Appendix 3-B

Groundwater Study

GROUNDWATER CONDITIONS IN THE YOSEMITE-MARIPOSA IRWM PLAN AREA

Final Report

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GROUNDWATER CONDITIONS IN THE YOSEMITE-MARIPOSA IRWM PLAN AREA

INTRODUCTION

The Regional Water Advisory Council (RWAC) is preparing an Integrated Regional Water Management Plan (IRWMP) which extends across Mariposa County. This report was done for the IRWM Plan and comprises three major elements:

1. An evaluation of tributary watersheds and pre-development water budgets for 10 subareas. Nine of the subareas were chosen based on the highest densities of private domestic wells. The Fish Camp subarea is primarily served by water system wells and was also included in this evaluation.
2. An evaluation of depths and yields of water supply wells in the nine subareas with the greatest densities of wells.
3. Results of a sampling and analyses program for 64 private wells that was conducted from late April to early June, 2014.

There is only one Department of Water Resources (DWR) defined alluvial groundwater base in the County (Yosemite Valley). Groundwater is normally produced from fractured hardrock in most of the rest of Mariposa County. Groundwater level elevation maps are not available for the area. However, the direction of groundwater flow in such terrane usually follows the topography (from higher elevations to lower elevations). Topographically low areas, such as drainages or streams, are normally locations of groundwater

discharge. Surface watersheds were mapped in the areas of highest well densities, which were evaluated based on well log data provided by the DWR to support this evaluation. Figure 1 shows the ten subareas that were evaluated. By far the most wells are concentrated in the Mariposa vicinity and to the east. The subareas evaluated in this area of high well density included the Agua Fria Creek, Mariposa Creek, and three tributaries of the Chowchilla River (West Fork, Middle Fork, and Oliver Creek). All of these subareas drain to the south toward the Chowchilla River. Three other subareas that were delineated (Coulterville, Greeley Hill, and Bear Creek) drain to the Merced River. The Catheys Valley subarea is drained by Owens Creek, which flows into the San Joaquin Valley. The Catheys Valley subarea is significantly lower in elevation than the other subareas. The Fish Camp subarea primarily drains to Big Creek and thence the Merced River.

The California Department of Water Resources (DWR) (1965) conducted the Mariposa Area Investigation, which focused primarily on surface water conditions. The DWR (1965, Plate 2) prepared an isohyetal map showing the average annual precipitation as of 1960. These isohyetal maps are extremely useful in evaluations of groundwater in the hardrock, because precipitation is generally the source of water for groundwater in each watershed. Because these maps were developed based on rainfall data through 1960, this data was compared to more recent rainfall data. Rainfall data was compared

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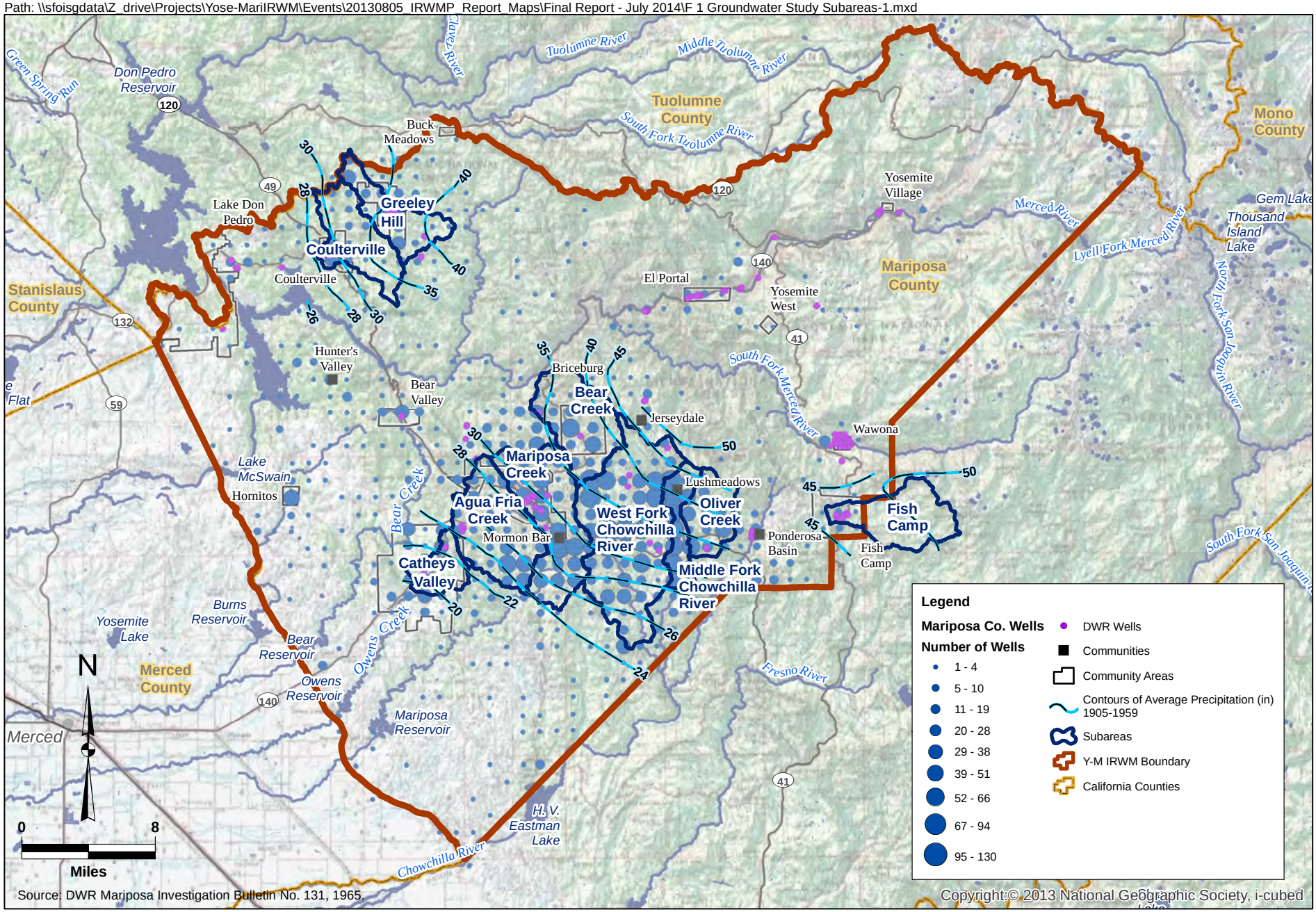

FIGURE 1 SUBAREAS IN MARIPOSA COUNTY

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to that collected at the same stations that were included in the report. As well, the Natural Resource Conservation District put together a PRISM model that uses a statistical-geographic approach to mapping climate. This model uses point measurements of climate data and a digital elevation model to generate estimates of rainfall data using GIS. Data over the period of 1961-1990 and 1981-2010 were compared to the data used in the DWR study and estimates provided by Ken Schmidt. Overall average rainfall estimates varied, but did not trend in any direction over the overall topography; therefore, it seems that overall the DWR analysis is still applicable for use within the Region. Additional information regarding this analysis is included in Appendix A.

Under pre-development conditions, this water either was consumed by native plants or evaporated (evapotranspiration), or ran off as streamflow. At higher elevations where the precipitation is much higher, the runoff is a much higher percentage of the precipitation than for lower elevation watersheds. For lower elevation watersheds, most of the precipitation is consumed by evapotranspiration and the percentage that runs off is small. Groundwater development in the foothills and mountains comes from water that would otherwise have been consumed or would have runoff. For developed watersheds, some of the native vegetation has usually been removed, areas have been paved, and other impermeable surfaces developed. In developed

areas, the consumptive use of water is normally associated with evapotranspiration from outside water use (i.e., landscaping).

GEOLOGIC CONDITIONS

The California Department of Water Resources (1965) provided a geologic map for Mariposa County (Plate 10), which was modified as Figure 2. Overall, the hardrock outcrops can be divided into 1) granitic rocks, 2) metamorphic rocks, and 3) metavolcanic rocks. Yosemite Valley, the Fish Camp area, and the southeast and south part of the County, including Catheys Valley, have extensive granitic rock outcrops. The Mariposa vicinity is dominated by metamorphic rocks. The northwest part of the County is dominated by metavolcanic or metamorphic rocks.

WATERSHEDS, PRECIPITATION, AND EVAPOTRANSPIRATION

The DWR (1965) presented an isohyetal map for the average annual precipitation in Mariposa County as of 1960. Updated precipitation records for specific sites such as the Mariposa Ranger Station have been reviewed (Appendix A). These records indicate that the earlier isohyetal contours are normally within an inch or less of recent long-term average values. Thus the earlier isohyetal maps were overlaid in each subarea to indicate near normal conditions.

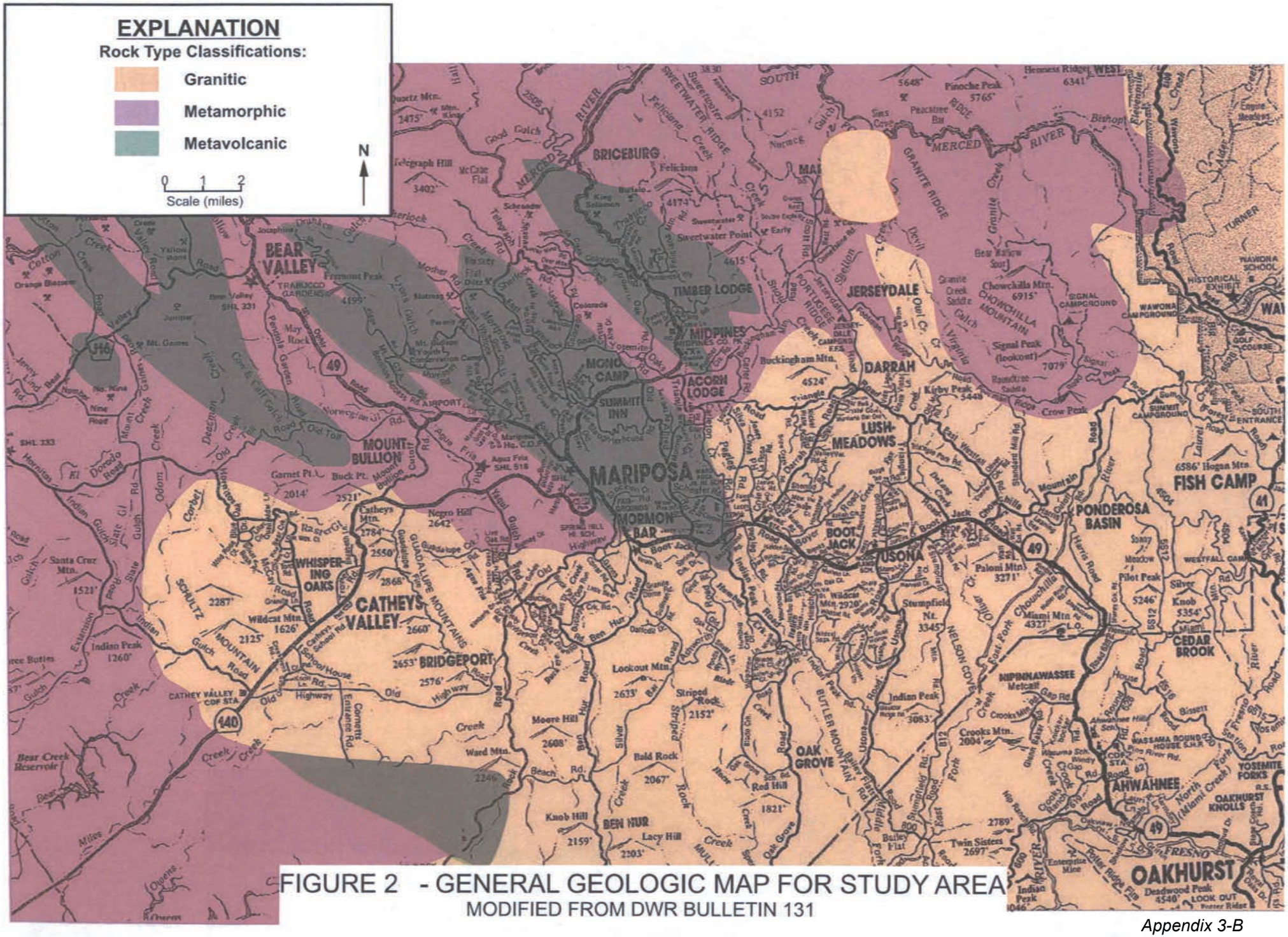

FIGURE 2 - GENERAL GEOLOGIC MAP FOR STUDY AREA
MODIFIED FROM DWR BULLETIN 131

Evapotranspiration by plants in the watersheds was evaluated from several sources. Markovic (1966) compared annual precipitation and runoff from the 1,687-square mile Kings River watershed above Piedra for 1951-64. The annual runoff was 49 percent of the annual precipitation. The difference between precipitation and runoff averaged 18 inches per year for the watershed. Almost all of this difference is associated with plant evapotranspiration (primarily native plants). Ken Schmidt (1977) reported on the results of a hydrologic monitoring program for a 1,700-acre watershed near Shaver Lake. Evapotranspiration was determined from measurements of precipitation, streamflow, and changes in groundwater storage. The elevation of the watershed averaged about 5,000 acre-feet, and the predominant plants were conifer forests, along with some meadows. The long-term average annual precipitation was about 31 inches per year. The calculated evapotranspiration for 1975-76 averaged 22.5 inches per year. These values agree well with values from the literature for conifer forests.

Evapotranspiration of plants in the lower foothills, close to the San Joaquin Valley, is indicated to be slightly less than the precipitation. For example, Cottonwood Creek in Madera County drains a 38-square mile area, including the O'Neals Experimental Station, and joins the San Joaquin River just below Friant Dam. The average precipitation on the watershed has been about 15 inches per year. Grass-oak woodland is the predominant vegetation in the

watershed. The average annual runoff from the watershed has been 4,500 acre-feet per year, or about 2.3 inches per year over the watershed. Thus evapotranspiration averaged about 13 inches per year. In summary, the native plant evapotranspiration is indicated to range from about 12 to 13 inches per year at the lowest elevations in Mariposa County to a peak of about 26 inches per year for high elevations where conifer forests are predominant.

Natural runoff is used in this report to mean runoff in the absence of man's activities, such as residential development.

Coulterville Subarea

The Coulterville subarea is drained by Maxwell Creek, which drains to Lake McClure within several miles of the outlet of the creek from the subarea (Figure 3). The tributary watershed comprises 11,900 acres. The average precipitation ranges from about 29 inches per year at an elevation of about 1,650 feet above mean sea level near the outlet of the creek from the subarea to about 37 inches per year at the highest elevations of the watershed (about 3,250 feet) near Coalpit Hill. The average annual precipitation on the watershed is about 33 inches per year. Considering the type of vegetation present (ranging from grass-oak woodlands at the lower elevations to conifer forests at the higher elevations), the average natural plant evapotranspiration should be at least about 20 inches per year.

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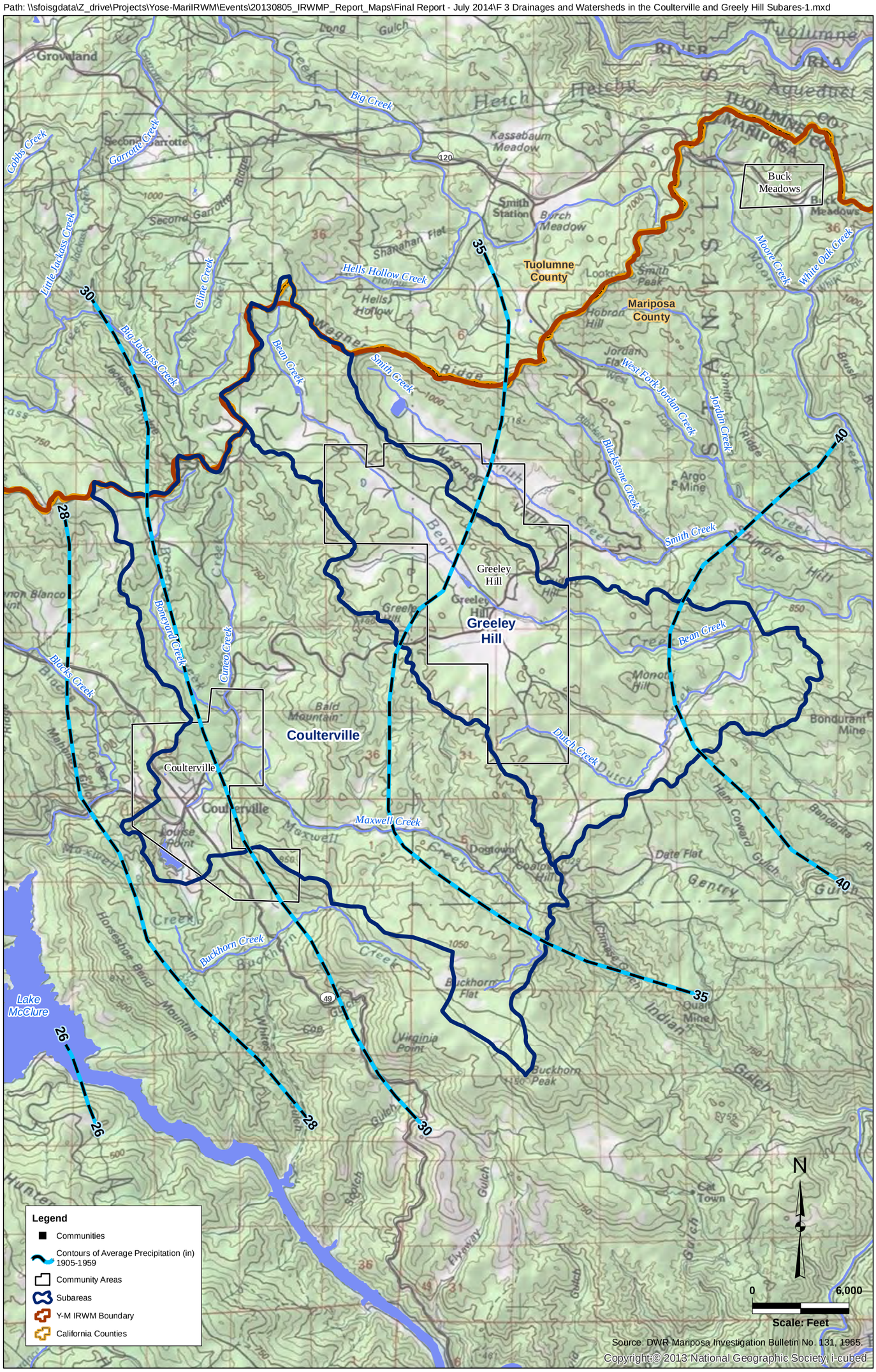

FIGURE 3 DRAINAGES AND WATERSHEDS
IN THE COULTERVILLE AND GREELY HILL SUBAREAS

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Appendix B contains streamflow records used in this evaluation. Owens Creek streamflow records were obtained from the U.S. Army Corps of Engineers in Sacramento. Records for the other stations were obtained from DWR Bulletins for Hydrologic Data.

