Matthew Rodriquez
Secretary for Environmental Protection

Air Resources Board

Mary D. Nichols, Chairman
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Edmund G. Brown Jr.
Governor

July 2, 2014

Mr. Jared Blumenfeld
Regional Administrator
U.S. Environmental Protection Agency
Region 9
75 Hawthorne Street
San Francisco, California 94105

Dear Mr. Blumenfeld:

The Air Resources Board (ARB) is providing an additional PM2.5 nonattainment area recommendation for the Portola Valley, in Plumas County, for the revised PM2.5 annual standard of 12.0 $\mu g/m^3$.

This recommendation is based on the most recent data PM2.5 measured from 2011 through 2013 that were not available in November, 2013, when ARB submitted its original recommendations. The Portola Valley is in Plumas County and is part of the Northern Sierra Air Quality Management District. This recommendation considers topography, meteorology, and population in the area and the enclosed analysis supports the proposal that the federal PM2.5 nonattainment area boundary coincide with the current State PM2.5 nonattainment boundary.

If you have any questions, please contact Ms. Lynn Terry, Deputy Executive Officer, at (916) 322-2739, or Ms. Sylvia Vanderspek, Chief, Air Quality Planning Branch, at (916) 324-7163.

Sincerely,

Richard Corey
Executive Officer

Enclosure

cc: See next page.

cc: Ms. Gretchen Bennitt
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Northern Sierra Air Quality Management District
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EO Chron
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Assignment: EO #18588, AQPS #9187

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PROPOSED NONATTAINMENT AREA
PORTOLA VALLEY, CALIFORNIA

RECOMMENDATION

The California Air Resources Board (ARB) recommends the Portola Valley, in Plumas County, as a nonattainment area for the revised annual PM2.5 standard. This recommendation is in addition to the recommendations submitted to the U.S. Environmental Protection Agency (U.S. EPA) on November 25, 2013, and utilizes air quality data not available at that time. This recommendation was developed utilizing guidance promulgated by U.S. EPA, which involved analysis of air quality data, emissions, geography and topography, meteorology, and current jurisdictional boundaries. Based on the analysis detailed in this report, ARB staff concludes that the appropriate nonattainment area would be smaller than the county level, but larger than the boundaries of the City of Portola, where the violating monitor is located. The currently existing State PM2.5 nonattainment area that encompasses the Portola Valley, including the City of Portola and surrounding population areas, is recommended for use as the federal PM2.5 nonattainment area boundary.

BACKGROUND

On December 14, 2012, U.S. EPA revised the annual PM2.5 standard from 15.0 $\mu g/m^3$ to 12.0 $\mu g/m^3$. The Clean Air Act requires ARB to submit nonattainment area recommendations to U.S. EPA for the revised standard within one year, by December 14, 2013. ARB submitted recommendations for three nonattainment areas on November 25, 2013. These recommendations were based on air quality data from 2010 through 2012. More recent air quality data, 2011 through 2013, shows the need for an additional nonattainment area in Portola Valley, Plumas County, based on an annual PM2.5 design value of 12.8 $\mu g/m^3$ at the Portola monitor.

The Clean Air Act requires that a nonattainment area must include not only the area that is violating the standard, but also nearby areas that contribute to violations. Accordingly, ARB's recommended nonattainment boundaries are sufficiently large to include both the violating and contributing areas. U.S. EPA guidance recommends that in making boundary recommendations for nonattainment areas, states evaluate each area on a case-by-case basis in consideration of the following five factors:

- Air quality data
- Emissions and emission-related data
- Meteorology
- Geography/topography
- Jurisdictional boundaries

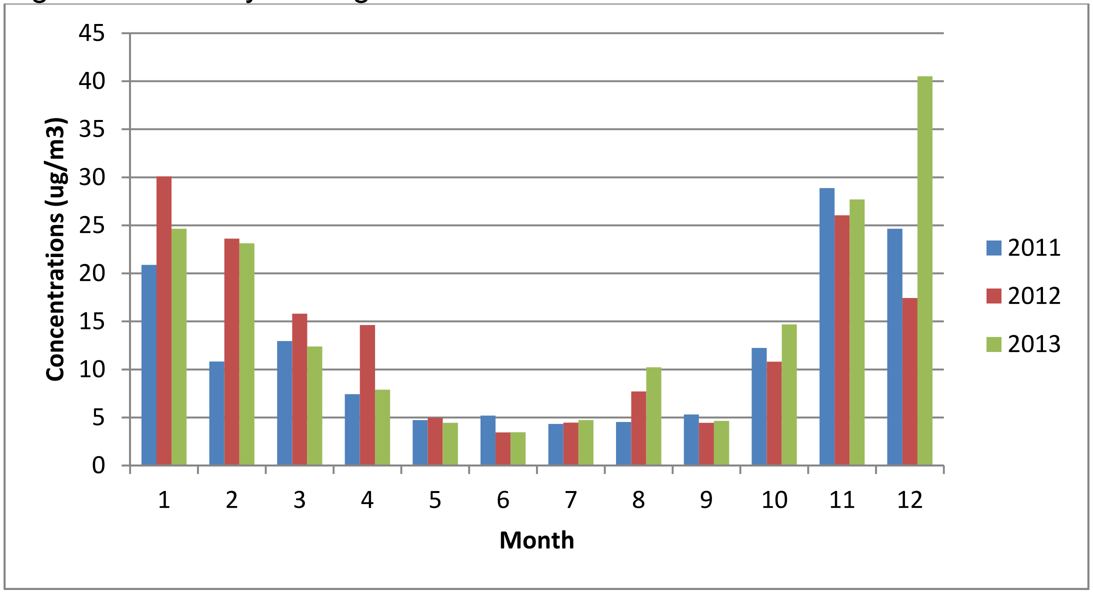
FIVE FACTOR ANALYSIS

Air Quality Data

PM2.5 Air Quality at Portola

Over the last 10 years, annual design values at Portola ranged from 10.3 $\mu g/m^3$ in 2011 to 15.1 $\mu g/m^3$ in 2003. The 2013 annual design value, based on combined data from the old site, Portola 161 Nevada Street, and the replacement site, Portola-Gulling Street, is 12.8 $\mu g/m^3$. Elevated PM2.5 concentrations at Portola are limited to winter. Surface temperature inversions play a major role in Portola's PM2.5 air quality. The strength and duration of the inversion will control PM2.5 levels by confining them to a shallow vertical layer. Portola Valley and its surrounding mountains act like a bowl, trapping a dense layer of cold air under a layer of warm air. Residents of the area typically burn wood for heat and emissions from wood stoves, cooking stoves, and fireplaces are trapped in the shallow vertical layer near the ground, leading to elevated PM2.5 concentrations. Figure 1 illustrates seasonality in PM2.5 concentration as well as year-to-year variations driven by the strength and duration of the inversion. Depending on the year, the average December concentrations ranged from 17 $\mu g/m^3$ to 41 $\mu g/m^3$.

Figure 1. Monthly Average PM2.5 Concentrations at Portola



PM2.5 concentrations at Portola are dominated by emissions from wood burning as substantiated by chemical composition, correlation between PM2.5 mass and levoglucosan, and diurnal patterns. As shown in Figure 2, carbonaceous aerosols comprise 87 percent of the PM2.5 mass annually. During winter time this contribution increases to over 90 percent. As shown in Figure 3, the combined contribution from all other components (geological material, elements, ammonium nitrate, and ammonium sulfate) on most winter days was about 1 $\mu g/m^3$ to 2 $\mu g/m^3$.

