

## CHAPTER 3

### SOCIETY, ECONOMY, AND LAND USES IN BEAR CREEK WATERSHED

Chapter 3 describes the residents and communities in Bear Creek watershed (Sections 3.1 and 3.2) and characterizes past, current, and potential land uses in the watershed beginning with Section 3.3. An analysis of land uses in Bear Creek watershed helps to understand people's roles in creating, continuing, or resolving environmental issues that affect the quality and access for key resources in Bear Creek watershed. Knowledge of past land uses is critical as well to locating sources of environmental damage and to prioritizing and designing restoration or remediation projects that reduce adverse impacts from past uses.

With the arrival of settlers with cultural roots mostly in Europe, land uses changed markedly from Native American hunting, gathering, and tending of traditional resources for food and material culture. Actions over the last 160 years to facilitate travel, water delivery, agriculture, and mining have affected hydrologic function, soil stability, and biological integrity in ways that are costly to repair today. Examples of present-day outcomes from past human land uses include: altered stream flows; loss of a flood plain capacity; degradation of water quality; introduction of non-native invasive species; and changes to soil physical properties and increased soil erosion.

As stakeholders look to the future and back to the past at the same time, the need for stewardship of Bear Creek watershed becomes apparent. One responsibility of watershed stewardship is to limit transferring costs of current land uses to future generations as the result of poor decision making today. People can repair past damages now, and people can also avoid creating future legacies of damage from current and planned land uses. By applying existing knowledge and best land management practices, stakeholders leave a legacy of land use that does not discount the value of resources for future generations.

#### 3.1 Characteristics of Watershed Residents

##### *Population*

##### *Current Population*

Information on the population of Bear Creek watershed comes from Census 2000 of the US Census Bureau. Data collected by the Bureau represent the most recent snapshot of residents of Bear Creek watershed.

Census data from 2000 show five census tracts that cover all or part of the watershed. Together, the tracts tallied 57 residents, of which perhaps only 20 people are full-time

## BEAR CREEK WATERSHED ASSESSMENT

residents in Bear Creek watershed. Eighty-two percent of the Census 2000 tract populations identified themselves as white, nine percent as black, and nine percent as mixed race. Slightly more than five percent of residents also listed themselves as Hispanic. Adults comprised 91 percent of the population, with roughly equal numbers of men and women. Nearly 30 percent of residents are older than 65 years.

The watershed population differs from the population overall of Colusa County, where 71 percent of the population consists of adults, 12 percent of people are older than 65 years, and 52 percent of residents are Hispanic (US Census Data 2009). Whereas Colusa County's population rose from 12,430 in 1970 to 18,804 in 2000 (California Department of Finance 2007a,b), the population of Bear Creek watershed may have been stable for that same period. .

Of the 32 households in the tracts, half were single-person households, and only sixteen percent of households consisted of more than two people. Most households (64 percent) resided in owner-occupied houses.

### ***Past Residents***

Native Americans resided in Bear Valley until at least 1872 (Rogers 1891). One Wintun (Patwin) village, Suku, is known from the south end of Bear Valley (Johnson 1978). The Yawisel group of Hill Patwin people inhabited another village called Yawi along Sulphur Creek near Wilbur Springs (Mabel McKay undated interview as related in Gennis and Associates, Engineers 1978). The first Americans of European ancestry came to settle in Bear Valley in 1854 (Rogers, op. cit.). During the 19<sup>th</sup> century Chinese-American farm workers tended orchards and vineyards in Bear Valley. The population of Bear Creek watershed was greatest during the peak of mercury mining and refining during the 1890s, reaching more than 300 residents.

### ***Communities***

No incorporated municipalities lie within the watershed. Gateway communities to Bear Creek watershed are: Clearlake Oaks (Lake County), Rumsey (Yolo County), Williams, and Lodoga (the latter two both in Colusa County).

### ***Income***

The US Census Bureau does not publish income data about residents at the geographic level of Bear Creek watershed census blocks because statistical information about the small number of residents in each block might compromise privacy of residents. Most people working in the watershed pursue livelihoods in resort tourism, farming and ranching, public land management, and fire suppression.

***Languages***

English is the major language of residents, although Spanish is the first language for some workers.

**3.2 Land Ownership**

The watershed has multiple land ownerships, including private citizens, limited liability corporations, trusts, and government agencies. Table 3.1 gives the number of acres for each ownership type, and Figure 3 depicts the geographic distribution of these acres.

Table 3.1 - Area and percentage of land by land management category

<b>Land Management</b>	<b>Acres</b>	<b>Percent of Total Area</b>
Private Ownership	34,594	52.6
State of California	665	1.0
Lands Commission	658	1.0
Department of Forestry and Fire Protection	7	< 0.1
Federal	30,505	46.4
Bureau of Land Management – Ukiah Field Office	26,345	40.1
US Forest Service – Mendocino National Forest	4,104	6.2
<b>Total</b>	<b>65,708</b>	<b>100.0</b>

***Federal Lands***

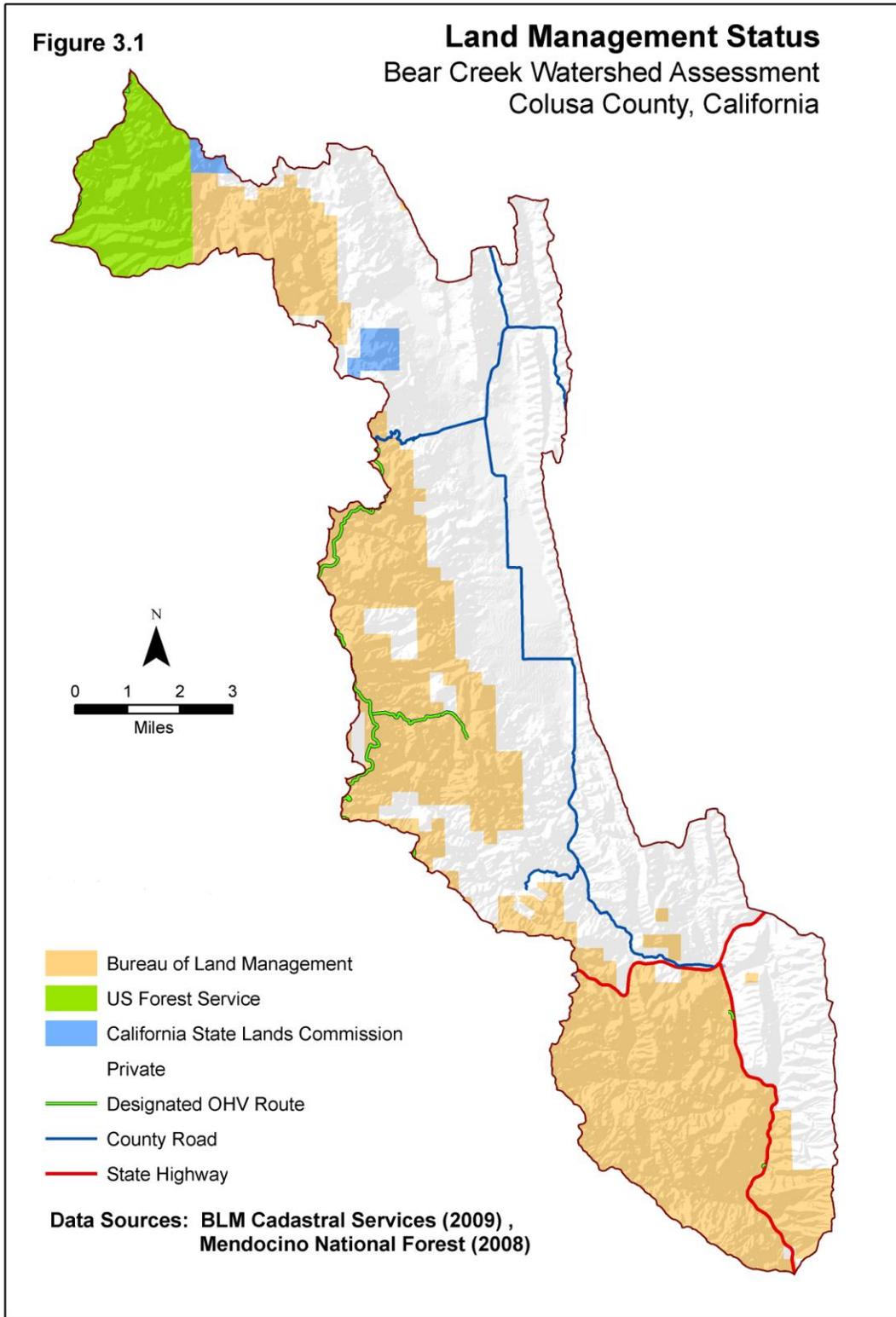
The US Federal Government manages public Federal lands in Bear Creek watershed under the auspices of two agencies: the US Department of Agriculture Forest Service, through the Mendocino National Forest, and the US Department of Interior Bureau of Land Management, through its Ukiah Field Office.

***State of California Lands***

The California Department of Conservation and the California Department of Forestry and Fire Protection (CALFIRE) manage State of California lands in Bear Creek watershed. Land holdings by state agencies are considerably smaller in extent than federal land holdings. CALTRANS manages highways and the easements along Highways 16 and 20.

***Tribal Lands***

No tribal lands lie within Bear Creek watershed. The following tribes have lands in adjacent watersheds: the Cortina Rancheria of Wintun Indians in the Cortina Creek watershed to the east and the Yocha Dehe Wintun Nation (formerly Rumsey Band of Wintun Indians) in the Middle Cache Creek watershed to the south.



***Local Government Lands***

Apart from county roadways and easements along these roadways, the County of Colusa does not manage any county public lands in the watershed. No municipal land holdings are present as well.

***Private Lands***

The largest category of land is under private ownership with corporate entities having the largest holdings. Seven corporations owning property in Bear Creek watershed operate as trusts or limited liability corporations. The remaining private land is divided among 32 individuals or families, who mostly reside outside the watershed.

**3.3 Ecosystem Services**

Ecosystem services are specific benefits to people from natural processes in the environment. The services enhance human life and maintain the quantity and quality of goods produced by land uses in a watershed (Brown et al. 2007). Ranches, for example, provide multiple ecosystem services to residents and other people regionally. Services include: wildlife habitat, open space, recreation lands, forage plants for honey bees and native pollinators, fire control, weed management, and water (County of Colusa Board of Supervisors 2008). Table 3.2 lists key ecosystem services in Bear Creek watershed that benefit the local and regional economy.

These services usually come at no direct cost to people but require stewardship to ensure their continued functioning in support of people's land uses. People often leave out consideration of how land uses affect ecosystem services when they make economic decisions. By not assigning an economic value to ecosystem services, landowners and resource managers may unintentionally ignore and impair the watershed functions that furnish the ecosystem services that in turn make land uses possible. The result is a loss of land productivity and lower economic returns for people.

The cost to restore a degraded ecosystem service and to regain its productivity can be high. A major example in Bear Creek watershed is the poor water quality that results from the impaired service of water purification, resulting in turn from the poor mining practices in the past. These past practices cause the current release of unnaturally large quantities of toxic mercury into streams. Mine site cleanups of mercury and its associated mine waste will require a significant societal investment. Recovering natural water quality in Bear Creek watershed due to mine pollution could cost as much as \$33,393,300 (TetraTech 2003, expressed in 2007 dollars).

