# SECTION 7.10

# UNPAVED ROAD DUST (NON-FARM ROADS)

(Updated August 1997)

**EMISSION INVENTORY SOURCE CATEGORY**
Miscellaneous Processes / Road Dust

**EMISSION INVENTORY CODES (CES CODES) AND DESCRIPTION**
**645-638-5400-0000 (47399)** Unpaved Road Travel Dust- City & County Roads

**645-640-5400-0000 (47407)** Unpaved Road Travel Dust- U.S. Forests / Park Rd

**645-644-5400-0000 (47423)** Unpaved Road Travel Dust- BLM & BIA Roads

## METHODS AND SOURCES

This source category provides estimates of the entrained geologic particulate matter emissions that result from vehicular travel over non-agricultural unpaved roads. The emissions are estimated separately for three major unpaved road categories: city and county roads, U.S. forests and park roads, and Bureau of Land Management (BLM) and Bureau of Indian Affairs (BIA) roads. The emissions result from the mechanical disturbance of the roadway and the vehicle generated air turbulence effects. Particulate matter estimates for unpaved roads are summarized in Table 1.

## OVERVIEW OF ESTIMATION METHODOLOGY

Dust emissions from unpaved road dust are computed by using an emission factor computed by averaging unpaved road dust emission measurements performed by the University of California, Davis (UCD), and the Desert Research Institute (DRI). Unpaved road vehicle miles traveled (VMT) are based on Caltrans estimates of the unpaved road miles in each county, and the assumption that each mile of unpaved road receives ten vehicle passes each day.

## EMISSIONS ESTIMATION METHODOLOGY

**Emission Factor.** The emission factor used for our estimates of geologic dust emissions from vehicular travel on unpaved roads is based on work performed by UC Davis,[1] and the Desert Research Institute.[2] The emission factor used for all unpaved roads statewide is 2.27 lbs $PM_{10}$/VMT. The derivation of this emission factor is provided in the ARB's unpaved road dust

background document.[3] In summary, the emission factor is the average of 22 unpaved road dust emissions tests performed in the San Joaquin Valley for light-duty truck traffic. Because the emission measurements were performed in California, this emission factor was used to replace the previous generic emission factor provided in U.S. EPA's AP-42 document.[4] The new emission factor is slightly smaller than the factors derived with the AP-42 methodology.

This methodology directly computes $PM_{10}$ emissions. The TSP emissions are $PM_{10}$ x 1.64.[5]

**Activity Data.** For the purpose of estimating emissions, is assumed that the unpaved road dust emissions are primarily related to the vehicle miles traveled (VMT) on the roads. Using data derived from the Caltrans, "Assembly of Statistical Reports" documents,[6] it was possible to estimate the unpaved road miles for each roadway category in each county to reflect 1993 mileage. The unpaved road dust background document provides the raw data for each road type; it also describes how the data were processed to consolidate it into the three road categories to estimate the unpaved road mileage for each county.

From the previous unpaved road dust methodology, it is then assumed that 10 daily VMT (DVMT) are traveled on unpaved city and county roads. This is based on 1976 and 1979 ARB staff surveys of several county traffic engineers. For U.S. forest and parks roads, it is assumed that 10 DVMT are also traveled per mile of road. This is based on a discussion with a member of the United States Forest Service.[7] Because of the potential similarity in the types of traffic, it is also assumed that the BLM and BIA also receive 10 DVMT.

Table 1 summarizes the VMT activity data for each road grouping and county. Road mileage, if needed, can be simply computed by dividing the annual VMT values by 3650 (which is 10 DVMT x 365 days).

## TEMPORAL ACTIVITY AND GROWTH

Daily activity on unpaved roads occurs primarily during daylight hours. Activity is assumed to be the same each day of the week. Monthly activity varies by county and is based on estimates of monthly rainfall in each county. This is to reflect that during wet months there is less unpaved road traffic, and there are also lower emissions per mile of road when the road soils have a higher moisture content. Table 2 shows the temporal profile for each county in California.