Figure 2. Portola 2011-2013 Average Composition

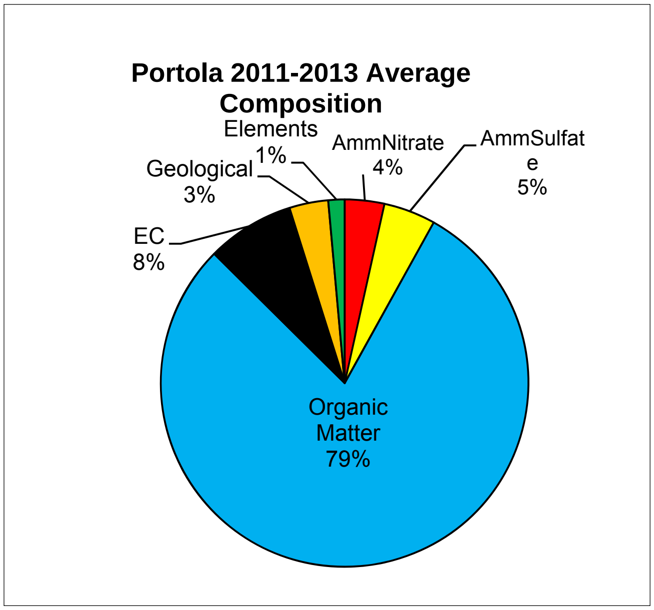
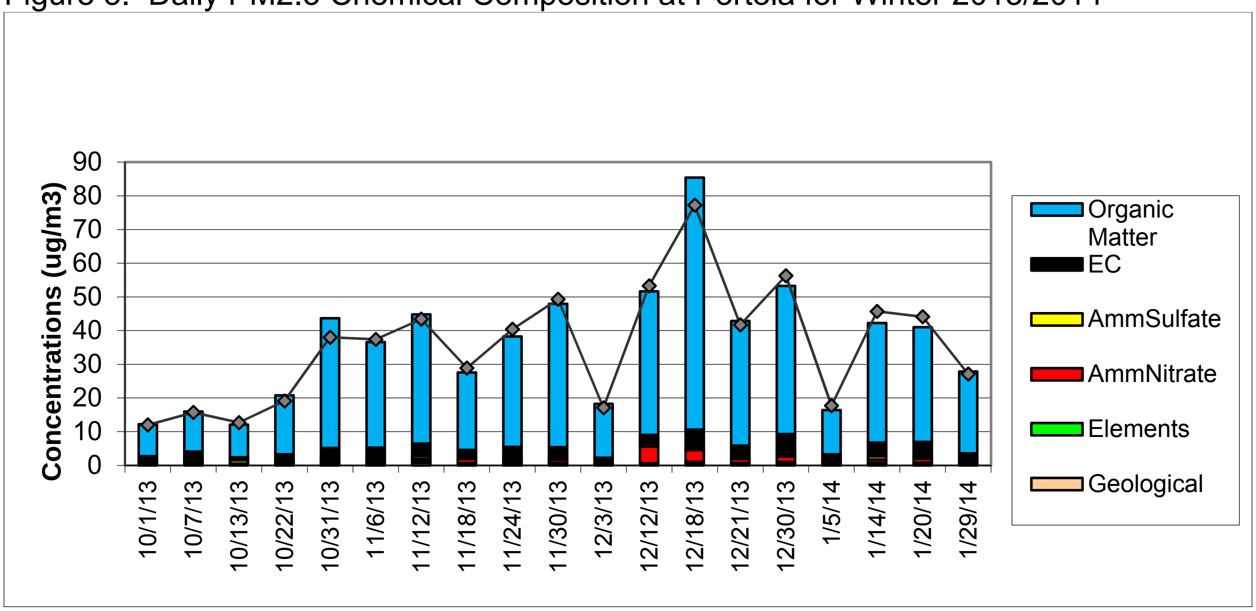
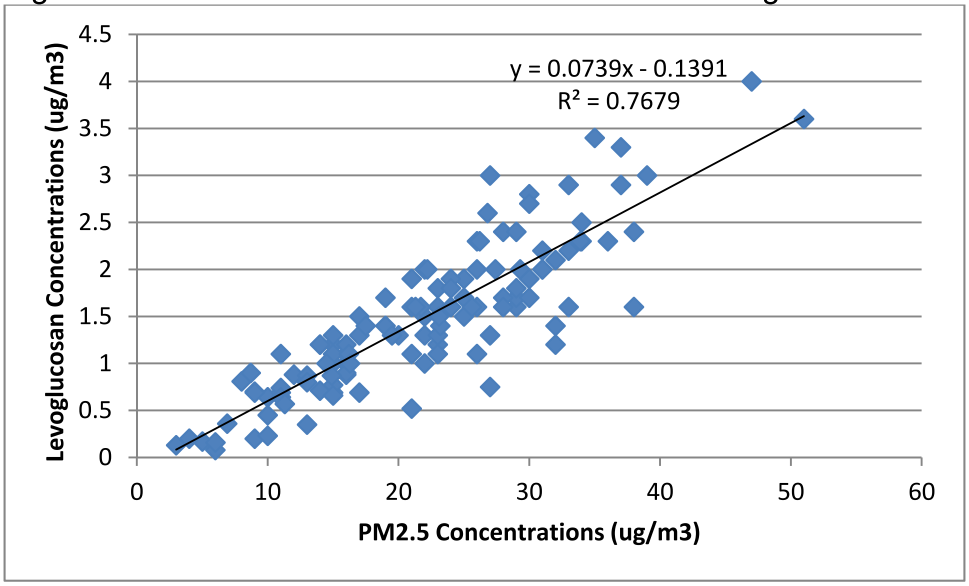


Figure 3. Daily PM2.5 Chemical Composition at Portola for Winter 2013/2014



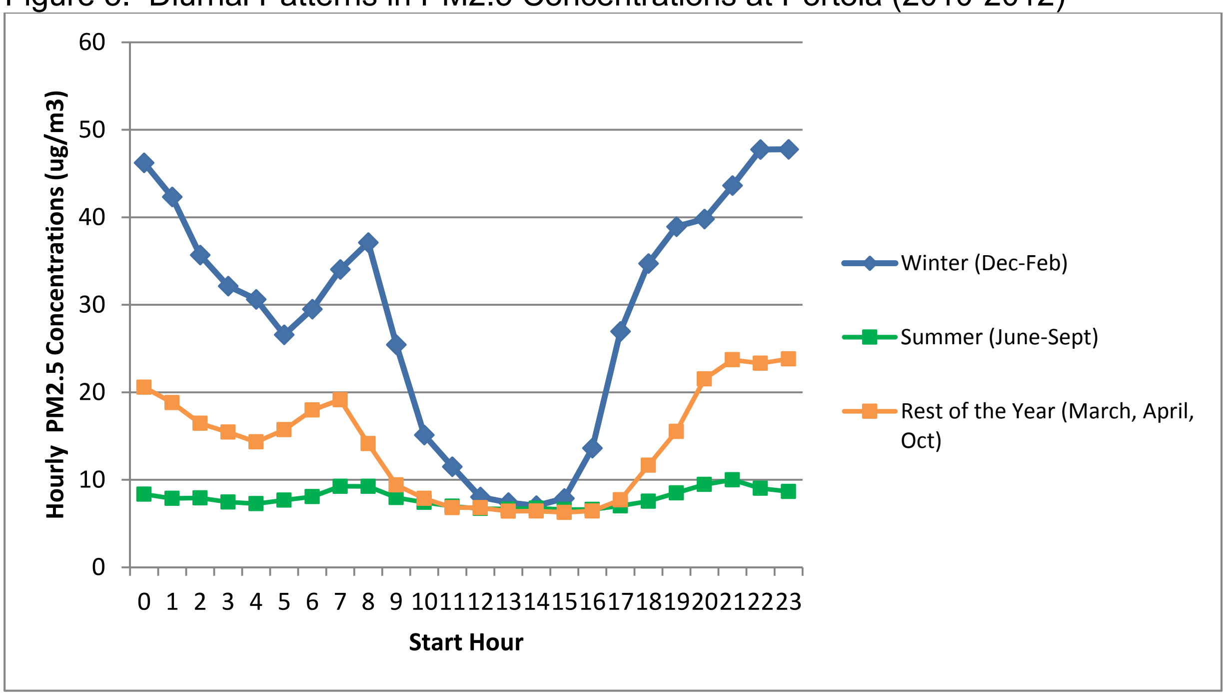
High correlation between PM2.5 concentrations and levoglucosan, a wood burning marker, further supports significant impact of wood burning emissions on PM2.5 concentrations (Figure 4).

