San Joaquin Valley Air Pollution Control District

2020 Air Monitoring Network Assessment

June 29, 2020

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1. INTRODUCTION

The U.S. Environmental Protection Agency (EPA) created the National Ambient Air Monitoring Strategy (NAAMS), with the purpose of optimizing U.S. air monitoring networks to achieve (with limited resources) the best possible scientific value while continuing to protect public and environmental health. An important element of NAAMS is a plan for periodic network assessments at national, regional, and local levels. A network assessment includes (1) evaluation of air monitoring objectives and budget, (2) evaluation of a monitoring network's effectiveness and efficiency relative to its objectives and cost, and (3) recommendations for network reconfigurations and improvements. Per 40 CFR Part 58 Subpart B, § 58.10, EPA expects that a multi-level network assessment will be conducted every five years, beginning in 2010. This report satisfies the network assessment requirement for the year 2020 (U.S. Environmental Protection Agency, 2005, 2006). For more detailed information on the San Joaquin Valley Air Pollution Control District's air monitoring network, refer to the District's 2020 Air Monitoring Network Plan[1].

1.1 BACKGROUND

Ambient air monitoring objectives and demographic characteristics change over time, thus motivating air quality agencies to reevaluate and reconfigure their monitoring networks. Several factors have prompted the changes in air monitoring objectives: improvement in air quality, changes in population distribution and behaviors, changes in air quality mandates, and advancements in the scientific understanding of air quality phenomena. As a result of these changes, air monitoring networks in some regions may have unnecessary, redundant, or ineffective monitoring locations for some pollutants, while other regions may lack necessary monitors altogether.

Changes in particulate matter less than 2.5 microns (PM2.5) and ozone (O3) National Ambient Air Quality Standards (NAAQS) and other air monitoring objectives are motivating air quality agencies to refocus their monitoring resources on pollutants of emerging interest or persistent challenge, such as PM2.5, ground-level ozone and precursor compounds, and air toxics. In addition, agencies are interested in designing networks to protect today's population and environment while maintaining a focus on long-term air quality trends. Moreover, agencies are using new air monitoring technologies and developing an improved scientific understanding of air quality issues.

Monitoring networks should be designed and configured to address multiple, interrelated air quality issues (i.e., a multipollutant approach) and to support other types of air quality studies (e.g., photochemical modeling and emission inventory assessments). Reconfiguring air monitoring networks to help meet the needs of current air quality research will enhance the network's value to stakeholders, scientists, and the general public. Performing an air monitoring network assessment involves re-evaluation of a network's effectiveness and efficiency relative to its objectives and costs, and making

[1] 2020 Air Monitoring Network Plan: http://valleyair.org/aqinfo/air-monitoring.htm

recommendations for network reconfigurations and improvements.

1.2 NETWORK ASSESSMENT OBJECTIVES

The San Joaquin Valley (SJV) is an area with rich agricultural resources, abundant industry, and a growing population. The San Joaquin Valley Air Pollution Control District (District) seeks to ensure that its monitoring network is (1) capable of effectively characterizing air quality and meteorology in the region and (2) meeting its monitoring objectives. The objectives of the District's air monitoring network are to ensure compliance with NAAQS, determine control strategy effectiveness, support air quality forecasting, provide information that helps inform the public of air quality conditions and potential public health risks, and support air quality modeling.

The objectives of this network assessment are to identify and recommend adjustments to the District's criteria pollutant, Photochemical Assessment Monitoring Station (PAMS), and meteorological monitoring network that may be needed to address air quality improvements, emissions reductions, population increases, and the five-year network assessment requirements set forth by the EPA. These requirements address questions as to whether sites are appropriately located to accomplish the following:

- determine the highest criteria pollutant concentrations expected to occur in the area covered by the network;
- measure typical concentrations in areas of high population density;
- determine the impact of significant sources or source categories on air quality;
- determine general background concentration levels;
- determine the extent of regional pollutant transport among populated areas; and
- measure air pollution impacts on visibility, vegetation damage, or other welfare-based impacts to support secondary standards.

Additionally, a network assessment can identify potentially redundant sites, areas where new sites may be needed, and evaluate new technologies that may add value to the air monitoring network.

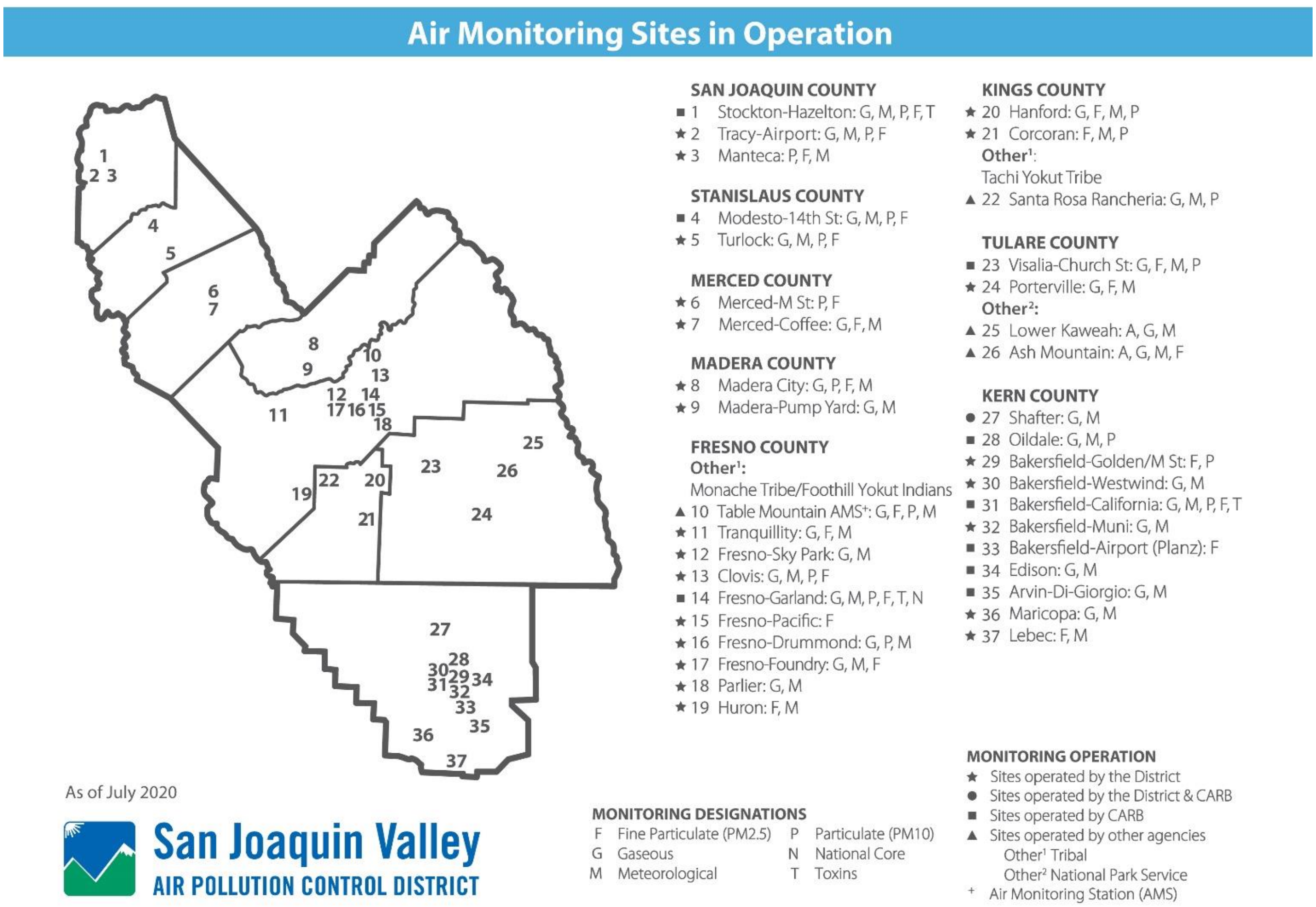
1.3 NETWORK OVERVIEW

The San Joaquin Valley (SJV) covers an area of 23,490 square miles, and is home to one of the most challenging air quality problems in the nation. The Valley is home to approximately 4 million residents, and includes several major metropolitan areas, vast expanses of agricultural land, industrial sources, highways, and schools. The Valley is designated nonattainment for federal PM2.5 and ozone standards, and attainment of the federal standards for lead (Pb), Nitrogen dioxide (NO2), Sulfur dioxide (SO2), and

Carbon monoxide (CO). The Valley is an attainment/maintenance area for the state and federal particulate matter less than 10 microns (PM10) standards. To address the air quality needs of this expansive and diverse region, the District operates a robust air monitoring program that meets federal requirements and provides vital information to the public.

The District's air monitoring network measures a variety of pollutants and has a long record of criteria pollutant data. A map of the District's air monitoring network and the general network assessment study domain is shown in Figure 1-1. In addition to District-operated sites, there are several sites in the SJV that are operated by other agencies (California Air Resources Board – CARB and National Park Service) and jurisdictions (federally-recognized tribes).

Figure 1-1 Monitoring Sites Operating in the San Joaquin Valley



1.4 DISADVANDAGED COMMUNITY AREAS

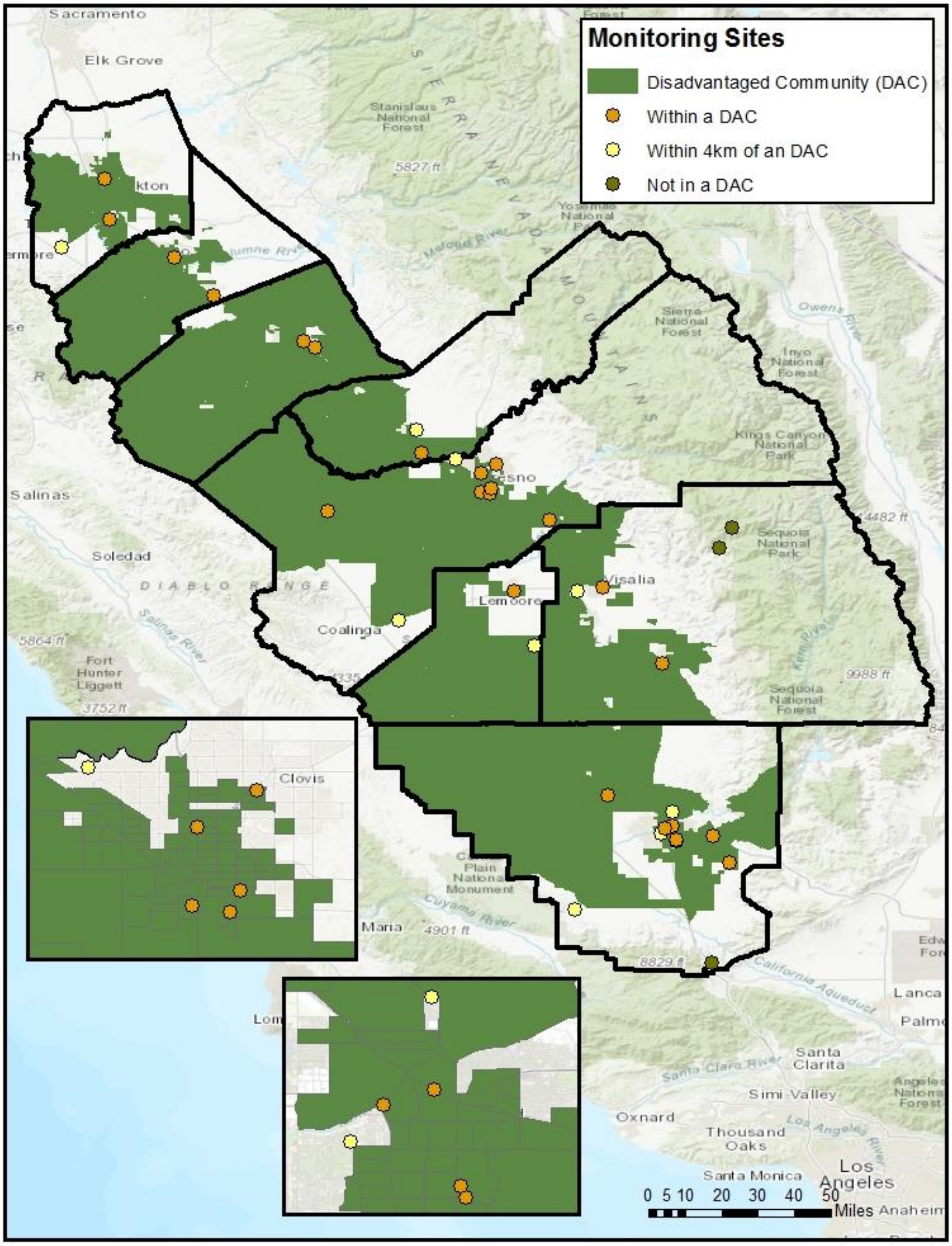
On behalf of the California Environmental Protection Agency (CalEPA), the Office of Environmental Health Hazard Assessment (OEHHA) released the California

Communities Environmental Health Screening Tool (CalEnviroScreen)[2]. CalEnviroScreen identifies California communities by census tracts that are disproportionately burdened by, and vulnerable to, multiple sources of pollution. Within the tool, CalEPA defines disadvantaged communities as the top 25% scoring areas from the CalEvniroScreen with a variety of criteria including areas with high amounts of pollution, low income, and low populations.

Figure 1-2 shows that a majority of the San Joaquin Valley air monitoring sites are within 4 km of a disadvantage community. The Lebec, Sequoia-Lower Kaweah, and Sequoia-Ash Mountain air monitoring sites are outside of a disadvantaged community. These three sites were placed in areas to address either transport between air basins or special air quality needs.

[2] See the CalEnviroScreen website for additional information on the tool and disadvantaged communities: https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30

Figure 1-2 Proximity of San Joaquin Valley Air Monitoring Sites to Disadvantaged Communities (DAC)



1.5 GUIDE TO THIS REPORT

The following sections of this report detail the analysis approach, findings, and recommendations from this network assessment document. Section 2 includes a discussion of the technical approach and findings of the criteria pollutant air monitoring network assessment. Section 3 includes a discussion of the technical approach and findings of the PAMS network assessment. Section 4 contains the technical finds of the meteorological network assessment. Section 5 includes the Air Monitoring Network Assessment recommendations.

2. TECHNICAL APPROACH AND FINDINGS – CRITERIA POLLUTANT AIR MONITORING NETWORK ASSESSMENT

The Monitoring Network Assessment Plan collects data from the Air Monitoring Sites throughout the District to detect if the network meets the monitoring objectives defined in Appendix D of the CFR (40 CFR Park 58.10 (d)). This assessment will determine whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network.

Table 2-1 lists the network assessment analyses that were used to address the monitoring objectives (as discussed in Section 1.2) and the following questions:

- Which sites provide the most value in terms of the number of pollutants measured, the length of data record, and data quality?
- Are sites appropriately located to determine the highest pollutant concentrations expected to occur in the area covered by the network?
- Are sites appropriately located to measure typical pollutant concentrations in areas of high population density?
- Are sites appropriately located to determine the impact of significant sources or source categories on air quality?
- Are sites appropriately located to determine general background concentration levels?
- Are sites appropriately located to determine the extent of regional pollutant transport among populated areas?
- Are sites appropriately located to measure air pollution impacts on visibility, vegetation damage, or other welfare-based impacts and to support secondary standards?
- Are there potentially redundant sites in the network?
- Are there areas where new sites may be needed?
- Are there new technologies that may add value to the air monitoring network?

The analyses listed in Table 2-1 are a subset of the analysis methods prescribed in the EPA's *Ambient Air Monitoring Network Assessment Guidance Document* (Raffuse et al., 2007).

Table 2-1 Summary of the Analyses Performed and the Monitoring Objectives or Questions Addressed

Objective or Question	**Site-by-Site Analyses**							**Bottom-up Analyses**		
	Data Above the Method Detection Limit (MDL)	**Number of Parameters Measured**	**Length of Trend Record**	**Measured Concentrations**	**Deviation from NAAQS**	**Wind Rose Analyses**	**Correlation Analyses**	**Area-Served**	**Population Density/ Population Served/ Population Change**	**Emissions Served**
Which sites provide the most value in terms of the number of pollutants measured, the length of data record, and data quality?	X	X	X							
Are sites appropriately located to determine the highest pollutant concentrations expected to occur in the area covered by the network?				X	X			X	X	
Are sites appropriately located to measure typical pollutant concentrations in areas of high population density?		X						X	X	
Are sites appropriately located to determine the impact of significant sources or source categories on air quality?										X
Are sites appropriately located to determine general background concentration levels?				X				X	X	X
Are sites appropriately located to determine the extent of regional pollutant transport among populated areas?				X				X	X	
Are sites appropriately located to measure air pollution impacts on visibility, vegetation damage, or other welfare-based impacts and to support secondary standards?								X		
Are there potentially redundant sites in the network?							X	X	X	
Are there areas where new sites may be needed?								X	X	X
Is the meteorological network adequate for characterizing regional surface and upper-air meteorology?		X				X	X			

A network assessment comprises several analysis methods that address specific objectives. The remainder of this section presents a discussion of the technical approach and findings for the site-by-site and bottom-up analyses for the criteria pollutant network.

2.1 TECHNICAL APPROACH AND FINDINGS FOR THE AIR MONITORING NETWORK ASSESSMENT FOR CRITERIA POLLUTANTS

This section contains a description of the technical approach and discussion of criteria pollutant monitoring network analyses. The site-by-site analyses focus on assessing individual sites within the network and include a determination of the number of parameters monitored; the fraction of data reported; the fraction of data above the method detection limit (MDL); the measured concentrations; the deviation from NAAQS; and the length of trend record at each site. While sites operated by both the District and CARB were included in the site-by-site analyses, comments and recommendations were focused on only those sites operated by the District since the District has direct jurisdiction and the authority to implement site-specific recommendations.

2.1.1 Data Sources

The following data (and sources) were acquired and used to perform the air monitoring network assessment:

- **Air quality data:** Air quality data for 2018 was acquired from EPA's Air Quality System (AQS) (https://aqs.epa.gov/aqs/). The analyses in this report are based on monitored data from the year 2018 only.

- **Population data:** Spatially resolved population data (block-group polygons) were acquired from the U.S. Census Bureau for the SJV for 2010. Block-groups where converted to 1 km grid cells within a geographic information system (GIS). Since block-groups change for each decadal census, this normalization allowed population trends to be evaluated.

- **Emission Inventory data:** The most recent annual average gridded emissions inventory was acquired from CARB for 2020.

2.1.2 Number of Parameters Monitored

Air quality monitoring sites with instruments that measure many pollutants and meteorological parameters are generally more valuable than sites that measure fewer parameters, assuming that the data collected are of high or similar quality.

In addition, sites that measure several pollutants are generally more cost effective to operate. The District assessed and ranked each air quality and meteorological site by the number of parameters collected at each site. Figure 2-1 shows the number of parameters monitored. The height of each bar represents the total number of parameters monitored at that site. The parameters monitored at the PAMS and toxic sites are not individually counted in the chart below. Sites are ordered from left to right along the x-axis corresponding to their north to south geographic locations in the SJV. The PAMS sites (Madera-Pump Yard, Clovis-Villa, Parlier, Bakersfield-Muni, and Shafter) are valuable sites because they measure the most parameters. Stockton-Hazelton, Fresno-Garland, and Bakersfield-California are important sites for criteria pollutants because they measure several parameters.

Figure 2-1 Summary of the Parameters Measured at each Air Monitoring Site

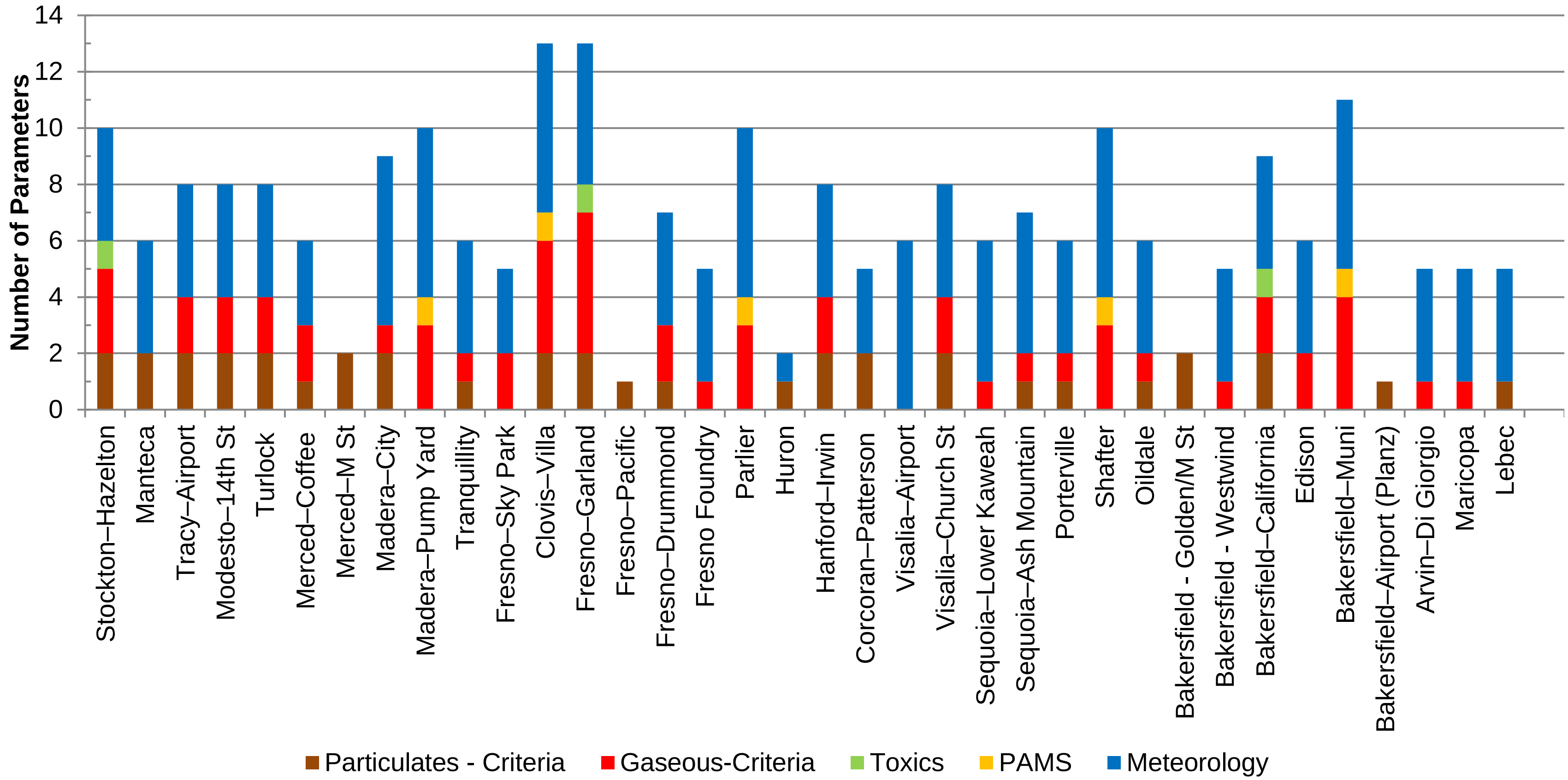
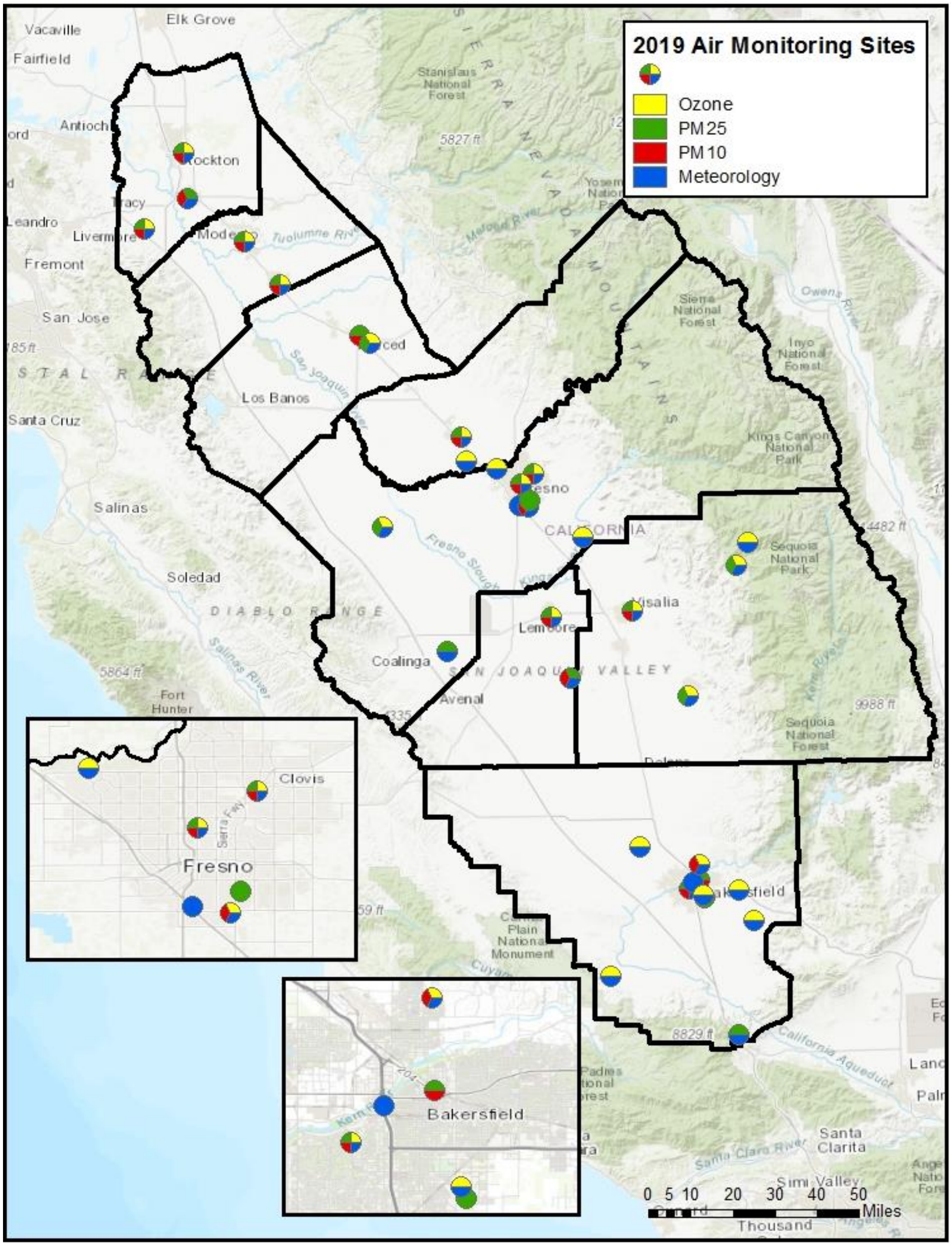


Figure 2-2 depicts the location of each monitor and the associated criteria pollutants measured (tribal monitors are not shown). Proper network analyses rely on the location of these monitoring sites relative to other monitors, nearby cities, influential geographic features, surrounding population, and meteorology.

Figure 2-2 San Joaquin Valley Air Monitoring Sites



2.1.3 Data Completeness, Data Above MDL, Measured Concentrations, and Deviation from NAAQS Analyses

This section discusses the approach and results of several site-by-site analyses including data completeness, percent above the MDL, measured concentrations, and the deviation from the NAAQS.

Data Completeness

Sites with complete data sets are more valuable for air quality analysis and tracking than sites that have long periods of missing or invalidated data. Data completeness is a measure of the number of actual data records collected and reported at a monitoring site relative to the number of expected data records based on the sampling interval and frequency for a given parameter or pollutant. Data completeness is calculated by dividing the actual number of data records reported by the expected number of data records. The expected number of data records for a given pollutant is based on the length of monitoring season and the sampling frequency. For example, a continuous ozone monitor operating year-round would be expected to have 8,760 data records for one year of operation (1 measurement per hour x 24 hours x 365 days per year = 8,760).

Data completeness is presented as the percent of data records reported taking into account the sampling frequency. Generally, EPA recommends that data completeness of 75% is considered good for a given site, indicating that there are enough data to perform robust data analyses assuming the data are of high quality. See the appendices of 40 CFR Part 50 for completeness requirements for specific criteria pollutants. Because of instrument calibration, data completeness will generally be 95-97% depending on how frequently an instrument is calibrated.

