



Section 4

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## 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 Thomas 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 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 Franciscan 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.

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%
<b>Total</b>	<b>668,168</b>	<b>100%</b>

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.

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	VIIIs-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, VIe-7, VIe-8, VIIs-4
Yollabolly-Rock Outcrop-Freezeout	VIIs-1, VIIs-4

Capability classes generalized to accommodate 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, gullyng, 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, VIe-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.
- Department of Water Resources. 1987. *Reeds Creek Flood Study*. California Department of Water Resources, Northern District.
- 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.

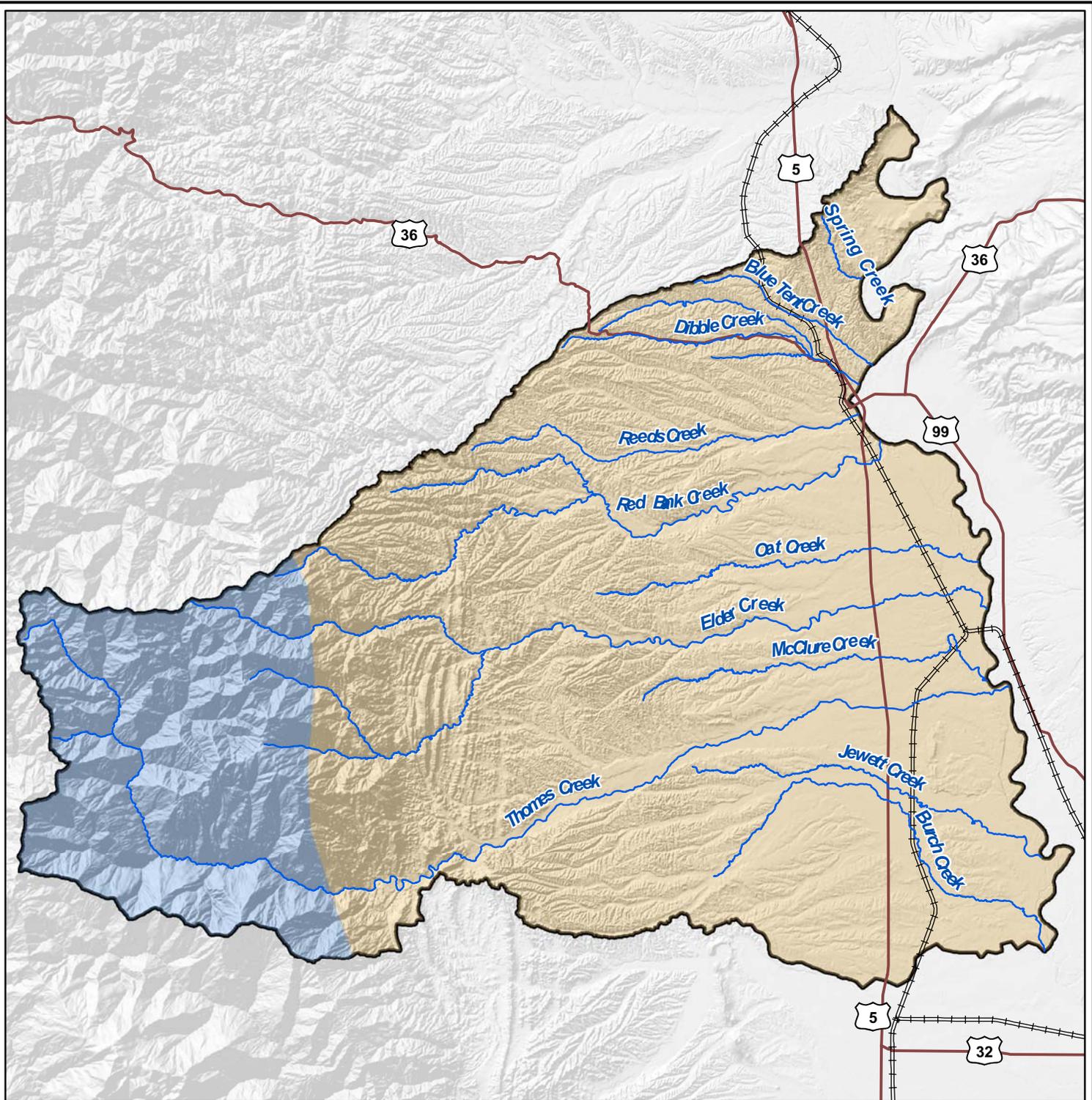
To more affectively assess, quantify, and ultimately provide sound management direction, it is recommended that a digital GIS database, which includes all factors affecting geologic and soil issues, be created.