Figure 4. Correlation between PM2.5 Mass and Levoglucosan at Portola.



The diurnal pattern, based on the non-FEM data collected at the site, also indicates that wood burning is a major source of PM2.5. Residents of Portola burn wood for heat and the overall diurnal pattern, by season, is shown in Figure 5. During summer, the PM2.5 concentrations are nearly flat across the day. As the temperatures drop and people start burning wood, morning and evening concentrations increase.

Figure 5. Diurnal Patterns in PM2.5 Concentrations at Portola (2010-2012)



Assessment of Homogeneity in PM2.5 Concentrations in the Mountain Counties Air Basin for the Purpose of Establishing Boundaries of the Nonattainment Area

Plumas county is located in the Mountain Counties air Basin. PM2.5 FRM data for 2010 to 2013 have been used to characterize spatial variability of PM2.5 concentrations in the Mountain Counties Air Basin. Different measures were used to characterize differences in concentrations among the sites.

Comparison of PM2.5 concentrations at the Mountain Counties Air Basin

Several different measures were utilized to describe variability between monitoring sites in the Mountain Counties Air Basin. ARB staff calculated the 2012 and 2013 design values for each site. A separate analysis was conducted based on paired data, including mean, maximum, and standard deviation of concentrations, as well as the number of days that the ambient concentrations exceeded the standard. To further address the differences in concentrations, the mean difference, percent difference, ratio of concentrations, 90th percentile of absolute difference, and the count of days with absolute difference greater than 10 $\mu g/m^3$ was calculated.

Another measure used to compare sites was a standard linear regression method which calculated slope, intercept, and coefficient of correlation (r). This method explores the relationship between corresponding measurements at two sites across a range of concentrations. The regression procedure determines the “best” available straight line for describing this relationship.

ARB staff also assessed relative spatial variability among any two sites by calculating the coefficient of divergence (COD). The COD is defined as

$$COD_{jk} = \sqrt{\frac{1}{p}\sum_{i=1}^{p}\left[(x_{ij} - x_{ik})/(x_{ij} + x_{ik})\right]^2}$$

Where x_{ij} is the ith average concentration for a pollutant measured at site j, j and k are two different sites, and p is the number of observations. The COD is important as a relative measure of uniformity as high correlations between sites demonstrate temporal homogeneity, but may not describe spatial concentration uniformity between sites. A COD value equal to zero means the concentrations are identical at both sites, while a value approaching one indicates substantial heterogeneity. COD values greater than approximately 0.2 indicate relatively heterogeneous spatial distribution.

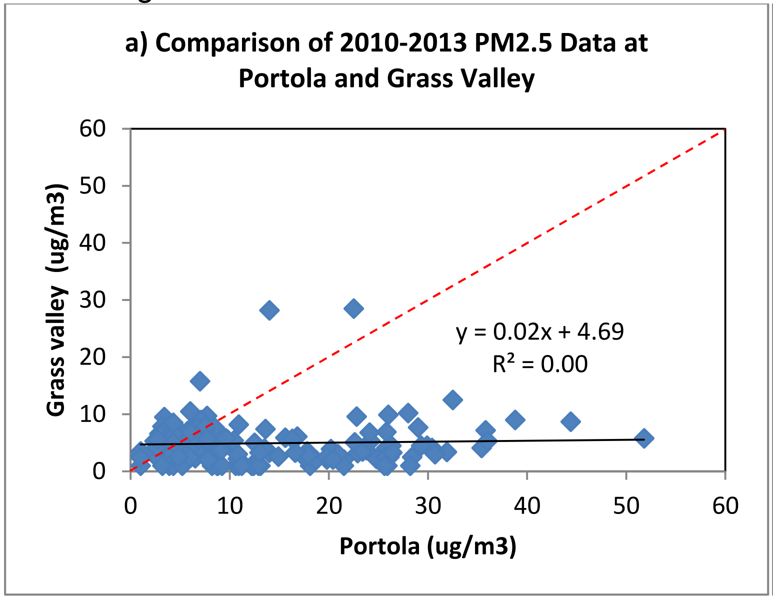
ARB staff initially compared annual design values and conducted a linear regression analysis (Table 1 and Figures 6a through 6e). From this comparison, it was evident that there is no correlation between concentrations at Portola and three other sites, in the Mountain Counties Air Basin; San Andreas, Grass Valley, and Truckee. The concentration correlation between the sites was low ($r \leq 0.45$) and the 2013 design values were 37 percent to 64 percent lower compared to Portola. Quincy was the only site moderately correlated to Portola and within 20 percent of Portola's design value. Therefore, the more detailed analysis was limited to comparing PM2.5 concentrations at Quincy to Portola.

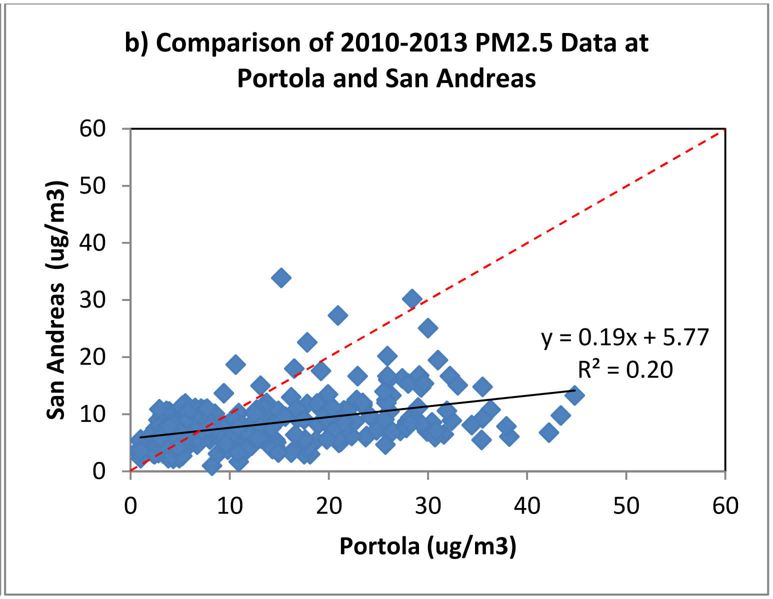
Table 1. Annual Average Concentrations and Design Values at the Mountain Counties Air Basin

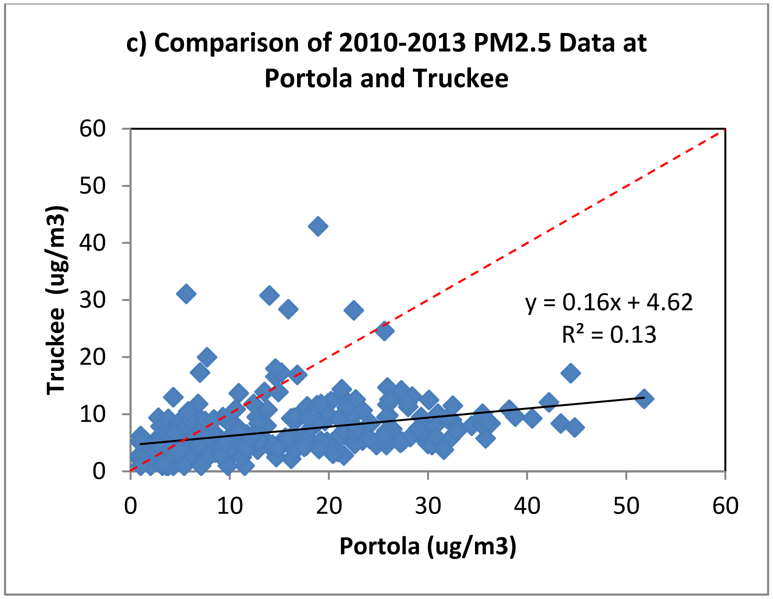
	Annual Average Concentrations ($\mu g/m^3$)				Design Values ($\mu g/m^3$)	
Site Name	2010	2011	2012	2013	2012	2013
Portola*	9.7	11.9	13	13.5	11.5	12.8
Quincy-N Church Street	7.1	10.8	9.5	10.3	9.1	10.2
Truckee-Fire Station	5.6	6.6	6.2	8.2	6.1	7
Grass Valley-Litton Building	4.5	4.2	3.8	5.7	4.2	4.6
San Andreas-Gold Strike Road	6.4	9.1	7	8.3	7.5	8.1

* Data for Portola-161 Nevada Street for January 1, 2011 through June 30, 2013 were combined with data for Portola-Gulling Street for July 1, 2013 through December 31, 2013 to calculate 2013 design value.