The Fresno-Foundry and Bakersfield–Westwind near-road NO2 sites are new stations that recently started reporting data. Fresno-Foundry started reporting NO2 data during January 2016, and added CO and PM2.5 during January 2020. Bakersfield-Westwind started sampling NO2 during January 2020. Although they are shown on the maps, not enough data is available to analyze these sites in this document.

Percent Above the MDL

The MDL is a value at which a measured concentration is considered statistically distinguishable from zero. An assessment of the percent of data above the MDL is performed to identify the number of samples in a data set that are considered to have concentration values statistically distinguishable from zero. While samples below the MDL can be used for some purposes, such as stating that a concentration is below the MDL for comparison to NAAQS, they are not as useful for quantifying ambient concentrations, trends analysis, and/or air quality model validation. The percent above the MDL analysis provides an indicator of data quality and the usefulness of the data collected for performing air quality analyses.

Measured Concentrations

Measured concentrations analysis identifies sites that consistently measure high pollutant concentrations. For this analysis, the average and maximum concentration values were examined. Results of this analysis were used to determine whether each site is meeting its objective(s). For example, if the objective of a particular site is to measure high pollutant concentrations but that site routinely measures low concentrations, then we may conclude that the objective of the site should be changed or the site should be relocated to an area of high pollutant concentrations in order to meet its objective.

Deviation from NAAQS

The deviation from NAAQS analysis indicates sites that are important for monitoring NAAQS compliance. This analysis was not designed to determine attainment status, but rather to provide an estimate of whether concentrations observed at a particular site are close to the NAAQS. Sites routinely measuring concentration values close to the NAAQS are considered important for meeting the monitoring objective of determining NAAQS attainment. The deviation from the NAAQS is the difference between the pollutant-specific design value observed at the site and the NAAQS compliance value (e.g., 1-hr, 8-hr, 4th highest maximum value, etc.). Small changes in measured pollutant concentrations can result in values above or below the NAAQS. In some cases, when information to determine the design value was not available, comparisons of the annual average or maximum pollutant concentrations were made. The deviation from NAAQS calculations presented here are not meant to be attainment calculations but general comparisons against the NAAQS to identify sites having measured values near (within 15% of) the NAAQS.

Summary and Discussion of Results

Tables 2-2 through 2-10 include a summary and discussion of the results of the analyses for data completeness, percent above MDL, measured concentrations, and deviation from NAAQS for sulfur dioxide, ozone, nitrogen dioxide, PM10, PM2.5, and carbon monoxide for all sites in the SJV.

In Tables 2-2 through 2-10, the cells shaded:

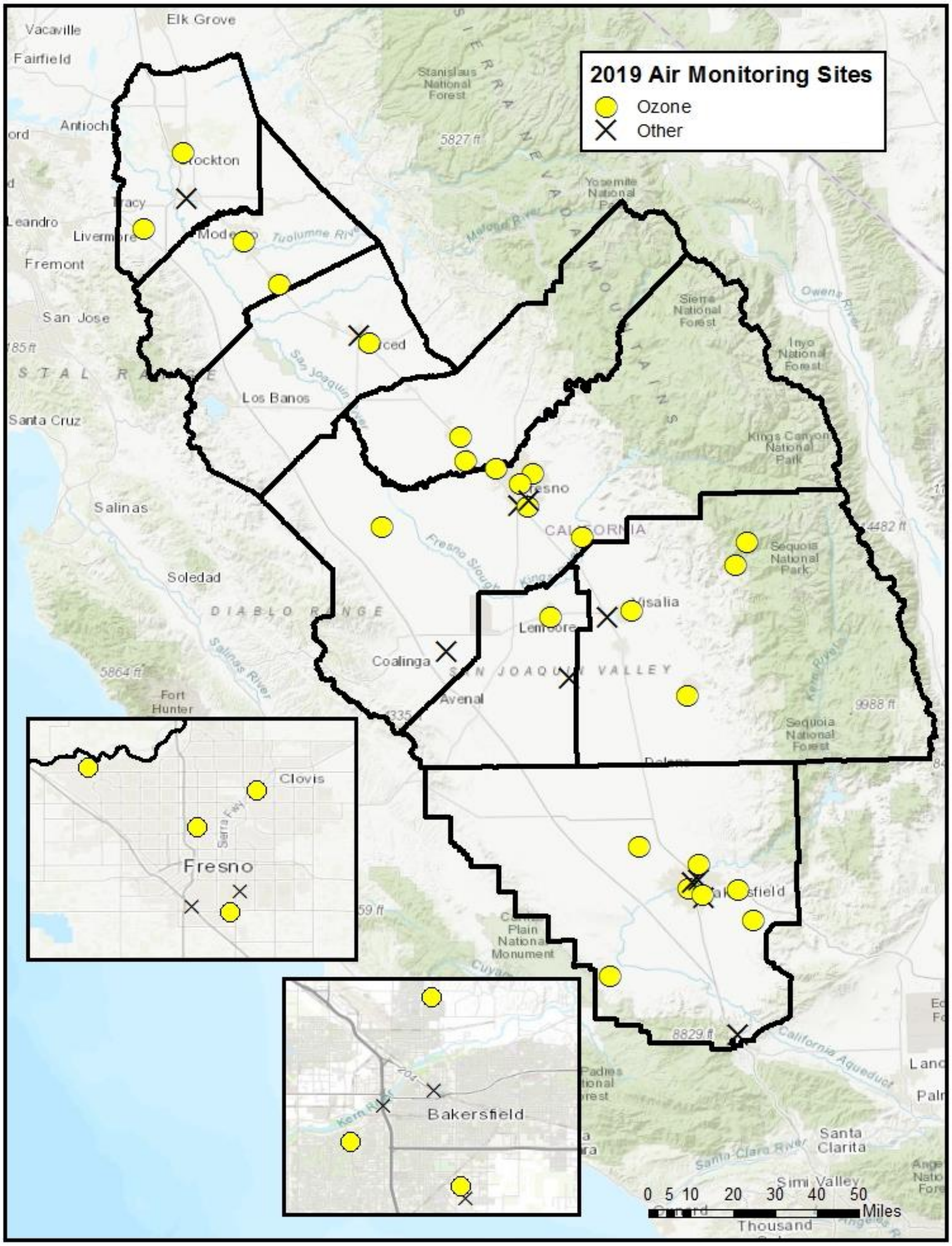
- Green: Percent complete – green shading indicates sites with a percent complete value less than 85%
- Orange: Percent above MDL – orange shading indicates sites with a percent above MDL value less than 85%
- Blue: Deviation from NAAQS – blue shading indicates sites with a deviation from NAAQS value that is within 15% of the NAAQS for the pollutant indicated.

2.1.3.1 Ozone (O3)

Figure 2-3 shows the ozone monitoring network across the San Joaquin Valley. Overall, the percent above MDL results are good. Several sites indicated in orange in Table 2-2 have percent above MDL values that are less than 85%; however, most of those values are greater than 80%, with the exception of

Fresno-Drummond at 79% and Stockton-Hazelton at 77%. The low values at the Fresno Drummond site are worth noting because this site is in an urban area. Urban sites may measure chemically titrated ozone concentrations, which could account for the lower percent above MDL values.

Figure 2-3 Location of Ozone Monitoring Sites in the San Joaquin Valley



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM), gas, and/or meteorology.

Table 2-2 Percent Above MDL and Maximum Concentrations Analyses for 1-Hr Ozone Data

Site Name	% Above MDL	Maximum Value
Stockton-Hazelton	77	88
Tracy-Airport	93	99
Modesto-14th St	85	103
Turlock	80	108
Merced-Coffee	85	104
Madera-City	87	97
Madera-Pump Yard	83	90
Tranquillity	92	88
Fresno-Sierra Sky Park	88	100
Clovis-Villa	82	121
Fresno-First	80	121
Fresno-Drummond	79	119
Parlier	87	129
Hanford-Irwin	80	108
Visalia-Church St	86	112
Sequoia-Lower Kaweah	96	105
Sequoia-Ash Mountain	98	101
Porterville	90	93
Shafter	84	98
Oildale	93	113
Bakersfield-California	82	107
Edison	93	120
Bakersfield-Muni	81	111
Arvin-Di Giorgio	93	113
Maricopa	95	98

Table reflects data for 2018.
Concentration data are reported in units of ppb.
Ozone MDL = 5 ppb.
Cells shaded in orange in the % Above MDL column indicate sites with fewer than 85% of data reported above the MDL.
Maximum value equals the 1-hr annual maximum.

The deviation from NAAQS analysis for 8-hour average ozone in Table 2-3 indicates that Stockton-Hazelton, Tracy-Airport, Modesto-14th St, Merced-Coffee, Madera-Pump Yard, and Tranquillity are particularly important sites for determining NAAQS attainment because they measure concentration values that are close to (within 15%) the 8-hr ozone NAAQS. At Stockton-Hazleton, the 3-yr averages of the 4th highest 8-hr daily maximum ozone measured concentrations were below the NAAQS.

Table 2-3 Summary of Data Completeness, Measured Concentrations, and Deviation from NAAQS Analyses for 8-Hr Average Ozone Data

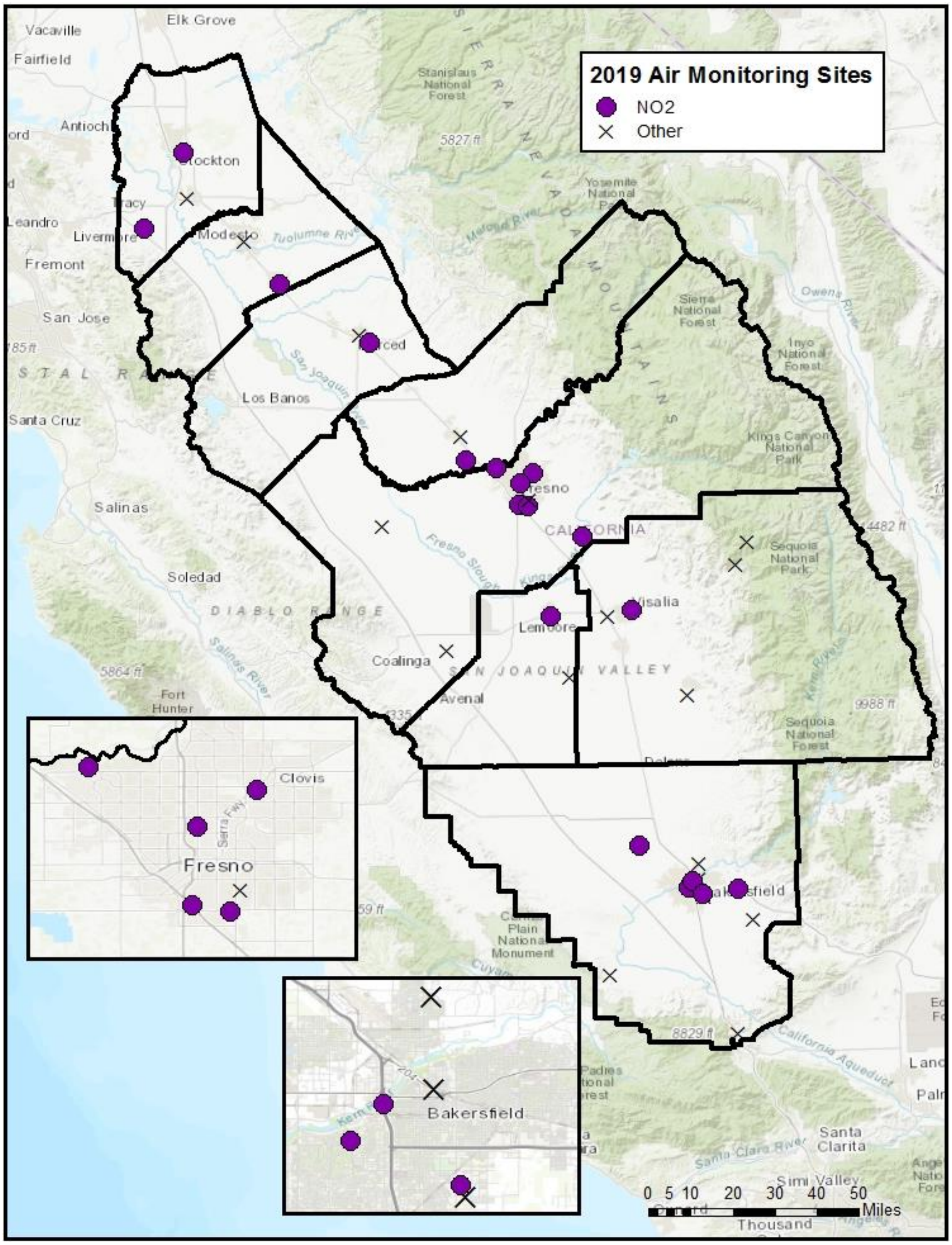
Site Name	% Complete	Maximum Value	Design Value 2016-2018	Deviation From NAAQS
Stockton-Hazelton	94	77	66	-4
Tracy-Airport	95	81	76	+6
Modesto14thSt	95	91	80	+10
Turlock	94	95	84	+14
Merced-Coffee	95	83	79	+9
Madera-City	95	82	81	+11
Madera-Pump Yard	94	78	78	+8
Tranquillity	94	83	75	+5
Fresno-Sierra Sky Park	94	87	83	+13
Clovis-Villa	94	94	89	+19
Fresno-Garland	95	99	90	+20
Fresno-Drummond	95	97	86	+16
Parlier	94	98	88	+18
Hanford-Irwin	94	82	82	+12
Visalia-Church St	95	94	85	+15
Sequoia-Lower Kaweah*	96	95	86	+16
Sequoia-Ash Mountain	95	91	89	+19
Porterville	95	85	83	+13
Shafter	95	90	81	+11
Oildale	95	97	82	+12
Bakersfield-California	95	98	88	+18
Edison	95	101	89	+19
Bakersfield-Muni	90	98	88	+18
Arvin-Di Giorgio	92	100	89	+19
Maricopa	94	92	85	+15

*Sequoia-Lower Kaweah only runs during summer months. Data completeness calculated for April – October.
Table reflects data for 2018.
Concentration data are reported in units of ppb.
Maximum value equals the 8-hr average annual maximum.
Design Value 2016-2018: Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years.
The deviation from the NAAQS is the difference between the pollutant-specific design value observed at the site and the NAAQS 8-hour average compliance value of 70 ppb.
Cells shaded in blue in the Deviation from NAAQS column indicate sites that are valuable for determining NAAQS attainment (+/-15%)

2.1.3.2 Nitrogen Dioxide (NO2)

Figure 2-4 shows the location of the NO2 sites in the San Joaquin Valley, including the Fresno-Foundry and Bakersfield-Westwind near-road NO2 sites. Although the near-road NO2 sites are shown on the maps, not enough data is available for Bakersfield-Westwind to do the analysis. The NO2 analysis of the NO2 sites in Table 2-4 shows high percent above MDL values. The “Deviation from 1-hr NAAQS” values are the difference between the pollutant-specific 1-hr design value (which is the 98th percentile averaged over a three year period), and the 1-hr NAAQS of 100 ppb. The “Deviation from Annual NAAQS” values are the difference between the pollutant-specific annual design value (which is the annual mean averaged over a three year period) and the annual NAAQS of 53 ppb. Sites are considered valuable for determining NAAQS compliance for both the 1-hr and annual NAAQS if the Deviation from NAAQS values are ±15% form the NAAQS. There are no sites in this range in Table 2-4. The data and analyses for the 1-hr and Annual NAAQS in Table 2-4 indicate that both the 1-hr and annual mean NO2 concentrations are well below the standard at all sites.

Figure 2-4 Location of NO2 Monitoring Sites in the San Joaquin Valley



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM), gas, and/or meteorology.

Table 2-4 Summary of 2018 Data Completeness, Percent above MDL, Measured Concentrations, and Deviation from NAAQS Analyses for NO2

Site Name	% Complete	% Above MDL	2018 Max Value (ppb)	1-hr Design Value 2016-2018 (ppb)	Deviation from 1-hr NAAQS (ppb)	2018 Annual Mean (ppb)	Deviation from Annual NAAQS (ppb)
Stockton-Hazelton	93	95	65.3	52	-48	12	-41
Tracy-Airport	95	95	48.8	30	-70	6	-47
Turlock	95	95	67.2	45	-55	10	-43
Merced- Coffee	95	95	45.8	34	-66	7	-46
Madera-Pump Yard	94	91	46.5	30	-70	6	-47
Fresno-Sierra Sky Park	94	94	43.3	33	-67	8	-45
Clovis-Villa	93	93	64.5	49	-51	10	-43
Fresno-Garland	96	96	68.1	51	-49	11	-42
Fresno-Foundry	88	100	61.3	57	-43	21	-32
Fresno-Drummond	91	93	75.9	56	-44	14	-39
Parlier	94	94	48	31	-69	8	-45
Hanford-Irwin	94	94	56.3	45	-55	9	-44
Visalia-Church St	92	95	69.2	51	-49	11	-42
Shafter	92	95	47.5	38	-62	10	-43
Bakersfield-California	94	95	61.5	53	-47	13	-40
Edison	86	95	42	28	-73	7	-46
Bakersfield-Muni	90	94	57.1	49	-51	11	-42

Nitrogen dioxide MDL = 1 ppb for the monitors operating in the District.
Maximum value equals the 1-hr annual maximum concentration.
The 2016-2018 1-hr design value is the annual 98th percentile of the daily maximum 1-hour concentration values, averaged over three consecutive years.
The 2018 Annual Mean Average is the annual average of the hourly concentration values to be comparable to the annual NAAQS.

2.1.3.2.1 Near-Road NO2 Sites

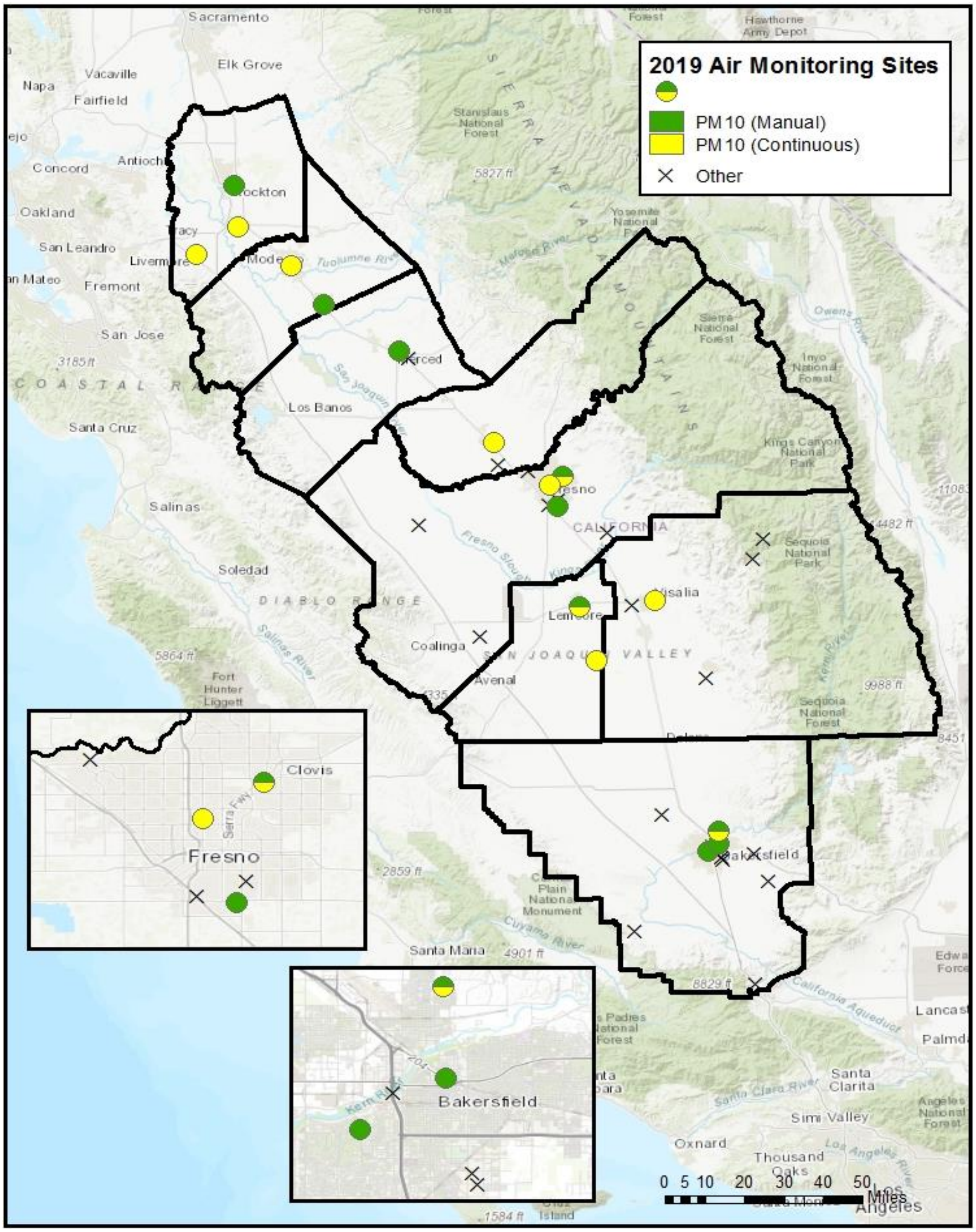
Per Section 4 of Appendix D in 40 CFR Part 58, one microscale near-road NO2 monitor is required in each CBSA with a population of 1,000,000 or more and must be located near a major road segment with a high annual average daily truck traffic (AADTT) count. An additional near-road NO2 monitor is required in CBSAs with populations of 2,500,000 or more or in CBSAs with populations of 1,000,000 or more that have one or more road segments with 250,000 or more AADTT counts.

Currently, Fresno is the only CBSA within the District that is comprised of more than 1,000,000 people, and as such, an NO2 monitor has been established and is operating in Fresno CBSA at the Fresno-Foundry near-road NO2 monitoring station. The District has also established the Bakersfield-Westwind near-road NO2 monitoring station in the Bakersfield CBSA, which is nearing a population of 1,000,000. Neither CBSA requires a second near-road NO2 monitor.

2.1.3.3 Particulate Matter (PM10)

Figure 2-5 shows the PM10 Manual and Continuous monitoring sites in the San Joaquin Valley. The summary of Manual (FRM) PM10 monitoring data in Table 2-5 indicates that data completeness and percent above MDL are very good. Cells shaded in orange in the "% above MDL" column indicate sites that are below 85% MDL. The "Deviation from the NAAQS" is the difference between the pollutant-specific Max 24-hour observed at the site and the 24-hour average NAAQS value of 150 μg/m^3. Cells shaded in blue in the "Deviation from NAAQS" column indicate sites that are valuable for determining NAAQS compliance (± 15%). A couple of sites indicated in orange in Table 2-5 have percent above MDL values that are less than 85%; however, most of those values are greater than 80%, with the exception of Clovis-Villa at 79%. The highest observed maximum concentration of FRM PM10 occurred at Turlock; which indicates that it the most valuable site for determining NAAQS compliance. Note that the values found in Table 2-5 include all data for the year 2018, including values influenced by exceptional events such as high-wind events and wildfires.

Figure 2-5 Location of PM10 Monitoring Sites in the San Joaquin Valley



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM2.5), gas, and/or meteorology.

Table 2-5 Summary of Results of 2018 Data Completeness, Percent Above MDL, Measured Concentrations, and Deviation from NAAQS Analyses for Federal Reference Method Manual (FRM) PM10 Measurements

Site Name	% Complete	% Above MDL	Maximum Measured Value (µg/m³)	Value for NAAQS Comparison (µg/m³)	Deviation from NAAQS (µg/m³)
Stockton-Hazleton	97	100	187	190	+40
Modesto-14th St	93	97	224	220	+70
Turlock	98	100	238	240	+80
Merced-M St	100	100	137	140	-10
Clovis-Villa	92	79	119	120	-30
Fresno-Drummond	100	100	149	150	0
Hanford-Irwin	98	83	188	190	+40
Visalia-Church St	99	99	153	150	0
Oildale	96	98	174	170	+20
Bakersfield-California	92	100	136	140	-10

PM10 MDL= 2 µg/m³ for 24-hr FRM monitors.
Some values in this table may be due to exceptional weather conditions (high winds or wildfires).
The District has submitted a 2018 24-Hour PM10 Exceptional Events Initial Notification Form to EPA.
The "Deviation from NAAQS" value is the difference between the "Value for NAAQS Comparison" and 150 µg/m³
Cells shaded in orange in the % Above MDL column indicate sites with fewer than 85% of data reported above the MDL.
Cells shaded in blue in the Deviation from NAAQS column indicate sites that are valuable for determining NAAQS attainment (+/-15%)

The summary of continuous PM10 monitoring data in Table 2-6 indicates that data completeness and percent above MDL are very good. The "Deviation from the NAAQS" in Table 2-6 is the difference between the pollutant-specific maximum value observed at the site and the 24-hour average NAAQS concentration of 150 µg/m³. Cells shaded in blue in the "Deviation from NAAQS" column indicate sites that are valuable for determining NAAQS compliance (±15%). Cells shaded in orange in the "% above MDL" column indicate sites that are below 85% MDL. The daily maximum 24-hr calculated PM10 concentration is highest at Tracy-Airport, and this site is the most valuable for determining NAAQS compliance. Note that the values found in Table 2-6 include all data for the year 2018, including values influenced by exceptional events such as high-wind events and wildfires.