Maxwell Creek was gaged by the DWR at a station near Coulterville (drainage area about 8,260 acres). The average runoff during 1962-85 was about 6,100 acre-feet per year, or about nine inches per year over the gaged watershed. These records indicate that the evapotranspiration may be about 24 inches per year. Most of the development in the subarea is in the Coulterville vicinity, which is located in an almost ideal area for groundwater development in terms of recharge (i.e., in the lower part of the watershed, with a large upstream tributary watershed).

Greeley Hill Subarea

The Greeley Hill subarea is drained by Bean Creek, which joins the North Fork of the Merced River several miles east of the outlet from the subarea (Figure 3). The tributary watershed comprises 9,300 acres. Land surface elevations in the subarea range from about 2,800 feet near the creek outlet from the subarea to about 3,950 feet along Wagner Ridge near the north edge of the subarea. The average annual precipitation ranges from about 32 inches to the west to about 42 inches to the east. The average precipitation on the watershed is about 36 inches per year. Considering the type of vegetation

present, the average natural plant evapotranspiration is estimated to have been at least about 20 inches per year. Based on measurements in Maxwell Creek, the average natural runoff in Bean Creek is estimated to have been about 7,000 acre-feet per year, or about nine inches per year. Greeley Hill and the other more developed areas are generally in the upper or central part of the watershed, and groundwater development would be based on recharge from only about 60 percent of the watershed.

Catheys Valley Subarea

The Catheys Valley subarea is drained by Owens Creek, which flows into the San Joaquin Valley and eventually drains to the San Joaquin River. The watershed in the subarea comprises 5,230 acres (Figure 4). Land surface elevations range from about 1,150 feet near the creek outlet from the subarea to about 2,870 feet at Catheys Mountain. This subarea is thus at the lowest elevation of the subareas discussed in this report. Average annual precipitation has ranged from about 20 inches near the creek outlet about half a mile south of Catheys Valley School to 24 inches near Catheys Mountain. The average annual precipitation over the watershed has been about 21 inches. Streamflow in Owens Creek has been measured by the U. S. Army Corp. of Engineers at a gaging station below the Owens Creek Reservoir, about six miles downstream of the outlet from the subarea. The tributary watershed above that gage

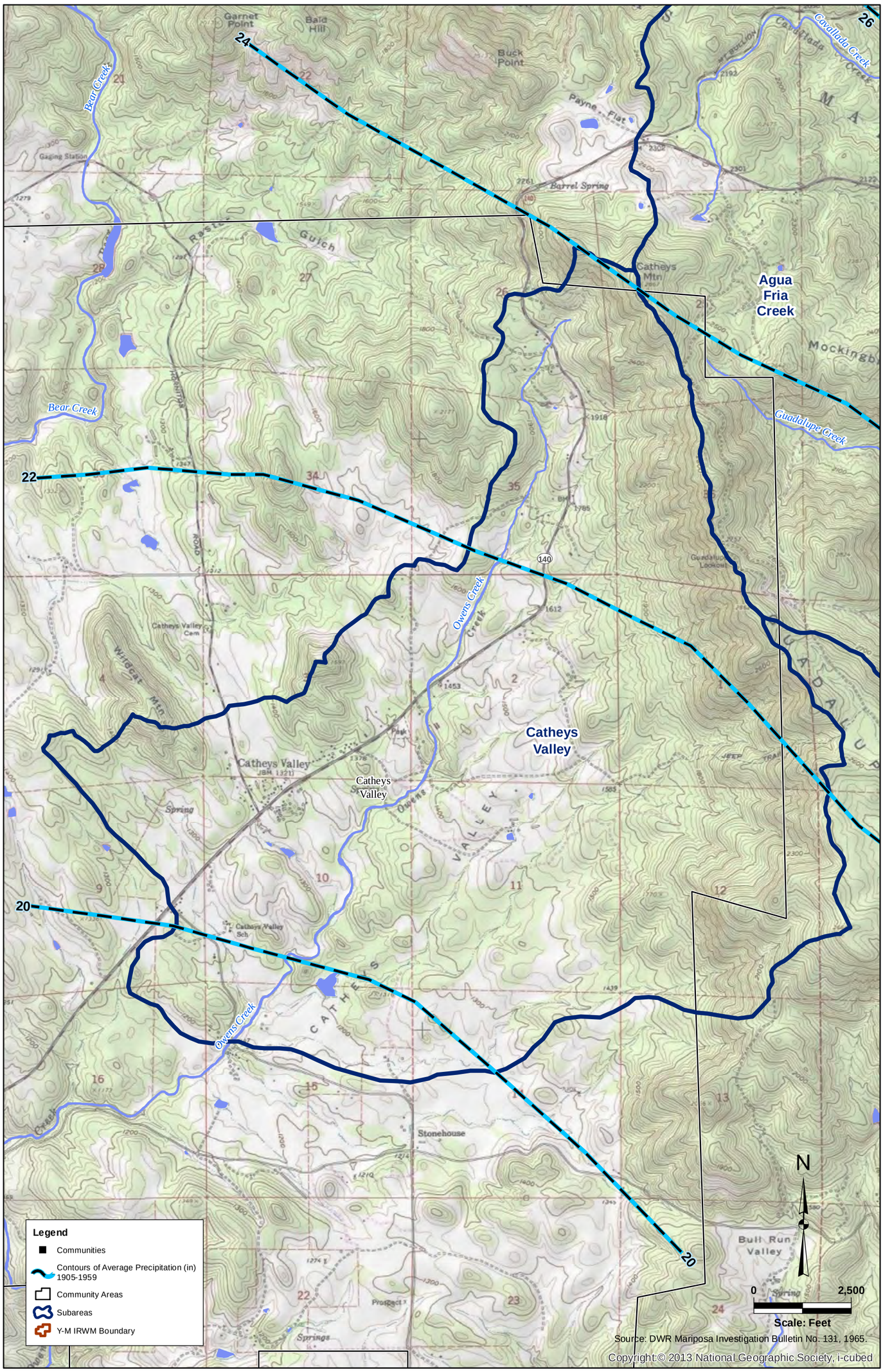

FIGURE 4 DRAINAGES AND WATERSHED
IN CATHEYS VALLEY SUBAREA

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is about 16,400 acres and the average annual runoff from 1960-2013 (Appendix B) was about 5,500 acre-feet per year, or about four inches per year. The natural runoff in Owens Creek at the outlet from the subarea is estimated to have been about 1,750 acre-feet per year (about four inches per year). The predominant vegetation in most of the watershed is grass-oak woodland, and the average annual evapotranspiration is estimated to be about 17 inches per year. The Catheys Valley community and proposed Vallecitos development located to the south are in the lower part of the watershed. Conditions for development of groundwater in this part of Catheys Valley are generally favorable in terms of recharge, due to the relatively larger tributary watershed upstream of this area.

Agua Fria Creek Subarea

The Agua Fria Creek subarea extends from near Mt. Bullion on the north to about a third of a mile upstream of the confluence of Agua Fria Creek and Mariposa Creek (Figure 5). Mariposa Creek subsequently drains to the Chowchilla River. The Agua Fria subarea comprises about 17,300 acres. Land surface elevations range from about 1,450 feet near the basin outlet to about 4,200 feet about two miles north of Mt. Bullion. Average annual precipitation ranges from about 23 inches near the southwest edge of the subarea to about 27 inches north of Mt. Bullion. The average annual precipitation in the subarea is about 26 inches. Vegetation in the subarea ranges

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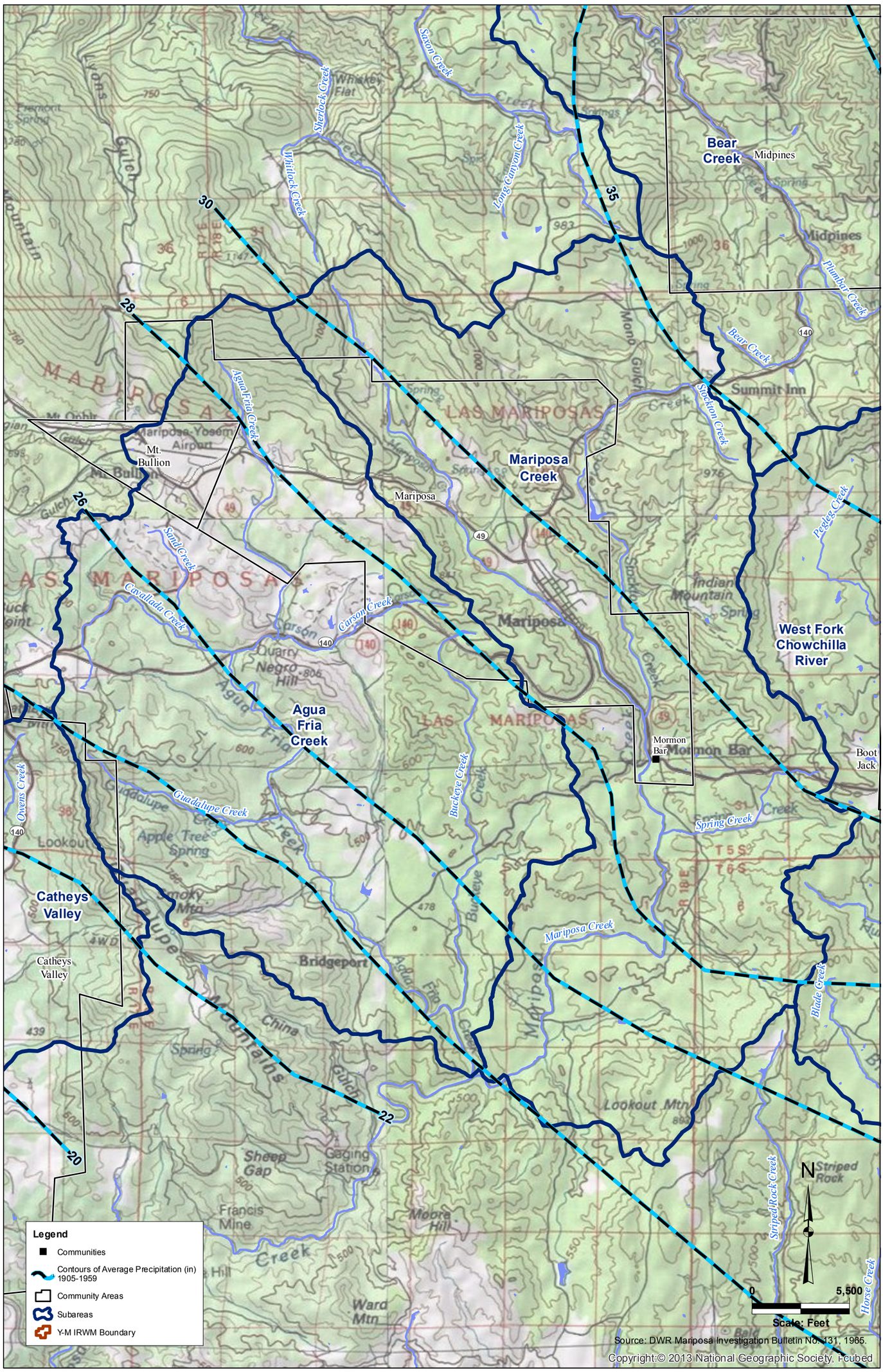

FIGURE 5 DRAINAGES AND WATERSHEDS
IN THE AGUA FRIA CREEK AND MARIPOSA CREEK SUBAREAS

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from grass-oak woodland at the lower elevations to conifer forests at the higher elevations. The average annual natural plant evapotranspiration has been about 20 inches per year. The average natural runoff in Agua Fria Creek, based on records for Mariposa Creek, which drains a comparable watershed, is indicated to be about 14,000 acre-feet per year, or about 6 inches per year. The community of Mt. Bullion is located in the upper part of the basin, where the tributary watershed is limited in size. However, most of the rest of the more developed part of the subarea is near and east of Bridgeport in the lower part of the watershed. This is considered a more favorable area for groundwater development in terms of recharge, because of the relatively large upstream tributary watershed.

Mariposa Creek Subarea

The Mariposa Creek subarea includes the Town of Mariposa. Mariposa Creek drains the area east of the Agua Fria Creek subarea, and leaves the Mariposa subarea at a point about two miles southwest of Bridgeport. The watershed area is about 18,300 acres. Land surface elevations range from about 1,400 feet near the creek outlet to about 3,590 feet northeast of Mono Camp. Average annual precipitation ranges from about 25 inches near the creek outlet from the subarea to 35 inches northeast of Mono Camp. The average annual precipitation in the subarea is about 30 inches. Vegetation in the subarea ranges from grass oak-woodlands at the lower elevations to

conifer forests at the higher elevations. The average annual natural plant evapotranspiration is estimated to have been at least about 20 inches per year. Measured streamflow in Mariposa Creek near Catheys averaged about 23,400 acre-feet per year during 1962-86, or about six inches per year, over the 47,400-acre watershed above the gage. A considerable part of the gaged watershed which was at a lower elevation than in the subarea. The estimated long-term natural runoff in Mariposa Creek at the subarea outlet is estimated to have been about 10 inches per year, or about 15,000 acre-feet per year.

The most heavily developed part of this subarea is near the Town of Mariposa, located in the central part of the watershed. The area to the south near Mormon Bar is in in the lower part of the watershed, and is considered more favorable for development of groundwater in terms of recharge, considering the upstream tributary watershed. However, the Town of Mariposa and Mormon Bar are also located in a relatively narrow area where the surrounding lands are relatively steep, and this poses a constraint in developing groundwater. This is the reason that surface water is used as the primary source of drinking water supply.

Bear Creek Subarea

Bear Creek flows to the northwest and joins the Merced River at the subarea outlet (Figure 6). The watershed area comprises about 14,400 acres. Land surface elevations range from about 1,450 feet near the outlet of the subarea to about 4,615 feet at Sweetwater Point, along the east drainage divide of the watershed. Average annual precipitation in the subarea ranges from about 33 to 45 inches and increases to the east toward the higher elevation part of the watershed. The average annual precipitation on the watershed is indicated to be about 37 inches. Based on the predominant vegetation in the area, the average natural plant evapotranspiration is estimated to have been at least about 20 inches per year. The average annual streamflow at the subarea outlet is estimated to have been about 9,600 acre-feet per year, or about 8 inches a year. This indicates that the evapotranspiration could have been about 25 inches per year. There are a number of wells in the flatter part of the watershed along Bear Creek. The size of the upstream watershed increases to the northwest toward the Merced River.

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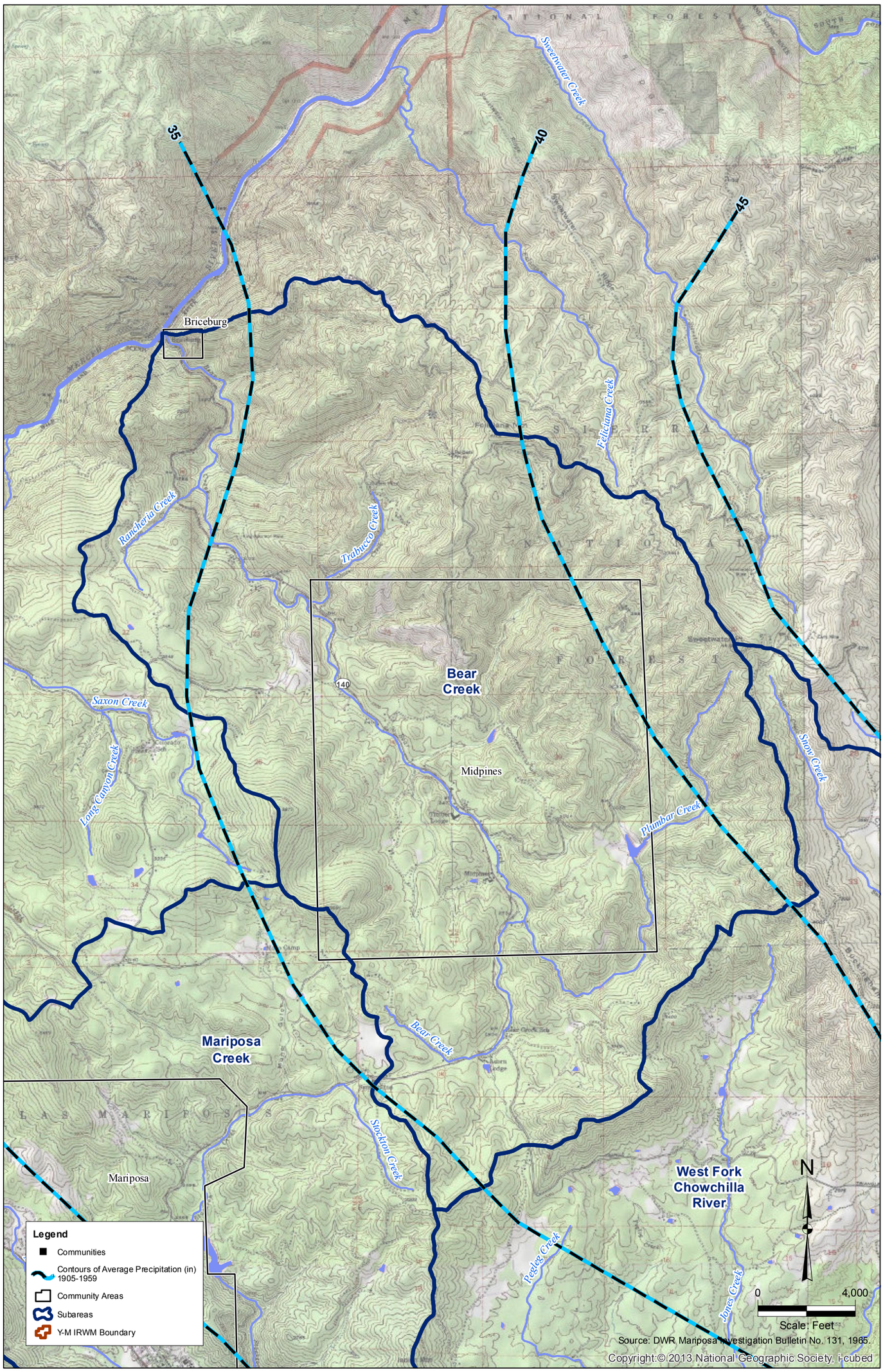

FIGURE 6 DRAINAGES AND WATERSHED
IN THE BEAR CREEK SUBAREA

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West Fork of Chowchilla River Subarea

The West Fork of the Chowchilla River outlet from the sub-area occurs just downstream of the confluence with Blade Creek, about two miles upstream from the Mariposa County-Madera County line (Figure 7). The north end of the subarea is a drainage divide southeast of Jerseydale. The community of Bootjack is in this subarea. The watershed in this subarea comprises 33,800 acres. Land surface elevations range from about 1,220 feet near the river outlet from the subarea to 4,610 feet at Sweetwater Point. The average annual precipitation in the watershed ranges from about 25 inches near the river outlet to almost 50 inches to the north, near Fortman Ridge. The average annual precipitation in the subarea is indicated to be about 32 inches. Given the predominance of conifer forests in much of the watershed, the average annual natural plant evapotranspiration should be at least about 22 inches. Streamflow in the West Fork was measured by DWR during 1962-85. The average streamflow was about 13,500 acre feet per year for about 21,500 acres of the watershed. The runoff thus averaged about eight inches per year during the period. These measurements indicate that the plant evapotranspiration could be about 24 inches per year.

