Resource Management Plan on federal lands and through partnerships on private and state-owned land within the drainage

- Encourage habitat restoration in areas associated with agricultural lands

- Encourage the concept of the working watershed aspect of land use—managing and producing natural resources as a land use goal

Table 3-16
PERMIT-ISSUING AGENCIES

Agency	Function
Agencies with Permitting Authority	
Tehama County	The County has land use jurisdiction over all lands outside of incorporated cities. Before construction can begin, the County reviews the project and grants its approval. If the County has jurisdiction, it must also serve as the "lead agency" for purposes of complying with the California Environmental Quality Act (CEQA). Encroachment and building permits, use permits and zoning administration all fall under the purview of Tehama County. In addition to the Planning Department, the Tehama County Public Works and Health Departments may also issue permits and establish conditions for construction projects.
State Lands Commission	The State Lands Commission has exclusive jurisdiction over all submerged lands owned by the State as well as the beds of navigable rivers, sloughs and lakes. The Commission has the authority to grant three kinds of permits (1) mineral extraction leases; (2) dredging permits (required for any dredging of navigable waterways for improvement of navigation, reclamation of flood control); and (3) land use leases (required for any proposal to utilize navigable waterways for any purpose other than dredging, e.g. piers, floats, docks).
California Department of Fish and Game (DFG)	The Department of Fish and Game has jurisdiction over "all water in the state," including any lakes, streams or rivers containing fish or wildlife resources. In Tehama County, such resources include the Sacramento River and all natural streams, creeks and drainage ways leading to it. The DFG has also claimed authority over all other local drainage facilities. The DFG has authority over two permitting processes: (1) streambed alteration agreements, required for any project that alters the flow of any lake, stream or river on the state; and (2) suction dredging permits, required for projects involving suction or vacuum dredging activities in state waters.
Regional Water Quality Control Board (RWQCB)	The Regional Board maintains jurisdiction over discharges into all rivers, creeks, streams and canals. Their agency also has jurisdiction over groundwater quality. Any project that will discharge wastes into any surface waters must conform to waste discharge requirements established by the RWQCB. These requirements serve as the Federal National Pollution Discharge Elimination System (NPDES) permit. The RWQCB also works to obtain coordinated action in water quality control, including prevention and abatement of water pollution and nuisances.
California Department of	CALTRANS has the authority over all state highways and freeway rights-of-way,

Table 3-16 PERMIT-ISSUING AGENCIES	
Agency	**Function**
Transportation (CALTRANS)	including easements, and undeveloped rights-of-way that have been acquired in anticipation of future construction. Any project that proposes to construct a road connection or perform earthwork adjacent to a state highway or freeway must obtain an encroachment permit from Caltrans.
United States Army Corps of Engineers	Pursuant to the Rivers and Harbors Act, the Corps maintains jurisdiction over all navigable waterways (including non-navigable streams, creeks, and marshes) and requires a permit for any work within these waterways, including dredging and filling. The U.S. Army Corps of Engineers operates the Black Butte Lake recreation area, which spans the county line of Tehama and Glenn Counties.
Tehama County Air Quality Management District	This regional agency regulates stationary sources of air pollution within the County. The District's boundaries are the same as Tehama County. The District's Board of Directors is the Board of Supervisors. The District's main purpose is to enforce local, state and federal air quality laws, rules and regulations. Sources of air pollution include industrial development and commercial businesses with air emissions such as lumber product companies and gasoline stations. The district also regulates open outdoor burning and a variety of other programs such as Air Toxic Control Measures (ATCM's) and New Source Performance Standards (NSPS). The District issues permits to ensure that all equipment and processes comply with federal and state laws and regulations, and District rules. Before any person builds, erects, alters, replaces, operates or uses anything that may cause emissions of air contaminants, a permit must be obtained from the District.
Agencies with Review Authority	
Local Agency Formation Commission (LAFCO)	LAFCO has authority over land use decisions affecting local agency boundaries, including city limits and sphere of influence boundaries for each of the three incorporated cities (Corning, Red Bluff, and Tehama) including various special and community services districts within Tehama County. Any proposed changes to city limits or sphere of influence boundaries must be reviewed and approved by the LAFCO.
California Department of Parks and Recreation	Parks and Recreation reviews development projects in relation to state recreational facilities and grants for local facilities. Within the Department of Parks and Recreation, the State Office of Historic Preservation is the designated State Historic Preservation Office (SHPO) and monitors State and Federally registered historic resources, as well as carrying out other statutory responsibilities.
California State Clearinghouse	The State Clearinghouse is the point of contact for review of environmental documents where one or more state agencies will be a responsible or trustee agency. The Clearinghouse circulates environmental documents among state agencies, coordinates review and forwards comments to the lead agency.
California Department of Forestry and Fire Protection (CDF)	The California Department of Forestry and Fire Protection is responsible for fire protection in all State Responsibility Areas (SRAs) of the County, including emergency response. The CDF is also responsible for the management and protection of natural resources, oversees the enforcement of California's Forest Practice Regulations that guide timber harvesting on private lands. Although, not a permitting agency, the CDF reviews development proposals including land divisions, new home construction and road construction for compliance with State Fire Safe Regulations adopted by the Board of Forestry in Title 14 of the California Administrative Code. These regulations govern emergency access standards, signing/addressing, emergency water supply, fuel modification and defensible space.
California Mining and Geology Board	Mines and Geology reviews petitions (by an individual or organization) to classify specific lands that contain significant mineral deposits and that are threatened by land use incompatibilities. Mineral lands classified as having regional or statewide significance, in accordance with California's Surface Mining and Reclamation Act (SMARA), ultimately must be recognized in the County General Plan through

Table 3-16 PERMIT-ISSUING AGENCIES	
Agency	**Function**
	adoption of an appropriate and compatible land use designation and through establishment of policies and implementation programs for conservation and development of these resources.
United States Environmental Protection Agency (EPA)	EPA has review authority over environmental documents that are prepared and circulated pursuant to the National Environmental Protection Act (NEPA). The EPA can comment on draft environmental impact statements (EISs). NEPA requires final EISs to be filed with the EPA. The EPA has authority over development projects pursuant to Section 404 of the Clean Water Act, an authority that overlaps with that of the Army Corps of Engineers. Generally, the EPA reviews Department of Army permits for compliance with guidelines for implementing Section 404 requirements. The EPA can, in rare cases, override an Army Corps of Engineers decision on a Department of Army permit in order to prohibit discharges into waterways.
United States Fish and Wildlife Service (USFWS)	The Fish and Wildlife Service must be consulted on all federal projects, such as Army Corps of Engineers/Department of Army permits, pursuant to the Fish and Wildlife Coordination Act. The Service comments on potential project effects on "endangered or threatened" plant and animal species under the Federal Endangered Species Act. In reviewing a project, the Fish and Wildlife Service could issue a "jeopardy" determination and would propose alternatives to the permitting agency, in a manner similar to the State Department of Fish and Game process. The Fish and Wildlife Service also comments on potential effects on fish and wildlife resources.
Bureau of Land Management (BLM)	The bureau is part of the Department of the Interior, and is a multiple-use land management agency responsible for administering 270 million acres of public land located primarily in the Western United States, including Alaska. The BLM manages many resource programs such as minerals, forestry, wilderness, recreation, fish and wildlife, wild horses and burros, archaeology and rangeland. Within Tehama County, the BLM manages approximately 120,730 acres of land.
U.S. Forest Service	The Forest Service is a division of the United States Department of Agriculture and is responsible for the management of the Tehama National Forest, which encompasses approximately 1,079,971 acres of land and lies within portions of Colusa, Lake, Glenn, Mendocino, Tehama and Trinity Counties. Within Tehama County, The National Forest includes approximately 174,000 acres of land. The Forest Service is responsible for the management of timber, mineral extraction, fire management and prevention, recreation, law enforcement, cultural, wildlife resources, fisheries, watersheds, soils, noxious weeds, ranges, etc. on government lands.
Tribal Governments	Native American tribes in Tehama County control many thousands of acres of land and manage the natural resources of those lands. Of these natural resources, the most important are forests, fish, wildlife and water quality. Government Code mandates that tribes be consulted whenever a County adopts, amends or revises a general plan.

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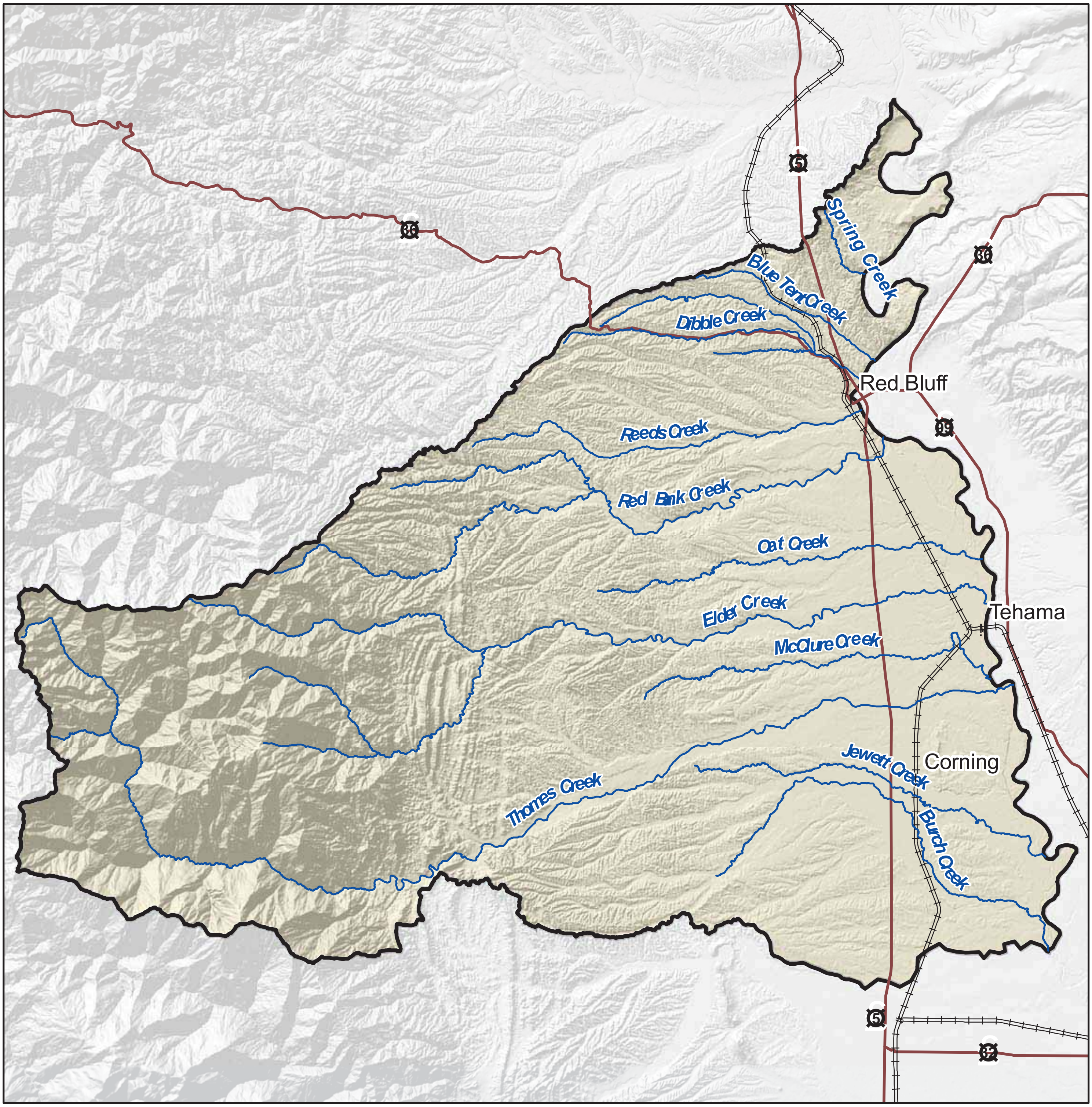


Legend

Railroad

Major Highway

MajorTributary

Tehama West Watershed

! Incorporated Cities

VESTRA

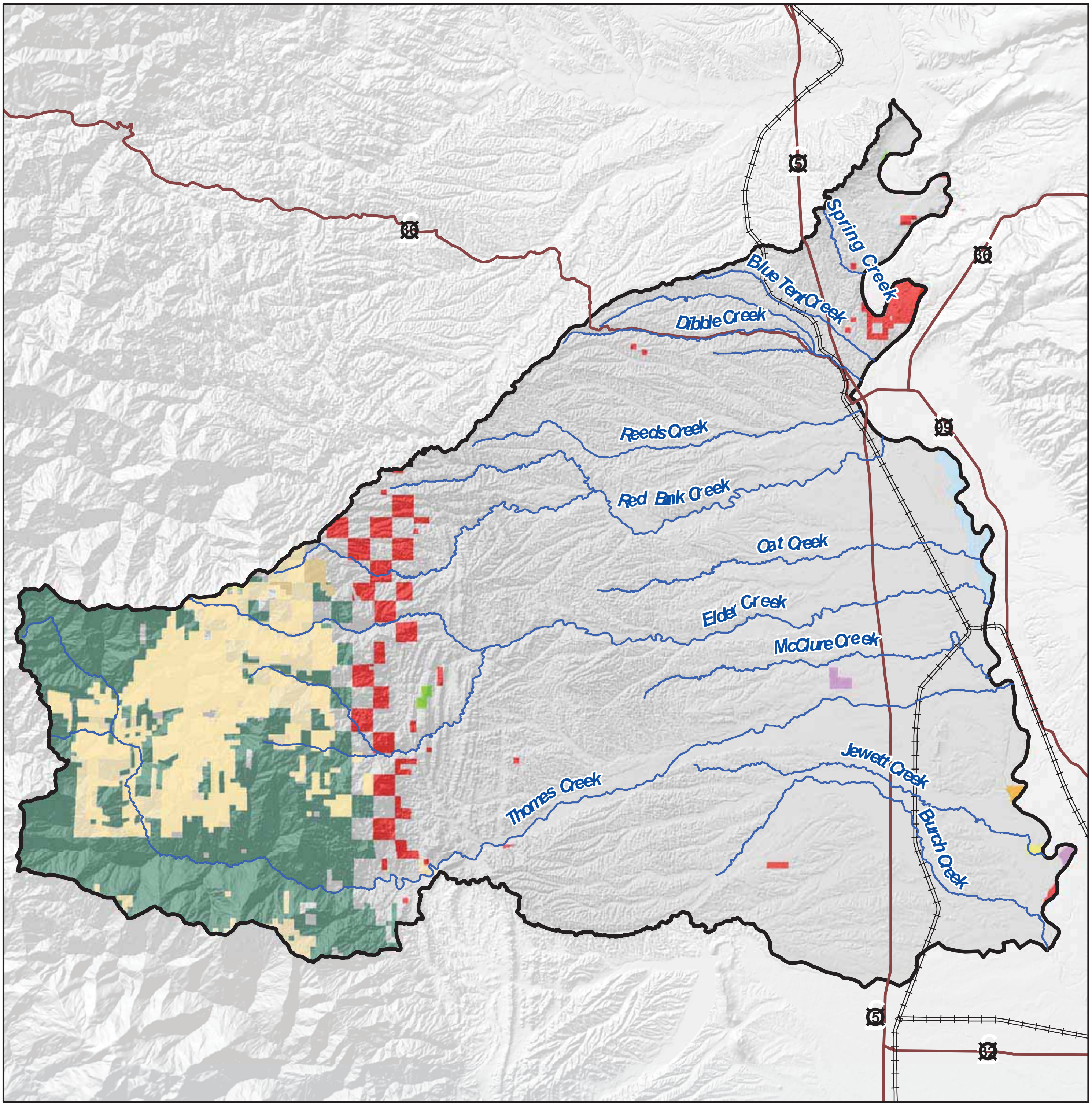
0 2.5 5 10 Miles

FIGURE 3-1

INCORPORATED CITIES

TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY



Legend

- Railroad
- Major Highway
- Major Tributary
- Tehama West Watershed
- Bureau Of Land Management (14,745 acres)
- CA Dept of Fish and Game (760 acres)
- CA Dept of Parks and Recreation (260 acres)
- Department of Defense (27 acres)
- State Lands Commission (410 acres)
- The Nature Conservancy (250 acres)
- US Fish and Wildlife Service (2767 acres)
- USDA Forest Service (83,826 acres)
- Private (508,592 acres)
- Crane Mills (55,530 acres)
- Sierra Pacific Ind. (1,001 acres)

VESTRA 5

0 2.5 5 10 Miles

FIGURE 3-2
GENERAL OWNERSHIP
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

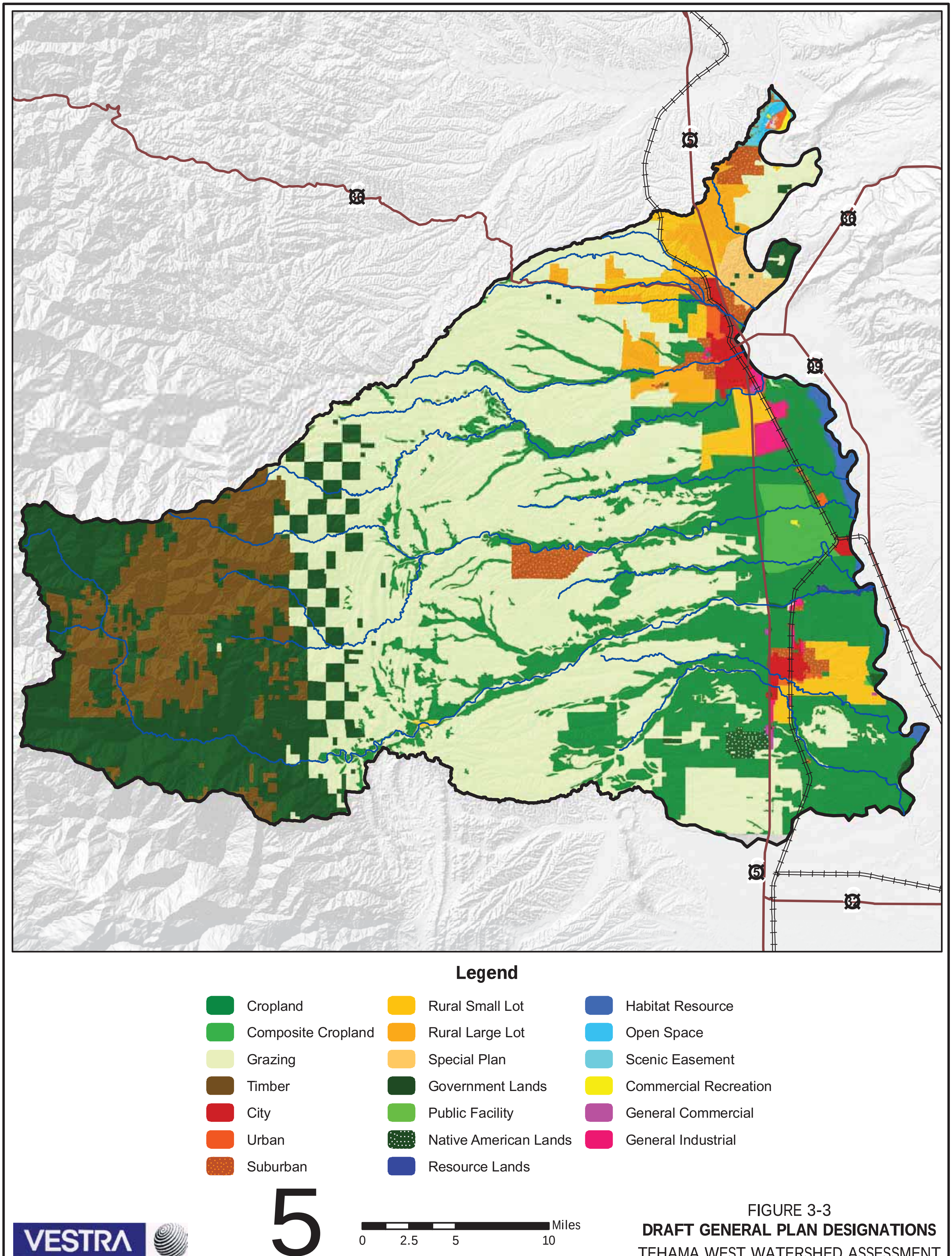
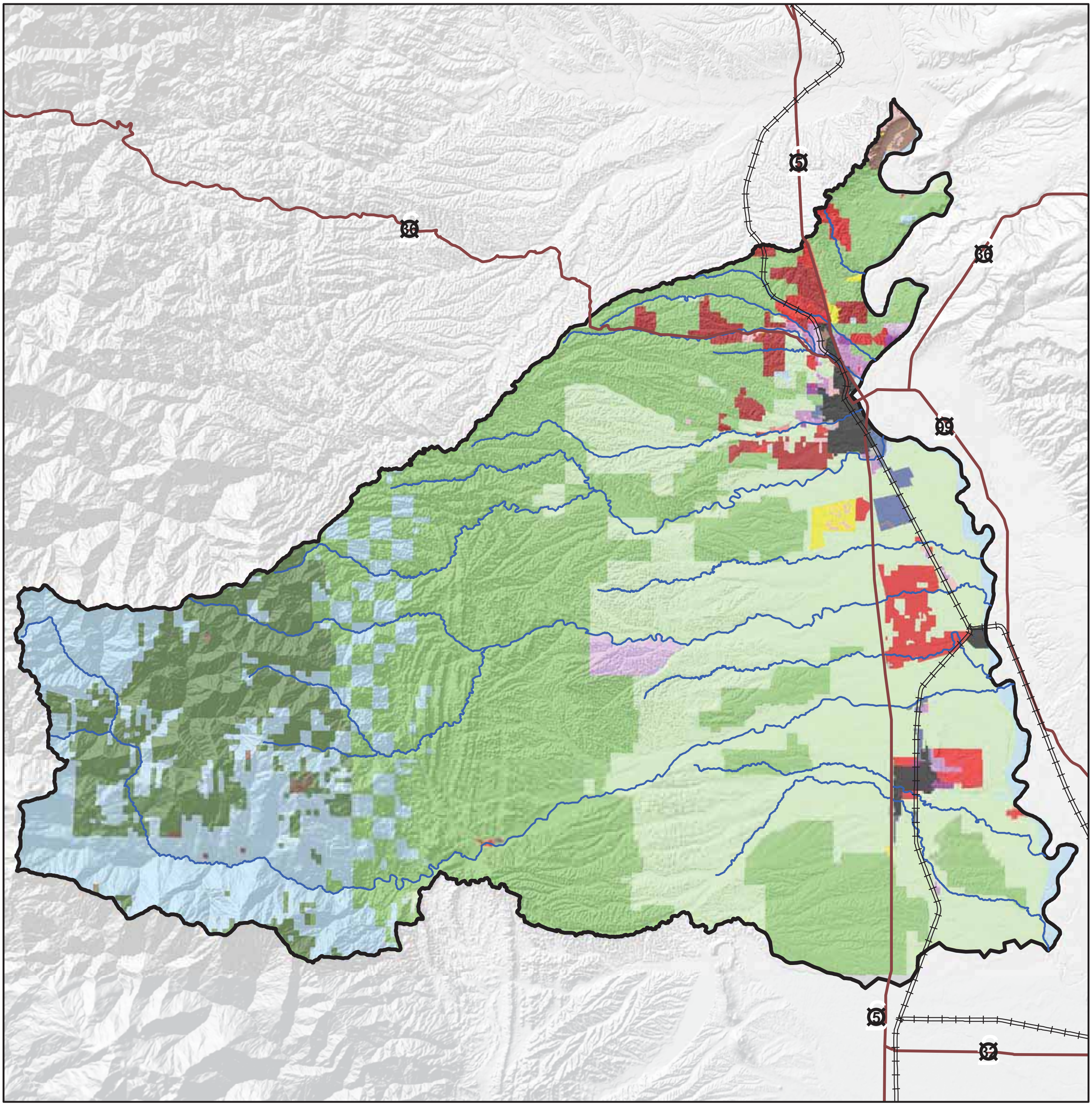


FIGURE 3-3
DRAFT GENERAL PLAN DESIGNATIONS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY 2005



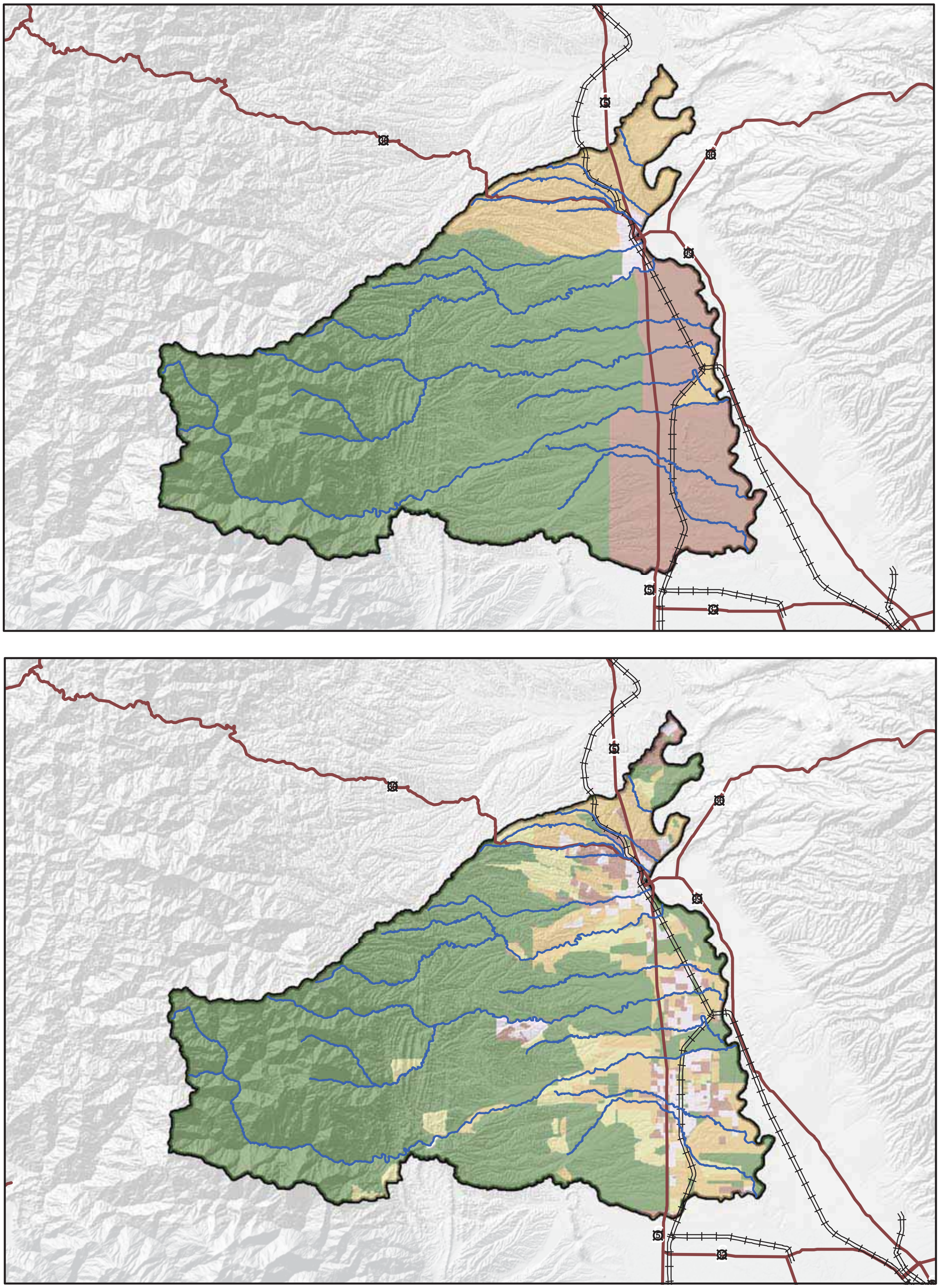
Legend

Railroad	Commercial	One Family Residential District	General Apartment District
Major Highway	City	One Family Residential District < 10 acres	Residential Estate District
Major Tributary	Agricultural Exclusive District	One Family Residential District 100 acres	Residential Estate District < 10 acres
Tehama West Watershed	General Recreation District	One Family Residential District 250 acres	Residential Estate District 100 acres
Airport District	Industrial	One Family Residential District > 250 acres	Residential Estate District > 100 acres
	Public	Two Family Residential District	Timber Preserve District
	Planned Development District	Neighborhood Apartment District	Upland Agricultural District

0 2.5 5 10 Miles

FIGURE 3-4
ZONING DISTRICTS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY



1990
Census
Population
Density

2000
Census
Population
Density

Legend

Railroad	Tehama West Watershed	10 - 50 persons per sq. mile
Major Highway	0 - 5 persons per sq. mile	50 - 100 persons per sq. mile
Major Tributary	5 - 10 persons per sq. mile	>100 persons per sq. mile

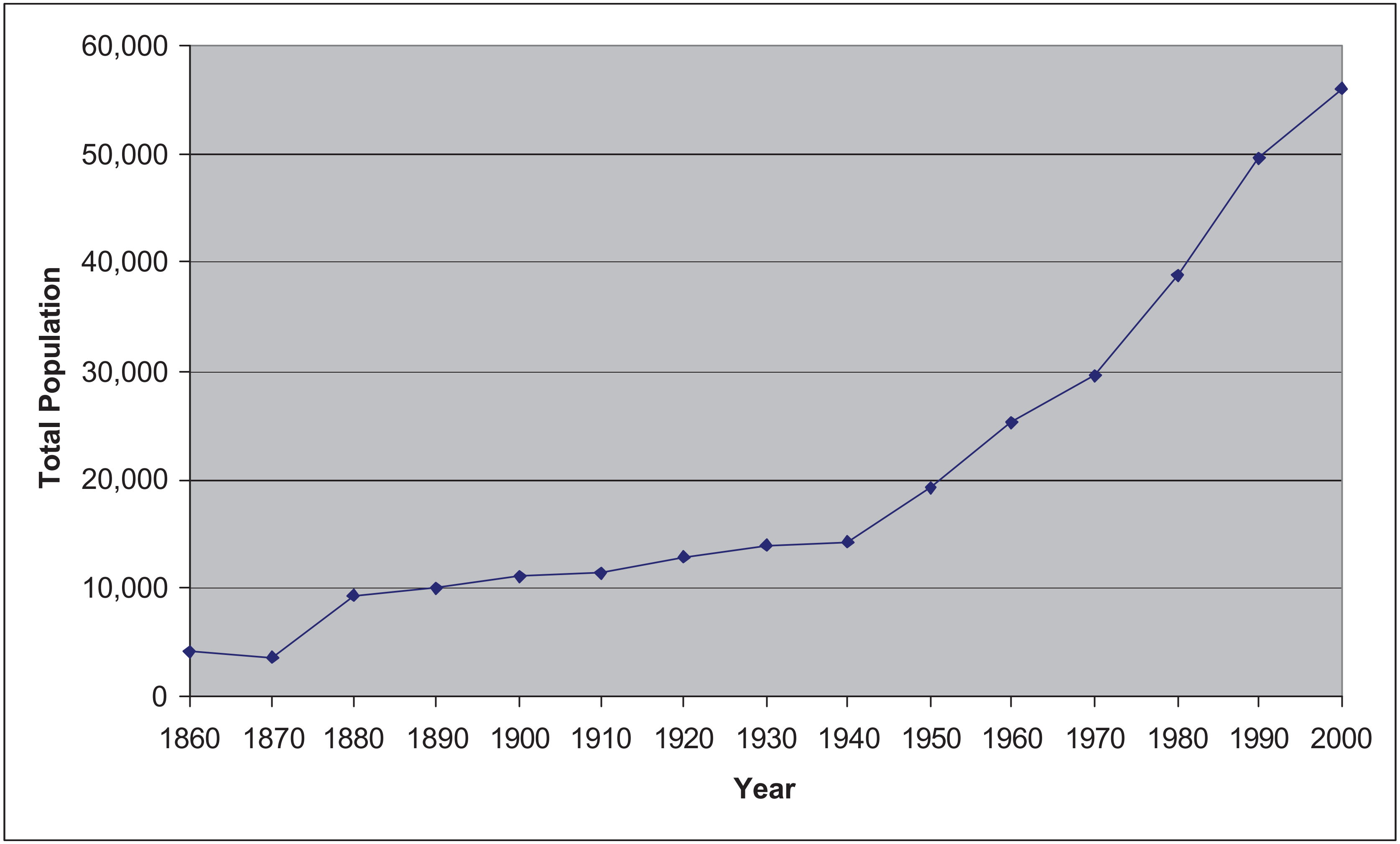
VESTRA

5

0 5 10 20 Miles

FIGURE 3-5
1990 AND 2000 POPULATION DENSITIES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY, 2000 CENSUS DATA



VESTRA

FIGURE 3-6
HISTORICAL POPULATION DATA
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: UNIVERSITY OF VIRGINIA LIBRARY, 2005

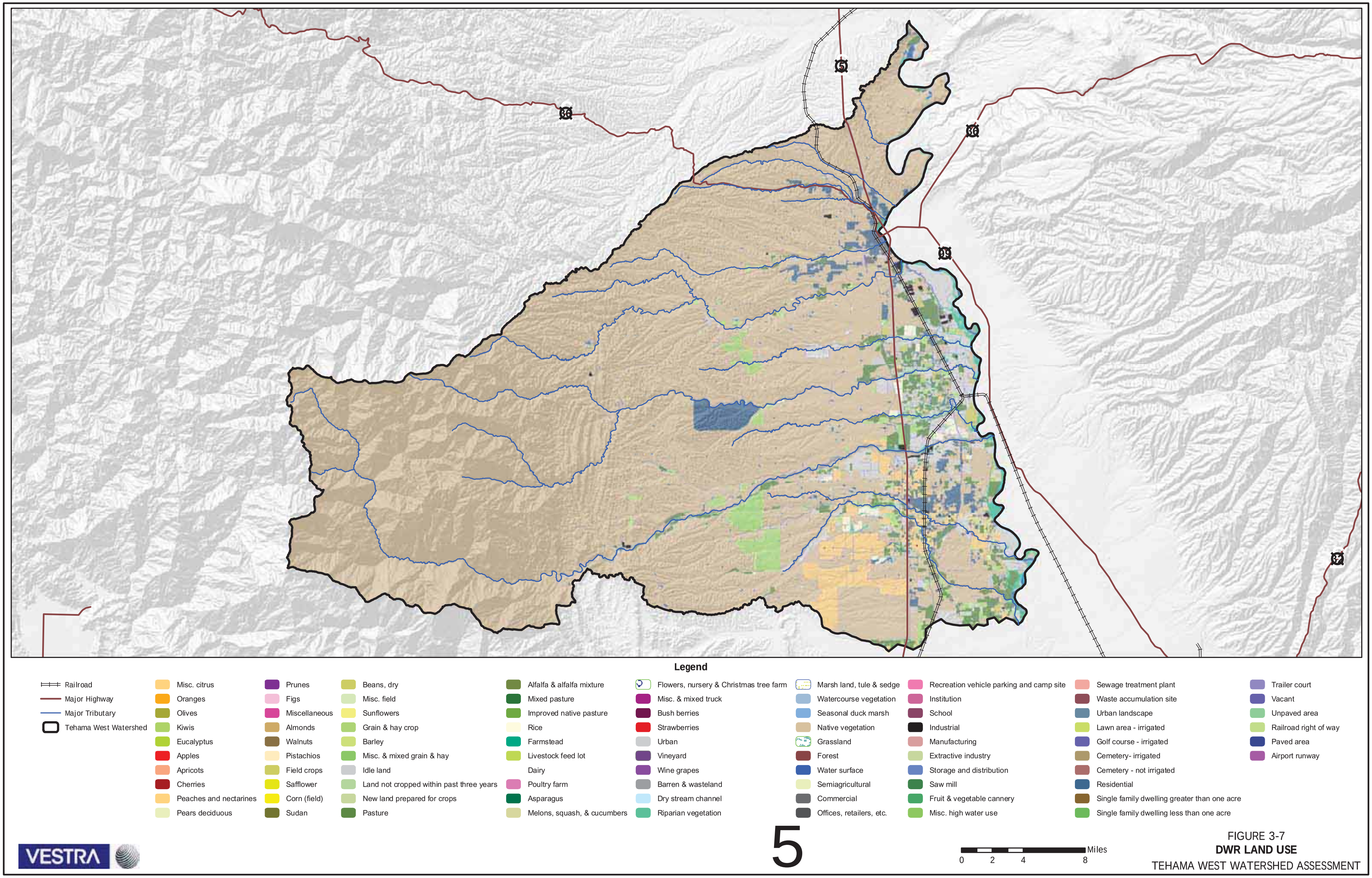
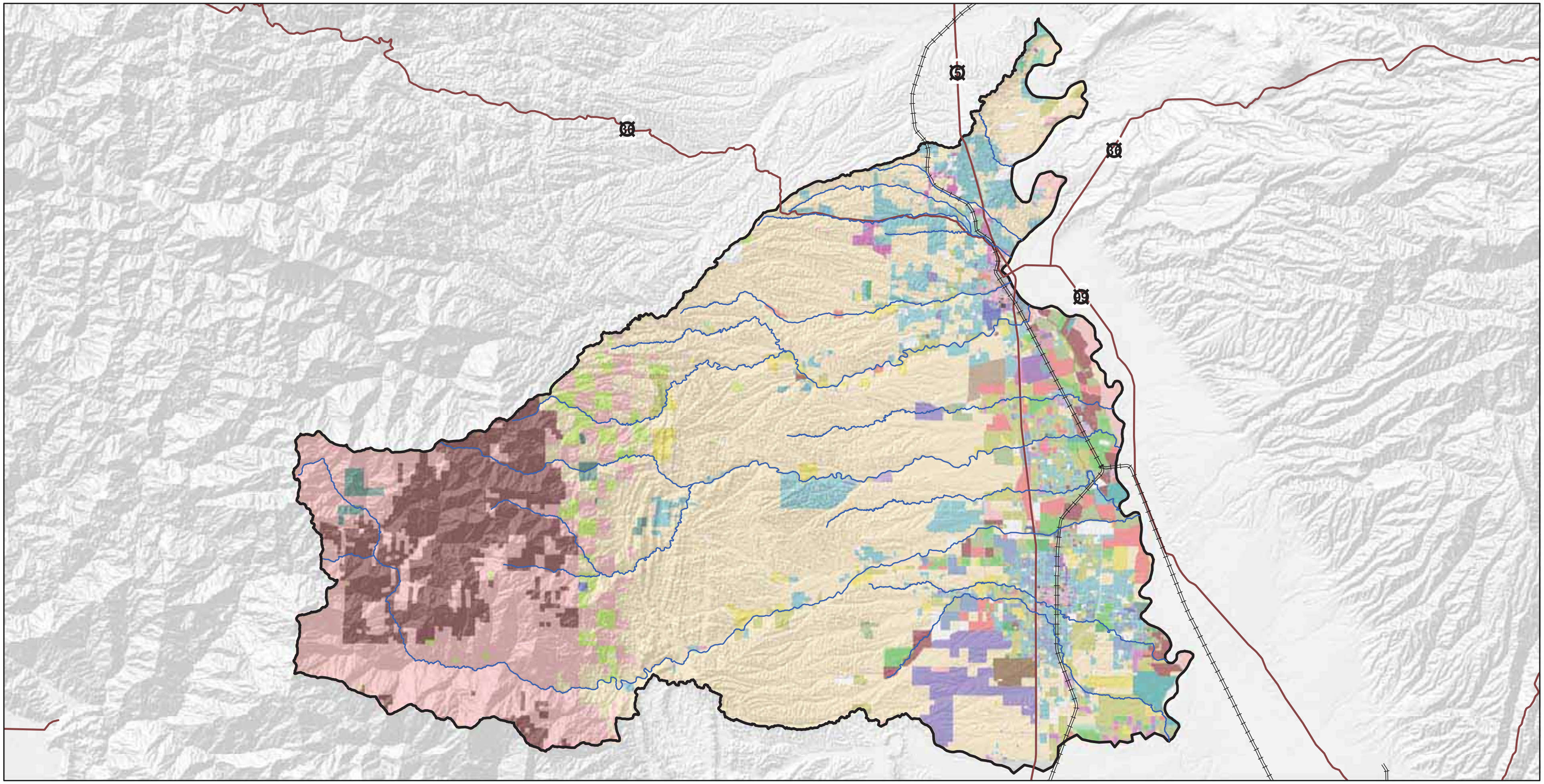


FIGURE 3-7
DWR LAND USE
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: DEPARTMENT OF WATER RESOURCES



Legend

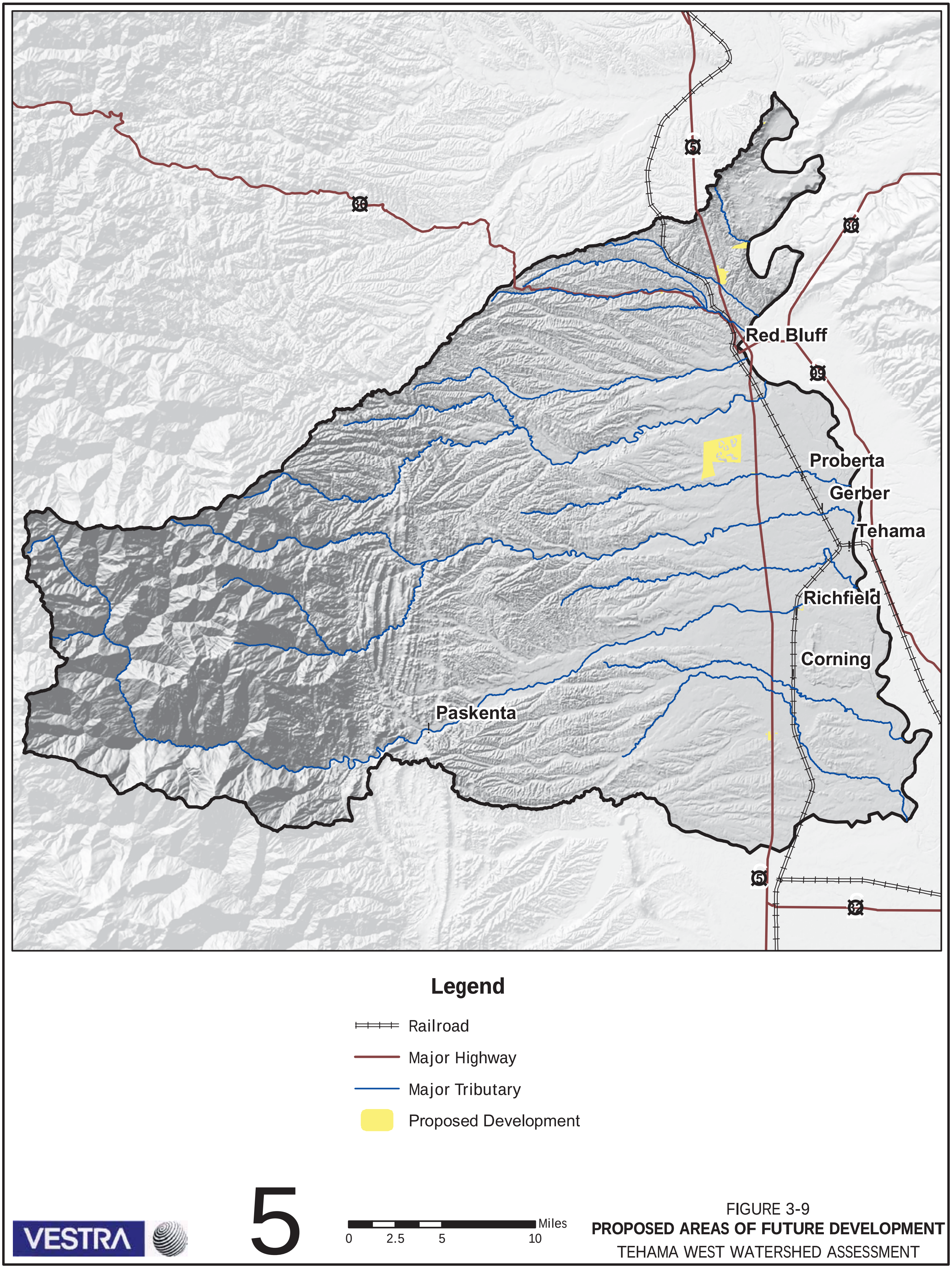
Railroad
Major Highway
Major Tributary
Tehama West Watershed
Other
Agricultural Commodities
Apartments
Camps
City Owned Property
Commercial Use Codes
County Government
Dairies - Irrigated
Duplex and Doubles
Extractable Commodities - Rights
Farm/Construction Machines
Federal Government
Feed Lots - Irrigated
Field Crops
Field Crops - Irrigated
Heavy Industry
Irrigated Almond Orchard
Irrigated Misc. Orchard
Irrigated Olive Orchard
Irrigated Prune Orchard
Irrigated Walnut Orchard
Light Manufacturing
Lumber
Mineral Processing
Misc. Commercial
Misc. Industrial
Misc. Items
Misc. Land
Misc. Recreational
Orchard
Packing Plants
Parking Lots - Private
Parks
Pasture
Pasture (Dry Grazing)
Pasture - Irrigated
Poultry - Irrigated
Private Owned Golf Club
Private Recreation
Privately Owned Hospitals
Processing Plants
Recreational Land
Residential Common Area
Restaurants - Bars - Theaters
Restaurants-Bars-Theaters
Rivers and Lakes
Row Crops - Irrigated
Rural Residence
Single Family Dwellings
Special Districts
Specialty Farms
Specialty Homes
State Government
Three and Four Units
Timber Land
Trailer Parks
Unclassified
Utility
Vacant Industrial Land
Vacant Land
Vine & Bush Fruits - Irrigated
Volunteer Fire Departments
Warehouse
Water Sources

VESTRA 5

0 2 4 8 Miles

FIGURE 3-8
TEHAMA COUNTY LAND USE
TEHAMA WEST WATERSHED ASSESSMENT

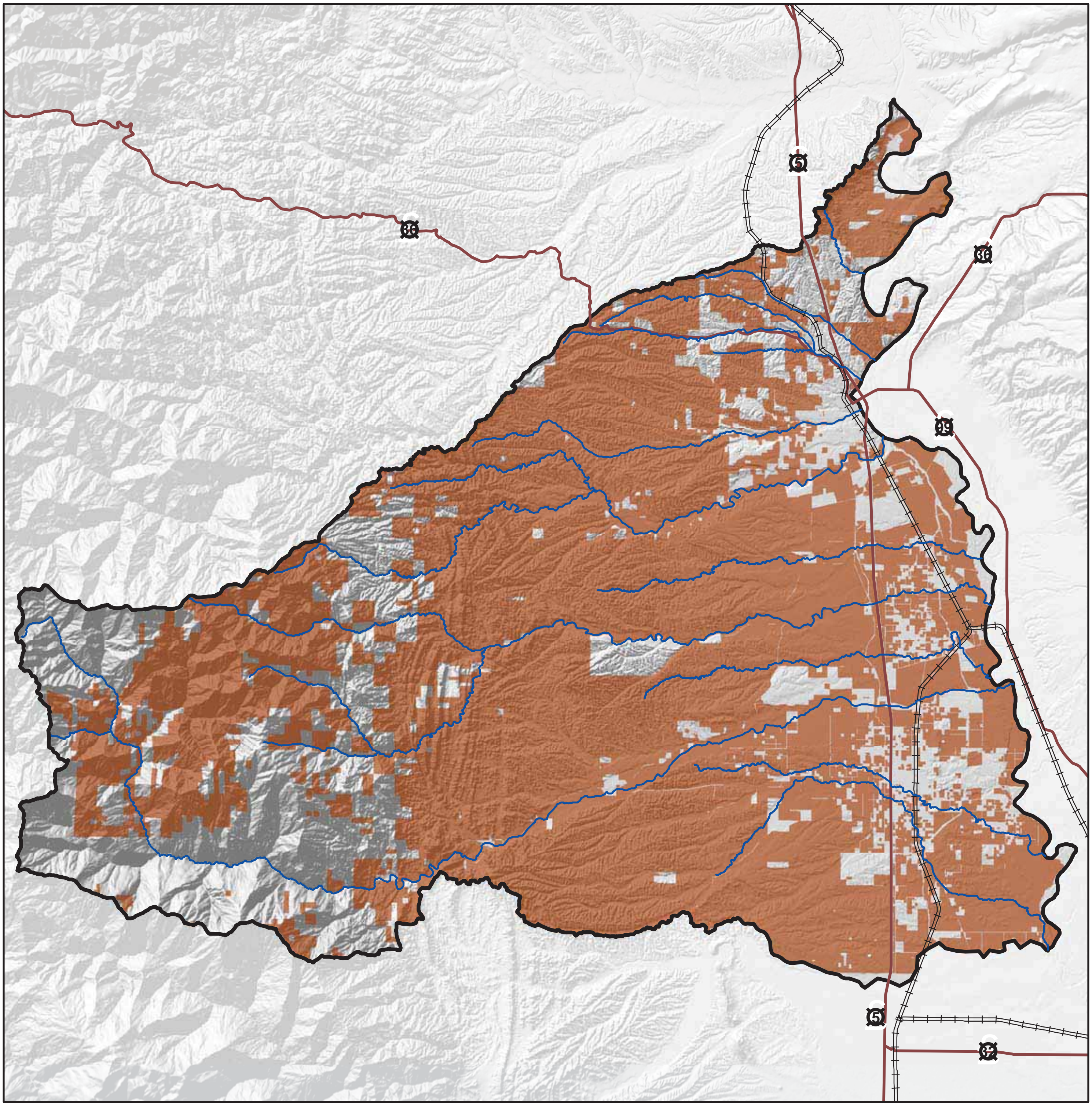
SOURCE: TEHAMA COUNTY, 2004



VESTRA

FIGURE 3-9
PROPOSED AREAS OF FUTURE DEVELOPMENT
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY, 2005



Legend

Railroad

Major Highway

Major Tributary

Agricultural and Timber Land Use

5

0 2.5 5 10 Miles

VESTRA

FIGURE 3-10
AGRICULTURAL LANDS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY, 2005

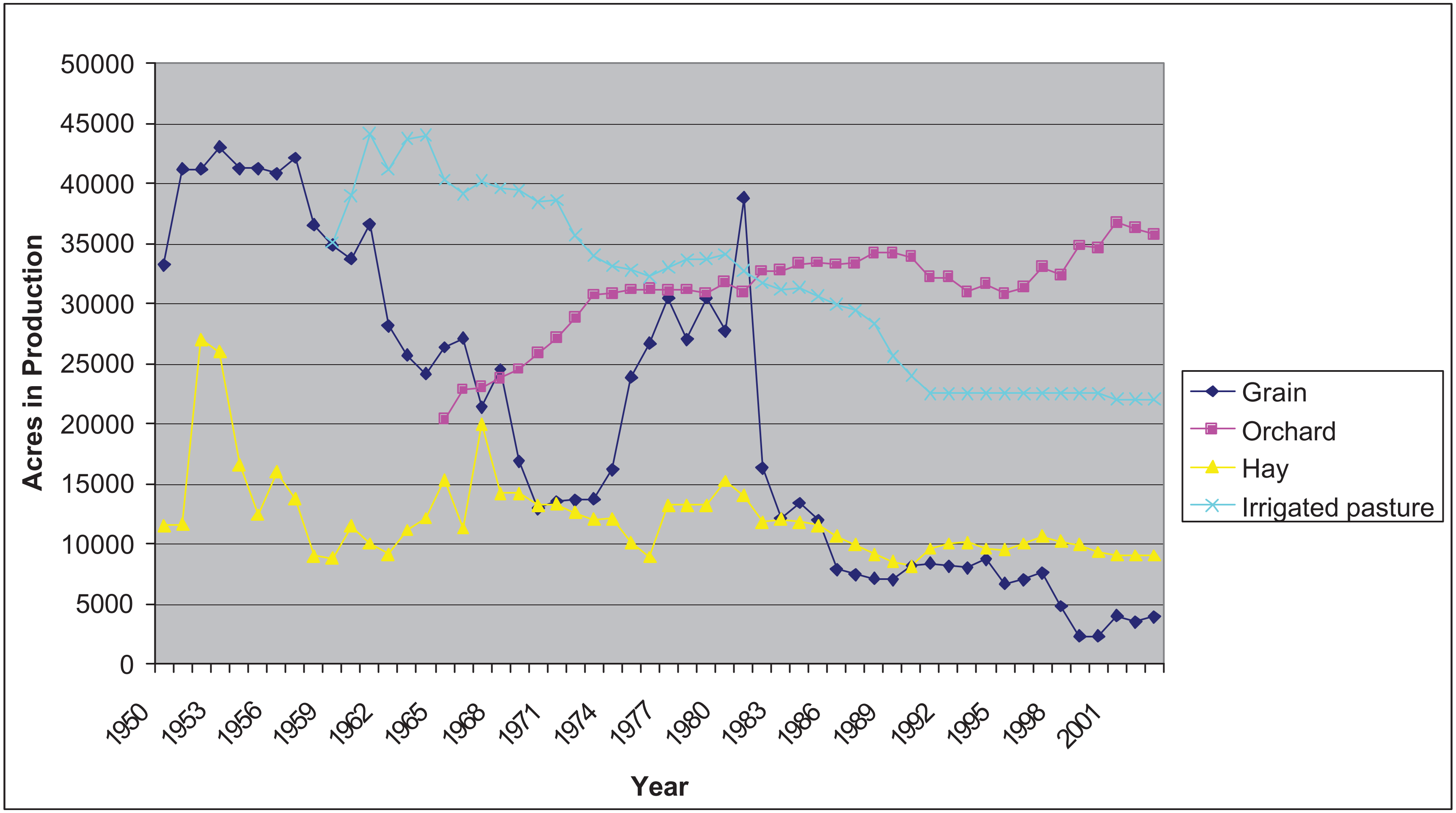


FIGURE 3-11
MAJOR CROP TYPES, 1950-2003
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS

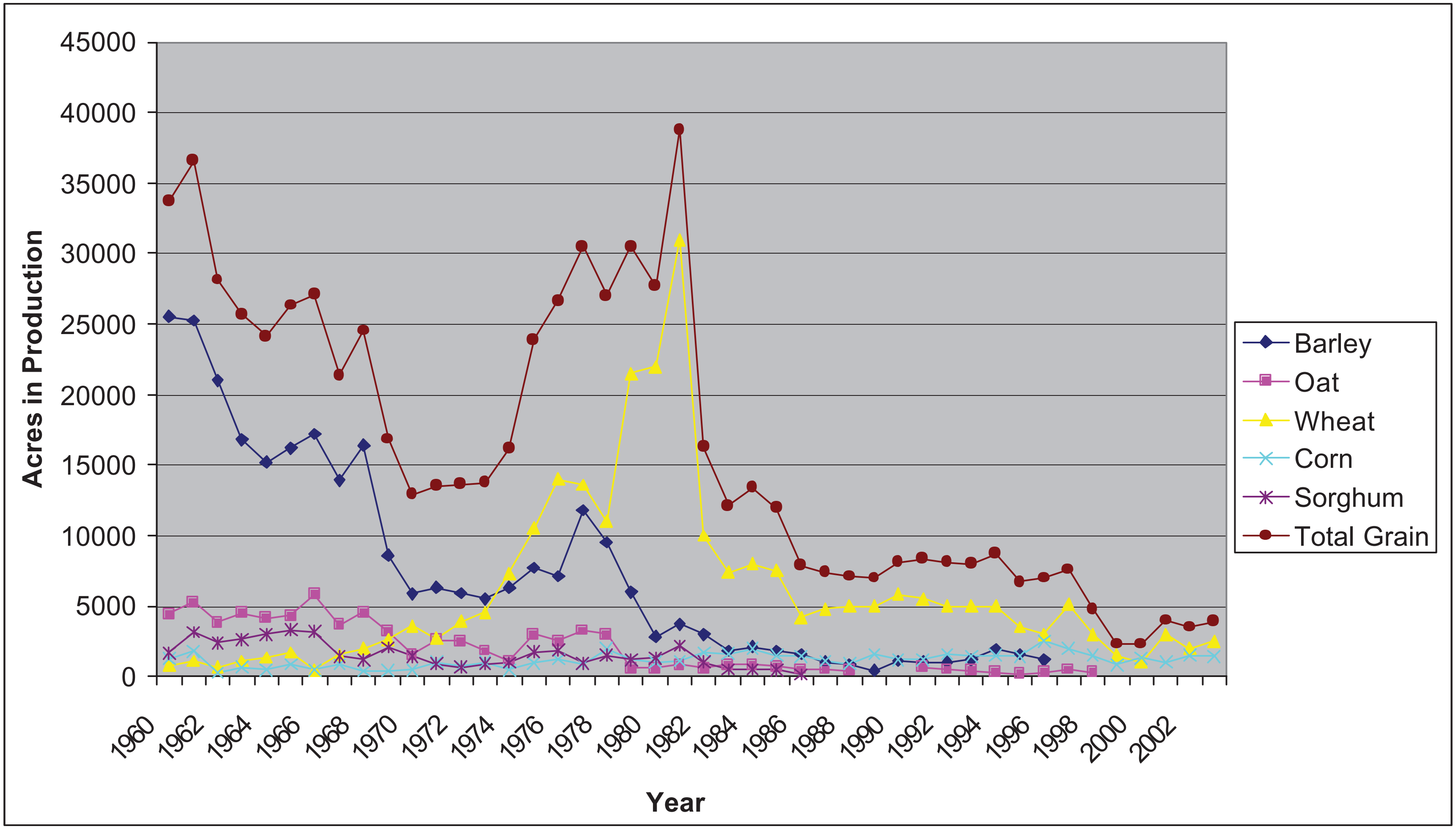
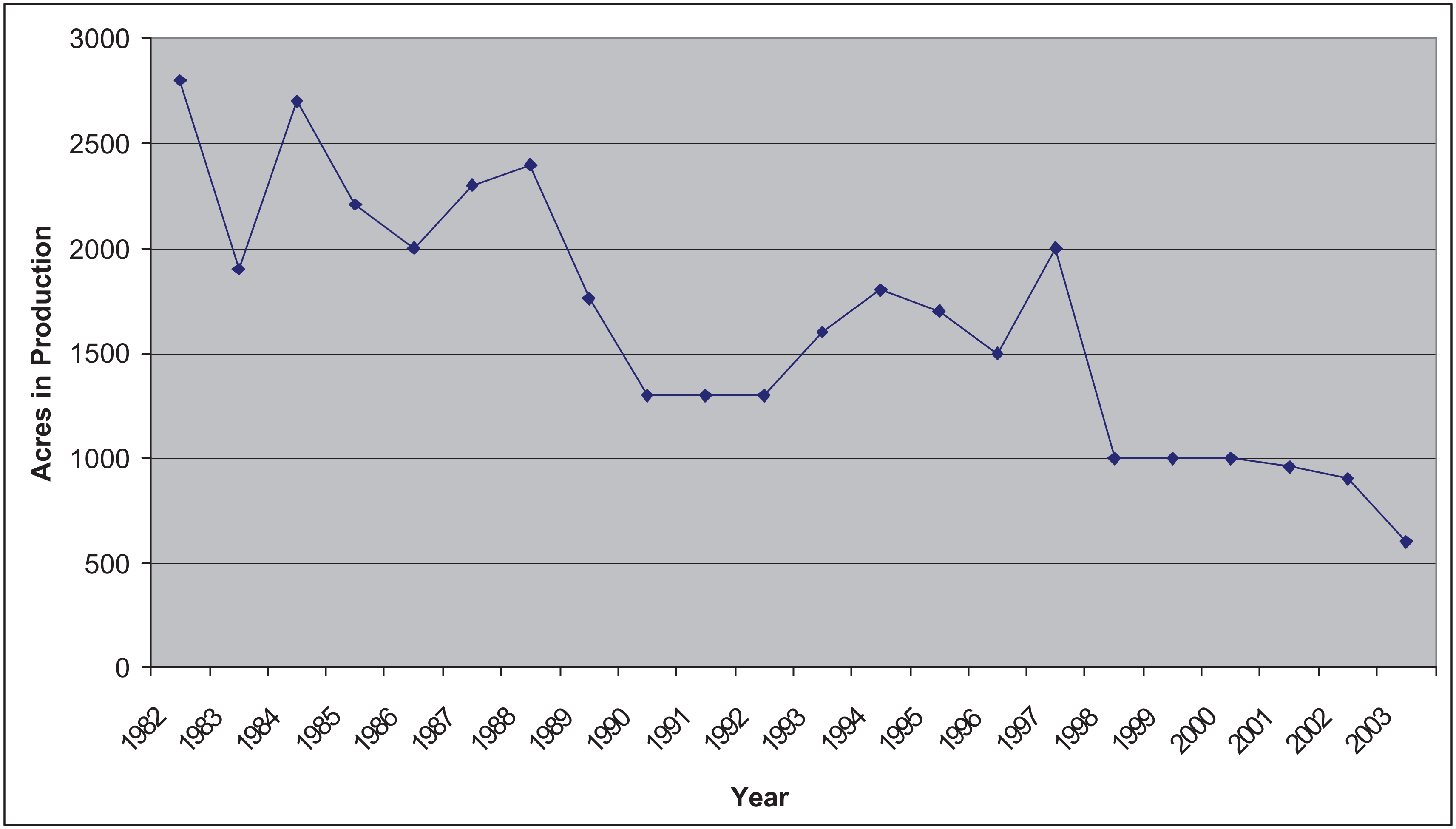


FIGURE 3-12
GRAIN PRODUCTION, 1960-2002
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS



VESTRA

FIGURE 3-13
RICE PRODUCTION, 1982-2003
TEHAMA WEST WATERSHED

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS

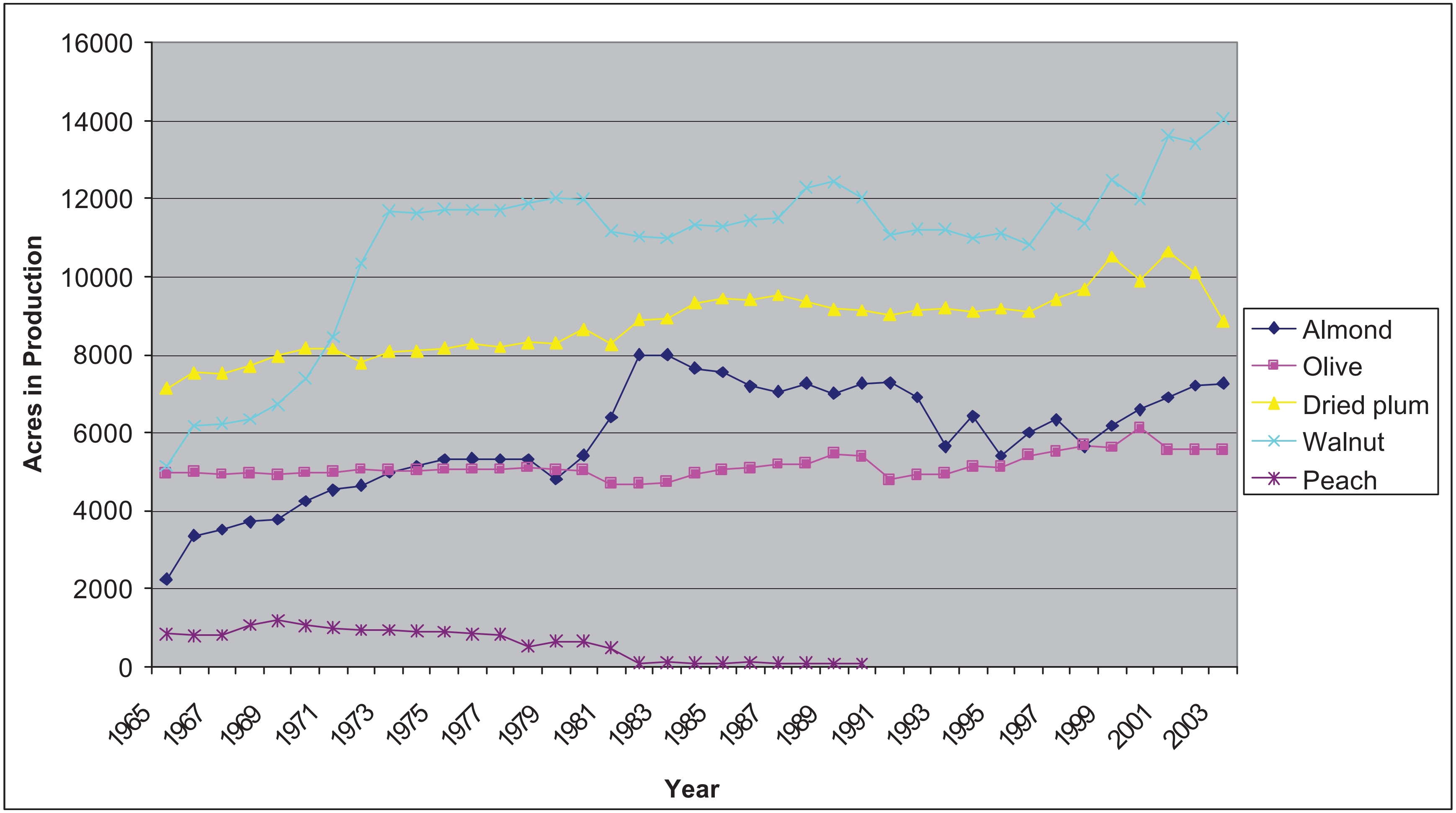
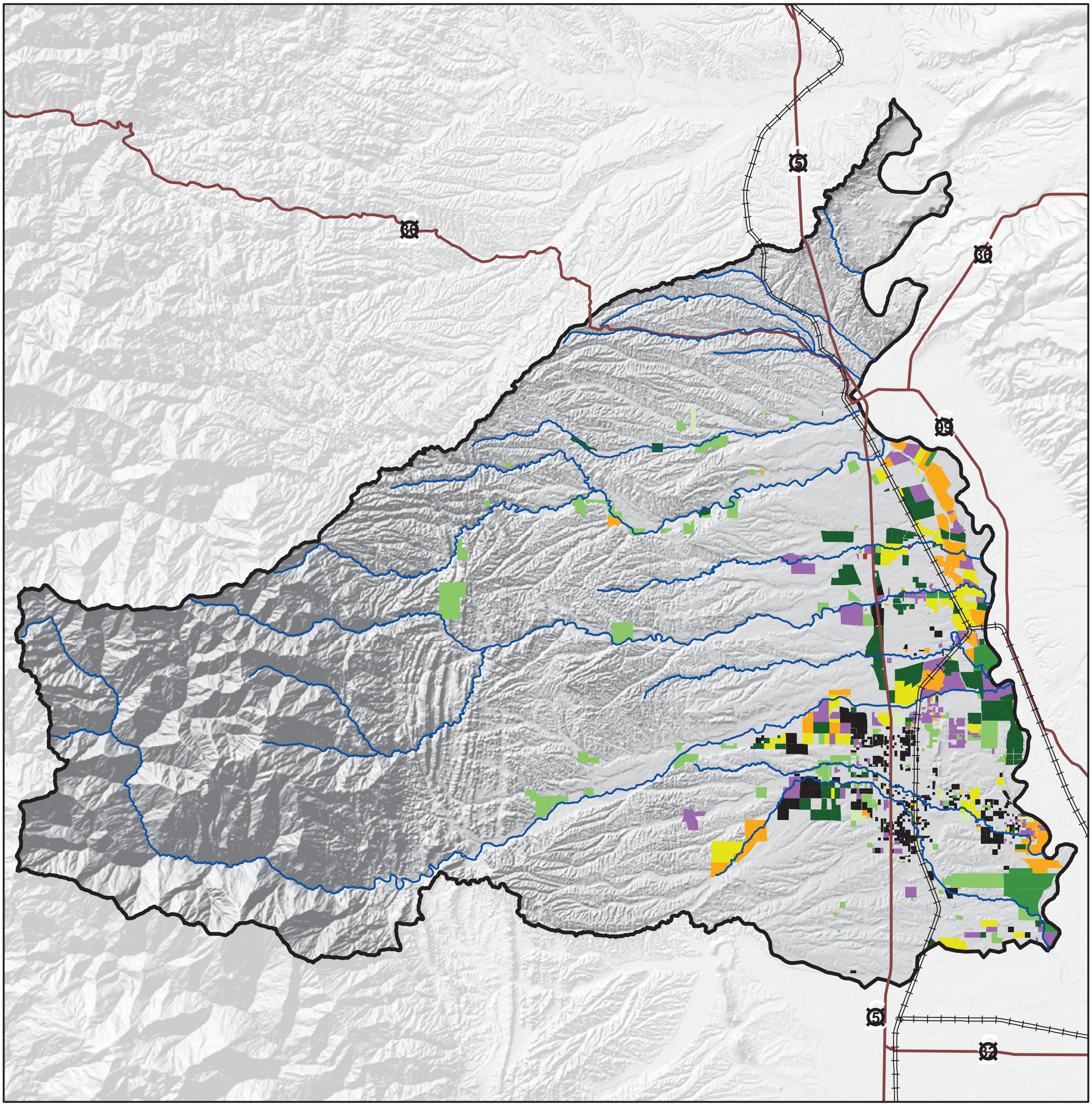


FIGURE 3-14
ORCHARD PRODUCTION, 1965-2003
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS



Legend

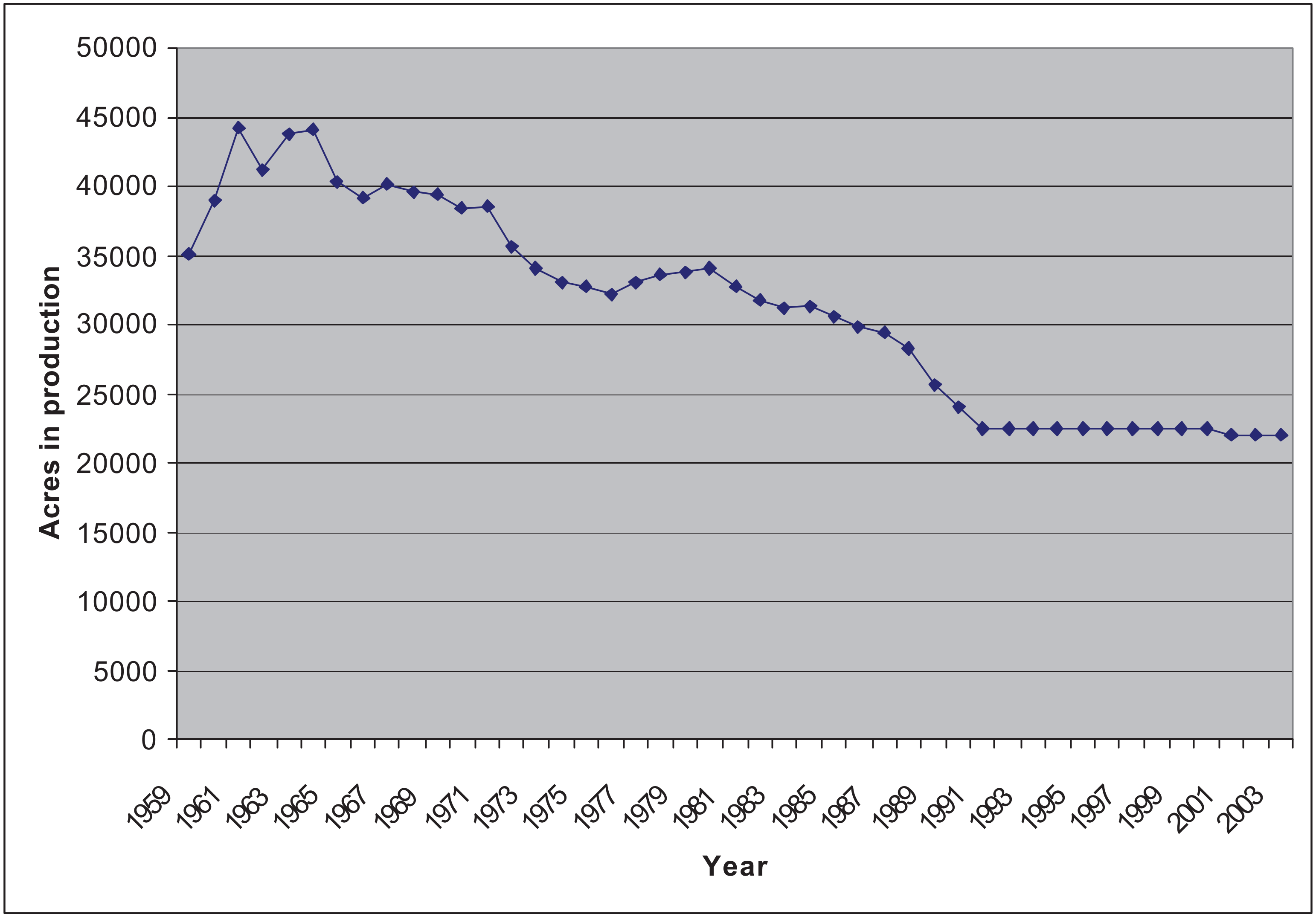
- Railroad
- Major Highway
- Major Tributary
- Field Crops
- Orchard
- Field Crops - Irrigated
- Row Crops - Irrigated
- Irrigated Olive Orchard
- Irrigated Prune Orchard
- Irrigated Walnut Orchard
- Irrigated Almond Orchard
- Irrigated Misc. Orchard
- Vine and Bush Fruits - Irrigated

VESTRA

0 2.5 5 10 Miles

FIGURE 3-15
CROP TYPES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY, 2005



VESTRA

FIGURE 3-16
IRRIGATED PASTURE PRODUCTION, 1958-2003
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS

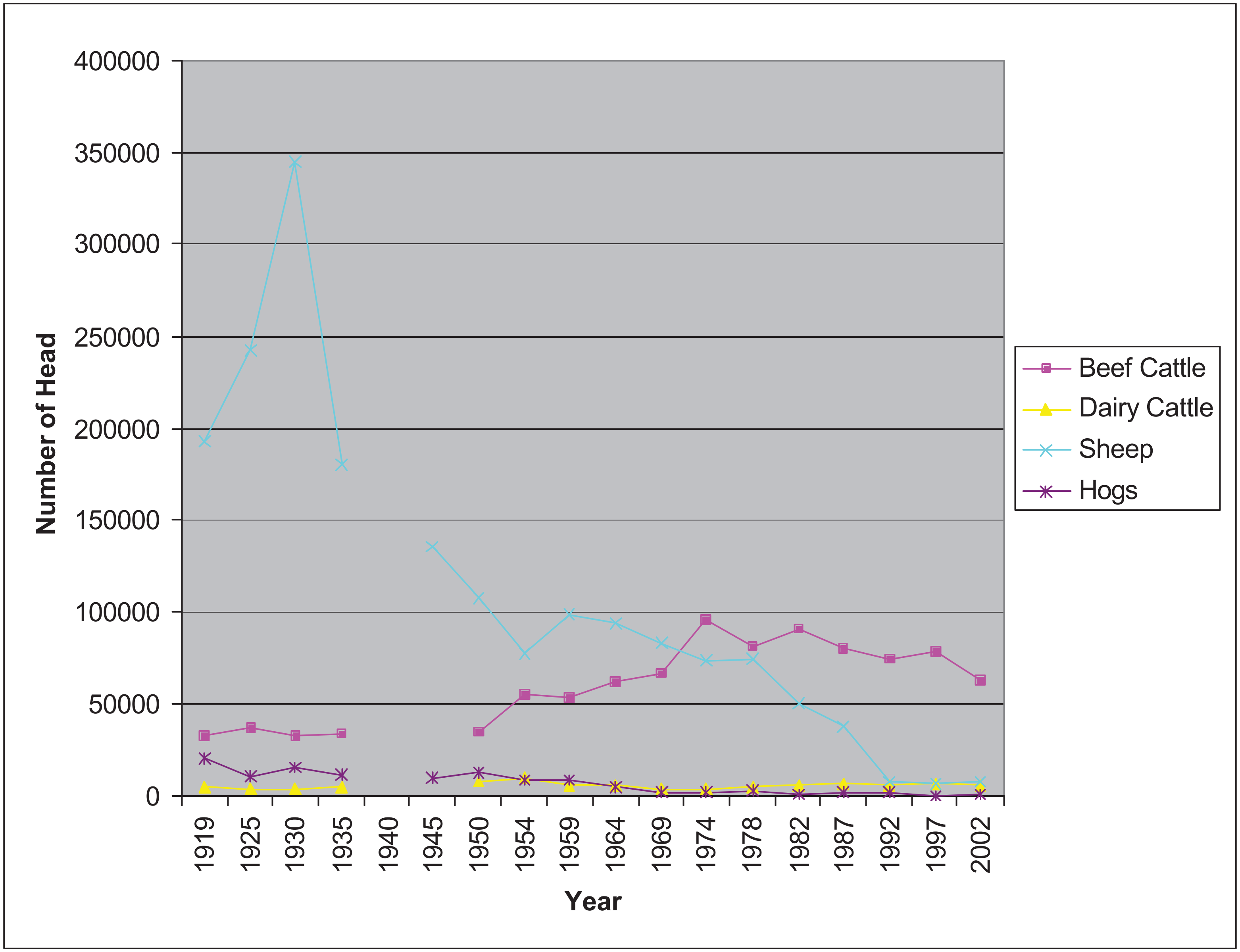


FIGURE 3-17
LIVESTOCK PRODUCTION, 1919 - 2002
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS

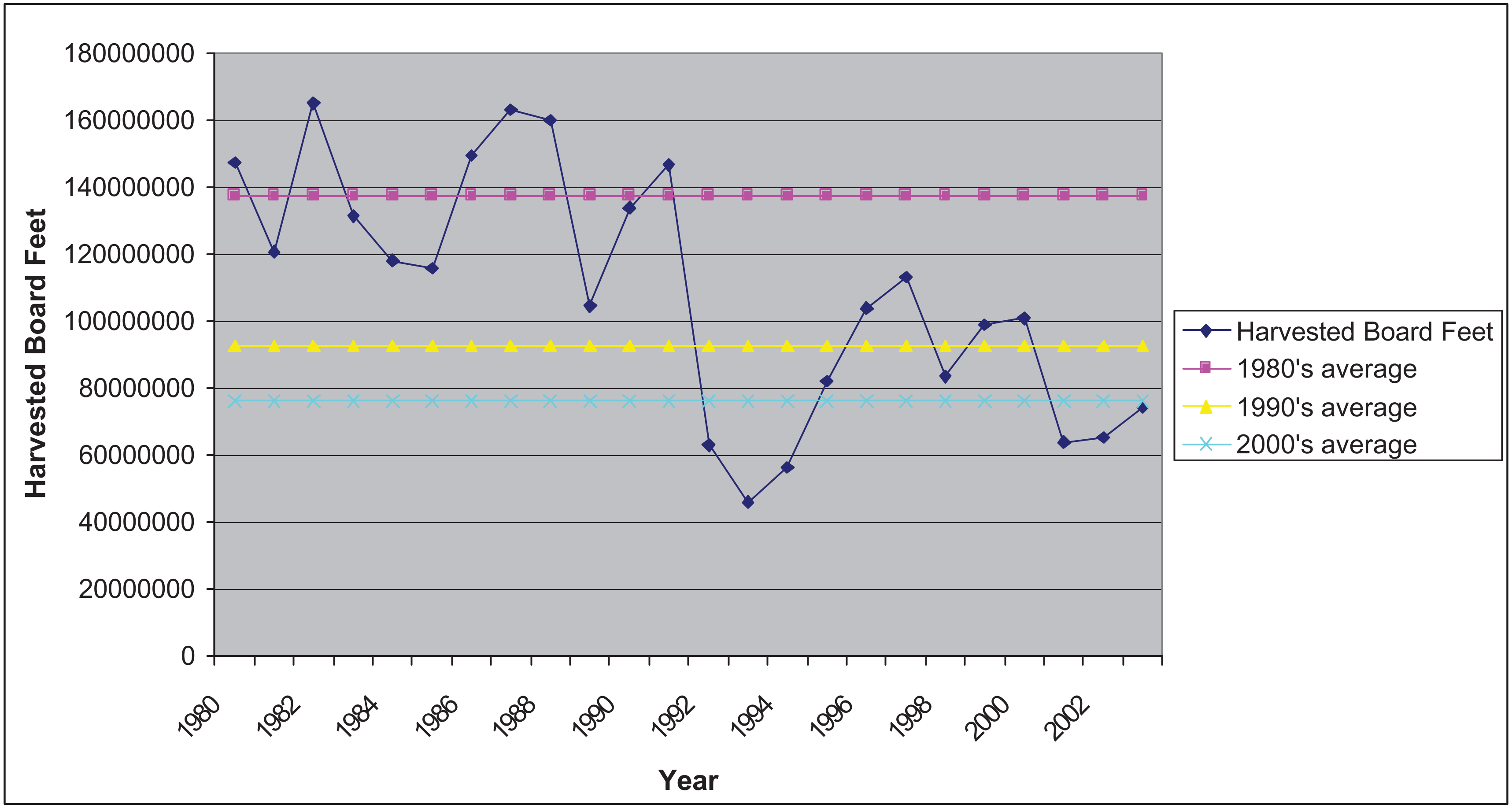
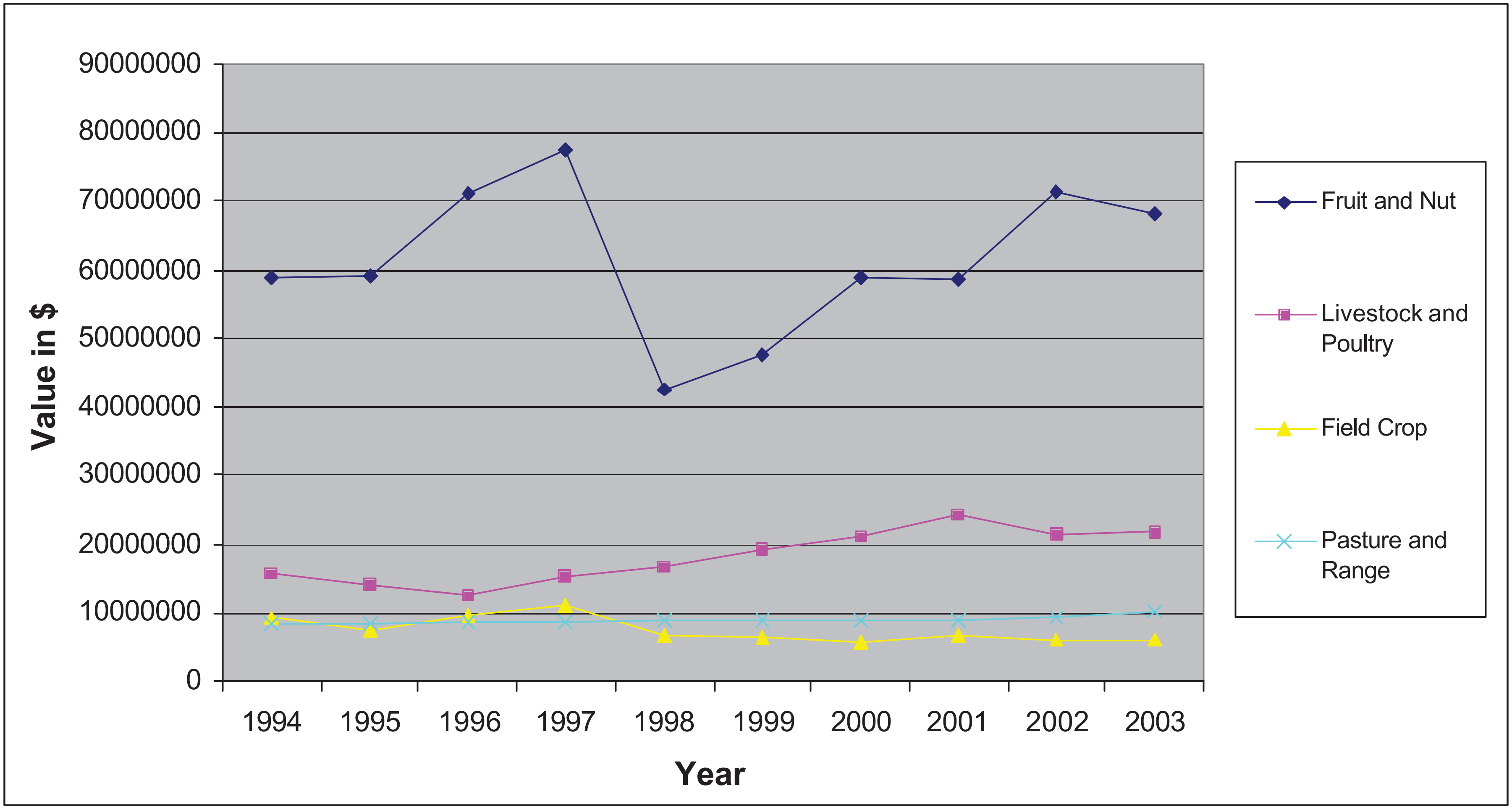


FIGURE 3-18
TIMBER PRODUCTION, 1980-2003
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS



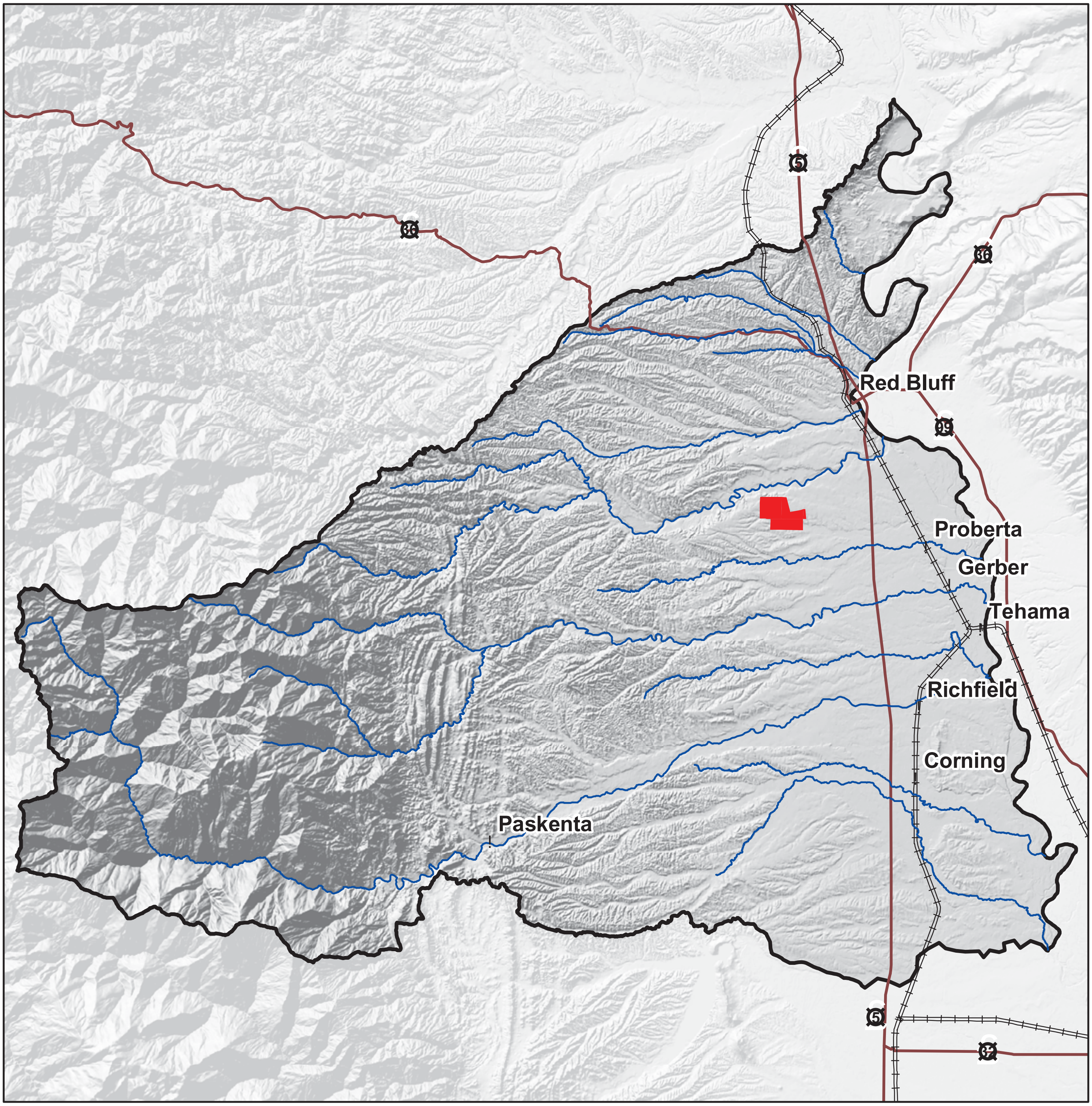
VESTRA

FIGURE 3-19

AGRICULTURE COMMODITY VALUE TRENDS, 1994-2003

TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS



Legend

- Railroad
- Major Highway
- Major Tributary
- Conservation Easements

5

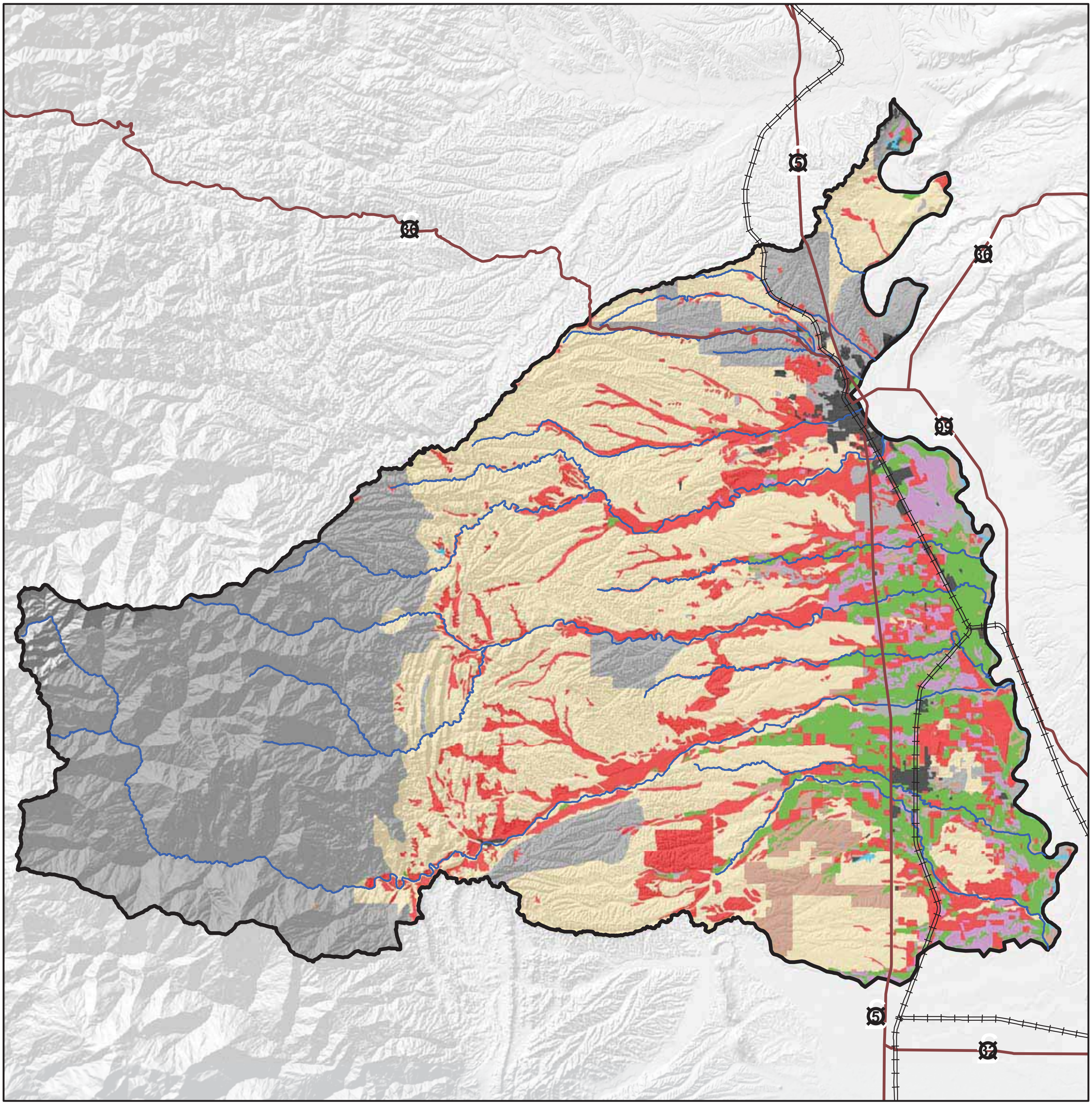
0 2.5 5 10 Miles

FIGURE 3-20

CONSERVATION EASEMENTS

TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY, 2005



Legend

Railroad	Farmland of Local Importance
Major Highway	Prime Farmland
Major Tributary	Farmland of Statewide Importance
Tehama West Watershed	Unique Farmland
Urban and Built Up Land	Water
Grazing Land	Other Land

5

0 2.5 5 10 Miles

VESTRA

FIGURE 3-21
FARMLAND MAPPING PROGRAM
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF CONSERVATION, DIVISION OF LAND RESOURCE PROTECTION

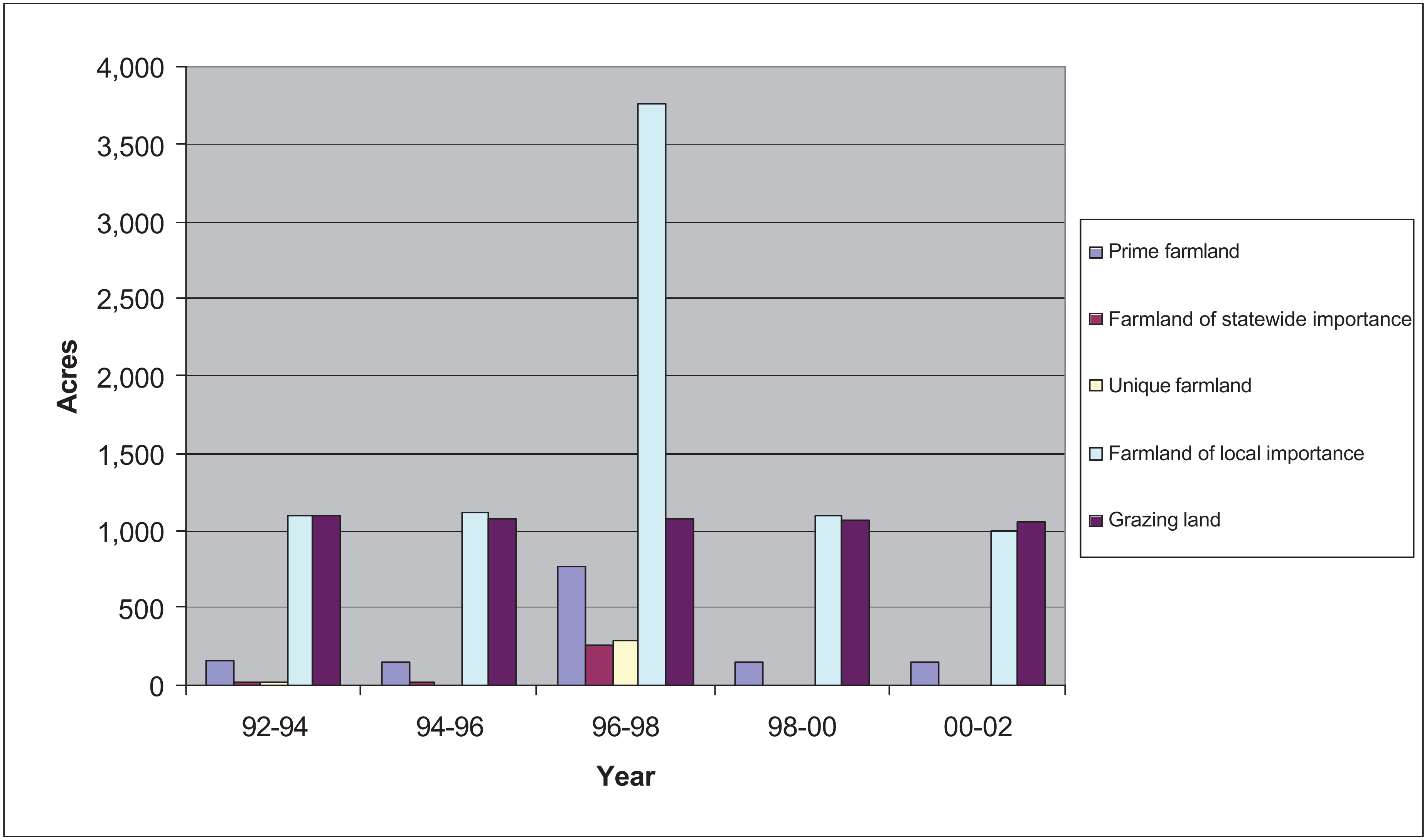
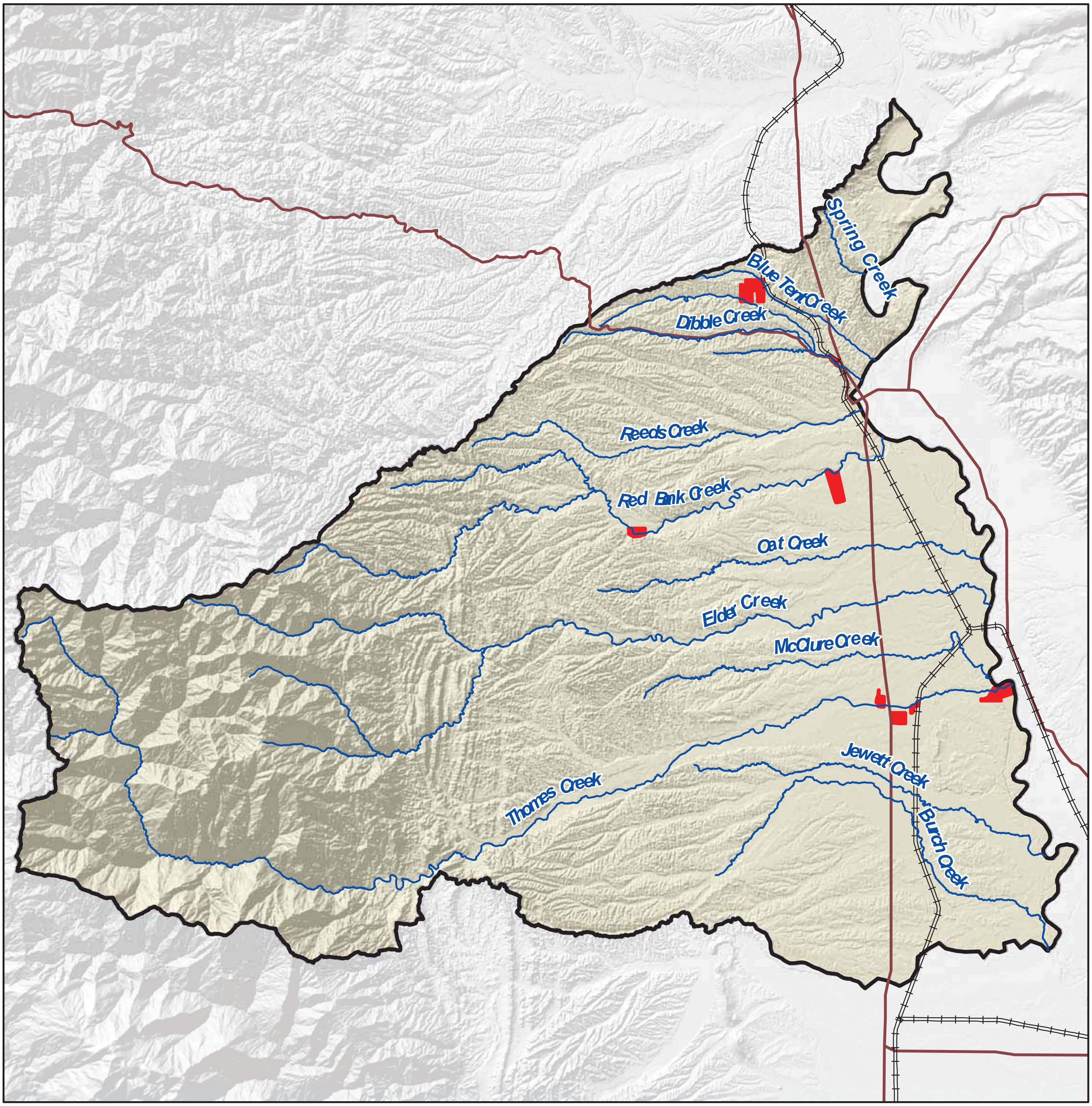


FIGURE 3-22
AGRICULTURAL LANDS CONVERTED TO URBAN LANDS
TEHAMA WEST WATERSHED ASSESSMENT

VESTRA

SOURCE: TEHAMA COUNTY AGRICULTURAL CROP REPORTS



Legend

Railroad

Major Highway

Major Tributary

Tehama West Watershed

Gravel Mining Operation

VESTRA

5

0 2.5 5 10 Miles

FIGURE 3-23
GRAVEL MINING OPERATIONS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY PLANNING DEPARTMENT

Section 4

Section 4
GEOLOGY AND SOILS

TABLES

FIGURES

Section 4
GEOLOGY AND SOILS

Basic information on the geology and soils of the Tehama West Watershed is presented in this section. The geology portion includes an area overview and discussion of prominent geologic units and associated faults. The soils portion includes a discussion of primary soil types, soil capabilities, erosion potential, channel migration, and change. Data gaps, conclusions, and recommendations are included at the end of the section.

SOURCES OF DATA

Primary sources of data used to create this section of the watershed assessment include:

- 1962 Geologic Map of California, Redding Sheet. U. S. Geologic Survey (USGS), California Division of Mines and Geology

- 1960 Geologic Map of California, Ukiah Sheet. USGS, California Division of Mines and Geology

- California Department of Water Resources (DWR). 1982 Thomes Creek Watershed Study

- DWR. 1992 Sacramento Valley Westside Tributary Watersheds Erosion Study

- U.S. Department of Agriculture. State Soil Geographic Database (STATSGO) (USDA 2005).

Additional references are included at the end of the section.

HISTORICAL CONTEXT

Although geology and soils have not changed appreciably in recent times, land use practices have exerted tremendous influence over hillslope and fluvial processes in watersheds since the arrival of Europeans nearly 150 years ago. Impacts from various mining, logging, farming and ranching, and industrial activities created significant sediment loading to the Sacramento River and its tributary streams.

During the late 1800s and early 1900s cattle ranching, sheep herding, and timber harvesting activities developed into major industries in the region and throughout much of the West. These activities influenced native vegetation and production of surface soils. In some areas these changes increased runoff and delivery of sediment to streams via logging roads and crossings, land conversion, landsliding, and direct stream alterations.

AREA OVERVIEW

The Tehama West Watershed encompasses an area of approximately 1,050 square miles, which includes a diverse landscape of geologic features critical to Tehama County's agricultural and mining industries. Mountain ranges along the western border of the assessment area reach elevations of approximately 7,500 feet (Solomon Peak) and are comprised of steep slopes and rock types susceptible to erosion. Two primary drainages, Elder Creek and Thomes Creek, continuously transport and deposit the eroded sediments along flood plains of the Sacramento River.

It is has been noted that, in general, streams originating from the Coast Ranges produce the highest sediment yields of all the Sacramento River tributaries. An analysis by the USGS showed that the annual suspended sediment yield of Thomes Creek is nearly three times higher than other streams of comparable size (DWR 1982, Jones et al 2000). Many other drainages also exist throughout the watershed and play a vital role in the development of the Sacramento Valley.

MAJOR LANDFORMS

Many landforms are visible throughout the assessment area, the majority of which include mountains, foothills, and flood plains. Depositional features such as alluvial fans and terrace deposits are also common. Fluvial erosion, hillslope erosion, and mass wasting are attributed to the development of each of these landforms.

A flood plain is an area subject to periodic flooding that is hydrologically connected to a stream and consists of unconsolidated materials from streams. Flood plains are typically the most productive areas for natural vegetation and agriculture, and are intrinsically important to the function of natural river systems (USDA SCS 1967, Ritter et al. 1995, Keppen and Slater 1996).

Alluvial fan and terrace deposits that form the foothills are located in the central portion of the assessment area. Alluvial fans often develop when sediment is deposited at the transition of a narrow canyon and a valley floor, generating an open fan appearance when viewed from above. Erosional activities, including sheetwash, rill erosion, soil creep, and channel erosion, create dissected terraces.

Mass wasting processes, such as rock falls, debris flows, and landslides, dominate landform evolution in the mountainous areas of this region and are initiated by freeze-thaw processes and infrequent precipitation events. These processes create characteristically steep, rocky cliffs and bedrock-controlled stream channels.

GEOLOGY

California is divided into 11 geologic provinces, each characterized by unique, defining features based on geology, topographic relief, and climate. The Tehama West Watershed includes portions of the eastern Coast Range and western Great Valley Geologic Provinces.

The Coast Range Province is characterized by north northwest-trending mountain ranges composed of thick Mesozoic and Cenozoic (240 million years old) strata generally rising 2,000 to 4,000 feet. The Coast Range Province is commonly characterized by zones of extensive shearing and the presence of ophiolite/serpentinite melanges (Jayko 1987). The western portion of the province is distinguished by ridges and valleys of upper Mesozoic sedimentary rocks overlain by alluvium of the Great Valley Province. Included within the Coast Range Province are highly erosive rocks of the Franciscan Complex, which produce large amounts of both suspended sediment and gravel (Blake et al. 1999, CH2M Hill 2002). The headwaters of Red Bank Creek, Elder Creek, and Thomes Creek are located in the Coast Range Province.

The Great Valley Province is a sedimentary basin approximately 400 miles long by 50 miles wide, located throughout the central portion of California. In the watershed, the province is characterized by a thick deposit of moderately deformed Jurassic and Cretaceous marine sedimentary layers that consist of detrital materials derived from uplifted basement rocks of the Klamath Mountain and Coast Range Provinces. Great Valley rocks consist primarily of mudstone, shale, and sandstone and occur mostly along the west side of the central valley. These units yield an abundance of suspended sediment but relatively little gravel to drainages. A map showing the geologic provinces is included as Figure 4-1. A geologic map is included as Figure 4-2.

Significant Geologic Units of the Coast Range Province

The Franciscan Complex can be described as a disorderly assemblage of various characteristic rocks that have undergone unsystematic deformation. The rocks include deep-water sediments and mafic marine volcanic materials, all of which are accompanied by masses of serpentine. The predominant rock type in the Franciscan assemblage is sandstone, primarily graywacke. Lithologic units vary in thickness and include beds of shale, conglomerates, volcanics, cherts, and limestones. The Franciscan is noted by both its distinctive thin-bedded cherts and characteristic dark blue metamorphic units containing glaucophane.

The Franciscan Complex can be divided into two units: the Pickett Peak Terrane and Yolla Bolly Terrane. The Pickett Peak Terrane contains the South Fork Mountain Schist and the Valentine Springs Formation. The South Fork Mountain Schist is located within the assessment area.

South Fork Mountain Schist

The South Fork Mountain Schist is quartz-veined mica schist with a strongly developed structure containing minor interlayers of metabasalt and metachert. In some areas the unit grades to schistose graywacke. The unit is intensely crumpled, highly unstable, and susceptible to erosion when exposed to human disturbance (DWR 1992).

Faulting

The Coast Range Fault is a north-south trending thrust fault that marks the contact between the Franciscan Complex and the ophiolite basement of the Great Valley Sequence. Geologic evidence implies Plio-Pleistocene movement (DWR 1982).

Significant Geologic Units of the Great Valley Province

The Great Valley Province consists of six principal geologic units including the Coast Range Ophiolite, Great Valley Sequence, Tehama Formation, Red Bluff Formation, Riverbank Formation, and the Modesto Formation. Unless otherwise indicated, geologic descriptions included below are summarized from the *Sacramento Valley Westside Tributary Watersheds Erosion Study* prepared by DWR in December 1992.

Coast Range Ophiolite

The Coast Range Ophiolite consists of a thin belt of mafic and ultramafic rocks, which separate the Fransiscan Complex from the Great Valley Sequence. Locally, the Coast Range Ophiolite is bounded to the west by the Coast Range Fault and on the east by the Stony Creek Fault (DWR 1982).

The Thomes Creek Watershed Study prepared by DWR in 1982 described three chaotically mixed subunits consisting of serpentinite, gabbro, and metabasalt. Serpentinite, the most common rock type, is pervasively sheared, highly weathered, and produces clayey soils.

Great Valley Sequence (Middle to Late Cretaceous)

The Great Valley Sequence consists of a thick sequence of interbedded sandstones, conglomerates, and mudstones forming north north-west trending valleys and ridges. The mudstones are typically dark gray, laminated to thin-bedded with minor interbeds of siltstone to fine grained sandstone, which dip steeply to the northeast.

Sandstone units are typically interbedded with mudstone and minor conglomerates. Conglomerate beds are noted as being massive, lenticular, and generally terminating along strike-forming linear northwest trending ridges.

Tehama Formation (Pliocene)

The Tehama Formation underlies a significant portion of the watershed, forming rounded hills with moderate relief. The Tehama Formation is composed of fluvial sedimentary deposits of semi-consolidated pale green, gray and tan sands, tuffaceous sands, silts, and clays with minor discontinuous gravel lenses and lenses of pebble and cobble conglomerates (Helley and Harwood 1985).

Along streams, exposures are noted as forming 20 to 60 feet high vertical bluffs. Soil erodibility depends on composition as silts are generally more erodible than associated sands, clays, or conglomerates.

Near the base of the Tehama Formation lies the Nomlaki Tuff Member, a white to light-gray dacite pumice tuff and lapilli tuff. The member is noted as ranging from approximately 15 to 30 feet thick, massive, non-layered volcanic ash that forms resistant vertical banks along stream channels and gullies.

Red Bluff Formation (Pleistocene)

The Red Bluff Formation is characterized by a coarse gravel deposit with a brick-red clayey matrix derived from metamorphic rocks of the Coast Ranges and Klamath Mountains. Erosional remnants of the Red Bluff crop out along the western base of the Coast Ranges and along the ridges near the Sacramento River at a maximum thickness of approximately 15 feet (Blake et al 1999).

Riverbank Formation (Pleistocene)

The Riverbank Formation is an alluvial deposit of Pleistocene age that overlies the Red Bluff Formation and underlies the Modesto Formation. The Riverbank Formation is located throughout the western Sacramento Valley ranging from almost coalescing old alluvial fans to stream terraces along present day creeks. It is characterized by a relatively subdued but well-developed erosion induced mound-depression topography and strong soil development. Soils with claypans and duripans are common and often form vernal pool features.

The Riverbank Formation has been divided into upper and lower members. The lower member is lithologically similar to the Red Bluff Formation and has a similar brick red color. It occurs on the higher of two terraces that have been cut and filled into the surface of the Red Bluff and/or Tehama Formations.

The upper member is younger and is characterized as extensive flat stream terraces along the major creeks in the watershed. A typical outcrop is noted by DWR as consisting of 8 to 10 feet of tan to light brown sandy silt underlain by one to three feet of gravel and scattered rocks up to eight inches in diameter.

Modesto Formation (Pleistocene)

The Modesto Formation is widespread throughout the Sacramento Valley and the watershed area. The Modesto Formation was deposited on the Riverbank Formation, Tehama Formation, and the Tuscan Formation. In general, the formation varies in thickness from less than 10 feet to nearly 200 feet (Helley and Harwood 1985). The formation consists of tan and light gray, gravelly sands, silts, and clays. The upper member of the Modesto shows no indication of weathering, while the lower member shows slight weathering.

Faulting

Figure 4-3 shows the faults located in the Tehama West Watershed. Brief descriptions of the major faults in the watershed are included in this section.

Willows Fault

The Willows Fault system is a northwest trending, steeply east dipping reverse fault (east side up movement). The fault system lies just west of the Orland Buttes extending northwest near the town of Red Bank. Fault activity is noted as occurring between approximately 60 and 53 million years ago (mya) (Harwood and Helley 1987).

Corning Fault

The Corning Fault is oriented roughly north-south along the Interstate-5 corridor. The fault has been identified from Red Bluff south through Orland, where it turns in a southwesterly direction before intersecting the Paskenta Fault Zone southwest of Artois. The Corning Fault is a reverse fault, dipping steeply to the east and passing west of the Corning domes and the Green Wood anticline (Harwood and Helley 1987). The youngest deposits deformed by the Corning Fault are noted as gravels of the Red Bluff Formation (Harwood et al 1981).

Red Bluff Fault

The Red Bluff Fault extends in a northeasterly direction through Red Bluff. The fault is a subsurface structure interpreted as showing approximately 450 feet of vertical offset (south side down) from seismic-reflection data (Harwood and Helley 1987).

SOIL TYPES

A soil association is a landscape that has a distinctive, proportional pattern of soils, often characteristic of their geologic parent material. Three primary associations (Columbia-Vina, Maywood-Tehama, and Corning-Redding) are found on floodplains and terraces along the Sacramento River and its tributaries. Soils of the foothills are derived mostly from unconsolidated sediments, sandstone, and shale parent material and include the Newville-Dibble, Millsholm-Lodo, and Toomes-Guenoc associations. Along the western margin of the watershed, above 3,000 feet, soil associations include the Maymen-Los Gatos and Henneke-Stonyford soil associations (USDA SCS 1967).

The State Soil Geographic Database (STATSGO) provides a level of mapping designed for broad planning and management uses. Soil association descriptions within the assessment area are derived from the Tehama County Soil Survey (USDA SCS 1967). The Natural Resources Conservation Service (NRCS) soil descriptions do not directly correspond with STATSGO mapped associations, and minor interpretations have been made as part of this assessment. As of October 2004, the NRCS (formerly Soil Conservation Service) has indicated that the Tehama County Soil Survey will be updated, but has not indicated when the project would be completed. Figure 4-4 shows the STATSGO soil associations found within Tehama West Watershed.

Columbia-Vina

The Columbia-Vina soil association is located in a narrow north-south trending strip along nearly level flood plains of the Sacramento River. Columbia and Vina soils are characterized as very deep, well-drained neutral soils formed in alluvium, derived from sedimentary, volcanic, and granitic rock types. These soils are moderately fine to moderately coarse in texture and found in elevations ranging from 200 to 1,000 feet with annual precipitation ranges of 19 to 25 inches. The brown Columbia and dark grayish brown Vina soils are generally smooth, except in areas where they have been cut by stream migration activity near the main channel. Soils containing very gravelly layers at a depth of less than 5 feet are found in some places in the channels.

Natural vegetation associated with these soils includes sycamore, valley oak, wild grape, elderberry, grasses, and forbs, which are found along the Sacramento River. Due to their high-productivity, native vegetation has been cleared from most other areas and replaced with agricultural species including beans, alfalfa, corn, beets, melons, peaches, prunes, and walnuts.

Maywood-Tehama

The Maywood-Tehama soil association is dominated by the Maywood and Tehama soil series, but also includes minor associated soils of the Yolo, Orland, Cortina, Zamora, Myers, Hillgate, Arbuckle, Kimball, Perkins, and Clear Lake series. The association is located west of the Sacramento River between elevation ranges of 300 to 800 feet with annual precipitation ranging from 19 to 25 inches on recent and older alluvium deposits. The alluvium is derived primarily from sedimentary and metamorphic rocks, although it may also include ultrabasic parent materials, and can be found on the nearly level to gently sloping flood plain and terrace deposits.

Maywood soils (and the associated minor Yolo, Orland, Cortina, Zamora, and Myers soils) form long east-west trending narrow flood plains and benches on nearly level recent alluvium along the Thomes, Red Bank, Burch, Rice, and Elder Creeks. Similar to the pale brown, medium textured Maywood soils, the brown Yolo and grayish-brown Orland soils are also medium textured, gravelly, and droughty. The Zamora soils exhibit an increase in the clay content in their subsoil, while the texture of the Myers is clay throughout.

Tehama soils are typically pale brown, well drained, and formed on the nearly level, older alluvium of the Sacramento River flood plains and terraces. These deep soils have a medium textured surface, moderately fine textured subsurface, and are neutral to slightly acidic. The similar minor associated Hillgate and Arbuckle soils are nearly level to gently sloping with a moderately deep claypan, although Arbuckle soils are gravelly throughout. Other associated minor soils include the reddish brown, neutral Kimball and Perkins soils, and the deep, black clays of the Clear Lake soils. Clear Lake soils are found in small, local basins on terraces and are very deep. These clay soils are poorly drained and form wide cracks during the dry summer periods. The percentage of the watershed that this association represents could not be determined at this time, since this association does not directly correspond with digital STATSGO data.

Prior to settlement, native vegetation of the Maywood-Tehama association consisted of grasses and forbs and varying amounts of blue oak, valley oak, cottonwood, and shrubs, but most areas have been cultivated now. Maywood and associated soils are used to grow alfalfa, corn, beans, milo, sugarbeets, barley, irrigated pasture, peaches, prunes, walnuts, and almonds. Despite dense clayey subsoil that limits productivity, irrigated pasture and dry-farmed grain are primarily grown on Tehama and associated soils, along with milo and alfalfa to a lesser degree, and a large acreage of olives near the town of Corning.

Corning-Redding

The Corning-Redding soil association consists of gravelly, medium-textured soils of stratified deposits of alluvium derived from Coast Range sedimentary and metamorphic rocks. These nearly level to sloping soils are found on the high western terraces of the Sacramento River and its tributaries between 350 to 800 feet in elevation, with an annual rainfall from 19 to 30 inches. Most areas of this association exhibit "hogwallow microrelief," which is characterized by hummocky mound and depression relief. Corning and Redding soils are typically reddish-brown gravelly to slightly gravelly loams, are moderately deep to shallow, to claypan (Corning) or cemented hardpan (Redding), that is slight to moderately acidic. The association includes minor Red Bluff Series soils, which have smooth surfaces, are strongly acidic, and have moderately dense clay subsoil. The topography and shallow depth to claypan cause the formation of vernal pools in these soils. These vernal pools are an important resource in the watershed.

Vernal pool on Redding soils

Native vegetation is dominated by forbs, and in the northern portion of the county, blue oak and manzanita. Although forage production and grain yields are low, much of the area associated with these soils is utilized as pasture, range, and dry-farmed grain.

Newville-Dibble

The Newville-Dibble soil association consists of typically brown, shallow to deep, moderately steep to steep, medium textured to fine textured soils and is found at elevations between 500 and 2,000 feet. Annual precipitation ranges from 19 to 30 inches. These soils are located on dissected terraces in the foothills west of the Sacramento River, overlying stratified soft sedimentary rock comprised mostly of siltstone, and in some areas, of very gravelly material and material high in lime or calcium carbonate. Dominant Newville soils have a gravelly loam surface layer and a gravelly clay subsoil, while dominant Dibble soils overlie dense, compact siltstone and are comprised of layers of silt loam or silty clay loam. The Nacimiento and Altamont terrace soils are two minor soils commonly associated with the Newville-Dibble association. Nacimiento soils overlie moderately soft limestone and consist of layers of light brownish-gray or light-gray calcareous silty clay loam. Altamont terrace soils have a brown, neutral clay surface layer and a brown, calcareous clay subsoil. In the southern most portion of the watershed, these soils have a minor occurrence of vernal pools in lower elevations.

Natural vegetation generally consists of grasses and forbs, with occasional blue oak, manzanita, buckbrush, interior live oak, and foothill pine. Most of these soils are utilized for pasture and range, although barley is grown in rotation with pasture where oaks have been removed on gentle slopes.

Millsholm-Lodo

The Millsholm-Lodo soils are typically brown. These soils are located in a 2- to 10-mile wide north-south trending belt along the western Tehama foothills, at elevations between 500 and 2,000 feet. The association consists of shallow to moderately deep soils located on moderate to very steep slopes underlain by hard sandstone and shale. Rainfall accumulations range from 20 to 35 inches, feeding streams that run in a north-south direction, and cut the sandstone and shale at nearly right angles. The dominant Millsholm soils are 12- to 30-inch deep clay loams, overlying sandstone or shale, while Lodo soils are 6- to 12-inch shaley loams overlying shale. Minor soils of this association include Millsap, Sehorn, and Altamont soils.

Natural vegetation consists of grasses, forbs, blue oak, manzanita, buckbrush, interior live oak, and foothill pine. This soil association is also used for pasture and range.

Toomes-Guenoc

The Toomes-Guenoc soils form shallow to moderately deep, rocky soils in a small northeastern portion of the watershed. These gently sloping to steep soils are dissected by numerous streams, which create a series of narrow sloping ridges and deep steep-walled canyons. The association is typically underlain by andesite with inclusions of basalt and volcanic mud and lava flows at elevations ranging from 500 to 4,000 feet. Rainfall accumulations range from 20 to 35 inches annually. Toomes soils are brown to reddish brown, very rocky loams less than 15 inches deep.

Guenoc soils are reddish-brown, 20 to 40 inches deep and consist of a rocky loam surface layer and a dense clay or clay loam subsoil. Minor association soils include the Supan, Inskip, and Cone soils. Supan soils are 36 to 48 inches deep with brown, rocky loam surfaces and reddish-brown or brown, rocky clay loam subsoils. Inskip soils are 10 to 30 inches deep, consisting of a pale-brown very rocky silt loam surface, overlying recent broken lava rock. Cone soils are yellowish-brown gravelly silt loams formed from volcanic cinder cones.

Natural vegetation of this association consists primarily of grasses and forbs, although blue oak, manzanita, buckbrush, interior live oak, and foothill pine are also occasionally found. In the watershed, all soils of this association are used for pasture and range.

