



San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Technical Evaluation of Sensor Technology (TEST) Program

*Clarity Node Sensor
2019 – 3rd Quarter*



Introduction and Sensor Profile

This analysis report is focused on assessing the performance of the Clarity Node sensor as a part of the District's Technical Evaluation of Sensor Technology (TEST) Program. The Clarity sensor uses optical laser-based particle counting methodology to estimate the concentration of PM_{2.5}. The Clarity sensor also measures CO₂, NO₂, Total VOCs, temperature, and relative humidity within a solar powered box. A unique feature of the Clarity Node sensor is its ability to self-correct its PM_{2.5} estimates based on real-time regulatory monitor readings in the area. This self-calibration process is aimed to result in more accurate PM_{2.5} measurements from the Clarity Node sensors, making them a more viable option for various monitoring projects.

Background and Approach of Evaluation Test

In late 2017, the Clarity Movement Company approached the District regarding the testing of their Clarity Node sensors in the conditions of the San Joaquin Valley. After coordination on where the sensors could be placed in the District's network for testing, on February 28, 2018, five Clarity sensors were installed and started collecting data to compare the performance of Clarity sensors to regulatory PM_{2.5} analyzers. Clarity Node sensors were installed at the District air monitoring stations of Clovis-Villa, Manteca, Merced-Coffee, Tracy-Airport, and Tranquillity. The data sets analyzed for this report compare PM_{2.5} data collected from Clarity sensors and Federal Equivalent Method (FEM) monitors that are collocated at the 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

