



Technical Evaluation of Sensor Technology (TEST) Program

*PurpleAir PA-II Sensor
2021 – 2nd Quarter*



Introduction and Sensor Profile

This analysis report is focused on assessing the performance of the PurpleAir PA-II sensor as a part of the District's Technical Evaluation of Sensor Technology (TEST) Program. The PurpleAir PA-II sensor uses an optical laser-based particle counting methodology to estimate the mass of varying diameters of particulate matter, including PM1, PM2.5, and PM10. The PA-II sensor also measures temperature, pressure, and relative humidity.

Background and Approach of Evaluation Test

In November of 2017, NASA began an air quality study to compare the performance of PurpleAir sensors to regulatory PM2.5 monitors. The study is focused on the conditions in the San Joaquin Valley and is based at California Air Resources Board (CARB) air monitoring sites of, Fresno-Garland, Modesto-14th St, Visalia-Church, and Bakersfield-California. In 2019, the District began operating PurpleAir sensors at the District's Clovis-Villa air monitoring site and in the Shafter and South Central Fresno AB 617 communities.

The data sets analyzed for this report compare PM2.5 data collected from PurpleAir sensors and Federal Equivalent Method (FEM) monitors that are collocated at the CARB and District air monitoring sites listed above. The scatter plots and time series graphs below show how the datasets compare for both hourly values and the 24-hour average.

Overview of Analysis Findings from Current Period

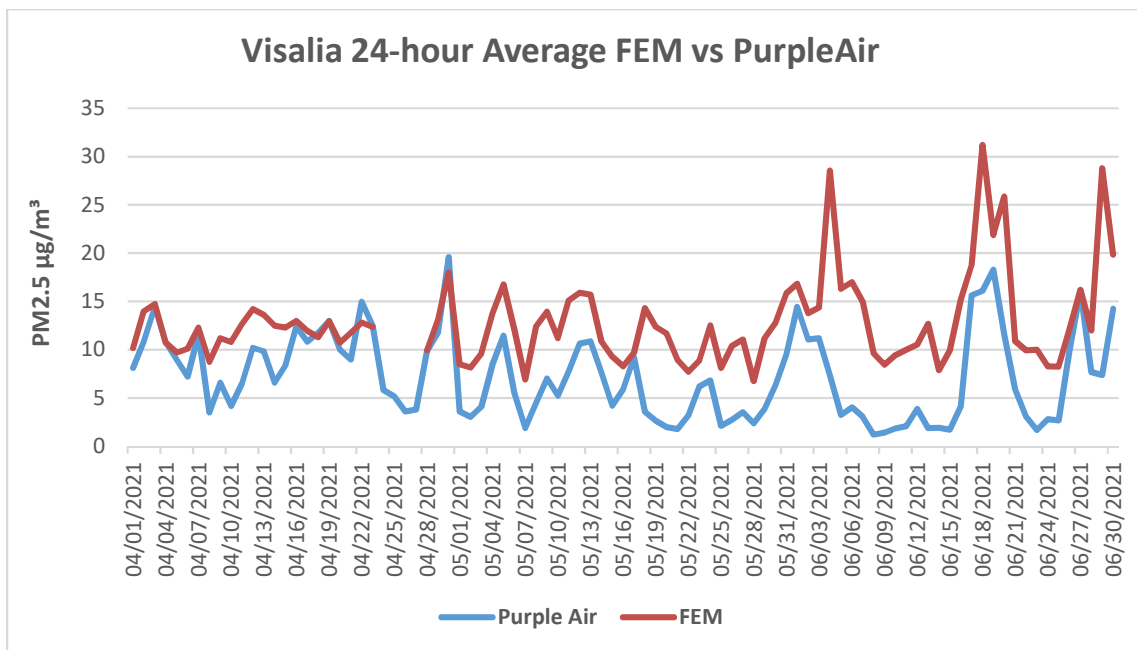
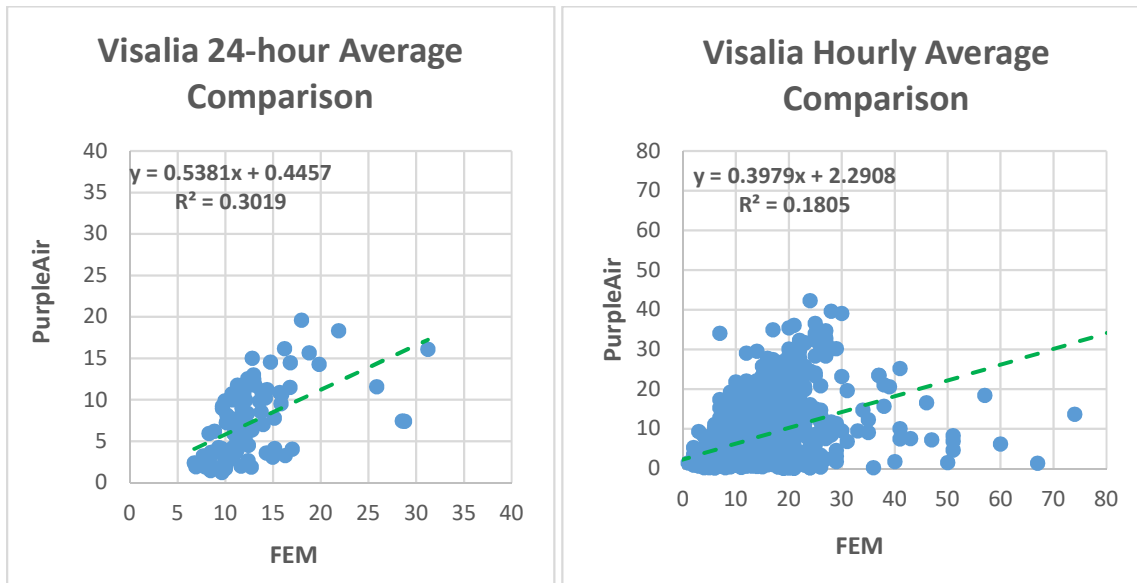
The analysis for this report covers the time period of April 1, 2021, through June 30, 2021 (2021 – 2nd quarter). During this period, hourly data was removed from the calculation of bias when either the PurpleAir sensor or regulatory monitor did not have a valid hourly sample. For the 24-hour averages, only days with 18 or more valid hourly samples (75% or greater completeness) are included.