Table 2-6 Summary of 2018 Data Completeness, Measured Concentrations, and Deviation from NAAQS Analyses for Continuous (1-Hr) PM10

Site Name	% Complete	% Above MDL	Mean Value (µg/m³)	Maximum Measured Value (µg/m³)	Value for NAAQS Comparison (µg/m³)	Deviation from NAAQS (µg/m³)
Manteca	93	100	31.8	223	220	+70
Tracy-Airport	99	99	24.7	249	250	+100
Modesto-14th St	93	95	31.8	224	220	+70
Madera-City	95	97	41.2	159	160	+10
Fresno-Garland	98	97	39.7	129	130	-20
Hanford-Irwin	90	84	53.0	188	190	+40
Corcoran-Patterson	97	98	54.6	221	220	+70

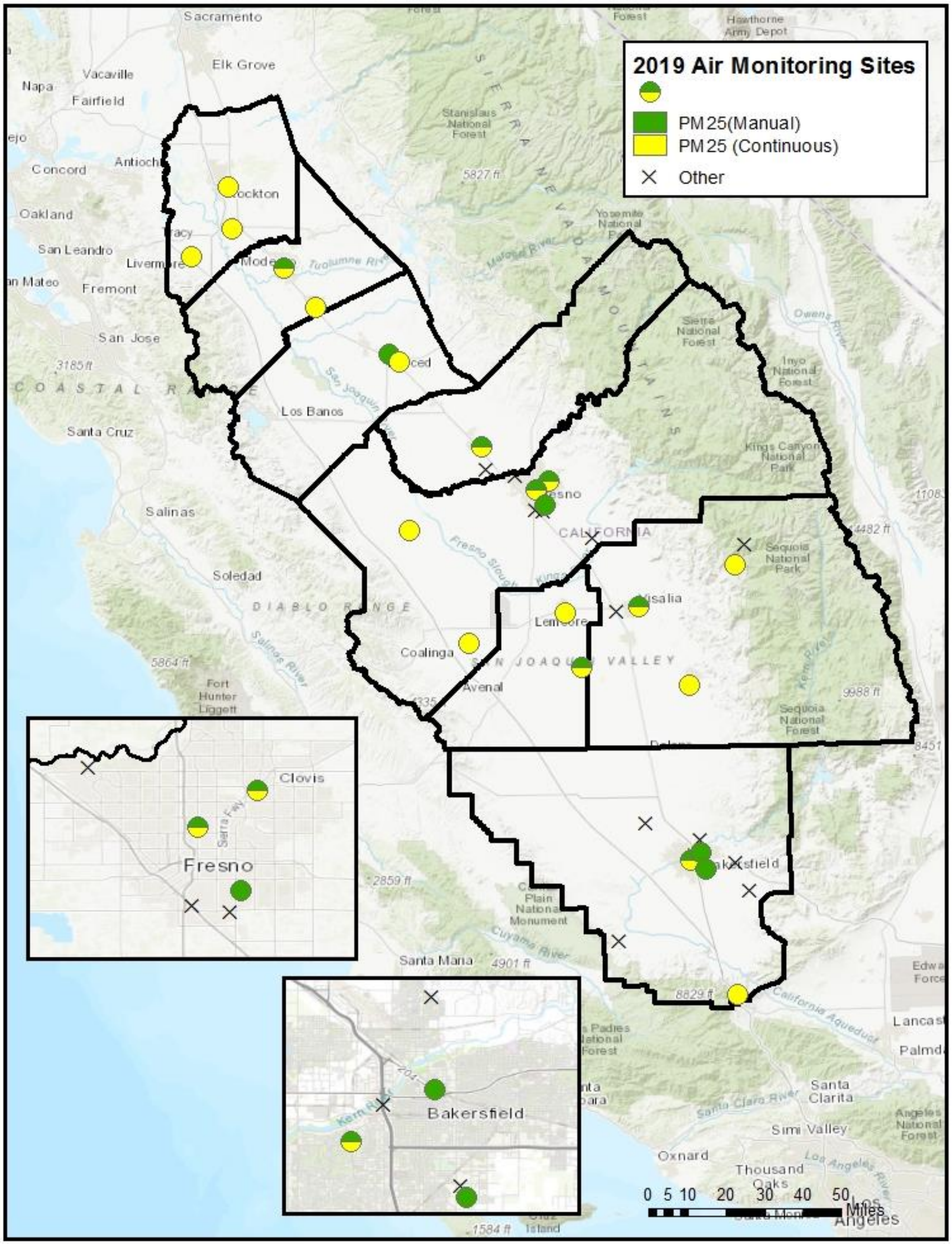
PM10 MDL for Teledyne 602 instrument = -50 µg/m3 for Manteca, Tracy-Airport, Madera-City, Hanford-Irwin, and Corcoran-Patterson.
PM10 MDL for TEOM instrument = 4 µg/m3 for Modesto 14th St, and Fresno-Garland.
Maximum value equals the 24-hr maximum value calculated from 1-hr data.
Some values in this table may be due to exceptional weather conditions (high winds or wildfires).
The District has submitted a 2018 24-Hour PM10 Exceptional Events Initial Notification Form to EPA.
Cells shaded in orange in the % Above MDL column indicate sites with fewer than 85% of data reported above the MDL.
Cells shaded in blue in the Deviation from NAAQS column indicate sites valuable for determining NAAQS attainment (+/-15%)

2.1.3.4 Particulate Matter (PM2.5)

Figure 2-6 shows continuous and manual PM2.5 monitors throughout the San Joaquin Valley. Tables 2-7 and 2-8 report site-by-site “Deviation from the NAAQS,” which is the difference between the pollutant-specific design value observed at the site and the annual average NAAQS of 12.0 µg/m^3 and 24-hour average NAAQS of 35 µg/m^3. Table 2-7 reports that all FRM PM2.5 24-hr filter sites demonstrated good data completeness and percent above MDL except for Bakersfield-Airport (Planz). The measured concentrations and deviation from NAAQS analyses indicate that the concentrations are higher than the 24-hour and annual standard at all sites. The Modesto-14th St., Merced-M St., and Clovis-Villa sites are valuable sites for determining NAAQS attainment.

Analysis of continuous measurement PM2.5 is reported in Table 2-8. All sites show good data completeness. Cells shaded in green in the “% Complete” column indicate sites with fewer than 85% of data reported as complete. Cells shaded in blue in the “Deviation from NAAQS” column indicate sites that are valuable for determining NAAQS attainment (± 15%). The measured concentrations and deviation from NAAQS analyses indicate that annual concentrations are higher than the standard at all sites with the exception of Manteca and Tranquillity, which are below the standard. Stockton-Hazleton, Manteca, Modesto-14th St., Merced-Coffee, Madera-City, and Clovis-Villa sites appear to be the most valuable for determining NAAQS attainment; however, note that the Deviation from NAAQS analysis is not meant to determine NAAQS compliance but to identify those sites that routinely measure concentrations close to the NAAQS. Note that the values found in Table 2-7 include all data for the year 2018, including values influenced by exceptional events such as high-wind events and wildfires.

Figure 2-6 Location of PM2.5 Monitoring Sites in the San Joaquin Valley



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM10), gas, and/or meteorology.

Table 2-7 Summary of 2018 Data Completeness, Percent above MDL, Measured Concentrations, and Deviation from NAAQS Analyses for FRM PM2.5 Measurements

Site Name	% Complete	% Above MDL	Maximum Value (µg/m^3)	24- Hour Design Value 2016-2018 (µg/m^3)	Deviation from 24-hr NAAQS (µg/m^3)	Annual Mean Design Value 2016-2018 (µg/m^3)	Deviation from Annual NAAQS (µg/m^3)
Modesto-14th St	97	98.7	224	63	+28	13.1	+1.1
Merced-M St	98	100	137	43	+8	12.7	+0.7
Clovis-Villa	97	99.1	119	50	+15	13.5	+1.5
Fresno-Garland	90	97.2	129	58	+23	14.6	+2.6
Fresno-Pacific	97	99.2	89.8	60	+25	15.0	+3.0
Corcoran-Patterson	96	99.8	221	65	+30	16.0	+4.0
Visalia-Church St	89	99.1	153	60	+25	16.1	+4.1
Bakersfield-California	86	99.7	136	63	+28	16.1	+4.1
Bakersfield-Airport (Planz)	82	100	100.9	60	+25	17.8	+5.8

Table reflects data for 2016-2018.
PM2.5 MDL = 2 µg/m3 for 24-hr. filter-based monitors that are operating in the District.
Maximum value equals the maximum daily average value.
Design Value: annual mean, averaged over 3 years (2016-2018) At sites where FRM/FEM data is present, data was combined according to 40 CFR Part 50, Appendix N.
Deviation from NAAQS column only shows sites that have an FRM monitor.
Some values in this table may be due to exceptional weather conditions (high winds or wildfires). The District has submitted a 2017, 2018 Annual and 24 Hour PM2.5 Exceptional Events Initial Notification Form to EPA.
Cells shaded in blue in the Deviation from NAAQS column indicate sites that are valuable for determining NAAQS attainment (+/-15%)
Cells shaded in green indicate sites with a percent complete value less than 85%

Table 2-8 Summary of 2018 Data Completeness, Percent above MDL, Measured Concentrations, and Deviation from NAAQS Analyses for 1-Hr Continuous PM2.5 Measurements

Site Name	% Complete	% Above MDL	Maximum Value (µg/m³)	Annual Mean (µg/m³)	24-Hr Design Value 2016-2018 (µg/m³)	Deviation from 24-hr NAAQS (µg/m³)	Annual Mean Design Value 2016-2018 (µg/m³)	Deviation from Annual NAAQS (µg/m³)
Stockton-Hazelton	99	100	305.0	16.5	56	+21	13.8	+1.8
Manteca	93	99.7	262.6	13.4	54	+19	11.5	-0.5
Modesto-14th St	98	98.9	317.0	15.2	63	+28	13.1	+1.1
Turlock	97	99.2	354.0	17.3	58	+23	14.2	+2.2
Merced-Coffee	98	98.6	140.0	15.2	43	+8	13.4	+1.4
Madera-City	94	99.5	143.3	14.1	44	+9	12.7	+0.7
Clovis-Villa	95	99.1	127.0	14.3	50	+15	13.5	+1.5
Fresno-Garland	97	97.3	142.4	14.9	58	+23	14.6	+2.6
Tranquillity	99	98.3	243.0	11.2	38	+3	9.1	-2.9
Hanford-Irwin	90	99.7	136.2	17.7	63	+28	16.8	+4.8

Non-Regulatory Sites	% Complete	% Above MDL	Maximum Value (µg/m³)	Annual Mean (µg/m³)
Tracy-Airport	95	96.0	458.0	12.3
Huron	97	96.3	127.0	10.3
Porterville	98	99.2	211.0	16.5
Sequoia-Ash Mountain	41	100	147.2	13.8
Lebec	90	89.8	85.0	7.4

Modesto-14th St, Fresno-Garland, Visalia-Church St, and Bakersfield-California real-time non-FEM PM2.5 monitors not included in table above.
PM2.5 MDL = 2 µg/m³ for 1-hr continuous monitors that are operating in the District, except Sequoia-Ash Mountain monitor's MDL is -10 µg/m³.
Deviation from NAAQS column only shows sites that have an FEM monitor.
Some values in this table may be due to exceptional weather conditions (high winds or wildfires). The District has submitted a 2017, 2018 Annual and 24 Hour PM2.5 Exceptional Events Initial Notification form to EPA At sites where FRM/FEM data is present, data was combined according to 40 CFR Part 50, Appendix N.
Annual Design Value 2016-2018: annual mean, averaged over 3 years. 24 Hour Design Value 2016-2018: 98th percentile, averaged over 3 years.
At sites where FRM/FEM data is present, data was combined according to 40 CFR Part 50, Appendix N
Cells shaded in blue in the Deviation from NAAQS column indicate sites that are valuable for determining NAAQS attainment (+/-15%)
Cells shaded in green indicate sites with a percent complete value less than 85%
.

2.1.3.4.1 Near-Road Sites (PM2.5)

Per Section 4 of Appendix D in 40 CFR Part 58, CBSAs with a population of 1,000,000 or more persons are required to have at least one PM2.5 monitor collocated at a near-road NO_2 station. Currently, Fresno is the only CBSA within the District that is comprised of more than 1,000,000 people. As such, the Fresno-Foundry near-road NO_2 monitoring station began PM2.5 monitoring January 1, 2020. There is currently not enough PM2.5 data collected to begin analysis for the Fresno-Foundry near-road NO_2 station. PM2.5 monitoring has not yet begun at the Bakersfield-Westwind near-road NO_2 monitoring station since the Bakersfield CBSA has not yet reached a population of 1,000,000 people. The District plans to begin PM2.5 monitoring at the Bakersfield-Westwind near-road site when the Bakersfield CBSA exceeds 1,000,000 people.

2.1.3.5 Carbon Monoxide (CO)

Monitoring requirements for CO are specified in 40 CFR Part 58 as follows:

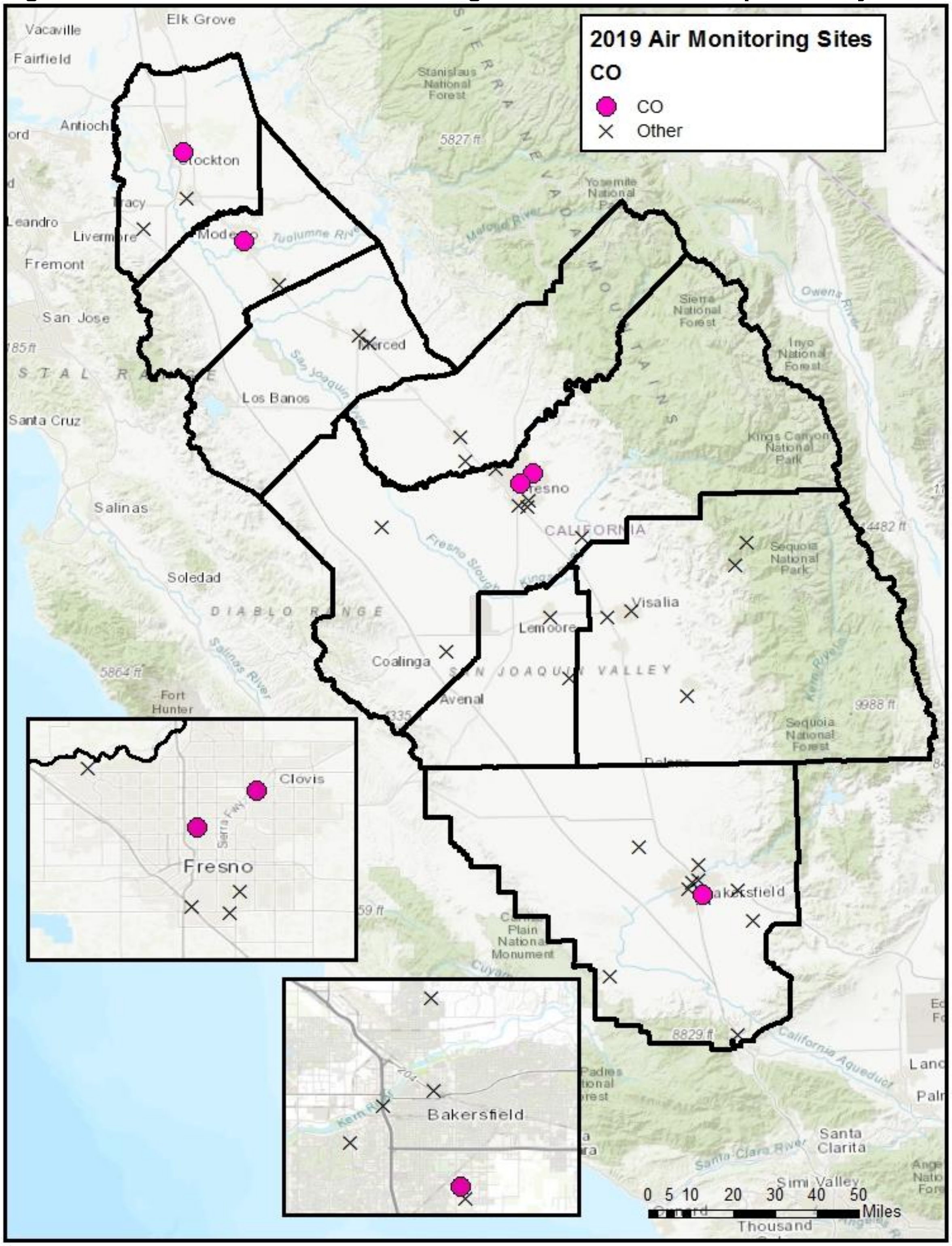
- CO monitors are required at all NCore sites. At least one NCore site is required in every state.
- One CO monitor is required to be placed at a near–road NO_2 monitoring station in a Core-Based Statistical Area (CBSA) with population of 1,000,000 or more. Moving an existing monitor to a new location is acceptable.
- EPA is providing authority to EPA Regional Administrators to require additional monitoring in case–by–case circumstances, such as in areas impacted by major stationary CO sources, in urban downtown areas, or urban street canyons, or in areas adversely impacted by meteorological and/or topographical influences.
- CO must be monitored at PAMS Type 2 sites with a trace level CO monitor.

Currently, only Fresno is the CBSA within the District that is comprised of more than 1,000,000 people, thus the District is required to place a CO monitor at a near-road NO2 monitoring station. Monitoring has shown that the Valley's CO concentrations have not exceeded the NAAQS for over a decade. As noted in Section 4.2 of Appendix D of 40 CFR Part 58, there are no minimum requirements of the number of CO monitoring sites. The District and California Air Resources Board continue CO monitoring to meet the requirement at its PAMS Type 2 sites and NCore site.

Figure 2-7 shows the location of CO monitors in the San Joaquin Valley. San Joaquin County has a monitor located at the Stockton-Hazelton air monitoring site (AMS). Stanislaus County a CO monitor located at the Modesto-14th AMS. Fresno County has two CO monitors, one each at Clovis-Villa AMS (PAMS) and Fresno-Garland AMS (NCORE). Kern County has one CO monitor located at the Bakersfield-Muni AMS.

To support the findings, data completeness and deviation analyses were performed on all sites currently in operation. Table 2-9 demonstrates that data completeness and % above MDL for CO is good at all sites. The deviation from the NAAQS is the difference between the pollutant-specific maximum value observed at the site and the 8-hr average NAAQS value of 9 ppm.

Figure 2-7 Location of CO Monitoring Sites in the San Joaquin Valley



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM), gas, and/or meteorology.

Table 2-9 Summary of 2018 Data Completeness, Percent above MDL, Measured Concentrations, and Deviation from NAAQS Analyses for 8-Hr CO Measurements

Site Name	% Complete	% Above MDL	Maximum Value (ppm)	Deviation From NAAQS (ppm)
Stockton-Hazelton	89	95.7	3.1	-5.9
Modesto-14th St	93	94.4	2.8	-6.2
Clovis-Villa	94	98.4	1.6	-7.4
Fresno-Garland	96	100	2.2	-6.8
Bakersfield-Muni	89	99.4	2.0	-7.0

CO MDL = 0.11 ppm at Fresno-Garland; 0.5 ppm at Stockton-Hazelton and Modesto-14^{th}; 0 ppm at Clovis-Villa and Bakersfield-Muni
Maximum Value equals the 8-hr average maximum value at a site for 2018.

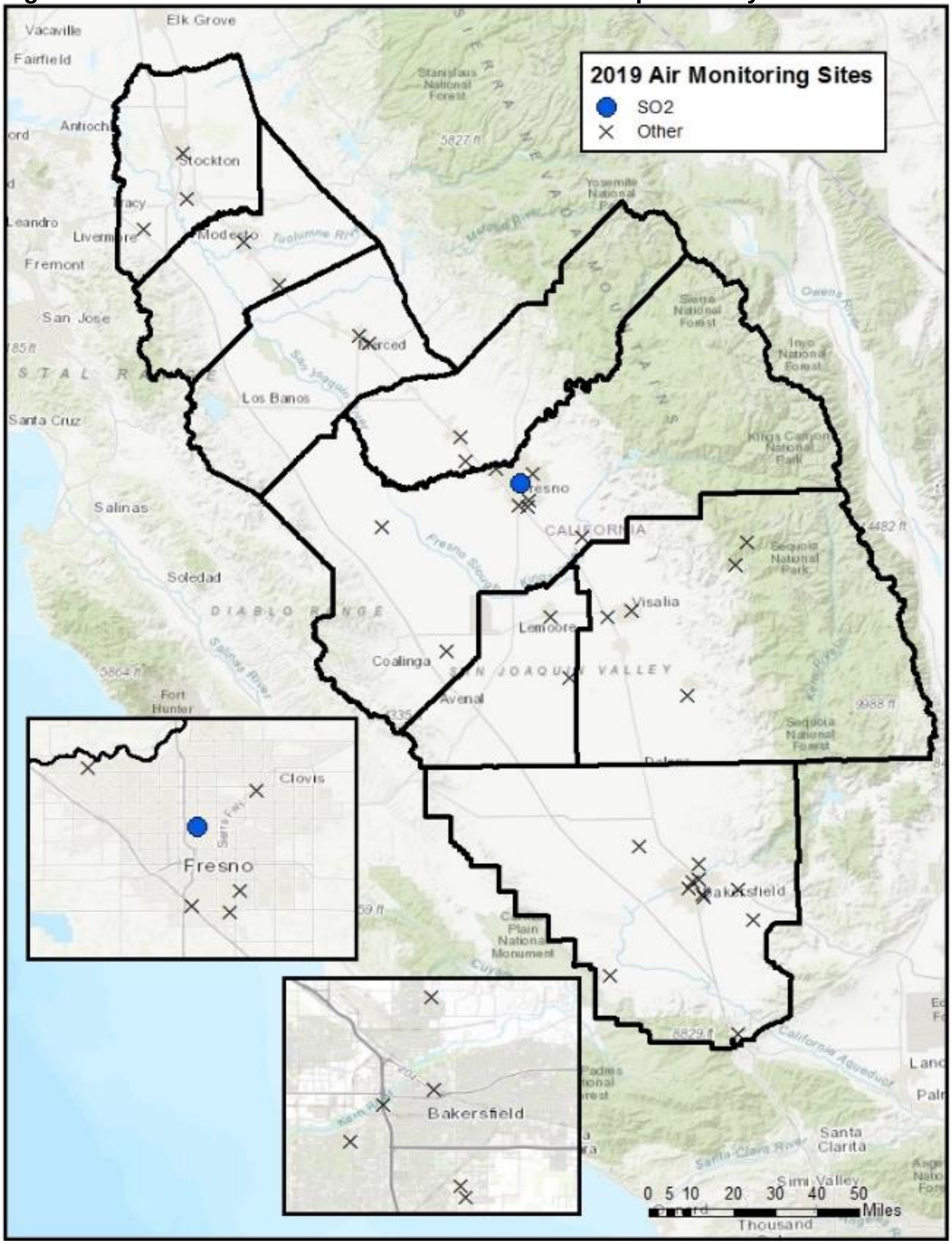
2.1.3.5.1 Near-Road Sites (CO)

Per Section 4 of Appendix D in 40 CFR Part 58, CBSAs with a population of 1,000,000 or more persons are required to have at least one CO monitor collocated at a near-road NO2 station. Currently, Fresno is the only CBSA within the District that is comprised of more than 1,000,000 people, and as such, the Fresno-Foundry near-road NO2 monitoring station has begun CO monitoring as of January 1, 2020. There is currently not enough CO data collected to begin analysis for the Fresno-Foundry near-road NO2 station. CO monitoring has not yet begun at the Bakersfield-Westwind near-road NO2 monitoring station since the Bakersfield CBSA has not yet reached a population of 1,000,000 people. The District plans to begin CO monitoring at the Bakersfield-Westwind near-road NO2 station when the Bakersfield CBSA exceeds 1,000,000 people.

2.1.3.6 Sulfur Dioxide (SO2)

Figures 2-8 show the location of the SO2 monitor at Fresno-Garland. Table 2-10 reports good data completeness and % above MDL for SO2 at the Fresno-Garland site. This is due to the low SO2 concentrations in the SJV relative to the NAAQS. Cell highlighted in blue in the “% above MDL” column indicate sites with fewer than 85% of data reported above the MDL. The “Deviation from the NAAQS” is the difference between the maximum value at the site and the 1-hour average NAAQS value of 75 ppb.

Figure 2-8 Location of SO2 Monitor in the San Joaquin Valley



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM), gas, and/or meteorology

Table 2-10 Summary of 2018 Data Completeness, Percent Above MDL, Measured Concentrations, and Deviation from NAAQS Analyses for 1-Hr SO2 Measurements

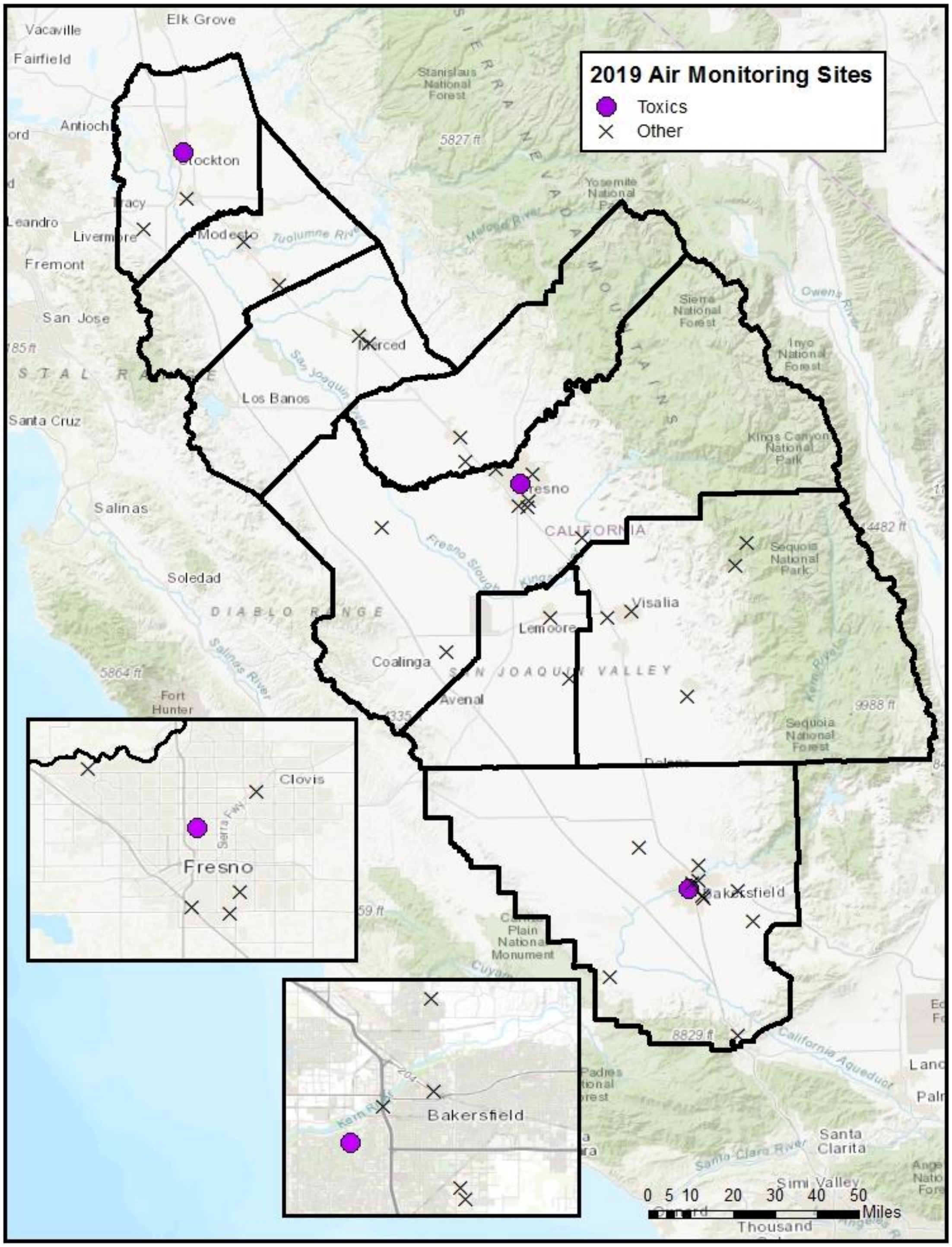
Site Name	% Complete	% Above MDL	Maximum Value (ppb)	Deviation From NAAQS (ppb)
Fresno-Garland	98	81.4	7.2	-67.8

SO2 MDL = 0.15 ppb for the monitors operating in the District.
Maximum value equals the 1-hr average maximum value at a site for 2018.
Cells shaded in orange in the % Above MDL column indicate sites with fewer than 85% of data reported above the MDL.
Maximum value equals the 1-hr annual maximum.

2.1.3.7 Toxics

Toxics monitoring in the SJV is conducted by the CARB at the sites of Stockton-Hazelton, Fresno-Garland, and Bakersfield-California. Figure 2-9 shows where the toxics monitoring sites are located in the San Joaquin Valley.

Figure 2-9 Location of Toxics Monitoring Sites in the San Joaquin Valley



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM), gas, and/or meteorology

2.1.4 Length of Trend Record Analysis

Monitors that have long historical data records are valuable for tracking pollutant trends and control strategy effectiveness. For the length of trend record analysis, the number of years of data collection was summed by site and pollutant. Table 2-11 shows the trend length by site and pollutant. Several sites in the San Joaquin Valley have long data records for multiple parameters. Most notably, the Stockton-Hazelton, Modesto-14th St., Turlock, Madera-Pump Yard, Fresno-Sierra Sky Park, Tranquillity, Clovis–Villa, Fresno-Garland, Fresno-Drummond, Parlier, Hanford-Irwin, Corcoran, Visalia-Church St., Shafter, and Bakersfield–California sites have been monitoring for more than a decade.

The numbers in Table 2-11 represent the number of years of data collected at each site. Sites with ten or more years of data are marked "10+" and highlighted green.

