Section 5

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CLIMATE

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

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

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

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

SOURCES OF DATA

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

HISTORICAL CONTEXT

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

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

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

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

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

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

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

PRECIPITATION

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

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

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

TEMPERATURES

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

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

EVAPOTRANSPIRATION

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

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

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

WIND SPEED AND DIRECTION

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

DEGREE DAYS

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

CONCLUSIONS AND RECOMMENDATIONS

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

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Meko, D.M., M. D. Therrell, C. H. Baisan, and M. K. Hughes. 2001. Sacramento River Flow Reconstructed to A.D. 869 From Tree Rings. *Journal of the American Water Resources Association*, v.37, No.4, August.

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WRCC (Western Regional Climate Center). 2005. *Historical Climate Information, Northern California, Various Sites*. Reno: Western Regional Climate Center [cited May 2005]. Available from World Wide Web: http://www.wrcc.dri.edu.

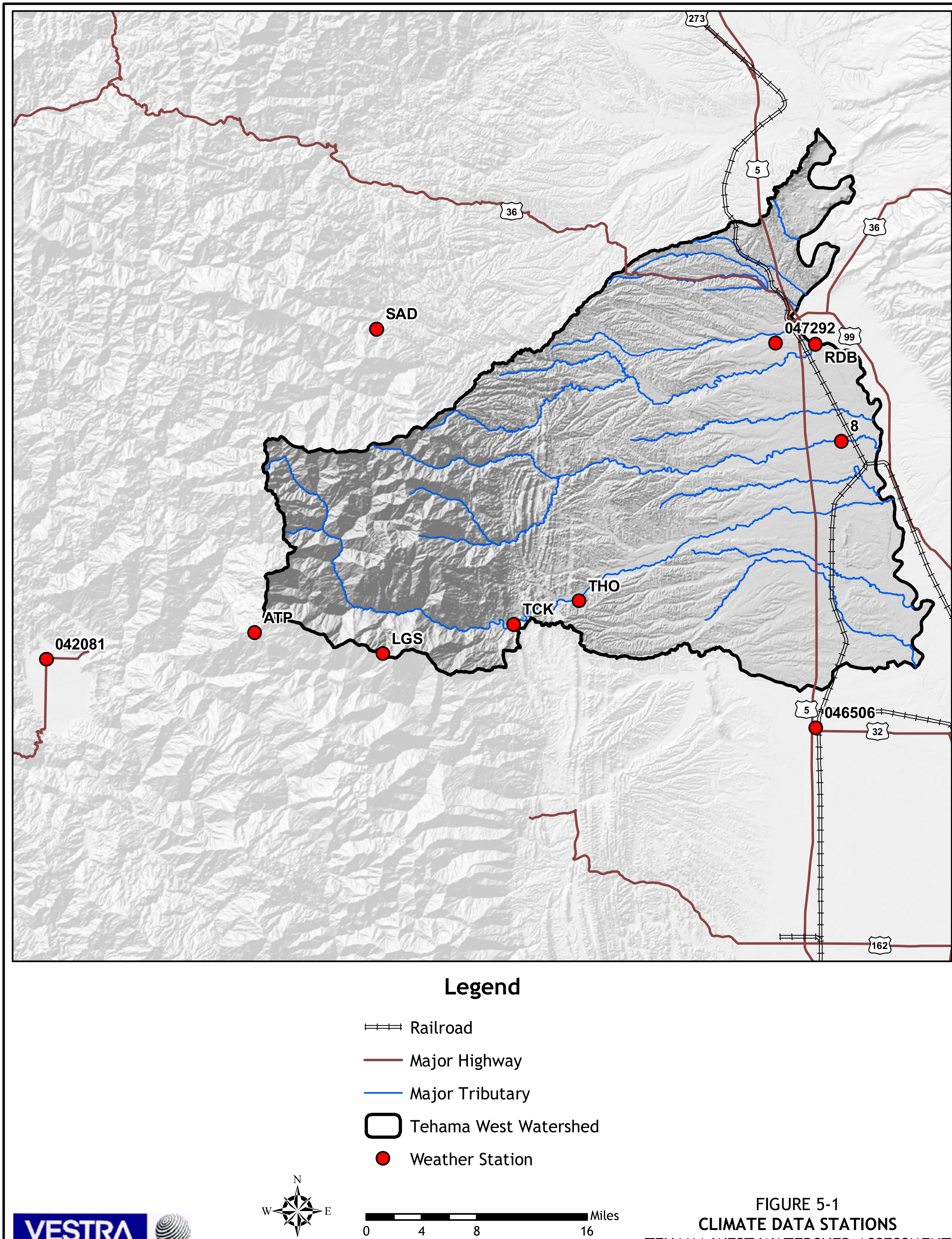


FIGURE 5-1
CLIMATE DATA STATIONS
TEHAMA WEST WATERSHED ASSESSMENT

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

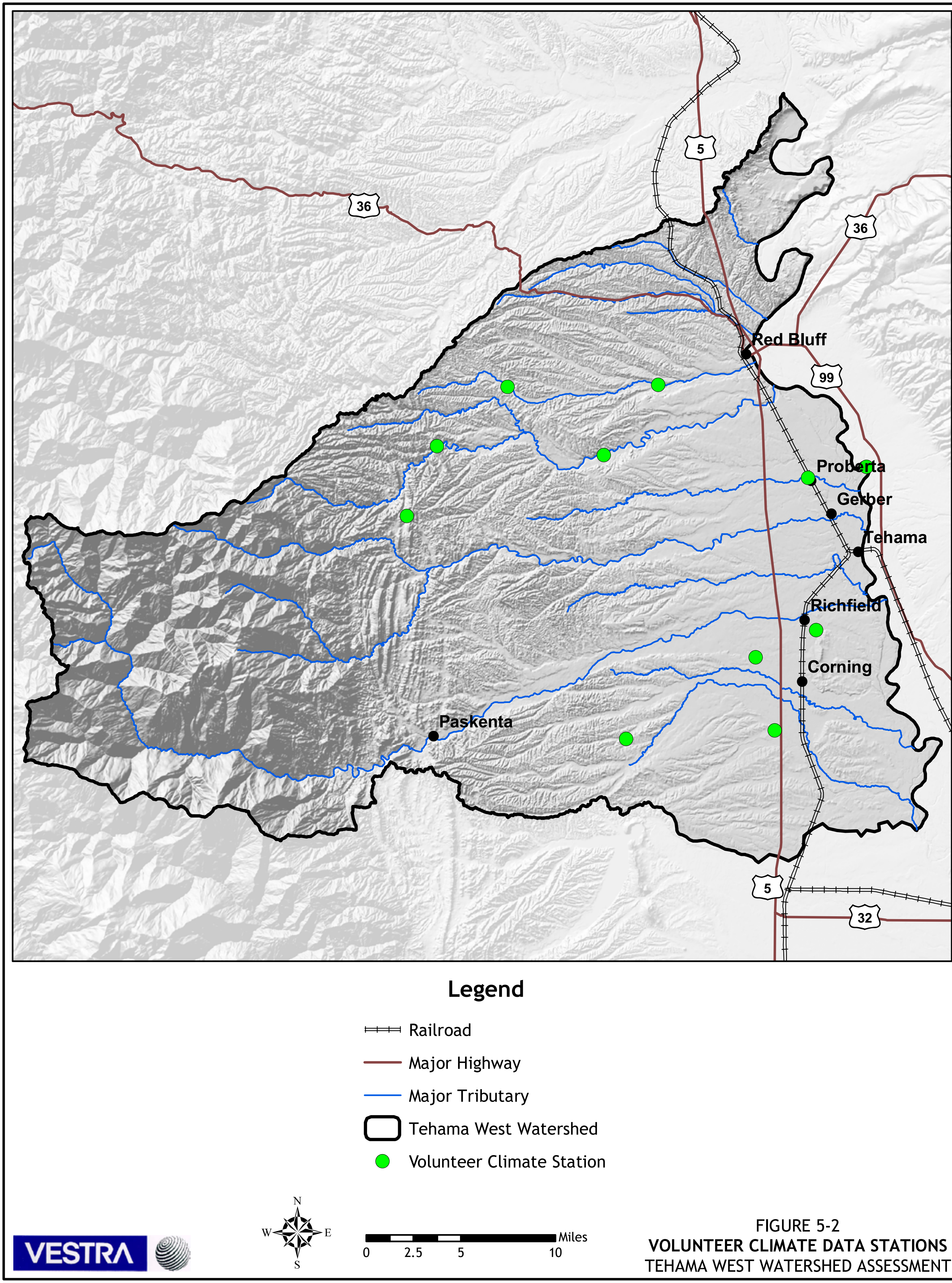


FIGURE 5-2
VOLUNTEER CLIMATE DATA STATIONS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: TEHAMA COUNTY RESOURCE CONSERVATION DISTRICT