Seasonally, PM2.5 is typically highest during the winter months and lowest during the summer months. Weather systems can influence PM2.5 levels by either trapping pollutants near the surface or dispersing them. Generally, California's weather pattern is characterized by high pressure systems and low pressure systems that move through the region every two to four days in alternating fashion. As the 2nd quarter progressed, temperatures grew warmer and the high pressure systems that built over the region rendered stronger stability, particularly during the end of May-beginning of June and mid-June time frames. The low pressure systems that passed through brought good dispersion to the area yet only one of them delivered precipitation to the Valley, and small amounts at that. As such, conditions across the Valley were quite dry by the end of the 2nd quarter.

Site Specific Analysis of PurpleAir PA-II Sensor Performance

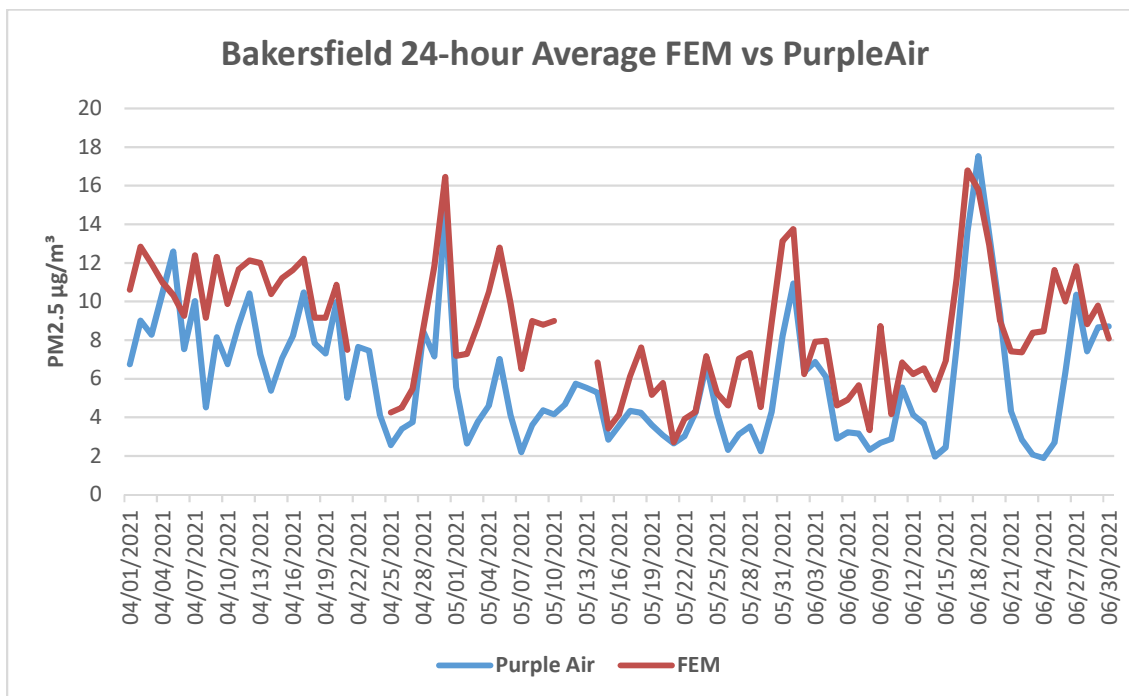
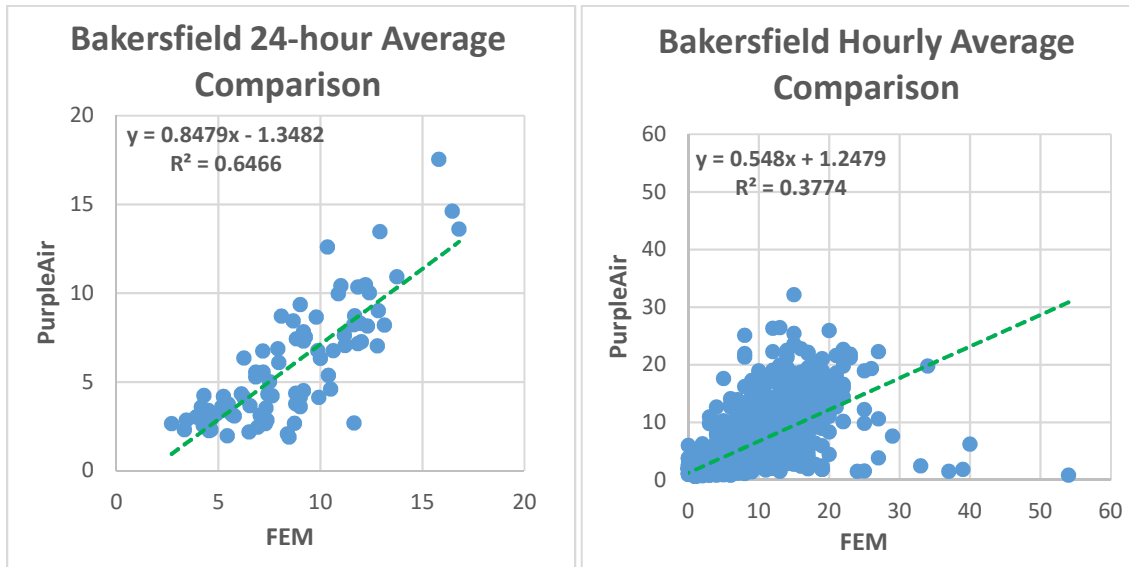
Visalia-Church

For the 24-hour average, PurpleAir data had a 5.6 µg/m³ low bias during the April 1, 2021, through June 30, 2021, period. For the hourly average, PurpleAir data had a low bias of 5.4 µg/m³ over the same period.