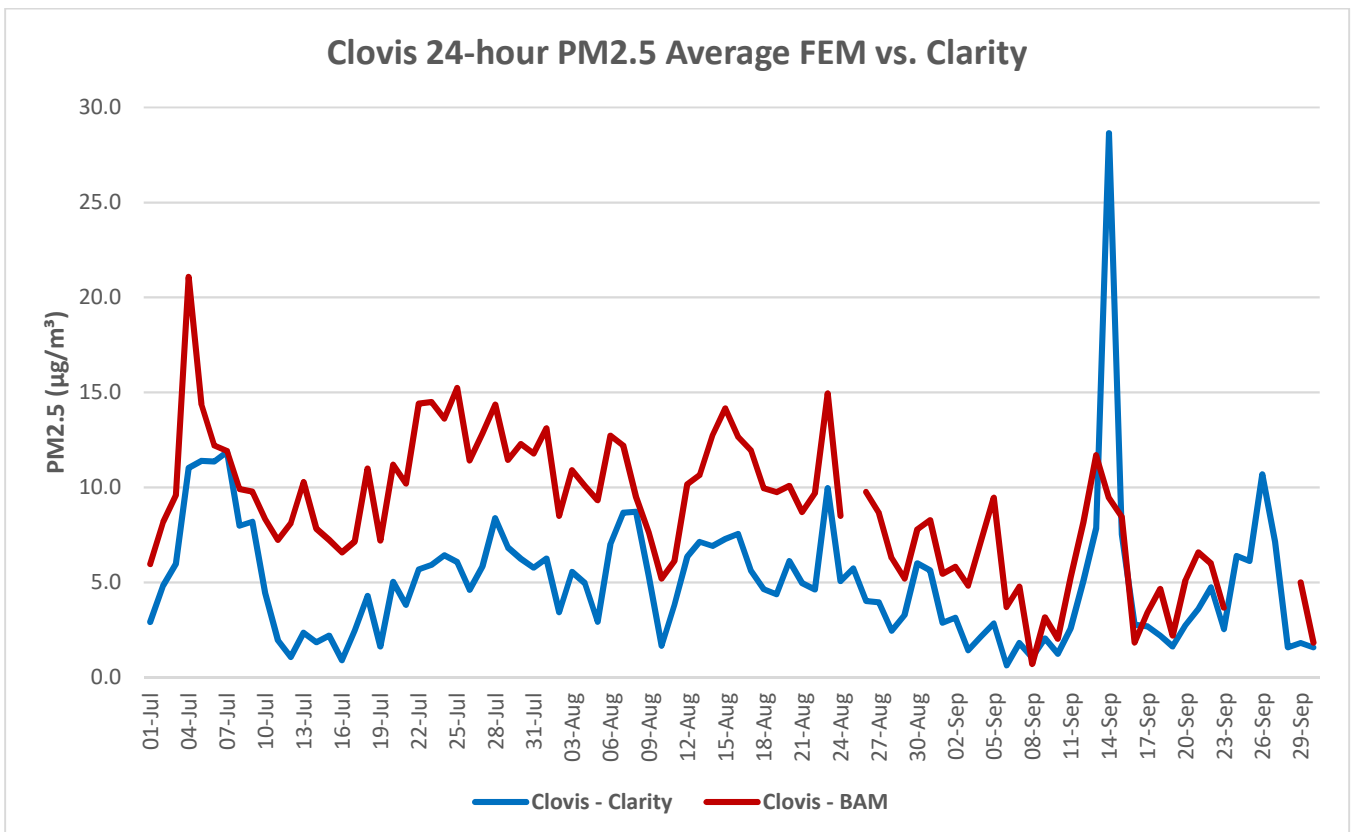
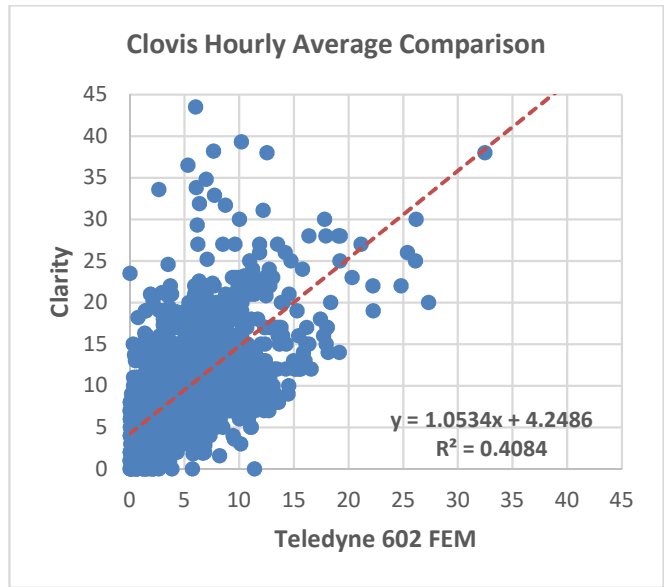
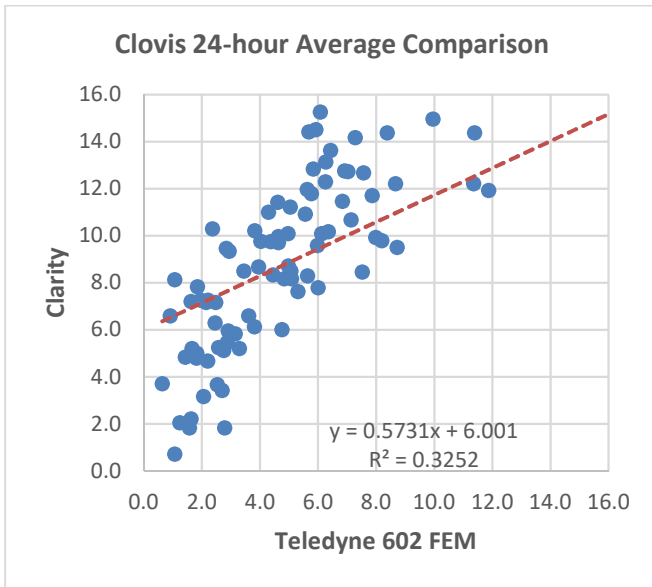
This assessment compares the Clarity Node performance against two different regulatory PM_{2.5} monitors operating in the District's network – the MetOne BAM-1020 and the Teledyne 602. The analysis for this report covers the period of July 2019 through September 2019 (2019 – 3rd quarter). During this period, hourly data was removed from the calculation of bias when either the Clarity sensor or regulatory monitor did not have a valid sample. For the 24 hour average line graphs, all available data is shown for each collocated analyzer and sensor. For the first part of the third quarter analysis, the Clarity sensor at the Clovis site was compared to data from the BAM from July 1 to Sept. 22 since it was more available than the 602, which was used in previous quarterly analyses.