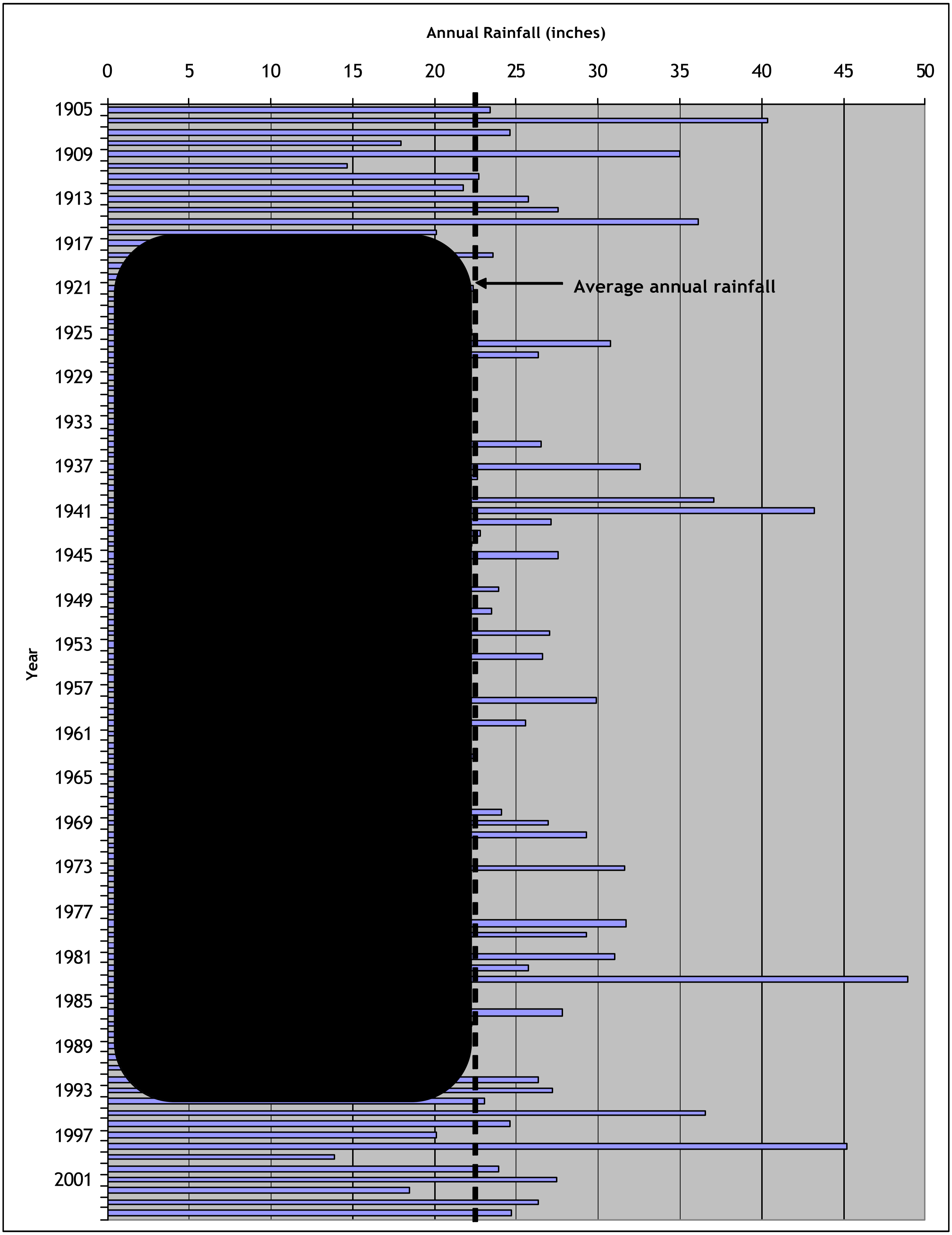


FIGURE 5-3
HISTORICAL PRECIPITATION AND CLIMATE RECORDS
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: WESTERN REGIONAL CLIMATE CENTER 2004