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Table 3.2: Ecosystem services in Bear Creek watershed

<b>Ecosystem Service</b>	<b>Dependent Land Uses</b>	<b>Examples of Relevance to the Local and Regional Economy</b>
Soil Fertility and Stability	all land uses	Provide the substrate, chemistry, and nutrients for growing plants, holding water, storing carbon, and maintaining land for agriculture
Water Purification	water delivery, development, agriculture, recreation	Maintain water quality of stream flows from contamination by toxic elements and compounds, bacteria, and parasites
Flood Control and Mitigation	water delivery	Slow water flow during times of high rainfall for more even supply of water to uplands, wetlands, riparian corridors, and downstream users; regulate the exit of water from watershed soils and streams; minimize soil erosion and stream sedimentation
Air Purification	recreation and tourism, human health	Provide high air quality in the watershed and adjacent Lake County, which has the best air quality in California, and lower healthcare costs, especially for children and the elderly
Biological Diversity	all land uses	Support the complex and diverse interactions among species that support agriculture, recreation (e.g., wildlife and wildflower viewing), landscape stability, and resilience to catastrophic changes (e.g., natural restoration of land productivity after avalanches, droughts, fire)
Native Pollinators	agriculture	Pollinate legume forage crops in Bear Valley; pollinate native plants that create wildflower displays
Open Space	recreation and tourism, subsistence hunting	Make available diverse recreation opportunities, solitude, and wildlife habitat, resources at an increasing premium in the three-county region around the watershed
Carbon Storage	forest and woodland management, grazing and agriculture,	Maximize the amount of carbon in soils and vegetation; reduce carbon in the atmosphere linked to climate change and potential economic disruptions; and make soil organic matter available for forage and crop production
Partial Stabilization of Temperature and Wind	forest and woodland management, grazing and agriculture	Provide shade from the sun, local cooling, and wind breaks with the structure of vegetation for the benefit animals and plants; reduce the force of rainfall impact and erosion on soils
Habitat for Game Animals and Economic Plants	recreation and subsistence gathering	Furnish private landowners and state agencies with income from hunting; give people alternative food sources and plant materials for cultural uses

The scope of projects needed to restore this and other impaired ecosystem services in Bear Creek watershed is part of the accompanying document *Stewardship for Bear Creek Watershed: Priorities, 2010 – 2014*.

### 3.4 Water Delivery

People have reworked the landscape and hydrology of Bear Creek watershed to enhance water delivery for uses benefitting landowners in the watershed. Wells, dams, stock ponds, bridges, culverts, and channel diversions modify the natural water flow in Bear Creek watershed. Figure 3.2 shows the locations of water-related infrastructure designed to alter water flow and delivery

#### *Wells*

Development of groundwater for human uses in the watershed is not extensive. The Colusa County Groundwater Management Plan (2008) maps seven wells in Bear Creek watershed, all found on private lands: three irrigation wells along the lower main stem of Mill Creek and four domestic water wells in elsewhere in Bear Valley and Sulphur Creek subwatershed. The wells are less than 250 feet deep with one exception. No information is available on the impact of human use of groundwater on its recharge, depletion, and trends in groundwater quality (Department of Water Resources 2003). The California Department of Water Resources and the US Geological Survey have no well monitoring stations in the watershed.

#### *Dams and Stock Ponds*

Large dams are absent from Bear Creek and its tributaries. Two small dams on private property, with a total capacity of 351 acre feet, fall under the jurisdiction of the California Department of Water Resources, Division of Safety of Dams. These dams provide water for crop irrigation and livestock operations and represent only a small portion of the total annual flow in the watershed.

National ID Number	Name	Year Built	Reservoir Area (acres)	Type	Reservoir Capacity (acre feet)
CA 00554	York Hill	1952	17	Earthen	245
CA 00555	Rancho Rubini	1955	10	Earthen	106

Source: California Department of Water Resources, Division of Safety of Dams, Dams within the Jurisdiction of the State of California

Small stock ponds are present throughout Bear Creek watershed: 32 permanent ponds covering 33 acres and twenty intermittent ponds covering six acres (USGS National Hydrography Database 2008), all of which are man-made. These ponds alter water flows at least seasonally.

The 1998 update to the California Water Plan (California Department of Water Resources 1998) postpones indefinitely consideration for a large-scale water project and dam in Bear Creek watershed because of environmental concerns and conflicts with federal land management policies.

***Stream Alterations***

Most stream alterations were constructed on private lands and relate to supplying water to stock ponds and forage crop fields. A more complete analysis to identify all locations of alterations is needed. More information on steam alterations is found in Section 6.3 Creek Channel Alterations.

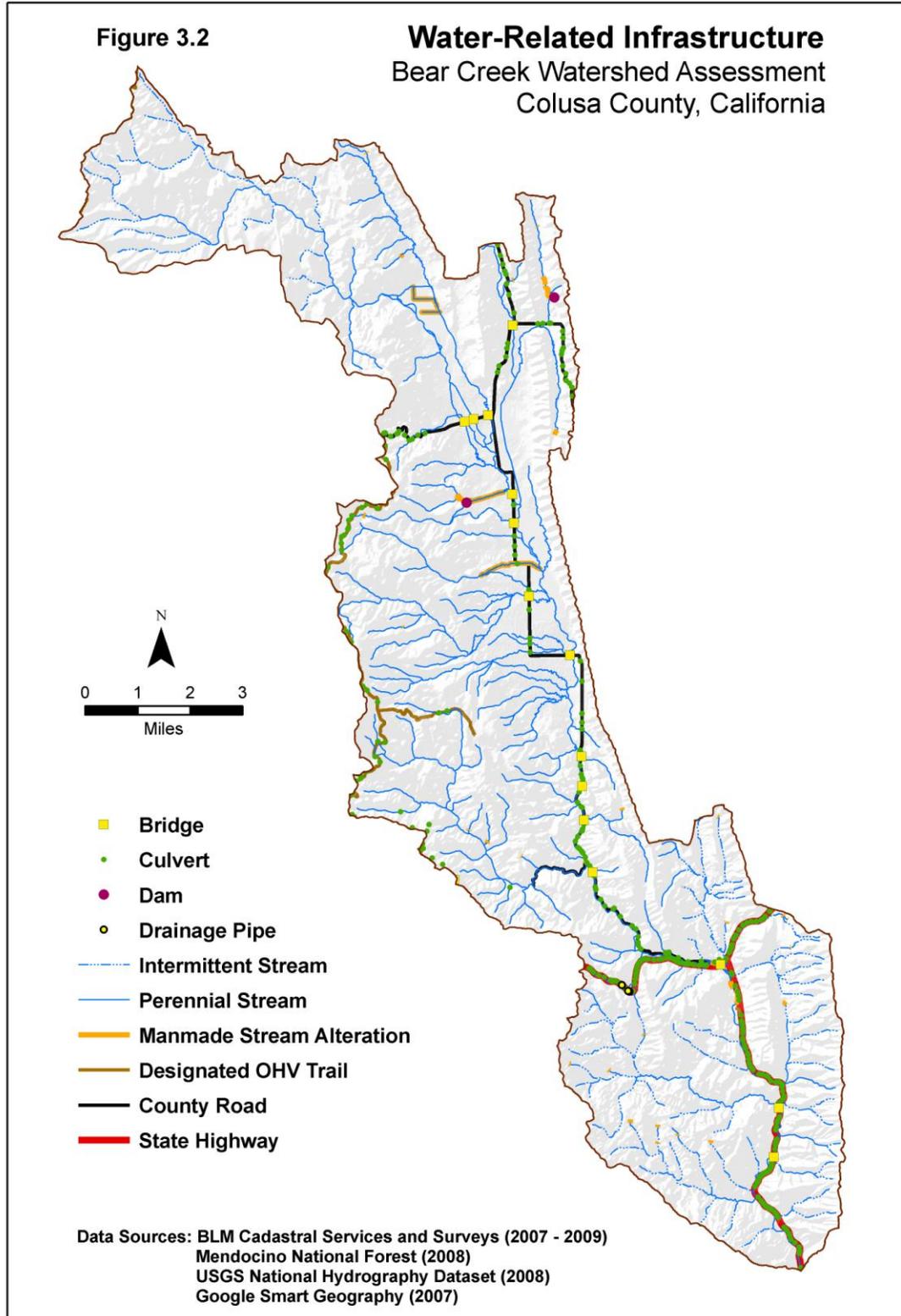
***Culverts***

Culverts placed to drain water are a major investment in infrastructure in Bear Creek watershed. More than 335 have been inventoried in the watershed. Along Highway 20 west of the Bear Creek Bridge, for example, the California Department of Transportation has installed an elaborate system of long, wide-diameter culverts to feed water running off of ultramafic rock slopes from the south side of Highway 20 more effectively into Bear Creek without creating slope erosion on creek banks that would impact stream water quality and undermine the highway itself. Figure 3.2 shows the distribution of culverts in the watershed.

***Contribution and Value of Bear Creek Water to Agricultural Water from the Cache Creek Basin***

Landowners in the watershed use its water to a limited extent in Bear Valley for irrigating forage crops and for livestock water. The greater economic contribution of water from Bear Creek watershed occurs when the water reaches the main stem of Cache Creek. The Yolo County Flood Control and Water Conservation District uses the Capay Diversion Dam in the Capay Valley south of the watershed to supply water to agricultural enterprises in Yolo County. Bear Creek contributes to the Yolo County water delivery system at the beginning of the irrigation season, beginning variously in March through May depending on winter rainfall, and ending in October or November. Water diversions come during the time of year when Bear Creek flows are at their lowest. Water during the high-flow winter months is not used for agriculture. Table 3.3 shows the variable nature of the contribution of Bear Creek and the market value of the water delivered from Bear Creek watershed.

The estimated annual contributions in volume and value of Bear Creek water to the irrigation water supply for agriculture in Yolo County between 1999 and 2007 ranged widely. By volume, Bear Creek watershed contributes on average usually less than three percent of the total water delivered to Yolo County agricultural water customers. Most water used for irrigation comes instead from Clear Lake and from Indian Valley Reservoir in the North Fork Cache Creek watershed.



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Table 3.3 – Bear Creek water volume used for irrigation and its value, 1999 to 2007

Year	Irrigation Water from Bear Creek (acre feet)	Water Price in constant 2007 dollars	Total Annual Value in constant 2007 dollars
1999	3709.2	\$ 17.41	\$ 64,565
2000	4614.1	\$ 16.45	\$ 75,921
2001	7540.2	\$ 16.28	\$ 122,725
2002	1324.9	\$ 15.81	\$ 20,070
2003	5226.0	\$ 16.56	\$ 86,557
2004	3959.8	\$ 15.89	\$ 62,927
2005	5142.5	\$ 15.36	\$ 78,975
2006	5176.9	\$ 15.20	\$ 78,668
2007	1238.8	\$ 15.50	\$ 19,201

Sources: USGS water gage records for remaining years from station 11451715 (Bear Creek at the mouth of Holsten Chimney Canyon north of Rumsey, CA); nominal water prices per acre foot from the Yolo County Flood Control and Water Conservation District (M. Stevenson, pers. comm.)

Note: Water prices in constant 2007 dollars are adjusted for inflation based on the average annual Total Producer Price Index time series from the Bureau of Labor Statistics stored at [www.economagic.com](http://www.economagic.com).

### 3.5 Forest and Woodland Management

Timber production is not an economic activity in the watershed. The common conifer species in Bear Creek watershed, foothill pine, knobcone pine, and McNab cypress, do not have the high-value wood properties required by the construction industry.

Oak woodlands provide the greater economic value as fuel- and firewood. In earlier times, miners used oak timbers for fueling retort furnaces to extract mercury from cinnabar ore. Photographs show extensive treeless slopes in Sulphur Creek subwatershed at the beginning of the 20<sup>th</sup> century (Goff et al. 2001). The dense even-aged oaks stands found today near mercury mine sites indicate that blue oak woodlands and other tree species regenerated naturally after deforestation for industrial and domestic fuelwood ceased in the Wilbur Springs area.