Concentrations during the 3rd quarter of 2019 were influenced by periods of high pressure over the region which caused an increase in temperatures and stability. Several low pressure systems moved through the region with gusty winds, especially on the west side and mountain passes. These systems also brought an increase of onshore flows that helped decrease temperatures and increase dispersion. The bias remained low at all stations, except for Tranquillity where the Clarity sensor reported five hours of 1,000 µg/m³ and above on July 16 and 17 which skewed the daily average to a high value. The FEM for both the hourly and 24-hour averages at Tranquillity remained below the teens.

Site Specific Analysis of Clarity-Node Sensor Performance

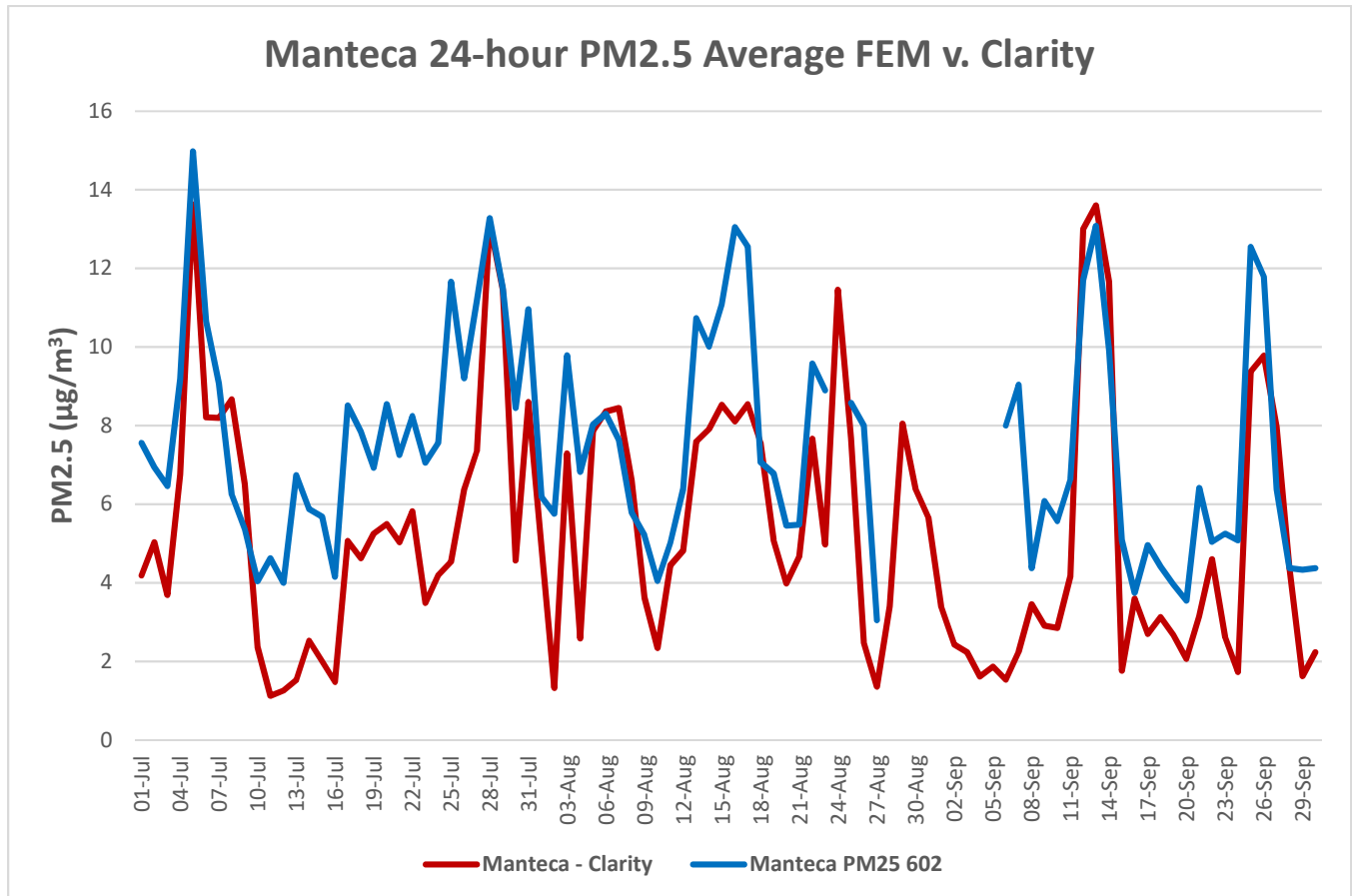
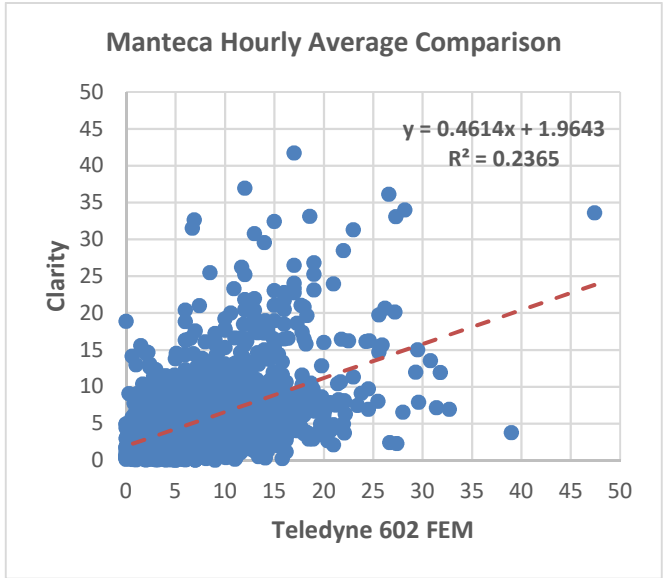
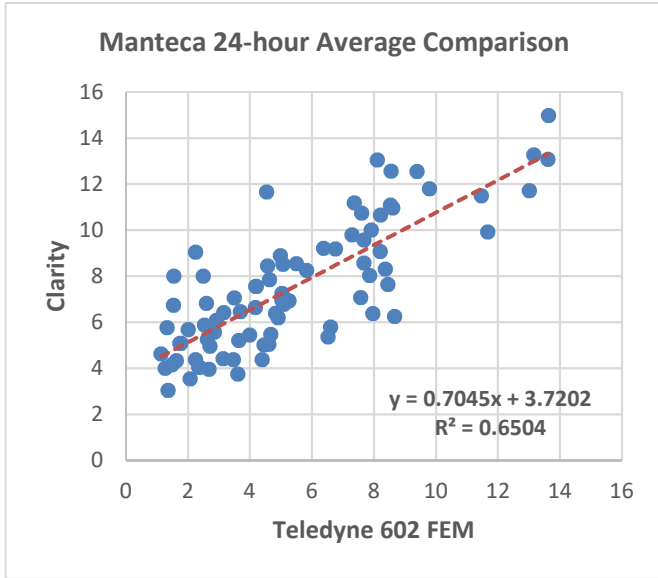
Clovis-Villa