Table 2-11 Length of Monitoring Analysis (Number of Years) through 2019

Site Name	O_3	1-hr PM10	24-hr PM10	1-hr PM2.5	24-hr PM2.5	NO_2	CO	PAMS	Pb	SO_2	Met
Stockton-Hazelton	10+	0	10+	9	0	10+	6	0	0	0	10+
Tracy-Airport	10+	9	0	9*	0	9	0	0	0	0	9
Manteca	0	0	9	9	0	0	0	0	0	0	9
Modesto-14th St	10+	10+	10+	10+	10+	0	9	0	0	0	10+
Turlock	10+		8	8	0	10+	10+	0	0	0	10+
Merced-M St	0	0	10+	0	10+	0	0	0	0	0	0
Merced-Coffee	10+	0	0	10+	0	10+	0	0	0	0	10+
Madera-City	9	8	0	8	5	0	0	0	0	0	9
Madera-Pump Yard	10+	0	0	0	0	10+	0	10+	0	0	10+
Fresno-Sierra Sky Park	10+	0	0	0	0	10+	0	0	0	0	10+
Tranquillity	10+	0	0	10+	0	0	0	0	0	0	10+
Clovis-Villa	10+	0	10+	10+	7	10+	10+	10+	0	0	10+
Fresno-Foundry	0	0	0	0	0	3	0	0	0	0	3
Fresno-Garland[1]	10+	10+	10+	10+	10+	10+	10+	0	10+	10+	10+
Fresno-Pacific	0	0	0	0	10+	0	0	0	0	0	0
Fresno-Drummond	10+	0	10+	0	0	10+	0	0	0	0	10+
Parlier	10+	0	0	0	0	10+	0	10+	0	0	10+
Huron	0	0	0	10+*	0	0	0	0	0	0	9
Hanford-Irwin	10+	9	10+	9	0	10+	0	0	0	0	10+
Corcoran-Patterson	0	10+	0	10+	10+	0	0	0	0	0	10+
Sequoia-Lower Kaweah	10+	0	0	0	0	0	0	0	0	0	10+
Sequoia-Ash Mountain	10+	0	0	10+*	0	0	0	0	0	0	10+
Visalia-Church	10+	0	10+	10+	10+	10+	0	0	0	0	10+

Table 2-11. Length of Monitoring Analysis (Number of Years) through 2019 (cont)

Site Name	O_3	1-hr PM10	24-hr PM10	1-hr PM2.5	24-hr PM2.5	NO_2	CO	PAMS	Pb	SO_2	Met
Visalia-Airport^	0	0	0	0	0	0	0	0	0	0	10+
Porterville	9	0	0	9*	0	0	0	0	0	0	9
Shafter	10+	0	0	0	0	10+	0	10+	0	0	10+
Oildale	10+	2	0	0	0	9	0	0	0	0	10+
Bakersfield-Golden/M St	0	0	4	0	5	0	0	0	0	0	0
Bakersfield-Westwind	0	0	0	0	0	1	0	0	0	0	1
Bakersfield-California	10+	0	10+	10+	10+	10+	0	0	10+	0	10+
Bakersfield-Muni	7	0	0	0	0	7	7	7	0	0	7
Bakersfield-Airport (Planz)	0	0	0	0	10+	0	0	0	0	0	0
Edison	10+	0	0	0	0	10+	0	0	0	0	10+
Arvin-Di-Giorgio[2]	10+	0	0	0	0	0	0	0	0	0	10+
Maricopa	10+	0	0	0	0	0	0	0	0	0	10+
Lebec	0	0	0	10+*	0	0	0	0	0	0	10+

[1] In December 2011, CARB moved the Fresno-First air monitoring station to Garland Avenue which is two blocks north of the previous site. The District considers the Fresno-First site (060190008) and the Fresno-Garland site (060190011) the same site which serves as an NCore site. After the relocation was complete, monitoring resumed as it was prior to the move.
+Sites with ten or more years of data are marked "10+" and highlighted green.
[2] In November 2010, Arvin Di Giorgio (060295002) became the replacement site for the Arvin-Bear Mountain site (060295001). The Arvin-Bear Mountain site was operational from June 1989 to January 2010 and measured ozone, meteorology, and PAMS parameters.
[*] Non-Regulatory PM2.5 monitor.
[^] Site includes a lower air profiler.

2.2 AREA-SERVED, POPULATION-SERVED, POPULATION CHANGE, AND EMISSIONS-SERVED ANALYSES

The purpose of the area-served analysis is to estimate the spatial coverage of each monitoring site to identify potential spatial gaps or redundancies in the overall monitoring network. Performing the area-served analysis is a multi-step process. The first step in the area-served analysis was to compile a map of the air quality sites which included both the District sites and other agency sites within and surrounding the boundary, using GIS software, then apply Thiessen polygons to assign a zone of influence or representativeness to the area around a given point—in this case, a monitoring site. The polygon defines the area closest to each site.

After the area-served boundaries were developed for each site and pollutant, the population-served analysis was performed. The purpose of the population-served analysis was to determine the population coverage represented by each monitoring site and to identify the sites surrounded by the highest population densities. It is also of interest to examine those areas within the SJV that have undergone substantial growth over the past several years and to examine monitoring site locations relative to areas of population growth.

Taking the area- and population-served analyses one step further, an emissions-served analysis was performed. The emissions-served analysis examines the proximity of monitoring sites to emissions sources and emissions densities within each area-served boundary. This analysis was performed by overlaying spatially resolved emissions (or activity) data onto the area-served boundaries to investigate the potential emissions impacts on each monitoring site. The most recent gridded NOx and PM2.5 emissions data were acquired from the California Air Resources Board. Emissions represent the 2020 daily annual average.

The following sections discuss the findings of the area-, population-, and emissions-served analyses for ozone and PM2.5, the two criteria pollutants for which the District is currently designated non-attainment. Because an individual monitoring site may measure a number of pollutants, the analyses are performed by first identifying the pollutant-specific networks and then performing the analyses for each individual network. The results below are presented for each of the non-attainment pollutants in the Valley.

Figure 2-10 Population Change from 1990-2010 Relative to District Monitoring Sites

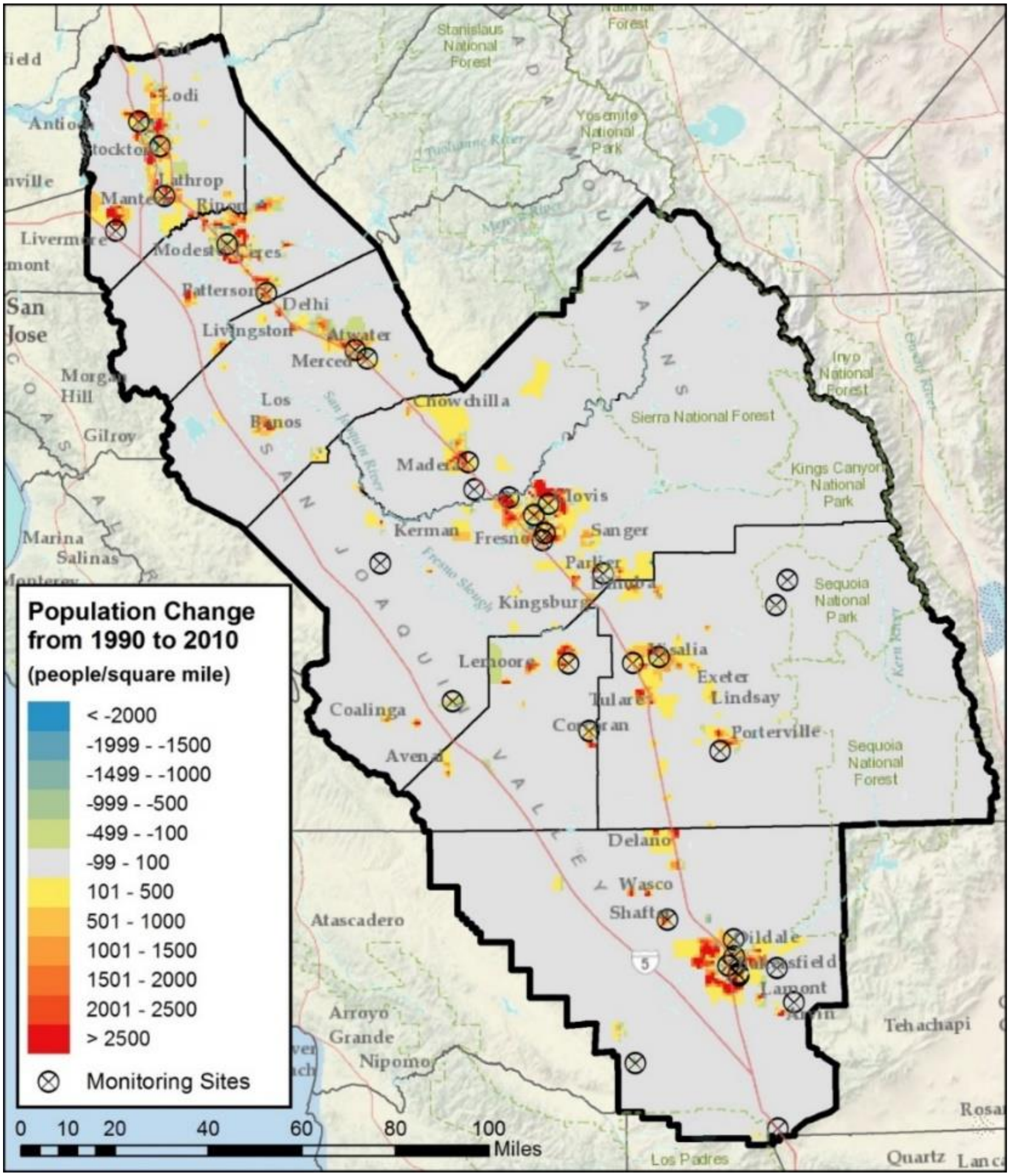


Figure 2-10 depicts the population change throughout the Valley and the proximity to all District monitoring sites. In many regions, areas that were once unpopulated are now densely populated. As a result, human encroachment and associated increases in emissions activity may affect monitoring sites. These impacts can change site characteristics (e.g., a former rural site may now be an urban site). The results of the population change analysis indicate that the areas northwest of Clovis, west of Merced

(Los Banos area), and west of Bakersfield all have high population growth. As the Valley's population grows, the District may look for opportunities to expand the air monitoring network to continue to ensure adequate monitoring throughout the Valley.

2.2.1 Area and Emissions-served PM2.5 Network

PM2.5 monitoring in the SJV is aimed at measuring representative pollutant concentrations on both a neighborhood and an urban scale. By identifying area-served boundaries as they relate to average PM2.5 concentrations, numbers of days PM2.5 values exceed the NAAQS standards, and population density near the monitors, the District can determine the effectiveness of the current PM2.5 network. Figures 2-11 and 2-12 depict the area of influence of the SJV PM2.5 monitoring sites and the population density of each 1 km grid. Figure 2-11 compares the population density to the 24-hr average PM2.5 concentration in each grid. Figure 2-12 compares the population analysis to number of days each of the 4 km grids exceeds the 24-hr average PM2.5 NAAQS of 35 µg/m^3.

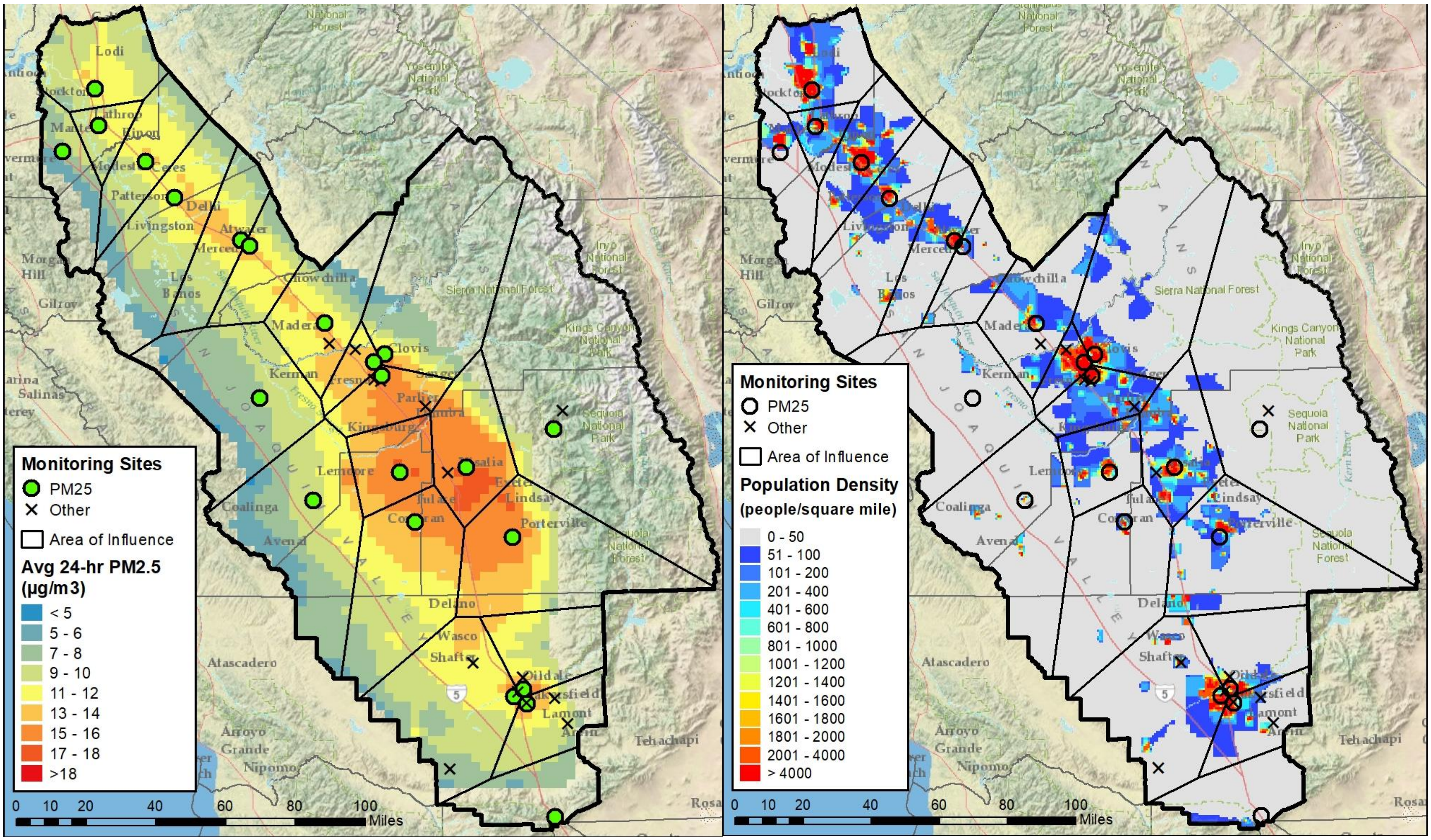
From population density and PM2.5 modeling analysis, the District can assess whether pollution in areas with significant populations is accurately represented by the nearest monitor. For example, the PM2.5 monitor at Turlock serves a large, mostly unpopulated area that encompasses the City of Los Banos. Based upon analysis of the PM2.5 concentrations represented in Figure 2-12, it is clear that the pollution levels are low in this populated pocket, so an additional site is unnecessary. An analysis of the remaining PM2.5 sites in the northern counties of San Joaquin, Stanislaus, Merced and Madera reveal that the PM2.5 network covers the local populations and areas impacted by PM2.5.

The monitor at Clovis-Villa serves a large area, including the mountain region of Oakhurst, northwest of Clovis in Madera County. If the District were to expand the PM2.5 network in the future, further investigation could help determine whether the addition of PM2.5 monitoring in Oakhurst could be a beneficial addition to the network. While the unmonitored community does not demonstrate a need based on associated modeled PM2.5 averages, monitoring PM2.5 in Oakhurst may benefit the District and the community during wildfire season.

Southeast of Fresno, towards the Sierra Nevada foothills, the population pockets of Parlier, Sanger, and Dinuba do not have PM2.5 monitoring nearby. If the District were to expand the PM2.5 network in the future, further investigation could help determine whether the addition of PM2.5 monitoring in these population pockets within southeast Fresno County could be a beneficial addition to the network.

An analysis of all the remaining PM2.5 sites in the southern counties of Fresno, Kings, Tulare, and Kern sufficiently cover the local populations and areas impacted by pollution.

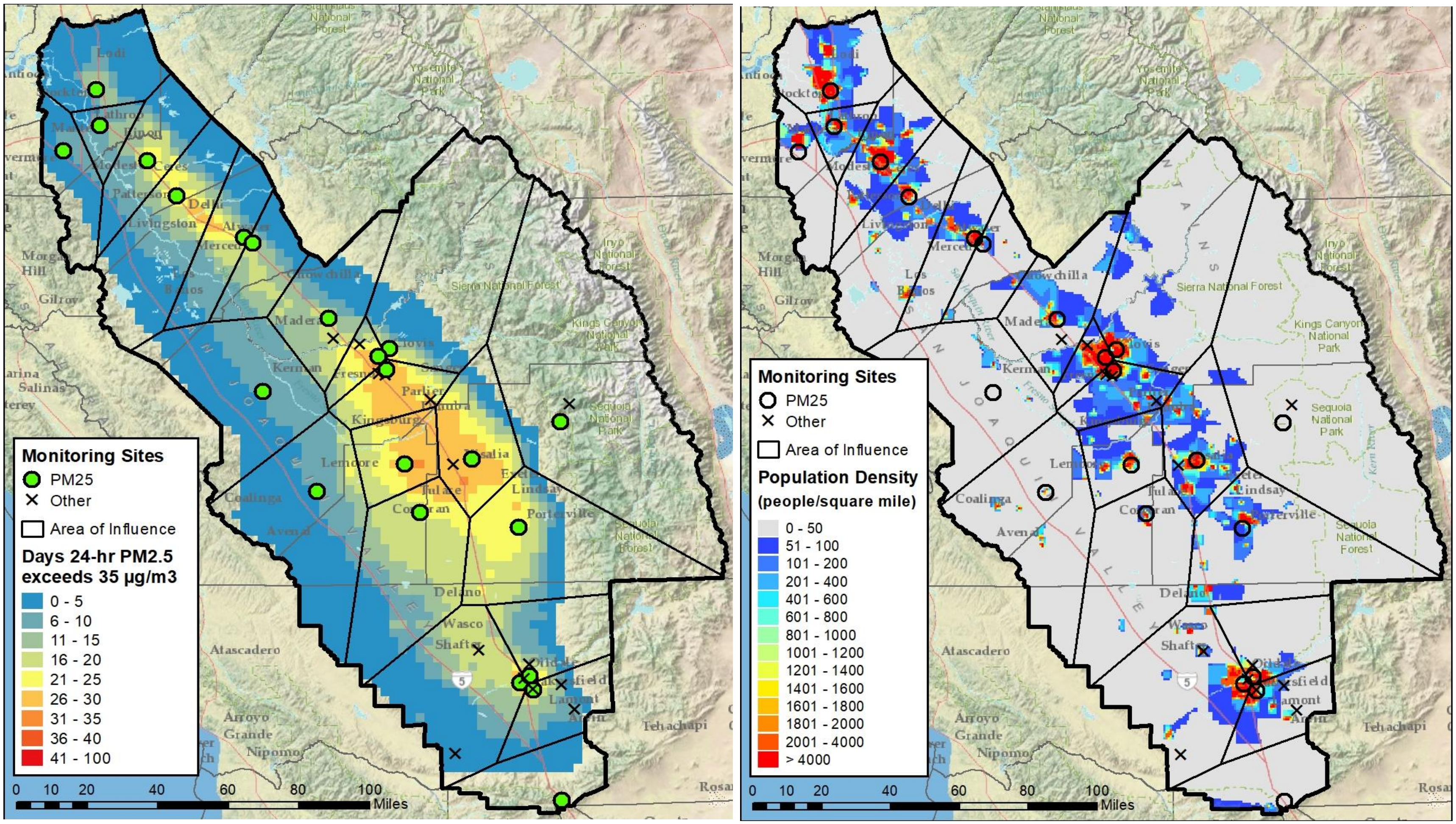
Figure 2-11 Left: Map of the areas served by the PM2.5 monitoring sites in the San Joaquin Valley with the associated average 24-hr PM2.5 concentrations for every 4 km grid in the District on the valley floor. Right: Map of the areas served by the PM2.5 continuous monitoring sites in the San Joaquin Valley with the associated population/mi²



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM), gas, and/or meteorology.

A similar analysis comparing regional population density to number of days over 35 µg/m^3 can give insight into whether significant populations are exposed to elevated pollution levels more frequently and help determine if an additional monitor is necessary to capture those concentrations more accurately. The District's analysis concludes that the network provides appropriate coverage for areas that may see frequent high concentrations of PM2.5.

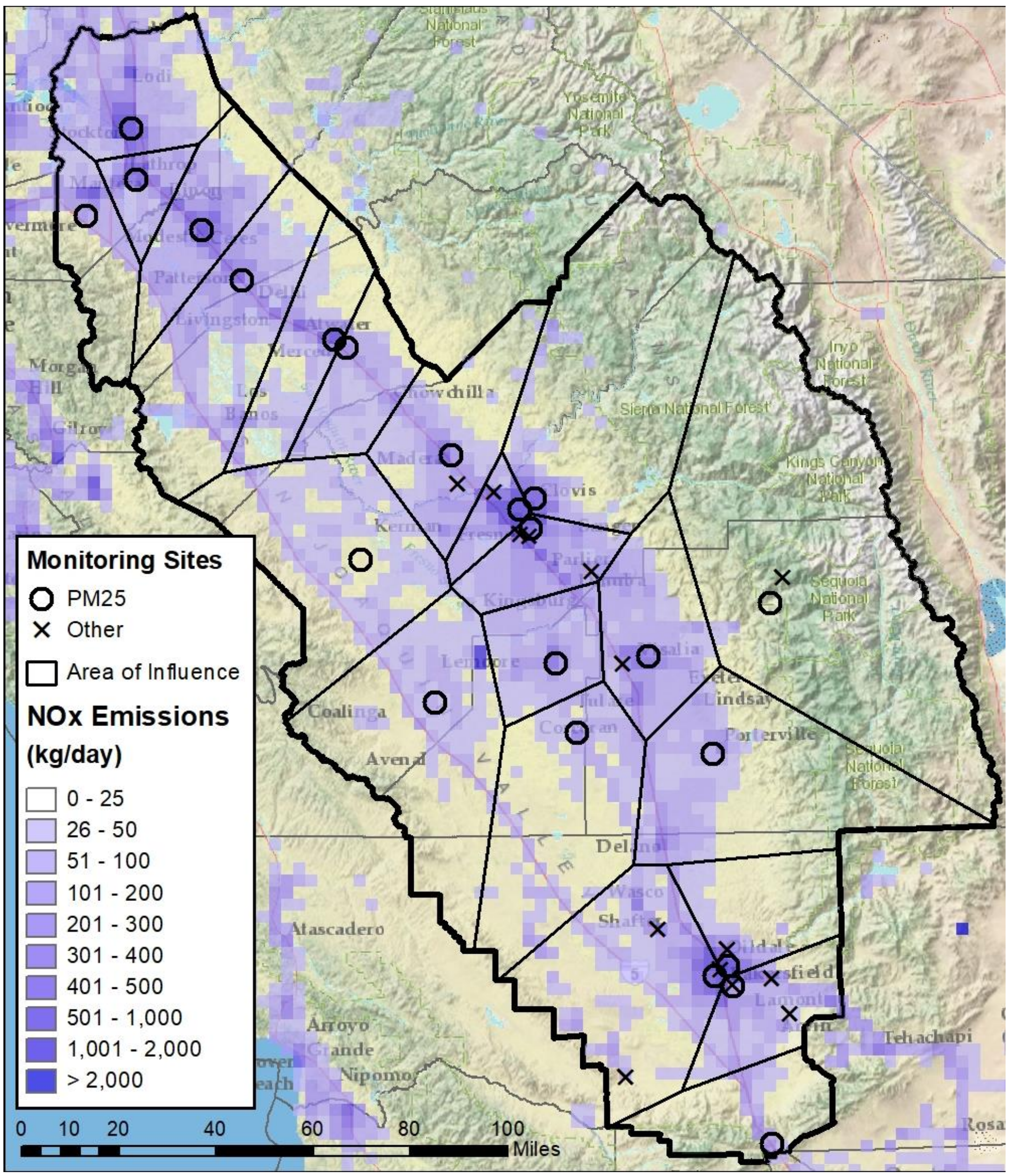
Figure 2-12 Left: Map of the areas served by the PM2.5 monitoring sites with the associated number days that the 24-hr PM2.5 concentration exceeds NAAQS. Right: Map associated population/mi^2 for each area served



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM), gas, and/or meteorology.

An emissions-served analysis of the PM2.5 network can give further insight into whether locations which emit high pollution levels are accurately monitored. As expected, high NOx emissions are associated with freeways and largely-populated cities. As expressed above, and shown again in Figure 2-13 below, the large cities are appropriately served by this network. Two near-road NO_2 sites have been set up to monitor NOx emissions along Highway 99; Fresno-Foundry and Bakersfield-Westwind. Fresno-Foundry not only monitors NOx, but also CO and PM2.5; and Bakersfield-Westwind monitors NOx to help understand NOx emissions from freeway sources.

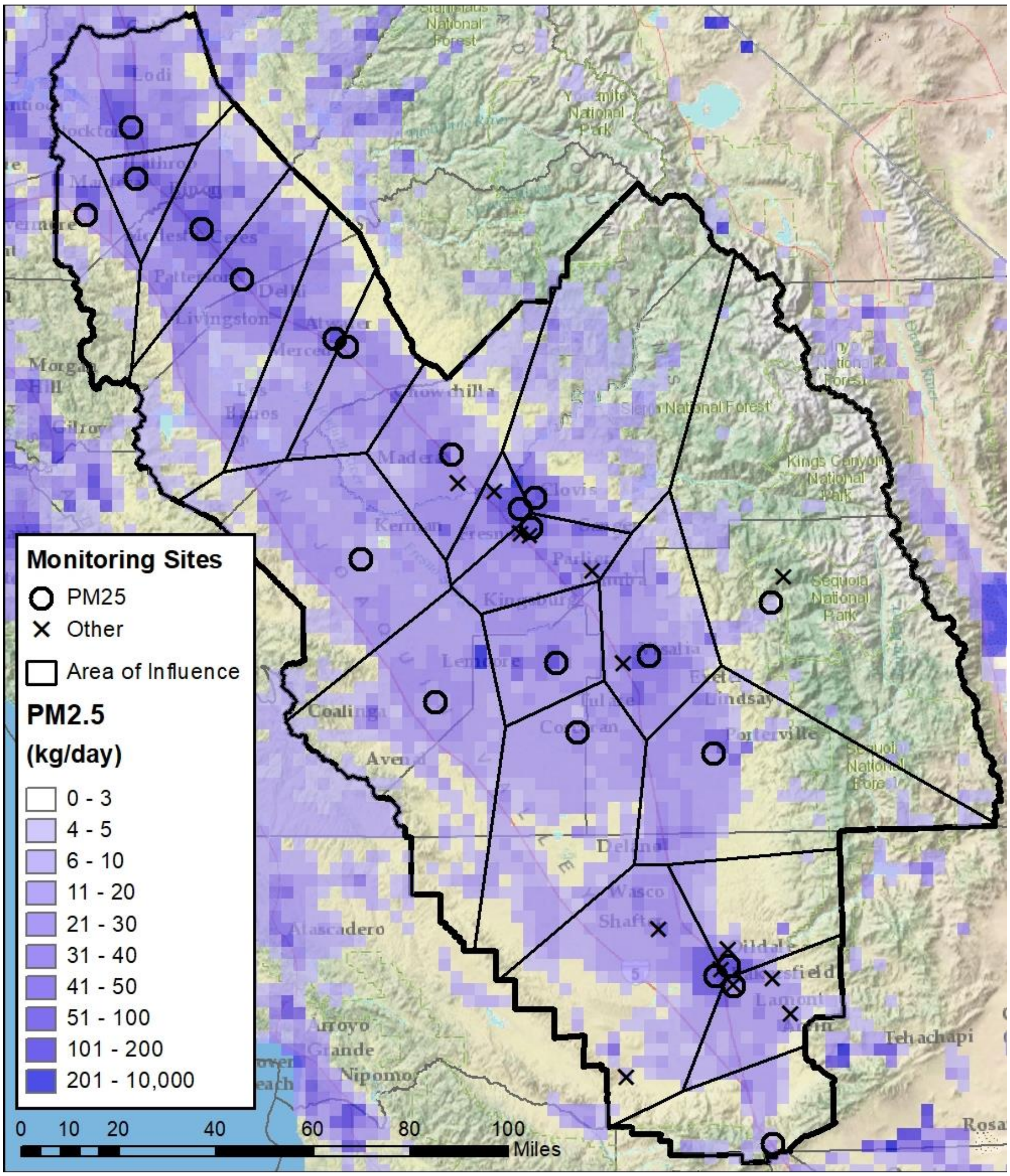
Figure 2-13 Map of NOx Emissions Assessed in Areas Served by PM2.5 Monitors



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM), gas, and/or meteorology.

Similarly, high PM2.5 emissions are associated with freeways, largely-populated cities, as well as mountain regions where residential wood-burning and wildfires occur. As described in the population-served analysis, the large cities are appropriately served by the PM2.5 network. Likewise, most areas with PM2.5 emissions are captured by the current monitors. See Figure 2-14 below.