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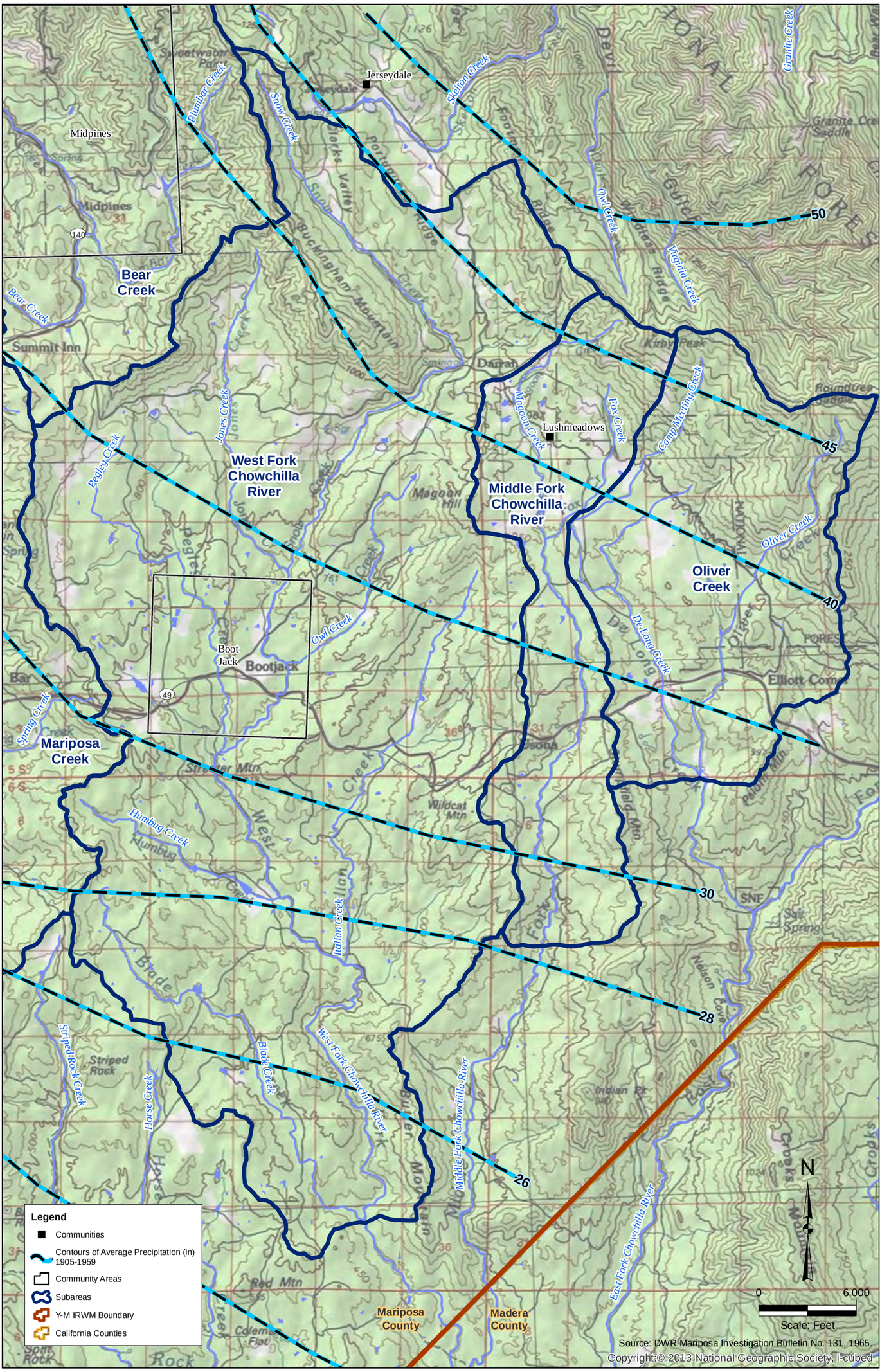

FIGURE 7 DRAINAGES AND WATERSHEDS IN THE WEST FORK AND MIDDLE FORK OF CHOWCHILLA RIVER AND THE OLIVER CREEK SUBAREAS

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Middle Fork of Chowchilla River Subarea

The watershed for the Middle Fork is elongated from north to south and comprises about 5,900 acres. The outlet for the subarea is located about a mile north of the Indian Peak School.
Land surface elevations range from about 2,050 feet near the subarea outlet to about 5,450 feet at Kirby Peak. Magoon Creek and Fox Creek are two tributaries that join in the north part of the subarea to form the Middle Fork. Average annual precipitation ranges from 28 inches near the outlet from the subarea to 47 inches to the north near the drainage divide. The average annual precipitation in the subarea is about 37 inches. Considering the predominance of conifer forests in the watershed, the estimated average annual evapo-transpiration is at least about 22 inches per year. DWR measured streamflow in the Middle Fork at the outlet during 1959-63. The average annual runoff was about 3,900 acre-feet per year, or about eight inches per year over the watershed. Despite the short period of these records, they suggest that the plant evapotranspiration may have been higher than 22 inches per year. Some of the densest areas of water supply wells are located in the north and central parts of the subarea. Although the tributary watershed is relatively small, the average annual precipitation is relatively high.

Oliver Creek Subarea

Oliver Creek drains a relatively small watershed east of the Middle Fork (Figure 7). Oliver Creek flows to the south and joins the Middle Fork of the Chowchilla River at a location about eight miles south of the subarea outlet. The combined area of the Oliver Creek drainage and an un-named tributary to the east in this subarea is 7,900 acres. Land surface elevations range from about 2,650 feet near the subarea outlet to about 5,450 feet at Kirby Peak. Average annual precipitation ranges from about 33 inches near the subarea outlet to 47 inches near the northerly drainage divide. The average annual precipitation in the subarea is about 39 inches. Considering the predominance of conifer forests, the estimated natural annual evapotranspiration was at least 22 inches. The estimated natural runoff was probably about 8,000 acre-feet per year, or about 12 inches per year.

Fish Camp Area

There is a drainage divide located south of Fish Camp (Figure 8). Runoff north of this divide flows toward Big Creek, which flows to the north and into Yosemite National Park, and eventually

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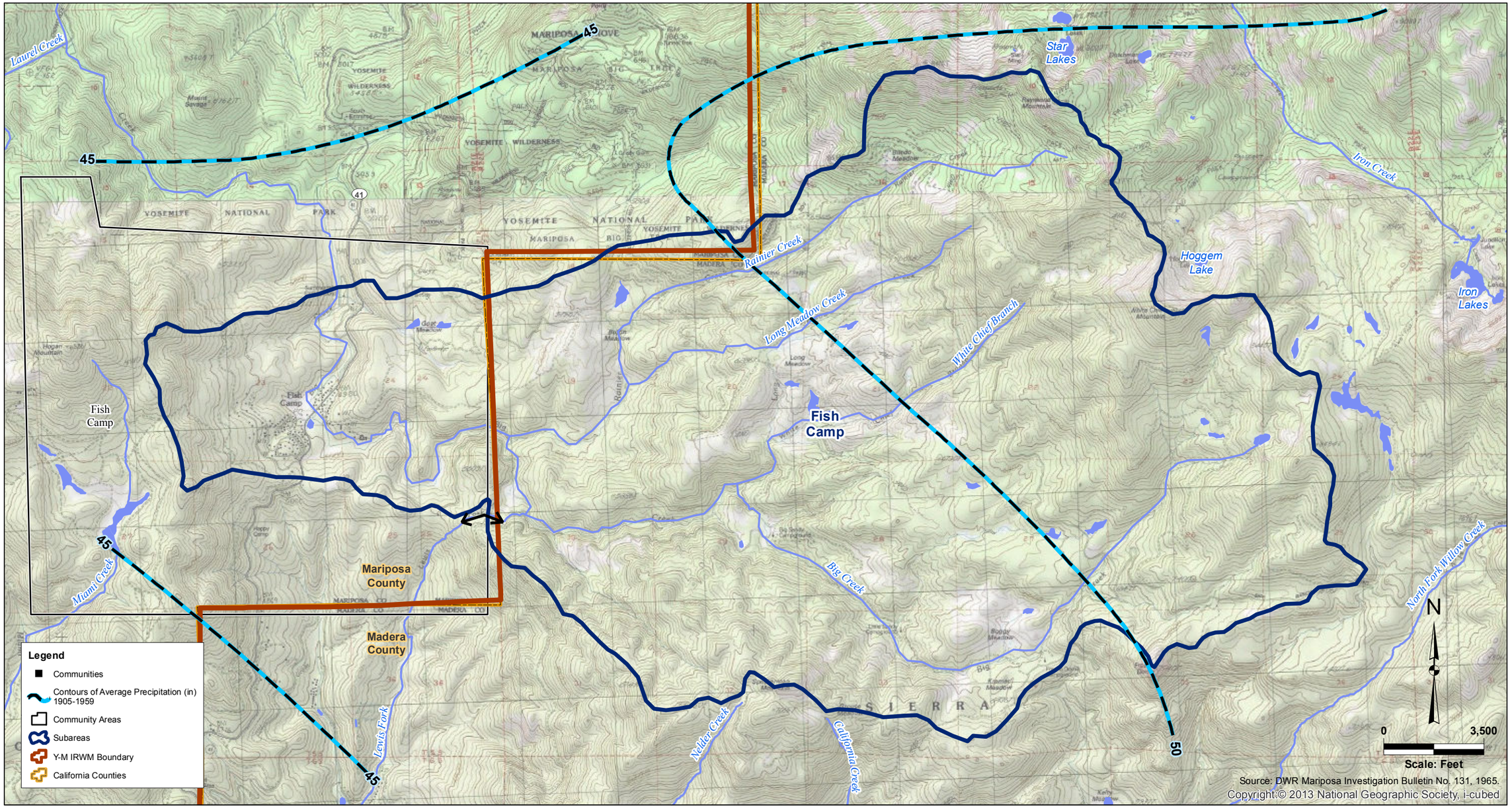

FIGURE 8 DRAINAGES AND WATERSHED IN THE FISH CAMP SUBAREA

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to the Merced River. Runoff south of this divide flows to the south and into Madera County north of Sugar Pine, to the North Fork of Lewis Creek, a tributary of the Fresno River. Most of the tributary watershed for Big Creek is located in Madera County. Elevations in the Fish Camp subarea range from about 5,000 feet near the subbasin outlet to about 9,400 feet. The average annual precipitation at Fish Camp is about 47 inches per year, and in the Fish Camp Subarea is almost 50 inches per year. Streamflow in Big Creek is measured by the U.S. Forest Service upstream of Fish Camp at the Big Sandy Campground, but not during the winter. Because of the predominance of conifer forest and meadows and the high precipitation, the estimated evapotranspiration of native plants (about 24 to 26 inches per year) is indicated to be slightly higher than that for Shaver Lake. Thus there is a large excess of streamflow over plant evapotranspiration in the 12,400-acre watershed tributary to Fish Camp. The estimated average streamflow at the subarea outlet is about 27,000 acre-feet per year, or about 23 inches per year. This subbasin has by far the greatest excess of precipitation over evapotranspiration, of those evaluated in the County, because of its high elevation. An unnamed tributary enters the meadow area west of Highway 41 and drains a local watershed about 240 acres in size. Wells for the Yosemite Alpine Village CSD and proposed Silvertip Resort are located in this watershed.

SUPPLY WELLS

Completion reports for wells in each of the nine subareas (excluding the Fish Camp Subarea) were assembled and summarized by township/range and section in terms of total depths and air- test yields. Tabulations of this information are provided in Appendix C. Since these reports are confidential, the owners' names and addresses aren't provided, rather the information is referenced to the well completion report number. In the mid 1960's, hardrock wells in the area began to be drilled by the air-rotary method. Virtually all of the hardrock wells drilled during the past five decades have been drilled by this method. Air is used to lift drill cuttings and water from the wells to the land surface. At the end of drilling, air is normally blown into the wells for at least one to two hours to develop the well. The resulting well yield at the end of development is termed the "airtest yield". This yield is fairly representative of the normal yields of many private wells. However, for heavily pumped wells such as public supply or commercial wells, the airtest yield often over estimates the sustainable pumping rate. Long-term (15 to 30 day) pump tests are necessary to determine the yields of these wells. Over the decades, hardrock wells in many parts of the Sierra Nevada have generally been drilled progressively deeper. However, in the subareas evaluated, most wells are less than 400 feet deep, and only a few wells are deeper than 1,000 feet. Some

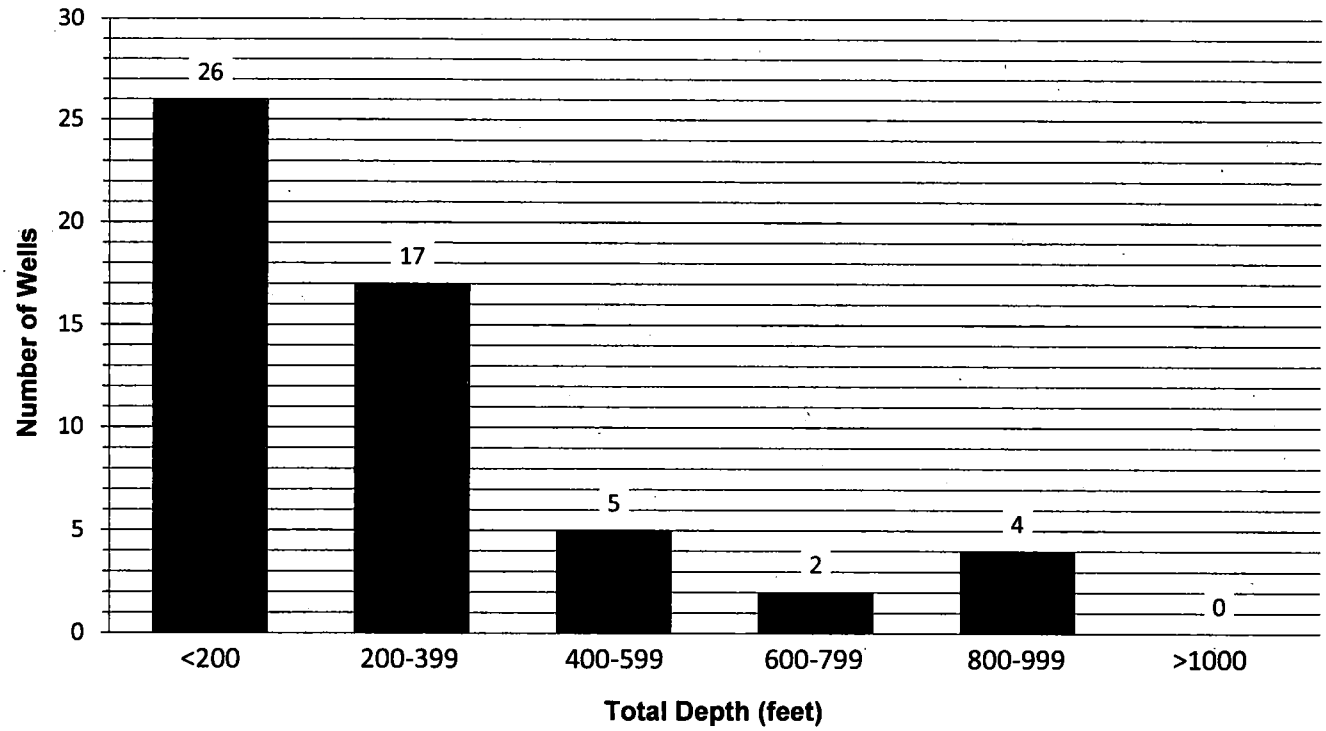
of the water system wells in the Fish Camp subarea are among the deepest wells.

Coulterville Subarea

Figure 9 shows the depths for 54 wells and airtest yields for 53 of these wells with records. Forty three of these wells, or more than 80 percent, are less than 400 feet deep, and only four are deeper than 800 feet. The distribution of airtest yields indicates that nine wells, or 17 percent, had airtest yields of less than 5 gpm (considered low in this terrane). Thirty of the wells, or 57 percent, had airtest yields exceeding 10 gpm (considered moderate). Eight of the wells had airtest yields exceeding 50 gpm (considered high in such terrane). Overall, the well productivity in this subarea ranges from low to high.

Greeley Hill Subarea

Figure 10 shows depths for 62 wells and airtest yields for 59 of these wells with records in the Greeley Hill subarea. Fifty four of these wells, or 87 percent, were less than 400 feet deep. Only two of these wells were deeper than 600 feet. Only one of the wells with records had an airtest yield of less than 5 gpm, whereas 33 of the wells, or 56 percent, had airtest yields exceeding 20 gpm. Sixteen of the wells had airtest yields exceeding 50 gpm. Overall, the well productivity in this subarea is considered moderate to high.