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**Legend**

- ⎓⎓⎓⎓ Railroad
- Major Highway
- Major Tributary
- ▭ Tehama West Watershed
- ▭ Coast Range
- ▭ Great Valley

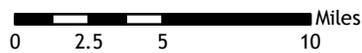
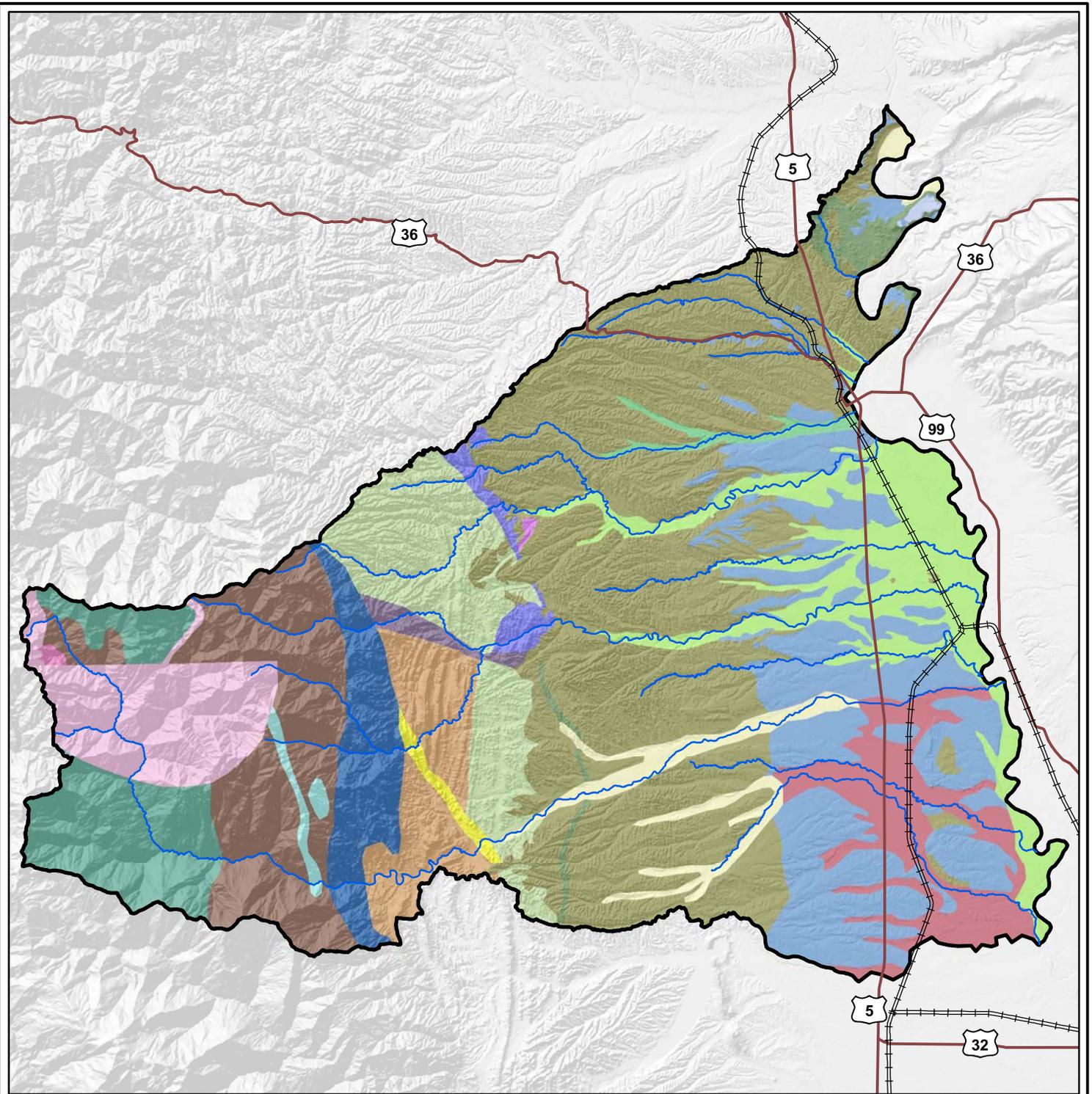