Figure 2-14 Map of PM2.5 Emissions Assessed in Areas Served by PM2.5 Monitors



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM), gas, and/or meteorology.

2.2.2 Area and Emissions-served Ozone Network

Like PM2.5 monitoring, ozone monitoring in the SJV is aimed at measuring representative pollutant concentrations on both a neighborhood and an urban scale to better understand the local and regional causes, effects, and solutions to the non-attainment ozone challenges faced by the District. By identifying area-served boundaries as they relate to maximum 1-hr ozone concentrations and numbers of days ozone values exceed the NAAQS standard, the District can determine the effectiveness of the current ozone network. Figures 2-15 and 2-16 depict the area of influence of the SJV ozone monitoring sites and the population density of each 4 km grid. Figure 2-15 compares the population density to the maximum 8-hr ozone concentration in each 4km grid. Figure 2-16 compares the population analysis to number of days each zone exceeds the 8-hr ozone NAAQS of 70 ppb.

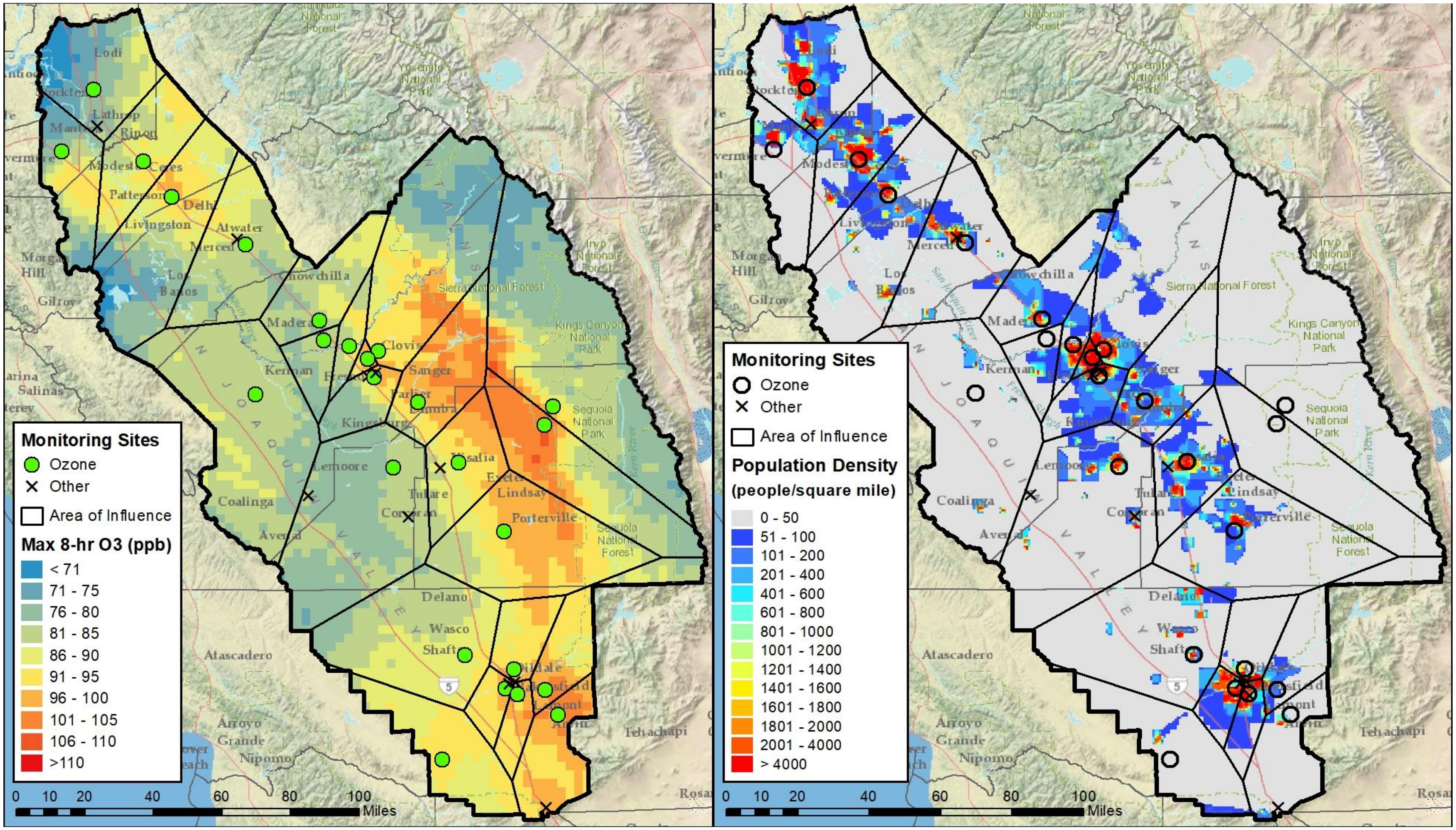
From population density and ozone modeling analysis, the District can assess whether areas with significant populations are adequately represented by the monitoring network. Analysis of the ozone monitors in the northern counties of San Joaquin, Stanislaus, Merced, and Madera reveal that area and population are well-served. Los Banos is one on the larger communities in the northern counties without air quality monitoring. However, as shown in Figures 2-15 and 2-16, modeling indicates that ozone concentrations are lower in Los Banos than at the nearest ozone monitor in Turlock. Therefore, no additional monitoring is needed.

There are a number of ozone monitors located in the Fresno metropolitan area. The monitor at Clovis-Villa measures the gaseous and PM pollution parameters in the highly-populated area of Fresno County as well as the mountain region of Oakhurst, northwest of Clovis in Madera County. If the District were to expand the ozone monitoring network in the future, further investigation could help determine whether the addition of ozone monitoring in Oakhurst could be a beneficial addition to the network.

An assessment of all the remaining ozone sites in the southern counties of Fresno, Kings, Tulare, and Kern demonstrates that the network sufficiently covers the local populations and areas impacted by pollution.

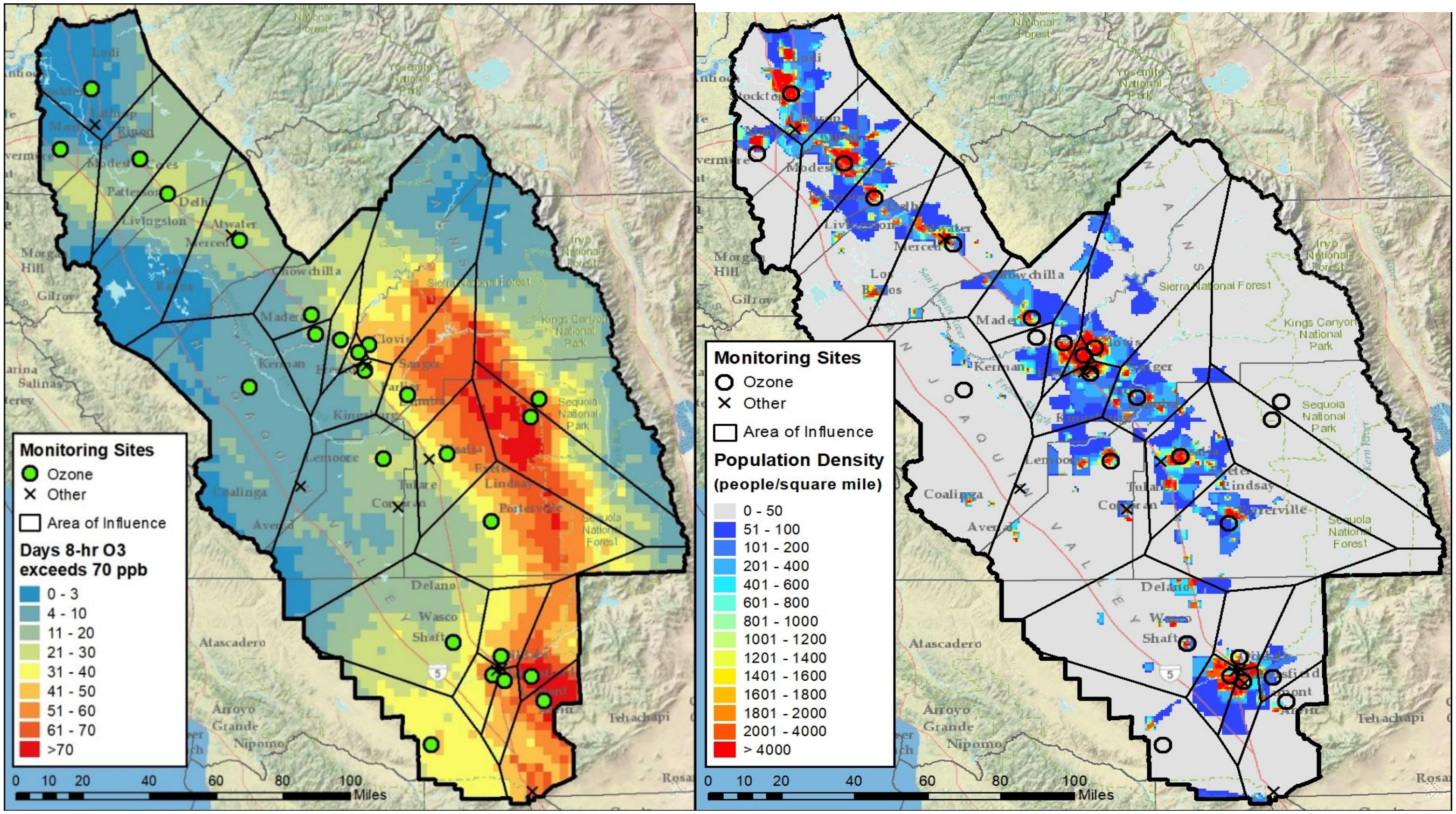
Figures 2-15 and 2-16 also give insight into the District's Ozone monitoring coverage for the Photochemical Assessment Monitoring Stations (PAMS) network, which rely on upwind and downwind maximum monitored ozone concentrations. As modeled, the current areas of maximum downwind ozone would be near Orange Cove in Fresno County, to the northeast of the Parlier air monitoring station, and the vicinity of Orosi in Tulare County, to the southeast of the Parlier air monitoring station. Furthermore, Figure 2-16 shows the area of maximum downwind ozone would be even further east and southeast of Parlier in areas of higher elevation. However, given the population exposure analysis shown earlier in this assessment, the District does not plan to add additional ozone monitors to the network at this time. Should additional monitoring be added, further investigation could help determine whether addition of ozone monitoring in these higher-elevation regions might be beneficial.

Figure 2-15 Left: Map of the areas served by the ozone monitoring sites in the San Joaquin Valley with the associated maximum 8-hr ozone concentrations in each zone in the District.
Right: Map of the areas served by the ozone monitoring sites in the San Joaquin Valley with the associated population/mi^2 for every 4km grid in the District



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM), gas, and/or meteorology.

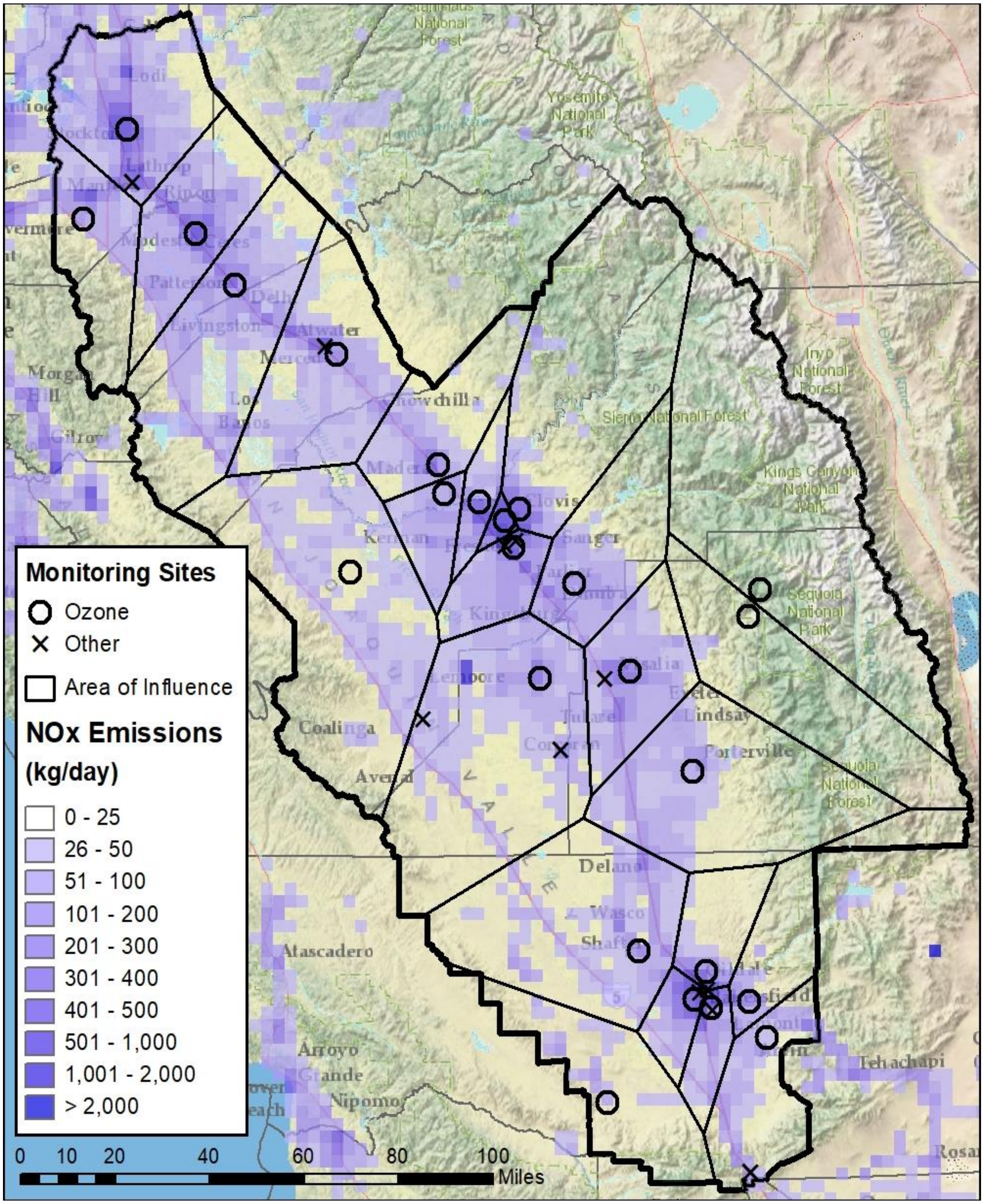
Figure 2-16 Left: Map of the areas served by the Ozone monitoring sites in the SJV with the associated number days that the 8-hr ozone concentration exceeds the NAAQS in each zone.
Right: Map of the areas served by the ozone monitoring sites in the SJV with the associated population/mi^2 for every 4 km grid



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM), gas, and/or meteorology.

An emissions-served analysis of the NOx compared to the ozone monitoring network can give further insight into whether locations that emit high pollution levels are accurately monitored. As mentioned above, high NOx emissions are associated with freeways and largely-populated cities. Figure 2-17 again confirms that the large cities are appropriately served by the ozone network. As for the emissions along the freeways, especially the 99 corridor, the District has two near-road NO_2 monitoring sites currently collecting NOx data to help fill the gaps indicated in the emissions-served map in Figure 2-17.

Figure 2-17 Map of NOx Emissions Assessed in Areas Served by Ozone Monitors



X - Other demarks sites besides the ones identified in the figure that monitor particulate matter (PM), gas, and/or meteorology.

2.2.3 Site-to-Site Correlation Analyses

To identify possible redundancies in the pollutant monitoring network, the District ran Pearson correlation analyses for 24-hr PM2.5 and 8-hr ozone concentrations using NetAssess, Ambient Air Monitoring Network Assessment Tool. The Pearson correlation coefficient (R) between site pairings shows how well the data agree. The R-value is a measure of the linear relationship between two variables and ranges from -1.00 to 1.00. An R value of 1.00 means that there is a positive linear relationship between the data from two sites which might indicate a redundancy in the monitoring network for sites near each other. Figures 2-18 through 2-23 and Tables 2-12 and 2-13 below show the results of the correlation analyses. An R-value of 1.00 would be light blue and value of -1 would be dark blue. The distances between the sites are reported as kilometers in the upper triangle.

Figures 2-18, 2-19, and 2-20 are the 8-hr ozone correlation plots between sites in the northern, central, and southern San Joaquin Valley, respectively. Table 2-12 shows the R-values for each correlation calculation. Figure 2-18 compares the northern SJV sites, all of which are spread apart. Due to the transport and formation components of ozone pollution which can cause a delay in ozone levels across a region, it would be expected that sites not near each other would not correlate as well as sites in the same metropolitan area. As such, many of the R-values in Figure 2-18 are less linear and the average difference between the sites is greater than the sites closest together. As expected, the site furthest from all others, Stockton-Hazleton, shows the least correlation with the other sites. Additionally, as shown in the area- and emission-served analyses for ozone, there tends to be a southeastward trend in ozone pollution as the precursors are emitted, formed into ozone, and transported from the northern-most region down through the central monitors. Therefore, the central and southern sites of Tranquillity, Fresno-Sierra Sky Park, Corcoran-Patterson, and Hanford-Irwin are more closely related than the distant northern sites.

For the central SJV monitors depicted in Figure 2-19, the Fresno area sites of Fresno-Garland, Fresno-Drummond, and Clovis-Villa correlated with one another well. Given their proximity and the regional nature of ozone pollution, we would expect that urban sites that are close together would approach R=1.00. Furthermore, the rural ozone sites of Parlier and Tranquillity do not correlate well with further sites. Similarly, the southern-most site in Figure 2-19 serves as a control group to demonstrate that a distant site will likely not see the same pollution levels.

The southern SJV monitors in Figure 2-20 continue with the trend. As mentioned, ozone pollution moves toward the southeast corner of the SJV, so sites in Kern County and southeastern Tulare County are likely to see a more even distribution of pollution levels. As expected, Porterville, Shafter, Arvin-Di Giorgio, Bakersfield-Muni, and Oildale have R-values greater than 0.97 despite their distances.

Although many of the sites have R-values greater than 0.95, this does not necessarily indicate that there are redundant sites. As discussed, ozone formation and transport is complex, so the local, short-lived differences between sites may not be captured in a simple correlation analysis. Additionally, the ozone network relies heavily on the spatial data obtained from up- and down-stream monitoring site analyses. As described in the area- and emissions-served analysis section, these monitors are placed in strategic areas of large population or emissions and are therefore necessary components of the network.

Figures 2-21, 2-22, and 2-23 are the 24-hr average PM2.5 correlation plots between sites in the northern, central, and southern San Joaquin Valley, respectively. Table 2-13 shows the R-values for each correlation calculation. Unlike ozone, PM2.5 pollution typically does not travel to distant sites and tends to be rather localized. As seen in all the PM2.5 figures, the sites are much less agreeable and most R values are between 0.6 and 0.9 and don’t necessarily increase with decreasing distance. Figure 2-21 compares the northern SJV sites, all of which are spread apart. The plots show that the R-values are varied, which confirms the earlier assessment that each PM2.5 monitor is a necessary part of the network. Figures 2-22 and 2-23 prove that this is also true for the central and southern sites, despite the closer proximity.

Figure 2-18 The 8-Hour Daily Maximum Ozone Concentrations Correlation Matrix for the Northern SJV Sites

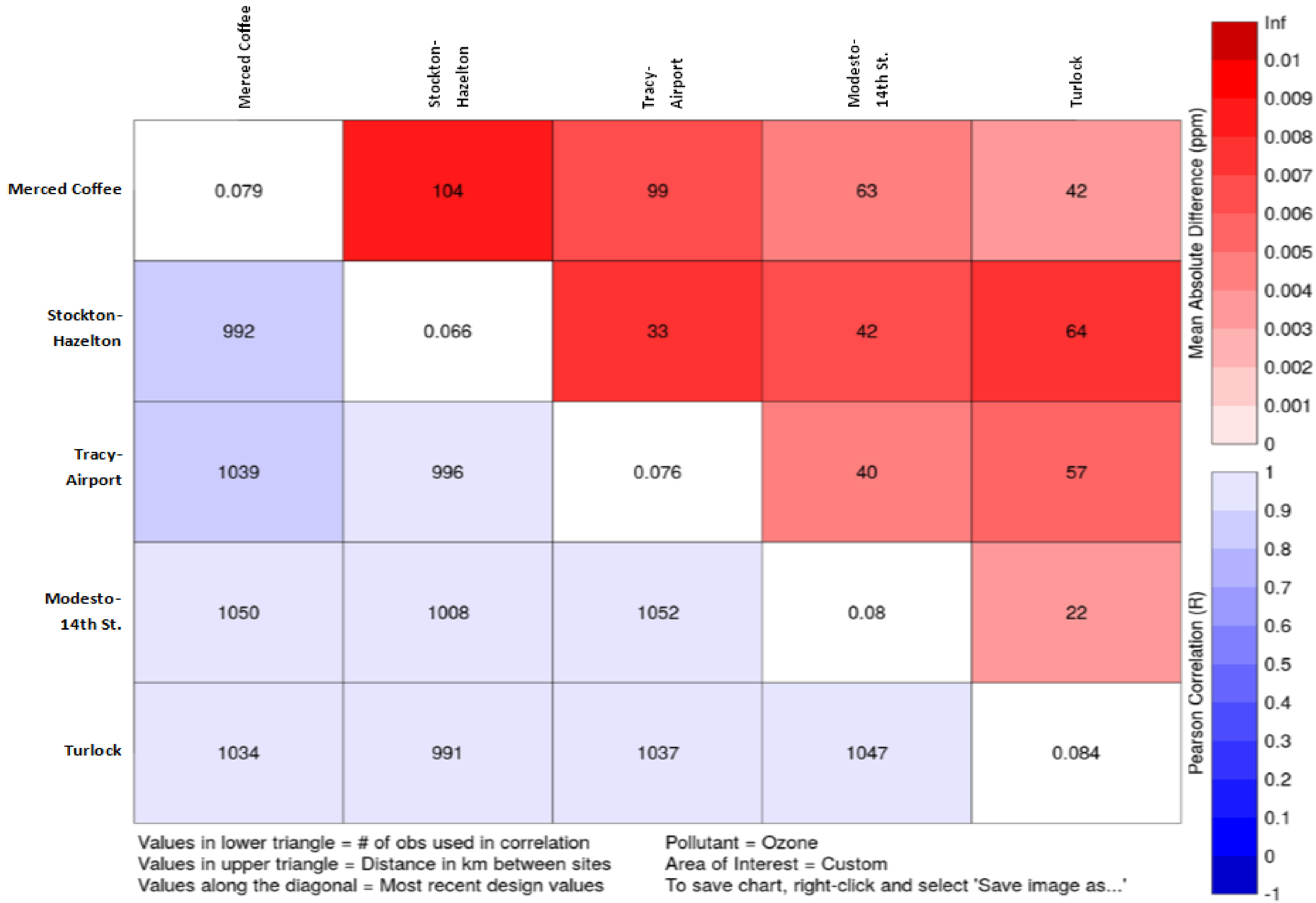


Figure 2-19 The 8-Hour Daily Maximum Ozone Concentrations Correlation Matrix for the Central SJV Sites

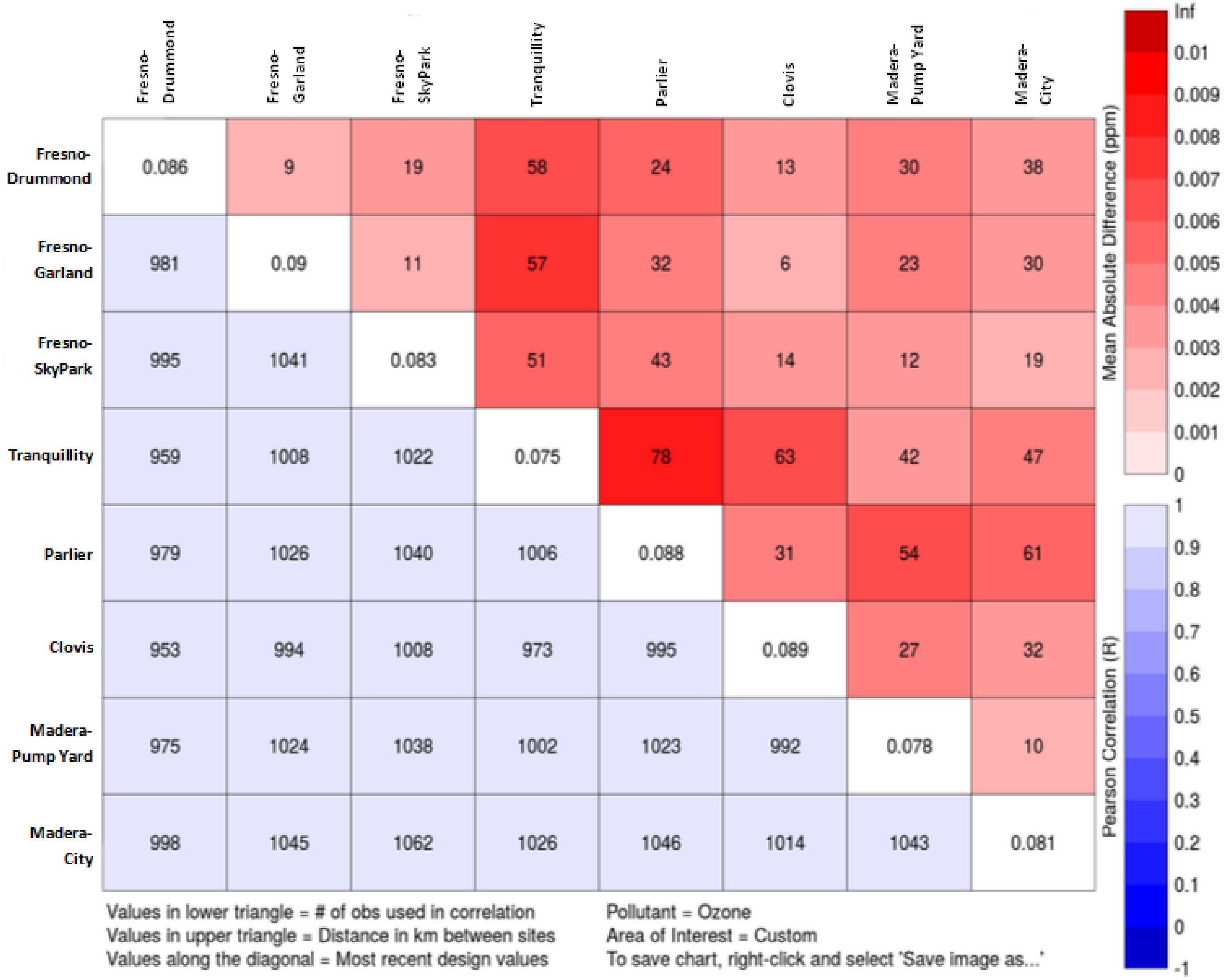


Figure 2-20 The 8-Hour Daily Maximum Ozone Concentrations Correlation Matrix for the Southern SJV Sites