Unpaved road growth is tied to on-road VMT growth for many counties. For other counties, growth is set to zero and VMT is not used.

## ASSUMPTIONS AND LIMITATIONS

1. This methodology assumes that all unpaved roads in California emit the same levels of

$PM_{10}$ per VMT during all times of the year for all vehicles and conditions.

2. It is assumed that all unpaved roads in California receive 10 VMT per day.

3. This methodology assumes that no controls are used on the roads included in this inventory.

4. It is assumed that the emission factors derived in the San Joaquin Valley are applicable to the rest of the State.

5. This inventory does not include private unpaved roads. Agricultural unpaved road estimates are computed in a separate methodology.

## CHANGES IN THE METHODOLOGY

There were three major methodology changes for this update. First, a new emission factor based on California unpaved road emissions tests was used. This emission factor was slightly less than previous emission factors. Second, the unpaved road mileage was updated to reflect 1993 estimates. The combination of these two changes reduced the estimates of $PM_{10}$ from unpaved roads by about 35% statewide. And finally, the monthly temporal profile was updated using regional rainfall to reflect the seasonal variations in unpaved road usage and emissiveness. The temporal profile is used to apportion the emissions to each month. It is not used to adjust the overall annual emissions.

## COMMENTS AND RECOMMENDATIONS

Virtually everything in this category could use improvement. Although expensive to develop, more region and season specific emission factors would help to improve the accuracy of the unpaved road dust particulate matter inventory. The VMT activity data are very simplistic, and probably do not well represent actual unpaved road travel conditions. The ARB has initiated a contract with UC Davis to develop better estimates of unpaved road travel in California.

Caltrans also no longer estimates actual unpaved road mileage, so determining the mileage requires scaling mileage from past years. It is likely that, at least for limited regions, better unpaved road mileage estimates can be determined by using updated geographic information systems (GIS) based road coverage maps. Also, inclusion of private roads, if they are determined to be significant, could be used to improve the emission estimates.

## SAMPLE CALCULATIONS

The instructions and associated table below provide an example of unpaved road dust emissions for Humboldt county.

Step 1: Road Miles. From Table 1, input the miles of unpaved road for each category.

Step 2: Passes per Day. Input the estimated vehicle passes per day for each road type. The current California default is 10.

Step 3: Vehicle Miles Traveled (VMT). Compute the annual vehicle miles traveled for each road type. This is: *Road Miles x Passes/Day x Days/Year* (i.e., *Step 1 x Step 2 x 365*), which, using the ARB default values is *Road Miles x 3650*.

Step 4: Emission Factor. Input the roadway emission factor. The default ARB emission factor for unpaved roads is 2.27 lbs $PM_{10}$/VMT.

Step 5: Compute Emissions. Multiply the vehicle miles traveled estimate (Step 3) by the emission factor (Step 4), and divide by 2000 lbs/ton to compute the annual road specific $PM_{10}$ emissions. *(VMT x Emission Factor)/2000 = Annual Emissions.*

Step 6: Total Emissions. Sum emissions for the unpaved roads to compute the total unpaved road emissions.

**Estimating Unpaved Road Dust**
**$PM_{10}$ Emissions in Humboldt County**

| | | Road Type | | | |
|---|---|---|---|---|---|
| | | City & County | U.S. Forest & Parks | BLM & BIA | Total |
| *Step 1* | Miles of Road | 372 | 233 | 292 | 897 |
| *Step 2* | Passes/Day | 10 | 10 | 10 | 10 |
| *Step 3* | VMT/year | 1,357,800 | 850,450 | 1,065,900 | 3,274,050 |
| *Step 4* | Emission Factor *(lbs $PM_{10}$/mile)* | 2.27 | 2.27 | 2.27 | |
| *Step 5* | Emissions *(tons $PM_{10}$/year)* | 1541 | 9665 | 1210 | 3717 |

## REFERENCES


1. Flocchini, Robert; et al. Evaluation of the Emission of $PM_{10}$ Particulates from Unpaved Roads in the San Joaquin Valley, Final Report. University of California, Davis. Air Quality Group, Crocker Nuclear Laboratory. San Joaquin Valley Grant File #20960. April 1994.