Figure 6. Scatter Plots of PM2.5 Data Collected between 2010 and 2013 Comparing Concentrations at Portola to Other Monitoring Sites in the Mountain Counties Air Basin







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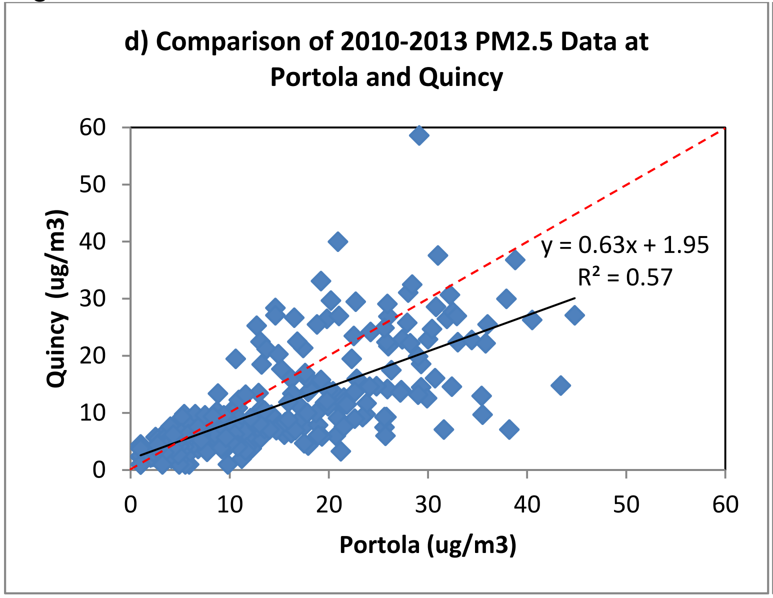
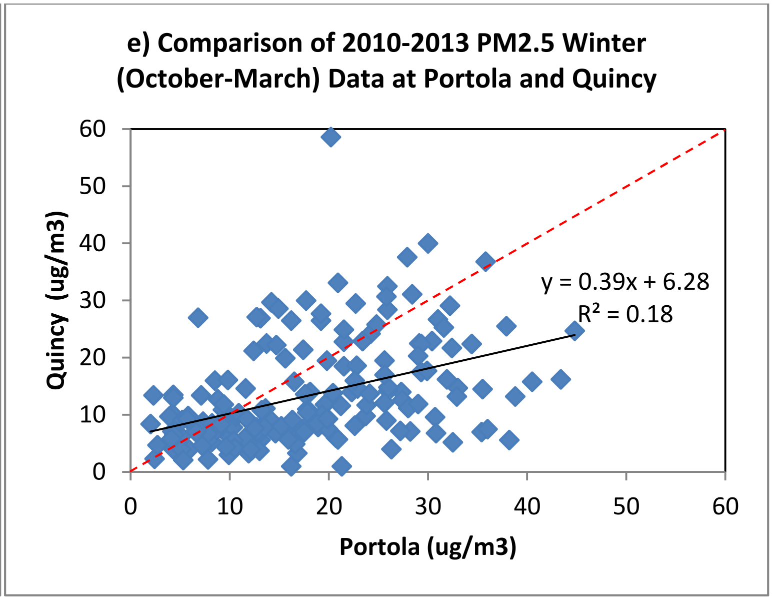




Comparison of PM2.5 concentrations at Portola and Quincy

PM2.5 concentrations at Portola and Quincy were moderately correlated with the average coefficient of correlation (r) of 0.75. During winter, the correlation was even lower with r=0.42. The relative measure of uniformity, represented by the mean COD was 0.25 for all data and 0.27 for winter data. A COD of zero means that there are no differences between concentrations at the two sites, while the value approaching one indicates maximum differences and absolute heterogeneity. CODs of 0.25 and 0.27 are indicative of a relatively heterogeneous spatial distribution.

The 2012 and 2013 design values at Quincy were 20 percent lower compared to Portola. The average concentrations based on paired data were within 2.2 ug/m3 of each other. Absolute differences, represented by the 90^{th} percentile of absolute daily concentration differences between paired data, were much larger than the difference in annual concentrations. The mean absolute value of the 90^{th} percentile was 10.7 $\mu g/m^3$. Table 2 includes a summary of concentrations and differences among sites for all data collected between 2010 and 2013 and separate analysis for winter data. Table 3 lists regression statistics. Figures 7a through 7d illustrate daily concentrations for each year between 2010 and 2013.

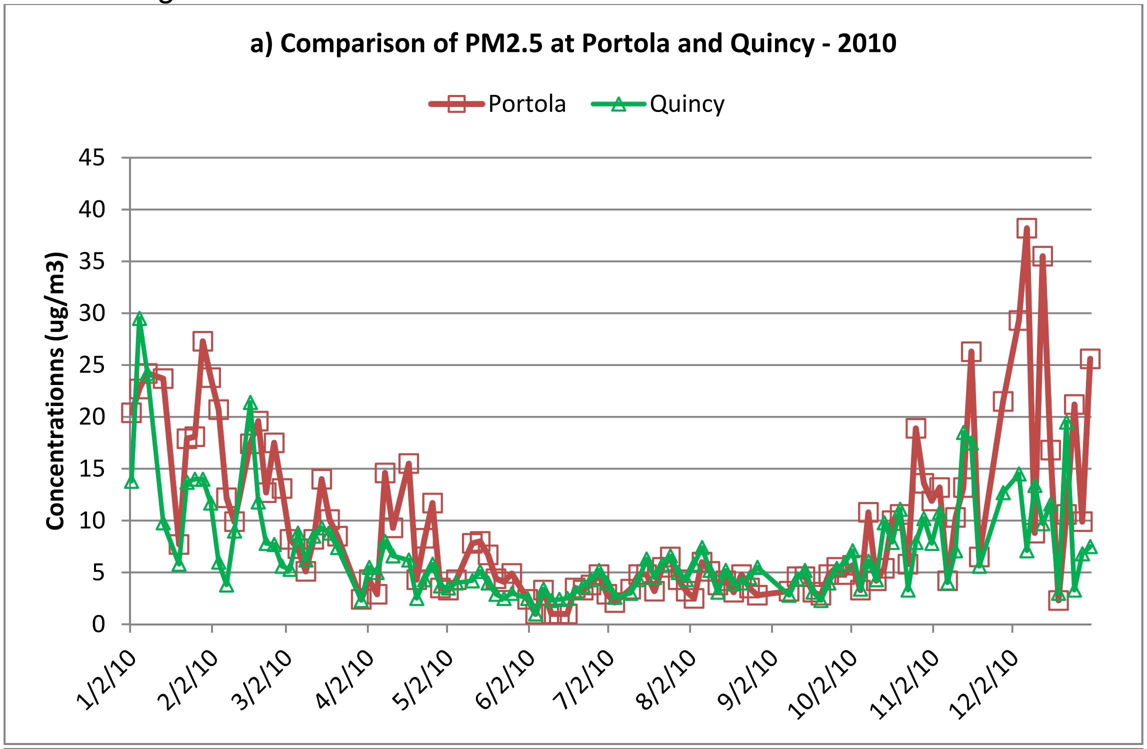
Table 2. Summary Statistics based on Paired Data Between 2010 and 2013