Oak harvesting continues at a low level on private lands, but data are not available. No commercial timber or fuelwood harvests have been reported from Colusa County since 2003 in records kept by the California State Board of Equalization under the California Timber Yield Tax Law (Revenue and Taxation Code, Division 2, Part 18.5).

Several opportunities are available for oak conservation. With the passage of the California Land Conservation Act of 1965 (the “Williamson Act”), the County of Colusa may contract

with private landowners to dedicate for ten-year periods specific private lands to agriculture and natural open space. In return, landowners receive lower property tax assessments based on farming and open space uses as opposed to full market value. This program relieves owners of high tax burdens and the pressure to sell their properties for urban and suburban development. Oak woodlands and other natural landscapes in the watershed also remain intact through conservation easements. Under the Act, private organizations pay a landowner a fixed sum to retain oak woodlands and other high-quality environments valued by society at large. Under these arrangements, both the private landowner and the public maintain natural environments on private lands and sustain rural lifestyles.

The Oak Woodland Conservation Act of 2001 now makes funds available through the Wildlife Conservation Board to private landowners to protect oak woodlands once a landowner's county has prepared a management plan for oak woodlands. In 2008, the Colusa County Resource Conservation District prepared and the Colusa County Board of Supervisors approved the *Colusa County Voluntary Oak Woodlands Management Plan*.

No permitted oak harvesting occurs on the Mendocino National Forest or BLM public lands in the watershed. In 2006, the BLM Ukiah Field Office completed its Record of Decision for the Field Office Resource Management Plan. A core conservation management action in the Plan is a ban on cutting oak trees on the BLM public lands except in cases of safety hazards.

At Wilbur Springs and on the BLM Bear Creek Ranch, efforts are underway to promote reestablishment of oak woodlands.

### **3.6 Agriculture: Livestock Grazing and Crop Production**

The California Department of Conservation, through its Farmland Mapping and Monitoring Program, evaluates the land use status and productivity of agricultural lands in Colusa County every two years to detect changes in rural land use (Figure 3.3). Although many other agricultural areas in California are undergoing rapid population increases and urbanization, agricultural land in Bear Creek watershed has remained virtually unchanged since 1986 when mapping began. The constancy of rural land uses has conserved the character of the watershed and its agricultural landscapes.

The bulk of agricultural land falls under the category of "farmland of local importance" and includes lands covering most of Bear Valley, the Leesville area, Sulphur Creek subwatershed, and the BLM Bear Creek Ranch. This farmland is principally used for livestock grazing. Crop yields for these lands, even with irrigation, are not likely to be as high as on prime farmland or farmland of statewide importance. Where existing vegetation is suitable only for livestock grazing, lands are classified as "grazing land", even though

grazing is also suitable on all other farmland types. Only one significant block of land in Bear Valley has irrigation and soil fertility to merit the status of “prime farmland.” One other area, also at the north end of the watershed qualifies for “unique farmland”, high-value but somewhat less productive farmland. Areas where ultramafic soils predominate or where remoteness and uneven terrain make most, if not all, agriculture infeasible economically, are classified as “other land.” Public land management agencies manage most of the “other land.”

### ***Crop Production***

The agricultural crop economy of Bear Creek watershed differs significantly from the portion of Colusa County in the Sacramento River Valley where rice and other irrigated crops are dominant. A water district does not cover the watershed, and irrigation water in commercial quantities is not available for summer crops.

Because water for irrigation is scarce, dryland farming has traditionally dominated agriculture in the watershed. Since the 19<sup>th</sup> century, most crops have been grains or forage crops such as alfalfa and hay; wheat, barley, and oats were dominant crops exported from the valley in the 1880s. In 1941, the Agricultural Extension Service of Colusa County estimated that 4,608 acres were suitable for grain production in Bear Valley. At mid-century, wheat and barley were principal grain crops, mostly grown on three-year rotations with hay production and fallowing. Before 1900, a few vineyards and orchards were present (Green 1950).

An estimated 212 acres of the watershed (0.3 percent of total area) were devoted to crops in 2006. Two ranches currently irrigate summer crops. In past decades, grain crop production has declined. Recent increases in grain prices, however, have revived wheat growing at the north end of Bear Valley.

Figure 3.4 shows the distribution of potential forage production during a year with average rainfall and temperature range. It serves as a surrogate for site fertility and suitability for crop production. The BLM Bear Creek Ranch, central Bear Valley, and the upper portion of Leesville subwatershed are the most productive agricultural areas

### ***Livestock Grazing***

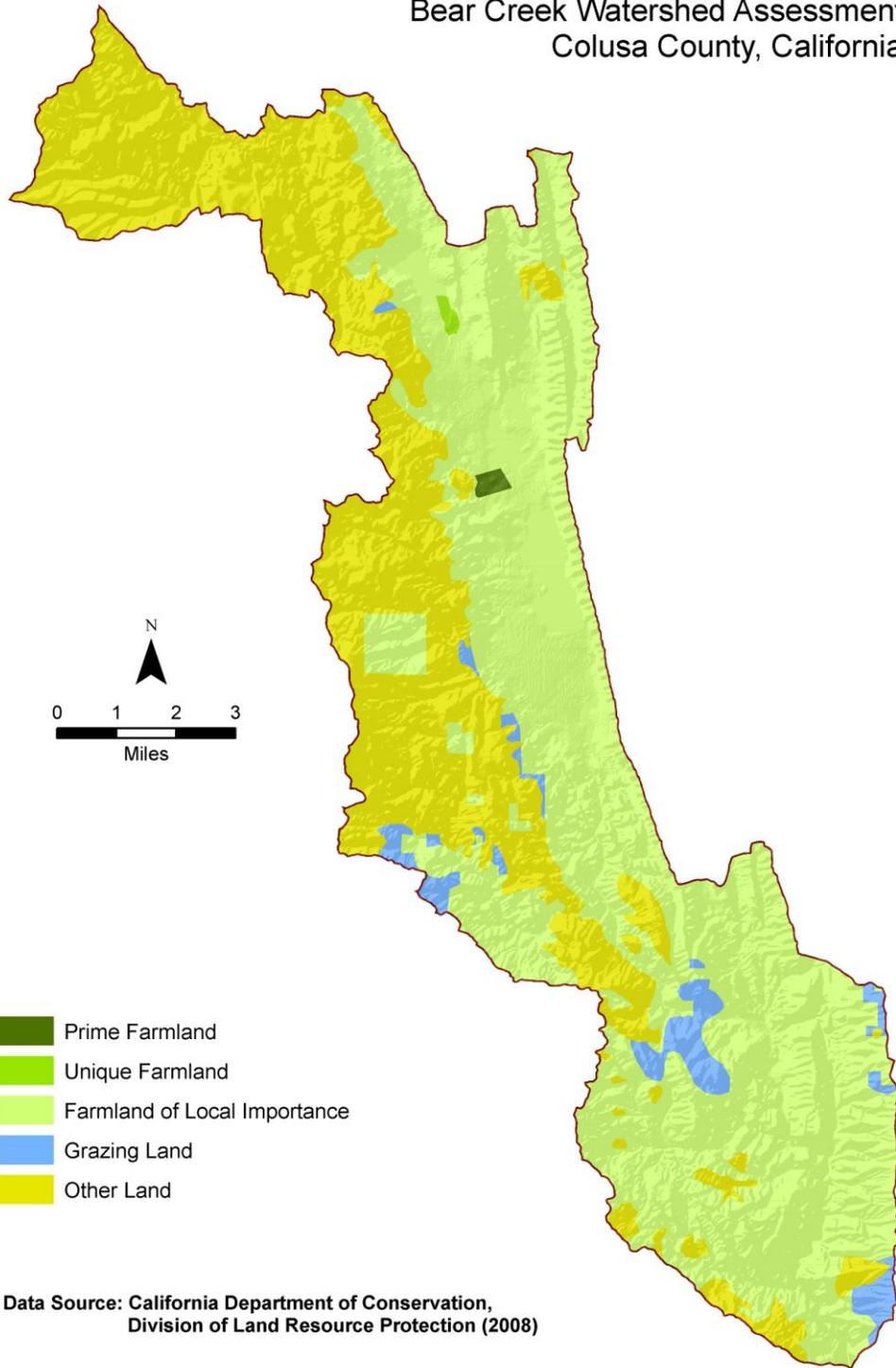
#### *Grazing on Private Lands*

Livestock grazing is the main agricultural source of income in Bear Creek. Estimated livestock carrying capacity is ten acres per animal per year (Agricultural Extension Service of Colusa County 1941). Past or current data on the average number of livestock in the watershed are not available. Grazing in the watershed is mostly winter grazing.

Figure 3.3

### Agricultural Land Use Classes, 2006

Bear Creek Watershed Assessment  
Colusa County, California



*Grazing on Public Lands*

Public lands of the Mendocino National Forest in Bear Creek watershed were at one time part of the Goat Rock grazing allotment, now closed to grazing. In 1941, the Agricultural Extension Service rated the quality of rangeland on what are now the BLM lands north Highway 20 as poor, due principally to the low forage productivity of vegetation growing on ultramafic soils. Permitted grazing continues on the BLM Bear Valley Ranch south of Highway 20 as a tool to suppress non-native grasses, principally medusahead.

*Marijuana Cultivation*

Marijuana (*Cannabis sativa*), a recent introduction to the crop economy of Bear Creek watershed, is grown both legally on private lands for authorized medical use and illegally under trespass on public lands. Illegal cultivation of marijuana has been occurring since at least 2007 in remote public lands of Bear Creek watershed. In 2007, BLM law enforcement staff halted a single operation; that number rose to three operations intercepted in 2008.

*Beekeeping*

Beekeepers benefit greatly from the native and introduced plants in Bear Valley. Yellow starthistle is the major nectar resource for European honeybees (*Apis mellifera*). Bear Valley provides an important niche for beekeepers in the early summer, after they complete pollinating nearby orchard crop trees and before they move on to higher and more northern areas for the late summer. The economic value of honey produced from Bear Valley is not known.