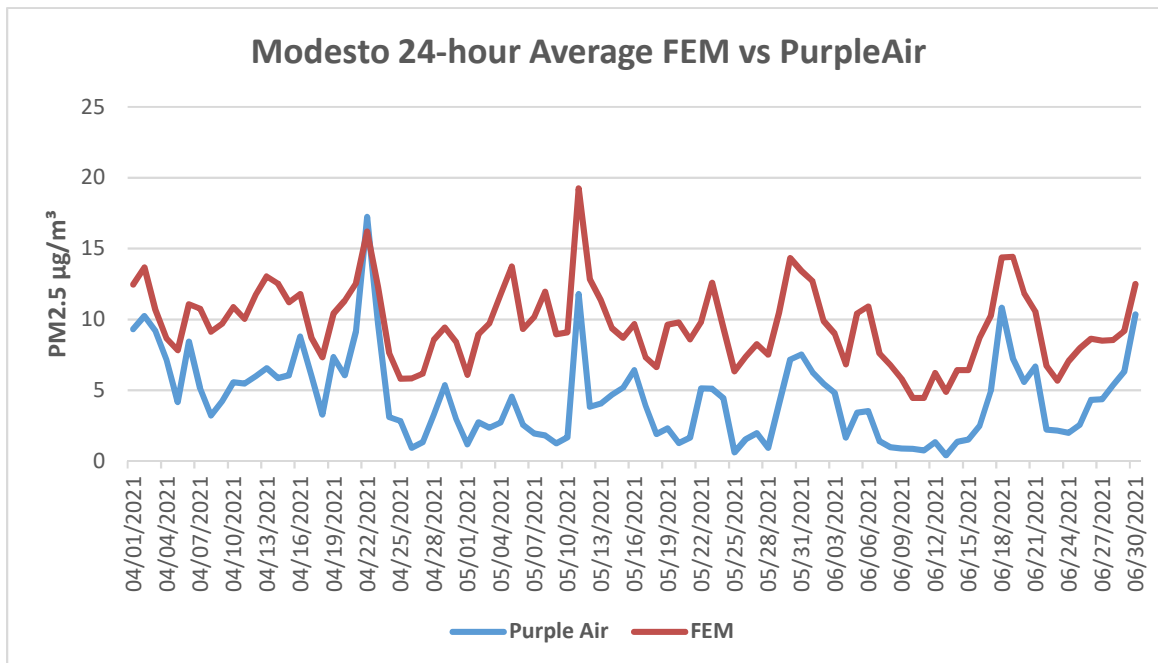
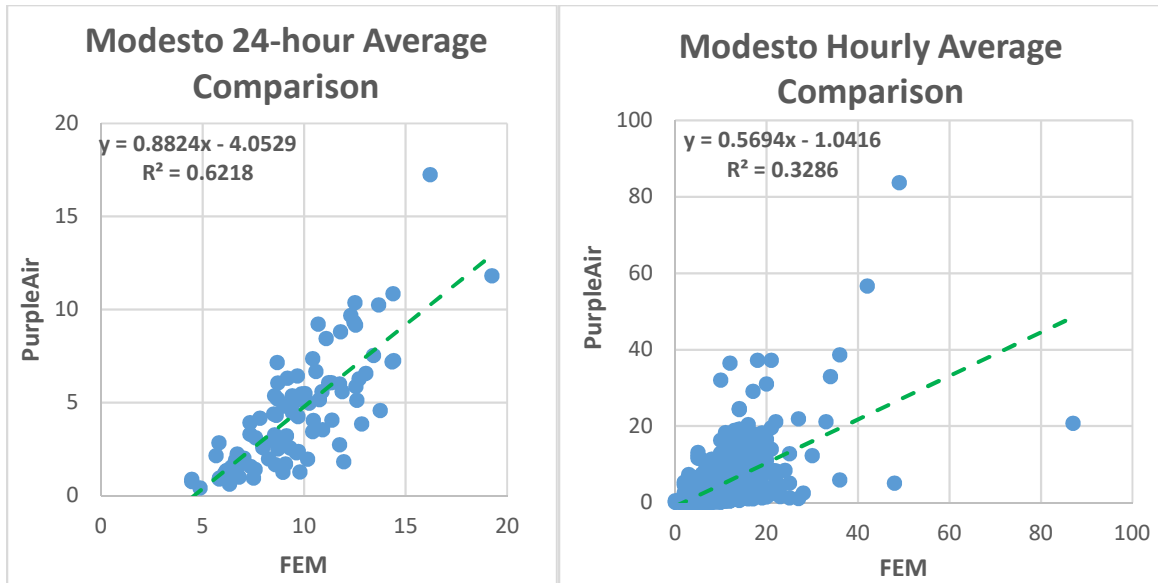
Bakersfield-California

For the 24-hour average, PurpleAir data had a 2.7 µg/m³ low bias during the April 1, 2021, through June 30, 2021, period. For the hourly average, PurpleAir data had a low bias of 2.7 µg/m³ over the same period.