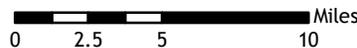
FIGURE 4-1  
**GEOLOGIC PROVINCES**  
 TEHAMA WEST WATERSHED ASSESSMENT





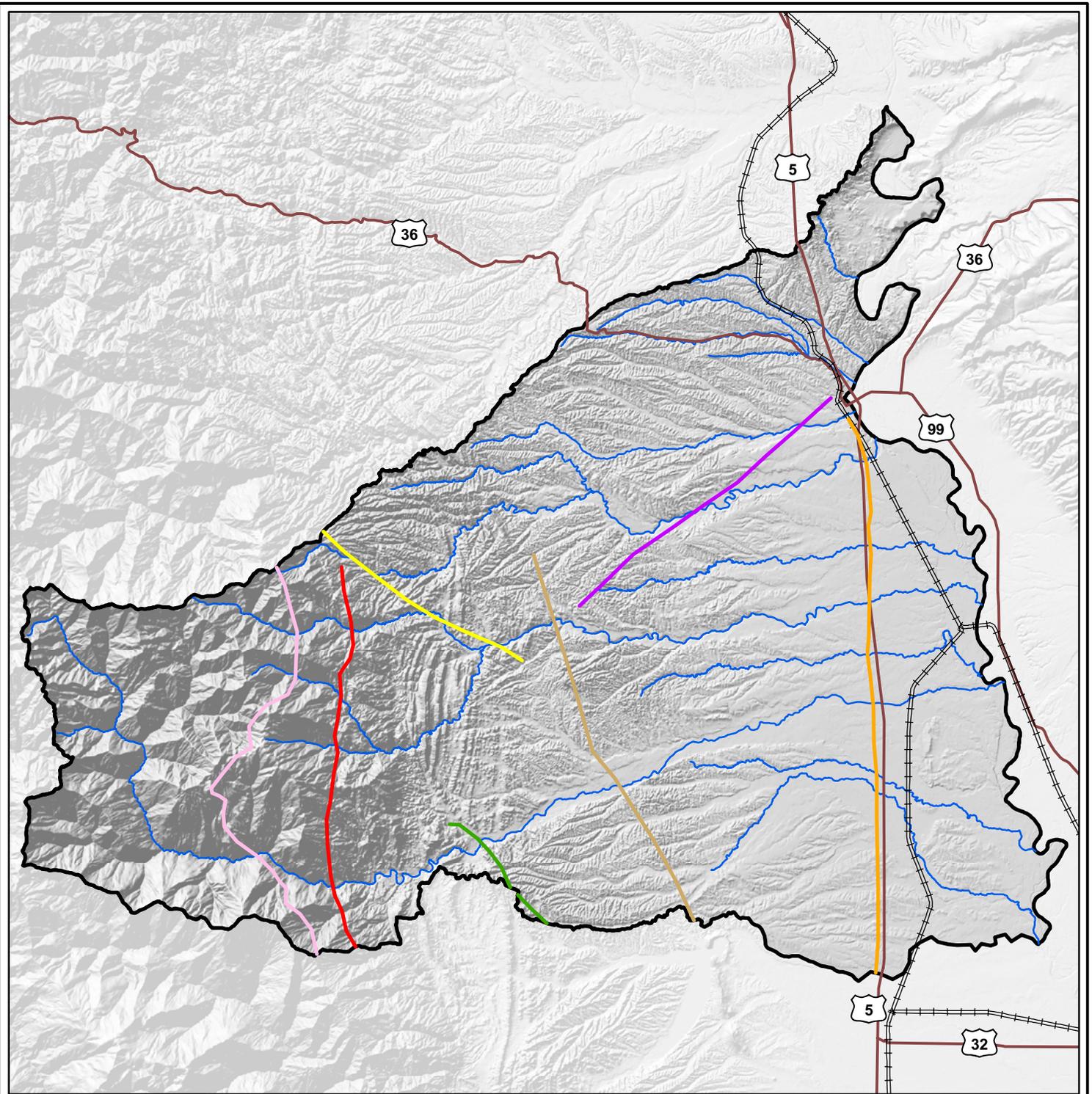
**Legend**

- ⚓ Railroad
- Major Highway
- Major Tributary
- ▭ Tehama West Watershed
- Alluvium
- Elder Creek Fault Zone
- Franciscan Formation
- Glacial deposits
- Incomplete
- Knoxville Formation
- Lower Cretaceous marine
- Mesozoic ultrabasic intrusive rocks
- Paskenta Fault Zone
- Pleistocene nonmarine
- Pliocene volcanic
- Pliocene volcanic basalt
- Pliocene volcanic pyroclastic rocks
- Pre-Cretaceous metasedimentary rocks
- Pre-Cretaceous metavolcanic rocks
- Quaternary nonmarine terrace deposits
- Stream channel deposits
- Upper Cretaceous marine
- Upper Pliocene nonmarine