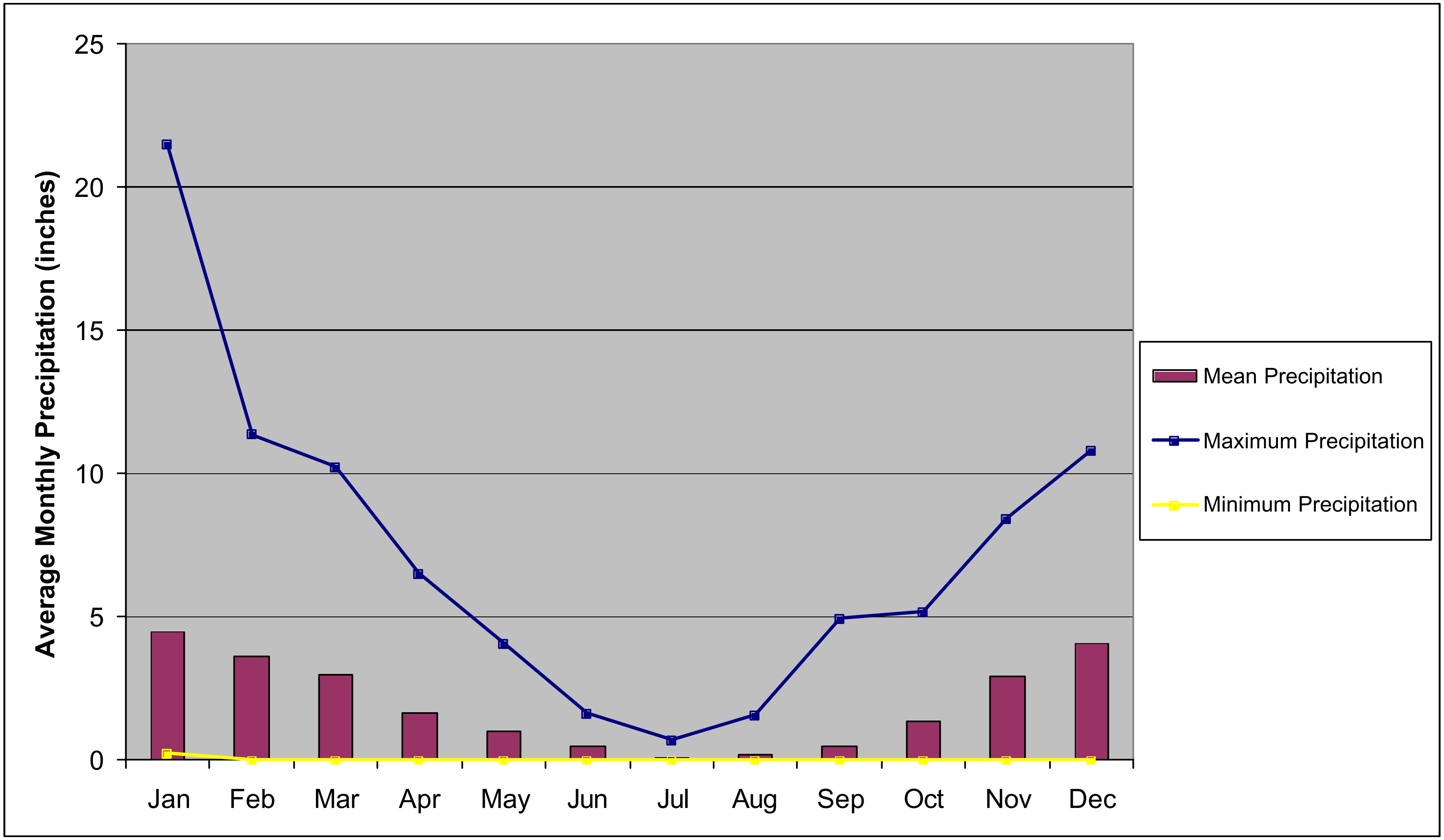