2. John Gillies; et al. Effectiveness Demonstration of Fugitive Dust Control Methods for Public Unpaved Roads and Unpaved Shoulders on Paved Roads, Final Report. Desert Research Institute. DRI Document No. 68505200.1F1, for the California Regional Particulate Air Quality Study. December 1996.

3. Gaffney, Patrick. Entrained Dust from Unpaved Road Travel, Emission Estimation Methodology, Background Document. California Air Resources Board. September 1997.

4. U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, AP-42, Section 11.2.1, Fifth Edition. January 1995.

5. Houck, J.E., Chow, J.C., Watson, J.G., et al. Determination of Particle Size Distribution and Chemical Composition of Particulate Matter from Selected Sources in California, Final Report. Desert Research Institute & OMNI Environmental. Prepared for California Air Resources Board. Agreement No. A6-175-32. June 30, 1989.

6. California Department of Transportation. Assembly of Statistical Reports, 1992, and Assembly of Statistical Reports, 1993. California Public Road Data Including Highway Performance Monitoring System (HPMS) Data. February 1994 and January 1995.


## UPDATED BY

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August 1997

## Table 1. 1993 Unpaved Road Dust Emissions.

| | | | ARB Inventory Unpaved Road Miles* | | | $PM_{10}$ Emissions (tons/year) | | | 1993 $PM_{10}$ Totals (non-Ag. Roads) | |
|---|---|---|---|---|---|---|---|---|---|---|
| AIR BASIN | COUNTY | COUNTY ID # | City/ County | BLM/ BIA | USFS/ Parks | City/ County | BLM/ BIA | USFS/ Parks | Miles | $PM_{10}$ (tons/year) |
| GBV | ALPINE | 2 | 52.8 | 0.6 | 62.0 | 218.6 | 2.6 | 256.8 | 115.4 | 478.1 |
| | INYO | 14 | 382.4 | 854.2 | 363.4 | 1584.4 | 3538.7 | 1505.4 | 1600.0 | 6628.4 |
| | MONO | 26 | 225.7 | 1015.6 | 455.4 | 934.9 | 4207.4 | 1886.7 | 1696.7 | 7029.0 |
| LC | LAKE | 17 | 201.2 | 125.8 | 141.3 | 833.3 | 521.3 | 585.5 | 468.3 | 1940.0 |
| LT | EL DORADO | 9 | 23.1 | 1.2 | 46.9 | 95.8 | 5.0 | 194.3 | 71.2 | 295.1 |
| | PLACER | 31 | 22.0 | 1.8 | 16.3 | 91.3 | 7.3 | 67.6 | 40.1 | 166.2 |
| MC | AMADOR | 3 | 162.0 | 4.3 | 92.5 | 671.3 | 17.9 | 383.3 | 258.9 | 1072.6 |
| | CALAVERAS | 5 | 250.7 | 31.4 | 160.6 | 1038.5 | 130.0 | 665.5 | 442.7 | 1834.0 |
| | EL DORADO | 9 | 169.6 | 8.8 | 343.9 | 702.7 | 36.6 | 1424.7 | 522.4 | 2164.0 |
| | MARIPOSA | 22 | 195.9 | 63.2 | 221.5 | 811.4 | 261.7 | 917.6 | 480.5 | 1990.6 |