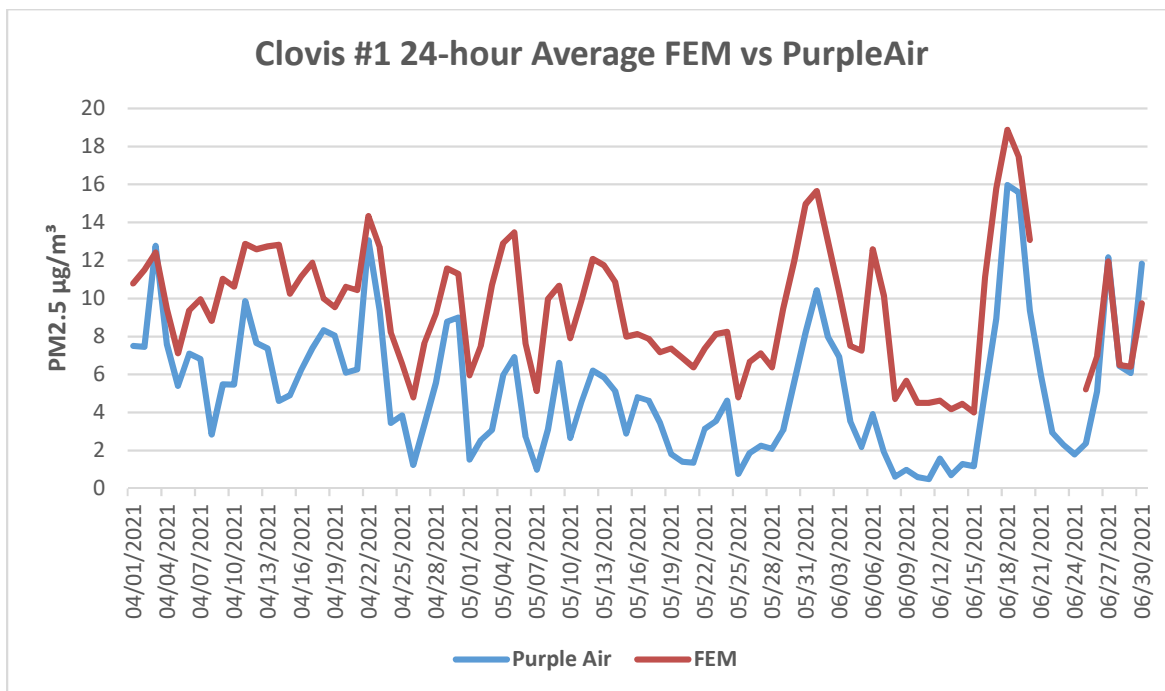
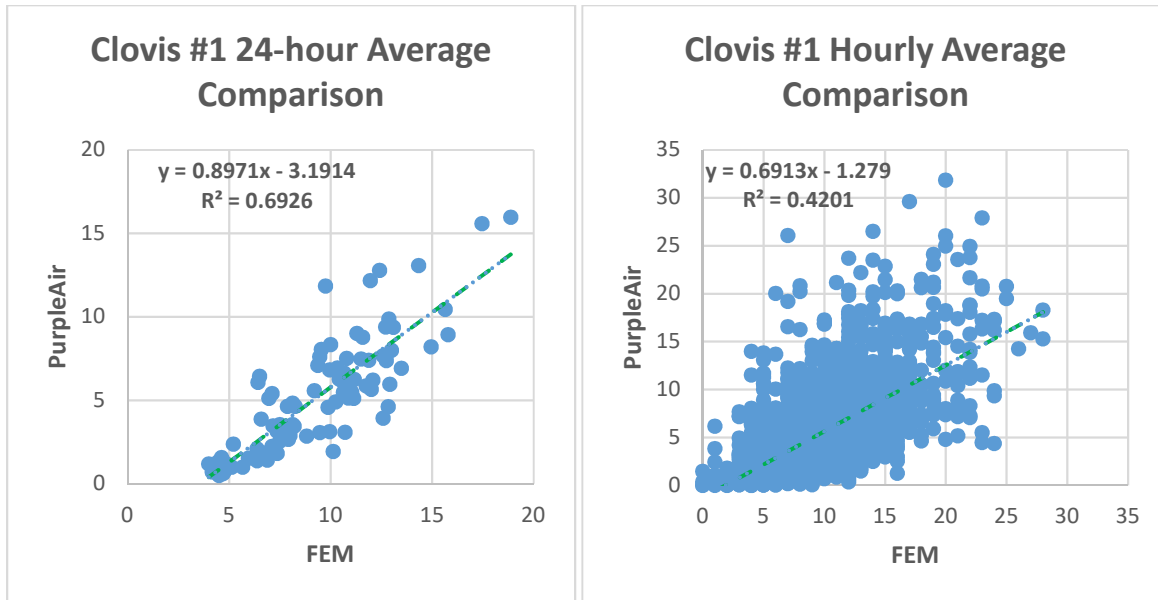
Modesto-14th St.

For the 24-hour average, PurpleAir data had a 5.2 µg/m³ low bias during the April 1, 2021, through June 30, 2021, period. For the hourly average, PurpleAir data had a low bias of 5.2 µg/m³ over the same period.