Maymen-Los Gatos-Parrish

The Maymen-Los Gatos-Parrish soil association is comprised of shallow or moderately deep, steep or very steep, rocky soils formed in an area of narrow ridges and deep canyons along the eastern Coast Range Mountains, between 1,000 and 4,000 feet in elevation. Maymen-Los Gatos-Parrish soils are underlain by steep sedimentary rocks consisting primarily of hard sandstone and shale, and a few areas are underlain by hard mica schist. Annual rainfall ranges from 25 to 45 inches. Maymen soils are brown, gravelly loam up to 20 inches deep. Los Gatos soils are deeper (up to 30 inches deep) with a subsoil of light clay loam. Parrish soils can be 40 inches deep with a reddish-brown clay subsoil. Less common Tyson and Hulls soils are associated with this series. Tyson soils are less than 36 inches deep, dark grayish brown gravelly sandy loams. Hulls soils are grayish-brown gravelly loams less than 30 inches deep.

Natural vegetation consists of dense brush consisting primarily of chamise, buckbrush, manzanita, and mountain-mahogany, and tree species including interior live oak, Brewer oak, and foothill pine. Most of the association remains native, except for Hulls soils that are used for pasture and range.

Henneke-Stonyford

The Henneke-Stonyford soil association consists of shallow or moderately shallow, steep or very steep rocky soils on the eastern edge of the Coast Range Mountains between 1,500 and 4,000 feet in elevation. The association is found primarily along a narrow strip of ultra basic parent material between metasedimentary and sedimentary units of the Knoxville Formation. Annual rainfall in this association ranges from 20 to 45 inches.

Serpentine soils and associated rock

Henneke soils are typically shallow and rocky, and are formed from underlying serpentine rock. Greenstone, which is comprised of altered basalt and andesite, is the parent material to the reddish-brown Stonyford and minor brown Goulding soils commonly associated with this series. Both of these soils are rocky and shallow to moderately shallow.

Natural vegetation is dominated by brush species, including chamise, buckbrush, mountain-mahogany, common manzanita, and whiteleaf manzanita. Native tree species include leather oak, scrub oak, California holly, and foothill pine. A high percentage of the rare plants found in western Tehama County are found on the serpentine soils in this soils association.

SOIL CAPABILITIES

Soils are grouped by capability in order to indicate their relative suitability for the production of agricultural products. Capability is based on limitations of the soils and the potential for damage to the soil as a result of use. Capability classification consists of three levels of increasing specificity including class, subclass, and unit. Table 4-1 lists the soil capabilities of the soil associations found within the watershed, based on the dominant soil types included in each association.

Table 4-1
PERCENT SOIL TYPE

Soil Type	Acres	Percent of Watershed
Columbia-Vina	22,865	3%
Corning-Redding	41,863	6%
Henneke-Stonyford	25,976	4%
Maymen-Los Gatos-Parrish	31,915	5%
Millsholm-Lodo	68,303	10%
Newville-Dibble	233,985	35%
Sheetiron-Goulding	103,623	16%
Tehama-Hillgate	125,954	19%
Toomes-Guenoc	2,948	<1%
Yollabolly-Rock Outcrop-Freezeout	10,736	2%
Total	**668,168**	**100%**

Capability classes are represented by roman numerals (I-VIII), with higher numerals indicating increased limitations on the types of use they can support:

Class I: Soils that have few limitations restricting their use

Class II: Soils with some limitations on the choice of plants or that require moderate conservation practices

Class III: Soils with some limitations that restrict the choice of plants or require special conservation practices, or both

Class IV: Soils that have very severe limitations restricting the choice of plants or that require very careful management, or both

Class V: Soils that are subject to little or no erosion, but have other factors that limit their use largely to pasture, range, woodland, or wildlife food and cover

Class VI: Soils having severe limitations, which make them generally unsuited to cultivation and limit their use largely to pasture, range, woodland, or wildlife food and cover

Class VII: Soils having very severe limitations, which make them unsuited to cultivation, with uses restricted to grazing, woodland, or wildlife

Class VIII: Soils and landforms having limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, water supply, or to esthetic purposes

Capability subclasses are soil groups within one class. They are designated by adding a small letter (e, w, s or c) to the class numeral:

e: Shows that the main limitation is risk of erosion unless close-growing plant cover is maintained

w: Shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage)

s: Shows that the soil is limited mainly because it is shallow, droughty, or stony

c: Shows that the chief limitation is climate that is too cold or too dry

Capability units are numbers (0-9) that indicate the chief limitation used to group soils in a class or subclass:

0: A problem or limitation caused by very gravelly material in the substratum

1: An erosion hazard, actual or potential

2: A problem or limitation of wetness because of a high water table, seepage, or flooding

3: A problem or limitation of slow permeability of the subsoil

4: A problem or limitation caused by coarse soil texture or excessive gravel

5: A problem or limitation caused by fine soil texture

6: A problem or limitation caused by salt or alkali

7: A problem or limitation caused by stones or rock outcrops

8: A problem or limitation caused by shallow depth of soil over bedrock

9: A problem or limitation caused by low fertility

Timber production is similar to agricultural uses in that the productivity of soil in a given area dictates growth rates and amounts of commercially important timber species. The Land and Resource Management Plan developed by the Mendocino National Forest (MNF) determined timber productivity site classes for the MNF, which includes some forested portions of the assessment area (USDA 1995). However, the management plan only provides a description of productivity classes by percentage for the entire MNF, and therefore is not included in this assessment. A description of natural vegetation and primary crops by soil association within the watershed follows. Table 4-2 shows the soil capability classification by soil association A soil hazard erosion map is included as Figure 4-5.

Table 4-2
SOIL CAPABILITY CLASSIFICATIONS BY SOIL ASSOCIATION

Name	Capability Classes
Columbia-Vina	1-1, IIe-1, IIw-2, IIs-0, IIs-8, VIw-1
Redding-Corning	IVe-3, IVs-3, IVe-8, IVs-8, VIIs-8
Henneke-Stonyford	VIIs-9, VIIIs-8, VIIIs-9
Maymen-Los Gatos-Parrish	VIIe-3
Millsholm-Lodo	IVe-5, VIe-5, VIIe-5, VIIs-4, VIIIs-8
Newville-Dibble	IVe-3, IVe-5, VIe-3, VIe-5, VIIe-3
Sheetiron-Goulding	IVe-4, VIIe-4, VIIs-1, VIIs-4, VIIIs-8
Tehama-Hillgate	IIe-3, IIe-4, IIs-3, IIs-4, IIIe-3, IIIs-3
Toomes-Guenoc	IVe-8, VIs-7, VIs-8, VIIs-4
Yollabolly-Rock Outcrop-Freezeout	VIIs-1, VIIs-4

Capability classes generalized to accomodate STATSGO data used in this assessment

EROSION POTENTIAL

Soil erosion is the removal of soil material and is controlled by factors such as soil type, slope, precipitation, wind, and vegetative cover. In areas with a high potential for erosion, management or development activities can create undesirable erosion problems, such as loss of productive soils, gullying, or excess sedimentation of streams.

Based on the Soil Survey for Tehama County (USDA SCS 1967), the soils most prone to erosion (severe to very severe erosion hazard) within the assessment area include soils with capability classifications of VIe-3, VIe-5 (when overgrazed), VIw-1 (scouring), VIIe-3, Vlle-5, and VIIIs-8. This includes some soils within the Columbia-Vina, Newville-Dibble, Maymen-Los Gatos-Parrish, Sheetiron-Goulding, and Millsholm-Lodo soil associations. It is important to note that the erosion hazard of most soils increases when vegetation is cleared, areas are cultivated, or improper grading methods are used. These hazards can be enhanced by logging practices and wildfire. Three primary sources of sediment generation in the watershed include mass wasting, stream scour, and road-generated erosion. These sources are described below. DWR has prepared numerous erosional studies throughout the watershed which include:

- Department of Water Resources. 1992. *Sacramento Valley Westside Tributary Watersheds Erosion Study: Instability and Erosion Hazard Map*. California Department of Water Resources, Northern District. December 1992.

- Department of Water Resources. 1982. *Thomes Creek Watershed Study*. California Department of Water Resources, Northern District. December 1982.

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- Department of Water Resources. 1987. *Red Bank Creek Watershed Erosion Investigation*. California Department of Water Resources, Northern District.

DATA GAPS

Data pertaining to geology and soils within the Tehama West Watershed are abundant. Numerous studies have been completed by the DWR, NRCS, and the USGS. Documents mentioned throughout this section and those included in the references section provide interested parties with an adequate foundation to base future decisions affecting the watershed.

CONCLUSIONS AND RECOMMENDATIONS

Land use activities, such as cattle grazing, mining, timber harvest, and development, have historically occurred within the assessment area and have impacted the soils and geology of the region. Several important issues exist within the assessment area including soil erosion and sediment delivery to streams, and landslide hazards.

To more affectively assess, quantify, and ultimately provide sound management direction, it is recommended that a digital GIS database, which includes all factors affecting geologic and soil issues, be created.

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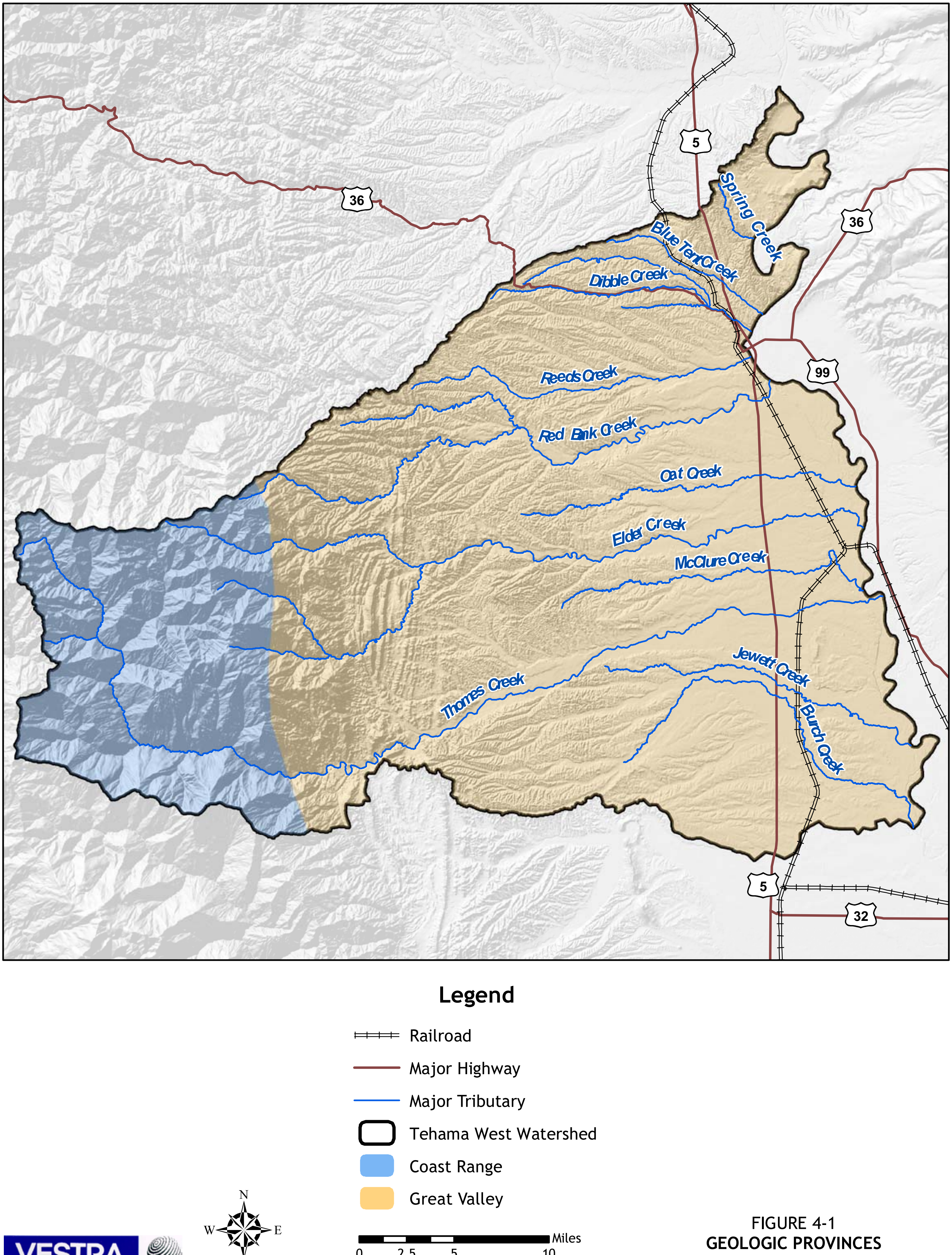


FIGURE 4-1
GEOLOGIC PROVINCES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: U.S. GEOLOGICAL SURVEY

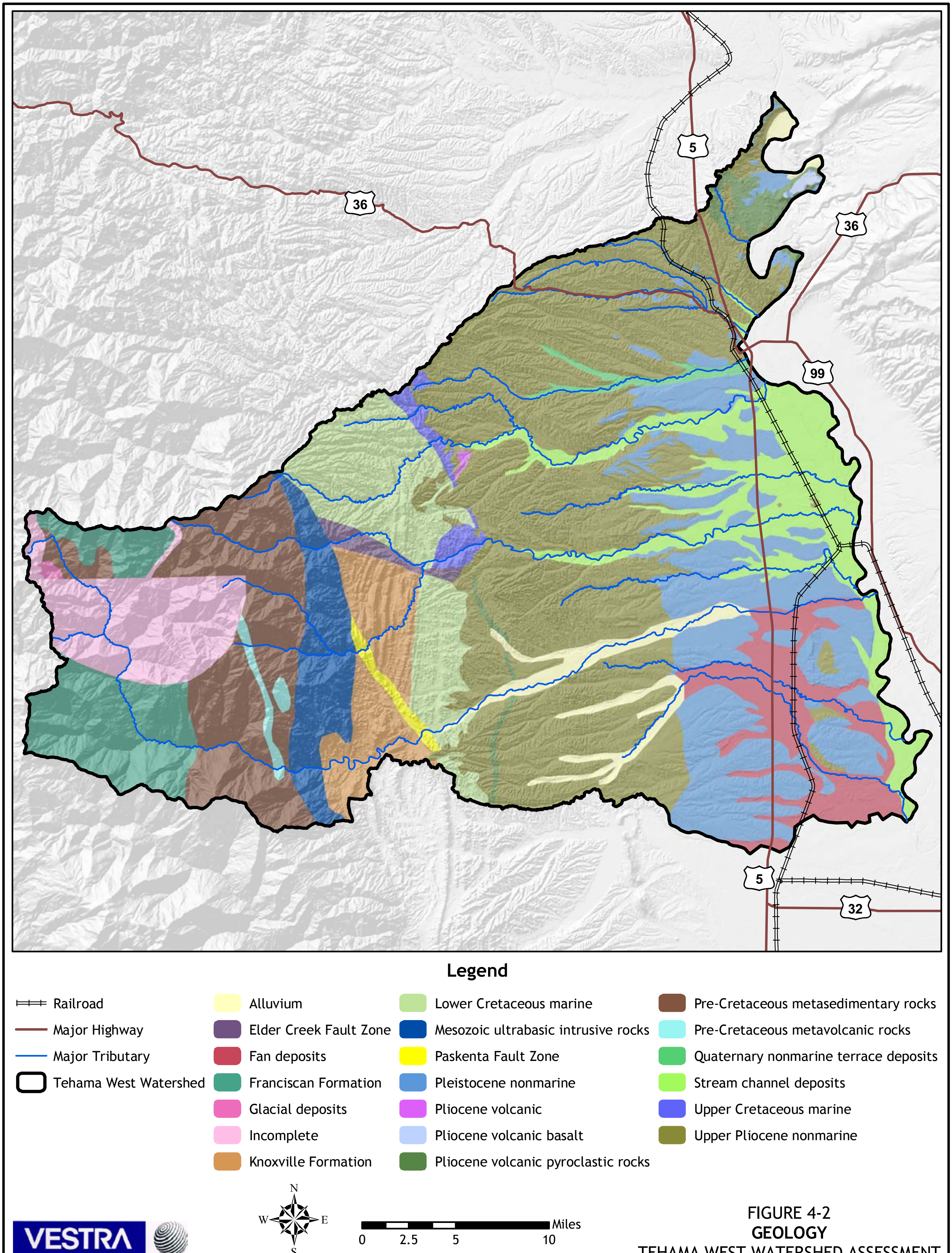


FIGURE 4-2
GEOLOGY
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: UNITED STATES GEOLOGICAL SURVEY

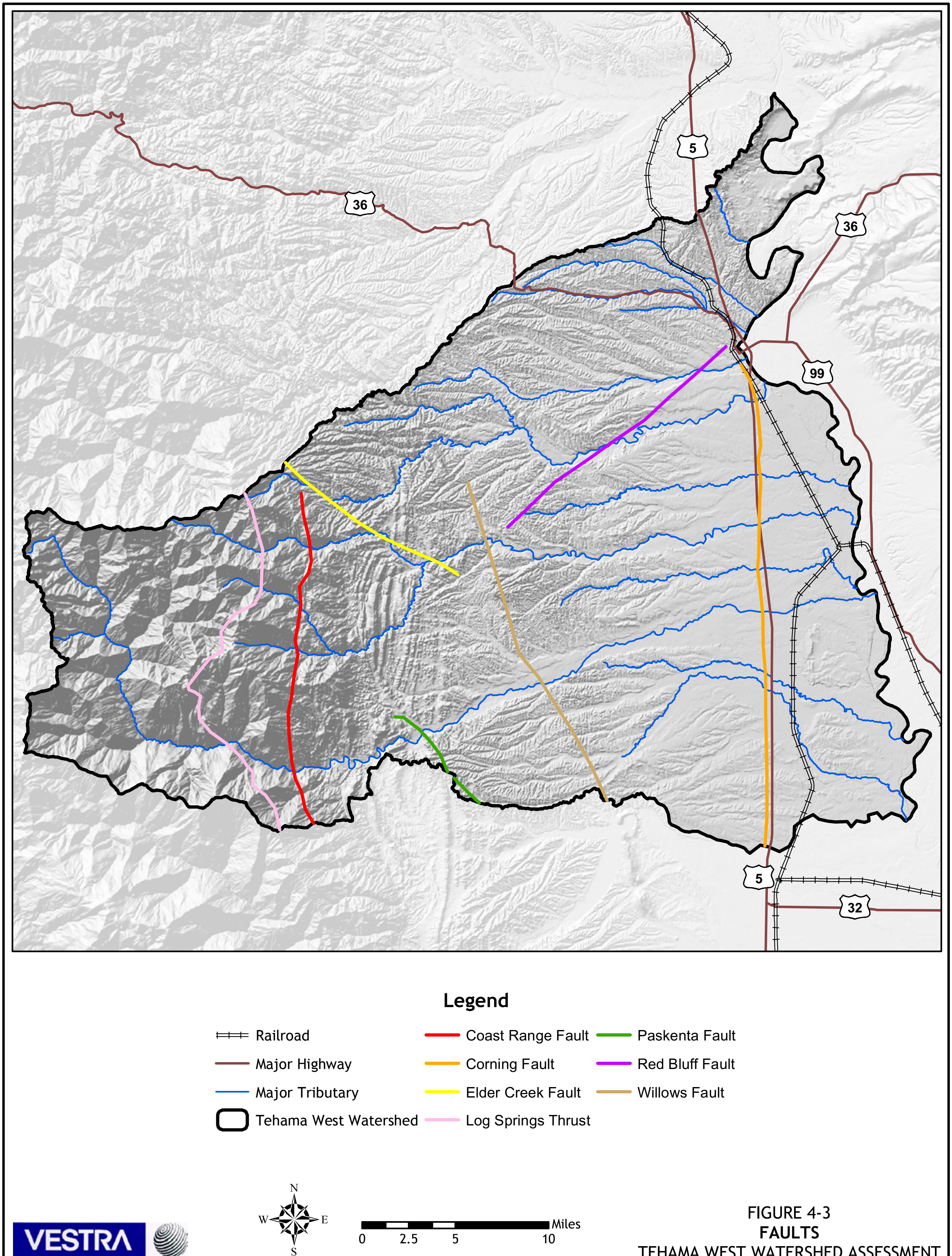
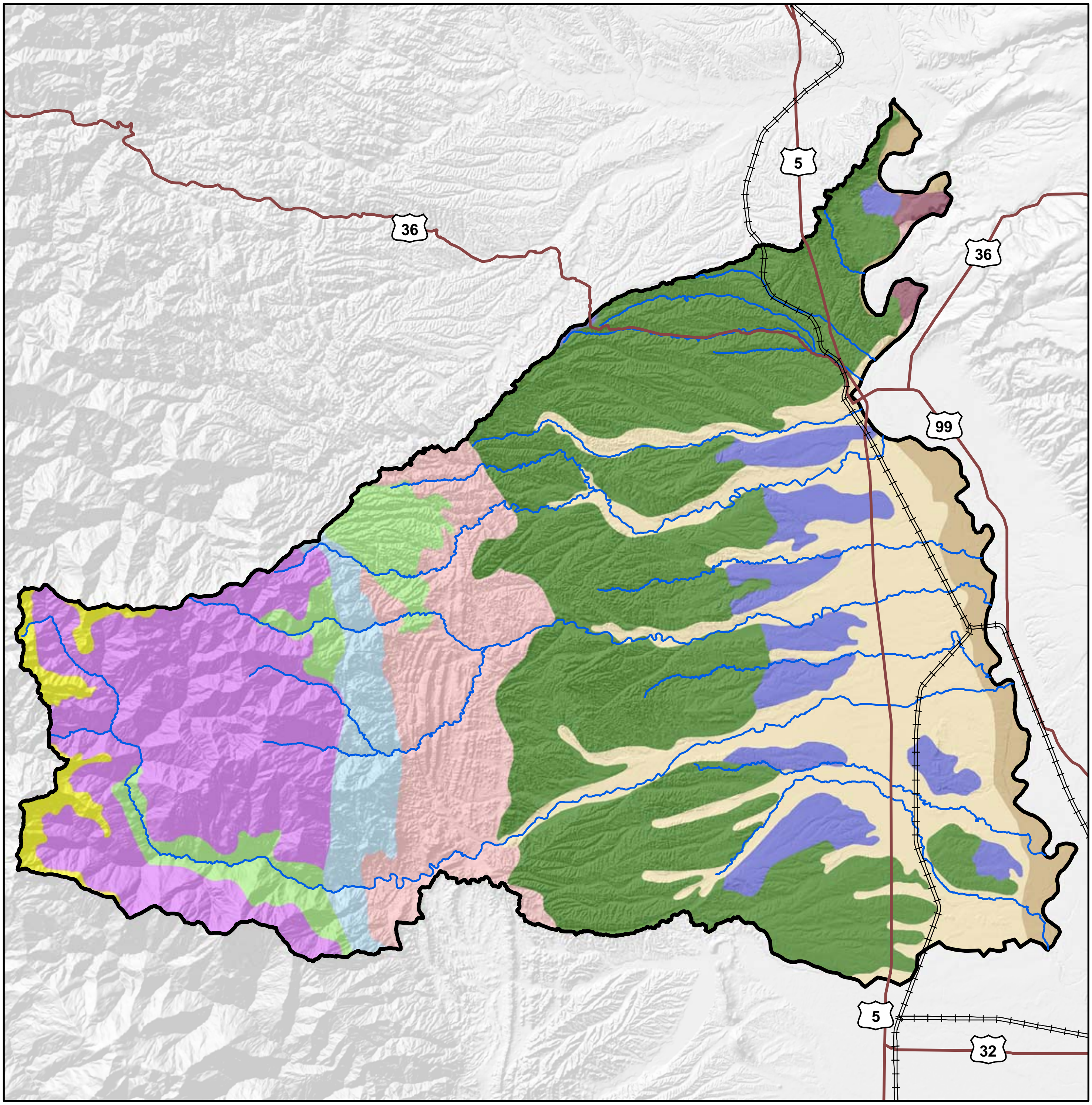


FIGURE 4-3
FAULTS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: UNITED STATES GEOLOGICAL SURVEY



Legend

- Railroad
- Major Highway
- Major Tributary
- Tehama West Watershed
- Columbia-Vina
- Corning-Redding
- Henneke-Stonyford
- Maymen-Los Gatos-Parrish
- Millsholm-Lodo
- Newville-Dibble
- Sheetiron-Goulding
- Tehama-Hillgate
- Toomes-Guenoc
- Yollabolly-Rock Outcrop-Freezeout

N W E S

0 2.5 5 10 Miles

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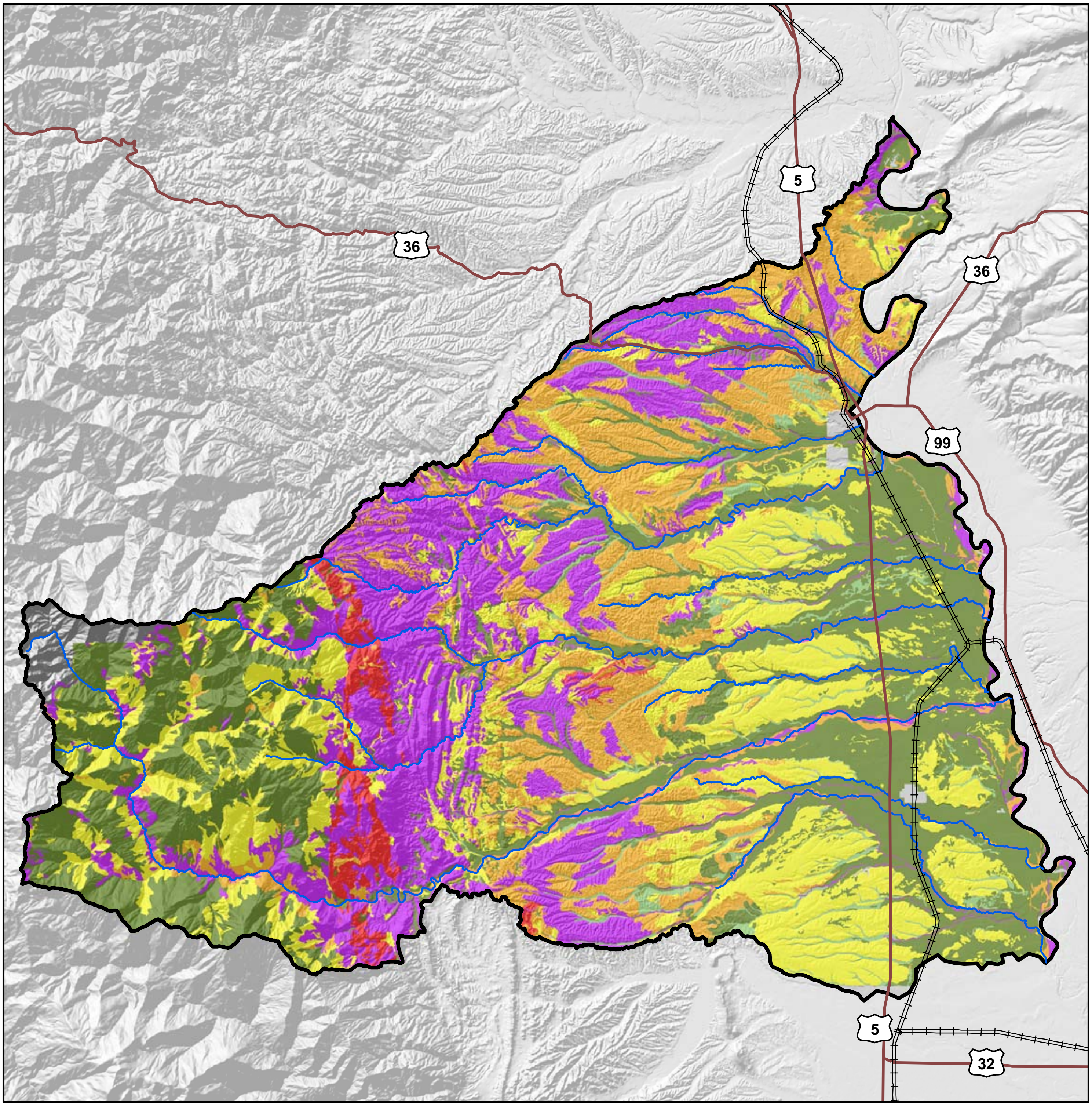
FIGURE 4-4
STATSGO SOIL TYPES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: NATURAL RESOURCES CONSERVATION SERVICE



Legend

Railroad	Low to Moderate
Major Highway	Moderate
Major Tributary	High
Tehama West Watershed	High to Extreme
Low	Extreme

N
W E
S

0 2.5 5 10 Miles

VESTRA

FIGURE 4-5
SOIL HAZARD EROSION RATINGS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: NRCS TEHAMA COUNTY SOIL SURVEY

Section 5

Section 5
CLIMATE

TABLES

FIGURES

Section 5
CLIMATE

The climate of the Tehama West Watershed is characterized as Mediterranean, with warm to hot dry summers and cool to wet winters. These conditions resemble lands bordering the Mediterranean Sea. This climate type occurs in four locations outside the Mediterranean region including California, Western Australia, Cape Province in South Africa, and Chile (DFG 2005).

In California the Mediterranean climate is subdivided into Hot Summer Mediterranean and Cool Summer Mediterranean. Hot Summer Mediterranean is characterized by hot dry summers, with the average temperature of the warmest month greater than 71.6°F. Winters are mild with very little snow fall. Elevations range up to 2,000 to 3,000 feet above mean sea level (msl). Vegetation is characterized by blue oak, foothill (digger) pine, and chaparral.

Cool Summer Mediterranean is characterized by warm to pleasant dry summers, with average temperatures of the warmest months less than 71.6ºF. Winter precipitation is a mixture of snow and rain. Elevations range from between 2,000 and 3,000 feet to between 6,000 and 7,000 feet msl. Vegetation is characterized by ponderosa pine. Sugar pine and incense cedar are common. Black oak is common in the lower portions of the zone. White fir is common in the higher portions of the zone.

Climate in the Tehama West Watershed ranges between Hot Summer Mediterranean in the east to Cool Summer Mediterranean in the west.

SOURCES OF DATA

Primary sources of climate data for the watershed include the National Climatic Data Center (NCDC), California Data Exchange Center (CDEC), and the California Irrigation Management Information System (CIMIS). Key stations located in or near the Tehama West Watershed include the Red Bluff Municipal Airport (NCDC Station 047292)/FAA Station KRBL), California Department of Forestry Station at Thomes Creek (CDEC Station TCK), and Gerber (CIMIS Station 8). These and other stations located in or near the Tehama West Watershed are summarized in Table 5-1. Station locations are shown on Figure 5-1. In addition, volunteers began recording precipitation within the watershed in 2004. The volunteer stations are shown on Figure 5-2.

HISTORICAL CONTEXT

Average annual precipitation in Red Bluff (NCDC Station 047292) between 1905 and 2004 is shown on Figure 5-3. Average annual precipitation during the period of record is 22.8 inches, ranging from 7.2 inches in 1976 to 49 inches in 1983.

Generally, the twentieth century was one of relatively high rainfall compared to the past 500 years. Recently, however, California's weather has been "normal" in the context of 100 years of record (Bartolome 2005). Droughts exceeding three years are relatively rare in Northern California. Historical multi-year droughts include: 1912–13, 1918–20, 1923–24, 1929–34, 1947–50, 1959–61, 1976–77, and 1987–92 (DWR 2000).

Table 5-1 CLIMATE DATA SOURCES								
Station	**ID**	**Lat.**	**Long.**	**Elev.**	**Data [1]**	**Begin**	**End**	**Source**
RB FSS (Airport)	047292	40.09	-122.11	350	t,p	1944 [2]	present	WRCC
Covelo	042081	39.47	-123.15	1,430	t,p	1935	present	WRCC
Orland	046506	39.45	-122.12	250	t,p	1931	present	WRCC
Thomes Creek	TCK	39.86	-122.61	1,025	t,p	1984 [3]	present	CDEC
RB Diversion Dam	RDB	40.15	-122.20	236	t	1990	present	CDEC
Log Springs	LGS	39.83	-122.78	5,100	p	1988	present	CDEC
Sac. River at Thomes Creek	THO	39.88	-122.52	720	p	1984	present	CDEC
Saddle Camp	SAD	40.17	-122.80	3,850	p	1987 [4]	present	CDEC
Anthony Peak	ATP	39.84	-122.95	6,200	s	1944	present	CDEC
Gerber	8	40.05	-122.16	250	t,p	1982 [5]	present	CIMIS

[1] t = air temperature, p = precipitation, s = snow accumulation.
[2] Although not available from WRCC, dew point, relative humidity, wind direction and speed are also collected at the Airport station. Monthly precipitation for this site is available on CDEC, station RBF, from 1905 to present.
[3] Relative humidity and wind speed and direction were added in 1995, solar radiation and atmospheric pressure were added in 2001.
[4] Air temperature was added in 1999.
[5] Also includes reference evapotranspiration, solar radiation, vapor pressure, relative humidity, dew point, and wind speed and direction.

A 420-year reconstruction of Sacramento River runoff from tree ring data was made for the California Department of Water Resources (DWR) in 1986 by the Laboratory for Tree Ring Research at the University of Arizona. The tree ring data suggested that the 1929 through 1934 drought was the most severe in the 420-year reconstructed record from 1560 to 1980. The data also suggested that a few droughts prior to 1900 exceeded 3 years, and none lasted over 6 years, except for one period of less than average runoff from 1839 through 1846. John Bidwell, an early pioneer who arrived in California in 1841, confirmed that 1841, 1843, and 1844 were extremely dry years in the Sacramento area (Meko et. al. 2001).

A 1994 study of relict tree stumps rooted in present-day lakes, rivers, and marshes suggested that California sustained two epic drought periods extending over more than 3 centuries. The first epic drought lasted more than 2 centuries before the year 1112; the second drought lasted more than 140 years before 1350. A conclusion that can be drawn from these investigations is that California is subject to droughts more severe and more prolonged than anything witnessed in the historical record (DWR 2000).

Notable climatic events in the area during the last 50 years include December 1955 flooding, 1975 through 1977 drought, 1982 through 1983 El Nino Storms, and the 1997 New Year's flood (NOAA 2005).

PRECIPITATION

Average annual precipitation at Red Bluff (NCDC Station 047292) between 1933 and 2004 is 22.9 inches. Minimum, maximum, and average monthly precipitation for Red Bluff is summarized in Table 5-2 and is shown on Figure 5-4. Average monthly precipitation varies between 0.6 inches in July to 4.44 inches in January. As shown on Table 5-2, the majority of the precipitation occurs during the rainy season between October and April.

Table 5-2 MONTHLY PRECIPITATION SUMMARY RED BLUFF NCDC STATION 047292			
Month	**Mean**	**Maximum**	**Minimum**
January	4.44	21.47	0.22
February	3.60	11.38	0.02
March	2.97	10.23	0.01
April	1.63	6.51	0
May	0.97	4.04	0
June	0.44	1.64	0
July	0.06	0.70	0
August	0.15	1.56	0
September	0.49	4.95	0
October	1.36	5.17	0
November	2.92	8.42	0
December	4.06	10.77	0
Total	22.90	---	---
Period of Record 1933 to 2005.			

An isohyetal map of the watershed is shown on Figure 5-5. As shown, annual precipitation along the western perimeter of the watershed approaches 50 inches.

TEMPERATURES

Minimum, maximum, and average monthly temperatures at Red Bluff (NCDC Station 047292) between 1933 and 2004 are summarized in Table 5-3 and shown on Figure 5-6. Average monthly temperatures range between a low of 45.8°F in January to 81.6°F in July. In the Red Bluff area, the first frost typically occurs during the first week of December, and the last frost occurs during the first week of March. There are approximately 275 frost free days per year.

Average monthly temperatures decrease with increasing elevation to the west. Average monthly temperatures at the Saddle Camp (CDEC Station SAD at an elevation of 3850 msl) are approximately 10ºF less than the average monthly temperatures at Red Bluff (NCDC Station 047292 at an elevation of 350 msl). The average temperature decrease is approximately 3ºF per 1,000 feet msl.

EVAPOTRANSPIRATION

Evapotranspiration (ET) is the sum of water lost to evaporation and plant transpiration**.** Evapotranspiration is usually estimated from pan evaporation measurements or indirectly from climatic input. It is becoming common to express ET as the water lost from a reference crop. Reference evapotranspiration (ETo) is the amount of water lost from a well-watered, actively growing, closely clipped grass that is completely shading the soil surface. Although typically used to schedule irrigation events, ETo data closely reflect evaporation rates from open water surfaces.

Table 5-3 MONTHLY TEMPERATURE SUMMARY RED BLUFF NCDC STATION 047292			
Month	**Mean**	**Maximum**	**Minimum**
January	45.80	51.18	35.45
February	50.17	55.77	45.31
March	54.01	63.15	48.05
April	59.43	65.98	49.37
May	67.76	75.1	60.6
June	75.89	82.35	70.18
July	81.63	87.29	74.77
August	79.48	84.56	74.97
September	74.87	79.90	66.82
October	64.95	71.55	59.95
November	53.07	58.38	46.87
December	46.66	53.40	39.77
Average	62.82	---	---
Period of Record 1933 to 2005.			

The annual ETo rate for Gerber (CIMIS Station 8) between 1982 and 2005 is 54.7 inches. Average monthly ETo rates are shown on Figure 5-7. Monthly ETo rates vary between 1.04 inches in January and 8.7 inches in July.

WIND SPEED AND DIRECTION

Wind speed and wind direction at Gerber (CIMIS Station 8) during 2004 are shown on Figure 5-8. Data clearly show that the predominant wind directions are from the northwest and southeast. A more detailed analysis shows that the predominate wind direction in the AM during the winter is from the northwest, and the predominate wind direction in the PM during the summer is from the southeast. Predominate wind speed is between 0.5 and 2.1 meters per second (1.1 and 4.8 miles per hour).

DEGREE DAYS

The concept of Growing Degree Days (GDD) has been widely used since the 1950s to track temperature accumulation. The GDD tracking process begins by picking a calendar date to begin from, and selecting a temperature range in which insect growth occurs. In the following example, a start date of March 15 was selected, and the temperature range was selected to be 50ºF with no upper cutoff (UC IPM 2005). Using these parameters, the GDD were calculated using temperature data from Gerber (CIMIS Station 8) between 1995 and 2004. The minimum, maximum, and average GDD for this time period are shown on Figure 5-9.

CONCLUSIONS AND RECOMMENDATIONS

The Mediterranean climate of the watershed is characterized by wet winter months and summer drought. Evaporative potential in low elevation areas exceeds rainfall totals. Climate science shows a trend in increasing temperatures that will raise evapotranspiration rates. In light of existing rainfall patterns and potential climate change, practices that enhance water capture (soil infiltration, ponds, etc) and have benefits to watershed ecosystems, productivity, and sustainability should be encouraged.

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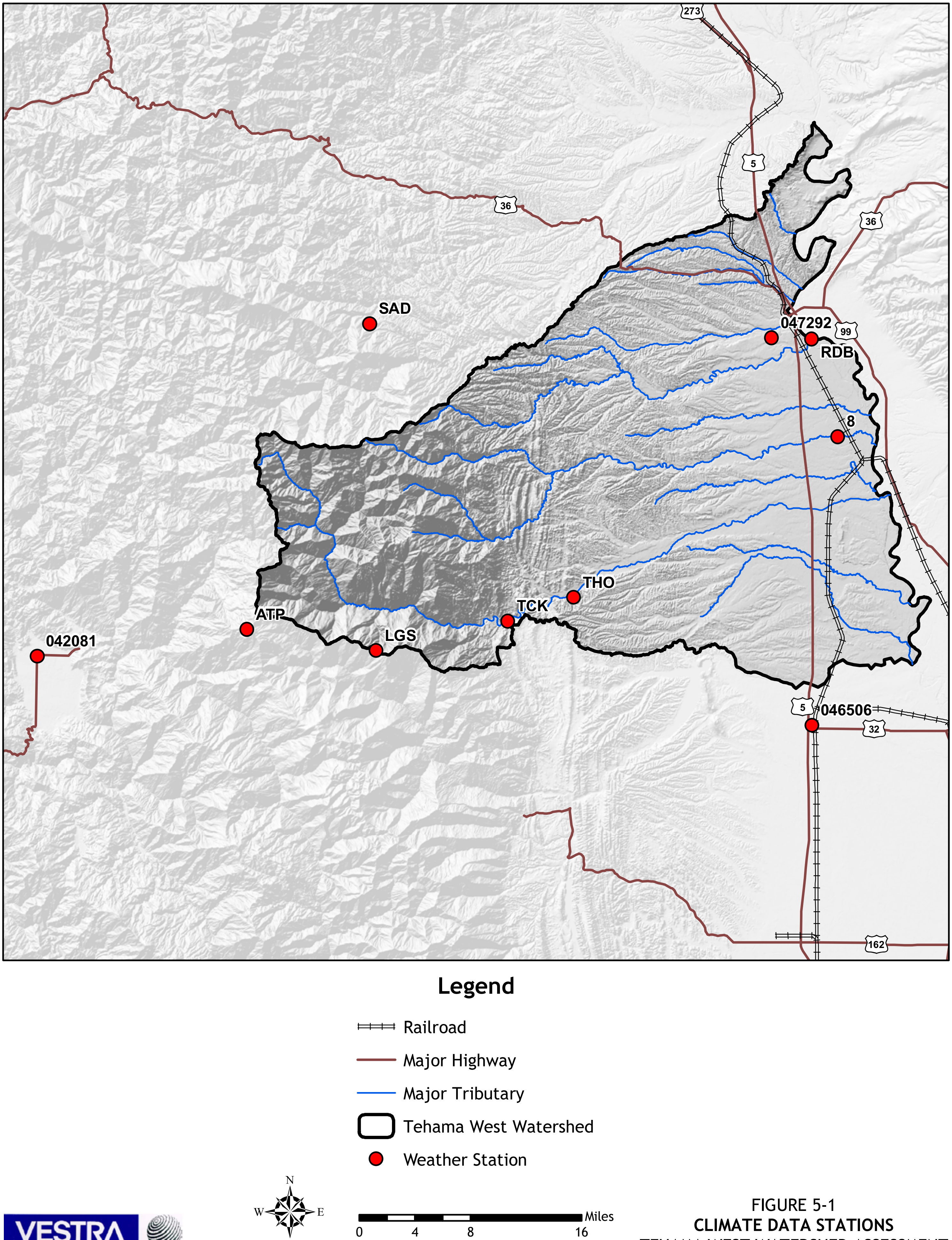

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FIGURE 5-1
CLIMATE DATA STATIONS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: WESTERN REGIONAL CLIMATE CENTER, CALIFORNIA DATA EXCHANGE CENTER,
AND CALIFORNIA IRRIGATION MANAGEMENT INFORMATION SYSTEM

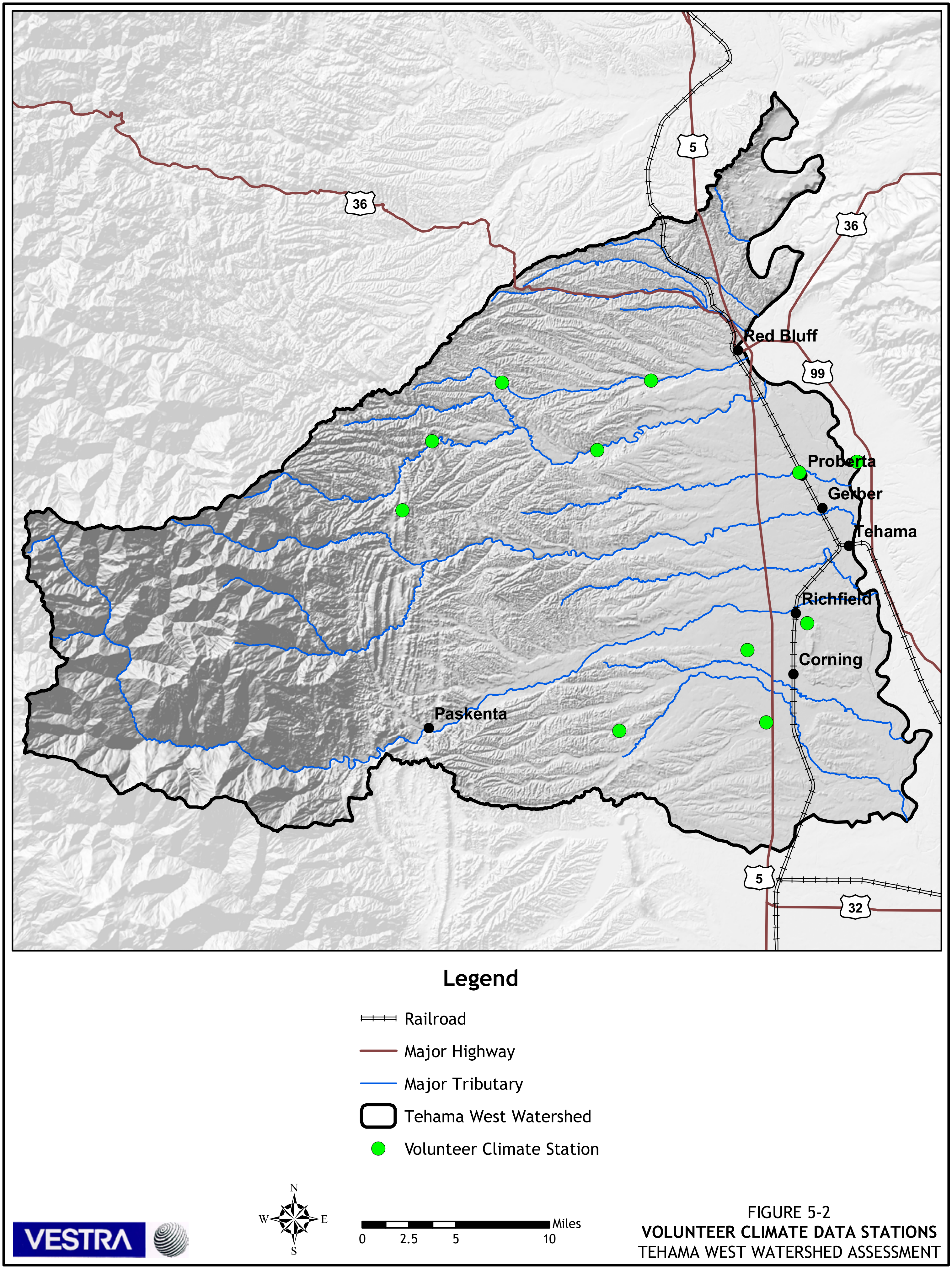
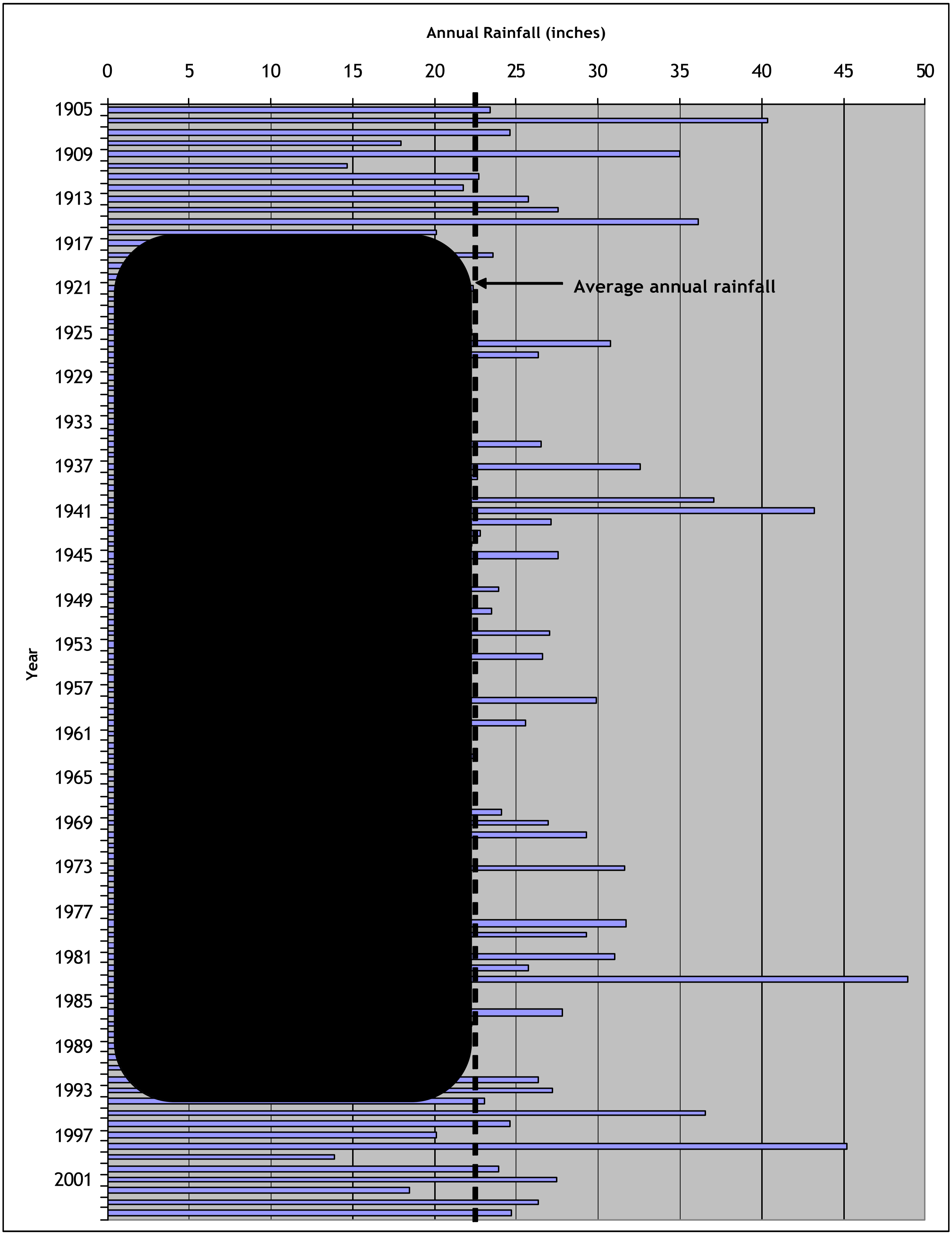


FIGURE 5-2
VOLUNTEER CLIMATE DATA STATIONS
TEHAMA WEST WATERSHED ASSESSMENT

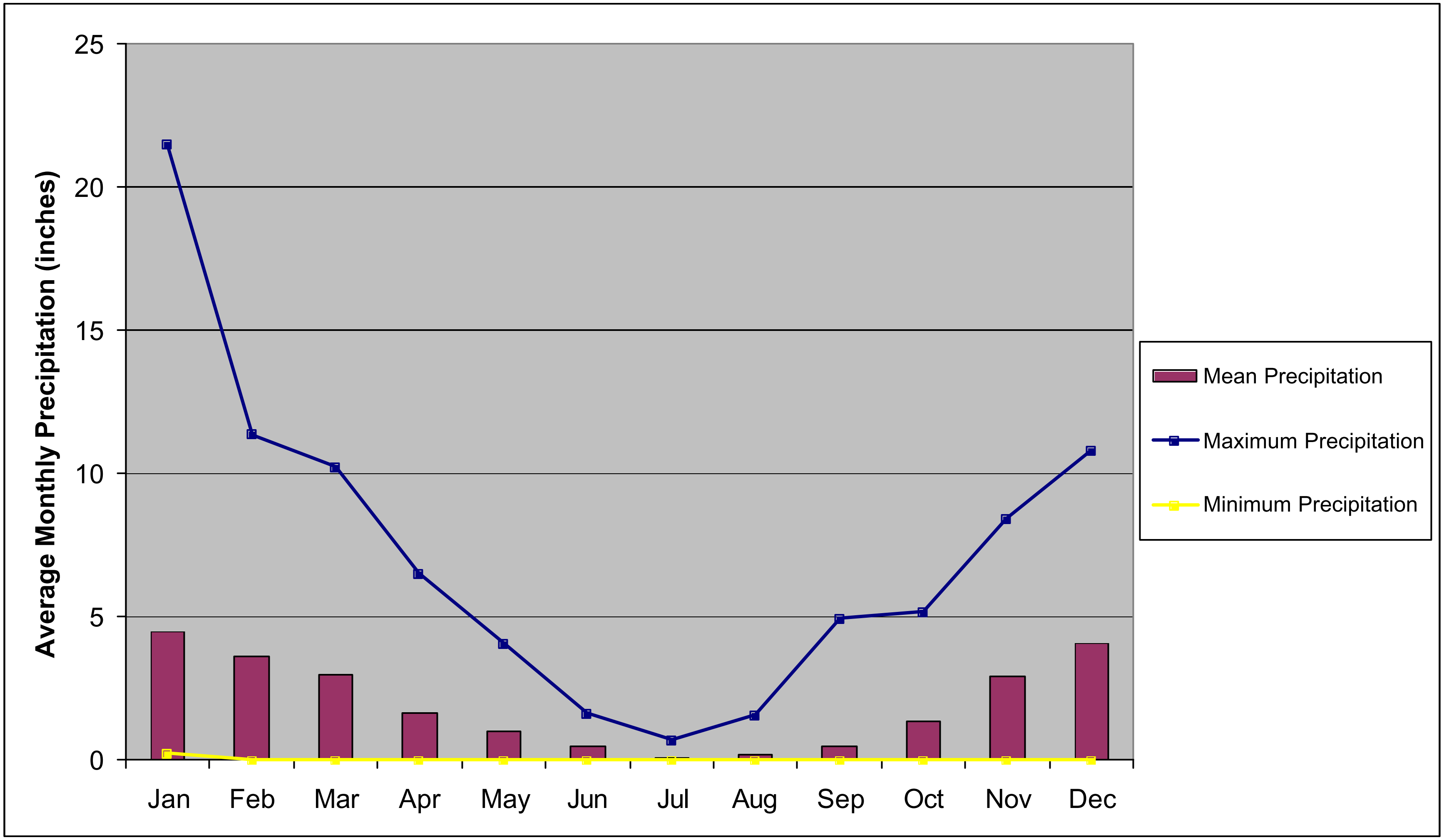
SOURCE: TEHAMA COUNTY RESOURCE CONSERVATION DISTRICT



VESTRA

FIGURE 5-3
HISTORICAL PRECIPITATION AND CLIMATE RECORDS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: WESTERN REGIONAL CLIMATE CENTER 2004



VESTRA

FIGURE 5-4
AVERAGE MONTHLY PRECIPITATION
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: REDDING NATIONAL WEATHER SERVICE OBSERVATION STATION

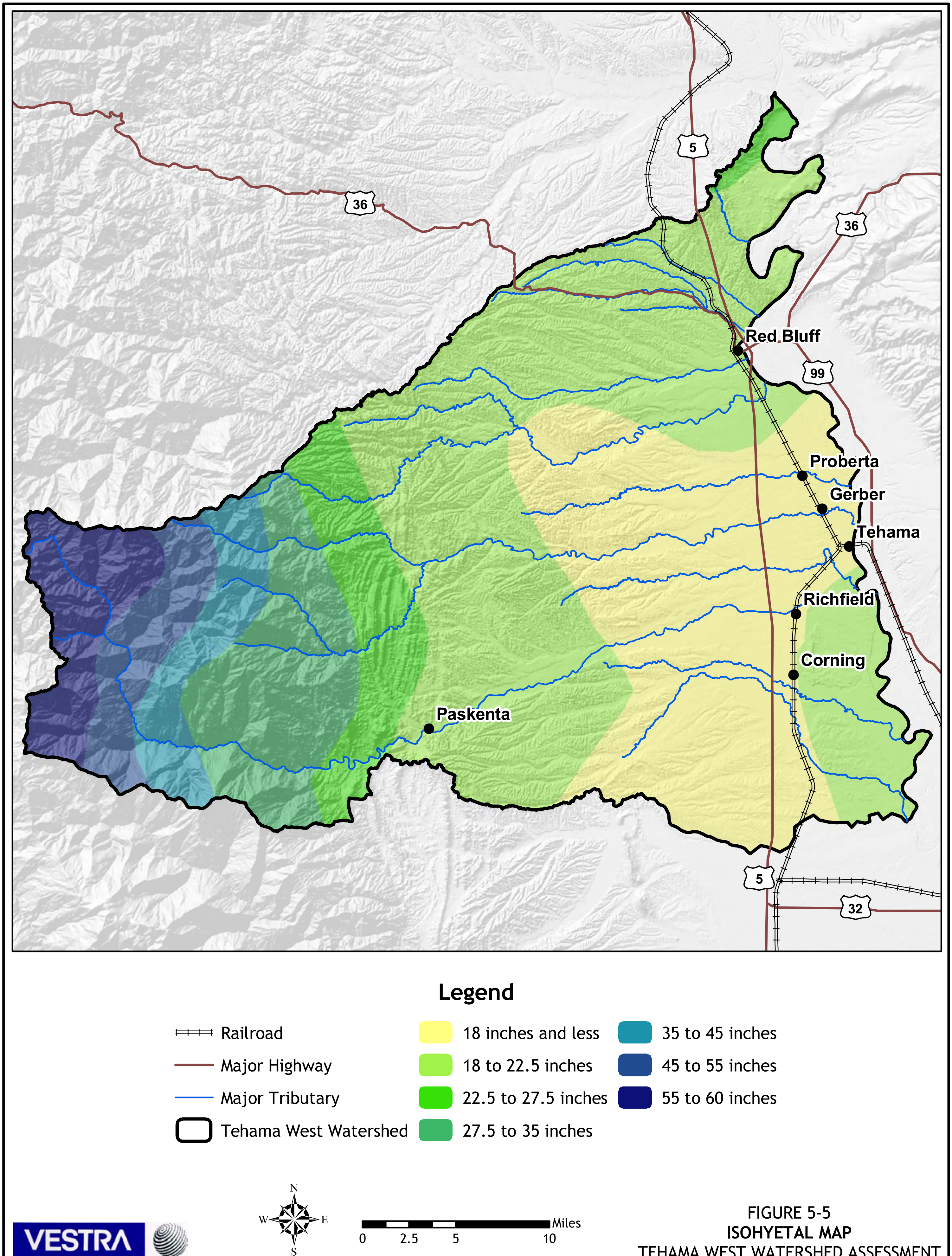


FIGURE 5-5
ISOHYETAL MAP
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

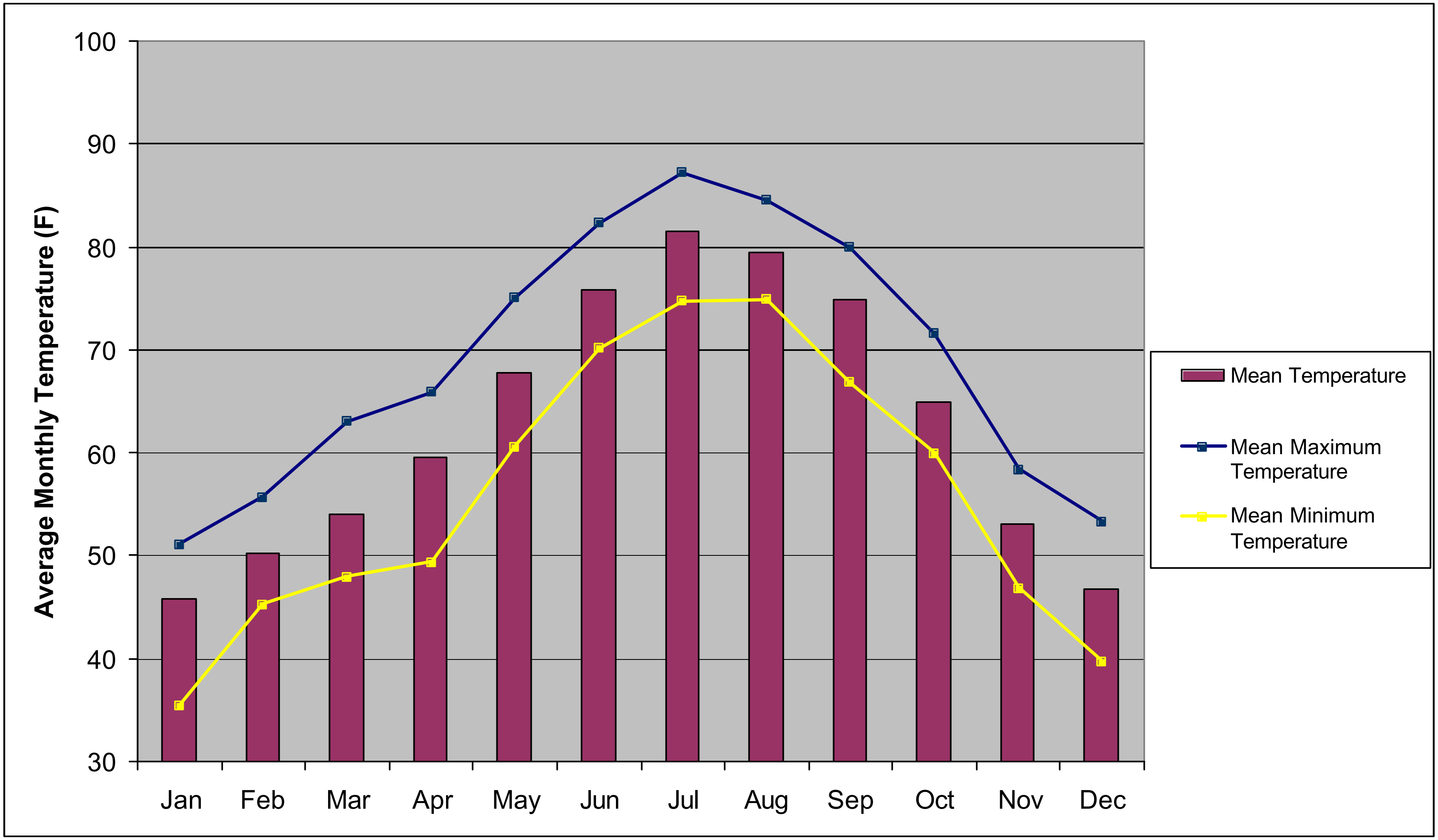


FIGURE 5-6
AVERAGE MONTHLY TEMPERATURES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: REDDING NATIONAL WEATHER SERVICE OBSERVATION STATION

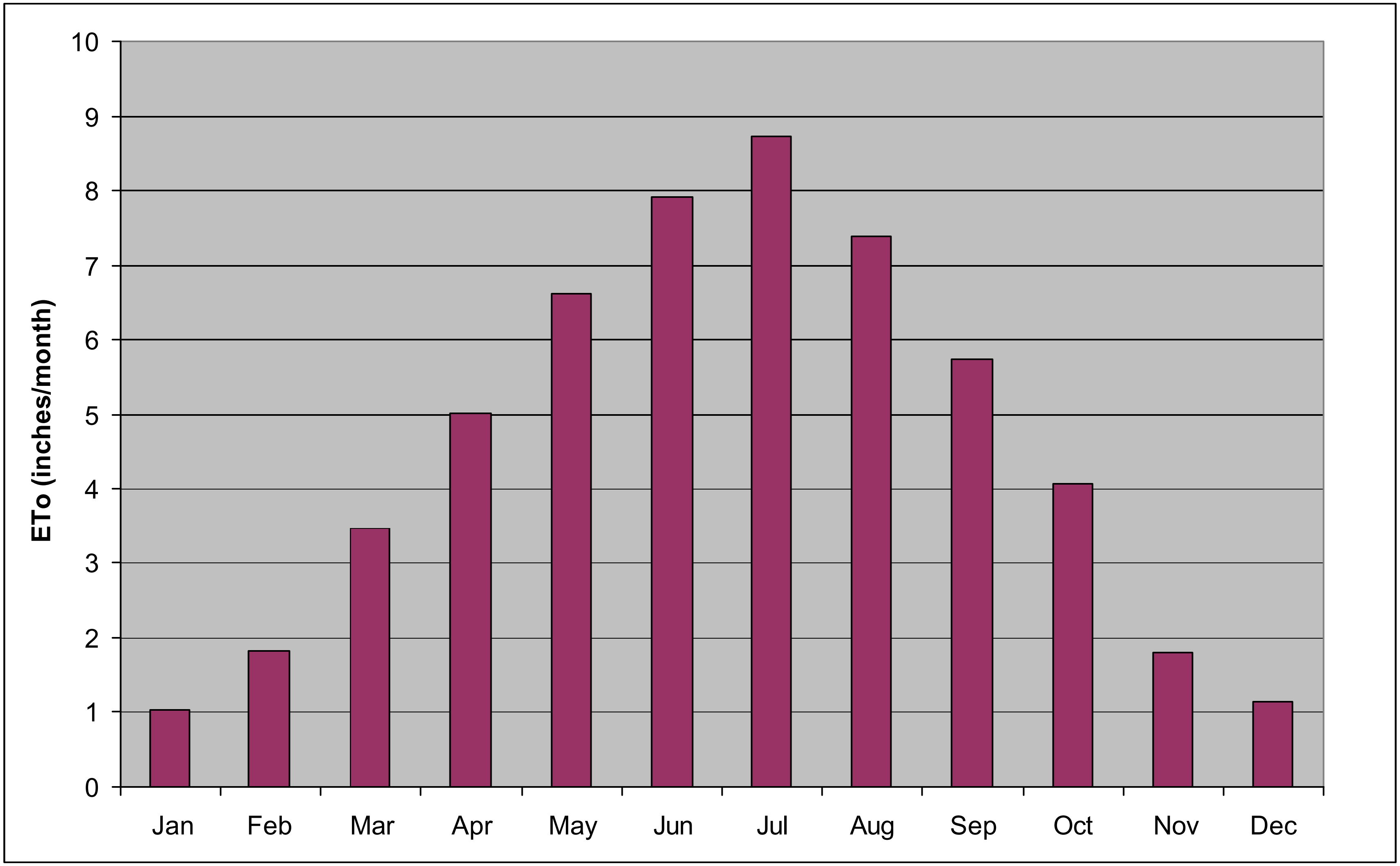
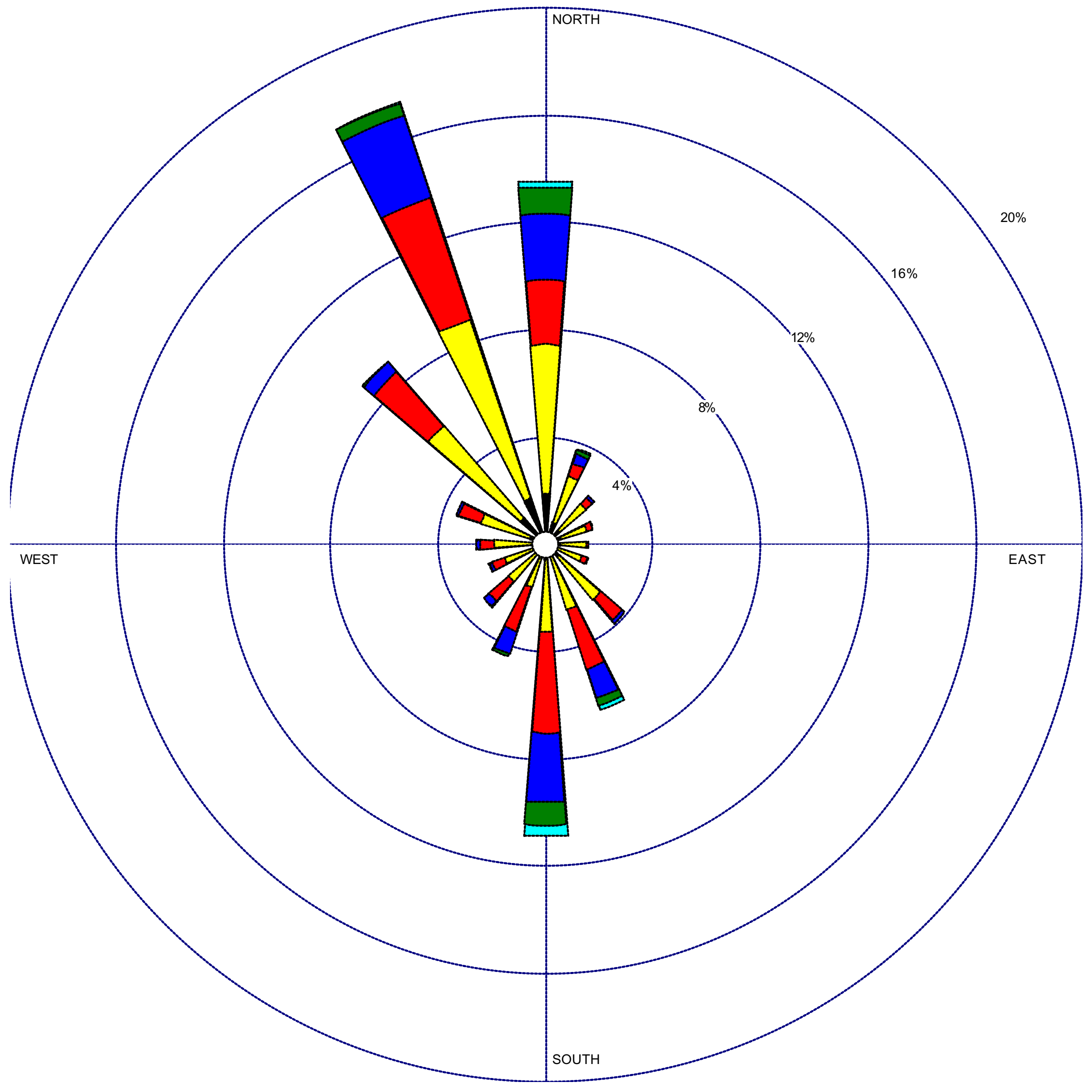


FIGURE 5-7
REFERENCE EVAPOTRANSPIRATION
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: REDDING NATIONAL WEATHER SERVICE OBSERVATION STATION

WIND ROSE PLOT

Station #24257 - REDDING/AAF, CA 1987-1989



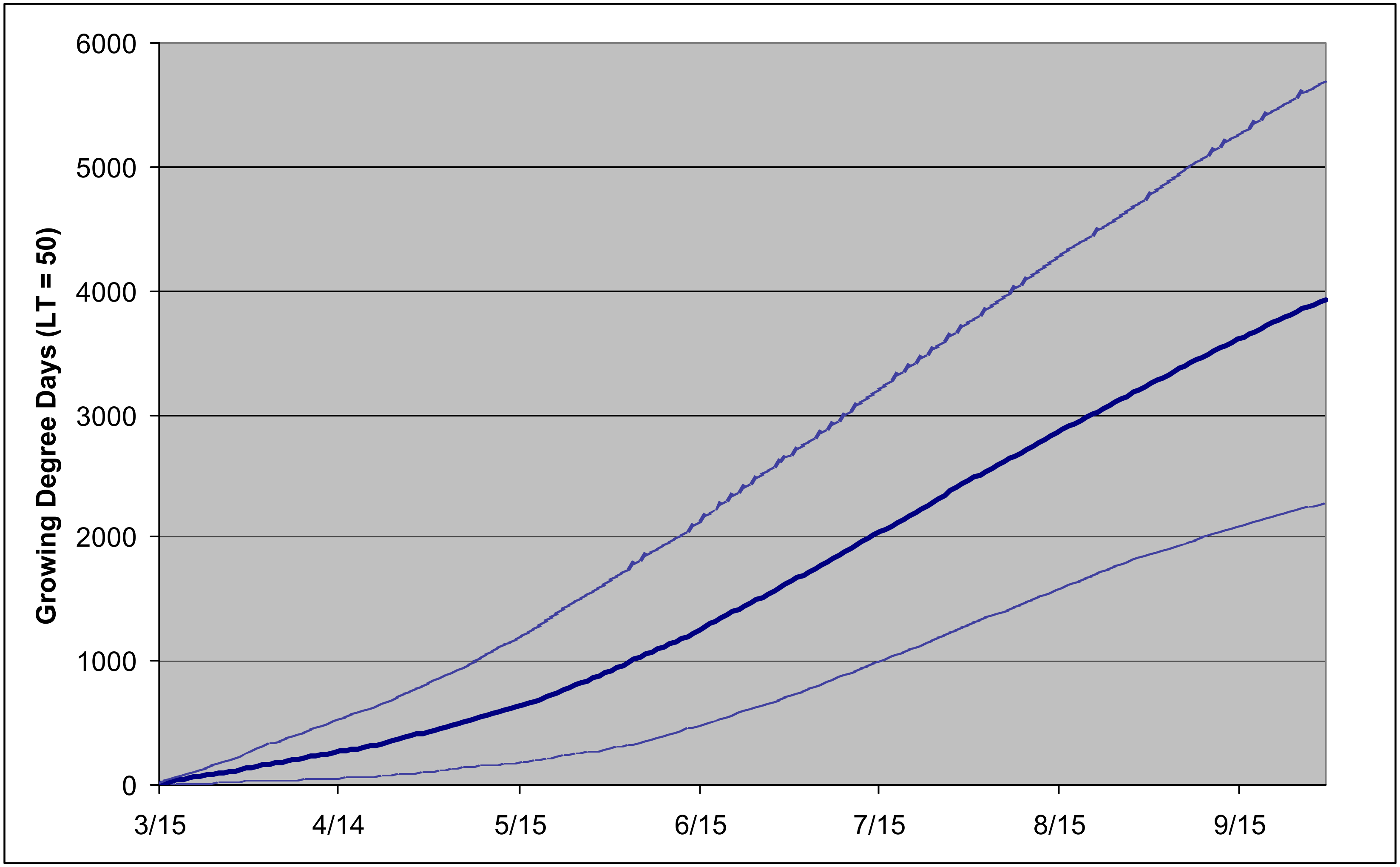
Wind Speed (m/s)	MODELER	DATE	COMPANY NAME
> 11.06		**5/28/2003**	
8.49 - 11.06	DISPLAY **Wind Speed**	UNIT **m/s**	COMMENTS
5.40 - 8.49	AVG. WIND SPEED **3.76 m/s**	CALM WINDS **11.75%**	
3.34 - 5.40			
1.80 - 3.34	ORIENTATION **Direction (blowing from)**	PLOT YEAR-DATE-TIME **1987** **Jan 1 - Dec 31** **Midnight - 11 PM**	PROJECT/PLOT NO. **1987-1989**
0.51 - 1.80			

WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com

VESTRA

FIGURE 5-8
WIND ROSE
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: NATURAL RESOURCES CONSERVATION SERVICE, 2004



VESTRA

FIGURE 5-9
GROWING DEGREE DAYS
TEHAMA WEST WATERSHED ASSESSMENT

Section 6

Section 6
HYDROLOGY, FLOODING, AND FLUVIAL GEOMORPHOLOGY

TABLES

FIGURES

Section 6

HYDROLOGY, FLOODING, AND FLUVIAL GEOMORPHOLOGY

Basic information on the surface water, groundwater, and geomorphology of the Tehama West Watershed is presented in this section. The surface water portion includes a discussion of reference conditions, surface water runoff, water rights, and water use. The groundwater portion includes a discussion of key groundwater basins and water use. Supporting information on geology and soils is summarized in Section 4, "Geology and Soils," and supporting information on climate is summarized in Section 5, "Climate."

Often, the relationship between hydrology, geomorphology, and geology is overlooked in a baseline watershed assessment. This relationship is critical to understanding conditions in the Tehama West Watershed because geology divides the watershed into two very distinct regions. The eastern portion of the watershed is underlain by rocks of the Great Valley Geomorphic Province. In general, this portion of the watershed is characterized by low elevations, low precipitation, relatively gentle topography, low erosion potential, and a significant groundwater reservoir. The western portion of the watershed is underlain by rocks of the Coast Range Geomorphic Province. This portion of the watershed is characterized by high elevations, high rainfall, steep slopes, high erosion potential, and a relatively poor fractured groundwater reservoir. As a result, streams originating in the eastern or Great Valley portion of the watershed have very different characteristics from streams originating in the western or Coast Range portion of the watershed. The transition between the two geomorphic provinces generally trends north-south, passing through Paskenta. This transition serves as the western boundary of the Sacramento Groundwater Basin. Significant groundwater recharge occurs in the alluvial deposits associated with this transition zone.

SOURCES OF DATA

Key sources of data used in the preparation of this section are listed below. Additional information is provided in the references section.

- Daily Stream Flow Statistics for Elder Creek near Paskenta, Elder Creek at Gerber, Thomes Creek at Paskenta, and Red Bank Creek near Red Bluff (USGS 2005)
- Thomes Creek Watershed Study (DWR 1982)
- Thomes Creek Sediment Budget (CSUC 2005)
- Sacramento Valley Westside Tributary Watershed Erosion Study (DWR 1992)
- Coordinated AB3030 Groundwater Management Plan, Tehama County Flood Control and Water Conservation District (Law 1996)
- Water Inventory and Analysis Report, Tehama County Flood Control and Water Conservation District (CDM 2003)
- California Groundwater Bulletin 118-03 (DWR 2003)

- Sacramento River Groundwater Basin Water Levels (DWR 2005)
- Tehama County: A Small Water Systems Drought Vulnerability Study (CDM 2005)
- Thomes Creek Watershed Analysis Report (USDA 1997)
- Resource Capabilities Affecting Sedimentation, Red Bank Creek Pilot Study Area, Tehama County, California (SCS 1978)

SURFACE WATER HYDROLOGY

As defined for this watershed assessment, the Tehama West Watershed includes approximately 670,000 acres, or approximately 1,050 square miles. It includes portions of the Sacramento Lower Cow Creek, Lower Clear Creek Hydrologic Unit (HUC 18020101), Sacramento Lower Thomes Creek Hydrologic Unit (HUC 18020103), and the Upper Elder Creek, Upper Thomes Creek Hydrologic Unit (HUC 18020114) as defined by the United States Geological Survey (USGS). The general location of the watershed is shown on Figure 6-1.

The Tehama West Watershed drains to the Sacramento River. Major tributaries are shown on Figure 6-2 and include:

- Thomes Creek
- Elder Creek
- Red Bank Creek
- Reeds Creek

Thomes and Elder Creeks are the largest drainages in the watershed. They originate in the rugged coniferous forest zone along the crest of the Coast Range, including the Yolla Bolla Wilderness Area. The upper-most elevations for these drainages exceed 5,000 feet and may have significant, but highly variable, snowpacks. Shorter drainages within the watershed originate in the foothill areas dominated by chaparral, oak woodlands, or rangelands. Snowfall is infrequent in this lower zone and does not significantly contribute to stream flow patterns. The watershed is comprised of 11 sub-units. These subunits are summarized in Table 6-1 and are shown on Figure 6-3.

In order to discuss the hydrology of a watershed, it is necessary to quantify the volume of precipitation received within the watershed boundaries. Average annual precipitation in Red Bluff (NCDC Station 047292) between 1905 and 2004 is 22.8 inches, ranging from 7.2 inches in 1976 to 49 inches in 1983. Throughout the watershed, average annual precipitation varies from less than 18 inches along the eastern side of the watershed, south of Red Bluff, to more than 50 inches along the crest of the Coast Range. Precipitation isohyetals are shown on Figure 6-4.

Average annual precipitation across the watershed is 24.8 inches, or approximately 1,380,000 acre-feet. In 1977, a drought year, average annual precipitation was approximately 54 percent of normal (CDM 2003). Additional climate data are summarized in Section 5, "Climate."

Table 6-1 WATERSHED SUB-UNITS			
Sub-unit	**Tributary Length (miles)**	**Acreage**	**Percent of Watershed**
Blue Tent Creek	10.0	15,142	2.3%
Burch Creek	24.1	94,199	14.1%
Dibble Creek	33.9	21,327	3.2%
Elder Creek	72.1	96,350	14.4%
Jewett Creek	21.4	35,902	5.4%
McClure Creek	22.4	29,761	4.5%
Oat Creek	22.4	44,612	6.7%
Red Bank Creek	56.2	74,450	11.1%
Reeds Creek	20.9	48,814	7.3%
Spring Creek	4.5	14,494	2.2%
Thomes Creek	70.0	193,117	28.9%
Total	357.9	668,168	100%

Reference Conditions

The twentieth century was one of relatively high rainfall compared to the past 500 years. However, current conditions are "normal" in the context of the last 100 years. Droughts exceeding 3 years are relatively rare in Northern California. Historical multi-year droughts include: 1912–13, 1918–20, 1923–24, 1929–34, 1947–50, 1959–61, 1976–77, and 1987–92 (DWR 2000a).

A 420-year reconstruction of Sacramento River runoff from tree ring data was made for the California Department of Water Resources (DWR) in 1986 by the Laboratory for Tree Ring Research at the University of Arizona. The tree ring data suggested that the 1929–34 drought was the most severe in the reconstructed record from 1560 to 1980. The data also suggested that a few droughts prior to 1900 exceeded 3 years, and none lasted over 6 years, except for one period of less than average runoff from 1839–46. John Bidwell, an early pioneer who arrived in California in 1841, confirmed that 1841, 1843, and 1844 were extremely dry years in the Sacramento area (Meko et al 2001).

A 1994 study of relict tree stumps rooted in present-day lakes, rivers, and marshes suggest that California sustained two epic drought periods. The first epic drought lasted more than 2 centuries before the year 1112, the second drought lasted more than 140 years before 1350. The conclusion that can be drawn from these investigations is that California is subject to droughts more severe and more prolonged than witnessed in the historical record (DWR 2000a).

Surface Water Runoff

Headwaters of the streams in the watershed have relatively little, if any, drainage area with significant snowpack. Therefore, in contrast to streams flowing from the high Sierra Nevada with relatively predictable and significant snow packs, snow melt and run-off play a minor role in the flow characteristics of the streams in the watershed. Watershed streams show rapid responses to storms, and flow levels fluctuate greatly between storm-periods and intervening dry spells.

Stream gaging stations within the Tehama West Watershed are summarized in Table 6-2. Mean annual flows for Thomes Creek at Paskenta between 1921 and 1996 are shown on Figure 6-5a. Mean annual flows vary between a minimum of 72.4 cubic feet per second (cfs) in 1976 and a maximum of 884 cfs in 1983, averaging 289 cfs. Mean annual flows for Elder and Red Bank Creeks are shown on Figures 6-5b and 6-5c.

Table 6-2
ANNUAL MEAN STREAM FLOW
UNITED STATES GEOLOGICAL SURVEY

USGS Site Name	USGS Site Number	Drainage Area (sqm)	Period of Record [1]	Min. (cfs)	Max. (cfs)	Mean (cfs)	Mean (aft/yr)
Red Bank Creek near Red Bluff	11378800	93.5	1960-1982	1.38 (1976)	114 (1978)	48.7	35,260
Red Bank Creek at Rawson Road Bridge near Red Bluff	11378860	109	1965-1967	---	---	48.8	35,330
Elder Creek near Paskenta	11379500	92.4	1949-2004	11.8 (1976)	343 (1983)	99.4	71,970
Elder Creek near Henleyville	11380000	130	1931-1941	10.3 (1939)	198 (1940)	73.6	53,290
Elder Creek at Gerber	11380500	136	1950-1979	44.1 (1959)	287 (1958)	100	72,400
Thomes Creek Tributary at Paskenta	11381990	0.65	1968-1970	---	---	0.5	360
Thomes Creek at Paskenta	11382000	203	1921-1996	72.4 (1976)	884 (1983)	289	209,240
Thomes Creek at Rawson Road Bridge near Richfield	11382090	284	1978-1980	---	---	338	244,700

[1] Based on a water year of October through September. For example, the 2004 water year extends from October 1, 2003 through September 30, 2004.

Monthly flows for Thomes Creek, Elder Creek, and Red Bank Creeks are summarized in Table 6-3 and are shown on Figures 6-6a through 6-6c. Peak monthly flows in Thomes Creek and Elder Creek occur in February. As peak monthly precipitation occurs in January, the February peak indicates that snowmelt affects runoff in these watersheds. For comparison, peak monthly flows in Red Bank Creek occur in conjunction with peak precipitation.

Assuming the runoff coefficient of 530 acre-feet per square mile for Elder Creek (72,400 acre-feet / 136 square miles) applies to the entire watershed, surface water runoff during an average year would be 550,000 acre-feet (530 acre-feet per square mile * 1,050 square miles). This represents approximately 40 percent of the average annual precipitation.

Table 6-3 MONTHLY STREAM FLOW									
Month	Thomes Creek (1921-1996)			Elder Creek (1949-2004)			Red Bank Creek (1960-1982)		
	Mean	Min.	Max	Mean	Min.	Max	Mean	Min.	Max
Jan	583	12.4	2,900	253	5.38	1,208	184	0	696
Feb	706	23.2	3,483	295	7	1,636	146	0	522
Mar	620	48.9	2,080	238	22.6	1,176	111	3.39	482
Apr	551	45.3	1,879	150	13.8	497	50.6	0.41	230
May	354	18.2	1,406	83.7	13.4	463	7.77	0	27.3
Jun	116	1.41	591	31.1	2.52	262	1.76	0	17.1
Jul	23.5	0	133	8.87	0.32	49.6	0.15	0	1.57
Aug	6.28	0	38.1	3.44	0.002	17.5	0	0	0
Sep	5.08	0	25.5	3.05	0.14	11.3	0.021	0	0.48
Oct	24.7	0	310	8.8	0.66	102	0.47	0	9.79
Nov	159	2.85	1,500	45.9	2.89	310	26.7	0	140
Dec	395	6.93	2,879	142	4.06	649	60.1	0	233
Average	295	---	---	99.4	---	---	48.7	---	---

Mean monthly flows for the Sacramento River above Bend Bridge near Red Bluff are shown in Figure 6-7. As shown, peak flows occur between January and March. Flows throughout the rest of the year are relatively constant. Being in an area characterized by heavy winter precipitation and long dry summers, these variations would be more pronounced under natural conditions. Shasta Dam, diversions into the Sacramento River from the Trinity River, and agricultural diversions from the Sacramento River mute or mask natural flow conditions. Present day Sacramento River flow patterns more closely reflect downstream water needs than natural hydrologic and weather factors.

Flood History

There is scarce information about floods in the Sacramento River basin prior to the 1850s. The primary sources of information during this period are histories of early settlement that include eyewitness accounts from Indians and pioneer settlers. Notable floods are reported to have occurred around 1800 and in 1826, 1840, and 1847.

Between 1850 and 1900 major flooding occurred in 1850, 1862, 1867, 1881, and 1890. Flooding during the 1860s constitutes one of the greatest flood periods in the history of California. Major floods after 1900 occurred in 1904, 1907, 1909, 1911, 1928, 1955, 1964, 1967, 1969, 1970, 1974, 1983, 1986, 1995, and 1997 (USAC 1999). The 1904 flooding resulted in the highest peak flows to date in the Upper Sacramento River between Kennet and Red Bluff.

Although 1983 was one of the wettest water years in California this century, due to the "El Nino" weather phenomenon, the magnitude of the peak flows were not the highest of the century. By early May, snow water content in the Sierra exceeded 230 percent of normal, and the ensuing runoff resulted in approximately four times the average volume for Central Valley streams.

The largest and most extensive flooding on record in the Upper Sacramento River occurred in December 1996 and January 1997. The flooding followed a series of three storms delivered over a period of 5 days between Christmas and New Year.

Annual peak flows occurring with a return period of 5 years or more in Thomes Creek at Paskenta and Elder Creek near Paskenta are summarized in Table 6-4. Thomes Creek peak flows in excess of 14,400 cfs have a return period of 5 years, and flows in excess of 20,000 cfs have a return period of 10 years. Recurrence intervals for peak annual flows in Thomes Creek are shown on Figure 6-8.

Table 6-4
ANNUAL PEAK FLOWS
RETURN PERIOD > 5 YEARS

Thomes Creek (1921-1996)			Elder Creek (1949-2004)		
Date	Gage Height (feet)	Flow (cfs)	Date	Gage Height (feet)	Flow (cfs)
Dec. 22, 1964	12.7	37,800	Feb. 28, 1983	12.1	17,700
Feb. 17, 1986	12.11	32,900	Feb. 14, 1986	11.62	15,300
Jan. 16, 1974	12.3	29,400	Mar. 04, 2001	11.58	15,100
Dec. 21, 1955	12.14	23,500	Dec. 11, 1983	11.17	13,200
Mar. 09, 1995	10.54	20,100	Dec. 16, 2002	12.11	13,100
Mar. 26, 1928	10.5	19,600	Feb. 24, 1958	13.9	11,700
Jan. 26, 1983	10.19	19,500	Dec. 31, 1996	10.75	11,500
Jan. 31, 1963	12.63	19,200	Dec. 22, 1964	13.23	10,300
Jan. 13, 1980	10.1	18,800	Mar. 09, 1995	10.3	9,740
Feb. 08, 1960	12.32	18,700	Mar. 07, 1975	11.22	9,000
Jan. 21, 1943	10.92	18,600	Jan. 16, 1974	11.14	8,850
Jan. 23, 1970	12	18,000	Dec. 21, 1955	12.52	8,840
Feb. 28, 1940	14.3	17,000	Jan. 23, 1970	11.05	8,690
Dec. 10, 1937	16.8	16,500	Feb. 17, 2004	10.41	8,340
Feb. 15, 1982	9.57	16,400	---	---	---
Feb. 24, 1958	9.78	14,300	---	---	---

Prior to the completion of Shasta Dam in 1945, the Sacramento Valley's low gradient, wide expanse, maze of sloughs, ox-bows, and low-lying swales allowed the river to quickly extend beyond its banks and cover immense areas. Early day flooding had serious impacts on transportation and the development of infrastructure within the Sacramento River Valley. Since flows over the dam have been regulated, the Sacramento River does not flood in the same pattern or with the same magnitude that it had previously. Currently, floods tend to be relatively infrequent and highly localized with damage occurring in well-known and expected locations. As the number and extent of the flooding has been reduced, development has extended into the areas where it was previously infeasible or impossible. One result from these changing land use patterns is that flood flow features, such as the natural levees and ox-bow lakes, are now often difficult to identify or have been modified.

The Federal Emergency Management Agency has determined areas within the watershed that are subject to flood inundation (see Figure 6-9). While most of these potential flood areas are located near the Sacramento River, significant acreage with flood potential exists along lower sections of Thomes, Elder, and Red Bank Creeks, as well as along low-gradient, Sacramento Valley reaches of all assessment area streams.

Jurisdictional Dams

Jurisdictional dams are defined as "artificial barriers, together with appurtenant works, which are 25 feet or more in height or have an impounding capacity of 50 acre-feet or more." Any artificial barrier under 6 feet, regardless of storage capacity, or that has a storage capacity less than 15 acre-feet, regardless of height, are not considered jurisdictional (CARA 2005). No jurisdictional dams are located within the Tehama West Watershed (CDM 2003).

It should be noted that DWR has studied the feasibility of constructing two water projects that would involve constructing dams within the Tehama West Watershed. The Red Bank Project would involve constructing a dam and reservoir on Red Bank Creek, and the Thomes-Newville Project would include constructing a dam and diverting water from Thomes Creek into the Newville Reservoir on Stony Creek. Much of the hydrologic data available for the Tehama West Watershed were collected in conjunction with these proposed projects.

Water Rights

Water rights in the Tehama West Watershed are either appropriated or riparian. An appropriated right is an exclusive right to take a specific amount of water from a particular source, for a specific use on a specific site, for a specific amount of time. Riparian rights, on the other hand, belong to the land bordering a water source. The following discussion is provided as a general introduction to the concept of water rights and should not be considered a legal opinion (California Water Law and Policy 2003).

Appropriated Rights
An appropriative right is an entitlement to water based on a specific use. This type of right may be sold or transferred with the property or separately. In general, the party that first diverts the water has priority rights over subsequent appropriators or users. Actual levels of priority are generally specified in the appropriation. In situations where priorities conflict, or in situations where rights were established prior to the appropriation system, the rights may be adjudicated. Adjudications are judgments decreed by the court and carry the full force of law. The court or an assigned water master generally administers adjudicated rights. Appropriated water rights in the Tehama West Watershed have not been adjudicated.

A senior may not change an established use of the water to the detriment of a junior. This restriction includes junior's reliance on a senior's return flow. A senior may not enforce a water right against a junior if such a right would not be put to beneficial use.

The elements of appropriation include:

- Intent to use the water
- Diversion or control of the water
- Reasonable and beneficial use of the water
- Priority of appropriation

Appropriative right is an acquisition of a water right subject to the issuance of a permit by the State Water Resources Control Board. The priority is based on the date a permit is issued. A priority-based permit system was implemented under the Water Commission Act of 1913. Presently, the system is codified in CWC § 1200, et seq.

Table 6-5 lists post-1914 major appropriative water rights for the Tehama West Watershed. Major water rights are defined as those greater than 1,000 acre-feet per year or approximately 600 gallons per minute (gpm).

Table 6-5
APPROPRIATIVE WATER RIGHTS HOLDERS

Owner	Filings (acre-feet)	Date Filed	Use	Source
State Water Resources Control Board	7,237,950	9/30/	Domestic, Fish & Wildlife Protection, Industrial, Irrigation, Municipal, Other, Recreational	Thomes Creek; North Fork Stony Creek; Stony Creek; Sacramento River
Bureau of Reclamation	4,806,792	7/30/1927	Domestic, Irrigation, Recreational, Stockwatering	Sacramento River
State Water Resources Control Board	3,039,939	9/30/1977	Domestic, Fish & Wildlife Protection, Incidental Power, Industrial, Irrigation, Municipal, Other, Recreational	Funks Creek; Willow Creek; Stone Corral Creek; Sacramento River
B. Fishman Corning Orchard	1,829	12/27/1954	Irrigation	Thomes Creek
Foley, Bill & Mke	1,344	5/21/1991	Fish & Wildlife Protection	Thomes Creek
Williams, D.	1,273	12/16/1953	Irrigation, Stockwatering	Thomes Creek
Leviathian, Inc.	1,126	3/31/1950	Irrigation, Stockwatering	Sacramento River

Riparian Rights

A riparian right is the right to use water based on the ownership of property that abuts a natural watercourse. Water claimed by virtue of a riparian right must be used on the riparian parcel. Such a right is generally attached to the riparian parcel of land except where a riparian right has been preserved on non-contiguous parcels after the land has been subdivided (*Hudson v. Dailey* 1909 156 Cal. 617). Riparian rights were adopted in California as a part of the English Common Law when California entered statehood in 1850. At that time, however, gold miners were already operating under their own system of prior appropriation to claim water rights. Conflicts between appropriations and riparian rights have continued since.

In general, riparian users are entitled to enough water to make beneficial use of the water on the land as long as no other riparian users are harmed by such use. Riparian rights in California are now limited to "reasonable and beneficial use." In contrast to appropriative rights, there is no priority of riparian right; senior and junior riparian users do not exist. Water conflicts between riparian users are resolved on the basis of reasonable use. The court has held that in times of water shortage, all riparians must adjust water use to allow for an equal sharing of the available water supply.

California Doctrine

The California Doctrine is a system of water rights that recognizes both appropriative and riparian rights. Early California law recognized both appropriation and riparian rights by applying priority to disputes between appropriators and by applying riparian principles to disputes between riparian users. In 1872, California officially recognized the rights of appropriators by allowing the filing of water claims with county recorders. Within 14 years, the California Supreme Court had to determine who had superior water rights when a downstream riparian rancher and an upstream appropriator each claimed a superior right to use water. The Supreme Court held that riparian rights are superior to the rights of an appropriator except in cases where the water had been appropriated before the riparian acquired the patent to his land, and after the passage of the 1866 Mining Act, which recognized appropriation. Generally, a reasonable use by a riparian will trump an appropriative right so long as the patent to the riparian parcel was acquired from the United States prior to the date of appropriation.

In 1926 the Supreme Court held that a riparian could assert priority over an appropriator to make beneficial use of the water even if the riparian use was unreasonable. In response, in 1928 the California Constitution was amended to require all water use in California to be "beneficial and reasonable." Generally today, a riparian user cannot defeat an appropriative right unless the riparian user proves the appropriation is causing undue interference with the riparian user's reasonable use of the water.

Surface Water Use

Water use history in the watershed has a direct correspondence to population and economic growth, development of regional water storage and supply projects, and water supply pricing and reliability. Agriculture is an economic driving force in the watershed and much of the water use history is directly tied to the development and use of water sources to satisfy agricultural needs (CDM 2003).

The history of agricultural development in Tehama County has documented gradual changes in the source of irrigation water. In the early days of European settlement, surface water was primarily used to irrigate fields in Tehama County. A gristmill operated on the Rancho Bosque, a Mexican Land Grant, served as the first water extraction device used for irrigation, sometime between 1847 and 1852. Even into the early years of the twentieth century agricultural users primarily depended upon surface water as no large storage areas existed that would allow wide-spread irrigation. However, during this time, most domestic water came from shallow wells.

Chronic flooding along the Sacramento River inhibited development in Tehama County, which along with the promise of irrigation water, led to the 1935 authorization of the Central Valley Project (CVP). Important elements of the CVP included the completion of Shasta Dam in 1945 and subsequent construction of the Tehama-Colusa and Corning Canals. Following these projects and the lessening of flood risk, agricultural development greatly expanded in the county and water usage increased significantly. In the 1970s two-thirds of irrigation water used in the county came from surface sources.

Gradually, the cost of CVP-delivered water increased at the same time as demand was increasing. This led to an increased usage of groundwater over the last quarter-century. By the 1990s, the proportion of surface-sourced irrigation water used declined to represent only one-third of that being used, with two-thirds coming from groundwater sources.

During this period of change there has been an excess of federal, state, and local programs to affect the management of the area's waters and resources. For instance, in 1992 the Central Valley Project Improvement Act required protection, restoration, and enhancement of fish and wildlife in CVP projects. Legislative actions have also been instrumental, including AB3030 (1992), Proposition 204 (1996), Proposition 13 (2000), and Proposition 50 (2002). All of these addressed various water quality and quantity issues and other environmental factors associated with the county's waters.

A Water Inventory and Analysis of water use in Tehama County was conducted by the Tehama County Flood Control and Water Conservation District in 2003 (CDM 2003). In this analysis, the county was divided into numerous inventory units. The inventory units encompassing the Tehama West Watershed include all of the Red Bluff East and Red Bluff West inventory units, and portions of the Corning East, Corning West, Bowman, and Mountain Region West inventory units. These units are shown on Figure 6-10.

A summary of the estimated 2000 water demand for each of these units along with the source is summarized in Table 6-6.

Table 6-6
2000 SURFACE WATER AND GROUNDWATER USE

	Red Bluff East	Red Bluff West	Corning East	Corning West
Water Demand (acre-feet per year applied)				
Agriculture	75,000	2,100	113,900	3,200
Municipal and Industrial	8,100	1,800	4,600	100
Conveyance Losses	2,300	0	1,300	400
Total	85,400	4,000	119,800	3,600
Water Supply (acre-feet per year supplied)				
Local Stream Diversions	0	200	2,200	2,400
CVP and Sacramento River	9,500	0	12,400	0
Groundwater Extraction	73,800	3,700	102,200	1,000
Surface Water Reuse	2,100	100	3,000	200
Total	85,400	4,000	119,800	3,600

Does not include West Mountain Unit because total demand is less than 500 acre-feet per year. Also, does not include Bowman Unit because the majority of the water demand in this unit is outside the watershed in Lake California, Anderson, and Cottonwood.

Nearly 90 percent of the water demand associated with the Red Bluff East and Corning East inventory units (188,900 out of 213,100 acre-feet) is for agricultural purposes, and the majority of this water is supplied from the groundwater reservoir (177,400 out of 182,400 acre-feet). Surface water is supplied primarily by the CVP via the Corning and Tehama-Colusa Canals which divert water from the Sacramento River at the Red Bluff Diversions Dam. Less than 5,000 acre-feet of surface water is derived from local stream diversions.

GROUNDWATER

Currently, groundwater is the primary water supply in the Tehama West Watershed, and because surface water supplies are unpredictable and limited, future growth in the region and water demand during drought conditions will depend on the continued availability of groundwater. Recognizing the importance of groundwater in the county, the Tehama County Flood Control and Water Conservation District has been authorized as a groundwater management agency to develop a comprehensive groundwater management plan. The overall purpose of the plan is to: 1) prevent long-term overdraft of groundwater, 2) provide a reliable long-term water supply, and 3) protect groundwater quality. Unfortunately, the majority of the groundwater used in the county is extracted by independent users, not organized districts, for agricultural purposes.

Groundwater can be defined as the portion of water occurring beneath the earth's surface, which completely fills (saturates) the void space of racks or sediment. Given that all rock has some degree of void space, it is fairly safe to say that groundwater can be found underlying nearly any location in the State. Several key properties help determine whether the subsurface environment will provide a significant, usable groundwater resource. Most of California's groundwater occurs in material deposited by streams, called alluvium. Alluvium consists of coarse deposits, such as sand and gravel, and finer-grained deposits such as clay and silt. The coarse and fine materials are usually coalesced in thin lenses and beds in an alluvial environment. In an alluvial environment, the coarse materials such as sand and gravel deposits, usually provide the best source of water and are termed aquifers, whereas the finer-grained clay and silt deposits are relatively poor sources of water and are referred to as aquitards.

Groundwater Basins

A groundwater basin is defined as alluvial aquifer or a series of alluvial aquifers with reasonably well-defined boundaries in a lateral direction and a definable bottom. Lateral boundaries are features that significantly impede groundwater flow such as rock or sediments with very low permeability or a geologic structure such as a fault. Bottom boundaries would include rock or sediments of very low permeability if no aquifers occur below those sediments within the basin.

Individual groundwater basins identified within the Tehama West Watershed are listed in Table 6-7 and are shown on Figure 6-11. In general, the basins encompass the portion of the watershed located between the Sacramento River to the east, and the geologic faults separating rocks of the Great Valley Sequence from the Franciscan Complex. The western area contains very little groundwater. Groundwater that does occur is generally found in fractures at relatively shallow depth. This area is not considered a groundwater basin and is designated as either the Western Highlands or Mountain Region West.

The following descriptions for the Red Bluff and Coring subbasins were taken from the California Department of Water Resources Bulletin 118-03 (DWR 2003).

Table 6-7 TEHAMA WEST GROUNDWATER BASINS			
Groundwater Basin	Subbasin	Subbasin Number	Total Area/Area in Watershed (acres)
Redding	Bowman	5-6.01	85,330/6,330
Sacramento	Red Bluff	5-21.50	266,750/266,750
Sacramento	Corning	5-21.51	205,640/143,920

Hydrogeology

Red Bluff Subbasin
The Red Bluff Subbasin is bounded on the west by the Coast Ranges, on the north by the Red Bluff Arch, on the south by Thomes Creek and on the east by the Sacramento River. The Red Bluff Arch is a hydrologic divide between the Redding Basin to the north and the Sacramento Valley. The Red Bluff Subbasin is likely contiguous with the Corning Subbasin at depth.

The Red Bluff Subbasin aquifer system is composed of continental deposits of late Tertiary to Quaternary age. The Quaternary deposits include Holocene stream channel deposits and Pleistocene Modesto and Riverbank formations. The Tertiary deposits consist of Pliocene Tehama and Tuscan formations.

Holocene Stream Channel Deposits. These deposits consist of unconsolidated gravel, sand, silt and clay derived from the erosion, reworking, and deposition of adjacent Tehama Formation and Quaternary stream terrace deposits found at or near the surface along stream and river channels. The thickness varies from 1 to 80 feet (Helley and Harwood 1985). This unit represents the upper part of the unconfined zone of the aquifer. Although it is moderately to highly permeable it is not a significant contributor to groundwater because of its limited areal extent.

Pleistocene Modesto Formation. The Modesto Formation (deposited between 14,000 to 42,000 years ago) consists of poorly indurated gravel and cobbles with sand, silt, and clay derived from reworking and deposition of the Tehama and Riverbank formations. The deposit ranges from less than 10 feet to nearly 200 feet across the valley floor (Helley and Harwood 1985). The terrace deposits are observed along Thomes, Elder, and Red Bank Creeks.

Pleistocene Riverbank Formation. The Riverbank Formation (deposited between 130,000 to 450,000 years ago) consists of poorly-to-highly permeable pebble and small cobble gravels interlensed with reddish clay sands and silt. The formation ranges from less than 1 foot to over 200 feet thick depending on location (Helley and Harwood 1985). Riverbank terrace deposits are observed along Thomes, Pine, Dibble, Reeds, Red Bank, Oat and Elder Creeks.

Pliocene Tehama Formation. The Tehama Formation consists of sediments originating from the Coast Range and Klamath Mountains, and is the primary source of groundwater for the subbasin. The majority of the Tehama Formation consists of fine-grained sediments indicative of deposition under floodplain conditions (McManus 1993). The thickness of coarse-grained beds of sand and gravel, as indicated by drill log data, are typically no more than 5 to 10 feet. The majority of both coarse and fine-grained sediments appear unconsolidated or moderately consolidated. The thickness of the formation is estimated to be up to 1,200 feet north of the City of Corning (DWR 2000b).

Pliocene Tuscan Formation. The Tuscan Formation consists of volcanic gravel and tuff-breccia, fine- to coarse-grained volcanic sandstone, conglomerate and tuff, and tuffaceous silt and clay; derived predominantly from andesitic and basaltic sources of the Cascade Range. In the subsurface the Tuscan Formation is found juxtaposed with the Tehama Formation in the axis of the valley near the Sacramento River. Permeability is moderate to high with yields ranging from 100 to 1,000 gpm, excluding areas where beds of the impermeable tuff-breccia exist.

Corning Subbasin

The Corning Subbasin comprises the portion of the Sacramento Valley Groundwater Basin bounded on the west by the Coast Ranges, on the north by Thomes Creek, on the east by the Sacramento River, and on the south by Stony Creek. Stony Creek is believed to be a hydrologic boundary throughout the year. The Corning Subbasin is likely contiguous with the Red Bluff Subbasin at depth.

The Corning Subbasin aquifer system west is comprised of deposits of late Tertiary to Quaternary age. The Quaternary deposits include Holocene alluvium and the Pleistocene terrace deposits of the Modesto and Riverbank Formations. The Tertiary deposits consist of the Pliocene Tehama and Tuscan Formations.

Holocene Stream Channel Deposits. These deposits consist of unconsolidated gravel, sand, silt and clay derived from the erosion, reworking, and deposition of adjacent Tehama Formation and Quaternary stream terrace deposits. The thickness varies from 1 to 80 feet (Helley and Harwood 1985). The unit represents the upper part of the unconfined zone of the aquifer and is moderately to highly permeable; however, the thickness and areal extent of the deposits limit the water-bearing capability.

Pleistocene Modesto Formation. The Modesto Formation (deposited between 14,000 to 42,000 years ago) consists of poorly indurated gravel and cobbles with sand, silt, and clay derived from reworking and deposition of the Tehama and the Riverbank formations. The deposit ranges from less than 10 feet to nearly 200 feet across the valley floor (Helley and Harwood 1985). These terrace deposits are observed along Thomes Creek, Burch Creek, and Stony Creek.

Pleistocene Riverbank Formation. The Riverbank Formation (deposited between 130,000 to 450,000 years ago) consists of poorly to highly permeable pebble and small cobble gravels interlensed with reddish clay sands and silt. The formation ranges from less than 1 foot to over 200 feet thick depending on location (Helley and Harwood 1985). Surficial deposits are observed over the eastern third of the subbasin and along Burch Creek and its tributaries.

Pliocene Tehama Formation. The Tehama Formation consists of sediments originating from the coastal mountains and is the primary source of groundwater for the subbasin. The formation ranges in thickness up to 2,000 feet, increasing in thickness from west to east, dipping 4 degrees to the east (DWR 1982). The majority of the formation consists of fine-grained sediments indicative of deposition under floodplain conditions (McManus 1993). The majority of both coarse and fine-grained sediments are unconsolidated or moderately consolidated.

Pliocene Tuscan Formation. The Tuscan Formation is located within the eastern third of the subbasin. The formation occurs at a depth of approximately 200 feet from the surface and is composed of a series of volcanic mudflows, tuff breccia, tuffaceous sandstone, and volcanic ash layers. The formation is described as four separate but lithologically similar units, A through D (with Unit A being the oldest), which in some areas are separated by layers of thin tuff or ash units (Helly and Harwood 1985). Units A, B, and C are believed to extend as far west as the Corning Canal. Unit A is the oldest water-bearing unit of the formation and is characterized by the presence of metamorphic clasts within interbedded lahars, volcanic conglomerate, volcanic sandstone, and siltstone. Unit B is composed of fairly equal distribution of lahars, tuffaceous sandstone, and conglomerate. Unit C consists of massive mudflow or lahar deposits with some interbedded volcanic conglomerate and sandstone. In the subsurface, these low permeability lahars form thick, confining layers for groundwater contained in the more permeable sediments of Unit B.

Subareas of the Corning Subbasin
Subareas of the Corning Subbasin located within the Tehama West Watershed include the Sacarmaneto Floodplain, Dissected Uplands, and Thomes Creek Floodplain.

Sacramento Valley Floodplain. Pleistocene and Holocene silt, sand, and gravel deposits in the vicinity of the City of Corning extend to depths of 50 to 185 feet. The proportion of sand and gravel in the unconsolidated alluvium overlying the Tehama Formation averages 20, 18, and 25 percent for depth intervals of 20 to 50 feet, 50 to 100 feet, and 100- to 200-feet respectively (Olmsted and Davis 1961). The Tehama Formation near the City of Corning consists of yellow clay, poorly consolidated sandstone, and conglomerate.

Dissected Uplands. The surface of the upland area within the central third of the subbasin between Thomes Creek and Stony Creek includes a coarsegrained gravelly conglomerate locally capping the Tehama Formation. Wells drilled in this area encounter up to 60 feet of coarse deposits before reaching fine-grained Tehama deposits. The deposits are believed to be formed as a response to a fixed base level by impeded or enclosed drainages and have been referred to as the Red Bluff Formation. (Helley and Harwood 1985). The shallow gravel is not a significant contributor to groundwater storage due to its position above the saturated zone.

Thomes Creek Floodplain. Bounding the northern extents of the subbasin, the Thomes Creek floodplain includes Holocene alluvium underlain by deposits of both the Modesto and Riverbank Formations. The floodplain averages about 1 mile in width and extends from the Coast Ranges to the Sacramento River floodplain.

Groundwater Recharge and Discharge

Natural recharge of aquifers occurs where mountain ranges intersect with a groundwater basin, where streams pass over permeable geologic formation, and where precipitation infiltrates through permeable soil and the underlying formations. In some cases, recharge occurs from infiltration from drainage ditches. Percolation of surface waterbodies where there are cross-permeable formations are considered to represent a significant portion of the natural recharge to aquifers in Tehama County (CDM 2003). However, there are no studies that quantify the amount of recharge that occurs in this or other manners.

Groundwater Use

Estimates of groundwater extraction for the Red Bluff Subbasin are based on a survey conducted by the DWR in 1994. The survey included land use and sources of water. The estimate of groundwater extraction for agricultural use is estimated to be 81,000 acre-feet. Groundwater extraction for municipal and industrial uses is 8,900 acre-feet. Therefore, total groundwater extraction in 1994 was 89,900 acre-feet. The total groundwater extraction estimate of 89,900 acre-feet in 1994 is slightly higher than the 2004 estimate of 77,500 acre-feet (see Table 6-6). Deep percolation from applied water in 1994 was estimated to be 20,000 acre-feet.

Estimates of groundwater extraction for the Corning Subbasin are based on surveys conducted during the years of 1993, 1994, and 1997. Surveys included land use and sources of water. Groundwater extraction for agricultural use is estimated to be 152,000 acre-feet. Groundwater extraction for municipal and industrial uses is estimated to be 6,600 acre-feet. The total groundwater extraction estimate of 158,600 acre-feet is significantly higher than the 2004 estimate of 103,200 (see Table 6-6). Deep percolation of applied water during 1993, 1994, and 1997 was estimated to be 54,000 acre-feet.

Groundwater Levels

Goundwater movement in the Tehama West Watershed generally flows from west to east. The Red Bluff Arch structure located between Cottonwood Creek and Red Bluff deflects water flow to the north, as north of this structure groundwater tends to flow to the northeast. Groundwater in the Tehama West Watershed seeps into and augments Sacramento River flow through much of the assessment area, as the river serves as a drain being recharged by valley aquifers.

Typically, water levels decline during the summer irrigation season and rebound during the winter. Also, groundwater levels typically are reduced during periods of drought, but generally rebound during moist cycles. However, an indication of depletion of groundwater is exhibited by lowering groundwater levels during periods of normal or above precipitation.

Review of hydrographs for long-term comparison of spring-spring groundwater levels indicates a decline of 3 to 12 feet associated with the 1976–77 and 1987–94 droughts, followed by a recovery to pre-drought conditions of the early 1970s and 1980s. Generally, groundwater level data show a seasonal fluctuation ranging from 3 to 15 feet for unconfined wells, up to 30 feet for semi-confined wells away from the Sacramento River, and up to 50 feet in confined wells. Data indicates a decline in groundwater levels during the period from 1998 to 2002, throughout the water basin, even though precipitation was at or above normal. This may indicate that groundwater usage exceeds recharge rates. Overall however, there does not appear to be any increasing or decreasing trends in the groundwater levels.

Example hydrographs for irrigation wells near Corning and Red Bluff are shown on Figures 6-12 and 6-13. As expected, the hydrographs show minimum groundwater levels occur in the late fall in response to irrigation pumping. Maximum groundwater levels occur in Spring. Variations are between 20 and 30 feet. Levels decreased during the 1970s drought and increased during the 1980s. During the period of record, there are no increasing or decreasing trends indicating that current extraction does not exceed recharge.

Fall 2004 and spring 2005 groundwater elevations for the groundwater basin are shown on Figures 6-14 and 6-15. The elevations show a decline of approximately 25 feet in the Corning area in response to seasonal irrigation use.

GEOMORPHOLOGY

Geomorphology is the study of landforms and the processes that create landforms, and fluvial geomorphology is the study of channel-forming processes. Understanding fluvial processes and the current condition of stream channels within the Tehama West Watershed is an important component of this watershed assessment. For example, Thomes Creek is one of the fastest eroding watersheds draining into the Sacramento Valley (DWR 1982).

Channel-forming processes include erosion, transport, and deposition. Erosion includes removal of sediment from hill slopes above the channel network as well as from channel banks and beds. Erosion within the channel may be lateral, causing channels to get wider, or vertical, causing channels to get deeper or to form gullies. Transport refers to the entrainment and movement of the material that is delivered to the channel, whether the material originates from within the channel or upslope. Channels transport water, sediment, and other materials such as wood and debris. Deposition of sediment, wood, and debris occurs when streams lose the physical capacity to transport the material. Deposition may occur within or above the channel.

The condition of the channel network in a watershed affects a wide variety of resources including the amount of water, sediment, and debris that the channel is capable of carrying; timing and duration of high-flow or flood events; health and vigor of riparian vegetation communities; water quality conditions including water temperature and turbidity; and habitat and passage conditions for fish and other aquatic organisms.

Channel Characteristics

Basin shape influences the discharge characteristics of a watershed. A circular watershed with a uniform slope and permeability will result in runoff from various parts of the watershed reaching the outlet at the same time. An elongated watershed with the same area, but having the outlet at one end of the major axis, will cause the runoff to be spread out over time, producing lower peak flows at the outlet.

As previously mentioned, Thomes Creek originates in the western portion of the watershed. This portion of the watershed is characterized by high elevations, high rainfall, steep slopes, and high erosion potential. The creek flows in a southerly direction for approximately 16 miles from its headwaters, and then flows eastward to the Sacramento Valley. The stream is approximately 36 miles long from its headwaters to Paskenta. It occupies an "L"-shaped basin 6 to 10 miles wide, having a dendritic drainage pattern. As shown in Figure 6-16, Thomes Creek has a rough, concave-upward stream profile. From its headwaters for 10 miles to the confluence of Fish Creek, Thomes Creek has an average gradient of 0.05 feet per foot. From there the gradient decreases to 0.025 for 17 miles to the confluence of Slate Creek. Below Slate Creek, the gradient is 0.0053 feet per foot.

The gradient change at Slate Creek corresponds with the mountain front of the Coast Ranges. Upstream, Thomes Creek and its tributaries are confined by steep-walled canyons having up to 3,000 feet of relief. Canyon slopes are steep, averaging 20 to 25 degrees. An "inner gorge" with slopes up to 40 degrees has formed at the bottom of the larger stream canyons. Below Slate Creek, Thomes Creek enters the valley, loses its confinement, and forms highly sinuous meander loops. The lateral meander movement of Thomes Creek has periodically cut terraces adjacent to the stream. Several remnant terraces are present at various levels above the present stream, giving the adjacent landscape a broad, stepped appearance.

Red Bank Creek also originates in the Coast Range Geomorphic Province at a maximum elevation of approximately 5,500 feet. The Red Bank Creek drainage is about 30 miles long and 7 miles at its widest. The lower 7 miles are only 2 miles wide at the widest point. The creek enters the Sacramento River just upstream from the Red Bluff Diversion Dam and the intake gates for the Tehama-Colusa Canal. The basin drains about 112 square miles.

In the upper reaches Red Bank Creek is incised deeply, forming narrow canyons and steep gorges. Just after entering the valley, the creek is joined by a number of side streams with alluvial sand and gravel channels. These include the North Fork Red Bank, Clover Creek, Pigpen Creek and Vale Gulch. In the lower 12 miles, Red Bank Creek flows as a single channel with steep banks downcut through the Tehama Formation. Peak flows occur between October and April in response to rainfall. During the summer months, Red Bank Creek is normally dry except for isolated places that tap the free water table and have standing water. Channel slope of Red Bank Creek is shown in Figure 6-17.

Reeds Creek is a geologically young stream system that developed after the Red Bluff pediment formed about a half million years ago. The pediment surface sloped gently toward the Sacramento River. The drainage that has developed on this uniform slope is approximately 18 miles long and has a maximum width of 6.7 miles. It is elongated in the east-west direction. Hydraulically, the Reeds Creek drainage more closely resembles a circular basin because the three major tributaries, Liza, Reeds, and Pine Creeks are approximately equal in length and they join Reeds Creek about 5 miles upstream from the mouth. Because of equivalent stream lengths, flood peaks meet at the same time, and have caused serious flooding in the lower 5 miles of stream.

The maximum elevation in Reeds Creek is about 1,150 feet. The stream flows eastward and enters Lake Red Bluff on the Sacramento River at the maximum pool elevation of 253 feet. Most of the basin topography consists of low, rounded hills and flat ridges between broad, flat-bottomed tributary stream valleys. The creek is an intermittent stream and is typically dry from June to October.

Most of Reeds Creek's tributaries are in narrow, incised channels that cut through flat bottomed valleys for most of their lengths. This configuration is effective in moving bedload through the system. The terraces that contain most of the gravel in the Reeds Creek basin are isolated from the active channel by steep banks. In some reaches, such as North Fork Reeds in Burr Valley, Liza Creek, and along parts of Pine Creek, the stream flows in multiple channels. In lower reaches near the mouth, the channel is alluvial. Channel slope of Reeds Creek is shown in Figure 6-18.

Channel Slope

A Level 1 assessment calls for the division of the channel network into slope ranges of greater than 20 percent, between 3 and 20 percent, and less than 3 percent. These slope ranges divide the channel network into areas that are likely to respond similarly to changes in input variables.

Channels and unchanneled areas with slopes greater than 20 percent are classified as source reaches. These very steep slope areas are likely to be dominated by mass-wasting processes (e.g., debris flows, landslides, etc.) and contribute sediment and debris to stream channels downstream or downslope. Channels with slopes between 3 and 20 percent are classified as transport reaches. Both mass-wasting and fluvial processes may significantly influence these moderate-to-steep reaches, but the channel slopes are steep enough to transport the sediment and debris. Channels with slopes less than 3 percent are classified as response reaches because they are "likely to exhibit pronounced and persistent morphologic adjustments to changes in sediment supply" (DNR 1997). These classifications are summarized in Table 6-8.

Table 6-8
CHANNEL SLOPE RANGES, RESPONSE POTENTIALS, AND TYPICAL BED MORPHOLOGIES

Slope Range (percent)	Response Potential	Typical Channel Bed Morphology
>20	Source	Colluvial
3–20	Transport	Cascade, step pool, plane-bed, forced pool-riffle
<3	Response	Plane-bed, forced pool-riffle, pool riffle, regime

Source reaches (i.e., channels that are greater than 20 percent slope) are dominated by colluvial processes. Sediment and other debris tend to accumulate in these channels, not as a result of running water (fluvial processes), but as a result of debris flows, landslides, soil creep, and other mechanisms related more to weathering and gravity.

Transport reaches (i.e., channels between 3 and 20 percent slope) exhibit a high variability of channel forms. Generally, cascades dominate channels between 8 and 20 percent. The cascades may be vertical at some locations (e.g., at knickpoints where falling water has undercut a resistant rock outcrop), but may also fall along the hill slope gradient. These channels may be deeply entrenched within walls that range from bedrock to various types of unconsolidated colluvial material, or they may be within shallow crenulations in a steep hill slope. Whatever the bank configuration, the steepness of the channel does not allow anything but very coarse substrate to remain, so bedrock or boulders usually dominate channel beds. In the 4 to 8 percent slope range, channels are likely to have step-pool morphologies in which relatively short (typically vertical) cascades alternate with plunge pools. The spacing of the pools is inversely related to channel steepness: the steeper the gradient the shorter the distance between pools. Specifically, pool spacing is related to the ratio of step steepness (height/length of the step) to the average channel slope, which is commonly between 1 and 2 in free-forming step-pool channels (Abrahams et al 1995). Pool lengths are typically on the order of only 3 to 4 channel-widths (Church 1994). In the 3 to 4 percent slope range, the likely channel types are plane-bed and forced pool-riffle.

Plane-bed channels may vary in roughness (i.e., coarseness of dominant substrate and amount of coarse material protruding from the bed), but they lack alternate pool-riffle or step-pool morphology. Instead, the beds are more uniform and relatively flat in both cross-section and longitudinal profile. Forced pool-riffle morphology is commonly found in bedrock-controlled channels. Bedrock outcropping along one side of a channel commonly results in scour of mobile material that creates and anchors a pool adjacent to the outcrop. Material scoured out of the pool tends to deposit immediately downstream of the pool creating a shallow riffle. The length and spacing of pools and riffles are controlled by the location of the resistant outcroppings rather than sediment transport and energy dissipation processes of free-forming pool-riffle channels (Church 1994). As a result, pools and riffles in this channel type may have very irregular lengths and spacing.