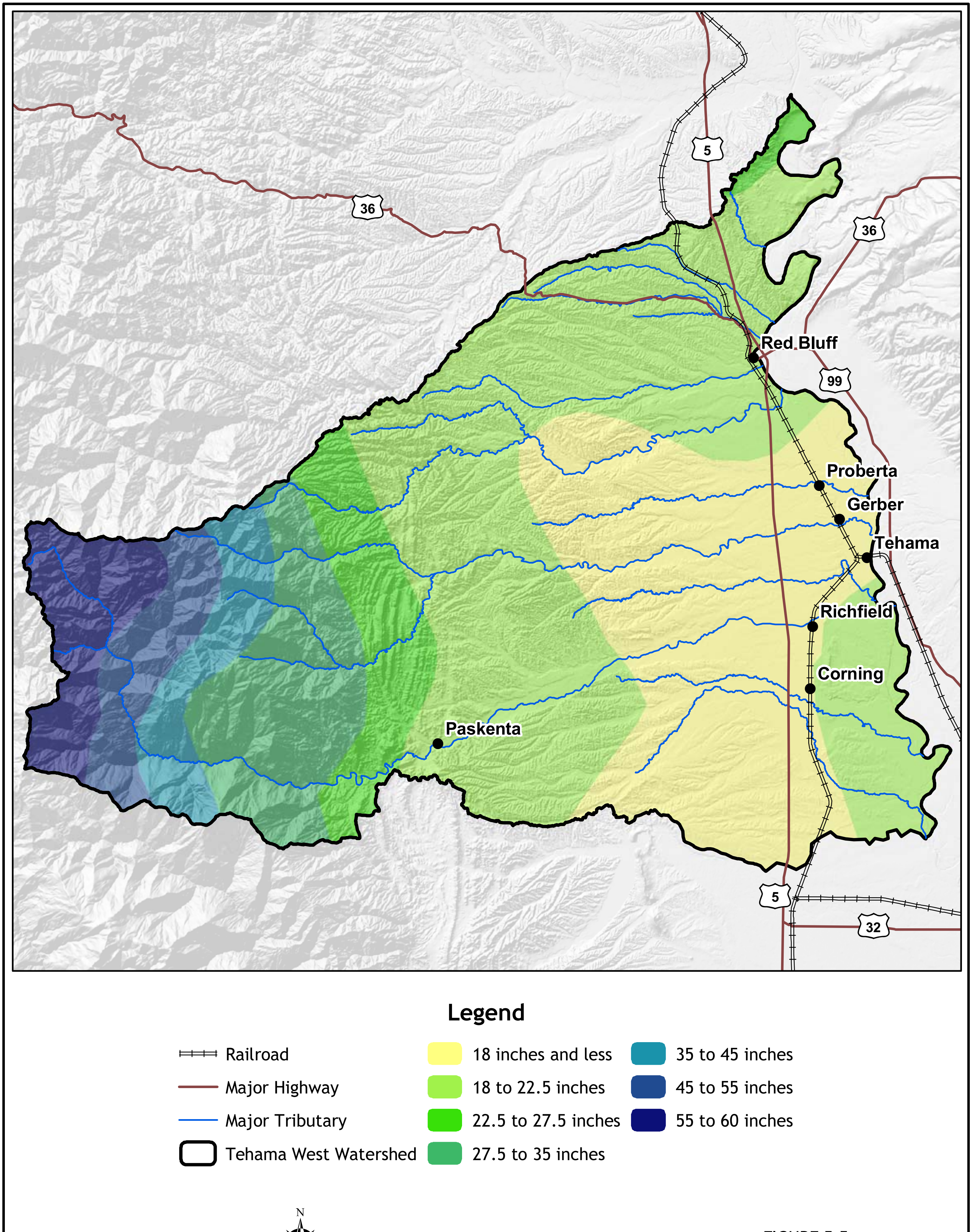