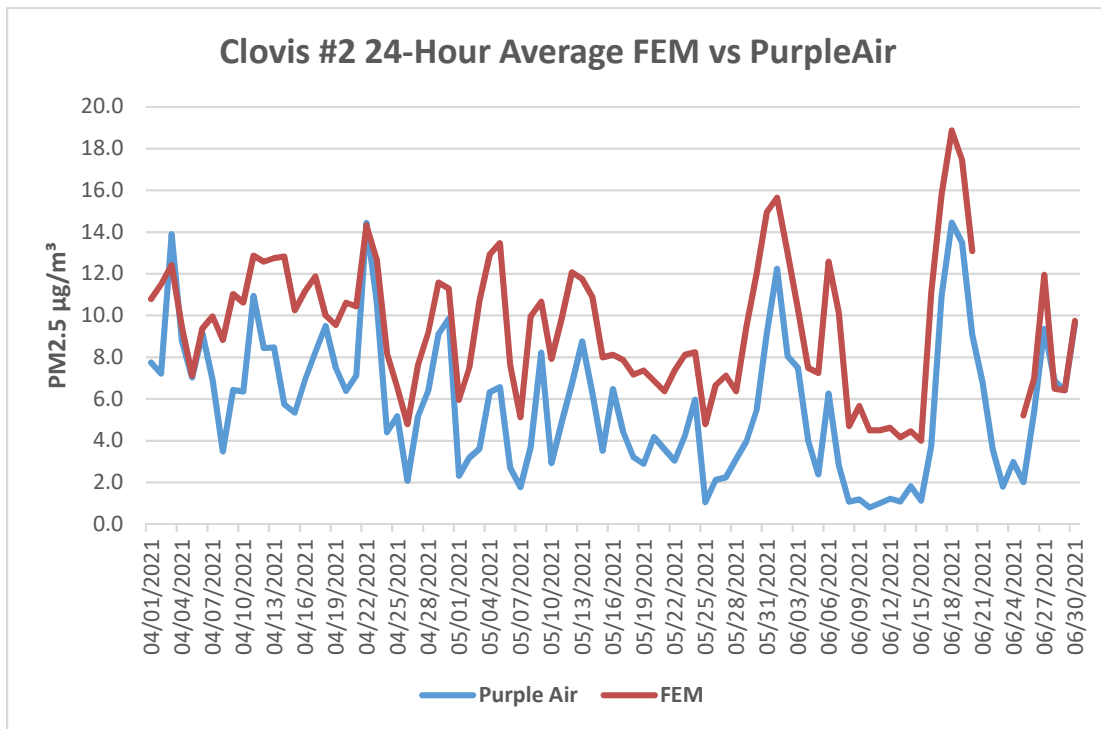
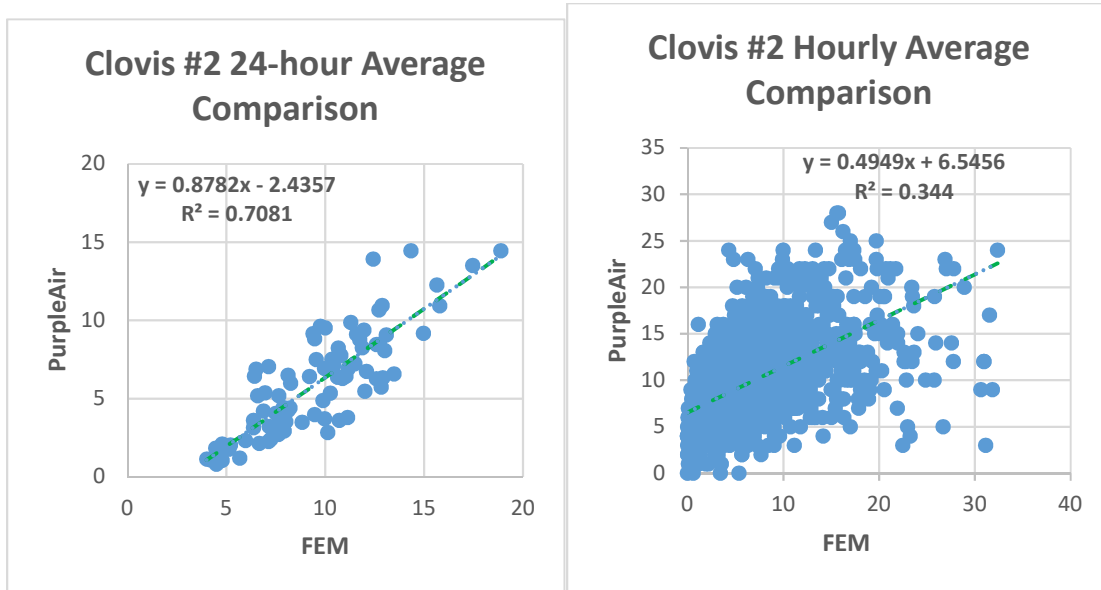
Clovis-Villa #1

For the 24-hour average, PurpleAir data had a 4.3 $\mu\text{g}/\text{m}^3$ low bias during the April 1, 2021, through June 30, 2021, period. For the hourly average, PurpleAir data had a low bias of 4.3 $\mu\text{g}/\text{m}^3$ over the same period.