*Traditional Native American Subsistence*

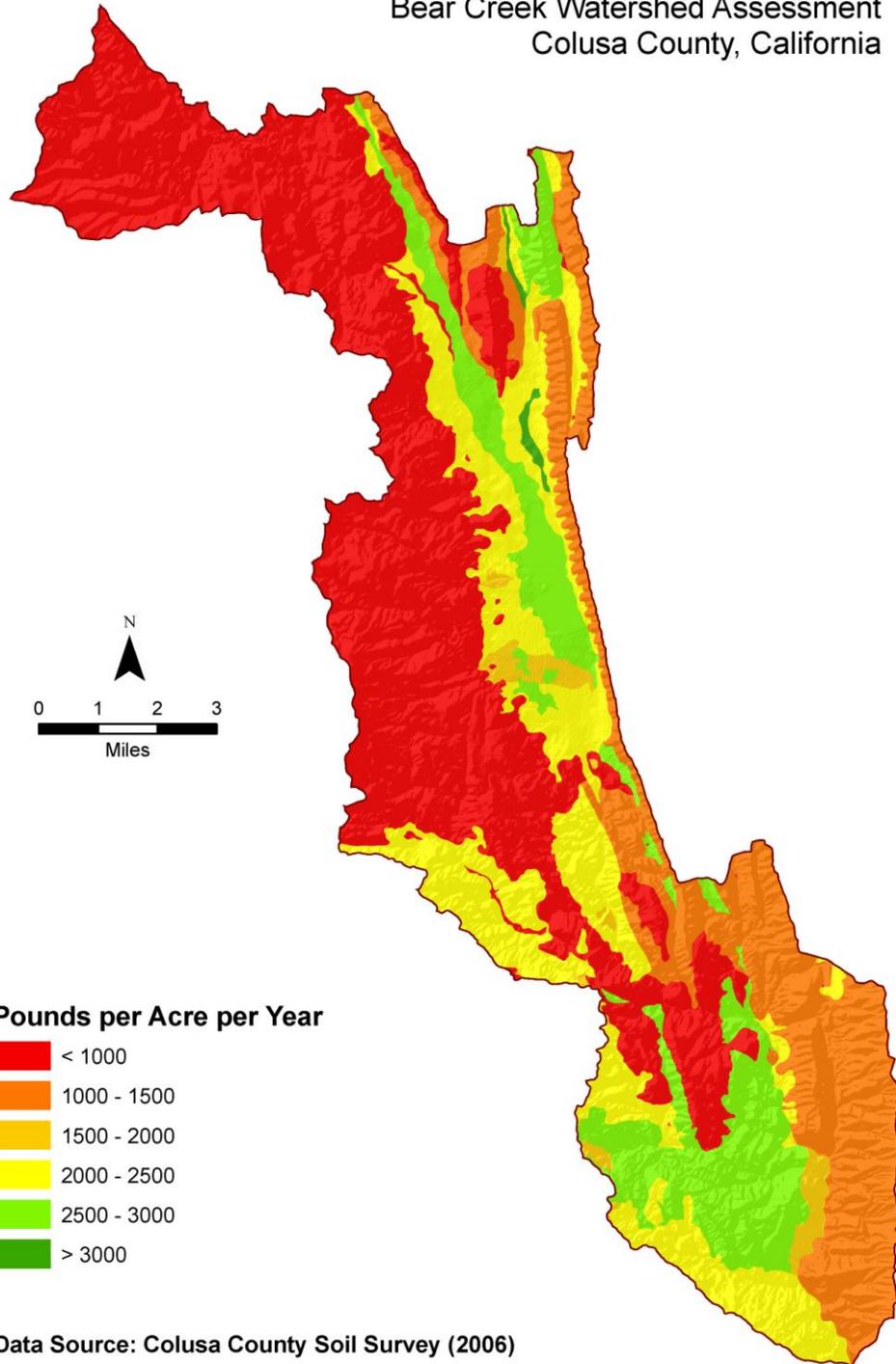
The Southern Wintun people who have traditionally fished, hunted, and gathered plants for food, medicines, and fiber plants in the watershed benefitted from the abundant elk, deer, and pronghorn that were plentiful the watershed (Green 1950). Oak woodlands and riparian areas are particularly important subsistence gathering sites. In past decades, private landowners in Bear Creek watershed held most of the land that produced traditional Native America foods, medicines, and material culture. Now that more lands are open to public access, opportunities for collecting and managing for native crops in oak woodlands and riparian areas for traditional products are again possible.

In 2007, the US Forest Service, Region 5, and the BLM California State Office established a common Traditional Gathering Policy for their public lands in California. This policy supports native cultural practitioners gathering traditional plants for non-commercial uses. In general, free use of plants, without permits, is granted for traditional cultural gathering. Federal land managers work locally with Tribes and traditional practitioners to identify, restore, and enhance important plant resources.

Figure 3.4

### Forage Production in Normal Years

Bear Creek Watershed Assessment  
Colusa County, California



### **3.7 Mining**

In the past, mining was central to the economy in the watershed. Settlers found coal in Bear Valley in 1855, and in 1863 a coal bed about two miles south of Wilbur Springs was briefly commercially mined (Rogers 1891). Copper, the first metal mined in the watershed, and gold were discovered in 1863. Commercial gold mining started in 1865 at Manzanita Mine, and gold has been historically the second-most important mining product in the watershed after mercury. The Sulphur Creek Mining District has been one of the three main gold-producing districts in the North Coast Range (Sherlock 2005). However, the potential yield for gold from sources in Sulphur Creek subwatershed was too low for economic profitability in the 1980s, the last time that gold was mined in the Coast Range.

Other minerals have been commercially developed for brief periods. Starting in 1866, sulfur was shipped commercially in large quantities. One mine, probably developed for extracting chromite, is found in Mill Creek subwatershed and marks the southern end of the chromium belt that runs from Colusa County to Tehama County. Prospecting has occurred in a few other sites in the watershed, notably on the ridgeline between Gaither Canyon and Trout Creek subwatersheds but has not resulted in commercial mineral production.

Table 3.4 outlines information on the commercial mines in Bear Creek watershed. Figure 3.5 shows the locations of major mines, quarries, and prospects plus areas designated by the California Department of Conservation as Principal Areas of Mine Pollution (PAMPs).

#### ***Mercury Mining***

Initial commercial production of mercury in California coincided with the gold mining era from the 1850s to 1890s. Mercury was widely used to separate metallic gold from its rock ore at mining sites in the Sierra Nevada foothills and a smaller number of mines in the inner North Coast Range. Mercury mines in the Coast Range produced the mercury needed for gold extraction throughout California.

Mercury was discovered in the watershed in 1865. Mines in Bear Creek watershed and vicinity were the third largest source of mercury in California. Mercury mining was intermittent because of irregular demand and fluctuating prices that determined the feasibility of mining operations. During periods of mercury mining, ranchers and farmers in Bear Creek watershed commonly shifted to work in the mines because of the higher wages. No mercury mines are operating in the watershed now. The most recent commercial mining, limited to the Rathburn-Petray mine complex, ceased in the early 1970s (Tetra Tech 2003).

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Table3.4 - Mines in Bear Creek watershed and their legacies

Mine Name	Subwatershed	Principal Products	Current Ownership	Mine Features	Years of Operation	Sources of Mercury Contamination	Amount of Mercury Contamination (pounds per year)	Treatment Acres of Mine Waste	Volume of Treated Mine Waste Volume (cubic yards)	Mid-Range Estimate for Cleanup and Remediation Cost
Black Bird	Mill Creek	chromium copper	Mendocino NF	1 tunnel	unknown	none known	none	n.a.	n.a.	\$200,000
Central	Sulphur Creek	mercury	private	4 adits	1891 to early 1900s, 1926, 1942	mine cuts, waste rock, tailings, processing facility	0.01 to 0.07	2.0	166	\$ 372,300
Cherry Hill	Sulphur Creek	gold mercury silver	private	2 adits	see Manzanita Mine	waste rock next to Sulphur Creek and around old stamp mill	<2.5	1.0	1,420	\$ 428,600
Clyde	Sulphur Creek	gold	BLM	2 shafts, 3 adits	1886 - 1890	tailings, bulldozer cuts	0.09 to 0.15	n.a.	n.a.	n.a.
Elgin	Sulphur Creek	mercury	private	3 adits and open cuts	1875, 1892-1893, 1905, 1916	waste rock, tailings, retort	8.60 to 20.50	1.9	4,227	\$ 772,900
Empire	Sulphur Creek	mercury	private	3+ adits	1873, 1875, 1890, 1926	waste left at site and in the retort	0.09 to 0.13	0.5	5,748	\$ 45,300
Manzanita	Sulphur Creek	gold, mercury	private	many adits and shafts	1863-1891, 1902-1909, 1911, 1917, 1929-1934, 1942	mine cuts, waste rock, tailings in Sulphur Creek floodplain and sediment in Sulphur Creek	0.66 to 14.33	4.1	300	\$ 877,100

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Mine Name	Subwatershed	Principal Products	Current Ownership	Mine Features	Years of Operation	Sources of Mercury Contamination	Amount of Mercury Contamination (pounds per year)	Treatment Acres of Mine Waste	Volume of Treated Mine Waste Volume (cubic yards)	Mid-Range Estimate for Cleanup and Remediation Cost
Petray North	Upper Bear Creek	mercury	BLM and private	open pit	Rathburn-Petray mine complex was the largest producer before 1900, closed in 1916, relocated in 1956 and produced until the early 1970s	waste rock, contaminated sediment in a Bear Creek tributary	0.09 to 8.37	6.9	9,837	\$ 1,147,400
Petray South	Upper Bear Creek	mercury	BLM and private	open pit		waste rock, overburden	0.88 to 1.76	4.1	400	\$ 194,300
Rathburn	Upper Bear Creek	mercury	BLM	open pit		waste rock, retort site	none outside the site	1.5	6,546	\$ 547,500
Rathburn-Petray	Upper Bear Creek	mercury	BLM	open pit		waste rock, contaminated sediment in a Bear Creek tributary	1.54 to 43.43	9.1	191,792	\$ 4,399,700
West End	Sulphur Creek	gold	private	3 adits	see Manazanita Mine	waste rock and sediment contaminating Sulphur Creek	<0.01 to 2.43	0.8	3,722	\$ 480,600
Wide Awake	Sulphur Creek	mercury	private	shafts	1874-1877, 1932, 1936-1937, 1942-1943	mine cuts, waste rock, tailings, processing facilities	0.04 to 0.97	3.2	10,014	\$ 1,270,300

Source: Churchill and Clinkenbeard (2003), TetraTech (2003), costs expressed in 2007 US dollars