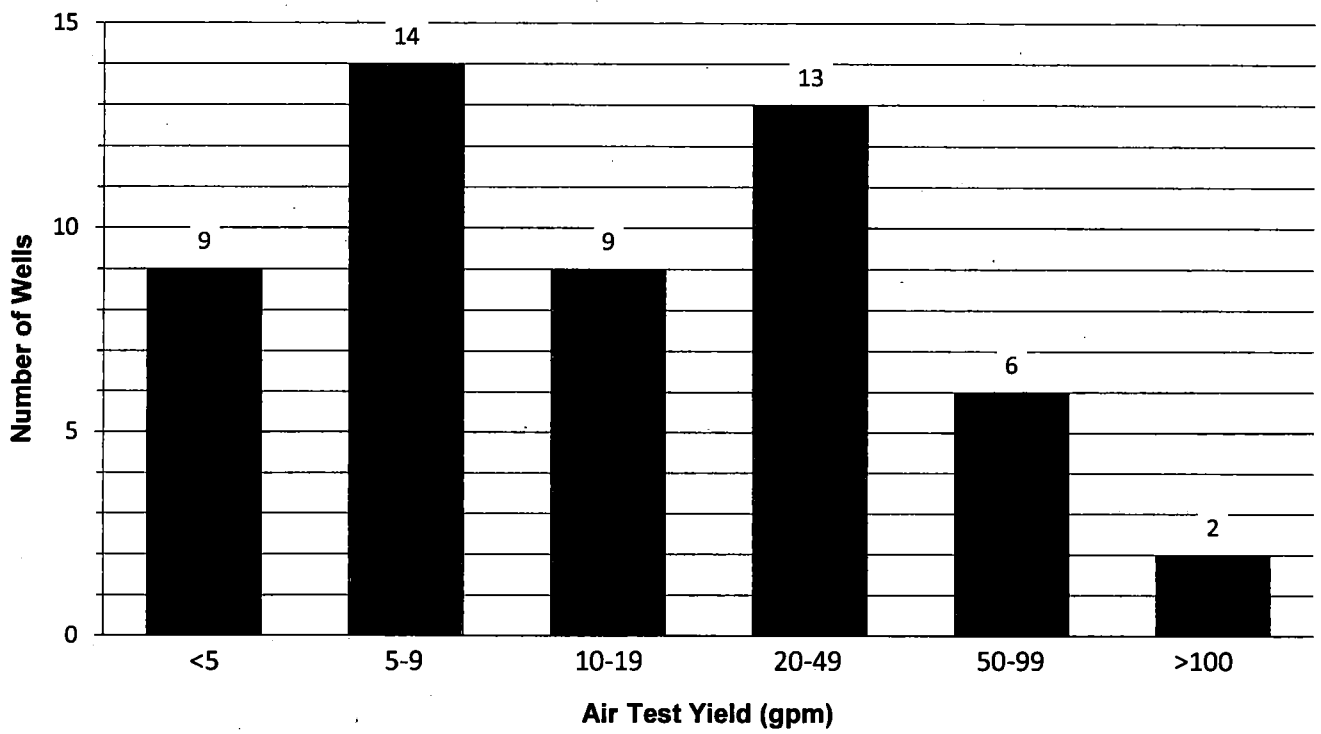
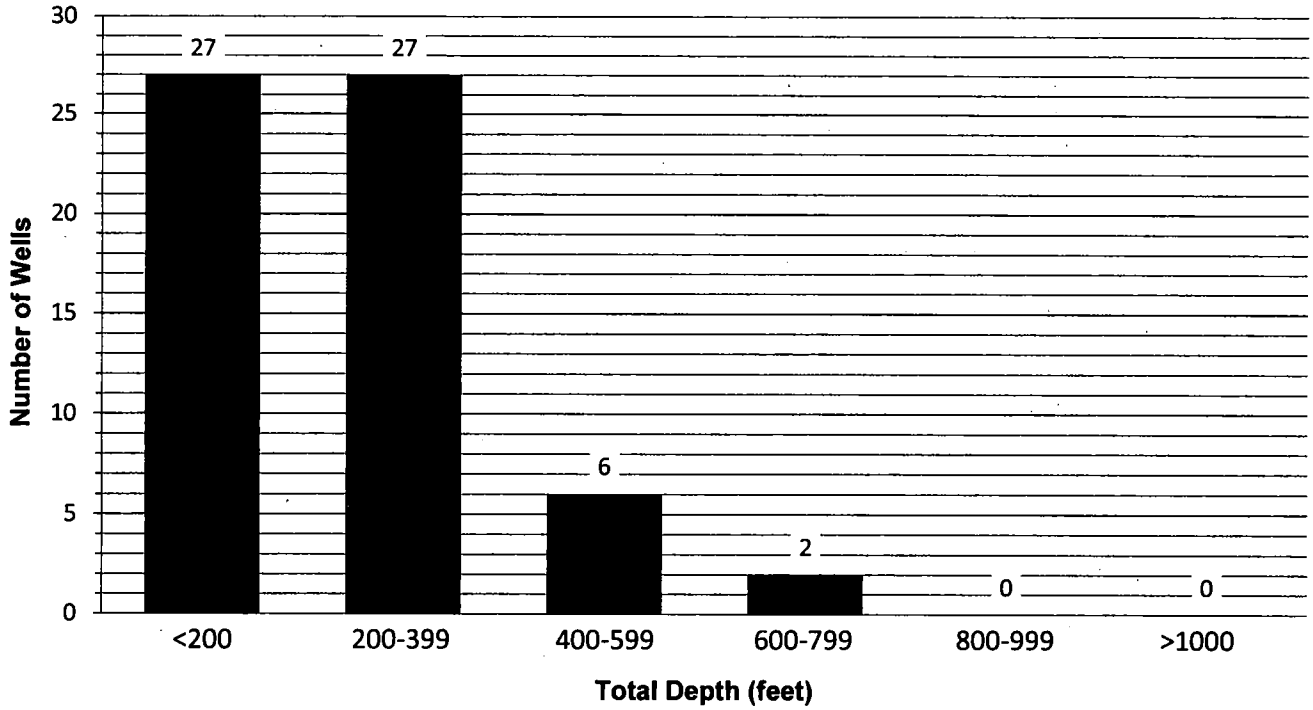


FIGURE 9-DEPTHS AND AIRTEST YIELDS OF WELLS IN COULTERVILLE SUBAREA



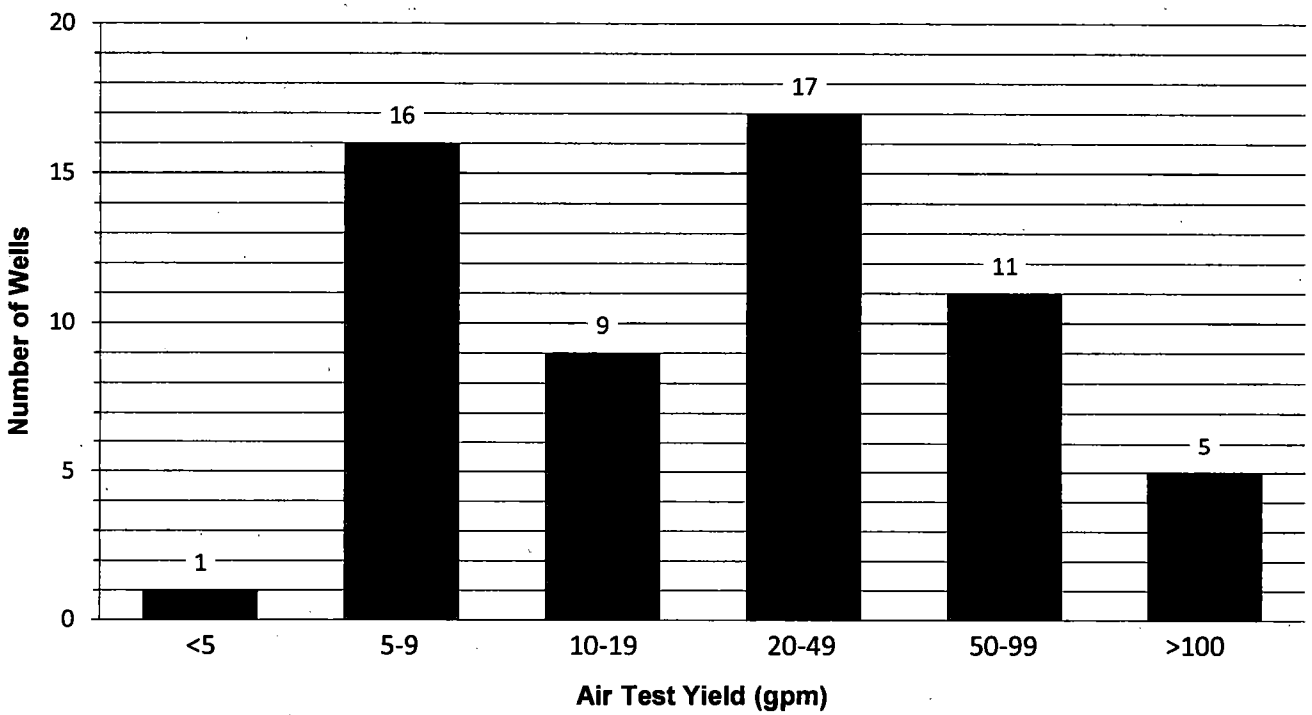


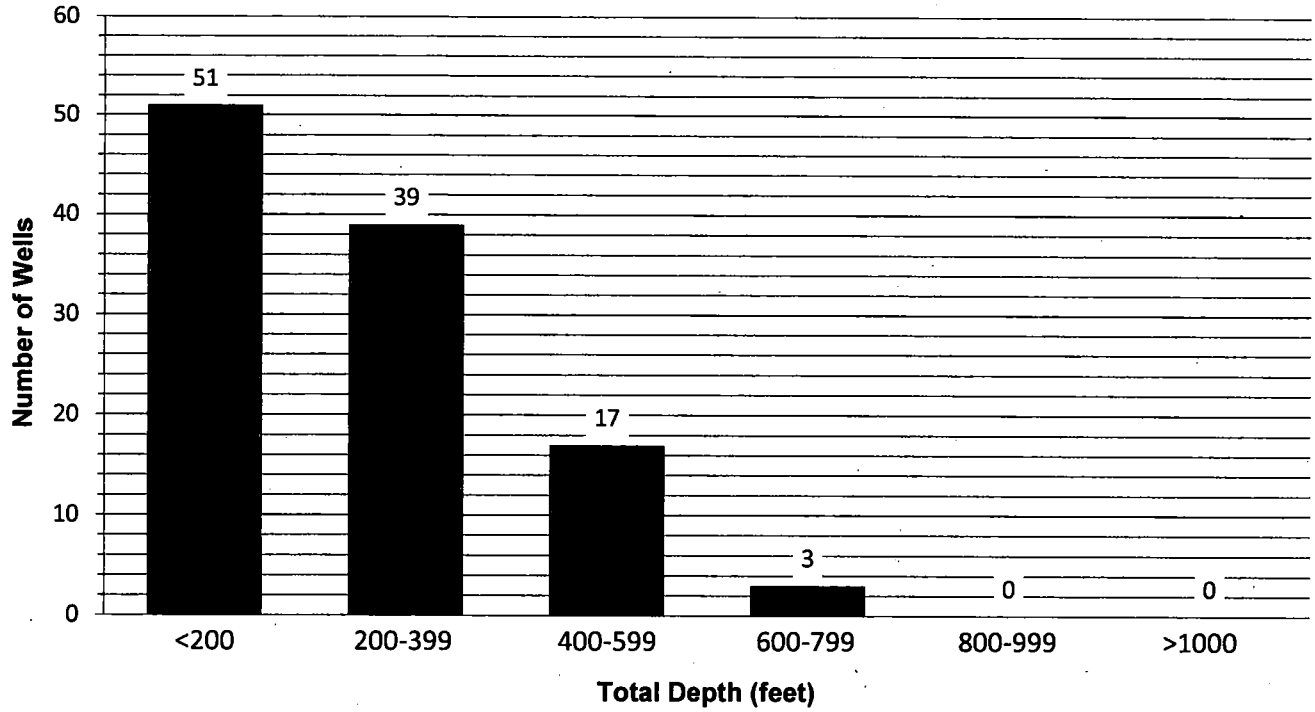
FIGURE 10-DEPTHS AND AIRTEST YIELDS OF WELLS IN GREELEY HILL SUBAREA

Catheys Valley Subarea

Figure 11 shows depths for 110 wells and airtest yields for 80 of these wells with records in the Catheys Valley subarea. Ninety of these wells, or 82 percent, are less than 400 feet deep. Most of the remaining wells are between 400 and 600 feet deep. The percentage of wells deeper than 400 feet in the Catheys Valley subareas is higher than in the Coulterville and Greeley Hill subareas. Airtest yields of 15 of the wells with records, or 19 percent, were less than 5 gpm. Fifty seven of the wells, or 72 percent of those with records, had airtest yields ranging from 5 to 20 gpm. Only three wells had airlift yields exceeding 50 gpm. Overall, the well production in Catheys Valley ranged from low to moderate in most cases.

Agua Fria Creek Subarea

Figure 12 shows depths for 178 wells and airtest yields for 134 of these wells with records in the Agua Fria subarea. One hundred and fifty eight of those wells, or almost 90 percent, are less than 400 feet deep. Of the remaining wells, 17 range from 400 to 600 feet deep, and two are between 800 and 1,000 feet deep. Airtest yields of 14 wells, or about 11 percent of those with records, were less than 5 gpm. Airtest yields of 98 wells, or about 74 percent of those with records, ranged from 5 to 20 gpm. Only two wells had airtest yields exceeding 50 gpm.



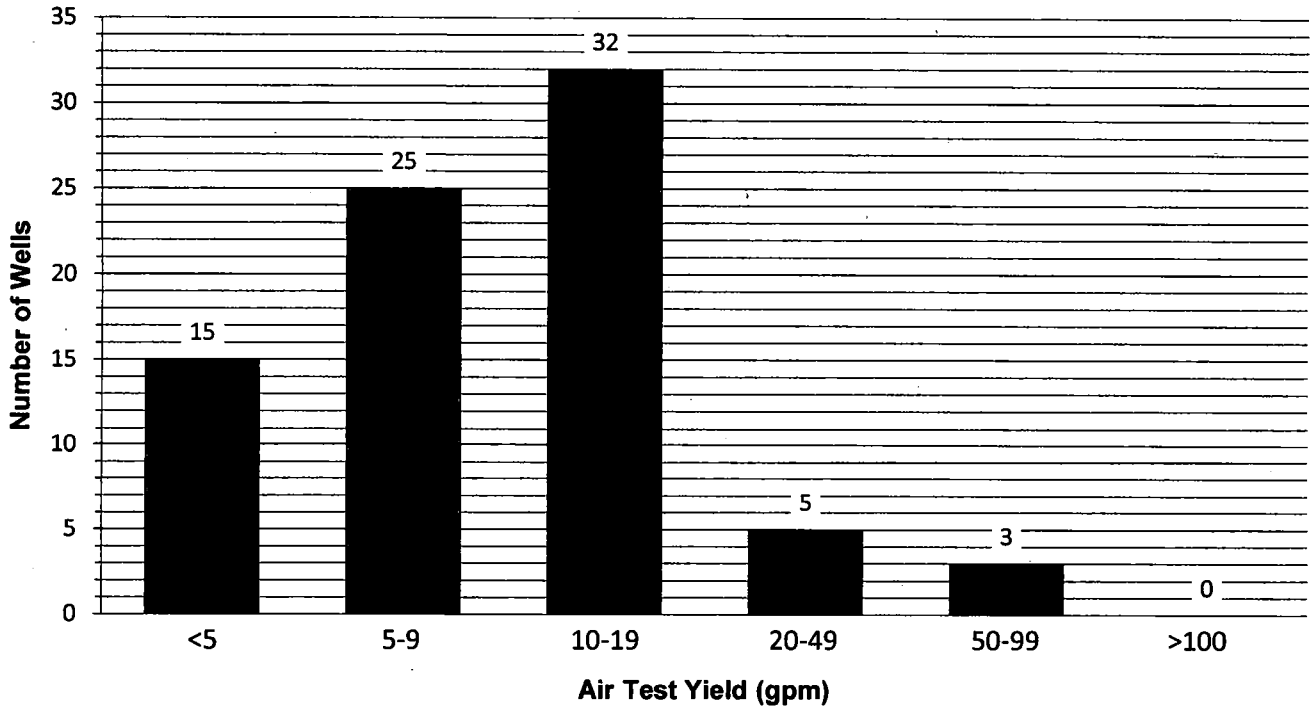
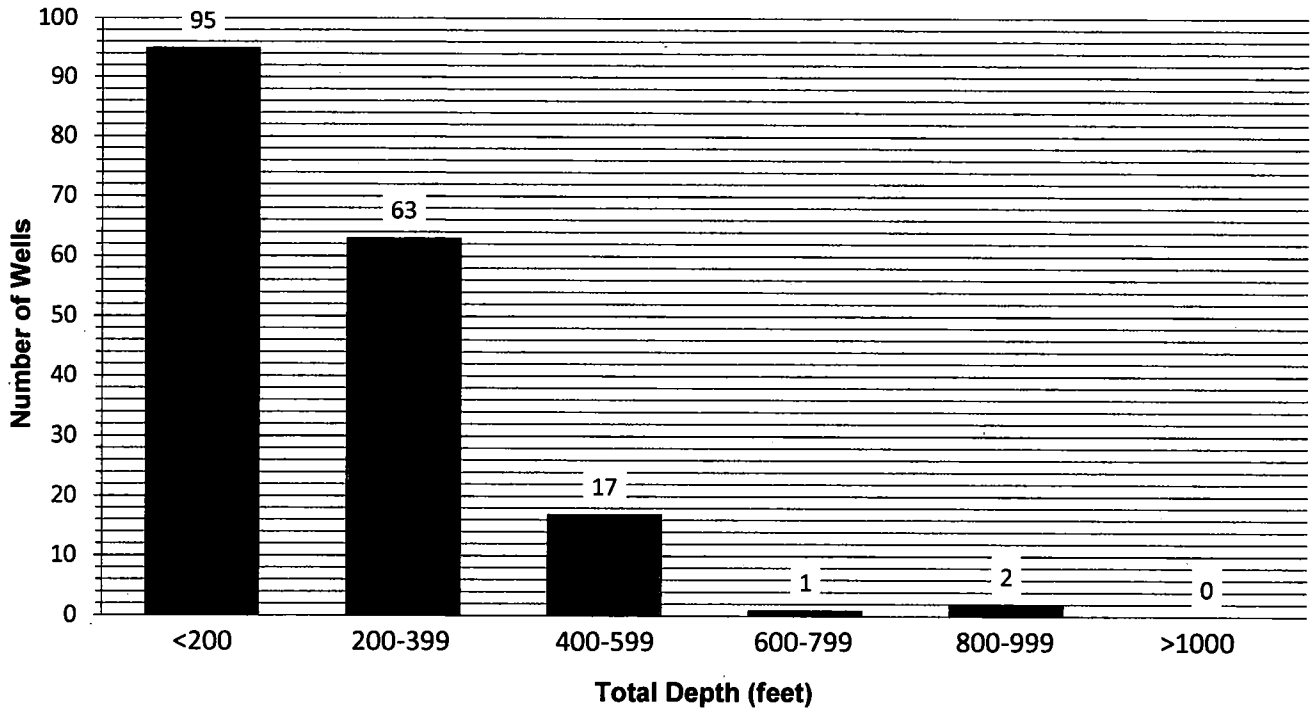