For the 24-hour average, Clarity data had a 3.9 µg/m³ low bias during the July 2019 through September 2019 period. For the hourly average, Clarity data had a 3.7 µg/m³ low bias over the same period.



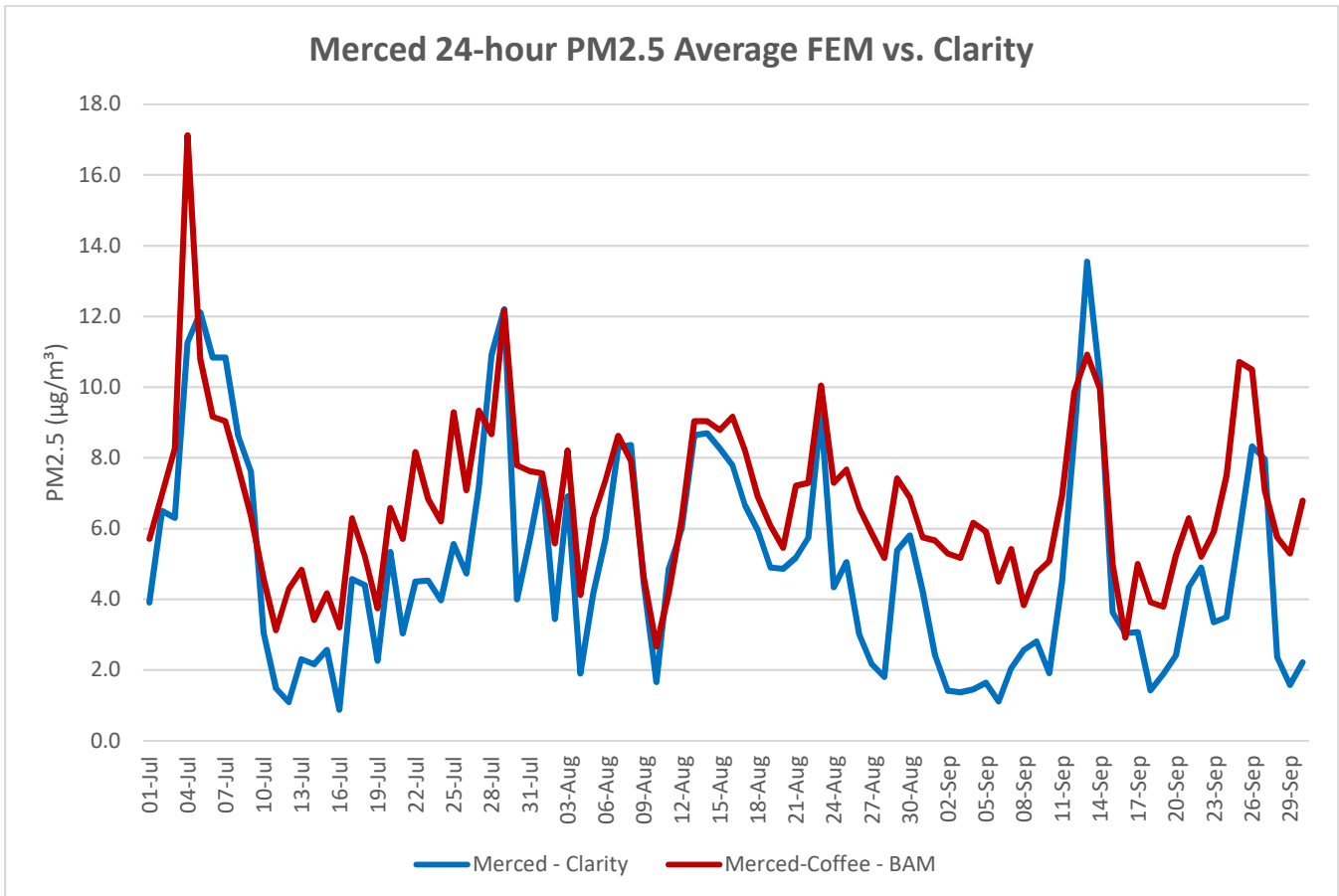
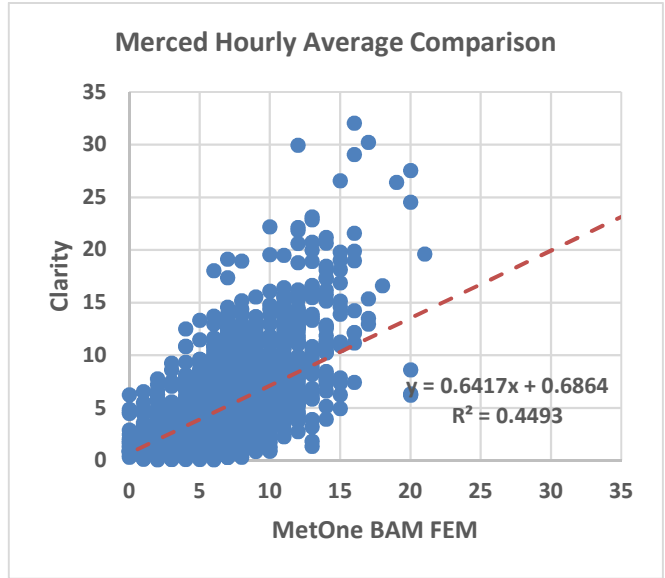
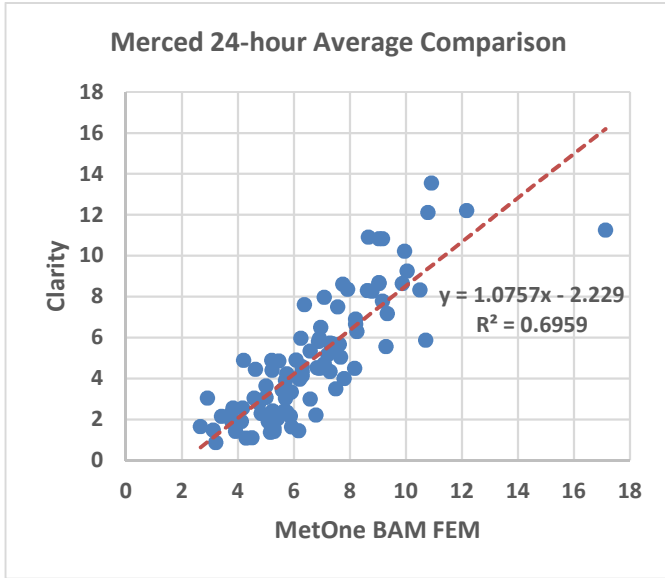
Manteca