Pair	Obs	Concentrations ($\mu g/m^3$)				Differences			
Name	Count	Mean	SD	Max	Exceedance Days	Avg	%	90^{th} Pct.	Ratio
All Data									
Portola	397	11	9.4	44.8	9	2.2	2.6	10.7	1.4
Quincy		8.9	7.8	58.6	4				
Winter Data (October-March)									
Portola	180	17.7	9.8	44.8	9	4.2	17.2		1.6
Quincy		13.5	9.2	40	4				

Table 3. Regression Statistics

Data Included	Obs Count	Slope	Intercept	Correlation (r)
All Data	397	0.63	1.90	0.75
Winter (October-March)	180	0.39	6.28	0.42

Figure 7. Daily Comparison of PM2.5 Concentrations between Portola and Quincy for 2010 through 2013



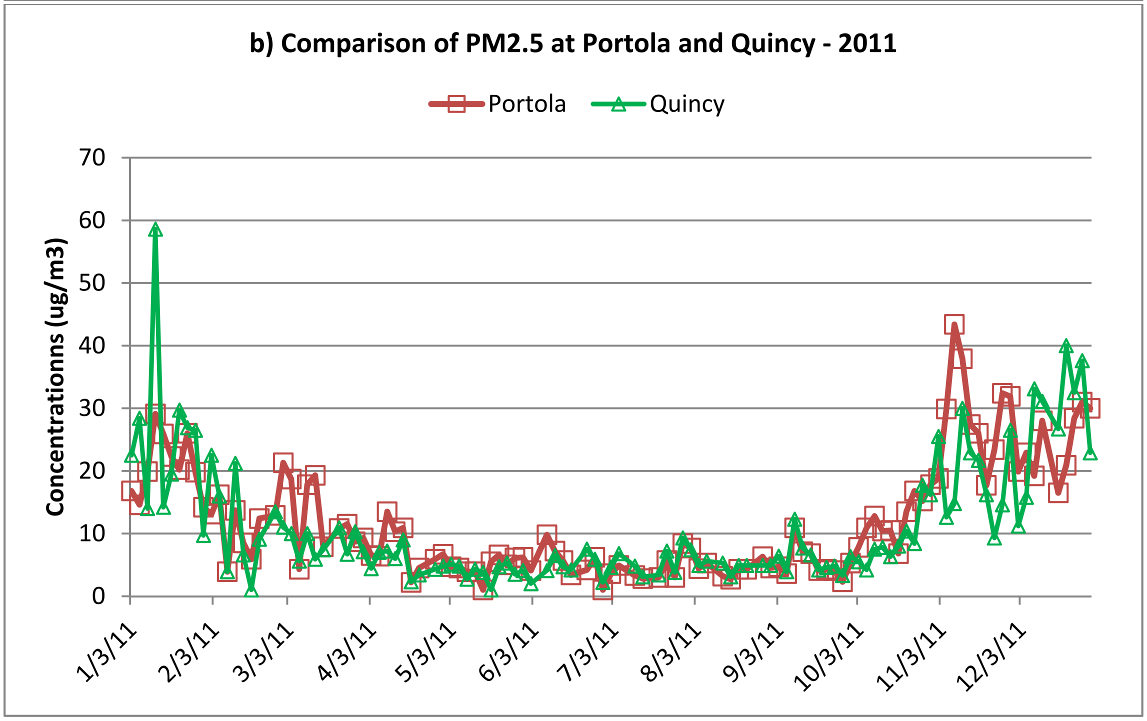
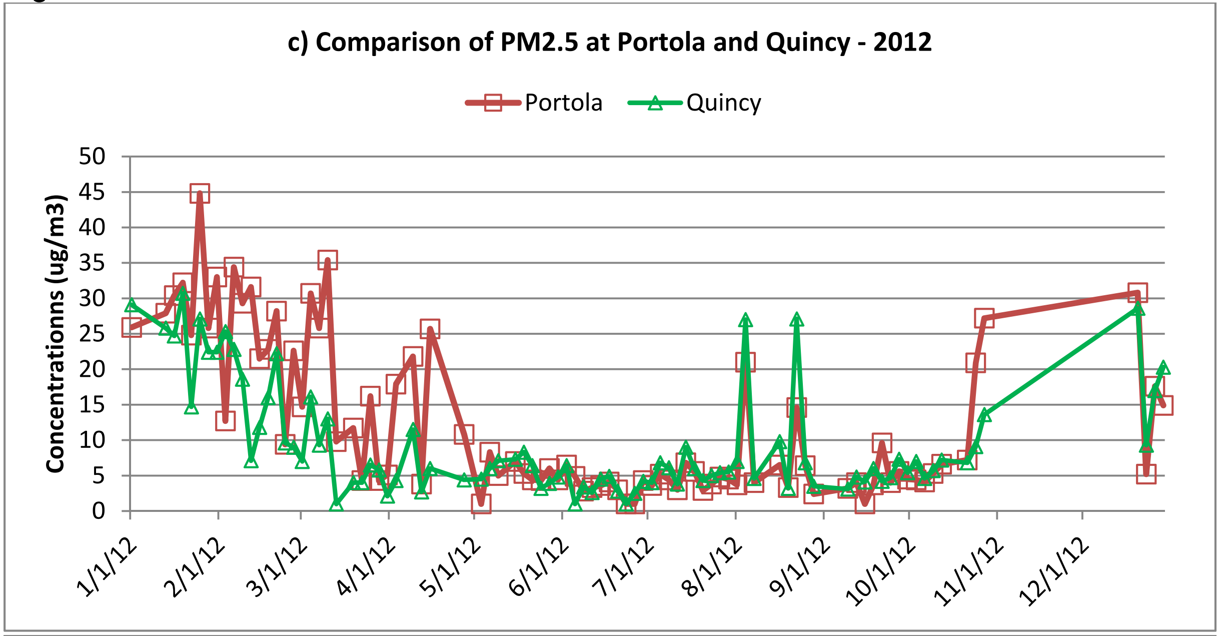
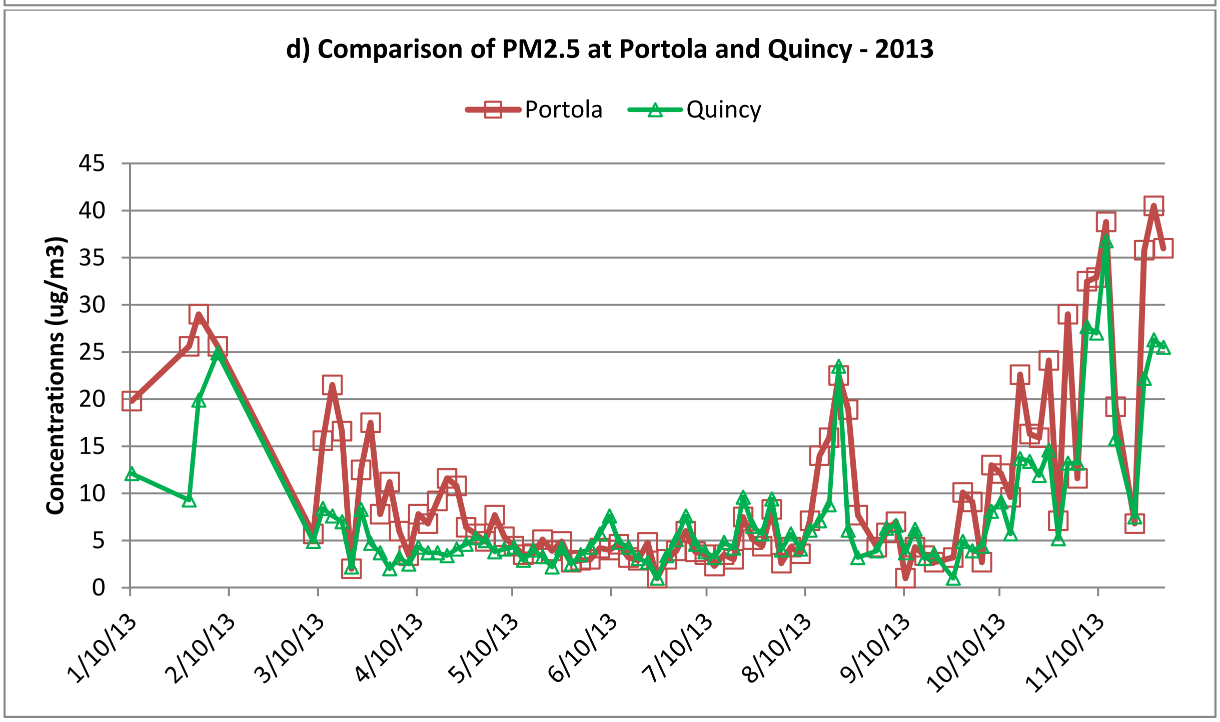


Figure 7 continued.