As with transport reaches, response reaches (i.e., channels with slopes less than 3 percent), which are the dominant channel morphology in the watershed, exhibit a variety of likely bed forms. Likely channel types associated with the 2 to 3 percent slope range are the same as that of the 3 to 4 percent range: plane-bed and forced pool-riffle (see description above). In the one to 2 percent slope range, the likely bed morphologies include plane-bed (see description above) and pool-riffle. Pool-riffle beds are free-forming channels whose beds are constructed primarily of alluvium. The dominant features of these beds are the regularly spaced pools and riffles. The spacing of riffles and pools is found to be in close balance to channel dimensions; riffles and pools are typically spaced every 5 to 7 bankfull channel-widths (Leopold 1994). Pool-riffle beds are also common at slopes less than 1 percent.

Regime bed channels have sand beds and lack regular pool-riffle morphology. Regime beds typically do have bedforms such as ripples, dunes, and bars. Because of their low slopes and relatively lower sediment transport capacities, regime channels are among the most susceptible channel forms to perturbation and adjustment (Montgomery and Buffington 1993).

Channel slope categories for major creeks in the Tehama West Watershed are shown on Figure 6-19.

Disturbances and Perturbations

Disturbances and perturbations can occur as man-caused or natural processes in a watershed. Severe storms for example, may result in disturbances such as debris flows, landslides, and large-scale tree blow-downs that are substantial enough to cause geomorphic channel adjustments. An example of a natural perturbation would be a lightening-caused wildfire resulting in a change in storm runoff rates or an increase in sediment influx to a channel that begins to push the channel network out of its old balance and toward a new one.

Events that create watershed perturbations or disturbances include, but are not limited to, severe storms, tectonic activity, fire, flooding, grazing, logging, agriculture, roads, dam construction, water diversion, stream channelization, mining, and urbanization.

Mass Wasting

As previously mentioned, Thomes Creek is one of the highest sediment-producing streams in the western Sacramento Valley of Northern California (CSUC 2005). Two primary sources of sediment include mass wasting in the upper watershed, especially the steeply sloped area between the Gorge and Slab (see Figure 6-19), and remobilization of sediment previously stored in the stream channel. Slope failures as debris slides, block slides, rotational/translational slides, debris avalanches and rock slides are common and widespread. It has been estimated that the annual sediment yield of the Thomes Creek watershed is greater than 450,000 cubic yards. As a result, there are 11 sand and gravel operations in the Thomes Creek channel between Paskenta and the Sacramento River confluence (CSUC 2005).

Landslide Types

The following landslide discussion was taken from the Thomes Creek Watershed Study (DWR 1982).

Common types of landslides are debris slides, debris flows, rock slides, translational-rotational slides, and mantle creep zones. Other mass movement features mapped in the Thomes Creek watershed include block slides, “gutted” streams, and undifferentiated slides. Debris slides and flows probably were the greatest sources of sediment during the December 1964 flood.

Debris slides involve slow-to-rapid downslope movement of predominantly unconsolidated and incoherent soil, rock, and organic matter. The mass becomes jumbled as it moves downhill from its source, leaving a barren main scarp and an irregular, hummocky deposit. These slides generally occur along oversteepened slopes of the inner gorge, especially along the outsides of meander bends where high floodwaters undercut riverbanks.

Debris flows involve similar materials as debris slides, but in a water-saturated state. The flow’s movement resembles that of a viscous fluid, leaving a chaotically mixed, lobate deposit. Flows also occur in the inner gorge, commonly along the metastable toe of a large, deep-seated slide mass. Debris flows are generally activated during large storm events, but observations indicate snowmelt and small, late-spring storms may also initiate them.

Rockslides are common in the watershed, especially in the Thomes Creek channel between Dark Canyon and the Gorge. Rockslides involve a sudden, rapid downward movement of bedrock fragments. These may break up further and accumulate as talus deposits.

Block slides are a relatively uncommon form of large, deep-seated mass movement. These coherent masses are displaced along a plane of weakness, commonly an inclined bedding or fracture surface.

Translational-rotational slides are generally large-scale, deep-seated features that have a composite failure surface. They typically originate from amphitheater-shaped scarp areas. The slide mass generally fails along a concave upward-shear surface and rotates outward. Some material is transported downhill over a shear plane roughly parallel to the original ground surface. Slide material accumulates as lobate, hummocky deposits at the toe, often blocking or displacing stream drainage. Translational-rotational landslides are generally found along the canyon slopes adjacent to Thomes Creek and major drainages. Most are found at mid-elevations of the watershed, where slopes are longer and steeper and thereby more prone to saturation and failure. These do not occur in the Great Valley Sequence; “gutted” stream channels are scoured and corraded by debris torrents or by torrential debris-laden floodwaters cresting well above the elevation of normal channel flow. Gutted channels are easily recognized because near-stream vegetation has been stripped. Gutted streams occur on steep slopes of the Lazyman Buttes unit, and in long, straight tributary streams on the

South Fork Mountain Schist. Although they occur more frequently in logged areas, they also occur in virgin forests. Gutted streams are indicators of very sensitive soil and rock types.

Soil mantle creep zones have indistinct boundaries and relatively shallow, irregularly moving slide material. Failure rates overall are generally imperceptible, but small-scale slumping does occur. Mantle creep zones support mostly grassy vegetation. The zone is highly susceptible to gullying.

Mantle creep zones typically occur on south-facing slopes in the upper watershed. These slopes undergo more extreme seasonal changes in soil water content. Clayey soils typical of these zones are subject to desiccation cracking. During the rainy season water percolates into cracks quickly and saturates these masses. The lack of deep or extensive rooted vegetation adds to the instability of these slopes.

Causes of Landslides

Landsliding and erosion are natural watershed processes related to such long-term events such as climatic changes and regional geologic uplift. In the last few decades, however, a dramatic increase in active landslides appears to be related to land-use activities.

The multi-staged uplift of the Coast Ranges from the late Pliocene to mid-Quaternary was accompanied by rapid erosion and landsliding of the unstable Franciscan terrain. Now deep V-shaped canyons with compound slopes and bedrock channels characterize the upper watershed. Large-scale inactive translational-rotational landslides are common on the steeper slopes of the watershed. These landslides were apparently initiated by a combination of factors: 1) the weak rock types present in the Franciscan Complex and ophiolite can be very unstable when wet, 2) rapid stream downcutting apparently oversteepened the adjacent valley slopes, and 3) the glacially dominated climate in the northern hemisphere during the Quaternary was much wetter than at present. It is possible that most of the large-scale, deep-seated landslides were products of a wetter climate and higher streamflow.

Many active debris slides and flows are present along Thomas Creek and its major tributaries, Willow, Fish and Auger Creeks. However, the number of active slides has increased dramatically since significant timber harvesting began in the watershed. Active landslides were mapped from 1952, 1962, 1969, and 1979 air photos. The landslide area and area increases are shown in Table 6-9. Active landslide area increased 400 percent between 1952 and 1979; nearly all the increase has been due to debris slides and flows activated, along stream channels of the middle and upper watershed.

TABLE 6-9
ACTIVE LANDSLIDE AREA
THOMES CREEK WATERSHED

Year Evaluated	Active Landslide Area (acres)	Percent Increase
1952	200	---
1962	300	50
1969	740	145
1979	1,000	35

Roads

Roads can also create significant watershed perturbations by channel impingement and increased sediment supply, leading to bank instability and sedimentation (i.e., sediment deposition and reduction of dominant substrate sizes within the channel). Failure of road crossings, particularly culverts, can cause disturbances including, bed and bank erosion and change in channel course. Ungated roads may also promote erosion by allowing vehicles into areas that should be closed seasonally because of sensitive conditions.

In January 2001, the Forest Service adopted a new road management policy for all national forests which directs the agency to maintain a safe, environmentally sound road network that is responsive to public needs and affordable to manage. As part of this process, the Mendocino National Forest completed a Road Analysis Process Report in 2002 (USDA 2002). The results included an evaluation of road impacts including sediment production. Although this study included the entire Mendocino National Forest, which covers significantly more area than the Tehama West Watershed, the results are applicable in the upland areas.

Overall, the study concluded that roads contribute about 3 to 7 percent of the average sediment production from natural and human causes. This includes both surface erosion and mass wasting sources. Furthermore, sediment from roads and other human causes does not appear to be in excess of the sediment transport capabilities of the stream systems.

A detailed evaluation of forest roads located in Thomes Creek, Elder Creek, and Red Bank Creek is included in the Analysis Process Report. Overall, roads within these three drainages are ranked as having a high sediment potential. Additional information on soil erosion hazards is included in Section 4, "Geology and Soils."

Fire

Fire deserves some specific discussion in its role as a disturbance/perturbation. Natural wildfires are among the agents that can cause disturbance within a watershed. Fire may also, however, be an intentional, human-caused disturbance or perturbation. In addition, fire has a greater potential to cause disturbance or perturbation since the advent of fire suppression as a forest management practice early in the twentieth century. Fire suppression has resulted in widespread over-accumulation of fuels throughout the forests in the west. Now when wildfires ignite, whether natural or human caused, they burn with much greater intensity and are much more detrimental ecologically than they would have been before fire suppression. From a channel morphology perspective, high-intensity burns are much more likely to result in disturbance or perturbation than presuppression wildfires that burned in more open forest stands with much lighter fuel loads.

DATA GAPS

Stream flow data are not available for most creeks in the watershed.

CONCLUSIONS AND RECOMMENDATIONS

- Evaluate the possibility of augmenting stream flows by storage and retention of winter flood flows to improve habitat for fish and wildlife
- Evaluate possibility of vegetation management, including riparian restoration, to augment stream flows to improve habitat for fish and wildlife
- Obtain more flow data on tributaries to determine potential impacts
- Determine how to improve water conditions for fish and other riparian obligate species
- Conduct a comprehensive, watershed-wide road inventory to evaluate the contribution to erosion and develop a plan for prioritizing road improvement activities
- Install water gauging stations on at least the major streams in the watershed, particularly those that can provide information for other streams that may not have gauging stations
- Assess the effects of storm water runoff and non-point source pollution especially along roads in development areas
- Establish baseline information on geomorphology of the streams including slope, basic channel types, extent and type of riparian vegetation, and gravel counts. Future planning and assessment strategies could include:
    - Stream prioritization of major streams based on a variety of criteria including water quality, biological value, and need and opportunities for restoration
    - Stream classification according to Rosgen Stream Classification System to develop basic quantitative and qualitative knowledge of natural channel conditions
    - Site specific geomorphic assessments including site reconnaissance, cross-section surveys, sediment sampling, and determination of important geomorphic parameters including bankfull-discharge channel geometry and flows, and sediment transport characteristics

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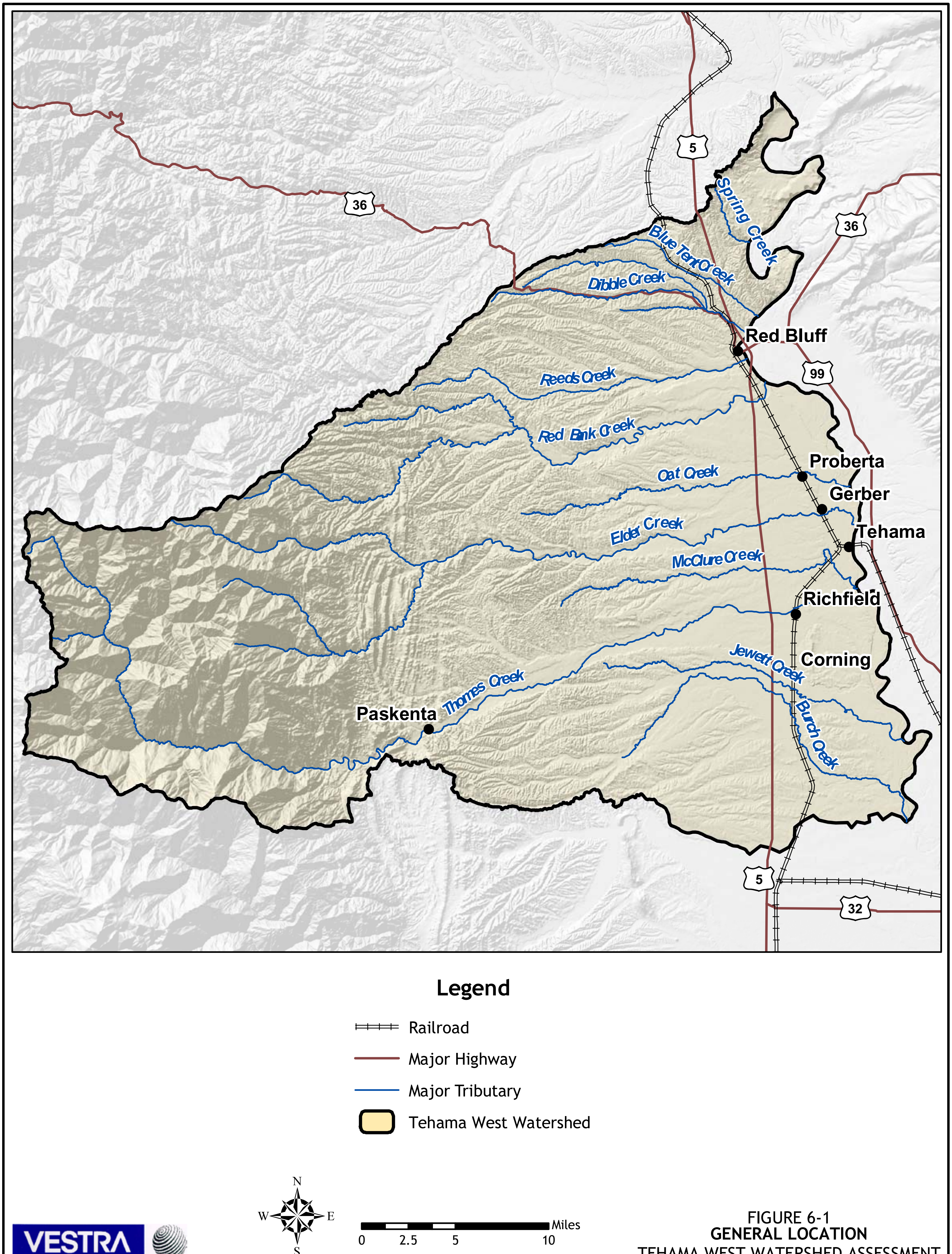

FIGURE 6-1
GENERAL LOCATION
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

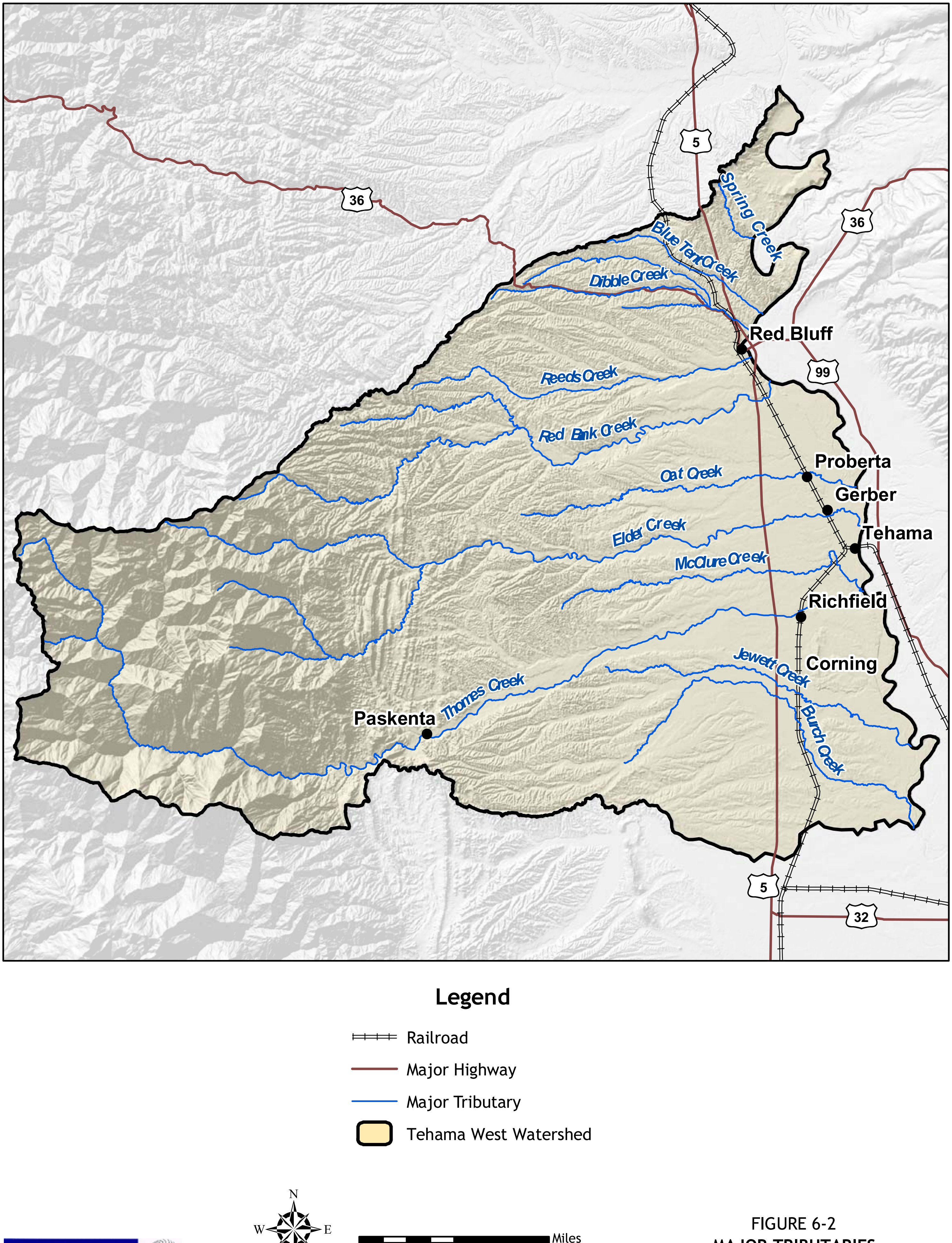

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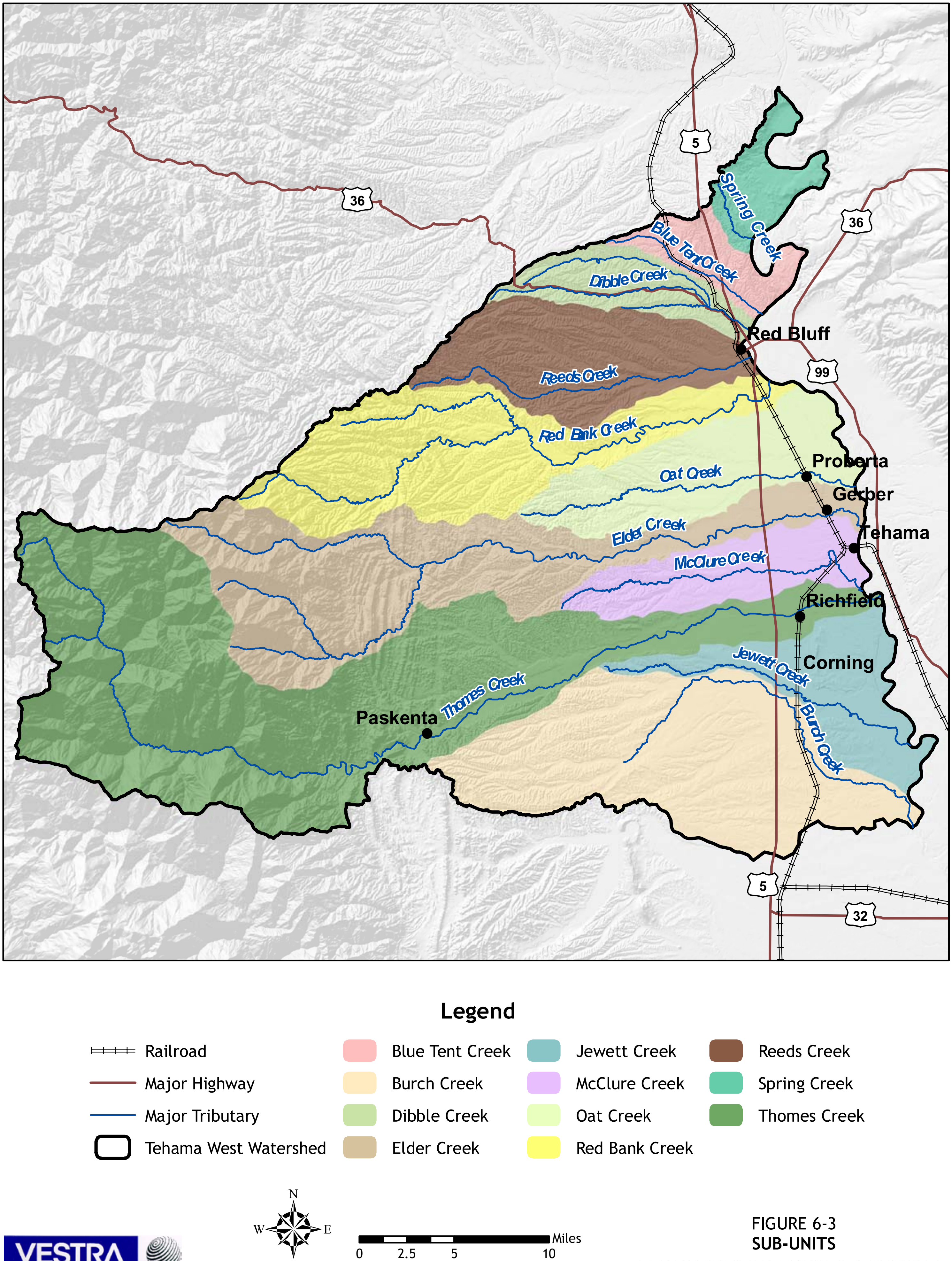
FIGURE 6-2
MAJOR TRIBUTARIES
TEHAMA WEST WATERSHED ASSESSMENT

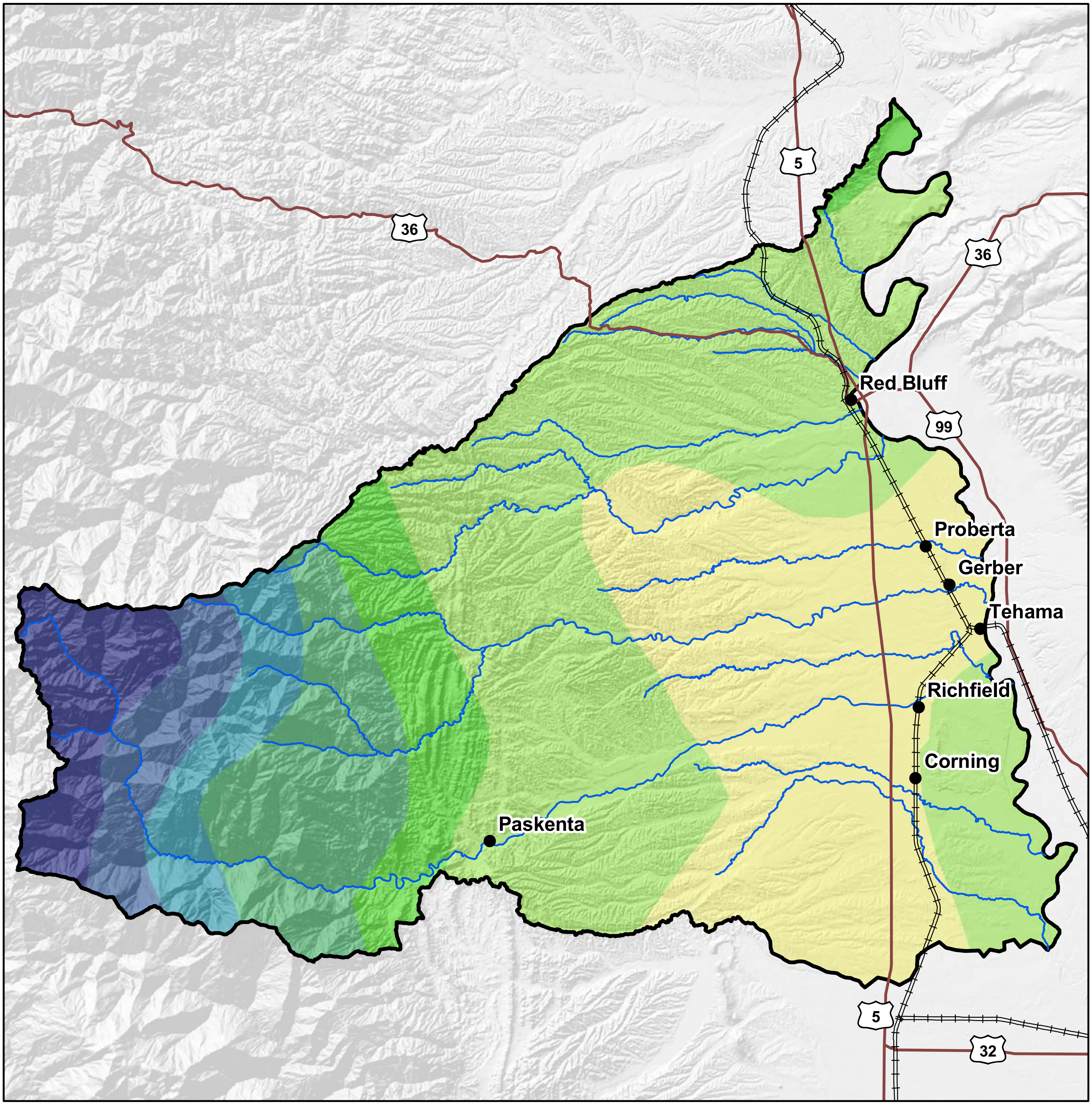
SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY



VESTRA

FIGURE 6-3
SUB-UNITS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY



Legend

Railroad	18 inches and less
Major Highway	18 to 22.5 inches
Major Tributary	22.5 to 27.5 inches
Tehama West Watershed	27.5 to 35 inches
	35 to 45 inches
	45 to 55 inches
	55 to 60 inches

N W E S

Miles
0 2.5 5 10

VESTRA

FIGURE 6-4
PRECIPITATION ISOHYETALS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

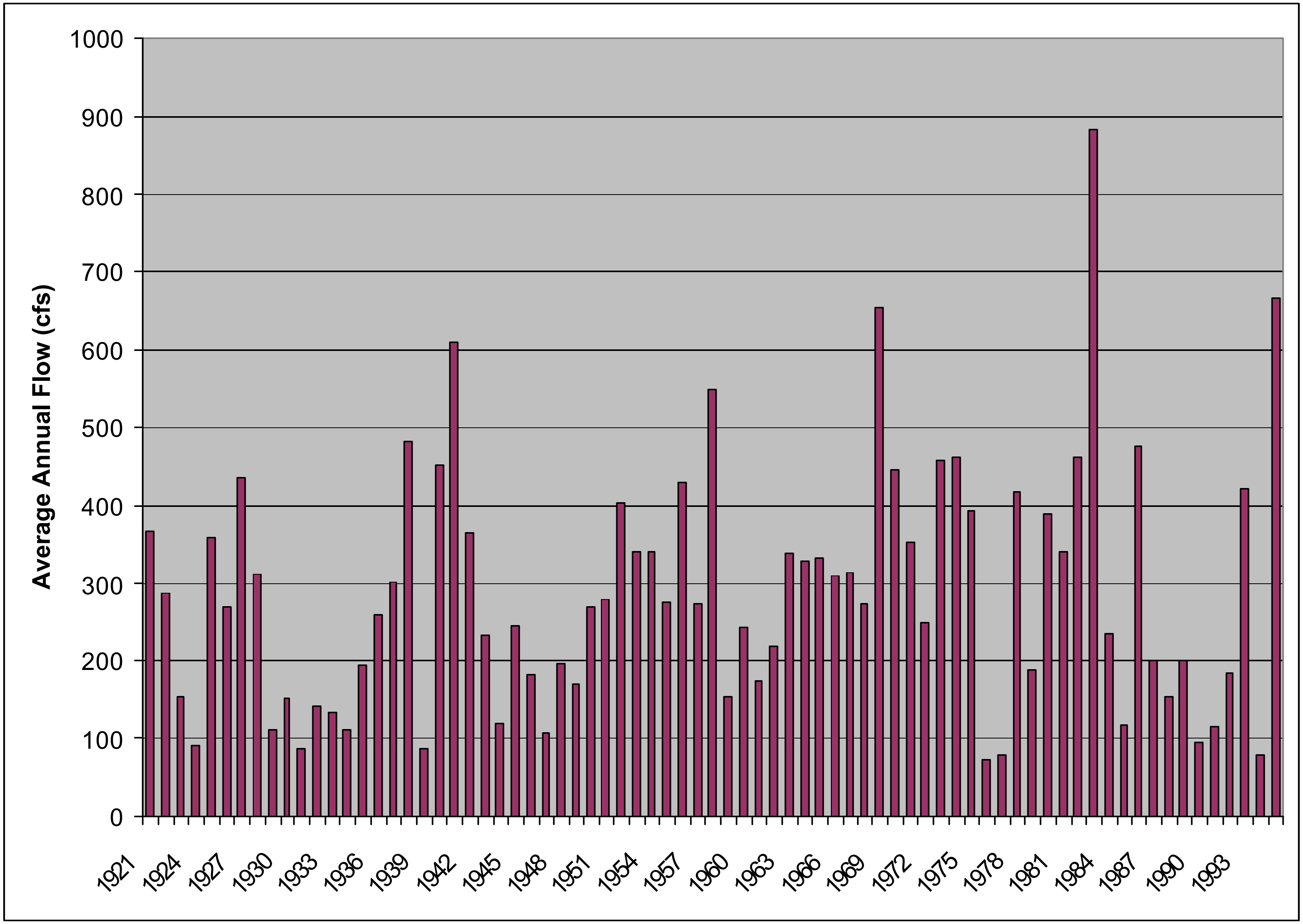


FIGURE 6-5A
MEAN ANNUAL FLOWS
THOMES CREEK AT PASKENTA
1921 - 1995
TEHAMA WEST WATERSHED ASSESSMENT

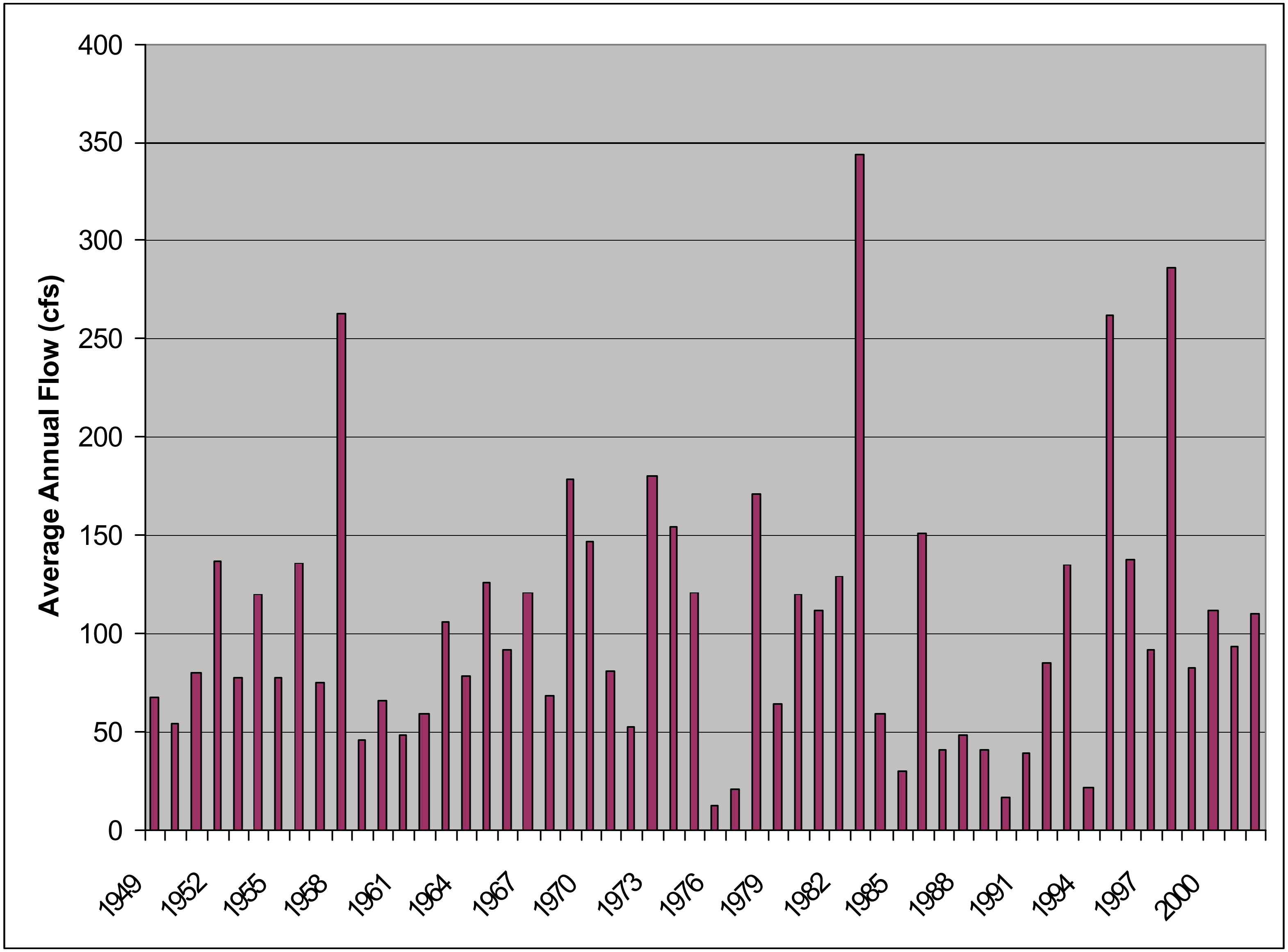


FIGURE 6-5B
MEAN ANNUAL FLOWS
ELDER CREEK NEAR PASKENTA
1949 - 2002
TEHAMA WEST WATERSHED ASSESSMENT

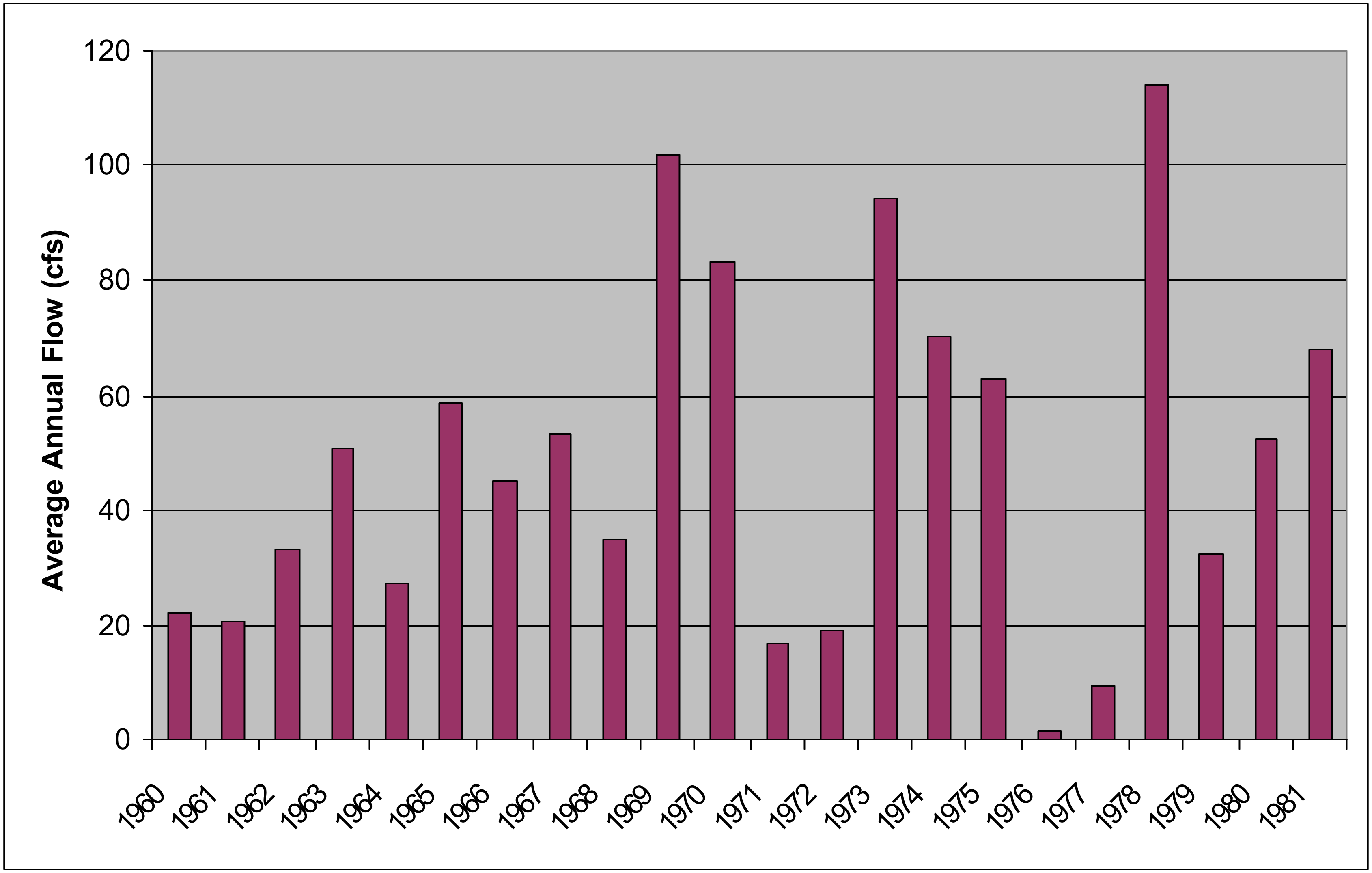


FIGURE 6-5C

MEAN ANNUAL FLOWS

RED BANK CREEK NEAR RED BLUFF STATION

1960 - 1981

TEHAMA WEST WATERSHED ASSESSMENT

VESTRA™

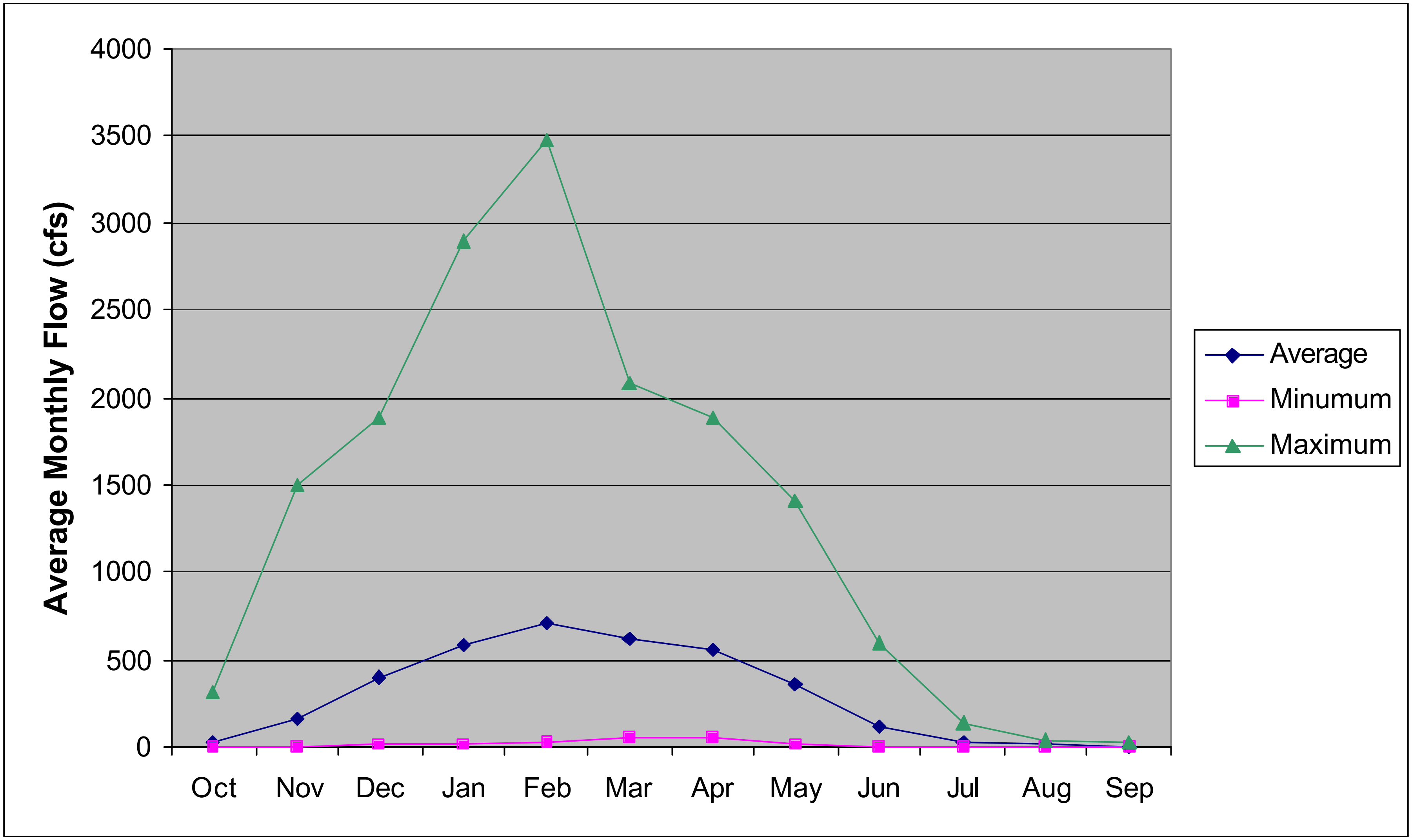


FIGURE 6-6A
MEAN MONTHLY FLOWS
THOMES CREEK AT PASKENTA
1920 - 1996
TEHAMA WEST WATERSHED ASSESSMENT

VESTRA

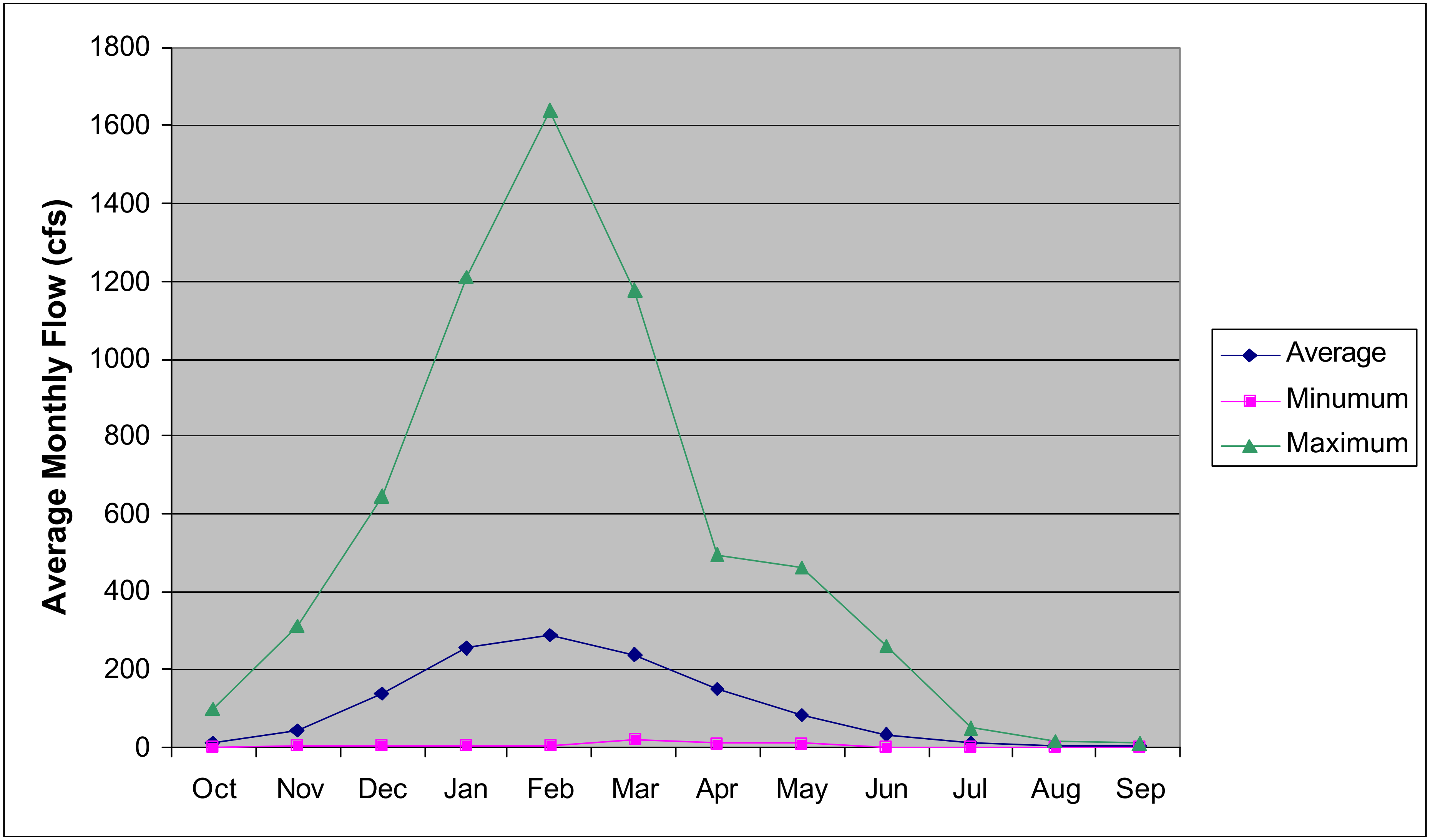


FIGURE 6-6B
MEAN MONTHLY FLOWS
ELDER CREEK NEAR PASKENTA
1948 - 2003
TEHAMA WEST WATERSHED ASSESSMENT

VESTRA™

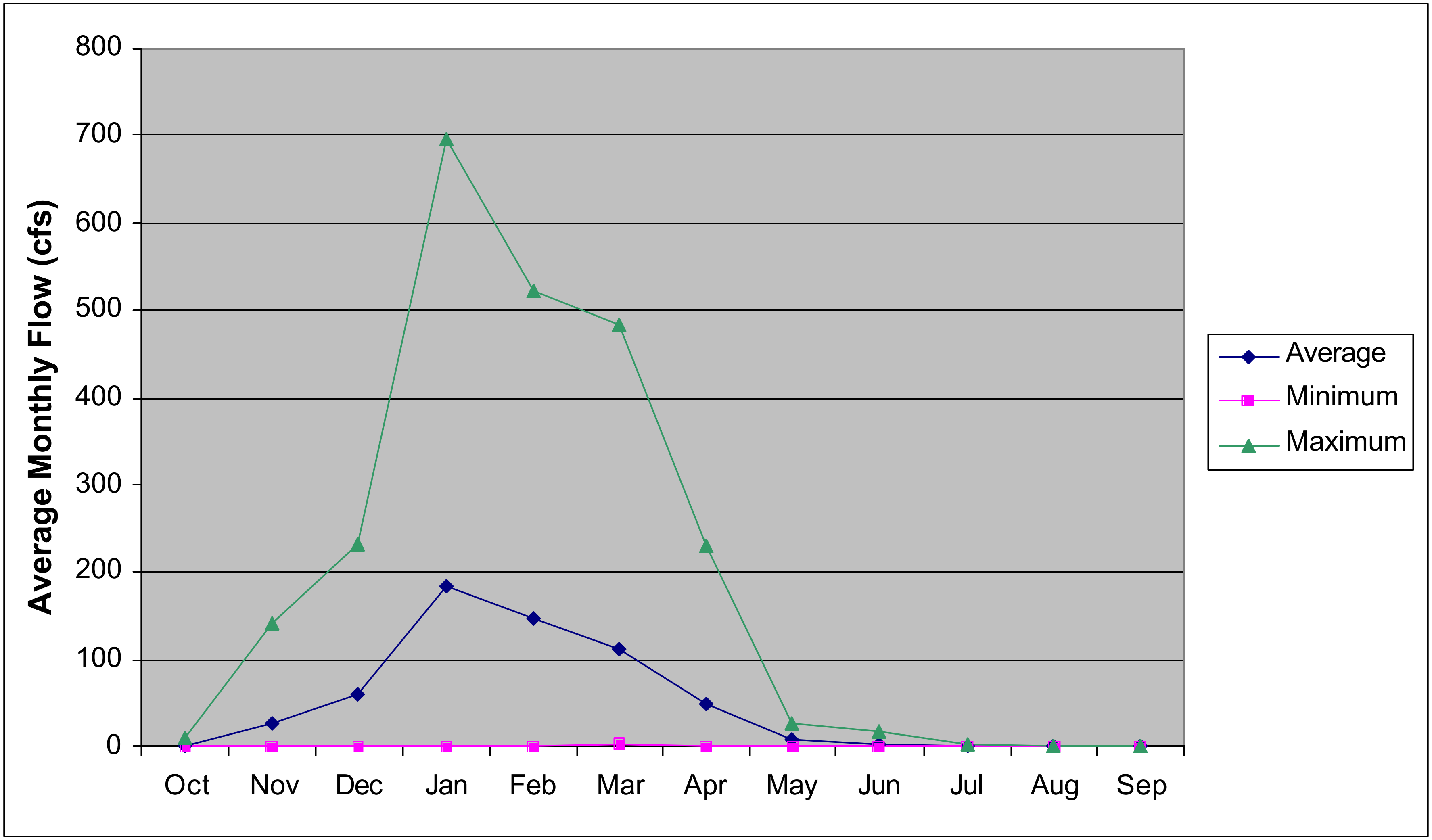


FIGURE 6-6C
MEAN MONTHLY FLOWS
RED BANK CREEK NEAR RED BLUFF
1959 - 1982
TEHAMA WEST WATERSHED ASSESSMENT

VESTRA

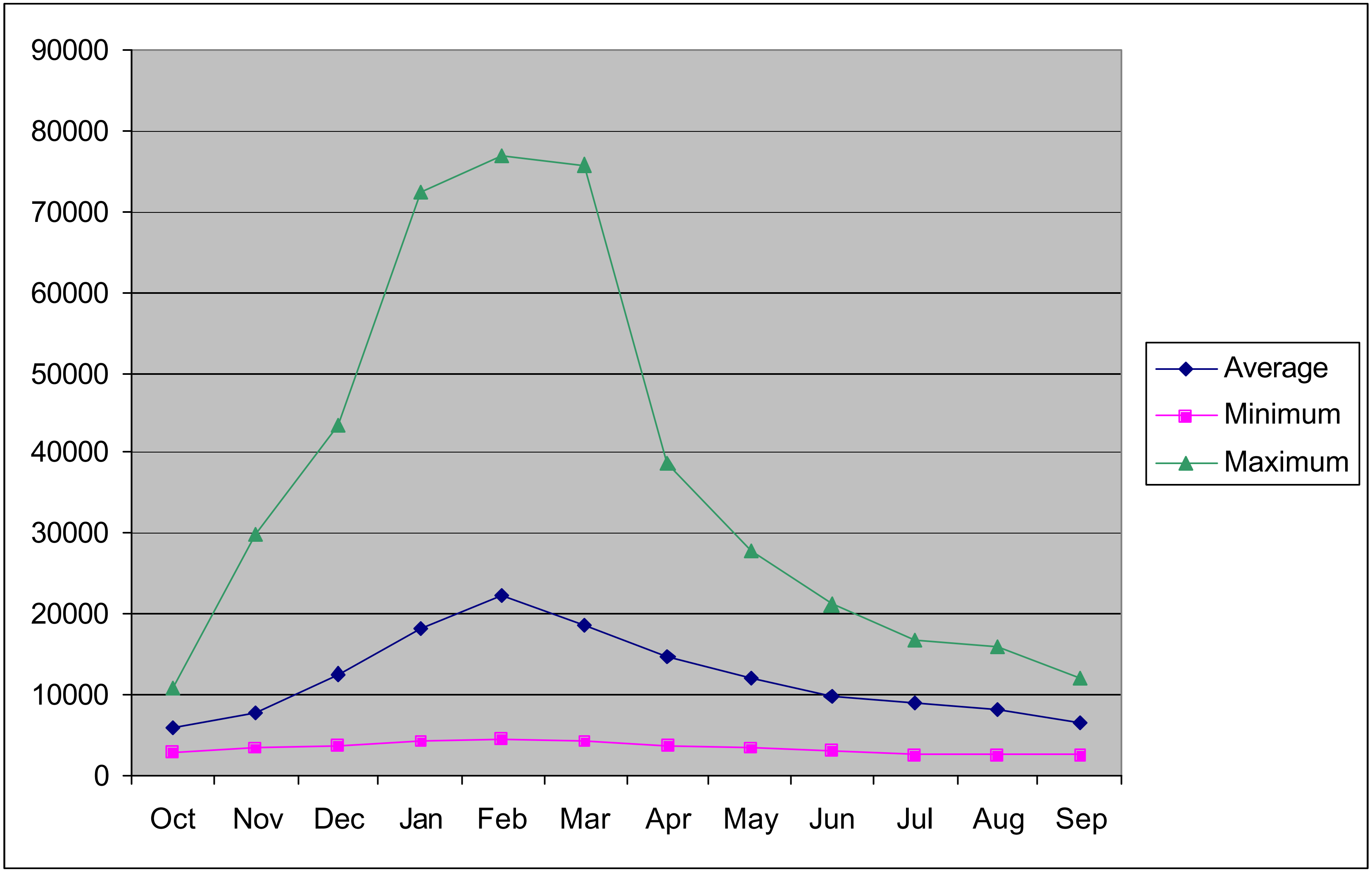


FIGURE 6-7
MEAN MONTHLY FLOWS
SACRAMENTO RIVER AT THE BEND ABOVE RED BLUFF
1891 - 2004
TEHAMA WEST WATERSHED ASSESSMENT

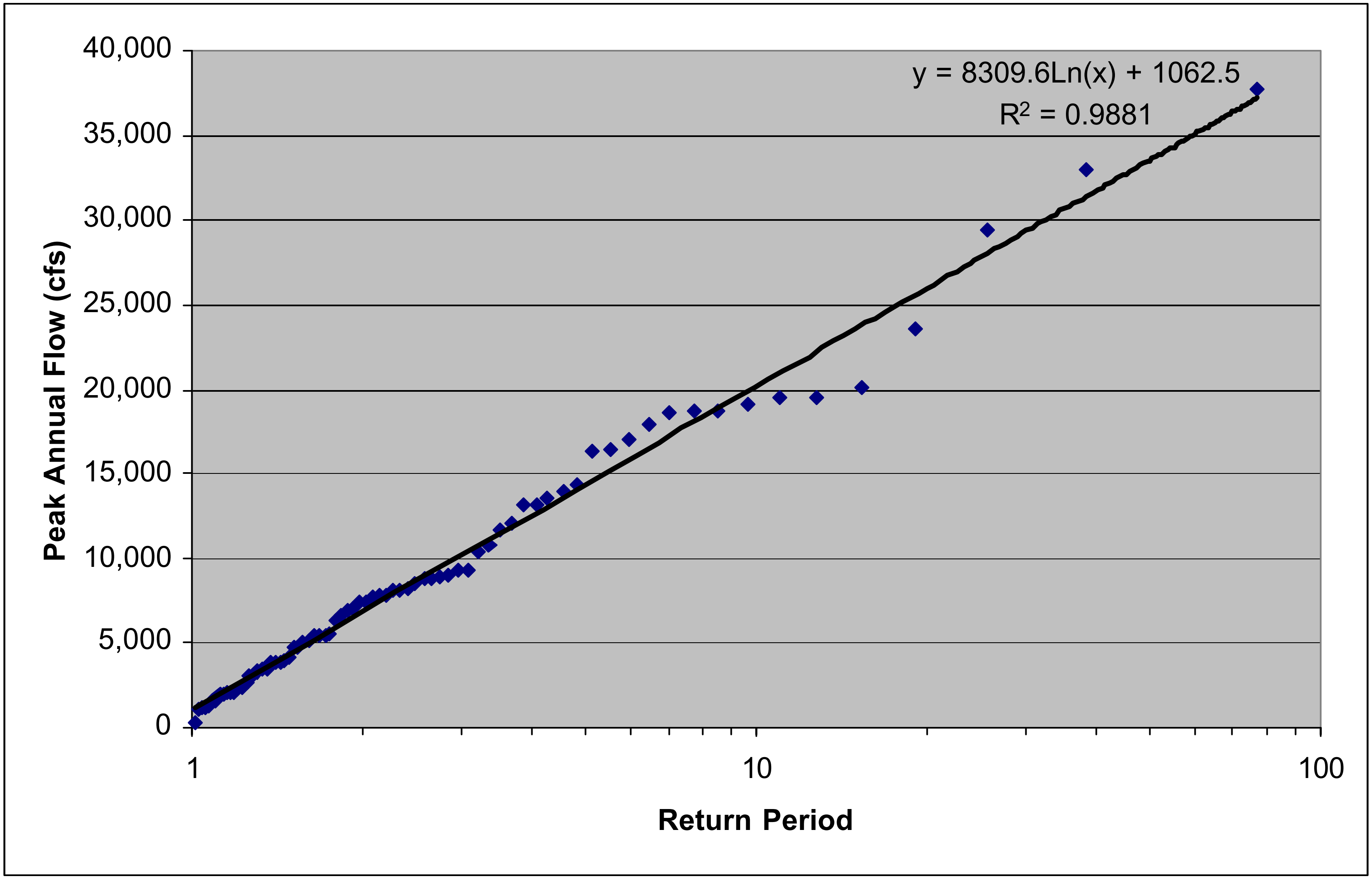


FIGURE 6-8
PEAK ANNUAL FLOW RETURN PERIOD
THOMES CREEK
TEHAMA WEST WATERSHED ASSESSMENT

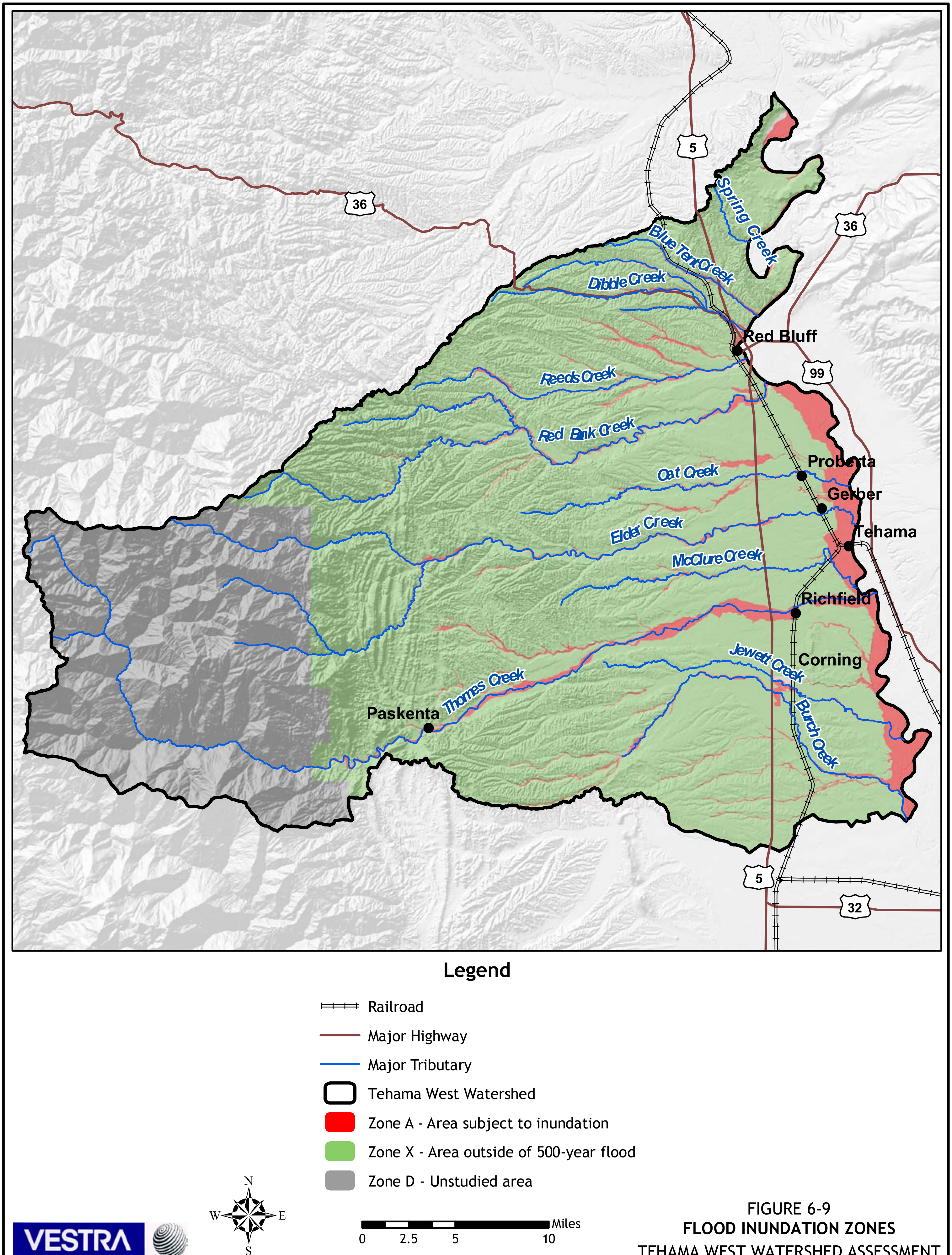


FIGURE 6-9
FLOOD INUNDATION ZONES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: FEDERAL EMERGENCY MANAGEMENT AGENCY

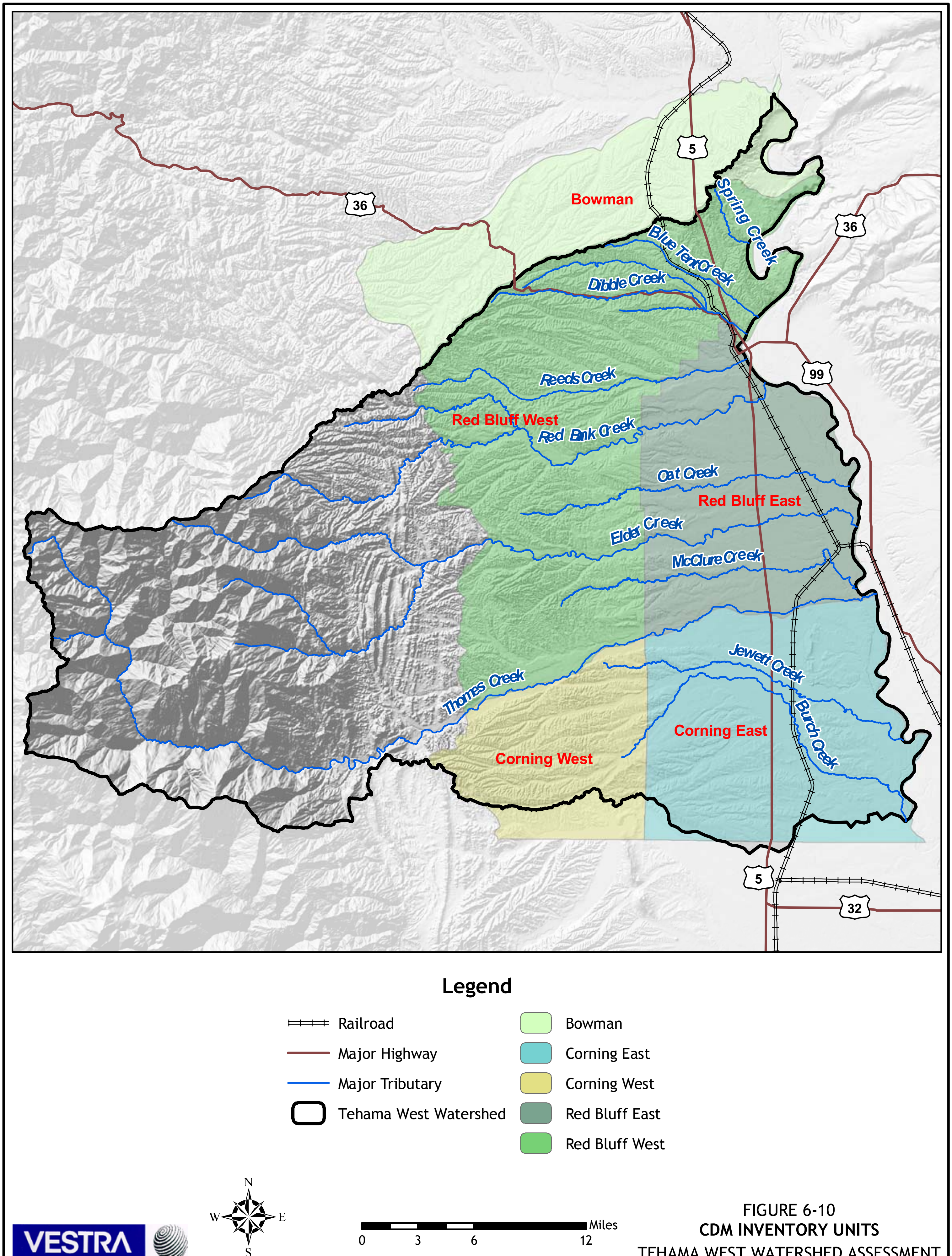


FIGURE 6-10
CDM INVENTORY UNITS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CDM

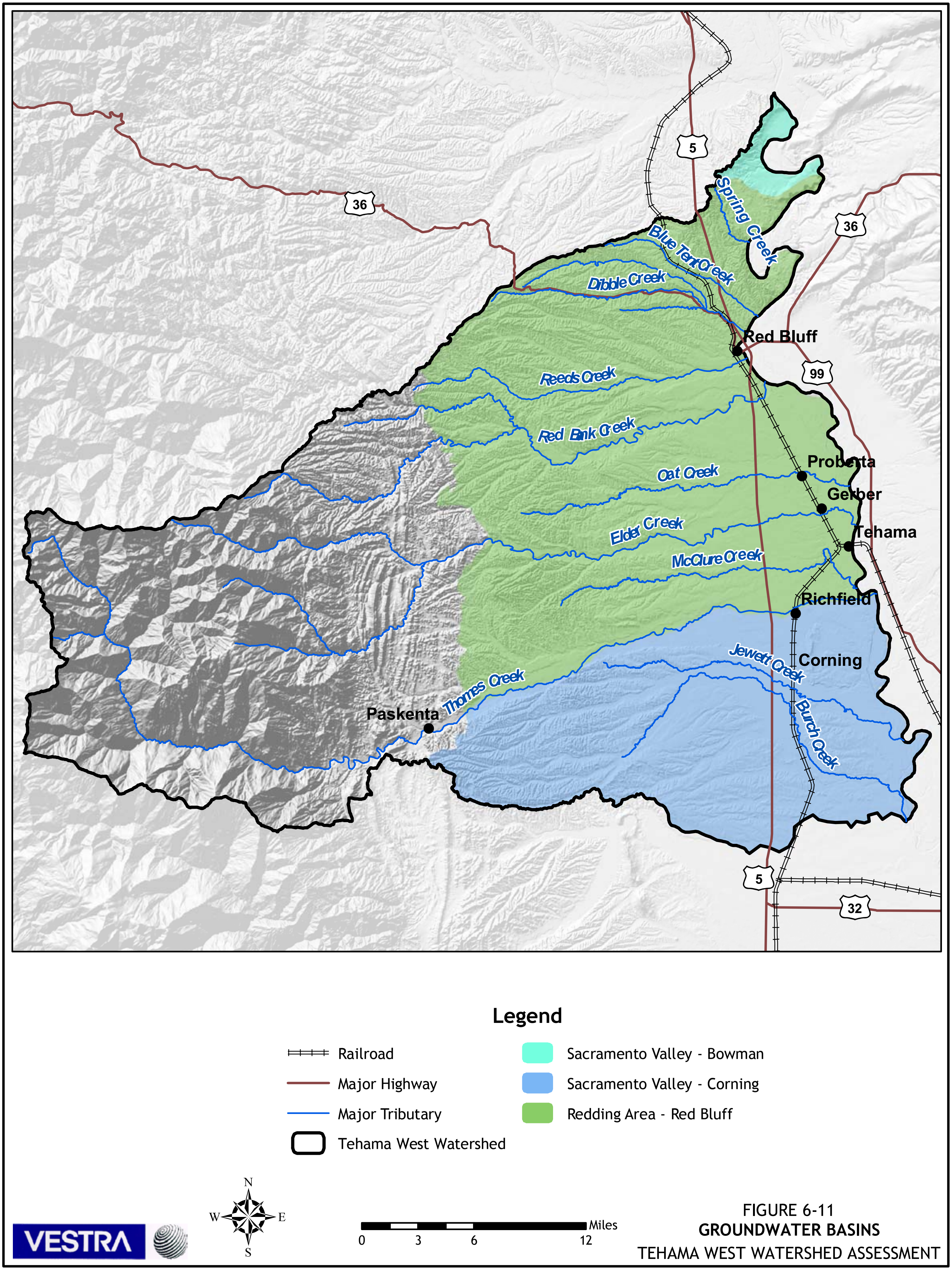
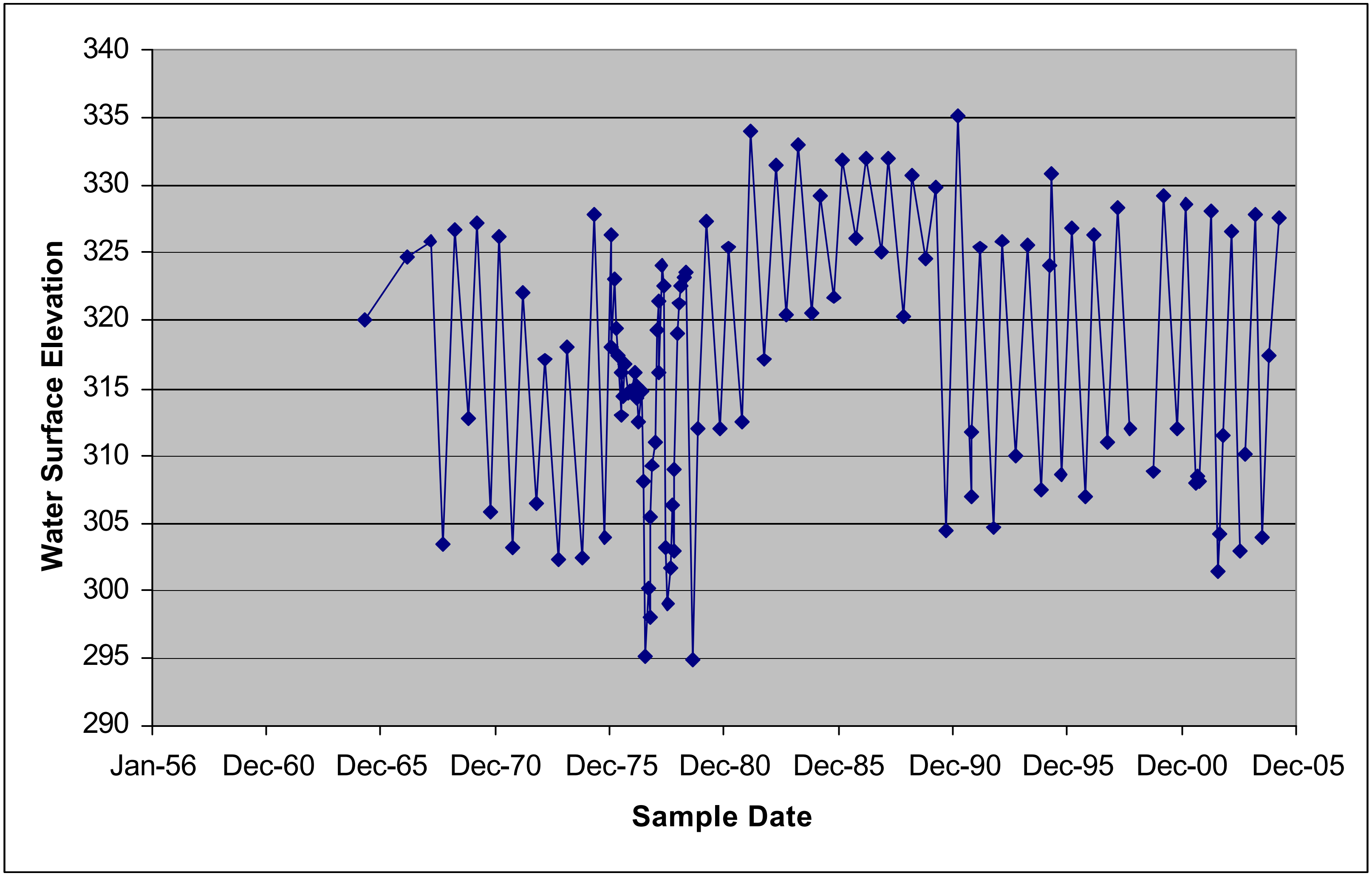


FIGURE 6-11
GROUNDWATER BASINS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CDM



VESTRA

FIGURE 6-12
GROUNDWATER HYDROGRAPH
WELL 27N04W35E001M
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF WATER RESOURCES, 2005

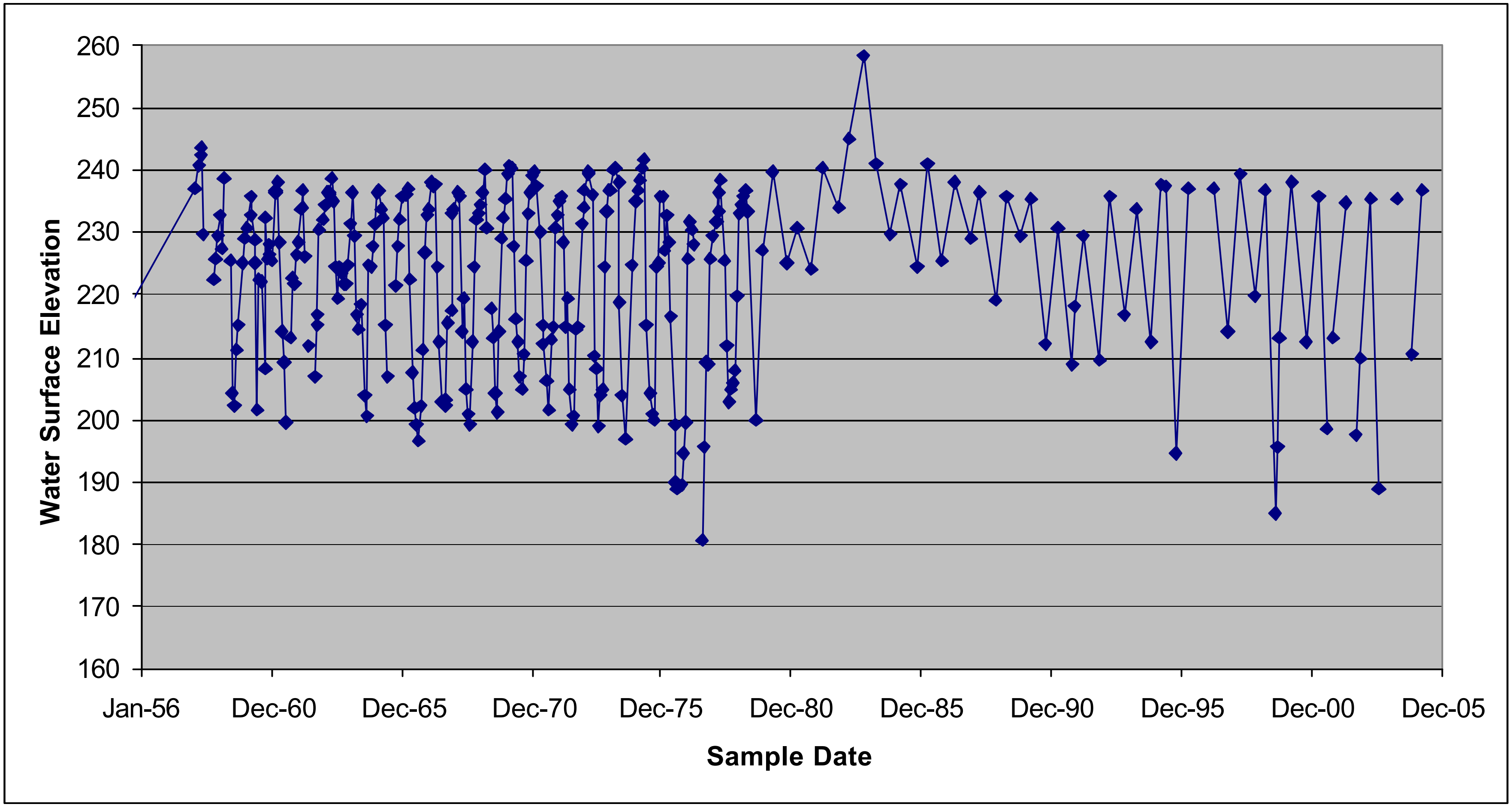


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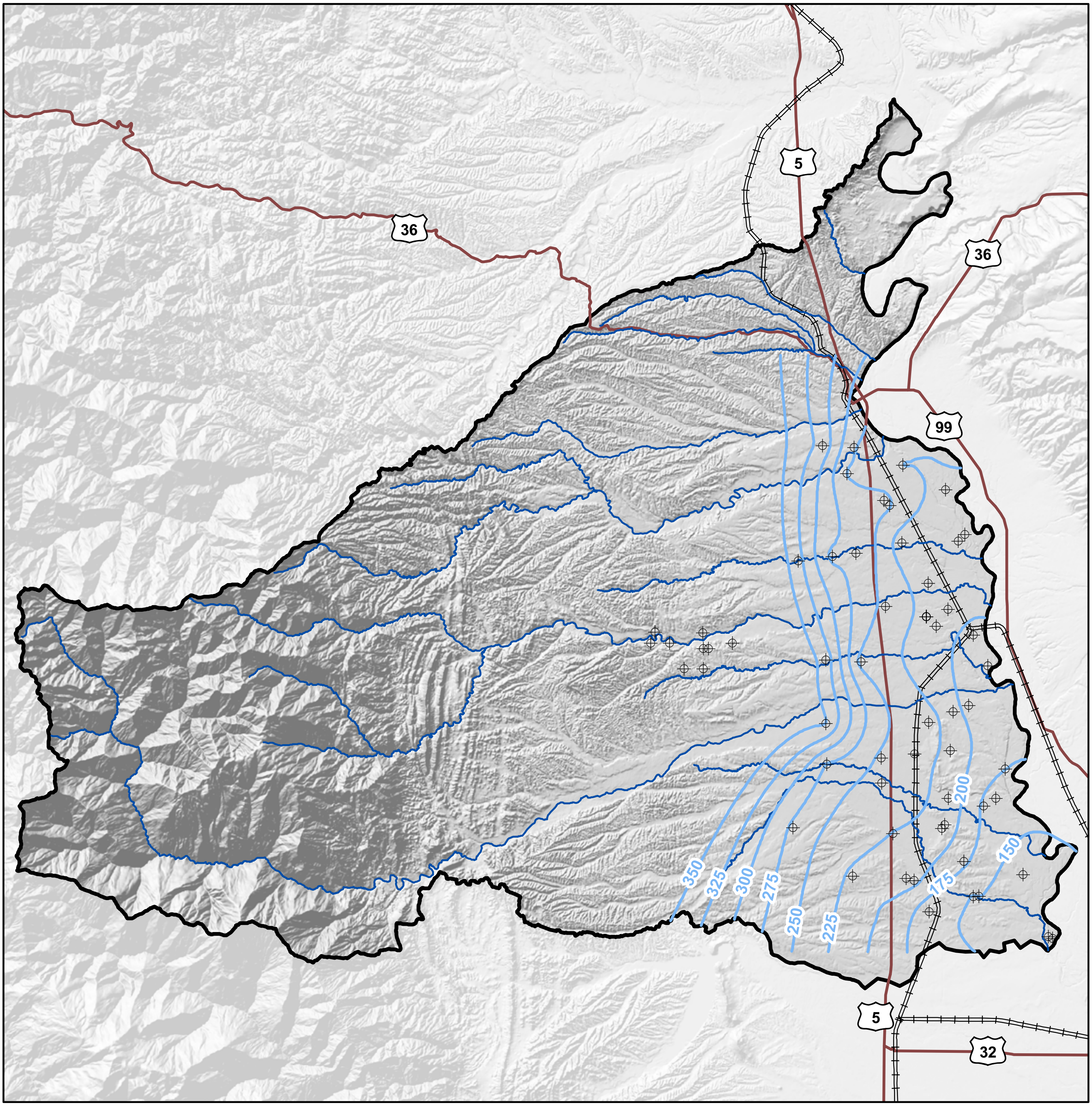
FIGURE 6-13
GROUNDWATER HYDROGRAPH
WELL 26N03W21P001M
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF WATER RESOURCES, 2005



Legend

Railroad

Major Highway

Major Tributary

Fall 2004 Monitoring Well

Fall 2004 Groundwater Contour

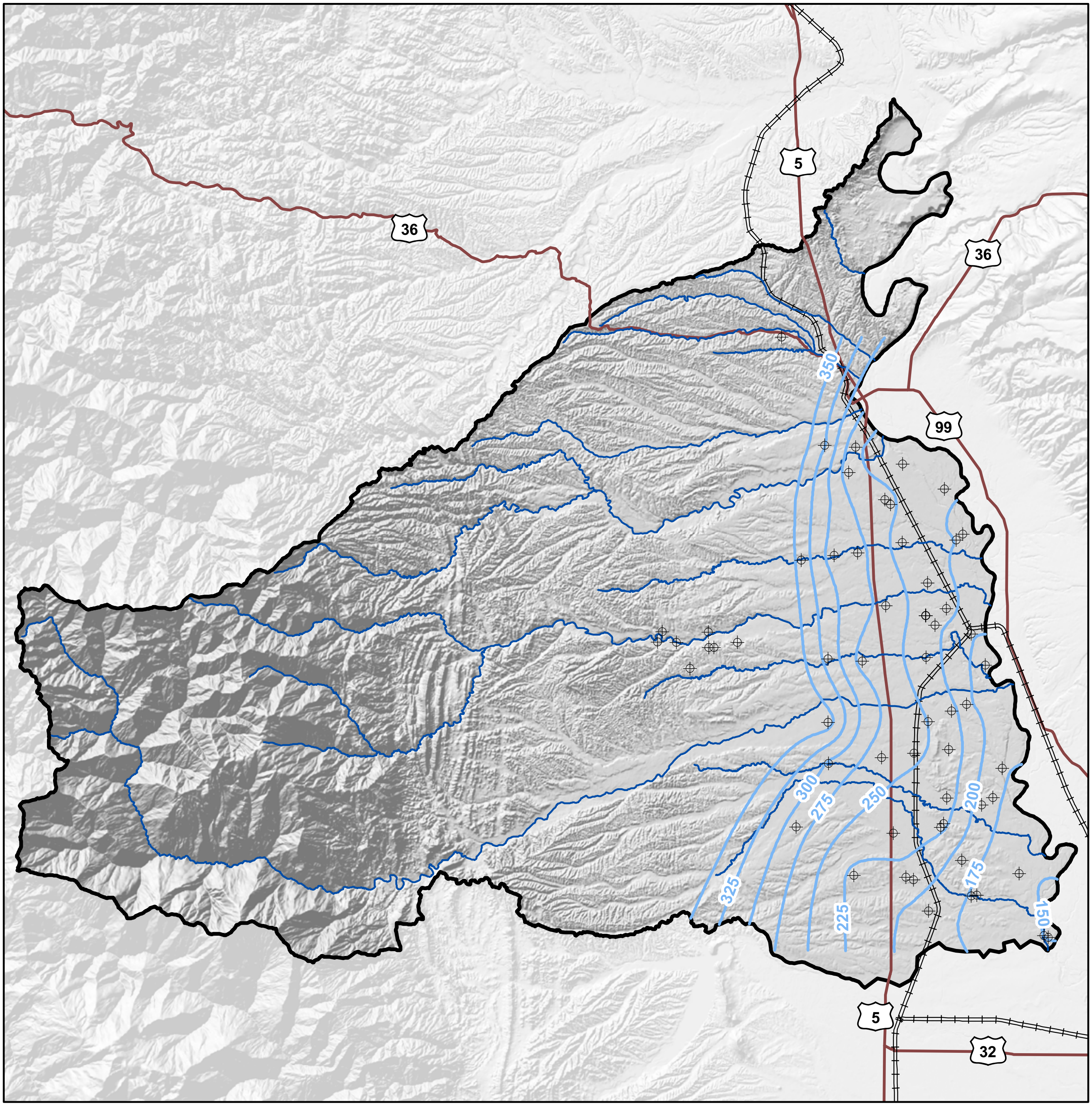
N
W
E
S

0 2.5 5 10 Miles

VESTRA

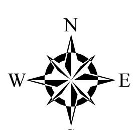
FIGURE 6-14
FALL 2004 GROUNDWATER ELEVATIONS
TEHAMA WEST WATERSHED ASSESSMENT

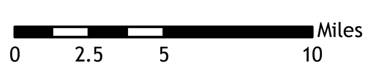
SOURCE: CALIFORNIA DEPARTMENT OF WATER RESOURCES, 2005



Legend

- Railroad
- Major Highway
- Major Tributary
- Spring 2005 Monitoring Well
- Spring 2005 Groundwater Contour

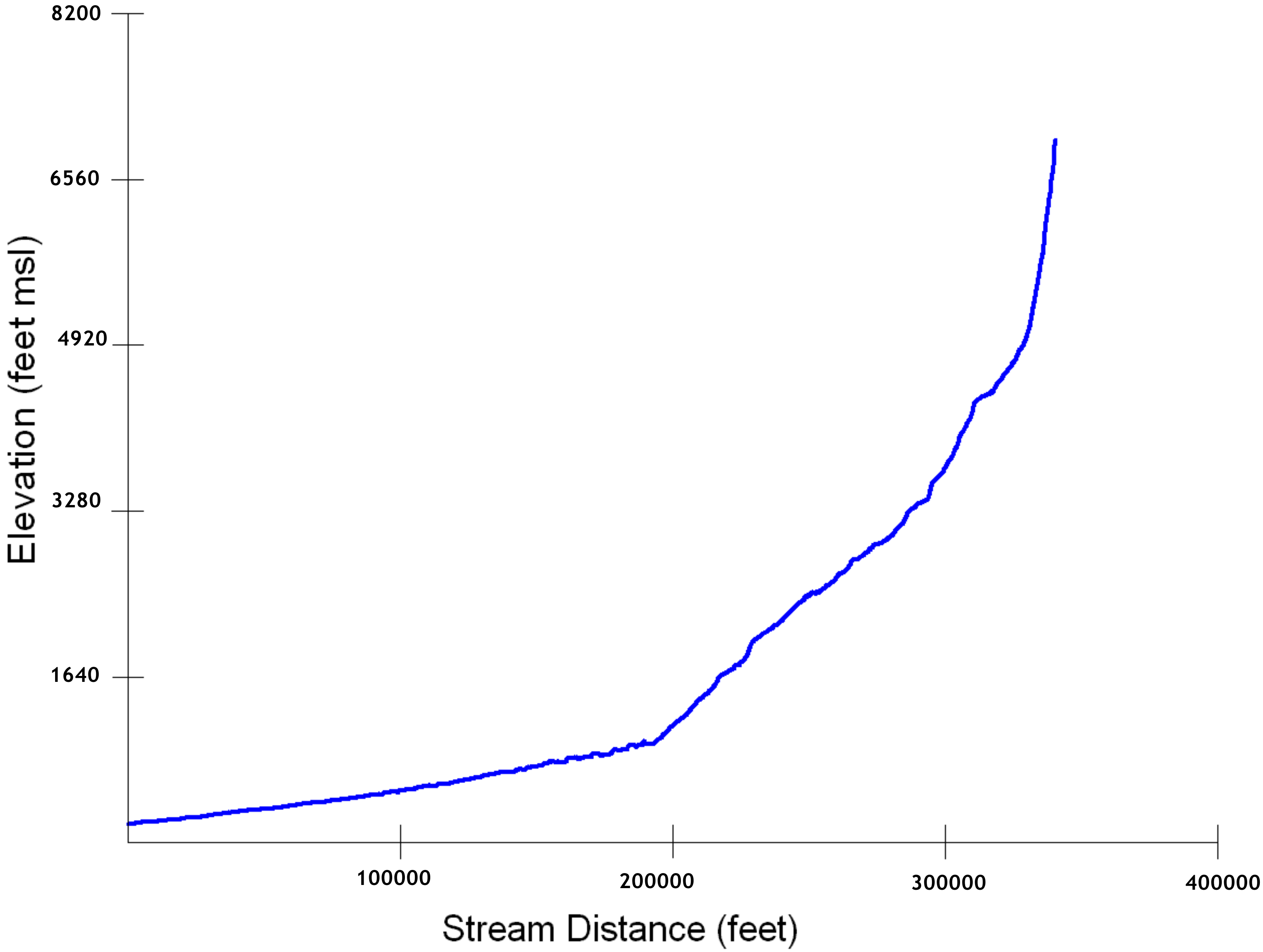




VESTRA

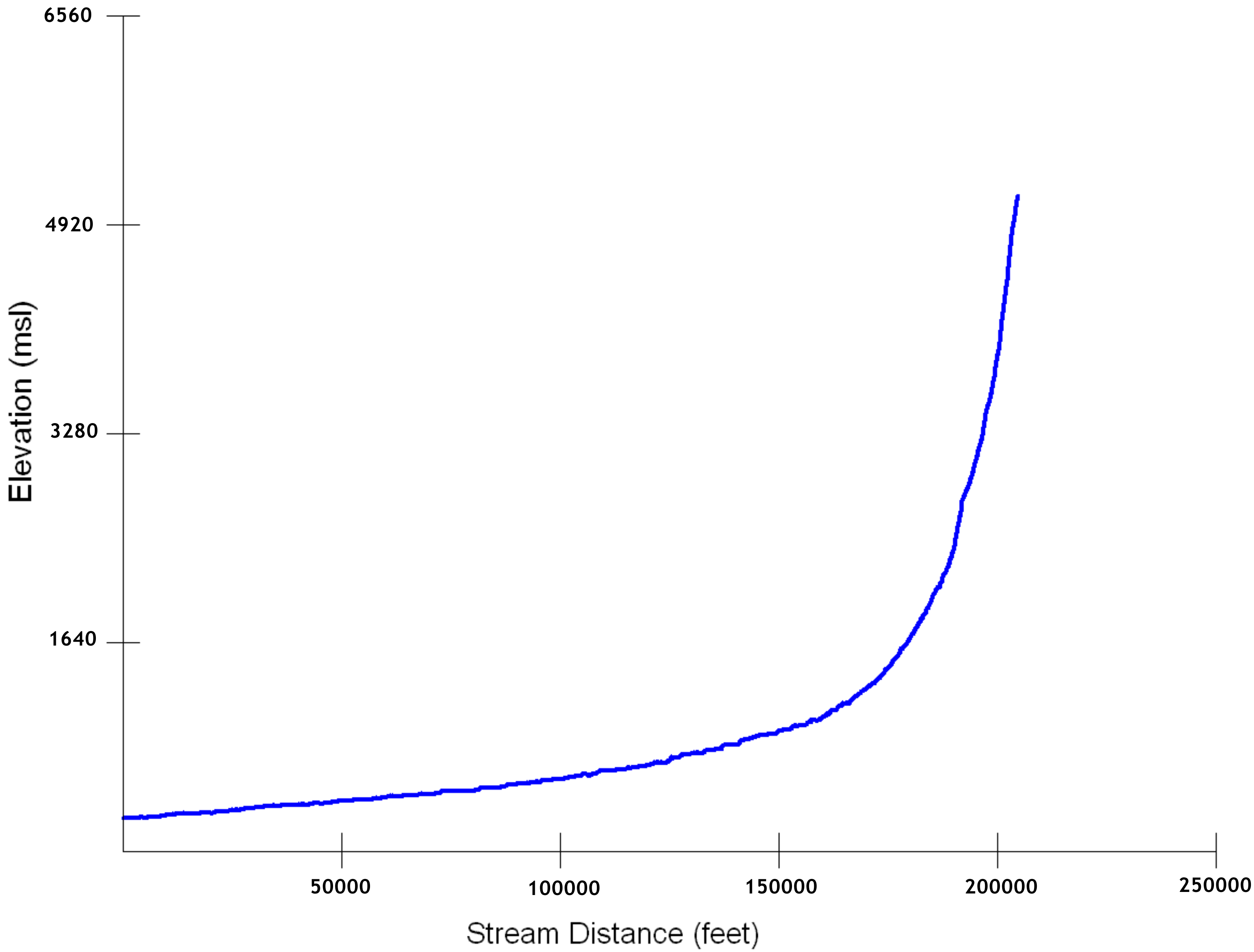
FIGURE 6-15
SPRING 2005 GROUNDWATER ELEVATIONS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF WATER RESOURCES, 2005



VESTRA

FIGURE 6-16
LONGITUDINAL PROFILE - THOMES CREEK
TEHAMA WEST WATERSHED ASSESSMENT



VESTRA

FIGURE 6-17
LONGITUDINAL PROFILE - RED BANK CREEK
TEHAMA WEST WATERSHED ASSESSMENT

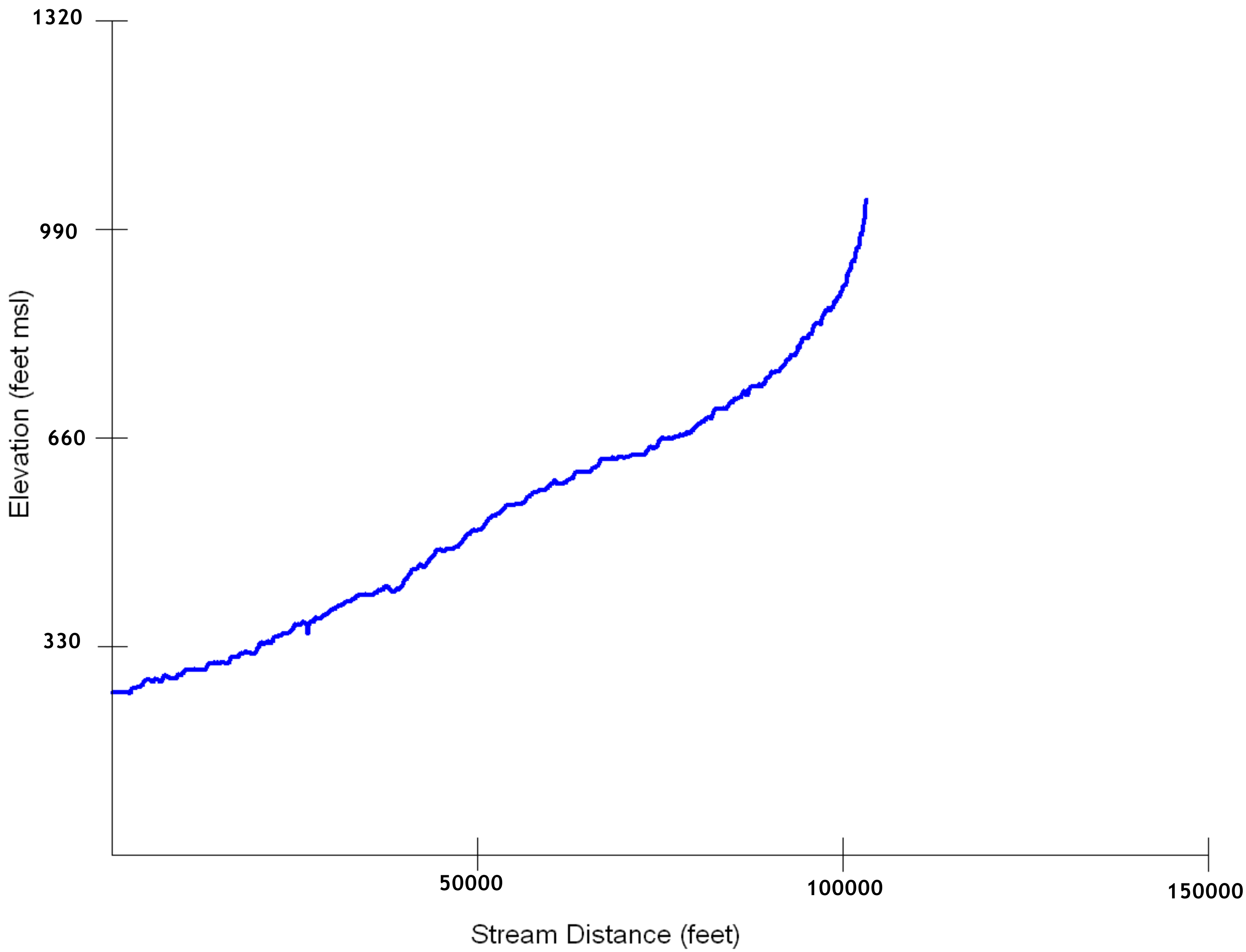


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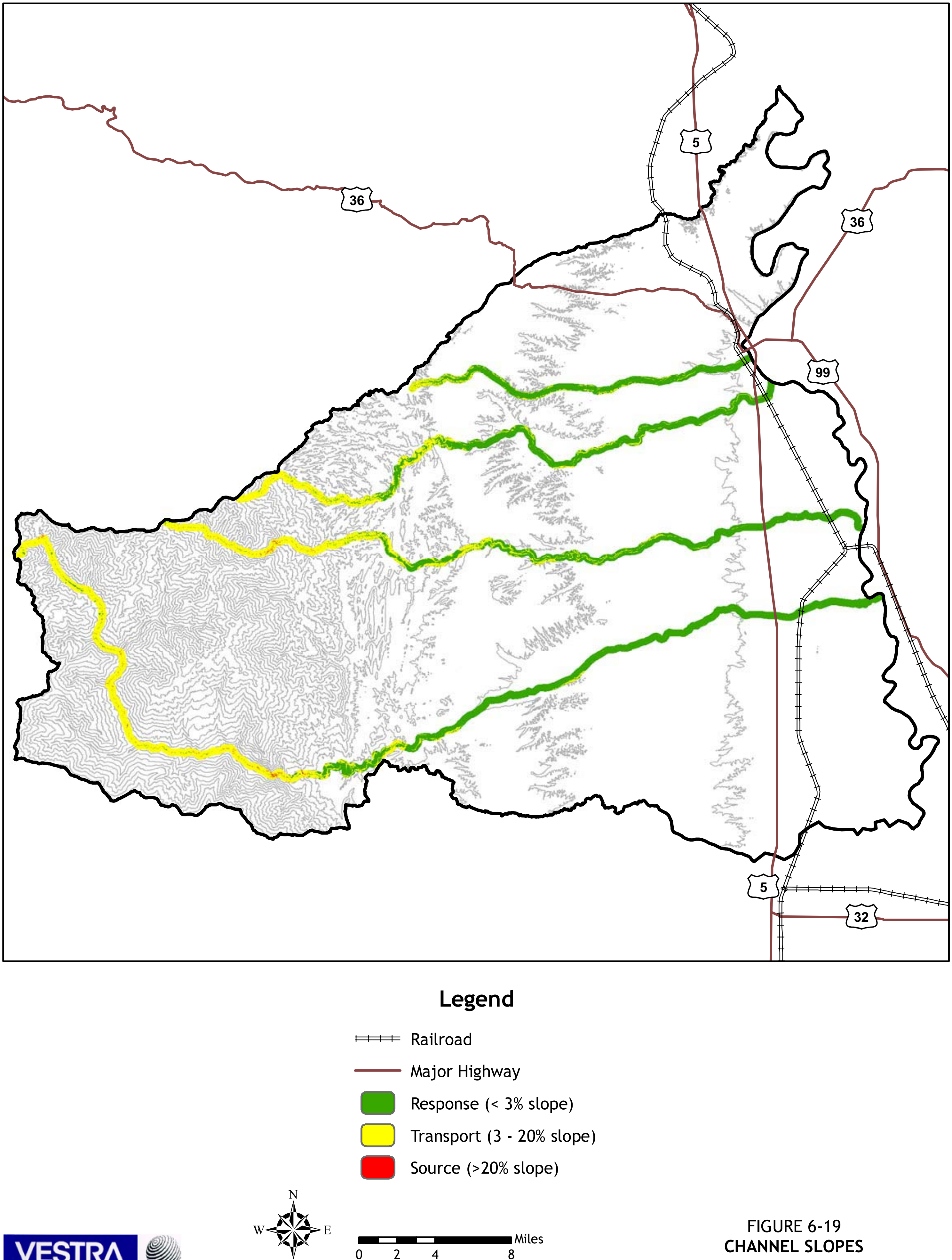
FIGURE 6-18
LONGITUDINAL PROFILE - REEDS CREEK
TEHAMA WEST WATERSHED ASSESSMENT



VESTRA

FIGURE 6-19
CHANNEL SLOPES
TEHAMA WEST WATERSHED ASSESSMENT

Section 7

Section 7
WATER QUALITY

TABLES

FIGURES

APPENDICES

Section 7
WATER QUALITY

Basic information on the surface water and groundwater quality of the Tehama West watersheds is presented in this section. Water rights and water use were discussed in section 6, "Hydrology." Supporting information on surface and groundwater hydrology and geomorphology is summarized in Section 6. Supporting information on climate is summarized in Section 5, "Climate."

Demographics and land use can have a pronounced effect on water quality; not only through the addition of contaminants to surface and groundwater, but through the use and management of soil and potential increases in sediment and nutrient loading over background levels. Sediment generation and the relationship between hydrology, geomorphology, and geology were discussed in Section 6. The eastern portions of these watersheds are underlain by rocks of the Great Valley Geomorphic Province. In general, this portion of the watershed is characterized by low elevations, low precipitation, relatively gentle topography, low erosion potential, and a significant groundwater reservoir. The western portion of the watershed is characterized by high elevations, high rainfall, and steep slopes with high erosion potential. Over time the transport of material from these rugged upland areas to the valley floor has resulted in the deposition of large alluvial fans and gravel reserves.

SOURCES OF DATA

Primary sources of data used in the preparation of this section are listed below. Additional information is provided in the references section.

- U.S. Geological Survey (USGS) stations for which water quality data was available
- Department of Water Resources, (DWR) stations for which water quality data was available
- Thomes Creek Watershed Study (DWR 1982)
- Thomes Creek Sediment Budget (CSUC 2004)
- Sacramento Valley Westside Tributary Watershed Erosion Study (DWR 1992)
- Coordinated AB3030 Groundwater Management Plan, Tehama County Flood Control and Water Conservation District (Law 1996)
- Water Inventory and Analysis Report, Tehama County Flood Control and Water Conservation District (CDM 2003)
- Tehama County: A Small Water Systems Drought Vulnerability Study (CDM 2005)
- Thomes Creek Watershed Assessment Analysis Report (USDA 1977)

- Data from the California Department of Pesticide Regulation
- Files from Crane Mills
- Water Quality Control Plan for the Central Valley/Sacramento River Basin.

HISTORICAL CONTEXT

Historical water quality in the watershed is unknown; however the primary constituents of concern would have likely been sedimentation and increases in temperature or dissolved oxygen resulting from drought or natural events.

Native Americans used fire as a tool to manage the landscape and the use of fire may have resulted in increased sedimentation or contribution of ash to watercourses. In the literature reviewed for the project, only the Thomes Creek Watershed Assessment prepared by the United States Forest Service (USFS) in 1997 provides any discussion of historical water quality and the discussion is limited to the impacts of land management on sediment. The USFS estimated that the frequent fires from Native American burning and natural causes "probably resulted in a significant volume of fine grained sediment eroding from the Watershed." The following discussion was extracted from that document.

The first significant increase in erosion and sediment production in the watershed over the moderate levels, believed to have occurred at the time of California Indian use, probably occurred between the 1860s and 1917, with a peak around 1900, coincident with grazing in the watershed. The Thomes Creek Watershed is reported to have been one of the most heavily grazed watersheds in the Mendocino National Forest. Large bands of sheep were grazed on both private and public land by ranchers in the Paskenta and Newville areas (USDA 1977).

When the stockmen left the higher elevations and forested areas in the fall, they set fires to improve the browse for their livestock. The fires removed some of the grasses and herbaceous vegetation that protected the high-elevation soils. Many higher elevation soils lost their "A" horizon during this period, which changed the ability of the soil to support vegetation. The lack of surface vegetation resulted in rapid surface runoff, high soil erosion and sedimentation.

Control of grazing and effective fire suppression began in 1917, following the establishment of the Mendocino National Forest. Since the area of the Thomes Creek Watershed and the Tehama West Watershed as a whole within the forest is quite large, the increasing effectiveness of fire suppression likely had a major impact on total soil erosion and sediments leaving the watershed. Organic matter began to build up on the forest floor, resulting in soils with a higher organic component and lower pH. This change in soil structure and chemistry improved the water-holding capacity of the soil, and the increased organic duff slowed runoff, which helped reduce soil erosion. Currently, soils are believed to be more resistant to erosion than the soils in place when California Indians occupied the region, due to this build-up of organic matter (USDA 1977). The buildup of vegetation, however, also increased the potential for large wildfires in the watershed (USDA 1977).

The greatest and most rapid increase in erosion and sedimentation in the watershed likely occurred from 1950 through about 1970. This increase appears to be correlated with timber harvest and road building. Timber harvest began in the watershed during the 1950s and peaked in the 1960s and 1970s. By the 1960s soil disturbance was extensive over large areas of the watershed. A study conducted in 1982 calculated areas affected by timber harvest for four periods of time between 1952 and 1978 using aerial photographs. They found that while in 1952 only 7 percent of the watershed's area had been cut, by 1978, 38 percent of the watershed had been entered at least once for timber removal.

This was also a period of maximum road building. Roads remain major contributors of sediments in the watershed (USDA 1977). It was also during this time period that the largest recorded flood event in the watershed occurred. The effects of this naturally occurring event were exacerbated by the sharp increase in timber harvest and road building prior to its occurrence (USDA 1977).

The high levels of erosion and sediment production present in the 1960s began to decrease in the 1970s, and are now believed to be similar to those following the grazing period. This drop is due to decreased road construction, stabilization of the existing roadbeds, and decreased timber harvest. Other contributing factors are the partial recovery of streamside vegetation that had been wiped out by the 1964 flood, especially during the flood-free years of 1975 through 1978, and implementation of Best Management Practices (BMPs) and the California Forestry Practices Act during the 1970s and 1980s.

WATER QUALITY STANDARDS

California's water quality standards are based on the anticipated use of the water source. In addition, California has adopted a non-degradation policy (Resolution 68-16), which prohibits anyone from damaging or degrading water to a condition worse than its current status.

Section 303 of the Clean Water Act (CWA) (33 U.S.C. §1313) provides for promulgation of water quality standards by states. The standards consist of designating uses of water and then developing water quality criteria based on the designated uses (40 CFR §131.3(i)). The criteria are "elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use" (40 CFR §131.3(b)). Water quality standards for the watershed are presented in the *Water Quality Control Plan for the Sacramento and San Joaquin River Basin Plan* (RWQCB, 1998).

The CWA requires states to protect beneficial uses of waters in the United States within their jurisdictional boundaries. The CWA further requires states to adopt water quality criteria (referred to as "objectives" in California) that protect the designated "beneficial uses" of water bodies. The designated beneficial uses, the water quality criteria to protect those uses, and an anti-degradation policy constitute water quality standards. California adopts standards through the basin planning process. Basin Plans are adopted and amended by the Regional Water Quality Control Board (RWQCB) using a structured process involving peer review, public participation, state environmental review, and state and federal agency review and approval. Designated beneficial uses are listed on Table II-1 of the Basin Plan. Only the Sacramento River and Thomes Creek have designated beneficial uses. If specific beneficial uses for a water body are not identified, the beneficial uses of the water body to which the water body is tributary apply. Beneficial uses applicable to the Tehama West Watershed are shown on Table 7-1.

Table 7-1
BENEFICIAL USES FOR SACRAMENTO RIVER AND THOMES CREEK

Designation	Definition	Existing Beneficial Use	Potential Beneficial Use	No Beneficial Use
Municipal and Domestic Supply	MUN – Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.	S		T
Irrigation	AGR – Uses of water for farming, horticulture, or ranching including but not limited to, irrigation (including leaching of salts), stock watering, or support of vegetation for range grazing.	S/T		
Stock Watering	As defined for irrigation	S/T		
Process	Proc – Uses of water for industrial activities that depend primarily on water quality.		S	T
Service Supply	IND – Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.	S		T
Power	POW – Uses of water for hydropower generation.	S	T	

Table 7-1 (cont.) BENEFICIAL USES FOR SACRAMENTO RIVER AND THOMES CREEK				
Designation	**Definition**	**Existing Beneficial Use**	**Potential Beneficial Use**	**No Beneficial Use**
Contact	REC 1 – Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white-water activities, fishing, or use of natural hot springs.	S/T		
Canoeing and Rafting	As defined for contact	S		T
Other Noncontact	REC 2 – Uses of water for recreational activities involving proximity to water but where there is generally no body contact with water, nor any likelihood of ingestion of water. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine-life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.	S/T		
Warm	WARM – Uses of water that support warmwater ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife including invertebrates.	S/T		
Cold	COLD – Uses of water that support coldwater ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.	S/T		
Warm (MIGR)	MIGR – Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as			T

Table 7-1 (cont.) BENEFICIAL USES FOR SACRAMENTO RIVER AND THOMES CREEK				
Designation	**Definition**	**Existing Beneficial Use**	**Potential Beneficial Use**	**No Beneficial Use**
	anadromous fish.			
Cold (MIGR)	As defined for Warm (MIGR)	S/T		
Warm (MIGR)	SPWN – Uses of water that support high-quality aquatic habitats suitable for reproduction and early development of fish.	S/T		
Cold (SPWN)	As defined for Warm (MIGR)	S/T		
Wildlife Habitat	WILD – Uses of water that support terrestrial or wetland ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats or wetlands, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.	S/T		
	NAV – Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.	S		T

The Basin Plan also establishes water quality objectives as required by the Porter-Cologne Water Quality Control Act. Under this act water quality objectives are defined as "…the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area" (Water Code Section 13050(h) as cited by RWQCB, 1998). Water quality objectives are set for a particular body of water, and include maximum and/or minimum allowable levels of several constituents. Water quality objectives are not established for specific tributaries in the watershed; however, certain constituents apply to the upper Sacramento River. These constituents, with their maximum and minimum allowable levels, relative time period, and applicable body of water, are shown in Table 7-2.

For constituents not included in the Basin Plan, water quality limits from other sources may apply. To be defensive, water quality limits should be chosen to implement all predictable water quality objectives and promulgated criteria. Water quality limits are found in many sources. Other sources of water quality limits applicable to the ground and surface water in the Tehama West Watershed follow as summarized from *A Compilation of Water Quality Goals* (RWQCB 2003a).

Table 7-2 WATER QUALITY OBJECTIVES FOR THE SACRAMENTO RIVER WITHIN THE WATERSHED				
Constituent	**Maximum Concentration /Level**	**Minimum Concentration /Level**	**Time Period**	**Applicable Water Body**
Arsenic	0.01 (mg/l)			Sacramento River from Keswick Dam to I Street Bridge at City of Sacramento
Barium	0.1 (mg/l)			As noted for Arsenic
Cadmium	0.00022 (mg/l)			Sacramento River and its tributaries above State Highway 32 bridge at Hamilton City
Cyanide	0.01 (mg/l)			As noted for Arsenic
Iron	0.3 (mg/l)			As noted for Arsenic
Manganese	0.05 (mg/l)			As noted for Arsenic
Silver	0.01 (mg/l)			As noted for Arsenic
Dissolved Oxygen		9.0 mg/l	June 1 to August 31	Sacramento River from Keswick Dam to Hamilton City
PH	8.5	6.5		All
Electrical Conductivity (at 25°C)	230 Micromhos/centimeter (μmhos/cm)			Sacramento River
Temperature	56°F			Sacramento River from Shasta Dam to I Street Bridge
[a]See the Water Quality Control Plan for the Sacramento River and San Joaquin River Basin for a complete listing of all constituents, applicable water bodies, and minimum and maximum levels.				

Drinking Water Standards, Maximum Contaminant Levels (MCLs)

Drinking water MCLs are directly applicable to water supply systems and at the tap and are enforceable by the Department of Health Services (DHS) and local health departments. MCLs are components of the drinking water standards adopted by the Department of Health Services (DHS) pursuant to the California Safe Drinking Water Act. California MCLs may be found in Title 22 of the California Code of Regulations (CCR).

Primary MCLs are derived from health-based criteria. MCLs also include technologic and economic considerations based on the feasibility of achieving and monitoring for these concentrations in drinking water supply systems and at the tap.

Secondary MCLs are derived from human welfare considerations (e.g., taste, odor, laundry staining) in the same manner as Primary MCLs. California MCLs, both Primary and Secondary, are directly applicable to groundwater and surface water resources when they are specifically referenced as water quality objectives.

Maximum Contaminant Level Goals (MCL Goals or MCLGs)

MCL Goals are promulgated by the United States Environmental Protection Agency (USEPA) as part of the National Primary Drinking Water Regulations. MCL Goals represent the first step in establishing federal Primary MCLs and are required by federal statute to be set at levels that represent no adverse health risks. They are set at "zero" for known and probable human carcinogens, since theoretically a single molecule of such a chemical could present some degree of cancer risk. Threshold levels posing no risk of health effects are used for non-carcinogens and for possible human carcinogens. Because they are purely health-based, non-zero MCL Goals may be useful to interpret narrative water quality objectives which prohibit toxicity to human consumers.

California Public Health Goals (PHGs)

The California Safe Drinking Water Act of 1996 requires the California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA) to perform risk assessments and to adopt Public health goals for contaminants in drinking water based exclusively on public health considerations. PHGs represent levels of contaminants in drinking water that would pose no significant health risk to individuals consuming the water on a daily basis over a lifetime. For carcinogens, PHGs are based on 10^{-6} incremental cancer risk estimates.

California State Action Levels

Action levels are published by DHS for chemicals for which there is no drinking water MCL. State Action Levels are based mainly on health effects – an incremental cancer risk estimate of 10^{-6} for carcinogens and a threshold toxicity limit for other constituents. As with MCLs, the ability to quantify the amount of the constituent in a water sample using readily available analytical methods may cause action levels to be set at somewhat higher concentrations than purely health-based values.

Drinking Water Health Advisories and Water Quality Advisories

Health Advisories are published by USEPA for short-term (1-day exposure or less or 10-day exposure or less), long-term (7-year exposure or less), and lifetime human exposures through drinking water. Health advisories for non-carcinogens and for possible human carcinogens are calculated for chemicals where sufficient toxicologic data exist. Incremental cancer risk estimates for known and probably human carcinogens are also presented.

Proposition 65 Safe Harbor Levels

Safe harbor levels are established pursuant to the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) for known human carcinogens and reproductive toxins. Proposition 65, an initiative statute, made it illegal to expose persons to significant amounts of these chemicals without prior notification or to discharge significant amounts of these chemicals to sources of drinking water. These "significant amounts" are adopted by the OEHHA in regulations contained in Title 22 of the CCR, Division 2, Chapter 3. For carcinogens, No Significant Risk Levels (NSRLs) are set at concentrations associated with a 1-in-100,000 (10^{-5}) incremental risk of cancer. These are the only California health-based limits derived from risk levels greater than 10^{-6}.

California Toxics Rule (CTR) and National Toxics Rule (NTR) Criteria

The CWA requires all states to have enforceable numerical water quality criteria applicable to priority toxic pollutants in surface waters. USEPA promulgated water quality criteria for priority toxic pollutants for California's inland surface waters and enclosed bays and estuaries in federal regulations called the "California Toxics Rule." Included are criteria to protect both human health and aquatic life, similar to those published in the *National Ambient Water Quality Criteria*, discussed below. The CTR criteria, along with the beneficial use designations in the Basin Plans, are directly applicable water quality standards for toxic pollutants in these waters under Section 304(c) of the federal Clean Water Act. Implementation provisions for these standards may be found in the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (SWRCB Resolution No. 2000-015), adopted by the State Water board in March 2000. The policy includes time schedules for compliance, provisions for mixing zones, analytical methods and reporting levels.

National Ambient Water Quality Criteria

These criteria, also called the national Recommended Water Quality Criteria, are developed by USEPA under Section 304(a) of the federal Clean Water Act to provide guidance to the states in developing water quality standards under Section 304(c) of the Act and to interpret narrative toxicity standards. These criteria are designed to protect human health and welfare and aquatic life from pollutants in freshwater and marine surface waters. In April 1999 and November 2002, USEPA published tables of *National Recommended Water Quality Criteria*, which summarize criteria from the sources discussed above and more recent updates. Due to their age and changes in methods used to drive the criteria, Blue Book criteria no longer appear in these summary tables.

Agricultural Water Quality Limits

Water Quality for Agriculture, Published by the Food and Agriculture Organization of the United Nations in 1985, contains limits protective of various agricultural uses of water, including irrigation of various types of crops and stock watering. Above these limits, specific agricultural uses of water may be adversely affected. These limits may be used to translate narrative water quality objectives that prohibit chemical constituents in concentrations that would impair agricultural uses of water.

SURFACE WATER QUALITY

The primary sources of surface water data in the watershed are from DWR and USGS monitoring stations. Other data is available on specific tributaries such as the Thomes Creek Sediment Budget (CSUC 2004), Sacramento Valley Watershed Coalition sampling at Burch Creek, and Crane Mills temperature data in Thomes Creek.

Department of Water Resources (DWR)

DWR monitored nine stations on four streams: Elder, Red Bank, Reeds,` and Thomes Creeks. Station locations are shown on Figure 7-1. Downloaded data includes over 2,500 individual samples of nearly 200 analytes over a seven-year period from 1998 to 2005 (DWR data downloaded from http://wdl.water.ca.gov/wq-gst/). Of the nearly 200 analytes sampled only 50 have results that exceed the Reporting Limit (RL) or whose maximum result is greater than zero. Where possible, limits for each analyte were established using the Basin Plan, the Environmental Protection Agency's (EPA) Water Quality criteria, and the CTR. The minimum, maximum, average, and standard deviation of the sample results of each of these analytes was calculated and then compared to the RLs determined by DWR. These limits were exceeded on five analytes at six stations. These included dissolved aluminum, dissolved iron, pH, total dissolved solids, and water temperature. Station information is included in Table 7-3. Results are shown on Tables 7-5 and 7-6 and summarized on Tables 7-7 and 7-8.

US Geological Survey (USGS)

USGS monitored seven stations on three streams including Red Bank, Elder, and Thomes Creeks at different periods from 1958 to 2000. The downloaded data includes over 10,000 individual samples of 94 parameters over the 22-year period (USGS data downloaded from http://nwis.waterdata.usgs.gov/usa/nwis/qwdata). USGS stations are included on Figure 7-2. Of the 94 parameters sampled 88 have results that are greater than the RL. Again, where possible, limits for each parameter were established using the Basin Plan, EPA's Water Quality Criteria, and the CTR. The minimum, maximum, average, and standard deviation of each parameter were calculated and then compared to these limits. These limits were exceeded on five parameters at five USGS stations. These included temperature, turbidity, specific conductance, pH, and chloride. Station information is included as Table 7-4. Results are shown on Tables 7-9 and summarized on Tables 7-10 and 7-11.

Table 7-3
NINE DWR STATIONS IN TEHAMA WEST WATERSHED

Station Number	Station Name	Lat.	Long.	Period of Sampling	Number of Samples
A0332000	Elder Creek at Gerber	40.0511	-122.1514	3/7/2001-7/26/2005	574
A0335000	Elder Creek near Henleyville	40.0322	-122.2900	5/29/1998-5/8/2001	54
A0340500	Red Bank Creek at Rawson	40.1403	-122.2383	3/6/2001-6/28/2005	475
A0346000	Red Bank Creek near Red Bluff	40.0900	-122.4125	5/28/1998-2/7/2001	26
A3471000	Red Bank Creek North Fork at Bell Road	40.1350	-122.5200	5/29/1998-5/29/1998	11
A0025700	Reeds Creek at Red Bluff	40.1686	-122.2369	3/6/2001-6/28/2005	516
A0321800	Thomes Creek at Hall Road	39.9853	-122.1233	3/7/2001-6/28/2005	514
A0325500	Thomes Creek at Henleyville	39.9564	-122.3292	5/19/2004-5/19/2004	31
A0350000	Thomes Creek at Paskenta	39.8878	-122.5281	5/28/1998-4/10/2002	336

Table 7-4 SEVEN USGS STATIONS IN TEHAMA WEST WATERSHED		
Station Number	Station Number	Sampling Period
11378800	Red Bank Creek near Red Bluff	12/5/1960-5/4/1966
11378860	Red Bank Creek at Rawson Rd. Bridge near Red Bluff	12/26/196-34/15/1969
11380500	Elder Creek at Gerber	12/6/1960-3/28/1979
11379500	Elder Creek near Paskenta	10/2/1958-1/19/2000
11382090	Thomes Creek at Rawson Rd. Bridge near Richfield	1/31/1977-4/8/1980
11382100	Thomes Creek near Mouth near Corning	12/6/1960-7/6/1966
11382000	Thomes Creek at Paskenta	10/2/1958-5/4/1983
Note: Table includes stations with > 1 sampling event		

CSUC Sediment Budget

A study completed by California State University, Chico proclaimed the Thomes Creek watershed as "one of the highest sediment-producing streams in the western Sacramento Valley." The objective of the study was to develop a sediment budget for Thomes Creek to determine if gravel extraction operations in the lower reaches of the creek below the I-5 Bridge were depleting the resource. The following four paragraphs were extracted from the executive summary of the report.

The Thomes Creek watershed is one of the highest sediment-producing streams in the western Sacramento Valley of Northern California. Consequently, sand and gravel mining is one of the major land uses in the lower watershed. Mining from the creekbed may not be without impacts, however. According to the California Department of Fish and Game (1993), mining, especially in the reach between the I-5 Bridge and Sacramento River confluence has resulted in local changes in channel cross-section as well as changes in stream stability. These alterations are postulated to have impaired migration of adult salmonids, diminished the availability of suitable spawning sites, altered the movement of spawning gravel, and increased the volume of suspended solids present in the water. In light of these concerns, and to develop effective management strategies for sustainable mining practices of sand and gravel in Thomes Creek, we have constructed a quantitative sediment budget for the Thomes Creek watershed. Our analysis indicates that although average annual bedload discharges are insufficient to replace the volume of sediments either permitted to be or historically mined annually, sediment stored in the channel during high-flow events may be sufficient to maintain mining operations in subsequent years under current permitted volumes and practices.