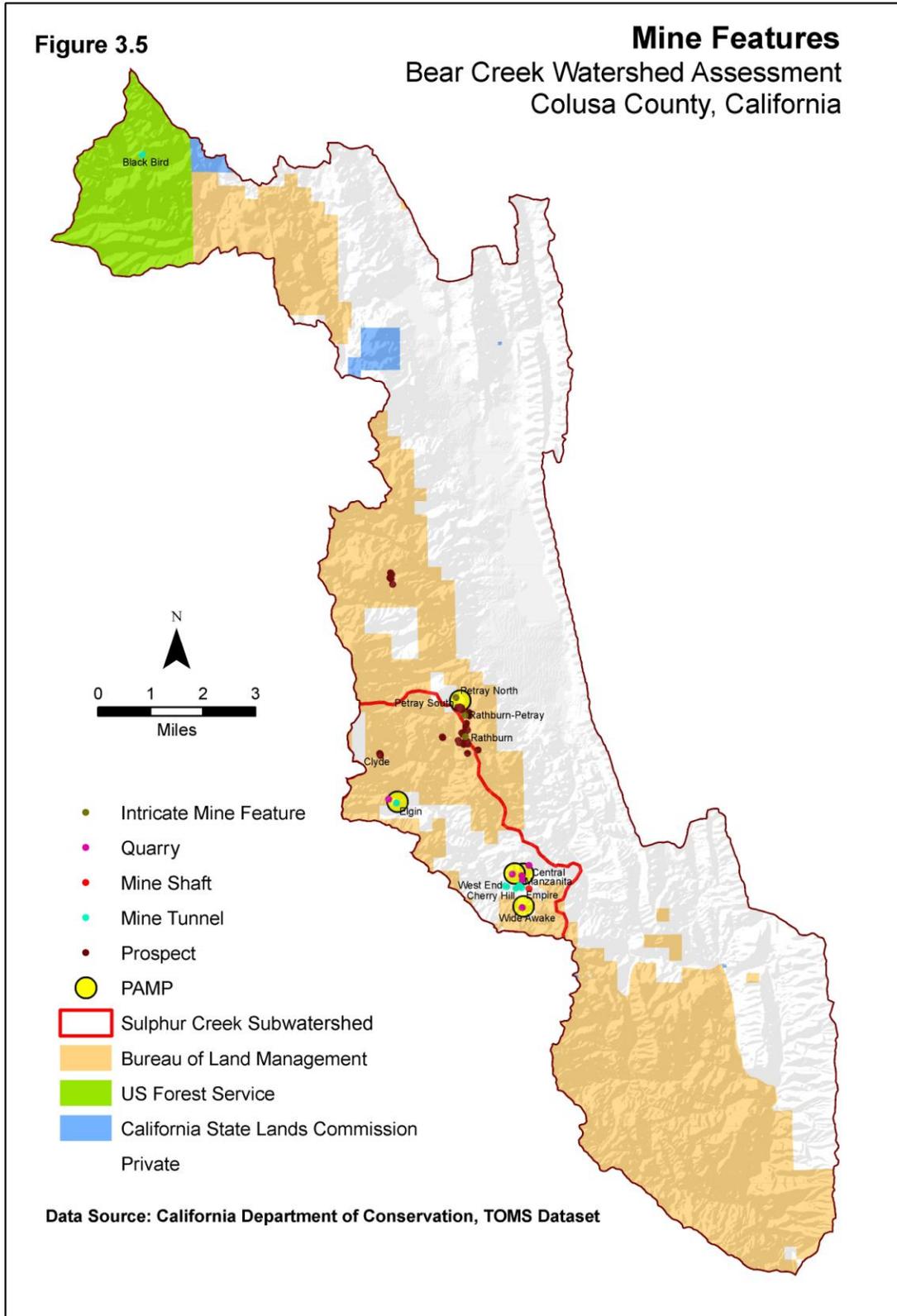
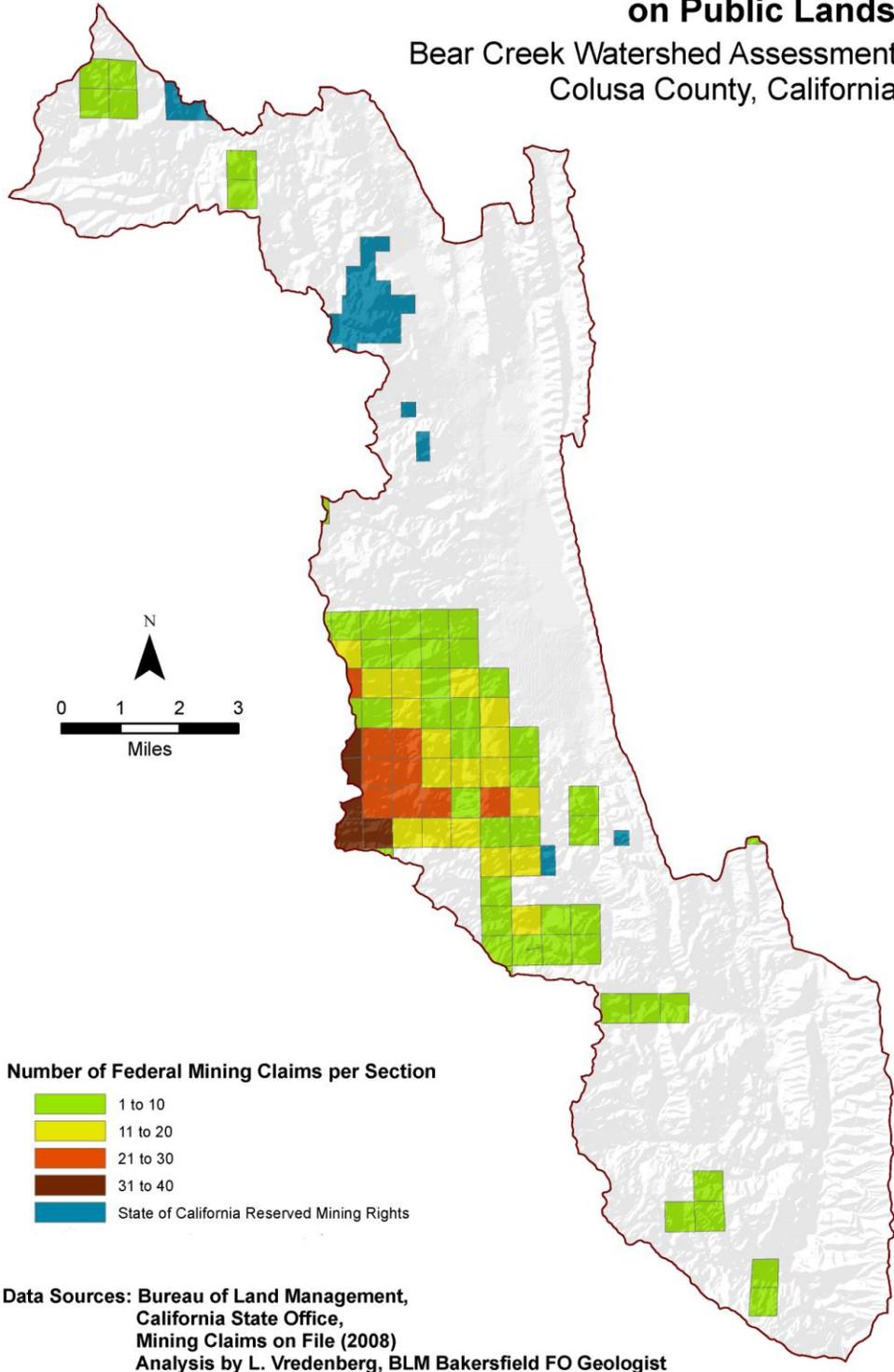


Figure 3.6

### Sections with Historical Mining Claims on Public Lands

Bear Creek Watershed Assessment  
Colusa County, California



Data Sources: Bureau of Land Management,  
California State Office,  
Mining Claims on File (2008)  
Analysis by L. Vredenberg, BLM Bakersfield FO Geologist

***Mining Legacies and Costs for Remediation and Restoration***

In Sulphur Creek subwatershed and in the Rathburn-Petray mine complex, the legacy of mining operations is especially visible with pits, adits, trails, and remains of processing facilities. Past mining activities continue to discharge unacceptably large amounts of mercury to creeks in the watershed. Mercury discharged from the mines and mine waste passes into creek channels and floodplains downstream from the mines. Over time, these mercury-rich wastes move downstream where they enter Cache Creek and ultimately the Sacramento River and the Bay/Delta region.

**3.8 Recreation and Tourism**

Data on recreation and tourism specific to Bear Creek watershed are scant. Studies of current and potential recreation uses, user demographic profiles, and economics of travel and tourism in the watershed are not available. Characterization of recreation activities is mostly qualitative.

***Major Recreation and Tourism Uses***

Both private landowners and public land management agencies provide opportunities and access to a full spectrum of recreation activities and pastimes in the watershed. Based on the federal Recreation Management Information System (RMIS) data from the BLM Ukiah Field Office for the Cache Creek Natural Area, which overlaps with Bear Creek watershed, an estimated 32,622 people visited state and federal public lands in the watershed during fiscal year 2008. Data for visitors to private lands are not available, but annually thousands of visitors come to Wilbur Springs, lodge in an historic hotel, and hike on private lands in Sulphur Creek subwatershed.

Recreation and tourism activities include automobile touring, birding, other wildlife and wildflower viewing, camping, cycling, equestrian sports, hiking, horse and buggy travel, hunting, long-distance running, mineral spa visits, off-highway motor vehicle riding, and rafting. The Capay Valley Hiking Club, a recreation group in the greater Cache Creek Basin, has annotated areas of scenic and recreational value in Bear Creek watershed on Google Earth (A. Fulks, pers. comm.).

In 2011, the BLM Ukiah Field Office will be considering expansion of the network of routes for off-highway riding on Walker Ridge public lands.

***Major Tourism Resources***

Bear Valley is home to one of the most spectacular wildflower displays in California (Ornduff et al. 2003), and visitors come from as far as Europe and Japan to view the Valley each spring. Many rare plants are also viewable along Walker Ridge Road and Brim Road.

## BEAR CREEK WATERSHED ASSESSMENT

Hospitality and lodging have a century-old tradition in the watershed. J.H. Cain constructed the first hotel at Leesville in upper Bear Valley in 1874 to accommodate travelers bound to and from the popular mineral spas of in western Colusa, Lake, and Mendocino counties (Rogers 1891). Today it is a private home. Many of the hot springs in Sulphur Creek subwatershed, have been famous as spa sites since the late-nineteenth century. Two elegant hotels offered guests a tranquil setting and good food at Wilbur Springs and Blanck Spring.

Anderson (1898) described the springs thus:

“These mineral springs are located thirty miles from Colusa in Colusa County. They are pleasantly situated and have acquired considerable reputation from their therapeutic properties. At the springs are good accommodations in the hotel and cottages and excellent camping facilities. The resorts are reached by railroad to Williams and thence by stage...”

The springs remain a tourist destination and a holiday getaway for health-conscious visitors.

The 12,000-acre BLM Bear Creek Ranch, part of the Cache Creek Natural Area (Bureau of Land Management 2004) comprises most of the southern third of the watershed. Highway 16 and Highway 20 form the east and north boundaries of the Ranch respectively. Recent public acquisition of this privately held ranch has made more recreation open space accessible. The Ranch is a destination for diverse non-motorized recreation and camping in a scenic rural landscape. Management for the Ranch focuses on maintaining natural biological diversity and ecosystems and high-quality recreation settings in intact landscapes. The Cowboy Camp recreation area is the hub for people to stop at a scenic viewpoint, learn from interpretive panels about the setting, and start on hikes or equestrian riding in the Ranch. Other entry points to the Ranch are spaced along Highway 16. Developed camping sites are available only at Cowboy Camp. Hunting is allowed but target shooting is not permitted.

Walker Ridge is a topographically diverse landscape that attracts many types of visitors annually. The area is ideal for camping, mountain biking, hiking, and equestrian use. It is a favored destination for botanists who visit the Ridge in search of its many rare and endemic plants, and for hikers looking for solitude and scenic vistas. Geology, botany, and natural history classes from UC-Davis frequently have field trips to Walker Ridge. Walker Ridge Road is a BLM-designated OHV trail.

### ***Hunting Opportunities***

Opportunities to hunt many game species in Bear Creek watershed draw people, both for sport and subsistence hunting. Archers report deer taken occasionally but most hunters use firearms.

Adjacent to the watershed at two locations in Lake County, the CDFG maintains two areas with a hunting focus: the Harley Gulch Unit of the Cache Creek Wildlife Area and the Indian

## BEAR CREEK WATERSHED ASSESSMENT

Valley Wildlife Area. A parking area for access to the Harley Gulch Unit by way of the Judge Davis trailhead lies 0.35 miles west from the watershed boundary along Highway 20. From there, hunters have non-motorized access east to the BLM Bear Creek Ranch. Indian Valley Wildlife Area to the west of Walker Ridge covers the shoreline of the Indian Valley Reservoir. Both Walker Ridge Road and Brim Road in Bear Creek watershed provide important travel corridors to access the Wildlife Area.

The BLM Bear Creek Ranch and the corridor along lower Walker Ridge are the major deer hunting areas in the watershed, based on CDFG deer tag data about where hunters report their deer kills (“spotkills”). Deer hunting on the Ranch has increased since the BLM assumed management in 2004. Private landowners in Bear Valley also allow fee hunters to hunt on their lands. Most deer reported as kills come from public lands, however. The CDGF maintains records of deer kills, and Table 3.5 shows the number of tags for deer kills reported since 1999 in the watershed. The total number of deer taken in the watershed has remained nearly constant. A shift has taken place where the public lands now provide the larger share of deer kills. Before the BLM acquired Bear Creek Ranch, most recorded deer kills were on private lands in Bear Valley.

Table 3.5 – Records of deer kills from Bear Creek watershed, 1999 - 2007

Year	Private Lands	Public Lands		Total
		BLM Bear Creek Ranch*	Walker Ridge	
1999	13	6	1	20
2000	14	4	1	19
2001	11	5	1	17
2002	n.a.	n.a.	n.a.	n.a.
2003	1	11	2	14
2004	5	13	3	21
2005	2	12	1	15
2006	6	9	1	16
2007	2	12	5	19

Source: Paul Hofmann, CDFG (pers. comm.)

\*The Bear Creek Ranch was in private ownership through 2003 but is included in the total for public lands for all years.

Information about the number of elk, wild pig, and game birds taken, and the economic value of the recreational and subsistence food hunting in the watershed is not available.