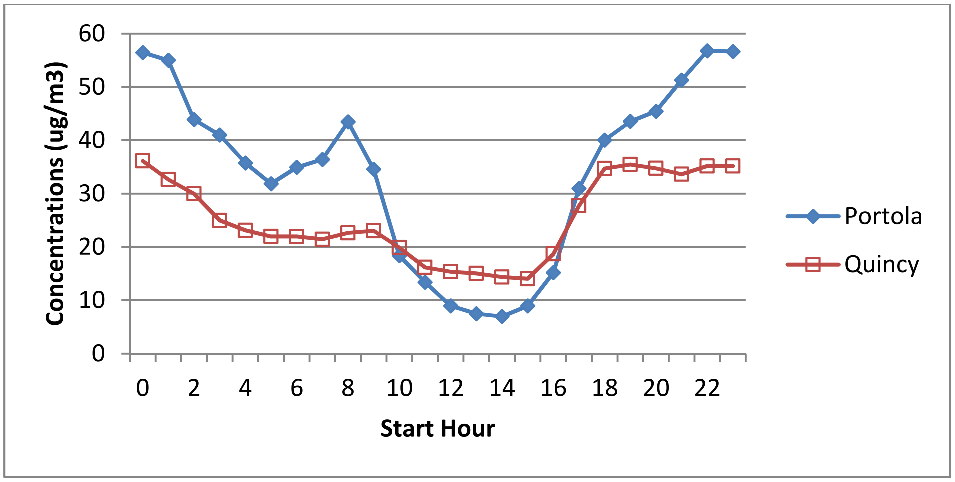


During the two key winter months, December and January, the diurnal patterns at the two sites were sufficiently different to indicate the impact of local environments. Concentrations at Portola exhibit an early morning peak, between the hours of 5 a.m. and 8 a.m. In the evening, concentrations increased steadily from 4 p.m. to 10 p.m. At Quincy, there is no morning peak and concentrations plateau by 6 p.m. Additionally, the mid-day concentrations, between the hours of 11 a.m. and 3 p.m. are higher at Quincy compared to Portola. Figure 8 depicts diurnal patterns based on January and December data collected between 2010 and 2013.

Analysis indicates that particle pollution from either of these sites is not likely transported to the other site given that the terrain and low mixing heights tend to prevent air masses from mixing. The data reveal that while these sites experience similar air quality patterns overall, the correlation between the two sites indicates there are significant differences in concentrations during the December and January periods. Specifically, the higher annual correlation between the two sites indicates that they are influenced by the same seasonal changes; however, the lower correlation observed during the winter is likely due to a different contribution of local sources at each site.

Diurnal differences between the sites further indicate that local, emission-related activity in the immediate area around the monitors in Quincy and Portola (e.g., employment, type of wood burning devices, and type of fuel used) independently influence the recorded PM2.5 concentrations at each site.

Figure 8. Diurnal Patterns in PM2.5 Concentrations during January and December based on 2010-2013 Data.



Emissions and Emissions-Related Data

Emissions Inventory

The emissions inventory for Plumas County (Table 4) shows that PM2.5 emissions are small and are expected to grow very little for the next 20 years. Emissions from residential fuel combustion are a larger component of the inventory, and are expected to remain constant due to the lack of population growth.

Table 4. Emissions Inventory for Plumas County, CA, tons per day (tpd)

	2012		2015		2025		2035	
	Annual	**Winter**	**Annual**	**Winter**	**Annual**	**Winter**	**Annual**	**Winter**
Residential Fuel Combustion	.300	.546	.300	.546	.300	.546	.300	.546
Total	2.545	1.501	2.606	1.562	2.758	1.712	2.871	1.872

Source: CEPAM: 2013 Almanac – Standard Emissions Tool [http://www.arb.ca.gov/app/emsinv/fcemssumcat2013.php]

Population

The California State Department of Finance[1] historical population estimates for Portola show a decrease of almost six percent from 2000 to 2010 (Figure 9), while the population for Plumas County as a whole decreased by almost four percent in the same time period. Population projections[2] (Figure 10) indicate that the County population will initially increase by four percent in 2025 but will then begin a steady decrease.

Figure 9. Population Trends for Portola California.