FIGURE 5-4
AVERAGE MONTHLY PRECIPITATION
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: REDDING NATIONAL WEATHER SERVICE OBSERVATION STATION



VESTRA

FIGURE 5-5
ISOHYETAL MAP
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: CALIFORNIA SPATIAL INFORMATION LIBRARY

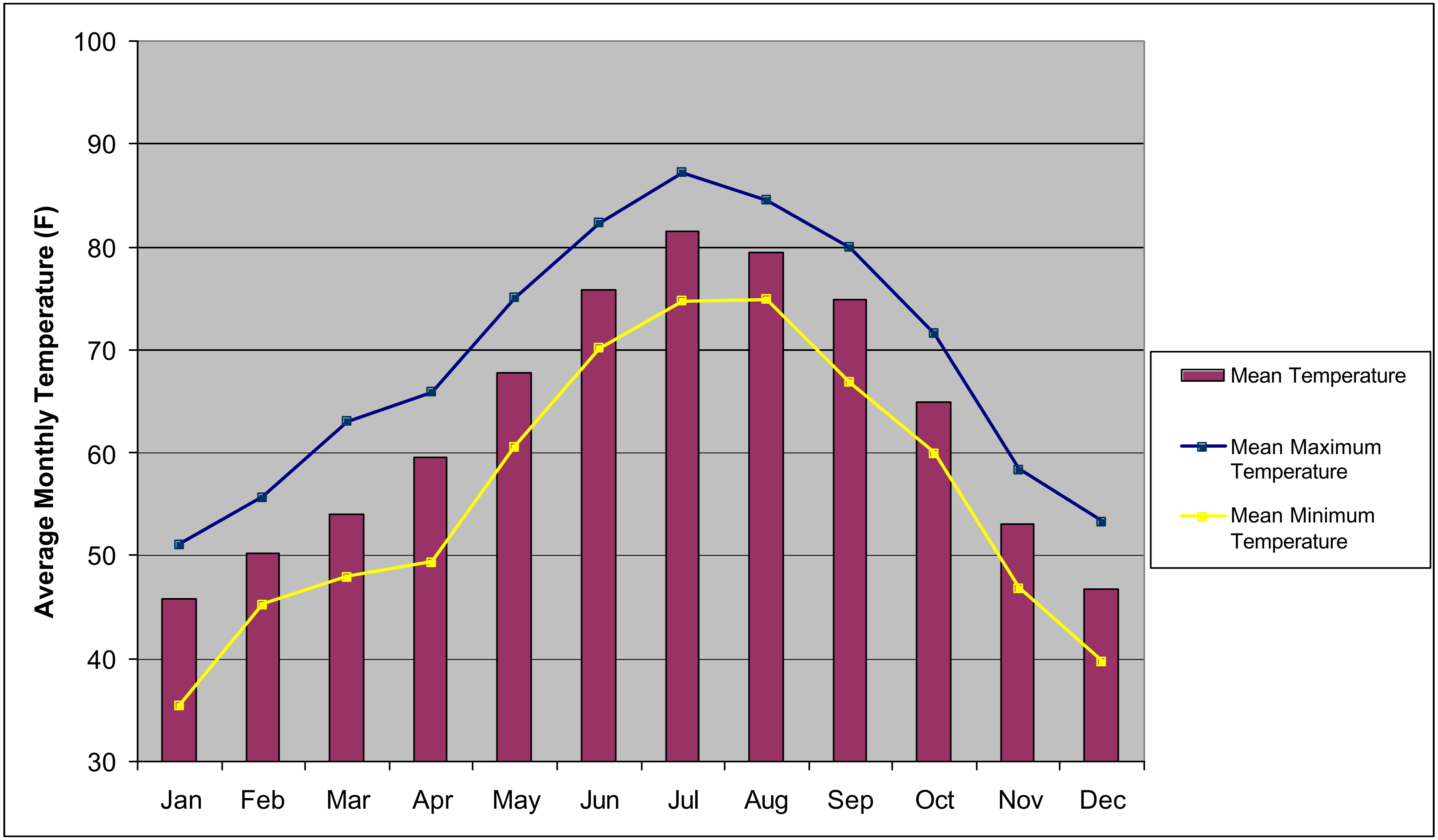


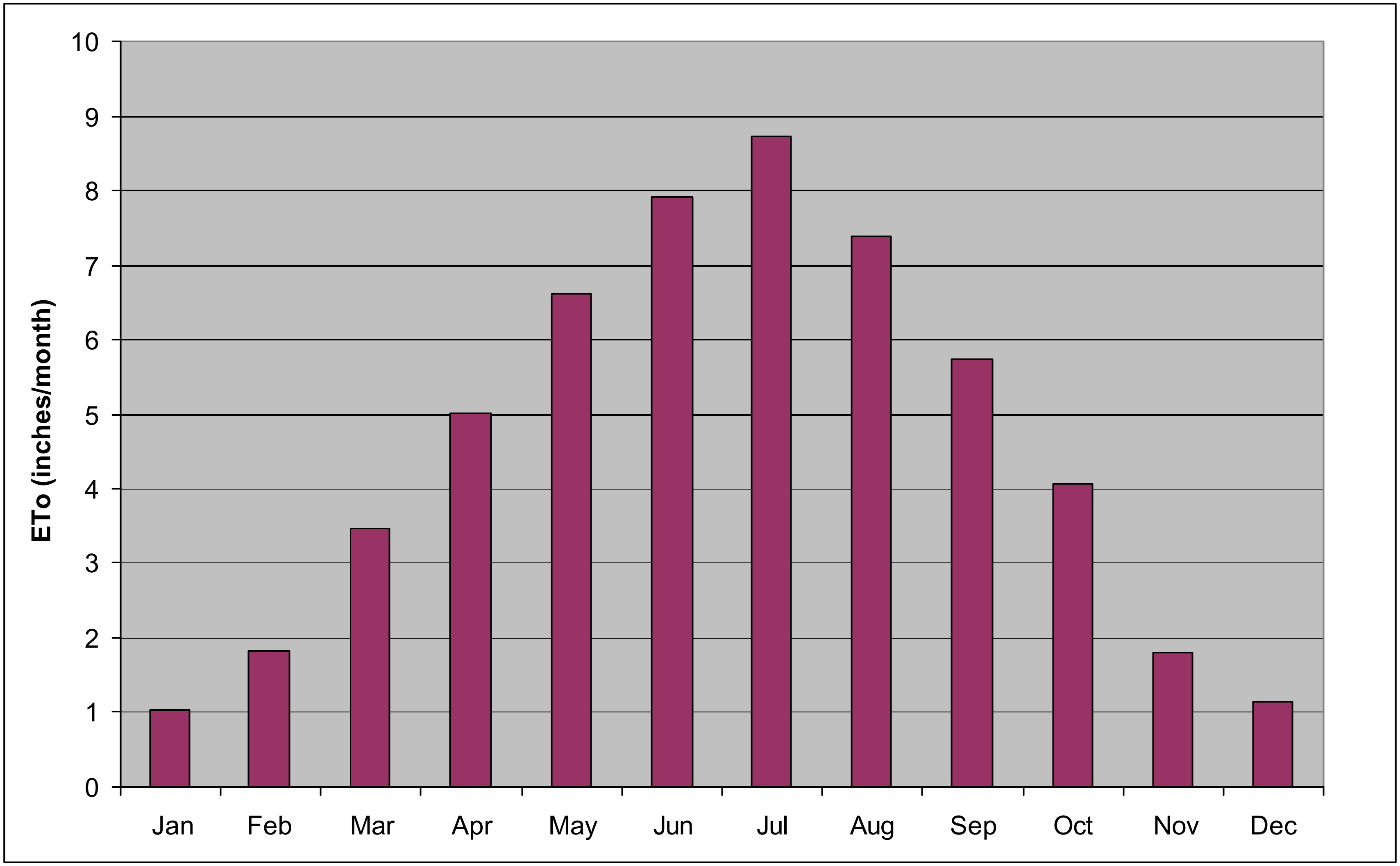