| | NEVADA | 29 | 250.6 | 27.1 | 310.1 | 1038.1 | 112.1 | 1284.5 | 587.7 | 2434.7 |
| | PLACER | 31 | 134.4 | 10.7 | 99.5 | 556.8 | 44.5 | 412.3 | 244.7 | 1013.6 |
| | PLUMAS | 32 | 187.0 | 0.4 | 777.8 | 774.5 | 1.5 | 3222.1 | 965.1 | 3998.2 |
| | SIERRA | 46 | 239.8 | 4.0 | 525.1 | 993.5 | 16.6 | 2175.3 | 768.9 | 3185.4 |
| | TUOLUMNE | 55 | 127.5 | 4.9 | 204.4 | 528.1 | 20.4 | 846.7 | 336.8 | 1395.3 |
| NC | DEL NORTE | 8 | 84.7 | 0.8 | 216.4 | 351.0 | 3.4 | 896.4 | 301.9 | 1250.7 |
| | HUMBOLDT | 12 | 372.0 | 233.3 | 292.0 | 1541.1 | 966.5 | 1209.7 | 897.3 | 3717.3 |
| | MENDOCINO | 23 | 273.5 | 120.9 | 580.5 | 1132.9 | 500.9 | 2404.9 | 974.9 | 4038.8 |
| | SONOMA | 49 | 36.1 | 0.6 | 7.3 | 149.4 | 2.5 | 30.3 | 44.0 | 182.2 |
| | TRINITY | 53 | 189.2 | 152.0 | 839.5 | 784.0 | 629.6 | 3477.8 | 1180.7 | 4891.3 |
| NCC | MONTEREY | 27 | 258.7 | 0.0 | 50.3 | 1071.8 | 0.0 | 208.3 | 309.0 | 1280.1 |
| | SAN BENITO | 35 | 95.0 | 77.4 | 241.3 | 393.7 | 320.5 | 999.6 | 413.7 | 1713.9 |
| | SANTA CRUZ | 44 | 217.5 | 0.0 | 144.8 | 901.1 | 0.0 | 599.9 | 362.3 | 1500.9 |
| NEP | LASSEN | 18 | 343.0 | 598.4 | 427.4 | 1421.0 | 2479.2 | 1770.4 | 1368.8 | 5670.6 |
| | MODOC | 25 | 314.4 | 184.1 | 609.2 | 1302.4 | 762.8 | 2523.7 | 1107.7 | 4588.9 |
| | SISKIYOU | 47 | 198.8 | 41.3 | 713.7 | 823.6 | 170.9 | 2956.8 | 953.8 | 3951.4 |
| SC | LOS ANGELES | 19 | 540.8 | 0.0 | 175.6 | 2240.5 | 0.0 | 727.6 | 716.4 | 2968.1 |
| | ORANGE | 30 | 22.6 | 0.0 | 1.7 | 93.5 | 0.0 | 7.2 | 24.3 | 100.7 |
| | RIVERSIDE | 33 | 181.8 | 12.7 | 36.8 | 753.2 | 52.6 | 152.4 | 231.3 | 958.2 |
| | SAN BERNARDINO | 36 | 60.9 | 78.2 | 18.2 | 252.5 | 324.1 | 75.5 | 157.4 | 652.1 |
| SCC | SAN LUIS OBISPO | 40 | 303.4 | 237.6 | 106.1 | 1256.9 | 984.1 | 439.3 | 647.0 | 2680.4 |
| | SANTA BARBARA | 42 | 85.4 | 0.5 | 68.3 | 353.8 | 2.1 | 282.9 | 154.2 | 638.8 |
| | VENTURA | 56 | 67.7 | 0.0 | 52.3 | 280.4 | 0.0 | 216.7 | 120.0 | 497.1 |
| SD | SAN DIEGO | 37 | 554.3 | 112.4 | 662.3 | 2296.2 | 465.5 | 2743.6 | 1328.9 | 5505.3 |
| SED | IMPERIAL | 13 | 1194.3 | 113.5 | 25.9 | 4947.7 | 470.3 | 107.2 | 1333.7 | 5525.2 |
| | KERN | 15 | 225.9 | 202.1 | 25.8 | 935.8 | 837.1 | 107.0 | 453.8 | 1879.9 |
| | LOS ANGELES | 19 | 254.5 | 0.0 | 82.6 | 1054.3 | 0.0 | 342.4 | 337.2 | 1396.7 |
| | RIVERSIDE | 33 | 517.5 | 36.1 | 104.7 | 2143.7 | 149.7 | 433.7 | 658.3 | 2727.2 |