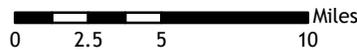
**FIGURE 4-2  
GEOLOGY  
TEHAMA WEST WATERSHED ASSESSMENT**





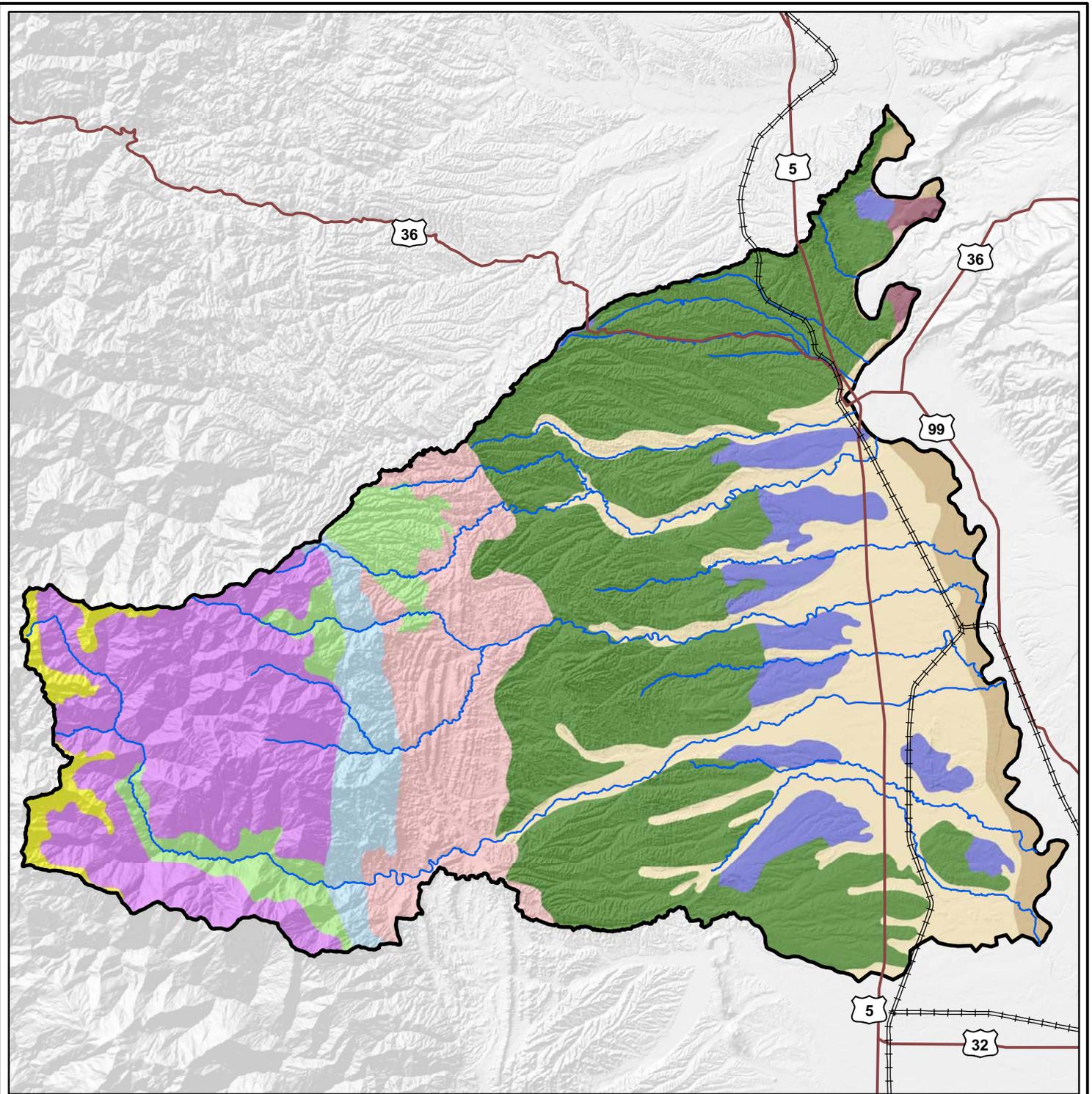
**Legend**

- |                         |                      |                   |
|-------------------------|----------------------|-------------------|
| ⚓ Railroad              | — Coast Range Fault  | — Paskenta Fault  |
| — Major Highway         | — Corning Fault      | — Red Bluff Fault |
| — Major Tributary       | — Elder Creek Fault  | — Willows Fault   |
| □ Tehama West Watershed | — Log Springs Thrust |                   |