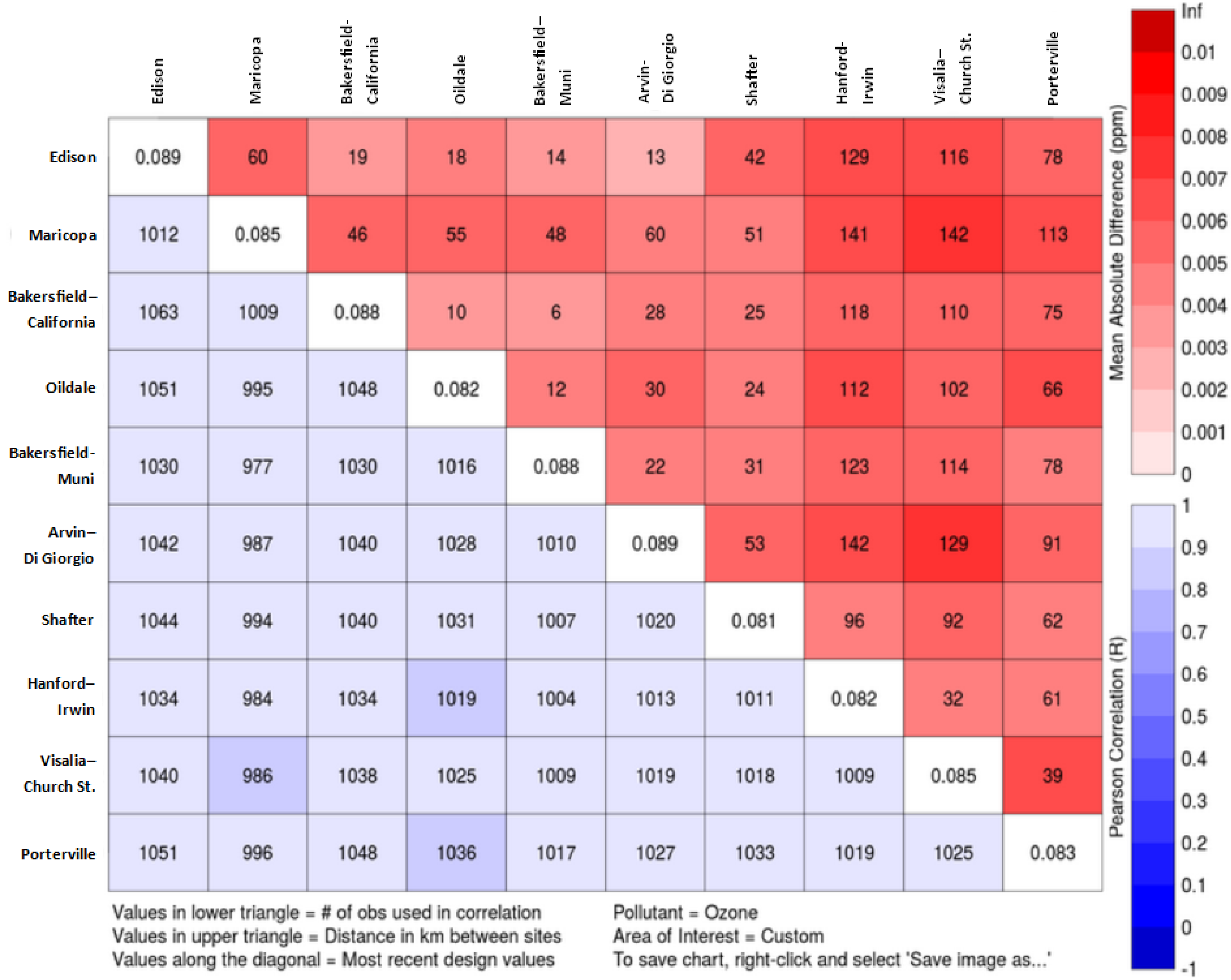


Table 2-12 8-Hour Daily Max Ozone Pearson Correlations (r)

	Fresno-Drummond	Fresno-Garland	Fresno- Sierra Sky Park	Tranquillity	Parlier	Clovis-Villa	Edison	Maricopa	Bakersfield-California	Oildale	Bakersfield-Muni	Arvin-Di Giorgio	Shafter	Hanford-Irwin	Madera-Pump Yard	Madera-City	Merced-Coffee	Stockton-Hazelton	Modesto-14^{th} St	Turlock	Visalia-Church St
Fresno-Garland	0.98																				
Fresno- Sierra Sky Park	0.98	0.99																			
Tranquillity	0.92	0.92	0.93																		
Parlier	0.97	0.97	0.96	0.91																	
Clovis-Villa	0.98	0.99	0.98	0.92	0.97																
Edison	0.90	0.91	0.91	0.86	0.93	0.91															
Maricopa	0.87	0.89	0.89	0.88	0.91	0.90	0.94														
Bakersfield-California Ave	0.90	0.92	0.92	0.87	0.93	0.91	0.97	0.94													
Oildale	0.87	0.89	0.89	0.84	0.90	0.89	0.95	0.92	0.97												
Bakersfield-Muni	0.93	0.93	0.93	0.89	0.94	0.93	0.98	0.94	0.98	0.95											
Arvin-Di Giorgio	0.90	0.91	0.91	0.87	0.93	0.91	0.98	0.94	0.96	0.93	0.97										
Shafter	0.93	0.93	0.93	0.91	0.95	0.93	0.95	0.94	0.96	0.93	0.96	0.95									
Hanford-Irwin	0.97	0.97	0.96	0.93	0.96	0.96	0.91	0.90	0.93	0.90	0.93	0.91	0.94								
Madera-Pump Yard	0.96	0.97	0.98	0.94	0.94	0.96	0.88	0.88	0.89	0.87	0.90	0.89	0.92	0.96							
Madera-City	0.97	0.98	0.98	0.94	0.95	0.97	0.89	0.88	0.91	0.88	0.92	0.90	0.93	0.96	0.99						
Merced-Coffee	0.93	0.94	0.93	0.93	0.91	0.94	0.86	0.84	0.87	0.84	0.88	0.87	0.90	0.92	0.94	0.96					
Stockton-Hazelton	0.88	0.87	0.87	0.87	0.84	0.85	0.79	0.75	0.81	0.78	0.81	0.78	0.82	0.86	0.87	0.88	0.90				
Modesto-14^{th} St	0.91	0.91	0.91	0.91	0.88	0.90	0.83	0.80	0.84	0.81	0.85	0.82	0.86	0.90	0.90	0.92	0.94	0.96			
Turlock	0.92	0.92	0.92	0.92	0.89	0.91	0.85	0.82	0.86	0.83	0.87	0.85	0.88	0.91	0.91	0.93	0.96	0.94	0.98		
Visalia-Church St	0.93	0.94	0.94	0.87	0.95	0.93	0.93	0.89	0.94	0.94	0.93	0.92	0.92	0.95	0.91	0.92	0.88	0.84	0.87	0.88	
Porterville	0.93	0.92	0.91	0.88	0.95	0.93	0.92	0.90	0.92	0.89	0.94	0.93	0.95	0.94	0.91	0.92	0.89	0.80	0.84	0.86	0.92

Figure 2-21 The 24-Hour Daily Average PM2.5 Concentrations Correlation Matrix for the Northern SJV Sites

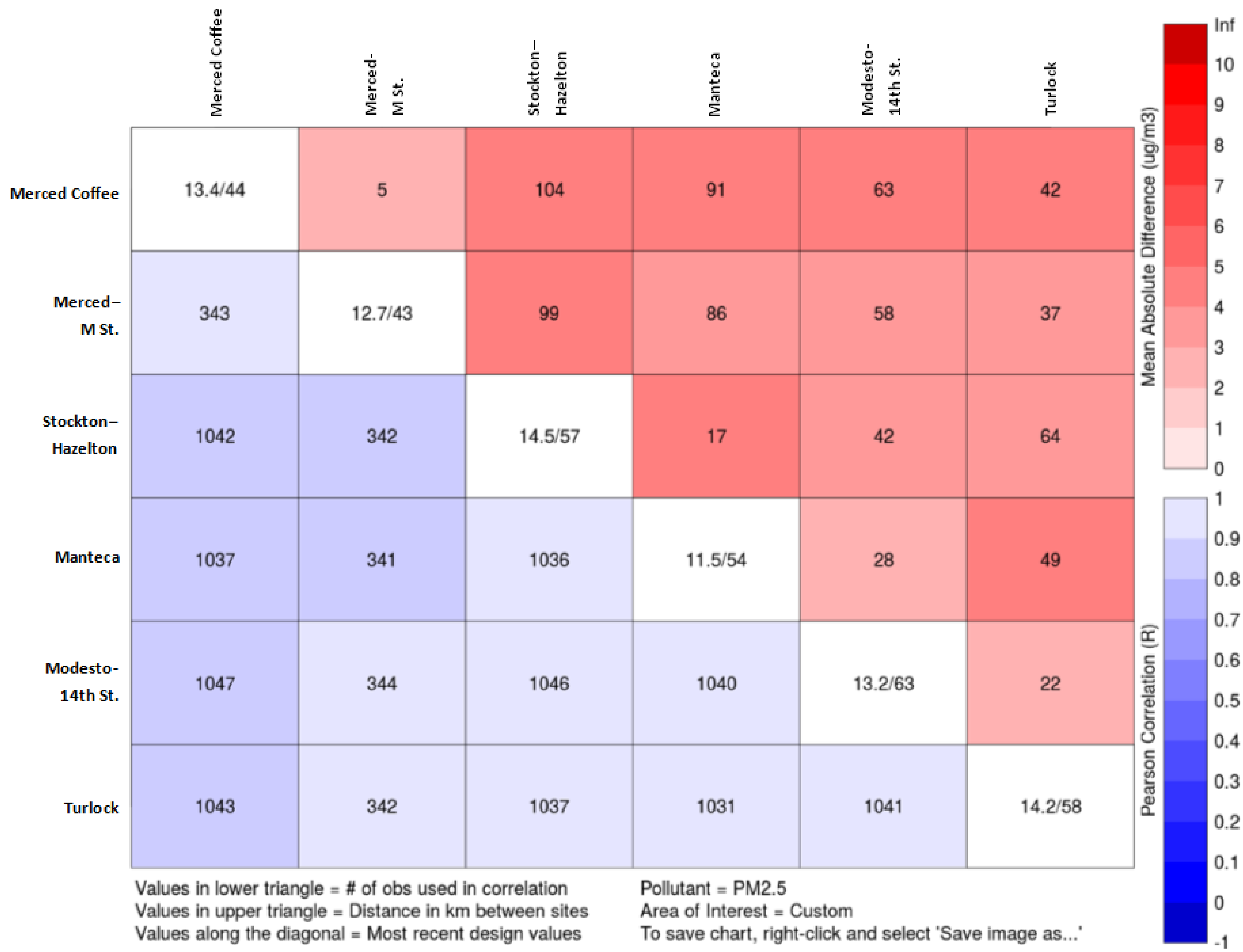


Figure 2-22 The 24-Hour Daily Average PM2.5 Concentrations Correlation Matrix for the Central SJV Sites

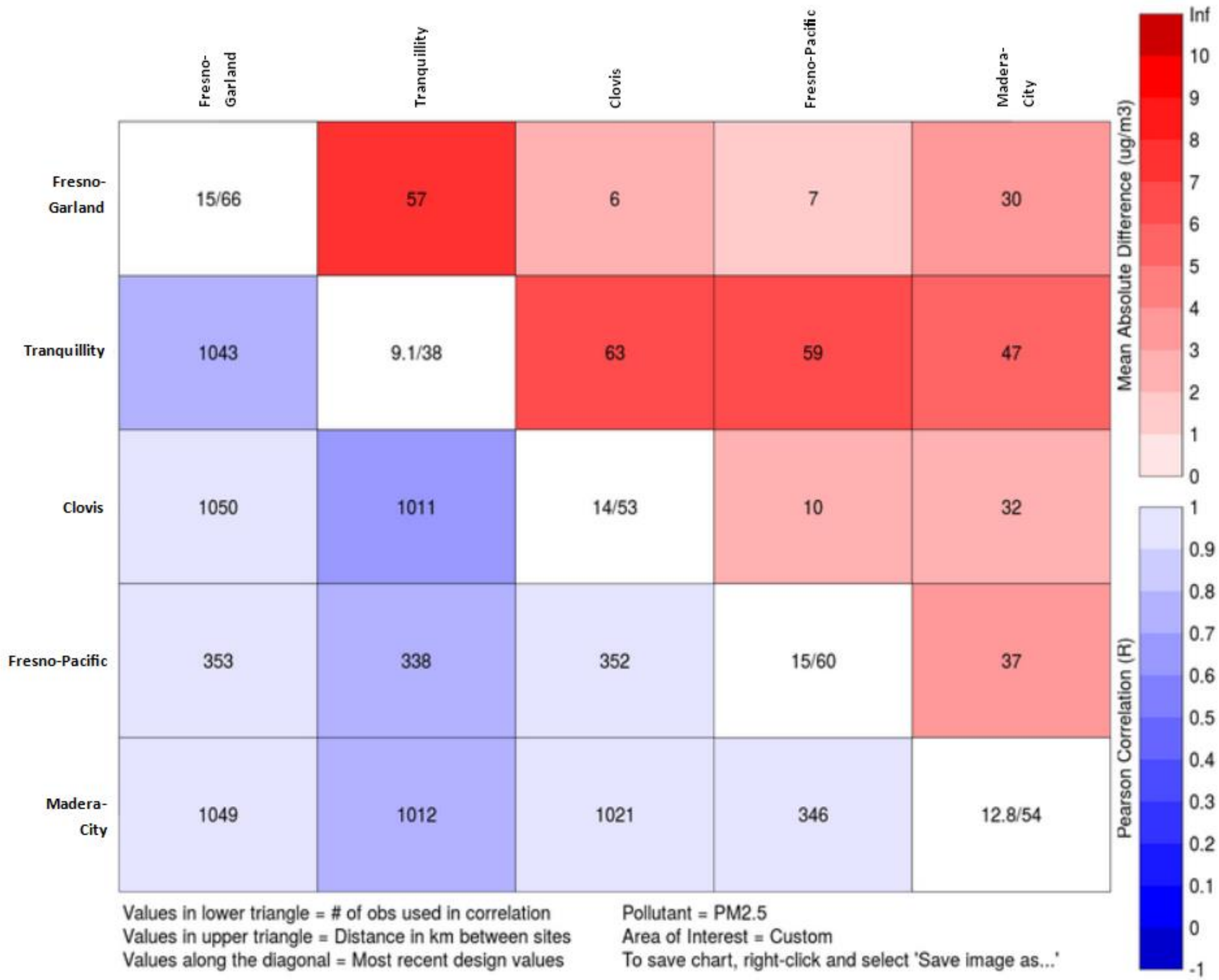


Figure 2-23 The 24-Hour Daily Average PM2.5 Concentrations Correlation Matrix for the Southern SJV Sites

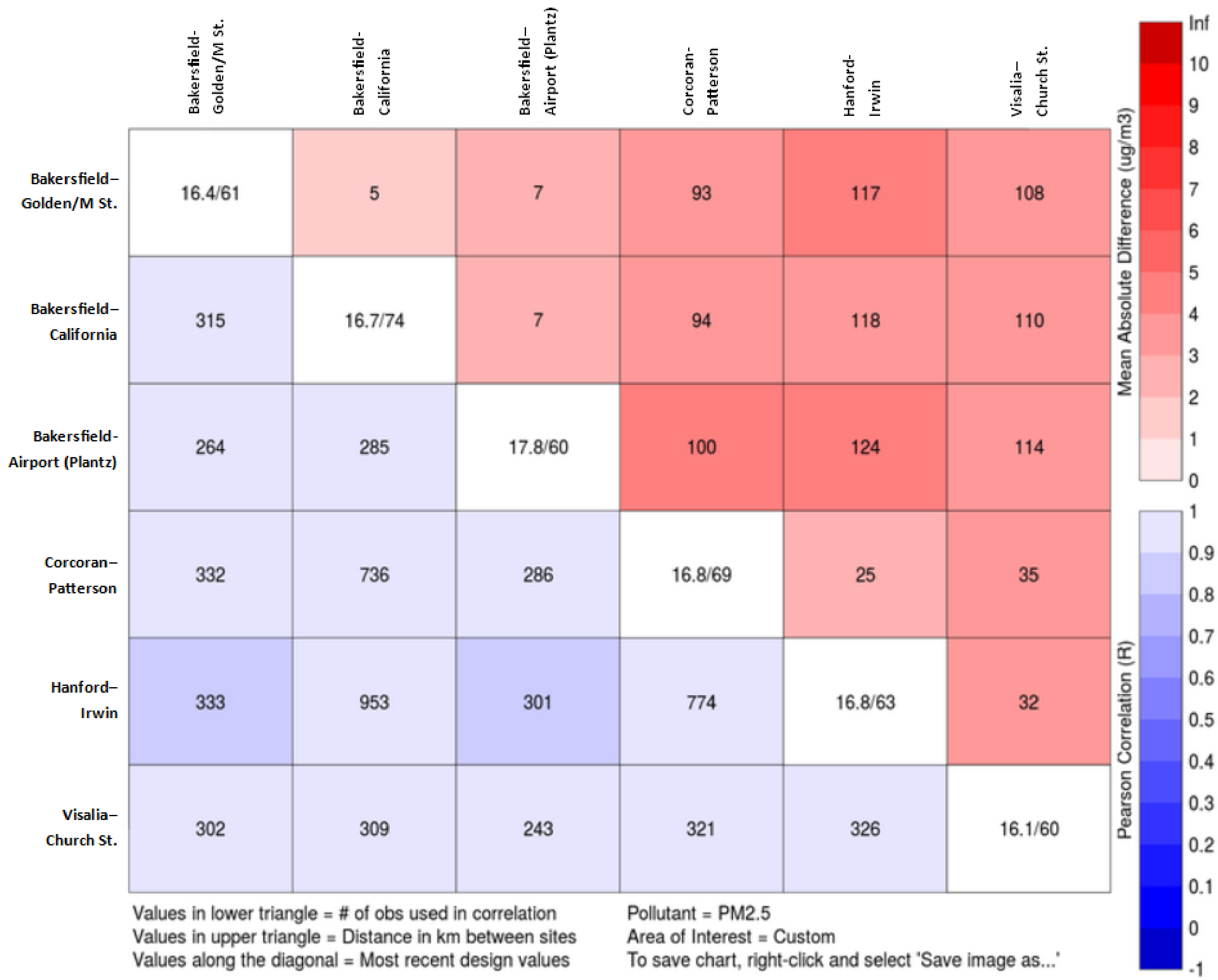


Table 2-13 24-Hour Average PM2.5 Pearson Correlations (r)

	Fresno-Garland	Tranquillity	Clovis-Villa	Fresno-Pacific	Bakersfield-Golden/M St	Bakersfield-California Ave	Bakersfield-Planz	Corcoran-Patterson	Hanford-Irwin	Madera-City	Merced-Coffee	Merced-M St.	Stockton-Hazelton	Manteca	Modesto-14th St	Turlock
Tranquillity	0.71															
Clovis-Villa	0.97	0.70														
Fresno-Pacific	0.99	0.72	0.98													
Bakersfield-Golden/M St	0.88	0.63	0.88	0.91												
Bakersfield-California Ave	0.90	0.65	0.88	0.93	0.98											
Bakersfield-Airport (Planz)	0.87	0.60	0.87	0.90	0.96	0.97										
Corcoran-Patterson	0.93	0.80	0.91	0.94	0.91	0.91	0.91									
Hanford-Irwin	0.94	0.77	0.91	0.94	0.88	0.90	0.88	0.98								
Madera-City	0.95	0.77	0.94	0.95	0.83	0.85	0.83	0.91	0.93							
Merced-Coffee	0.87	0.85	0.85	0.87	0.76	0.77	0.74	0.86	0.87	0.92						
Merced-M St.	0.91	0.83	0.87	0.90	0.81	0.83	0.80	0.89	0.90	0.92	0.96					
Stockton-Hazelton	0.71	0.82	0.67	0.71	0.65	0.65	0.60	0.75	0.74	0.74	0.84	0.85				
Manteca	0.65	0.81	0.61	0.65	0.59	0.57	0.55	0.69	0.68	0.68	0.80	0.83	0.95			
Modesto 14th St	0.76	0.84	0.70	0.75	0.67	0.68	0.63	0.80	0.80	0.78	0.86	0.90	0.96	0.96		
Turlock	0.78	0.86	0.74	0.77	0.69	0.71	0.65	0.82	0.82	0.82	0.89	0.91	0.94	0.93	0.97	
Visalia-Church St	0.94	0.64	0.95	0.96	0.92	0.92	0.92	0.93	0.91	0.88	0.78	0.82	0.68	0.61	0.73	0.73

3. TECHNICAL APPROACH AND FINDINGS – PAMS MONITORING NETWORK ASSESSMENT

The Photochemical Assessment Monitoring Stations (PAMS) program collects ambient air measurements in areas classified as serious, severe, or extreme ozone nonattainment, as required by Section 182(c)(1) of the Clean Air Act. The District is currently operating under the PAMS Alternative Network Plan Revision of April 21, 1995.

3.1 Overview of the PAMS Network

The monitoring objective of Photochemical Assessment Monitoring Stations is "research support". Federal regulations (Clean Air Act Section 182 and 40 CFR 58) require serious, severe, and extreme ozone nonattainment areas to have PAMS sites measure speciated ozone precursors in order to better understand the effect of precursors and photochemistry as well as control strategies on ozone formation.

PAMS sites measure ozone, carbon monoxide (CO), nitrogen oxide (NO), nitrogen dioxide (NO2), oxides of (NOx), and non-methane hydrocarbon (NMH) as well as meteorology. Although the San Joaquin Valley (Valley) does not exceed federal or state standards for NO2, NOx reductions contribute to air quality improvement for both ozone and particulate matter (PM).

There are four classifications of PAMS:

- Type 1: **Background sites** upwind of urban areas, where ozone concentrations are presumed not to be influenced by nearby urban emissions.
- Type 2: **Maximum ozone precursor emissions sites**, typically located in an urban center, where emissions strengths are the greatest.
- Type 3: **Maximum ozone concentration sites**, intended to show the highest ozone concentrations.
- Type 4: **Downwind ozone monitoring sites,** intended to capture concentrations of transported ozone and precursor pollutants, and determine possible areas from which most of the transport may originate. Type 4 sites are currently not required for the Valley.

As shown in Table 3-1 the District has six PAMS sites configured as two networks, one for the Fresno Metropolitan Statistical Area (MSA) and one for the Bakersfield MSA. In May 2016, the EPA approved the relocation of the ozone State and Local Air Monitoring Station (SLAMS) monitor formerly at Arvin-Bear Mountain to the Arvin-Di Giorgio location in Kern County. Additionally, CARB has begun the process of building a permanent shelter that should have enough space to accommodate all of the PAMS equipment intended for the site. Due to upcoming changes to PAMS program requirements, plans to continue PAMS monitoring at Arvin are pending (see *Planned Changes/Improvements* section of the District's Annual Air Monitoring Network Plan). Every year the PAMS program operates from June 1 through August 31 on a 1 in 3 day sampling schedule. At least four, three-hour integrated samples are collected each sampling day, which is referred to as a "Trend Day." However, additional samples are collected on "Episode Days," days forecasted to have high ozone concentrations. The goal is to sample on three to five multi-day episodes each ozone season.

Table 3-1 San Joaquin Valley PAMS Network

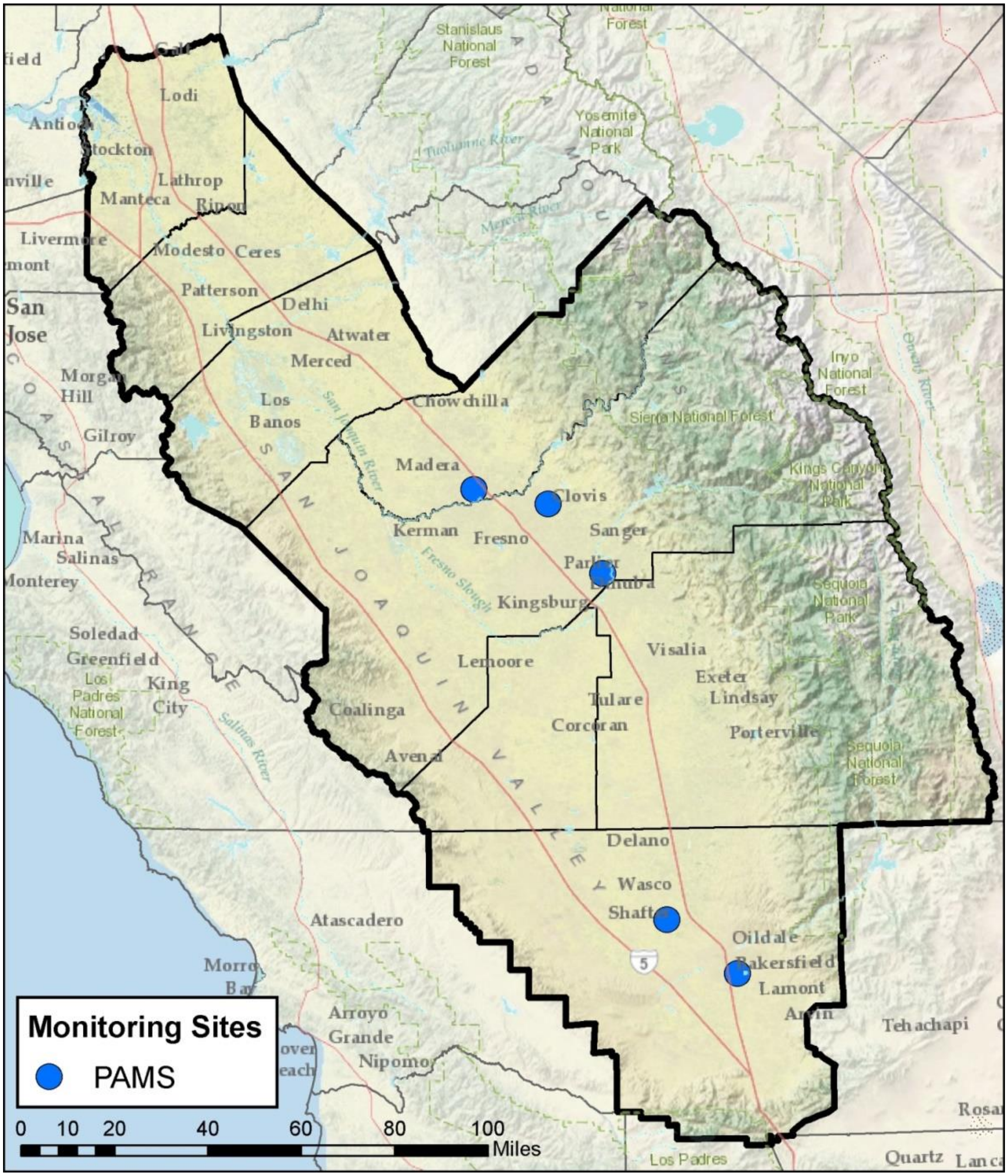
MSA	Site	Site Type
Fresno	Madera–Pump Yard	Type 1: Upwind/Background site
	Clovis–Villa	Type 2: Maximum precursor emissions
	Parlier	Type 3: Maximum ozone concentrations
Bakersfield	Shafter	Type 1: Upwind/Background site
	Bakersfield–Muni	Type 2: Maximum precursor emissions
	Arvin-Di Giorgio*	Type 3: Maximum ozone concentrations

* PAMS equipment for the Arvin-Di Giorgio Type 3 site may be installed when space becomes available.

3.2 Requirements for 8-Hour Ozone Enhanced Monitoring Plan (EMP)

As a part of the October 1, 2015, revisions to the PAMS requirements in 40 CFR Part 58, Appendix D, areas that are classified as Moderate nonattainment or above for 8-hour ozone must develop and implement an Enhanced Monitoring Plan (EMP) explaining how continued measurements of ozone and ozone precursors will assist in understanding the formation of ozone in the area. CARB is responsible for submitting the EMP for the entire state. According to CARB, EPA has made it clear that only an EMP submitted by CARB will satisfy the requirement. As such, the District attached the California 2019 Enhanced Monitoring Plan as Appendix D of the District's Annual Air Monitoring Network Plan to support this requirement.

Figure 3-1 Location of PAMS Monitoring Sites in the San Joaquin Valley



3.3 PAMS Data Analyses

As part of the PAMS network assessment, the District performed analyses to show how well the network is operating and meeting the objectives of the PAMS program. As described in 40 CFR Appendix B to Part 136, the Method Detection Limit (MDL) procedure is applied to estimate that the lowest concentration of a substance whose chemical constituents are being identified and measured, can be reported with 99%

confidence that the actual concentration is greater than zero. Table 3-2 shows that the District's PAMS analyzers captured concentrations greater than zero, and the majority of them reported above the MDL by 85% or higher. When compared to the previous analyses of percent above MDL for 2013 PAMS data, analysis of the 2018 PAMS data reveals a significant improvement in the capture of concentrations greater than zero.