***Potential Recreation Benefits to Regional Communities***

Members of the public have recently proposed creation of the “Berryessa Snow Mountain National Conservation Area” comprising 500,000 acres of federal public lands managed by the BLM, the Bureau of Reclamation, and the US Forest Service. The Conservation Area may encompass the federal public lands in Bear Creek watershed. Background research in support of establishing the Conservation Area found that designating the Area would increase recreation and tourism to the area and would support economic diversification for gateway cities to the Conservation Area such as Winters and the Clear Lake communities (Vatland 2008). No projections are available yet to show how Conservation Area designation might affect Bear Creek watershed residents or the City of Williams, which is another gateway city to the watershed or the proposed National Conservation Area.

**3.9 Energy Production and Conveyance**

Few watersheds the size of Bear Creek watershed have the suite of potential energy resources found there: geothermal, natural gas, petroleum, biofuel, wind, and solar energy. Not all energy sources are likely to be developed commercially. The watershed lies at the interface between the Arbuckle oil and gas field in the Central Valley and the Clear Lake - Geysers geothermal zone in the North Coast Range. Current energy production is on a small scale on private lands for self-sufficiency. However, geologists and engineers have studied options for extraction or development of energy resources extensively in the watershed (Gennis and Associates 1978, Goff et al. 1993). Development of new technologies, changes in energy prices and availability, and national interest in energy sustainability and self-sufficiency are prompting reconsideration of possibilities for energy production in the watershed.

New projects to develop energy resources, export energy generated in the watershed, or convey energy across the watershed in utility lines would create significant ground disturbance during construction and maintenance. These disturbances could alter hydrologic conditions, destabilize steep terrain, impair visual quality for people, and degrade wildlife habitat.

***Hydrocarbons: Oil and Gas***

Naturally occurring hydrocarbon seeps appear locally in Bear Creek watershed. Geologists have traditionally relied on locations of natural seeps to discover oil or gas fields in California. Uplifted sedimentary rock sources from the Great Valley Sequence contain hydrocarbon compounds that originated from remains of ancient oceanic organisms that accumulated on the floor of the Central Valley when the Valley formed a primeval ocean bottom. Sedimentary rocks containing at least one percent total organic carbon are potential sources of natural gas, tar, and petroleum. Where concentrations of hydrocarbons are particularly high, subsurface pressure may push volumes of fossil hydrocarbons through

breaks in the sedimentary rock to the surface. Naturally occurring hydrocarbon seeps containing tar or oil may contaminate water sources, but seeps found in Bear Creek watershed are not known to impact water quality.

Figure 3.7 displays the specific locations of known petroleum and gas seeps as well as areas where seeps are known to occur but are poorly documented. Information about most seeps comes from less precise 19<sup>th</sup>-century sources. Hodgson (1987) found that many seeps reported a hundred years ago were no longer visible. Most petroleum seeps are in southeast Bear Valley and the Blue Ridge area north of the junction of State Routes 16 and 20.

Presence of seeps has led geologists to drill exploratory wells in the watershed in search of commercial quantities of hydrocarbons. Petroleum was first noted near Wilbur Springs in 1863 and later elsewhere in Bear Valley but only in small amounts (Rogers 1891). Two early entrepreneurs constructed a water-wheel to tap the energy of Sulphur Creek to operate drills to explore for oil.

Figure 3.7 also displays locations of well sites and the extent of closed oil and gas leases managed by the Bureau of Land Management and the California Department of Conservation, Division of Oil, Gas, and Geothermal Resources, in Bear Creek watershed. The earliest corporate exploratory drilling for commercial oil and gas reserves occurred in 1909, and the last well was closed in 1984. No commercial production of oil or gas has come from the watershed. Some state and federal government leases involve subsurface rights to oil and gas beneath private property.

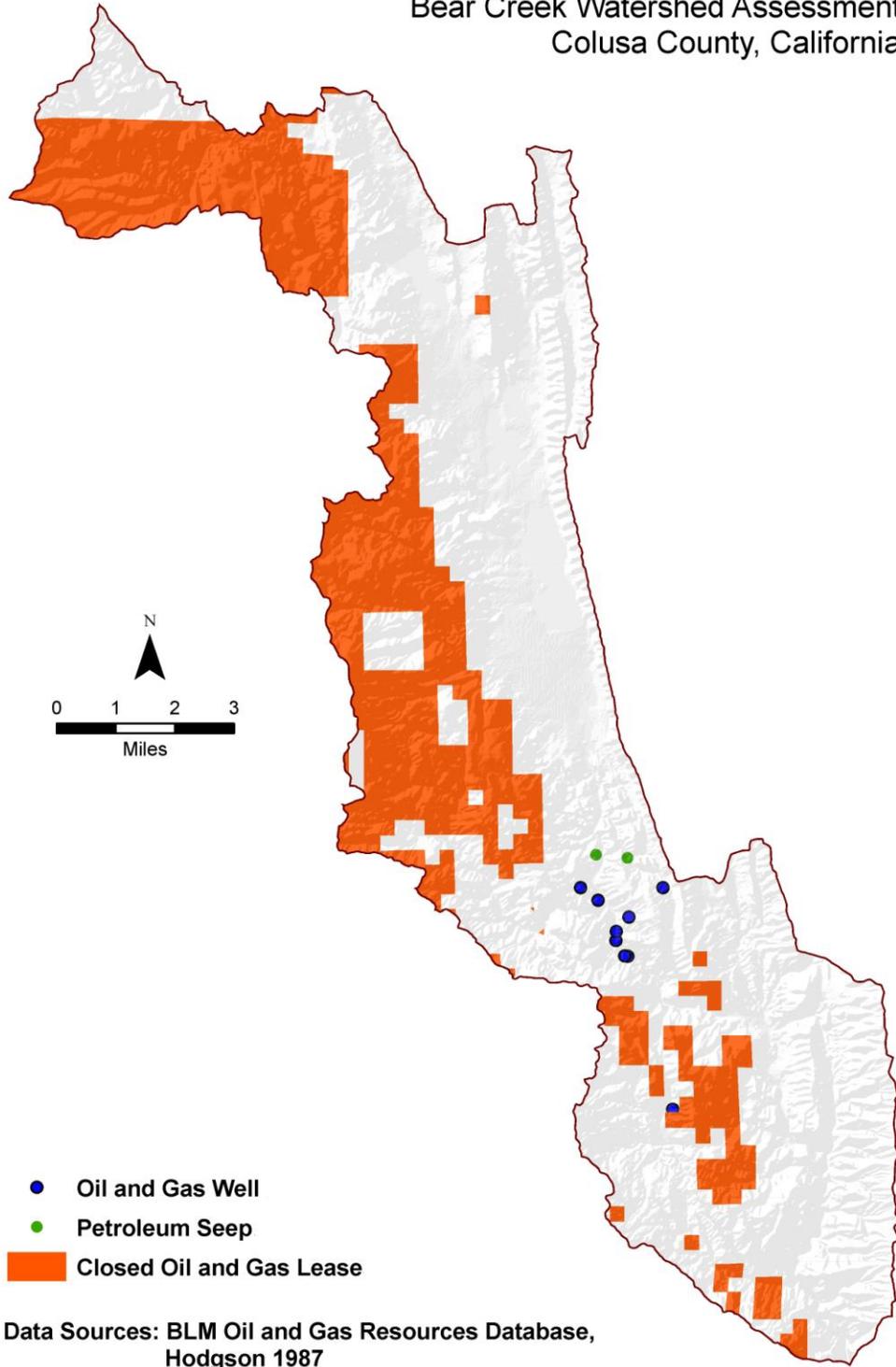
The US Geological Survey has designated additional areas of likely valuable oil and gas resources for commercial extraction at the east edge and southern third of the watershed. Local officials in Colusa County have expressed concern over the number of natural gas wells that are being drilled in Colusa County (Northern California Water Association 2006) because of potential cumulative impacts to groundwater. There are no plans to drill for oil or gas resources in Bear Creek watershed.

### ***Geothermal Energy***

Hot springs indicate potential sources for extracting geothermal energy in Sulphur Creek subwatershed. Water sufficiently hot for energy use is available from these springs at relatively shallow depths (<1,000 m) (Division of Mines and Geology 1980). Blanck Springs, Elgin Spring, Jones Fountain of Life, and Wilbur Hot Springs are the major named springs. Other unnamed springs with geothermal potential are also present.

Figure 3.7

**Oil and Gas Resources and Exploration**  
Bear Creek Watershed Assessment  
Colusa County, California



## BEAR CREEK WATERSHED ASSESSMENT

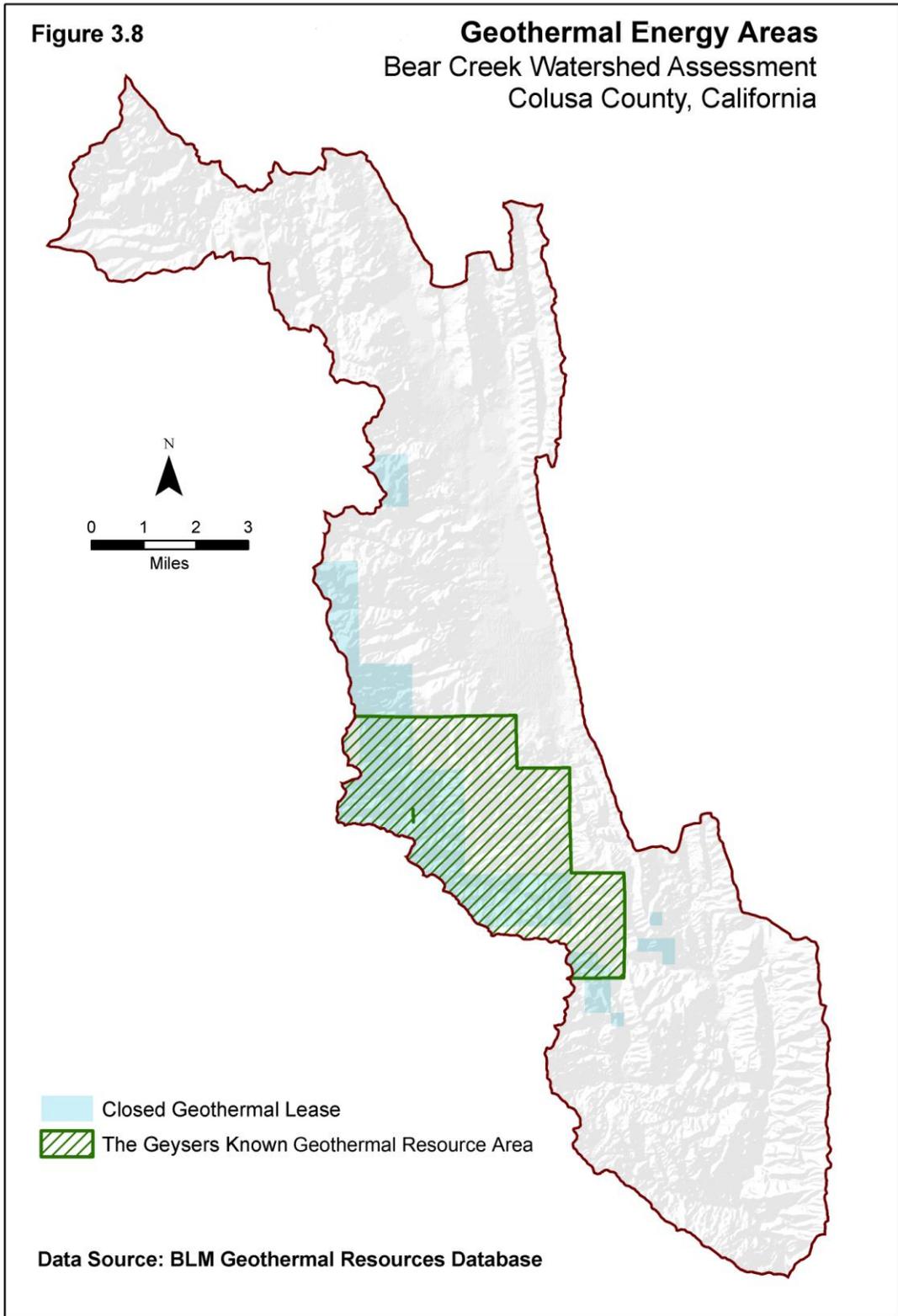
The BLM manages federal rights to subsurface geothermal energy resources in Bear Creek watershed. Of particular significance are the federally designated Known Geothermal Resource Areas (KGRAs). KGRAs include one or more geothermal fields, most of the geothermal wells, and additional promising sites in a region where geothermal resources have a high potential for economic use. The major geothermal springs in Bear Creek watershed comprise the northeast edge of the Geysers KGRA, the most productive of all geothermal regions in the United States. Because the springs lie distant from the core geologic faults in the KGRA, the volume of accessible water and amount of energy capacity is less than at the KGRA core (S. Hagerty, BLM geothermal resource specialist, pers. comm.). No energy for economic use has thus far come from geothermal sources in the portion of the KGRA in Bear Creek watershed. Litigation halted planning for a geothermal project in the 1970s in Sulphur Creek subwatershed.