FIGURE 11-DEPTHS AND AIRTEST YIELDS OF WELLS IN CATHEYS VALLEY SUBAREA



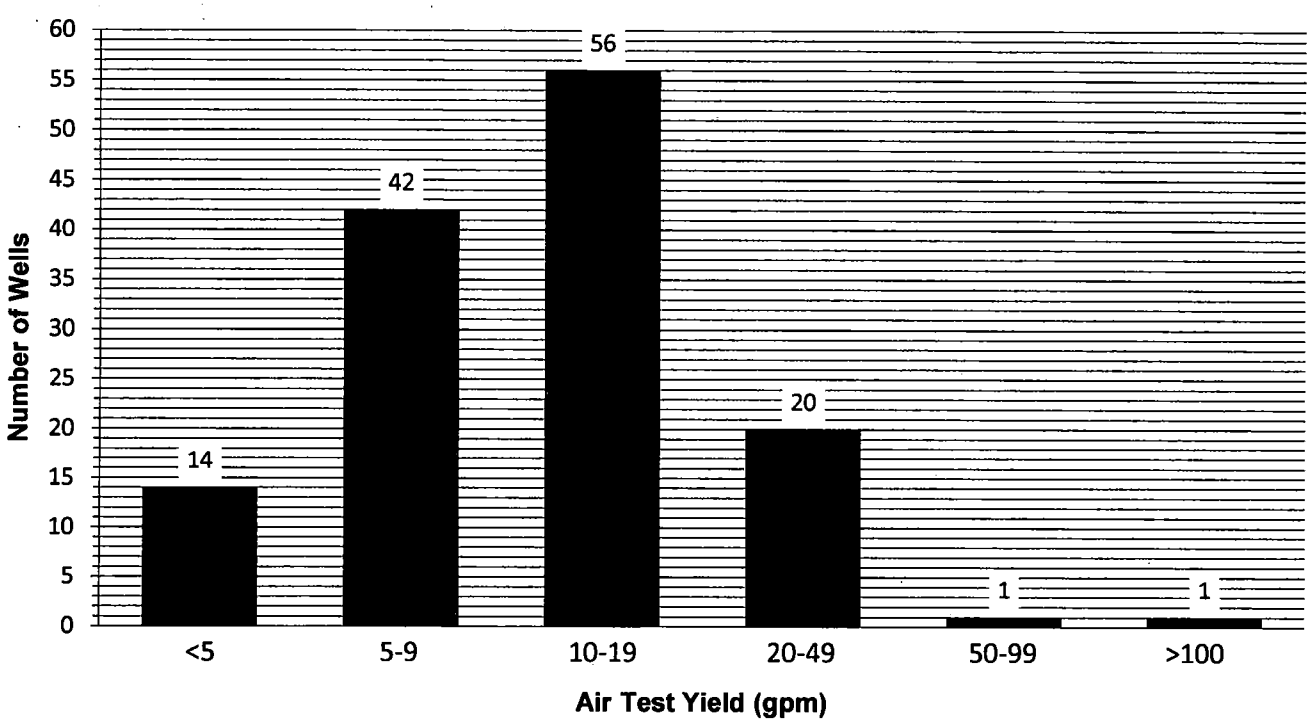


FIGURE 12-DEPTHS AND AIRTEST YIELDS OF WELLS IN AGUA FRIA CREEK SUBAREA

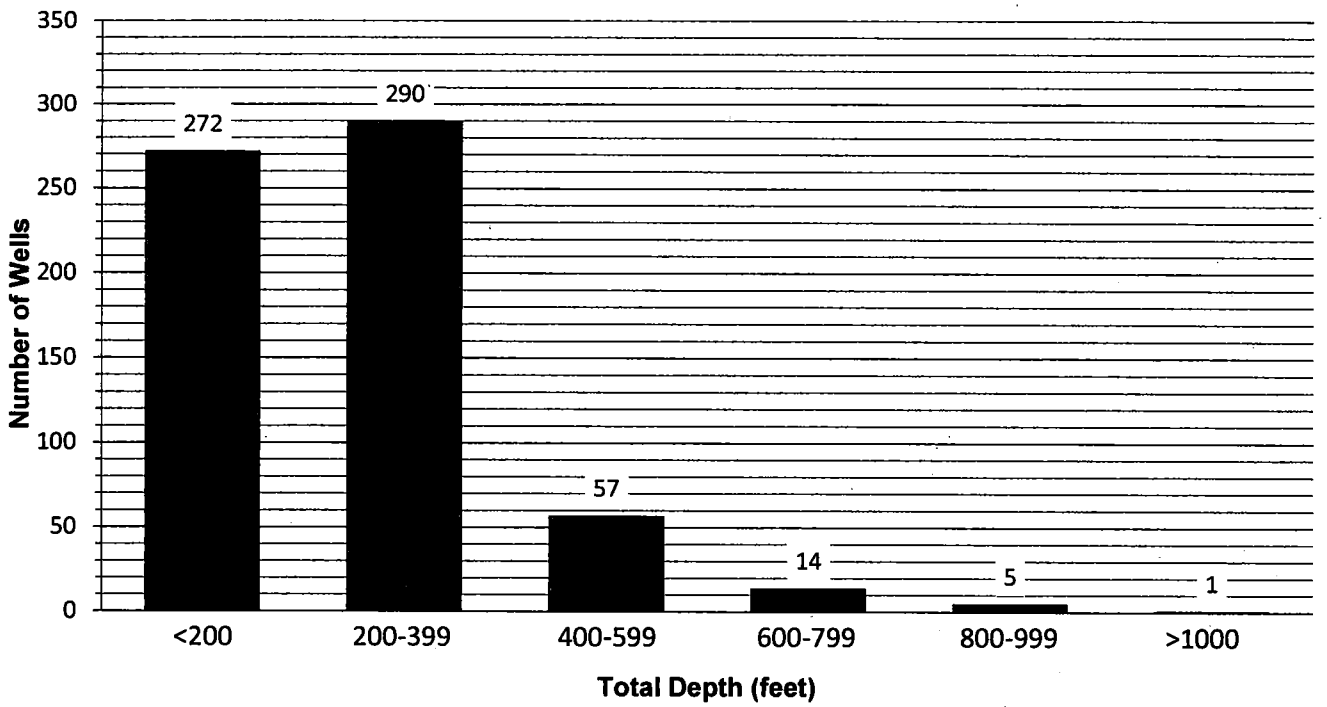
Overall, the well production in the Agua Fria subarea is considered moderate.

Mariposa Creek Subarea

Figure 13 shows depths for 639 wells and airtest yields for 504 of these wells with records in the Mariposa Creek subarea. A total of 562 of the wells, or 88 percent, are less than 400 feet deep. Fifty seven wells, or nine percent, are between 400 and 600 feet deep. Fourteen wells are between 600 and 800 feet deep, and six wells are deeper. Airtest yields of 96 wells, or 19 percent of the wells with records had airtest yields of less than 5 gpm. A total of 307 wells, or 61 percent of those with records had airtest yields between 5 and 20 gpm. Sixty five wells, or 13 percent, had airtest yields ranging from 20 to 50 gpm. Thirty six wells had airtest yields exceeding 50 gpm.

Bear Creek Subarea

Figure 14 shows depths for 255 wells and airtest yields for 206 of these wells that have records in the Bear Creek subarea. A total of 221 of these wells, or 87 percent, are less than 400 feet deep. Twenty six wells, or 11 percent, range from 400 to 600 feet deep. Only two wells with records are greater than 800 feet deep. Airtest yields for 33 wells, or 16 percent of these with records, were less than 5 gpm. Airtest yields for 138 wells, or 67 percent of these



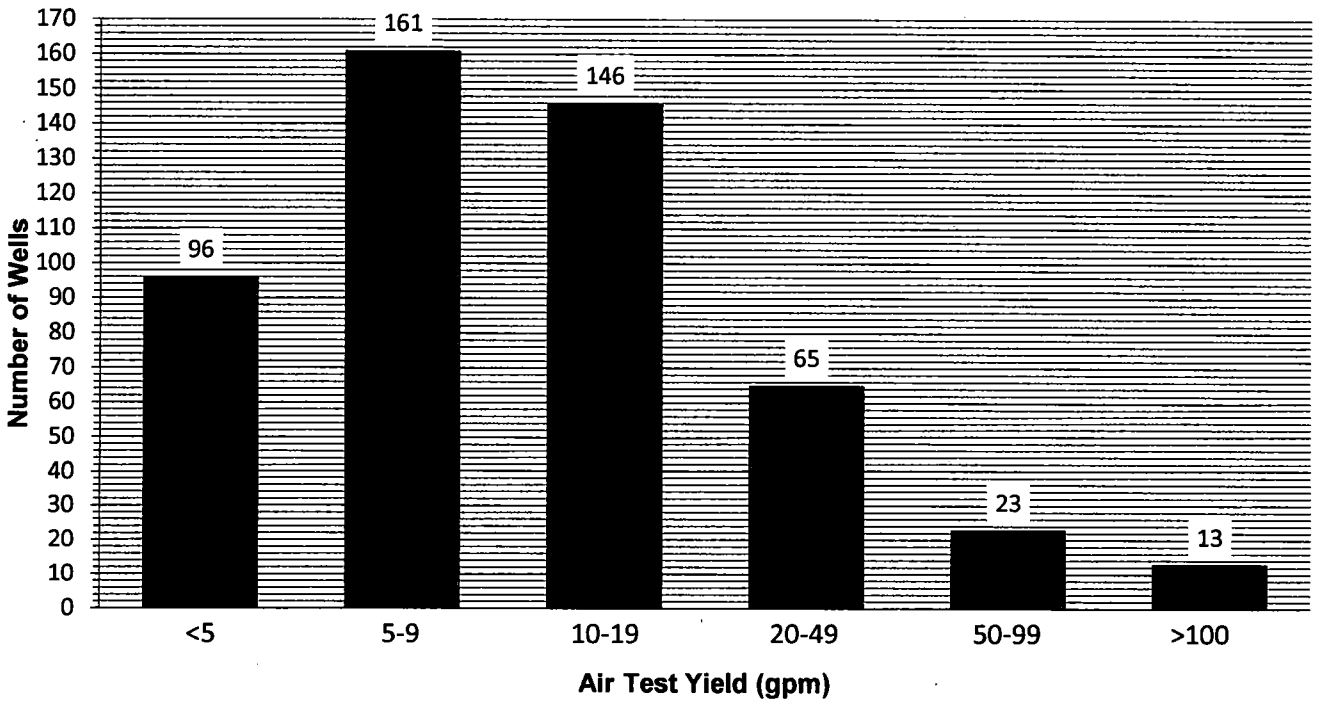
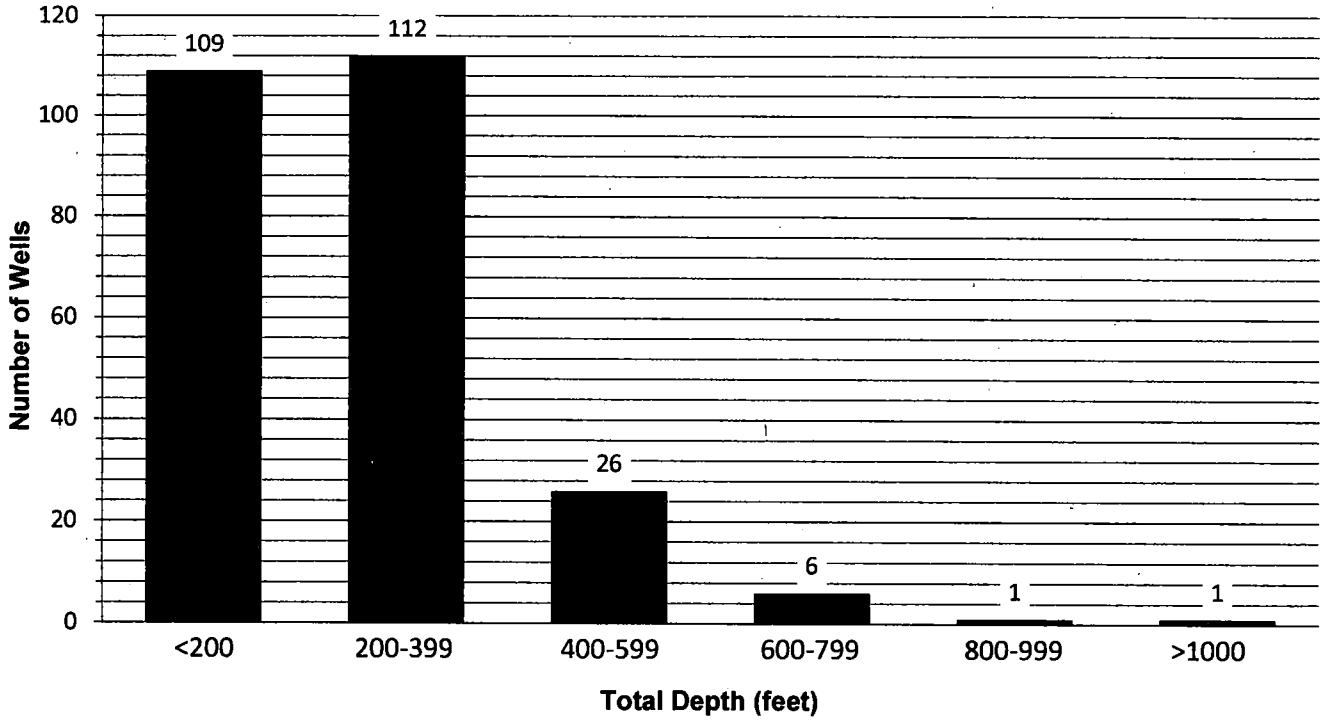


FIGURE 13-DEPTHS AND AIRTEST YIELDS OF WELLS IN MARIPOSA CREEK SUBAREA



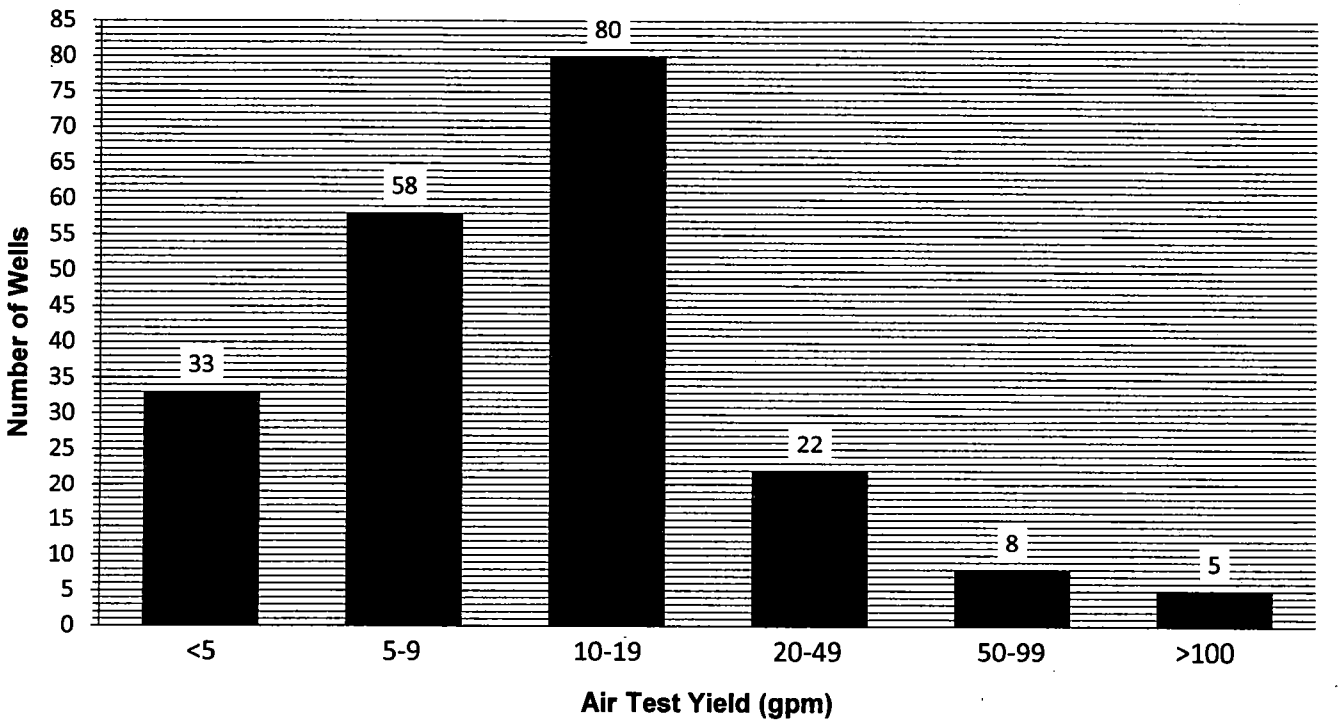


FIGURE 14-DEPTHS AND AIRTEST YIELDS OF WELLS IN BEAR CREEK SUBAREA

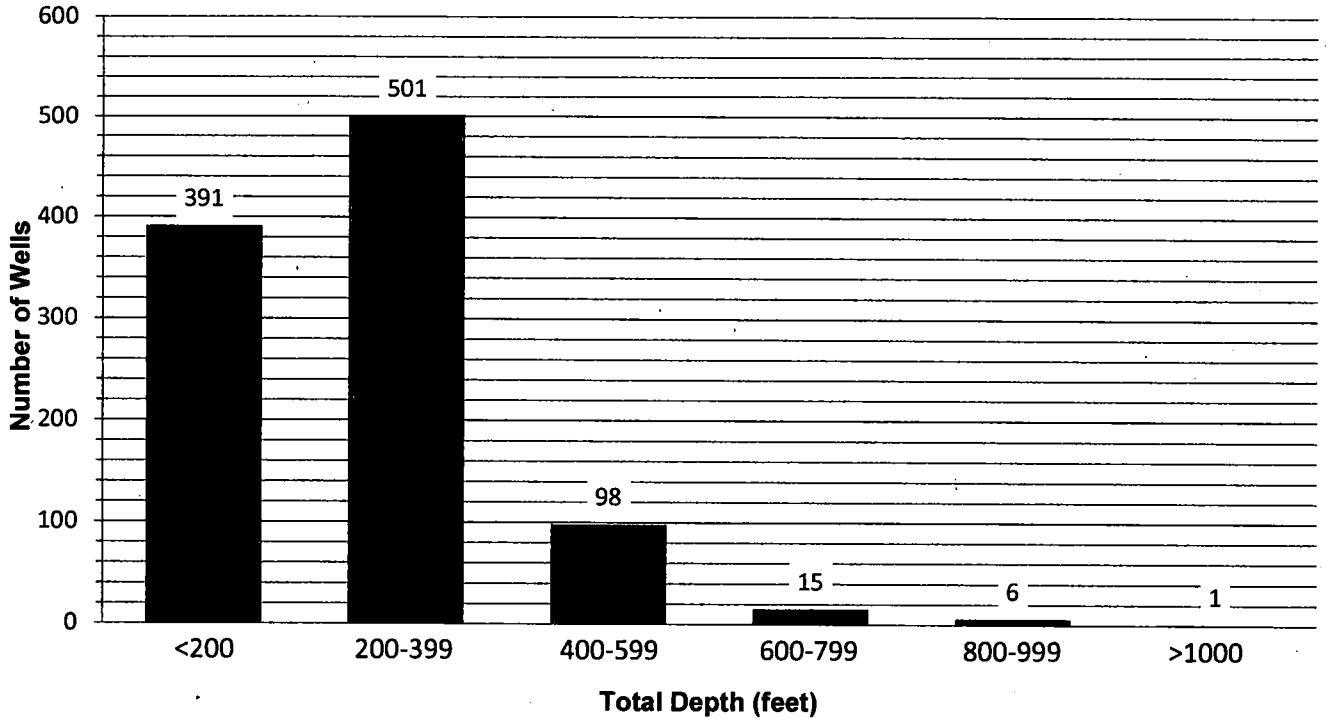
with records, ranged from 5 to 20 gpm. Twenty two wells, or 11 percent of these with records, had airtest yields between 20 and 50 gpm. Thirteen wells had air-test yields exceeding 50 gpm. Overall, the well production ranges from low to high and is variable in this subarea.