FIGURE 5-6

AVERAGE MONTHLY TEMPERATURES

TEHAMA WEST WATERSHED ASSESSMENT

VESTRA

SOURCE: REDDING NATIONAL WEATHER SERVICE OBSERVATION STATION



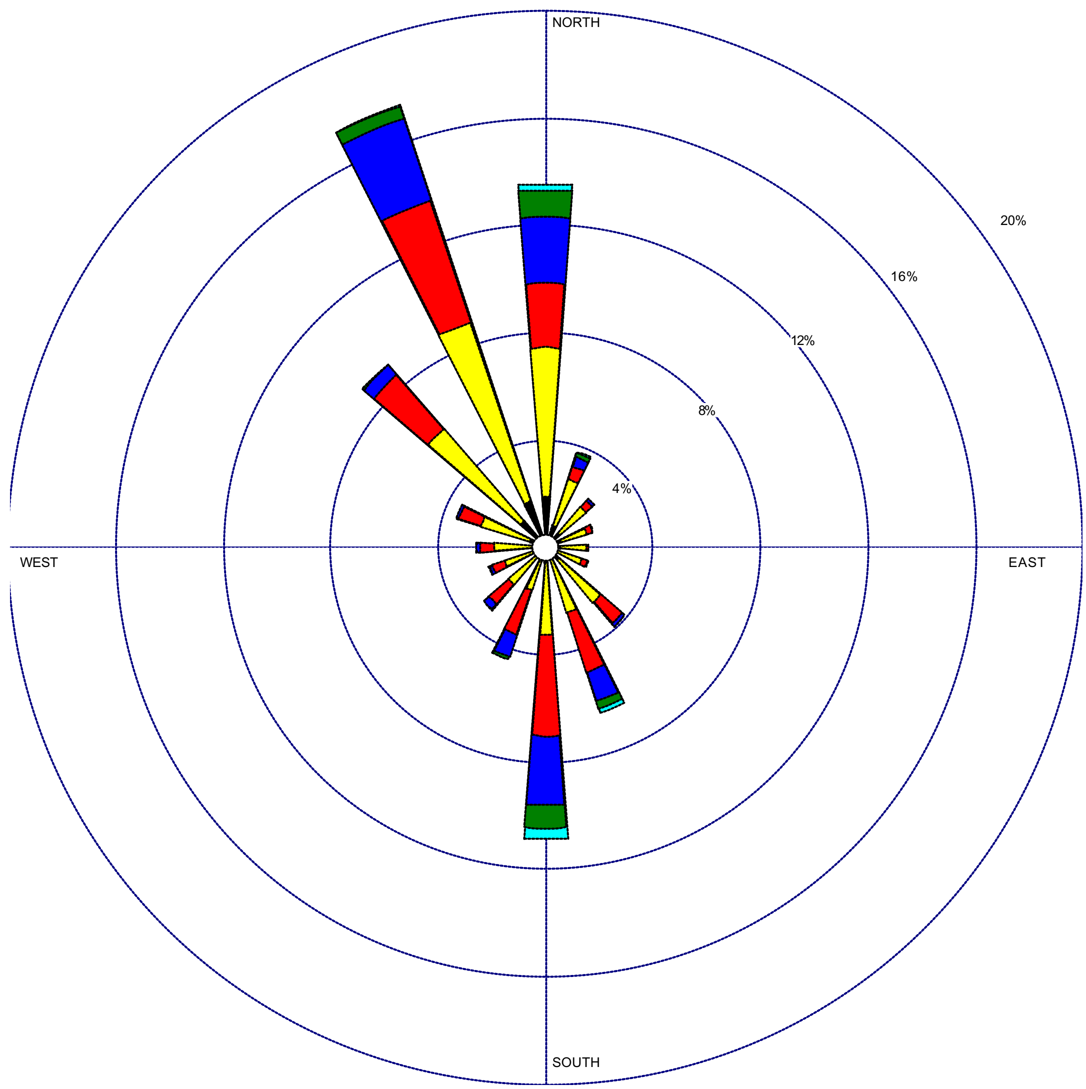
VESTRA

FIGURE 5-7
REFERENCE EVAPOTRANSPIRATION
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: REDDING NATIONAL WEATHER SERVICE OBSERVATION STATION