In the current analysis, we have identified two sources of sediment in the Thomes Creek channel: mass wasting in the upper watershed, especially in the steeply sloped area between the Gorge and the Slab, and remobilization of sediment previously stored in the channel. Slope failures as debris slides, block slides, rotational/translational slides, debris avalanches and rock slides/rock falls are common and widespread. Most of the sediment entering the channel is derived from debris slides fed by large, deep-seated rotational/translational slides located upslope; examination of sequential aerial photographs reveal that the same locations tend to fail year after year. Debris slides deliver all sizes of sediment to the channel, from clay to boulders. Much of the sediment that moves out of the upper watershed during high flow events is trapped in the lower watershed as channel lag, bars and terraces. We estimate that over 309,000,000 yd^3 [cubic yards] of sediment currently reside in the active portion of the Thomes Creek channel. Sedimentologic analysis of modern channel deposits indicate unsystematic downstream fining in pebbles, cobbles and boulders coupled with an increase in the relative proportions of sand, silt and clay in the downstream direction, ranging from approximately 30% in the vicinity of the Slab crossing and Paskenta to 43% at Flournoy and up to 60% at Henleyville and Rawson Road. Flanking the active channel are terraces of various ages whose relative stability is indicated by the presence of soil development.

To construct a sediment budget for the watershed, the estimated 89,700 yd^3/yr of sediment delivered to the Thomes Creek channel in the upper watershed was routed downstream on a reach-by-reach basis utilizing the bedload rating curves derived for each measured cross-section in conjunction with yearly flood flows. Results of our calculations indicate that bedload transport rates are highly variable, both as a function of location and time, and the use of average annual bedload transport rates calculated from yearly estimates tend to disguise the wide variability inherent in the Thomes Creek system. Of the sediment delivered to the channel in the upper watershed, approximately 75,200 yd^3/yr is transported at the Slab, 45,000 yd^3/yr [cubic yards per year] is transported at Paskenta, 24,300 yd^3/yr moves through the Flourney, 25,300 yd^3/yr moves past Henleyville and about 44,000 yd^3/yr passes under the Rawson Road bridge.

The greatest amounts of sand and gravel are transported downstream during high discharge events, which typically have fairly low recurrence intervals. Exceedence probabilities and return periods for Thomes Creek flows recently calculated using 75 years of annual discharge data indicate that discharges of about 10,000 cfs have an average return period of between two and five years. The 10-year flood has an associated discharge of 19,500 cfs, while the 25-year and 50-year floods have discharges of approximately 27,000 cfs and 33,000 cfs, respectively. At 20,000 cfs the Thomes Creek channel on average is capable of transporting nearly 100,000 yd^3 of sediment per day. Because of the proportionate increase in sand in the downstream reaches, much of the sediment that will be transported to the mining sites under higher flood flows will be sand-sized or finer. We estimated the relative sizes of particles transported in each reach as the fraction available, rescaled to preclude the sizes not transported, times the total yearly average bedload discharge. Transport of sand and finer sediment as bedload at Rawson Road may average 30,500 yd^3/yr or more, comprising nearly 70% of the total sediment load (CSUC 2004).

DWR 1982

The most complete assessment of sources and causes of high sediment yield in the Thomes Creek upper watershed was from the two-year study by Howard and Varnum (1982). The authors found that most sediment entering the creek channel in the upper watershed comes from landslides along the main channel and tributaries. The authors identified that the landslides are caused by a combination of unstable geology, (particularly within the South Fork Mountain Schist and Valentine Spring formations), steep slopes, intense precipitation, (including large storm events), snowmelt, or small, late spring storms; and human activities such as timber harvesting and road construction. Movement of unconsolidated material is exacerbated by high flows, generally in excess of 17,600 cfs as gauged at Paskenta. These flows carry high volumes of sediment that aggrade the channel and lead to undercutting of the streambanks, thus initiating sliding. Minor amounts of sediment are delivered to the Thomes Creek channel by rock slides within the gorge, by large, deep-seated translation-rotational slides in the middle watershed, which probably date from the late Pliocene to mid-Quaternary, from gutted stream channels scoured by debris torrents in long, straight, steep tributaries to Thomes Creek, and by soil mantle creep in the upper watershed, especially on south-facing slopes.

United States Forest Service (USFS)

The USFS conducted a landslide inventory in the Mendocino National Forest. Active results of the inventory are shown on Figure7-3. The inventory identified 16,970 acres of active or dormant slides in the Thomes Creek Drainage and 3,221 acres of active or dormant landslides in the Elder Creek drainage.

Crane Mills Temperature Data

Crane Mills has monitored water temperature at two locations in Thomes Creek (Upper Thomes Creek at the bridge and Lower Thomes Creek at the Slab). Data was collected from 1995 through 2002 from approximately June 15 to November 15 of each year. The Data sheets supplied as records of this work are included in an appendix to this section. In general the data reflects seasonal snowmelt in June with average temperatures near 50°F in both upper and lower locations. As the summer progresses and base flow conditions occur, the temperatures rise consistently with average air temperature such that the lower Thomes Creek location temperatures increases from 5° to 10° over the temperature at the upper location.

Surface Water Quality Summary

DWR and USGS monitoring have recorded analytes that have exceeded their limits on Elder, Red Bank, Reeds, and Thomes Creeks for dissolved aluminum, dissolved iron, pH, total dissolved solids, water temperature, turbidity, specific conductance, and chloride. However, overall water quality in the watershed is good.

Sediment loading in Thomes Creek continues to be a problem. Studies conducted by CSUC and DWR attribute sediment loading to landslides and remobilization of sediment. Concerns caused by sediment include changes in channel cross-section, changes in stream stability, impaired salmonid migration and spawning sites, and increased volume of suspended solids.

The potential sources and causes of water quality impairment vary from subwatershed to subwatershed. Table 7-12 lists potential sources and causes of water quality impairment.

Table 7-5
DWR STATION INFORMATION – DISSOLVED ANALYTES WITH SAMPLE RESULTS EXCEEDING THE REPORTING LIMIT (>RL) <u>OR</u> WITH MAXIMUM RESULTS > 0

Constituent	Number of Samples	Result				Basin Plan Limit (ug/l)	CTR (1) (ug/l)		Federal MCL (ug/l)		CA MCL (ug/l)	
		Minimum	Maximum	Average	Standard Deviation		Contin. Acute	4 Day Chronic	Primary	Secondary	Primary	Secondary
Ammonia (mg/l as N)	54	0	0.04	0.00	0.01							
Arsenic (µg/l)	28	0.349	1.54	0.67	0.30	10	340	150	10		50	
Boron (mg/l)	62	0	0.6	0.01	0.08							
Calcium (mg/l)	62	2	52	26.68	10.05							
Chloride (mg/l)	62	0	74	7.18	10.90					250,000		250,000
Chromium (µg/l)	28	0.37	7.12	1.85	1.37		550	180	100			50
Copper (µg/l)	28	0.46	5.22	1.08	0.93	5.6	13	9	1300	1000	1300	1000
Iron (µg/l)	28	0	1525	97.42	291.60	300				300		300
Lead (µg/l)	28	0	0.647	0.04	0.12		65	2.5	15		15	
Magnesium (mg/l)	62	1	38	14.06	7.99							
Manganese (µg/l)	28	0.21	21.4	2.05	3.96	50				50		50
Nitrate (mg/l)	9	0	2	0.64	0.61				10,000		45,000	
Nitrite + Nitrate (mg/l as N)	62	0	1.1	0.11	0.20				1000		1000	
Organic Nitrogen (mg/l as N)	3	0.1	0.6	0.30	0.26							
Ortho-phosphate (mg/l as P)	48	0	0.14	0.02	0.03							
Potassium (mg/l)	62	0.5	1.9	0.92	0.33							
Sodium (mg/l)	62	2	35	9.39	6.61							
Sulfate (mg/l)	62	2	46	14.34	10.39				500,000	250,000		250,000
Zinc (µg/l)	28	0	3.37	0.38	0.63	16	120	180		5000		5000

Notes: (1) CTR values vary by hardness for freshwater life or lowest shown.
Blank spaces denote no current State or Federal value available.

Table 7-6
DWR STATION INFORMATION – NON- DISSOLVED ANALYTES WITH SAMPLE RESULTS EXCEEDING THE REPORTING LIMIT (>RL) OR WITH MAXIMUM RESULTS > 0

Constituent	Number of Samples	Result				Basin Plan Limit (ug/l)	CTR (ug/l)		Federal MCL (ug/l)		CA MCL (ug/l)	
		Minimum	Maximum	Average	Standard Deviation		Contin. Acute	4 Day Chronic	Primary	Secondary	Primary	Secondary
Hardness (mg/l as CaCO3)	58	11	262	133.93	53.53							
Ortho-phosphate (mg/l as P)	14	0	0.23	0.05	0.06							
pH (units)	40	6.4	8.8	7.57	0.61	6.5				6.5-8.5		
Alkalinity (mg/l as CaCO3)	30	56	225	136.73	40.77							
Arsenic (µg/l)	30	0.431	2.97	0.81	0.49	10	340	150	10		50	
Cadmium (µg/l)	30	0	0.138	0.01	0.03	0.22	2	0.25	5		5	
Calcium (mg/l)	38	15	50	29.66	9.44							
Chromium (µg/l)	30	0.66	36.4	4.09	7.14		550	180	100		50	
Copper (µg/l)	30	0.47	31.2	2.63	5.74	5.6	13	9	1300	1000	1300	1000
Dissolved Solids (mg/l)	63	38	317	172.49	64.56	125			500		500	
Hardness (mg/l as CaCO3)	8	54	222	108.00	57.45							
Iron (µg/l)	30	0	17775	1169.35	3468.98	300				300		300
Lead (µg/l)	30	0	6.34	0.37	1.18		65	2.5		15		15
Magnesium (mg/l)	38	4	37	15.82	7.48							
Manganese (µg/l)	30	0.23	443	31.11	86.83	50				50		50
Suspended Solids (mg/l)	58	0	680	40.75	111.64							
Zinc (µg/l)	30	0	45	3.11	8.61	16	120	120		5000		5000
Temperature °C	8	6	26	13.58	7.43	21.1						

Notes: (1) CTR values vary by hardness for freshwater life or lowest shown.
Blank spaces denote no current State or Federal value available.

Table 7-7
DWR STATION INFORMATION – ANALYTES WITH SAMPLE RESULTS EXCEEDING THE REPORTING LIMIT (>RL) BY ANALYTE

Constituent	Number of Samples	Result				Basin Plan Limit (ug/l)	Federal MCL (ug/l)		CA MCL (ug/l)	
		Minimum	Maximum	Average	Standard Deviation	Acute	Primary	Secondary	Primary	Secondary
Dissolved Aluminum (µg/L)	28	0.94	2572	151.87	484.78			50 – 200	1000	200
Dissolved Iron (µg/L)	28	0	1525	97.42	291.60	300		300		300
pH(units)	40	6.4	8.8	7.57	0.61	6.5		6.5-8.5		
Total Dissolved Solids (mg/l)	63	38	317	172.49	64.56	125		500,000		500,000
Temperature °C	8	6	26	13.58	7.43	21.1				

Blank spaces denote no current State or Federal value available.

Table 7-8
DWR STATION INFORMATION – ANALYTES WITH SAMPLE RESULTS EXCEEDING THE REPORTING LIMIT (>RL) BY STATION

Station Name	Parameter	Number of Samples	Minimum	Maximum	Average	Standard Deviation
Elder Creek at Gerber	Dissolved Iron (µg/l)	8	0	398	60.50	137.10
	pH (units)	9	6.6	8.8	7.66	0.73
	Total Dissolved Solids	12	110	317	186.58	52.08
Elder Creek at Henleyville	Total Dissolved Solids (mg/l)	3	148	239	179.67	51.42
Red Bank Creek at Rawson	Total Dissolved Solids (mg/l)	14	165	284	245.57	37.36
Reeds Creek at Red Bluff	Total Dissolved Solids (mg/l)	12	107	210	166.92	36.42
Thomes Creek at Hall Road	Dissolved Aluminus (µg/l)	7	30.5	2572	415.76	951.05
	Dissolved Iron (µg/l)	7	0	1525	246.93	563.91
	pH (Units)	7	6.4	8.1	7.06	.052
	Total Dissolved Solids (mg/l)	11	99	199	134.45	31.39
Thomes Creek at Paskenta	Total Dissolved Solids (mg/l)	9	65	276	112.00	64.82
	Temperature ºC	8	6	26	13.58	7.43

Table 7-9
USGS STATION INFORMATION –ANALYTES WITH SAMPLE RESULTS EXCEEDING THE REPORTING LIMIT (>RL) OR WITH MAXIMUM RESULTS > 0

Constituent	Number of Samples	Result			
		Minimum	Maximum	Average	Standard Deviation
Acid neutralizing capacity (mg/l as $CaCO_3$)	112	40	210	99.38	39.59
Ammonia (mg/l as N)	1	0.8	0.8	0.80	
Bicarbonate (mg/l)	399	49	286	143.47	53.57
Boron (mg/l)	399	0	400	62.53	74.98
Carbonate (mg/l)	356	0	19	3.13	3.85
Carbon dioxide (mg/l)	20	1.2	3.4	2.07	0.73
Calcium (mg/l)	95	4.6	99	33.45	15.26
Chloride (mg/l)	399	0	660	30.21	73.14
Dissolved oxygen (mg/l)	143	7.3	15	10.91	1.60
Hardness (mg/l as $CaCO_3$)	400	44	540	152.56	70.78
Iron (µg/l)	5	0	30	6.00	13.42
Magnesium (mg/l)	95	2	70	16.11	12.81
Nitrate (mg/l)	1	0.8	0.8	0.80	
Nitrate, No_3 (mg/l)	131	0	4.9	0.58	0.75
Manganese (µg/l)	30	0.23	443	31.11	86.83
Orthophosphate (mg/l as P)	23	0	0.02	0.01	0.01
pH (units)	439	7.4	8.8	8.22	0.26
Phosphorus (mg/l)	1	2.5	2.5	2.50	
Phosphate (mg/l)	21	0	3.5	0.40	0.94
Potassium (mg/l)	94	0.2	4.4	1.02	0.68
Sodium (mg/l)	401	2	232	17.33	28.52
Sulfate (mg/l)	89	1.9	95	21.87	19.92
Fluoride (mg/l)	29	0	0.2	0.10	0.08

Table 7-9 (cont.) USGS STATION INFORMATION –ANALYTES WITH SAMPLE RESULTS EXCEEDING THE REPORTING LIMIT (>RL) <u>OR</u> WITH MAXIMUM RESULTS > 0					
Constituent	Number of Samples	Result			
		Minimum	Maximum	Average	Standard Deviation
Silica (mg/l)	76	8.2	40	14.13	4.67
Specific conductance (ms/cm)	474	96	2420	352.00	250.98
Strontium (mg/l)	1	20	20	20.00	
Suspended sediment (%<0.063 mm) sieve	120	15	100	75.37	17.38
Suspended sediment (%<0.125 mm) sieve	113	18	100	80.99	15.41
Suspended sediment (%<0.25 mm) sieve	105	27	100	87.51	12.96
Suspended sediment (%<0.5 mm) sieve diameter	94	66	100	94.37	7.42
Suspended sediment (%<1 mm) sieve diameter	73	79	100	97.58	4.18
Suspended sediment (%<2 mm) sieve diameter	37	94	100	99.49	1.37
Suspended sediment (%<0.002 mm) fall diameter	138	1	65	22.75	10.50
Suspended sediment (%<0.004 mm) fall diameter	175	5	84	30.06	12.61
Suspended sediment (%<0.008 mm) fall diameter	161	8	94	40.29	14.61
Suspended sediment (%<0.016 mm) fall diameter	175	10	99	51.09	15.02
Suspended sediment (%<0.031 mm) fall diameter	161	11	99	61.01	14.66
Suspended sediment (%<0.063 mm) fall diameter	136	42	100	70.29	14.17
Suspended sediment (%<0.125 mm) fall diameter	133	46	100	79.47	12.20
Suspended sediment (%<0.25 mm) fall diameter	131	57	100	89.14	8.90
Suspended sediment (%<0.5 mm) fall diameter	119	80	100	96.65	4.21
Suspended sediment (%<2 mm) fall diameter	93	97	100	99.67	0.74
Suspended sediment concentration (mg/l)	634	0	44100	1218.62	3332.33
Suspended sediment discharge (tpd)	625	0	1520000	15910.75	79134.68
Temperature °C	816	0	55	11.14	6.35
Turbidity (JTU)	70	0	200	13.76	33.28
Turbidity (mg/l as SiO_2)	37	0	500	59.47	110.31
Turbidity (NTU)	24	0	800	40.54	162.91
Notes: CTR values vary by hardness					

Table 7-10 USGS STATION INFORMATION – PARAMETERS EXCEEDING THE REPORTING LIMIT (>RL)						
		Result				
Constituent	Number of Samples	Minimum	Maximum	Average	Standard Deviation	Basin Limit
Temperature °C	816	0	55	11.14	6.35	21.1
Turbidity (NTU)	24	0	800	40.54	162.91	150
Specific conductance (mS/cm)	474	96	2420	352.00	250.98	
pH (units)	439	7.4	8.8	8.22	0.26	8.5
Chloride (mg/l)	399	0	660	30.21	73.14	

Table 7-11 USGS STATION INFORMATION – PARAMETERS EXCEEDING THE REPORTING LIMIT (>RL) BY STATION						
Station Name	Parameter	Number of Samples	Minimum	Maximum	Average	Standard Deviation
Red Bank Creek near Red Bluff	pH (units)	39	8.1	8.6	8.36	0.13
Red Bank Creek at Rawson Rd. Bridge near Red Bluff	Temperature °C	286	1.7	31.1	10.36	3.09
Elder Creek near Paskenta	Temperature °C	113	1.1	31.1	11.96	6.21
	Specific conductance (mS/cm at 25 °C)	85	166	2420	613.09	444.53
	pH (units)	70	8	8.8	8.44	0.18
	Chloride (mg/l)	85	1.8	660	99.97	136.40
Elder Creek at Gerber	pH (units)	49	7.6	8.8	8.41	0.22
Thomes Creek at Paskenta	Temperature °C	303	0	55	12.07	8.99
	Turbidity (NTU)	24	0	800	40.54	162.91
	pH (units)	227	7.5	8.6	8.09	0.24
Notes: CTR values vary by hardness Blank spaces indicate no current state or federal value available.						

Table 7-12 POTENTIAL SOURCES AND CAUSES OF WATER QUALITY IMPAIRMENT		
Source of Contamination	**Pollutant or Stressor**	**Possible Sources**
General	Dissolved minerals	Mineral deposits, mineralized waters, hot springs, seawater intrusion
	Asbestos	Mine tailings, serpentinite formations
	Hydrogen sulfide	Subsurface organic deposits, such as peat soils in Delta islands
	Metals	Mine tailings
	Microbial agents	Wildlife
	Radon	Geologic formations
Commercial businesses	Gasoline	Service stations' underground storage tanks
	Solvents	Dry cleaners, machine shops
	Metals	Photo processors, laboratories, metal planting works
Municipal	Microbial agents	Sewage discharges, storm water runoff
	Pesticides	Storm water runoff; golf courses
	Nutrients	Storm water runoff
Industrial	SOCs industrial solvents, metals, acids	Electronics manufacturing, metal fabricating and planting, transformers, storage facilities, hazardous waste disposal
	Pesticides	Chemical formulating plants
	Wood preservatives	Plants that pressure treat power poles, wood pilings, railroad ties
Solid waste disposal	Solvents, pesticides, metals, organics, petroleum wastes, microbial agents, household waste	Disposal sites receive waste from a variety of industries, municipal solid wastes, petroleum products
Agricultural	Pesticides, fertilizers, concentrated mineral salts, microbial agents, sediment, nutrients	Tailwater runoff, agricultural chemical applications, fertilizer usage, chemical storage at farms and applicators; air strips, packing sheds and processing plants, dairies, feed lots, pastures
Disasters	Solvents petroleum products, microbial agents, other hazardous materials	Earthquake-caused pipeline and storage tank failures and damage to sewage treatment and containment facilities, major spills of hazardous materials, floodwater contamination of storage reservoirs and groundwater sources
Source: DWR 1998		

GROUNDWATER QUALITY

The primary sources of groundwater data in the watershed are from the RWQCB, DWR and USGS monitoring stations, and various reports compiled by DWR.

The Sacramento River Basinwide Water Management Plan was developed by DWR in 2003 as a comprehensive assessment of the occurrence, movement, and chemistry of groundwater in portions of the Sacramento Valley. The report contains an analysis of groundwater quality in the Sacramento Valley based primarily on existing data collected from DWR's groundwater quality monitoring wells and a generalized characterization by USGS.

In 1993, USGS evaluated the general water quality of the Redding Groundwater Basin. Approximately one-third of the Tehama West Watershed is located within this basin. The report concluded that for the majority of the basin groundwater quality was considered good to excellent for most uses. Areas of poor water quality are largely limited to the margins of the basin. In these areas, shallow wells within marine sedimentary rock of the Great Valley Sequence tend to have high salinity levels. For the central portions of the basin, the groundwater geochemistry is characterized as magnesium-calcium bicarbonate (DWR 2003).

In the Sacramento Valley Groundwater Basin water quality is generally characterized as calcium-magnesium bicarbonate. Isolated areas may contain sodium bicarbonate, calcium bicarbonate, and magnesium bicarbonate water types.

USGS Groundwater Data

Groundwater samples were collected sporadically in the study area from 1957 to 1997. Table 7-13 summarizes the analytical results obtained from these groundwater sampling events, presenting minimum, maximum, and average values for each constituent, as well as EPA, RWQCB, and California domestic limits for these constituents, where applicable. No constituents exceeded the California maximum contamination for drinking water.

DWR Groundwater Data

The groundwater chemistry in the watershed shows little variability. Groundwater samples were collected over a two month period in late 2000. Table 7-14 summarizes the analytical results obtained from these groundwater sampling events, presenting minimum, maximum, and average values for each constituent.

Due to the short time period of the sampling conducted by DWR, it is difficult to determine any water quality trends in the watershed. More studies are recommended so that water quality trends can be established.

RWQCB GeoTracker

GeoTracker is a geographic information system (GIS) maintained by the RWQCB that provides online access to environmental data. GeoTracker is the interface to the Geographic Environmental Information Management System (GEIMS), a data warehouse which tracks regulatory data about underground fuel tanks, fuel pipelines, and public drinking water supplies. GeoTracker and GEIMS were developed pursuant to a mandate by the California State Legislature to investigate the feasibility of establishing a statewide GIS for leaking underground fuel tank (LUFT) sites where groundwater contamination had occurred. GeoTracker contains well, tank, pipeline, and contamination site data from all of California. This makes it an important resource to both regulators and the public (SWRCB 2006). Table 7-15 shows the GeoTracker sites by contamination source located in the watershed.

Table 7-13 USGS GROUNDWATER QUALITY DATA, MULTIPLE LOCATIONS						
Constituent	**Number of Samples**	**Minimum**	**Maximum**	**Average**	**California Primary MCL (ug/l) (c)**	**California Secondary MCL (ug/l) (d)**
Metals (measured in ug/l)						
Aluminum	51	1	250	50	1000	200
Arsenic	70	0	10	1.2	50	
Boron	243	1	2100	163.3		
Chromium (total)	27	1	10	1.2	50	
Copper	39	1	60	11.6	1300	1000
Iron	120	0	610	75.7		300
Manganese	43	0	190	11.1		50
Zinc	38	0	750	78.7		5000
Other Constituents (measured in mg/l unless otherwise noted)						
Bicarbonate	228	74	550	181.1		
Calcium	322	2.5	99	26.3		
Carbon dioxide	228	0.3	152	14.1		
Carbonate	191	1	10	0.6		
Chloride	360	1.1	100	15.4		250,000
Fluoride	162	0	10	0.2	2000	
Hardness (a)	284	36	540	149.1		
Magnesium	321	1.6	106	17.5		
Nitrate	224	0	50	9.6	45,000	
pH (b)	84	6.4	8.3	7.5		6.5 – 8.5
Potassium	272	0.3	8	1.4		
Silica	185	12	74	38		
Sodium	344	4.4	98	18.5		
Sulfate	301	0.2	66	11.9		250,000

Source: USGS 2005
Notes: (a) Hardness is in mg/L CaCO3
(b) pH is measured in pH units
(c) Taste and odor
(d) If not shown, no number or limit available.

Table 7-14 DWR GROUNDWATER QUALITY DATA, MULTIPLE LOCATIONS				
Constituent (a)	**Number of Samples**	**Minimum**	**Maximum**	**Average**
Dissolved Calcium	12	7	67	29.1
Dissolved Chloride	12	3	50	14.2
Dissolved Magnesium	12	7	63	21.3
Dissolved Nitrate	12	3.2	25.8	10.1
Dissolved Potassium	12	0.8	3.4	1.4
Dissolved Sodium	12	8	98	27.3
Dissolved Sulfate	12	<1	54	15.7
Electrical Conductivity (b)	12	179	936	407.8
pH (c)	12	6.8	7.8	7.2
Hardness (c)	12	50	427	160.2
Total Copper	12	0.001	0.072	0.01
Total Dissolved Solids	13	112	520	248.5
Total Iron	12	0.01	0.36	0.08
Total Phosphorus	12	0.03	0.21	0.08
Total Zinc	12	0.007	3.15	0.37

Source: DWR 2005
Notes: (a) Most constituents measured in mg/l, unless otherwise noted
(b) EC measured in uS/cm at 25ºC
(c) pH measured in pH units
(d) Hardness is in mg/l CaCO3

Table 7-15 GEOTRACKER SITE SUMMARY			
Type	**Town**	**Number**	**Status**
LUFT (Leaking Underground Fuel Tank)	Paskenta	1	Open with RWQCB
	Corning	6	Open with RWQCB
	Red Bluff	9	Open with RWQCB
	Proberta	1	Open with RWQCB
	Gerber	1	Open with RWQCB
SLIC (Spills, Leaks, Investigation, and Cleanup)	Corning	5	Open with RWQCB
	Red Bluff	7	Open with RWQCB
	Richfield	1	Open with RWQCB
Landfill	Red Bluff	8	Open with RWQCB
	Corning	4	Open with RWQCB
	Paskenta	1	Open with RWQCB
Source: SWRCB 2006 Note: Open status implies active groundwater contamination without resolution.			

Groundwater Quality Summary

DWR and USGS monitoring stations have recorded constituents that have exceeded their limits at several monitoring sites in the watershed. Overall, groundwater quality in the watershed is good. However, it is recommended that further studies be conducted to monitor groundwater quality.

WATER QUALITY ISSUES

Ag Waivers

The RWQCB regulates discharges of waste primarily though issuance of Waste Discharge Requirements (WDRs) and National Pollutant Discharge Elimination System (NPDES) permits.

The requirement for WDRs may be waived by a RWQCB for a specific discharge or type of discharge where such a waiver is not against the public interest. On March 26, 1982 the RWQCB adopted Resolution No. 82-036, *Waiving Waste Discharge Requirements for Specific Types of Discharge*. The resolution listed 23 categories of waste discharges, including irrigation return flows and stormwater runoff from agricultural lands, and the conditions required to comply with the waiver. In 1999, Senate Bill 390 was adopted and changed waiver authorizations. As a result of the changes, all waivers in place on January 1, 2000 would sunset January 1, 2003 if the Regional Board had not readopted them. This change in the law meant that the 1982 waiver, which included irrigation return flows and stormwater runoff from agricultural lands in the Central Valley, would sunset. Additionally, waivers could no longer exceed five years in duration. In November 2000, an environmental organization submitted a petition asking the RWQCB to rescind the waiver and use WDRs to control discharges of pesticides from irrigated lands (RWQCB 2003b). In December 2002 the RWQCB adopted a revised waiver. The waiver is based on a watershed approach that depends on coalition groups to evaluate risks and conduct surface water sampling. The Tehama West Watershed lies within the area of the Sacramento Valley Coalition Group headed up by Northern California Water User

Association (Coalition). The Coalition has completed the submittal of initial watershed information, and conducted sampling. Only one sampling location was located in the Tehama West Watershed. The sample was taken on Burch Creek at Woodson Avenue.

Coalition and subwatershed monitoring data collected from July 2004 through January 2005 were compared to applicable narrative and numeric water quality objectives in the Basin Plan and the California Toxics Rule. Statistically significant toxicity was observed in four water quality samples collected during the January 2005 sample event including Burch Creek at Woodson. The observations of toxicity to *Ceriodaphnia* and *Selenastrum* were considered exceedances of the Basin Plan narrative objective for toxicity. The results were reported to the RWQCB by the Coalition in two Communication Reports dated February 3 and February 9, 2005, as required by the Conditional Waiver and the Coalition's Monitoring and Reporting Program Plan (MRPP). Each of the three samples was retested to determine whether toxicity was persistent in the original sample, and new samples were collected from the same sites and retested to evaluate the duration of toxicity in the water body. The retested samples did not reveal significant or persistent toxicity. The results of the testing of the Burch Creek Samples are summarized in Table 7-16. Diazinon was detected at 0.316 μg/l in the Burch Creek January 26, 2005 sample. No other pesticides were detected in the Burch Creek sample.

Although the results for Burch Creek do not provide definitive proof that diazinon was the cause of toxicity to *Ceriodaphnia* in the initial Burch Creek sample, the data support diazinon as a likely cause of at least some portion of the toxicity. Application of dormant spray pesticides in this drainage in the dry period prior to sampling are a probable source of the diazinon detected in the Burch Creek sample collected January 26, 2006. The more rapid and complete mortality observed in the February 2, 2005 follow up sample, suggests that diazinon concentrations may have been higher in the later sample, although other causes of toxicity cannot be ruled out in this case. Other potential sources of toxicants (in addition to agricultural sources) in this drainage include runoff from a fairly dense area of rural housing, a solid waste management facility and truck stop facilities. These other sources complicate the process of identifying the primary source of toxicity in samples from the current Burch Creek site.

In response to Burch Creek toxicity, growers in the Burch Creek drainage were contacted and participated in reviewing drafts of the Coalition's initial reports. Growers in the subwatershed have surveyed the drainage area upstream of the Burch Creek monitoring site to better understand the nature of the current land uses. This survey revealed a mixed-use landscape, including rural residential housing, a waste management facility and a truck stop facility. The survey also identified a potential alternative upstream sampling site that may be used if needed to isolate potential sources of toxicity or exceedances of numeric objectives. The Tehama County Agricultural Commissioner's Department also performed a qualitative analysis of land and typical pesticide use trends in this drainage area.

Because pesticide usage is a likely source of the observed toxicity, the Coalition evaluated pesticide use trends in the subwatershed (including Tehama West). These are shown in Table 7-17.

Table 7-16 EXCEEDANCES FOR TOXICITY BURCH CREEK AT WOODSON AVE				
Site and Sample Description	**Sample Date**	**Parameter**	**Result (1)**	**Objective Exceeded**
Initial sample	01/26/05	Ceriodaphnia	20% survival*	Toxicity (Narrative)
Initial sample	01/26/05	Diazinon	0.316 µg/l	Non-regulatory limit
Retest of initial sample at 5 days	01/26/05	Ceriodaphnia	85% survival	Toxicity (Narrative)
Follow-up sample	02/02/05	Ceriodaphnia	0% survival	Toxicity (Narrative)
Note: An asterisk indicates that the result is statistically significant at the 95% confidence level.				

Table 7-17 TRENDS IN SHASTA/TEHAMA SUBWATERSHEDS 2000-2003					
Applied Pesticide	**2000(1)**	**2001**	**2002**	**2003**	**Trend**
Azinphos-methyl	1,580	1,182	167	350	Down
Carbofuran	0	0	0	0	No trend
Chlorpyrifos	11,820	11,640	15,301	12,099	No trend
Diazinon	3,233	3,864	5,006	5,051	Up
Malathion	3,420	3,332	10,561	5,390	No trend
Methyl Parathion	0	262	0	0	No trend
Note: Tabled values are total annual pounds of active ingredient applied per Coalition Subwatershed, as reported in the California Department of Pesticide Regulation PUR Database (2004).					

Landslides

Although BMP and general land use practices have improved significantly, sediment continues to be generated for the upland areas and from bank instability in the transition zones. USFS landslide mapping was included as Figure 7-3.

Pesticide Use

Based on the increasing interest in pesticide use and potential for water quality impacts, the Department of Pesticide regulation databases were queried for the Tehama West Watershed. The pesticide data is available on a county and section basis. Actual field tracking is not yet implemented in Tehama County. Pesticide use by watershed sub-unit for the year 2003 is included on Table 7-19 and shown on Figure 7-4. The purported source of contaminated stormwater runoff under the Ag Waiver program is dormant spray from orchard croplands. A summary of cropland acres (irrigated acres) by watershed sub-unit from 2004 Tehama County parcel records is included as Table 7-20 and shown on Figure 7-5.

The top 50 crops by pesticide use, in gross pounds and acres treated, from the DPR PAN data set for Tehama County in 2003 are shown in Table 7-20. Non–agricultural uses are included and marked as (non-ag). The top 50 pesticides in Tehama County are included in Table 7-21 in order of amount used (gross pounds) from a DPR PAN data set for Tehama County, 2003. Both data sets are for the County of Tehama, not just the Tehama West Watershed area.

Municipal Stormwater Runoff

Municipal runoff from roads, parking facilities, sidewalks, buildings, rooftops, and other impervious surfaces can transport trash, debris, metals, hydrocarbons, and fecal matter that pollute receiving streams. Lawns and other landscaped areas may also contaminate runoff with nutrients, fertilizers, and suspended solids. Agricultural runoff may carry nutrients, animal wastes, sediment, salts, pesticides, fertilizers, and other ingredients that may be harmful in high concentrations. High concentrations of nutrients, for example, can stimulate excessive or undesirable forms of aquatic growth such as algae and noxious weeds. These plants may consume oxygen faster than natural processes can produce it, and as a result, fish and lower species in the food chain may be destroyed. Nutrient enrichment can also drive up the pH levels in water through increased photosynthetic activity. Animal wastes can accelerate the production of algae and contaminate water used for fishing, swimming, and drinking with related microorganism pathogens (Office of Infrastructure 2006).

The most common contaminants in runoff are heavy metals, inorganic salts, aromatic hydrocarbons and suspended solids that accumulate on the road surface as a result of regular highway operation and maintenance activities. Salting and sanding practices, for example, may leave concentrations of chloride, sodium, and calcium on the roadway surface. Ordinary operations and the wear and tear of our vehicles also result in the dropping of oil, grease, rust, hydrocarbons, rubber particles, and other solid materials on the highway surface. These materials are often washed off the highway during rain or snow storm events.

Receiving surface and groundwaters are susceptible to contamination from all these sources. Contamination of groundwater tends to occur gradually because contaminants percolate downward through the soil at slow rates. Highway runoff that soaks into soil with or without the presence of any type of vegetation, channel, or basin is usually harmless to the environment. Surface waters (streams, rivers, ponds, and lakes) are particularly vulnerable because they are directly exposed to contaminants released into the air and to direct discharges from point or non-point sources. Excessive concentrations of these microorganisms can prevent receiving waters from being used for certain water supply and/or recreational activities.

Table 7-18
APPLICABLE WATER QUALITY OBJECTIVES AND METHOD DETECTION LIMITS FOR ANALYTES MONITORED IN THE AGRICULTURAL WAIVER PROGRAM AT THE BURCH CREEK SITE

Basin Plan Objectives					
Analyte	**Units**	**MDL**	**WQO**	**WQO Basis**	**Application**
Temperature	°F	NA	narr.	<°F increase above natural	All waters designated WARM or COLD
Dissolved Oxygen	mg/l	NA	7.0 5.0 7.0	Minimum Minimum Minimum	Sacramento River below the I Street Bridge waters designated WARM waters designated COLD
PH	$-\log[H^+]$	NA	6.5-8.5	"appropriate averaging period" protective of beneficial uses	All waters
Conductivity	µmhos/cm	NA	230 235	50th percentile 95th percentile	Sacramento River above Colusa Basin Drain
			240 340	50th percentile 95th percentile	Sacramento River at I Street Bridge
			150	90th percentile	Feather River Basin
Color	CU	2	narr.	NA	All waters
Hardness as $CaCO_3$	mg/l	3	none	NA	NA
Nitrate	mg/las N		10	Maximum	All waters designated MUN
Turbidity	NTU	0.1	narr.	NA	All waters
Total Dissolved Solids (TDS)	mg/l	6	125	90th percentile	American River basin
Total Suspended Solids (TSS)	mg/l	2	narr.	NA	All waters
E. Coli bacteria	MPN/100ml	2	126 235	5-sample geo. Mean; Single sample max	Waters designated REC-1 Waters designated REC-1

Table 7-18 (cont.)
APPLICABLE WATER QUALITY OBJECTIVES AND METHOD DETECTION LIMITS FOR ANALYTES MONITORED IN THE AGRICULTURAL WAIVER PROGRAM AT THE BURCH CREEK SITE

Other Objectives					
Analyte	**Units**	**MDL**	**WQO**	**WQO Basis**	**Application**
Ammonia	mg/l			PH and temperature dependent; 30-day avg., 4-day avg., and 1-hour avg.	USEPA 1999
Azinphos-methyl	μg/l	0.01	0.01	Instantaneous max	USEPA 1976
Carbofuran	μg/l	0.25	0.5	Instantaneous max	Menconi and Gray 1992 (CDFG)
Chlorpyrifos	μg/l	0.005	0.014 0.02	4-day average 1-hour maximum	Siepmann and Finlayson 2000 (CDFG)
Diazinon	μg/l	0.005	0.05(1) 0.08(1)	4-day average 1-hour maximum	Siepmann and Finlayson 2000 (CDFG)
Malathion	μg/l	0.005	0.1	Instantaneous max	USEPA 1999
Parathion, Methyl	μg/l	0.01	0.08	Instantaneous max	Menconi and Harrington 1992 (CDFG)
Monitored Analytes Without Objectives					
Analyte	**Units**	**MDL**	**WQO**	**WQO Basis**	**Application**
Total Organic Carbon (TOC)	mg/l	0.3	none	NA	NA
Dissolved Organic Carbon (DOC)	mg/l	0.3	none	NA	NA
Ultraviolet Absorbance at 254nm	cm^{-1}	NA	none	NA	NA

Notes: MDL – Method Detection Limit
WQO – Water Quality Objective

Table 7-19
PESTICIDE USE BY SUB-UNIT

Watershed Sub-unit	Pesticide Use (pounds/acre/year)
Burch	78,567
Dibble	237
Elder	31,643
Jewett	67,853
Oat	122,428
Red Bank	11,949
Reeds	30
Spring	17,863
Thomes	56,595

Table 7-20
IRRIGATED ACRES BY SUB-UNIT

Watershed Sub-unit	Acres
Burch	11,414
Dibble	139
Elder	15,410
Jewett	12,978
Oat	40
Red Bank	6,146
Reeds	10,685
Spring	650
Thomes	12,654

CONCLUSIONS AND RECOMMENDATIONS

- Encourage voluntary landowner participation in educational opportunities such as water quality short courses, field demonstrations, participation in citizen monitoring program activities, and distribution of water quality "fact sheets."

- Develop a strong road design and management element to assist landowner recognition of road erosion problems and their solutions

- Pursue grant funding or cost-share payments for landowners to inventory, prepare plans, and implement best-management practices that reduce water quality impacts.

- Evaluate the effectiveness of vegetation management alternatives to manage seasonal surface runoff and underflow. Evaluate the effectiveness of reducing brush to increase flows in springs and creeks.

- Offer livestock and small animal operators increased opportunities to participate in voluntary cooperative water quality short courses to help livestock operators understand the possible sources of livestock impacts to water quality.

Table 7-21 TOP 50 CROPS AND SITES FOR ALL CHEMICALS USED IN TEHAMA COUNTY					
Crop or Site	**Gross Pounds**[1]	**Application Rate (lbs/acre treated)**	**Acres Planted**	**Acres Treated**	**Number of Applications**
All Sites	630,900	2.27	80,919	245,292	10,807
Walnuts	253,764	2.45	16,066	97,341	4,214
Prunes	122,475	2.96	8,744	41,312	1,096
Almonds	89,030	1.74	7,755	51,308	1,062
Outdoor Propagation Nursery	31,155	49.2	256.7	632.8	100
Right of Way (non-ag)	27,038	0.86	180.0	290.0	455
Wine Grapes	21,621	13.1	191.1	1,645	68
Aquatic Area (non-ag)	17,997	8.76	1.50	273.8	20
Olives	17,502	0.98	4,930	17,908	743
Commodity Fumigation (non-ag)	8,235	-	-	-	28
Alfalfa for Forage	7,752	0.71	3,688	10,963	204
Public health pest Control (non-ag)	5,634	-	-	-	61
Forests	4,970	1.70	24,675	2,881	70
Rice	3,366	11.1	358.1	304.1	6
Beans	3,102	1.10	1,160	2,828	53
Figs	3,038	20.2	150.0	150.0	2
Wheat	2,332	0.55	2,282	4,203	59
Oats	1,941	0.66	3,122	2,954	71
Structural Pest Control (non-ag)	1,160	-	-	-	1,864
Uncultivated Agricultural Area (non-ag)	1,133	0.77	803.0	1,475	105
Other Fumigation (non-ag)	1,021	-	-	-	6
Sunflowers	1,003	2.45	245.0	409.0	7
Landscape (non-ag)	947.5	-	-	-	234
Peaches	732.1	4.50	50.5	162.8	39
Oranges	708.5	7.09	25.0	100.0	10
Corn for Forage	705.4	0.55	790.5	1,286	34
Barley	536.5	0.73	796.0	738.0	8
Pistachios	382.5	0.59	138.5	645.0	31

Table 7-21 TOP 50 CROPS AND SITES FOR ALL CHEMICALS USED IN TEHAMA COUNTY					
Crop or Site	**Gross Pounds[1]**	**Application Rate (lbs/acre treated)**	**Acres Planted**	**Acres Treated**	**Number of Applications**
Squash	302.8	4.92	31.0	61.5	6
Rangeland	286.9	0.07	2,951	4,006	16
Pasture	283.7	0.75	796.0	376.0	13
Dried Beans	143.8	0.55	123.0	261.0	6
Pecans	142.2	0.81	136.0	176.0	10
Nectarines	135.8	5.22	4.00	26.0	10
Apples	97.6	3.88	11.9	25.2	14
Plums	70.7	0.42	187.6	170.1	9
Grains	46.9	0.47	60.0	100.0	5
Sudangrass for Forage	38.4	1.92	20.0	20.0	1
Non-Agricultural Areas	31.1	0.70	8.00	44.5	10
Apricots	21.2	2.65	4.00	8.00	2
Greenhouse Propagation	18.4	-	-	-	17
Irrigation Systems	16.3	-	-	-	2
Melons	10.9	0.23	30.0	48.0	3
Outdoor Flower Nursery	8.91	1.75	7.50	5.10	4
Watermelons	6.15	0.09	66.0	66.0	2
Strawberries	5.86	0.41	9.10	14.2	7
Cucumbers	5.12	0.09	56.0	55.0	1
Blueberries	5.01	1.25	4.90	4.00	1
Pumpkins	1.58	0.26	3.00	6.00	1
Cherries	0.75	0.75	1.00	1.00	1
[1] Includes: herbicides, pesticides, rodenticides and fungicides					

Table 7-22 TOP 50 PESTICIDES USED ON ALL SITES IN TEHAMA COUNTY 2003					
Chemical Name	**Chemical Class**	**Gross Pounds**	**Application Rate (lbs/acre treated)**	**Acres Planted**	**Acres Treated**
All Chemicals		630,900	2.27	80,919	245,292
Copper hydroxide Uses: Fungicide, Microbiocide, Nematicide	Inorganic-Copper	140,006	4.83	15,501	28,962
Mineral oil Uses: Insecticide, Adjuvant	Petroleum derivative	88,081	20.7	4,390	4,265
Glyphosate, isopropylamine salt Uses: Herbicide	Phosphonoglycine	47,602	0.84	46,021	49,475
Sulfur Uses: Fungicide, Insecticide	Inorganic	46,981	11.1	3,102	4,230
Maneb Uses: Fungicide	Dithiocarbamate	45,664	1.76	13,503	25,937
Methyl bromide Uses: Fumigant, Insecticide, Herbicide, Nematicide	Halogenated organic	39,026	34.1	2,476	648.3
Petroleum oil, unclassified Uses: Insecticide, Herbicide, Fungicide, Adjuvant	Petroleum derivative	28,357	10.1	3,851	2,797
Copper sulfate (pentahydrate) Uses: Algaecide, Fungicide, Insecticide, Water Treatment, Molluscicide	Inorganic-Copper	27,002	16.0	401.1	347.1
1.3-dichloropropene Uses: Fumigant, nematicide	Halogenated organic	18,757	319.5	194.0	58.7
Diuron Uses: Herbicide	Urea	14,198	1.56	5,911	2,866
Chloropicrin Uses: Fumigant, Nematicide	Unclassified	11,619	20.2	1,204	573.9
Chlorpyrifos Uses: Insecticide, Nematicide	Organophophorus	11,497	1.30	10,622	8,863
Propargite Uses: Insecticide	Unclassified	9,982	1.57	9,482	6,370
Ziram Uses: Fungicide, Microbiocide, Dog and Cat Repellent	Dithiocarbamate, Inorganic-Zinc	9,312	5.26	2,152	1,769
2,4-D, dimethylamine salt Uses: Herbicide	Clorophenoxy	8,494	0.70	12,924	10,830
Captan Uses: Fungicide	Thiophthalimide	7,607	2.47	4,223	3,076
Propylene oxide Uses: Fumigant	Alcohol/Ether	7,240	-	-	-
Paraquat dichloride Uses: Herbicide	Bipyridylium	6,372	0.91	9,726	7,002
Malathion Uses: Insecticide	Organophosphorus	5,564	2.19	3,330	2,452

Table 7-22 TOP 50 PESTICIDES USED ON ALL SITES IN TEHAMA COUNTY 2003					
Chemical Name	**Chemical Class**	**Gross Pounds**	**Application Rate (lbs/acre treated)**	**Acres Planted**	**Acres Treated**
Petroleum distillates Uses: Insecticide, Adjuvant, Solvent	Petroleum derivative	5,371	-	-	-
Diazinon Uses: Insecticide	Organophosphorus	5,331	1.44	4,652	3,602
Simazine Uses: Herbicide	Triazine	4,805	1.68	5,651	2,605
Phosmet Uses: Insecticide	Organophosphorus	3,448	1.97	3,473	1,747
Hexazinone Uses: Herbicide	Triazinone	3,289	1.37	10,982	2,402
Solvent naphtha (petroleum), light aromatic Uses: Solvent, Insecticide	Petroleum derivative	3,284	1.20	3,589	2,729
Lime-sulfur Uses: Insecticide, Fungicide	Inorganic	3,060	25.5	144.2	120.2
Dicofol Uses: Insecticide	Organocholorine	2,159	1.22	2,826	1,767
Oryzalin Uses: Herbicide	2,6-Dinitroaniline	1,747	2.16	1,587	620.5
Ethephon Uses: Plant Growth Regulator	Organophosphorus	1,738	1.01	2,480	1,709
Cyrodinil Uses: Fungicide		1,597	0.23	8,333	7,070
Oxyfluorfen Uses: Herbicide	Diphenyl ether	1,538	0.10	17,442	14,315
Acrolein Uses: Algaecide	Aldehyde	1,397	-	-	-
Pendimethalin Uses:Herbicide	2,6-Dinitroaniline	1,289	1.74	1,721	668.6
Methidathion Uses: Insecticide	Organophosphorus	1,077	1.53	905.9	705.9
Sodium chlorate Uses: Defoliant, Herbicide, Micorbiocide	Inorganic	996.5	3.57	279.0	279.0
MCPA, dimethylamine salt Uses: Herbicide	Chlorophenoxy acid or ester	870.1	0.82	1,231	1,055
Iprodione Uses: Fungicide	Dicarboximide	844.6	0.49	1,951	1,7147
Norflurazon Uses: Herbicide	Pyridazinone	737.6	0.93	963.1	783.8
Triclopyr, butoxyethyl ester Uses: Herbicide	Chloropyridinyl, Glycol Ether	716.6	0.18	2,715	885.0
Thiophanate-methyl Uses: Fungicide	Benzimidazole precursor	646.7	0.85	765.9	745.0
Azoxystrobin Uses: Fungicide	Strobin	611.2	0.15	3,911	4,170

Table 7-22 TOP 50 PESTICIDES USED ON ALL SITES IN TEHAMA COUNTY 2003					
Chemical Name	**Chemical Class**	**Gross Pounds**	**Application Rate (lbs/acre treated)**	**Acres Planted**	**Acres Treated**
Carbon dioxide Uses: Fumigant, Insecticide, Rodenticides	Inorganic	583.1	-	-	-
Trifuralin Uses: Herbicide	2,6-Dinitroaniline	571.7	1.87	653.7	306.0
Permethrin Uses: Insecticide	Pyrethroid	551.6	0.18	3,230	2,518
Aluminum phosphide Uses: Fumigant, Fungicide	Inorganic	495.1	0.06	2,206	451.6
EPTC Uses: Herbicide	Thiocarbamate	476.0	2.60	183.0	183.0
Methomyl Uses: Insecticide, Breakdown product	N-Methyl Carbamate	475.1	0.47	1,605	1,010
Metam-soldium Uses: Fumigant, Herbicide, Fungicide, Microbiocide, Algaecide	Dithiocarbamate	414.6	-	-	-
2,4-D,2-ethylhexyl ester Uses: Herbicide	Chlorophenoxy acid or ester	394.5	1.85	3,239	213.0

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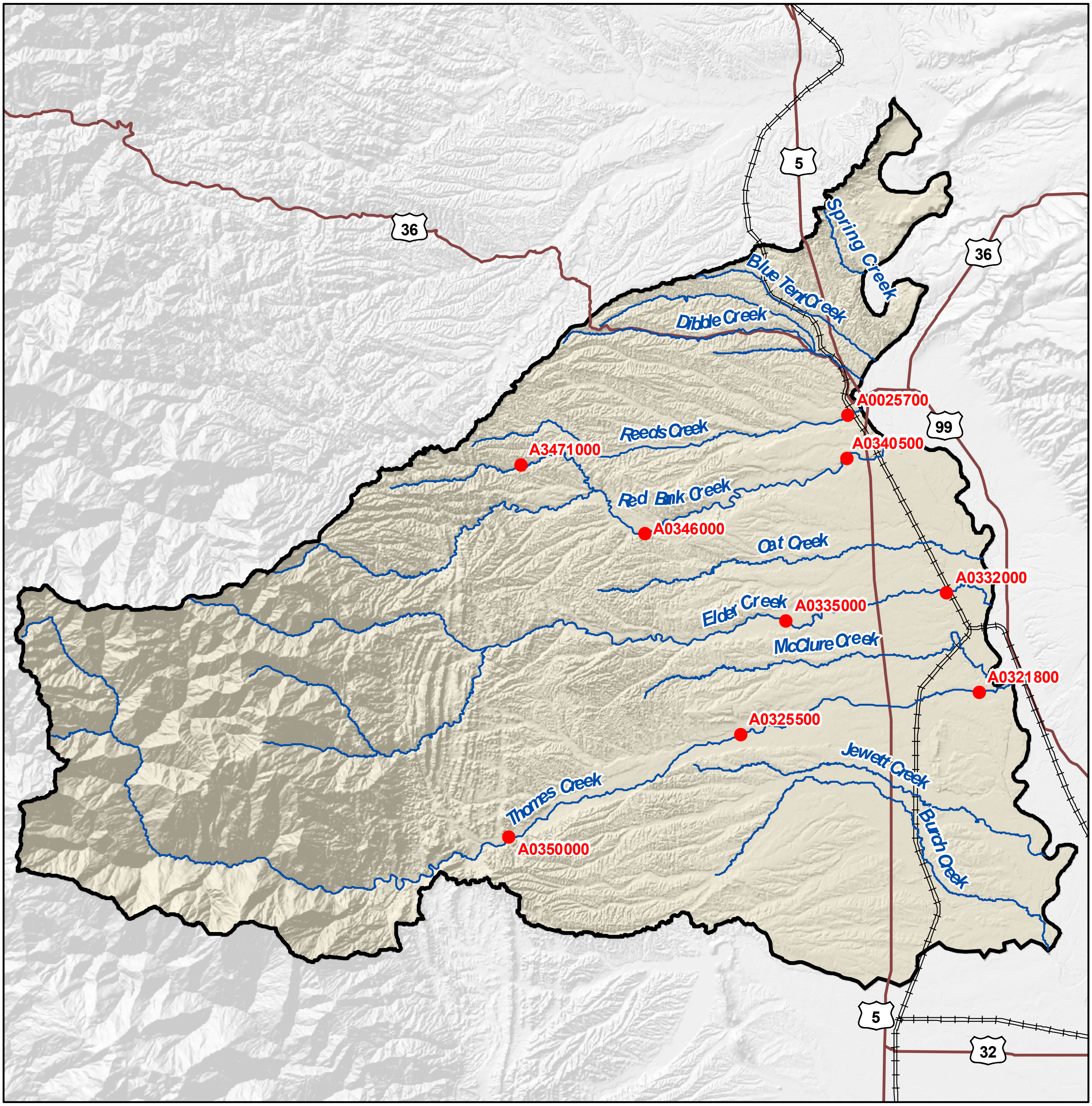


Legend

- Railroad
- Major Highway
- Major Tributary
- DWR Station
- Tehama West Watershed

N
W E
S

0 2.5 5 10 Miles

VESTRA

FIGURE 7-1
DWR STATIONS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF WATER RESOURCES, 2005

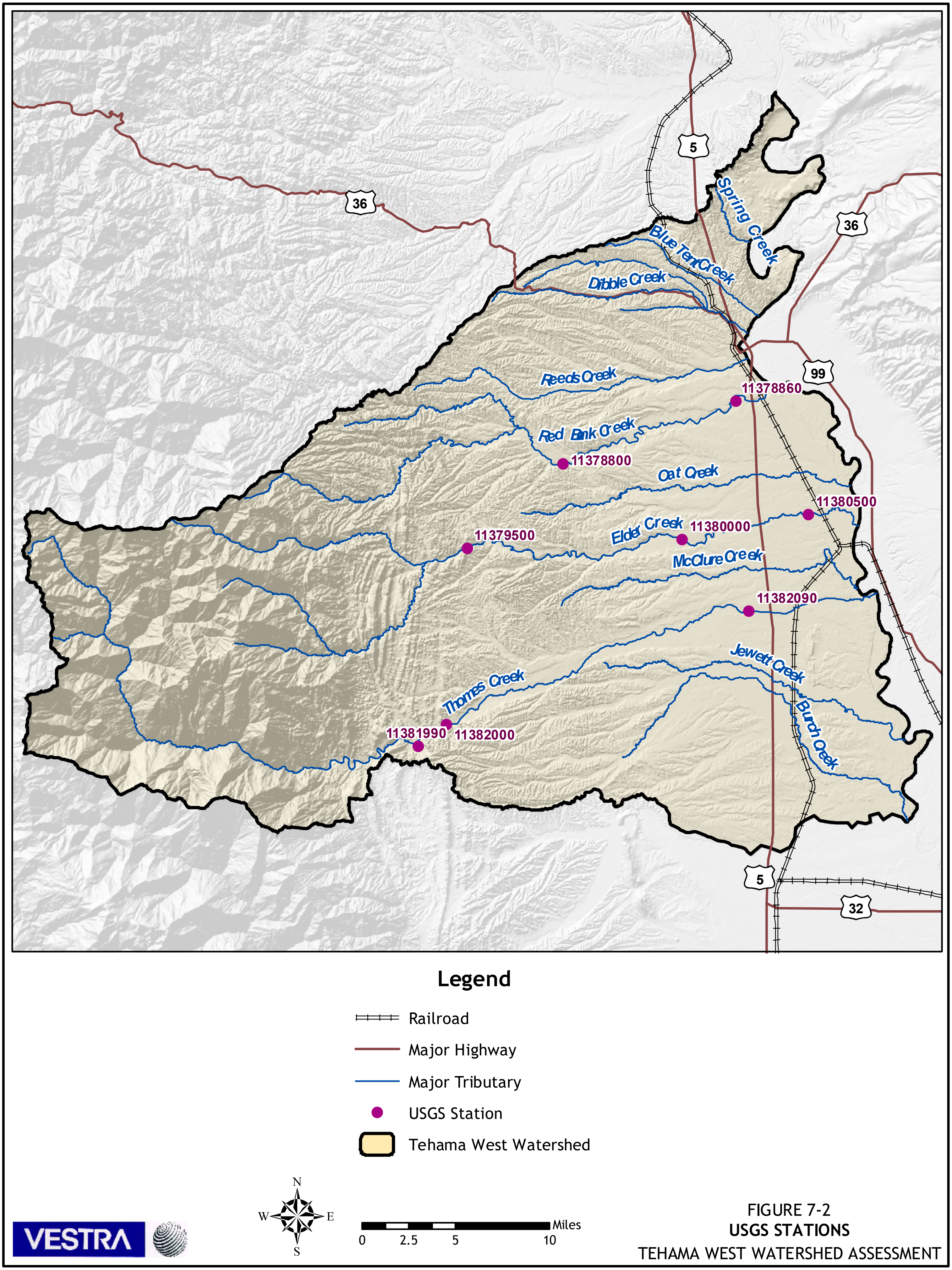
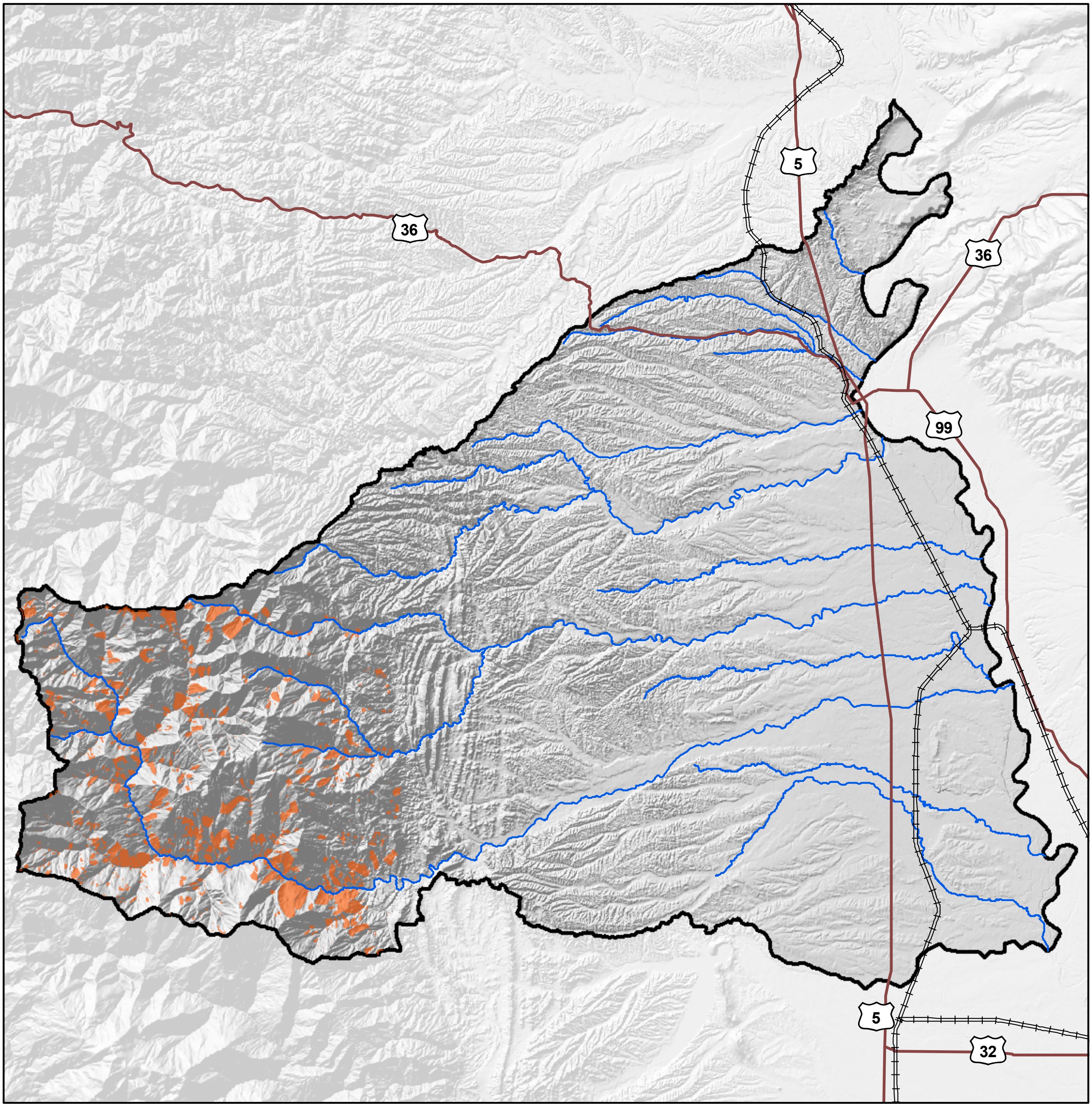


FIGURE 7-2
USGS STATIONS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF WATER RESOURCES, 2005



Legend

Railroad

Major Highway

Major Tributary

Tehama West Watershed

Landslide Boundary (Mendocino National Forest only)

N
W
E
S

0 2.5 5 10 Miles

VESTRA

FIGURE 7-3
LANDSLIDES - MENDOCINO NATIONAL FOREST
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: UNITED STATES FOREST SERVICE, MENDOCINO NATIONAL FOREST, 2003

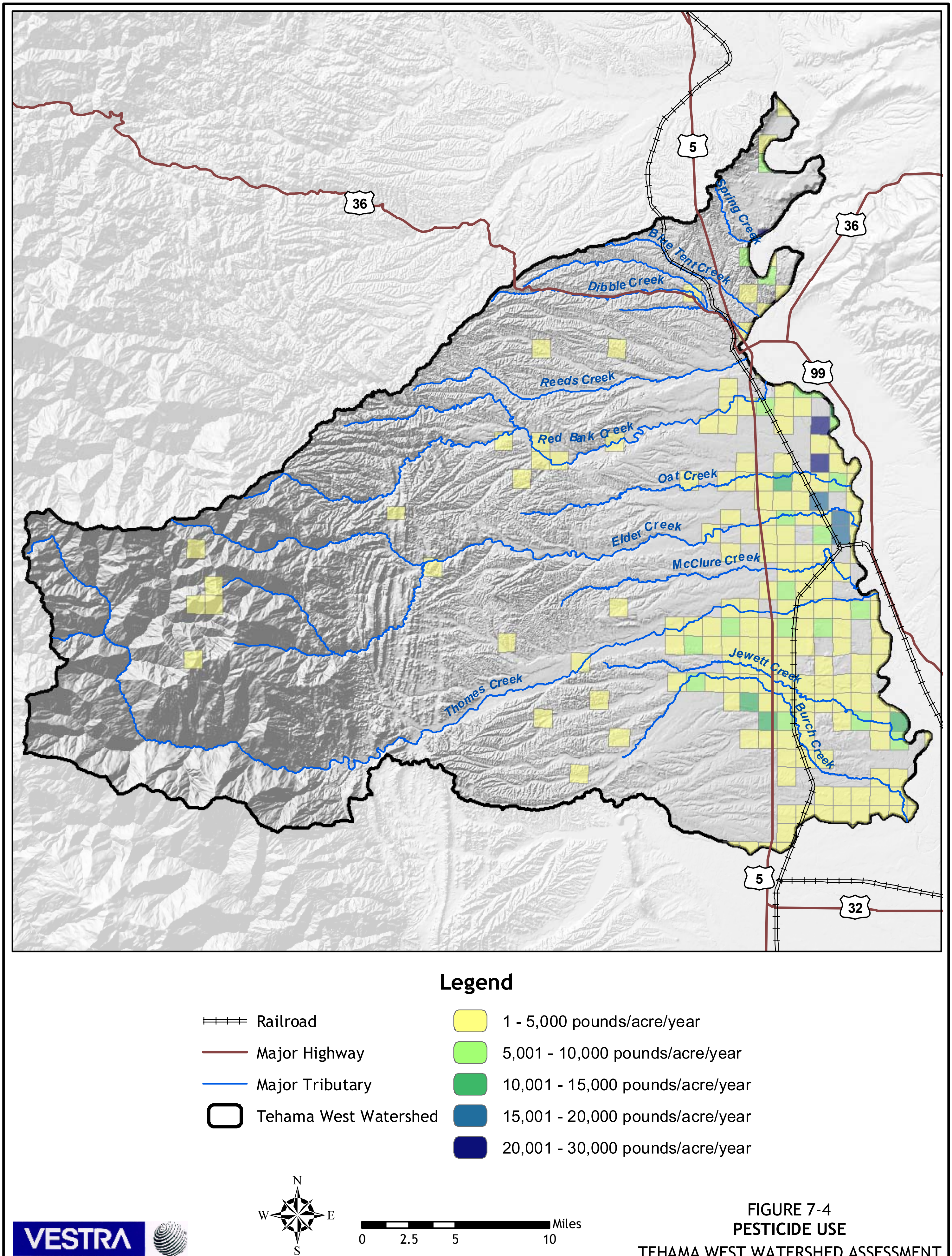
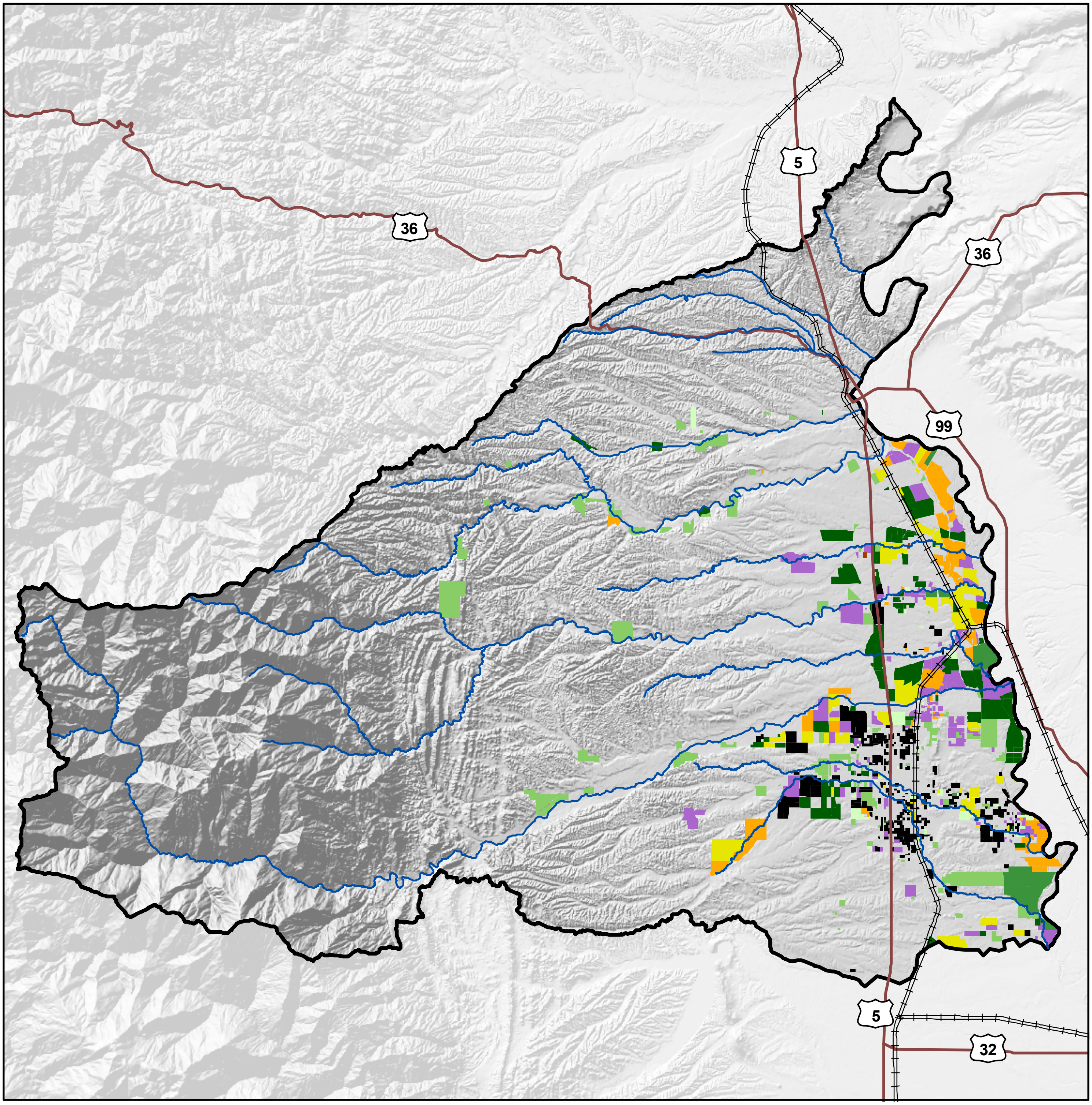


FIGURE 7-4
PESTICIDE USE
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF PESTICIDE REGULATION, 2004



Legend

Railroad	Field Crops - Irrigated
Major Highway	Row Crops - Irrigated
MajorTributary	Irrigated Olive Orchard
Field Crops	Irrigated Prune Orchard
Orchard	Irrigated Walnut Orchard
	Irrigated Almond Orchard
	Irrigated Misc. Orchard
	Vine and Bush Fruits - Irrigated

VESTRA

N W E S

0 2.5 5 10 Miles

FIGURE 7-5
IRRIGATED ACRES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY, 2005

OCTOBER 2005

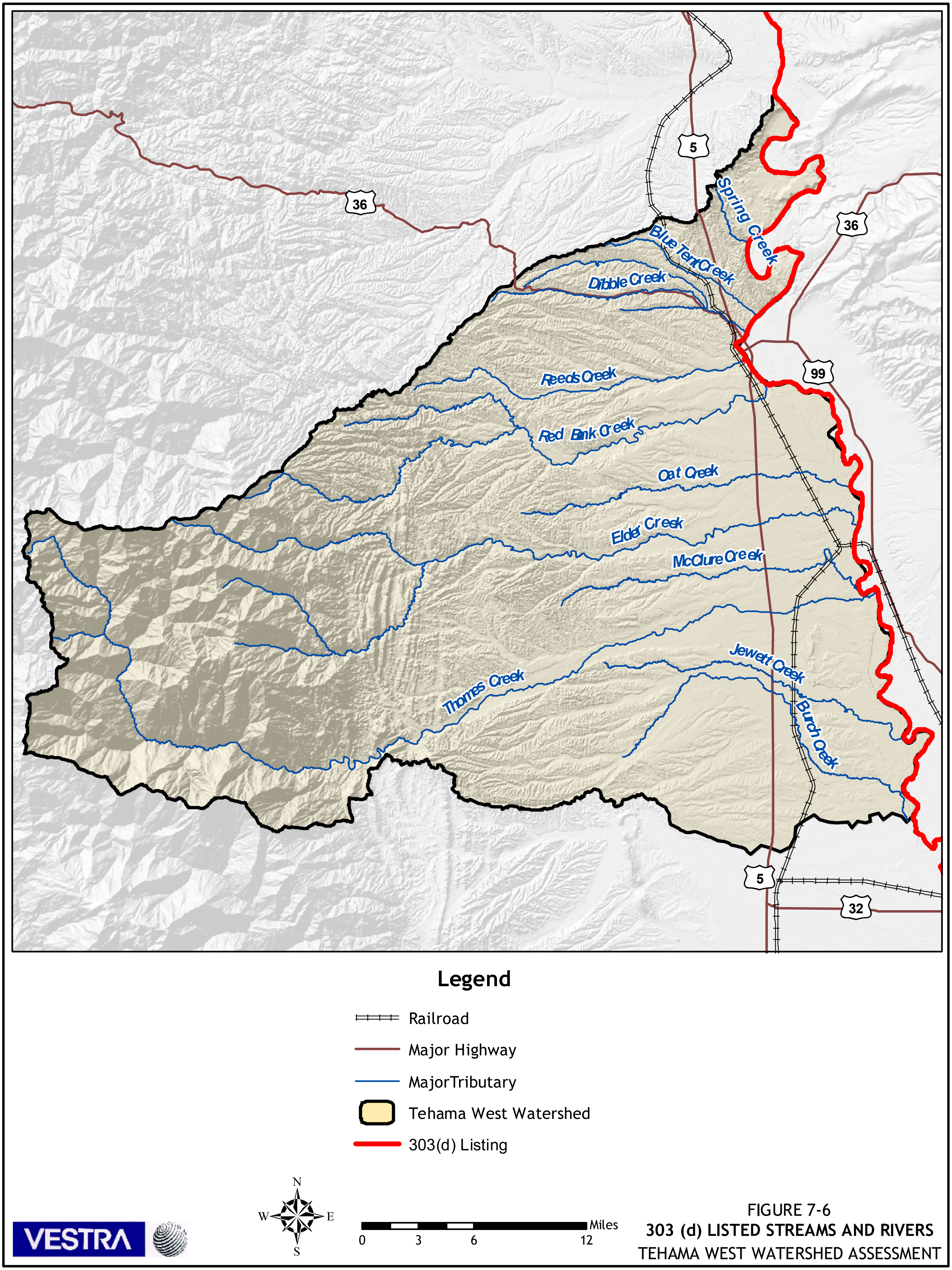
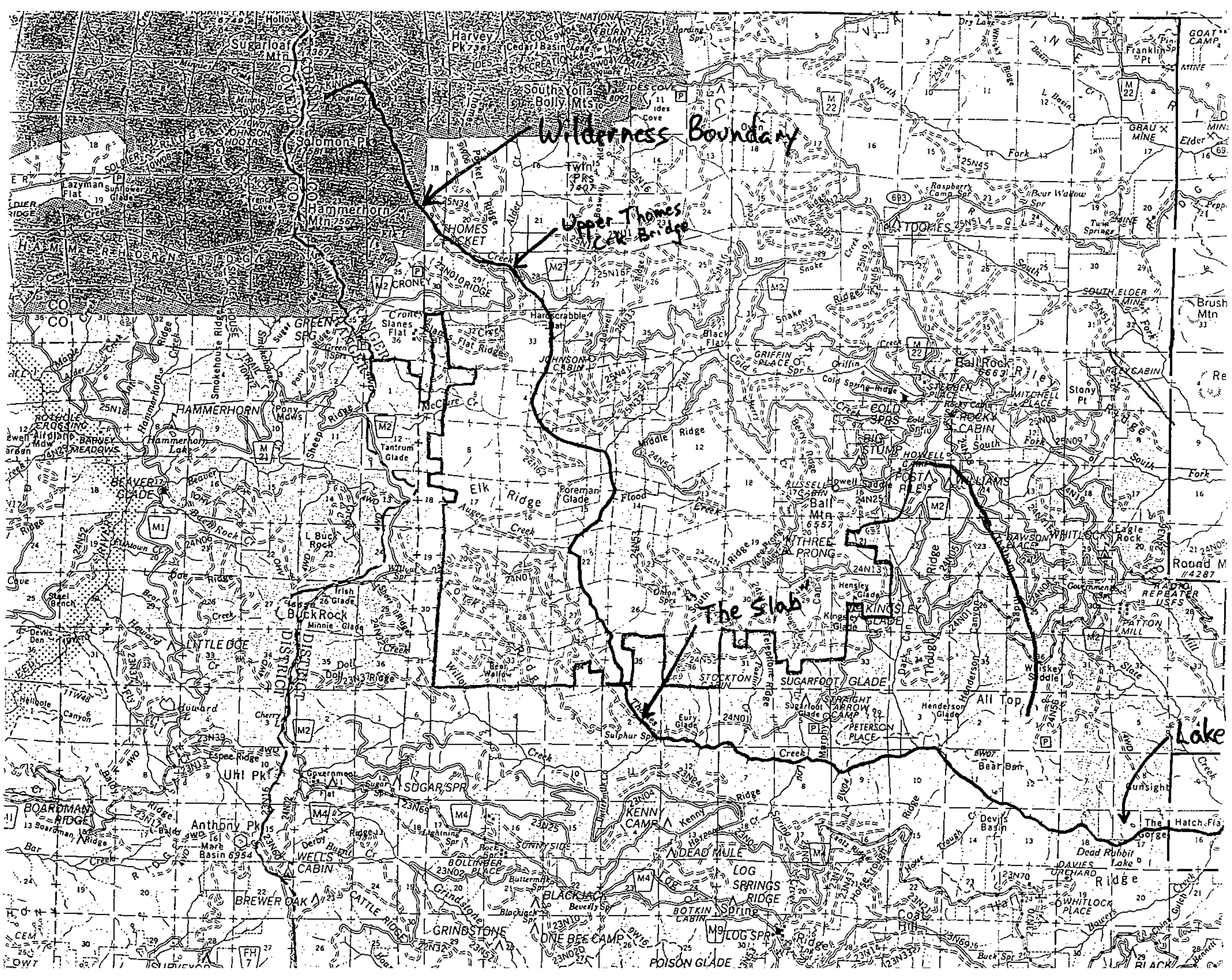


FIGURE 7-6
303 (d) LISTED STREAMS AND RIVERS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA STATE WATER RESOURCES CONTROL BOARD, 2005

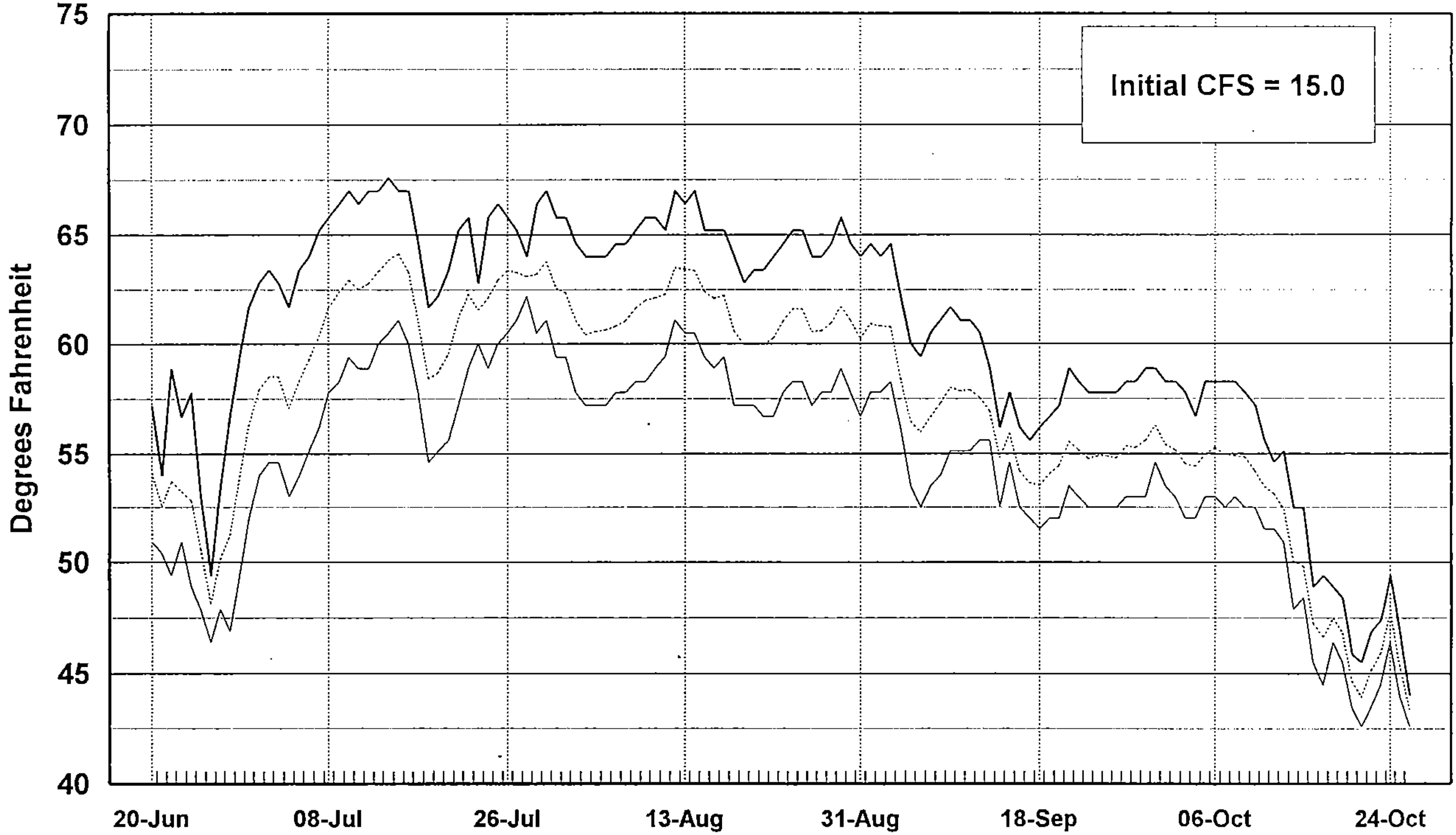
Appendix 7-1

Crane Mills Temperature Data



Wilderness Boundary
Upper Thomes Crk Bridge
The Slab
Lake
Sugarloaf Mtn
Harvey Pk
South Yolla Bolly Mts
Solomon Pk
Hammerhorn Mtn
Lazyman Flat
Thomes Pocket
Twin Pks
Croney
Slanes Flat
Hardscrabble Flat
Johnson Cabin
Griffin Place
Ball Rock
Cold Sprs
Big Stump
Howell Saddle
Ball Mtn
Three Prong
Elk Ridge
Foreman Glade
Hammerhorn
Hammerhorn Lake
Tantrum Glade
Beaver Glade
Buck Rock
Little Doe
Kingsley Glade
Sugarfoot Glade
Stockton Cabin
Straight Arrow Camp
Peterson Place
Henderson Glade
All Top
Whiskey Saddle
Round Mtn
Radio Repeater USFS
Patton Mill
Eagle Rock
Dawson Place
Whitlock
Gunsight
Bear Ben
Devils Basin
The Gorge
Hatch Flat
Dead Rabbit Lake
Davies Orchard
Uhl Pk
Anthony Pk
Mare Basin
Boardman Ridge
Sugar Spr
Kenny Camp
Dead Mule
Log Springs Ridge
Wells Cabin
Brewer Oak
Cattle Ridge
Grindstone
Blackjack
One Bee Camp
Botkin Cabin
Log Spr
Poison Glade
Coal Hill
Whitlock Place
Sulphur Spr
Eury Glade
Brush Mtn
Stony Pt
Mitchell Place
Rocky Cabin
Franklin Pt
Goat Camp
Grau Mine
Ides Cove
Raspberry Camp Spr
District

Upper Thomes Crk Sta.



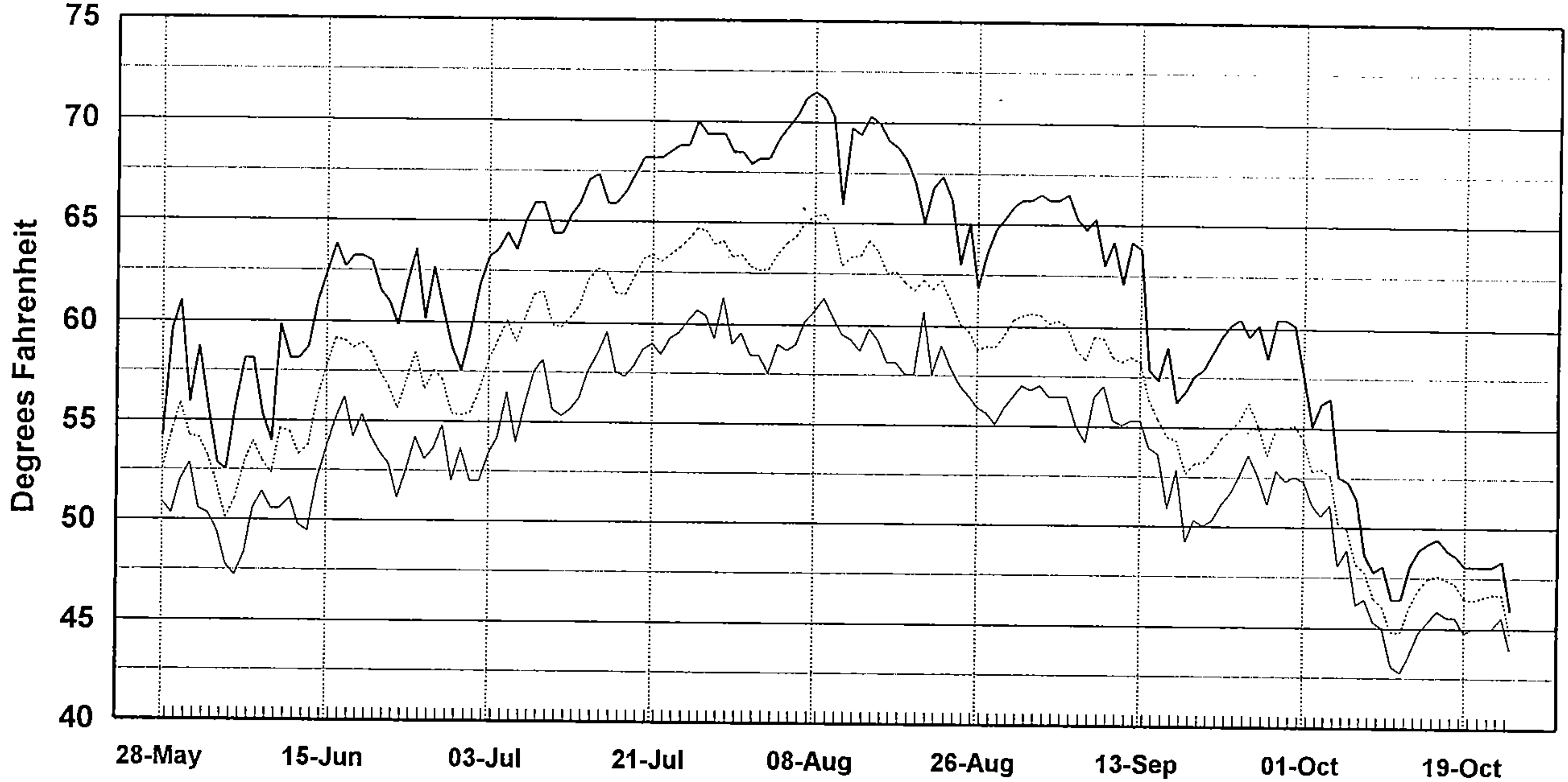
CRANE's THOMES << >> 25N09W28 NW 1/4
Position #303 UPPER THOMES CREEK

Position #303 UPPER THOMES CREEK

M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG
6	20	57.2	50.9	54.1	7	28	64	62.2	63.1	9	4	62.2	56.2	58.44	10	12	54.6	51.5	53.12
6	21	54	50.4	52.53	7	29	66.4	60.5	63.2	9	5	60	53.5	56.45	10	13	55.1	50.9	52.4
6	22	58.9	49.4	53.72	7	30	67	61.1	63.78	9	6	59.4	52.5	55.97	10	14	52.5	47.9	50.03
6	23	56.7	50.9	53.23	7	31	65.8	59.4	62.56	9	7	60.5	53.5	56.66	10	15	52.5	48.4	49.81
6	24	57.8	48.9	52.79	8	1	65.8	59.4	62.34	9	8	61.1	54	57.32	10	16	48.9	45.5	47.26
6	25	53	47.9	50.58	8	2	64.6	57.8	61.08	9	9	61.7	55.1	58.02	10	17	49.4	44.5	46.63
6	26	49.4	46.4	48.15	8	3	64	57.2	60.4	9	10	61.1	55.1	57.86	10	18	48.9	46.4	47.5
6	27	53.5	47.9	50.13	8	4	64	57.2	60.56	9	11	61.1	55.1	57.9	10	19	48.4	45.5	46.81
6	28	56.7	46.9	51.24	8	5	64	57.2	60.62	9	12	60.5	55.6	57.56	10	20	45.9	43.5	44.64
6	29	59.4	49.4	53.94	8	6	64.6	57.8	60.8	9	13	58.9	55.6	56.93	10	21	45.5	42.6	43.92
6	30	61.7	52	56.29	8	7	64.6	57.8	61.04	9	14	56.2	52.5	54.79	10	22	46.9	43.5	45.15
7	1	62.8	54	57.93	8	8	65.2	58.3	61.65	9	15	57.8	54.6	55.91	10	23	47.4	44.5	45.9
7	2	63.4	54.6	58.53	8	9	65.8	58.3	62	9	16	56.2	52.5	54.2	10	24	49.4	46.4	47.75
7	3	62.8	54.6	58.53	8	10	65.8	58.9	62.11	9	17	55.6	52	53.64	10	25	46.9	44	45.38
7	4	61.7	53	57.07	8	11	65.2	59.4	62.27	9	18	56.2	51.5	53.54	10	26	44	42.6	43.36
7	5	63.4	54	58.33	8	12	67	61.1	63.5	9	19	56.7	52	54.07					
7	6	64	55.1	59.27	8	13	66.4	60.5	63.43	9	20	57.2	52	54.43					
7	7	65.2	56.2	60.33	8	14	67	60.5	63.37	9	21	58.9	53.5	55.54					
7	8	65.8	57.8	61.68	8	15	65.2	59.4	62.39	9	22	58.3	53	55.15					
7	9	66.4	58.3	62.36	8	16	65.2	58.9	62.1	9	23	57.8	52.5	54.74					
7	10	67	59.4	62.93	8	17	65.2	59.4	62.22	9	24	57.8	52.5	54.89					
7	11	66.4	58.9	62.52	8	18	64	57.2	60.58	9	25	57.8	52.5	54.89					
7	12	67	58.9	62.77	8	19	62.8	57.2	59.94	9	26	57.8	52.5	54.8					
7	13	67	60	63.33	8	20	63.4	57.2	59.95	9	27	58.3	53	55.32					
7	14	67.6	60.5	63.85	8	21	63.4	56.7	59.95	9	28	58.3	53	55.26					
7	15	67	61.1	64.14	8	22	64	56.7	60.25	9	29	58.9	53	55.59					
7	16	67	60	63.32	8	23	64.6	57.8	61.04	9	30	58.9	54.6	56.29					
7	17	64.6	57.8	61.03	8	24	65.2	58.3	61.6	10	1	58.3	53.5	55.42					
7	18	61.7	54.6	58.42	8	25	65.2	58.3	61.6	10	2	58.3	53	55.15					
7	19	62.2	55.1	58.68	8	26	64	57.2	60.56	10	3	57.8	52	54.54					
7	20	63.4	55.6	59.56	8	27	64	57.8	60.57	10	4	56.7	52	54.38					
7	21	65.2	57.2	61.15	8	28	64.6	57.8	60.97	10	5	58.3	53	54.94					
7	22	65.8	58.9	62.29	8	29	65.8	58.9	61.71	10	6	58.3	53	55.26					
7	23	62.8	60	61.55	8	30	64.6	57.8	61.07	10	7	58.3	52.5	54.95					
7	24	65.8	58.9	62.11	8	31	64	56.7	60.23	10	8	58.3	53	54.89					
7	25	66.4	60	62.93	9	1	64.6	57.8	60.91	10	9	57.8	52.5	54.84					
7	26	65.8	60.5	63.37	9	2	64	57.8	60.79	10	10	57.2	52.5	54.19					
7	27	65.2	61.1	63.3	9	3	64.6	58.3	60.78	10	11	55.6	51.5	53.49					

1997

Upper Thomes Crk Sta.

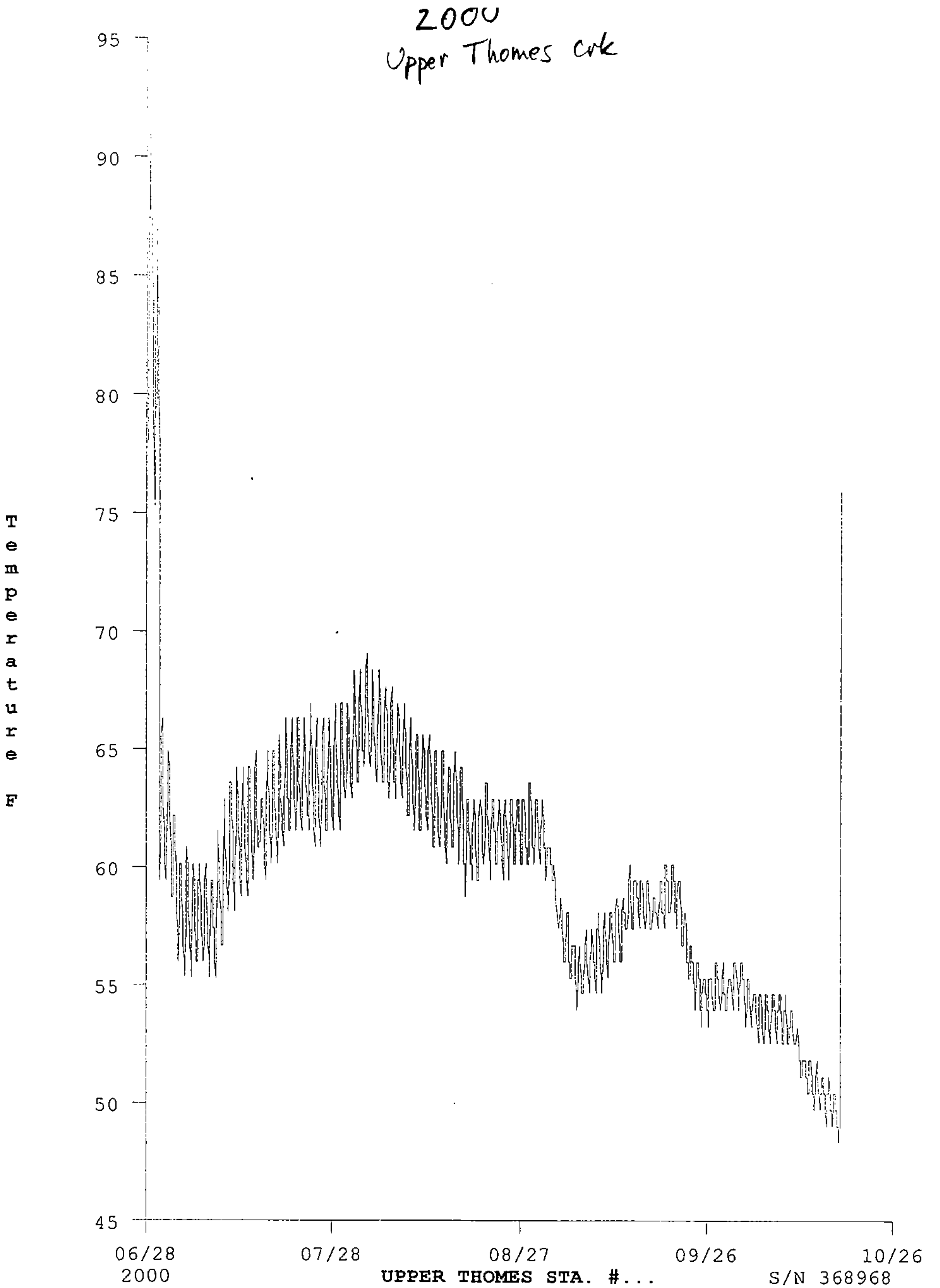


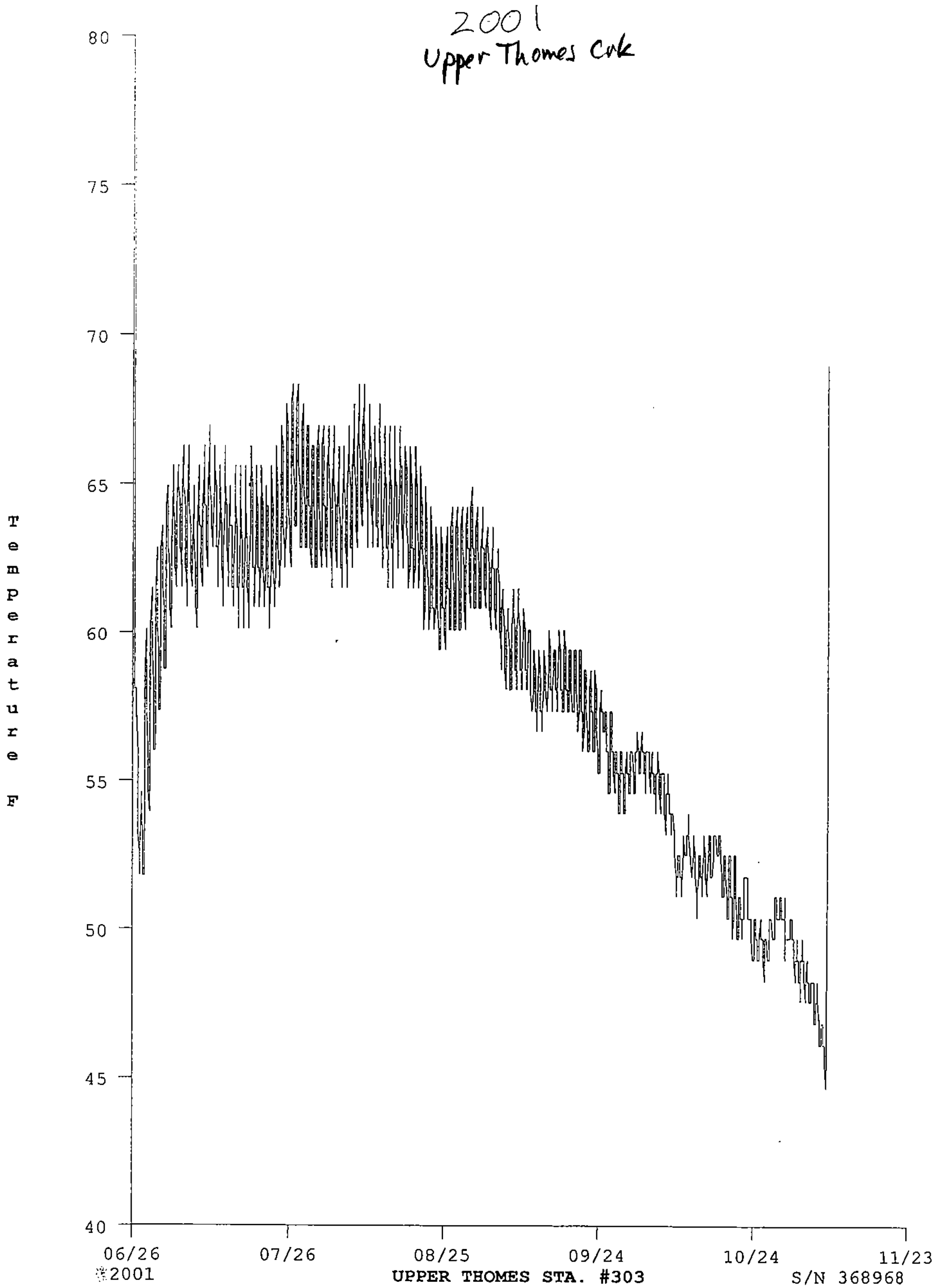
CRANE's THOMES <<>> 25N09W28 NW 1/4
Position #303 THOMES

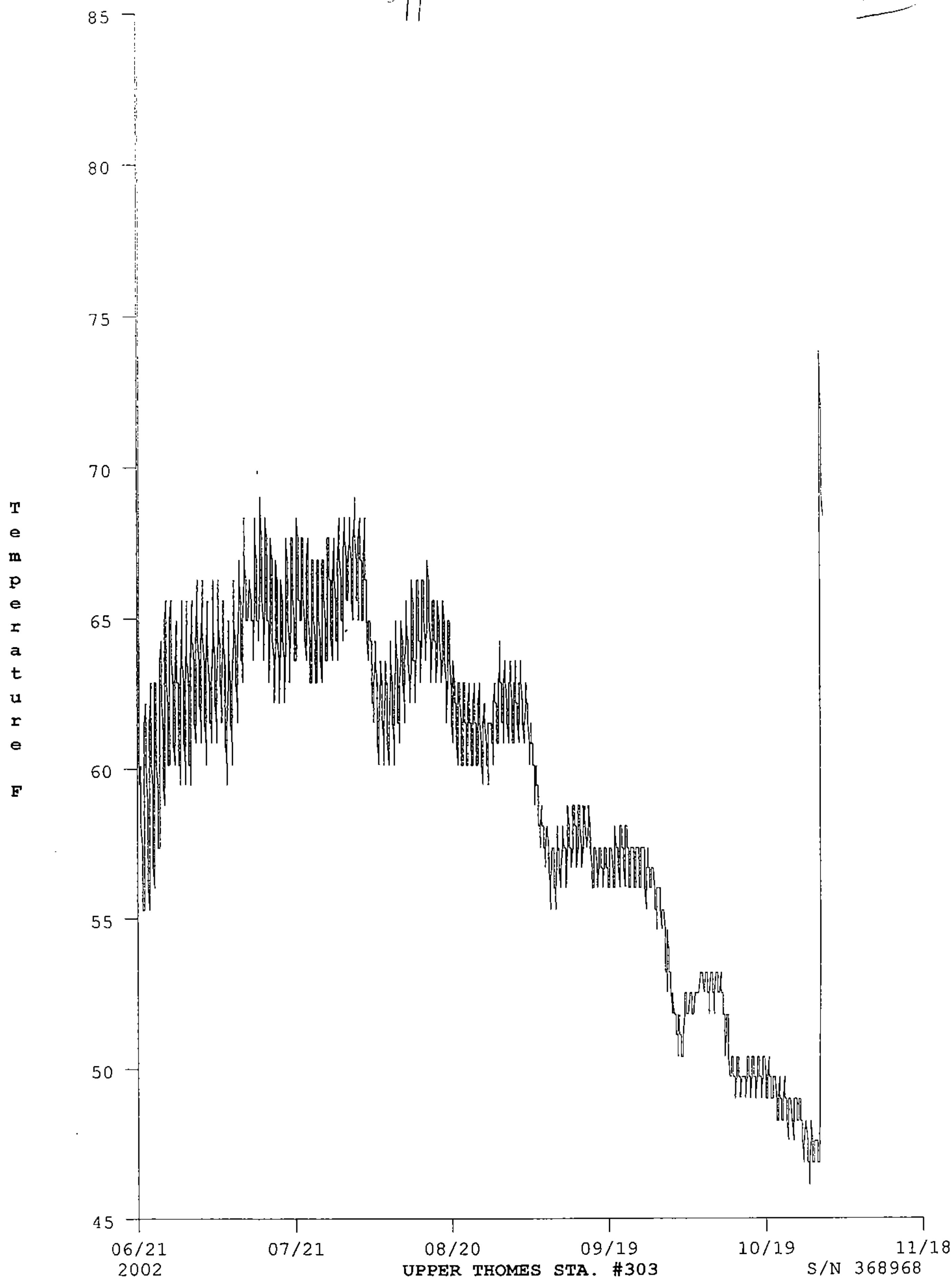
1997
Upper Thomes Crk Sta.

Position #303 THOMES

M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG
5	28	54.21	50.88	52.59	7	5	64.40	56.45	60.09	8	12	69.73	59.26	63.32	9	19	57.56	50.33	53.16
5	29	59.57	50.33	54.42	7	6	63.54	53.96	59.03	8	13	69.39	58.70	63.38	9	20	57.87	50.02	53.24
5	30	60.96	51.99	55.83	7	7	65.03	55.89	60.28	8	14	70.32	59.83	64.16	9	21	58.70	50.33	53.75
5	31	55.89	52.86	54.21	7	8	65.90	57.56	61.40	8	15	69.98	59.26	63.60	9	22	59.57	51.12	54.47
6	1	58.70	50.57	54.14	7	9	65.90	58.12	61.53	8	16	69.13	58.12	62.55	9	23	60.14	51.67	54.88
6	2	55.63	50.33	53.17	7	10	64.40	55.63	59.87	8	17	68.80	58.12	62.60	9	24	60.40	52.55	55.33
6	3	52.86	49.46	51.69	7	11	64.40	55.33	59.80	8	18	68.18	57.56	62.08	9	25	59.57	53.65	56.24
6	4	52.55	47.79	50.09	7	12	65.29	55.63	60.26	8	19	67.04	57.56	61.71	9	26	60.14	52.55	55.14
6	5	55.63	47.23	51.03	7	13	65.90	56.19	60.84	8	20	65.03	60.68	62.23	9	27	58.44	51.12	53.63
6	6	58.12	48.35	52.89	7	14	67.04	57.56	62.09	8	21	66.77	57.56	61.76	9	28	60.40	52.86	55.04
6	7	58.12	50.57	53.97	7	15	67.35	58.44	62.66	8	22	67.35	59.01	62.22	9	29	60.40	52.30	55.01
6	8	55.33	51.42	52.99	7	16	65.90	59.57	62.41	8	23	66.20	57.87	61.17	9	30	60.14	52.55	55.12
6	9	53.96	50.57	52.35	7	17	65.90	57.56	61.47	8	24	62.98	57.00	60.13	10	1	57.56	52.30	54.43
6	10	59.83	50.57	54.59	7	18	66.47	57.31	61.42	8	25	65.03	56.45	59.73	10	2	55.08	51.12	52.81
6	11	58.12	51.12	54.41	7	19	67.35	57.87	62.29	8	26	61.85	55.89	58.81	10	3	56.19	50.57	52.92
6	12	58.12	49.76	53.31	7	20	68.18	58.70	63.14	8	27	63.54	55.63	58.97	10	4	56.45	51.12	52.65
6	13	58.70	49.46	53.75	7	21	68.18	59.01	63.37	8	28	64.73	55.08	58.98	10	5	52.55	48.08	50.23
6	14	60.96	51.99	56.08	7	22	68.18	58.44	63.00	8	29	65.29	55.89	59.60	10	6	52.30	48.89	49.88
6	15	62.42	53.65	57.76	7	23	68.51	59.26	63.37	8	30	65.90	56.45	60.31	10	7	51.42	46.12	48.18
6	16	63.82	55.08	59.16	7	24	68.80	59.57	63.69	8	31	66.20	57.00	60.53	10	8	48.64	46.42	47.80
6	17	62.66	56.19	59.05	7	25	68.80	60.14	64.15	9	1	66.20	56.76	60.62	10	9	47.79	45.31	46.47
6	18	63.23	54.21	58.69	7	26	69.98	60.68	64.68	9	2	66.47	57.00	60.56	10	10	48.08	45.00	46.05
6	19	63.23	55.33	58.95	7	27	69.39	60.40	64.59	9	3	66.20	56.45	60.15	10	11	46.42	43.08	44.79
6	20	62.98	54.21	58.45	7	28	69.39	59.26	63.90	9	4	66.20	56.45	60.27	10	12	46.42	42.76	44.79
6	21	61.52	53.41	57.40	7	29	69.39	61.28	64.06	9	5	66.47	56.45	60.05	10	13	48.08	43.63	46.08
6	22	60.96	52.86	56.66	7	30	68.51	59.01	63.26	9	6	65.29	55.08	58.90	10	14	48.89	44.75	46.96
6	23	59.83	51.12	55.62	7	31	68.51	59.57	63.42	9	7	64.73	54.21	58.32	10	15	49.20	45.31	47.46
6	24	61.85	52.55	57.06	8	1	67.93	58.44	62.83	9	8	65.29	56.45	59.51	10	16	49.46	45.87	47.61
6	25	63.54	54.21	58.47	8	2	68.18	58.44	62.65	9	9	62.98	57.00	59.42	10	17	48.89	45.56	47.40
6	26	60.14	53.10	56.60	8	3	68.18	57.56	62.69	9	10	64.15	55.33	58.48	10	18	48.64	45.56	47.19
6	27	62.66	53.65	57.57	8	4	69.13	59.01	63.50	9	11	62.09	55.08	58.24	10	19	48.08	44.75	46.47
6	28	60.68	54.77	57.08	8	5	69.73	58.70	63.99	9	12	64.15	55.33	58.50	10	20	48.08	45.00	46.40
6	29	58.70	51.99	55.38	8	6	70.32	59.01	64.33	9	13	63.82	55.33	58.23	10	21	48.08	45.00	46.55
6	30	57.56	53.65	55.30	8	7	71.14	60.14	65.00	9	14	57.87	53.96	56.35	10	22	48.08	45.00	46.69
7	1	59.57	51.99	55.44	8	8	71.49	60.68	65.35	9	15	57.31	53.65	55.37	10	23	48.35	45.56	46.69
7	2	61.85	51.99	56.55	8	9	71.14	61.28	65.41	9	16	59.01	50.88	54.52	10	24	45.87	43.89	44.71
7	3	63.23	53.41	58.16	8	10	70.32	60.40	64.77	9	17	56.19	52.86	54.37					
7	4	63.54	54.21	59.06	8	11	65.90	59.57	62.91	9	18	56.76	49.20	52.67					

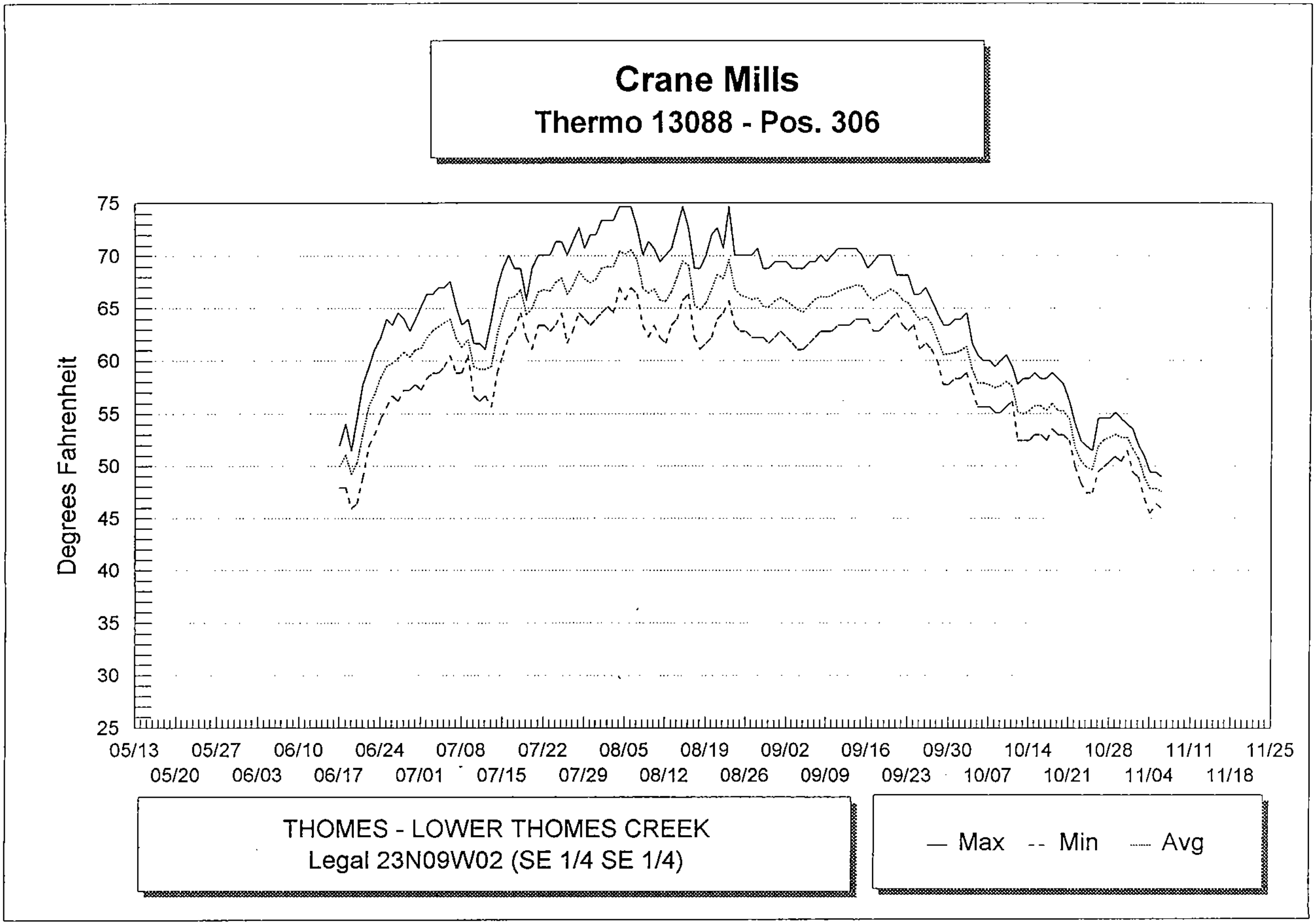

2000
Upper Thomes Crk
95
90
85
80
75
70
65
60
55
50
45
Temperature F
06/28
2000
07/28
08/27
09/26
10/26
UPPER THOMES STA. #...
S/N 368968


2001
Upper Thomes Crk
80
75
70
65
60
55
50
45
40
Temperature F
06/26
07/26
08/25
09/24
10/24
11/23
©2001
UPPER THOMES STA. #303
S/N 368968



85
80
75
70
65
60
55
50
45
Temperature F
06/21
2002
07/21
08/20
09/19
10/19
11/18
UPPER THOMES STA. #303
S/N 368968

1995 Lower Thomes Crk Sta.



Alpine Land Information Services

12/08/95

1995 Lower Thomes Crk. Sta.

Crane Mills — **THERMOGRAPH SUMMARY** — **THOMES - LOWER THOMES CREEK**

Thermograph 13088 — **Position 306** — **Legal 23N09W02 (SE 1/4 SE 1/4)**

Date	Max	Min	Avg
05/16			
05/17			
05/18			
05/19			
05/20			
05/21			
05/22			
05/23			
05/24			
05/25			
05/26			
05/27			
05/28			
05/29			
05/30			
05/31			
06/01			
06/02			
06/03			
06/04			
06/05			
06/06			
06/07			
06/08			
06/09			
06/10			
06/11			
06/12			
06/13			
06/14			
06/15			
06/16			
06/17	51.97	47.91	49.93
06/18	54.05	47.91	51.06
06/19	51.45	45.94	49.18
06/20	54.58	46.43	50.36
06/21	57.78	48.91	53.04
06/22	59.43	51.97	55.77
06/23	61.11	53.00	56.86
06/24	62.25	54.58	58.43
06/25	63.99	55.63	59.54
06/26	63.41	56.70	59.79
06/27	64.58	56.17	60.27
06/28	63.99	57.24	60.87
06/29	62.83	57.24	60.41
06/30	63.99	57.78	61.09
07/01	65.18	57.24	61.22
07/02	66.37	58.33	62.19

Date	Max	Min	Avg
07/03	66.37	58.88	62.88
07/04	66.98	58.88	63.28
07/05	66.98	59.43	63.63
07/06	67.59	60.55	63.97
07/07	65.18	58.88	62.16
07/08	63.41	58.88	61.30
07/09	63.99	60.55	62.03
07/10	61.68	56.70	59.50
07/11	61.68	56.17	59.23
07/12	61.11	56.70	59.22
07/13	63.99	55.63	59.49
07/14	66.98	58.88	62.48
07/15	68.83	60.55	64.46
07/16	70.08	62.25	66.06
07/17	68.83	62.83	66.10
07/18	68.83	64.58	66.81
07/19	65.77	62.25	64.41
07/20	68.83	61.11	64.99
07/21	70.08	63.41	66.59
07/22	70.08	63.41	66.77
07/23	70.08	62.83	66.65
07/24	71.36	63.41	67.51
07/25	71.36	64.58	67.90
07/26	70.08	61.68	66.31
07/27	71.36	62.83	67.16
07/28	72.66	64.58	68.56
07/29	70.72	63.99	67.81
07/30	72.01	63.41	67.45
07/31	72.01	63.99	67.76
08/01	73.32	64.58	68.88
08/02	73.32	65.18	69.00
08/03	73.32	64.58	69.01
08/04	74.66	66.98	70.45
08/05	74.66	65.77	70.20
08/06	74.66	66.98	70.57
08/07	72.66	66.37	69.61
08/08	70.08	63.41	66.95
08/09	71.36	62.25	66.50
08/10	70.72	63.41	66.89
08/11	69.45	62.25	65.81
08/12	70.08	61.68	65.70
08/13	70.72	63.41	66.60
08/14	72.66	63.99	68.02
08/15	74.66	65.77	69.58
08/16	72.66	66.37	69.11
08/17	68.83	62.25	65.38
08/18	68.83	61.11	64.87
08/19	70.08	61.68	65.59

Date	Max	Min	Avg
08/20	72.01	62.25	66.87
08/21	72.66	63.99	68.27
08/22	70.72	64.58	67.86
08/23	74.66	65.77	69.70
08/24	70.08	63.41	66.89
08/25	70.08	62.83	66.29
08/26	70.08	62.83	66.11
08/27	70.08	62.25	65.87
08/28	70.72	62.25	66.00
08/29	68.83	62.25	65.21
08/30	68.83	61.68	65.15
08/31	69.45	62.25	65.69
09/01	69.45	62.83	66.05
09/02	69.45	62.25	65.75
09/03	68.83	61.68	65.33
09/04	68.83	61.11	64.86
09/05	68.83	61.11	64.68
09/06	69.45	61.68	65.33
09/07	69.45	62.25	65.86
09/08	70.08	62.83	66.17
09/09	69.45	62.83	66.10
09/10	70.08	62.83	66.23
09/11	70.72	63.41	66.65
09/12	70.72	63.41	66.89
09/13	70.72	63.41	66.96
09/14	70.72	63.99	67.25
09/15	70.08	63.99	67.14
09/16	68.83	63.99	66.27
09/17	69.45	62.83	65.80
09/18	70.08	62.83	66.23
09/19	70.08	63.41	66.46
09/20	70.08	63.99	66.89
09/21	68.21	64.58	66.51
09/22	68.21	63.41	65.85
09/23	68.21	62.83	65.55
09/24	66.37	63.41	64.70
09/25	66.37	61.11	63.90
09/26	66.98	61.68	64.19
09/27	65.77	61.11	63.48
09/28	64.58	59.99	62.09
09/29	63.41	57.78	60.57
09/30	63.41	57.78	60.68
10/01	63.99	58.33	60.74
10/02	63.99	58.33	60.95
10/03	64.58	58.88	61.36
10/04	61.68	57.24	59.22
10/05	60.55	55.63	57.91
10/06	59.99	55.63	57.91

Date	Max	Min	Avg
10/07	59.99	55.63	57.74
10/08	59.43	55.10	57.52
10/09	59.99	55.10	57.63
10/10	60.55	55.63	58.07
10/11	59.43	56.17	57.63
10/12	57.78	52.48	55.17
10/13	58.33	52.48	54.96
10/14	58.33	52.48	55.28
10/15	58.88	53.00	55.76
10/16	58.33	53.00	55.75
10/17	58.33	52.48	55.33
10/18	58.88	53.53	55.97
10/19	58.33	53.00	55.33
10/20	57.78	53.00	55.29
10/21	56.17	52.48	54.48
10/22	54.05	49.92	51.77
10/23	52.48	48.41	50.54
10/24	51.97	47.42	49.88
10/25	51.45	47.42	49.68
10/26	54.58	49.41	51.88
10/27	54.58	49.92	52.55
10/28	54.58	50.43	52.75
10/29	55.10	50.94	53.06
10/30	54.58	50.43	52.75
10/31	54.05	51.45	52.75
11/01	53.53	49.41	51.61
11/02	51.97	48.91	50.69
11/03	50.94	46.92	48.92
11/04	49.41	45.45	47.82
11/05	49.41	46.43	47.82
11/06	48.91	45.94	47.53
11/07			
11/08			
11/09			
11/10			
11/11			
11/12			
11/13			
11/14			
11/15			
11/16			
11/17			
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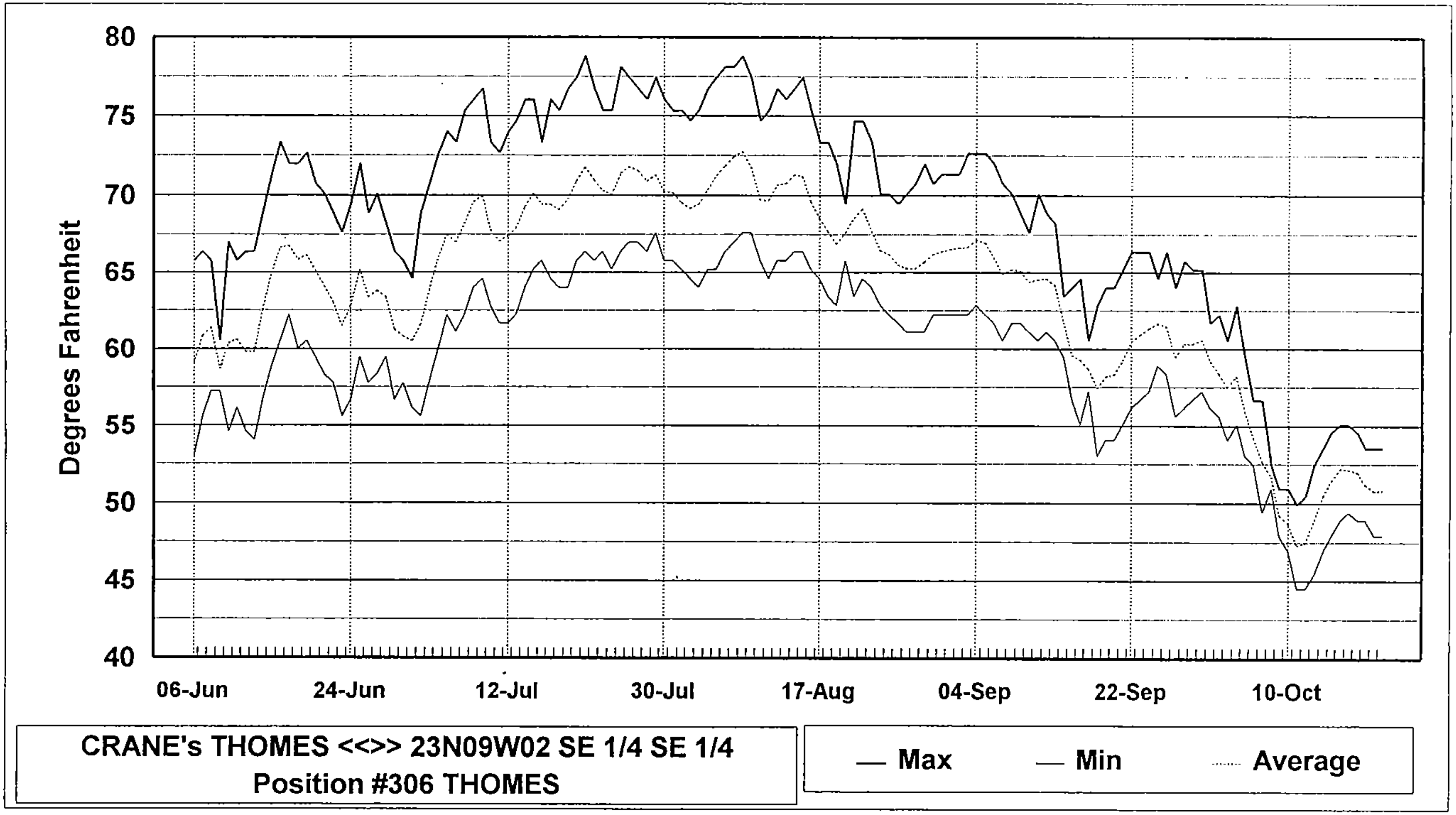
11/19			
11/20			
11/21			
11/22			