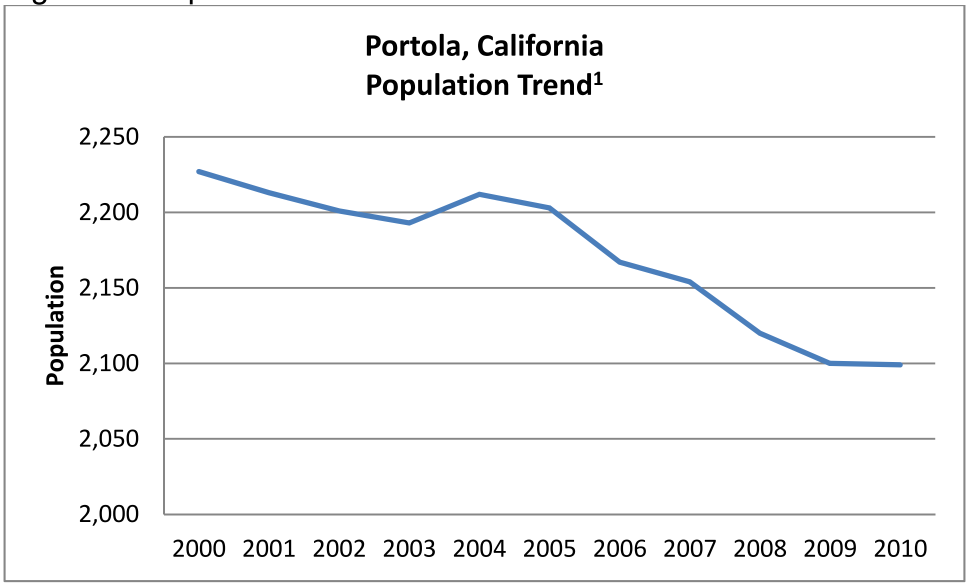
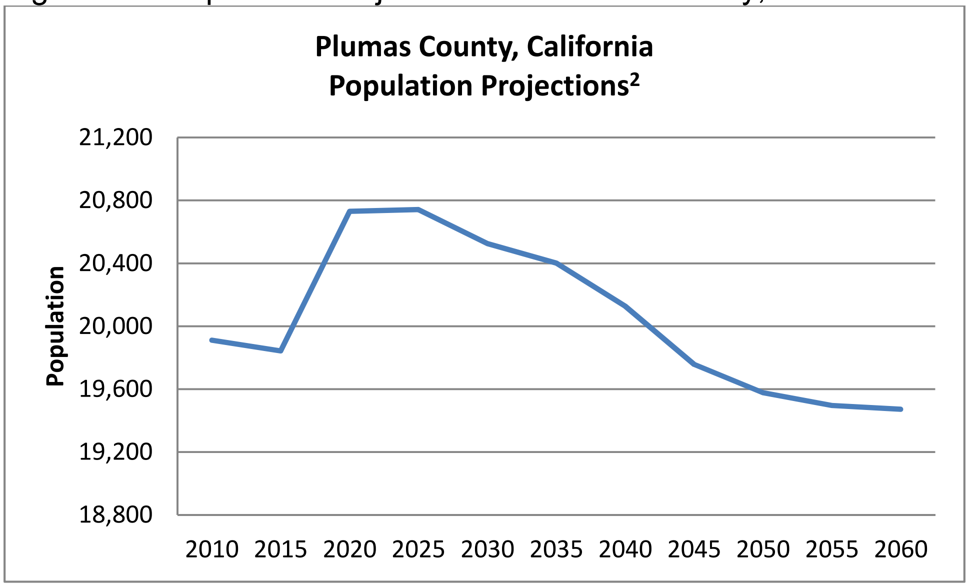
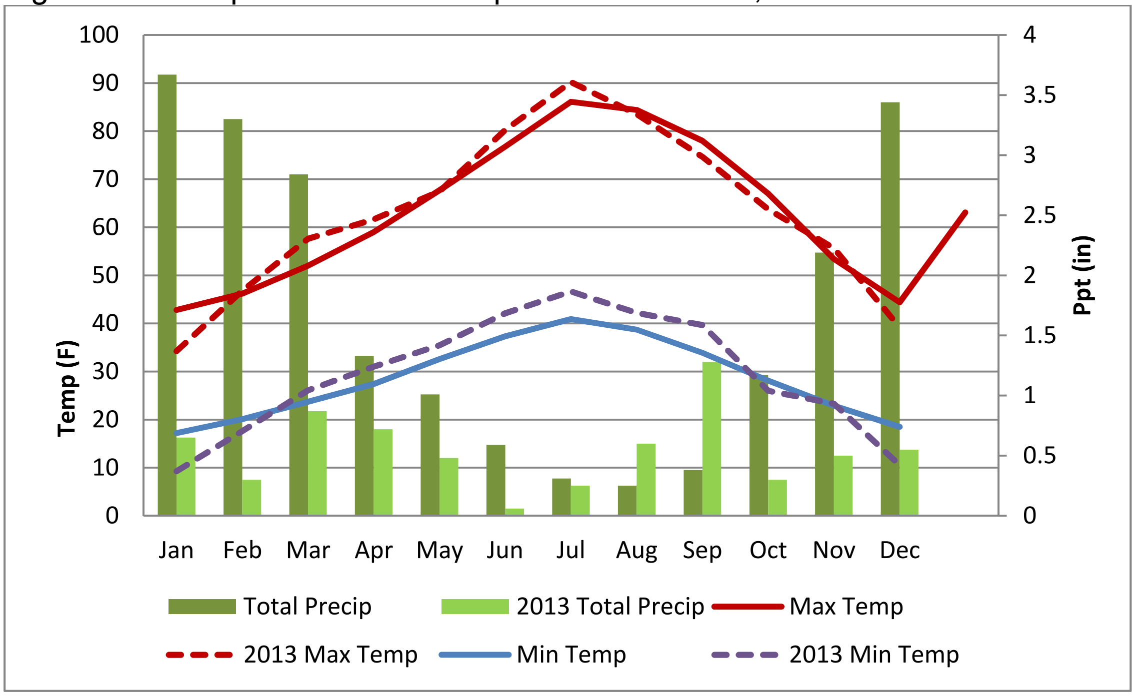


Figure 10. Population Projections for Plumas County, California



Meteorology

Figure 11. Temperature and Precipitation for Portola, California



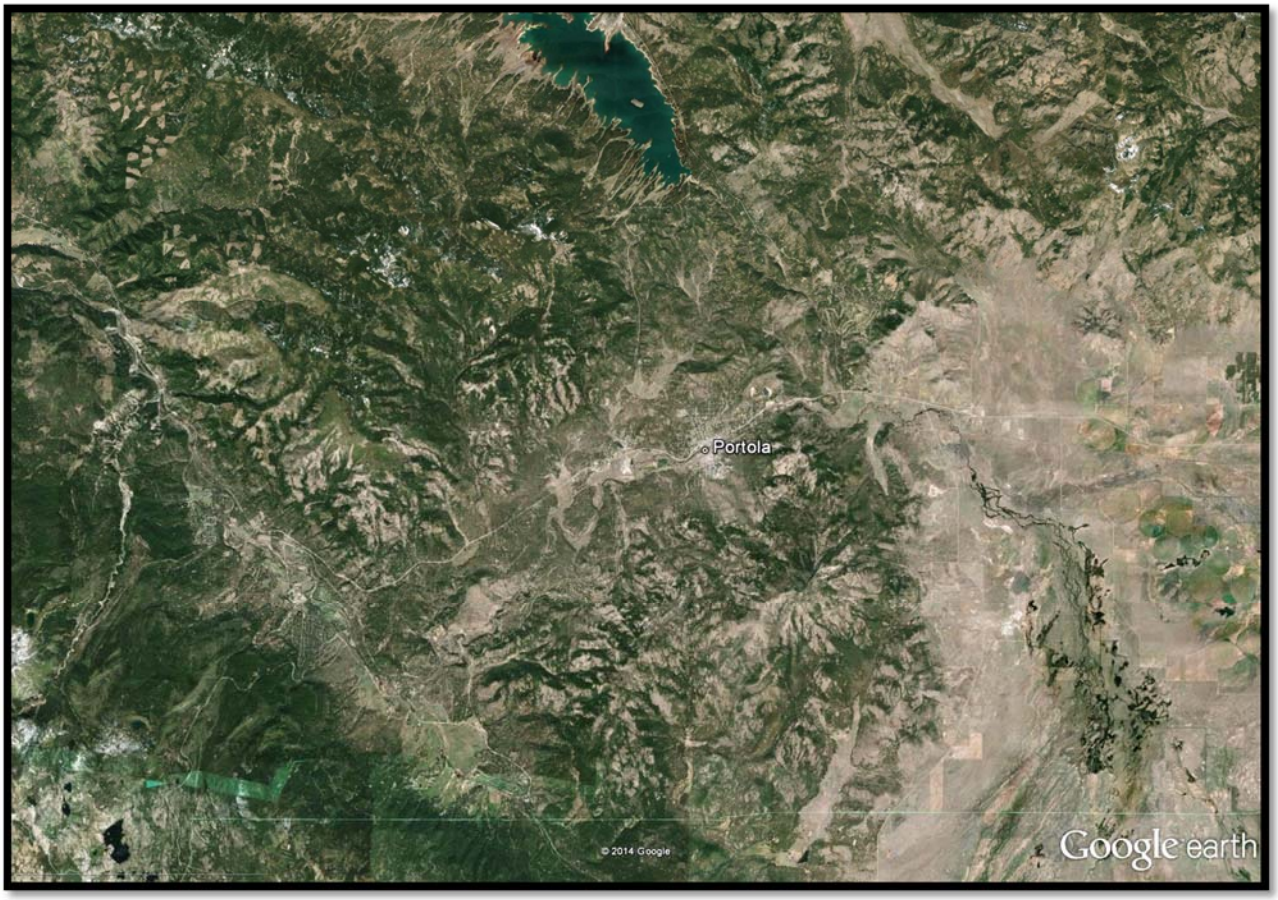
In Portola, the average maximum temperatures (based on data from 1915 to 2014) range from 40 F in January to 90 F in July, with average minimum temperatures ranging from 17 F to 40 F (also January and July). Temperatures in 2013 were close to historical averages for maximums but ranged a little more widely for minimums with an average low of 9 F in January and a low of 47 F in July.[3]

Precipitation varies widely throughout the year, with average highs in the winter months of 3.5 inches and the summer months averages below half an inch. In 2013, only 6.5 inches of precipitation was recorded in 2013, far below the historical annual average of 29 inches. The highest monthly average was just over an inch of precipitation in September. [3]

Geography/Topography

Portola, at an elevation of almost 5000 feet, is in an area comprised of the Humbug and Mohawk Valleys and is geographically isolated from the remainder of Plumas County (Figure 12). However, there are a number of other communities within this area in addition to Portola. We refer to this entire area as the Portola Valley.