Table 3-2 Summary of Percent above MDL for PAMS Sites

	Percent Above MDL				
Target PAMS Compounds	**Madera-Pump Yard**	**Clovis-Villa**	**Parlier**	**Shafter**	**Bakersfield-Muni**
Trans-2-Pentene	100%	100%	100%	95%	86%
Trans-2-Butene				100%	100%
Total NMOC	3%	9%	3%	17%	27%
Toluene	2%	24%	18%	33%	51%
Sum of PAMS Target Compounds	100%	100%	100%	100%	100%
Styrene					
Reactive Oxides Of Nitrogen					
Propylene	100%	99%	99%	98%	99%
Propane	100%	100%	100%	100%	100%
P-Ethyltoluene	90%	95%	98%	97%	97%
P-Diethylbenzene			100%	100%	100%
O-Xylene		4%		8%	8%
O-Ethyltoluene		100%	100%	100%	50%
N-Undecane	84%	96%	93%	93%	95%
N-Propylbenzene		100%	80%	100%	100%
N-Pentane	100%	100%	100%	100%	100%
N-Octane	95%	90%	90%	97%	96%
N-Nonane	90%	96%	83%	87%	89%
N-Hexane	100%	98%	96%	100%	100%
N-Heptane	100%	98%	99%	100%	99%
N-Decane	86%	99%	95%	96%	96%
N-Butane	100%	100%	100%	100%	100%
M-Ethyltoluene	100%	97%	96%	92%	98%
Methylcyclopentane	95%	98%	97%	100%	100%
Methylcyclohexane	90%	92%	97%	100%	98%
M-Diethylbenzene			100%	100%	
M/P Xylene		4%		9%	10%
Isopropylbenzene				100%	
Isoprene	96%	99%	97%	100%	99%
Isopentane	100%	100%	100%	100%	100%
Isobutane	100%	100%	100%	100%	100%
Formaldehyde		99%			100%
Ethylene	100%	100%	100%	100%	100%
Ethylbenzene					
Ethane	100%	100%	100%	100%	100%

Table 3-2 Summary of Percent above MDL for PAMS Sites (continued)

	Percent Above MDL				
Target PAMS Compounds	**Madera-Pump Yard**	**Clovis-Villa**	**Parlier**	**Shafter**	**Bakersfield-Muni**
Cyclopentane	33%	87%	91%	96%	95%
Cyclohexane	91%	97%	96%	100%	97%
Cis-2-Pentene		67%	100%	100%	100%
Cis-2-Butene				100%	100%
Benzene	59%	63%	59%	83%	78%
Acetylene	100%	100%	100%	100%	100%
Acetone		99%			100%
Acetaldehyde		99%			100%
3-Methylpentane	100%	99%	100%	100%	100%
3-Methylhexane	94%	98%	96%	98%	99%
3-Methylheptane	100%	96%	91%	89%	94%
2-Methylpentane	97%	100%	99%	100%	100%
2-Methylhexane		100%	100%	100%	94%
2-Methylheptane	100%	88%	86%	91%	97%
2,4-Dimethylpentane	83%	94%	91%	97%	98%
2,3-Dimethylpentane	89%	98%	96%	92%	98%
2,3-Dimethylbutane	89%	96%	100%	100%	100%
2,3,4-Trimethylpentane	57%	96%	92%	92%	98%
2,2-Dimethylbutane	71%	88%	91%	95%	94%
2,2,4-Trimethylpentane	93%	98%	96%	100%	100%
1-Pentene	100%	97%	78%	94%	91%
1-Butene	80%	100%	100%	100%	89%
1,2,3-Trimethylbenzene	100%	100%	80%	83%	100%
1,2,4-Trimethylbenzene	100%	95%	97%	93%	96%
1,3,5-Trimethylbenzene	67%	95%	97%	86%	93%

Table reflects data from June, July, and August 2018.
Cells shaded in blue indicate sites with less than 85% of data reported above the MDL.
Blank cells indicate no data was collected.

Air Quality and Precision data are required to be submitted to EPA 90 days after the end of the calendar quarter once all air quality assurance checks are completed. Data completeness quantifies the amount of valid data obtained from a monitoring network compared to the amount of data that was expected to be obtained per 40 CFR Part 58 Appendix A. As shown in Table 3-3, the PAMS data measured by the District's network during the 2018 PAMS season had a high percentage of completeness.

Table 3-3 Summary of Data Completeness for PAMS Sites

Percent Completeness					
Street Address	Madera-Pump Yard	Clovis-Villa	Parlier	Shafter	Bakersfield-Muni
Trans-2-Pentene	94%	95%	100%	100%	100%
Trans-2-Butene	94%	95%	100%	100%	100%
Toluene	94%	95%	100%	100%	100%
Styrene	94%	95%	100%	100%	100%
Propylene	94%	95%	100%	100%	100%
Propane	94%	95%	100%	100%	100%
P-Ethyltoluene	94%	95%	100%	100%	100%
P-Diethylbenzene	94%	95%	100%	100%	100%
O-Xylene	94%	95%	100%	100%	100%
O-Ethyltoluene	94%	95%	100%	100%	100%
N-Undecane	94%	95%	100%	100%	100%
N-Propylbenzene	94%	95%	100%	100%	100%
N-Pentane	94%	95%	100%	100%	100%
N-Octane	94%	95%	100%	100%	100%
N-Nonane	94%	95%	100%	100%	100%
N-Hexane	94%	95%	100%	100%	100%
N-Heptane	94%	95%	100%	100%	100%
N-Decane	94%	95%	100%	100%	100%
N-Butane	94%	95%	100%	100%	100%
M-Ethyltoluene	94%	95%	100%	100%	100%
Methylcyclopentane	94%	95%	100%	100%	100%
Methylcyclohexane	94%	95%	100%	100%	100%
M-Diethylbenzene	94%	95%	100%	100%	100%
M/P Xylene	94%	95%	100%	100%	100%
Isopropylbenzene	94%	95%	100%	100%	100%
Isoprene	94%	95%	100%	100%	100%
Isopentane	94%	95%	100%	100%	100%
Isobutane	94%	95%	100%	100%	100%
Formaldehyde		94%			90%
Ethylene	94%	95%	100%	100%	100%
Ethylbenzene	94%	95%	100%	100%	100%
Ethane	94%	95%	100%	100%	100%
Cyclopentane	94%	95%	100%	100%	100%
Cyclohexane	94%	95%	100%	100%	100%
Cis-2-Pentene	94%	95%	100%	100%	100%
Cis-2-Butene	94%	95%	100%	100%	100%
Benzene	94%	95%	100%	100%	100%
Acetylene	94%	95%	100%	100%	100%
Acetone		93%			90%
Acetaldehyde		93%			90%
3-Methylpentane	94%	95%	100%	100%	100%
3-Methylhexane	94%	95%	100%	100%	100%
3-Methylheptane	94%	95%	100%	100%	100%
2-Methylpentane	94%	95%	100%	100%	100%

Table 3-3 Summary of Data Completeness for PAMS Sites (continued)

Percent Completeness (Continued)					
Street Address	**Madera-Pump Yard**	**Clovis-Villa**	**Parlier**	**Shafter**	**Bakersfield-Muni**
2-Methylhexane	94%	95%	100%	100%	100%
2-Methylheptane	94%	95%	100%	100%	100%
2,4-Dimethylpentane	94%	95%	100%	100%	100%
2,3-Dimethylpentane	94%	95%	100%	100%	100%
2,3-Dimethylbutane	94%	95%	100%	100%	100%
2,3,4-Trimethylpentane	94%	95%	100%	100%	100%
2,2-Dimethylbutane	94%	95%	100%	100%	100%
2,2,4-Trimethylpentane	94%	95%	100%	100%	100%
1-Pentene	94%	95%	100%	100%	100%
1-Butene	94%	95%	100%	100%	100%
1,3,5-Trimethylbenzene	94%	95%	100%	100%	100%
1,2,3-Trimethylbenzene	94%	95%	100%	100%	100%
1,2,4-Trimethylbenzene	94%	95%	100%	100%	100%
Nitric Oxide	94%	94%	95%	93%	92%
Nitrogen Dioxide	94%	94%	95%	90%	92%
Oxides of Nitrogen	94%	94%	95%	91%	92%
Ozone	94%	94%	95%	91%	92%
Total NMOC	92%	93%	87%	90%	90%

Table reflects data from June, July, and August 2018.
Blank cells indicate no data was collected.

As mentioned above, measuring speciated ozone precursors reveals the degree to which they influence ozone formation. As such, the District examined the 2018 speciated ozone precursor data to determine which PAMS sites measured the highest precursor concentrations. Table 3-4 shows the degree of increase or decrease in precursor levels compared to the maximum ozone concentrations measured at those sites.

Table 3-4 Maximum Concentration for PAMS Sites

Year 2018						
Parameter	**Unit of Measure***	**Madera-Pump Yard**	**Clovis-Villa**	**Parlier**	**Shafter**	**Bakersfield-Muni**
Ozone	ppb	90.2	121.6	129.7	98.4	111.0
1,2,3-Trimethylbenzene	ppbc	0.4	0.2	0.2	0.2	0.4
1,2,4-Trimethylbenzene	ppbc	0.2	0.9	1.1	1.3	1.3
1,3,5-Trimethylbenzene	ppbc	0.2	0.9	0.6	0.6	0.8
1-Butene	ppbc	0.2	0.5	0.4	0.3	0.3
1-Pentene	ppbc	0.2	1.6	0.3	1.4	3.6
2,2,4-Trimethylpentane	ppbc	0.5	2.7	1.8	5.5	10.2
2,2-Dimethylbutane	ppbc	0.1	1.7	2.7	3.6	0.9
2,3,4-Trimethylpentane	ppbc	0.2	0.6	0.4	1.1	4.1
2,3-Dimethylbutane	ppbc	0.2	3.1	3.0	6.2	2.2
2,3-Dimethylpentane	ppbc	0.2	1.0	0.6	2.2	2.1
2,4-Dimethylpentane	ppbc	0.1	1.4	1.2	2.3	1.8
2-Methylheptane	ppbc	0.1	0.4	0.2	0.8	0.7
2-Methylhexane	ppbc	0.0	1.4	0.5	2.3	1.5
2-Methylpentane	ppbc	0.6	10.3	10.9	17.5	6.7
3-Methylheptane	ppbc	0.2	0.4	0.2	0.7	0.6
3-Methylhexane	ppbc	0.4	2.1	1.0	2.9	2.2
3-Methylpentane	ppbc	0.4	5.7	5.1	10.1	4.8
Acetaldehyde	ppbc		34.5			17.4
Acetone	ppbc		42.2			26.8
Acetylene	ppbc	1.7	3.5	2.7	2.9	2.7
Benzene	ppbc	2.1	3.9	3.8	2.4	2.0
Cis-2-Butene	ppbc	0.0	0.0	0.0	0.8	0.1
Cis-2-Pentene	ppbc	0.0	0.7	0.1	1.3	0.3
Cyclohexane	ppbc	0.3	2.0	2.8	3.3	4.0
Cyclopentane	ppbc	0.2	3.3	7.0	3.8	3.6
Ethane	ppbc	6.9	21.9	10.1	23.7	23.6
Ethylbenzene	ppbc	0.3	0.9	0.5	1.2	1.2
Ethylene	ppbc	2.3	4.8	4.2	2.6	3.1
Formaldehyde	ppbc		37.4			7.0
Isobutane	ppbc	6.4	24.2	14.6	32.6	14.6
Isopentane	ppbc	3.1	49.6	37.7	104.1	23.1
Isoprene	ppbc	0.9	10.6	1.4	3.8	1.4
Isopropylbenzene	ppbc	0.0	0.0	0.1	0.1	0.0
M/P Xylene	ppbc	1.0	3.3	1.5	4.2	4.1
M-Diethylbenzene	ppbc	0.0	0.0	0.1	0.2	0.0
Methylcyclohexane	ppbc	0.2	1.2	1.0	3.1	4.0
Methylcyclopentane	ppbc	0.4	5.9	5.7	10.1	8.1
M-Ethyltoluene	ppbc	0.3	1.0	1.1	1.2	1.2

Table 3-4 Maximum Concentration for PAMS Sites (continued)

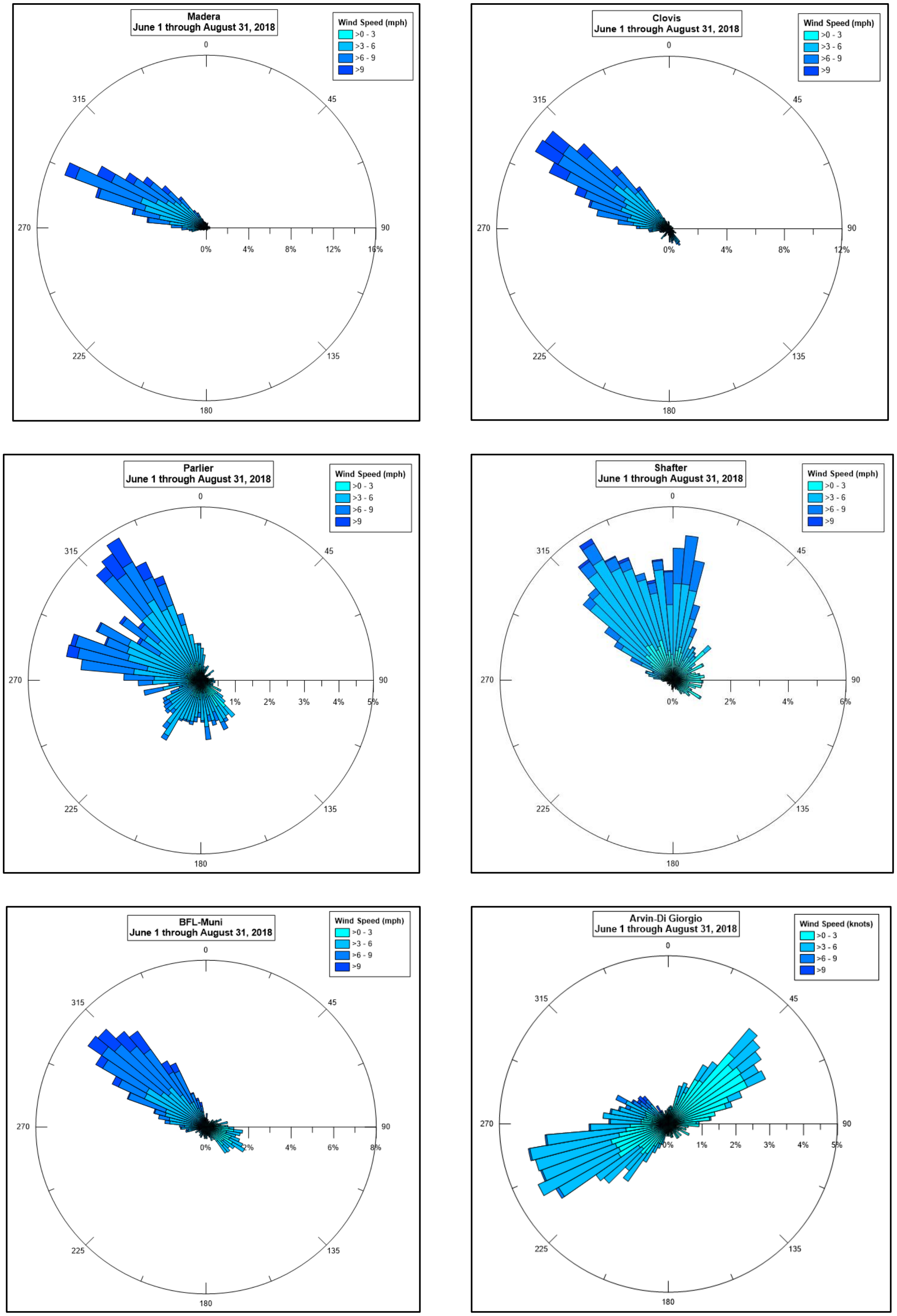
Year 2018						
Parameter	**Unit of Measure***	**Madera-Pump Yard**	**Clovis-Villa**	**Parlier**	**Shafter**	**Bakersfield-Muni**
N-Butane	ppbc	1.6	3.6	3.4	31.7	34.7
N-Decane	ppbc	0.3	0.9	1.0	0.5	0.6
N-Heptane	ppbc	0.8	2.0	0.9	2.6	2.8
N-Hexane	ppbc	0.6	7.4	5.5	8.4	6.5
N-Nonane	ppbc	0.3	0.7	0.6	0.6	0.5
N-Octane	ppbc	0.4	0.7	0.4	1.0	0.8
N-Pentane	ppbc	1.3	42.0	14.6	36.6	17.8
N-Propylbenzene	ppbc	0.0	0.3	0.1	0.2	0.4
N-Undecane	ppbc	0.3	0.4	0.9	0.9	0.6
O-Ethyltoluene	ppbc	0.0	0.7	9.0	10.2	0.4
O-Xylene	ppbc	0.3	1.1	0.6	1.7	1.7
P-Diethylbenzene	ppbc	0.0	0.0	0.1	0.4	0.2
P-Ethyltoluene	ppbc	0.3	1.1	0.7	0.8	1.0
Propane	ppbc	16.6	19.5	28.0	31.7	36.7
Propylene	ppbc	1.1	47.5	1.6	1.7	1.8
Styrene	ppbc	0.0	0.3	0.1	0.0	0.0
Toluene	ppbc	1.5	24.5	3.2	10.4	9.3
Trans-2-Butene	ppbc	0.0	0.0	0.0	0.9	0.1
Trans-2-Pentene	ppbc	0.1	1.3	0.3	2.6	0.6
Nitric Oxide	ppb	84.6	73.7	47.3	74.7	135.4
Nitrogen Dioxide	ppb	46.5	64.5	48.0	47.5	57.1
Oxides Of Nitrogen	ppb	103.0	104.9	71.7	98.9	156.5
Total NMOC	ppm	2.9	1.1	0.4	2.7	1.3

ppbc - parts per billion carbon
ppb – parts per billion
ppm – parts per million
Blank cells indicate no data was collected.

3.4 Wind Roses

Wind flow patterns play a significant role in the distribution of air pollutants in the Valley. The Valley's prevailing summer-time wind direction is generally from the northwest (northwesterly) during the day, with air flowing from Stockton southeastward toward Bakersfield. At night, the northwesterly winds continue but slow down due to the influence of surface cooling, eddies, and downslope flow from the surrounding mountains and foothills. As such, this wind flow pattern tends to carry ozone and its precursors southward where they get mixed via circular eddies, and then accumulate in the central and southern portions of the Valley. Figure 3-4 shows wind roses for each site in the District's PAMS network. Air essentially flows unobstructed between Madera and Shafter so the wind roses clearly depict the prevailing northwesterly wind direction at the PAMS sites located upwind of the Arvin Di Giorgio site. In contrast, the northwesterly wind flow gets diverted by the mountains and protruding foothills when it reaches southern Kern County so it becomes more southwesterly as a result. Additionally, during the night hours wind from the northeast typically flows downslope through the Highway 58 corridor and drains into the southern part of the San Joaquin Valley. Because of these topographic influences, wind directions are very different at the Arvin Di Giorgio site as is depicted on the site's wind rose.

Figure 3-2 Wind Roses for District's PAMS sites



Madera = Madera-Pump Yard, Clovis = Clovis-Villa, BFL-Muni = Bakersfield-Muni

4. TECHNICAL APPROACH AND FINDINGS – METEOROLOGICAL NETWORK ASSESSMENT

4.1 Meteorological Network Assessment Objectives

The goal of the meteorological network assessment presented in this section was to assess the number of meteorological parameters measured by the network, conduct wind rose and correlation analyses, and address the following questions:

- Are meteorological sites appropriately located to determine the extent of regional pollutant transport among populated areas?
- Are there potentially redundant meteorological sites in the network?
- Are there areas where new meteorological sites may be needed?
- Are there new technologies that may add value to the meteorological network?
- Is the meteorological network adequate for characterizing regional surface and lower atmosphere meteorology?

The remainder of this section describes the technical approach and findings of the meteorological network assessment.

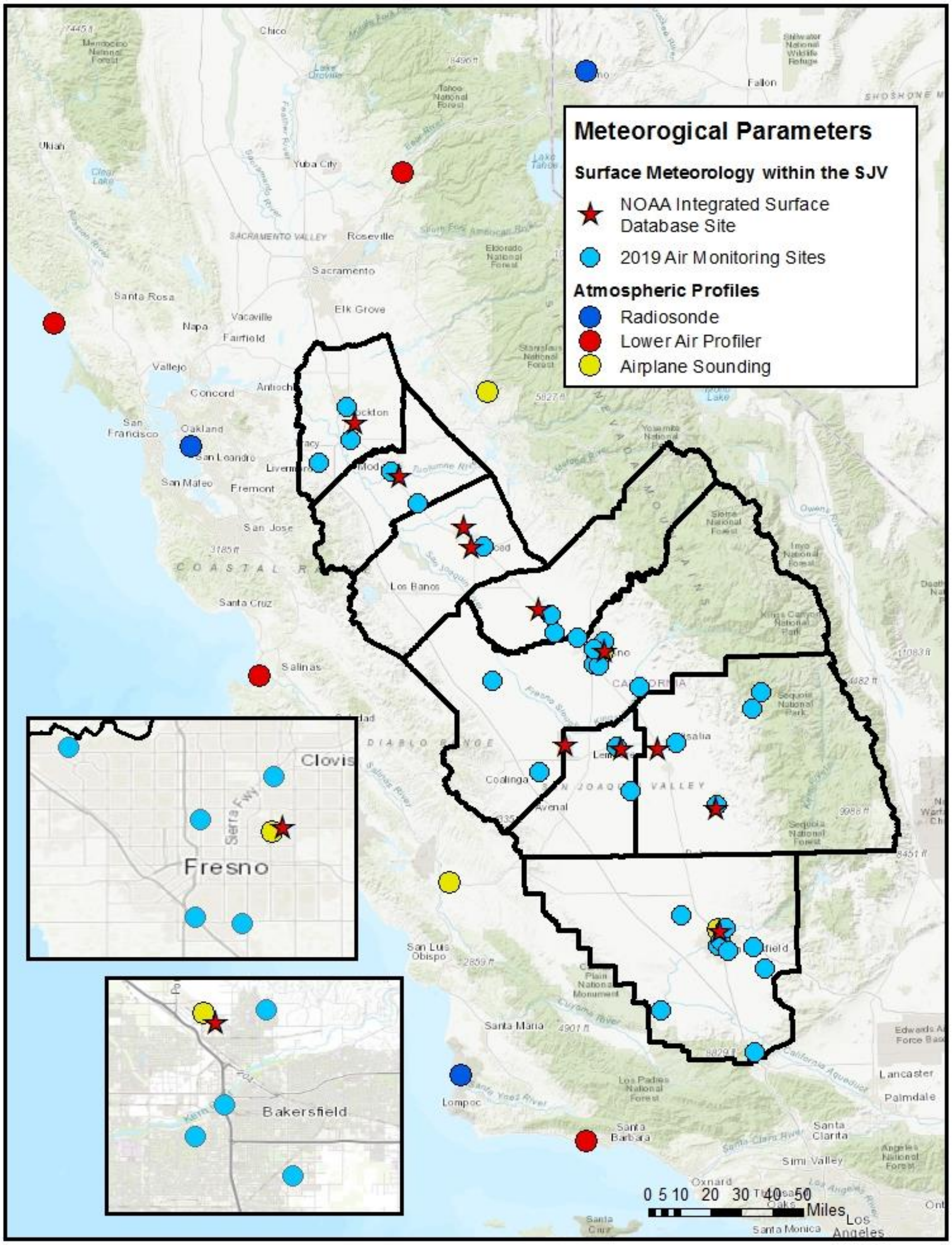
4.2 Meteorological Parameters and Site Locations

Accurate representation of the spatial and temporal characteristics of a region's meteorology is needed to understand the physical and chemical processes that influence air quality and to help determine ways to mitigate future air quality impacts. The main meteorological conditions that influence air quality include transport of pollutants by winds, recirculation of air by local wind patterns, horizontal dispersion of pollution by wind, variations in sunlight due to clouds and seasons, temperature, moisture, vertical mixing, and dilution of pollution within the atmospheric boundary layer.

A variety of meteorological parameters are measured for the various District objectives affected by the weather. Such objectives include air quality forecasting, PAMS analysis, exceptional events reporting, long–term air pollution control planning, and pollutant trend assessment. These efforts help protect public health and increase awareness of what can be done to reduce air pollution.

Figure 4-1 shows a map of the NOAA (National Oceanic and Atmospheric Administration) and Air Monitoring surface meteorological sites and atmosphere profile sites operating in and around the San Joaquin Valley. The meteorological parameters measured by the surface network include outdoor temperature, wind speed, wind direction, barometric pressure, relative humidity, and solar radiation. All valley sites are located in or near populated areas and tend to be around areas of higher pollution concentrations. The meteorological sites currently in operation are appropriately located to determine the extent of regional pollutant transport among populated areas. In addition, a robust meteorological network of California Irrigation Management Information System (CIMIS), CAL-Trans, Remote Automatic Weather Stations (RAWS), and Public Utilities (such as PG&E) meteorological instruments can be utilized to monitor atmospheric conditions around the San Joaquin Valley.

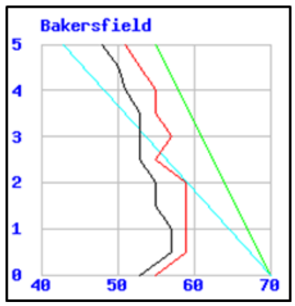
Figure 4-1 Map of the locations measuring various meteorological parameters within and around District



4.3 Upper Air Observations

Radiosondes launched twice a day are meteorological instrument packs suspended beneath a six-foot wide hydrogen or helium balloon. Once the balloon is launched, meteorological measurements are recorded and transmitted to a ground receiver as the balloon ascends to high altitudes.

Airplane soundings are vertical temperature profiles, and sometimes other variables that are captured by a plane equipped with meteorological instruments. The measurements are taken during portions of the plane's ascent or descent flight track.



4.4 Surface Meteorological Data Analysis

To evaluate the surface meteorological network, the District reviewed meteorological data obtained from the EPA's AQS (Air Quality System). The data sets included relative humidity, barometric pressure, outdoor temperature, wind speed, and wind direction data collected in the San Joaquin Valley during 2018. The District used this data to determine meteorological data completeness and for each site.

4.4.1 Data Completeness

Data completeness was compiled using AMP430 AQS Report. The District, along with the California Air Resources Board (CARB), and the National Park Service (NPS) operate sites that measure meteorology year-round round in the San Joaquin Valley, and the Tulare County foothills. Table 4-1 lists the 30 sites that measure meteorology, the site operating agencies, and the 2018 meteorological data completeness for those sites. The findings were as follows:

- 29 of 30 sites had more than 75% data completeness for all of the meteorological parameters measured which included relative humidity, barometric pressure, temperature, wind speed, and wind direction.

- Data completeness for 14 of 18 sites measuring relative humidity was 95% or greater.

- Data completeness for 14 of 18 sites measuring barometric pressure was 99% or greater.

- Data completeness for 6 of 9 sites measuring solar radiation was 89% or greater.
- Data completeness for 27 of 29 sites measuring temperature was 89% or greater.
- Data Completeness for 27 of 30 sites measuring wind speed and wind direction parameters 89% or greater.

Table 4-1 Data Completeness for Sites Measuring Meteorology in the San Joaquin Valley

Site Name	Site Operator	Data Completeness (%)					
		Relative Humidity	Barometric Pressure	Solar Radiation	Outdoor Temperature	Wind Speed	Wind Direction
Stockton-Hazelton^	CARB	98			98	98*	98**
Manteca	SJVAPCD		100		100	100	87
Tracy-Airport	SJVAPCD		100		100	100	100
Modesto-14th St^	CARB	84			84	98*	98**
Turlock	SJVAPCD		99		99	99	99
Merced-Coffee	SJVAPCD				100	100	100
Madera–City	SJVAPCD	89	100	84	100	100	100
Madera-Pump Yard	SJVAPCD	100	100	100	100	100	100
Tranquillity	SJVAPCD		76		100	100	100
Fresno-Sierra Sky Park	SJVAPCD				90	90	90
Clovis-Villa	SJVAPCD	99	89	99	99	99	99
Fresno-Garland^	CARB	95			95	95*	95**
Fresno–Drummond	SJVAPCD	96	96			96	96
Fresno-Foundry	SJVAPCD		100		100	100	100
Parlier	SJVAPCD	99	99	99	99	99	99
Huron	SJVAPCD		100				
Hanford-Irwin	SJVAPCD		100		100	100	100
Corcoran-Patterson	SJVAPCD				100	100	100
Visalia Airport	SJVAPCD	98	100	100	100	100	100
Visalia-Church St^	CARB	100			100	100*	100**
Sequoia-Ash Mountain	NPS	99		99	99	93*	93**
Porterville	SJVAPCD		99		99	98	98
Shafter	CARB	100	100	50	100	100	100

Table 4-1. Data Completeness for Sites Measuring Meteorology in the San Joaquin Valley (continued)

Site Name	Site Operator	Data Completeness (%)					
		Relative Humidity	Barometric Pressure	Solar Radiation	Outdoor Temperature	Wind Speed	Wind Direction
Oildale^	CARB	97			97	97*	96**
Bakersfield-California Ave^	CARB	99			99	98*	98**
Edison^	CARB	94			94	94*	94**
Bakersfield-Muni	SJVAPCD	100	100	100	100	100	100
Arvin-Di Giorgio^	CARB	99			99	100*	100**
Maricopa	SJVAPCD		98		98	90	98
Lebec	SJVAPCD		100		100	100	100
Sequoia-Lower Kaweah[1]	NPS	58		58	58	57*	57**

Table reflects data from 2018.
Blank cells indicate that a parameter was not measured at the site.
Cells shaded orange indicate data completeness was below an 85% target.
* Resultant Wind Speed
** Resultant Wind Direction
^ CARB sites began measuring Scalar Wind Speed and Scaler Wind Direction in June 2018.
[1] Sequoia-Lower Kaweah operates seasonally measuring meteorology during the summer months only.