1997
Lower Thomes Creek Sta.

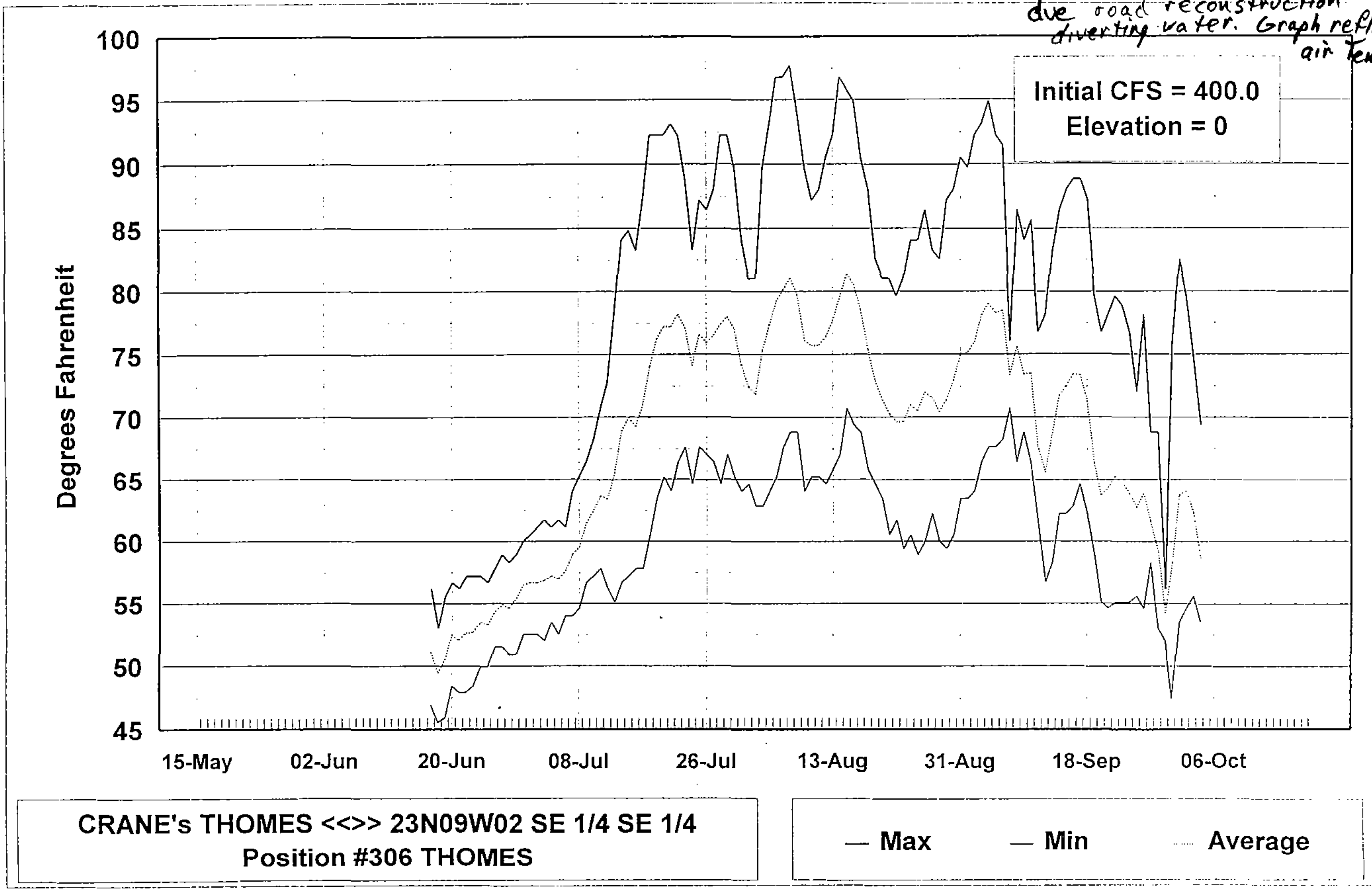


1997
Lower Thomes Crk. Sta.

Position #306 THOMES

M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG
6	6	65.77	53.00	59.00	7	14	76.03	63.99	69.26	8	21	74.66	63.41	68.55	9	28	65.77	56.17	60.32
6	7	66.37	55.63	60.85	7	15	76.03	65.18	70.12	8	22	74.66	64.58	69.14	9	29	65.18	56.70	60.31
6	8	65.77	57.24	61.39	7	16	73.32	65.77	69.43	8	23	73.32	63.99	67.70	9	30	65.18	57.24	60.59
6	9	60.55	57.24	58.66	7	17	76.03	64.58	69.42	8	24	70.08	62.83	66.41	10	1	61.68	56.17	59.18
6	10	66.98	54.58	60.33	7	18	75.34	63.99	69.06	8	25	70.08	62.25	66.18	10	2	62.25	55.63	58.35
6	11	65.77	56.17	60.61	7	19	76.72	63.99	69.76	8	26	69.45	61.68	65.46	10	3	60.55	54.05	57.49
6	12	66.37	54.58	59.79	7	20	77.42	65.77	70.90	8	27	70.08	61.11	65.23	10	4	62.83	55.10	58.20
6	13	66.37	54.05	59.77	7	21	78.83	66.37	71.80	8	28	70.72	61.11	65.24	10	5	59.43	53.00	55.97
6	14	68.83	56.70	62.54	7	22	76.72	65.77	70.94	8	29	72.01	61.11	65.67	10	6	56.70	52.48	54.21
6	15	71.36	58.88	64.94	7	23	75.34	66.37	70.27	8	30	70.72	62.25	66.18	10	7	56.70	49.41	52.61
6	16	73.32	60.55	66.61	7	24	75.34	65.18	70.04	8	31	71.36	62.25	66.36	10	8	52.48	50.94	51.71
6	17	72.01	62.25	66.74	7	25	78.12	66.37	71.41	9	1	71.36	62.25	66.50	10	9	50.94	47.91	49.22
6	18	72.01	59.99	65.82	7	26	77.42	66.98	71.78	9	2	71.36	62.25	66.61	10	10	50.94	46.92	48.67
6	19	72.66	60.55	66.11	7	27	76.72	66.98	71.56	9	3	72.66	62.25	66.63	10	11	49.92	44.48	47.28
6	20	70.72	59.43	65.09	7	28	76.03	66.37	70.86	9	4	72.66	62.83	67.11	10	12	50.43	44.48	47.48
6	21	70.08	58.33	64.08	7	29	77.42	67.59	71.29	9	5	72.66	62.25	66.93	10	13	52.48	45.45	48.94
6	22	68.83	57.78	63.02	7	30	76.03	65.77	70.22	9	6	72.01	61.68	65.95	10	14	53.53	46.92	50.45
6	23	67.59	55.63	61.49	7	31	75.34	65.77	70.16	9	7	70.72	60.55	64.88	10	15	54.58	47.91	51.42
6	24	69.45	56.70	62.83	8	1	75.34	65.18	69.52	9	8	70.08	61.68	65.16	10	16	55.10	48.91	52.19
6	25	72.01	59.43	65.17	8	2	74.66	64.58	69.16	9	9	68.83	61.68	65.09	10	17	55.10	49.41	52.14
6	26	68.83	57.78	63.37	8	3	75.34	63.99	69.43	9	10	67.59	61.11	64.37	10	18	54.58	48.91	51.98
6	27	70.08	58.33	63.79	8	4	76.72	65.18	70.32	9	11	70.08	60.55	64.52	10	19	53.53	48.91	51.21
6	28	68.21	59.43	63.34	8	5	77.42	65.18	71.23	9	12	68.83	61.11	64.56	10	20	53.53	47.91	50.75
6	29	66.37	56.70	61.28	8	6	78.12	66.37	71.86	9	13	68.21	60.55	64.15	10	21	53.53	47.91	50.80
6	30	65.77	57.78	60.81	8	7	78.12	66.98	72.44	9	14	63.41	59.43	61.74					
7	1	64.58	56.17	60.49	8	8	78.83	67.59	72.76	9	15	63.99	56.70	59.52					
7	2	68.83	55.63	61.58	8	9	77.42	67.59	71.75	9	16	64.58	55.10	59.27					
7	3	70.72	57.78	63.83	8	10	74.66	65.77	69.70	9	17	60.55	57.24	58.66					
7	4	72.66	59.99	65.95	8	11	75.34	64.58	69.67	9	18	62.83	53.00	57.40					
7	5	73.99	62.25	67.50	8	12	76.72	65.77	70.62	9	19	63.99	54.05	58.17					
7	6	73.32	61.11	66.96	8	13	76.03	65.77	70.74	9	20	63.99	54.05	58.28					
7	7	75.34	62.25	68.15	8	14	76.72	66.37	71.32	9	21	65.18	55.10	59.22					
7	8	76.03	63.99	69.57	8	15	77.42	66.37	71.19	9	22	66.37	56.17	60.44					
7	9	76.72	64.58	69.94	8	16	75.34	65.18	69.58	9	23	66.37	56.70	60.88					
7	10	73.32	62.83	67.78	8	17	73.32	64.58	68.50	9	24	66.37	57.24	61.34					
7	11	72.66	61.68	67.01	8	18	73.32	63.41	67.66	9	25	64.58	58.88	61.65					
7	12	73.99	61.68	67.39	8	19	72.01	62.83	66.85	9	26	66.37	58.33	61.49					
7	13	74.66	62.25	67.89	8	20	69.45	65.77	67.60	9	27	63.99	55.63	59.41					

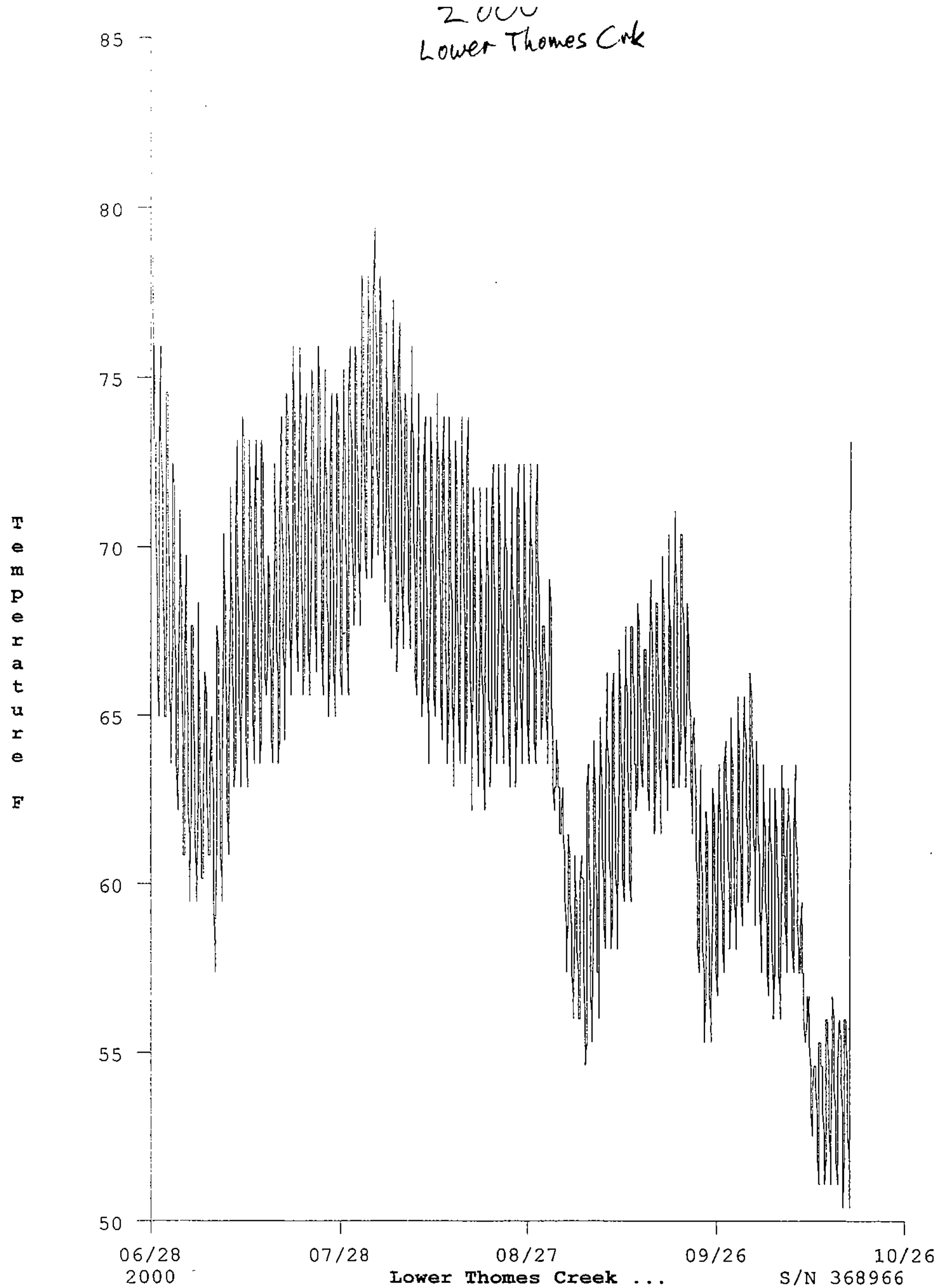
1998
Lower Thomes Creek Sta. – HOBO went dry due to road reconstruction diverting water. Graph reflect air Temp



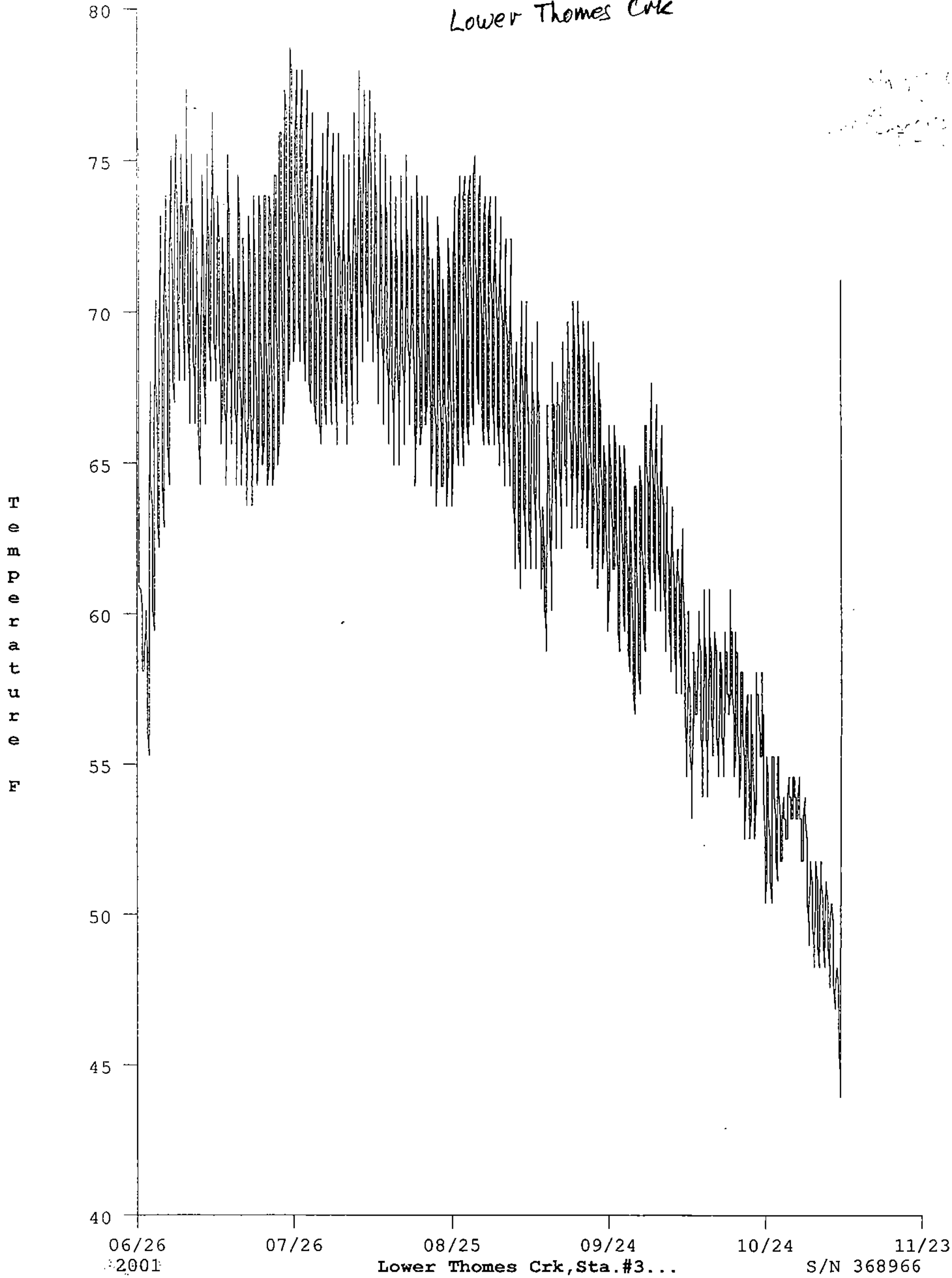
HOBO went dry due to channel diversion above. Data reflects air temp.

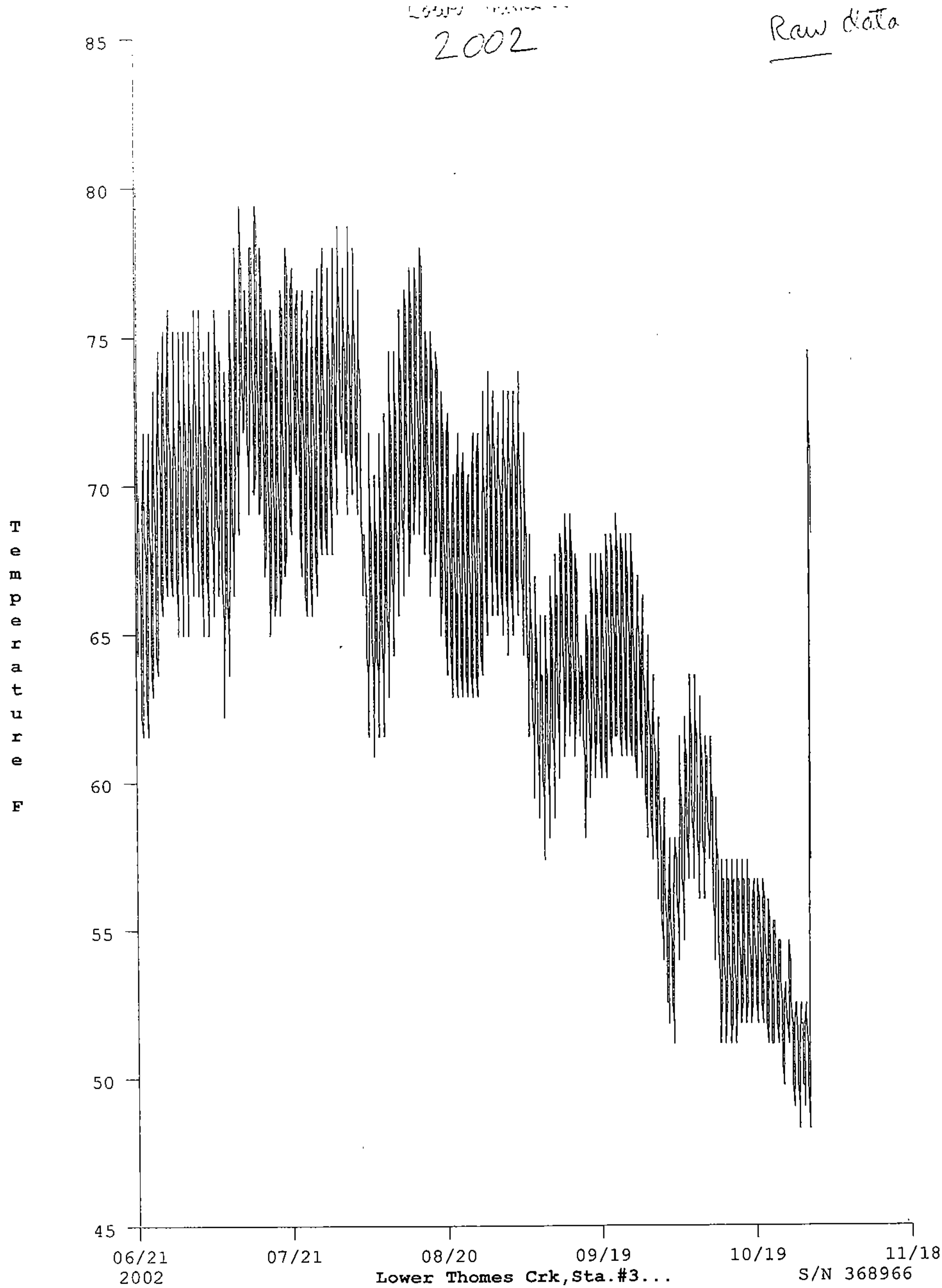
Position #306 THOMES

M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG	M	D	MAX	MIN	AVG
5	15				6	16				7	18	92.20	60.50	74.09	8	19	82.50	64.60	72.94	9	20	76.70	55.10	63.71
5	16				6	17	56.20	46.90	51.09	7	19	92.20	63.40	76.24	8	20	81.00	63.40	71.43	9	21	78.10	54.60	64.32
5	17				6	18	53.00	45.50	49.44	7	20	92.20	65.20	77.22	8	21	81.00	60.50	70.29	9	22	79.60	55.10	65.25
5	18				6	19	55.60	45.90	50.53	7	21	93.10	64.00	77.20	8	22	79.60	61.70	69.66	9	23	78.80	55.10	64.72
5	19				6	20	56.70	48.40	52.46	7	22	92.20	66.40	78.19	8	23	81.00	59.40	69.67	9	24	76.70	55.10	63.83
5	20				6	21	56.20	47.90	52.05	7	23	88.80	67.60	77.12	8	24	84.00	60.50	71.04	9	25	72.00	55.60	62.68
5	21				6	22	57.20	47.90	52.62	7	24	83.20	64.60	74.15	8	25	84.00	58.90	70.52	9	26	78.10	54.60	63.84
5	22				6	23	57.20	48.40	52.67	7	25	87.20	67.60	76.62	8	26	86.40	60.00	72.03	9	27	68.80	58.30	61.59
5	23				6	24	57.20	49.90	53.48	7	26	86.40	67.00	75.97	8	27	83.20	62.20	71.60	9	28	68.80	53.00	59.12
5	24				6	25	56.70	49.90	53.34	7	27	88.00	66.40	76.53	8	28	82.50	60.00	70.45	9	29	56.20	52.00	54.22
5	25				6	26	57.80	51.50	54.40	7	28	92.20	64.60	77.40	8	29	87.20	59.40	71.41	9	30	76.00	47.40	58.30
5	26				6	27	58.90	51.50	54.91	7	29	92.20	67.00	77.99	8	30	88.00	60.50	72.95	10	1	82.50	53.50	63.70
5	27				6	28	58.30	50.90	54.65	7	30	89.70	65.20	77.00	8	31	90.50	63.40	75.07	10	2	79.60	54.60	64.06
5	28				6	29	58.90	50.90	55.45	7	31	84.00	64.00	74.17	9	1	89.70	63.40	75.18	10	3	74.70	55.60	62.26
5	29				6	30	60.00	52.50	56.51	8	1	81.00	64.60	72.42	9	2	92.20	64.00	76.00	10	4	69.40	53.50	58.61
5	30				7	1	60.50	52.50	56.77	8	2	81.00	62.80	71.82	9	3	93.10	66.40	78.09	10	5			
5	31				7	2	61.10	52.50	56.74	8	3	89.70	62.80	75.31	9	4	94.90	67.60	79.06	10	6			
6	1				7	3	61.70	52.00	56.92	8	4	93.10	64.00	77.31	9	5	92.20	67.60	78.30	10	7			
6	2				7	4	61.10	53.50	57.25	8	5	96.80	65.20	79.16	9	6	91.40	68.20	78.48	10	8			
6	3				7	5	61.70	52.50	57.02	8	6	96.80	67.60	80.10	9	7	76.00	70.70	73.35	10	9			
6	4				7	6	61.10	54.00	57.65	8	7	97.70	68.80	81.05	9	8	86.40	66.40	75.62	10	10			
6	5				7	7	64.00	54.00	58.99	8	8	94.00	68.80	79.69	9	9	84.00	68.80	73.43	10	11			
6	6				7	8	65.20	54.60	59.57	8	9	89.70	64.00	76.12	9	10	85.60	66.40	73.54	10	12			
6	7				7	9	66.40	56.70	61.47	8	10	87.20	65.20	75.68	9	11	76.70	61.70	67.72	10	13			
6	8				7	10	68.20	57.20	62.51	8	11	88.00	65.20	75.71	9	12	78.10	56.70	65.58	10	14			
6	9				7	11	70.70	57.80	63.70	8	12	90.50	64.60	76.36	9	13	83.20	58.30	68.73	10	15			
6	10				7	12	72.70	56.20	63.42	8	13	92.20	65.80	77.65	9	14	86.40	62.20	71.74	10	16			
6	11				7	13	78.10	55.10	65.57	8	14	96.80	67.00	79.52	9	15	88.00	62.20	72.50	10	17			
6	12				7	14	84.00	56.70	68.92	8	15	95.80	70.70	81.36	9	16	88.80	62.80	73.44	10	18			
6	13				7	15	84.80	57.20	70.00	8	16	94.90	69.40	80.52	9	17	88.80	64.60	73.40	10	19			
6	14				7	16	83.20	57.80	69.27	8	17	90.50	68.80	78.49	9	18	87.20	62.20	71.28	10	20			
6	15				7	17	87.20	57.80	71.00	8	18	88.00	65.80	75.42	9	19	79.60	58.90	66.33					


2000
Lower Thomes Crk
85
80
75
70
65
60
55
50
Temperature F
06/28
2000
07/28
08/27
09/26
10/26
Lower Thomes Creek ...
S/N 368966

2001
Lower Thomes Crk





Lower Thomes ...
2002
Raw data
85
80
75
70
65
60
55
50
45
Temperature F
06/21
2002
07/21
08/20
09/19
10/19
11/18
Lower Thomes Crk,Sta.#3...
S/N 368966

Section 8

Section 8
VEGETATION RESOURCES

TABLES

FIGURES

Section 8
VEGETATION RESOURCES

SOURCES OF DATA

The information and summaries presented in this section were derived from a number of sources, including documents and databases. A complete list of references is found at the end of the section; however sources particularly useful include:

- CALVEG habitat mappings GIS layers (U.S. Forest Service, 1999)
- California Natural Diversity Database (CNDDB 2005 version)
- Wildlife Habitats of California (Mayer and Laudenslayer 1988)
- USDA (United States Department of Agriculture) Mendocino National Forest Management Plan, 1995
- Terrestrial Vegetation of California (Barbour and Major 1977)
- Early accounts by settlers and travelers (e.g., Muir 1894)
- Annual Crop Reports (Tehama County Agricultural Commissioner)
- Draft Voluntary Oak Management Plan
- California Department of Conservation Land Mapping Program
- Tehama County Parcel Land Use Information

The primary resource used to characterize vegetation at the watershed scale is the CALVEG data. This data set relies on interpretation of satellite imagery with verification of the images in the field. The CALVEG database was updated in 1998. The minimum mapping unit for this coverage is 2.5 acres. This system classifies the existing plant communities in California. The plant communities are based on one or several dominant plant species or the dominant vegetation form (i.e., meadows or grasslands). CALVEG provides a reasonably accurate assessment of forests and woodland features. Little information is available about the structure of vegetation dominated by shrublands or herbaceous plants. Other sources of information reviewed include Department of Water Resources files pertaining to the water storage projects proposed in the watershed, and information on the Farmland Mapping and Monitoring Program available from the California Department of Conservation, Upper Thomes Creek Watershed Assessment (United States Fish & Wildlife Service [USFWS]) and publications by the California Department of Fish and Game (CDFG) and others. The California Native Plant Society's (CNPS) Inventory of Rare and Endangered Vascular Plants and the California Natural Diversity Database (CNDDB) were searched for the US Geological Survey (USGS) 7.5-minute quadrangles that occur within the boundaries of the watershed for sensitive species.

HISTORICAL CONTEXT

The vegetation of the Tehama West Watershed has changed significantly since the arrival of the first European settlers. These changes include alterations in plant species composition, diversity, and density. Three primary forces have been the driving factors behind these changes:

- Introduction of non-native plant species
- Intensive grazing by imported livestock (prior to regulations)
- Radical alteration of the pre-existing fire regime

To a lesser degree timber management, water management, and agricultural and urban development have also resulted in change. This section summarizes what is known regarding historical vegetation changes and the causes for these changes in western Tehama County.

Historical changes to California's vegetation first began as a by-product of the establishment of missions in coastal areas of California from the Mexican border to just north of San Francisco Bay. Many species of plants were imported intentionally, such as grains to establish an agricultural base. However, there were many other plant species that were introduced unintentionally. These were usually brought in as seed in livestock fodder, animal hair, packing materials, ship ballast, or in soil surrounding fruit cuttings. While the intentionally imported seeds, such as wheat and corn, have been the basis for the highly successful agricultural infrastructure California currently supports, the unintentional species have had major irreversible, and often detrimental, impacts on our wildlands.

Introduced weed seeds primarily came from the Mediterranean region and consisted of species that had evolved in a climate very similar to California. In addition, they were species that had been able to cope with millennia of heavy grazing, overuse of farming land, and severe competition from other aggressive species. Consequently, when these species were released in California, they were pre-adapted to aggressively compete with native grasses and forbs. While the invasion started in the coastal areas near the missions, it quickly extended throughout the Sacramento Valley and adjacent grasslands.

Most of the introduced plants were annuals, forbs, and grasses, including: red brome (*Bromus madritensis* ssp. *rubens*), downy chess (*Bromus tectorum*), false foxtail fescue (*Festucea myuros*), European foxtail (*Festuca bromoides*), foxtail fescue (*Festuca megalura*), hare barley (*Hordeum leporinum*), glaucous barley (*Hordeum glaucum*), nitgrass (*Gastridium ventricosum*), purple falsebrome (*Brachypodium distachyon*), and silver hairgrass (*Aira caryophyllea*). Early Spaniards may have also directly imported wild oats (*Avena fatua*), slender wild oats (*Avena barbata*), annual ryegrass (*Lolium multiflorum*), and soft chess (*Bromus mollis*) and ripgut brome (*Bromus diandrus*). Some annual legumes, such as bur clover (*Medicago polymorpha*) and the filarees (*Erodium* spp.), were also probably imported in this manner.

Additional changes to the state's vegetation came about when appreciable numbers of livestock were imported. Sheep and cattle were originally brought in by the Spaniards but were relatively localized until the Gold Rush and the time of Statehood. Early in the history of Tehama County sheep were the dominant rangeland species. They were seasonally driven into the higher elevations to take advantage of the summer pasturage; consequently, some of the effects noted in the foothill and valley areas also extended into the mountains. The early patterns of sheep use were an asserted factor in the reduction of native perennials and replacement of more aggressive annuals in upper elevation meadows (Muir 1894, Douglass and Bilbao 1975, Rowley 1985, Belsky 1996). John Muir was particularly disenchanted with the effects he saw of sheep grazing.

Sheep populations increased in Tehama County from the Gold Rush/statehood period and peaked in the period from 1890-1930. During this time thousands per year were exported from California to the Midwest, Wyoming, and Idaho (Wagoner 1886). Between 1880 and 1896 from 20,000 to 80,000 sheep per year were driven from the Red Bluff area, north of Mt. Lassen, and through Modoc County. Sheep production peaked in 1930, when Tehama County reported 350,000 head. Since that time numbers have steadily declined while the number of cattle has increased. During the past 40 years, the number of cattle in Tehama County has remained fairly constant (65,000 to 100,000) but sheep populations have declined dramatically and numbered only 5,800 in 2002 (Tehama County 2003). See Figure 2-10 in Section 2, "General Watershed History."

Historical accounts suggested that the sheep usage affected rangeland conditions to a greater degree than cattle. This was likely due to a higher number of concentrated animals over a longer season. The grazing effects were exacerbated by the herders' burning practices that were more frequent and intense than those used by the Native Americans (Wagoner 1886). For areas receiving heavy domestic livestock grazing, the native plants were at a serious disadvantage. Timing of new grazing pressure also contributed to species changes. The result was a very rapid invasion and replacement of many Californian native valley and foothill plants and plant communities with introduced species.

The effects of early-day, unrestrained livestock use of rangelands led to increased federal actions to address the problems. In the 1930s the U.S. Forest Service (USFS) adopted new policies for federal land grazing with the intent to balance range use with their conditions. Grazing permits were issued and some areas were closed to allow for rangeland recovery. During that time predator control and poisonous plant reduction programs were initiated. The 1934 passage of the Taylor Act challenged the USFS's control of rangelands by creating the rival Grazing Service of the U.S. Department of Interior. This competition resulted in longer grazing lease periods and an increased number of permits.

Many range improvement programs were initiated during the period from 1934 to 1944. Additional water sources were developed in dry areas, which allowed greater dispersal of livestock. Seeding and planting efforts were widespread; however, because little attention was given to the use of native seeds, many of the projects actually spread additional exotic species. A common seed mix that was used included wheat grass, common timothy (*Phleum pratense*) and smooth brome (*Bromus inermis*), all introduced species (Menke, et al 1996).

The nineteenth and twentieth centuries were also a time of significant expansion of agriculture in Tehama County, which resulted in significant changes to native grassland and riparian areas. The earliest farming occurred on the large scattered Mexican Land Grants. Farming then spread onto homesteaded valley land due to the demand for food prompted by a rapidly expanding population during the Gold Rush. Cereal farming was first to make its appearance, followed by more diversified and extensive agriculture. In the late 1800s the number of farms in Tehama County ranged from 600 to 800 and increased to 1,900 by 1945. Since then the number of farms have fluctuated, but with a general decline, with 1,679 farms reported in 1997. The farming was concentrated initially along the quality soils in the flat valley areas and rolling foothills. Annual dryland crops were dominant through the 1940s (Tehama County Department of Agriculture 2003). However, these were replaced with orchards following flood control and irrigation supply systems associated with the construction of Shasta Dam. Grazing and agricultural land use reduced the areas of native riparian forest reported to have existed during this period.

The settlers' early and extensive use of fire and heavy grazing has been blamed for exacerbating changes in foothill grassland communities. By 1900 there was a strong sentiment within America that fires in forests needed to be stopped. These fires, whether set by hunters, livestock owners, or by lightning, were viewed to be extremely detrimental to forests and watersheds. Consequently, very effective steps were taken to prohibit intentionally set fires and suppress accidental or natural fires. While well intentioned, halting of fire has had a number of serious consequences.

The forests in the Tehama West Watershed were likely a product of frequent fires. Native Americans set fires and others were ignited by lightning. Because the fires burned frequently, fuel loading (including limbs, downed logs, scattered brush, and litter) was limited. Therefore, when fires burned they produced relatively low amounts of heat and had short durations. The larger trees could endure such fires and an open, "park-like" condition developed (Muir 1901). Suppressing fires has allowed more time for debris and undergrowth to accumulate. After many decades of fire suppression, forests now are much denser, with much higher amounts of forest floor level fuels. The result is that when fires now start, they are very difficult to control and the intensity and severity of the fires tend to kill all or nearly all of the trees.

FOREST MANAGEMENT

Active forest management and harvesting began in the timber portions of the watershed in the later 1940s and early 1950s (Barron 2005, Schoendienst 2005). Up until that point most of the access into the steep country was along game trails via horseback (Barron 2005). The steeper rough topography of the area limited access until the development of larger earthmoving equipment after World War II (Schoendienst 2005). The first entries into the forest and private timberlands were generally correlated to the development of milling facilities in the 1940s. The Crane Mill in Paskenta was constructed in 1946 and the first access roads into the forest were constructed in the same year (Barron 2005). Logging began in late 1948 (Barron 2005).

The first cutting cycle through the timberlands occurred between 1948 and 1960, and included the removal and salvage of high risk trees (Barron 2005, Schoendienst 2005). It is likely that these initial removals favored pine. Local mills were generally pine mills, as pine had the most value of the species at that time.

Subsequent entries into the timberlands began about 1960. The period of 1960 to around 1970 reflected a period of selective harvesting. Larger trees were removed in the more accessible areas to allow regeneration in the understory. Topography continued to limit access to certain areas (Schoendienst 2005). This period resulted in the creation of early seral stage habitat conditions that have continued through today. The period of 1970 through the current period resulted in numerous subsequent reentries to the timbered areas for resource removal. Since 1970 cutting practices have varied by owner. Crane Mills, the largest private land owner in the watershed, has continued to practice a conservative, uneven-aged, selective management strategy, while other private land owners employed more aggressive harvesting practices. The USFS conducted harvesting activities through the late 1980s, when harvesting was greatly reduced due to concern over the spotted owl, and has generally maintained harvesting levels significantly below those prior to the spotted owl management requirements and the Northwest Forest Plan.

The harvesting activities have created significant acres of early seral habitat condition and, when coupled with the fire suppression management strategies of the last century, resulted in significant changes in stand composition. Chuck Schoendienst of the California Department of Forestry and Fire Protection (2005) compared tree inventory data from the western portion of Glenn and Tehama Counties for his upcoming book. The comparison was based predominately on the inventories for the private tracks of land once known as the Commander (or L-P) tract, most recently owned by Pioneer, and divided recently between the USFS and Crane Mills. The initial Commander inventory in 1945 showed that the private forests contained as much as 20,000 board feet per acre. Recent numbers for the same holding indicate that the current stocking is largely in smaller trees (hence the smaller board feet per acre volume) and in a non-climax condition of 2,000 board feet per acre or higher (Schoendienst 2005). The analysis was based on the original 1945 Lolo and Forest inventory and the recent 2003 Pioneer inventory data. This analysis showed that the volume of ponderosa pine had decreased throughout the ownership by 33 percent. In the same time period (1945 to 2003) Douglass fir had increased by 16 percent and white fir/red fir and cedar volumes had increased by 17 percent. The increase of more shade tolerant species is likely a result of the combination of silvicultural techniques not resulting in sufficient stand opening to allow the establishment of ponderosa pine, as well as the continuous strategy of fire suppression. These changes in stand dynamic and species composition to smaller, more shade tolerant species are common throughout California and the western United States. Both Crane Mills and the USFS are reported to carry more volume per acre than the Commander tract residual volumes. It also should be noted that "the private forest land in the western watershed has more early seral stage forest on a percentage basis than does the Mendocino National Forest, but the private land is by no means all early seral stage forest or lacking stand characteristics of more mature forests. Successful regeneration in the watershed requires open canopies because of soil types and precipitation" (Barron, 2005).

EXISTING PLANT COMMUNITIES

Vegetation patterns are shaped by the ecological forces at work in a region. Climate, topography, soil, the frequency of natural disturbance such as fire, and human management are all driving factors that affect how vegetation is distributed on the landscape. Unfortunately, patterns in nature are rarely an unchanging picture. Individual trees grow and die. Fires and other natural calamities periodically result in instantaneous change to entire forests. In this sense, the mosaic of vegetation types (e.g., conifer forest, sagebrush, aspen, etc.) constantly changes with time. To give an example, a mere 12,000 years ago glacial ice covered great portions of California. On a time scale closer to one in which we live, we can use ecology to describe the range of variability in vegetation patterns, and the trend of change in place. Tree ring and glacial records show that as recently as 1760 to 1820, California experienced an extensive period of drought unparalleled anywhere in the recent 2,000 years.

Plants tend to grow in areas where climate and soil are favorable to their specific needs. There are often a wide number of plants that have similar preferences or requirements and consequently are often found together. This mixture of species commonly existing together is known as a plant community. Existing plant communities within the Tehama West Watershed have been classified by CALVEG and cross-walked to Wildlife Habitat Relationship (WHR) habitat types (Mayer and Laudenslayer 1988). The plant communities existing in the Tehama West Watershed are shown in Figure 8-1 and their approximate acreage is summarized in Table 8-1. Although numerous vegetation mapping systems exist, the CALVEG system was selected for this watershed assessment because of the level of detail that it provides, its correlation to databases available with coverage on a statewide basis, and because of the relationship between these vegetation types and wildlife habitat functions.

A description of Tehama West Watershed plant communities beginning with those found in the highest elevations and working downslope follows in this section. USDA (1995), Mayer and Laudenslayer (1988), and Barbour and Major (1977) were used heavily for this section.

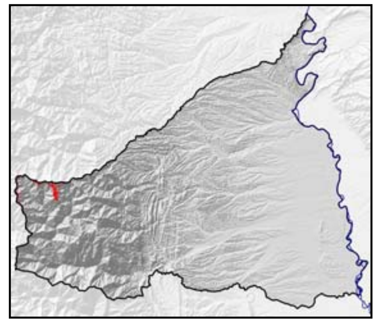
Table 8-1
VEGETATION TYPES (CALVEG WHR) IN THE TEHAMA WEST WATERSHED

WHR Type	Acres	Percent of Tehama West Watershed
Conifer-Dominated Habitats		
Red Fir	1,301	0.19%
White Fir	11,904	1.78%
Klamath Mixed Conifer	47,508	7.11%
Douglas Fir	38,293	5.72%
Ponderosa Pine	5,023	0.75%
Jeffrey Pine	20	0.01%
Montane Hardwoods-Conifer	17,673	2.64%
Closed-Cone Pine-Cypress	725	0.11%
Total	**122,447**	18.33%
Hardwood-Dominated Habitats		
Montane Hardwood	18,228	2.73%
Montane Riparian	83	0.01%
Blue Oak-Foothill Pine	19,931	2.98%
Blue Oak Woodland	110,923	16.60%
Valley Oak Woodland	6,739	1.01%
Eucalyptus	7,746	1.16%
Total	**163,650**	24.49%
Shrub-Dominated Habitats		
Montane Chaparral	3,084	0.46%
Mixed Chaparral	31,632	4.73%
Chamise-Redshank Chaparral	11,256	1.68%
Total	**45,972**	6.88%
Herbaceous-Dominated Habitats		
Wet Meadow	81	0.01%
Annual Grassland	207,668	31.08%
Total	**207,749**	31.09%
Agriculture-Crop-Dominated Habitats	**32,926**	4.93%
Urban-Dominated Habitats	**3,596**	0.54%
Barren Habitats	**2,870**	0.43%
Water/Aquatic Habitats	**1,028**	0.15%
Unclassified Areas	87,930	13.16%
TOTAL	**668,168**	**100.00%**

Note: No data for area east of Interstate 5 (unclassified)

Conifer-Dominated Habitats

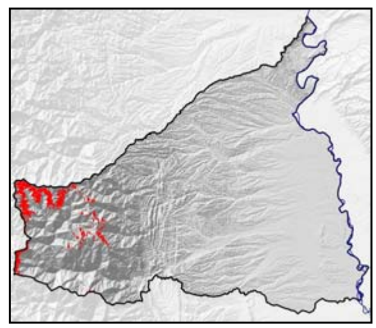
Red Fir



Conifer-dominated habitats extend over 122,000 acres of the Tehama West Watershed, or almost 18 percent of the total area. Red Fir (WHR:RFR) habitats exist on approximately 1,300 acres (<1 percent) of the Tehama West Watershed. This type is located on the highest slopes of the Coast Range, generally above 6,000 feet elevation. Higher elevations are generally sub-alpine or barren. This RFR type tends to have open to moderately open forests with relatively scant undergrowth. The dominant species is red fir (*Abies magnifica*), occasionally with mountain hemlock (*Tsuga heterophylla*) or white fir (*Abies concolor*).

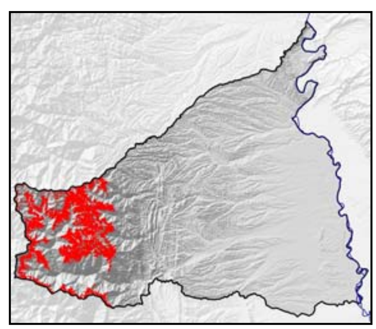
Wet meadows (WHR:WTM) are frequently associated with this habitat because of the occurrence of springs and glacial lakes or bogs at this elevation.

White Fir



White Fir type (WHR:WFR) occurs slightly lower in elevation than RFR habitats and are more widely spread. Almost 2 percent of Tehama West Watershed (11,904 acres) consists of this habitat. In Tehama County this type lies in the 5,000 to 6,000 feet zone, although it can extend lower on north-facing slopes. White fir (*Abies concolor*) is the dominant tree species but it may be mixed with red fir, sugar pine (*Pinus lambertiana*), and Jeffrey pine (*Pinus jeffreyii*). White fir stands, like red fir, tend to be relatively open habitat, however, following fire exclusion policies, occasionally dense understories comprised of trees from seedling to sapling in height exist. WFR stands can also be associated with wet meadows or with narrow riparian stringers (WHR:MRP) along headwater streams. Both RFR and WFR stands have often developed from wildfire-caused brushfields that the shade tolerant conifers eventually overtopped.

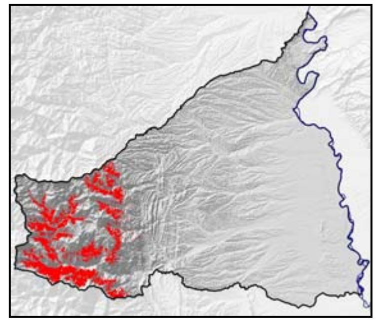
Klamath Mixed Conifer



The most abundant conifer-dominated habitat in Tehama West Watershed is Klamath Mixed Conifer (WHR:KMC) type. KMC covers approximately 47,500 acres or about 7 percent of the watershed. The type extends from approximately 5,000 feet downslope to approximately 2,500 feet elevation, depending upon slope aspect. It is comprised of a mixture of conifer species, including ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudtsuga menziesii*), incense cedar (*Libocedrus decurrens*), white fir and sugar pine, along with California black oak (*Quercus kelloggii*). This type is considered to be the most valuable and intensely managed of the commercial conifer forest types in this region.

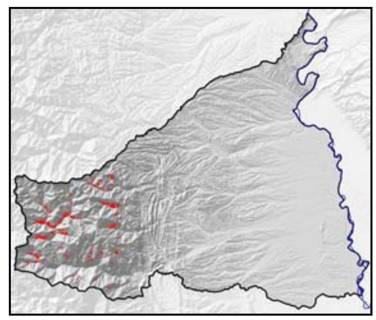
While originally an open forest type, fire suppression and timber management has tended to result in dense KMC stands with relatively high amounts of dead and down logs and litter. Small openings often have shrub and sub-tree species, including deerbrush (*Ceanothus integerrimus)* and Nuttall's dogwood (*Cornus nuttallii*). Species composition is also strongly associated with aspect and south facing slopes are dominated by ponderosa pine and north slopes dominated by Douglas fir within the mixed conifer type.

Douglas Fir



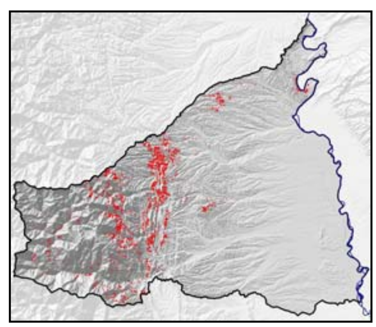
Occasionally, mixed in the KMC type elevation belt, three other conifer-dominated types Douglas Fir (DFR), Ponderosa Pine (PPN), and Montane Hardwood (MHC) are found. They have strong similarities to the KMC type but have slightly different conifer makeup: due to soil characteristics or past fire history. The first example are the stands dominated by Douglas Fir (WHR:DFR). Tree associates include California black oak and canyon live oak (*Quercus chrysolepis*). The understory can be quite variable in composition and density. It is usually found at mid- or lower elevations within the conifer zone and on north-facing slopes. Approximately 38,300 acres of dry fir forests exist in Tehama West Watershed, or slightly more than 5 percent of the total area.

Ponderosa Pine and Jeffrey Pine



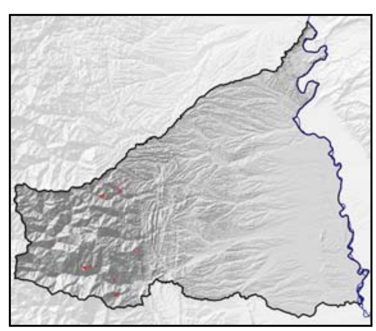
Stands dominated by Ponderosa Pine (WHR:PPN) occur on southern aspects at mid- or lower conifer zone. While sometimes growing as a monoculture, these stands often include a number of the other tree species found in KMC habitats. Undergrowth tends to be light. This habitat covers only about 5,000 acres. Jeffrey Pine (WHR:JFP) habitat types are rare and only found on 20 acres of the watershed. The type is dominated by Jeffrey pine and is often associated with soils high in magnesium and iron (ultra-mafic).

Montane Hardwood-Conifer



Montane Hardwood-Conifer habitats (WHR:MHC) exist in the same elevation zone as the KMC habitat. These stands have a mix of conifers and hardwood species in their overstory, especially Douglas fir, canyon live oak and California black oak. They appear to be a gradation in all manners between conifer- and hardwood-dominated habitats. This habitat tends to form near the lower elevations of the conifer-dominated habitats on relatively poor and rocky soils, and is estimated to cover 17,673 acres (almost 3 percent of the watershed).

Closed-Cone Pine-Cypress

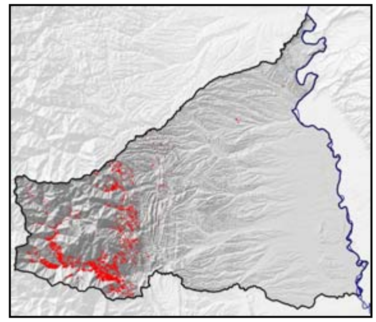


Closed-cone pine-Cypress habitats (WHR:CPC) cover 725 acres and are generally dominated by knobcone pine. In many ways this conifer type is much more like a chaparral habitat than a conifer type, as it is highly dependent upon high severity fires to regenerate its stands, is relatively short-lived, and tends to exist on harsh sites with poor soils. Knobcone pine's serotinous cones hold seeds tightly enclosed until heat pops them open. These stands often are densely covered with the pine, but heavy shrub islands can also occur, comprised of several species of manzanita and other chaparral. These habitats can be found from 3,000 feet down to 1,000 feet elevation, often on south-facing slopes.

Hardwood-Dominated Habitats

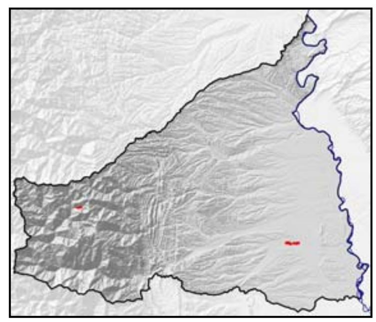
Hardwood-dominated habitats cover approximately 25 percent of the Tehama West Watershed (about 164,000 acres).

Montane Hardwood



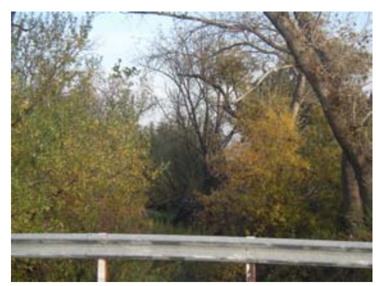
Montane hardwood habitats (WHR:MHW) can be found from 3,000 down to 1,000 feet elevation. Dominant trees include California black oak, coast (*Quercus agrfolia nee*) and interior live oak (*Quercus wislizeni*), and California bay-laurel (*Umbellularia californica*). Stands of this type are frequently found adjacent to conifer (e.g., KMC) or chaparral communities. Typically, soils are shallow and rocky, probably one reason why conifers do not dominate the sites. Chaparral species such as deerbrush, buckbrush, and manzanita often form a shrubby understory. This habitat exists on 18,228 acres of the watershed (almost 3 percent of the watershed area).

Montane Riparian



Montane riparian habitats (WHR:MRP) generally exist as narrow streamside buffers from 6,000 down to 2,500 feet elevation. Primary overstory trees include black cottonwood (*Populus balsamifera ssp trichocarpa)* and white alder (*Alnus rhombifolia*), with a willow (*Salix lasiandra*) and dogwood understory. In many cases this habitat is a very narrow swath on either side of streams, because the floodplain is constrained by the steep canyon slopes that support upland conifer- or hardwood-dominated habitats. Only 83 acres of this habitat has been typed (see Table 8-1).

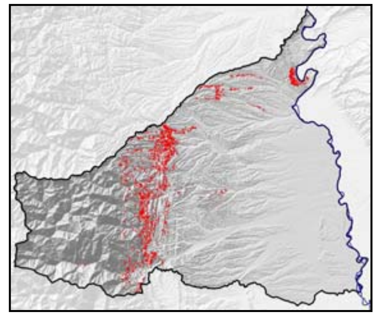
Valley Foothill Riparian



Valley Foothill Riparian Habitat, Houghton Creek

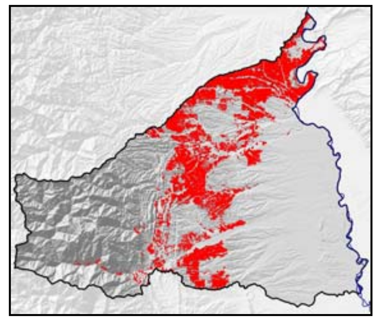
As Tehama West Watershed streams flow out of the Coast Range, the montane riparian habitat (MRP) gradually transitions into Valley Foothill Riparian (WHR:VFR) habitats. Dominant tree species include Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), white alder, and valley oak (*Quercus lobata nee*). Understory shrubs include wild grape, wild rose, California blackberry, poison oak, and willows. Lianas (hanging vines) such as wild grapes are a common feature of this habitat type. Because this habitat exists along streams that are unconstrained by canyon topography, the VFR riparian zone can be relatively wide. In prehistoric times it was likely up to 20 miles wide in the lower Sacramento and San Joaquin River reaches (World Wildlife 2005). In cases where disturbances such as floods or gravel mining occur in valley streamside zones, shrub willows are often the first species to be established in this type, followed by the taller growing tree species. There is no available estimate of the amount of VFR in the watershed.

Blue Oak-Foothill Pine



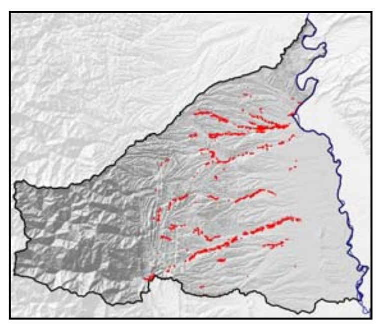
The eastern foothills of the Coast Range are commonly covered by Blue Oak-Foothill Pine (WHR:BOP) habitats. This habitat often occurs on rocky and thin-soiled slopes below 2,000 feet elevation. Blue oak (*Quercus douglasii*) and foothill pine (*Pinus sabiniana*) typically comprise the overstory of this type, with scattered pockets of interior live oak. The understory can have significant amounts of chaparral shrub species (see later description of Mixed Chaparral habitat) or annual grasslands. Over 19,000 acres of the Tehama West Watershed consists of this type.

Blue Oak Woodland



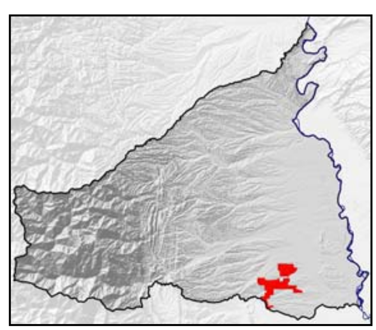
Blue Oak Woodlands (WHR:BOW) are similar to BOP habitats but lack the scattered overstory of foothill pine and have less chaparral understory. The BOW habitat typically occurs lower in elevation, generally below 1,500 feet elevation. This is the most common tree-dominated habitat in Tehama West Watershed, extending over almost 111,000 acres or 16 percent of the entire watershed. The type forms a discontinuous ring in the foothills around the Central Valley. It is dominated by open-grown blue oak over an annual grass and forb understory but there may be occasional pockets of chaparral. Characteristically, blue oak communities occur on dry, rocky slopes in infertile soils. This community gradually thins out and is replaced by annual grasslands below 500 feet elevation. Cattle grazing, low seedling recruitment, and land conversions are contributing to the gradual loss of blue oak woodland throughout the state. Extensive areas of this type were converted to grasslands through the 1950s to improve cattle range.

Valley Oak Woodland



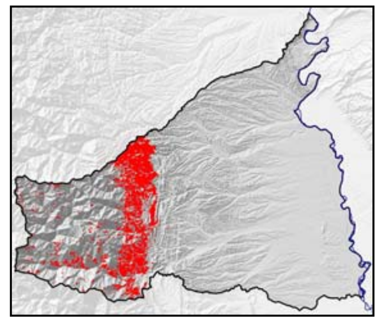
Valley oak are among the tallest growing of all California's oaks and provide the dominant overstory tree in the Valley Oak Woodland (WHR:VOW) community. Mature valley oaks can reach a height of 115 feet. These stands occur in the Sacramento Valley floor along natural drainages. VOW stands with little or no grazing and those in riparian areas tend to develop a partial shrub understory of poison-oak, toyon, wild grape, and coffeeberry. In other situations the tree cover is open-grown with an annual grass and forb understory. Common associates of the valley oak include California sycamore, Hinds black walnut, interior live oak, and boxelder. This type covers over 6,700 acres in the watershed.

Eucalyptus



Eucalyptus woodlands (WHR:EUC) exist within the hardwood habitat covering almost 8,000 acres in the lower elevations of the Sacramento Valley, close to Interstate 5. Eucalyptus (*Eucalyptus globulus*) was originally introduced a century ago to provide wood lots for fire wood, as well as for fuel to power steam engines (Schoendienst 2005). Eucalyptus cuttings were initiated several decades ago to provide a wood chip base for the pulp industry in northern California. The trees are irrigated by drip-hoses and grow very rapidly. Management consists of periodic whole-tree shearing and chipping, allowing the sprouting tree to regrow. Because the pulp mill that was to use this product has closed, the final product coming from the EUC stands now goes to garden mulch, but the plantations are still being managed and maintained in a manner similar to that originally planned. Very little, if any, competing trees or shrubs exist in these plantations, but annual grasses and forbs exist in openings.

Shrub-Dominated Habitats

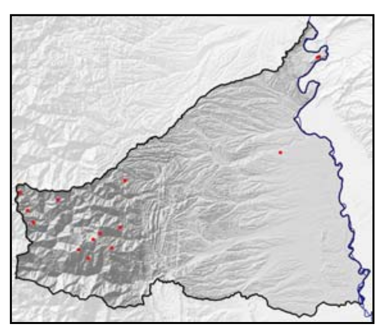


About 8 percent of the Tehama West Watershed area is dominated by shrub communities (about 46,000 acres). Three chaparral-dominated habitats constitute these shrub types, including: Montane Chaparral (WHR:MCP), Mixed Chaparral (WHR:MCH), and Chamise-Redshank Chamise (WHR:CRC). These habitats tend to form dense canopies comprised of relatively few chaparral species. Generally speaking, MCP habitats exist at the highest elevations and are often associated with conifer-dominated stands. Common shrub species include manzanita species, chinquapin (*Chrysolepis* spp.), deerbrush (*Ceanothus integerrimus*) or wedgeleaf ceanothus (*Ceanothus cunneatus*) and silk-tassels (*Garrya* spp.). MCH stands are found at intermediate elevations at or near the lower limits of the KMC zone and include several manzanita, Ceanothus species, and birch-leafed mahogany (*Cercocarpus betuloides*). CRC habitats are found the lowest elevation of the chaparral habitats and are dominated by nearly pure stands of chamise (*Adenostoma fasciculatum*). The MCH and CRC habitats exist on poor, rocky soils, often with severe, southerly aspects, while MCP stands may represent the result of recent fires and ultimately may evolve into conifer stands.

Mature chaparral-dominated habitats have little herbaceous growth, due to nearly total canopy cover by the shrub's foliage. However, these types are well adapted to periodic wildfires and respond by both resprouting (e.g., chamise and some manzanitas) and rapid reseeding (some *Ceanothus* and some manzanita species). For several years following wildfire, where reduced shrub canopy cover allows sunlight on the soil, annual forbs growth can be very abundant. This likely stems from seed that persisted in the soil for long periods of time. These three chaparral habitats cover approximately 46,000 acres or about 6 percent of the Tehama West Watershed.

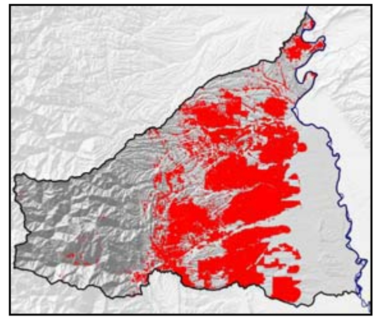
Herbaceous-Dominated Habitats

Wet Meadow



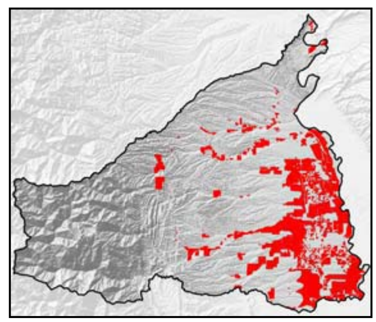
Wet Meadows (WHR:WTM) are uncommon and scattered in the Tehama West Watershed, comprising only 81 acres. Because they tend to be small in size, CALVEG typing likely failed to detect many of these meadows and their true extent may be greater. They can be found at any elevation within the watershed. Wet meadows consist of herbaceous species (grass and forbs) that require or tolerate saturation of soils all, or nearly all, of the year. The saturated soil conditions that create this habitat can be attributed to adjacent springs or streams or local sub-surface soil conditions that prevent surface water from infiltrating the ground. Scattered patches of shrubs, such as willow (*Salix spp.*) or dogwoods (*Cornus spp.*) can exist along the edges or within these meadows. Likewise, moist-soil-tolerant conifer species, such as lodgepole pine (*Pinus contorta*), can be associated with WTM margins. These habitats can be spectacular in early summer with their colorful show of wildflowers.

Annual Grassland



Annual Grasslands (WHR:AGS) are by far the most common habitat existing within the watershed, covering almost 208,000 acres, or about 30 percent of the Tehama West Watershed. These annual grasslands are generally made up of introduced annual grasses and both native and introduced forbs. They exist in elevations below blue oak woodlands, where soil conditions do not favor other hardwood growth, or as openings in blue oak woodlands. Decades of ranching, agricultural use, and extended drought periods have nearly converted the state's dry upland from perennial bunchgrass-dominated grasslands to an annual system dominated by grasses, forbs, and broad leaf. A unique sub-set of the remaining native grassland community is comprised of nodding needlegrass (*Nasella cernua*), found at its northern limit in Tehama County, just north of Black Butte Reservoir (CNDDB 2005).

Agricultural-Crop-Dominated Habitats



For the purpose of this discussion, the term "agricultural-crop-dominated habitats" refers to orchard, field crops, and row crops (WHR:AGC). In some cases pastures may also be included, but not rangelands seasonally-used for grazing, which are generally termed annual grasslands (AGS). Typically, agricultural lands are monotypic; however, trees and shrub rows often exist as windbreaks at field edges or fence lines and some weedy vegetation is found along field edges and roads. There are approximately 80,500 acres of agricultural land in the Tehama West Watershed (almost 5 percent of the total area), with grain, rice, orchards, and hay making up the majority of the acreage. Table 8-2 contains acreage statistics for the agricultural land uses in the watershed based on Tehama County parcel data. These are discussed in more detail in Section 3, "Demographics, Land Use, and Economic Activity" and Section 7, "Water Quality."

Urban-Dominated Habitats

Scattered metropolitan areas and suburban and rural communities constitute urban habitats (WHR:URB). These habitats are characterized by human modifications to allow year-round habitation. Plant composition is highly variable and includes high concentrations of exotic ornamental shade trees and shrubs, as well as small inclusions of habitat dominated by native vegetation (e.g., riparian areas). Within western Tehama County the largest urban areas are Red Bluff and Corning, with smaller urban areas including Paskenta, Flournoy, Richfield, Tehama, Gerber, and Proberta. Urban habitats take up almost 3,600 acres of land (< 1 percent) of the watershed area. These urban habitats are a source of exotic species that pose a continuous threat to wildlands.

Table 8-2 AGRICULTURE LAND USE IN THE TEHAMA WEST WATERSHED		
Land Use Code	**Land Use Description**	**Acreage**
30X: 300-306	Irrigated Prune Orchard	9,140
31X: 310-316	Irrigated Walnut Orchard	7,160
32X: 320-326	Irrigated Almond Orchard	7,053
33X: 330-336	Irrigated Olive Orchard	7,665
34X: 340-346	Irrigated Miscellaneous Orchard	1,278
35X: 350-356	Irrigated Vine & Bush Fruits	53
36X: 360-366	Irrigated Row Crops	3,301
37X: 370-376	Irrigated Field Crops	10,433
40X: 400-408	Irrigated Pasture	23, 883
50X: 500-506	Dry Land Orchard	19
52X: 520-526	Dry Land Field Crops	10,517
TOTAL		**80,502**
Source: Tehama County Parcel Data		

Barren Habitats

Barren areas (WHR:BAR) can be found scattered throughout the Tehama West Watershed at virtually any elevation. These sites have little or no vegetation due to adverse soil conditions or recurring soil movement. Examples include shear rock faces and cliffs and areas with serpentine soils that have excess levels of magnesium and iron. The plants living on these areas are highly adapted for dealing with the significant moisture retention and chemical-imbalance challenges associated with these barren sites. These soil types support unique assemblages of plant species with many endemic and rare species. These will be discussed in the following section.

Serpentine Soils (Barren Habitats)

Water/Aquatic Habitats

Both perennial and seasonal aquatic habitats exist within the Tehama West Watershed. Perennial aquatic habitats are those existing in reservoirs, streams, and ponds (WHR:LAC). Emergent vegetations, such as tule are typical. Seasonal aquatic habitats include vernal pools, which have water during the wet season and quickly dry in the spring. The vernal pools and marshes are sensitive botanical resources that have limited distribution in Tehama County. Marshes tend to be very effective at filtering water of sediment and contaminants, and are therefore valuable for water quality. The vernal pools are well-known for providing habitat for rare plant and animal species, which will be described in the following section as well as in Section 3, "Demographics, Land Use, and Economic Activity" and Section 9, "Wildlife Resources." Aquatic habitats cover approximately 1,000 acres of land in the Tehama West Watershed.

SENSITIVE BOTANICAL RESOURCES

Freshwater Marsh, Central Valley

Sensitive botanical resources are defined to be Tehama West Watershed plant communities that are limited in extent, contain a variety of rare species, or are at significant risk of reduction due to human activities or other factors. In some cases a given plant community may have all of these attributes. The sensitive botanical resources identified for the Tehama West Watershed includes those listed by the California Natural Diversity Database (2005) and others known to have environmental sensitivities or outstanding attributes:

- Great Valley (Central Valley) mixed riparian forests
- Great Valley oak riparian forests
- Great Valley cottonwood riparian forests
- Great Valley willow shrub habitats
- Great Valley freshwater marshes
- Great Valley needlegrass grasslands
- Northern hardpan vernal pools
- Plant communities on serpentine soils
- Oak woodlands

Great Valley Riparian and Related Habitats

The Great Valley habitats delineated (including mixed, cottonwood, and oak riparian forests), have been greatly reduced during historical times due to conversion of croplands, flood control and stream channelization, and urbanization. These habitats occurred in low-lying areas, near the Sacramento River or major tributaries that are now considered prime for either agricultural development or urbanization. There are likely remnants of these habitats in scattered locations along the eastern edge of the watershed.

Great Valley needlegrass habitats represent what portions of the Central Valley might have been like prior to settlement. Only a few examples of this community still exist, with a site just north of Black Butte Reservoir being the northern representative.

Great Valley freshwater marshes have been greatly affected by gravel mining, stream channel modifications, and water flow management, including the diversion of water from streams. At one time the rivers and low-lying areas of the Central Valley supported vast freshwater marshlands and it is estimated that less than 6 percent remains today of what originally existed (World Wildlife 2005).

Vernal Pool Habitats

One significant example of sensitive wetlands is the hardpan vernal pools found in a band from Red Bluff in the north to the Glenn County line in the south (see Figure 8-2). Vernal pools are habitats that are inundated for a few days to a few months during the spring. They typically form in small depressions that are underlain by impermeable sub-soils (see Section 4, "Geology and Soils"). They provide a unique habitat for both plant and animal species, particularly invertebrates. Some of these species are endemic, not being found anywhere else on the earth.

Vernal pools in the Sacramento Valley are essentially islands of native vegetation in non-native grasslands; only about 20 of the 200 species known to exist in them are non-native (Holland and Jain 1984). The water relations in these pools and their landscapes can be easily altered by plowing, paving, road construction, ripping the subsoils, flood control activities or simply by altering the landscape that lies upstream of existing pools. It is generally in landscapes that have unaltered hydrologic regimes that vernal pools and their associated flora are found to persist.

Vernal Pool, Central Valley

Because of their importance, vernal pools were mapped by CDFG in 1998. This mapping provides the sources of Figure 8-2. CDFG is also responsible for managing a vernal pool reserve located northwest of Corning. Ongoing studies include the effects of grazing on the vegetation and ecological function; the habitat values of the pools; and techniques of managing vernal pool landscapes to maintain diversity. Through the past decade efforts have been placed into creation of vernal pool habitats.

Vernal pool landscapes evolved under the impacts of grazing from native herbivores. One management decision that may indirectly affect hydrology is the cessation of livestock grazing. Although vernal pools may not have evolved under extensive grazing practices common today, the current hydrology and ecology of most vernal pool landscapes in the Sacramento Valley have been influenced by a livestock grazing regime. Observations of vernal pool sites where livestock were excluded for fifteen years indicate that removal of livestock favors exotic annual species around the margin of vernal pools. Complete rest from livestock grazing may also alter the hydrology of the vernal pool landscape by increasing residual dead plant material and altering the soil structure (Barry 1996; UCAE 2005).

Numerous studies have been conducted on vernal pool habitats in California by The Nature Conservancy (TNC), CDFG, Natural Resources Conservation Service (NRCS) and others showing that grazing can help reduce the cover of invasive non-native species (DiTomaso 2000, Marty 2004). Locally in Tehama County (eastern portion), CDFG biologists are evaluating community interaction and grazing effects on vernal pool plants and macroinvertebrates (Lis and Eggeman 1999) however, the results of grazing trials have not been published. In areas where native herbivores have been eliminated, livestock grazing may replicate ecological disturbance processes vital to local ecosystems (Marty 2004, Collins 1998). In 2000, researchers in TNC Consumnes River Preserve began an experiment examining the role cattle grazing plays in the maintenance of plant and animal wetlands. A summary of the results from 2004 are as follows.

TNC tested the impact of four grazing treatments on two soil types. After just 3 years, the ungrazed vernal pools became overgrown with non-native vegetation following grazing, and the small species composition of the pools shifted to non-native grass. The hydrology of the ungrazed pools also changed significantly over the 3 years of the experiment. In 2003, the pools that were ungrazed had an average maximum inundation period of 65 days, whereas the continuously grazed pools were inundated for a maximum of 115 days. In addition to this reduction in the inundation period, the ungrazed pools dried and refilled an average of twice per season, while the continuously grazed pools dried fewer than once per season on average. Invertebrate taxa richness was negatively affected by these hydrologic changes. By the third year, taxa richness was approximately 20 percent lower in the ungrazed treatment group than in the continuously grazed control group. The research found that livestock grazing plays an important role in maintaining species diversity in the vernal pool grasslands studied. Grazing removal resulted in significant negative effects on the pools native plant communities, hydrology, and aquatic invertebrate communities. Researchers concluded that grazing should be considered a potentially positive force for the maintenance of biodiversity in some situations.

On the other hand, improperly managed grazing can negatively impact vernal pools. Disturbance can include the compaction of soils, particularly when they are wet, and excessive loss of native vegetation. In planning for grazing livestock, managers should consider the effects of grazing different livestock, season of grazing, and grazing intensity (Barry 1996; UCAE 2005).

Ultra-Mafic Habitats

The Coast Range contains significant acreage of temperate forest and Mediterranean scrub (chaparral) and savanna. The temperate coniferous forests of northwestern California contain significant expressions of biodiversity due to the area's complex terrain, geology, climate, and biogeographic history. Although well-known among biologists, few Americans realize the uniqueness of these coniferous forests (Rickets 1999). Plant communities located in this area, whether dominated by conifer, shrub, or herbaceous cover are particularly rich in endemic plants and these plants support endemic invertebrates (Rickets 1999). Rare species located in these habitats of the Tehama West Watershed will be described later in this section.

The main reason for the high number of rare, endemic plants in the Coast Range is the presence of outcrops of ultra-mafic soil that are rich in magnesium and iron. Many species of plants cannot grow in these conditions and others can survive but appear stunted. These areas have an unusual appearance, as if they had been burned, greatly reducing the density of vegetation. Because of the chemical imbalances inhibiting many species and the patchy nature of these geologic formations, many rare plant species that are tolerant of the chemical anomalies have evolved. A list of the rare plants known to exist in the Tehama West Watershed (many of which live exclusively or frequently on serpentine soils) is presented in the next section.

THREATENED AND ENDANGERED SPECIES

The United States Congress passed the Federal Endangered Species Act (FESA) in 1973 with the goal of protecting species that were endangered or threatened with extinction. The State of California enacted a similar law, the California Endangered Species Act (CESA) in 1984 and Native Plant Protection Act. Both regulatory entities have processes by which species are nominated and reviewed for suitability to be considered and placed on a list as either threatened or endangered. California also has a list of animal species that are not included under CESA but potentially could be at-risk, called "Species of Special Concern." Lists of federal- and state-listed species can be found in Section 9, "Wildlife Resources." Any project that could affect the habitat or individual species on any of these lists requires species assessments, permits, and mitigation.

For plants, an additional entity, the California Native Plant Society (CNPS), maintains a list of species that have low numbers, limited distribution, or are otherwise threatened with extinction. The USFS and Bureau of Land Management (BLM) also maintain special species listings and should be continued for projects on federal land. This information is published in the Inventory of Rare and Endangered Vascular Plants of California (CNPS 1994). The categories used by CNPS to describe individual species' conditions are:

- 1A-Plants presumed extinct
- 1B-Plants rare, threatened, or endangered in California and elsewhere
- 2-Plants rare, threatened, or endangered in California, but more common elsewhere
- 3-Plants for which more information is needed to determine status
- 4-Plants with limited distribution

Table 8-3 lists the rare, threatened and endangered plants known to occur in western Tehama County. It is important to appreciate that of the 28 species shown, 11 (39 percent) are known to be strongly associated with serpentine soils, 6 (21 percent) occur only in vernal pools, and two (7 percent) are found in marshes and other wetlands. In other words, 19 of 28 rare plant species (68 percent) exist in habitats that are represented in only a very small percent of the watershed's lands, and in the case of wetlands and marshes, habitats that have been greatly reduced through historical development.

Table 8-3
ENDANGERED, THREATENED, AND RARE PLANT SPECIES

Common Name	Latin Name	Status	Preferred Habitats	Records for Tehama West
Hendersons' bent grass	*Agrostis hendersonii*	CNPS 3	Wetlands	1
Scabrid alpine tarplant	*Anisocarpus scabridus*	CNPS 1B	Sub-alpine	5
Sonoma manzanita	*Arctostaphylos canescens ssp. sonomensis*	CNPS 1B	Serpentine/Forest	1
Konocti manzanita	*Arctostaphylos manzanita ssp. elegans*	CNPS 1B	Mixed Conifer	1
Jepson's milk-vetch	*Astragalus rattanii ssp. jepsonianus*	CNPS 1B	Serpentine/Oak Woodlands	1
Big-scale balsamroot	*Balsamorhiza macrolepis* var. *macrolepis*	CNPS 1B	Serpentine/Chaparral	3
Indian Valley brodiaea	*Brodiaea coronaria* ssp. *rosea*	State Endangered CNPS 1B	Serpentine/Closed Pine and Chaparral	2
Stony Creek spurge	*Chamaesyce ocellata* ssp. *rattanii*	CNPS 1B	Valley and Foothill Grasslands	18
Dwarf soaproot	*Chlorogalum pomeridianum* var. *minus*	CNPS 1B	Serpentine/Grasslands and Chaparral	11
Silky cryptantha	*Cryptantha crinita*	CNPS 1B	Gravelly Streambeds	2
Dwarf downingia	*Downingia pusilla*	CNPS 2	Vernal Pools	11
Four-angled spikerush	*Eleocharis quadrangulata*	CNPS 2	Marshes/Ponds	4
Oregon fireweed	*Epilobium oreganum*	CNPS IB	Serpentine/Forest Bogs	1
Brandagee's eriastrum	*Eriastrum brandageeae*	CNPS 1B	Barren Volcanic Chaparral	26
Tracy's eriastrum	*Eriastrum tracyi*	State Rare CNPS 1B	Chaparral	1

Table 8-3 (cont.) ENDANGERED, THREATENED, AND RARE PLANT SPECIES				
Common Name	**Latin Name**	**Status**	**Preferred Habitats**	**Records for Tehama West**
Adobe-lily	*Fritillaria pluriflora*	CNPS 1B	Chaparral/Adobe Soil	1
Boggs Lake hedge-hyssop	*Gratiola heterosepala*	State Endangered CNPS 1B	Vernal Pool	2
Nile's harmonia	*Harmonia doris-nilesiae*	CNPS 1B	Serpentine/Chaparral	1
Stebbin's harmonia	*Harmonia stebbinsii*	CNPS 1B	Serpentine/Chaparral	5
Tehama County western flax	*Hesperolinon tehamense*	CNPS 1B	Serpentine/Chaparral	9
Red Bluff dwarf rush	*Juncus leiospermus* var. *leiospermus*	CNPS 1B	Vernal Pools	5
Colusa layia	*Layia septentrionalis*	CNPS 1B	Serpentine/Chaparral	1
Mt. Tedoc leptosiphon	*Leptosiphon nuttallii ssp. Howellii*	CNPS 1B	Serpentine/Lower Forest	4
Anthony Peak lupine	*Lupinus antoninus*	CNPS 1B	Sub-alpine	1
Leafy-stemmed miterwort	*Mitella caulescens*	CNPS 1B	Conifer Forest/Seeps	1
Baker's navarretia	*Navarretia leucocephala* ssp. *bakeri*	CNPS 1B	Vernal Pools	1
Pincushion navarretia	*Navarretia myersii* var. *myersii*	CNPS 1B	Vernal Pools	1
Ahart's paronychia	*Paronychia ahartii*	CNPS 1B	Vernal Pools	10
Source: CNDDB, 2005				

Endangered plants within the watershed area are found in six major habitat types. Figure 8-3 displays occurrences of rare plants in the watershed. Habitat types and number of species per type are included in Table 8-4.

Table 8-4 HABITAT TYPES AND NUMBER OF SPECIES IN THE WATERSHED	
Type	**Number of Species**
Vernal pool	12
Serpentine soils	31
Chaparral (non-serpentine soil)	15
Conifer forest	12
Mesic (bogs, riparian areas, meadows, etc, but not vernal pools)	23
Grasslands	6
Miscellaneous (rock outcrops, rocky streams, etc)	6

Although vernal pool habitats discussed previously have received, by far, the greatest regulatory attention, other habitat types such as serpentine soil areas (both chaparral conifer and grassland) also harbor populations of species narrowly adapted to the specific habitat.

Serpentine soils are derived from deep ocean rock formations that were metamorphosed, pushed up to the surface, and weathered. While relatively rare on the surface of the earth, they are common in California and the watershed's Coastal Range Mountains. These soils have high levels of magnesium and iron but relatively low amounts of other essential minerals, such as calcium. In addition, the soils are often thin and retain little moisture. These conditions create a physical environment that severely challenges most plant species. While some taxa cannot endure the conditions, other species can. For this reason, the vegetation growing on serpentine soils often looks relatively stunted (Raven 1977).

Serpentine soils tend to be patchy in distribution; consequently, the species that can endure these soils are often surrounded by vegetation communities where they cannot compete as well. This isolation of populations resulted in the evolution of a large number of rare, endemic plant species with very limited geographic distribution. There are approximately 282 rare plant species existing in California that are primarily associated with serpentine soils and Tehama West Watershed supports some of these species.

INVASIVE PLANTS AND OTHER NOXIOUS WEEDS

Some experts consider invasive species to be a serious threat to global biodiversity, second in importance only to direct habitat loss and fragmentation. Invasive plants are usually non-native species that spread easily and displace native species. The problem with "weeds" or "pest plants" in California is widespread and serious due to the State's varied topography, geology and climate. Invasive plants can adversely impact native vegetative communities by altering patterns of nutrient cycling, hydrological processes, and the intensity of fire (Bossard et al 2000). Plant pests are defined by law, regulation, and technical organizations, and regulated by many different sources, which include the California Department of Food and Agriculture (CDFA), United States Department of Agriculture (USDA), and the California Invasive Plant Council (CalIPC). The CDFA uses an action-oriented pest-rating system. The rating assigned to a pest by the CDFA does not necessarily mean that one with a low rating is not a problem, but the rating system is meant to prioritize response by the CDFA and County Agricultural Commissioners. Plants on the CDFA's highest priority "A" list are defined as plants, "of known economic importance subject to state-county enforced action involving eradication, quarantine regulation, containment, rejection or other holding action."

A group of technical experts called the California Invasive Plant Council has developed a list of plant pests specific to California wildlands. The "CalIPC" list is based on information submitted by land managers, botanists, and researchers throughout the state and published sources. The list highlights non-native plants that pose serious problems in wildlands (i.e., natural areas that support native ecosystems, including national, state and local parks, ecological reserves, wildlife areas, national forests, BLM lands, etc.). Plants found mainly in disturbed areas, such as roadsides and agricultural fields, and plants that establish sparingly and have minimal impact on natural habitats are not included on the list. The CDFA and CalIPC list categories are explained in more detail in Table 8-5

The Tehama County Agricultural Commissioner maintains a list of the CDFA-rated invasive plants known to occur in the county. This list and the CDFA and CalIPC designations of these plants are provided in Table 8-6. Table 8-7 provides a list of the CalIPC invasive pests.

Table 8-5 CDFA AND CALIPC LIST CATEGORIES FOR INVASIVE PLANTS AND NOXIOUS WEEDS	
CDFA List Categories	
A	An "A" rated organism is one of known economic importance subject to state-county enforced action involving eradication, quarantine regulation, containment, rejection or other holding action.
B	An organism of known economic importance subject to eradication, containment, control or other holding action at the discretion of the individual county agricultural commissioner, or an organism of known economic importance subject to state endorsed holding action and eradication only when found in a nursery.
C	An organism subject to no state enforced action outside of nurseries except to retard spread, generally at the discretion of a commission or an organism subject to no state enforced action except to provide for pest cleanliness standards in nurseries.
Q	An organism requiring temporary "A" action pending determination of a permanent rating. The organism is suspected to be of economic importance but its status is uncertain because of incomplete identification or inadequate information.
D	No action.
CalIPC List Categories	
A	Most Invasive Wildland Pest Plants; documented as aggressive invaders that displace natives and disrupt natural habitats. Includes two sub-lists: List A-1 includes widespread pests that are invasive in more than three Jepson regions, and List A-2 includes regional pests invasive in three or fewer Jepson regions.
B	Wildland Pest Plants of Lesser Invasiveness; invasive pest plants that spread less rapidly and cause a lesser degree of habitat disruption; may be widespread or regional.
Red Alert	Pest plants with potential to spread explosively; infestations currently small or localized. If found, alert CalIPC, County Agricultural Commissioner, or California Department of Food and Agriculture.

Additional information on common invaders is included on Table 8-8. Weed Management Areas (WMA) are local organizations that bring together various private and government officials to cooperatively coordinate efforts for controlling the spread of common invasive plants. The Tehama WMA is participating in a multi-county effort with Glenn and Colusa Counties to map and control invasive plants.

Once invasive plants have spread into native vegetative communities, such as riparian areas or annual grassland, it is very difficult to eradicate them. Weed control methods include physical control (e.g., burning, hand pulling), chemical control (e.g., selective or non-selective herbicides), and biological control (e.g., insects that eat the pest). A group of sixteen state and federal agencies called the California Interagency Noxious Weed Coordinating Committee created the Calweed database that provides information on weed control projects underway in California counties. According to the database there are presently nine weed control projects in Tehama County, including focused efforts against seven of the species listed in Table 8-8. These projects include the county agricultural commissioner, conservation groups, and the Tehama County Resource Conservation District (TCRCD).

In 2002 stream restoration projects for Reeds Creek and Red Bank Creek were initiated through a partnership with the TCRCD, CSU Chico, Chico's Non-Native Eradication Team, and the Tehama County Agriculture Department. During the first season, 12 acres of Red Bank Creek and 8 acres of Reeds Creek were treated with the EPA aquatically approved herbicide, Rodeo™. This project has been successful, involving over 100 landowners.

Table 8-6 CDFA NOXIOUS WEEDS FOUND IN TEHAMA WEST WATERSHED					
Rank	**Latin Name**	**Common Name**	**Found in Tehama County**	**Verified in Tehama West Watershed**	**Target for Eradication**
A					
	Centaurea diffusa	Diffuse knapweed	X	X	X
	Centaurea maculosa	Spotted knapweed	X	X	X
	Chondrilla juncea	Skeletonweed	X		X
	Linaria genistifolia ssp *dalmatica*	Dalmation toadflax	X	X	X
	Hydrochoris morsus-ranae	European frogbit	X		X
B and C					
	Allium vineale	Wild garlic	X		
	Cardaria draba	Heart-podded hoarycress	X		X
	Cirsium arvense	Canada thistle	X	X	X
	Elytrigia repens	Quackgrass	X		
	Isatis tinctoria	Dyer's woad	X		X
	Lepidium latifolium	Perennial peppercress	X		
	Euphorbia oblongata	Oblong spurge	X		X
	Carduus pycnocephalus	Italian thistle	X	X	
	Centaurea solstitialis	Yellow starthistle	X	X	
	Convolvulus arvensis	Field bindweed	X	X	
	Cuscuta spp.except *C. reflexa*	Dodder	X	X	
	Cynodon spp and *hybrids*	Bermudagrass	X	X	
	Cytisus scoparius	Scotch broom	X	X	
	Genista monspessulana	French broom	X		
	Hypericum perforatum	Klamath weed	X	X	
	Salsola tragus	Common Russian thistle	X		
	Sorghum halepense	Johnston grass	X	X	
	Taeniatherum caput-medusae	Medusahead	X	X	
	Cenchrus echinatus	Southern sandbar grass	X	X	X
	Cyperus esculentus	Yellow nutsedge	X	X	
	Eichhornia crassipes	Common water hyacinth	X		
	Senecio jacobaea	Tangy ragwort	X		
	Solanum elaeagnifollim	White horsenettle	X		

In 2003 tamarisk was treated by cutting and planting native vegetation on Red Bank Creek. Cutting and leaving the exotic root-wads in place provides stabilization for the stream bank, and the opportunity for native plant growth. Additional work on arundo (*Arundo donax*) in Reeds Creek was completed in 2003.

Additional information on these and other invasive plants can be found at:

- http://www.nps.gov/plants/alien/factmain.htm
- http://www.cdfa.ca.gov/phpps/ipc/weedinfo/winfo_photogal-fameset.htm

Table 8-7 CALIPC LIST OF INVASIVE PESTS					
Rank	**Latin Name**	**Common Name**	**Found in Tehama County**	**Found in Tehama West Watershed**	**Target for Eradication**
Red Alert: Species with potential to spread explosively; infestations currently restricted					
	Centaurea maculosa	Spotted knapweed	X	X	
	Hydrilla verticillata	Hydrilla	X		
	Lythrum salicaria	Purple loosestrife	X		
List A-1 – Most invasive wildland pest plants; widespread					
	Arundo donax	Giant reed, arundo	X	X	
	Bromus tectorum	Cheat grass, downy brome	X	X	
	Centaurea solstitialis	Yellow starthistle	X	X	
	Cortaderia selloana	Pampas grass	X	X	
	Cytisus scoparius	Scotch broom	X	X	
	Genista monspessulana	French broom	X		
	Lepidium latifolium	Perennial pepperweed, tall whitetop	X		
	Rubus discolor	Himalayan blackberry	X	X	
	Taeniatherum	Medusahead	X	X	
	Tamarisk chinensis, T. gallica, T. parviflora & T. ramosissima	Tamarisk, salt cedar	X	X	
List A-2 – Most invasive wildland pest plants; regional					
	Ailanthus altissima	Tree of heaven	X	X	
	Cardaria draba	White-top, hoary cress	X		
	Elaeagnus angustifolia	Russian olive			
	Ficus carica	Edible fig	X	X	
	Mentha pulegium	Pennyroyal			
List B – Wildland pest plants of lesser invasiveness					
	Carduus pycnocephalus	Italian thistle	X		
	Centaurea melitensis	Tocalote, Malta starthistle			
	Cirsium arvense	Canada thistle	X	X	
	Cirsium vulgare	Bull thistle	X	X	
	Conium maculatum	Poison hemlock			
	Hypericum perforatum	Klamath weed, St. John's wort	X	X	
	Myriophyllum aquaticum	Parrot's feather	X		
	Phalaris aquatica	Harding grass	X	X	
	Robinia pseudoacacia	Black locust	X		
	Spartium junceum	Spanish broom	X		
	Vinca major	Periwinkle	X	X	
Need more information					
	Descurainia sophia	Flixweed, tansy mustard	X		
	Isatis tinctoria	Dyers' woad	X		
	Ludwigia uruguayensis	Water primrose	X		
	Pinus radiata cultivars	Monterey pine			
	Pyracantha angustifolia	Pyracantha			
	Salsola tragus	Russian thistle, tumbleweed	X	X	
	Salvia aethiopis	Mediterranean sage			
Annual grasses					
	Aegilops triuncialis	Barbed goatgrass	X		
	Avena fatua	Wild oat	X		
	Bromus diandrus	Ripgut brome	X		

Table 8-7 (cont) CALIPC LIST OF INVASIVE PESTS					
Rank	**Latin Name**	**Common Name**	**Found in Tehama County**	**Found in Tehama West Watershed**	**Target for Eradication**
Considered, but not listed					
	Dipsacus sativus, D. fullonum	Wild teasel, Fuller's teasel	X		
	Medicago polymorpha	California bur clover	X	X	
	Melilotus officinalis	Yellow sweet clover	X	X	
	Nerium oleander	Oleander	X	X	
	Silybum marianum	Milk thistle	X	X	
	Xanthium spinosum	Spiny cocklebur	X	X	

Yellow Starthistle

Yellow starthistle is one of the most invasive weeds in Tehama County. It is usually found in moderately dry fields, roadsides, and rangelands. It does not compete well with dense vegetation in fields that are well watered. Insect species have been introduced in the past, collected from the weed's originating country, to help control this species, including: hairy weevil (*Eustenopus villosus*), seedhead weevil (*Bangasternus orientalis*), gall fly (*Urophora sirunaseva*), and the flower weevil (*Larinus curtis*) (Tehama County 2003).

Tamarisk

Thicket-forming members of the genus tamarisk or saltcedar, were originally introduced to North America from Eurasia for windbreaks and ornamentals, or to assist with erosion control. Since their introduction around 1950, seven species have spread through 23 states, and dominate 1.2 million acres of riparian and shrub habitats (Zavaleta 2000). The tamarisk group has many of the classic characteristics of weedy invasive plants, including rapid reproduction and the ability to dominate a site where it becomes established. In addition, it can alter the ecosystem to its own advantage and to the disadvantage of native species. Tamarisk can produce as many as 80 seeds per square inch, per year, which germinate quickly and easily in a wide range of conditions. After germination, the plants can grow up to 2 inches per day, consuming tremendous quantities of water and drawing salts up to the surface from deep in the soil. These salts are secreted on the foliage, and when the foliage drops onto the soil each year, the salinity increases until it reaches up to 20 times the tolerance level of willow and cottonwood (Zavaleta 2000).

Table 8-8 SIGNIFICANT INVASIVE PLANTS KNOWN TO EXIST BY WILDLAND COMMUNITY						
Plant Species	**Type**	**Location**	**Reproduction**	**Risk**	**Control Strategy**	**Source**
Riparian Invaders						
Arundo donax Giant Reed	Reed	Isolated in main-stem Cow Creek	Vegetative rhizome or parts	High, voracious competitor	Herbicide on method – do not burn	Sub-Indian continent – In LA by 1820 – Spreading north major problem.
Ailanthus altissima Tree of Heaven	Tree	Isolated locations mainstem and in LCC and Tributaries – in developed areas	Seeds and root sprouts	Moderate	Herbicide or grazing – burning not effective	Eastern China. Introduced as shade tree. Planted in 1890. Ubiquitous.
Cortaderia selloana Pampas grass	Shrub/ grass	Isolated in developed areas near Palo Cedro and along MS Cow Creek and Lower Cow Creek	Seeds, but sprouts after fire and by plant parts	Low to moderate. Isolated populations	Herbicide. Following burning will sprout, grazing effective in N.Z.	Native to Argentina and Brazil. Introduced to CA in 1874. Planted in SCS in LA in 1946 for vegetation control.
Rubus discolor Himalayan blackberry	Vine	Ubiquitous throughout the watershed	Seeds spread by bird and mammals and vegetatively	Serious problem. Invades pasture area; inhibits wildlife access to streams; replaces native plants, low water yield	Difficult to control. Manual removal and repeated herbicide and burning and grazing	Introduced to North America by Luther Burbank in 1885 as cultivar from native Western Europe.
Fiscus carica Edible fig	Tree	Lower reaches of watershed; maybe elsewhere	Seeds and vegetatively	Moderate	Difficult to control; basal treatment Herbicide effective	Native to Arabia. Introduced to LA by missionaries in 1769.
Tamarisk Salt Cedar	Woody shrub	Isolated in lower reaches of watershed	Seeds and vegetatively	Moderate	Herbicide or grazing	Central Asia and near east. Planted widely for erosion control in LA.
Vinca major Periwinkle	Vine	In isolated areas and near historic residences	Vegetatively	Low	Herbicide	Northern Africa; imported as ornamental and medicinal herb.

Table 8-8 (cont.) **SIGNIFICANT INVASIVE PLANTS KNOWN TO EXIST BY WILDLAND COMMUNITY**						
Plant Species	**Type**	**Location**	**Reproduction**	**Risk**	**Control Strategy**	**Source**
Grassland and Meadows						
Bromus tectorum Cheat grass	Grass	Ubiquitous in watershed	Seeds	High	Herbicides, plant competition, spring burning, mechanical	Native to North Africa. Introduced to LA in 1860s. Ubiquitous – has significantly displaced native plants.
Centaurea solstitialis Yellow starthistle	Forb	Ubiquitous below 6,000 ft.	Seeds	High	Herbicide, burning, grazing, biological limited success	Significant competitor and invader; significantly lowers forage quality and yield in pastures and range condition.
Cirsium vulgare Bull thistle	Forb	Isolated to disturbed areas	Seeds	Moderate	Easily controlled with herbicide; bio tried, but no success	Introduced from Europe and North Africa. Common in forest areas and clear cuts; displaces native forage. Common in disturbed areas.
Cirsium arvense Canada thistle	Forb	Isolated to disturbed areas	Seeds	Moderate	Herbicide	Introduced from SW Europe. Serious pest to cultivated agriculture. Usually found in disturbed areas and along roads.
Hypericum perforatum Klamath Weed	Forb	Isolated individual	Seeds	Moderate	Herbicide	Introduced from Europe. Ingestion by livestock can cause serious illness and death.
Phalaris aquatica Harding grass	Grass	Numerous locations in grasslands	Seeds	Moderate	Herbicide	Field planting forage crop.
Taeniatherum caput-medusae Medusahead	Grass	Everywhere – has resulted in losses of <40-75% carrying capacity	Seeds	High – serious problem throughout watershed	Herbicide, burning prior to seed dispersal, in early spring grazing (sheep)	Introduced from the Mediterranean in the late 1800s. Has reduced grazing capacity on some ranches from 40 to 75% (Whiston 2000).

Mature tamarisk is drought-tolerant and can survive flood conditions in which native species have difficulty. In addition, fire may enhance this species, as it rapidly re-sprouts from below-ground parts and can quickly overtop other post-fire vegetation. When tamarisk invades and dominates a riparian area it can cause dramatic impacts. Because it consumes water 35 percent more rapidly on average than native vegetation, it has been known to draw down water tables, dry up springs, and decrease the volume of flows in waterways. Finally, tamarisk provides little habitat value for either fish or wildlife resources (Zavaleta 2000), while out-competing high value native riparian habitat.

Arundo

Another very significant threat to California's dwindling riparian resources is the non-native grass species known as *Arundo donax*. This species was introduced approximately 25 years ago, and once established along a stream channel, root parts are readily spread downstream by high water. It can form dense stands up to 30 feet tall, but, like tamarisk, provides little in the way of fish or wildlife habitat. Arundo dramatically alters the ecological and successional processes in riparian areas and ultimately dominates the near-stream areas to the detriment of native species. Also, like tamarisk, arundo survives fire and rapidly re-sprouts, quickly becoming reestablished after being burned.

The California Invasive Plant Council included arundo as one of the top five species of concern. In some areas, arundo infestation is the greatest risk to dwindling riparian habitats. Furthermore, arundo and tamarisk are frequently found together.

Arundo can dramatically change channel morphology by retaining sediments and constricting flow. Its shallow rhizomes provide little structural integrity to streambanks resulting in undercutting, bank slumping, and sedimentation of the stream. Arundo rapidly and catastrophically alters ecological processes in riparian systems, ultimately moving formerly diverse ecosystems toward pure stands of arundo through a regime of intensified flooding and fire (Bell 1997).

***Arundo*, Stony Creek**

Lessons learned from southern California, where thousands of acres are infested by this species, suggest that early prevention of spread is the most cost-effective approach. Once arundo becomes heavily established and habitat value is destroyed, its elimination is very problematic and costly (Bell 1997). The most effective control appears to be systemic herbicides such as Rodeo, licensed for use near water. Follow-up treatments to kill missed or re-sprouting plants may be necessary for 1 to 5 years following initial treatment. Following eradication, a short-term spike in downstream fine sediment has been noticed before native vegetation becomes reestablished or restoration efforts become effective. However, the potential increase in riparian habitat values of restored streamside zones is considered to greatly outweigh the short-term effects (Bell 1997).

Because the short-term environmental damage and expense of arundo eradication becomes greater if infestations get larger, it is imperative that control efforts proceed immediately after detection. Projects should be encouraged to:

- Include multiple stakeholders with significant local landowner involvement, including using local volunteer and/or landowner labor
- Foster riparian zone health as a preventive measure against arundo invasion or re-invasion
- Proceed with eradication efforts from the top of the watershed down, cognizant of the rapid downstream spread capabilities of the species
- Work with downstream agencies or landowners to assist with eradication of propagule sources located upstream (Bell 1997)

If continued re-introductions of arundo are to be prevented, broad-based action is necessary. Individual landowners along waterways need to be aware of the plant and its dangers. Nurseries need to be prevented from selling arundo for use along streams. CDFG is producing educational materials with the Sonoma Ecology Center to reach landowners, the general public, and local organizations building eradication programs.

CHANGES IN COMMUNITIES OVER TIME

Vegetative communities change over time. Some changes are influenced by natural causes such as fill, landslides, and floods. Man-induced changes are caused by invasive plants, fire suppression, water diversion, grazing, and development. In general no one factor is responsible for large scale changes in vegetative communities. The earth's climate has changed drastically in the last 10,000 years (see Section 5, "Climate"). Historical climate records are constructed from tree rings, glacial cores, and sediments. Historical population dynamics are reconstructed from fossils and pollen analysis.

Table 8-9
CLIMATE SUMMARY VEGETATIVE RESPONSE

Historical Time Frame	Responses
> 8,500 years ago	Much cooler
8,500-2,500 years ago	Mild winters, warmer dry summers
2,500-400 years ago	Moist and cooler
400-100 years ago	Abnormally dry and cold
120 years ago to present	Warmer with more precipitation

Even prolonged short term changes such as the droughts of the 1920s and 1970s can significantly affect species diversity and composition. Many changes in vegetation commonly associated in European settlements after 1860 may in fact be associated with climate change. In a *Watershed Analysis Report for the Middle Fork Eel River Watershed* (USDA 1994) a pollen analysis study done at an unnamed lake just south of the Yolla Bolly-Middle Eel Wilderness (located at approximately latitude

(39 °57'45" N by longitude 123 °2' E at an elevation of 3,320 feet which the author calls A-M Lake), the author concludes:

> The A-M Lake pollen record reconfirms that North Coast Range plant communities are dynamic ecosystems with ever changing compositions and relationships. While some taxa appear to have long histories of association, the notion of regional stable communities with unchanged composition, structure, and functional relationships over long periods of time must be rejected. With little exception, the current plant communities in the North Coast Ranges are the result of multiple trajectories of vegetation succession in response to climatic variability.

The USFS presented the following example in the Thomes Creek Watershed Assessment (USDA 1997). Extreme weather fluctuations can lead to floods, droughts, or windstorms. Droughts, especially those lasting several years, can lead to an increase in insect damage to conifer stands. The degree of damage or disturbance is related to stand density. During periods of above-average rainfall, forests stand densities increase to utilize the higher site potential. But when multi-year wet periods are followed by a drought, these stands are suddenly overstocked for the reduced site conditions. When this happens, large numbers of trees are unable to get the amount of water they need to stay vigorous. These trees become weakened by moisture stress, which increases the likelihood of large-scale insect epidemics. There may also be more large-scale fires in drought years.

Windstorm can damage forest stands over entire regions; however, their impacts are usually more localized. The damage from windstorms is normally most severe on ridge tops and in natural wind funnels. Damage is also related to logging practices. Large conifer trees recently deprived of the support and protection of their neighbors due to partial cutting, or along the edges of clearcuts, are vulnerable to windthrow for many years after logging. Trees, both hardwood and conifer, whose roots are damaged by grazing, logging, road building, or recreation activities (as campgrounds) are also more vulnerable to windthrow. Heavily stocked stands of young conifers that have not been adequately thinned (often called dog-hair thickets) are sometimes blown down in blocks (USFS 1997).

Fire suppression activities beginning in 1920 have resulted in denser stands with significantly different species composition than those of 100 years ago. The Thomes Creek Watershed Assessment by the USFS (1997) compared average conifer stand characteristics determined from data collected during a 1913 inventory with current (1991) old-growth inventory plot statistics from the same area. The comparison shows that in 1991 conifer stands had an average of over 5 times more trees per acre, and over 50 percent more basal area than in 1913. Stocking density relative to normal basal area was twice as high in 1991, while annual conifer mortality is over 12 times as high. Average conifer stand age and diameter are both less today. Board foot volume per acre is also slightly higher today.

Another factor which has influenced vegetation since 1850 has been the amount, intensity, and duration of grazing. Table 8-11 shows how grazing has declined in the Mendocino Forest since 1912. Native herbivores have grazed the watershed for thousands of years, but the introduction of domestic livestock has changed the intensity, seasonality and duration of grazing.

Table 8-10 AVERAGE CONIFER STAND CHARACTERISTICS ON FEDERAL LAND IN THE THOMES CREEK UNIT IN 1913 AND 1991		
Average Stand Characteristics	**1913**	**1991**
Number of trees per acre	20	106
Conifer diameter (in.)	28	16
Conifer basal area (ft ^{2}/ac.)	89	141
Conifer volume (bd. ft./ac.)	18,400	20,900
Stand age (years) (est. for 1913)	300	182
Relative stand density (% normal BA)	31	62
Annual mortality (per 10,000 conifers)	4	52
Source: USFS 1997		

Table 8-11 LIVESTOCK GRAZED IN THE MENDOCINO NATIONAL FOREST BY FISCAL YEAR					
Stock Type	**Number of Animals**				
	1912	**1922**	**1935**	**1960**	**1996**
Sheep and goats	61,000	50,900	19,542	0	0
Cattle and horses	3,500	11,600	7,363	1,586	1,949

Coniferous Forest Habitats

As stated earlier in this section, both wildfire suppression and commercial timber management have caused changes in the composition, density, and mean tree size in the Tehama West Watersheds as well as the entire American West. The extent or degree of change has not been well-quantified because there are little data pertaining to forest stands prior to the period when fire suppression was well established. However, anecdotal accounts of the early days and photographic analyses of historical photos support the notion of the following general structural and compositional changes. Fire exclusion allowed conifer seedlings and saplings in the understory to grow into trees, resulting in much denser stands than existed previously. Because of stands developing in a more dense condition, shade-tolerant species were often favored, including white fir and incense cedar, rather than shade-intolerant species such as the pines and black oak

These changes have had significant effects on wildfire behavior, as the results lead to burns with much greater intensity and severity than the stands likely to have existed 150 years ago. These are due both to greater fuel loading and development of ladder fuels.

The California Land Cover Mapping and Monitoring Program (LCMMP), a collaboration between USFS and the California Department of Forestry and Fire Protection (CDF), uses Landsat Thematic Mapper (TM) satellite imagery to derive land cover change (losses and gains) within 5-year time periods. The Northeastern California area, including Tehama County, was completed last in 1997 and addressed change from 1991-1996. The LCMMP quantifies changes in habitat at a landscape scale to provide regional level assessments.

Table 8-12 AREAS OF HARDWOOD CHANGE, CONIFER CHANGE, AND CHAPARRAL CHANGE			
	Hardwood	**Conifer**	**Chaparral**
Decrease in Vegetation	10,634	11,208	1,403
% Decrease	2	8	1
Increase in Vegetation	9,394	16,743	12,884
% Increase	2	11	12
Total change	20,028	27,951	14,287
Total % change	4	19	13
Wildfire	9,136	6,049	12,339
Prescribed fire	0	0	0
Harvest	231	8,204	58
Mortality	0	0	0
Development	415	2	18
Regeneration	0	5,288	326
Total	9,782	19,543	12,741

Chaparral Habitats

Chaparral habitats are highly adapted to wildfire and reproduce quickly following a burn. Wildfire suppression has widened the time between these events; therefore, chaparral stands may be older, more decadent and less palatable for wildlife than prior to fire suppression actions. The conifer habitat suppression actions lead to more severe and intense fires than typically occurred prior to the policy of fire suppression. Wildlife species requiring younger and more palatable plant growth, with higher amounts of protein and minerals, such as black-tailed deer, have likely been impacted by this change. Recent deer herd numbers reflect this decline (see Section 9, "Wildlife Resources"). Fire suppression may also have diminished the mosaic of dipping age classes of chaparral.

Riparian Habitats

It is likely that montane riparian habitats have been affected by fire suppression. These narrow corridors are comprised primarily of hardwoods that are regenerated by a disturbance, such as floods or fires. Because of the fewer and wider spaced timing of wildfires, the opportunity to reproduce has been changed, leading to older trees along the streams. Forest management may have affected the riparian areas by removing the largest conifers and leaving smaller trees. This has become an issue in many areas due to the importance of riparian areas to provide large wood debris recruitment to streams and the importance of these large pieces to fisheries habitat. However, on Thomes Creek, below the confluence with Fish Creek, large wood debris plays a very limited role in channel development as more control is exerted by geomorphology.

Riparian habitats in the foothill and valley stream reaches have likely had much greater historical impacts than of those in the mountain regions, but have not been quantified for the Tehama West Watershed. Livestock grazing has likely affected hardwood regeneration; aggressive non-native weeds have been introduced that have likely reduced the extent of many of these habitats. Constructing dikes and channels for flood control and gravel mining likely eliminated entire riparian areas or predisposed the systems to colonization by non-native invaders.

Hardwood Habitats

Harvest for firewood, range improvement, and subdivision development has affected large acreage within the watershed, resulting in reduced habitat area. This has resulted in reducing the number of acres covered by this species and reducing the amount of canopy cover of oak woodlands. There has also been concern regarding whether blue oaks are adequately regenerating to replace dying trees. Failure to regenerate may also be influenced by changes in climate since 1850.

Valley oaks were more restricted in distribution than blue oak because of the lowland habitat preference of this species and the good soil it requires. Valley oaks generally live in areas with deeper soils near streams. All the factors responsible for reducing valley riparian habitats also would potentially have affected this oak. The State of California has recognized valley oak habitat as a special concern (CDFG 2005). Recent amendments to the California Environmental Quality Act to protect the habitat of oak woodlands reveal a rising concern over oak species.

Tehama County has produced a plan to help in management of its oak resources (Tehama County 2004). Guidelines presented in the 2004 Draft pertain to fuel wood and range management projects. Some specific practices include:

- Retain at least 30 percent canopy cover in a variety of sizes and species originally present
- Educate landowners regarding the economic benefits of maintaining oaks
- Retain old trees with hollow limbs and boles for wildlife habitat
- Seek management assistance from U.C. Extension and other local experts
- Protect oaks during construction and avoid summertime watering
- Cluster housing to preserve wildlife corridors and habitats

The county encourages the voluntary protection of oak woodlands through partnerships and conservation easements with government and non-profit groups, developing sustainable ranching and farming operations, and establishing Williamson Act contracts.

Annual Grassland and Vernal Pool Habitats

Human activities such as wildfire suppression, grazing, and the introduction of aggressive grass and forbs have been responsible for effects to the ecology and composition of the Tehama West Watershed's grasslands. Nearly all other annual grassland in the watershed is dominated by species known or suspected to be alien. A unique needlegrass habitat is known to occur north of Black Butte Reservoir.

CDFG biologists believe that the vernal pool landscape we see today is completely changed from its appearance prior to invasion and settlement by Europeans (Lis and Eggeman 1999). Even those landscapes remaining are not isolated pristine habitats (Pollack and Kan 1998). For the remaining vernal pool landscape, the primary changes have been in the composition of plant species and in the large herbivores that used to inhabit the region. Vernal pools remaining in Tehama County are located generally in annual grassland and blue oak woodland plan communities, which in turn are dominated by non-native plant species that have established themselves (Pollack and Kan 1998).

The vernal pool ecosystem is maintained through several factors including: water cycle, soil type, seasonal patterns, nutrient cycles, and animal impacts. Animal impacts from deer, pigs, ground squirrels, birds, insects, earthworms, nematodes, and many others through their interactions with the environment play a role influencing the plant community (Lis and Eggeman 1998). In the late Pleistocene a wide variety of grazing and browsing animals shaped the plant community (Edwards 1996). These animals include: *Mammuthus* (mastodons), *Glossotherium* (ground sloths), *Camelops* (camels), *Cervus* (elk), *Bison antiquus* (bison), *Euceratherium* (shrub ox), and *Symbos* (woodland musk ox) (Edwards 1996). DFG stated that even the predators that are now absent, wolves and predatory cats, played an important role in the development of the plant community by keeping the grazing and browsing animals moving (Lis and Eggeman 1998). Since the late Pleistocene there has been a reduction in the number of large herbivores and their predators (Van Devender 1995).

The reasons for the declines are speculative, particularly for the Pleistocene extinctions, which have been variously attributed to dramatic climatic changes and to hunting pressure from early Native American peoples. The changes brought about with the arrival of Europeans are more clearly documented, and include increased hunting pressures, importation of livestock and establishment of ranches, clearing and draining land, and controlling natural hydrologic cycles. These activities resulted in disruptions to the landscape that disturbed migration patterns, summer and winter feeding grounds and breeding territories. With the invasion of Europeans came the seeds of non-native plants, which found the new lands to be suitable habitat. They have spread rampantly during the past 50 years (Lis and Eggeman 1998).

Three significant impacts to the vernal pool plant communities: 1) loss of large herbivores and their predators, 2) invasion and establishment of non-native plants, and 3) invasion and settlement of Europeans. The loss of large herbivores and their predators changed the dynamics that maintained the native plant communities. The settlement of Europeans was in direct competition with the large herbivores and predators and resulted in their decline through direct removal and habitat loss. In addition, Europeans replaced the native herbivores with domestic livestock, which were managed in ways that were not conducive to the native plants and the grazing patterns with which they had evolved. The result was overgrazing and land degradation (Lis and Eggeman 1998).

Overgrazed, disturbed lands were perfect sites for the non-native species to colonize. As they invaded and displaced the native species, the entire community structure changed. The change in plant species composition changed the community type as well as its response to fire. The large influx of non-native annual grasses resulted in the community burning more easily and frequently than it probably did in the past. The fire return interval can be dramatically increased by the presence of dense stands of both cheat grass (*Bromus tectorum*) and medusa-head (*Taeniatherum caput-medusae*). In areas of dense cheat grass or medusa-head, the fire return interval has declined to 5 years or less because the continuity of fine textured fuels promotes larger, more frequent fires (Moseley et al. 1999).

Vernal pool ecosystems evolved under grazing pressure from a variety of large and small herbivores and had a periodicity of fire in the evolution of the vernal pool ecosystem (Lis and Eggeman 1998). With the invasion of many non-native plant species, the loss of the herbivore grazing patterns,and changes in fire cycles, the communities of the vernal pool ecosystem have undergone varying degrees of compositional changes. The uplands have gone through such extensive species compositional changes that the original composition is now unknown. Flats and swales have a greater percentage of native species, but some non-natives are quite dominant and may be increasing. The vernal pool ecosystem appears not to be of an equilibrium that will be self sustaining over time. Rather it appears to be one where non-equilibrium determines the biological community structure, whereby disturbance and heterogeneity, generate and maintain biodiversity of the communities within the ecosystem (Lis and Eggeman 1998).

As stated previously, two forms of grazing effects are being monitored by CDFG: 1) controlled experimental grazing, where a high density of cattle graze in pastures for periods ranging from 1-3 weeks in the late spring; and 2) less controlled grazing, where cattle are grazed at a much lower density during a longer period from late fall until late spring. The vernal pools and surrounding uplands are affected very differently by these two forms of grazing. One of the objectives in the CDFG study is to determine how varying grazing pressure influences vegetation composition. Preliminary results provided for this report by CDFG state that water quality measurements (temperature, pH, dissolved oxygen, conductivity, and salinity) have been recorded at bimonthly intervals during the 1999-2005 vernal pool seasons. Temperature has also been recorded hourly within the pools during the time they contain water. Preliminary observations show water quality variables do not vary dramatically between grazed and ungrazed pools. In some cases dissolved oxygen is slightly higher in lightly grazed pools and this benefit may be due to three possible grazing effects: 1) reduced previous season plant matter standing in the pool water column during early pool season, 2) reduced levels of filamentous green algae in the pool water column, and 3) cooler water temperatures during early pool season due to increased adiabatic cooling effects.

Vernal pool branchiopods (*Branchinecta lynchi*, *Linderiella occidentalis*, and *Lepidurus packardi*) have been quantitatively sampled at bimonthly intervals in the pools for four vernal pool seasons. Preliminary results suggest that branchiopods are not randomly distributed throughout an individual pool, but have preferred habitat locations within the pool as well as in the water column. Pool habitat for branchiopods does not equate to pool dimensions. Pools may be grouped by branchiopod density differences and these may be related to vegetation mosaic patterns which exist in the pool. With light to moderate grazing, vernal pool branchiopods may also benefit from the grazing effects listed above under water quality. These preliminary observations remain to be confirmed or refuted through data analysis.

Vegetation is being monitored using permanent transects and quadrats in the pools and in the surrounding habitat including upland mounds and flats. Over 1,300 permanent quadrats were established in 1999 and have been monitored for 4 years. Native, non-native, and special status plant species (primarily *Orcuttia tenuis*, *Sagittaria sanfordii*, and *Paronychia ahartii*) are being monitored within the permanent plots. In the controlled-grazing pastures the goal of grazing was to reduce and control the non-native grass, medusa-head (*Taeniatherum caputmedusae*). Grazing has significantly reduced medusa-head as well as less aggressive non-native grasses that colonized the upland sites. Data analysis is currently underway on the vegetation composition and changes over time of the native species and special status species.

In conclusion, grazing may be important in developing and maintaining vegetation mosaics in vernal pools and in the uplands, and will be more accurately defined during data analysis. These mosaics may in turn be important in maintaining plant species diversity and are speculated to have some relationship to observed differences in branchiopod densities (Lis and Eggeman 2000.

DATA GAPS

The following data gaps exist for information, on vegetative resources assessment:

- Quantitative trends regarding historical and ongoing habitat changes (vernal pools, riparian, and noxious plants)
- Hardwood reproduction rates in the various habitats
- Amount of protected habitat in each "at risk" habitat
- Inventory of noxious weeds, including GIS mapping by region, and a noxious weed management plan and monitoring the effectiveness of current control methods
- Vernal pool management BMPs for aquatic and terrestrial species
- Inventories of fuel loading and size classes

CONCLUSIONS AND RECOMMENDATIONS

The issues that should be addressed from a watershed perspective to manage vegetation on a sustainable basis include:

Development

Development of commercial and residential properties, roads, utilities, and other infrastructure is likely to occur in and near existing communities and along the Interstate 5 corridor. In some cases, sensitive botanical resources lie in the path of this development. These resources include riparian plant communities, oak woodlands, vernal pool landscapes, and prime agricultural lands.

- Support planning processes that sustain the natural resources, agriculture, and rural environment of western Tehama County
- Policies should be developed, and practices encouraged, that preserve and protect sufficient areas of these sensitive botanical resources so that they can continue to thrive and provide ecologic diversity in the landscape
- Develop plans to include practice that discourages exotic species invasion

Grazing and Grasslands

How grazing is managed can affect watershed systems in various ways. In many cases grazing contributes to open space and the maintenance of annual grassland and vernal pool landscapes. Grazing of livestock can be done in a manner that provides long term protection of Tehama County's soils, vegetation, and other sensitive resource such as vernal pools.

- Policies and practices should be developed that promote and encourage the continuation of livestock ranching in a sustainable manner. This may be achieved in part by research, education, and demonstrations that provide practical examples of livestock management that build soil fertility and diverse plant communities over time.

- Evaluate the effectiveness of TNC Lassen Foothills Vina Grassbank project to determine if a similar project would assist Westside landowners in improving grassland ecosystem.
- Inventory non-native grassland impacts and develop BMPs for re-establishment of healthy grasslands. Specifically develop control strategies for cheatgrass and medusa-head and provide funding support for control efforts.
- Evaluate additional opportunities to provide offstream water sources for livestock and fencing to protect sensitive riparian areas.

Oak Woodlands

Oak woodland averages have decreased in the last 50 years due to harvesting, range conversion, and development (FRAP, Tehama County 2004). Oak woodland habitat (both valley and blue oak) is important for maintenance of deer winter range as well as habitat for a number of other wildlife species. The following recommended actions were taken from the draft county oak management plan 2004.

- Encourage voluntary education and protection programs that assist private landowners in the management of their productive oak woodlands, by promoting economic studies on the value of alternative and sustainable rangeland products such as fee hunting, ecotourism, wild herb production, and firewood production
- Use the resources and expertise of the County Economic Development Corporations and the Tehama local Development Corporation in order to promote non-traditional low intensity business ventures within the oak woodlands of Tehama County
- Educate county landowners on the economic benefits of maintaining and restoring oak woodlands

    1. When harvesting oaks for fuel or range improvement, encourage land owners to maintain an average leaf canopy of at least 30 percent
    2. Retain trees of all sizes and species represented at the site
    3. When safety permits, leave old hollow trees and those actively being used for nesting, roosting or feeding
    4. Where low fire risk and aesthetics allow, pile limbs and brush to provide wildlife cover
    5. Where commercial or extensive harvest is being contemplated, seek professional advice from such resources as UC Cooperative Extension (Farm Advisor), NRCS, California Department of Forestry and Fire Protection (CDF) and private consultants

- When building within oak woodland encourage landowners to:

1. Consider the impact of construction practices on the long-term management of oaks found on their property.
2. Cluster houses to preserve wildlife corridors and habitats.
3. Protect existing oaks during construction.
4. Avoid root compaction by limiting heavy equipment in the root zone.
5. Carefully plan roads, cuts and fills, building foundation and septic systems to avoid damage to tree roots.
6. Design roads to minimize erosion and sedimentation to downstream resources.
7. Avoid landscaping that requires or allows irrigation within the drip line of oak trees. Consider replacing trees whose removal during construction is unavoidable.
8. Remove dead and rotting trees from areas immediately adjacent to homes and other structures.