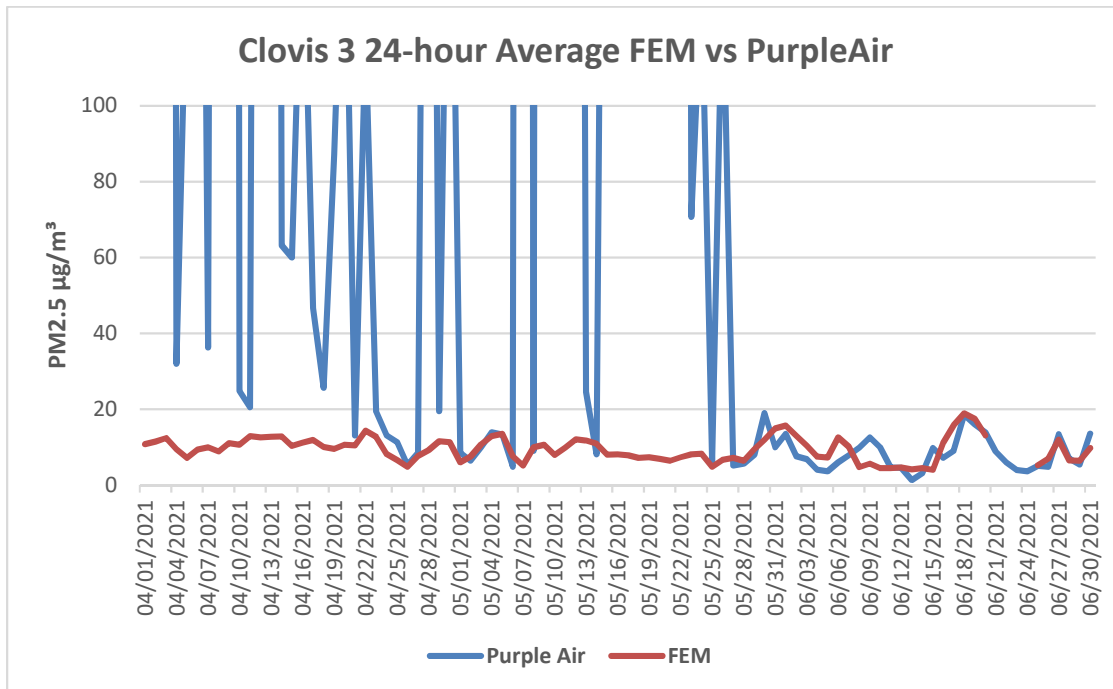
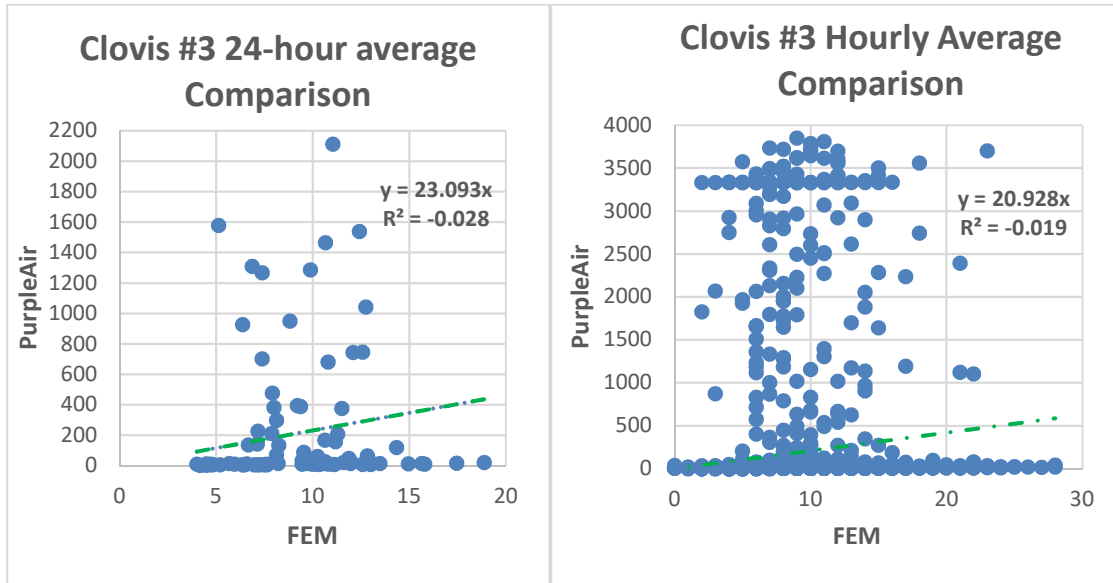
Clovis-Villa #2

For the 24-hour average, PurpleAir data had a 3.7 $\mu\text{g}/\text{m}^3$ low bias during the April 1, 2021, through June 30, 2021, period. For the hourly average, PurpleAir data had a low bias of 3.7 $\mu\text{g}/\text{m}^3$ over the same period.