For the 24-hour average, Clarity data had a 2.1 µg/m³ low bias during the July 2019 through September 2019 period. For the hourly average, Clarity data had a 2.1 µg/m³ low bias over the same period.



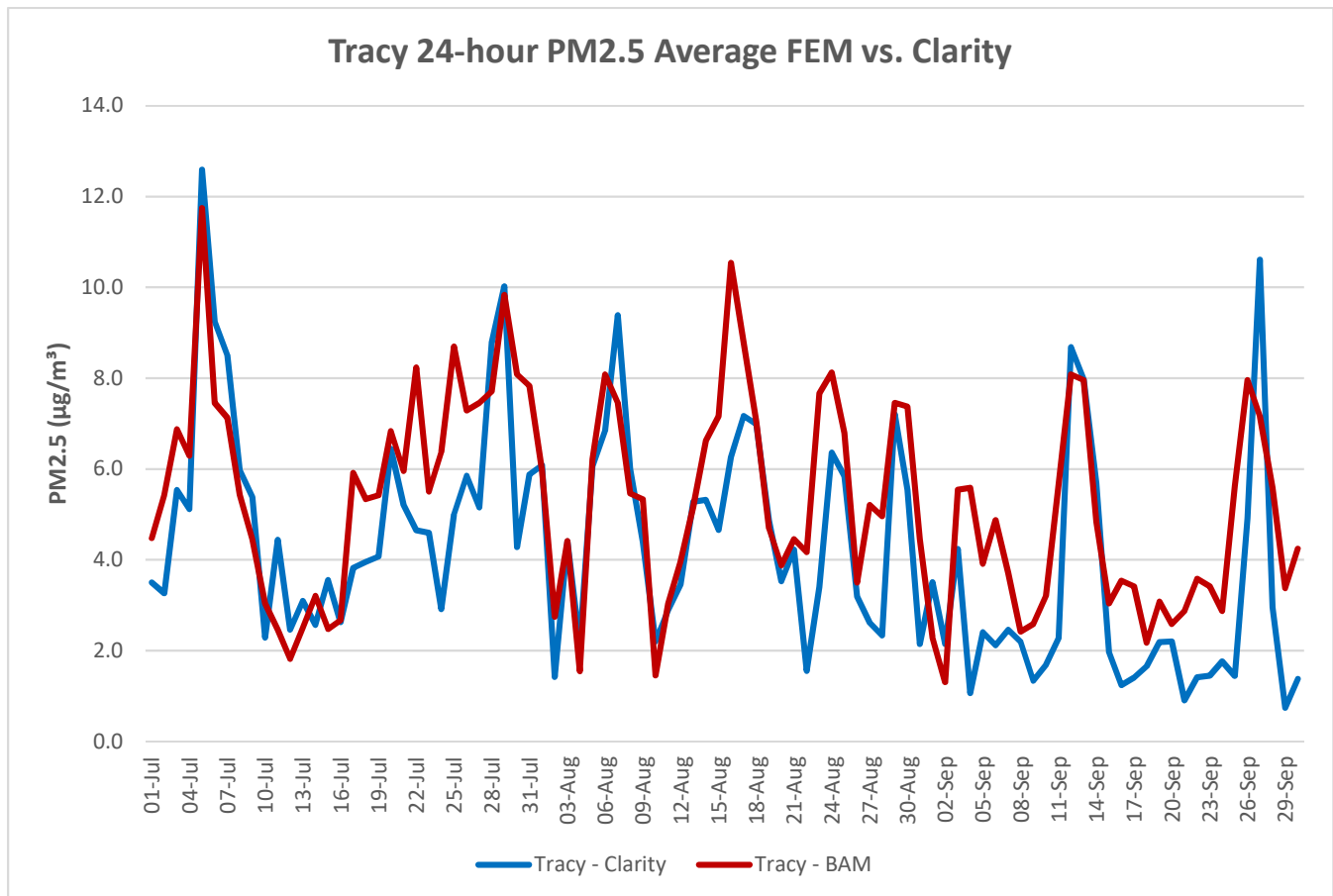
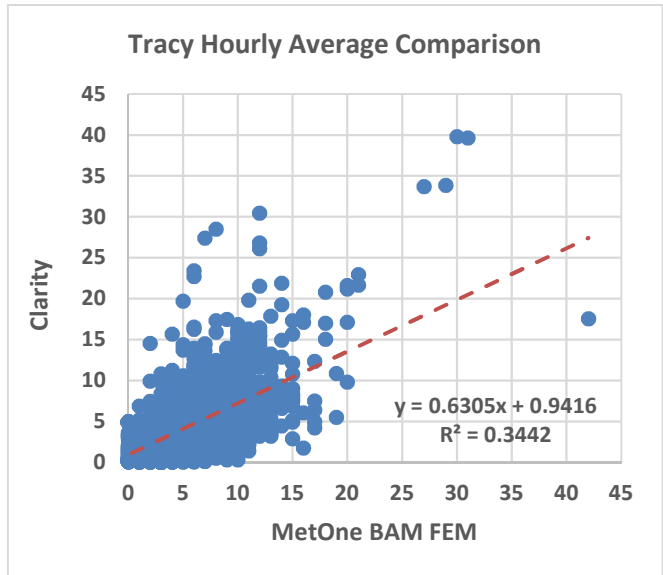
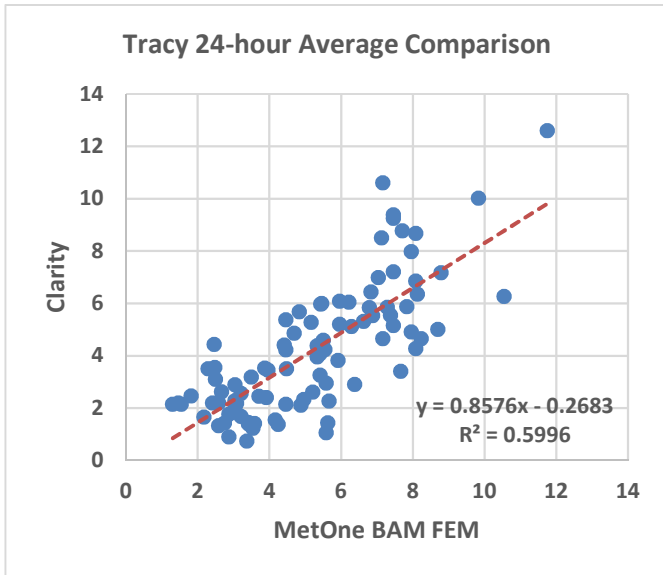
Merced-Coffee

For the 24-hour average, Clarity data had a 1.8 µg/m³ low bias during the July through September 2019 period. For the hourly average, Clarity data had a 1.7 µg/m³ low bias over the same period.