The other KGRA designated within Bear Creek watershed was the Love Lady Ridge KGRA, established in 1970. The Area was thought to constitute a secondary concentration of geothermal resources. Love Lady Ridge KGRA spans both BLM and US Forest Service lands in the northwest corner of the watershed. BLM offered 5,517 acres in the Love Lady Ridge KGRA for lease sales in 1982. At the time, BLM received no bids for leases, and BLM subsequently delisted the area as a KGRA. Remoteness and difficulty of access to the Love Lady Ridge KGRA are obstacles to economic feasibility of geothermal resources there.

The Sacramento Geothermal Resources District (District 6) of the State of California Department of Conservation, Division of Oil, Gas, and Geothermal Resources, represents State of California jurisdiction over State of California and private lands in Colusa County. No State of California geothermal fields are found in Bear Creek watershed.

Figure 3.8 provides a map of the Geysers KGRA and currently closed geothermal lease areas.

The Energy Policy Act of 2005 changed the way that the federal government awards leases for geothermal fields. Formerly, competitive bidding for leases only covered lands within the federally designated KGRAs. Other lands required only a flat processing fee plus a per-acre fee. Now competitive bidding is required for all leases for access to federal subsurface geothermal resources. This provision is designed to generate larger federal revenues from individual geothermal energy leases



Recent technical innovations may permit efficient capture of geothermal energy from smaller sites with cooler water temperatures with the help of binary (closed-cycle) technology. Binary technology systems for capturing geothermal energy pump water under pressure into a heat exchanger. Isopentene or isobutene gases take up the energy transferred from water vapor and run turbines to generate energy. This system prevents emissions of water vapor and associated geothermal gases from being released into the atmosphere. Instead geothermal water remains on site. Efficiency is increased because geothermal sources down to 95°C are feasible in contrast to 160°C for traditional “flash” technology with vapor emissions.

Prospectors have drilled three geothermal wells in the watershed, all of them in Sulphur Creek subwatershed, one each in 1965, 1968, and 1982. Increasing energy prices may interest corporate energy providers or Bear Creek watershed households to apply for permits from the BLM to tap into the geothermal sources in the watershed. One commercial leaseholder has rights to parts of the Geysers KGRA in Bear Creek watershed.

The BLM Ukiah Field Office Resource Management Plan Appendix H (2006) anticipates up to 30 new geothermal wells across 6,000 acres of geothermal leases in the Geysers-Clear Lake KGRA and the nearby Calistoga KGRA. However, the Plan is not explicit about how many, if any, of the new geothermal wells will be drilled in the small portion of the Geysers-Clear Lake KGRA inside the Bear Creek watershed.

### ***Wind Energy***

Technology for capturing wind energy is evolving quickly in California. One private landowner already uses wind energy from a wind mill for home use. About 7,865 acres of BLM public lands are potentially available for wind energy development on Walker Ridge and seven smaller ridges branching off of the north-south axis of Walker Ridge at the west flank of Bear Creek watershed. The leaseholder, AltaGas Income Trust, has an authorized right of way and is investigating the economic feasibility of installing wind turbines there.

The BLM Ukiah Field Office Resource Management Plan Appendices J and K (2006) discuss the practicality of deploying a commercial array of wind turbines on Walker Ridge. Any development of wind energy facilities would follow BLM best management practices to protect wildlife, avoid soil erosion, and maintain recreation opportunity. Terrain with slopes greater than fifteen percent would be avoided for turbine placement. New service roads and upgraded off-highway vehicle trails would be necessary for energy development.

Initial scenario models conducted by the BLM and the US Department of Energy cited in the Resource Management Plan indicate that the Walker Ridge area has medium to low capacity for generating wind energy. In scenarios developed by the Department of Energy, National Renewable Energy Laboratory, up to 73 1.5-megawatt turbines could occupy feasible sites in

the Walker Ridge lease area. Turbines would be distributed partially in Bear Creek watershed and the adjacent North Fork Cache Creek watershed.

### ***Solar Power***

One watershed landowner has installed solar panels to supply virtually all domestic and business energy needs. Commercial arrays of solar panels designed for export to urban areas are not planned for the watershed.

### ***Hydropower***

No licensed hydropower operations are present in Bear Creek watershed.

### ***Energy Transmission***

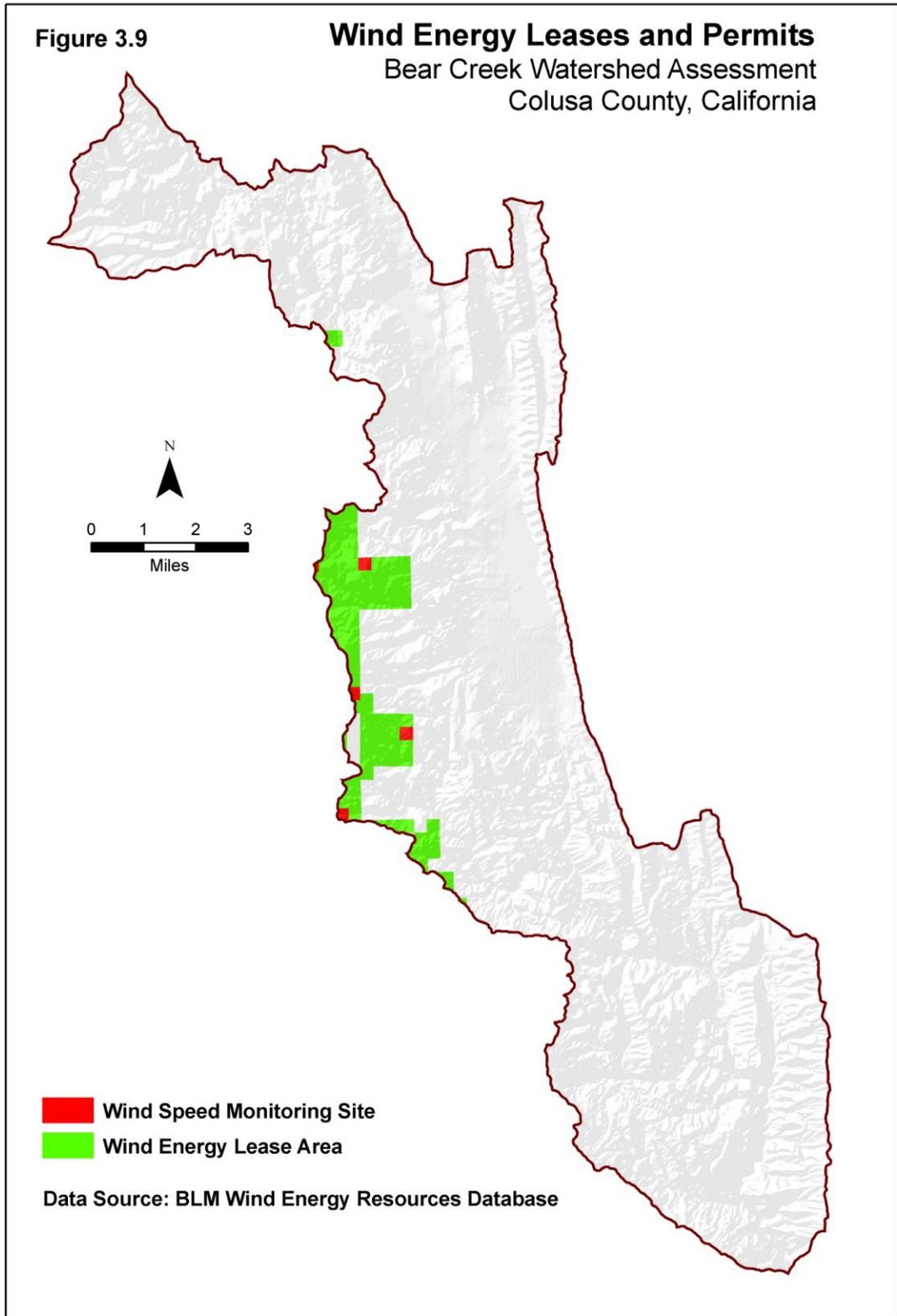
Pacific Gas and Electric Company maintains an electrical transmission line that bisects the watershed from northeast to southwest in the steep terrain south of Bear Valley and across Sulphur Creek subwatershed.

## **3.10 Developed Areas**

Developed areas comprise a very small fraction of the total land area of Bear Creek watershed. One indicator of development is human-made impervious surfaces such as roads, concrete pads, and houses. Most impervious surfaces are from asphalted state highways and portions of some county roads. Developers have put forward concepts for residential development when ranches have been put up for sale, but new home building did not occur during the last decade. Sulphur Creek and Leesville subwatersheds remain the centers of human-occupied portions in the watershed as they were 100 years ago but with much smaller numbers of residents. Two privately owned ranches currently have conservation easements on their properties. These easements limit options for commercial and residential development to maintain the traditional rural character and economy of ranch lands in the watershed.

## **3.11 Transportation**

Locations of public roads, the designated off-highway vehicle trail network, and non-motorized recreation trails appear in Figure 3.10. These elements comprise the transportation system of Bear Creek watershed.



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### *Major Traffic Corridors*

State Highway 20 connects Bear Creek watershed to Interstate Highway 5 at Williams to the east with the Clear Lake region in Lake County and then on to State Highway 101 in Mendocino County to the west. To the north of Highway 20, Bear Valley Road, a county-maintained dirt-surface road 17.4 miles long connects to the paved Lodoga Road that exits the watershed north to the settlement of Lodoga, East Park Reservoir, and a main road into the Mendocino National Forest. To the south of Highway 20, State Highway 16 travels along lower Bear Creek in Colusa County, enters Yolo County at the confluence of Bear Creek and Cache Creek, passing Yolo County's Cache Creek Canyon Park, and then turns south to Rumsey and other Capay Valley communities.

From the northwest side of the watershed, Brim Road (an extension of Bartlett Springs Road in Lake County) runs from Walker Ridge Road east to Bear Valley Road. On the northeast side of the watershed, Leesville Road connects the northern part of the watershed to Williams more directly than by way of Bear Valley Road.

Numerous roads maintained by private landowners are present. Private roads were not surveyed or mapped as part of this assessment. Pacific Watershed Associates has mapped all roads in Sulphur Creek subwatershed, with landowner permission, because of the critical need to redesign roadways in the subwatershed to curb sediment and mercury flowing into Sulphur Creek and its tributaries (Hoorn et al. 2008).