| | SAN BERNARDINO | 36 | 954.8 | 1225.8 | 285.5 | 3955.6 | 5078.1 | 1182.7 | 2466.1 | 10216.4 |
| SF | ALAMEDA | 1 | 43.2 | 0.0 | 0.1 | 178.8 | 0.0 | 0.6 | 43.3 | 179.4 |
| | CONTRA COSTA | 7 | 53.5 | 0.0 | 12.4 | 221.8 | 0.0 | 51.2 | 65.9 | 273.0 |
| | MARIN | 21 | 49.4 | 0.0 | 39.2 | 204.8 | 0.0 | 162.3 | 88.6 | 367.0 |
| | NAPA | 28 | 23.7 | 0.0 | 1.2 | 98.2 | 0.0 | 5.0 | 24.9 | 103.2 |
| | SAN FRANCISCO | 38 | 0.2 | 0.0 | 0.0 | 0.8 | 0.0 | 0.1 | 0.2 | 0.8 |
| | SAN MATEO | 41 | 102.7 | 0.0 | 20.0 | 425.3 | 0.0 | 83.1 | 122.7 | 508.3 |
| | SANTA CLARA | 43 | 329.3 | 0.0 | 152.8 | 1364.3 | 0.0 | 632.9 | 482.1 | 1997.2 |
| | SOLANO | 48 | 28.5 | 0.0 | 0.3 | 118.1 | 0.0 | 1.1 | 28.8 | 119.2 |
| | SONOMA | 49 | 23.1 | 0.4 | 4.7 | 95.5 | 1.6 | 19.3 | 28.1 | 116.5 |
| SJV | FRESNO | 10 | 1079.3 | 153.4 | 509.5 | 4471.2 | 635.6 | 2110.7 | 1742.2 | 7217.5 |
| | KERN | 15 | 480.0 | 429.4 | 54.9 | 1988.6 | 1778.9 | 227.4 | 964.3 | 3994.9 |
| | KINGS | 16 | 76.3 | 0.3 | 0.0 | 316.1 | 1.2 | 0.0 | 76.6 | 317.3 |
| | MADERA | 20 | 199.8 | 0.0 | 91.5 | 827.8 | 0.0 | 379.0 | 291.3 | 1206.8 |
| | MERCED | 24 | 572.8 | 0.0 | 35.8 | 2372.9 | 0.0 | 148.4 | 608.6 | 2521.3 |
| | SAN JOAQUIN | 39 | 384.1 | 0.0 | 14.2 | 1591.4 | 0.0 | 58.6 | 398.3 | 1650.1 |
| | STANISLAUS | 50 | 59.6 | 0.0 | 0.5 | 247.0 | 0.0 | 2.0 | 60.1 | 249.0 |
| | TULARE | 54 | 272.2 | 45.0 | 74.3 | 1127.7 | 186.5 | 307.7 | 391.5 | 1621.9 |
| SV | BUTTE | 4 | 380.0 | 21.5 | 167.4 | 1574.2 | 88.9 | 693.3 | 568.8 | 2356.4 |
| | COLUSA | 6 | 258.0 | 24.0 | 37.5 | 1069.0 | 99.6 | 155.4 | 319.6 | 1324.0 |
| | GLENN | 11 | 175.6 | 0.1 | 39.4 | 727.7 | 0.5 | 163.3 | 215.2 | 891.5 |
| | PLACER | 31 | 63.9 | 5.1 | 47.3 | 264.7 | 21.2 | 196.0 | 116.3 | 481.9 |
| | SACRAMENTO | 34 | 552.5 | 0.0 | 4.2 | 2289.0 | 0.0 | 17.2 | 556.7 | 2306.3 |
| | SHASTA | 45 | 382.6 | 97.8 | 659.6 | 1585.0 | 405.2 | 2732.5 | 1140.0 | 4722.7 |
| | SOLANO | 48 | 114.0 | 0.0 | 1.1 | 472.4 | 0.0 | 4.5 | 115.1 | 476.9 |
| | SUTTER | 51 | 144.8 | 0.0 | 0.0 | 599.9 | 0.0 | 0.0 | 144.8 | 599.9 |
| | TEHAMA | 52 | 313.3 | 10.2 | 276.6 | 1298.1 | 42.2 | 1145.8 | 600.1 | 2486.1 |
| | YOLO | 57 | 137.0 | 0.1 | 0.0 | 567.6 | 0.4 | 0.0 | 137.1 | 568.0 |
| | YUBA | 58 | 157.2 | 2.8 | 53.0 | 651.2 | 11.8 | 219.5 | 213.0 | 882.4 |
| | | TOTALS | 16428 | 6372 | 11886 | 68058 | 26397 | 49241 | 34686 | 143697 |