West Fork of Chowchilla River Subarea

Figure 15 shows depths for 1,012 wells and airtest yields for 859 of these wells that have records in the West Fork subarea. A total of 892, or 89 percent, of the wells are less than 400 feet deep. Ninety eight, or 10 percent, of the wells are between 600 and 800 feet deep, and seven wells are deeper than 800 feet. Airtest yields of 96 wells with records, or 12 percent, were less than 5 gpm. Airtest yields of 543 wells, or 61 percent, ranged from 5 to 20 gpm. Airtest yields of 132 wells, or 15 percent, ranged from 20 to 50 gpm. Airtest yields of 88 wells, or 10 percent, exceeded 50 gpm.

Middle Fork of Chowchilla River Subarea

Figure 16 shows depths for 549 wells and airtest yields for 472 of these wells with records. A total of 479 wells, or 85 percent, were less than 400 feet deep. Fifty six of the wells, or 11 percent, ranged from 400 to 600 feet deep. The remaining 14 wells ranged from



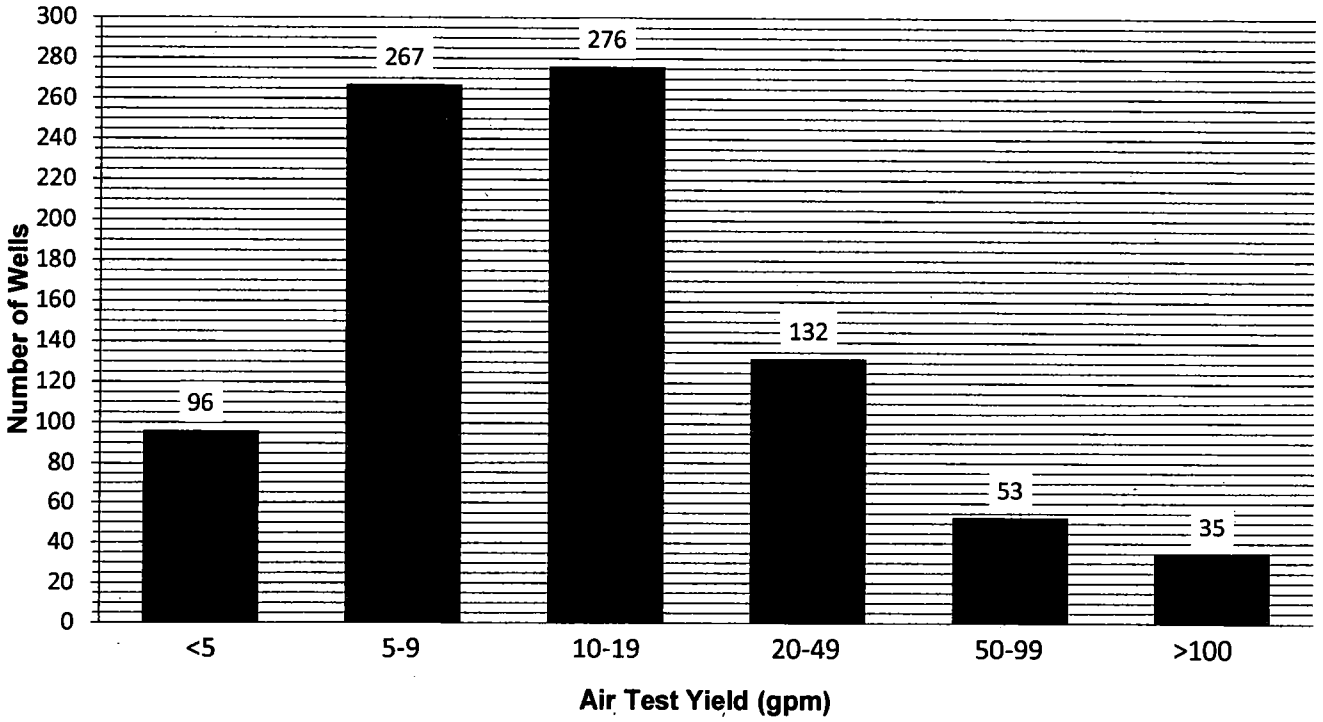
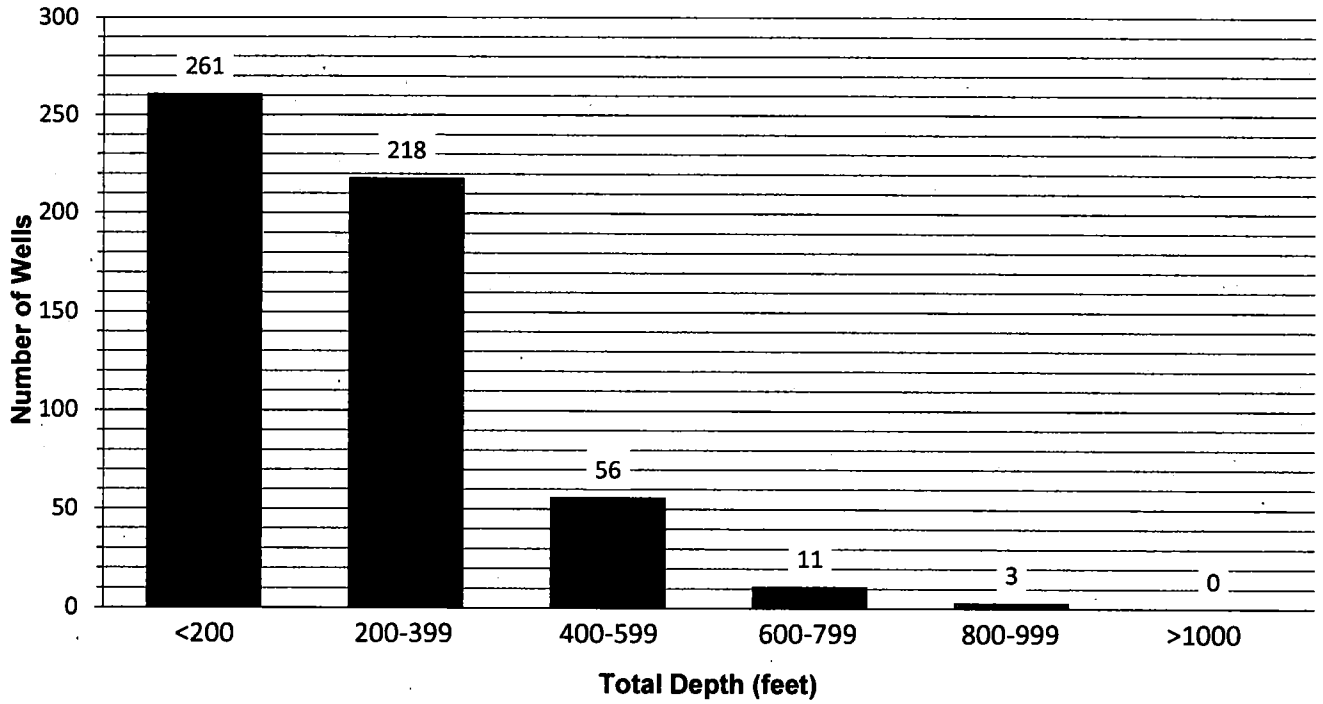


FIGURE 15-DEPTHS AND AIRTEST YIELDS OF WELLS IN WEST FORK OF THE CHOWCHILLA RIVER SUBAREA



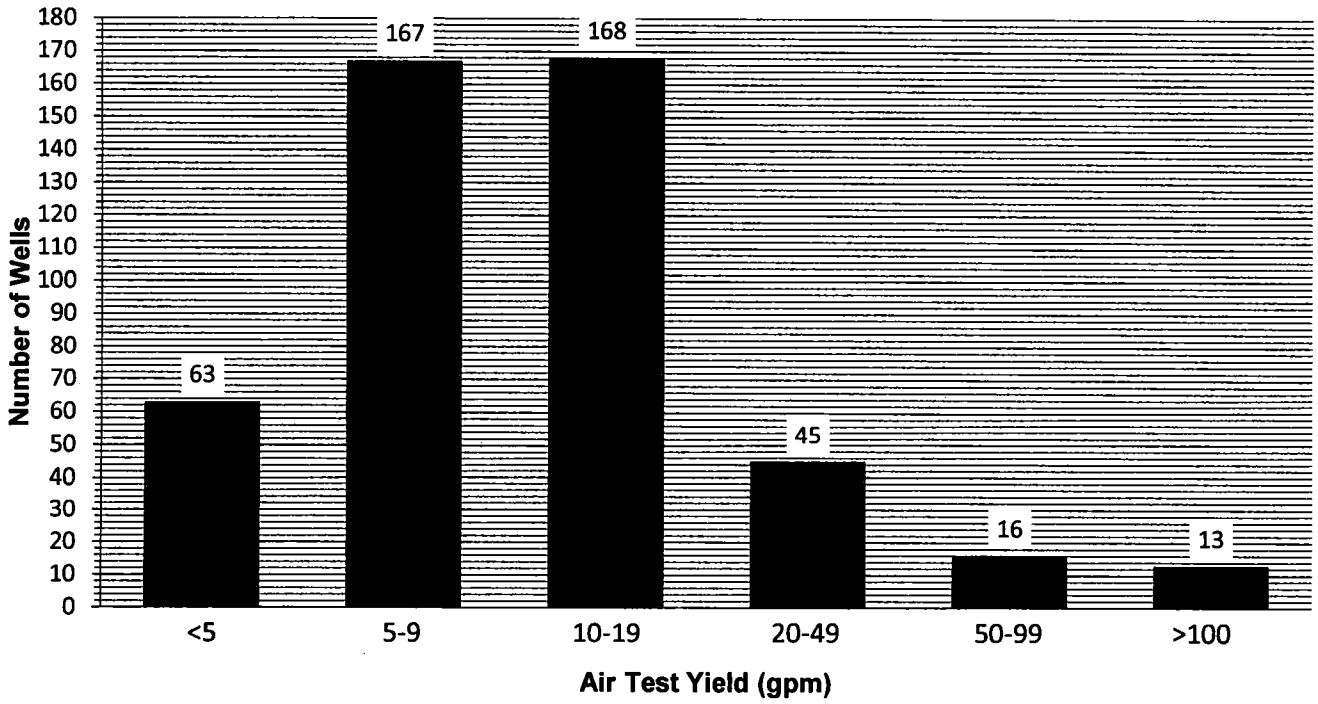


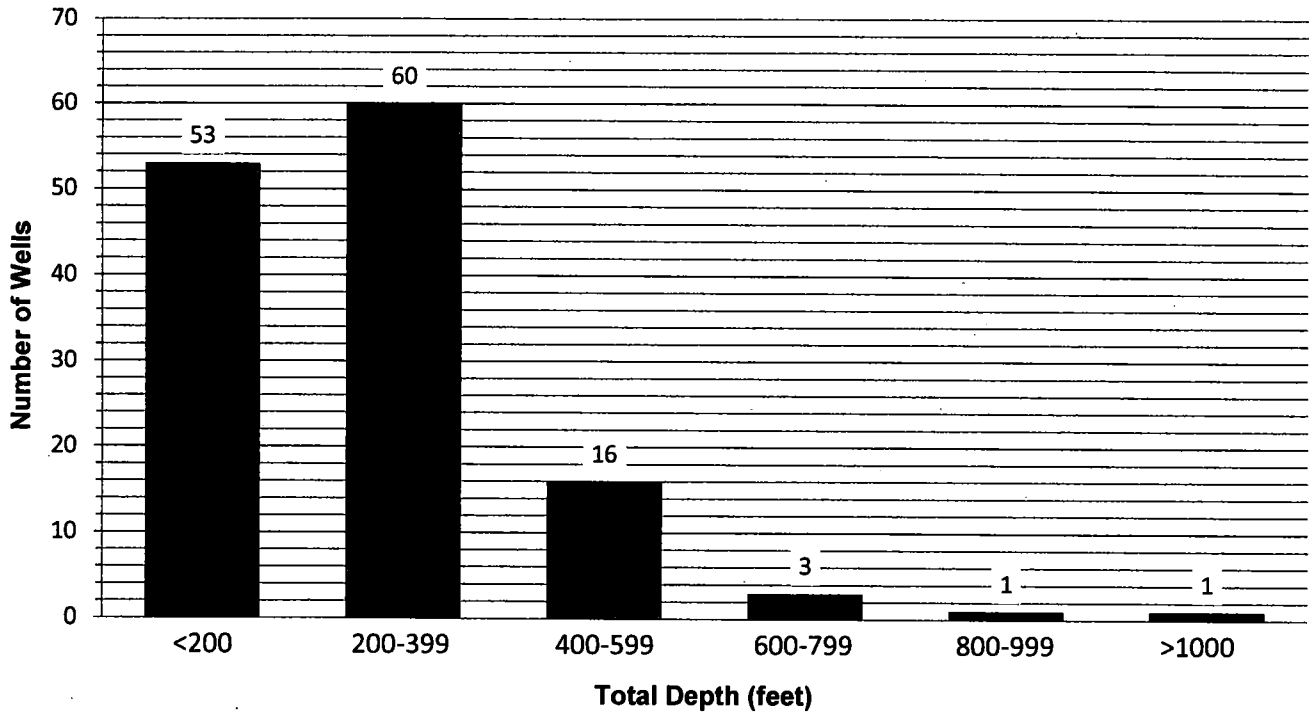
FIGURE 16-DEPTHS AND AIRTEST YIELDS OF WELLS IN MIDDLE FORK OF THE CHOWCHILLA RIVER SUBAREA

600 to 800 feet deep. Airtest yields of 63 wells, or 14 percent of those with records, were less than 5 gpm. Airtest yields for 335 wells, or 71 percent of those with records, ranged from 5 to 20 gpm. Airtest yields of 45 wells, or 10 percent of those with records, ranged from 20 to 50 gpm. Airtest yields of 29 wells, or seven percent of those with records, exceeded 50 gpm. Overall, the well production in the subarea ranges from low to high, and is predominantly in the moderate range.

Oliver Creek Subarea

Figure 17 shows depths for 134 wells and airtest yields for 119 of these wells with records. Depths of 113 of these wells, or 85 percent, were less than 400 feet. Sixteen of the wells, or 12 percent, ranged from 400 to 600 feet deep. Three wells were between 600 and 800 feet deep and the remaining two wells were deeper. Airtest yields of 17 wells, or 15 percent of those with records, were less than 5 gpm. Airtest yields of 77 wells, or 65 percent of those with records, ranged from 5 to 20 gpm. Airtest yields of 18 wells, or 16 percent of the wells with records, ranged from 20 to 50 gpm. Airtest yields of seven wells exceeded 50 gpm. Overall, most of the area has moderately producing wells.

Table 1 provides a summary of well depths in the new subareas evaluated.



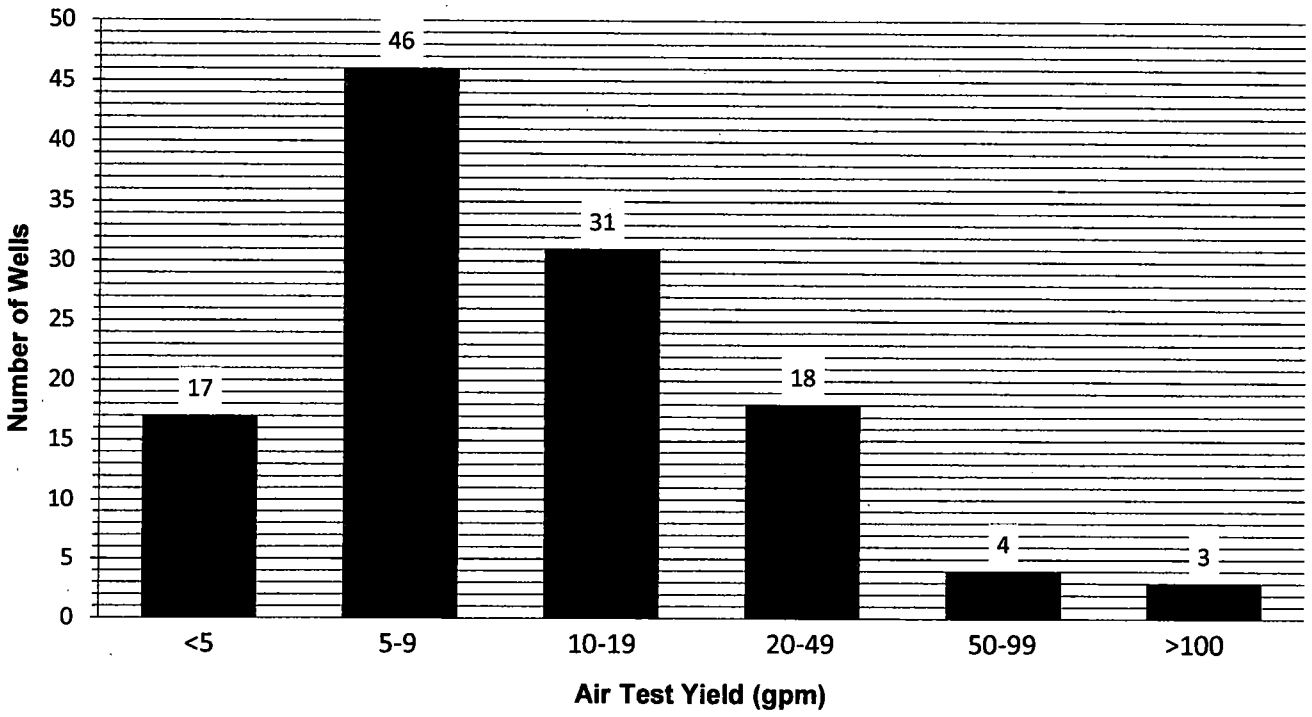


FIGURE 17-DEPTHS AND AIRTEST YIELDS OF WELLS IN OLIVER CREEK SUBAREA

TABLE 1 – SUMMARY OF WELL DEPTHS IN SUBAREAS

Number of Supply Wells

	Drainage Subarea								
Well Depth (feet)	**Coulter-ville**	**Greeley Hill**	**Catheys Valley**	**Agua Fria**	**Mariposa Creek**	**Bear Creek**	**West Fork Chowchilla**	**Middle Fork Chowchilla**	**Oliver Creek**
<200	26	27	51	95	272	109	391	261	53
200-399	17	27	39	63	290	112	501	218	60
400-599	5	6	17	17	57	26	98	56	16
600-799	2	2	3	1	14	6	15	11	3
800-999	4	0	0	2	5	1	6	3	1
>1000	0	0	0	0	1	1	1	0	1
Total	54	62	110	178	639	255	1012	549	134

Percent of Well Logs by Depth of Well

	Drainage Subarea								
Well Depth (feet)	**Coulter-ville**	**Greeley Hill**	**Catheys Valley**	**Agua Fria**	**Mariposa Creek**	**Bear Creek**	**West Fork Chowchilla**	**Middle Fork Chowchilla**	**Oliver Creek**
<200	48%	44%	46%	53%	43%	43%	39%	48%	40%
200-399	31%	44%	35%	35%	45%	44%	50%	40%	45%
400-599	9%	10%	15%	10%	9%	10%	10%	10%	12%
600-799	4%	3%	3%	1%	2%	2%	1%	2%	2%
800-999	7%	0%	0%	1%	1%	0%	1%	1%	1%
>1000	0%	0%	0%	0%	0%	0%	0%	0%	1%
# Well Logs	54	62	110	178	639	255	1012	549	134

Fish Camp Subarea

DWR completion reports are available for only several private and commercial wells, as most of Fish Camp is served by water system wells. Thus graphs of airtest yields and well depths for individual private wells were not prepared.