Figure 12. Satellite View of Portola, California



Jurisdictional Boundaries

In California, if the air pollution problem is regional in nature, the primary considerations for air quality planning are air basin and air district boundaries. Consistent with State law, California's air basin boundaries were established based on a scientific assessment of emissions, geography, and meteorology, with consideration of political jurisdictions. Basin boundaries are formally adopted by ARB in regulation. Local air districts have been established, and their jurisdictions defined, by State statute. ARB typically uses a combination of air basin and air district lines to identify areas that violate air quality standards, with the exception of situations where a single city or community has a unique air pollution problem distinct from the region.

In 2003, the State of California established a nonattainment boundary for the Portola Valley for the State PM2.5 annual standard. This area encompassed city, county, and hydrographic boundaries and was designed to include the majority of the population in the area by incorporating both the existing nonattainment area (City of Portola) and the surrounding communities.

The hydrographic boundaries, watersheds, are based on the State of California's Department of Conservation Statewide Watershed Program and are defined as a ridge of high land that separates areas drained by different river systems. Specifically, the Portola Valley would be defined as that portion of Plumas County within the following Super Planning Watersheds (SPWS): Humbug Valley (# 55183301), Sulpher Creek (#55183302), Frazier Creek (#55183303), and Eureka Lake (#55183304) (Figure 13). These are the SPWS as created by the California Interagency Watershed Mapping Committee and described in CalWater version 2.2, October 1999.

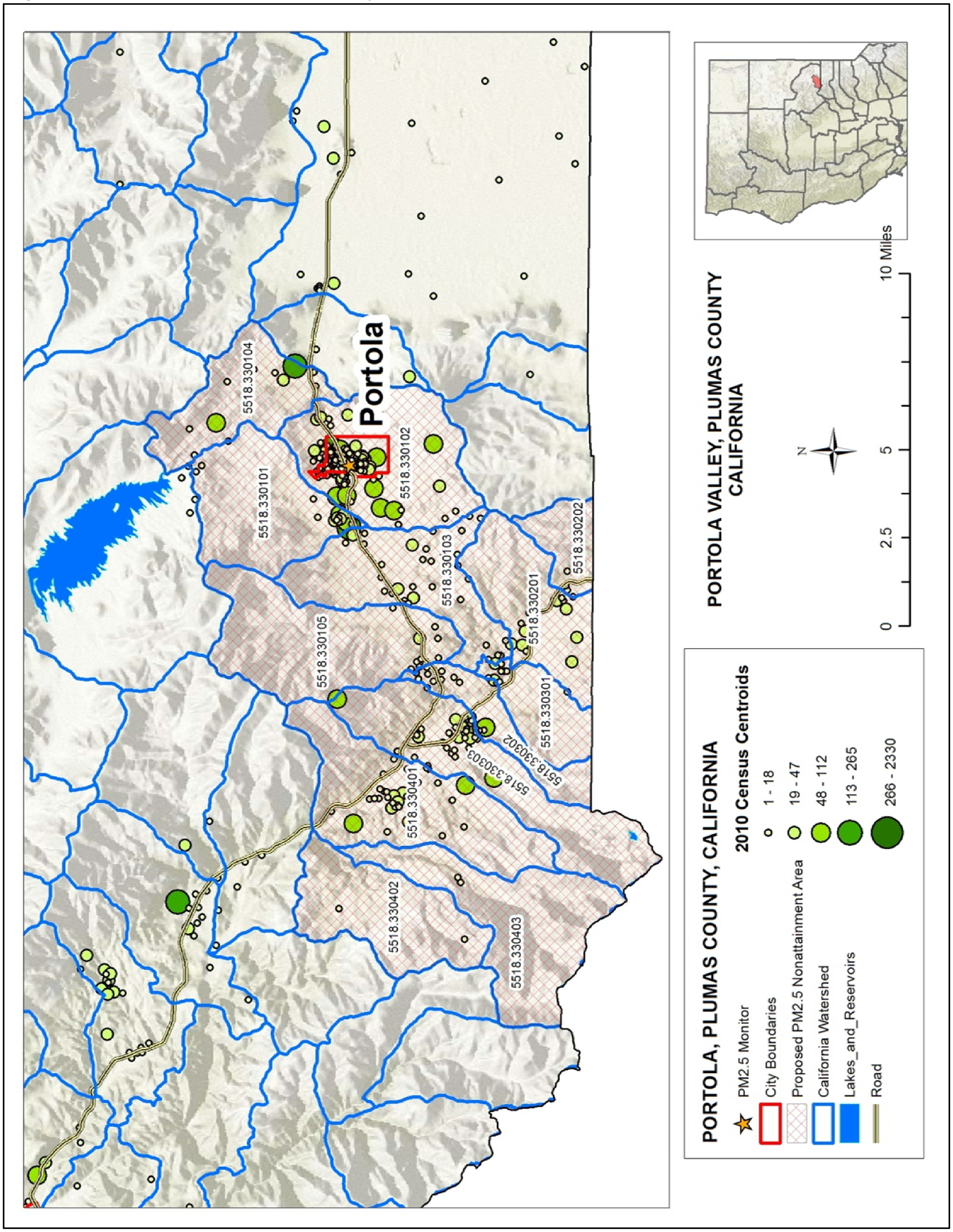
Current information about CalWater version 2.2 can be found at Marine Pollution Studies Laboratory's Surface Water Ambient Monitoring Program (SWAMP) data management and quality assurance information site.[4] The GIS shapefiles used to define the nonattainment boundary area can also be found via this website.[5]

CONCLUSION

The geography and meteorology of the Mountain Counties Air Basin, combined with local emissions, lead to the accumulation of PM2.5 during the winter months. The severity of the problem depends on the interplay of these factors. PM2.5 air quality data indicate that while all of the monitoring sites in the Mountain Counties Air Basin experience elevated wintertime concentrations, any similarity of measured concentrations is due to sampling of comparable local environments rather than a uniformly regional air mass. Surface temperature inversions play a major role in the air quality of the area by trapping a dense layer of cold air under a layer of warm air. The terrain, valleys surrounded by mountains, further exacerbates the problem. Since residents in the area burn wood for both heating and cooking, emissions from wood stoves, cooking stoves, and fireplaces are trapped in the shallow layer of cold air near the ground, leading to high PM2.5 levels.

PM2.5 seasonality as well as chemical composition and diurnal data support the idea that localized residential wood burning on stagnant winter days causes the annual PM2.5 concentrations to exceed the standard. While all of the monitoring sites in the area experience the same pattern, Portola is the only location where the PM2.5 levels are high enough to violate the annual PM2.5 standard. Therefore, as detailed in this report, the appropriate nonattainment area would be smaller than the county level, but larger than the boundaries of the City of Portola, where the violating monitor is located. The currently existing State PM2.5 nonattainment area that encompasses the Portola Valley, including the City of Portola and surrounding population areas, is recommended for use as the federal PM2.5 nonattainment area boundary.

Figure 13. Proposed Portola Valley Nonattainment Area



Notes

[1] *State of California, Department of Finance, E-8 Historical Population and Housing Estimates for Cities, Counties, and the State, 2000-2010. Sacramento, California, November 2012;* http://www.dof.ca.gov/research/demographic/reports/estimates/e-8/2000-10/view.php

[2] http://www.dof.ca.gov/research/demographic/reports/projections/P-1/

[3] Western Regional Climate Center, Cooperative Climatological Data Summaries, http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7085

[4] http://swamp.mpsl.mlml.calstate.edu/

[5] http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/database-management-systems/swamp-25-database/templates-25/gis-shapefile-layers