*Road miles are shown. To compute annual VMT, multiply miles by 10 passes/day times 365 days per year ( VMT = miles x 3650).

PM Fraction: $PM_{10}$ = TSP x 0.61 (TSP Emissions = $PM_{10}$/0.61)

## Table 2
## Seasonal Profile for Unpaved Road Dust Emissions

| Basin | Co # | County | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GBV | 2 | ALPINE | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 14 | INYO | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 26 | MONO | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| LC | 17 | LAKE | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| LT | 9 | EL DORADO | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 31 | PLACER | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| MC | 3 | AMADOR | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 5 | CALAVERAS | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 9 | EL DORADO | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 22 | MARIPOSA | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 29 | NEVADA | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 31 | PLACER | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 32 | PLUMAS | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 46 | SIERRA | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 55 | TUOLUMNE | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| NC | 8 | DEL NORTE | 0.021 | 0.029 | 0.032 | 0.074 | 0.087 | 0.151 | 0.166 | 0.178 | 0.080 | 0.106 | 0.050 | 0.025 |
| | 12 | HUMBOLDT | 0.021 | 0.029 | 0.032 | 0.074 | 0.087 | 0.151 | 0.166 | 0.178 | 0.080 | 0.106 | 0.050 | 0.025 |
| | 23 | MENDOCINO | 0.021 | 0.029 | 0.032 | 0.074 | 0.087 | 0.151 | 0.166 | 0.178 | 0.080 | 0.106 | 0.050 | 0.025 |
| | 49 | SONOMA | 0.021 | 0.029 | 0.032 | 0.074 | 0.087 | 0.151 | 0.166 | 0.178 | 0.080 | 0.106 | 0.050 | 0.025 |
| | 53 | TRINITY | 0.021 | 0.029 | 0.032 | 0.074 | 0.087 | 0.151 | 0.166 | 0.178 | 0.080 | 0.106 | 0.050 | 0.025 |
| NCC | 27 | MONTEREY | 0.021 | 0.029 | 0.032 | 0.074 | 0.087 | 0.151 | 0.166 | 0.178 | 0.080 | 0.106 | 0.050 | 0.025 |
| | 35 | SAN BENITO | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 44 | SANTA CRUZ | 0.014 | 0.017 | 0.025 | 0.046 | 0.059 | 0.169 | 0.228 | 0.224 | 0.046 | 0.115 | 0.044 | 0.013 |