Completion reports are available for two Fish Camp Mutual Water Co. wells. One well was deepened from 180 feet to a depth of 375 feet and the airtest yield of this well was 14 gpm. The other well is 675 feet deep. The airtest yield of this well was not reported. There is a third Fish Camp Mutual Water Co. well, but the depth is not known. Information is available for two wells at the Yosemite Alpine CSD. Well No 1 is 320 feet deep and Well No. 2 was 230 feet deep. Completion reports aren't available for these wells. There are two active wells for the Tenaya Lodge. Depths of these range from 600 to 1,000 feet. Five wells have been drilled for the proposed Silvertip Resort project. Depths of these ranged from 525 to 1,000 feet. Included are some of the deepest wells in Mariposa County. Long-term pump tests were conducted by KDSA on STR wells No. 2, 3, and 4, and the long-term yields were 32 gpm, 11 gpm, and 5 gpm, respectively. STR Well No. 5 was constructed in a hydrogeologically favorable area near Big Creek. A long-term pump test on this well by KDSA indicated a yield of 104 gpm (KDSA, 1999), which is considered high in such hardrock terrane.

GROUNDWATER USE

Groundwater is the predominant source of water supply in the subareas evaluated. Water from springs is used to some extent, but most of the groundwater used is pumped from wells. The Mariposa PUD supplies surface water from Stockton Reservoir and well water for use in the community of Mariposa. There are a number of water systems in Mariposa County and K/J Consultants summarized the number of connections and estimated population served. Pumpage records for many of these systems are not available. Where pumping records are not available, an average annual water use of 0.5 acre-foot per connection was used. This was derived from a number of measured foothill and mountain water systems in Madera County. Google aerial photos were used to estimate the number of residences not served by water systems. The same water use factor was used for the residences as for the water systems.

Coulterville Subarea

There is one water system in this subarea. The MPWD Coulterville CSA 1 serves 95 connections and an estimated population of 165. There are about 110 other residences in the subarea, or a total of about 205. The estimated average water use for these is about 100 acre-feet per year, and the consumptive use of this water is

estimated to be about 50 acre-feet per year. The residual between water use and consumptive use is recharged through septic tank disposal system.

Greeley Hill Subarea

There are two water systems for mobile homes in the Greeley Hill subarea. The Yosemite Westland Mobile Estates serves 52 connections and an estimated permanent population of 40. The Wamper Hill Trailer Village serves 35 connections and an estimated permanent population of 70. There are also water systems for two schools in the subarea, which serve as estimated population of 97. The Buck Meadows Lodge has ten connections and serves a population of 25.

There are an estimated 163 residences in the subarea that are not served by water systems. The water use for these is estimated to average about 80 acre-feet per year and the consumptive use to be about 40 acre-feet per year.

Catheys Valley Subarea

There are three small water systems in the subarea. Catheys Valley Park has four connections and serves a population of 250. Hornitos County Park has three connections and serves a population of 25. The Catheys Valley School serves a population of 80.

There are an estimated 216 residences not served by the water systems in Catheys Valley. The water use for these is estimated to average about 110 acre-feet per year and the consumptive use to be about 55 acre-feet per year.

Agua Fria Creek Subarea

There is one water system in the Agua Fria Subarea. The Mariposa Industrial Park Water Company serves a population of 25.

There are an estimated 182 residences not served by a water system in this subarea. The estimated annual water use is about 90-acre-feet per year, and the consumptive use is estimated to be about 45 acre-feet per year.

Mariposa Creek Subarea

There are six water systems in the subarea. The CDF&FP-Mt. Bullion system has nine connections and serves a population of about 110. The Mariposa PUD serves 678 connections and an estimated population of 2,000 in Mariposa, primarily with surface water (about 97 percent). The Spring Hill High School serves a population of 93. The LPS and Mariposa Lutheran Church serve a transient population of 165. The Mariposa District Fairgrounds serves a transient population of 7,500.

There are about 414 residences in the subarea that not served by the water system. The average annual water use is estimated to be

210 acre-feet per year and the estimated consumptive use is about 105 acre-feet per year.

Bear Creek Subarea

There are six water systems in the Beer Creek subarea. The Muir Lodge, the BLM Briceburg Water System, and the Outward Bound Wilderness serve a population of about 125. There are three transient systems (KOA Campground, Mid Pines Park, and Yosemite Bug Hotel) which serve a transient population of about 470.

There are about 247 residences in the subarea that are not served by the water systems. The estimated average water use is about 125 acre-feet per year, and the estimated consumptive use is about 65 acre-feet per year.

West Fork of Chowchilla River Subarea

There are five water systems in the West Fork subarea. The Tavis Corporation and Woodland Park serve a population of 140. The Whispering Pines Apartments have 26 service connections, which serve a population of 55. There are two transient systems (Darrah School Park and New Life Christian Fellowship) which serve a population of 180.

There are an estimated 1,146 residences not served by water systems in this subarea. The average water use is estimated to be

about 570 acre-feet per year, and the average consumptive use to be about 285 acre-feet per year.

Middle Fork of Chowchilla River Subarea

There are no water systems in this subarea. There are an estimated 519 residences in this subarea. The average water use is estimated to be about 260 acre-feet per year, and the estimated consumptive use to be about 130 acre-feet per year.

Oliver Creek Subarea

There is one water system in this subarea. The Bootjack Stompers Hall is a transient system that serves a population of 60.

There are an estimated 209 residences in this subareas that are not served by the water system. The average water use is estimated to be about 105 acre-feet per year and the average consumptive use to be about 50 acre-feet per year.

Fish Camp Subarea

There are three relatively large water systems and several smaller water systems in the Fish Camp subarea. The Fish Camp Mutual Water Company serves an estimated population of 200 with 76 connections. The Yosemite Alpine CSD serves an estimated population of 50 with 36 connections. The Tenaya Lodge has 29 connections for the hotel and cottages. The estimated water use for all of these is about 100

acre-feet per year, or a consumptive use of about 50 acre-feet per year.

Table 2 provides a summary of average precipitation, native plant evapotranspiration, streamflow, and water use in the subareas evaluated.

GROUNDWATER QUALITY

Private Wells

During April 28-June 2, 2014, water from a total of 64 private wells in Mariposa County were sampled by Kenneth D. Schmidt and Associates for determination of the following constituents.

Major Cations and Ions	Electrical Conductivity
pH	Total Dissolved Solids
Iron	Fluoride
Manganese	Alpha Activity
Asbestos	Stable Isotopes of Water

These constituents were selected based on a review of recent available analyses for water systems wells in Mariposa County, and experience primarily in hardrock areas of Madera County, Fresno County, and Tuolumne County. Asbestos was determined due to the abundance of metamorphic rocks (including serpentine) in the area. The stable isotope analyses provide information on the relative elevations of tributary watersheds for recharge to groundwater pumped from the sampled wells.

TABLE 2 – COMPARISON OF AVERAGE PRECIPITATION, EVAPOTRANSPIRATION, STREAMFLOW, AND WATER USE IN SUBAREAS EVALUATED

Subarea	Range of Elev. (ft)	Average Precip. (in/yr)	Evapotranspiration (in/yr)	Estimated Streamflow		Drainage Area (acres)	Water Use (Acre-ft/yr)
				(Acre-ft/yr)	(in/yr)		
Coultervilie	1,650-3,250	33	20-24	6,100	9	11,900	50
Greeley Hill	2,800-3,950	36	20-23	7,000	9	9,300	40
Catheys Valley	1,150-2,870	21	17	1,750	4	5,320	55
Agua Fria Creek	1,450-4,200	26	20	14,000	6	17,300	45
Mariposa Creek	1,400-3,590	30	20-24	9,000	6	18,300	105
Bear Creek	1,450-4,615	37	20-24	9,600	8	14,400	65
W. Fork Chow. R.	1,220-4,610	32	22-24	22,500	8	33,800	285
M. Fork Chow. R.	2,050-5,450	37	22-25	3,900	8	5,900	130
Oliver Creek	2,650-5,450	39	22-25	8,000	12	7,900	50
Fish Camp	5,000-9,400	50	24-26	27,000	23	12,400	50

The water use values are for consumptive use of groundwater. An average of about 11,000 acre-feet per year is diverted from Big Creek above the basin outlet.

The normal procedure was to collect samples after at least 15 minutes of pumping the well. Samples were collected as close to the well as possible, and to not be influenced by water treatment devices, if present. Samples for inorganic chemical constituents and alpha activity were preserved and shipped by overnight delivery to FGL Environmental in Santa Paula for analysis.

Samples for asbestos were preserved and hand delivered to APPL, Inc. in Clovis. These samples were then shipped to EMSL Analytical, Inc. in San Leandro for analysis. Samples for deuterium and oxygen-18 (stable isotopes) determinations were preserved and shipped by overnight delivery to the University of Arizona Environmental Isotope Laboratory in Tucson, Arizona for analysis. Figure 18 shows the general locations of the sampled wells. For confidentiality purposes, the exact locations, such as owners' names or street addresses, are not provided in this report. Appendix D contains information on depths of the sampled wells and the results of analyses of water from them.

Total Dissolved Solids

Total dissolved solids (TDS) concentrations in water from the sampled wells ranged from about 55 to 520 mg/l. The lowest TDS concentrations (less than 100 mg/l) were in wells in the Fish Camp area and other higher elevation areas. TDS concentrations in water

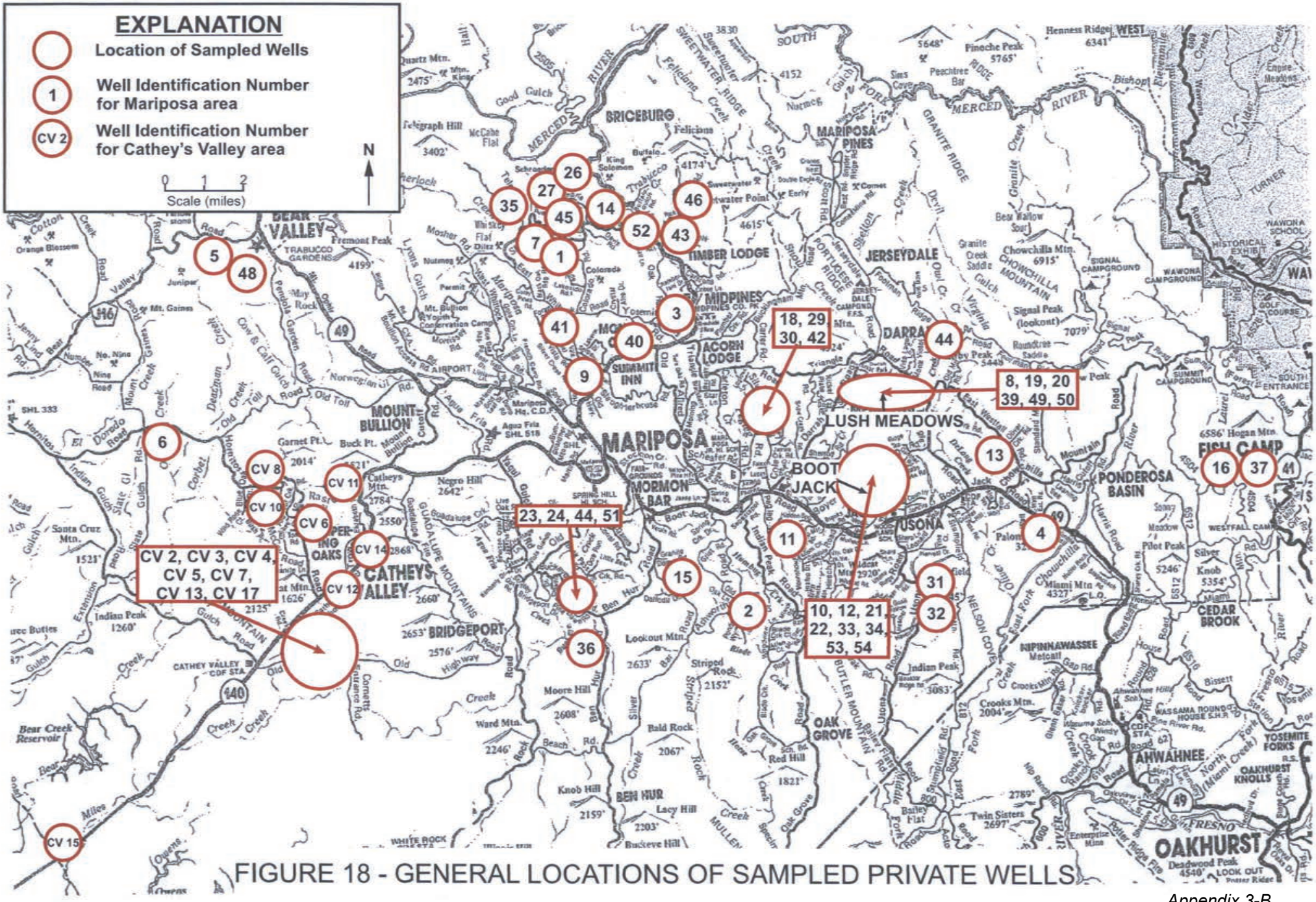


FIGURE 18 - GENERAL LOCATIONS OF SAMPLED PRIVATE WELLS

from most wells ranged from about 170 to 340 mg/l. Water from all but one of the sampled wells had TDS concentrations below the maximum contaminant level (MCL) of 500 mg/l. Bicarbonate was the major anion in all cases. Water with high TDS concentrations generally had higher bicarbonate and sometimes higher sulfate concentrations.

Nitrate

Overall, nitrate concentrations were low in water from most of the sampled wells. Almost half of the sampled wells had non-detectable (less than 0.4 mg/l) nitrate concentrations. About 40 percent of the sampled wells had nitrate concentrations ranging from the 1 to 6 mg/l, well below the MCL of 45 mg/l. Water from about ten percent of the wells had nitrate concentrations ranging from 16 to 20 mg/l, which are considered intermediate. Only two sampled wells had nitrate concentrations exceeding 20 mg/l. The highest nitrate concentration (44.5 mg/l) was in water from Well No. 18, located west of Lush Meadows. The value was just below the MCL. The well is indicated to be about 200 feet deep. The other well with a high nitrate concentration (40 mg/l) was No. CV 7 in Catheys Valley. The depth of this well is unknown.

Iron and Manganese

The iron concentration in water from one well (No. 20) was 1.5 mg/l, exceeding the recommended MCL of 0.3 mg/l. This well is in

the Lush Meadows area and is of unknown depth. Water from this well had a low pH (5.9), and low pH values in this area are discussed in a subsequent section of this report. An iron concentration of 0.25 mg/l, just below the MCL, was found in water from two other sampled wells (No. 51 and CV 10). These wells are 240 feet and 300 feet deep, respectively. Well No. 51 is northeast of Bridgeport and CV 10 is in the upper part of Catheys Valley. Iron concentrations in most of the rest of the sampled wells were less than 0.1 mg/l, well below the MCL. Manganese concentrations in about two thirds of the sampled wells were non detectable (less than 0.01 mg/l). Water from four wells (No. 20, 27, 54, and CV 10) had manganese concentrations ranging from 0.36 to 0.84 mg/l, exceeding the recommended MCL of 0.05 mg/l. Well No. 20 is in the Lush Meadows areas, Well 27 is southwest of Briceburg, and Well 54 is in Bootjack. Wells No. 20 and No. 54 are of unknown depth. Well No. 27 is 125 feet deep and CV 10 is 300 feet deep. The highest manganese concentration was in water from a well (No. 20) with a pH of 5.9. Water from four other wells had manganese concentrations ranging from 0.16 to 0.31 mg/l, also exceeding the MCL. High manganese concentrations were found in meta-volcanic rock terrane north of Mariposa and in granitic rock terrane east of Mariposa (including the Bootjack and Lush Meadows areas). Manganese concentrations in water from the rest of the sampled wells ranged from 0.01 to 0.04 mg/l, below the MCL.

Arsenic

Arsenic concentrations in water from most of the sampled wells ranged from less than 2 to 2 ppb, well below the MCL of 10 ppb. However, water from three wells (No. 6, 15 and 45) had arsenic concentrations ranging from 10 to 21 ppb, equal to or excluding the MCL of 10 ppb. Well No. 15 is located south of Mormon Bar in granitic rock terrane, and Well No. 45 is located southwest of Briceburg in metavolcanic rock terrane. Well No. 6 is located west of Mt. Bullion in metavolcanic rock terrane. Well No. 6 is 340 feet deep, Well 15 is about 200 feet deep, and Well 45 is 700 feet deep. Water from Well No. 3 had an arsenic concentration of 9 ppb, just below the MCL. This well is in the Midpines area in metavolcanic terrane, and is of unknown depth. Water from Well No. CV 13 had an arsenic concentration of 8 ppb. This well is 235 feet deep and located in granitic rock terrane.