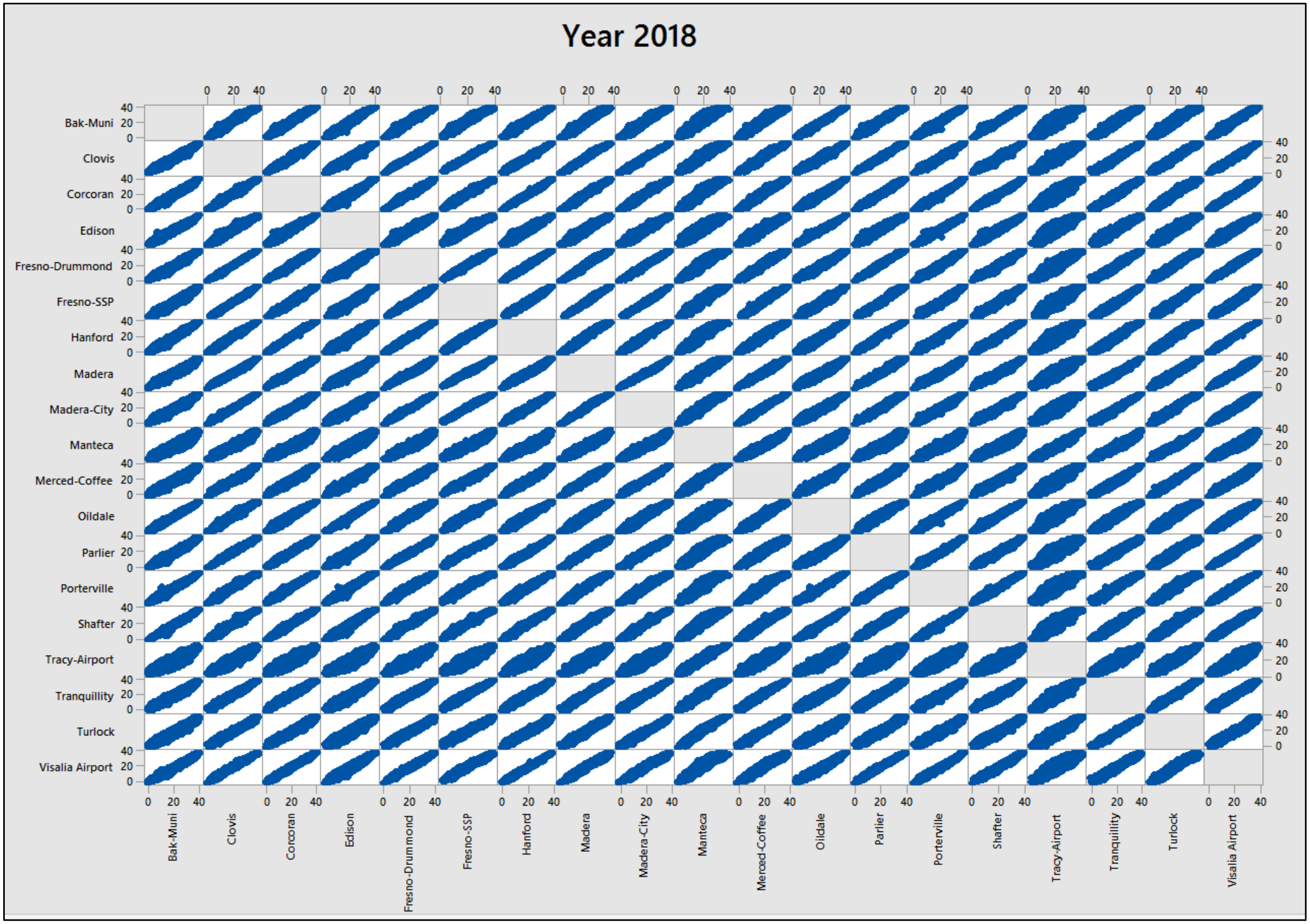
4.4.2 Site-to-Site Correlation Analyses

To identify possible redundancies in the surface meteorological network, the District conducted Pearson correlation analyses for hourly outdoor temperature, relative humidity, and solar radiation from 2018 AQS data. The Pearson correlation coefficient (R) between site pairings shows how well the data agree. The R value is a measure of the linear relationship between two variables and ranges from -1.00 to 1.00. An R value of 1.00 means that there is a positive linear relationship between the data from two sites which could indicate a redundancy in the monitoring network for sites near each other. Figures 4-2 through 4-5 and Tables 4-2 through 4-5 below show the results of the correlation analyses.

4.4.2.1 Outdoor Temperature

The outdoor temperature correlations are quite good, and reflect the geographic and environmental characteristics of the San Joaquin Valley. As shown in Table 4-2 below, the correlations between sites reveal a strong linear relationship between outdoor temperature readings among most Valley sites near one another. Outdoor temperatures tend to be regional and rarely differ by more than a few degrees across large portions of the valley. The correlations for the foothill and mountain sites are also good, which are indicative of seasonal and climatic similarities at those sites.

Figure 4-2 Outdoor Temperature Correlations for Valley Floor Sites

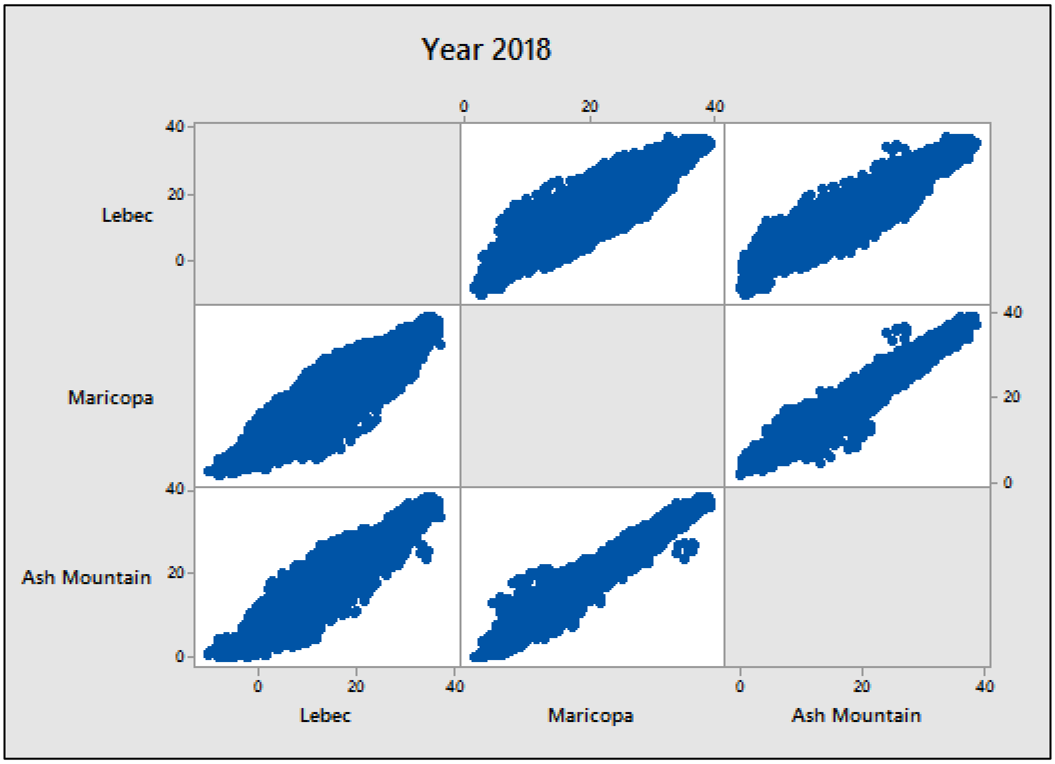


Bak-Muni = Bakersfield-Muni AMS, Clovis = Clovis-Villa AMS, Fresno-SSP = Fresno-Sierra Sky Park AMS, Madera = Madera-Pump AMS

Table 4-2 Outdoor Temperature R-Values for Valley Floor Sites

Year 2018																		
Pearson Correlation Coefficients																		
	Bakersfield-Muni	Clovis-Villa	Corcoran-Patterson	Edison	Fresno-Drummond	Fresno-Sierra Sky Park	Hanford-Irwin	Madera-Pump Yard	Madera-City	Manteca	Merced-Coffee	Oildale	Parlier	Porterville	Shafter	Tracy-Airport	Tranquillity	Turlock
Clovis-Villa	0.98																	
Corcoran-Patterson	0.98	0.99																
Edison	0.98	0.98	0.97															
Fresno-Drummond	0.98	1.00	0.99	0.97														
Fresno-Sierra Sky Park	0.98	0.99	0.99	0.97	0.99													
Hanford-Irwin	0.99	0.99	0.99	0.97	1.00	0.99												
Madera-Pump Yard	0.97	0.99	0.99	0.97	0.99	0.99	0.98											
Madera-City	0.98	0.99	0.99	0.97	0.99	1.00	0.99	0.99										
Manteca	0.94	0.96	0.96	0.94	0.96	0.96	0.96	0.97	0.97									
Merced-Coffee	0.97	0.99	0.99	0.96	0.99	0.99	0.98	0.99	0.99	0.98								
Oildale	0.99	0.98	0.98	0.99	0.98	0.98	0.98	0.97	0.97	0.94	0.97							
Parlier	0.98	0.99	0.99	0.97	0.99	0.99	0.99	0.99	0.99	0.96	0.98	0.98						
Porterville	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.95	0.98	0.99	0.99					
Shafter	0.99	0.99	0.99	0.98	0.99	0.98	0.99	0.98	0.99	0.95	0.98	0.99	0.99	0.99				
Tracy-Airport	0.92	0.94	0.93	0.92	0.94	0.94	0.94	0.94	0.94	0.97	0.95	0.93	0.93	0.93	0.92			
Tranquillity	0.97	0.99	0.99	0.97	0.99	0.99	0.99	0.99	0.99	0.97	0.99	0.97	0.98	0.98	0.98	0.95		
Turlock	0.96	0.98	0.98	0.95	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.96	0.98	0.97	0.97	0.96	0.99	
Visalia Airport	0.98	0.99	0.99	0.98	0.99	0.99	0.99	0.99	0.99	0.96	0.98	0.98	0.99	0.99	0.99	0.94	0.98	0.98

Figure 4-3 Outdoor Temperature Correlations for the Foothill and Mountain Sites



Ash Mountain = Sequoia-Ash Mountain air monitoring site

Table 4-3 Outdoor Temperature R-Values for the Foothill and Mountain Sites

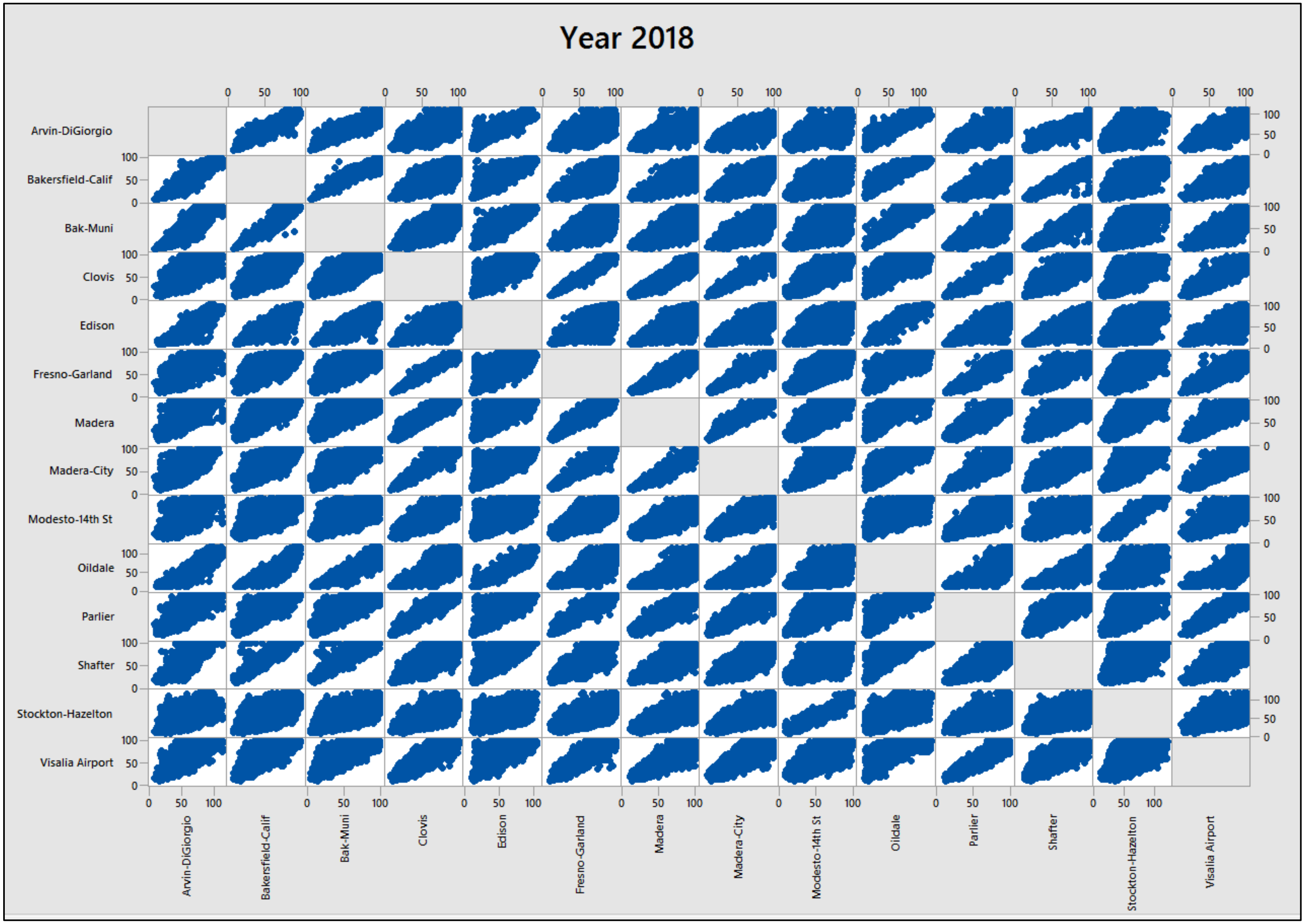
Year 2018		
Pearson Correlation Coefficients		
	Lebec	**Maricopa**
Maricopa	0.89	
Ash Mountain	0.92	0.97

Ash Mountain = Sequoia-Ash Mountain air monitoring station

4.4.2.2 Relative Humidity

Overall, the correlations for relative humidity for the valley floor and the mountain sites are good, but the range is also wider than that exhibited by the outdoor temperature correlations. Relative humidity can vary and change significantly depending on location, time of day, and season. Such variations in relative humidity can cause fluctuations in ozone and particulate concentrations that are challenging to forecast and evaluate. The variability among sites, as indicated by the large range of correlation values, demonstrates that there is little monitor redundancy.

Figure 4-4 Relative Humidity Correlations for Valley Floor Sites



Bak-Muni = Bakersfield-Muni AMS, Clovis = Clovis-Villa AMS, Fresno-SSP = Fresno-Sierra Sky Park AMS, Madera = Madera-Pump AMS

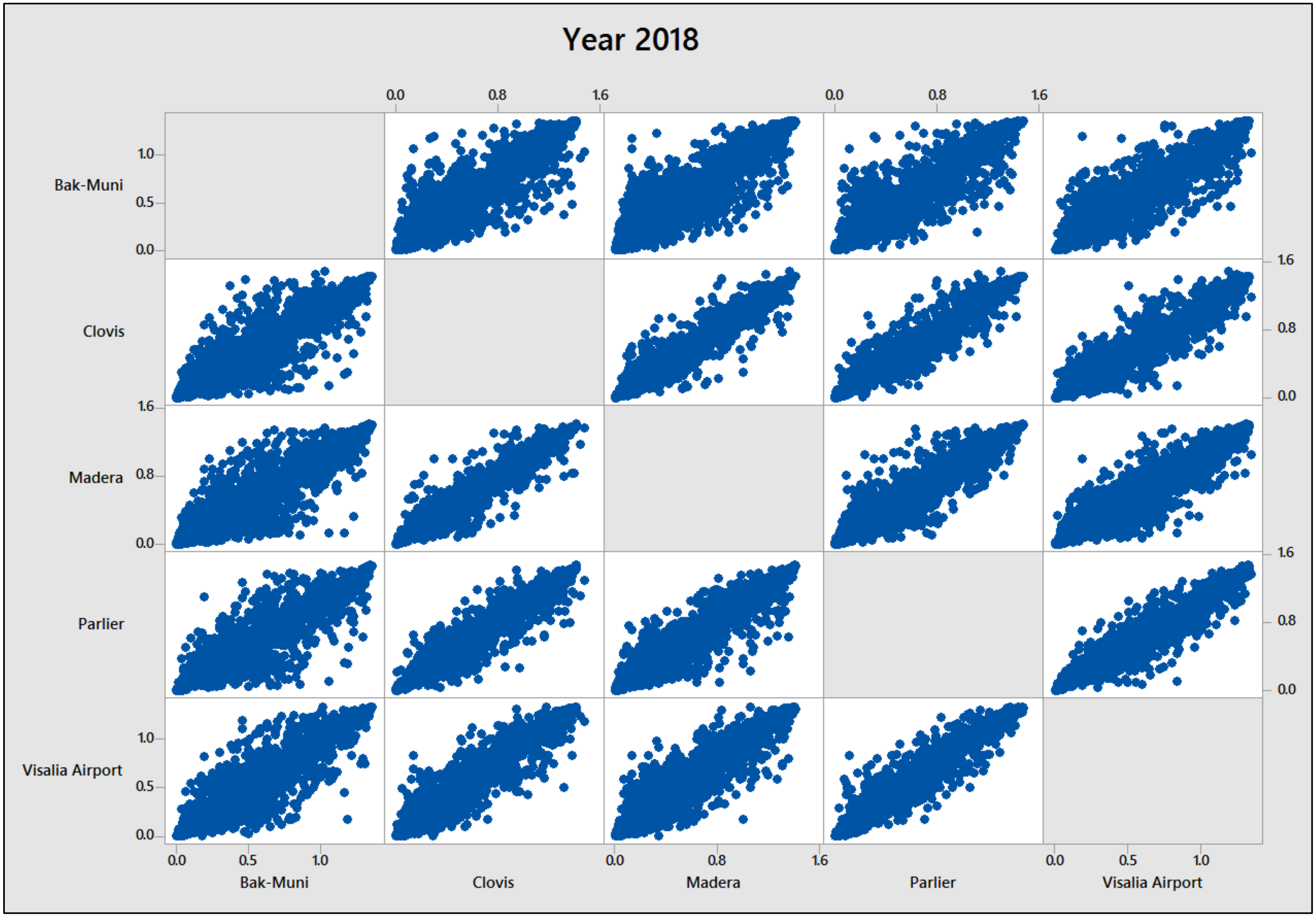
Table 4-4 Relative Humidity R-Values

Year 2018														
Pearson Correlation Coefficients														
	Arvin-DiGiorgio	Bakersfield-California Ave	Bakersfield-Muni	Clovis-Villa	Edison	Fresno-Garland	Madera-Pump Yard	Madera-City	Modesto-14th St	Oildale	Parlier	Shafter	Stockton-Hazelton	Visalia Airport
Bakersfield-California Ave	0.94													
Bakersfield-Muni	0.93	0.98												
Clovis-Villa	0.88	0.91	0.91											
Edison	0.91	0.92	0.93	0.86										
Fresno-Garland	0.88	0.92	0.90	0.98	0.84									
Madera-Pump Yard	0.87	0.88	0.87	0.96	0.81	0.95								
Madera-City	0.87	0.89	0.88	0.97	0.83	0.97	0.97							
Modesto-14th St	0.80	0.82	0.82	0.88	0.76	0.88	0.88	0.88						
Oildale	0.89	0.93	0.94	0.86	0.96	0.85	0.80	0.83	0.78					
Parlier	0.87	0.90	0.90	0.96	0.83	0.96	0.95	0.95	0.86	0.83				
Shafter	0.92	0.96	0.95	0.91	0.87	0.92	0.91	0.91	0.83	0.87	0.92			
Stockton-Hazelton	0.78	0.80	0.79	0.85	0.73	0.85	0.86	0.85	0.96	0.74	0.83	0.80		
Visalia Airport	0.88	0.90	0.91	0.94	0.84	0.93	0.94	0.93	0.86	0.84	0.97	0.93	0.83	
Visalia-Church St	0.91	0.93	0.92	0.95	0.88	0.95	0.92	0.93	0.86	0.89	0.96	0.93	0.83	0.96

4.4.2.3 Solar Radiation

The solar radiation correlations for the valley floor sites are very good and are representative of the daily diurnal pattern of daylight hours as well as effects of cloud cover and the seasonal changes in sun angle. Due to the regional nature of solar radiation, high correlation among sites is expected.

Figure 4-5 Solar Radiation Correlations for Valley Floor Sites



Bak-Muni = Bakersfield-Muni air monitoring station Clovis = Clovis-Villa air monitoring station Madera = Madera-Pump air monitoring station

Table 4-5 Solar Radiation R Values for Valley Floor Sites

Year 2018				
Pearson Correlation Coefficients				
	Bakersfield-Muni	Clovis-Villa	Madera-Pump Yard	Parlier
Clovis-Villa	0.98			
Madera-Pump Yard	0.98	0.99		
Parlier	0.98	0.99	0.99	
Visalia Airport	0.98	0.99	0.98	0.99

4.4.3 Discussion of Surface Meteorological Network Assessment

A comparison of surface meteorological parameters shows the expected amount of variability between sites. Meteorology measured at mountain sites tends to be more variable from site to site while the Valley floor sites all correlate well with one another, especially as the distance between the sites decreases. Given that the correlations among the outdoor temperature for the Valley floor sites are rather high, an investigation to determine redundancy is needed. Correlations for the remaining meteorological parameters reveal that there are no other redundancies in the District.

Other meteorological parameters such as wind speed and direction can be highly localized and short-lived, so the differences between sites may not be captured in a simple correlation analysis. Analyzing the pollutants and wind direction during high wind or localized pollution events is extremely important during exceptional events such as high winds or fires. It is therefore important to continue surface meteorological monitoring at the sites already in use.

4.4.4 Wind Rose Analyses

The ability of the surface meteorological network to represent the spatial and temporal variations of meteorological flow patterns that affect the San Joaquin Valley largely depends on site location. In 2010, Sonoma Technologies, Inc. (STI) conducted a detailed wind rose analysis which assessed the District's meteorological network's representativeness. The analysis is found in the District's *Ambient Air Quality Monitoring Network Assessment for the San Joaquin Valley*, which was submitted to the EPA with the *San Joaquin Valley Air Pollution Control District's Air Monitoring Network Plan* in July 2010. The District examined wind roses which showed prevailing wind directions at various locations and helped determine that the District's meteorological network is representative of the San Joaquin Valley air flow patterns.

4.5 Lower Atmosphere Profiler Network Assessment

In 1998, the District began monitoring meteorology at the Visalia Airport and Tracy Airport sites as part of the aforementioned PAMS network. The PAMS program requirements included lower air profile measurements which the District met by operating lower atmosphere profilers (LAPs) at those sites. EPA recently revised the PAMS program requirements and LAPs are no longer required in PAMS networks.

Given that lower air profile data is useful to the air quality forecasting process, the District has considered the prospect of a ceilometer network as a replacement for the LAPs. Ceilometer data is used for determining mixing layer height which indicates the degree of vertical mixing occurring in the lower atmosphere. CARB is currently operating a ceilometer network which includes sites in Fresno and Bakersfield. This network is measuring backscatter raw data to assess boundary layer for research purposes. The District inquired about gaining access to the ceilometer data and CARB agreed to make the data available. Additionally, the District may continue to investigate the possibility of adding ceilometers to its own air monitoring network.

4.6 Technology Advancements

Sonic Anemometer

The District's surface meteorological network includes measuring wind speed and direction with cup anemometers and sonic anemometers. The sonic anemometers use ultrasonic sound waves to measure wind speed and direction. They have no moving parts and are maintenance-free. As the District upgrades its air monitoring network over the next several years, it will gradually retire the remaining cup anemometers and replace them with sonic anemometers.

Ceilometer

Ceilometers use lasers to measure cloud ceilings and mixing heights. According to Eresmaa, et. al., mixing heights are measured based on changes in particulate concentrations at the top of the boundary layer (2006). These instruments are more cost effective and have smaller footprints than did the previous LAPs.

5. AIR MONITORING NETWORK ASSESSMENT RECOMMENDATIONS

The conclusions drawn from the monitoring network assessment are listed below. Methods, results, and discussions of these recommendations are provided in the assessment above.

Criteria Pollutants

- The current network accurately represents populated areas impacted by PM2.5 and ozone pollution and meets regulatory requirements.
- Method Detection Limit (MDL) and data completion analyses reveal that the current criteria pollutant network sufficiently and accurately monitors criteria pollutants in the District.
- Tracy, Merced-Coffee, Madera-Pump Yard, and Tranquillity sites are the most valuable District operated sites for determining ozone NAAQS attainment.
- Merced-M St and Clovis-Villa sites are the most valuable District operated sites for determining PM2.5 NAAQS attainment.
- CARB operated sites are important to monitoring Valley pollution. Stockton-Hazelton and Modesto-14th St. sites are valuable CARB operated sites at determining Ozone and PM2.5 NAAQS attainment.
- Area- and population-served analyses of PM2.5 and ozone monitoring networks prove that there are no redundant monitors.
- Population-served analysis indicates that the majority of District monitors are either in or within 4 km of Environmental Justice areas.
- There are some locations in the Valley, particularly the foothill regions of Fresno and Madera Counties, which may need investigation as to whether they may benefit from additional PM2.5 and ozone monitoring if feasible in the future.
- Emissions-served analysis shows the two near-road Nitrogen Dioxide (NO_2) sites (Fresno-Foundry and Bakersfield-Westwind) will provide data to cover the State Route-99 corridor.
- Statistical correlation analysis among sites measuring PM2.5 and ozone confirm the population- and emissions-served conclusions that the network is adequate.

PAMS

- The analyses of percent completion for 2018 data show an overall high percentage of completion for all of the District's PAMS sites.
- Photochemical modeling of 2018 ozone data supports that the current PAMS configuration is adequate.

Meteorology

- Statistical correlation analyses among the sites measuring meteorological parameters in the San Joaquin Valley and adjacent foothill and mountain areas is quite good and indicates that there are no redundant monitors in the District's meteorological network.

- Analysis of the District's meteorological sites located in or near populated areas reveals that those sites are representative of those areas and indicates that the District's meteorological network is adequate.
- If feasible in the future, further investigation could help determine whether addition of meteorological monitoring in the foothill region of Fresno and Madera counties, could be a beneficial addition to the network.
- The District is gradually replacing cup anemometers with new, maintenance-free, cost effective sonic anemometers for measuring wind speed and direction throughout the Valley. Additionally the District is working to acquire access to meteorological data being measured by ceilometers being operated by CARB.

6. REFERENCES

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