- Inform private landowners regarding the value of well-managed oak woodlands. Educate landowners about potential threats to this resource and seek funding that supports outreach to private landowners through the Tehama County RCD, the NRCS, and UC cooperative Extension, Wildlife Conservation Board as well as others.
- Encourage landowners to protect oak woodlands for future generations by conserving large working landscapes with significant oak woodlands.
- Recognize sites according to landscape variables (size, shape, and connectivity to other habitats such as riparian) that support rich sustainable wildlife populations.
- Establish a monitoring program to evaluate the conservation efforts.
- Encourage the Hardwood Advisory Committee to conduct biannual evaluations of the County's oak woodlands, utilizing FRAP and other appropriate data sources.
- Increase communication between land managers, ranchers, and scientists regarding the protection and management of oak woodlands.
- Encourage research on oak woodland habitats.
- Encourage studies that evaluate oak regeneration in Tehama County.
- Encourage studies that evaluate the effects of changing land uses on oak woodland's current values (wildlife, ranching, water, economics, etc.)
- Encourage studies that provide Tehama County ranchers the ability to manage oak woodlands in a sustainable manner.

Vernal Pools

The nature and intensity of the grazing that occurred in vernal pool landscapes prior to the arrival of Europeans and domesticated livestock is unknown. The threat to vernal pool landscapes from development and other changes in land use is one of the largest threats to the Tehama West Watershed. A successful program to protect these resources and limit the losses will require a combination of education, voluntary compliance, property tax and other incentives, land use regulation at the local level, and regulatory compliance under the California Environmental Quality Act, the federal Clean Water Act, and both state and federal Endangered Species Acts. A combination of both protection of existing resource and creation of additional vernal pools is likely to provide the greatest benefit at the lowest overall cost. Careful consideration should be given to the development of goals for managing vernal pool landscapes.

- Landscape management plans should be developed to meet these goals, and to utilize the existing conditions of non-native vegetation and the grazing intensity that may be afforded by domestic livestock.
- Monitoring of success in meeting the landscape management goals can be used to revise and fine tune management strategies, including the timing and intensity of grazing and fire.
- Additional research should be conducted on the benefits of balanced grazing on vernal pool landscapes. Additional information on vernal pools with soils and climatic conditions similar to those found in western Tehama County would be most useful.
- Ranchers and land managers should be encouraged to develop range management plans that protect and enhance vernal pool resources. This may include educational efforts by the Tehama County Resource Conservation District, cost sharing for fencing or watering troughs from the Soils Conservation Service, and other programs.

Agriculture

Agriculture is an important land use for maintaining open space and some types of wildlife habitat.

- Agricultural practices that protect and encourage sensitive botanical resources, particularly wetlands and riparian areas, should be promoted. This can be accomplished through education, demonstration farms, the United States Department of Agriculture (USDA) Wetland Reserve Program, Natural Resources Conservation Service (NRCS) cost-sharing for water quality protection, and property tax incentives for the protection of riparian areas and conservation easements.

Fire Management

Excess fuels and fire hazards exist in all wild habitats within the watershed. Fire management is essential to protecting vegetation resources in the watershed.

- Prescribed fire should be considered in situations that can foster the natural process of succession in chaparral and forest communities and also be considered in grasslands that may benefit from prescribed fire.

Riparian Communities

Riparian communities have been significantly changed over the last 50 years. Overgrazing, introduction of non-native plants and gravel mining reduced original riparian areas. Little historical data is available in the watershed.

- Initiate a study of historical riparian habitat trends in the watershed. Develop GIS mapping for the watershed in conjunction with this inventory effort.
- Initiate a detailed study to analyze historical aerial photographs from CDF, Caltrans, NRCS, DWR, and other sources to determine the change in riparian resources over time.
- Promote restoration projects on pubic and private lands focused on improving the understanding of the relationship between ecological health of riparian areas and land management practices.
- Gravel mining provides necessary materials for construction. In Tehama County, much of the gravel mining occurs in or near streams and riparian areas. It can and should be conducted in a manner that protects riparian habitats by avoiding mature stable areas and restoring other riparian areas with native trees and shrubs after mining activities have been completed, and to control and prevent invasive species infestations.
- Encourage the development of riparian buffer zones to maintain native riparian habitat, benefit fish and native plant species, provide buffering benefits, and reduce the potential for damage from floods.

Invasive Plants

Once established, invasive plants are extremely costly and difficult to remove. The control of tamarisk and arundo should be a priority for the watershed. The research and tools that have been developed to deal with these and other noxious weeds should be included in programs to detect and eradicate newly introduced invasive species.

Map the extent and type of noxious weeks in the watershed and work cooperatively with adjacent watersheds in the eradication of these species

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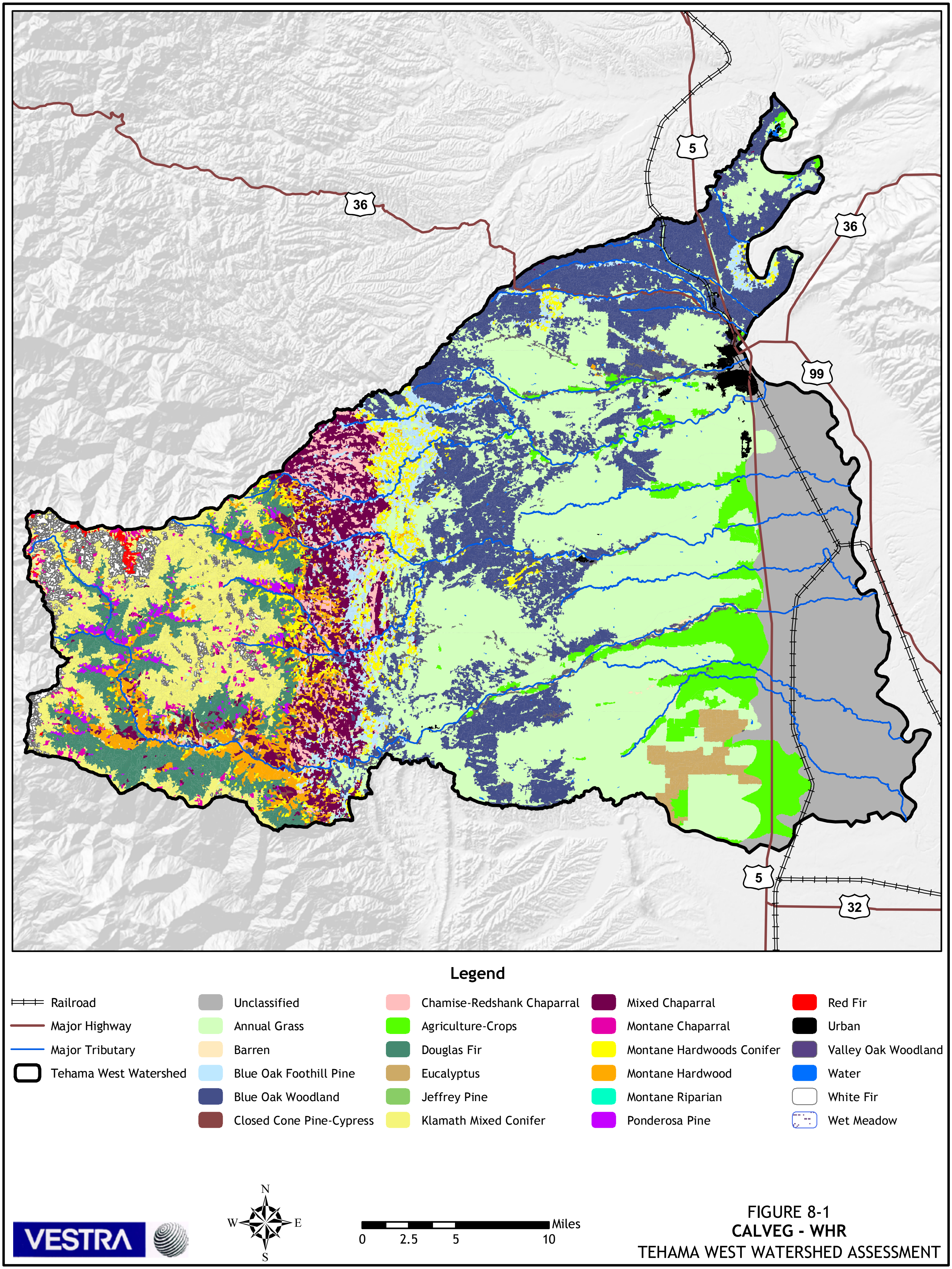


FIGURE 8-1
CALVEG - WHR
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: U.S. FOREST SERVICE

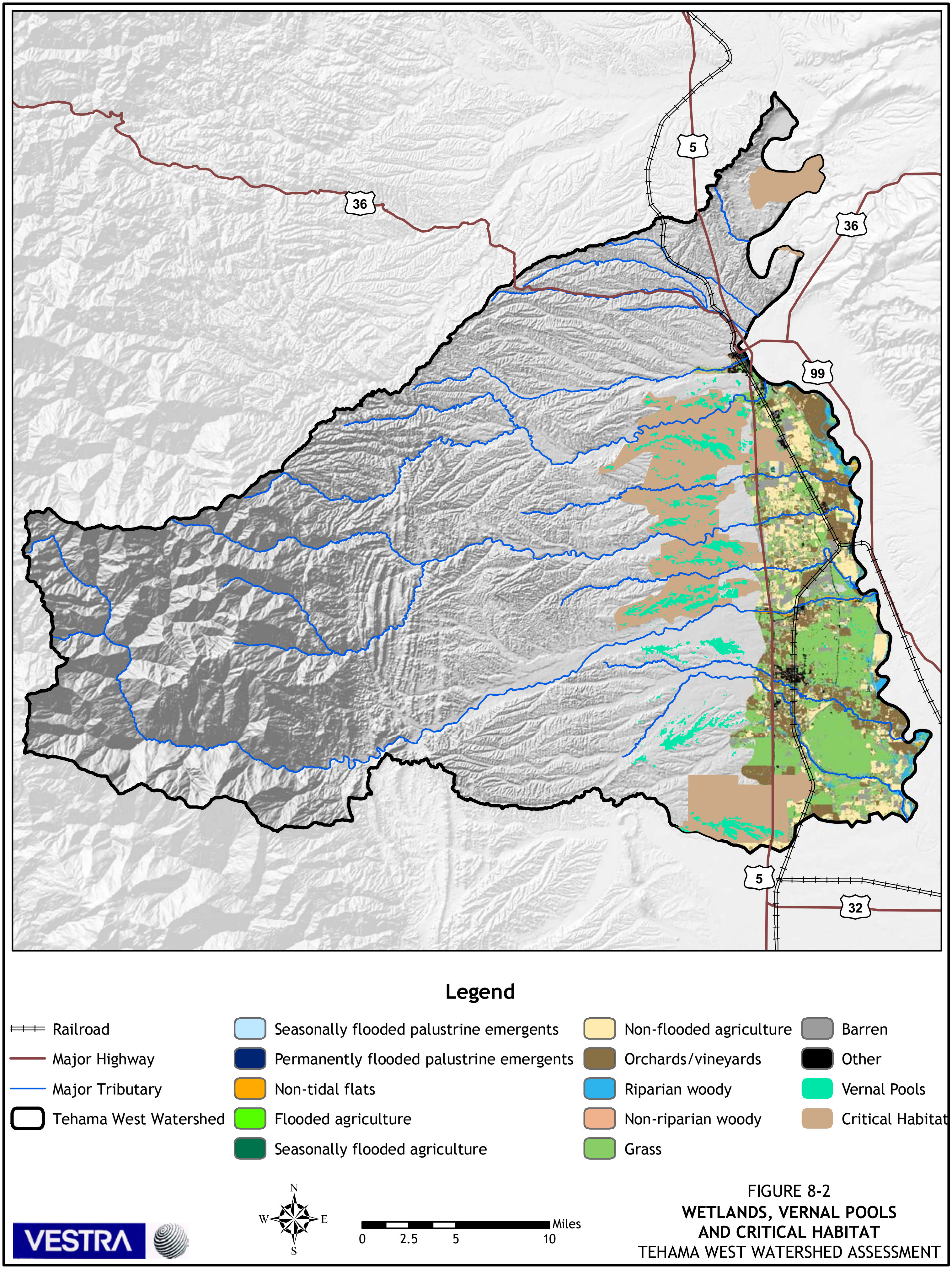
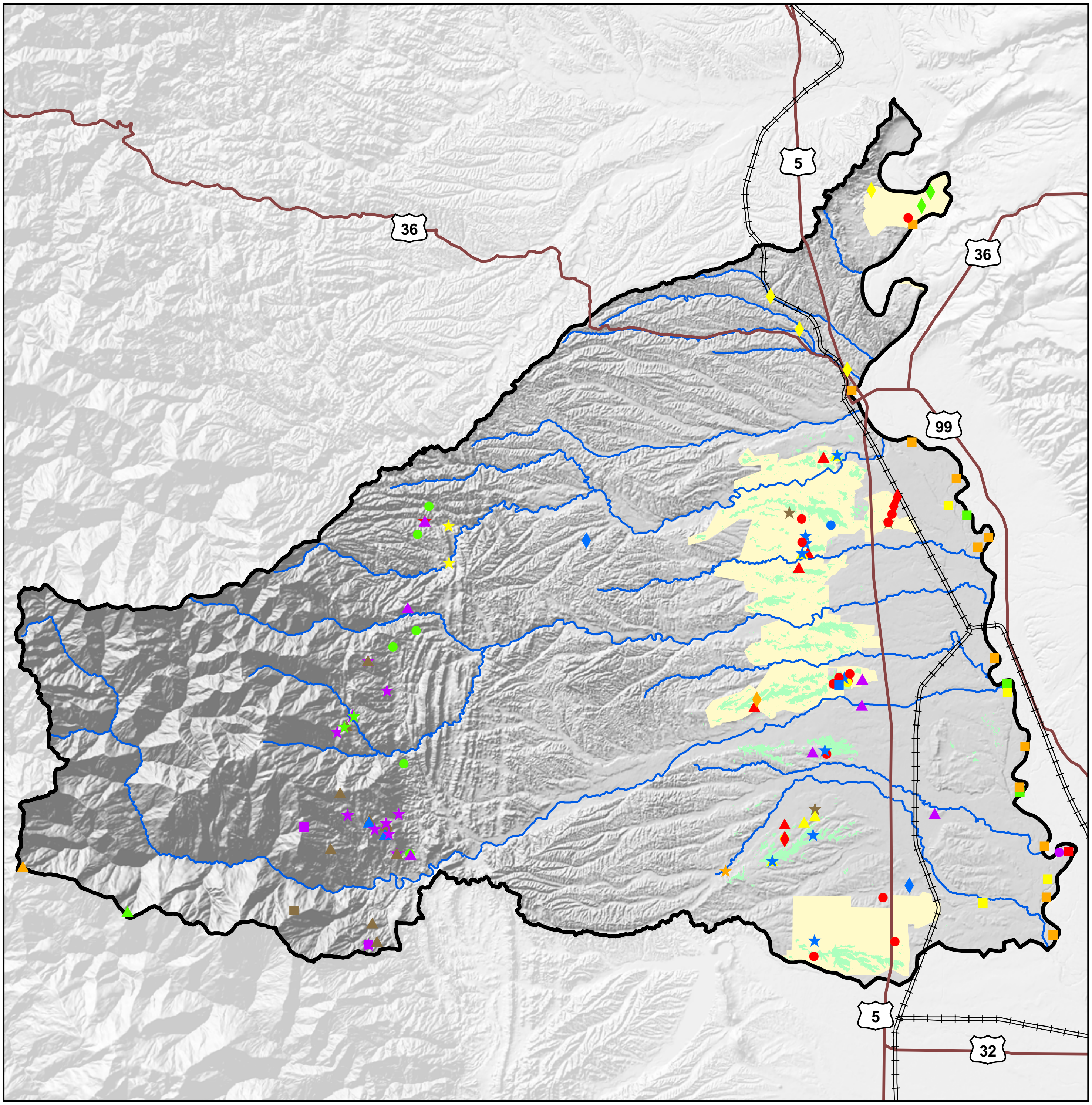


FIGURE 8-2
WETLANDS, VERNAL POOLS AND CRITICAL HABITAT
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF FISH AND GAME



Legend

- Railroad
- Major Highway
- Major Tributary
- Tehama West Watershed
- DFG Vernal Pool
- USFWS Critical Habitat
- Ahart's paronychia
- Baker's navarretia
- Boggs Lake hedge-hyssop
- Brandegee's eriastrum
- California linderiella
- Coastal and Valley Freshwater Marsh
- Colusa layia
- Great Valley Cottonwood Riparian Forest
- Great Valley Mixed Riparian Forest
- Great Valley Valley Oak Riparian Forest
- Great Valley Willow Scrub
- Henderson's bent grass
- Indian Valley brodiaea
- Konocti manzanita
- Northern Hardpan Vernal Pool
- Oregon fireweed
- Red Bluff dwarf rush
- Sonoma manzanita
- Stebbins's harmonia
- Stony Creek spurge
- Tehama County western flax
- Tracy's eriastrum
- Valley Needlegrass Grassland
- Adobe-lily
- Big-scale balsamroot
- Dwarf downingia
- Dwarf soaproot
- Four-angled spikerush
- Legenere
- Pincushion navarretia
- Silky cryptantha
- Slender orcutt grass
- Western spadefoot

N W E S

0 2.5 5 10 Miles

VESTRA

FIGURE 8-3
CNDDB OCCURRENCES OF RARE PLANTS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA NATURAL DIVERSITY DATABASE, 2004

Section 9

Section 9
WILDLIFE RESOURCES

TABLES

FIGURES

Section 9
WILDLIFE RESOURCES

SOURCES OF DATA

Information used to produce this section was derived from documents pertaining to the natural resources of the watershed area and California Natural Diversity Data Base maps and GIS data layers. A complete list of references is found at the end of this chapter. Documents and databases that were reviewed include:

- Digital sources, including: California Wildlife Habitat Relationship System (WHR): U.S. Forest Service (USFS) Calveg data; California Department of Forestry and Fire Protection Land Cover Mapping and Monitoring Program (LCMMP); California Department of Fish and Game Natural Diversity Database and Website (CNDDB); U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory maps; California Spatial Information Library; maps of public land ownership; and critical habitat maps from the USFWS

- Various reference books and documents, including the Tehama County Soils Survey; historical accounts of Tehama County natural resources; and the Draft Tehama County Voluntary Oak Woodland Management Plan

Several reviewers alluded to biological studies that have been completed regarding potential dam sites in the watershed. Late in the review process, one of these studies, CALFED's North of the Delta Offstream Storage Investigation (CALFED 2000), was provided to the author. This study contains much information regarding the wildlife resources of two relatively small portions of the Tehama West Watershed, the Thomes-Newville and Upper Red Bank Creek areas. Although a document of earlier studies for these and other dam sites could not be obtained CALFED 2000, this document summarizes the results of these earlier assessments.

HISTORICAL CONTEXT

The overall history of the watershed is presented in Section 2, "Watershed History," and known or suspected historical changes to vegetation communities are described in Section 8, "Vegetation Resources." Vegetation patterns over the landscape provide wildlife habitat, therefore wildlife populations are particularly dependant upon changes to the vegetation. The historical changes to vegetation described in Section 8 have undoubtedly affected wildlife populations in the Tehama West Watershed.

In general, the greatest historical impacts have been to wildlife species that require specialized habitats ("niches") that have been altered. Examples are the wildlife species requiring vernal pool, valley oak, or riparian habitats, as these habitats have been greatly reduced and fragmented (see Section 8, "Vegetation Resources"). On the other hand, wildlife species that require habitats that have not significantly changed during the past 150 years probably have not been seriously affected. Following this logic, those wildlife species requiring habitats that have increased in abundance, such as urban habitats, have greatly benefited by the changes.

In many situations the link between habitat abundance and wildlife species' welfare is not always clear. For instance, if a wildlife species is a habitat generalist and exists in a variety of habitats, changes to a specific habitat type may not have a significant effect on the species. To complicate it even further, many wildlife species found in the Tehama West Watershed are only here for a portion of the year; the other times they are far to the south and possibly in tropical areas. Any local changes to these species' populations may be more attributable to alterations that have occurred in distant locations than habitat changes in the local area. Changes in habitat can also result in non-intuitive impacts on wildlife species. For instance, it is possible that alterations of one habitat may enhance prey populations, resulting in an increase in a predator's population, which in turn may prey more heavily on wildlife species living in adjacent habitats.

European and American settlement in the watershed entailed many direct and indirect effects on wildlife resources. Examples of direct impacts are from historical trapping and hunting. During the nineteenth and early twentieth centuries, fur trapping for beaver (*Castor canadensis*), mink (*Mustela vison*), otter (*Lutra canadensis*), red fox (*Vulpes vulpes*), marten (*Martes americana*), fisher (*Martes pennanti*), and wolverines (*Gulo gulo*) reduced all of these populations. At the time of European settlement, large herds of tule elk (*Cervus elaphus*) and pronghorn antelope (*Antilocapra americana*) were documented in the interior valley, and black-tailed deer (*Odocoileus hemionus*) dominated the foothills. All three ungulates were hunted heavily by early European settlers, which greatly reduced populations. Focused hunting for grizzly bear (*Ursus arctos*) and grey wolf (*Canis lupus*), known by the ranchers for their aggressiveness toward humans or livestock, led to the extinction of these species in the state.

In California considerable effort has been placed on testing the relationship between fire and wildlife habitat (Biswell et al. 1952; Grifantini et al. 1991; Leopold 1950; Taber and Dasmann 1958). These studies showed that some habitat can be improved by disturbances. Depending upon local environmental factors and the conditions under which fire takes place, increased deer populations have been documented:

> An area of prescribe-burned chamise and chaparral was compared with a similar unburned area as a control. Counts of deer in the burned area showed a summer population density of about 98 per square mile after the initial burning treatment. This rose to 131 in the second year, and dropped to 84 in the fifth and sixth years. In the dense, untreated brush the summer density was only 30 deer per square mile. Ovulation rate in adult deer was 175 percent in treated brush and only 82 percent in untreated brush. Deer weights were higher in prescribed-burned brush than in the untreated area. (Biswell *et al*. 1952)

Small-game populations have also been documented to be affected by fire changes to vegetation. Studies in chaparral regions (Biswell et al. 1952) have shown that valley quail (*Callipepla californica*) were two and one-half times more abundant in burned areas than in unburned areas; black-tailed jackrabbit (*Lepus californicus*) densities were two to four and one-half times greater; and the number of mourning doves (*Zenaida macroura*) also increased after fire.

Tehama County contrasts with many of the agricultural counties in California in that grazing has been of greater relative importance than row crops. The result is that much of the low elevation landscape has been grazed over long periods, but has not been physically altered. Of the assessment area's landbase, only 5.5 percent (see Section 8, "Vegetation Resources") has been totally altered from natural conditions, including areas currently in intense agricultural production (row crops, orchards, and vineyards) or urban areas. As a result, much of the hummocky land and low spots, coniferous forests, and annual grasslands have been retained. This has allowed small vernal pools and seasonal wetlands to persist in areas where the subsoils and topography allow for the seasonal ponding of water. These vernal pool landscapes provide remnants of habitat for fauna that have adapted to these unique environments. However, the overall quality and number of vernal pools has declined, both in Tehama County and in California as a whole (U.C. Extension 2005).

The devastating impact of alien plant species to habitats has been described in Section 8, "Vegetation Resources"; however, introduced animal species have also caused significant problems. These will be discussed in later portions of this section.

Other changes to habitats, including excessive grazing, stream channelization, gravel mining, and habitat fragmentation have all undoubtedly had a role in affecting wildlife populations. Each has the potential to eliminate or degrade habitat. The degree and extent of these impacts can not be quantified due to a lack of data pertaining to the pre-disturbance period of time, as well as the lack of a comprehensive program to determine populations today, following the habitat changes.

HABITAT TYPES

It is impossible to discuss wildlife without addressing their habitat. Habitat is the type of environment in which an organism or group of organisms normally lives or occurs. Wildlife populations are dependent on the habitat in which they live and the quality of that habitat. Habitat fragmentation is common within the Tehama West area, in part due to natural climate changes, soil, and elevation factors, and in part because of changes caused by humans. Because of this, there are many areas where two or more vegetation types meet or merge: areas known as a habitat "edge". These edges have been well documented as sites where tremendous diversity and densities of wildlife can occur. This is because they exhibit a combination of habitat values from each of the individual habitats, plus values unique to the edge. This biological concept is known as "edge effect" (Thomas 1979).

An example of edge effect and its biological importance is in the Coast Range where woodland-oak forest, chaparral, and grassland habitats meet. Leopold (1950) described these edges and their importance for wildlife and native people in the following manner:

> "Prior to settlement, deer seem to have occurred principally along "edges" where forest and grassland met or on recent burns in the forest. Neither dense timber nor extensive prairie supported many deer. The woody shrubs and tree reproduction which constitute staple items of deer diet are characteristic of sub-climax ecological conditions (in other words, of early stages in a forest successional cycle), such as occur even today on prairie borders where woody plants encroach on the grass only to be pushed back periodically by drought or fire . . . the borders of the Sacramento Valley were maintained in young brush by recurrent fires, some of them probably set by Indians for the specific purpose of producing more game."

While edge habitats do benefit some species, it has a negative effect on others. An increase in edge in riparian forests, for example, is known to increase the potential for cowbird parasitism, and predation on Neotropical migratory birds.

The existing plant communities in the watershed were classified by CalVeg according to Wildlife Habitat Relationship (WHR) type (Mayer and Laudenslayer 1988). These types are described in Section 8, "Vegetation Resources," and their physical distribution within the watershed is shown on associated maps. Besides allowing the classification of California's vegetation communities, the WHR program has computer models that help users predict which wildlife species occur in different habitats and what changes to the wildlife complement might occur if habitats were altered. The various Tehama West Watershed habitats currently existing, and described in Section 8, "Vegetation Resources", will be discussed as they pertain to wildlife. The diversity of wildlife species predicted to use the various habitats in the watershed, at some time of the year, is shown on Figure 9-1. The predicted number of wildlife species deriving a high degree of hiding, forage, and reproductive values for the various watershed habitats are included in Figure 9-2.

Conifer-Dominated Habitats

Conifer-associated habitats cover approximately 18.33 percent of the watershed, or 122,447 acres (see Section 8, "Vegetation Resources"). These habitats are ones that are either dominated by coniferous trees or those in which conifers make up a significant component of the vegetation. These habitats are found in the Coast Range from approximately 2,000 feet elevation upward to the crest of the range. Their habitat attributes are described below:

Red Fir (WHR:RFR)
Only 1,301 acres of RFR habitats have been mapped within the watershed, 0.19 percent of the total assessment area. These habitats only exist in the highest elevations, near the Coast Range crest. Red fir habitats in Tehama County are estimated to provide food or cover for at least one season to a total of 159 wildlife species (0 amphibians, 4 reptiles, 100 birds, and 55 mammals). These high elevation forest stands offer a high degree of feeding, cover, and reproduction habitat for 26 species, including 1 reptile, 18 bird, and 7 mammal species. Wildlife usage of RFR habitats is greatly affected by the high elevations and the long winter season, with many species only using these areas seasonally. Species of note that make use of this habitat most, if not all of the year, include northern goshawk (*Accipiter gentilis*), blue grouse (*Dendragapus obscurus*), grey jay (*Perisoreus canadensis*), and pine marten (*Martes americana*) (DFG 2005d).

White Fir (WHR:WFR)
WFR stands also occur in locations where long winters and constant snowpacks exist in the extreme western edge of the Tehama West Watershed. They are generally found immediately downslope from RFR stands and generally intergrade with them. In total, 1.78 percent of the watershed is comprised of this habitat (11,904 acres; Section 8, "Vegetation Resources"). However, considerably more total wildlife species are predicted to use this habitat than RFR, including 14 amphibian, 20 reptile, 111 bird, and 70 mammal taxa, for a total of 215 species. WFR stands are considered to provide high feeding, cover, and forage values for 60 species, or more than twice the number provided for in RFR habitat. This total includes 2 reptile, 45 bird, and 13 mammal species. WFR stands, as they mature, are known to have high numbers of defective trees from a variety of factors, including heart rot fungus. This results in relatively high densities of snags and resulting down log

concentrations (Hopkins 1982). The snags provide excellent nesting cavity habitat, for both birds and mammals, especially when breaks occur between 50 and 100 feet in height. Forest carnivores, including fisher (*Martes pennanti*) and pine marten use concentrations of large, down logs for denning and foraging.

Species commonly found in this habitat during the summer include insect-gleaning birds, such as mountain chickadee (*Parus gambeli*), chestnut-backed chickadee, (*P. rufescens*) and golden-crowned kinglet (*Regulus satrapa*) (Airola and Barrett 1985). As in the case of the RFR habitat, many species that use this habitat during the warm season move downslope or to southern latitudes with the onset of harsh, wintertime conditions.

Klamath Mixed Conifer (WHR:KMC)

The KMC habitat zone covers large areas in the mountains of northwestern California, in the elevation range of 2,500 to 4,500 feet. It is the most widely spread and abundant of conifer types in the watershed, covering 7.11 percent of the total area (47,508 acres; Section 8, "Vegetation Resources"). This habitat type is predicted to support 225 total species in this area at some time of the year, including 15 amphibian, 20 reptile, 113 bird, and 73 mammal taxa. Sixty-one species are believed to accrue high degrees of cover, forage, and reproductive value from this habitat, including 2 reptile, 44 bird, and 15 mammal species, but no amphibians.

This habitat includes a mix of four or five conifer species, along with a minor hardwood element (usually black oak). The mix of tree species is a factor likely responsible for the relatively high diversity of species using the habitat. Following fire in these stands, a diverse mix of shrub and herbaceous species quickly develops and creates excellent habitat for many early-seral species, including black-tailed deer (*Odocoileus hemionus columbianus*) and spotted towhee (*Pipilo erythrophthalmus*).

Douglas-Fir (WHR:DFR)

There are 209 total species thought to use this habitat at some time of the year. These include 13 amphibian, 17 reptile, 114 birds, and 65 mammal species. Of all the species potentially using DFR habitats, 48 taxa acquire high values for reproduction, feeding, and cover, including 1 amphibian, 3 reptiles, 29 bird, and 15 mammal species. Bird species typical of this habitat include the northern spotted owl, western flycatcher (*Empidonax difficilis*), Hutton's vireo (*Vireo huttoni*), and varied thrush (*Ixoreus naevius*).

DFR stands are the second most common conifer-associated habitat in the drainage, covering 38,293 acres (5.72 percent of the total area; Section 8, "Vegetation Resources"). These habitats often are near monocultures of Douglas-fir, often with scant understory growth. They exist at moderate elevations (2,500 to 4,000 feet) and are often adjacent to KMC, chaparral, or hardwood-dominated habitats that occur on slightly different aspects or soil types.

Ponderosa Pine (WHR:PPN)

PPN stands, dominated by Ponderosa pine, cover approximately 5,023 acres, or 0.75 percent of the drainage. These habitats exist near the lower elevation of conifer-dominated habitats in the Coast Range (generally from 2,000 to 3,500 feet).

Ponderosa pine habitats are believed to provide habitat for 232 wildlife species in western Tehama County, which includes 14 amphibian, 20 reptile, 136 bird, and 62 mammal species. Fifty-three species gain high values for cover, forage, and reproduction from PPN stands, including 2 reptile, 40 bird, and 11 mammal species (however, no amphibian species). The PPN habitat is sometimes a transitional or migratory habitat for black-tailed deer, as the animals move from wintering areas in the foothills to higher elevation summering and fawning areas. During the migrations the deer often "hold" in these areas until vegetation develops in higher elevations that annually received appreciable quantities of snow. Pygmy and red-breasted nuthatches (*Sitta pygmaea* and *S. canadensis*) often are seen in and use this habitat

Jeffrey Pine (WHR:JPN)

Jeffrey Pine stands are uncommon in the Tehama West Watershed, with only 20 acres identified in the CalVeg typing effort (see Section 8, "Vegetation Resources"). Oftentimes these habitats, comprised of a Jeffrey pine overstory extending over a scant understory, only exist on serpentine soils.

The value of the Jeffrey pine forest type as a habitat for wildlife is due in large part to the food value of the Jeffrey pine seeds. Pine seeds are included in the diet of more wildlife species than any other genus except oak (Light 1973). The total number of wildlife species that are likely to use this habitat is 195, including 7 amphibian, 13 reptile, 113 bird, and 62 mammal species. However, of these only 38 species gain high lifelong (cover, forage, and reproductive) values, including 1 reptile, 24 birds, and 11 mammal species. Both the total number of wildlife species predicted to occur in this habitat and the number of species that receive high year-round habitat values is lower than for PPN habitats. This disparity may be because even though Jeffrey pine is a very similar species to ponderosa pine, JPN habitats, due to their association with serpentine soils, have much less diverse understory tree and shrub layers. Typical species of this habitat include brown creeper (*Certhia americana*) and white-headed woodpecker (*Picoides albolarvatus*).

Montane Hardwood-Conifer (WHR:MHC)

Montane Hardwood-Conifer habitats exist near the lower elevational limit of stands having conifers; are often located on steep and rocky terrain; and frequently are found adjacent to hardwood-dominated or chaparral stands. The drainage contains approximately 17,673 acres of this habitat, equating to 2.64 percent of the total area (see Section 8, "Vegetation Resources").

MHC habitats are used by a wider variety of wildlife species than any other stand type with a significant conifer tree component. Two hundred and forty total species are considered to use these habitats in Tehama County during some time of the year, which includes 13 amphibian, 21 reptile, 137 bird, and 69 mammal species. Similarly, there are more species that derive high lifecycle values, including forage, cover, and reproductive values, than any other conifer-associated habitat (a total of 65 species). Although no amphibian fall in this category, there are 2 reptiles, 50 bird, and 13 mammal species.

The habitat diversity provided by this vegetation type is likely due to the presence of both conifer and hardwood species, as well as the stands' frequent juxtaposition (and therefore "edge-effect") with hardwood and chaparral stands'. The stands' conifers provide a form of high level cover and diversity of foliage heights, while the black or canyon live oak always present in these stands provide mast, an important food source for many birds as well as mammals. Some typical wildlife species include Steller's jay (*Cyanositta stelleri*) and dusky-footed woodrat (*Neotoma fuscipes*).

Closed-Cone Pine-Cypress (WHR:CCP)
Very little of this habitat type occurs in the Tehama West Watershed, only 725 acres (0.11 percent of the drainage; see Section 8, "Vegetation Resources"). Where it exists it is found on severe southern aspects with very poor soil and often associated with chaparral stands.

Of all the habitat types with significant conifer presence, CCP stands provide the least diverse use, with only 147 wildlife species predicted to utilize it at some time of the year. Of these, 8 species are amphibian, 16 reptile, 94 bird, and 29 mammal species. There are 28 species deriving high cover, forage, and reproductive values from this habitat, the second lowest of all conifer-associated habitats (next to RFR). Only 4 reptile, 21 bird, and 3 mammal taxa (28 total species) receive high lifecycle (forage, cover, and reproductive) values from the CCP type. The monotypic nature of the stands, along with their tendency to be located on severe site locations, are likely contributing factors for its relatively low contribution to wildlife diversity. Two species commonly found in this vegetation type are western skink (*Eumeces skiltonianus*) and western wood peewee (*Contopus sordidulus*).

When considering all of the conifer-associated habitats within the Tehama West Watershed, both stand elevation and diversity of tree and shrub species appear to be important in determining the number of wildlife species they potentially hold. The habitats that are located highest and lowest in elevation (RFR and CCP) have the least wildlife diversity. In addition, these same stand types tend to be the least structural and floralistically diverse. The mid-elevation habitats, specifically MHC and KMC habitats, have a greater diversity of trees and shrubs and also have the greatest diversity of wildlife species.

The forested portion of the Thomes Creek drainage has been considered in light of potential seral stage changes between 1913 and 1991 (USFS 1997). The authors theorize that barren and water habitats have not changed during that time-span, but there has been a slight decline in the proportion of grass/forb and moderate decline in large tree seral stages. During this time, they also predict that the relative presence of shrub/seedling/sapling and pole/medium-sized tree stands have increased slightly or moderately. If this analysis is correct and it holds for the rest of the Tehama West's Coast Range conifer zone, there is a more even distribution of seral stages in the assessment area today than nearly a century ago, when 49 to 69 percent of the forested habitat acreage was dominated by large trees.

Habitat of the northern spotted owl, a federally-listed species, has also been assessed in the upper Thomes Creek drainage (USFS 1997). Suitable nesting habitat for the species is provided by approximately 16.7 percent of the federally-administered timberland. The birds can use an additional 29 percent of the federal land for dispersal. There are 34 known activity centers (historic nests or repeated roost sites) located in the Thomes Creek drainage, probably distributed among several of the conifer-associated habitat types previously described.

Hardwood-Dominated Habitats

Hardwood-dominated habitats exist adjacent to waterways, scattered throughout the elevational zone dominated by conifer stands, and in the Coast Range foothills. In total, they cover almost one-quarter of the drainage's area (163,650 acres; see Section 8, "Vegetation Resources"). Their values to wildlife taxa are described below:

Montane Hardwood (WHR:MHW)
MHW stands are dominated by a variety of tree-form hardwood species and are often intermixed over the Tehama West landscape with conifer-dominated stands and chaparral. These habitats cover 18,228 acres in the watershed, 2.73 percent of the landbase (see Section 8, "Vegetation Resources").

Bird and animal species characteristic of the MHW habitat include disseminators of acorns: scrub (*Aphelocoma coerulescens*) and Steller's jays, acorn woodpecker (*Melanerpes formicivorus*), and western gray squirrel (*Sciurus griseus*). Black-tailed deer also forage upon the foliage of several hardwoods to a moderate extent, and relish the acorns. A total of 222 wildlife species use this habitat seasonally, including 12 amphibian, 21 reptile, 132 bird, and 57 mammal species. Fifty-nine species receive high forage, cover, and reproduction habitat values from MHW stands, including 1 reptile, 45 bird, and 13 mammal taxa.

Montane Riparian (WHR:MRP)
Montane riparian habitats usually exist in narrow corridors adjacent to Coast Range streams. Only 83 acres are mapped by the CalVeg typing project (0.01 percent of the land); however, these habitats are likely more abundant because aerial mapping processes often overlook them due to their small size.

Riparian habitats have been repeatedly documented to have an exceptionally high value for many wildlife species (Thomas 1979; Marcot 1979; Sands 1977). These areas provide water, thermal cover, migration corridors and diverse nesting and feeding opportunities. The shape of many riparian zones, particularly the linear nature fringing streams, maximizes the development of habitat edge, which is so highly productive for wildlife (Thomas 1979). In Tehama County 263 wildlife species may potentially use this habitat (16 amphibian, 20 reptile, 150 bird, and 77 mammalian species), a number higher than any of the conifer-associated habitats. These habitats also provide high values for reproduction, foraging, and hiding for more wildlife species than any conifer-associated habitat. In total, 87 species, including 2 amphibians, 4 reptiles, 60 bird, and 21 mammal taxa receive these high habitat values. Black salamander (*Aneides flavipunctatus*) and downy woodpeckers (*Picoides pubescens*) are species that can be typically found in this habitat type.

Valley Foothill Riparian (WHR:VFR)
Satellite imagery (CalVeg typing) does not detect any of this habitat type within the watershed (see Chapter 8, "Vegetation Resources"); however, observations made during preparing this assessment suggest that small amounts exist along assessment area streams in the foothills and Sacramento Valley. This habitat is believed to be used by a total of 271 species, a total greater than any other habitat that exists within the watershed. Based on these observations, 12 amphibians, 19 reptiles, 179 birds, and 61 mammal Species make use of this vegetation. VFR stands provide high value, year-round habitat to include a total of 91 wildlife species; 1 amphibian, 9 reptiles, 60 birds, and 21 mammals. The fact that this habitat has been greatly reduced by human activities over the past 150 years (see Section 8, "Vegetation Resources") is particularly distressing, considering its extremely high importance to wildlife species.

Osprey Nest on Nesting Platform, Valley Foothill Riparian Habitat, Southern Tehama County

Likely, the presence of water and the edge effect mentioned previously are important contributors to the density of wildlife species using this habitat. Violet-green (*Tachycineta thalassina*) and tree swallows (*T. bicolor*), both cavity-nesters, and yellow-billed magpies (*Pica nuttalli*), a species that constructs stick-nests, are frequently noted in the VFR habitat. The few significant patches of this habitat remaining in the Sacramento Valley also harbor the rare yellow-billed cuckoo (*Coccyzus americanus*).

Blue Oak Foothill Pine (WHR:BOP)

The BOP habitat has foothill pine, blue oak, and shrub species in variable amounts and combinations. The habitat covers 19,931 acres (2.98 percent of the watershed; see Section 8, "Vegetation Resources") and is generally found in the foothill zone where the Coast Range transitions into the Sacramento Valley.

Blue Oak Foothill Pine woodlands provide breeding habitats for a large variety of wildlife species, although no species is totally dependent on them for breeding, feeding, or cover (DFG 2005d). In Tehama County 236 species likely use the habitat at some time, including 11 amphibians, 19 reptiles, 151 birds, and 55 mammals. In addition, 99 species are thought to gain high values from this habitat for cover, forage, and reproductive needs, more than any other habitat found in the watershed. These species include 5 reptile, 80 bird, and 14 mammal taxa. The structural diversity of trees and combination of conifers and blue oaks in this habitat, along with patches of grassland and chaparral intermixed, is likely responsible for this density of wildlife species usage (Barrett 1980). Communally nesting acorn woodpeckers and brown towhees (*Pipilo fuscus*) can be considered characteristic of the BOP habitat.

Blue Oak Woodland (WHR:BOW)

Approximately 110,923 acres of the watershed consist of this habitat, which is 16.60 percent of the entire assessment area (see Section 8, "Vegetation Resources"). This makes it the most abundant tree-associated habitat in the Tehama West Watershed. BOW habitats are generally found on sites with relatively poor soil conditions near the Sacramento Valley.

Oak woodlands support a wide diversity of wildlife species and are highly productive. The trees provide mast (acorns) and foliage, which provide food for many species during various times of the year. The oaks form many cavities, which provide nesting and resting sites for birds and mammals. In addition, the grass and forb understory provides forage and seeds for a variety of taxa. Partly because of the mild wintertime climate, many wildlife species are able to thrive in oak woodlands on a year-round basis, and the habitat also provides important winter cover and forage for migratory species that live at higher elevations during the summers. BOW stands afford habitat to 228 species, almost as many species as BOP stands. This includes 12 amphibians, 20 reptiles, 137 birds, and 59 mammals. BOW also yields high lifecycle values for 99 species. These include 5 reptiles, 79 birds, and 15 mammals. The California endemic yellow-billed magpie is often found in this habitat, or along its edge, as well as the California ground squirrel (*Spermophilus beecheyi*).

Tehama County (2004) has prepared a voluntary oak woodland management plan that addresses the values of blue oak woodlands, and other oak habitats, and provides management guidelines for landowners and developers. These include:

- Maintain an average leaf canopy of 30 percent

- Retain trees of all size classes and species represented
- Retain hollow trees, if safety allows
- Seek professional advice if extensive harvest is planned
- Cluster proposed homesites and protect existing oaks during home and road construction
- Avoid landscaping in which irrigation occurs within 10 feet of the trunk of an oak
- Replace trees for which removal during construction is unavoidable

Valley Oak Woodland (WHR:VOW)
VOW habitats, in contrast to BOW woodlands, often occur in the Sacramento Valley or adjacent slopes, where soils are deep. Approximately 1 percent, or 6,739 acres, of the watershed contains this habitat (see Section 8, "Vegetation Resources").

Valley Oak Woodland

Oaks have long been considered important to many birds and mammals as a food resource (i.e., acorns and browse). Verner (1980) reported that 30 bird species known to use oak habitats in California include acorns in their diet. An average of 24 species of breeding birds were recorded on a study plot at Ancil Hoffman Park, near Carmichael, in Sacramento County from 1971 to 1973 (Gaines 1977). At one time of the year or another, there are predicted to be 224 wildlife species that use the VOW habitat in Tehama County. These include 12 amphibian, 20 reptile, 132 bird, and 55 mammal species. 98 species with high reproduction, feeding, and cover values, provide this habitat one of the highest of any hardwood habitat. These species include 5 reptile, 78 bird, and 15 mammal species. Gray fox (*Urosyon cinereoargenteus*), house finch (*Carpodacus mexicanus*), and Nuttall's woodpecker (*Picoides nuttallii*) often use this habitat year-round.

Eucalyptus (WHR:EUC)
Eucalyptus habitats are solely human-made and exist in the Sacramento Valley, generally on poorer soils. These hardwood plantations were planned to be a source of wood chips for local mills or as windbreaks. The EUC habitats cover 7,746 acres, 1.16 percent of the watershed (see Section 8, "Vegetation Resources").

Eucalyptus groves are non-native monocultures in which the trees are grown quite densely. In addition to the lack of plant species variety in the stands, the trees tend to be all the same height; hence, little structural (height) diversity exists. Even so, a total of 240 wildlife species are suspected of making some use of these habitats, a high number relative to all of the watershed's vegetation types. However, only three species acquire high year-round values for foraging, cover, and reproduction. This is by far the lowest number for any habitat found in the Tehama West Watershed. Some of the species that do use this habitat in good numbers are the American crow (*Corvus brachyrhynchos*) and yellow-billed magpie.

When considered as a whole, the hardwood-dominated habitats within the watershed harbor a greater diversity of wildlife species than conifer-associated stands. In addition, most of the hardwood habitats provide lifelong values for many more wildlife species than conifer stands. The notable exception is the human-created EUC stands, which very few species use for all of their needs. The heavy use of most hardwood habitats can likely be attributed to a variety of reasons, including the frequent existence of oaks, which produce nutritious acorns; abundant cavities for nesting and structures for other nest-types and perching; and foliage that has high insect densities, which provide a prey base for many species. The decline in a number of these habitats during historical times is particularly unfortunate due to their importance to wildlife.

Chaparral-Dominated Habitats

Chaparral habitats generally exist in the elevational zone between coniferous stands in the mid- and upper portions of the Coast Range and the Sacramento Valley. Oftentimes, they exist on severe sites, with poor and shallow soil and southern exposure. In total, the assessment area contains 45,972 acres of these habitats, about 6.88 percent of the drainage.

Montane Chaparral (WHR:MCP)

MCP habitats cover approximately 3,084 acres, 0.46 percent of the entire area (see Section 8, "Vegetation Resources"). These habitats exist in the mid- to upper-elevation conifer zone and often are a seral condition resulting from wildfires that burned the pre-existing conifer forests. Given enough time, if further disturbances do not occur, these stands often will revert back to coniferous stands.

The MCP stands provide seeds, fruits, insects, protection from predators and climate, as well as singing, roosting and nesting sites (Verner et al 1980). MCP stands also provide critical summer range foraging areas, escape cover and fawning habitat for deer. A total of 189 wildlife species are thought to use this habitat during some time of the year, including 8 amphibian, 21 reptile, 96 birds, and 64 mammal taxa. Wildlife species that gain high value forage, reproduction, and cover values from this habitat include 2 reptile, 28 bird, and 10 mammal species, for a total of 40 taxa. Characteristic species of this habitat include green-tailed towhee (*Pipilo chlorurus*) and mountain quail (*Oreortyx pictus*).

Mixed Chaparral (WHR:MCH)

MCH stands usually occur in the watershed at lower elevations than MCP stands and characteristically contain a greater diversity of chaparral shrub species than the montane chaparral habitats. This habitat is the most abundant chaparral type, contributing 31,632 acres in the watershed (4.73 percent of the landbase, see Section 8, "Vegetation Resources").

MCH stands are predicted to provide habitat for more wildlife than any of the shrub-dominated types, for a total of 219 species. This list includes 11 amphibian, 20 reptile, 129 bird, and 59 mammal species. However, a lower number of species are considered to derive high forage, cover, and reproductive values from this habitat than the MCP stands (only 34 taxa). These include 6 reptile, 17 bird, and 11 mammal species. Species that typify this habitat include brown towhee, black-tailed deer, and wrentit (*Chamaea fasciata*).

Chamise-Redshank Chaparral (WHR:CRC)
The CRC habitats exist on the lowest elevations and most severe sites of all chaparral types. The Tehama West Watershed contains 11,256 acres of the type (1.68 percent of the landbase) usually in the 1,500 to 2,500 foot elevation zone.

These habitats burn quite easily and likely burned frequently both in pre-historic as well as historical times. Most animal populations that use this habitat reach peak densities in the first decade after fire. During this time annual grasses and forbs flourish and the re-sprouting chamise is more nutritious and palatable. In the past, some of these stands have been seeded with grasses following wildfire, but populations of most small vertebrates decline sharply or are eliminated when chaparral is converted to grassland (Lillywhite 1977). Of all the shrub-dominated habitats, the CRC stands have the fewest total species that use it, as well as species that gain high year-round habitat values. There are 167 wildlife species predicted to use the habitat during some portion of the year, including 5 amphibian, 16 reptile, 104 birds, and 42 mammals. Only 24 species are considered to gain high values from the habitat for forage, cover, and reproductive purposes, including 3 reptile, 13 bird, and 8 mammal species. The severe slopes upon which this habitat is found, the denseness of the shrub layer a few years after burning, and the relative homogeneity of the shrub makeup are likely factors responsible for the relatively low wildlife diversity. Black-tailed deer, wrentit, and California thrasher (*Toxostoma redivivum*) are frequently found in this habitat.

In general, the chaparral-dominated stands that occur within the Tehama West Watershed tend to support fewer wildlife species than either the conifer-associated or hardwood-dominated habitats. Their relative homogeneous nature and tendency to rapidly form dense canopy structures following disturbances are probably factors limiting wildlife use. However, these habitats are considered to be very valuable for many species, including black-tailed deer. When the chaparral habitats exist in a landscape supporting a variety of other habitats, they certainly contribute significantly to the area's diversity.

Herbaceous-Dominated Habitats

Approximately 31.09 percent of the Tehama West Watershed landscape consists of habitats dominated by herbaceous growth (grass and forbs). These habitats exist in both seasonally-dry and perennially-wet conditions and in a large range of elevational zones.

Wet Meadow (WHR:WTM)
This habitat exists in small amounts and in small patches from the high elevations of the watershed all the way to the valley floor. Satellite imagery has only detected 81 acres of this vegetation type; however, because it often occurs in small patches, survey techniques can easily miss these meadows. Consequently, it is likely more abundant than suggested by the acreage figures (see Section 8, "Vegetation Resources").

Wildlife species that use this habitat for some time of the year total 233, including 15 amphibian, 16 reptile, 137 bird, and 65 mammal species—a moderate number relative to the watershed's other habitats (see Figure 9-1). In contrast, the species that potentially use the habitat and can acquire high forage, hiding, and reproductive values total 108, including 4 amphibian, 6 reptile, 79 bird, and 19 mammal species. This is the second highest value for any habitat within the watershed.

Given the Mediterranean climate of the Tehama West Watershed, with long, hot and dry summers, wet meadows provide an essential function by providing water and succulent forage to wildlife species found nearby. As an example, in summer black-tailed deer often feed in WTM stands, seeking their nutritious forbs and palatable grasses. Many of their fawning areas occur at high elevations near WTM stands. Waterfowl, especially mallards (*Anas platyrhynchos*), frequent streams flowing through these meadows. Yellow-headed (*Xanthocephalus xanthocephalus*) and red-winged blackbirds (*Agelaius phoeniceus*) occasionally nest in lower elevation WTM habitats that have adjacent tall vegetation and with adequate water depth to discourage predators. Various frog species can be abundant in WTM stands.

Seasonal Wetlands, Central Valley

Annual Grassland (WHR:AGS)
AGS habitats are the most common of all vegetation types existing within the Tehama West Watershed. Slightly over 31 percent of the watershed (207,668 acres) consists of this habitat. These habitats exist in flat or gently-sloping areas near the Sacramento Valley. Introduced grass and forb species dominate these habitats. In some cases areas that were originally covered with blue oak stands have been converted to AGS habitats due to cutting of the trees for firewood or for improved forage yields for livestock.

There are 194 wildlife species predicted to use this Tehama West habitat during some time of the year, including 10 amphibian, 18 reptile, 109 bird, and 57 mammal species. Of these, 98 taxa gain high values for reproduction, feeding, and cover, including 2 amphibian, 3 reptile, 74 bird, and 19 mammal species. These diversity values are less than those for the wet meadow (WTM) habitats.

Many wildlife species use annual grasslands for foraging and some nest on the ground or in associated burrows. However, many of the species that seasonally used these grasslands require special habitat features such as cliffs, caves, ponds, or wooded habitats for breeding, resting, and escape cover. If these features do not exist locally, the AGS habitats might not be able to support some species. Wildlife commonly noted in this habitat include the California vole (*Microtus californicus*), coyote (*Canis latrans*), Western meadow lark (*Sturnella neglecta*), and black-tailed jackrabbit.

The two herbaceous-dominated habitats that exist in the Tehama West Watershed (WTM and AGS) provide seasonal habitat for a moderate number of wildlife species relative to other Tehama West Watershed habitats. However, they provide high year-round values (forage, hiding, and reproductive needs) for more wildlife species than nearly any other available habitats. Following the concept of edge-effect, it is likely that zones where these herbaceous-dominated habitats abut other habitat types, especially ones dominated by trees very high wildlife diversity exists.

Miscellaneous Habitats

Agriculture-Crops (WHR:Various)
Agriculture and croplands cover 4.93 percent of the Tehama West Watershed (32,926 acres); all 32,926 acres exist in the Sacramento Valley. This habitat includes a number of agricultural crops, including row crops, irrigated fields, rice, and orchards. These croplands were established on the watershed's most fertile soils, which historically supported an abundance of wildlife in a variety of

native habitats. Agricultural development has reduced the wildlife richness of California; on the other hand, many species of rodents and birds have adapted to living in croplands and do quite well. In addition, many introduced species that are highly prized for hunting prefer these habitats.

Prior to establishing State and Federal wildlife refuges, waterfowl depredation of crops was widespread in the Sacramento Valley. That problem has been greatly reduced, but still some species of waterfowl depend on waste rice and corn that remain in the fields after harvesting. Black-tailed deer, American crow, and wild pigs also forage in alfalfa and grain fields and can cause depredation problems.

There are 236 wildlife species predicted to use the area's various croplands at some time of the year. These species include 6 amphibian, 10 reptile, 163 bird, and 57 mammal taxa. Of this, 83 species acquire high reproduction, foraging, and cover values, including 1 amphibian, 1 reptile, 65 bird, and 16 mammal species. Yellow-billed magpie, many species of waterfowl and shorebirds, and American crow are very common in this habitat.

Urban (WHR:URB)
Urban habitats cover 3,596 acres of the assessment area (0.54 percent, see Section 8, "Vegetation Resources"). Three urban zones relevant to wildlife can be distinguished in the American West: downtown, urban residential, and suburbia. The heavily-developed downtown zone is usually at the center, followed by concentric zones of urban residential and suburb habitats. There is a progression outward of decreasing development and increasing vegetative cover. Species richness and diversity is extremely low in the inner zone, where vegetation cover and diversity is least. The European-introduced rock dove (*Columba livia*), house sparrow (*Passer domesticus*), and starling (*Sturnus vulgaris*) comprise over 90 percent of all avian density and biomass (Emlen 1974). The urban residential zone has a denser and more varied mosaic of vegetation, including shade trees, lawns, hedges, planted gardens, small parks, and remnant riparian areas. Oftentimes, approximately 40 percent of the land's surface is covered by impervious material in this urban zone. This region is characterized by species including tree swallow, brush rabbit (*Sylvilagus bachmani*), Norway rat (*Rattus norvegicus*), Bullock's oriole (*Icterus bullockii*), and raccoon (*Procyon lotor*).

Suburban areas serve similar roles as native grasslands and woodlands in terms of wildlife habitat functions. In addition to landscaped gardens and lawns, relatively large tracts of adjacent natural vegetation such as chaparral, grasslands, riparian stringers, and oak woodland often exist. Bird species include wrentits, bushtits (*Psaltriparus minimus*), oak titmouse (*Baeolophus inornatus*), and California quail. A total of 190 species are predicted to make use of this habitat for some portion of the year, including 3 amphibian, 7 reptile, 145 bird, and 35 mammal species. Of this total number an amazingly high 61 percent (115 species) gain high value for all their life requirements (forage, cover, and reproduction). This is a greater number of species than for any other habitat occurring in the watershed and includes 106 bird and 9 mammal species. The large number of species that achieve high year-round values from URB habitats is likely due to the presence of water, a large variety of trees and plants that provide food and cover, and a unique intermix of these elements within the drainage.

Barren (WHR:BAR)
Barren habitats exist throughout the Tehama West Watershed and are estimated to cover 2,870 acres (0.43 percent of the land base). Because these habitats often are related to unusual soil or geological features and can be quite small in size, the acreage figure may under-estimate the actual amount.

Where there is little or no vegetation, as in the case of BAR habitats, the structure of the substrate becomes a critical component of the habitat. Many birds-of-prey nest on rock ledges and shorebirds, gulls and terns, common nighthawks (*Chordeiles minor*) and common poorwills (*Phalaenoptilus nuttallii*) rely on open ground covered with sand or gravel for their small scrape nests. The rare bank swallow (*Riparia riparia*) uses barren vertical cliffs with friable soils along river corridors to dig nest holes. Rocky river canyon walls above open water are preferred foraging habitat for many bats, and many birds-of-prey can use cliffs for nesting. BAR habitats provided some use during the year for approximately 79 species, including 1 reptile, 55 bird, and 23 mammal species. This is by far the lowest species number for habitats within the watershed (see Figure 9-1). However, of this total number, 55 taxa (an extremely high proportion of 70 percent), derive high year-round (forage, cover, reproduction) values from the habitat. This list includes 44 bird and 11 mammal species. As in the case of urban habitats, the BAR habitat is quite unique and distinctive and likely offers habitat characteristics that few other areas exhibit.

Water and Aquatic Habitats (WHR:Various)

These habitats only exist in lowland areas of the Sacramento Valley. The open water zones of large rivers provide resting and escape cover for many species of waterfowl. Gulls, terns, osprey (*Pandion haliaetus*) and bald eagle (*Haliaeetus leucocephalus*) hunt over open water. Near-shore waters provide food for waterfowl and belted kingfisher (*Ceryle alcyon*). Many species of insectivorous birds (including swallows, swifts, and flycatchers) capture their insect prey over water. Some of the more common mammals found in riverine habitats include river otter (*Lutra canadensis*), mink (*Mustela vison*), muskrat (*Ondatra ziberthicus*), and American beaver (*Castor canadensis*).

Fairy Shrimp

There are 120 species of wildlife predicted to use the open water or aquatic habitat some time of year, including 13 amphibian, 4 reptile, 79 bird, and 24 mammal species. Of these, 54 species use the habitat year-round for all their needs, including 5 amphibian, 3 reptile, 42 bird, and 4 mammal species. These seasonal and year-round use numbers are moderate, relative to the other habitats that exist in the watershed (see Figures 9-1 and 9-2).

A very valuable and interesting wetland habitat found in the watershed is vernal pools, existing in a band west from Interstate 5 from Red Bluff south to Glenn County (see Section 8, "Vegetation Resources") (USFWS Various; USFWS 2004). Vernal pools are small freshwater wetlands that are inundated for a few days to a few months during the spring. They typically form in small depressions that are underlain by impermeable subsoils (see Section 4, "Geology, Geomorphology, and Soils," and Section 8, "Vegetation Resources"). They provide a unique habitat for both plant and animal species, particularly invertebrates. Some of these species are endemics, meaning they are found nowhere else in the world, and the federal and state government has listed some of these taxa as either threatened or endangered.

Vernal Pool, Central Valley

The U.S. Fish and Wildlife Service (2004) has described the following factors to be major threats to vernal pool endemics (both animals and plants):

- historical and current habitat loss and fragmentation
- gravel mining
- habitat degradation
- altered hydrology
- water quality degradation
- human waste, recreational use, and vandalism
- loss of insect pollinator species
- inappropriate grazing
- inappropriate management and monitoring
- random, naturally occurring events
- over-utilization (including collection by collectors); disease
- inadequate regulations

THREATENED, ENDANGERED, AND RARE SPECIES

The Tehama West Watershed has had relatively little work completed to determine the wildlife species present and their densities. However, a wealth of data exists for the Thomes-Newville and Upper Red Bank Creek areas, where proposed dams have been studied during the past several decades. Late in the writing of this section, the North of the Delta Offstream Storage Investigation (CALFED 2000) was provided to the author. In addition to summarizing the findings of the 1997-1998 wildlife surveys, it also referred to the results of previous work that had been completed in the same two vicinities in the 1980s.

Swainson's Hawk

Because wildlife survey data could not be found for other portions of the drainage, a CNDDB (2005) query was made. This resulted in a list of 23 special status species that had been observed in the Tehama West assessment area and for which a database entry had been made. These species include federal or state level endangered or threatened species, candidates for such listing, or are on the list of California Species of Special Concern. Unfortunately, many of the special status species observations made in dam studies and summarized in CALFED (2000) are not included in the CNDDB. By combining the CNDDB (2005) database query and the results of surveys done in the past several decades at dam sites (reported in CALFED (2000)), Table 9-1 has been compiled. This table includes each specie's regulatory status and the locations where they have been recorded within the watershed.

These CNDDB occurrences are mapped on Figure 9-3; however, the dam study observations are not shown because their exact locations are not known. Because the CNDDB is based on voluntary data submission, it is likely that important wildlife observations have occurred elsewhere in the watershed, but have never been submitted to the database. The location of the CNDDB observations (Figure 9-3) suggests that a majority of the rare wildlife species exist in the Sacramento Valley portion of the watershed. This may be true; however, it may only be because the Sacramento Valley has had many more observers than other portions of the watershed. If this is so, large portions of the Tehama West Watershed may have rare species that have never been surveyed for, or if seen, never reported.

Table 9-1
SPECIAL STATUS WILDLIFE SPECIES KNOWN TO EXIST IN THE TEHAMA WEST WATERSHED

Common Name Scientific Name	Regulatory Status (Federal/ State)	Habitat Requirements	Occurrence in Watershed (CNDDB Occurrences in Normal Font, CALFED, 2000 Observations in Bold)
Invertebrates			
Vernal pool fairy shrimp *Branchinecta lynchi*	FT	Vernal pools, swales, and ephemeral freshwater habitat	Thomes Creek, 5 miles NW of Corning; Truckee Creek; vernal pools S of Red Bluff
Vernal pool tadpole shrimp *Lepidurus packardi*	FE	Vernal pools, swales, and ephemeral freshwater habitat	Annual grassland habitat, with vernal pools S of Red Bluff.
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	FT	Riparian habitats with blue elderberry shrubs	Along Sacramento River, in elderberry shrubs; Thomes Creek E of Paskenta
Amphibians/Reptiles			
California red-legged frog *Rana aurora draytonii*	FT CSC	Perennial, slow moving streams; ponds; or marsh communities with emergent vegetation	Sunflower Gulch (Red Bank Creek tributary) in 1986; **Sunflower Gulch in 1998**
Foothill yellow-legged frog *Rana boylii*	FSC	Sunny shallow streams with cobble and boulder edges	Coast Range foothill stream reaches; **Red Bank Creek and tributaries in 1997-98; Thomes Creek in 1997-98**
Western spadefoot toad *Spea hammondii*	CSC	Vernal pools and associated uplands	Rice Creek; **Paskenta area in 1997-98**
Northwestern pond turtle *Clemmys marmorata marmorata*	CSC	Wetlands; low gradient streams; marshes; ponds and nearby uplands.	Thomes Creek; **Red Bank Creek in 1997-98**
Birds			
Bald eagle *Haliaeetus leucocephalus*	FT CE	Stick nests near permanent water sources with fish and waterfowl; winters near lakes and rivers	Along Sacramento River; **winter use along Thomes Creek in 1980s and 1997-98; Upper Red Bank Creek**
Golden eagle *Aquila chrysaetos*	CSC	Nests on cliffs or in large trees on steep slopes; hunts relatively open habitats	**Paskenta area winter, spring of 1997-98; year-round on Upper Red Bank Creek**
Northern goshawk *Accipiter gentilis*	CSC	Mature conifer forests; may move downslope during winters	Upper McClure Creek and Doll Ridge.
Northern spotted owl *Strix occidentalis caurina*	FT	Mature coniferous forests	Coast Range forests above 3,000' elevation
Osprey *Pandion haliaetus*	CSC	Stick nests in snags or other open perches near lakes and rivers having fish	Sacramento River S of Tehama; likely near other streams and lakes; **Upper Red Bank Creek (1997-98)**

Table 9-1 (cont.)
SPECIAL STATUS WILDLIFE SPECIES KNOWN TO EXIST IN THE TEHAMA WEST WATERSHED

Common Name Scientific Name	Regulatory Status (Federal/ State)	Habitat Requirements	Occurrence in Watershed (CNDDB Occurrences in Normal Font, CALFED, 2000 Observations in Bold)
Cooper's Hawk *Accipiter cooperii*	CSC	Constructs stick nest; various habitats, including woodlands; riparian stringers; and coniferous forests	**Paskenta area winter, 1997-98; Upper Red Bank Creek fall, winter, spring 1997-98**
Sharp-shinned hawk *Accipiter striatus*	CSC	Constructs stick nest; various habitats, including woodlands; riparian strings; and coniferous forests	**Upper Red Bank Creek fall, winter, spring 1997-98**
Northern harrier *Circus cyaneus*	CSC	Nests on the ground; hunts over fields, marshes, and grasslands	**Paskenta area winter, spring 1997-98**; **Upper Red Bank Creek fall, winter, spring 1997-98**
Swainson's hawk *Buteo Swainsoni*	CT	Stick nest in isolated trees or riparian woodlands adjacent to agricultural fields or grasslands	McClure Creek; Burch Creek; and Thomes Creek W of Richfield
Western burrowing owl *Athene cunicularia hypugaea*	CSC	Nests in burrows in the ground within open dry grassland and desert habitat	S of Red Bluff; Hall Creek; Jewett Creek; and N of Elder Creek.
White-tailed kite *Elanus leucurus*	CFP	Stick nest in isolated trees or woodland areas with surrounding open foraging habitat	Elder Creek; NNW of Gerber
Prairie falcon *Falco mexicanus*	CSC	Nests on cliffs and forages for avian prey over extensive areas	Sensitive locations—not stated in CNDDB; **Paskenta area winter and spring, 1997-98; Upper Red Bank Creek spring, 1997-98**
Peregrine falcon *Falco peregrinus anatum*	Federal Delisted CE	Nests on cliffs near water and forages for avian prey over extensive areas	Sensitive locations—not stated
Merlin *Falco columbarius*	CSC	Winter use of Sacramento Valley and adjacent open habitats	**Paskenta area in winter, 1997-98; Upper Red Bank Creek spring of 1997-98**
Tri-colored blackbird *Agelaius tricolor*	CSC	Emergent wetlands with nearby open water	**Scattered Sacramento Valley locations; Paskenta area winter and spring, 1997-98**
Bank swallow *Riparia riparia*	CT	Nests in vertical stream banks and forages over nearby streams and riparian areas	Along Sacramento River near Vina and Tehama; Table Mt.; Thomes Creek near Henleyville; **Thomes Creek near Paskenta**
Loggerhead shrike *Lanius ludovicianus*	CSC	Hunts for insects on perches in open terrain	**Paskenta area winter and spring, 1997-98**
California horned lark *Eremophila alpestris actia*	CSC	Open areas dominated by herbaceous growth	**Paskenta area in winter and spring, 1997-98**
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	FC CE	Nests in large, mature riparian forests with dense canopy	Sacramento River, near Foster Island, Burch, Jewett, and Deer Creeks

Table 9-1 (cont.) **SPECIAL STATUS WILDLIFE SPECIES KNOWN TO EXIST IN THE TEHAMA WEST WATERSHED**			
Common Name **Scientific Name**	**Common Name** **Scientific Name**	**Common Name** **Scientific Name**	**Common Name** **Scientific Name**
Lark sparrow *Chondestes grammacus*	MNBMC	Found in grasslands with scattered shrubs	**Paskenta area, winter and spring of 1997-98; Upper Red Bank Creek winter and spring of 1978-98**
Lawrence's goldfinch *Carduelis lawrencei*	MNBMC	Open oak and chaparral areas, near water	**Upper Red Bank Creek winter and spring of 1997-98**
Yellow warbler *Dendroica petechia brewsteri*	CSC	Nests in dense riparian vegetation	Sunflower Gulch and Red Bank Creek
Yellow-breasted chat *Icteria virens*	CSC	Nests in dense riparian thickets	No records for Tehama West; however, likely along major streams
Mammals			
American badger *Taxidea taxus*	CSC	Constructs burrows in friable soils of grasslands and open conifer forests	Upper Coast Range; **Paskenta area 1997-98**
Ringtail *Bassariscus astutus*	CFP	Low to mid-elevation shrub and riparian habitats	**Paskenta area, 1997-98**
Yuma myotis Myotis yumanensis	CSC	Many habitats, near water	**Paskenta area, 1997-98; Upper Red Bank Creek, 1997-98**
Palid bat *Antrozous pallidus*	CSC	Forage in relatively open habitats with rocky areas where roosting occurs	**Paskenta area and Upper Red Bank Creek, 1997-98**
Pale big-eared bat *Corynorhinus townsendii pallescens*	CSC	Variety of habitats near water	Upper Coast Range

Federally Listed and Management Concern Species:
FE = federal endangered
FT = federal threatened
FC = candidate
PT = proposed threatened
MNBMC = Migratory Nongame Birds of Management Concern (USFWS)

California State Listed Species:
CE = California state endangered
CT = California state threatened
CSC = California Species of Special Concern
CFP=California Fully Protected

Source: CNDDB 2005 and Barron, F. Pers. Communications; CALFED 2000 (Dam study observations are included in **bold**)

The 35 rare species (or those on watch lists) known to exist in the assessment area, as shown on Table 9-1, tend to be found in several general habitat categories. This break-down is shown in Table 9-2:

Table 9-2
HABITAT TYPES HARBORING KNOWN RARE SPECIES IN THE TEHAMA WEST WATERSHED

Habitat	Number of Species
Vernal Pools	2
Other Wetlands	1
Riparian Habitats (foothill and montane)	6
River, Pond, or Stream-associated	6
Forest/Woodlands	4
Grasslands/Fields	9
Chaparral	1
Miscellaneous/varied	5

A full 15 of the 35 rare species (43 percent) have a direct or linked-association with some form of wetland or near-stream habitat. This is striking, considering the rather limited extent of these habitats within the watershed. Also, 14 of the 35 taxa on this list (40 percent) are birds-of-prey.

By considering the habitats that exist within the Tehama West assessment area, and the known distribution of wildlife species found in northern California, many additional rare species have the potential to exist. These potentially occurring species are shown on Table 9-3, along with their habitat requirements and possible locations where they might exist. (A larger list would result if species on the Bureau of Land Management and U.S. Forest Service watch lists were included.)

A majority of the potentially existing special status species listed on Table 9-3 would only occur for part of the year in the Sacramento Valley. In addition, most are classified as California Species of Special Concern (CSC). Because the CSC status is less restrictive, from a regulatory status, than federally- or state-listed species, observers of these species often fail to submit their findings to the CNDDB database. In addition, many casual wildlife observers may not realize that some of these species have a regulatory status. For this reason, it is possible that some of these special status species may be wide spread or common in the watershed, even though no state database entries exist for them.

CRITICAL HABITAT

Critical habitat areas are designated by the USFWS as part of an overall plan designed to facilitate the recovery of listed species. Critical habitat areas in the Tehama West Watershed are located in the areas having vernal pools and along the Sacramento River at Table Mountain.

Table 9-3 **SPECIAL STATUS WILDLIFE SPECIES WITH THE POTENTIAL TO EXIST IN THE TEHAMA WEST WATERSHED**			
Common Name **Scientific Name**	**Regulatory Status (Federal/ State)**	**Habitat Requirements**	**Areas of Potential Occurrence in Watershed**
Invertebrates			
Conservancy Fairy Shrimp *Branchinecta conservation*	FE	Vernal pools, swales, and ephemeral freshwater habitat	Sacramento Valley
Birds			
Common loon *Gavia immer*	CSC	Winter use of interior California lakes	Sacramento Valley lakes and larger ponds
American white pelican *Pelecanus erythrorhynchos*	CSC (Nesting colonies)	Winter use of interior California lakes	Sacramento Valley lakes and larger ponds
Double-crested cormorant *Phalacrocorax auritus*	CSC (Rookery sites)	Winter use of interior California lakes	Sacramento River and valley lakes and larger ponds
White-faced ibis *Plegadis chihi*	CSC (Rookery sites)	Winter use of fields and marshes	Sacramento Valley
Barrow's goldeneye *Buchephala islandica*	CSC	Winter use of ponds and lakes	Sacramento Valley lakes and larger ponds
Ferruginous hawk *Buteo regalis*	CSC	Winter use of Sacramento Valley	Open areas in Sacramento Valley
Long-billed curlew *Numenius americanus*	CSC (Nesting)	Winter use of Sacramento Valley	Sacramento Valley fields and marshes
Black tern *Chlidonias niger*	CSC (Nesting colony)	Winter use of Sacramento Valley	Sacramento Valley marshes and ponds
California gull *Larus californicus*	CSC (Nesting colony)	Winter use of Sacramento Valley	Sacramento Valley fields, marshes, and potentially urban areas
Short-eared owl *Asio flammeus*	CSC	Grassy areas; nests on the ground	Sacramento Valley fields and marshes, possibly extending into the annual grasslands and blue oak woodlands
Long-eared owl *Asio otus*	CSC	Nests in dense trees; hunts in nearby open areas	Sacramento fields and marshes, riparian areas, and lower elevation coniferous forests of Coast Range
Vaux's swift *Chaetura vauxi*	CSC	Nests in cavities of large trees; makes long, insect capturing forays	Coniferous forests of the Coast Range
Black swift *Cypseloides niger*	CSC	Very localized nesting sites, usually on cliffs near waterfalls; makes long, insect capturing forays	Coniferous forests (canyons) of the Coast Range, near waterfalls

Table 9-3 (cont.)
SPECIAL STATUS WILDLIFE SPECIES WITH THE POTENTIAL TO EXIST IN THE TEHAMA WEST WATERSHED

Common Name Scientific Name	Regulatory Status (Federal/ State)	Habitat Requirements	Areas of Potential Occurrence in Watershed
Purple martin *Progne subis*	CSC	Nests in tree cavities; makes long, insect capturing forays	Low elevation wooded habitats, including riparian, oak woodland, and lower coniferous stands of the Coast Range
Yellow-breasted chat *Icteria virens*	CSC	Nests in riparian thickets	Sacramento Valley and foothill riparian zones
Bell's sage sparrow *Amphispiza belli belli*	CSC	Breeds and forages in shrub communities	Coast Range shrub communities, possibly in chamise and mixed chaparral stands
Mammals			
California wolverine *Gulo gulo*	CT	Feeds upon small mammals; forest habitats with large down wood	Mid- to upper elevation forest habitats of Coast Range
Pine martin *Martes americana humboldtensis*	CSC	Feeds upon small mammals; high elevation forests with rocky areas and large down wood	Upper-elevation forest habitats of Coast Range
Pacific fisher *Martes pennanti*	CSC FC	Feeds upon small mammals; mid-elevation forests, with large down wood, near streams	Mid-elevation coniferous forests habitats of Coast Range

Federally Listed Species:
FE = federal endangered
FT = federal threatened
FC = candidate
PT = proposed threatened

California State Listed Species:
CE = California state endangered
CT = California state threatened
CSC = California Species of Special Concern
CFP=California Fully Protected

Source: Zeiner et al 1988; Zeiner et al 1990a; Zeiner et al 1990b; CDFG 2005; DFG 2005d

Section 4(f) of the Endangered Species Act of 1973, as amended, directs the Secretary of the Interior and the Secretary of Commerce to develop and implement recovery plans for species of animals and plants listed as endangered or threatened unless such plans will not promote the conservation of the species. The USFWS and the National Marine Fisheries Service have been delegated the responsibility of administering the Federal Endangered Species Act. Such a plan has been drafted for vernal pool habitats of the Sacramento Valley (USFWS 2004).

California Red-Legged Frog

Recovery is the process by which the decline of an endangered or threatened species is arrested or reversed, and threats to its survival are neutralized, so that its long-term survival in nature can be ensured. The goal of this process is the maintenance of secure, self-sustaining wild populations of species with the minimum necessary investment of resources. A recovery plan delineates, justifies, and schedules the research and management actions necessary to support recovery of a species. Recovery plans do not, of themselves, commit manpower or funds, but are used in setting regional and national funding priorities and providing direction to local, regional, and state planning efforts. Means within the Endangered Species Act to achieve recovery goals include the responsibility of all Federal agencies to seek to conserve endangered and threatened species; the Secretary's ability to designate critical habitat, enter into cooperative agreements with the states, to provide financial assistance to the respective state agencies, acquire land, and develop Habitat Conservation Plans with applicants.

Bank Swallow—A Rare Species Found Along Rivers and Streams of Tehama County

The Endangered Species Act mandates the preparation of recovery plans for listed species unless such a plan would not contribute to their conservation. Recovery plans detail the actions necessary to achieve self-sustaining, wild populations of listed species so they will no longer require protection under the Endangered Species Act. Species of concern are not required to have recovery plans, however, they are included in draft recovery plans because a community-level strategy provides opportunities for pre-listing conservation of species with needs similar to those of listed species (USFWS 2004).

Valley Elderberry Longhorn Beetle (photo by Ted Gantenbein)

The CNDDB (2005) also includes a listing of habitats that experts have considered to be rare and important, several of these exist in the Tehama West Watershed. Project proponents are required by the California Environmental Quality Act (CEQA) to assess whether their actions might impact these habitats, and in some cases to mitigate the impacts. The designated special habitats known to exist within the assessment area include:

- Great Valley Mixed Riparian Forest (located along the Sacramento River and possibly along some tributaries)

- Great Valley Willow Scrub (located along Sacramento River)

- Northern Hardpan Vernal Pool (located southwest of Red Bluff, along Paskenta Road, other locations)

- Valley Needlegrass Grassland (located 3 miles north of Black Butte Reservoir)

- Coastal and Valley Freshwater Marsh (located along Sacramento River in vicinity of Merrill's Landing).

PREDATOR SPECIES

The large mammal predators are among the best-known wildlife species in the watershed. These predators include black bear (*Ursus americanus*), mountain lion (*Felis concolor*), and coyote. Each species has been known, at least on occasion, to prey on livestock and cause other human concerns.

Black Bear

Adult black bear females weigh 100-200 pounds whereas adult males are larger, at 150-350 pounds, though individuals over 600 pounds have been taken by hunters in California. Black bears are omnivorous and opportunist and have teeth adapted for feeding on both plant and animal matter. Bear commonly consume ants and other insects in summer, but prefer nut crops, especially acorns and manzanita berries in the fall. As omnivores, black bears will eat whatever is available and can become adept at catching young deer fawns. Bears frequently adapt to human presence, often because bears are attracted to human garbage, pet food and other food items. In suburban areas and mountain communities, bears may damage private property while foraging. These events are most likely to occur in spring if natural foods are scarce, or in late summer and fall, especially during years of poor berry and acorn yields.

In California black bear are relatively common with a population estimate of about 30,000. Since 1985 there has been an annual harvest ranging from 1,000-1,800 animals per year (CDFG 2004c). Black bears "thrive" in some habitats, while gaining only marginal or seasonal benefits from other habitat types. For instance, black bears are known to use annual grasslands (AGS) and valley foothill hardwood habitats (BOW, BOP, VFR, VOW) sporadically during the year; however, self-sustaining bear populations are not usually found in these habitats. In contrast, montane hardwood (MHW), montane chaparral (MCP), and Klamath mixed conifer (KMC) forests sustain high bear populations because they supply sufficient food, cover, and water. Habitats with both vegetative and structural diversity provide alternate food resources when other foods are in short supply. An important feature for successful reproduction is secure, dry den sites were the female bears give birth to the cubs. While black bears have been found to den in slash piles, under large rocks, and even on open ground, the most secure and thermally protective den sites are located in large, down logs or in hollowed-out bases of large trees.

Habitat loss is a leading threat to most wildlife species in California. In the case of the wide-ranging black bear, over half of the state's suitable habitat is in public ownership, of which an estimated 10 percent is managed as either wilderness or park. This allows for large blocks of habitat to remain undeveloped and for core areas within these blocks to exist, where bears encounter few humans; however, land management activities on these public lands can affect the capability of an area to support bear populations. For instance, many of the important food plants such as manzanita berries and acorns grow from plants (manzanita shrubs and oaks) that require full sunlight. Therefore, controlled burns or other management strategies, aimed at creating a mosaic of forest openings where manzanita and the various oak species thrive, can be especially beneficial for black bears by providing abundant food resources in close proximity to cover. Additionally, retention and recruitment of snags and large woody debris provide den sites and potential food sources (colonial insects). Conversely, management practices which result in densely grown, even-aged stands without structural and vegetational diversity decrease habitat value for black bears (CDFG 2004c).

An ongoing issue relating to black bear is the illegal hunting and trade in bear gall bladders. These body-parts are considered important in Asian markets and many animals are killed for this purpose throughout California (Castle 2005).

Mountain Lion

Another important predator in the watershed is the mountain lion. The current population of mountain lions in California is estimated between 4,000 and 6,000 (CDFG 2005b; CDFG 2005c). Mountain lions live an average of 12 years in the wild and up to 25 years in captivity. They often have three kittens in the winter or spring. On average, two of these live for 1 year after birth.

The highest density of lions in California is in the western slope of the Sierra Nevada and northwestern California, including the Tehama West Watershed, where up to 10 animals can live per 100 square miles of habitat (CDFG 2005c). Generally speaking, mountain lions can be found wherever black-tailed deer are present, as they are the predator's main food source. Foothills and mountains are most suitable mountain lion habitat, while valleys are considered much less suitable.

California residents have seen a variety of management approaches for this species. In 1907 bounties were first placed on lions, with 12,500 individuals taken in the following 57 years, in some years the harvest exceeding 350. In the 1960s the specie's legal status was changed to a game animal and in 1969 a record 4,953 animals were taken. Environmental pressures increased to restrict or halt hunting and in 1972 a law was enacted that ended recreational harvest. Figure 9-4 shows the summary of mountain lion depredation incidents from 1972 through 1999. Following this action, in the period from 1986 to 1995, there were 10 verified attacks by mountain lions on humans. To put this in perspective, prior to 1986 there had only been two verified lion attacks in Californian history, in 1890 and 1909 (CDFG 2005c).

Following the expression of public concern regarding mountain lion attacks, the California Department of Fish and Game placed considerable time into researching the species and the condition under which these attacks have occurred. They have found that the species is more widespread and abundant than it was 25 years ago. With regards to why there are more human attacks, CDFG conjectures that most good lion habitat is taken up by existing territorial animals. When animals without territories (young animals or ones forced out by stronger animals) seek their own area, they must go to the habitats with less quality—in many cases this is where humans also exist (CDFG 2004a; CDFG 2005c).

Usually, there is no apparent explanation for why a mountain lion seems to abandon its instinctive wariness of humans. Mountain lions are typically solitary and elusive. Studies of collared mountain lions show that they often co-exist around people, unseen and unheard. People who live in mountain lion habitat can take precautions to reduce the risk of encountering a mountain lion, including: deer-proofing the landscape so that less of the predator's time will be spent near the dwelling, removing dense vegetation from around rural homes, and installing outdoor lighting to make it difficult for mountain lions to approach unseen.

Although biologists have generally thought that predators have little role in limiting prey populations, recent research with mountain lions suggest that this may not be the case. In some situations, predation upon mountain sheep (*Ovis canadensis*) and mule deer has been a factor, along with disease and drought, in keeping the prey populations low (CDFG 2005c).

Coyote

The last of the three well-known mammalian predators in the Tehama West Watershed is the coyote. Their range now extends from Central America to the Arctic. In spite of being hunted and trapped for more than 200 years, more coyotes likely exist today than when the U.S. Constitution was signed (CDFG 2004d).

Adult coyotes weigh between 20 and 45 pounds. Females are generally smaller than males and individuals look similar to small collie dogs. They have erect pointed ears, slender muzzle, and a bushy tail. The coyote's color varies, depending upon the geographic region and the time of year. Most coyotes have dark or black hairs over their back and tail.

Coyotes are highly adaptable, and are found in deserts, swamps, tundra, grasslands, brush, and dense forests, from below sea level to the high mountains. A true scavenger, omnivore, and opportunist, the coyote will eat just about anything. Identified as a killer of sheep, poultry and deer, the coyote will also eat snakes and foxes, rodents and rabbits, fruits and vegetables, birds, frogs, grass and grasshoppers, pet cats and cat food, pet dogs and dog food, carrion, and just plain garbage.

Part of the reason for the coyote's success has been a high reproductive rate, rapid growth of offspring and its ability to adapt to a wide variety of environments. Coyotes breed in February and March and pups are born about 60 days later. An average coyote litter contains four or five pups, which are born in dens. In urban environments, coyotes use dens in storm drains, under storage sheds, in holes dug in vacant lots, parks, or golf courses, or any other dark, dry place (APHIS 2002).

In areas where they are hunted or trapped, coyotes are extremely wary of human beings. However, in urban areas, where they are less likely to be harmed and more likely to associate people with an easy and dependable source of food, they can become very bold. The U.S. Department of Agriculture's Animal and Plant Health Inspection Service, Wildlife Services suggests (and offers technical assistance for) the following non-lethal methods to reduce coyote damages (CDFG 2004d):

- Use net-wire or electric fencing to keep coyotes away from livestock
- Shorten the length of calving or lambing seasons
- Confine livestock in a coyote-proof corral at night when coyotes are most likely to attack livestock
- Use lights above corrals
- Remove dead livestock so coyotes won't be attracted to scavenge
- Remove habitats that provide homes to natural prey of coyotes, like rabbits, from lambing and calving areas
- Use strobe lights and sirens to scare coyotes away
- Use guard animals, such as dogs, donkeys, and llamas, to protect livestock

California Department of Fish and Game (2004d) espouses the notion that the best way to avoid problems with coyotes is to avoid feeding them so that they will not be encouraged to spend time near habitations.

HARVESTED SPECIES

A large number of wildlife species can be legally harvested in California, primarily through hunting and trapping. Species considered to be nuisances, such as feral pigs (*Sus scrofa*) and Amercian crows *(Crovas brachyrhynchos)*, have unlimited seasons and bag limits, while many hunters must adhere to strict seasons and bag limits for other species. Black-tailed deer, waterfowl, and upland game birds are typically the most popular game species. Many of the species that provide hunting opportunities are introduced species, including the ring-necked pheasant (*Phasianus colchicus*), turkey (*Meleagris gallopavo*), and feral pigs.

Black-Tailed Deer

Columbian black-tailed deer are found in virtually all habitats within the Tehama West Watershed. However, the preferred habitats are those with abundant sources of high quality browse species, including a variety of shrubs. These prime habitats include chaparral-dominated habitats, the conifer zone, where fires have burned recently and shrubs and herbaceous plants have quickly become established. Seasonally, acorn mast crops are heavily used and animals will concentrate in these areas in late summer and the autumn.

Although there are resident black-tailed deer that spend all year in the Sacramento Valley, many of the deer in Tehama West move upslope during the spring, to take advantage of developing vegetation and to access traditional fawning areas. The fawning areas are often near water, where an abundance of lush herbaceous growth exists, which helps the doe produce an abundance of milk. Following fawning the animals will stay in the general area and then slowly begin to move downslope during the autumn. If acorns are in abundance in a given year, deer will often stage or hold in these areas for a period of time. Before the winter snows arrive, the deer generally reach the lower foothill habitats dominated by blue oak, foothill pine, and chaparral stands. This is where they will winter and breed and move from in the following spring to complete the yearly cycle.

Deer summering in the higher elevations of the Coast Range face the same dilemma as they do in most regions of the State. Their winter ranges, along the base of the mountains and at an elevation below the deep and persistent snow level, are frequently heavily impacted by man's actions and developments. In some cases, critical winter ranges have been degraded to the point that they can not support the deer populations that would normally use the summer habitats; consequently, the herd populations have declined or crashed (Loveless 1967).

Due to the historical importance of deer hunting to California, much study has gone into both their biology and habitat needs. Early-on researchers determined that deer were an early-seral species, meaning that they did best shortly after vegetation disturbances, primarily fire. There were many examples of where California deer populations exploded following large fires. Because of the correlation between fires and high deer populations, many researchers collaborated to determine techniques to burn forest and chaparral stands in a controlled manner, to improve deer habitat (Biswell et al 1952; Dasmann 1956; Taber 1956). A generalized, historical representation of deer population densities for California during the past two centuries is shown on Figure 9-5. The relationship between large fires and buck harvest rate (potentially an indicator of herd population) is shown on Figure 9-6.

Important deer nutritional studies were completed in the mid-1900s in eastern Tehama County. Dasmann (1956) found that browse quality, with regards to palatability and nutritive value, varied by plant species, time of year, and whether plants were re-sprouting following a recent burn or were well-established. In the eastern Tehama study area, preferred browse species included wedge-leafed ceanothus (*Ceanothus cuneatus*), birch-leafed mahogany (*Cercocarpus betuloides*), and acorns. These findings probably hold true for the Tehama West herds also.

The deer season in northern California is an important social event for many people, although less so than several decades ago, and infuses considerable economic input to the county. Deer season in Tehama County begins with an archery hunt in late summer, followed by the regular firearm season extending into the autumn. Based upon the 2002 deer harvest (CDFG 2002), there were a total of 17,741 deer recorded as taken during the regular season statewide; 909 of which were from Tehama County (5.1 percent of the statewide total). Due to a variety of reasons, the actual harvest is estimated to be considerably larger, or approximately 33,000. Therefore, it is possible that the actual Tehama County hunting take is almost 1,800 animals. The 2002 archery season take was 1,340 animals statewide, with 57 coming from Tehama County. Likewise, the actual numbers are estimated to be almost twice as many.

The economic value of deer hunting to local counties may be considerable. California Department of Fish and Game (1997) completed an economic analysis for five counties north and east of Tehama County, showing that the average rifle hunter spent $223 per season and higher amounts for archery and muzzle-loader hunters.

Wild Pig

Wild pigs have become an increasingly sought after game species. They occur within the Tehama West Watershed from the shrub-dominated community's downslope through the agricultural lands. First introduced from European domestic varieties, they appear to be increasing in population and distribution in California. They are now considered a big game species. The number of wild pigs harvested on public land increased from 5,800 in 1997 to 9,600 in 1999. There is no reliable estimate of how many are killed on private land; however, they may be approaching deer in the amount of their annual kill (Ahlborn 2004; CDFG 2004b).

Wild pigs are prolific, with the potential of having two litters per year and up to 15 piglets per litter. Landowners complain about the variety of damage they can incur, including damage to fences, rooting-caused damage to fields and rangelands, and eating of acorns important to wild species. They are also known to be susceptible to anthrax (Barrett 1997; CDFG 2004b).

Waterfowl

Waterfowl occur throughout the Sacramento Valley and provide much recreation for hunters. Approximately 30 species of waterfowl may, on occasion, exist in the watershed and be hunted. There are large numbers of waterfowl that breed in California each year, from 400,000 to 800,000 breeding pairs were noted during the period from 1992 to 2005 (CDFG 2005a). In addition, the Sacramento and San Joaquin Valleys are major wintering areas for many other birds that breed further north and inland.

Waterfowl hunting is an important recreational activity in the Sacramento Valley and many landowners with ponds or slough areas likely make money from allowing hunting to occur on their property.

Other Harvested Species

Pronghorn antelope (*Antilocapra americana*) and tule elk (*Cervus elaphus nannodes*) occurred historically in the Sacramento Valley but were eliminated by habitat disruption and excessive hunting. Although the re-introduction of pronghorn in eastern Tehama County has been discussed for years, apparently there are no current plans to do so. It is also possible that tule elk could be re-established in Tehama County. However, it is unlikely, due to the land ownership pattern, and the limited amount of habitat remaining, that either species can expand to numbers that can support hunting in the watershed.

There are many other hunted species that occur within the watershed and provide enjoyment and economic benefits to the county. Although difficult to quantify, it is very likely that many ranchers and farmers bring in some to considerable income from offering their lands to hunters or hunting clubs for the opportunity to hunt these species.

EXOTIC SPECIES

In the past, wildlife species have been introduced into America both accidentally and intentionally. Well-known introduced wildlife species in the watershed include the bullfrog, ring-necked pheasant, wild turkey, feral pig, European starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), house mouse (*Mus musculus*), Virginia opossum (*Didelphis virginiana*), muskrat (*Ondatra zibethicus*), rock dove (*Columba livia*), and New Zealand mud snail (*Potamopyrgus antipodarum*). Descriptions follow for some of these species with regards to their potential impacts on local habitats and wildlife resources:

Bullfrog

The results of bullfrog importations have been varied. On the negative side, the bullfrog has directly impacted aquatic species by preying upon and out-competing native amphibians and reptiles, including the California red-legged (*Rana aurora draytonii*) and foothill yellow-legged frogs (*Rana boylii*) and northwestern pond turtle (*Clemmys marmorata marmorata*) (Moyle 1973; Hayes and Jennings 1986). In addition, they have a voracious nature and can capture ducklings, fish, and many other species (Basey and Sinclear 1980; Zeiner et al 1988).

The bullfrog is native to eastern portions of North America, and was introduced into western states for mosquito control, mainly in the 1920s and 1930s. Records indicate bullfrog invasions were appearing in California as early as 1895. Bullfrogs likely exist through the lower elevations of the watershed, wherever warm, weedy, permanent ponds and lakes, ditches and slow-moving streams and ponds, or perennial streams exist (Zeiner et al 1988).

The reduction or elimination of bullfrogs from specific areas should aid the native frog population. Following population control, it may be possible to re-introduce native frog species that historically inhabited specific locations.

Wild Pig

Domestic pigs were brought to California by the Spanish in 1769. Throughout the following century European settlers, including the Russians at Fort Ross, continued to transport domestic swine into the state. Most of these pigs were variously colored mongrels exhibiting short-legged, chuffy, lard pig traits (Wood and Barrett 1979; Barrett 1997). In 1925 Eurasian wild boar stock from North Carolina was introduced near Carmel, Monterey County. Since that time, the species has continually expanded its range (Barrett 1997).

Wild pigs are common in foothill and valley habitats. The minimum requirements for good wild pig habitat are dense vegetation and the presence of a water source nearby. The existence of mast crops is also an important factor influencing pig distribution and population density. Adjacent agricultural lands also enhance the value of the pig's habitat because the fields and orchards provide many forage opportunities. Wild pigs are omnivorous and their diet changes with the seasons. During the dry summer months, pigs eat green plants. During the autumn, they consume acorns, walnuts, and fruit when they are available. During the winter, when rains soften the soil, wild pigs eat roots, bulbs, insects, and worms that they locate by plowing or "rooting" the ground with their tough snouts. In the spring, as the soil dries, they gradually shift back to green plant parts. In some agricultural areas, barley and alfalfa are preferred foods. Small animals and carrion form a minor part of the pig's diet year-round (Barrett 1997). Feral pigs were noted at both the proposed Upper Red Bank and Thomes-Newville dam sites (CALFED 2000).

Rooting by pigs in moist or irrigated soil is normally quite visible. Sometimes only a few small sites are rooted or the disturbed area may cover several hundred square feet or more. Rooting can harm pastures, crops, and native plants and may cause soil erosion. Pig rooting can alter the relative abundance of different plant species at the site and can change the functioning of natural ecosystems. In years of acorn shortage, wild pigs may compete with wild turkey, mule deer, squirrels, and black bears. Destruction by pigs of native vegetation and nests of ground-nesting birds may also be a serious problem (Barrett 1997).

Wild Turkey

Wild turkey can be found throughout much of the Tehama West Watershed; however, no data regarding local turkey populations were found. Consequently, this section is based on statewide data and generally understood biology.

The California Fish and Game Commission first introduced Merriam's wild turkeys to California in June of 1908, with many more releases since that time. The historical range of this species is suspected to be Arizona, New Mexico, and Colorado. They have established populations in approximately 37 counties in California, and are generally found in deciduous riparian, oak, and conifer-oak woodlands. They prefer large trees with some canopy, ideally with numerous grass/forb openings near water in hilly terrain. Densities range from 60 to 120 acres per bird in portions of their range, with a total estimated population of at least 154,000 birds in the state. Nest size averages 10.5 eggs per clutch and hatching success is around 87 percent. An average of 17,176 birds per year are taken in the annual harvest.

The California Department of Fish and Game has an active program to expand and enhance wild turkey populations through translocation programs. The turkey is not native to California and this program has been receiving opposition from environmental groups. A suit has been filed by the California Native Plant Society against CDFG, stating the potential impacts of these releases to sensitive flora and fauna. CDFG is currently researching the wild turkey habitat relationship and food habits in California to better address the possible impacts of continued translocations.

Pheasant

Ring-necked pheasants are medium-sized game birds characteristic of the Sacramento Valley. They are generally found on agricultural lands where grain crops exist near herbaceous and woody cover. This habitat exists in the Tehama West Watershed, however no pheasant surveys have been found. Pheasant hunting does occur within the watershed. Current statewide hunting regulations permit the harvest of males only, and because pheasants are polygamous, hunting should not effect the reproduction of the species.

The ring-necked pheasant is not native to this continent and was first introduced from China to the Willamette Valley of Oregon in 1881, and then brought to California sometime in the 1880s. By 1925, the pheasant population established itself in California in sufficient numbers for a hunting season. There are an estimated 732,214 birds throughout the state, and a density of 0.66 to 12 acres per bird. The nesting success of the pheasant is around 53 percent, with a clutch size averaging 12 and an 83 percent hatching rate (CDFG 2005b).

New Zealand Mud Snail

The New Zealand mud snail's (*Potamopyrgus antipodarum*) discovery in Putah Creek in 2003, only a short distance south of the Tehama West drainage, is a real concern for fishery biologists. They are very small aquatic snails native to New Zealand, accidentally introduced into the Rocky Mountains of North America in the1980s. Their first California appearance was in 2000, in the Owens River. These snails were certainly spread by fishermen from the original introduction sites (CDFG 2003). They are not yet known to occur in the Tehama West Watershed.

To date, there has been little research on the potential impacts of New Zealand mud snails on other aquatic resources. It is thought that when the snails become very dense they can compromise the macro-invertebrate populations. They also have the potential to reduce a stream's algal production, which affects the forage values for small invertebrates, and which in turn would affect fish (CDFG 2003).

DATA GAPS

Many data gaps exist with regard to the wildlife species that actually exist in this watershed, their range and distribution, and their population and trend. These data gaps are not unique to this area—the same can be said for most rural portions of the state. The studies initiated by the state for proposed dams at the Thomes-Newville and Upper Red Bank Creek during the past several decades have resulted in a great amount of valuable information, including findings of potential isolated populations of both the California red-legged frog and the Western spadefoot toad, as well as significant populations of other uncommon species. It is possible that important information pertaining to individual species or habitats exist, in individual's or agency's files; however, they were not accessed for this assessment.

To complete a comprehensive inventory of wildlife for all habitats existing throughout the Tehama West drainages is probably beyond the range of what realistically can be expected. However, proper management of certain species, including determination of whether individual taxa are doing well or at risk, requires some data and knowledge of historical trends. More information is also needed regarding the distribution of each special-status and introduced wildlife species to assess potential impacts to wildlife habitats and native species

It is suggested that a program be initiated to collect baseline data regarding wildlife usage of Tehama West habitats and, over time, determine population trends for various controversial species or ones considered to be indicators of ecosystem health. This inventory can be based upon the model used by the CALFED (2000) studies of dam sites. Specifically, systematic data collected regarding uncommon or declining habitats and animal groups tending to be sensitive to habitat changes (e.g., raptors, bats, amphibians, and mammalian predator species) would greatly assist in the management of wildlife populations and their habitats.

An additional data gap that limits the ability to enhance native populations and habitats pertains to introduced species. Many of these species are known or suspected to have major impacts on native species. A better understanding of the distribution and population dynamics of these alien species would certainly help managers. The CALFED (2000) dam studies have begun this work, documenting bullfrog distribution and densities in two areas of the Tehama West drainage (both areas having sensitive, native amphibian species).

Finally, a data void pertains to adaptive management strategies for vernal pool habitats and their associated species, both plants and animals. This could be accomplished in concert with the *Draft Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2004) and involve the Tehama Resource Conservation District, private landowners, and the University of Davis Cooperative Extension, among others.

CONCLUSIONS AND RECOMMENDATIONS

Wildlife in the Tehama West watershed provides opportunities for observation, hunting and other recreational activities, and greatly contributes to the quality of life. Drainage-specific data pertaining to the wildlife species resources are limited and are artificially focused on areas near the Sacramento River, Interstate 5, and proposed dam sites at the base of the Coast Range. In most cases, we can only surmise, by using models, which species exist; their population trends can only be assumed by considering statewide trends, if known.

Restoration of degraded wildlife habitats is important, as well as protection of existing high quality and/or unique habitats. Considering the information available at this time, a statement regarding which habitats have been degraded and their degree of degradation cannot be made, other than to say that water-related habitats certainly have been severely affected by development. In addition, given the available information pertaining to existing habitats, the location and status of high quality or value habitats can only be identified in a general manner. Identification of unique or uncommon habitats in the Tehama West area can be done reasonably well, because of the ability to classify all vegetation using satellite imagery. This inventory has shown that habitats known to harbor a large diversity of wildlife species, including wetlands and riparian habitats, are very uncommon within the drainage and those that still exist likely harbor many rare or at-risk species.

Important wildlife issues identified in this assessment, or suggested by reviewers, include:

- Loss or decline of special status species and habitats, including vernal pool invertebrates and raptors
- Impacts of introduced species on native taxa and habitats
- Loss of riparian forest and wetland habitats, including riparian impacts of channelization and destabilization of streams from gravel mining
- Loss and degradation of oak woodlands
- Agricultural management, vector abatement, and urban development impacts to sensitive species and their habitats
- Impacts of historical fire and forest management on wildlife species

Specific recommendations are located in the following sections.

Inventory of Habitats and Wildlife Species

Tehama West Watershed would benefit from an inventory of the most valuable habitats and habitat features in the county. These include habitats that support a high diversity of species, are uncommon or widely scattered, or at risk of degradation. Until more is known about the wildlife in the watershed, these likely include: oak woodlands and riparian areas, vernal pool landscapes, caves, and cliffs. Those vegetation communities and localized habitats that are rare or uncommon and contribute disproportionately to the watershed's habitat values should be identified wherever possible so that if opportunities arise, they can be acquired by the state or federal government or protected by conservation easements. Collecting data regarding the current conditions will allow a future determination regarding changes that occur over time and habitat quality trends.

Geographic Information Systems (GIS) can be used to analyze habitat characteristics in a manner and at a speed that no other technology can do. Habitat edge, while considered by biologists to be very valuable for many wildlife species, is rarely quantified or evaluated over time. For some species, it is suspected that habitat fragmentation, a process that increases edge, may be detrimental. It is possible to use habitat inventories and existing habitat mapping data to determine edge or habitat continuity metrics and to periodically re-assess to determine trends. This could be incorporated with wildlife surveys geared toward answering the question of how habitat fragmentation affects various wildlife species.

While a comprehensive inventory of wildlife species throughout the watershed is probably not possible, it can be done for a variety of high-value habitats. Special effort can be placed on the status of the lesser-known special species listed on Table 9-3, because of their lower environmental profile and the possibility that they might become rare in the future. As in the case of a habitat inventory, these data should help planners understand future trends and help prioritize habitat protection and restoration efforts.

Inventory and Control of Invasive Species

It is also recommended that the control and exclusion of invasive species be a priority. Because of their occurrence and potential impact to riparian habitats, these invasive species control efforts should be focused on arundo, tamarisk, non-native aquatic plants, and the New Zealand mud snail. It is also recommended that inventories be completed for the wildlife species most thought to be causing habitat degradation or impacts to native species, including feral pig and bullfrog. Following inventories, control efforts can be planned.

Institution of an Integrated Wildlife Data Management Program

The California Department of Fish and Game, through the California Natural Diversity Database (CNDDB), provides a repository of information regarding special status species and uncommon habitats. Unfortunately, federal agencies frequently fail to use this database, and even in the case of dam studies sponsored by the State of California, the data collected was not all entered into the state database. It is certain that a large amount and variety of information exists in different agencies' files that are almost impossible to find and use.

Data collection only makes sense if the data goes into a management system that allows easy access. For this reason, it is recommended that time and effort be spent finding existing data and placing it into existing databases, such as the CNDDB. In addition, data collection activities by a variety of agencies should be strongly encouraged to be done cooperatively and maintained in a cooperative database.

Cooperative Management Programs

Cooperative relationships between private landowners and local governments with wildlife management agencies for the monitoring of species and habitats would provide many benefits. Wildlife management agencies will have additional information for making management decisions and will also gain a greater understanding of the priorities and challenges facing private landowners in conducting resource management. Cooperative programs that are currently available to private landowners in the watershed, such as the Wetland Reserve Program and the cost-sharing available through the Natural Resources Conservation Service, should be expanded and utilized to their fullest capacity in the watershed.

Land Use

Retention of large tracts of land for species that require certain stand sizes of habitat should be encouraged. This includes incorporation into city, county, state, and federal planning documents. An assessment of the effects of various forms of recreation on the fish and wildlife populations and habitat should also be conducted to develop a plan to provide for recreation in a way that minimizes impacts on fish and wildlife.

Prior to future development, an assessment of barriers, impacts of roads (including new roads), and development on species guilds should be developed.

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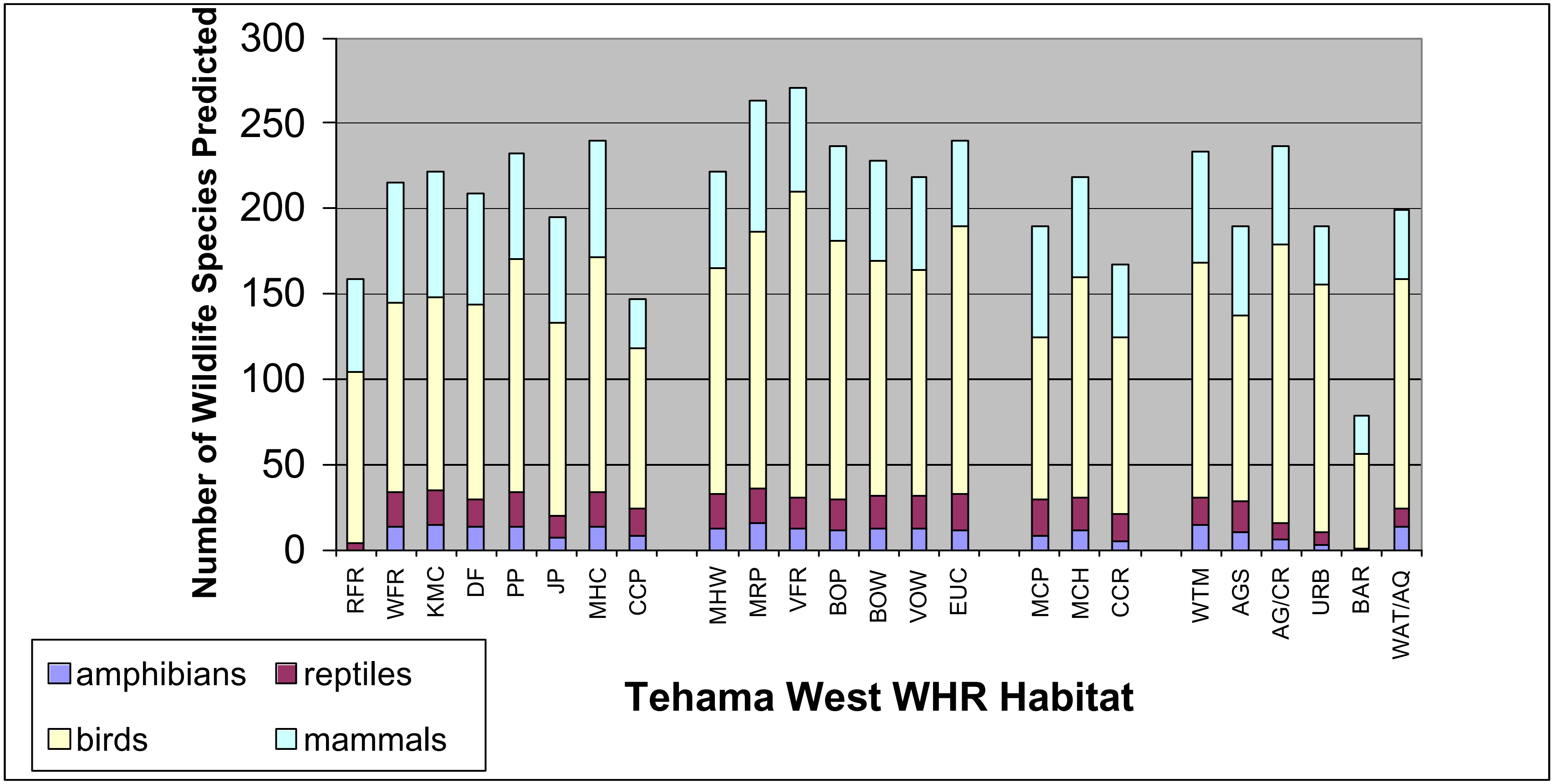


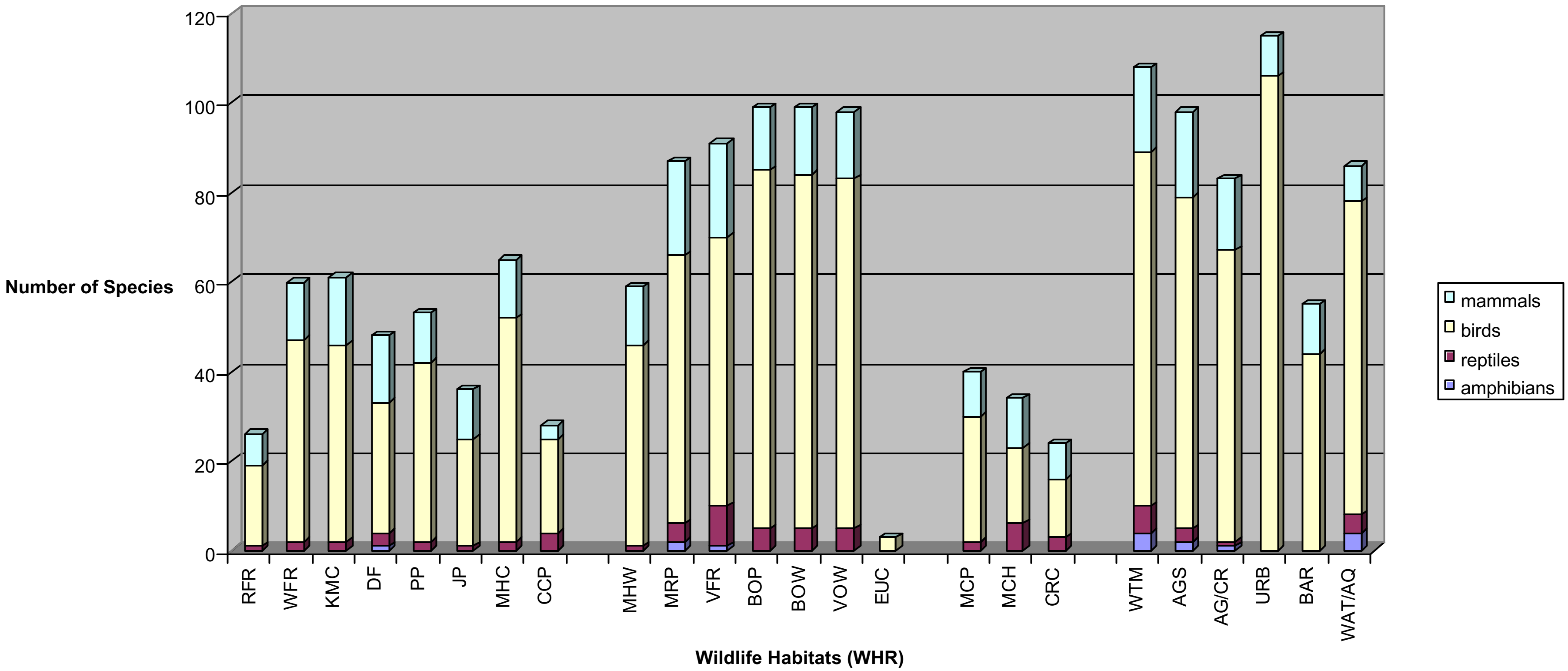
RFR - Red Fir
WFR - White Fir
KMC - Klamath Mixed Conifer
DF - Douglas Fir
PP - Ponderosa Pine
JP - Jeffrey Pine
MHC - Montane Hardwood Conifer
CCP - Closed Cone Pine-Cypress

MHW - Montane Hardwood
MRP - Montane Riparian
VFR - Valley Foothill Riparian
BOP - Blue Oak Foothill Pine
BOW - Blue Oak Woodland
VOW - Valley Oak Woodland
EUC - Eucalyptus
MCP - Montane Chaparral

MCH - Mixed Chaparral
CCR - Chamise-Redshank Chaparral
WTM - Wet Meadow
AGS - Annual Grassland
AG/CR - Agriculture/Crops
URB - Urban
BAR - Barren
WAT/AQ - Water and Aquatic Habitats

FIGURE 9-1
VERTEBRATE WILDLIFE SPECIES PREDICTED TO USE TEHAMA WEST HABITATS DURING SOME PART OF THE YEAR
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: US FOREST SERVICE CALVEG DATA



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WTM - Wet Meadow
AGS - Annual Grassland
AG/CR - Agriculture/Crops
URB - Urban
BAR - Barren
WAT/AQ - Water and Aquatic Habitats

FIGURE 9-2
VERTEBRATE WILDLIFE SPECIES PREDICTED TO USE AND GAIN HIGH FORAGE, HIDING, AND REPRODUCTIVE VALUES FROM TEHAMA WEST HABITAT
TEHAMA WEST WATERSHED ASSESSMENT

VESTRA

SOURCE: US FOREST SERVICE CALVEG DATA

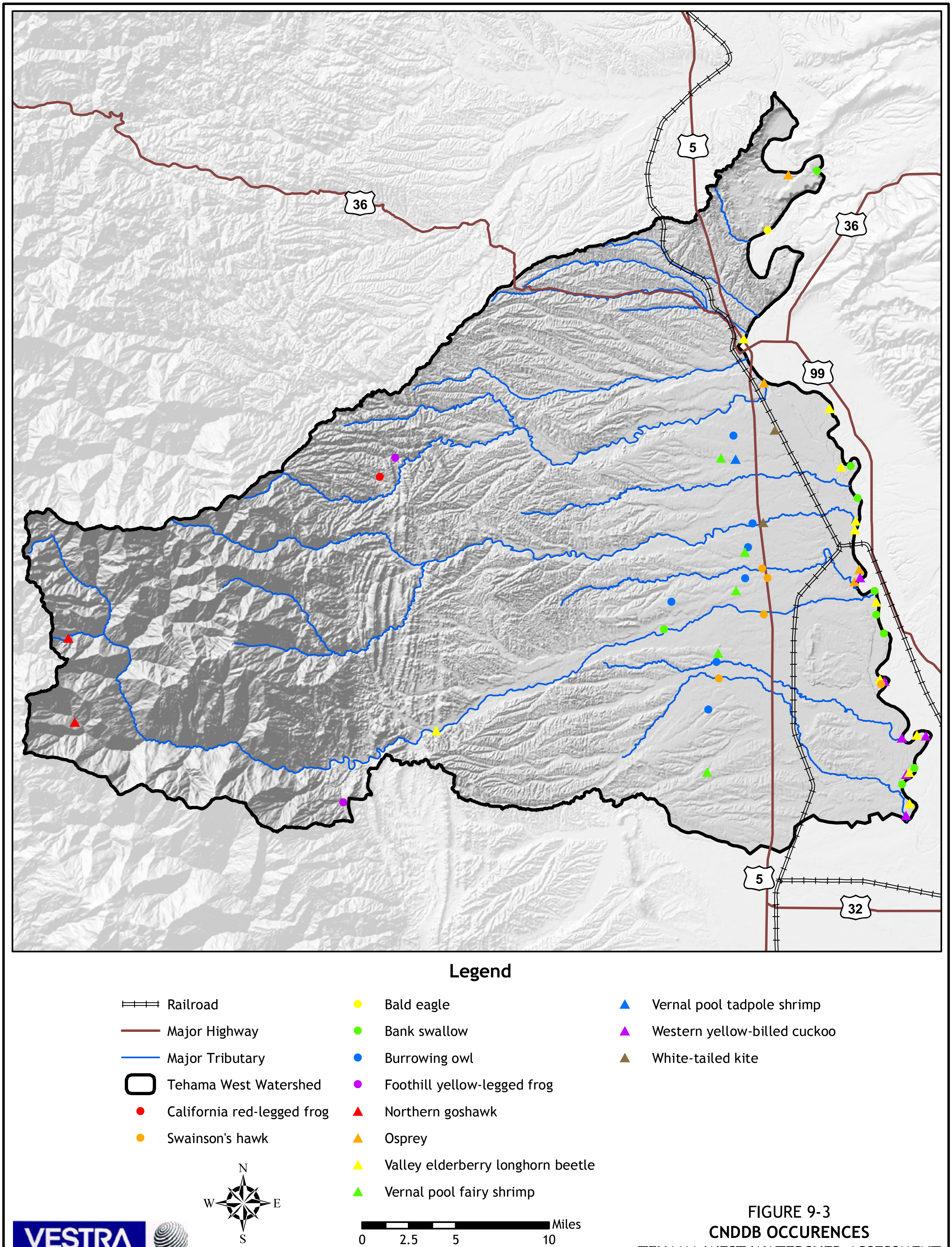
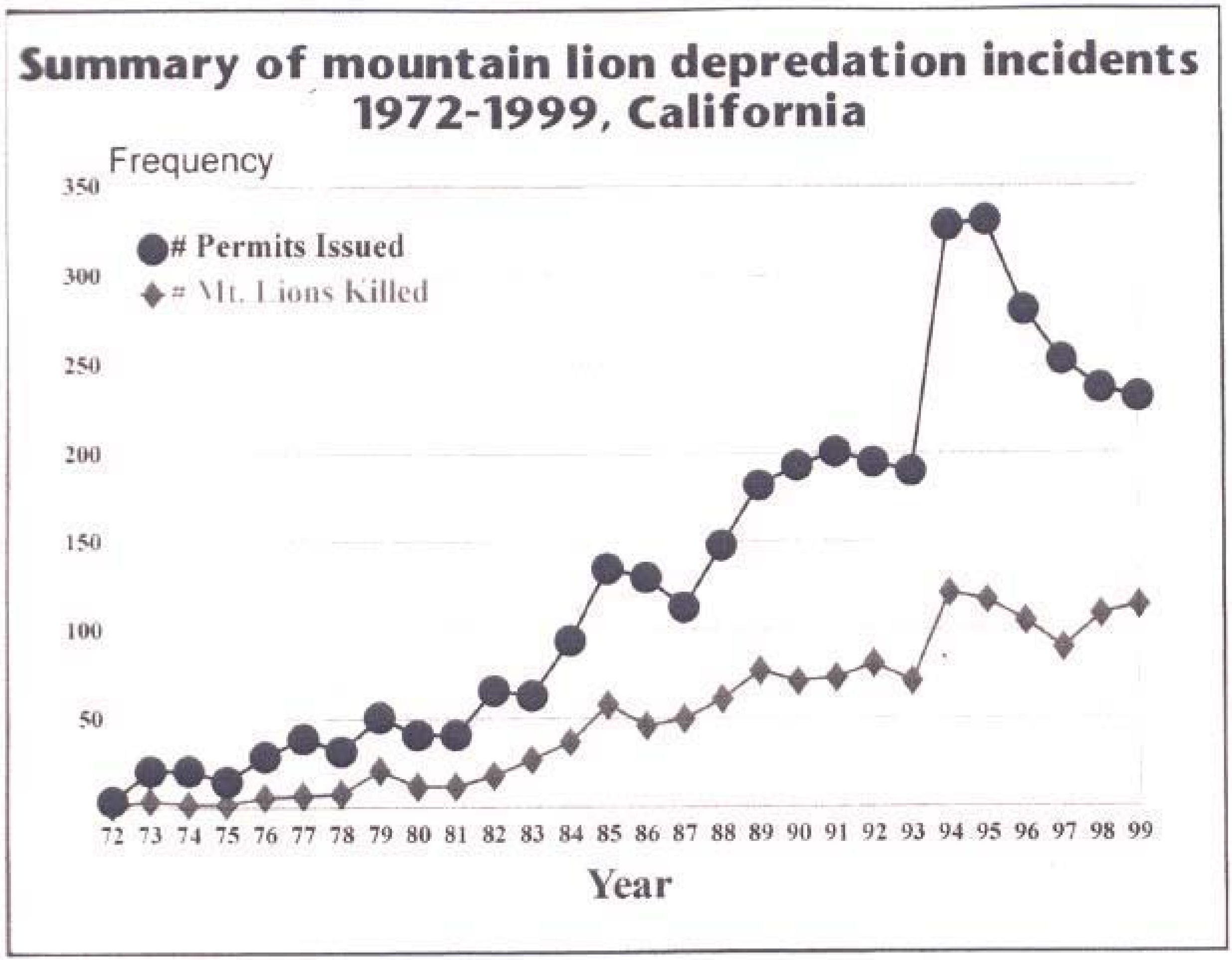


FIGURE 9-3
CNDDB OCCURENCES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA NATURAL DIVERSITY DATABASE, 2004



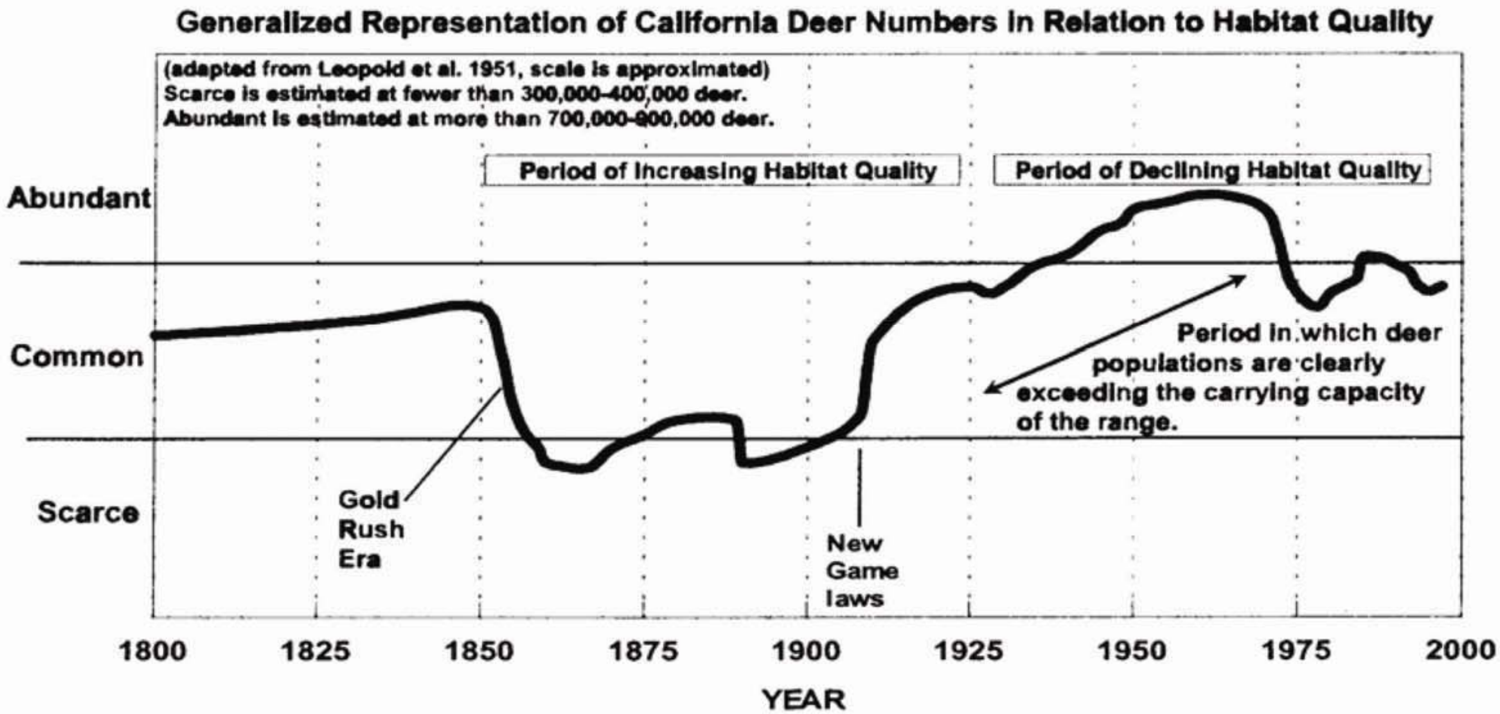
Graphic © Steve Torres

California observed a dramatic increase in conflicts between mountain lions and humans over the last 30 years of the 20th century.