Alpha Activity

Alpha activities in the sampled wells ranged from 0.5 to 6.5 picocuries per liter, below the MCL of 15 picocuries per liter. Alpha activities in water from most of the sampled wells were less than 4 picocuries per liter. Thus overall uranium activities were significantly lower than in hardrock areas evaluated previously in the Oakhurst and Raymond-Hensley Lake areas in Madera County.

pH

The desirable pH level for public water supplies is in the range of 6 to 8. Water from slightly less than half of the sampled wells was acidic (pH less than 7.0). This is not uncommon for hardrock wells in the Sierra Nevada. Water from seven wells had pH values of 6.2 or less. These wells were in granitic rock terrane east of Mariposa (including the Bootjack and Lush Meadows areas). Water from only one well (No. 20) had a pH of less than 6.0 (5.9). This well is in the Lush Meadows area and is of unknown depth. More than half of the sampled wells had water that was basic (pH greater than 7.0). One well (No. 2) had a pH of 7.7, and sodium was the predominant cation in this sample. This well was southwest of Bootjack in granitic rock terrane, and is 365 feet deep. Water from most of the rest of the sampled wells had pH values ranging from 7.1 to 7.5. Copper and zinc were also analyzed in the samples collected from the private wells. Water from two of the sampled wells with low pH contained slightly elevated zinc concentrations (about 0.06 mg/l). These concentrations were well below the recommended MCL of 5 mg/l for zinc for public water supplies.

Low pH values (less than about 6.2) may be of concern because this water can react with trace metals (i.e., lead, copper, and zinc) in pipes or other features which the pumped water comes into contact with. This could cause the metals to be at problem levels in the tap water. However, water from the distribution pipes wasn't sampled as part of this

program. Figure 19 shows the general locations of known groundwater quality problems in hardrock areas of Mariposa County.

Asbestos

Asbestos was not detected in water from any of the sampled wells at a detection limit of 0.2 million fibers per liter (MFL), well below the MCL of 7 MFL.

Stable Isotopes of Water

Deuterium and oxygen-18 concentrations are expected to be isotopically heavier (with respect to standard mean ocean water) in groundwater that is derived from lower elevations compared to higher elevations. For example, groundwater in Catheys Valley that originates from recharge in the local watershed is expected to be isotopically heavier than groundwater originating from watersheds at much higher elevations (i.e., exceeding 5,000 feet).

The isotopically heaviest delta deuterium concentrations in areas outside of Catheys Valley (Figure 20) were found in water from two wells (No. 21 and 54) and ranged from -37 to -38 $^{0}/_{00}$. The corresponding delta oxygen-18 concentrations in water from these wells averaged about -3 $^{0}/_{00}$. These two wells were in the Lush Meadows and Bootjack areas, and also produced water with low pH values.

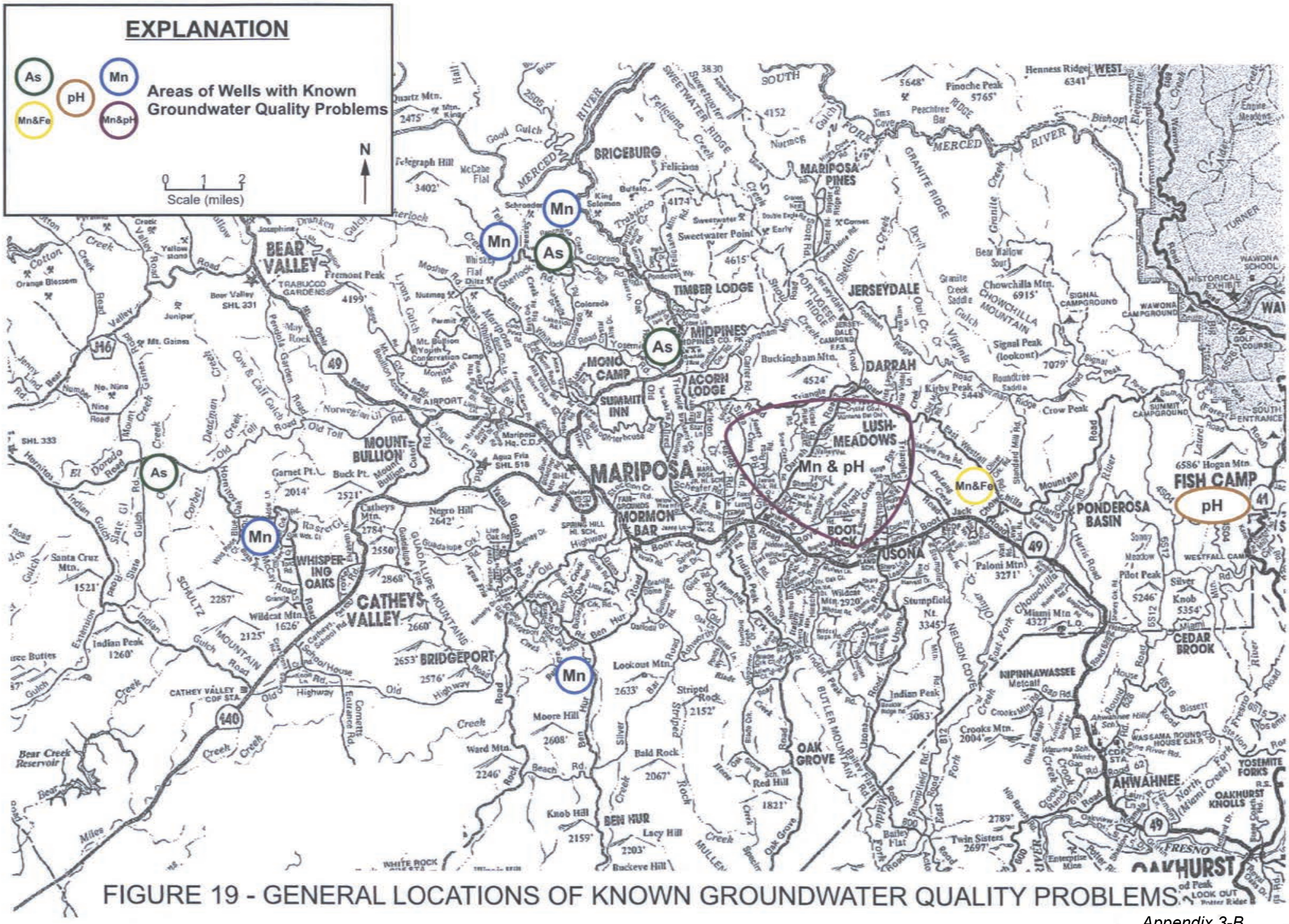


FIGURE 19 - GENERAL LOCATIONS OF KNOWN GROUNDWATER QUALITY PROBLEMS

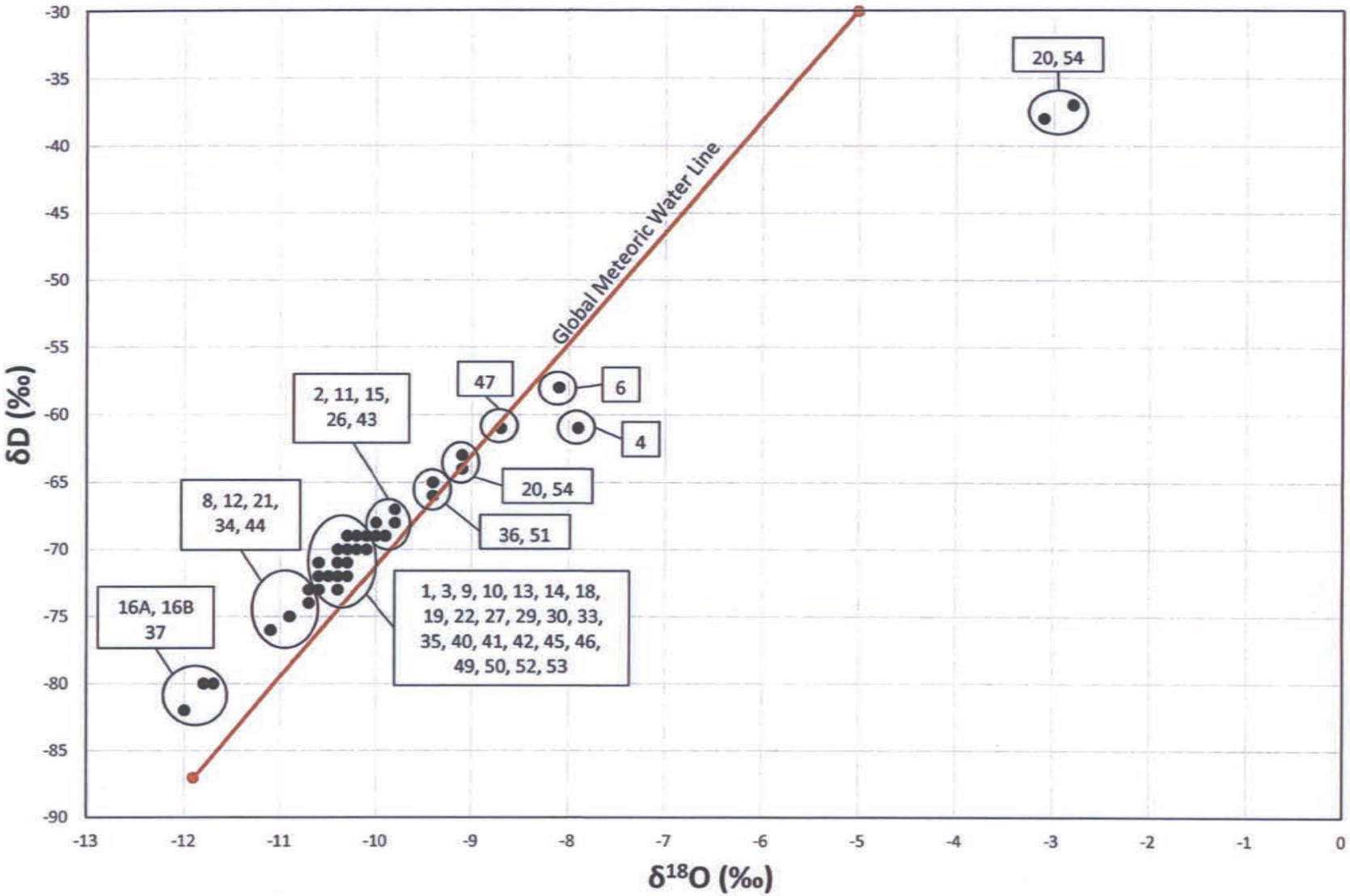


FIGURE 20 - DELTA DEUTERIUM AND OXYGEN-18 CONCENTRATIONS IN WATER FROM WELLS FROM OUTSIDE OF CATHEYS VALLEY

For the remaining wells, most of the isotopically heavier water was from wells in topographically lower parts of the sampled area (i.e., Wells No. 4, 6, and 47). In contrast, the isotopically lightest concentrations for this sampling were found in water from three wells (No. 16A, 16B, and 37) in the Fish Camp subarea. As discussed earlier, the watershed above these wells is at the highest elevation of the sub-areas evaluated. Delta oxygen-18 concentrations ranged from -11.7 to -12.0 $^{0}/_{00}$ and delta deuterium concentrations ranged from -80 to -85 $^{0}/_{00}$ for this group of wells. The next lightest isotope concentrations were in water from five wells (No. 8, 12, 21, 34, and 44) in the Bootjack and Lush Meadows areas.

Water samples were collected from wells at a range in elevations in Catheys Valley. Delta deuterium concentrations for three wells in higher topographic areas (CV 8, CV 11, and CV 14) ranged from -62 to -63 $^{0}/_{00}$ (Figure 21). Delta oxygen-18 concentrations in water from these wells ranged from -8.9 to -9.2 $^{0}/_{00}$. Delta deuterium concentrations in water from five wells in lower topographic areas (near Old Highway Road) ranged from -58 to -60 $^{0}/_{00}$. The corresponding delta oxygen-18 concentrations were -8.0 to -8.3 $^{0}/_{00}$. For the Well CV 10, the delta deuterium concentration was -48 $^{0}/_{00}$ and the delta oxygen-18 concentration was -5.1 $^{0}/_{00}$, or the heaviest in the area. The global meteoric water line is also shown on Figures 21 and 22.

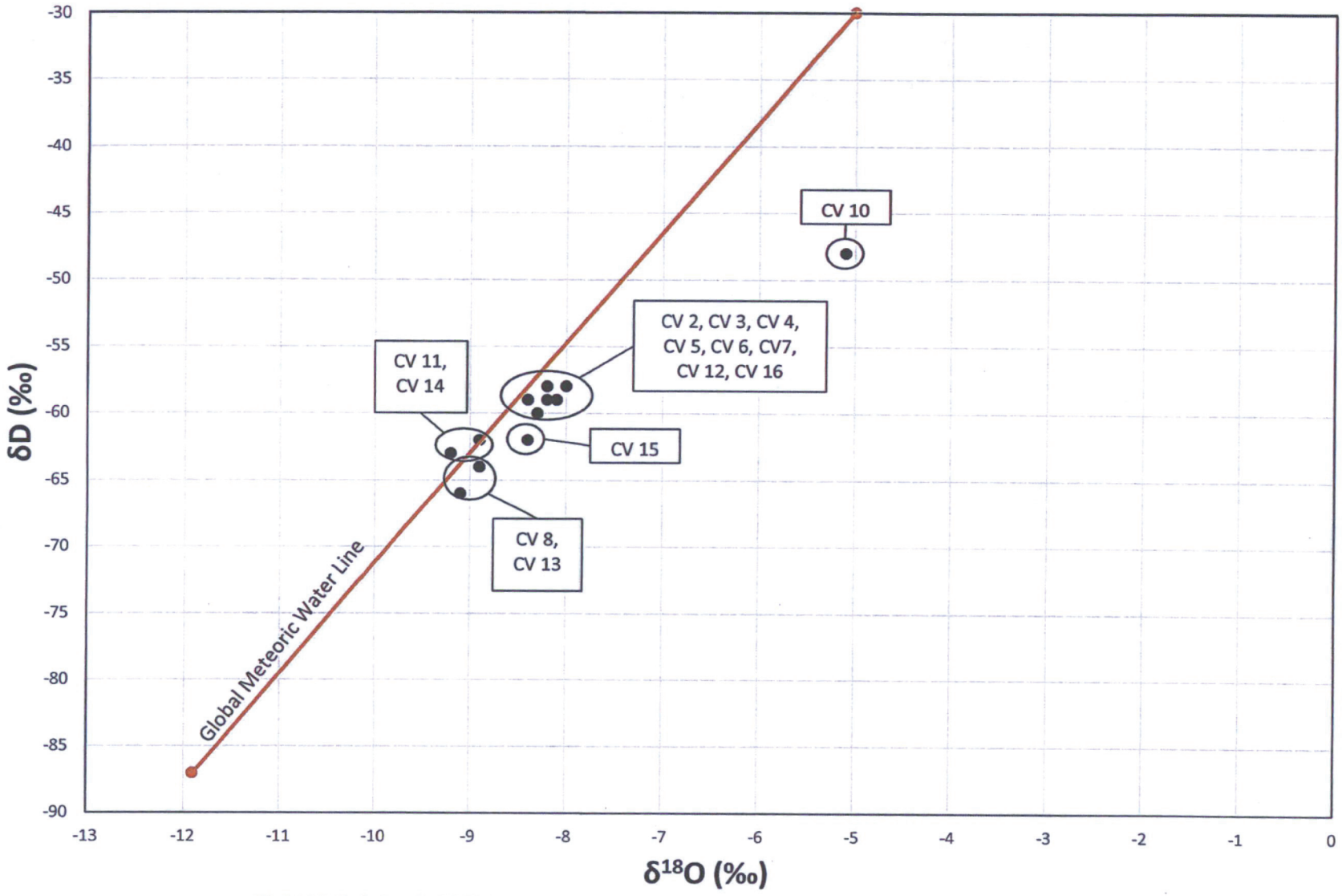


FIGURE 21 - DELTA DEUTERIUM AND OXYGEN-18 CONCENTRATIONS IN WATER FROM WELLS IN THE CATHEYS VALLEY AREA

These figures can be used to evaluate possible concentration of the heavy isotopes in the groundwater due to evapotranspiration. For example, Figure 20 indicates that plots for four wells (No. 4, 6, 20, and 54) deviate to the right of this line, indicating concentration by evapotranspiration or evaporation. Figure 21 indicates that almost all of the samples plot close to the meteoric water line, except for CV-10. Water from this well thus seems to have also been concentrated due to evaporation or evapotranspiration. In summary, the stable isotope concentrations in well water indicate that recharge to the groundwater tapped by most of the sampled wells is from local precipitation in the watershed, as opposed to from sources more distant (tens of miles).

Water System Wells

Recent chemical analyses of water from water system wells were obtained from the California Department of Public Health data base. In general, values of the selected parameters were below the MCLs, except for arsenic in one small water system in Mariposa, where a concentration of 19 ppb was found. An arsenic concentration of 8 ppb, just below the MCL of 10 ppb, was found in a water system well in Coulterville. The well at the Catheys Valley School has periodically had elevated nitrate concentrations, but the most recent available concentration (34 mg/l) was less than the MCL.

SUMMARY AND CONCLUSIONS

1. Watersheds in the County vary greatly in elevations and precipitation. Average annual precipitation ranges from about 20 inches in the lower part of the Catheys Valley to about 47 inches at Fish Camp.
2. Under pre-development conditions, the precipitation was either consumed by evapotranspiration or runoff as streamflow. In the lower foothills near the San Joaquin Valley, evapotranspiration consumes much of the precipitation. In contrast, at high elevations, such as in the Fish Camp subarea, a considerable part of the precipitation becomes streamflow.
3. Groundwater development in the part of the County outside of Yosemite Valley is primarily from hardrock (granitic rock, metamorphic rock, and metavolcanic rock). Over the long-term, groundwater development either decreases the evapotranspiration or the runoff.
4. Estimates of groundwater use in the subareas indicate that it is relatively small compared to the native evapotranspiration and runoff.
5. Although yields of most individual domestic wells are less than 50 gpm, they appear to be adequate in many cases. The majority of these wells are 400 feet deep or less. There are more low producing wells (airtest yields of 5 gpm or less)

in the Mariposa Creek and West Fork of the Chowchilla River subareas than elsewhere.

6. Groundwater quality records for water system wells were obtained and reviewed. In addition, a total of 64 wells were sampled during late April-early June 2014, as part of the program. Overall, the chemical quality of the groundwater was good. Arsenic is the only constituent tested for that had concentrations exceeding a Primary MCL. This was in water from three wells in metavolcanic terrane. Manganese concentrations in water from eight wells exceeding the recommended MCL. High manganese concentrations are much more prevalent in the hardrock areas of Madera County than in Mariposa County. An area of low pH groundwater (less than 6.2) was indicated in the Lush Meadows-Bootjack area. The low pH levels don't appear to have significant health effects. Total dissolved solids, nitrate, and iron concentrations were low throughout the area, except for two wells with elevated nitrate concentrations (less than the MCL) and one well with an iron concentration exceeding the recommended MCL.

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