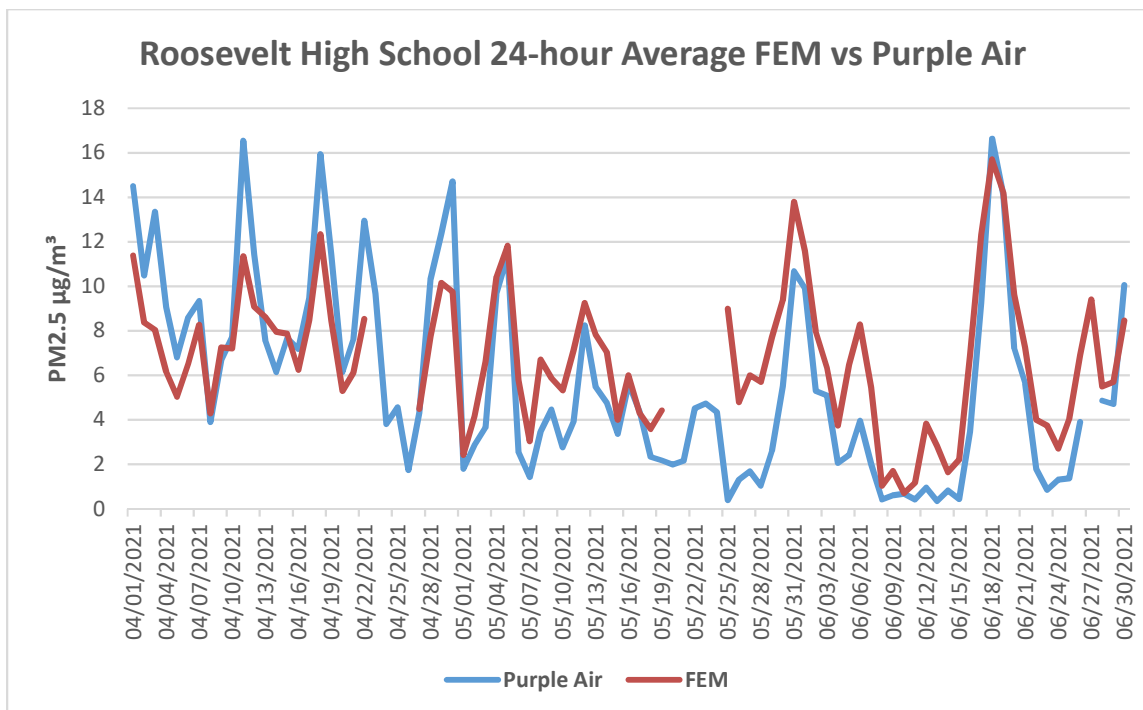
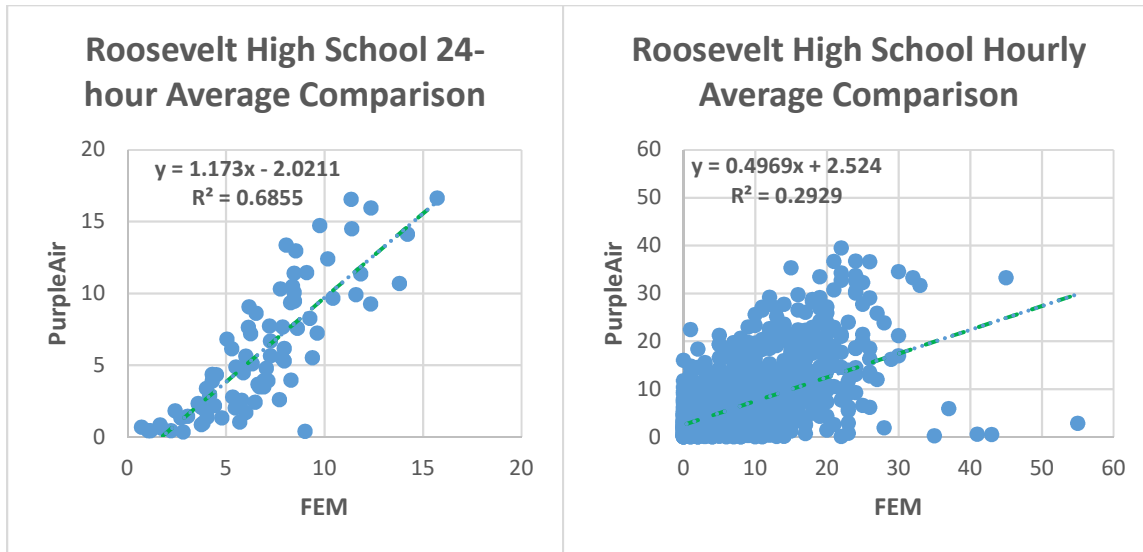
Clovis-Villa #3

For the 24-hour average, PurpleAir data had a 222.3 $\mu\text{g}/\text{m}^3$ high bias during the April 1, 2021, through June 30, 2021, period. For the hourly average, PurpleAir data had a high bias of 224.7 $\mu\text{g}/\text{m}^3$ over the same period.



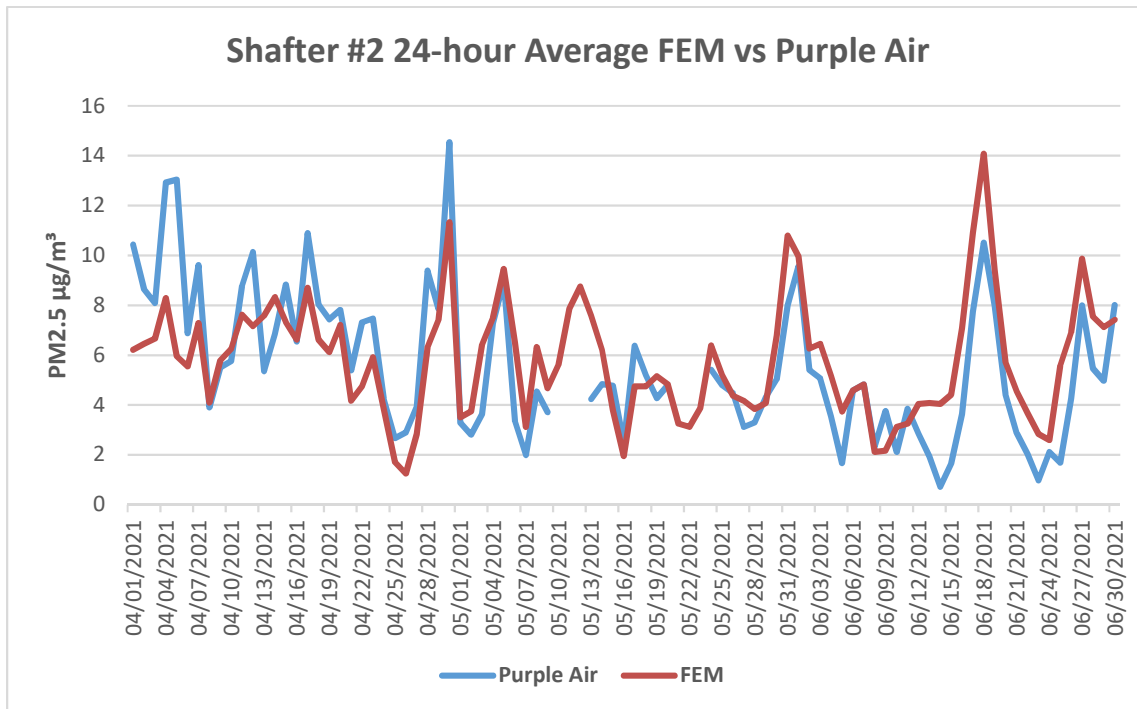
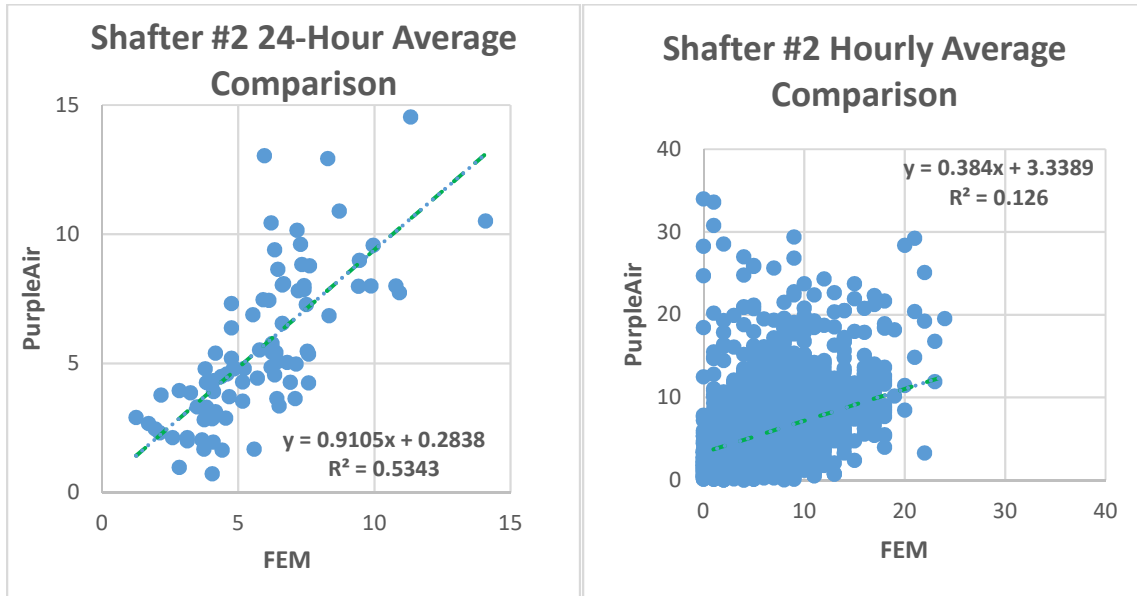
South Central Fresno – Roosevelt High School