WIND ROSE PLOT

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



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

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

FIGURE 5-8
WIND ROSE
TEHAMA WEST WATERSHED ASSESSMENT

SOURCE: NATURAL RESOURCES CONSERVATION SERVICE, 2004

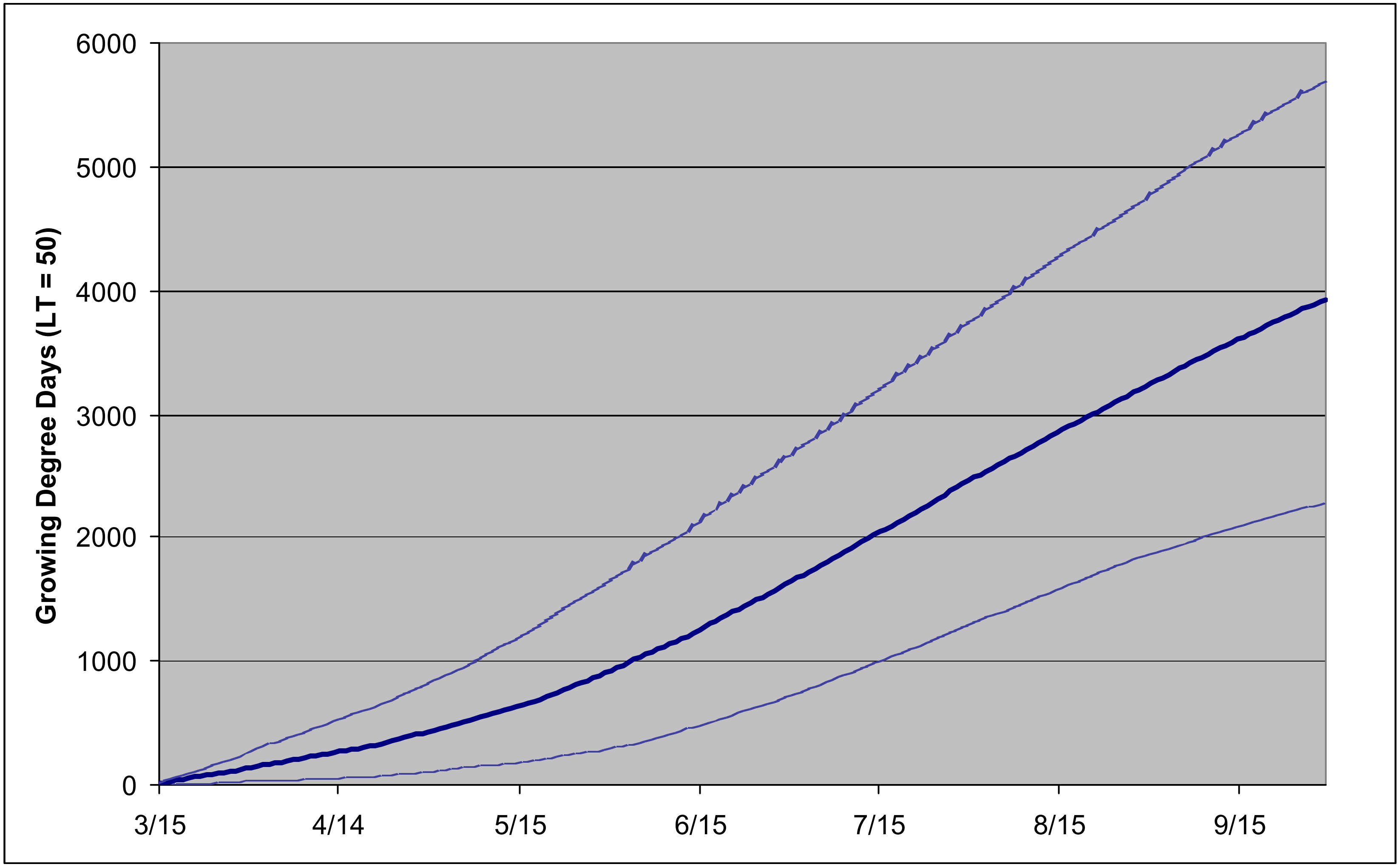


FIGURE 5-9
GROWING DEGREE DAYS
TEHAMA WEST WATERSHED ASSESSMENT