VESTRA

FIGURE 9-4
SUMMARY OF MOUNTAIN LION DEPREDATION INCIDENTS: 1972 – 1999, CALIFORNIA
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF FISH AND GAME



Generalized deer population trends as they relate to key periods of increasing habitat quality due to disturbances (e.g., fire and logging) and decreasing habitat quality due to declining disturbance (fewer fires and more regulated logging). Opening of forests as a result of post World War II logging activities likely contributed to the final peak in deer numbers in the 1960s, but also signaled the start of the decline as those forests began to “close” again.

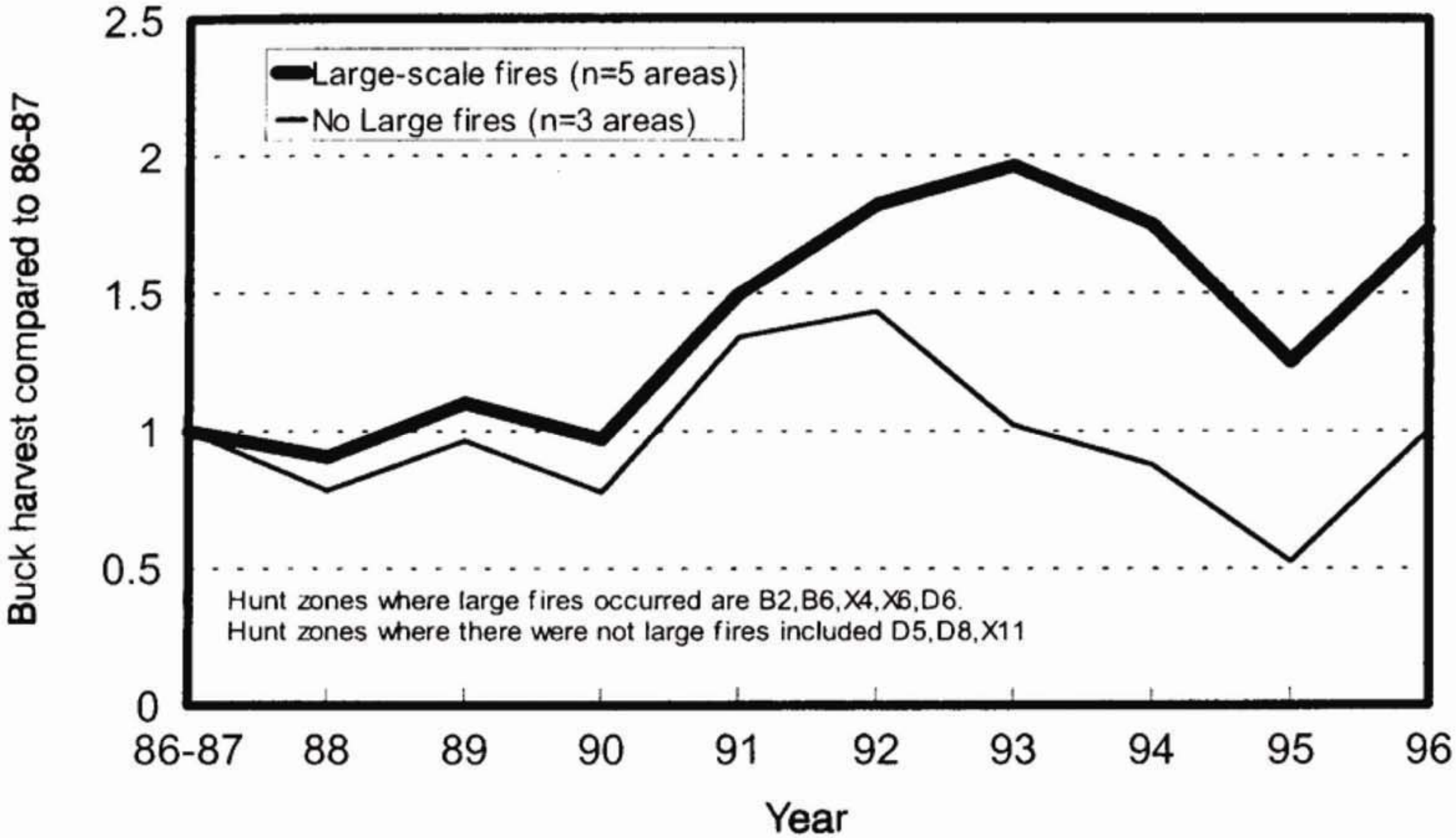
FIGURE 9-5

GENERALIZED REPRESENTATION OF CALIFORNIA DEER NUMBERS IN RELATION TO HABITAT QUALITY

TEHAMA WEST WATERSHED ASSESSMENT

VESTRA

SOURCE: CALIFORNIA DEPARTMENT OF FISH AND GAME



Buck deer harvest in years following 1987 fire year on forested deer ranges. Numbers reflect proportional change in deer harvest compared to 1987 values in five areas with, and three areas without, large fires. These zones comprise portions of the DAUs. Fires were each greater than 30,000 acres in size.

VESTRA

FIGURE 9-6
DEER HARVEST YEARS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF FISH AND GAME

Section 10

Section 10
FISHERIES AND AQUATIC RESOURCES

TABLES

FIGURES

APPENDICES

Section 10
FISHERIES AND AQUATIC RESOURCES

SOURCES OF DATA

All information on the biology, distribution, and abundance of fishery resources and their habitats was obtained from various studies and reports. No field surveys were conducted for this assessment. Several documents served as the primary sources of information on fishery resources. Dr. Peter Moyle's book, *Inland Fishes of California,* provided most of the biological background information on native and non-native fish life history characteristics. Information on the Sacramento River was primarily extracted from state and federal agency documents pertaining to restoration of anadromous salmonid fishery resources and ecosystem restoration. These included:

- California Department of Fish and Game's (CDFG) *Restoring Central Valley Streams: A Plan for Action*
- U.S. Fish and Wildlife Service's (USFWS) Anadromous Fish Restoration Program (AFRP);
- California Resources Agency's *Upper Sacramento River Fisheries and Riparian Habitat Management*
- The CALFED *Ecosystem Restoration Plan*

Because extensive information on fishery resources and their habitats in the Sacramento River are provided in these and other documents, and because of large-scale, ongoing state and federal programs on the Sacramento River, the main stem Sacramento River is only briefly discussed in this section of the watershed assessment.

Information on fish and associated habitats in the small intermittent streams of western Tehama County is limited. The primary documents used to provide recent information on fishery resources within these streams included several reports from California State University, Chico by Dr. Paul Maslin and his students. These reports focused on non-natal rearing of anadromous salmonids in the lower-most reaches of western Tehama County streams, but included data relevant to other native and non-native fish species in those areas. Additionally, information regarding Thomes and Elder Creeks was gleaned from CDFG files, while CALFED studies of offstream storage sites provided data for portions of Thomes and Upper Red Bank Creeks.

HISTORICAL CONTEXT

The historical abundance and distribution of Sacramento River salmon and steelhead populations within the main stem and anadromous salmonid-producing tributaries are described within numerous documents (e.g., CALFED Ecosystem Restoration Program, CDFG's Central Valley and fishery restoration plans, USFWS Anadromous Fish Restoration Program). In the CDFG Fish Bulletin No. 179, Yoshiyama et al. (2001) state:

> Chinook salmon (*Oncorhynchus tshawytscha*) formerly were highly abundant and widely distributed in virtually all the major streams of California's Central Valley drainage –

encompassing the Sacramento River basin in the north and San Joaquin River basin in the south.

In the Sacramento River basin, constituting the northern half of the Central Valley system (covering about 24,000 square miles), most Coast Range streams historically supported regular salmon runs; however, those 'westside' streams generally had streamflows limited in volume and seasonal availability due to the lesser amount of snowfall west of the valley, and their salmon runs were correspondingly limited by the duration of the rainy season.

Riparian forests near the Sacramento River have declined to just 2 to 3 percent of the original area (McGill 1979 and 1987, as cited by CALFED, 1999). Large-scale agricultural clearing and fuel harvest for riverboats from about 1850 to the turn of the century initiated this reduction. During the early to mid 1900s, reservoir and levee projects to assist with flood control resulted in additional reductions in floodplain riparian stands. Loss of riparian habitats likely affected the associated streams and the quality of their fishery habitat. At the same time, large multipurpose reservoirs and diversion dams impounded the Sacramento River. These structures stopped the upstream migration of anadromous fish into tributaries where spawning and rearing historically occurred.

HABITAT TYPES

Sacramento River

The Sacramento River is a major river of the western United States and comprises the largest and most important riverine ecosystem in California. It yields 35 percent of the state's water supply, while providing passage, spawning and rearing capabilities for all species of anadromous fish found in the Central Valley.

The Sacramento River in Tehama County provides habitat attributes to support cold and warm water fish species year round. While the upper reach above Red Bluff Diversion Dam (RBDD) flows through confined canyons, the southern reach meanders over a broad alluvial floodplain. The RBDD, located in central Tehama County, is a portion of the federal Central Valley Project (CVP). According to CALFED (1999), the CVP is one project that contributed to the alteration of the Sacramento River's natural flow regime, sediment transport capabilities, and riparian and riverine habitats. Fish habitat characteristics of the main stem Sacramento River are described in state and federal salmon and ecosystem restoration plans.

Tehama West Tributary Streams

Relatively little is known about the fishery resources of the Tehama West Watershed. However, it appears that the fisheries are affected by the "flashy" nature of their water flow. These streams often have high flows during winter storms, frequently dry out in summer in Sacramento Valley reaches, experience high summertime water temperatures prior to drying, and lack habitat heterogeneity (e.g., pools). These conditions result in an unusual situation where the streams exhibit three fishery zones. The first zone, for the larger West Tehama tributaries, is in the Coast Range canyons. Here the streams are perennial and support a variety of native and introduced fish species. Fish have the ability to access some of these headwater areas from the Sacramento River during periods of moderate stream flow.

The second stream zone for these tributaries is where they reach and cross the Sacramento Valley. In this mid-zone the streams become ephemeral and have few, if any, fish present much of the year. Then, as the streams come closer to the Sacramento River, the third zone occurs. The streams pick up irrigation runoff and hold small amounts of water all summer long. In these lowest reaches the streams become seasonally used by a variety of fish species that spend most of their life in the Sacramento River or come up from the ocean. More information about each of the major watershed streams can be found in the following discussions.

Thomes Creek

Thomes Creek drains the east side of the Coastal Range from the Yolla Bolly-Middle Eel Wilderness Area south to Anthony Peak. Much of the upper portion of the drainage is near 6,000 feet elevation. The stream flows eastward for approximately 70 miles through southern Tehama County, before entering the Sacramento River near the community of Tehama. The drainage area encompasses approximately 188 square miles and contributes a mean annual run-off of about 200,000 acre-feet (CDFG 1969). No significant dams are on the stream, although there are two seasonal diversion dams located near Paskenta and Henleyville.

The upper tributaries contain a variety of native species including rainbow trout (see species descriptions and Table 10-1). Well-known habitat features in the steep canyon portions of this drainage mentioned in this assessment include: the "Slab", close to the Willow Creek confluence, where a major road crosses the stream and has served as access to the historical survey and planting efforts; a natural anadromous fish barrier near the confluence of Horse Trough Creek (Barron, F. personal communications); Lake Hollow, a point where road access has allowed fishery surveys; and the "Gorge", a steep, rocky canyon with a partial, natural barrier to fish species at its upper end (CDFG Various) (see Figure 10-1).

Table 10-1
NATIVE FISH SPECIES IN UPPER SEGMENTS OF THOMES, ELDER, AND RED BANK CREEKS, TEHAMA COUNTY

Common Name	Scientific Name	Thomes Creek[1,2,3]	Elder Creek[1,3]	Red Bank Creek[2]
California roach	*Lavinia symmetricus*	x		x
Hardhead	*Mylopharodon conocephalus*	x		
Pacific lamprey	*Lampetra tridentata*	x		x
Rainbow trout	*Oncorhynchus mykiss*	x	x	x
Sacramento pikeminnow	*Ptychocheilus grandis*	x		x
Sacramento sucker	*Catostomus occidentalis*	x	x	x
Speckled dace	*Rhinichthys osculus*	x		

Sources:
1California Rivers Assessment; http://ice.ucdavis.edu/California_Rivers_Assessment;
2CALFED 2000;
3CDFG Various

Thomes Creek flows out of the Coast Range near Paskenta where an upper irrigation diversion dam is located. This structure is pushed up from streambed gravel and cobble each year (Barron, F., personal communications.) Downstream from this point the stream gradient is gentle and summertime flow is intermittent until fall, when the first heavy rains occur. Fish use of this section of stream varies greatly with the season.

From the stream's confluence with the Sacramento River to approximately 7 miles upstream, the habitat is suitable for juvenile Chinook rearing during December to March (Maslin et al 1995). In this reach Thomes Creek provides spawning habitat for native fish such as the Sacramento pikeminnow (*Ptychocheilus grandis*) and Sacramento sucker (*Catostomus occidentalis*). The lower reaches have been significantly altered by the construction of flood-control levees and bank protection projects and contain large amounts of sediment and gravel. (Thomes Creek is the largest commercial gravel source in Tehama County.) However, the upper watershed supports a variety of fish.

In 1982, during studies for a proposed dam, 22 species of fish were recorded within various portions of Thomes Creek (Brown et al 1983 as cited in CALFED 2000). Steelhead were reported to be the most abundant fish above the "Gorge", while Sacramento pikeminnow, Sacramento sucker, hardhead, California roach, and speckled dace were among the most common fish below that feature. (Note that the "steelhead" mentioned in this reference likely means "rainbow trout", as there is an andromous fish barrier a short distance above the "Gorge".) Fish observed near Paskenta included: bluegill and green sunfish; brown bullhead, channel and white catfish; carp, golden shiner, and goldfish; hitch; largemouth and smallmouth bass; mosquitofish; Pacific lamprey; prickly sculpin; speckled dace; threespine stickleback; and tule perch.

Elder Creek

The Elder Creek watershed drains the ridges east of the Yolla Bolly-Middle Eel Wilderness Area and contains approximately 142 square miles of area. It enters the Sacramento River near the community of Gerber.

The drainage contains mostly shale, mudstone, and fine sedimentary deposits that produce minimal amounts of gravel, in contrast to the Thomes Creek drainage. No large gravel deposits exist in the lower stream reaches where a flood-control levee system has directed and concentrated flows, resulting in increased sediment transport and degradation throughout the reach. The upstream reach (approximately 20 miles from the valley floor) flows through a rugged canyon area that supports resident fish, and possibly has limited value for steelhead (CDFG Various; CALFED 1999). The mid-reach, through the Sacramento Valley, is ephemeral and has fish only during certain times of the year. The lowest reach is used by a variety of fish that spend most of their time in the Sacramento River, as will be discussed in later portions of this section.

Red Bank Creek

Red Bank Creek is the smallest of the three main Tehama West drainages, containing approximately 117 square miles of land. Its headwaters are located in the ridges east of the Yolla Bolly-Middle Eel Wilderness Area and it flows through rugged canyons in the Coast Range. Within the canyon reaches this stream and its tributaries contain water year-round and support a variety of fish species; however, no evidence of trout stocking was found. In 1998 the stream and tributaries Dry and Grizzly Creeks were sampled at a proposed dam site (CALFED 2000). Fish captured included California roach, Pacific lamprey, Sacramento pike minnow, Sacramento sucker, bluegill, green sunfish, largemouth bass, and steelhead (juvenile).

As in the case of Thomes and Elder Creeks, Red Bank Creek has intermittent flow through the Sacramento Valley until near its confluence with the Sacramento River at Red Bluff. A variety of fish species use its lower-most portions, as will be described later in this section.

Appendix 10-2 summarizes those native fish species observed in lower reaches of the tributaries of the Sacramento River by Maslin et al. (1995-1999), Moore (1997), and Villa (1985).

DESCRIPTION OF FISH SPECIES

Native Fish Species

The California Rivers Assessment (CARA 1997) at the University of California, Davis identified 18 native fish species in the Sacramento River and other waters of Tehama County. These taxa are listed in Table 10-2. Other sources of information regarding the fish found in the watershed area include: CALFED (2000), which provides information regarding fish presence at proposed dam sites on Thomes Creek (near Paskenta) and Upper Red Bank Creek; NOAA (2006) and CDFG files (CDFG Various), which offer survey information for Upper Elder Creek and the portions of Thomes Creek between Paskenta and the "Slab" (see Figure 10-1). The biology, distribution, and abundance of these native fish species in the watershed is described below in order of taxonomic family.

Lampreys: Family Petromyzontidae

Pacific Lamprey (Lampetra tridentate)
Pacific lamprey spend most of their adult life phase in the ocean where they prey on a wide variety of fish species. Spawning migration into the river is usually between early March and June (Moyle 2002). Large numbers have been seen in the Sacramento River clinging to the Red Bluff Diversion Dam gate piers during the spring (USFWS unpublished observations). Male and female lamprey construct nests and spawn in gravelly, swift areas of the river and both sexes usually die shortly thereafter. Lamprey embryos hatch in about 19 days at 59°F, and the resulting larvae (ammocoetes) spend a short time in the gravels before moving with the current to downstream areas of soft sand and mud where they rear for several years. Upon reaching about 6–7 inches in length, the ammocoetes transform (metamorphose) into adults, migrating downstream during high-flow events in winter and spring (Moyle 2002). Although the species is commonly found in the Sacramento River, it has also been recorded in mid-reaches of Thomes and Red Bank Creeks (CALFED 2000). Presumably, the fish could not successfully propagate in lower reaches of those streams because of intermittent flow conditions, but would move from the Sacramento River to the tributaries mid-reaches when stream flows are moderate.

During trapping operations at RBDD from July 1994 through June 2000, the U.S. Fish and Wildlife Service captured 5,199 of these fish (Appendix 10-1). It ranked as the fifth most abundant of all species captured.

River Lamprey (Lampetra ayresi)
River lamprey life history characteristics are not as well known as Pacific lamprey because the species has not been studied in California (Moyle 2002). Most observations have been made in the lower Sacramento-San Joaquin River systems. The timing of spawning migrations is not well known.

The species reproduces in a similar riverine environment as Pacific lamprey and adults die after spawning. The ammocoete metamorphosis into the adult life phase is the longest among lamprey species (9–10 months) (Moyle 2002). The population status of river lamprey is largely unknown, which may be attributable to a small population or lack of research on the species. A total of only 79 river lampreys were captured by the USFWS during trapping operations at RBDD from July 1994 to June 2000 (Appendix 10-1). Presumably, the fish could not successfully propagate in lower reaches of the small streams in western Tehama County because of their flow regimes.

Table 10-2
NATIVE FISH SPECIES IN THE SACRAMENTO RIVER IN TEHAMA COUNTY AND POPULATION STATUS

Common Name	Scientific Name	Status (see below)
California roach	*Lavinia symmetricus*	4
Chinook salmon[a]	*Oncorhynchus tshawytscha*	1
Green sturgeon[b]	*Acipenser medirostris*	2
Hardhead	*Mylopharodon conocephalus*	3
Hitch	*Lavinia exilicauda*	4
Pacific lamprey	*Lampetra tridentata*	0
Prickly sculpin	*Cottus asper*	5
Rainbow trout/Steelhead[c]	*Oncorhynchus mykiss*	5/1
Riffle sculpin	*Cottus gulosus*	5
River lamprey	*Lampetra ayresi*	2
Sacramento blackfish	*Orthodon microlepidotus*	5
Sacramento pikeminnow	*Ptychocheilus grandis*	5
Sacramento splittail	*Pogonichthys macrolepidotus*	3
Sacramento sucker	*Catostomus occidentalis*	5
Speckled dace	*Rhinichthys osculus*	4
Threespine stickleback	*Gasterosteus aculeatus*	4
Tule perch	*Hysterocarpus traski*	4
Western brook lamprey	*Lampetra richardsoni*	3
White sturgeon	*Acipensar transmontanus*	5

Fish Status Ratings (defined by Dr. Peter Moyle, U.C. Davis)

Status	Meaning
0	Not specified
1	Threatened or endangered-usually formally listed but not always
2	Special concern species is in decline or has very limited distribution
3	Watch list species in decline but not yet in serious trouble. Monitoring needed
4	Species overall not in decline or in danger of extinction but has subspecies or distinctive populations that are
5	Species widespread and abundant

Notes, based upon more recent Federal actions:
[a] Spring-run has Threatened status; winter-run has Endangered status; fall and late-fall runs are candidates for listing.
[b] Proposed for Federal Threatened status in 2005.
[c] Rainbow exist in the headwaters; steelhead only exist below the Horse Trough Creek barrier of Thomes Creek. Steelhead are federally-listed.

Source: CARA 1997; NOAA 2006

Western Brook Lamprey (Lampetra richardsoni)
Western brook lamprey is a small non-predaceous species with major inland distributions in the Sacramento River drainage. Neither the adults nor larvae enter salt water. Spawning in river gravels begins when water temperatures exceed 50°F and is similar to Pacific lamprey (Moyle 2002). The CARA (1997) project identified the species in the watershed tributary streams, where perennial

reaches exist; however, the species was not recorded by CALFED in proposed dam sites on Thomes Creek near Paskenta or Upper Red Bank Creek (2000).

Minnows: Family Cyprinidae

California Roach (Lavinia symmetricus)

California roach are widely distributed throughout Central Valley streams in a variety of habitats, particularly small warm streams and including intermittent streams. The species is omnivorous and tolerant of very warm water (86–95ºF) and low oxygen levels (1–2 ppm) (Moyle 2002). Roach do not persist well in streams dominated by non-native predatory fish (e.g., largemouth bass and green sunfish) and tend to be most abundant when found by themselves or with only one or two other fish species (Moyle 2002). Spawning occurs from March through early July in stream currents over small rocks when water temperatures exceed 60.8ºF (Moyle 2002). The USFWS captured 275 of the species (less than 1 percent of the total captured) from July 1994 to June 2000 at RBDD (Appendix 10-1).

The species is widely distributed throughout western Tehama County streams. During springtime studies by Maslin et al. in 1997 and 1998, California roach were observed in lower reaches of Elder, Red Bank, Reeds, Thomes, Dibble, Jewett, McClure, and Oat Creeks. Two other studies, one during December 1980 to June 1981 (Villa 1985) and the other from January to April 1996 (Moore 1997), noted this species in these same streams. California Department of Fish and Game files report roach present in several mid-reaches of Thomes Creek, including between Paskenta and Lake Hollow; however, none were found above the partial fish barrier at Lake Hollow (CDFG Various). This species was also found in Upper Red Bank Creek during CALFED (2000) investigations.

Hardhead (Mylopharodon conocephalus)

Hardhead resemble Sacramento pikeminnow, although they are sufficiently different to be taxonomically placed in a different genus. Hardhead are widely distributed in low to mid-elevation streams in the Sacramento drainage and the river. The omnivorous species is always associated with Sacramento pikeminnow and usually with Sacramento sucker, but tend to be absent in streams with introduced species (e.g., centrarchids) (Moyle 2002). Although the species can tolerate relatively warm water temperatures (optimal 75.2–82.4ºF), it is relatively intolerant of low oxygen levels, limiting their distribution to well-oxygenated streams (Moyle 2002). Hardhead prefer clear deep pools and runs with sand-gravel-boulder substrates and slow velocities. Spawning behavior has not been documented but is believed to be similar to pikeminnow or hitch. A study performed by the USFWS at RBDD from July 1994 to June 2000 reported the capture of 1,309 hardhead (see Appendix 10-1).

Maslin et al. observed hardhead during studies in 1997 and 1998 in lower, near-river reaches of Elder, Reeds, Thomes, and McClure Creeks. Additionally, a study of the Sacramento sucker life history performed by Villa (1985) on Thomes Creek reported the presence of hardhead during the period of December 1980 to June 1981. Hardhead also have been recorded in the Coast Range portions of the Thomes Creek drainage from near Paskenta (CALFED 2000) to the "Slab" (CDFG Various) (see Figure 10-1).

Hitch (Lavinia exilicauda)

Hitch are widespread in warm, low-elevation, slow-moving river reaches and sloughs; clear, low-gradient streams; and lakes (Moyle 2002). The species has the highest temperature tolerances of native fishes in the Central Valley and prefers temperatures of 80.6–84.2°F. Hitch are open-water, omnivorous feeders commonly found with both native and non-native species, but mainly with native species in less disturbed habitats (Moyle 2002). Hitch spawn in stream riffles with fine to medium gravel at water temperatures of 57.2–64.4°F. Hatching is rapid (3–7 days); larvae become free swimming in 3–4 days, and the fry move quickly downstream. These attributes allow the species to reproduce in intermittent streams that dry up in summer (Moyle 2002). The USFWS noted the presence of small numbers of hitch during trapping operations at RBDD from July 1994 to June 2000 (Appendix 10-1).

Maslin et al. found hitch in Elder and Dibble Creeks during springtime studies performed in 1997 and 1998 (Appendix 10-2), and Villa (1985) observed the species in lower Thomes Creek during the period of December 1980 to June 1981.

***Sacramento Blackfish (Orthodon microlepidotus*)**

Sacramento blackfish, a commercially important species for Asian food markets, are found in low-elevation reaches of the Sacramento River and its major tributaries. The species is abundant in highly modified, warm, turbid Central Valley waterways and in Sacramento River oxbow lakes (Moyle 2002). The species is very tolerant of warm water (71.6–82.4ºF) and can be commonly found in water exceeding 86ºF with low dissolved oxygen. Spawning is presumed to occur between April and July, at water temperatures of 53.6–75.2ºF, in shallow areas among aquatic plants (Moyle 2002). In the Sacramento River the USFWS caught only one Sacramento blackfish during trapping operations between 1994 and 2000 (Appendix 10-1). Because of the species' habitat needs, it is unlikely to be found in the small streams of western Tehama County, but would likely be found in the Sacramento River, particularly in oxbow-lake environments.

***Sacramento Pikeminnow (Ptychocheilus grandis*)**

The Sacramento pikeminnow (previously called "squawfish") is widespread in both large and small streams throughout the Sacramento River basin, including western Tehama County. The piscivorous (fish-eating) pikeminnow mainly inhabits pools and runs in clear, warm (64.4°–2.4°F), low-gradient river sections with muddy or rocky bottoms and overhanging vegetation (Moyle 2002). It is commonly found with hardhead and Sacramento suckers. Spawning occurs during the spring months at night, when they congregate in favorable spawning areas. Females release eggs near the bottom; eggs are simultaneously fertilized by one or more males and then sink to the bottom and adhere to rocks and gravel (Moyle 2002). The fish is seasonally abundant in the Sacramento River (Appendix 10-1).

California Department of Fish and Game office memos and proposed dam studies (CDFG Various; CALFED 2000) reported the species' presence throughout much of the lower and mid-portions of the Thomes Creek drainage. Their presence was also noted at the Highway 99E crossing of the stream; in the Paskenta area; and at Lake Hollow, immediately upstream from the "Gorge". The partial-fish barrier at Lake Hollow may be their upper limit in the drainage (see Figure 10-1).

The species was also recorded for Upper Red Bank Creek by CALFED (2000). It is likely that they also exist in the mid-reaches of Elder Creek; however, no records were found regarding this assertion.

Sacramento Splittail (Pogonichthys macrolepidotus)

Sacramento splittail are native to Central Valley lakes, rivers, and sloughs and are relatively long-lived (5–7 years). Early surveys found the species in the Sacramento River upstream as far as Shasta County, but presently they are only found upstream as far as Red Bluff during wet hydrological conditions. Two of the species were caught at RBDD during trapping operations from July 1994 through June 2000 (Appendix 10-1). Where found, the fish is typically in water temperatures between 41-75.2ºF (Moyle 2002). Splittail feed on bottom invertebrates and detritus. Their spawning primarily occurs in March and April and ideal spawning habitat for the species is within flooded vegetation, which also provides habitat for hatched young fish. The onset of spawning is associated with increased photoperiod and water temperatures (57.2–66.2ºF), and rising water levels. Adhesive eggs stick to vegetation and hatch in 3–7 days (Moyle 2002).

Sacramento splittail was listed by the USFWS as threatened on February 8, 1999 (64 FR 5963). On June 23, 2000, the Federal Eastern District Court of California found the USFWS final rule to be unlawful and on September 22, 2000, remanded the determination back to USFWS for a re-evaluation of the agency's decision. After a thorough review and consideration of all the best scientific and commercial information available, the USFWS removed the Sacramento splittail from the list of threatened species on September 22, 2003 (68 FR 55139). The USFWS recognized that the Sacramento splittail may be experiencing a decline in population and continues to face potential threats from habitat loss. Other threats include the effects of drought and climate change on habitat, non-native competitors and predators, and possible threats of disease and environmental contaminants. Because of these threats the agency moved the splittail to its species of concern list (USFWS 2005).

Speckled Dace (Rhinichthys osculus)

Speckled dace inhabit virtually a wide variety of habitat from slow to fast moving water and either small creeks or large rivers—as long as the water is well-oxygenated, clear, and provides ample deep cover in the form of vegetation and rocks (Moyle 2002). The species generally spawns on gravel edges of riffles in June and July but can spawn throughout summer. A total of 175 speckled dace were captured during trapping operations from July 1994 through June 2000 at RBDD (see Appendix 10-1).

Spawning in intermittent streams may be induced by high-flow events. The fish thrives in small streams in habitats characterized by shallow, rocky riffles and runs where they feed (Moyle 2002). Villa (1985) noted the presence of the species in lower Thomes Creek during the period of December 1980 through June 1981 and California Department of Fish and Game recorded them during surveys of the stream immediately below the Lake Hollow barrier (CDFG Various), about 6 air-miles west of Paskenta (see Figure 10-1). There are no records for this species in either Upper Red Bank or Elder Creeks.

Sturgeon: Family Acipenseridae

White Sturgeon (Acipensar transmontanus)

White sturgeon, valuable sport fish, spend most of their lives in the Sacramento–San Joaquin estuary or ocean, returning to the Sacramento River to spawn. White sturgeon are a long-lived species; male sturgeon reach sexual maturity at 10–12 years and females at 12 –16 years. Spawning migration in the Sacramento River occurs between late February and early June when water temperatures are

46.4–66.2°F, peaking around 57.2°F (Moyle 2002). Most spawning occurs in the Sacramento River between Knights Landing and Colusa over deep gravel riffles. Only a fraction of the adult sturgeon population spawns each year and the species returns every several years to spawn (Moyle 2002). White sturgeon have been observed immediately downstream of RBDD in the Sacramento River (USFWS unpublished observations), but no sturgeon would be expected to be found in the small western Tehama County tributaries.

***Green Sturgeon (Acipenser medirostris*)**

Green sturgeon are the most marine species of sturgeon but have been studied less than white sturgeon, probably because of a smaller population, limited spawning distribution, and lesser value as a sport and commercial species (Moyle 2002). Spawning in the Sacramento River is believed to occur from March to July, peaking from mid-April to mid-June. Spawning takes place in deep, swift water and adult fish have been observed as far upstream as Red Bluff (Moyle 2002). Only three green sturgeons were captured during trapping operations at RBDD by the USFWS between 1994 and 2000 (Appendix 10-1). Green sturgeons are not likely to exist in streams of western Tehama County because of their life-history requirements.

Suckers: Family Catostomidae

Sacramento Sucker (Catostomus occidentalis)

Adult Sacramento suckers are most abundant in cool larger streams with moderate gradient and many pools. The juveniles are often associated with smaller tributaries and slower reaches of the Sacramento River (Moyle 2002). The species is typically associated with native minnows such as pikeminnow, hardhead, and roach, but it is also common in habitats dominated by non-native species. The spawning migrations occur in tributary streams during late February and early June, with a peak in March and April, when temperatures are 53.6–64.4°F. Sacramento suckers congregate to spawn in gravel riffles and fertilized eggs adhere to gravel or settle in small backwaters (Moyle 2002). They can be long-lived and often have a non-uniform age structure and strong year classes, indicating that reproductive success is variable. Reproductive success is highest during wet years, when high flows improve access to spawning habitat and provide additional rearing habitat for larvae and small juveniles. Sacramento suckers prefer temperatures around 68-77°F but can be found in streams where temperatures may reach 84.2–86°F. If habitat conditions exist year-round, juvenile suckers may rear in the spawning stream for 2 to 3 years before moving down to the larger river with high flows (Moyle 2002).

The species is abundant in the Sacramento River (Appendix 10-1), as well as locally or seasonally in Tehama West tributaries. For example, as many as 240,000 adult suckers were estimated during a spawning run in a lower reach of Thomes Creek (Villa 1985) between December 1980 and June 1981. Moore (1997) found 25 juveniles and more than 1,000 adults in lower Blue Tent and Dibble Creeks, Maslin et al. (1997) reported the presence of the species in lower portions of Coyote, Dibble, Elder, Jewett, McClure, Oat, Red Bank, Reeds, and Thomes Creeks.

The Sacramento sucker is also known to exist in the Coast Range portions of both Elder Creek and Thomes Creek (CDFG Various). Specifically, large sucker populations were noted during a stocking trip on the North Fork of Elder Creek in 1966 (CDFG Various) and they have been sighted in the Thomes Creek drainage at Lake Hollow, immediately upstream from the “Gorge” (see Figure 10-1). The species was also recorded in Red Bank Creek (CALFED 2000)

Trout and Salmon: Family Salmonidae

***Chinook Salmon* (*Oncorhynchus tshawytscha*)**

The Sacramento River in Tehama County supports four races or runs of Chinook salmon. These distinct runs are defined by the primary period of entry into freshwater from the ocean and begin their upstream migration: fall-run, late-fall run, winter run, and spring run. The Sacramento River in Tehama County supports each freshwater life phase for these runs (i.e., upstream migration, holding, spawning, egg incubation, fry and juvenile rearing, and juvenile downstream migration). Trapping operations at RBDD from July 1994 through June 2000, in which downstream migrant fish were captured, tallied 744,925 juvenile Chinook salmon—87 percent of the entire fish catch. Of all the Chinook, 87 percent were fall-run, two percent late-fall run, six percent winter run, and five percent spring run (see Appendix 10-1). The following description of Chinook salmon life history characteristics is extracted from Vogel and Marine (1991):

> The life span of Chinook salmon may range from 2 to 7 years. Chinook salmon will spend from 1-1/2 to 5 years feeding and roaming in the ocean before maturing and returning to their natal streams to spawn. Both life span and the timing of spawning migrations are primarily genetically controlled. All Chinook salmon die upon completion of spawning.
>
> The eggs are laid in nests, referred to as redds, excavated by the female in uncompacted gravels. Appropriate gravel beds selected by female Chinook salmon consist mainly of gravel ranging in size from one to six inches in diameter. Optimal survival of eggs and pre-emergent fry occurs when the largest fraction of the redd is composed of the smaller-sized gravels. The female will seek out gravel beds with water depths and velocities sufficient for spawning activities and egg incubation. Depths where Chinook salmon redds may be located range from shallow riffle areas (0.5 to 2 feet deep) to deep runs or glides (5 to over 20 feet deep). Spawning depth is a function of physiological requirements, available habitat, and specific preferential differences between stock of salmon, probably under genetic influence. For instance, some winter-run Chinook salmon have been observed to spawn on gravels in deeper water than the other three Sacramento River salmon runs. Preferred spawning velocities are generally in the range of 1.5 to 2.5 feet per second just above the surface of the gravel bed.
>
> As the female lays the eggs in the redd, one or more male salmon fertilize the eggs. The female subsequently buries the eggs in the redd by displacing gravels upstream of the redd onto the eggs.
>
> Eggs hatch after a variable incubation period dependent on water temperature, but is generally about 40 to 60 days. Maximum survival of incubating eggs and pre-emergent fry occurs at water temperatures between 40ºF and 56ºF. The newly hatched larvae, or pre-emergent fry, will remain in the redd and absorb the yolk stored in their yolk-sac to grow into fry. This period of larval incubation will last approximately 2 to 4 weeks depending on water temperatures. The fry then wiggle their way out of the redds, up into the water above. The fry will seek out shallow nearshore areas with slow current and vegetative and/or boulder cover nearby where they begin to feed on insects and crustaceans drifting in the current. As they grow,

the juvenile salmon (approximately 50 to 75 mm in length) move out into deeper, swifter water for rearing, but continue to remain near boulders, fallen trees, and other such cover to reduce chances of being preyed upon and minimize energy expenditure. Juvenile salmon may emigrate downstream toward the estuary at any time from immediately after they emerge from the redd to after spending over one year in freshwater. The length of juvenile residence time in freshwater and estuaries varies between salmon runs and depends on a variety of factors including season of emergence, riverflow, turbidity, water temperature, and interactions with other species.

Figure 10-2 shows the life history characteristics for the four Chinook salmon runs at and upstream of Red Bluff. Based on available data, none of the small streams in western Tehama County support a sustained run of any of the four Sacramento River salmon runs. Sufficient cold-water instream flows are necessary to attract salmonids into Sacramento River tributaries prior to spawning activities. For intermittent streams these conditions are usually not present until late fall when runoff events begin and ambient air temperatures cool water temperatures to acceptable levels for salmon. Adult salmonids are known to stray into non-natal streams; however, salmon use of a stream is largely genetically "driven". An established run of salmonids into a stream explicitly requires that the returning spawning fish were originally hatched in the stream several years prior to their return.

On occasion, some adult salmon stray into Tehama West tributaries and spawn, if suitable conditions exist in a given year (e.g., flow, water temperature, physical spawning habitat features). For instance, there have been years when fall-run salmon have been observed in Thomes Creek and Coyote Creek, presumably attracted by suitable flows during the principal fall migration period (Table 10-3). However, due to the intermittent flow characteristics in these tributaries, the life cycle is unlikely to be completed and a run to be established, because of insufficient, sustained stream flows to support all freshwater life stages.

Table 10-3 provides a summary of spawning Chinook salmon population estimates between 1952 to 2003 in Tehama West streams, when surveys occurred and the results were reported in the CDFG database, Grandtab. Grandtab is a compilation of data from annual reports from streams throughout the Central Valley. The counts include hatchery as well as naturally spawning fish. Of all the western Tehama County streams in this assessment area, Thomes Creek has the highest potential of supporting a fall Chinook salmon run because of the size of the watershed and more-protracted runoff than the other tributaries. Chinook salmon observed in Coyote Creek in the 1970s were likely attributable to operation of the Tehama-Colusa Fish Facilities salmon spawning channels, which required releases of water from the Tehama-Colusa Canal into Coyote Creek (a concept “mothballed” in the late 1980s).

California Department of Fish and Game files (CDFG Various) give anecdotal information regarding Chinook salmon usage of Thomes Creek. In one memo, spring-run Chinook were reported in the stream in 1946 and 1961; however, the location of the observations was not noted. Also, in 1958 a rancher observed 30–40 spring-run salmon near Henleyville.

Thomes Creek has been evaluated in recent years with regards to its upper reach accessibility to anadromous fish. In May 2004 the California Department of Fish and Game determined that an impassible barrier to Chinook salmon and steelhead exists at the point immediately above the confluence of the stream with Horse Trough Creek (Barron, F. Personal communications; CDFG

Various). This point is approximately 9 miles upstream from Paskenta and at an elevation of approximately 1,500 feet, (see Figure 10-1).

Table 10-3 FALL-RUN CHINOOK SALMON SPAWNER POPULATIONS FROM SURVEYS CONDUCTED IN THE CENTRAL VALLEY FROM 1952–2003		
Year	**Thomes Creek**	**Coyote Creek**
1957	25	
1974	60	100
1975	170	160
1976		160
1977		200
1980	151	
1981	167	
Source: CDFG GRANDTAB 2004 Note that missing years indicate no exist.ing data		

The phenomenon of "non-natal rearing" of fry and juvenile salmon occurs in the lower-most reaches of many western Tehama County streams. Non-natal juvenile salmon rearing was first described for some tributaries to the lower Fraser River in British Columbia (Murray and Rosenau 1989) and Vogel (1993) first reported non-natal rearing of juvenile Chinook salmon in intermittent streams of the Central Valley. Non-natal rearing occurs when fry and juvenile salmonids, originally hatched and reared in the Sacramento River, migrate into the lower reaches of some small intermittent streams to rear as long as suitable seasonal habitats are present (primarily controlled by flow and water temperature) (Vogel 1993). Maslin et al (1997) researched rearing Sacramento River juvenile Chinook salmon in several small, intermittent streams from Keswick Dam to Chico. Table 10-4 lists those tributaries in the assessment area that Maslin et al. (1997) suggested have potential for non-natal Chinook rearing.

Table 10-4 TEHAMA WEST STREAMS WITH POTENTIAL FOR NON-NATAL CHINOOK REARING (EXTRACTED FROM MASLIN ET AL., 1997)				
Creek	**River Mile at (Sacramento River) Mouth**	**Gradient (lowest 0.3 mi.)**	**Drainage (sq. mi.)**	**Maximum Distance Upstream 1997 (mi.) ****
Jewett	215	0.14%	52	.
Thomes	225	0.27%	300	14
McClure	226.5	0.22%	33.7	3.1
Elder	230	0.15%	140	6.5
Coyote	233	0.17%	30	2
Oat	233	0.17%	65.5	3
Red Bank	243	0.48%	115	4.5
Reeds	244.8	0.47%	74.4	1
Dibble	246	0.54%	28.2	.
Blue Tent	247.7	0.68%	18.1	.
** Estimated maximum distance juvenile Chinook salmon moved upstream for rearing				

The USFWS (1995) listed several Sacramento River western tributaries as potentially providing only rearing habitat for salmonids (Sacramento River Mile in parentheses): Oat Creek (RM 233), Coyote Creek (RM 233), Reeds Creek (RM 245), Blue Tent Creek (RM 248), Dibble Creek (RM 246), Burch Creek (RM 208), Jewett Creek (RM 215), and Red Bank Creek (RM 243).

Field studies by Maslin et al. (1994, 1995, 1996, 1997, 1998, and 1999) and Moore (1997) confirmed that juvenile salmon exist in some western Tehama County tributaries and estimated their numbers (Table 10-5). Although juvenile salmon were observed in each year of the studies, data for every year are not included in this table. For example in 1995, Maslin et al. (1995) reported seeing juvenile salmon in all of the tributaries sampled, but did not include the tabulated data.

Table 10-5
OBSERVATIONS AND POPULATION ESTIMATES OF JUVENILE SALMON DURING WINTER- SPRING-TIME ON INTERMITTENT WESTERN TEHAMA COUNTY STREAMS

Year	Creek	Number Observed	Population Estimate
	Elder	624	
1994	Thomes	202	
	Blue Tent	1682	
	Dibble	311	
1996	Reeds	14	
	Blue Tent	159	~966
	Elder		4000
	Red Bank	73	
	Oat	29	
	McClure	185	
	Coyote	26	
	Reeds	168	
1997	Thomes	156	
	Blue Tent	10	1125[1]
	Coyote		400[4]
	Dibble	84	500[1]
	Elder	8	3600[3]
	Jewett	60	2875[1]
	McClure	163	8500[1]
	Oat		900[4]
	Reeds	6	400[1]
	Thomes		16250[4]
1998	Red Bank	25	
	McClure	125	
	Blue Tent	426	
	Dibble	180	
	Red Bank	131	
	Reeds	21	
1999	Elder	58	

Footnotes from Maslin et al., 1998
[1] based on several good estimates of density
[2] based on several minimal estimates of density
[3] based on a density estimate at one site and the approximation that density typically decreases by 1 fish/meter over 5 km [refer to Figure 13 in Maslin et al., 1998 (p. 21)]
[4] based on data from previous years and comparison with similar streams
Source: Maslin et al (Various) and Moore (1997)
Note: Blank entries are "Not Reported" in the original report.

Rainbow Trout/Steelhead (Oncorhynchus mykiss)

Rainbow trout and steelhead are a popular sport fish in California. Steelhead are an ocean-run (anadromous) form of rainbow trout but both are considered the same species. Spawning migrations of steelhead generally occur in the Sacramento River from July to mid-March, with the peak passage past Red Bluff during late September and early October. Spawning occurs from late December through April (Hallock 1989). Females dig redds and lay eggs in gravel, usually at the end of a pool or in a riffle, at water depths of 4 to 6 inches and water velocities ranging from 0.7 and 6.0 feet per second (Moyle 2002). Females lay 200 to 12,000 eggs that hatch in 3 to 4 weeks, and fry emerge from the gravel 2 to 3 weeks later (Moyle 2002). Juvenile steelhead rear in freshwater for 1 or 2 years prior to migrating to the ocean. Downstream migration occurs anytime from a period beginning in the fall with the first heavy runoff until early spring. Studies conducted during the 1950s found that returning Upper Sacramento River steelhead consisted of 17 percent two-year old fish, 41 percent 3-year old fish, 33 percent 4-year old fish, 6 percent 5-year old fish, and 2 percent 6-year old fish (Hallock 1989).

On the Sacramento River the USFWS performed trapping operations from July 1994 to June 2000 at RBDD and captured 3,592 juvenile rainbow trout/steelhead (less than 1 percent of the total catch). The origin of these fish could be: wild rainbow trout, wild steelhead, or hatchery steelhead from Coleman National Fish Hatchery.

Sustained populations of rainbow trout occur in upper Thomes and Elder Creeks (CARA; CALFED 2000; and CDFG Various). Thomes Creek is claimed to have over 25 miles of stream supporting the species, and an additional 22 miles of tributaries (USFS 1997). California Department of Fish and Game planting records for Elder Creek show a long period of rainbow trout releases. The South Fork received fish from 1946 through 1957; the South Fork of the South Fork in 1958 through 1966; and the North Fork from 1946 through 1967. A CDFG memo from 1966 suggested that yearly plantings in Elder Creek be halted due to the difficult and time-consuming nature of the work and that the stream be allowed to revert to a wild fishery. The suggestion was approved by the department head. Fish surveys in various sections of Thomes Creek, from the 1940s onward, showed rainbow trout in nearly all reaches above the "Gorge", approximately 7 miles west of Paskenta; however, their presence below this point is possible. Planting records for Thomas Creek showed regular releases of rainbow trout from 1946 through 1972 in upper reaches of the stream (CDFG Various).

Observations of juvenile "steelhead" along the Upper Red Bank Creek (CALFED 2000) suggest that either a small number of Sacramento River rainbow trout or steelhead negotiate at least 15 air-miles up this stream to spawn, at least on occasion. Villa (1985) found rainbow trout in lower reaches of Thomes Creek and Moore (1997) observed two juvenile rainbow trout in lower reaches of Blue Tent and Dibble Creeks. Additionally, Maslin et al. (1997 and 1998) noted the species in the Elder, Oat, Thomes, Blue Tent, Dibble, and McClure Creeks. These occurrences were likely attributable to either non-natal fish moving in from the Sacramento River and rearing during the winter; spawning fish coming into the streams from the Sacramento River; or fry produced from fish that spawned in the streams. The longitudinal distribution of trout in the smaller western Tehama County streams is seasonally limited by the availability of adequate amounts of cool water.

Sculpins: Family Cottidae

Prickly Sculpin (Cottus asper)

Prickly sculpin are widespread and abundant and live in a wide variety of freshwater, brackish, and marine environments. In streams, the fish can live in a range of habitats from small, clear, and cold waters to large, turbid, and warm rivers. In those environments prickly sculpin commonly utilize cover (e.g., rocks, woody debris, overhanging vegetation) and primarily feed on large benthic invertebrates (Moyle 2002). The fish can tolerate very warm water (82.4–86°F), but are not found in polluted waters. Prickly sculpin lay eggs during March and April in flowing water in a nest among loose rocks (Moyle 2002). Young fish exhibit a downstream movement with currents where the fish rear in lower reaches until they grow to a length of 0.5 to 0.7 inches and exhibit upstream migration. Although the species adapts to altered environments, small barriers on streams can adversely impact their life cycle (Moyle 2002). Prickly sculpin are found in the Sacramento River (Appendix 10-1); Villa (1985) noted their presence in lower Thomes Creek and Moore (1997) found three adult prickly sculpin in her study of lower Blue Tent and Dibble Creeks. Furthermore, Maslin et al. (1997 and 1998) encountered the species in lower Red Bank, Reeds, Thomes, Blue Tent, Jewett, and McClure Creeks. The species has not been recorded in Coast Range segments of Tehama West streams.

Riffle Sculpin (Cottus gulosus)

Riffle sculpin are generally found in cooler waters compared to prickly sculpin and are most abundant in streams that don't exceed 77 to 79ºF. for extended periods. The fish are most commonly found in permanent, cold headwater streams with swift water and gravelly, rocky substrates, similar to rainbow trout environments (Moyle 2002). As a result of their narrow range of habitats, the species has a more restricted and fragmented distributional range than prickly sculpin, but is, nevertheless, considered widespread and abundant (Moyle 2002). Riffle sculpin are found in the Sacramento River (Appendix 10-1) and possibly in the upper tributaries; however, there were no documents found that support their presence in Tehama West streams.

Sunfishes and Basses: Family Centrarchidae

Sacramento Perch (Archoplites interruptus)

Sacramento perch, which are the only centrarchid that occurs naturally west of the Rocky Mountains, are native to the Sacramento-San Joaquin river system (Moyle 2002). They originally inhabited slow moving, fairly clear rivers and lakes with abundant aquatic vegetation and submerged objects necessary for immature fish, but they have been able to adapt to turbid water conditions and lack of aquatic plants (Moyle 2002). Adult Sacramento perch are piscivorous and appear to prey selectively on cyprinids (Moyle 2002). Male Sacramento perch defend small territories with vegetation, rocks, and debris to which a female adheres her eggs (Calhoun 1966, as cited by Moyle 2002).

Stickleback: Family Gasterosteidae

Threespine Stickleback (Gasterosteus aculeatus)

Threespine stickleback live in shallow, weedy pool and backwater habitats or among emergent vegetation at stream margins over gravel, sand, and mud substrates. The species can complete their entire life cycle in fresh or salt water, or migrate between those environments and usually complete their life cycle in one year (Moyle 2002). Threespine stickleback are generally not found in turbid water because the fish are sight feeders. The species spawns in April through July with increasing daylight and warming water. Stickleback reproduce in sand, utilizing small pieces of algae and aquatic plants pasted together to form a nest. Eggs hatch in 6-8 days at 63 to 68°F and fry remain in the nest for several days (Moyle 2002). Both young and adult fish generally shoal and rear with similarly-sized fish. Populations of threespine stickleback tend to disappear from highly altered or polluted streams or with introductions of predatory fishes (Moyle 2002). Threespine stickleback are common in the Sacramento River (Appendix 10-1) and were found in the lower reaches of several western tributaries by Maslin et al. (1997 and 1998), including: Coyote, McClure, Red Bank, and Thomes Creeks.

Surfperches: Family Embiotocidae

***Tule Perch* (*Hysterocarpus traski*)**

Tule perch are found in a wide variety of habitats. In riverine environments, the fish are found with complex cover (e.g., emergent plants, overhanging riparian plants, fallen trees, undercut banks), riprap, and deep pools (Moyle 2002). The species are strongly associated with permanent flows and well-developed riparian habitat. Tule perch need cool, well-oxygenated water and generally prefer water temperatures below 71.6°F and are rarely found at water temperatures more than 77°F. The viviparous (live-bearing) reproductive cycle begins with mating from July through September; intromission of the male's sperm with fertilization of the eggs occurring months later in the winter; and young being born in May or June (Moyle 2002). When found in streams, Tule perch are primarily associated with other native fish species and their absence from areas dominated by non-native taxa is probably caused by poor water quality in those habitats (e.g., high water temperatures, low dissolved oxygen, and low clarity) (Moyle 2002). The species is commonly found in the Sacramento River (Appendix 10-1) but its occurrence may be limited in the western Tehama County streams because of unsuitable habitats. However, the species may be more widespread than suspected, as Villa (1985) observed the species on lower Thomes Creek during the period December 1980 to June 1981, and it has been found in the South Fork of Cottonwood Creek, immediately north of the Red Bank Creek drainage (CALFED 2000).

Non-Native Fish Species

The following sub-section describes the biology, distribution, and abundance of non-native fish species. Refer to Appendix 10-3 for a summarization of non-native species observed in western Tehama County tributaries to the Sacramento River.

Herring: Family Clupeidae

***American Shad (Alosa sapidissima*)**

American shad from New York were introduced into the Sacramento River between 1871 and 1881 and are presently abundant (Moyle 2002). The species is a popular sport fish and has spawning runs up to Red Bluff, where they are blocked by the RBDD. The fish do not migrate from the ocean to freshwater until March and May, when water temperatures exceed 57.2ºF. Peak spawning runs and spawning activity occur when temperatures are between 62.6 and 75.2ºF (Moyle 2002). Spawning occurs in the water column of Sacramento River and large tributary channels over a variety of substrates, usually sand and gravel. The slightly negatively buoyant eggs drift downstream with embryos hatching in about a week at 62.6ºF (Moyle 2002). Young fish usually spend the first several months in freshwater before their transition to salt water (Moyle 2002). Because of its habitat requirements the species would not be expected to be found in the Tehama West streams.

***Threadfin Shad (Dorosoma petenense*)**

Threadfin shad were introduced from Tennessee to southern California in 1953 as a forage potential species by game fish in reservoirs. Subsequently, it was planted by CDFG throughout California, including the Central Valley in 1959, and have become established in that region (Moyle 2002). The species are planktivores (plankton-feeders) and inhabit open water of lake environments and river backwaters. The fish cannot tolerate cold water (below 46.4ºF) and does best in water temperatures exceeding 72ºF (Moyle 2002). Threadfin shad usually live only to 2 years of age and spawning occurs from April through August and peaks in June to July when temperatures exceed 68ºF. Adhesive eggs attach to floating or partially submerged objects and hatch in 3–6 days. The effect of this species' introduction on native fishes in the Central Valley is unknown (Moyle 2002). Threadfin shad have not been recorded in western Tehama County streams and would not be expected.

Minnows: Family Cyprinidae

***Carp (Cyprinus carpio*)**

Carp were brought to California in 1872 (Dill and Cordone 1997, as cited by Moyle, 2002). Carp are most common in low-elevation reservoirs with warm turbid water where they bottom feed on insect larvae, mollusks, algae, and vegetation (Moyle 2002); however, they are often found in slow-moving streams. Females will oviposit 50,000 to 200,000 eggs (~500 at a time) per season, which adhere to vegetation and bottom debris. Fry will remain under cover of vegetation until they reach 3 to 4 inches in length (Moyle, 2002). In California waters, carp have been held responsible for both the decline of native fish populations and the destruction of waterfowl habitat (Moyle 2002). On the Sacramento River at RBDD, 31 carp were captured by the USFWS during trapping operations performed from July 1994 to June 2000 (Appendix 10-1). The species was encountered during a study of lower Thomes Creek by Villa (1985) and above Paskenta at Lake Hollow (CDFG Various). California Department of Fish and Game suggested that the Lake Hollow partial-fish stream barrier blocked carp passage, as they were noted below but not above the feature (CDFG Various) (see Figure 10-1).

***Fathead Minnow (Pimephales promelas*)**

Fathead minnow is a species native to the eastern and midwestern United States and was introduced to California as a bait fish in the early 1950s. The California Department of Fish and Game subsequently spread the species for forage and these fish are now established throughout the Central Valley (Moyle 2002). Fathead minnow populations are most successful in pools of small, muddy streams and ponds, where other species are scarce, and can often be found in intermittent streams they prefer temperatures of 71.6 to 73.4ºF. These minnows are bottom browsers feeding on algae, invertebrates, and organic matter (Moyle 2002). Fathead minnows mature rapidly and can spawn during their first summer. The species can spawn repeatedly throughout the summer when temperatures exceed 59ºF. Adhesive eggs are laid under submerged objects, hatching in 4-6 days at temperatures about 77ºF. Fathead minnows may adversely impact California roach, a native species, in intermittent streams (Moyle 2002). This species has not been documented in Tehama West streams.

***Golden Shiner (Notemigonus chrysoleucas*)**

Introduced in 1891 (Dill and Cordone 1997, as cited by Moyle 2002), golden shiner have been widely used as a forage and baitfish and, as such, have become widely established particularly in reservoirs. Females lay eggs on submerged vegetation where a male fertilizes them. Fry form schools and feed on rotifers and diatoms, while larger fish feed on crustaceans (i.e., cladocerans, copepods) and other large zooplankton (i.e., protozoans, rotifers) (Moyle 2002). Little is known about the impact golden shiner have had on native fish (Moyle 2002), but the fish may compete with some species utilizing the same forage organisms.

The USFWS trapping operations on the Sacramento River at RBDD from 1994 to 2000 captured 541 golden shiners during that period (Appendix 10-1). In the western tributaries Moore (1997) observed four juvenile and eight adult golden shiners in 1996 on Blue Tent and Dibble Creeks, while Maslin et al. (1997 and 1998) encountered the species in Jewett, McClure, Reeds, Oat, Red Bank, and Thomes Creeks.

***Goldfish (Carassius auratus*)**

Goldfish are native to Eastern Europe and China and were introduced into California in the 1860s (Moyle, 2002). Since then, bait fishermen and aquarists have spread the fish (Moyle 2002). The species can become established in very warm water (80.6 to 98.6ºF) and in highly disturbed, polluted habitats possessing other non-native fish species, but rarely become established in streams. Goldfish can be found in warm water sloughs with dense aquatic vegetation and are omnivores, but feed primarily on algae. Goldfish first spawn in April or May, laying highly adhesive eggs over vegetation and submerged objects (Moyle 2002). Eggs hatch in about a week and young fish seek cover among vegetation. Although the species is widely distributed in California, their populations are usually small and their ecological role is not well understood (Moyle 2002). They have not been found in the Tehama West Watersheds.

Bullheads and Catfishes: Family Ictaluridae

***Black Bullhead (Ameiurus melas*)**

Introduced as a gamefish in the 1930s (Dill and Cordone 1997, as cited by Moyle 2002), black bullhead are native to the eastern United States. They prefer slow moving, warm, turbid waters with muddy bottoms (Moyle 2002). Black bullheads are omnivorous and feed on aquatic insects, crustaceans, mollusks, algae, dead fish, and an occasional live fish. Females construct nests as shallow depressions in the substrate where 1,000 to 7,000 eggs are deposited. After hatching, a parent guards the young until they reach approximately 1 inch in length (Moyle 2002). Their distribution in California appears to be expanding as a result of plantings and self-dispersal, but it is uncertain what impact black bullheads have on native taxa (Moyle 2002). On the Sacramento River at RBDD, 17 black bullhead were captured by the USFWS during their 6-year-long trapping operations (Appendix 10-1).

***Brown Bullhead (Ameiurus nebulosus*)**

Brown bullhead are native to areas east of the Great Plains and were first introduced in California in 1874 as a game and food fish (Dill and Cordone 1997, as cited by Moyle 2002). In 1890 the California Fish Commission reported that brown bullhead had been planted in every county in California (Moyle 2002). Brown bullheads are omnivorous and feed on aquatic insects, crustaceans, mollusks, algae, dead fish, and an occasional live fish. Females construct nests as a shallow depression in sand or gravel near aquatic vegetation and oviposit 2,000 to 14,000 eggs. Both parents guard the egg clutch and young until the young reach a length of approximately two inches (Moyle 2002). Although the aquaculture industry produces small numbers to stock ponds for fee fishing, their range appears to be static (Moyle 2002). It is not known what impact brown bullhead have on native fishes (Moyle 2002). Brown bullheads were occasionally caught by USFWS during trapping operations at RBDD from July 1994 to June 2000 (Appendix 10-1). They have also been observed in near-river reaches of Jewett Creek during a study performed in 1998 (Maslin et al 1998); in the 1960s in Elder Creek, from Interstate 5 downstream (Borchard, R., Personal communications); and in Thomes Creek west of Paskenta and below Lake Hollow (CDFG Various).

***Channel Catfish* (*Ictalurus punctatus*)**

Channel catfish are endemic to the Mississippi-Missouri River system, but were widely introduced in California in the late 1800s and early 1900s (Dill and Cordone 1997, as cited by Moyle 2002). Adult channel catfish move into river channels at night to feed on crustaceans and fish, while juveniles spend most of their time in riffles (Moyle 2002). Channel catfish have a cavern-nesting behavior, and use old muskrat burrows, undercut banks, log jams, or human objects (e.g., barrels) to oviposit 2,000 to 70,000 eggs. The male usually aerates and guards the egg clutch and young until the young are approximately 7 days old (Moyle 2002). It is uncertain what impact channel catfish have had on native fishes, amphibians, and crustaceans, but Moyle (2002) speculates that it has not been positive based on their feeding habits. From July 1994 to June 2000, 44 channel catfish were caught by the USFWS during the RBDD trapping operations (Appendix 10-1).

***White Catfish* (*Ameiurus catus*)**

White catfish were transplanted from the east coast to the Central Valley in 1874 where the fish spread rapidly and have become a popular sport fish (Moyle 2002). The species is a carnivorous bottom feeder and increasingly preys on other fish as individual's size increase. White catfish prefer slow current areas and avoid deep, swift channels preferred by channel catfish and can be very successful in reservoirs and farm ponds (Moyle 2002). The fish mature at 3–4 years of age. Spawning generally occurs in June and July when temperatures exceed 69.8ºF. Reproductive behavior is similar to bullheads (Moyle 2002). White catfish was the most abundant catfish species observed during USFWS trapping operations at RBDD (1,059 fish) (Appendix 10-1).

Trout, Salmon, Char, and Whitefish: Family Salmonidae

***Brown Trout* (*Salmo trutta*)**

Brown trout were first introduced from Europe into California in 1893 (Dill and Cordone 1997, as cited by Moyle 2002). Their distribution through the state is widespread but spotty, which may reflect hatchery-planting practices. They inhabit lakes and clear, cool (53.6 to 68°F), well-shaded water with deep pools or runs, often with aquatic plants. Brown trout have shown to be extremely adaptable to changing conditions. After 400 years of selection pressure from anglers, they are able to maintain relatively high populations even in the presence of high angling pressure. Females select gravel bottoms to build redds where they will lay 200 to 21,000 eggs (Moyle 2002). On the Sacramento River at RBDD, a single brown trout was captured by the USFWS during trapping operations (Appendix 10-1).

In a 1946 CDFG file memo (CDFG Various) brown trout were estimated to represent approximately ten percent of the trout population near Thomes Creek's confluence with Willow Creek, near the "Slab" (see Figure 10-1). Even though no CDFG planting records of brown trout were found, this species obviously was released in the upper Thomes Creek drainage and possibly Elder Creek over a half-century ago. Because recent memos do not refer to the presence of brown trout in assessment area streams, they have possibly died out.

***Kokanee/Sockeye Salmon (Oncorhynchus nerka*)**

Kokanee are a non-anadromous form of sockeye salmon with similar life cycles, except kokanee mature in lakes instead of the ocean. Sockeye only rarely occur in California as strays mixed with other salmon runs, but have similar life cycles. Kokanee/sockeye salmon found in the Sacramento River are probably either non-spawning strays or emigrating kokanee (Moyle 2002). A total of 16 of this species were captured at RBDD by the USFWS from 1994 through 2000 (Appendix 10-1). Because of its rare occurrence in the Sacramento River and cold-water habitat requirements, the species is not expected to be found in western Tehama County streams.

Live Bearers: Family Poeciliidae

***Western Mosquitofish (Gambusia affinis*)**

In 1922 western mosquitofish were brought into California from central North America in efforts to control mosquitoes (Dill and Cordone 1997, as cited by Moyle 2002). Mosquitofish feed on the most abundant food present, ranging from mosquito larvae, to algae, to zooplankton (Moyle 2002). Mosquitofish exhibit internal fertilization and females give birth to live young in shallow water with aquatic vegetation (Moyle 2002). They have been recorded to negatively impact native invertebrates and the eggs of amphibians (i.e., California newt (*Taricha torosa*) and Pacific treefrog (*Hyla regilla*) in California (Moyle 2002)). In Jewett, McClure, and Oat Creeks, Maslin et al. encountered the species in reaches close to the Sacramento River during studies performed in 1997 and 1998. In 1945 the California Department of Fish and Game captured one sub-adult at the Highway 99E crossing of Thomes Creek, and in 1980 others were captured near the "Slab" (CDFG Various) (see Figure 10-1).

Striped Basses: Family Moronidae

***Striped Bass (Morone saxatilis*)**

In order to maintain a viable population, striped bass require large cool rivers to spawn, a large water body with large populations of prey fish for adults, and large estuaries with an abundance of invertebrates for juveniles (Moyle 2002). On the West Coast only the San Francisco Bay provides all three conditions for striped bass and fish from this population migrate up the Sacramento River as far as the Red Bluff Diversion Dam (Moyle 2002). Appendix 10-1 shows that only three striped bass captured at trapping operations performed at RBDD. This species was introduced as a gamefish in 1879 (Dill and Cordone 1997, as cited by Moyle 2002). They are native to east and south coast rivers and estuaries of North America, the Atlantic Ocean, and the Gulf of Mexico. Striped bass have not been recorded in Tehama West drainages.

Sunfishes and Basses: Family Centrarchidae

***Black Crappie (Pomoxis nigromaculatus*) and White Crappie (*Pomoxis annularis*)**

Black and white crappie were probably introduced from the Midwest into southern California about 1908, with subsequent introductions into the Central Valley in the period from 1916 to 1919 and are now abundant (Moyle 2002). The two species are popular game fish and are most commonly found in large, warm water lakes and reservoirs, preferring temperatures between 80.6 and 84.2ºF. The fish generally feed on planktonic cructaceans. Spawning occurs in shallow water in constructed depressions in mud or gravel substrate or in beds of aquatic vegetation during March or April when water temperatures exceed 57.2º F, and peak between 64.4 and 68º F. The effects of these species on native fishes is unknown but is believed to be minimal because the fish primarily inhabit reservoirs and other disturbed aquatic habitats (Moyle 2002). Because of its preferred lacustrine habitats, these species are not expected to be found in western Tehama County streams.

***Bluegill (Lepomis macrochirus*)**

Introduced for sport fishing in 1908 (Dill and Cordone 1997, as cited by Moyle 2002), bluegill are common in warm-water reservoirs and warm, slow streams over much of California. Bluegills are highly prolific and, in combination with their broad feeding habits, they may have seriously impacted native fish populations (Moyle 2002). Males form a nesting colony, constructing and defending their own nests made in gravel, sand, dead leaves, sticks, or mud (Calhoun 1966, as cited by Moyle 2002). Females lay 2,000 to 50,000 eggs, which they deposit over many nests; a nest generally holds 2,000 to 18,000 eggs, but may hold as many as 62,000 (Moyle 2002).

Bluegills were the most abundantly captured non-native fish species at the RBDD between 1994 and 2000 (Appendix 10-1). In the western tributaries one juvenile bluegill was observed by Moore (1997) during a 1996 study of Blue Tent and Dibble Creeks, while Maslin et al. (1997 and 1998) found the species in Jewett, McClure, Oat, and Red Bank Creeks. Additionally, the species was observed during a study performed by Villa (1985) on lower Thomes Creek.

***Redear Sunfish (Lepomis microlophus*)**

Redear sunfish were introduced in the early 1950s (Dill and Cordone 1997, as cited by Moyle 2002), well after the establishment of most other exotic fishes in California. Redear sunfish have not been associated with the demise of native fishes due in part to their relatively recent introduction, but also because of their predominately invertebrate diet (e.g., snails, immature insects, and crustaceans) (Moyle 2002). Males construct a nest in a nesting colony in sand, gravel, or mud (Calhoun 1966, as cited by Moyle 2002). Females lay between 9,000 and 80,000 eggs (Moyle 2002). On the Sacramento River at RBDD, 48 redear sunfish were captured by the USFWS during trapping operations between 1994 and 2000 (Appendix 10-1).

***Green Sunfish (Lepomis cyanellus*)**

Green sunfish were introduced by mistake in 1891 or 1908 (Dill and Cordone 1997, as cited by Moyle 2002). Green sunfish are opportunistic feeders that prey on insects, crustaceans, and small fish. This habit has probably been an important factor in the decline of the California roach in central California (Moyle 2002). They are equally at home in small, shallow ponds and slow moving streams. Males construct nests on gravel or sandy bottoms, at locations that provide maximum exposure to full sunlight (Calhoun 1966, as cited by Moyle 2002). Females may spawn with several males and deposit 2,000 to 10,000 eggs, depending on their size (Moyle 2002). At RBDD on the Sacramento River, 51 green sunfish were captured from 1994 to 2000 (Appendix 10-1). Villa (1985) found green sunfish in lower Thomes Creek and Maslin et al. (1997 and 1998) found them in near-river reaches of Elder, Jewett, McClure, and Red Bank Creeks.

Largemouth Bass (Micropterus salmoides)

Introduced as a game fish in 1891 or 1895 (Dill and Cordone 1997, as cited by Moyle 2002), largemouth bass have become widespread in California. As a highly prized warm-water gamefish, largemouth bass have been widely planted and are under regulatory restrictions by the CDFG to maintain strong populations for anglers (Moyle 2002). This taxa, while preferring shallow ponds and lakes, also is found in warm, slow-moving streams.

Males create nests near submerged objects or vegetation as depressions in sand, gravel, or debris bottoms in which females will oviposit 2,000 to 94,000 or more eggs (Calhoun 1966, as cited by Moyle 2002). Males guard the eggs and fry for 2 to 4 weeks (Moyle 2002). On the Sacramento River at RBDD, the USFWS captured 185 largemouth bass while performing trapping operations from 1994 to 2000 (Appendix 10-1). In 1996, juvenile largemouth bass were observed by Moore (1997) in a study of lower reaches of Blue Tent and Dibble Creeks and, in 1998, Maslin et al saw largemouth bass in lower McClure Creek. Additionally, the species was found in lower Thomes Creek by Villa (1985).

Smallmouth Bass (Micropterus dolomieu)

Smallmouth bass are native to the upper Mississippi and the Great Lakes watershed, but were introduced as a gamefish in California in 1874 (Dill and Cordone 1997, as cited by Moyle 2002). Summer water temperature, which needs to range between 68 to 80.6°F, is an important factor in the establishment of smallmouth bass populations (Calhoun 1966, as cited by Moyle 2002), and most smallmouth bass populations occur in waters that have an extended summer water temperature period of 69.8 to 71.6°F (Moyle 2002). Other habitat preferences are clear water with a moderate gradient, an intricate system of cobbles, pools, and runs, and overhanging riparian vegetation (Calhoun 1966, as cited by Moyle 2002). Crayfish appear to be an important prey item, and smallmouth bass may play a roll in controlling exotic crayfish populations (Moyle 2002). Smallmouth bass also prey on other crustaceans, insects, amphibians, and small mammals. Females oviposit 2,000 to 21,000 eggs in the nest, built by the males on gravel or sand bottoms near aquatic vegetation (Calhoun 1966, as cited by Moyle 2002). Males will defend the nest and young for 1 to 4 weeks (Moyle 2002).

Smallmouth bass, though found in some nearby reservoirs, appear to prefer low to moderate gradient streams with boulders or rock ledges. The impact smallmouth bass have on native fish populations is uncertain, but they may have caused local extinction of native frogs and other amphibians (Moyle 2002). The USFWS captured 33 individuals of this species on the Sacramento River at RBDD (Appendix 10-1). This taxa has not been previously reported in Tehama West streams, but given the correct combination of spring-time runoff and its presence in the Sacramento River, it could be present in near-river reaches.

Spotted Bass (Micropterus punctulatus)
Spotted bass are native to the central and lower Mississippi basin, but were introduced as a gamefish into California in 1933 (Moyle 2002) or 1936 (Dill and Cordone 1997, as cited by Moyle 2002). The species is very common in upstream reservoirs, including Shasta and Whiskeytown Lakes, but they also inhabit low-gradient, clear, warm river sections where they hold up in pools, while avoiding riffles and runs (Calhoun 1966, as cited by Moyle 2002). Males construct nests in gravel or among cobbles and boulders and defend the eggs (2,000 to 14,000 per female) and young for 1 to 4 weeks (Moyle 2002). On the Sacramento River the USFWS captured 188 spotted bass in their trapping operation at RBDD from 1994 to 2000, which represented less than 1 percent of the total catch (Appendix 10-1).

THREATENED AND ENDANGERED SPECIES

Table 10-6 provides the current status of threatened or endangered fish species in the assessment area.

Table 10-6
FEDERAL OR STATE LISTED SPECIES IN THE TEHAMA WEST ASSESSMENT AREA

Common Name	Scientific Name	Status Federal / State	Date Federally Listed
Steelhead	*Oncorhynchus mykiss*	Federal = Threatened State = Not Listed	March 19, 1998 (63 FR 13347)
Winter-run Chinook salmon	*Oncorhynchus tshawytscha*	Federal = Endangered State = Endangered	January 4,1994 (59 FR 440)
Spring-run Chinook Salmon	*Oncorhynchus tshawytscha*	Federal = Threatened State = Threatened	September 16, 1999 (64 FR 50394)
Fall and Late-Fall Chinook Salmon	*Oncorhynchus tshawytscha*	Federal Species of Concern; Candidates for Listing	

Central Valley steelhead were listed as a threatened species in 1998 (63 FR 13347; March 19, 1998). This species includes all naturally spawned populations of *O. mykiss* in the Sacramento and San Joaquin Rivers and their tributaries, but excludes *O. mykiss* from San Francisco and San Pablo Bays and their tributaries. Based on an updated status review and an assessment of hatchery populations located within the range of the Evolutionary Significant Unit (ESU), NMFS recently proposed that steelhead remain listed as a threatened species (69 FR 33102; June 14, 2004). In addition NMFS proposed that resident *O. mykiss* occurring with anadromous populations below impassable barriers (both natural and man made) and two artificially propagated populations (Coleman National Fish Hatchery on Battle Creek and Feather River Hatchery on the Feather River) also be included (69 FR 71880).

The National Marine Fisheries Service (NMFS) originally listed winter-run Chinook as threatened under emergency provisions of the Endangered Species Act (ESA) on August 4, 1989 (54 FR 32085), and formally listed the species on November 5, 1990 (55 FR 46515). The State of California listed winter-run Chinook as endangered in 1989 under the California State Endangered Species Act. On January 4, 1994, NMFS reclassified the winter-run Chinook as an endangered species (59 FR 442).

Spring-run Chinook was listed as a threatened species in 1999 (64 FR 50394). The listed species includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries. The agency recently conducted a review to update the winter-run Chinook's status, taking into account new information and considering the net contribution of artificial propagation efforts. NMFS has recently proposed that the Central Valley spring-run Chinook remain listed as a threatened species (69 FR 33102; June 14, 2004) (69 FR 71880).

On April 6, 2005, National Oceanic and Atmospheric Administration (NOAA) Fisheries proposed listing green sturgeon as a threatened species (70 FR 17386). The proposed listing is based on: "new information showing that the majority of spawning adults are concentrated into one spawning river (i.e., Sacramento River), thus increasing the risk of extirpation due to catastrophic events; threats that have remained severe since the last status review and have not been adequately addressed by conservation measures currently in place; fishery independent data exhibiting a negative trend in juvenile green sturgeon abundance; and new information showing evidence of lost spawning habitat in the upper Sacramento and Feather Rivers." (70 FR 17386)

CRITICAL FISHERIES AND AQUATIC HABITAT

In determining what areas are critical habitat for federally listed species, regulations (50 CFR 424.12(b)) require that federal agencies must, "consider those physical or biological features that are essential to the conservation of a given species including space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, and rearing of offspring; and habitats that are protected from disturbance or are representative of the historical geographical and ecological distribution of a species." The regulations further direct us to, "focus on the principal biological or physical constituent elements that are essential to the conservation of the species" and specify that the, "known primary constituent elements (PCE) shall be listed with the critical habitat description" (69 FR 71880).

These PCEs include sites essential to support one or more life stages of the listed species (sites for spawning, rearing, migration and foraging). These sites in turn contain physical or biological features essential to the conservation of the listed species (for example, spawning gravels, water quality and quantity, side channels, forage species). Specific types of sites and the features associated with them during the species' freshwater life stage (estuarine and marine features are also included, but not listed here) include:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development

- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks

- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival (69 FR 71880)

On June 16, 1993 NMFS designated critical habitat for the winter-run Chinook from Keswick Dam to the Golden Gate Bridge (58 FR 33212), which includes the entire Sacramento River in Tehama County. The essential features of the critical habitat include (1) the river water, (2) the river bottom including those areas used as spawning substrate, (3) the adjacent riparian zone used for rearing, and (4) the estuarine water column and essential foraging habitat and food resources of the Delta and Bay, used for juvenile emigration and adult up-migration (NMFS 2005).

In September, 2005 critical habitat was designated for spring-run Chinook salmon and steelhead in northern California. Designated critical habitat for Chinook salmon includes the Sacramento River, Thomes Creek upstream to slightly west of Paskenta, and the lower-most reaches of most western Tehama County streams (see Figure 10-3 and Table 10-7). The designated habitat for the Central Valley steelhead ESU is essentially the same as for the spring-run Chinook (NOAA 2005; see Figure 10-4 and Table 10-8).

In past designations of critical habitat for anadromous salmonids, the extent of the riparian zone considered critical habitat was vague. As a result, NMFS, in the December 10, 2004 federal register notice, has designated the lateral extent of critical habitat as "the width of the stream channel defined by the ordinary high-water line as defined by the U.S. Army Corps of Engineers (Corps) in 33 CFR 329.11. In areas for which the ordinary high-water line has not been defined pursuant 33 CFR 329.11, the width of the stream channel shall be defined by its bankfull elevation."

Table 10-7
TEHAMA WEST TRIBUTARIES TO THE SACRAMENTO RIVER PROPOSED AS CRITICAL HABITAT FOR SPRING-RUN CHINOOK SALMON

Stream Name	Upstream Endpoint of Critical Habitat Designation (Decimal Degrees, WGS84 datum)	
	Latitude (North)	Longitude (West)
Sacramento River	39.6998	-121.9419
Blue Tent Creek	40.2284	-122.2551
Burch Creek	39.8526	-122.1502
Coyote Creek	40.0929	-122.1621
Dibble Creek	40.2003	-122.2420
Elder Creek	40.0526	-122.1717
Jewett Creek	39.8913	-122.1005
McClure Creek	40.0074	-122.1729
Oat Creek	40.1873	-122.1350
Red Bank Creek	40.1391	-122.2157
Reeds Creek	40.1687	-122.2377
Rice Creek	39.8495	-122.1626
Thomes Creek	39.8822	-122.5527
Unnamed Tributary to Burch Creek	39.8532	-122.1627

Note: The area begins at the Sacramento River and ends upstream at the listed locations.
Source: 69 FR 71880

Table 10-8 TEHAMA WEST TRIBUTARIES TO THE SACRAMENTO RIVER THAT ARE PROPOSED AS CRITICAL HABITAT FOR STEELHEAD		
Stream Name	Upstream Endpoint of Critical Habitat Designation (Decimal Degrees, WGS84 datum)	
	Latitude (North)	Longitude (West)
Sacramento River	39.6998	-121.9419
Blue Tent Creek	40.2284	-122.2551
Burch Creek	39.8526	-122.1502
Dibble Creek	40.2003	-122.2420
Elder Creek	40.0526	-122.1717
McClure Creek	40.0074	-122.1729
Oat Creek	40.1873	-122.1350
Red Bank Creek	40.1391	-122.2157
Rice Creek	39.8495	-122.1626
Thomes Creek	39.8822	-122.5527
Note: The area begins at the Sacramento River and ends upstream at the listed locations. Source: 69 FR 71880		

SPECIES OF SPECIAL CONCERN

Table 10-9 lists state and federal species of special concern in the Sacramento River within Tehama County. These species receive no legal protection and the use of the term does not imply that they will eventually be proposed for listing. These species have been designated by either the USFWS and NMFS or CDFG as having problems in only parts of their ranges. 'Species of concern" is an informal term used by some but not all USFWS offices and refers to those species that they believe might be declining or may be in need of concentrated conservation actions to prevent decline. The CDFG describes "species of special concern" as those that have declined in abundance over recent years with low, scattered, or highly localized populations in need of active management to prevent them from becoming threatened or endangered.

Table 10-9 FEDERAL AND STATE SPECIES OF CONCERN		
Common Name	Scientific Name	Federal / State
Fall and Late-Fall Chinook salmon	*Oncorhynchus tshawytscha*	Yes / No
River lamprey	*Lampetra ayresi*	Yes / Yes
Pacific lamprey	*Lampetra tridentate*	Yes / No
Sacramento splittail	*Pogomichthys macrolepidotus*	No / Yes
Sacramento perch	*Archoplites interruptus*	Yes / No

POTENTIAL ADVERSE CONDITIONS

Water Quality

Most of the focus concerning potential water quality impacts on fishery resources in Tehama County has related to main stem Sacramento River issues. Remediation of heavy metal contamination from acid mine drainage at Iron Mountain Mine (an EPA Superfund site) near Redding has been the most prominent water quality factor affecting upper Sacramento River fish populations. However, those past impacts were localized upstream of Tehama County because of dilution effects caused by tributary accretions between Redding and Tehama County. The California Department of Water Resource's literature review of Sacramento River water quality found several general trends in some water quality parameters in the Sacramento River: electrical conductivity, suspended sediments, dissolved solids, turbidity, color, and nutrient concentrations all increase in a downstream progression (DWR 1986). The USFWS (1995) stated that, although largely unquantified, water quality impacts on fish populations in the Sacramento River and its tributaries include effects related to high levels of suspended sediments and elevated levels of nutrients, herbicides, and pesticides from agricultural drainage.

In 1991 the U.S. Geological Survey (USGS) initiated the National Water-Quality Assessment Program (NWQA). From 1995 until April 1998 water quality data were collected and analyzed in 55 streams in the Sacramento River Basin, including Thomes and Elder Creeks.

The USGS performed an Occurrence Survey in 1995 that led to the Spatial Distribution Survey in 1997. In 1997 water quality samples were taken in depositional zones of the Sacramento River and select tributaries for a Spatial Distribution Metals Survey. The results of the 1997 survey have been included in this document because of data collected for Elder and Thomes Creeks. A description of the study design follows (USGS 2000):

> Two types of surveys are completed in NWQA investigations to obtain information on the occurrence and distribution of hydrophobic organic contaminants and trace metals and other elements in streambed sediment and tissues of aquatic organisms. The Occurrence Survey is designed to provide information throughout the study unit. Sites are chosen on the major rivers and on smaller streams which may be important because of land uses (transport of pesticides or other organic contaminants, or metals) or because of distinctive geological features (geological deposits of specific trace metals, for example). Interpretation of data from the Occurrence Survey leads to the design of a Spatial Distribution Survey. A Spatial Distribution Survey is designed to provide more information on the distribution of specific contaminants within a study unit. The Spatial Distribution Survey for the Sacramento River Basin study was focused on trace elements, specifically mercury.

Data from collection sites found in the western Tehama County assessment area are presented in Table 10-10 and depict the presence of trace metals found in streambed sediment (USGS 2000). The results, for most metals, show that Thomes, Elder, and the Upper Sacramento River have similar sediment concentrations. For instance, lead varies from 10–14 mg/g, mercury from 0.04–0.1 mg/g, and arsenic from 5.1–11.0 mg/g. The element with the most graphic disparity between streams is inorganic carbon. Thomes Creek sediments have 41 times the inorganic carbon levels as the Sacramento River and Elder Creek has 15 times the river's concentrations. It is not clear what may be responsible for these differences. These data may be used in the future to compare changes or trends over time. (It is important to keep in mind that the sample data set used in Table 10-10 is very small and that any conclusions based upon the data shown should be made very cautiously.)

Table 10-10 RESULTS OF A SPATIAL DISTRIBUTION SURVEY PERTAINING TO METALS AND OTHER ELEMENTS IN STREAMBED SEDIMENT				
Metal or Other Element	**Sacramento River above Bend Bridge near Red Bluff, CA 10/22/97 at 11:00 hrs**	**Sacramento River at Woodson Bridge, CA 10/16/97 at 13:00 hrs**	**Thomes Creek at Flournoy, CA 7/21/97 at 18:30 hrs**	**Elder Creek below Government Gulch near Tehama, CA 7/21/97 at 17:00 hrs**
Aluminum (%)	8.1	7.7	7.5	7.8
Antimony (mg/g)	1.3	1	0.9	0.8
Arsenic (mg/g)	11	9.3	7.9	5.1
Barium (mg/g)	560	490	530	510
Beryllium (mg/g)	<1	<1	<1	<1
Bismuth (mg/g)	<10	<10	<10	<10
Cadmium (mg/g)	1	0.7	0.1	0.1
Calcium (%)	1.7	1.7	2.2	1.6
Inorganic carbon (%)	0.01	0.01	0.41	0.15
Organic carbon (%)	1.65	1.21	1.18	1.02
Organic plus inorganic carbon (%)	1.66	1.22	1.59	1.17
Cerium (mg/g)	35	34	43	37
Cobalt (mg/g)	27	24	25	32
Chromium (mg/g)	180	180	230	310
Copper (mg/g)	82	70	61	68
Europium (mg/g)	<2	<2	<2	<2
Gallium (mg/g)	17	17	17	20
Gold (mg/g)	<8	<8	<8	<8
Holmium (mg/g)	<4	<4	<4	<4
Iron (%)	5.1	4.6	4.6	5.6
Lanthanum (mg/g)	19	18	21	18
Lead (mg/g)	14	10	10	10
Lithium (mg/g)	28	31	52	48
Magnesium (%)	1.7	1.8	2	2.9
Manganese (mg/g)	780	720	700	850
Mercury (mg/g)	0.08	0.1	0.09	0.04
Molybdenum (mg/g)	<2	<2	<2	<2
Neodymium (mg/g)	23	22	27	24
Nickel (mg/g)	130	120	100	200
Niobium (mg/g)	7	6	5	<4
Phosphorus (%)	0.11	0.1	0.16	0.07
Potassium (%)	0.95	0.97	1.3	1.2
Scandium (mg/g)	22	21	18	23
Selenium (mg/g)	0.5	0.4	0.6	0.2
Silver (mg/g)	0.2	0.2	0.2	0.1
Sodium (%)	1.4	1.6	1.8	1.4
Strontium (mg/g)	210	180	140	110
Sulfur (mg/g)	0.07	0.06	0.1	<.05
Tantalum (mg/g)	<40	<40	<40	<40

Table 10-10 RESULTS OF A SPATIAL DISTRIBUTION SURVEY PERTAINING TO METALS AND OTHER ELEMENTS IN STREAMBED SEDIMENT				
Metal or Other Element	**Sacramento River above Bend Bridge near Red Bluff, CA 10/22/97 at 11:00 hrs**	**Sacramento River at Woodson Bridge, CA 10/16/97 at 13:00 hrs**	**Thomes Creek at Flournoy, CA 7/21/97 at 18:30 hrs**	**Elder Creek below Government Gulch near Tehama, CA 7/21/97 at 17:00 hrs**
Thorium (mg/g)	8	4	4	7
Tin (mg/g)	<5	<5	<5	<5
Titanium (%)	0.52	0.49	0.41	0.54
Uranium (mg/g)	2.2	1.9	2	1.6
Vanadium (mg/g)	190	170	160	190
Ytterbium (mg/g)	3	2	2	3
Yttrium (mg/g)	24	22	24	23
Zinc (mg/g)	230	180	100	110
Source: USGS 2000				

Entrainment

There are over 300 diversions on the Sacramento River between the cities of Redding and Sacramento. Unknown numbers of vulnerable juvenile fish are entrained (stranded) in large diversions that do not have screens. California Fish and Game Code Sections 5980-5993, 6020-6028, and 6100 provide the authority to require fish screens and bypass flows at water diversions according to specified criteria (SRA 1989).

Within the assessment area the Red Bluff Diversion Dam (RBDD) provides agricultural water to the Tehama-Colusa Canal (TCC) and Corning Canal along with wildlife refuge water. During the principal non-irrigation season of mid-September to mid-May, the RBDD gates are raised, providing unimpeded upstream and downstream fish passage at the dam. From mid-May to mid-September, the dam gates are lowered to provide gravity flow of Sacramento River water into the Tehama-Colusa Canal and to the Corning Canal pumping plant. Sacramento River fish are protected from entrainment into these two irrigation canals by angled, rotary drum screens completed in 1990 (Vogel et al 1990). Prior to construction of those fish screens, large numbers of fish were entrained into the canals (Vogel and Smith 1988). The Red Bluff Research Pumping Plant (RPP) was constructed adjacent to RBDD in an effort to minimize the detrimental impacts of water diversions on anadromous salmonids during periods when irrigation water is pumped from the river between mid-September and mid-May. The RPP's ability to deliver water to the TCC without entraining fish has allowed the USBR to modify its operation of RBDD to protect upper Sacramento River fish populations. The pumps are operated annually from March through mid-May and mid-September through October (BOR 2005).

Diversions and fish passage barriers on tributary streams have been identified as being major issues affecting salmonids (DWR 2003). Small dams on streams can prevent passage if streamflow is not adequate or if the downstream face of the dam is too long or shallow for fish to negotiate. In addition, instream gravel pits and associated ponds have been known to provide habitat for salmonid fry predators, warm to lethal temperatures, and trap or strand fish when stream flows decline. Finally, roads crossings and infrastructure features frequently block fish migration. The effects of diversions, gravel mining, and obstructions on fish have not been quantified, but the USFWS's Anadromous Fish Restoration Program has an ongoing program to prioritize and screen Central Valley diversions to protect fish. No information on unscreened diversions in the western Tehama County streams was found for this assessment.

Water Temperature

Water temperature in rivers and streams has a large effect on the distribution of native and non-native fish assemblages. Water temperature is strongly influenced by ambient air temperature. CALFED (1999) defined several important environmental functions that stream temperatures influence including:

- algae blooms
- aquatic invertebrate reproduction and growth
- fish migration, spawning, development and growth
- metabolism and behavioral cues of aquatic organisms
- amount of dissolved oxygen available in the water body
- rates of organic material decay and nutrient recycling in aquatic habitats

The California Department of Water Resources has been measuring water temperature in the Sacramento River since 1987 and has four stations in the assessment area. Water temperature data can be accessed through the California Data Exchange Center (CDEC 2005). The Shasta Dam Temperature Control Device was completed in 1997 in order to mitigate declines of winter-run Chinook salmon populations in the main stem Sacramento River to areas as far downstream as Red Bluff. This device allows water to be drawn from the lower, cooler levels of Shasta Lake when necessary, without loss of revenue from power generation.

Most of the tributaries in the assessment area are intermittent; consequently, the effects of water temperatures in those streams are only seasonally relevant to fish. Some species that may exist (e.g., juvenile Catostomids, Cyprinids, and Centrarchids) may be able to tolerate high summertime water temperatures in the Sacramento Valley reaches of these streams and could persist in pools over summer until conditions naturally cool in the fall. Alternatively, the headwaters of some watersheds (e.g., Thomes and Elder Creeks) provide sufficiently cool water to maintain those species with lower temperature requirements over summer. The longitudinal seasonal water temperature gradient in western Tehama County streams would partially define the potential distribution of native and non-native fish species in the watersheds. However, the seasonal temperature regime is presently unknown due to a lack of data.

Maslin et al (1995) provided water temperature data for the lower reaches of some western Tehama County tributaries and discussed the importance of temperature fluctuations as it pertains to fish growth. He cites Spigarelli et al. (1982) study of brown trout growth in three different temperature regimes, showing that the best weight gain and average food consumption by individual fish was from those reared in the 48 to 64°F temperature cycle. In Maslin, *et al's* study (1995), diel temperature fluctuations in Dibble and Red Bank Creeks, during periods when non-natal rearing salmonids were present, averaged about 13° F while temperature ranges in the Sacramento River averaged about 4°F. It is possible that non-natal rearing may increase salmonid fry growth rates and may be one of the adaptive reasons that this behavior exists.

Physical Barriers

The Red Bluff Diversion Dam is the only partial barrier for fish on the Sacramento River in Tehama County. When the dam gates are lowered from mid-May to mid-September, upstream fish passage is provided by fish ladders on the east and west sides and middle portion (Gate 6) of the dam. Some fish species (e.g., sturgeon, shad) do not utilize the fish ladders during that period and are blocked during a portion of their upstream migration period.

Inventories of man-caused physical barriers for fish in the west-side tributaries have been conducted and the California Department of Water Resources (DWR 2003) has identified three priority projects on Thomes Creek. These include: un-named gravel mines, the Henleyville Diversion Dam, and the Paskenta Diversion Dam. A data query in CalFish (2005) listed Sunflower Dam, on a tributary to Red Bank Creek, as a fish barrier.

In recent years, streambed degradation downstream of the TCC siphon crossing has caused a partial barrier to salmon migration that may attempt to spawn in Thomes Creek. The erosion is caused by downstream gravel mining that is removing gravel faster than can be naturally replaced. In addition, flood control levees and bank protection projects have significantly altered the lower reach of Thomes Creek. In addition, the Corning Canal siphon crosses Elder Creek just west of Interstate 5, approximately 4 miles from its mouth, and creates a barrier to migrating Chinook salmon attempting to spawn in that tributary during low to moderate flow conditions. The blocking of adult fall-run Chinook salmon by the Corning Canal siphon has been observed on several occasions since 1970 (USFWS 1995).

Anthropogenic barriers such as high-gradient rapids created by placement of large boulders around bridge foundations are found at Red Bank Creek at the railroad bridge by Highway 99W and Dibble Creek at the I-5 bridge. Such obstructions are not complete barriers because juvenile Chinook have been observed upstream from most of them (Maslin et al 1997). Additional partial or full barriers to instream movements of non-salmonid fish species may exist in some of the tributaries but have not been surveyed or inventoried.

Field collaboration between the CDFG and Crane Mills has identified an anadromous fish barrier on Thomes Creek, approximately 10 miles upstream from Paskenta (Barron, F., personal communications; see Figure 10-1). It is not known if natural barriers in the assessment area's other streams have been identified.

Spawning Areas and Sediment

Sediment in rivers and streams can have deleterious effects on fish, depending on the nature of the sediment (e.g., particle size), timing of deposition and stream transfer, and magnitude of discharge. Sediment discharge varies from year to year in all streams and is based on numerous factors including main stem and tributary streamflow, land use, floods, landslides, localized erosion, and other factors.

An interesting aspect of sediment discharge is that large storms that occur less than 5 percent of the time typically move 90 percent of the annual sediment yield. As a more extreme example, very high flow events such as the December 1964 flood, moved as much sediment in a day as would usually be moved in the Tehama West streams in a decade.

In 1982 the California Department of Water Resources (DWR) completed a 2-year study to identify causes responsible for the high sediment yield in Thomes Creek. They found that Thomes Creek was one of the fastest eroding watersheds draining into the Sacramento Valley. The high yield is directly related to unstable geologic terrain, including landsliding, erodible soils, and high relief. Although the annual yield of suspended sediment and bedload decreased significantly since the mid-1960s, the yield is still from 3-10 times higher than other westside tributaries (DWR 1982). Land use changes are factors that may cause landslides and accelerate erosion (DWR 1982); however, there is no strong evidence that this has occurred within the Tehama West drainage.

Large amounts of sediment and gravel (mostly deposited during the 1964 flood) remain in the lower reaches of Thomes Creek. At least three year-round and several seasonal gravel mining operations utilize the tributary and the extraction of gravel has impaired the upstream migration of adult salmon. Although the most stable spawning areas are above the gravel extraction reach, numerous braided channels and pits trap salmon, particularly during the rapid flow fluctuations. In addition, there is limited and heavily silted spawning habitat in lower Elder Creek (USFWS 1995).

Several flood control and water development projects have dramatically changed the natural flow regime and sediment-moving characteristics of the Sacramento River (SRA 1989). After the construction of Shasta and Keswick Dams, the natural gravel recruitment and transport in the main river channel ceased for areas immediately downstream of the dams. When high flows are released from the dams, gravel moves downstream faster than it is replaced from small tributaries below Keswick Dam. This leaves mainly large rock or bedrock in the river channel, making it unsuitable for spawning. Presently, 85 percent of the spawning gravel coming into the river between Redding and Red Bluff comes from the tributaries, primarily Cottonwood Creek (SRA 1989).

Some land uses and changes in traditional land use are factors that may cause landslides and accelerate erosion (DWR 1982). However, for the Tehama West drainages, there were no data found that show an increase in sediment discharge attributable to these factors.

Loss of Riparian Habitat

Riparian habitat provides vegetative canopy for shading and cooling stream flows; a source of food from terrestrial insects; protective cover from terrestrial predators such as birds; and wood debris pieces and jams that can provide protective cover from predators and instream rearing habitat. The stream environment is greatly influenced by the riparian plant community. Stream depth, current velocity, composition of substrate, shade, temperature, nutrient load, bank stability and other important factors can dramatically change when the riparian community is altered (SRA 1989). Loss of riparian habitat can decrease the abundance of native fishes and increase the abundance of non-native fish species.

About 150 years ago the Sacramento River was lined by up to 500,000 acres of riparian forest, with vegetation spreading up to 4–5 miles wide in the riparian corridor (SRA 1989). Development of agricultural and urban areas gradually reduced the riparian vegetation. Presently, less than 5 percent remains of the original acreage. Additionally, less than one-half of the original vegetation benefiting anadromous and resident fisheries production remains on the river's edge (SRA 1989).

Below the RBDD the river is generally unleveed and holds significant and substantial remnants of the Sacramento Valley's riparian forest. A long history of erosion, deposition, and channel migration is evident on the floodplain. During recent times this stretch of the river has meandered in deep alluvial soils. Above RBDD the river is also generally unleveed and can be considered stable. This reach is determined to be a geologically stable corridor containing Iron Canyon and generally non-erodible riverbanks throughout (SRA 1989).

Maslin et al. (1997) reported that destabilizing activities such as mining, construction, logging, or improper grazing can result in mass movement of rock debris. In the lower reaches of the Tehama West streams, deposits are deposited, creating high gravel bars. Plants have difficulty colonizing these bars and lateral scouring occurs, which widens the channel and disrupts riparian vegetation. This process results in extremely high width to depth ratio and leaves riparian habitats in poor condition (Maslin et al 1997). Attempts to mechanically shape the Tehama West tributaries have compounded this problem. According to Maslin et al. (1997), channelization has been responsible for habitat degradation on Thomes, Red Bank, Reeds, Dibble, and Blue Tent Creeks.

Elder Creek was singled out as a special case by Maslin et al. (1997). Although this stream also has mass movement of sediment (a similar characteristic of west side tributaries), levees artificially confine the channel and prevent lateral scour. The almost uniform channel shape and gradient creates a very unstable stream-bed which differs from the pool and riffle condition of most streams. Riparian vegetation is slowly returning to the artificial banks, but recruitment of large woody debris that could provide hiding cover or help scour pools is lacking (Maslin et al 1997).

Predation

Predation occurs naturally within all river and stream ecosystems. Native fish species have evolved and persisted in the presence of naturally occurring predation pressures. Natural defense mechanisms used by fishes include, among others: fish shoaling (schooling); segregation into different instream habitat types (e.g., shallow versus deep water, swift versus slow water); utilization of instream and overhead cover; etc. However, unnatural levels of predation may occur when the stream ecosystem is altered by changing habitat conditions for native fish or through the introduction of non-native fish species.

High levels of predation typically occur in the Sacramento River near instream structures such as RBDD, supporting structures for diversion pumps, and bridge piers and pilings (CALFED 1999). These forms of predation may be considered "un-natural" because prior to water management efforts, such structures and stream characteristics did not exist. For example, one specific finding from extensive research conducted at RBDD was that predation was the primary cause of downstream-migrant salmon mortality at the dam (SRA 1989; Vogel et al 1990). Sacramento pikeminnow, striped bass, and American shad were documented to prey on juvenile salmonids (USFWS unpublished data and Hall 1977, as cited by USFWS 1989). Downstream migrating juvenile fish pass under the dam gates and become disoriented and are consumed by predatory fish that accumulate below the dam.

The level of predation in west-side tributaries and its significance to native fish species is unknown; however, the presence of non-native, predatory fish such as bass and other centrarchids is undoubtedly detrimental to native fishes. Anthopogenic alterations of stream habitats that favor increases in non-native fishes are generally considered detrimental to native fish assemblages (Moyle 2002). In most years, the fish in Tehama West tributaries appear to depart to the Sacramento River prior to becoming trapped or being eliminated by predation. However, during dry years the situation may be different. In those years, stream flow in the streams may be reduced to such a level before juvenile salmonids reach smolting size and would naturally emigrate. Thus, they become trapped in pools and can be highly vulnerable to avian predators. This was observed in streams such as McClure, Blue Tent and Dibble Creeks (Maslin et al 1997).

AQUACULTURE

The CDFG reported in April 2005 that there is one registered aquaculturist in the assessment area. Westover Fisheries operates a catfish farm next to the USFWS's abandoned Chinook salmon spawning channel near Coyote Creek. The facility uses well water and rears channel catfish and common carp for commercial sale. However, CDFG states that the list may not be complete because some registered facilities were not listed at the owners' request.

PLANTING HISTORY

Coleman National Fish Hatchery in Anderson, California has conducted salmon and steelhead plantings on the Sacramento River in Tehama County for decades. A summary of Chinook salmon and steelhead plantings in areas of the Sacramento River encompassing the assessment area are located in Appendix 10-4, respectively.

California Department of Fish and Game (CDFG Various) records from 1946 to 1972 document catchable rainbow trout stocking for several locations on Upper Thomes Creek. In addition, there are CDFG records for rainbow trout stockings in the South Fork of Elder Creek from 1946 through 1957; the South Fork of the South Fork in 1958 to 1966; and the North Fork from 1946 through 1967. Stockings in the Elder Creek drainage likely stopped after 1967 internal discussions by the CDFG and it now exists as a wild trout fishery. The same is probably true of the upper Thomes Creek drainage; however, no evidence of the decision to halt stockings for this drainage were found in CDFG files.

CHANGE OVER TIME

Moyle (2002) describes how land and water development have altered stream ecosystems and stream fish faunas over time. Effects on the stream environment are often gradual and subtle and may not be attributable to a single cause. Causes are usually a result of long-term, multiple changes in entire watersheds: e.g., livestock grazing, logging, road building, off-road vehicle use, urban development, dams and diversions (Moyle 2002). Specific data related to western Tehama County stream habitat changes over time were not obtained for this assessment. The focus of state and federal agencies has been on the main stem Sacramento River and its salmon-producing tributaries (e.g., CALFED Ecosystem Restoration Plan).

DATA GAPS

There are data gaps concerning fishery resources and their associated habitats in western Tehama County streams. There have been limited fish surveys conducted by CDFG in Thomes Creek; studies of proposed dam locations near Paskenta and Upper Red Bank Creek; and research on non-natal anadromous salmonid rearing in the lower-most reaches of some western Tehama County tributaries by California State University, Chico during the mid to late 1990s. The relevance of the non-natal rearing phenomenon to Sacramento River salmon populations is not known (Vogel 1993). In addition, the spatial and seasonal distribution and abundance of native and non-native fish species and their habitats are largely unknown in these watersheds. Reach-specific, seasonal hydrologic, thermal, and physical habitat characteristics would largely define the distribution of native and non-native fish species, but are presently unknown. Finally, the effects of water diversions and distribution of fish screens are information that should be learned.

Ongoing state and federal agency fishery and ecosystem restoration programs previously discussed are addressing data gaps on main stem Sacramento River fishery resources and habitats, as well as those of other larger tributaries.

CONCLUSIONS AND RECOMMENDATIONS

The fishery resources of the Tehama West drainages are defined by the presence of the Sacramento River and its fisheries and the physical characteristics of streams that flow off the eastern slope of the Coast Range. The Sacramento River has a varied fish fauna including some taxa that stay in the stream year-round and others that travel to the ocean for a portion of their life. Over time, the natural diversity has been modified by the accidental and intentional introduction of many non-native fish species. Many native species, particularly the anadromous fishes, have been seriously affected by physical changes to the Sacramento River and its tributaries, as well as changes to ocean conditions. For instance, several runs of Chinook salmon, steelhead, and possibly several lamprey and sturgeon species have all been negatively affected by these human-caused changes.

The physical characteristics of the Tehama West drainages also play an integral role in the fisheries. Their streamflow tend to rise quickly following wet-season storms; drop equally promptly following storms; and carry very large quantities of sediment. This leads to conditions where individual streams may appear like a river during major storms and be dry or nearly dry during mid-summer. The snowpack in the headwaters of these drainages is generally less than that for most Sierra Nevadan streams, resulting in relatively light seasonal warm-season run-off. It also results in an interesting situation where the upper Coast Range stream reaches may be perennial with resident fish populations, the mid-reach sections of these streams may be dry in mid-summer, and lowest reaches (close to the Sacramento River) may have small amounts of water from irrigation run-off and support a number of fish species that seasonally enter the tributaries from the Sacramento River.

Human activities, including channelization, water diversions, and gravel mining have altered the streams in many ways and have led to a reduction in riparian habitats, reduced summertime flow, and created warmer summertime temperatures. There is no known evidence to suggest that the Tehama West drainages were ever significant anadromous fish streams. However, the changes created by human activity have likely reduced salmonid usage and possibly that of other native fishes, and changed the makeup of the fishery fauna. It is possible that improvement of watershed conditions and stream habitats could increase late spring and early summer flows in the lower reaches of the area's streams—thereby improving anadromous fisheries attributes, such as non-natal salmonid rearing.

Given the characteristics of the Tehama West drainages and their limited historical fishery values, it is likely that any efforts toward salmonid habitat restoration will be considerably lower in priority than for many other streams in the Sacramento River drainage. Regardless, NOAA Fisheries has stated that the lower reaches of the Tehama West drainages are critical habitat for Chinook salmon and steelhead and efforts should be placed in improving the stream's habitat potential.

Recommendations for habitat improvements and studies to close important data gaps follow.

Riparian Habitat Inventory and Restoration

Tehama West riparian habitats have been tremendously altered during the past century and a half. These habitats are extremely valuable for wildlife but also play important stream stabilization, water quality, and fishery habitat roles. The location of existing riparian habitats is not well known but would be the first step in planning future restoration projects. Following the identification of existing riparian stands and their attributes, steps could be taken to protect the most important ones and then to re-connect scattered habitats. The result would be a landscape planning tool that, when implemented, would improve fisheries, wildlife, and water quality.

Salmonid Spawning Surveys

Spawning surveys of the major Tehama West tributaries have been sporadic and have not given insight into the specific conditions during which spawning occurs. Yearly surveys should give insight into the timing and location of salmonid spawning and whether opportunities exist to expand either factor through enhancement projects.

Special Status Species Inventories

Several species considered to be special status (Table 10-9) have the potential of existing in Tehama West drainages. Based upon past history, it is very possible that these species may become major issues in the future. Because of this and the lack of information regarding most of these species in Tehama County, it would be proactive to conduct focused surveys for these species. The results would add to the available information regarding their status and distribution and help with future regulatory decisions. Based upon the results of the inventories, correlation may be found with land management strategies, which might give insight into ways to enhance special status species populations.

Investigations of Non-Natal Rearing

The importance of non-natal fish rearing in Tehama West drainages, relative to other forms of rearing, is not well understood. The use of small Sacramento River tributary streams by fish hatched from distant locations has been well documented, which may suggest that non-natal rearing is an important factor in the drainage's anadromous fishery. A better understanding of these tributaries' roles and potential ways to enhance this role may be of benefit to Chinook salmon and steelhead populations.

At the same time, an evaluation of predaceous fish relationships with non-natal salmonid fry would be important. It is possible that current tributary conditions encourage non-natal fry to enter the mouths of the Tehama West drainages to their doom. It is also possible that the salmonid fry and predatory fish biology is such that predation is minor. Once a better understanding of predator and prey relationships exists in the lower stream reaches, as well as the role of non-natal rearing, managers can determine if enhancement projects would be of value for the fishery resource.

Water Quantity

An analysis of water quantity in the watershed should be conducted. Quantifying how much water is being diverted and how much groundwater is being pumped from the watershed's creeks would enable fisheries' biologists to better assess their impacts on populations of anadromous fish that spawn in the watershed.