| NEP | 18 | LASSEN | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 25 | MODOC | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 47 | SISKIYOU | 0.024 | 0.022 | 0.023 | 0.084 | 0.093 | 0.151 | 0.151 | 0.151 | 0.151 | 0.082 | 0.040 | 0.031 |
| SC | 19 | LOS ANGELES | 0.010 | 0.012 | 0.015 | 0.100 | 0.120 | 0.081 | 0.135 | 0.135 | 0.135 | 0.134 | 0.100 | 0.024 |
| | 30 | ORANGE | 0.010 | 0.012 | 0.015 | 0.100 | 0.120 | 0.081 | 0.135 | 0.135 | 0.135 | 0.134 | 0.100 | 0.024 |
| | 33 | RIVERSIDE | 0.052 | 0.088 | 0.084 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.074 |
| | 36 | SAN BERNARDINO | 0.052 | 0.088 | 0.084 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.074 |
| SCC | 40 | SAN LUIS OBISPO | 0.020 | 0.023 | 0.022 | 0.071 | 0.069 | 0.126 | 0.159 | 0.159 | 0.132 | 0.104 | 0.078 | 0.036 |
| | 42 | SANTA BARBARA | 0.015 | 0.020 | 0.020 | 0.087 | 0.066 | 0.127 | 0.137 | 0.128 | 0.145 | 0.130 | 0.087 | 0.037 |
| | 56 | VENTURA | 0.010 | 0.012 | 0.015 | 0.100 | 0.120 | 0.081 | 0.135 | 0.135 | 0.135 | 0.134 | 0.100 | 0.024 |
| SD | 37 | SAN DIEGO | 0.010 | 0.012 | 0.015 | 0.100 | 0.120 | 0.081 | 0.135 | 0.135 | 0.135 | 0.134 | 0.100 | 0.024 |
| SED | 13 | IMPERIAL | 0.052 | 0.088 | 0.084 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.074 |
| | 15 | KERN | 0.042 | 0.044 | 0.029 | 0.106 | 0.106 | 0.106 | 0.106 | 0.106 | 0.106 | 0.106 | 0.087 | 0.057 |
| | 19 | LOS ANGELES | 0.010 | 0.012 | 0.015 | 0.100 | 0.120 | 0.081 | 0.135 | 0.135 | 0.135 | 0.134 | 0.100 | 0.024 |
| | 33 | RIVERSIDE | 0.052 | 0.088 | 0.084 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.074 |
| | 36 | SAN BERNARDINO | 0.052 | 0.088 | 0.084 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.074 |
| SF | 1 | ALAMEDA | 0.014 | 0.017 | 0.025 | 0.046 | 0.059 | 0.169 | 0.228 | 0.224 | 0.046 | 0.115 | 0.044 | 0.013 |
| | 7 | CONTRA COSTA | 0.014 | 0.017 | 0.025 | 0.046 | 0.059 | 0.169 | 0.228 | 0.224 | 0.046 | 0.115 | 0.044 | 0.013 |
| | 21 | MARIN | 0.014 | 0.017 | 0.025 | 0.046 | 0.059 | 0.169 | 0.228 | 0.224 | 0.046 | 0.115 | 0.044 | 0.013 |
| | 28 | NAPA | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 38 | SAN FRANCISCO | 0.014 | 0.017 | 0.025 | 0.046 | 0.059 | 0.169 | 0.228 | 0.224 | 0.046 | 0.115 | 0.044 | 0.013 |
| | 41 | SAN MATEO | 0.014 | 0.017 | 0.025 | 0.046 | 0.059 | 0.169 | 0.228 | 0.224 | 0.046 | 0.115 | 0.044 | 0.013 |
| | 43 | SANTA CLARA | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 48 | SOLANO | 0.014 | 0.017 | 0.025 | 0.046 | 0.059 | 0.169 | 0.228 | 0.224 | 0.046 | 0.115 | 0.044 | 0.013 |