For the 24-hour average, PurpleAir data had a 1.1 µg/m³ low bias during the April 1, 2021, through June 30, 2021, period. For the hourly average, PurpleAir data had a low bias of 1.1 µg/m³ over the same period.



Shafter #2

For the 24-hour average, PurpleAir data had a 0.2 µg/m³ low bias during the April 1, 2021, through June 30, 2021, period. For the hourly average, PurpleAir data had a low bias of 0.2 µg/m³ over the same period.



Non-Reporting Sites

Fresno-Garland

Data from this sensor was not available for the April 1, 2021, through June 30, 2021, period. This sensor will be included in future analysis reports if the data becomes available.

Statistical Summary

The following tables provides a statistical summary of the PM2.5 data collected during the analysis period of this report.

Table A – Fresno-Garland, Visalia-Church, Bakersfield-California, and Modesto-14th Sites

Statistic	Fresno-Garland	Visalia-Church	Bakersfield-CA	Modesto-14 th
FEM Avg. 24-hr	PurpleAir sensor at this site did not report during this period	12.8	8.6	9.6
Sensor Avg. 24-hr		7.2	6.0	4.4
FEM Max 1-hr		86.0	54.0	87.0
Sensor Max 1-hr		42.3	32.2	83.7
FEM Max 24-hr		31.2	16.8	19.3
Sensor Max 24-hr		19.6	17.5	17.2
1-hr R ²		0.1805	0.3774	0.3286
1-hr Slope		0.3979	0.5480	0.5694
1-hr Intercept		2.2908	1.2479	-1.0416
24-hr R ²		0.3019	0.6466	0.6218
24-hr Slope		0.5381	0.8479	0.8824
24-hr Intercept		0.4457	-1.3482	-4.0529

Table B – Clovis-Villa Site

Statistic	Clovis-Villa PurpleAir #1	Clovis-Villa PurpleAir #2	Clovis-Villa PurpleAir #3
FEM Avg. 24-hr	9.4	9.4	9.4
Sensor Avg. 24-hr	5.2	5.8	231.7
FEM Max 1-hr	28.0	28.0	28
Sensor Max 1-hr	31.8	32.4	3849.72
FEM Max 24-hr	18.9	18.9	18.9
Sensor Max 24-hr	16.0	14.5	2111.2
1-hr R ²	0.4201	0.3440	-0.019
1-hr Slope	0.6913	0.4949	20.928
1-hr Intercept	-1.2790	6.5456	-
24-hr R ²	0.6926	0.7081	-0.028
24-hr Slope	0.8971	0.8782	23.093
24-hr Intercept	-3.1914	-2.4357	-

Table C – South Central Fresno and Shafter Sites

Statistic	South Central Fresno	Shafter
FEM Avg. 24-hr	6.8	5.8
Sensor Avg. 24-hr	5.8	5.6
FEM Max 1-hr	55.0	24.0
Sensor Max 1-hr	39.5	45.0
FEM Max 24-hr	15.7	14.1
Sensor Max 24-hr	16.6	14.5
1-hr R ²	0.2929	0.1260
1-hr Slope	0.4969	0.3840
1-hr Intercept	2.5240	3.3389
24-hr R ²	0.6855	0.5343
24-hr Slope	1.1730	0.9105
24-hr Intercept	-2.0211	0.2838