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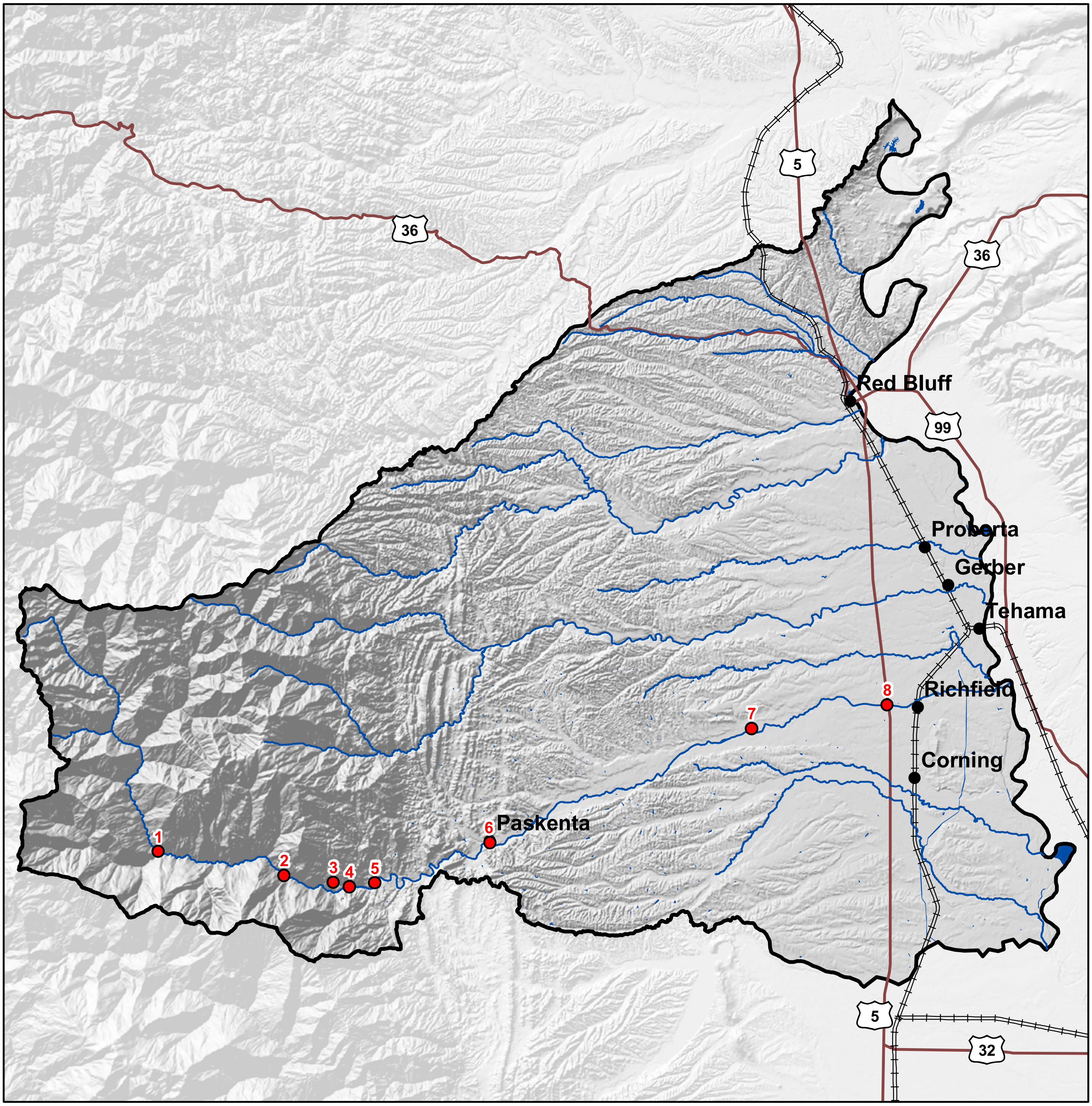

Note: "The Slab" is 15 air miles from Paskenta; Lake Hollow is considered to be a barrier to some non-salmonid fish species

Legend

- Railroad
- Major Highway
- Major Tributary
- Tehama West Watershed
- Water Body
- Important Fishery Location

Key

1 "The Slab"
2 Anadromous Barrier
3 Lake Hollow
4 "The Gorge"
5 Hatch Flat
6 Paskenta
7 Henleyville
8 Interstate 5

N E S W

0 2.5 5 10 Miles

VESTRA

FIGURE 10-1
STREAMS AND GEOGRAPHICAL FEATURES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

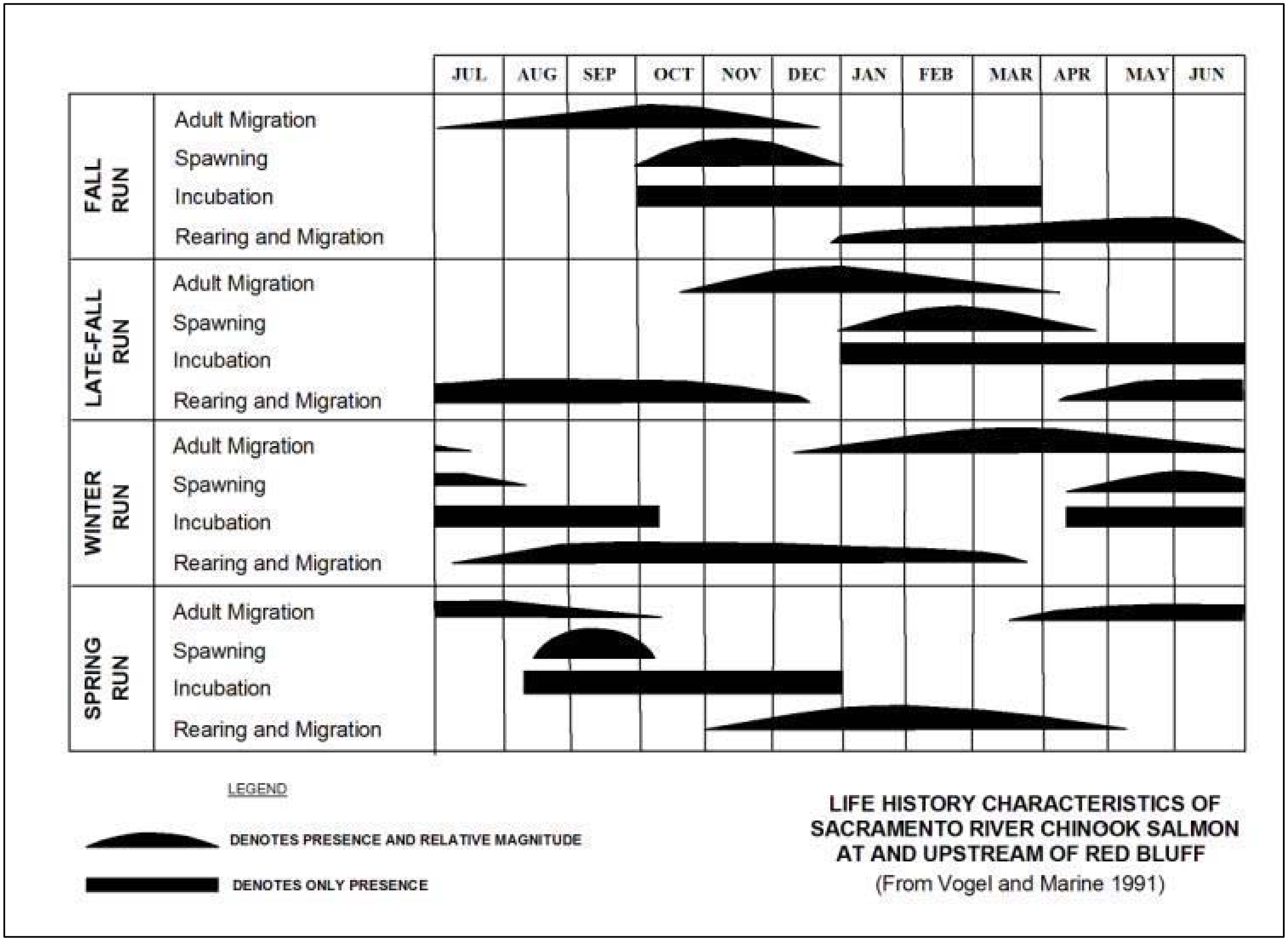

FIGURE 10-2
LIFE HISTORY CHARACTERISTICS OF SACRAMENTO RIVER CHINOOK SALMON AT AND UPSTREAM OF RED BLUFF
TEHAMA WEST WATERSHED ASSESSMENT

VESTRA

SOURCE: VOGEL AND MARINE 1991

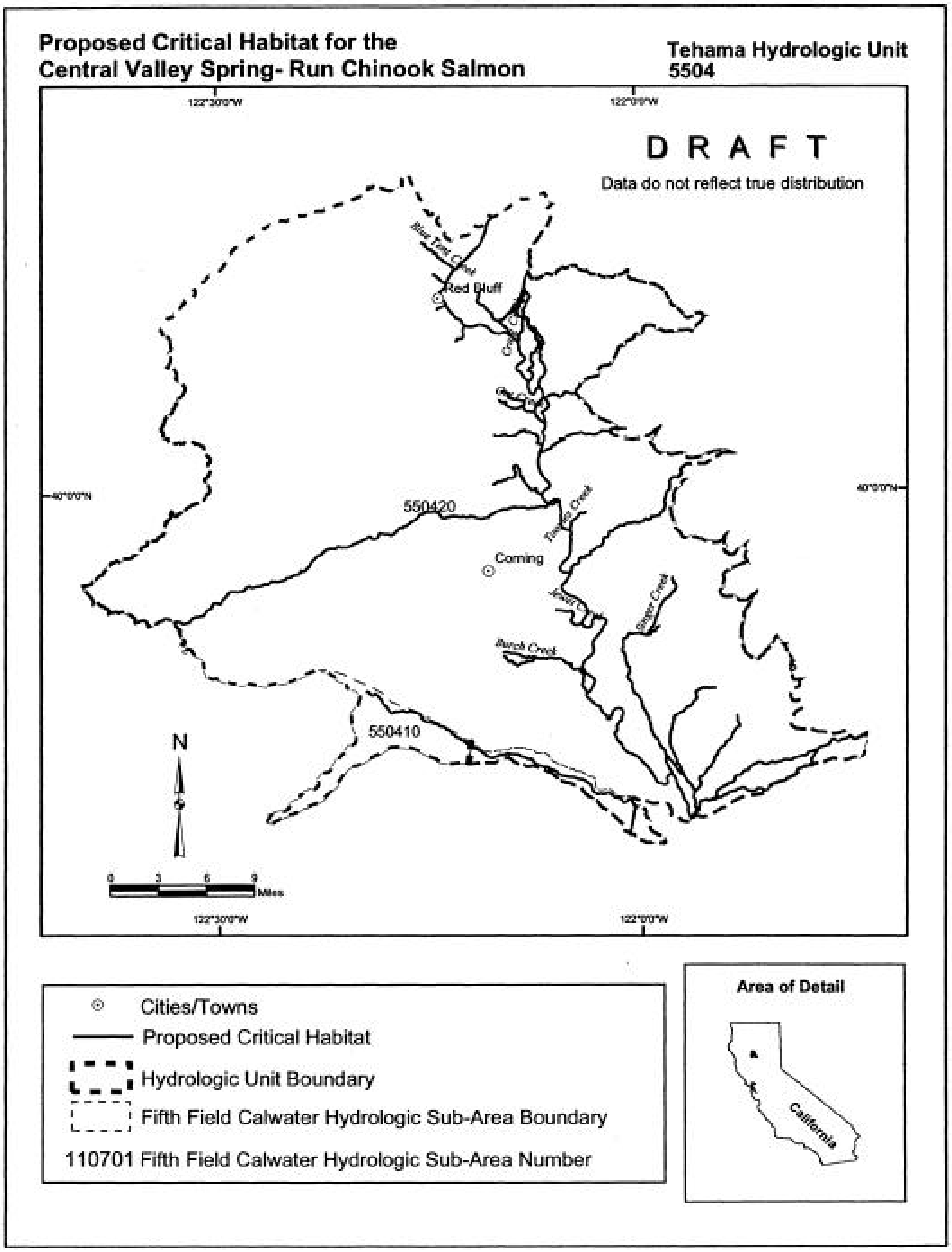

FIGURE 10-3
PROPOSED CRITICAL HABITAT FOR SPRING-RUN CHINOOK SALMON IN WESTERN TEHAMA COUNTY
TEHAMA WEST WATERSHED ASSESSMENT

VESTRA

SOURCE: FROM 69 FR 71880

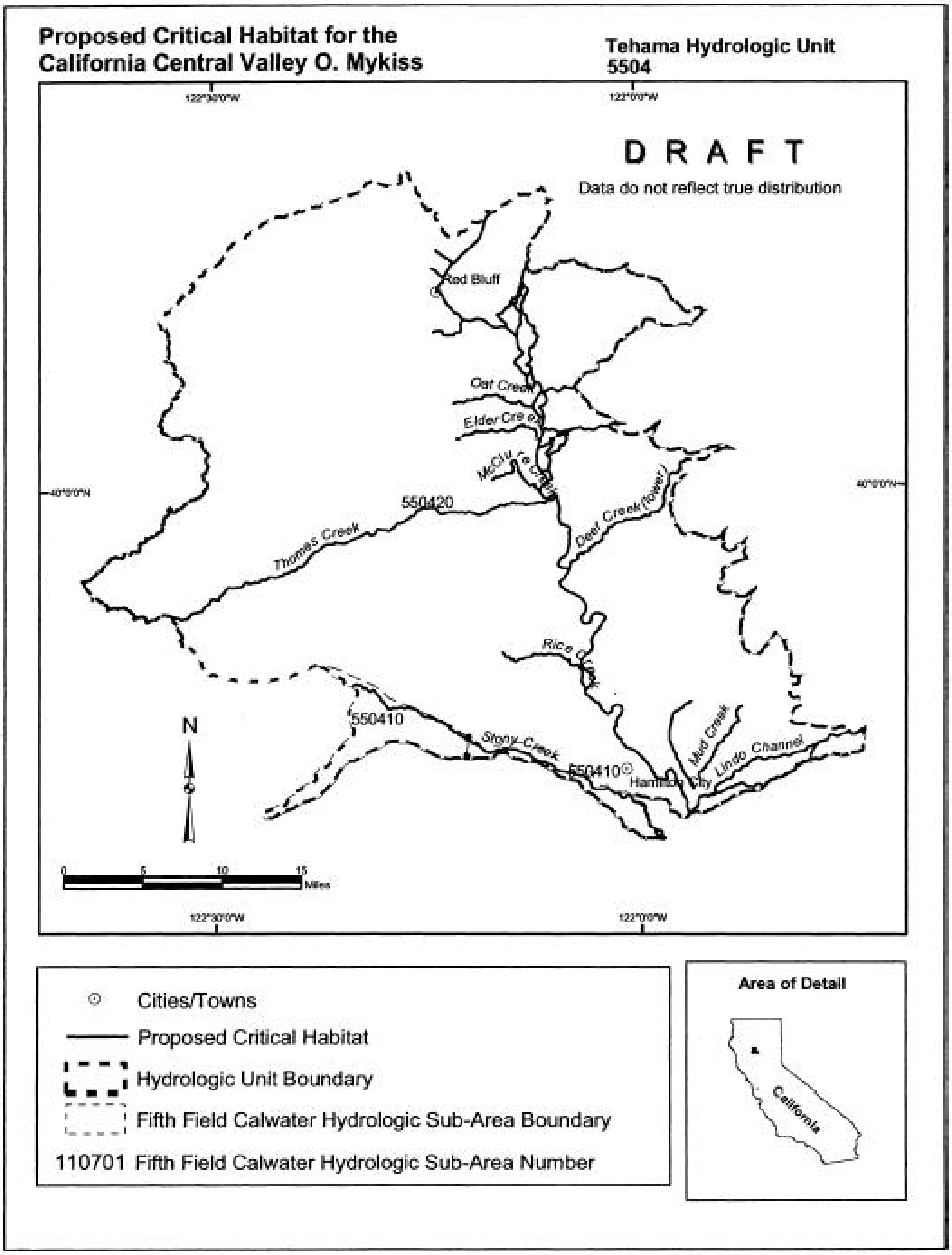

FIGURE 10-4
PROPOSED CRITICAL HABITAT FOR STEELHEAD IN WESTERN TEHAMA COUNTY
TEHAMA WEST WATERSHED ASSESSMENT

VESTRA

SOURCE: FROM 69 FR 71880

Appendix 10-1

FISH SPECIES AND NUMBER CAPTURED BY ROTARY SCREW TRAPS

Appendix 10-1 FISH SPECIES AND NUMBER CAPTURED BY ROTARY SCREW TRAPS AT RED BLUFF DIVERSION DAM, SACRAMENTO RIVER, CALIFORNIA, FROM JULY 1994 THROUGH JUNE 2000				
Common Name	**Scientific Name**	**Number Captured**	**Percent**	**Species Classification**
Chinook salmon	*Oncorhynchus tshawytscha*	744,925	87	native
Fall run		649,693	76	native
Winter run		48,408	6	native
Spring run		33,604	4	native
Late-fall run		13,220	2	native
Sacramento pikeminnow	*Ptychocheilus grandis*	33,951	4	native
Sacramento sucker	*Catostomus occidentalis*	33,242	4	native
prickly sculpin	*Cottus asper*	10,523	1	native
Pacific lamprey	*Lampetra tridentate*	5,199	*	native
lampetra fry	*Lampetra spp.*[1]	4,104	*	native
cypriniformes fry	Cypriniformes[2]	3,798	*	native
rainbow trout/steelhead	*Oncorhynchus mykiss*	3,592	*	native
sturgeon fry	*Acipenser spp.*[3]	2,605	*	native
riffle sculpin	*Cottus gulosus*	2,087	*	native
bluegill	*Lepomis macrochirus*	2,013	*	non-native
hardhead	*Mylopharodon conocephalus*	1,309	*	native
cottus fry	*Cottus spp.*[4]	1,263	*	native
threadfin shad	*Dorosoma petenense*	1,260	*	non-native
white catfish	*Ictalurus catus*	1,059	*	non-native
golden shiner	*Notemigonus crysoleucas*	541	*	non-native
threespine stickleback	*Gasterosteus aculeatus*	326	*	native
California roach	*Lavinia symmetricus*	275	*	native
spotted bass	*Micropterus punctulatus*	188	*	non-native
largemouth bass	*Micropterus salmoides*	185	*	non-native
speckled dace	*Rhinichthys osculus*	175	*	native
centrarchidae fry	Centrarchidae[5]	87	*	non-native
river lamprey	*Lampetra ayresi*	79	*	native
tule perch	*Hysterocarpus traski*	77	*	native
green sunfish	*Lepomis cyanellus*	51	*	non-native
redear sunfish	*Lepomis microlophus*	48	*	non-native
channel catfish	*Ictalurus punctatus*	44	*	non-native
black crappie	*Pomoxis nigromaculatus*	41	*	non-native
hitch	*Lavinia exilicauda*	41	*	native
smallmouth bass	*Micropterus dolonieui*	33	*	non-native
carp	*Cyprinus carpio*	31	*	non-native
black bullhead	*Ictalurus melas*	17	*	non-native
kokanee/sockeye	*Oncorhynchus nerka*	16	*	non-native
white crappie	*Pomoxis annularis*	16	*	non-native
brown bullhead	*Ictalurus nebulosus*	8	*	non-native
American shad	*Alosa sapidissma*	4	*	non-native
green sturgeon	*Acipenser medirostris*	3	*	native
striped bass	*Morone saxatilis*	3	*	non-native
fathead minnow	*Pimephales promelas*	2	*	non-native

Appendix 10-1 FISH SPECIES AND NUMBER CAPTURED BY ROTARY SCREW TRAPS AT RED BLUFF DIVERSION DAM, SACRAMENTO RIVER, CALIFORNIA, FROM JULY 1994 THROUGH JUNE 2000				
Common Name	**Scientific Name**	**Number Captured**	**Percent**	**Species Classification**
goldfish	*Carassius auratus*	2	*	non-native
Sacramento splittail	*Pogonichthys macrolepidotus*	2	*	native
brown trout	*Salmo trutta*	1	*	non-native
Sacramento blackfish	*Orthodon microlepidotus*	1	*	native
Total		853,227		

* Less than 1% of total fish captured by rotary-screw traps
[1] Fry were grouped to genus (*Lampetra tridentate*, *Lampetra ayresi*, or *Lampetra pacifica*).
[2] Fry were grouped to order (likely *Ptychocheilus grandis*, *Mylopharodon conocephalus*, *or Catostomus occidentalis*).
[3] Fry were grouped to genus (likely *Acipenser medirostris*).
[4] Fry were grouped to genus (*Cottus asper* or *Cottus gulosus*).
[5] Fry were grouped to order (*Micropterus spp*. Or *Lepomis spp*.).
Source: USFWS 2002

Appendix 10-2

NATIVE FISH SPECIES OBSERVED IN TEHAMA WEST TRIBUTARIES

Appendix 10-2
NATIVE FISH SPECIES OBSERVED IN TEHAMA WEST TRIBUTARIES,

Species	Tributary										
	Blue Tent Creek	Brickyard Creek	Coyote Creek	Dibble Creek	Elder Creek	Jewett Creek	McClure Creek	Oat Creek	Red Bank Creek	Reeds Creek	Thomes Creek
California roach	x			x	x			x	x	x	x
Chinook salmon	x	x	x	x	x	x	x	x	x	x	x
Fathead minnow			x								
Hardhead					x		x			x	x
Hitch				x	x						x
Pacific lamprey									x		x
Prickly sculpin	x					x	x		x	x	x
Rainbow trout / steelhead	x			x	x		x	x	x		x
Sacramento sucker	x		x	x	x	x	x	x	x	x	x
Sacramento pikeminnow	x		x	x	x		x	x	x	x	x
Speckled dace											x
Threespined stickleback			x				x		x		x
Tule perch											x

Source: Maslin et al. (1995 – 1999), Moore (1997), Villa (1985); CALFED (2000); and CDFG (Various)

Appendix 10-3

NON-NATIVE FISH SPECIES OBSERVED IN TEHAMA WEST TRIBUTIARIES

Appendix 10-3
NON-NATIVE FISH SPECIES OBSERVED IN TEHAMA WEST TRIBUTARIES,

Species	Tributary									
	Blue Tent Creek	Coyote Creek	Dibble Creek	Elder Creek	Jewett Creek	McClure Creek	Oat Creek	Red Bank Creek	Reeds Creek	Thomes Creek
Bluegill	x		x		x	x		x		x
Brown bullhead				x	x					x
White catfish										x
Carp										x
Golden shiner	x		x		x	x	x	x		x
Goldfish										x
Green sunfish				x	x	x		x		x
Smallmouth bass										x
Largemouth bass	x		x			x				x
Mosquitofish					x	x	x			x

Source: Maslin et al. (1995 – 1999), Moore (1997), and Villa (1985); Borchard (2005)

Appendix 10-4

COLEMAN NATIONAL FISH HATCHERY RELEASES OF CHINOOK SALMON TO THE SACRAMENTO RIVER

Appendix 10-4 COLEMAN NATIONAL FISH HATCHERY RELEASES OF CHINOOK SALMON TO THE SACRAMENTO RIVER FROM 1941 THROUGH JANUARY 2000			
Date	Race	Number Released	Release Location on Sacramento River
8/11/1965	Fall	65,000	Red Bluff
9/10/1965	Fall	36,000	Red Bluff
10/4-21/1965	Fall	1,183,900	Jelly's Ferry Area
11/2-30/1965	Fall	3,083,600	Jelly's Ferry Area
7/20-29/1965	Fall	570,800	Jelly's Ferry Area
8/1/1966	Fall	56,000	Red Bluff
8/8-25/1966	Fall	746,900	Jelly's Ferry Area
9/1/1966	Fall	47,500	Red Bluff
9/6-19/1966	Fall	871,100	Jelly's Ferry Area
2/9/1965	Winter	4,300	Jelly's Ferry Area
7/5/1969	Fall	2,500	Red Bluff
6/3/1975	Fall	457,250	RBDD
5/14-28/1976	Fall	433,090	Lake Red Bluff
5/14-28/1976	Fall	403,232	Above RBDD
5/14-28/1976	Fall	401,018	Below RBDD
6/1/1976	Fall	124,230	Above RBDD
6/1/1976	Fall	38,270	Below RBDD
6/1/1976	Fall	49,770	Lake Red Bluff
5/6-24/1977	Fall	932,312	Red Bluff
11/3-7/1977	Fall	302,373	Red Bluff
12/14/1977	Fall	200,124	Red Bluff
12/14-19/1977	Fall	115,318	Red Bluff
1/8-9/1978	Fall	225,680	Red Bluff
9/4-7/1979	Fall	522,575	Red Bluff
2/11/1980	Late-Fall	50,200	Red Bluff
2/29/1980	Fall	54,410	Red Bluff
3/12/1980	Fall	51,284	Red Bluff
2/5/1981	Late-Fall	51,200	Red Bluff
2/6-27/1981	Fall	11,186	Red Bluff
5/18/1981	Fall	101,477	Red Bluff
1/27/1982	Late-Fall	51,757	Red Bluff
2/5-25/1982	Fall	101,421	Red Bluff
5/5/1982	Fall	99,240	Red Bluff
5/24-27/1983	Fall	1,173,350	Red Bluff
6/1-9/1983	Fall	1,258,400	Red Bluff
11/17-21/1983	Late-Fall	287,475	Red Bluff
1/17-19/1984	Late-Fall	651,083	Red Bluff
3/1-23/1984	Fall	102,740	Red Bluff
4/26/1984	Fall	300,000	Red Bluff
5/3/1984	Fall	564,450	Red Bluff
5/9-17/1984	Fall	3,199,490	Red Bluff
11/20/1984	Late-Fall	154,575	Red Bluff
1/10/1985	Late-Fall	65,380	Red Bluff
2/14/1985	Fall	56,500	Red Bluff
3/14/1985	Fall	53,600	Red Bluff
4/18-22/1985	Fall	2,007,000	Red Bluff
5/14-15/1985	Fall	2,482,237	Red Bluff
12/9/1985	Late-Fall	103,704	Red Bluff
3/19/1986	Fall	1,583,676	Red Bluff

Appendix 10-4
COLEMAN NATIONAL FISH HATCHERY RELEASES OF CHINOOK SALMON TO THE SACRAMENTO RIVER FROM 1941 THROUGH JANUARY 2000

Date	Race	Number Released	Release Location on Sacramento River
4/14/1986	Fall	608,140	Red Bluff
5/9-13/1986	Fall	3,419,026	Red Bluff
11/4/1986	Late-Fall	317,988	Red Bluff
3/13/1987	Fall	54,280	Red Bluff
5/3-13/1987	Fall	269,365	Red Bluff
2/22/1988	Fall	54,247	Red Bluff
4/1-15/1988	Fall	725,187	Red Bluff
5/9-13,1988	Fall	4,573,025	Red Bluff
2/3-24/1989	Fall	5,678,534	Red Bluff
3/23/1989	Fall	684,193	Red Bluff
5/9-10/1989	Fall	5,537,520	Red Bluff
5/12/1990	Fall	52,212	Red Bluff
2/28/1991	Fall	307,819	Bend Bridge
3/1-25/1991	Fall	4,518,601	Red Bluff
5/1/1991	Fall	64,700	Red Bluff
2/13-28/1992	Fall	4,761,200	Red Bluff
3/3-19/1992	Fall	6,318,720	Red Bluff
4/15/1992	Fall	54,556	Red Bluff
3/10/1993	Fall	123,743	Red Bluff
2/7-16/1994	Fall	2,226,597	Red Bluff
3/1-10/1994	Fall	2,287,347	Red Bluff
2/13-23/1995	Fall	1,482,415	Red Bluff
3/10/1995	Fall	101,331	Red Bluff
1/29/1996	Fall	1,319,814	Red Bluff
2/8-28/1996	Fall	5,222,300	Red Bluff
3/5-15/1996	Fall	1,001,507	Red Bluff
2/20-27/1997	Fall	3,097,705	Bow River Boat Ramp
3/4-12/1997	Fall	2,915,824	Bow River Boat Ramp
2/4-26/1998	Fall	8,203,920	Below RBDD
1/29/1999	Fall	384,882	Bow River Boat Ramp
1/29/1999	Fall	370,191	Woodson Bridge

Note: Plantings in the assessment area began in 1965.
Source: USFWS, 2001

Section 11

Section 11
FIRE HISTORY, WILDLAND FUELS, AND FIRE MANAGEMENT

TABLES

FIGURES

Section 11

FIRE HISTORY, WILDLAND FUELS, AND FIRE MANAGEMENT

INTRODUCTION

The objective of this section is to present a general overview of fire and fuel issues in the Tehama West Watershed. Additional detail on fire management and planning specific to the Tehama West Watershed is included in the Tehama West Fire and Fuels Management Plan (FFMP) prepared by the Tehama County Resource Conservation District (TCRCD), which is being written concurrently with this assessment. The Tehama West FFMP is included as an appendix to this section.

SOURCES OF DATA

A variety of literature provided general information on fire and fuels management in areas with similar characteristics to the Tehama West Watershed. The general information included published results of regional, statewide, or national research on issues such as fuel, fire severity, policy, and protection.

- The California Department of Forestry and Fire Protection (CDF) was the primary source for watershed specific information on fire history and fuel loading within the Tehama West Watershed.

- The CDF Fire and Resource Assessment Program (FRAP) data for fuel ranks and fire hazard severity zones were the sources used to categorize fuel distribution and potential fire severity areas.

- FRAP data also provided fire severity and vegetation hazard and density rankings for the area within the watershed boundaries.

The Draft FFMP for the Tehama West Watershed was used as a primary reference to ensure consistency between documents and the final report will be included in the final Tehama West Watershed Assessment

A complete bibliography of references is included at the end of this section. The watershed assessment for the Thomes Creek Watershed, was also used to prepare history and risk evaluation.

FIRE HISTORY

Fire frequency, and its subsequent management, has had a significant effect on the landscape of ecosystems in the Tehama West Watershed. Throughout California, including the Tehama West Watershed, early Native Americans, sheepherders, and cattlemen used fire as a tool to manage natural landscapes. Since fire suppression in the 1920s much ground once open is now over-dense brush or timber (Menke et al 1996).

Pre-European Fire History

Over 300 years of dry, cool weather preceding the arrival of European man, coupled with Native American fire use, resulted in many frequent, low-intensity fires. The hot, dry summer climate provided suitable weather conditions and dry fuels for burning. Lightning provided a ready ignition source, supplemented by Native Americans, who used fire for a variety of purposes. Fires could spread until weather conditions or fuels were no longer suitable.

Fire-scar records in tree rings have shown variable fire-return intervals in pre-settlement times. Median values are consistently less than 20 (and as low as 4) years for the ponderosa pine and mixed conifer zones of the Sierra Nevada (McKelvey et al 1996). Only one study in high-elevation red fir found a median fire-return interval greater than 30 years (see Table 11-1).

Table 11-1
HISTORICAL FIRE-RETURN INTERVALS
SIERRA NEVADA

Forest Type	Pre–1900
Red fir	26 - 30
Mixed conifer-fir	12
Mixed conifer-pine	15
Ponderosa pine	11
Blue oak	8

Source: McKelvey et al 1996

Studies of past fire occurrence have been conducted on several areas within the Klamath and Six Rivers National Forests. Prehistoric fire dating with slabs was done on the Six Rivers National Forest in Douglas-fir clearcut areas, where trees dated back to 1750 (Salazar 1994). Preliminary results from this unpublished study on the Mad River District showed mean intervals of 12.7 years between fires intense enough to leave scars. From the multi-aged nature of the old-growth Douglas-fir stands that they surveyed, and the scarring of trees, the persons conducting this study concluded that frequent, low-intensity ground fires were the common type of fire, rather than stand-replacing, high-intensity fires.

In the Siskiyou Mountains, Agee (1993) analyzed fire slabs for the period 1550 to 1930. He found natural fire rotations varying from 37 years in the Douglas-fir-oak type, to 54 years in the white fir-herbaceous type.

On the Salmon River Ranger District of the Klamath National Forest, Salazar (1994) analyzed fire slabs within the Douglas-fir/hardwood forest. This study involved three sites and split the analyzed time periods into pre-settlement, settlement, and suppression periods. Table 11-2 shows the range for the mean fire return interval for the three periods.

In a small study within the Middle Fork Eel watershed, examination of stump scars indicated that, on average, a fire intense enough to scar trees occurred every 30 years. Additional small studies conducted in the Sugarfoot Fire area of the Corning Ranger District and on the Upper

Lake District showed a fire return interval between 10 and 21 years for low-elevation ponderosa pine-dominated forest. Slab analysis is limited to detecting fires that were intense enough to leave scars on trees. It is possible that many low-intensity fires occurred that did not leave scars. Based on these studies it is reasonable to state that the average interval between scarring fires prior to effective fire suppression was likely between 10 and 30 years for most of the lower elevation forest ecosystems.

Table 11-2
FIRE RETURN INTERVALS IN DOUGLAS-FIR – HARDWOOD FOREST

Time Periods	Fire Return Intervals (years)
Pre-settlement (1745 – 1849)	10.3 – 17.3
Settlement (1849 – 1894)	9.2 – 15.0
Suppression (1894 – 1987)	28.7 – 45.5

The variable nature of pre-settlement fire helped create diverse landscape forest conditions. In many areas frequent surface fires minimized fuel accumulation, keeping understories relatively free of trees and other vegetation that could form fuel ladders, to carry fire into the main canopy. The effects of frequent surface fires would largely explain the reports and photographs of those early observers who described Northern California forests as typically "open and park-like." However, such descriptions must be tempered by other early observations emphasizing dense, impenetrable stands of brush and young trees.

Almost all scientists agree that fire played a significant role in shaping the vegetative patterns and systems of California vegetation. There is a significant divergence of views as to fire frequency and vegetative composition of pre-settlement fire. The differences in point of views center on the belief that there were probably many variations in the return frequencies and fire intensity patterns that contributed to the mosaic of vegetation patterns on the landscape today.

A second major point of difference relates to the relative "openness" of forests before the disturbances caused by settlers. Alternative views conclude that forest conditions were not largely "open or park-like" in the words of John Muir; rather they were a mix of dark, dense, or thick forests in unknown comparative quantities. Select early accounts support an open, park-like forest, but there were many similar accounts that describe forest conditions as dark or dense or thick. J. Goldsborough Bruff, a forty-niner who traveled the western slopes of the Feather River drainage between 1849 and 1851, kept a detailed diary. He clearly distinguished between open and dense forest conditions and recorded the dense condition six times more often than the open. Many other accounts of early explorers (e.g. John C. Fremont, Peter Decker, and William Brewer) identify dark or impenetrable forest; the pre-settlement forest was far from a continuum of open, park-like stands. From these records, it seems clear that Northern California forests were a mix of different degrees of openness and an unknown proportion of dark, dense, nearly impenetrable vegetative cover with variations from north to south and foothill to crest.

A third point of departure has to do with the frequency of stand-terminating fires in pre-settlement times. One group concludes that such events were rare or uncommon. The alternative view is that stand-threatening fires were probably more frequent. They were heavily dependent upon combinations of prolonged drought; an accumulation of dead material resulting from natural causes (e.g., insect mortality, windthrow, snow breakage); and severe fire weather conditions of low humidity and dry east winds coupled with multiple ignitions, possibly from lightning associated with rainless thunderstorms. Such fires were noted during the last half of the nineteenth century by newspaper accounts, official reports (Leiberg 1902), and diaries. Settlers, stockmen, or miners caused most fires. Fuel loads were sufficient at that time, even before suppression policies had affected fuel loads, thus strongly suggesting that similar conditions existed in earlier times with unknown frequencies (Leiberg 1902).

It is now widely accepted that early Native Americans used fire as a tool, both for hunting and to manage the resources needed for survival (Blackburn and Anderson 1993). There is evidence for almost every tribe in the western Unites States having used fire to modify their respective environments. This included burning grasslands to improve basket materials, foothills to assist in hunting small game and to encourage new edible shoots, and in the coniferous forests to assist in hunting and to keep the forests open and passable. In addition, use of seeding and oak management to augment food supplies is documented (Blackburn and Anderson 1993). Within California at least 35 tribes used fire to increase the yield of desired seeds; 33 used fire to drive game; 22 groups used it to stimulate the growth of wild tobacco; while other reasons included making vegetable food available, facilitating the collection of seeds, improving visibility, protection from snakes, and "other reasons" (Blackburn and Anderson 1993). While the use of fire is noted for almost every Native American group in California, little is known about the timing or method of fire.

In Northern California there is much historical evidence that many of the tribes inhabiting the area used fire for a variety of uses. Some, such as the Wintu, Karuk, and Shasta are reported to have burned grass, brush, and riparian areas of valley and hill slopes to improve basket-making raw materials. Hazel sticks, required for ribs of baskets, had prime shoots available 1 to 2 years after fire (Blackburn and Anderson 1993). Especially common in the fall, fire was also used as a tool to improve habitat for deer and other animals, and to move mammalian game and insects to be collected for food. Deer were driven into snares or circled by fire and killed. The Wintu are reported to have collected grasshoppers "by burning off large grass patches" in chaparral, woodland grass, and coniferous forest areas (DuBois 1935). Unfortunately, neither the specific vegetation cover nor the time of year in which the burning took place is mentioned. Holt discusses the use of fire by the Shasta people:

> The second method was used on the more open hills of the north side of the river, where the white oak grew. When the oak leaves began to fall, fires were set on the hills. Then they came down... in the late Fall... It was at this time they had the big drive, encircling the deer with fire (Blackburn and Anderson 1993).

Blackburn and Anderson (1993) document general features of Native American patterns of burning. Fall, and secondarily spring, burning involved not simply an intensification of the natural pattern of fires, but a pronounced departure from the seasonal distribution of natural fires. The pattern previously shown for the woodland, grassland, and coniferous forest involved the intensification of the natural pattern. Ethnographic data strongly indicate that such a pattern of environmental manipulation and control did exist. Most important, by creating and maintaining openings within the chaparral, the Native Americans increased the overall resource potential of an area and created the enclosures, or "yarding areas," where these resources were readily exploited.

Post-European Fire History

Conservation, since its beginning with Gifford Pinchot in the late 1890s, has led many to believe that fire is the bane of the forest (Williams 1999). The national firestorms of 1910 cemented the exclusion of fire from national forests. It was believed that fire should be suppressed and eliminated to allow young forests to grow. The understanding that humans influenced ecosystems through the use of fire shifted after European settlement in North America, when it was believed that fire should and could be controlled to protect both public and private land (Williams 1999).

At the turn of the century, some settlers used "light-burn" as a farm management tool. The United States Forest Service (USFS) experimented with the same theory in the 1910s, but determined that it was too damaging to young seedlings needed for regeneration (Williams 1999). By 1933, with the advent of the Civilian Conservation Corps (CCC), fire fighting and the suppression of wildfires became a fulltime occupation. Thousands of men were trained to fight fire on public and private lands. The primary fire-related mission of land management agencies was to stop fires whenever possible, and to prevent large fires from developing (Moore 1974). Indiscriminate use of fire by sheep ranchers and miners from approximately 1870 to 1900 resulted in significant environmental damage and furthered the developing cause for fire suppression (Moore 1974).

The decision to exclude fire from public lands came about as a result of a debate over whether to permit light fire, such as Indian burnings, or use complete suppression. Logging and grazing interests held that light fires were beneficial because they reduce fuel loading and created more open forests (Ayers 1958; Cermak 1988). The USFS excluded fire in national forests after the "Big Blow Up" in 1910, a firestorm that "incinerated 3 million acres in Idaho and Montana". The California Forestry Commission was created to hear disagreement on both sides of the argument. Finally, a study completed by Show and Kotok in 1923 showed that although repeat burning maintained an open and park like condition, it killed young trees and discouraged regeneration of forests. The argument continued that if forests were to provide a sustainable timber supply, regeneration was required. In 1924 the Clarke-McNary Act was passed by Congress and clearly established fire exclusion as national policy. Decades ago, Aldo Leopold warned that working to keep fire out of the forest would throw nature out of balance and have untoward consequences. "A measure of success in this is all well enough," he wrote in the late 1940s, "but too much safety seems to yield only danger in the long run."

In the specific areas of the Mendocino National Forest, suppression activities did not begin "in earnest" until establishment of the forest reserve in 1910. The USFS (1997) states that the 1922 grazing chapter of the Supervisor's Annual Working Plan for the California National Forest (later renamed the Mendocino National Forest) included:

> Since the creation of the Forest, there have been few serious fires on sheep ranges and the oak brush has, over large areas, grown so high and thick that it does not furnish the sheep feed it formerly did. During these years of fire protection, it is undoubtedly true that coniferous reproduction has come in very extensively and in places is further decreasing the forage capacity. While damage to the reproduction is noticeable here and there, there is undoubtedly a large amount of reproduction coming in on the sheep ranges. While the condition of the ground feed may have deteriorated, there is no doubt but that the timber

> stand has increased in area and density, so that from a timber standpoint we are gaining (barring insect depredation).

Fire suppression became progressively more effective in the Mendocino National Forest in the 1930s with the availability of Civilian Conservation Corps personnel, and after World War II with an increase in mechanized (bulldozer) and aerial equipment. Success in fire suppression has contributed to changes in forest cover and density which in turn have caused changes in fire frequencies and intensities.

The story on the first airtanker in fire fighting history follows (for more information on the program, see www.airtanker.com).

During the 1950s, Joe Ely was the Fire Control Officer at the Mendocino National Forest headquartered in Willows, California. In July 1953, 15 firefighters died during a flare-up of the Rattlesnake Fire because of a sudden change of wind in the thick, dry chaparral. Mr. Ely began actively looking for a way to gain control over backcountry fires without putting ground forces at such great risk. Due to the large number of "ag" flying services located near the Mendocino National Forest headquarters, Mr. Ely immediately envisioned the use of modified crop dusting aircraft for fighting wild fires using a similar "water cascade" technique. "Ag" biplanes were rugged, highly maneuverable, and used to carrying liquid cargo. Combined with the skilled "ag" pilots, these "water tankers with wings" could fly at slow speeds close to the ground while releasing their liquid cargo with a reasonable degree of accuracy. In July 1955, Mr. Ely met with several of the local "ag" service operators to discuss the idea. He recalls asking Floyd Nolta, of the Willows Flying Service, if he could effectively drop water on a forest fire. Mr. Nolta, a resourceful stunt pilot for the motion picture industry, became enamored with the idea. He cut a hole in the bottom of a Boeing Stearman 75 Kaydet (N75081) underneath the rice hopper (in lieu of a front seat) that was used for seeding operations. He added a 1-foot square water release gate with hinges, a snag and pull-rope so the pilot could open and close the gate when required. The first air drop on an actual wildfire was made during the Mendenhall Fire, August 13, 1955, in the Mendocino National Forest. Vance Nolta flew this historic mission in the Stearman, dropping six loads of water in support of firefighters on the ground trying to contain the blaze. This operation was considered so successful, America's first "fire pilot" Vance worked another fire the very next day.

In 1956, more water drop tests revealed that on hot or windy days, plain water barely made it to the ground unless the pilot flew hazardously low. USFS personnel created a more effective solution, using a slurry of sodium calcium borate mixed with the water. After the 1956 season, it was discovered this borate mixture sterilized the ground upon which it landed. The Forest Service then switched to mixing bentonite with water for a few years (however, the airtanker industry was stuck with the term "borate bomber" by the media for many years after). Some fires were so large, the airtanker loads were mixed in cement trucks sent to the airstrip to assist!

By the summer of 1956, seven biplane "borate bombers" had been modified to handle retardant drops during the dry summer and fall months. Local USFS rangers requested air support by just radioing their needs into the dispatch office. Charlie Lafferty, the dispatcher, would then call one or more of the contracted flying services to provide the location of the fire plus what airstrip might have reloading capability. Soon, rangers from all across the state began dialing "Willows 80" to reach Mr. Ely and Mr. Lafferty, asking for help. The fledgling Aero Fire Squadron fought 25 fires all over the state that summer, and their success was duly noted.

By 1957, the USFS realized air attack was a valuable weapon to have in its fire control arsenal. But these biplanes were just too small to carry more than 120 gallons of the heavy bentonite retardant and were useless on large project fires. To increase the effectiveness of fire control operations, the USFS engaged with other better-funded contractors for more expensive, but larger and faster aircraft. Though the agricultural pilots proved that wildfires could be fought from the air, they were nudged out by the bigger, faster airtankers with specialized crews. By 1964, they had disappeared from the airtanker program.

Forests today have undergone significant changes in species composition and structure. They now contain multi-level stands with a ladder fuel structure. Fires that occur are carried into the tree crowns by the ladder fuels. Once in the tree crowns, the fires move quickly with greater intensity. In general, the trend in fire size and severity has taken an interesting turn. As noted in the National Fire Plan overview, the numbers of acres burned have decreased from the 1960s, yet the dollar damage and structures lost have more that doubled from the 1980s to the 1990s. This jump is due in a large part to two factors, the increasingly heavy fuel load caused by decades of total suppression in California's woodlands and an increase in population in areas outside traditional urban zones.

By the 1950s controlled burns to reduce fuels and improve habitat for wildlife had become commonplace in much of California's rangelands, but all other fires were vigorously controlled. The "RI" fires in Tehama County were common NRCS (then the Soil Conservation Service) and CDF assistance methods for ranching interests. In 1963 Leopold and others (Leopold 1963) published a report on the ecological conditions of the National Parks in the United States, and, as a result, managers and the public began to see the benefit of fires in the wildlands (Lyon et al. 2000). The Leopold Report stated that wildlife habitat is not a stable entity that persists unchanged, but rather a dynamic entity. Suitable habitat for many wildlife species and communities must be renewed by fire. As a result of the Leopold Report, by 1968, the fire policy of the National Park Service changed as managers began to adopt the recommendations of the report (Lyon et al. 2000).

Table 11-3
ACREAGE BURNED SUMMARY

Date	Fire Events	Total Acres Burned	% Watershed Burned
1920-1929	4	17,446	3%
1930-1939	6	17,178	2%
1940-1949	14	5,878	Less than 1%
1950-1959	8	3,356	Less than 1%
1960-1969	13	4,453	Less than 1%
1970-1979	7	25,437	3%
1980-1989	5	5,175	Less than 1%
1990-1999	11	8,130	1%
2000-2003	12	10,093	1%

Source: CDF
Note: These figures have been modified from the source file and acreages have been recalculated to show only acres burned in the watershed.

Wildfire History

There is considerable variability in the seasonality of fires in the Tehama West Watershed. Fuels are driest and ignition sources are most frequent in the summer. Thus, the vast majority of fires occur in summer, while winter and early spring fires are relatively uncommon. The watershed is broken up into CDF fire hazards severity zones as shown on Figure 11-1. A summary of acreage burned in the Tehama West Watershed from 1930-2003 can be found in Table 11-3. A map depicting historical and recent fire boundaries can be found in Figures 11-2 and 11-3.

In the 10 years from 1993 to 2003, Tehama-Glenn CDF zones 1, 6, and 9 that cover the watershed area reported 787 fires. Of those, 71 percent were determined to have been caused by humans. Of that 71 percent, the leading cause of fire was equipment use, at 41%, followed by vehicle use at 22 percent. Table 11-4 shows the breakdown of fires and their origins within these zones.

Table 11-4
FIRES AND CAUSES, 1993-2003

Cause	Zone 1	Zone 6	Zone 9	Total
Undetermined	13	9	90	102
Lightening	15	2	20	37
Campfire Escapes	2	2	6	10
Smoking	3	7	29	39
Burn Barrel/Pile Escapes	5	15	43	63
Arson	3	19	28	40
Equipment Use	21	46	185	252
Playing With Fire	4	3	9	16
Other	8	19	48	75
Vehicle	20	12	93	125
Power lines	0	2	8	10

Source: CDF

FUELS, WEATHER, AND TOPOGRAPHY

Understanding basic fire behavior is helpful in better comprehending the current and historical role of fire in the watershed. Fire behavior is a complex science, but can be generally described as the speed a fire travels or rate of spread, and the intensity with which it burns. There are three key factors that influence fire behavior:

- Fuel
- Weather
- Topography

All three factors can influence fire behavior independently, but they are all interconnected and accounted for in assessing fire behavior (NWCG 2001). For figures containing fuel ranks and fire severity, please see Figures 11-4 and 11-1.

Fuels

Fuel loading is the most dynamic factor affected by human activities through our impact on species, utilization, and indirectly through suppression and impacts on wildlife. Fuel arrangement and fuel moisture are key characteristics that can influence fire behavior. The intensity with which a fire burns is often dictated by the type and amount of fuel available to burn (NWCG 2001). Fuel loading pertains to the amount of fuel over a given area and is a significant factor in determining the fire behavior. Grass vegetation types, which have a fuel loading significantly lower than heavy timber types, ignite more readily and support fires of more rapid spread, but generally burn with a lower intensity than fuels with a higher load (Anderson 1982). Fuel arrangement pertains to the compactness and continuity of fuels. Less compact fuels tend to ignite easier than those that are more compact. Fuel continuity describes the distribution of fuels. It is further described by both horizontal and vertical continuity. Horizontal continuity pertains to the amount of ground covered by fuel and the distance between surface fuels. Vertical continuity relates to the spatial relationship between surface fuels and aerial fuels such as brush and tree canopy (NWCG 2001).

Another factor in defining fire behavior is fuel moisture as based on fuels in a given vegetation community. Fuel moisture pertains to both live and dead fuels and how it fluctuates slowly over a season for heavier fuels or drastically over just a few hours for fine fuels. Current weather conditions can greatly affect fuel moisture of fine dead fuels such as small twigs and leaf litter; this concept will be described in more detail below. Vegetation type also can dictate the fluctuation of live fuel moisture based on a plant's physiology. Drier fuels burn more readily and with greater intensity than do fuels with higher moistures (Anderson 1982).

Recognizing fire's natural role in and effects to different vegetation types is imperative to understanding not only the different fire management practices and policies that are implemented within the watershed, but also the potential effects to the ecosystem of total fire exclusion. See Section 8, "Vegetation Resources," for a more detailed description of the various vegetation types within the watershed, information on their distribution, and other factors that influence them.

Weather

Weather can be the most erratic of the three key factors in influencing fire behavior. During the fire season, fire managers continuously monitor weather patterns to assess burning conditions of on-going fires or in the event of a new start. However, it is important to keep in mind that local weather patterns often differ greatly from the regional pattern. Furthermore, a large fire can also influence the local weather. Wind speed and direction can dictate not only the rate of spread but also the direction of a fire. Higher winds bring not only additional oxygen to a fire, increasing its intensity, but also assist in drying fuels ahead of the fire. Relative humidity also influences fire behavior primarily by affecting fuel moisture of fine dead fuels, as mentioned above. These fuels are often the primary carrier of surface fires and are receptive fuel beds for spot fires. Wind and lower relative humidity can independently or jointly dry fine dead fuels, increasing the fire behavior in these fuels. Ambient temperature is a major factor in controlling relative humidity, particularly the changes in humidity that occur throughout a 24-hour period. Within the Tehama West Watershed, summers are typically hot and dry, and the dominant wind direction typically blows from the southwest to the northwest. Fires in the watershed can be severely affected by the high winds pushing fire through the grasslands and chaparral. Although south winds dominate 75 percent of the summer, the north winds are also a factor. North winds have much lower relative humidity, 10–18 percent, instead of a 24–30 percent south wind. Consequently, north winds cause 75 percent of the big fire acreage. North wind events usually last three to four days.

Topography

Topography describes the lay of the land, and the three components of topography that are of particular interest to fire managers are slope, aspect, and elevation. With all other factors held constant, the steeper the slope, the faster fire travels up it. Aspect of a slope describes the direction that slope is facing. In the United States, south and west facing slopes receive greater portions of the hotter afternoon sun. This heats up the fuels and lowers the fuel moisture on these slopes, allowing for an increased rate of fire spread and fire intensity. Shifts in elevation affect ambient air temperature and relative humidity, which, as mentioned above, affect fuel moisture. Topography can often influence local weather conditions, particularly wind. Thus, as mentioned above, local wind direction and speed may be quite different from the regional conditions. All of these topographical influences can alter fire behavior as fire moves across the landscape. Tehama West Watershed is predominately comprised of rolling to steep hills with poor accessibility over much of the area.

FIRE MANAGEMENT

Both CDF and USFS use fuel models to combine the elements above to predict fire behavior. For the Upper Thomes Creek area, the USFS estimated flame length and intensity (see Table 11-5). Flame length and fire intensity are important in the ability to suppress and control wildfire.

Table 11-5
FLAME LENGTHS EXPECTED IN MID-SUMMER BY FUEL MODEL

Vegetation Type	Flame Lengths (feet)
Grass	5 – 10
Mature chaparral	10 – 20
Oak or pine woodland	4 – 10
Old-growth forest	8 – 14

Source: USFS 1997

Exact flame lengths for any given site and day are dependent on weather, topography, time of day, and actual fuel loading. The fuel models can also be used to predict the type of resources needed for effective fire suppression by comparing the flame length predicted and the specific conditions. The rates of spread and flame lengths are grouped into four categories. The flame length groupings conform to the values used in fire behavior charts which reflect the ability to succeed at fire suppression as indicated (Rothermel 1972). Table 11-6 shows effectiveness of fire suppression activities at various intensities.

Comparison of the flame lengths predicted (under uniform burning conditions) shows that change of vegetation from fuel of open stands with little understory vegetation to stands with a great deal of understory vegetation greatly increases the flame lengths and suppression difficulty. Longer flame lengths (which indicate higher intensity) also increase firefighter risk and damage to vegetation and soils. Given late fire season weather situations, this would result in a stand-replacing fire.

Table 11-6 EFFECTIVENESS OF FIRE SUPPRESSION FOR FIRES OF VARIOUS INTENSITY			
Fire Intensity	**Rate of Spread (ft/min)**	**Flame Length (feet)**	**Effective Suppression Resources**
Low	0 – 10	0 – 4	Hand crews
Moderate	11 – 50	4 – 8	Engines and dozers
High	51 – 100	8 – 12	Aerial suppression
Extreme	> 100	> 12	All suppression efforts ineffective
Source: USFS 1997			

The USFS believes that change in the fire regime from one of frequent, low-intensity fires to one of infrequent moderate- to high-intensity fires brings on changes in vegetation which will tend to be self-perpetuating. When fires of severity sufficient to replace entire stands (or portions of them) occur, the vacant areas are occupied by pioneering vegetation. As a consequence, these fire-adapted plants develop densities that discourage reestablishment of native coniferous vegetation and encourage the retention of fire disturbance-dependent plant communities. In many cases, these plant communities will reach a stable state with the new fire regime that will be difficult or impossible to change without active management.

WATERSHED VALUES AT RISK

Uncontrolled stand replacing wildfire is detrimental to both watershed function and quality, and can negatively impact all aspects of the watershed. In a catastrophic wildfire, typically all vegetation is removed or damaged, including seeds, soil microorganisms, minerals, and nutrients. Prescribed or planned fires generally remove some vegetation but soil micrograms and many elements of the ecosystem remain unaffected. All fires produce a range of conditions across the landscape, from benign to stand-replacing. A "catastrophic" fire is large in acreage and a higher proportion of it is stand-replacing. The high intensity and high acreage causes a multiplier effect on water quality sedimentation, wildlife, and damage to human infrastructure.

Soil

The frequency and severity of wildfire affects the magnitude of accelerated erosion. The potential for accelerated erosion is primarily through its effects and removal of vegetation. During an intense wildfire, all vegetation may be destroyed and organic material in the soil may be burned away or decomposed into a water-repellent substance that prevents water from percolating into the soil (hydrophobic soils). The potential for fire to increase erosion increases with fire severity, soil credibility, steepness of slope, and intensity or amount of precipitation.

In most cases, hydrophobic layers are not created. The extreme temperature gradient just below the surface layer protects dormant seeds in the soil allowing them to germinate during the spring after the fire.

As the temperature of the wildfire increases, quality of soil decreases. Minerals and nutrients at temperatures 220 to 460°C begin to mineralize, nitrogen vaporizes, organic materials oxidize, and more sand size particles are formed. At temperatures greater than 460°C, permanent changes in structure, texture, porosity, plasticity, and elasticity occur.

Soil pH may increase after a wildfire. This is a result of the addition of ash minerals leaching out after precipitation events. Many fungi and bacteria thrive in basic conditions, and with the increased pH levels and the scarring effect of fire, may increase the likelihood of disease to the forest (Ahlegren and Kozlowski 1974).

Wildfires result in the net loss of nutrients from the ecosystem. Although there are few estimates of such loss, Christensen (1994) proposed four mechanisms to account for these losses:

- Oxidation of compounds to a gaseous form (gasification), nitrogen and sulfur, easily oxidized, are directly proportional to the loss of organic matter

- Vaporization of compounds that were solid at normal temperatures, nitrate

- Convection of ash particles in fire generated winds, loss of important plant development nutrients

- Leaching of ions in solution out of soils

Water

The increase of sediment into streams and rivers is often one of the most dramatic responses associated with fire. Loss of ground cover such as needles and small branches and the chemical transformation of burned soils make watersheds more susceptible to erosion from precipitation events. High precipitation events in the watershed, where at least 75 percent of the vegetation has been removed, can increase sediment discharge. Depending upon the amount of precipitation, the discharge to the basin can range from 0.1 to 0.8 acre-feet per acre of burned forest. Additional sediment storage can alter a stream's form and function in a deleterious manner. Studies in the Stanislaus National Forest indicate large intense fires produce an average of 20 to 50 tons of sediment per acre per year of erosion for the first 2 years (CDF 1995).

Changes in water quality due to wildfire are thought to be minimal and short-lived. However, in some cases, increases in specific ions or pH can cause fish mortality. Large woody debris jams will likely increase post-fire because of fire-killed snags falling into the stream, but new recruitment of debris will be reduced in subsequent years. In addition, retention of woody debris (which creates pools and habitat for fish) may be decreased post-fire because of increased flow.

Turbid waters tend to have higher temperatures and lower dissolved oxygen concentrations. A decrease in dissolved oxygen levels can kill aquatic vegetation, fish, and other aquatic organisms.

Increases (or decreases) in water temperature outside the tolerance limits can be detrimental or even lethal to aquatic organisms, especially cold-water fish such as trout and salmon (Brown 2000). Elevated temperatures may also occur due to loss of protective canopy.

Large intense fires have a much greater effect on stream ecology than smaller, less-intense fires. In addition, the proportion of the burned area within the watershed also influences the effects of the fire on stream ecology. Tree removal reduces evapotranspiration, which increases water availability to stream systems. Increased stream flows can scour channels, erode stream banks, increase sedimentation, and augment peak flows. Hoyt and Troxell first documented the effects of wildfire on stream flow in 1932. They found that burning chaparral caused the average annual stream flow of one specific creek to increase 29 percent. In addition they found that peak discharges and sediment loads carried by the streams also increased.

Air

National Ambient Air Quality Standards (NAAQS) are defined in the Clean Air Act as the amount of pollutants above which detrimental effects to public health or welfare may result. NAAQS has established criteria for particulate matter (PM) also called total suspended solids (TSP), based upon size. PM10 is particulate matter less than 10 microns in diameter and PM2.5 is less then 2.5 microns in diameter. The major pollutant for wildfire in smoke is fine particulate matter, PM10 and PM2.5. Studies show that 90 percent of all smoke particles emitted during wildland burning are PM10, and 90 percent of PM10 is PM2.5 (Sandberg et al. 2002).

Suppression of wildfires provides a short-term benefit to air quality by reducing the amount of vegetation consumed, which reduces smoke emissions. However, by delaying a natural event to a later date, poor air quality is simply pushed to a future time. Estimating the impacts from air pollutants is difficult in general, and is more complex in a wildland setting. Wildfire smoke, and in some cases prescribed burning, can affect visibility, human health, and vegetation. Overall air quality impacts of smoke are important, especially given the fact that the Sacramento Valley Air Basin has a non-attainment status for PM10. Wildland fires are categorized as an "area source" by many pollution agencies, since they tend to release pollutants over large areas (CDF 1999). A single wildfire that consumes 100 acres of heavy forest fuels can emit as much as 90 tons of particulate matter into the atmosphere. Wildfires generally occur during the time of year, Summer and Fall, when smoke and particulate matter is trapped in lower lying areas, increasing exposure to the effects of smoke and reducing visibility.

Health issues contributed to prescribed burns and wildfires affect the younger and older generations, as shown in Table 11-7. Reactions to smoke exposure range from itchy and scratchy throat to more serious reactions such as asthma, emphysema, and congestive heart failure (DEQ 2003).

Ozone, a product of biomass combustion, is a precursor to greenhouse gases. Although ozone produced by prescribed fire usually is quickly diluted and dispersed into the air, it may bring wildland fire under scrutiny as a contributor to the greenhouse effect.

Wildlife

Assessing the economic implication of fire on wildlife without a recognized valuation technique makes quantifying problematic. However, wildlife can be generally expressed in terms of the value of a consumptive use (i.e. hunting) or non-consumptive use (viewing, bird watching). Due to wildland fires, loss of revenue may be seen in hotels, restaurants, gasoline stations, and grocery stores because patrons are not visiting the area.

Table 11-7
HEALTH EFFECTS BASED ON VISIBILITY

Visibility	Health Category	Health Effects	Cautionary Statements
10 miles and up	Good	None	None
6 to 9 miles	Moderate	Possibility of aggravation of heart or lung disease among persons with cardiopulmonary disease and the elderly.	None
3 to 5 miles	Unhealthy for sensitive groups	Increasing likelihood of respiratory symptoms in sensitive individuals, aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly.	People with respiratory or heart disease, the elderly and children should limit prolonged exertion.
1 to 2 miles	Unhealthy	Increase aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; increased respiratory effects in general population.	People with respiratory or heart disease, the elderly and children should avoid prolonged exertion; everyone else should limit prolonged exertion.
1 mile	Very unhealthy	Significant aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; significant increase in respiratory effects in general population.	People with respiratory or heart disease, the elderly and children should avoid any outdoor activity; everyone else should avoid prolonged exertion.
Under 1 mile	Hazardous	Serious aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; serious risk of respiratory effects in general population.	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly and children should remain indoors.
Source: Air Quality: Department of Environmental Quality, Oregon			

The major impact of wildfire on wildlife centers is its influence on vegetation structure and composition. The loss of down and dead woody material, during wild and prescribed burns, removes essential structural habitat components for a variety of wildlife and reduces species diversity. Loss of brush fields and forestlands restrict the ability of wildlife to forage for food and find shelter. Fire has the potential to accentuate impacts on fish and wildlife associated with other landscape fragmentation and development (timber harvesting, road building, and forest management practices). For fish, the primary concerns relative to fire are increases in water temperature, sediment loading, stream cover, and the long-term loss of woody debris from stream channels. Vegetation also decreases the rate of erosion along stream banks.

Change in species composition from intense wildfire favor early successional habitat and its assorted wildlife populations. Significant increases in browsing species populations (such as deer) are common following severe fire. Physical movement of animals is also enhanced after wildfire. However, in chaparral, mountain lions are attracted to the edges of the burned area where deer tend to congregate (Lyon et al. 2000). Low intensity fires do not generally result in significant changes to vegetation composition and resulting wildlife species, but may have similar benefits by increasing the diversity of vegetation mosaics providing better food and cover border areas. Low intensity fires tend to modify species composition and seral stage, thus affecting habitat elements used by wildlife. The overall effect on the wildlife population depends on the landscape distribution of those habitat components.

Bird populations generally respond to changes in food, cover, and nesting caused by fire. Fire effects on insect and plant-eating bird population depend on alterations in food and cover. Some species of birds may increase in numbers after a fire, such as the swallow, swifts, and flycatchers, allowing greater access to forage. Several species such as the California gnatcatcher require structure and cover provided by mature scrub (Lyon et al. 2000). Bird nest site selection, territory establishment, and nesting success can be affected by season of fire. Spring burns may destroy active nest (Lyon et al. 2000).

Direct effects on wildlife population due to wildfires vary, depending on body size, mobility of the species, and intensity of the fire. The majority of animals move away from wildfires, but some (insectivorous birds, raptors) may be attracted, to take advantage of available prey (Lyon et al. 2000). Large mammal mortality most likely occurs when fire fronts are wide and fast moving, fires are actively crowning, and thick ground smoke occurs (USGS 2000). Although few studies have been conducted, it is believed that losses to wildlife caused by fire are negligible. The large fires of 1988 in the greater Yellowstone area killed about 1 percent of the elk population. Most of the larger animals died of smoke inhalation (Lyon et al. 2000). However, like birds, spring fires may impact mammal population due to limited ability of cover and the availability of food. Carnivores and omnivores are opportunistic species and although little increase in species occurs, they tend to thrive in areas where their preferred prey or forage is most plentiful, often in recent burn areas (Lyon et al. 2000).

Recreation

Wildfire impacts recreation values through loss of use, reduced wildlife habitat, and change in species mix of vegetation. Areas burned that attract visitors for hunting and fishing will diminish in value after wildfire, as visitors are not attracted to burned forests. Wildlife that loses habitat and forage will disperse to other locations, resulting in lower hunting numbers for several years.

While direct economic loss from land use can be measured, it is more difficult to estimate losses to recreational activities. Recreation use numbers tend to display visitors in terms of users per day and are detailed toward specific attractions (campgrounds, park, and forests). Three National Park Service (NPS) studies determined that air quality conditions affected the amount of time and money visitors are willing to spend at NPS units.

Within the watershed boundaries the most important industries are related agricultural and grazing. With over half of the watershed covered by grasslands and oak woodlands, this is an area historically devoted to rangeland. Fires in this type of vegetation can move quickly and can cover large areas. As the population of Tehama County grows, urban areas are being stretched and pushed outward into these traditional rangelands. In the Tehama-Glenn Unit Fire Plan, CDF notes that these circumstances have required them to place a greater emphasis on the protection of structures and lives (CDF 2004).

In addition to human loss, ranchers in the watershed also face the loss of feed. If the rangelands burn in the summer, the grasses will not regenerate until the spring. With the loss of feed, ranchers then have to truck in outside feed to their cattle.

CDF FIRE ZONES

The California Department of Forestry and Fire Protection has divided Tehama County into a number of fire zones (shown on Figure 11-5). Zones within the Tehama West Watershed are shown on Table 11-8.

Table 11-8
CHARACTERISTICS OF CDF ZONES

Zone	CDF Battalion	Fuels	Topograp hy	Access	Water Supply	Level of Service	Primary Assets
1. Red Bank, R-Ranch, Paskenta	3 4	Oak-woodland, chaparral, brush	Rolling to steep hills	Poor: mostly rugged, difficult	Poor: steep drainages, seasonal ponds and streams	3 fire stations, 1 conservation camp	Communities, ranches, rangeland, and ag lands
1. Bowman, Dibble Creek, Lake California, Wilcox	2 3	Grass rangeland, oak woodland, brush	Rolling to steep hills	Moderate to poor: some rugged terrain	Moderate: water sources range from adequate to poor	3 fire stations	Homes, ranches, structures, rangelands, watersheds
6. Live Oak, West Red Bluff	3	Grass rangeland, oak woodland, brush	Rolling hills	Good (moderate in western portion of zone)	Variable poor to good	2 fire stations	Rural homes, ranches, rangelands
9. Flourney, Rancho Tehama	3 4	Grass rangeland, oak woodland, brush	Rolling hills	Moderate	Variable poor to moderate	2 fire stations	Communities, rural homes, ranches, rangelands

Zone 1

Zone 1 encompasses much of western Tehama County and includes the communities of Paskenta and R-Ranch along with the Red Bank District. Besides residences and urban infrastructure, fires in this zone threaten timberlands, rural ranches, and agricultural land. Grassy fuels at lower elevations present the primary fire threat within this zone. These fuels are often located where the threat of human caused ignition is greatest such as in developed areas and along major roads. In addition, these "flashy" fuels ignite easily and carry fire rapidly. The other vegetation types in the area that affect fire danger include blue oak and live oak-woodlands along with mixed chaparral brush. Between 1994 and 2004, the leading causes of wildfire in this zone was vehicle and equipment use. Zone 1 is particularly affected by severe weather because high winds carry fire quickly through the predominantly grass and brush covered lands. Much of the area is difficult to access with fire equipment (TCRCD 2005).

Zone 2

Zone 2 encompasses the northern valley floor of Tehama County and includes the Lake California development and rural communities of Bowman, Wilcox, and Dibble Creek. Most undeveloped land in the area is used for livestock grazing. Three vegetation types are present in the zone including grassland, chaparral, and oak-woodland. Grasses are the major fire risk. Expanding human population in this zone is accompanied by an increasing threat of fires along the wildland urban interface. Activity along roads (e.g. equipment use, vehicle exhaust, and smoking) has been the leading cause of vegetation fires from 1994 to 2004. Fires in grasslands may spread quickly into inaccessible areas (TCRCD 2005).

Zone 6

Zone 6 is located in central Tehama County. Human population is concentrated in the eastern part of the zone adjacent to the City of Red Bluff. There are many rural ranch houses and ranchettes in the area. These developments and the rangelands surrounding them are considered to be the primary assets at risk of fire. Equipment use, arson, and other human activities are a significant cause of fire in the zone (TCRCD 2005).

Zone 9

Zone 9 encompasses much of the southern portion of Tehama County and includes the residential communities of Flournoy and Rancho Tehama. Vegetation is a mixture of grassland, chaparral, and woodland. Grasses are the major carrier of fire. The zone has the second highest occurrence of fires during the period from 1990 to 2001. High winds in the zone can spread fires rapidly (TCRCD 2005).

FEDERAL RESPONSE AREA WEST

Federal Response Area West (FRA) consists of federal lands managed by the Mendocino and Shasta-Trinity National Forests. Within the Tehama West Fire Plan project area FRA lands are exclusively within the boundaries of the Mendocino National Forest. Portions of these lands are protected from wildfire through cooperative response agreements with CDF. Under this agreement, the firefighting agency having available equipment and manpower closest to a wildfire incident will respond. In addition, some federal lands are protected on a permanent basis utilizing CDF firefighting resources, and some non-federal land adjacent to the National Forest is protected by USFS resources.

LOCAL RESPONSIBILITY AREA

In addition to lands within Tehama County under direct state fire protection responsibility and those protected through intergovernmental agreements established between the State of California and federal firefighting agencies, portions of the county, particularly in the valley regions closest to the Sacramento River, are classified as Local Responsibility Areas (LRA). Within these LRAs, fire protection is provided by the County Fire Department, other local firefighting entities, or through CDF via contract. At the present time, fuels reduction efforts within the LRAs are limited to wildlands and other areas along the Sacramento River.

FIRE HAZARDS AND RANKINGS

The California Department of Forestry and Fire Protection provides fire and other resource information to the public through FRAP. California Public Resource Code 4789 requires CDF to periodically assess California's forest and rangeland resources. FRAP data layers are presented to describe graphically the fire environment within the Tehama West Watershed.

Figure 11-1 shows the average hazard rating for areas throughout the Tehama West Watershed. Zones are classified into three ratings: moderate, high, or very high. Zones were delineated based on areas with similar vegetative cover, slope, and weather. The zones are designed to give an average hazard rating for the area and do not define the exact conditions for all areas within the zones.. Variations in fuels, slope, weather, aspect, elevation, and air stability will influence hazard conditions at actual locations within each zone. For individual structures, the risk of damage from fire also depends on site-specific factors such as access, water supply, clearance, and characteristics of the structure. As a result, the fire hazard map cannot be used as a measure of risk to individual structures (TCRCD 2005).

Surface Fuels

Surface fuels are generally described as vegetative materials near the ground through which fire will spread. These fuels include downed woody material such as dead branches, longs, and other loose surface litter on the soil surface along with living plants such as grasses, shrubs, tree seedlings, and forbs. The amount, size, and moisture content of surface fuel types determine how fast a fire spreads, how hot it burns, and how high its flames reach. CDF has developed surface fuels data by translating vegetation data from a variety of sources into several fuel characteristic models used to predict fire behavior. The fuel models are based on vegetation attributes such as cover type, vegetation type, size, and crown closure, as well as other factors such as slope, aspect, elevation, and topography. Annual fire perimeter data is used to update fuel model characteristics based on "time since last burned" to account for both initial changes in fuels resulting from fuel consumption by the fire and for vegetation re-growth (TCRCD 2005) (see Figure 11-6).

Fire Threat

Fire threat is a combination of fire frequency or the likelihood that a given area will burn as well as potential fire behavior. These two factors are combined to create four threat classes ranging from moderate to extreme. Fire threat can also be used to estimate the potential for impacts on various assets and values susceptible to wildfire. Impacts are more likely to occur and/or be of increased severity for higher threat classes. CDF calculated a numerical index for fire threat based on the combination of fuel rank and fire rotation class. A one to three ranking of fuel ranks was summed with the one to three ranking from rotation class to develop a threat index ranging from two to six. This threat index is then grouped into four threat classes. Areas that do no support wildland fuels (e.g. open water, agriculture lands, etc.) were omitted from the calculation; however, areas of very large urban centers were left but received a moderate threat value (TCRCD 2005) (see Figure 11-7).

Condition Class

Condition class refers to the general deviation of an ecosystem from its pre-settlement or natural fire regime. It can be viewed as a measure of sensitivity to fire damage, or a measure of fire-related risk to ecosystem health. Classes are assigned based on current vegetation type and structure, an understanding of its pre-settlement fire regime, and current conditions regarding expected fire frequency and potential fire behavior. The conceptual basis for assigning condition classes is that in fire-adapted ecosystems much of their ecological structure and processes are driven by fire, and disruption of fire regimes leads to many alterations to the ecosystem including changes in plant composition and structure, uncharacteristic fire behavior and other disturbance agents (pests), altered hydrologic processes, and increased smoke production. Condition Class 1 is associated with low level disruption of fire regime, and consequently low risk to loss or damage to the ecosystem. Condition Class 2 indicates some degree of departure from natural fire regimes, with some loss and change in elements and processes within the ecosystem. Condition Class 3 is highly divergent from natural regime conditions, and represents the highest level of risk of loss (TCRCD 2005) (see Figure 11-8).

Fire Regime

Fire regime refers to the pattern and variability of fire occurrence and its effect on vegetation. A simple statewide fire regime classification system provides an approximate idea of the range in fire frequency and severity as it existed before European settlement. This classification is based on a similar classification system developed in conjunction with the Coarse-Scale Condition Class assessment done for the National Fire Plan, modified from the USFS National Fire Plan Condition Class Assessment. This classification, while highly generalized, can illustrate only coarse differences in fire regimes (TCRCD 2005) (see Figure 11-9).

FIRE PROTECTION

The issue of fire protection in western Tehama County is an ongoing juggling act. Most of the watershed is located within the CDF's area of responsibility. Due to budget constraints, state fire protection resources have been strained. In an effort to counteract this, the Tehama-Glenn unit analyzed the area based on asset value and fire risk. This analysis allowed the unit to identify those areas that would potentially have a higher need for emergency fire response and the effort has been made to shift emphasis to these high-risk areas. In addition to the steps taken by CDF, there are some Tehama West communities that are listed on the National Registry of 'Communities at Risk.' They are Corning, Hamilton City, Paskenta, R-Ranch, and Red Bluff. All of these communities have high fire threat rankings (CDF 2004).

Firefighting responsibilities in Tehama County are divided into a number of organizational units whose responsibilities are described below. Those fire fighting units dealing primarily with fires within Western Tehama County's wildlands and wildland/urban interface areas are listed in Table 11-9 and shown in Figure 11-10.

Table 11-9
SUMMARY OF FIRE FACILITIES WITHIN WESTERN TEHAMA COUNTY

Department	Station Name	Address	City
CDF/Tehama County Fire Department	Baker	14800 Bowman Road	Cottonwood
CDF/Tehama County Fire Department	Bowman	18355 Bowman Road	Cottonwood
CDF/Tehama County Fire Department	Corning	988 Colusa Street	Corning
CDF/Tehama County Fire Department	El Camino	9580 Highway 99W	Proberta
CDF/Tehama County Fire Department	Paskenta	P.O. Box 211	Paskenta
CDF/Tehama County Fire Department	Red Bank	15905 Red Bank Road	Red Bluff
CDF/Tehama County Fire Department	Red Bluff	604 Antelope Boulevard	Red Bluff
USFS	Paskenta	Paskenta Road	Paskenta
USFS	Log Springs	Log Springs Ridge	Tehama County
USFS	Cold Springs	Cold Springs Ridge	Tehama County

City of Red Bluff Fire Department

Primary responsibility for this department is for the City of Red Bluff and rural areas immediately adjacent to the city limits. The department operates one fire station.

City of Corning Fire Department

Primary responsibility for this department is for the City of Corning and areas immediately adjacent to the city limits. The department operates one fire station.

Tehama County Fire Department

Primary responsibility for this department is for Tehama County's LRA. The department operates seven fire stations within the watershed. One of these (Bowman Station) shares facilities with the CDF.

Gerber Fire Protection District

The Gerber station is run by volunteers from the Gerber community. It is a separate entity from the Tehama County Fire Department and is dispatched by the Tehama-Glenn Unit of CDF.

California Department of Forestry and Fire Protection

The California Department of Forestry and Fire Protection is responsible for controlling wildland fires on 283,778 acres of SRA lands throughout Tehama County and has fiscal responsibility over an additional 10,767 acres of SRA lands, which are directly protected by the USFS. California Public Resources Code 4125 establishes that local and federal agencies have primary responsibility for fire prevention and suppression in all county areas not classified as SRA. In addition to the stations within the county with which the CDF either operates or is responsible for, other firefighting resources are available in neighboring counties including aerial attack bases.

The California Department of Forestry and Fire Protection and the California Department of Corrections operate the Salt Creek Conservation Camp minimum-security facility jointly. The camp provides inmate fire crews, which can be dispatched throughout the county as well as the entire state. At the present time, the camp has one wildland engine, a bulldozer, as well as various service and transportation equipment.

U.S. Forest Service

The Mendocino National Forest manages the majority of lands within the westernmost portion of the watershed. The primary responsibility of this agency is for the control and suppression of wildland fires (not structural fires) on federal land. Within the watershed, the USFS operates three fire stations (Paskenta, Log Springs, and Cold Springs). Crews and fire equipment are also available at stations located within the Mendocino National Forest boundaries in Glenn, Mendocino, Colusa, and Lake Counties. In addition, the agency has access to substantial firefighting personnel and equipment throughout the region, utilizing operating agreements established between the national forests.

Bureau of Land Management

The Bureau of Land Management (BLM) oversees the management and operation of 23,300 acres within its Yolla Bolly Fire Management Unit located in Western Tehama County. At the present time, either the USFS or CDF conduct all fire suppression operations on these lands. In the event of a wildfire, BLM fire management and fuels personnel would serve as duty officers and agency representatives to an interagency team. In addition, a number of local BLM staff has Red Cards, which allow them to join fire suppression forces if needed.

Interagency Approach to Firefighting in Tehama County

Wildland fires ignore civil boundaries. Consequently, it is necessary for cities, counties, special districts, as well as state and federal agencies, to work together in order to minimize the adverse impacts of wildfires. All Tehama County fire fighting organizations are coordinated through automatic mutual aid agreements to assist one another as needed. This interagency array of firefighting forces is dispatched by the Tehama-Glenn Emergency Command Center (TGECC) in Red Bluff according to a Standard Response Plan (SRP). The TGECC will dispatch fire engines, other emergency equipment, and personnel from the closest resources available to fill the requirements of the SRP, regardless of jurisdiction.

Communities at Risk

In an attempt to improve this situation, federal fire managers authorized state foresters to determine which communities adjacent to federal lands were exposed to a significant threat from wildland fire originating on public property. The CDF undertook the task of generating a state list of at-risk communities that, in the case of California, included developed areas located away from the immediate vicinity of federal lands. In developing the California list, CDF assessed all areas of the state regardless of ownership.

Three main factors were used to determine fire threats to wildland urban interface areas within the state:

- Fuel hazards ranking (ranking vegetation types by their potential fire behavior during a wildfire)
- Assessing the probability of fire (the annual likelihood that a large damaging wildfire would occur within a particular vegetation type)

- Assessing housing densities in wildland urban interface areas (areas of intermingled wildland fuels and urban environments that are in the vicinity of fire threats)

Out of this statewide assessment, a list of 1,283 fire threatened communities was developed. Of these threatened communities, 843 were found to be adjacent to federal lands. Table 11-10 lists the officially recognized communities in the watershed. The Hazard Level Code designates the fire threat level for the communities with a "3" indicating the highest level of threat.

Table 11-10
OFFICIALLY RECOGNIZED COMMUNITIES AT RISK WITHIN THE TEHAMA WEST WATERSHED

Community Number	Community Name	Federal Threat	Hazard Level
85	Bend	F	2
257	Corning		3
283	Dairyville		2
656	Los Molinos	F	2
920	Red Bluff	F	3
1204	Wilcox	F	2
835	Paskenta	F	3

FUEL REDUCTION METHODS AND MAINTENANCE

Tehama County RCD is currently in the process of compiling a Fire Plan. Within the Tehama West Watershed the RCD has been focusing their attention on the Elder Creek Watershed. The hope is to expand their efforts to other drainages such as Reeds, Red Bank, and Thomes Creeks, as additional funding and time are made available. Since the Fire Plan is not yet completed for the watershed, the following fuel management plans and policies have been taken from a variety of sources that address general concerns, fuel loads, and fuel management issues of a nature similar to those faced by public and private entities within the watershed. These sources include CDF's 2004 Tehama-Glenn Unit Fire Management Plan, the Shasta West Fire Plan, and other various local and national fire plans.

Fuel Management Plan

One of the first steps in fuel management strategy is the development of a fuels management plan. The Tehama County Resource Conservation District is in the process of completing a Fire Plan with the help of the Tehama-Glenn Fire Safe Council. Based upon the goals and desires stated by the Tehama-Glenn Fire Safe Council, the plan will focus on fire management, fuel reduction and fire prevention issues within Tehama and Glenn Counties. Specific attention will be focused on the Elder Creek drainage located within the Western Tehama Watershed. The goal is to develop a plan that deals with both wildland and urban interface issues such as smoke regulation, coordination between agencies and landowners in regards to prescribed burning and wildland fire incidents, fire prevention and public education, fire training for land managers, and fuel break and vegetation treatment projects (CDF 2004). The Council will adapt the plan designed for Elder Creek to other drainages located in Tehama West Watershed as funding and time allows. As the plan has not yet been concluded, this section draws upon solutions brought forth by other agencies that have responsibility areas within the watershed, as well as from other Fire Safe and Resource Conservation Districts in Northern California, facing the same issues and situations as those faced in western Tehama County.

The Tehama West Watershed faces the growing problem of expansion of development into increasingly remote and historically fire prone areas. This mix is known as urban interface areas. These areas usually fall outside the boundaries of local fire districts and in State Responsibility Areas (SRA) that are handled by CDF. This adds a new complication to standard wildland firefighting tactics as the focus is shifted to include the need to protect human life and property. As such, CDF has recognized the need to educate residents in the urban interface areas on topics such as fuel management, proper clearance around structures, and responsible, fire safe behavior during fire seasons. The Tehama-Glenn Unit understands the positive impact that groups such as Resource Conservation Districts and local Fire Safe Councils have when reaching the public and garnering funds for projects that focus on fuel management, reduction, and education of landowners.

Shaded Fuel Breaks

Shaded fuel breaks are constructed as a means to create a defensible space in which firefighters can conduct relatively safe fire suppression activities. Fuel breaks may also slow a wildfire's progress enough to allow supplemental attack by firefighters. The main idea behind fuel break construction is to break up fuel continuity and prevent a fire from reaching the treetops, thus forcing the fire to stay on the ground, where it can be more easily and safely extinguished. Fuel breaks may also be utilized to replace flammable vegetation with less combustible vegetation that burns less intensely. In addition to fuel reduction, a well-designed shaded fuel break also provides an aesthetic setting for people and a desirable habitat for wildlife. The California Board of Forestry has addressed the requirement to strengthen community fire defense systems, improve forest health, and provide environmental protection.

- Fuel breaks should be easily accessible by fire crews and equipment at several points. Rapid response and the ability to staff a fire line are very important for quick containment of a wildfire.

- The edges of a fuel break are varied to create a mosaic or natural look. Where possible, fuel breaks should compliment natural or man-made barriers such as meadows, rock outcroppings, and roadways.

- The most important component is maintenance. A maintenance plan should be developed before construction of a fuel break. Although a fuel break can be constructed in a few weeks, maintenance must be conducted periodically to keep the fuel break functioning properly.

- The establishment of a shaded fuel break can lead to erosion if not properly constructed. Short ground cover, such as grass, should be maintained throughout the fuel break to protect the soil from erosion.

- A properly treated area should consist of well-spaced vegetation with little or no ground fuels or understory brush. Tree crowns should be approximately 10–15 feet apart. The area should be characterized by an abundance of open space and have a "park like look" after treatment.

Mechanical Treatments

Mechanical methods to remove fuels include, but are not limited to, the utilization of bulldozers with or without brush rakes, excavators, chainsaws, mechanized falling machines, masticators, chippers, and grinders. Mechanical treatments are typically conducted on chaparral landscapes with some type of masticator, which grinds standing brush and reduces it to chips, which are typically left on the ground. Brush may also be mechanically removed and fed into a grinder for biomass production. Mechanical treatments are also utilized on industrial and non-industrial timberlands, where trees are thinned by mechanized tree cutting or falling machines. In most cases stands of trees are thinned from below as a means to eliminate the fuels that allows a fire to shoot higher into the tree canopy (ladder fuels). However, stands of trees may also be thinned from above to eliminate crown continuity.

Due to air quality concerns, the mechanical treatment method is fast becoming the acceptable method of fuel reduction in Urban Interface areas. Compared to prescribed fire, mechanical treatment involves less risk, produces less air pollutants, is more aesthetically pleasing and allows landowners to leave desirable vegetation.

Defensible Fuel Profile Zones (DFPZs) are strategically located lineal fuel reduction and fire protection areas that are generally constructed a quarter mile wide along public and private roads that traverse communities, watersheds, and areas of special concern. These are similar to shaded fuel breaks. The shaded fuel break objective is to reduce fire intensity, while DFPZ fuel management is designed to allow fire fighters quicker and safer access for attacking and suppressing oncoming forest fires. The DFPZ is more of a defensive line fighting area that manages fire behavior through fuels management. The lineal connectivity of the DFPZ network allows various property owners within a watershed the opportunity to connect fuel reduction projects to adjoining properties through local County Fire Safe Councils. The DFPZ network is the starting point for addressing the scale of the existing hazardous fuel problems at the appropriate pace of annual acres treated.

DFPZs are best placed primarily on ridges and upper south and west slopes and, where possible, along existing roads. They also should be located with respect to urban-wildland intermix and other high-value areas (such as old-growth or wildlife habitat areas), areas of high historical fire occurrence, and/or areas of heavy fuel concentration. Thinning from below and treatment of surface fuels can result in fairly open stands, dominated mostly by larger trees of fire-tolerant species. DFPZs need not be uniform, monotonous areas, however, but may encompass considerable diversity in age, size, and distribution of trees. The key feature should be the general openness and discontinuity of crown fuels, both horizontally and vertically, producing a very low probability of sustained crown fire. DFPZs should offer multiple benefits by providing not only local protection to treated areas (as with any fuel-management treatment) but also safe zones, within which firefighters have improved odds of stopping a fire. In addition DFPZs interrupt the continuity of hazardous fuels across a landscape, and provide various benefits not related to fire, including improved forest health, greater landscape diversity, and increased availability of relatively open forest habitats dominated by large trees.

Prescribed Fire

Prescribed fire is the controlled application of fire to the land used to accomplish specific land management goals. These goals can vary from annual burning around residences to clear grass and weeds, agricultural field burning for preparation of crop planting, range improvement burning, burning of brush piles, and landscape burning of forest to remove brush and accumulation of forest fuel. Forestlands can benefit from prescribed fire by attempting to regulate or moderate the frequency and intensity of wildfires. The advantages of using fire and improvement cuttings to restore and maintain seral, fire-resistant species include:

- Resistance to insect and disease epidemics and severe wildfire
- Providing continual forest cover for aesthetics and wildlife habitat
- Frequent harvests for timber products
- Stimulation of forage species
- Moderate site disturbance that allows for tree regeneration

By returning to regular burning, forests can achieve a measure of protection from catastrophic loss, by reducing the amounts and concentration of brush and other forest fuels.

Prescribed fire can also be an effective tool for managing fuels. In most forested areas, however, fuel structures are currently too hazardous to safely attempt prescribed ignitions without pre-treating the stand mechanically. Planned non-suppression fires are fires resulting from unplanned ignitions (caused by either lightning of humans). In areas that prescribed natural fire, plans have been adopted that specify conditions under which planned non-suppression fires are allowed to burn. Following specific fire management activities, prescribed natural fire planning represents an important opportunity to have wildfire help meet watershed management objectives.

A key element to fuel management planning is the initiation of market uses for small trees and biomass removed from wildlands under fuels management programs. The intensity and temperature of most prescribed fire scenarios are significantly less than catastrophic wildfire and produce positive rather than negative ecosystem impacts. Benefits of prescribed fire include:

- Reduction of fuel buildup of dead wood, overcrowded, unhealthy trees and thick layers of pine needles and ground vegetation that can contribute to larger in size, intensity, and more uncontrollable fires

- Thinning of overcrowded forests that have previously been thinned by fire. These forests are generally healthier and more vigorous, recover quicker, and are more resistant to insect and disease attacks

- Preparation of the site for new growth by removing excess vegetation. As the excess vegetation is burned, nitrogen and other nutrients are released, allowing the soil to be receptive for new plants to grow and allowing conifer seeds to germinate. Additionally, some forms of conifers and brush (knob cone pine, lodge pole pine manzanita, deer brush) rely on frequent fire for germination of seeds and new growth development

- Creation of diverse vegetation for wildlife by having varying ages and type of plants available for animals to forage on, and find shelter in. Wildlife that graze (deer, elk) benefit from new growth as young plants provide more nutrients. Fire can create more open stands that allow predators to be seen and down wood for small mammals and insects

- Increase in water and spring yield by removing encroaching chaparral and shade-tolerant species and decreasing evapotranspiration. Increases occur in local springs and groundwater discharge to creeks. Significant increased flows are common after fires; and spring yield may increase as much as 200 percent (Bursy, undated)

- Increase in nutrients such as phosphorus, potassium, calcium, and magnesium in the ash deposits (Ahlegren and Kozlowski 1974)

The California Vegetation Management Plan (CVMP) is a cost-sharing program that focuses on the use of prescribed fire and mechanical means for addressing wildland fire fuel hazards and other resource management issues on State Responsibility Area (SRA) lands. The use of prescribed fire mimics natural processes, restores fire to its historical role in wildland ecosystems, and provides significant fire hazard reduction benefits that enhance public and firefighter safety.

CVMP allows private landowners to enter into a contract with CDF to use prescribed fire to accomplish a combination of management goals on both forestlands and grasslands. Since 1981 approximately 500,000 acres (an average of 31,000 acres per year) have been treated with prescribed fire under CVMP in California. Cost of the prescribed burning averages $25 to $30 per acre but can vary, based on the number of acres and resources necessary for the prescribed fire project. This cost, sharing program includes the landowner paying approximately 25 to 30 percent of the total project costs.

The recent CVMP and other prescribed burns in the watershed are included on Table 11-11.

Wildland Fire Use

Wildland Fire Use is the management of lightning and other naturally caused fires to accomplish resource management objectives. The current and forecasted weather conditions, fuel conditions, availability of fire resources, and resource goals for the specific site are all taken into account before designating a particular fire as fire use. These factors are then continuously monitored as the fire progresses. Furthermore, extremely detailed plans are drafted that outline the conditions required for the fire to continue burning under this designation. The presence of structures in the vicinity of a fire often excludes that area as a fire use zone.

Table 11-11
CDF VEGETATION MANAGEMENT PROGRAM
PROJECT DATA 1979 TO 2005

Year	Project Name	Acres	Agency
1979	Roney	865.51	CDF
1981	Roney	1,397.09	CDF
1983	Brushy	1,098.30	CDF
1983	Partch	1,018.60	CDF
1983	Plum Creek	1,061.43	CDF
1984	A & K (Meyers)	455.05	CDF
1984	Brushy	4,716.72	CDF
1985	Keenan	166.68	CDF
1985	Rancho Rio Frio	115.53	CDF
1986	Burrows	438.34	CDF
1986	Cameron	2,030.52	CDF
1987	Rancho Rio Frio	15.17	CDF
1987	Rio Frio	160.29	CDF
1987	Storer	346.23	CDF
1987	Vantress	126.34	CDF
1988	Brushy Mountain	7,105.64	CDF
1988	Cox	311.56	CDF
1988	Grapevine	1,797.92	CDF
1989	Rancho Rio Frio	265.59	CDF
1989	Roseburg	267.57	CDF
1989	Vantress	125.17	CDF
1990	Bald	3,939.87	CDF
1990	Cohasset	1,300.25	CDF
1990	Giovanetti	321.94	CDF
1990	Round Valley	323.13	CDF
1990	Sunflower	275.11	CDF
1991	Giovanetti	209.40	CDF
1991	Nature Conservancy	805.82	CDF
1991	Roseburg 91	1,004.42	CDF
1992	PG&E	227.43	CDF
2003	Grindstone Type Conversion	216.21	USFS
2003	SPI VMP BURN	48.79	CDF
2004	Grindstone Brush (GS)	1,946.67	USFS
2004	Valentine Ridge	98.38	USFS
2005	Little Wildcat	854.75	CDF
2005	Little Wildcat 2	854.45	CDF

DATA GAPS

No major data gaps were identified during the watershed analysis process. The upcoming Tehama West Fire and Fuels Management Plan will be a detailed document presenting significant planning and implementation projects.

CONCLUSIONS AND RECOMMENDATIONS

The following recommendations apply to fire and fuel related activities in the watershed.

- Implement Tehama West Fire and Fuels Management Plan

- Identify projects that result in the protection of residents and firefighters, and public and private properties, such as projects that:

  - Provide immediate and direct impacts on the threat and intensity of wildfires such as fuel breaks and fuel reduction projects

  - Result in improvements to firefighting and fire protection infrastructure including access for firefighting forces, egress of residents along with water storage, and water delivery system upgrades

  - Involve regulatory matters such as changes in laws, ordinances, and codes that relate to fire safety and fire management

  - Formally classify a number of small communities as officially recognized communities at risk and identify these communities' Wildland Urban Interface areas

  - Improve water storage handling and delivery systems to be used for fire suppression in the county

  - Provide incentives to property owners that provide access to water storage structures during fire events

  - Review the Tehama County building and land development standards and zoning

    - Fire hydrants and fire sprinklers
    - Ingress and egress provisions
    - Densities
    - Evaluate wood shake roofs and clearance standards
    - Fire safe landscaping

  - Public outreach
  - Tehama County-wide adjoining county fire plan

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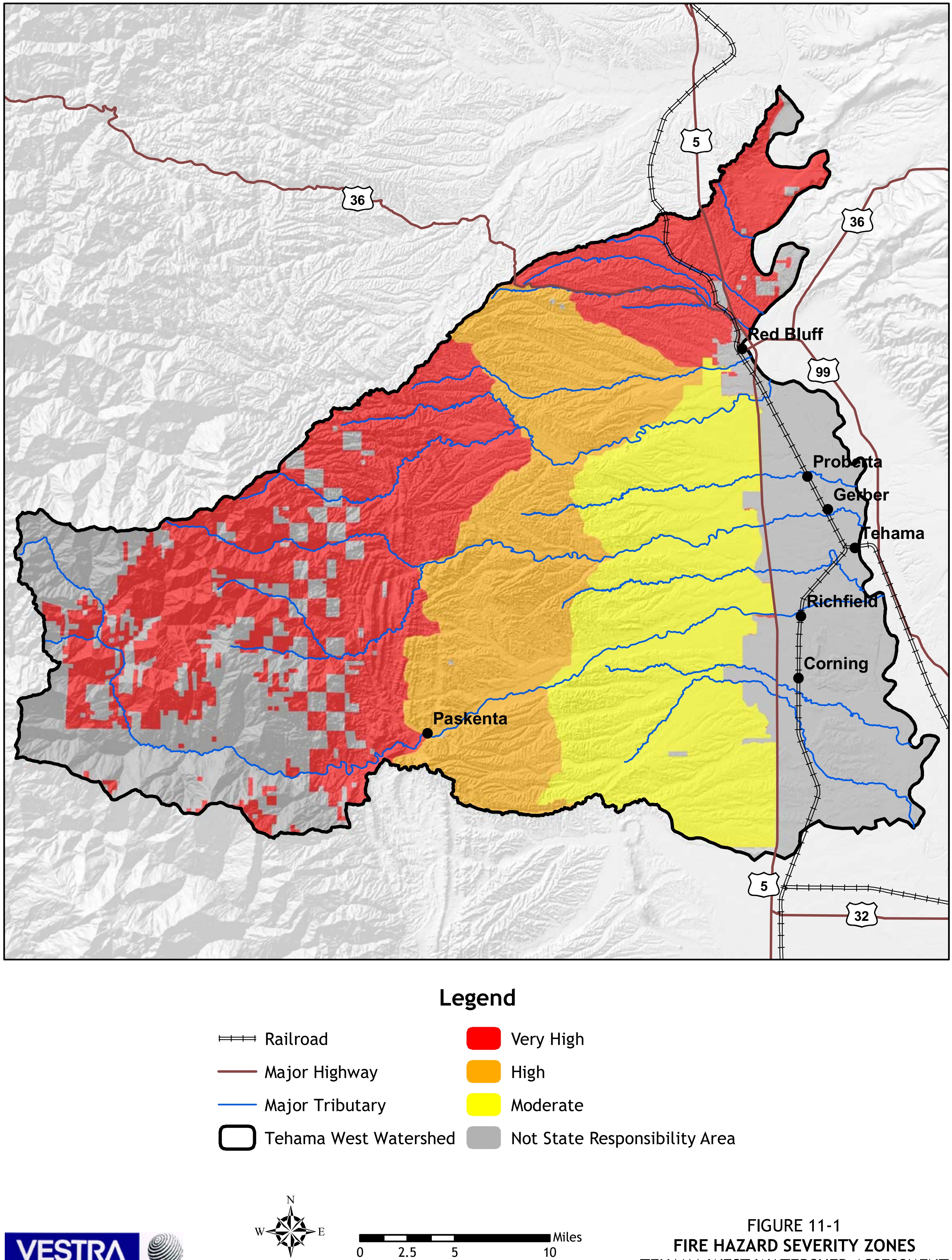


VESTRA

FIGURE 11-1
FIRE HAZARD SEVERITY ZONES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION

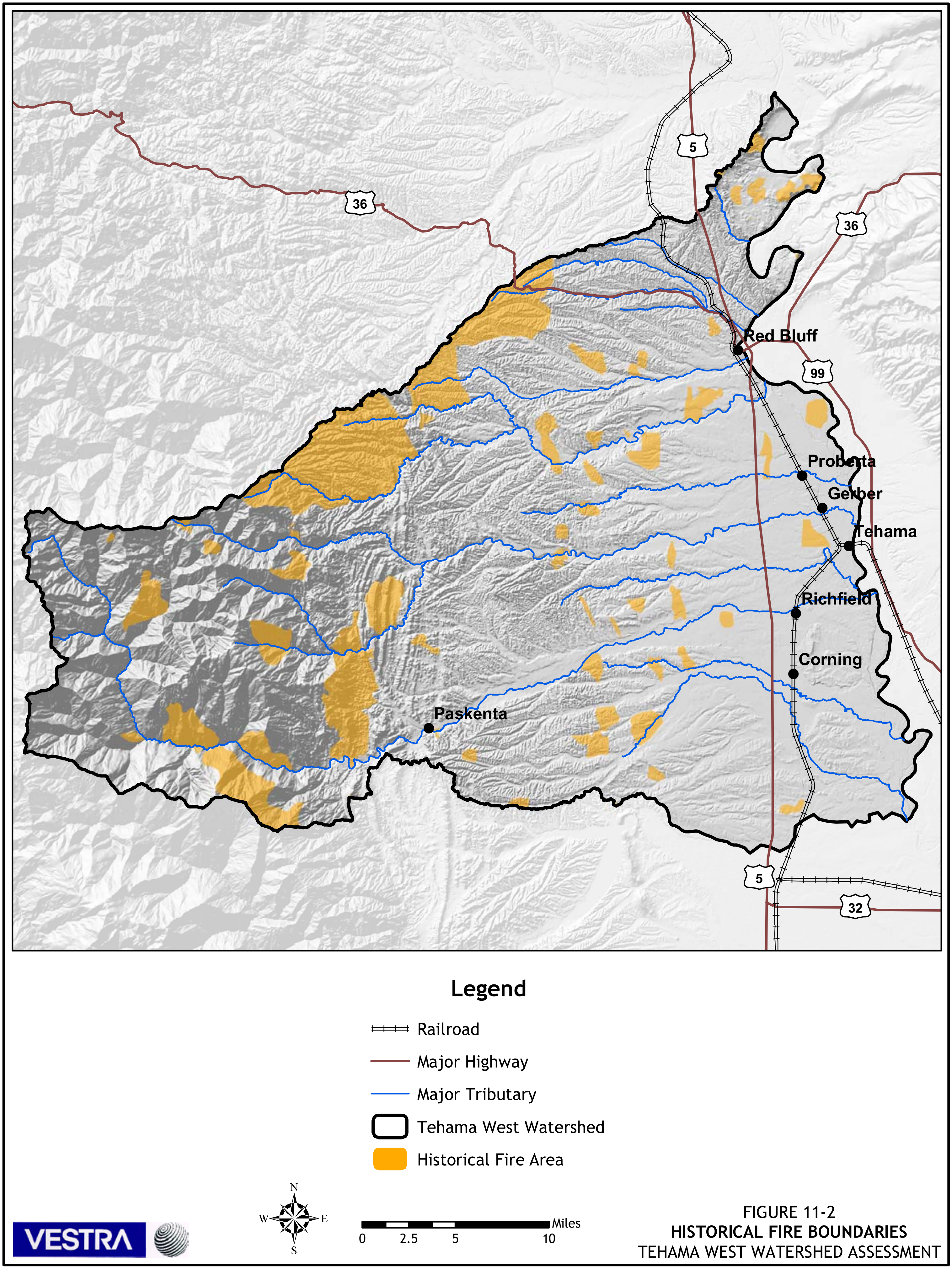


FIGURE 11-2
HISTORICAL FIRE BOUNDARIES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION

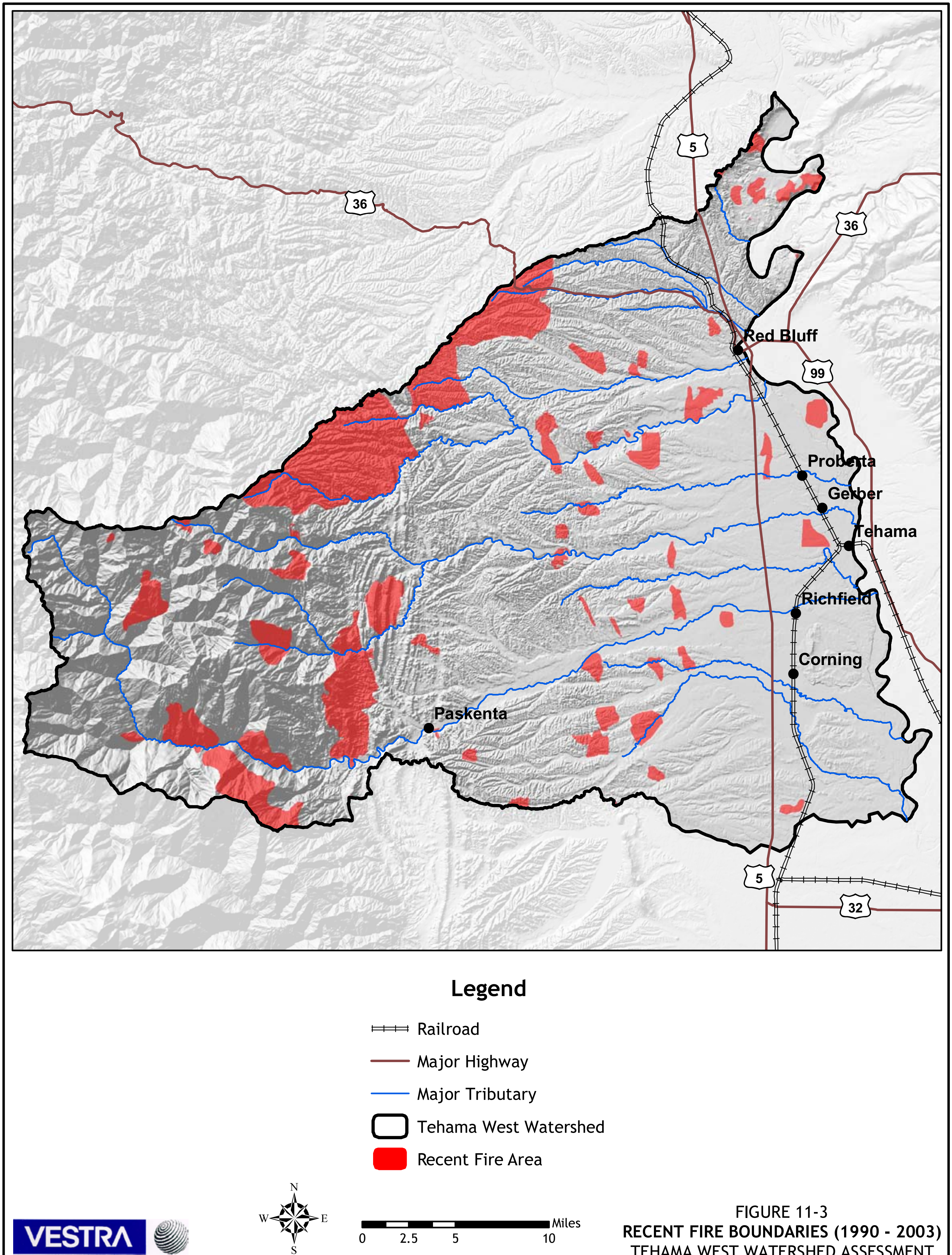
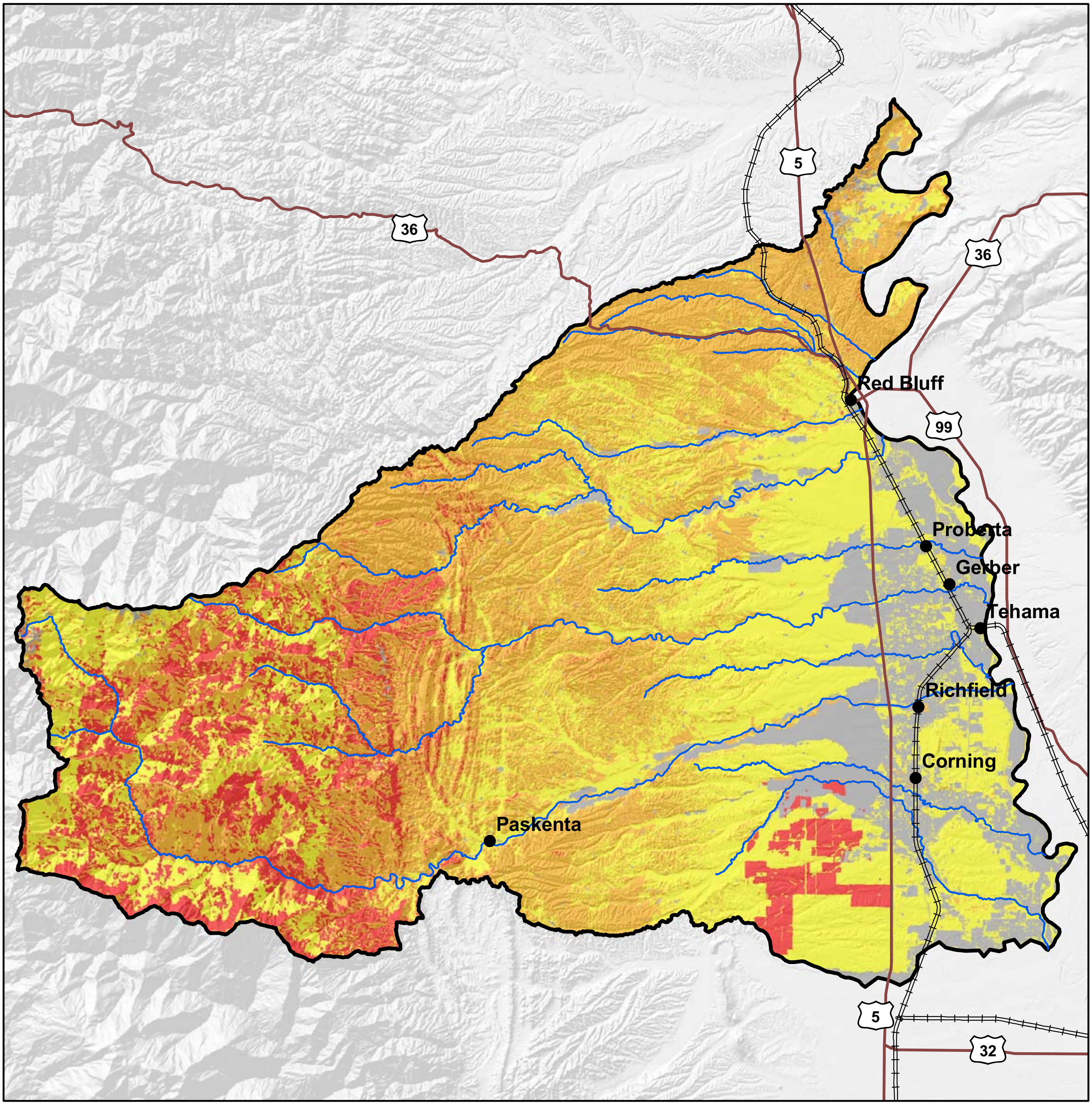


FIGURE 11-3
RECENT FIRE BOUNDARIES (1990 - 2003)
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION



Legend

	Railroad		Non-Fuel
	Major Highway		Moderate
	Major Tributary		High
	Tehama West Watershed		Very High

N W E S

0 2.5 5 10 Miles

VESTRA

FIGURE 11-4
FUEL RANKS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION

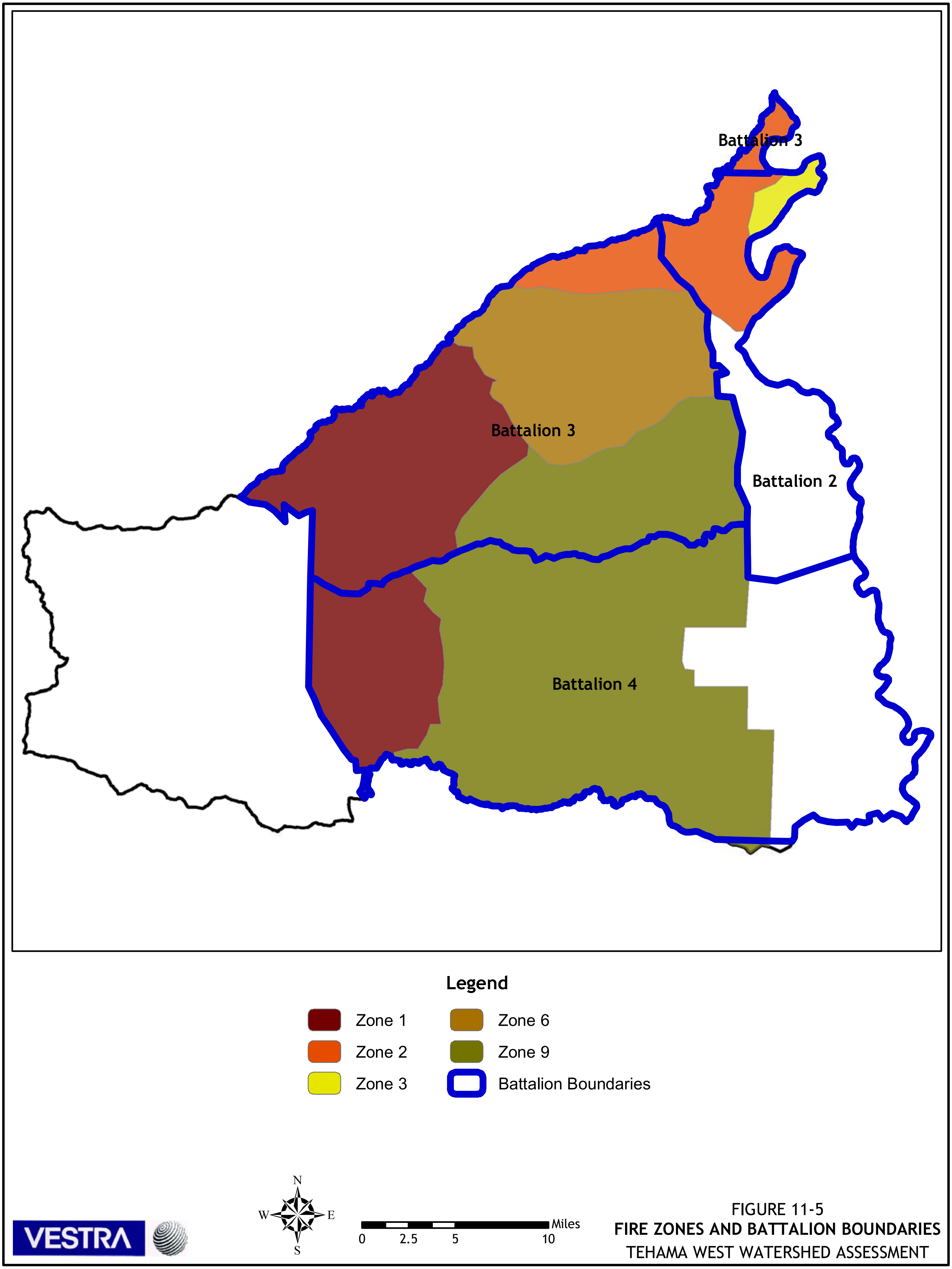
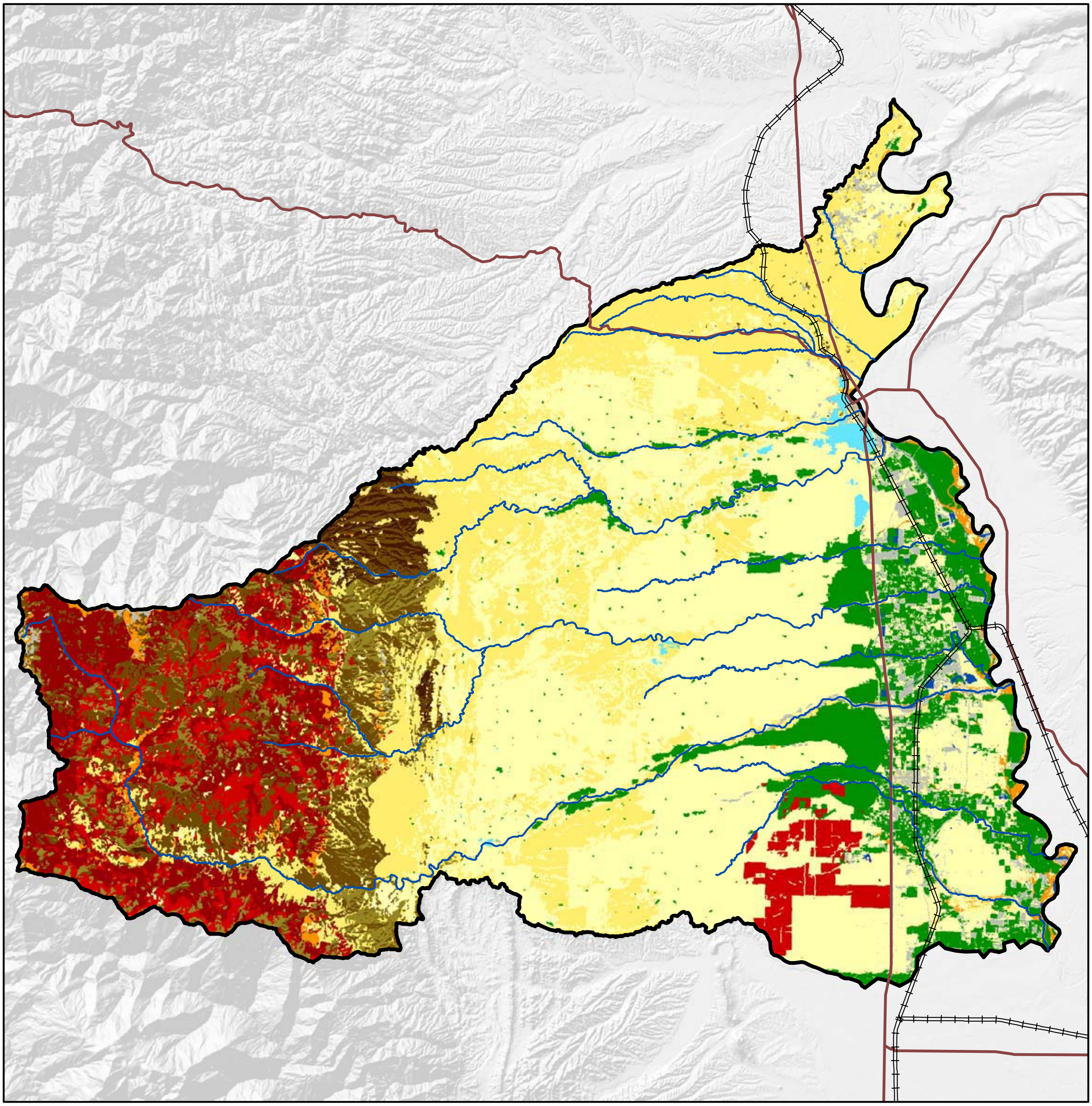


FIGURE 11-5
FIRE ZONES AND BATTALION BOUNDARIES
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CDF, 2005



Legend

Urban	Tall Chapparal
Agriculture	Light Brush
Water	Intermediate Brush
Rock/Barren	Hardwood/Light Conifer
Grass	Medium Conifer
Pine/Grass	Heavy Conifer

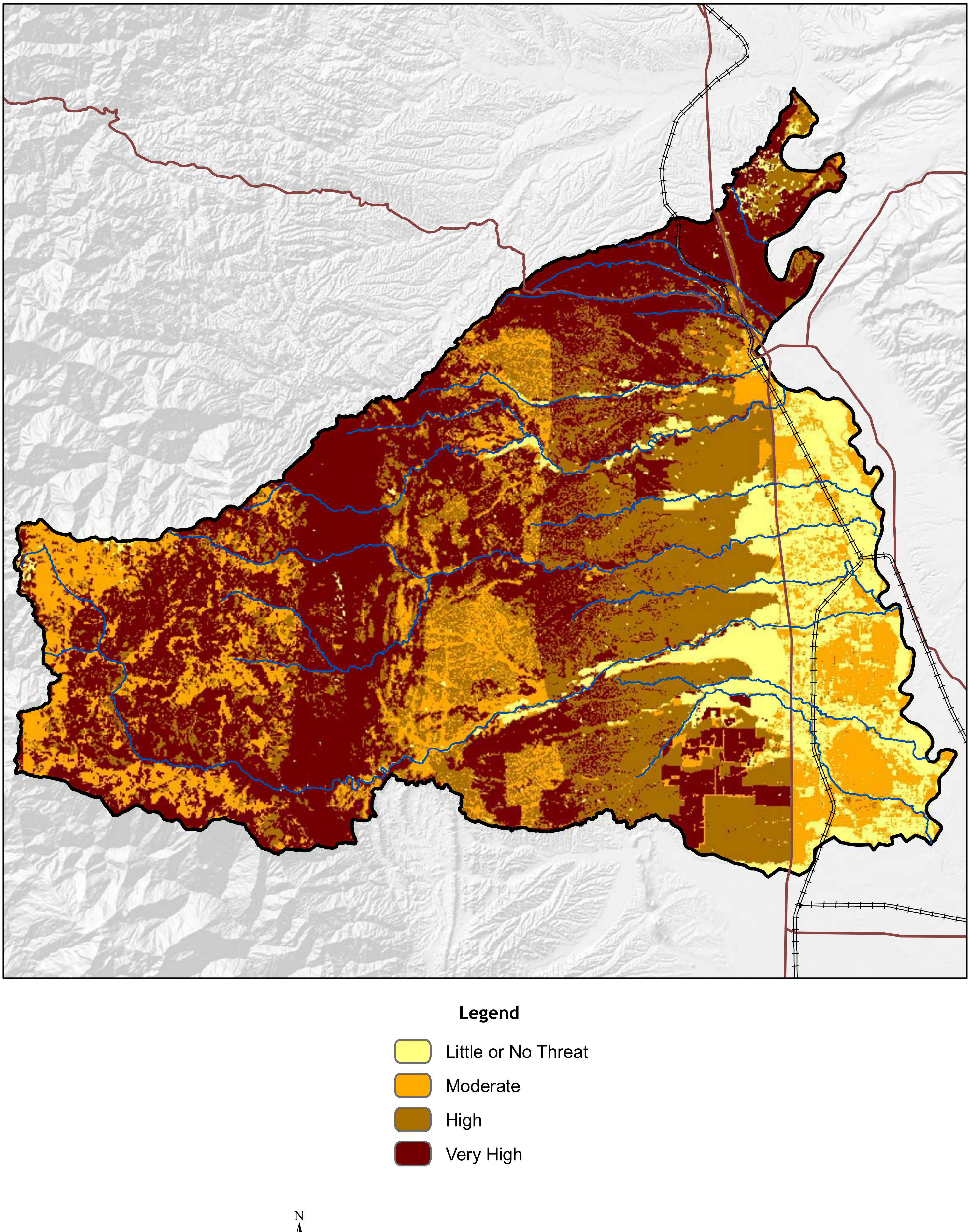
N W E S

0 2.5 5 10 Miles

VESTRA

FIGURE 11-6
SURFACE FUELS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CDF, 2005



VESTRA

FIGURE 11-7
CDF FIRE THREAT
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CDF, 2005

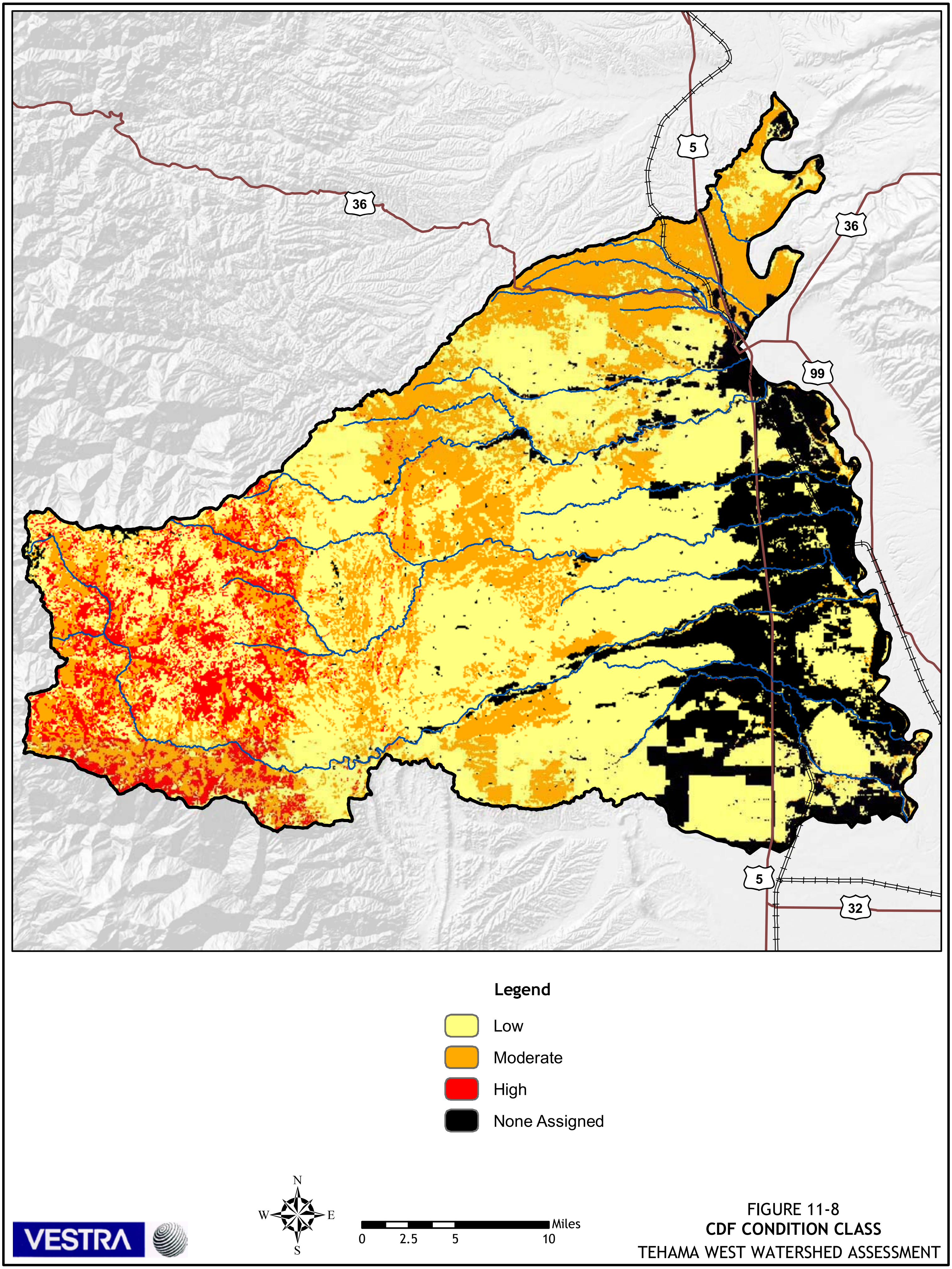


FIGURE 11-8
CDF CONDITION CLASS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CDF, 2005

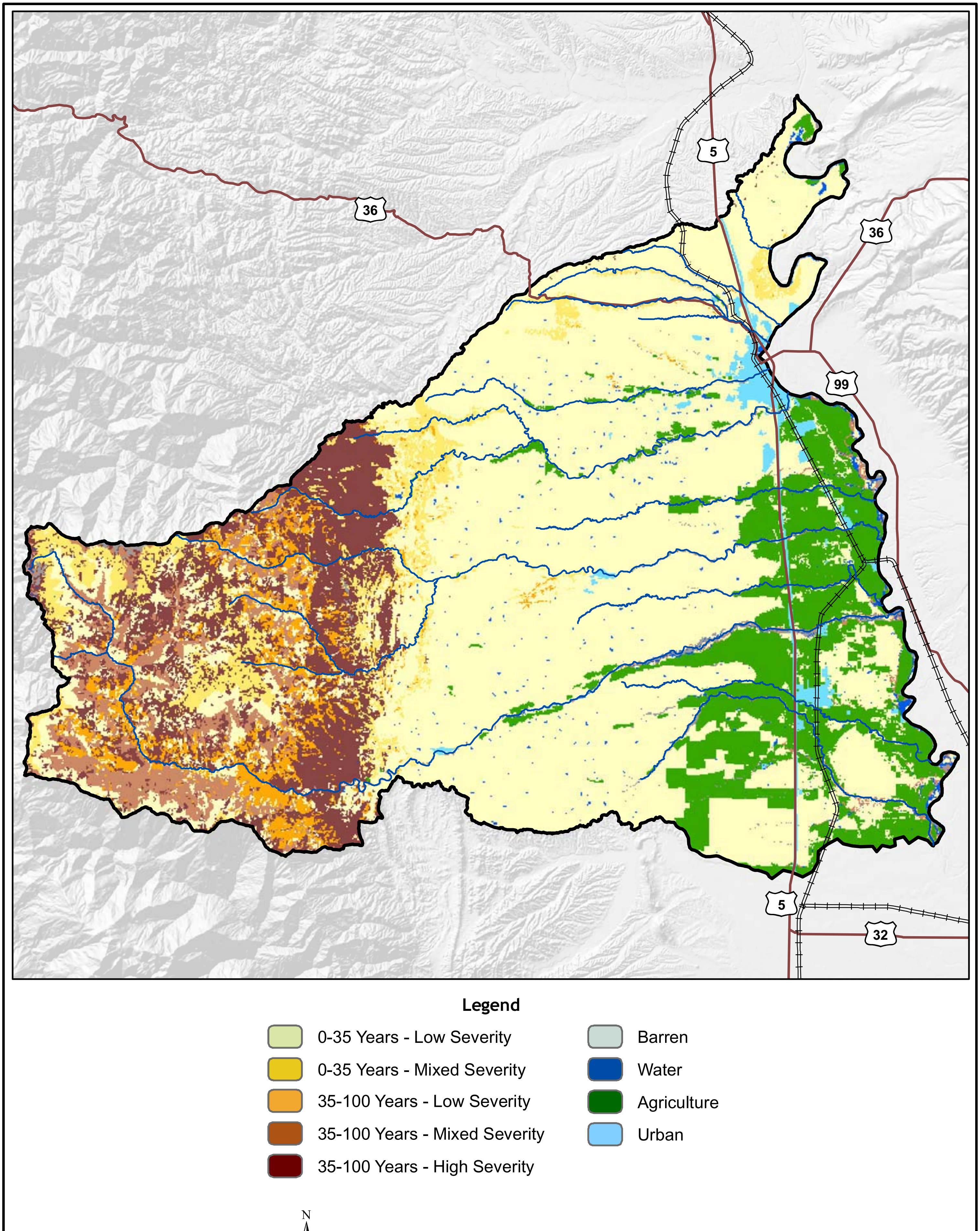
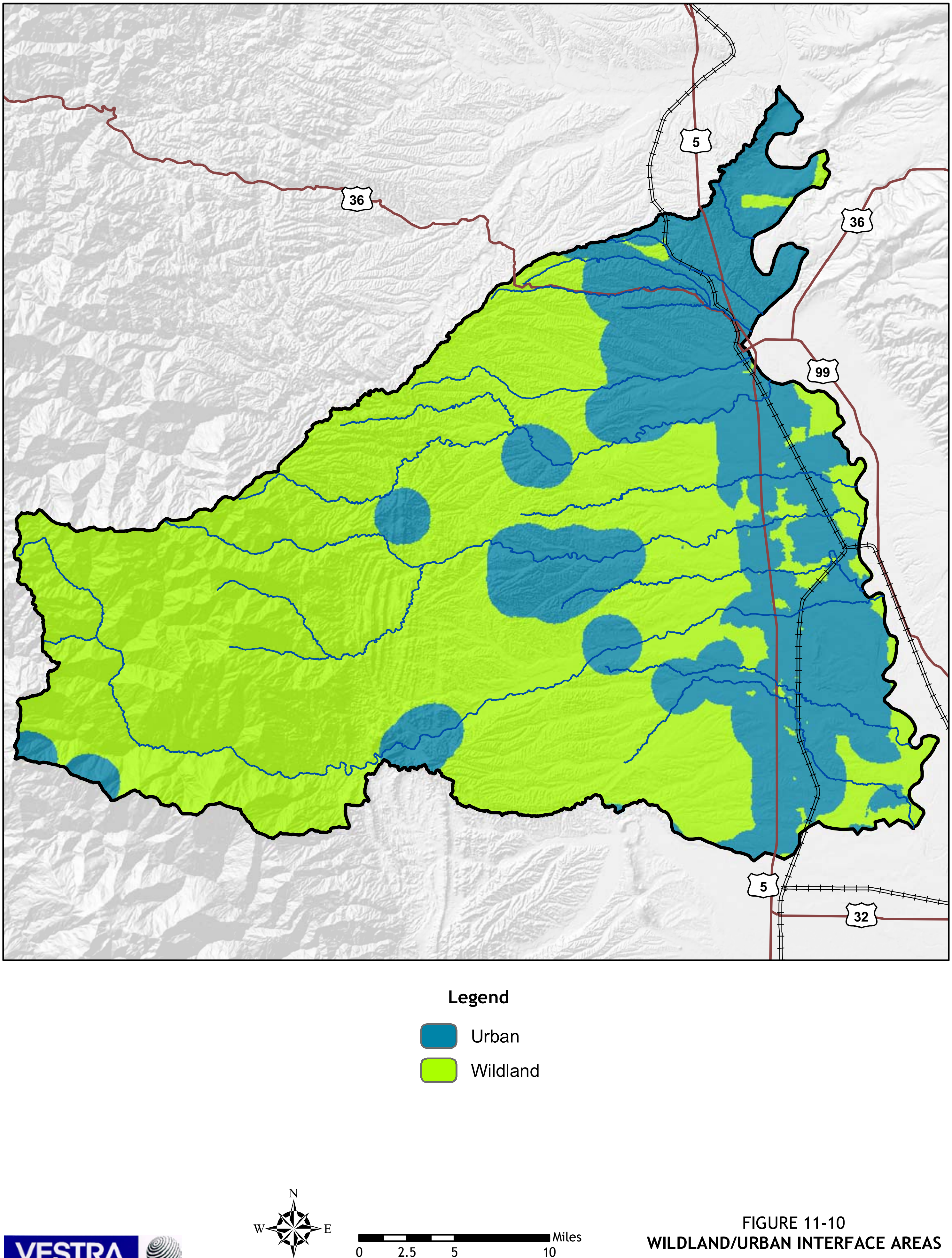


FIGURE 11-9
CDF FIRE REGIME
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CDF, 2005



VESTRA

FIGURE 11-10

WILDLAND/URBAN INTERFACE AREAS

TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CDF, 2005