| | 49 | SONOMA | 0.021 | 0.029 | 0.032 | 0.074 | 0.087 | 0.151 | 0.166 | 0.178 | 0.080 | 0.106 | 0.050 | 0.025 |
| SJV | 10 | FRESNO | 0.030 | 0.033 | 0.026 | 0.099 | 0.121 | 0.121 | 0.121 | 0.121 | 0.121 | 0.104 | 0.058 | 0.046 |
| | 15 | KERN | 0.042 | 0.044 | 0.029 | 0.106 | 0.106 | 0.106 | 0.106 | 0.106 | 0.106 | 0.106 | 0.087 | 0.057 |
| | 16 | KINGS | 0.039 | 0.035 | 0.028 | 0.107 | 0.107 | 0.107 | 0.107 | 0.107 | 0.107 | 0.107 | 0.093 | 0.060 |
| | 20 | MADERA | 0.030 | 0.033 | 0.026 | 0.099 | 0.121 | 0.121 | 0.121 | 0.121 | 0.121 | 0.104 | 0.058 | 0.046 |
| | 24 | MERCED | 0.029 | 0.023 | 0.026 | 0.110 | 0.094 | 0.110 | 0.110 | 0.110 | 0.110 | 0.110 | 0.110 | 0.055 |
| | 39 | SAN JOAQUIN | 0.024 | 0.026 | 0.025 | 0.080 | 0.096 | 0.138 | 0.138 | 0.138 | 0.138 | 0.103 | 0.051 | 0.043 |
| | 50 | STANISLAUS | 0.028 | 0.028 | 0.029 | 0.092 | 0.080 | 0.121 | 0.121 | 0.121 | 0.121 | 0.115 | 0.098 | 0.047 |
| | 54 | TULARE | 0.028 | 0.032 | 0.021 | 0.104 | 0.115 | 0.121 | 0.121 | 0.121 | 0.121 | 0.121 | 0.058 | 0.039 |
| SV | 4 | BUTTE | 0.024 | 0.029 | 0.026 | 0.069 | 0.078 | 0.099 | 0.209 | 0.209 | 0.115 | 0.075 | 0.037 | 0.030 |
| | 6 | COLUSA | 0.020 | 0.022 | 0.025 | 0.077 | 0.099 | 0.153 | 0.153 | 0.153 | 0.133 | 0.105 | 0.034 | 0.027 |
| | 11 | GLENN | 0.017 | 0.025 | 0.023 | 0.074 | 0.060 | 0.147 | 0.147 | 0.147 | 0.133 | 0.123 | 0.075 | 0.029 |
| | 31 | PLACER | 0.009 | 0.022 | 0.023 | 0.054 | 0.090 | 0.170 | 0.170 | 0.170 | 0.170 | 0.050 | 0.032 | 0.041 |
| | 34 | SACRAMENTO | 0.023 | 0.021 | 0.022 | 0.086 | 0.105 | 0.153 | 0.153 | 0.153 | 0.153 | 0.074 | 0.035 | 0.024 |
| | 45 | SHASTA | 0.024 | 0.022 | 0.023 | 0.084 | 0.093 | 0.151 | 0.151 | 0.151 | 0.151 | 0.082 | 0.040 | 0.031 |
| | 48 | SOLANO | 0.023 | 0.026 | 0.023 | 0.068 | 0.076 | 0.185 | 0.185 | 0.185 | 0.096 | 0.079 | 0.030 | 0.024 |
| | 51 | SUTTER | 0.023 | 0.021 | 0.022 | 0.086 | 0.105 | 0.153 | 0.153 | 0.153 | 0.153 | 0.074 | 0.035 | 0.024 |
| | 52 | TEHAMA | 0.023 | 0.026 | 0.023 | 0.068 | 0.076 | 0.185 | 0.185 | 0.185 | 0.096 | 0.079 | 0.030 | 0.024 |
| | 57 | YOLO | 0.016 | 0.020 | 0.021 | 0.076 | 0.086 | 0.155 | 0.155 | 0.155 | 0.149 | 0.108 | 0.039 | 0.021 |
| | 58 | YUBA | 0.021 | 0.020 | 0.021 | 0.055 | 0.067 | 0.144 | 0.178 | 0.178 | 0.178 | 0.069 | 0.045 | 0.023 |