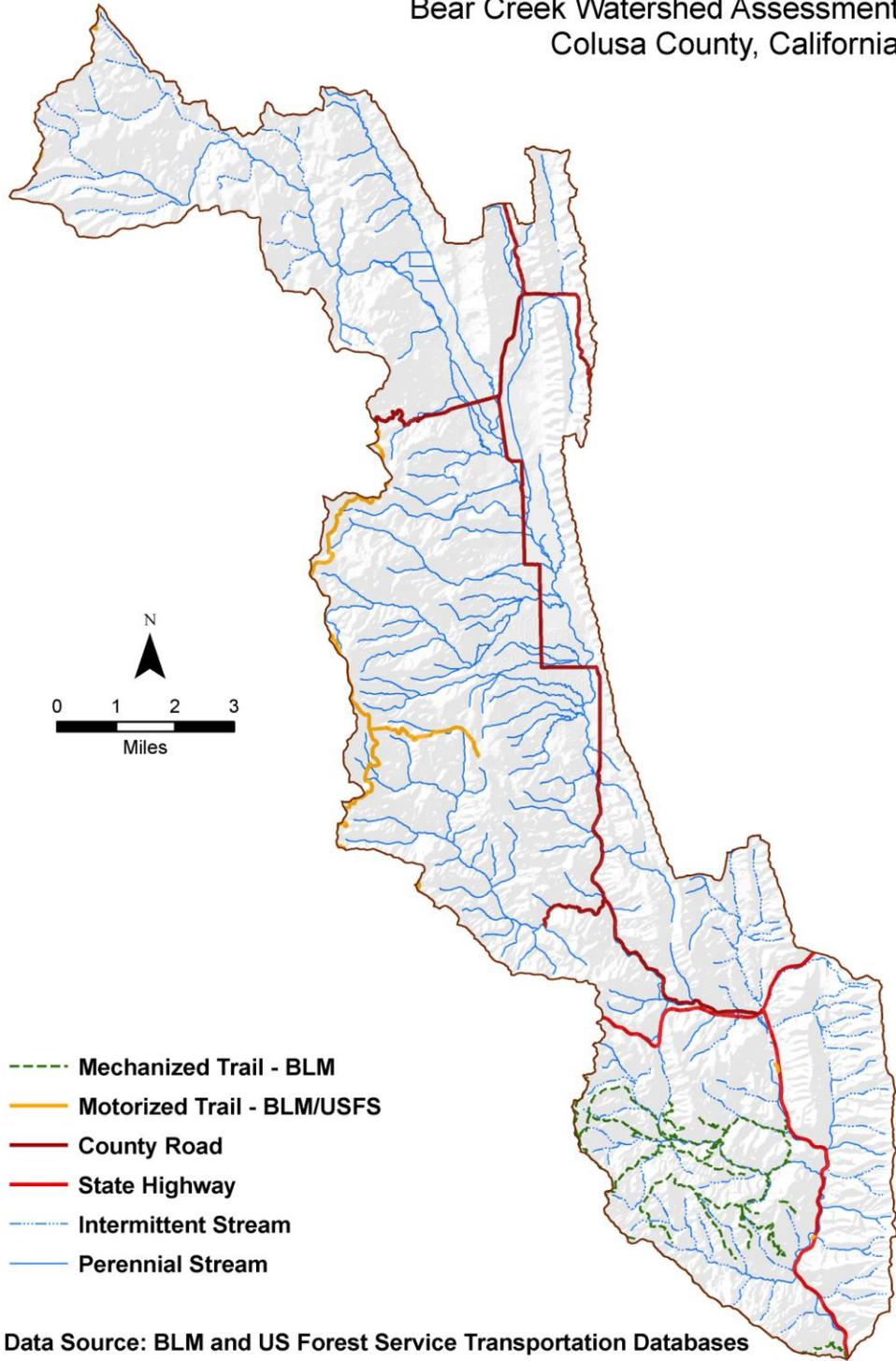
### *Road Mileages and Surfaces*

The miles of publicly maintained roads are broken out by type of road surface and by responsible agency as follows:

	Paved Road Miles	Unpaved Road Miles
<b>CALTRANS</b>		
Route 16	6.9	0.0
Route 20	4.9	0.0
<b>Subtotal</b>	<b>11.9</b>	<b>0.0</b>
 <b>Colusa County Department of Public Works</b>		
Bear Valley Road		17.4
Brim Road		1.4
Leesville Road	2.7	
Lodoga Road	1.6	
Wilbur Springs Road	1.0	0.7
<b>Subtotal</b>	<b>5.3</b>	<b>19.5</b>
<b>TOTAL</b>	<b>17.2</b>	<b>19.5</b>

Figure 3.10

**Transportation Network**  
Bear Creek Watershed Assessment  
Colusa County, California



The existing travel network has a density of 0.36 public road miles per square mile in Bear Creek watershed. The road networks tend to follow Bear Creek and Sulphur Creek closely, indicating the care needed to ensure that roads do not contribute to the total sediment load in watershed streams.

### ***Traffic Counts***

The daily volume of traffic in both directions on Highway 20 at the intersection of Highways 20 and 16 totals 11,200 vehicles per day (2007 traffic volume data from CALTRANS, Traffic Data Branch), a 3.7 percent increase since 2004. During the peak travel month, the travel volume increases to 13,600 vehicles per day. Traffic volume on Highway 16 at the Yolo-Colusa county line at the south end of Bear Creek watershed is much less: 1,400 vehicles per day in both directions on average, rising to 1,650 vehicles per day in the highest traffic month. Traffic data for county roads or for off-highway vehicle trails are not available.

### ***Bridges***

In 2008, CALTRANS began reconstruction of the Bear Creek Bridge on Highway 20 and realignment of the roadbed to provide better visibility and meet current design standards for state highways. Bear Creek flooded Highway 20 most recently in December 1983 and January 1997, and the Highway 20 Bear Creek Bridge has been inundated six or more times since 1965 (California Department of Transportation 2006). Loss of the bridge from flood waters and interruption of commercial traffic on Highway 20 would be an immediate economic detriment to the regional economy. The dimensions of the old bridge have also been insufficient to keep debris from tangling among the bridge columns, and water scouring was exposing the bridge footings.

Bridges on Highway 16 are less problematical because the highway is mostly situated high above the canyon course of Bear Creek at bridge crossings. Flooding in Bear Creek upstream of Highway 20 and in Sulphur Creek, however, could damage bridges over each of these creeks and restrict movements of residents, tourists, and business people. These bridges are in the 100-year floodplain zones of the two creek courses and are vulnerable.

### ***Erosion Hazard on Roads and Trails***

Construction of new roads and off-highway vehicle trails pose challenges to engineers in parts of Bear Creek watershed where soil erosion and landslides are more likely. Erosion hazard has the potential to damage resources such as water quality or harm riders. Figures 3.11 and 3.12 display the erosion hazard ratings from the Colusa County Soil Survey (Reed 2006) for state- and county-maintained roads and for off-highway vehicle trails respectively.

### **3.12 Telecommunications**

The BLM provides rights of way to communications companies and to other government agencies on public lands in Bear Creek watershed. American Telephone and Telegraph (AT&T) Corporation, CALFIRE, and the Colusa County Sheriff's Department all have telecommunications relay towers on Walker Ridge. The 2008 Walker fire destroyed one telecommunications facility.

### **3.13 Scientific Research and Monitoring**

The US Geological Survey, the California Department of Water Resources, and the Yolo County Flood Control and Water Conservation District all maintain permanent water monitoring sites in lower Bear Creek. In 2008, the University NAVSTAR Consortium (UNAVCO), a non-profit research institute for earth sciences arranged for an earthquake monitoring station on BLM public lands in the watershed. In addition, university faculty and graduate students in geology, plant ecology, wildlife biology, and other disciplines have conducted research in Bear Creek watershed since the 1950s. Institutions recently engaged in scientific research include the University of California at Davis and Berkeley, Stanford University, and Harvard University.

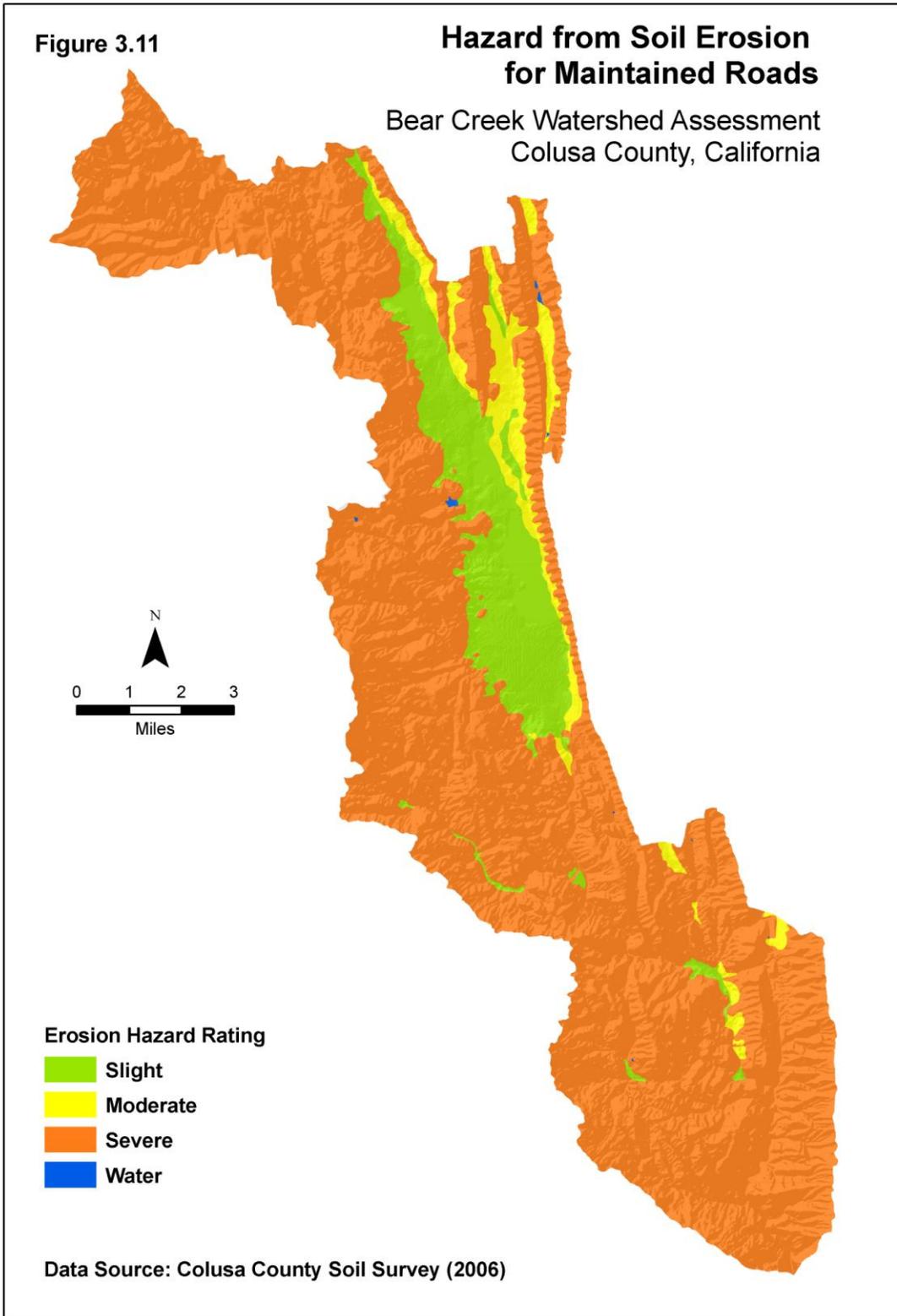


Figure 3.12

### Hazard from Soil Erosion with Off-Road Motorized Trails

Bear Creek Watershed Assessment  
Colusa County, California