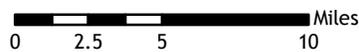
**FIGURE 4-3  
FAULTS  
TEHAMA WEST WATERSHED ASSESSMENT**





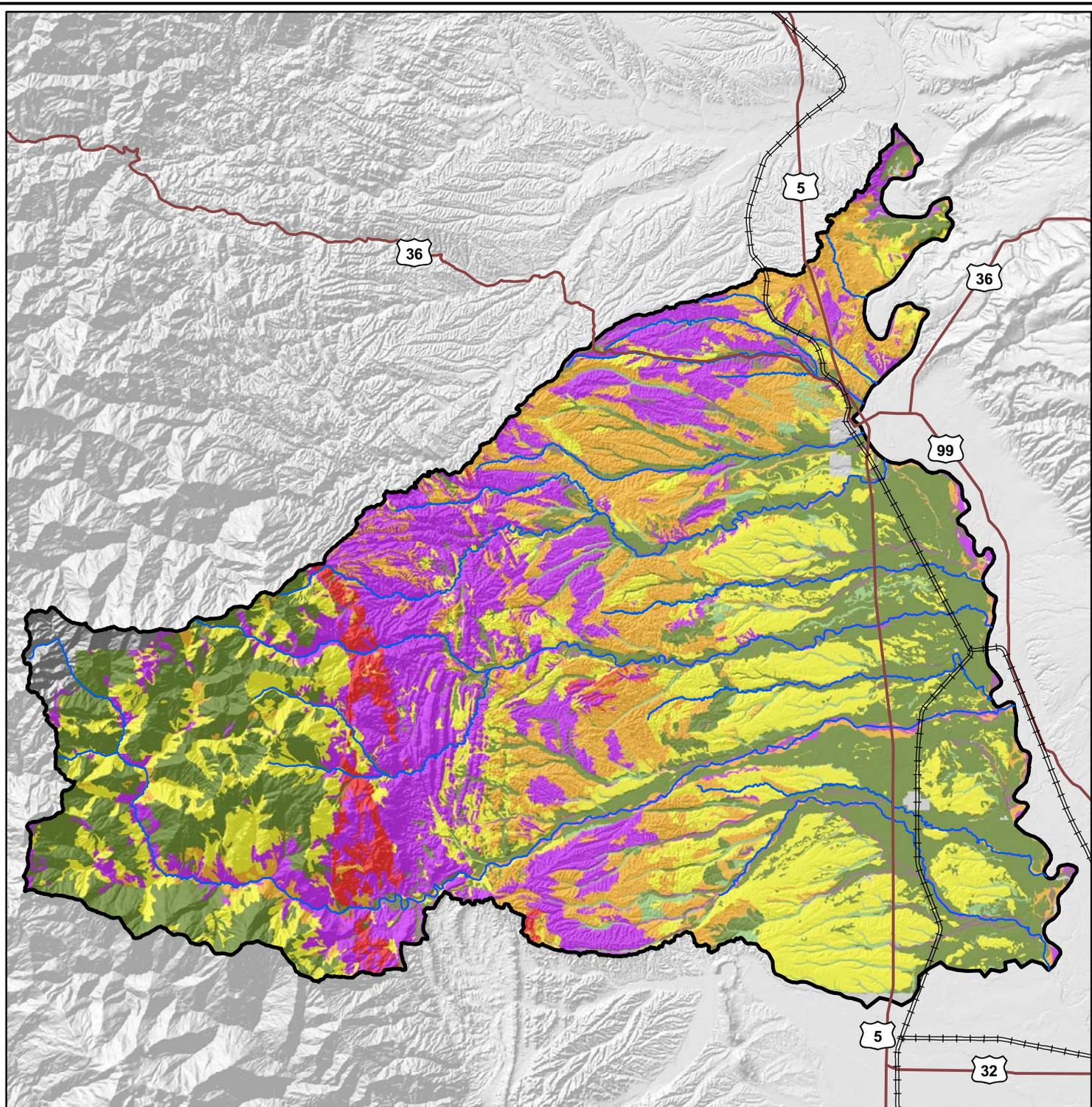
**Legend**

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



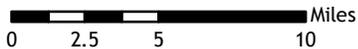
**FIGURE 4-4**  
**STATSGO SOIL TYPES**  
**TEHAMA WEST WATERSHED ASSESSMENT**





**Legend**

- |                         |                 |
|-------------------------|-----------------|
| ⊢⊢⊢ Railroad            | Low to Moderate |
| — Major Highway         | Moderate        |
| — Major Tributary       | High            |
| □ Tehama West Watershed | High to Extreme |
| Low                     | Extreme         |



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