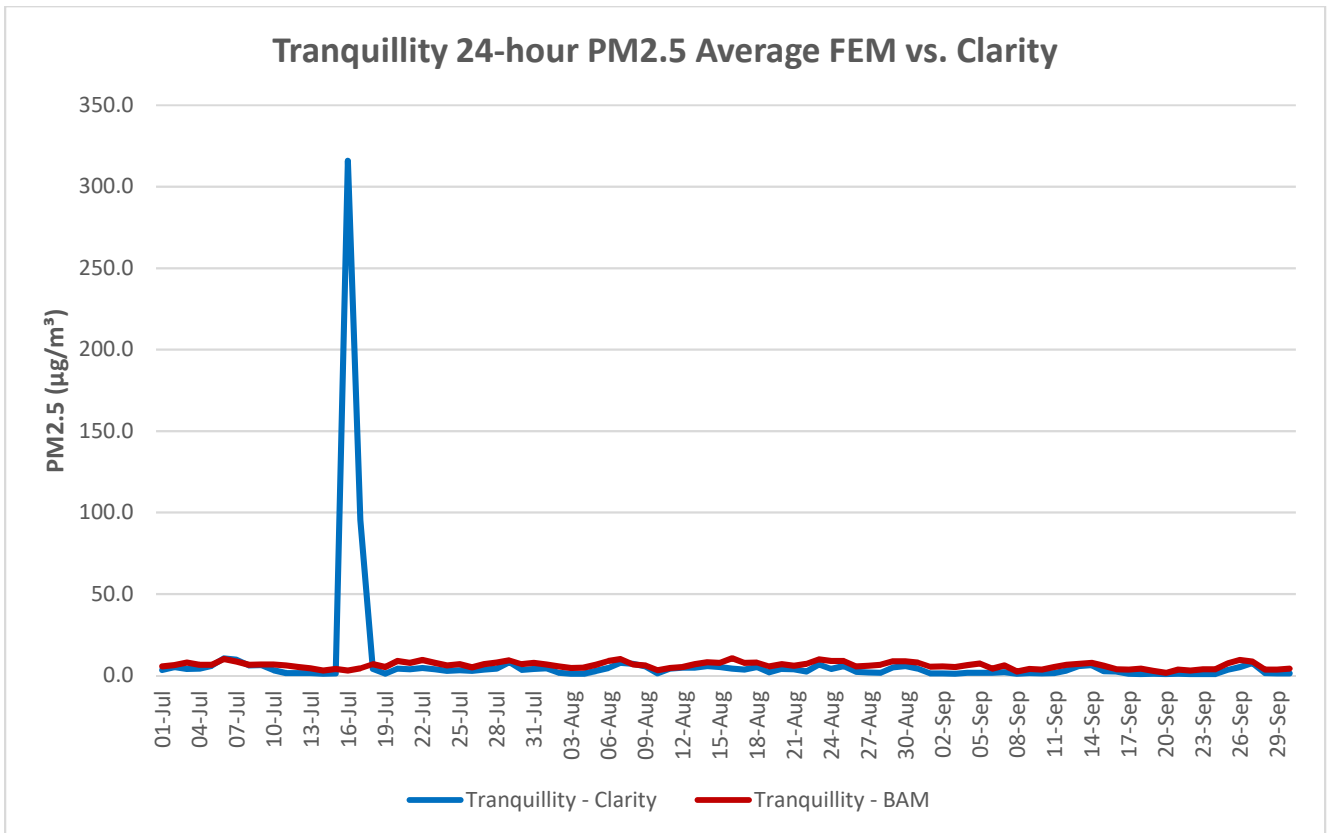
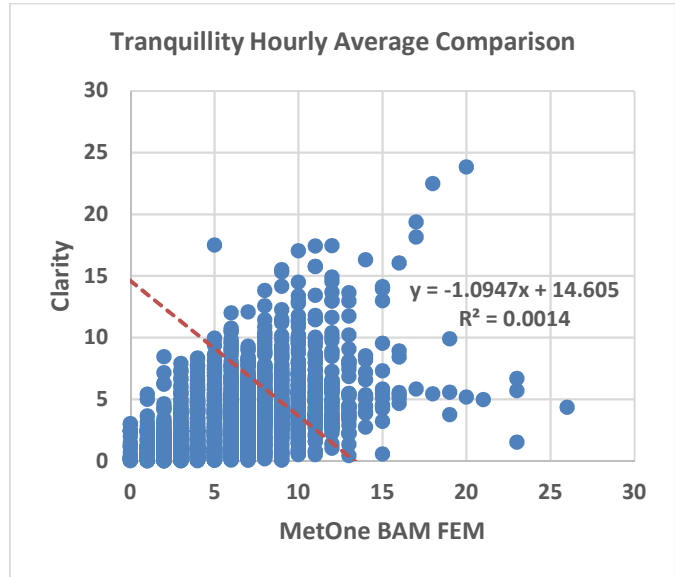
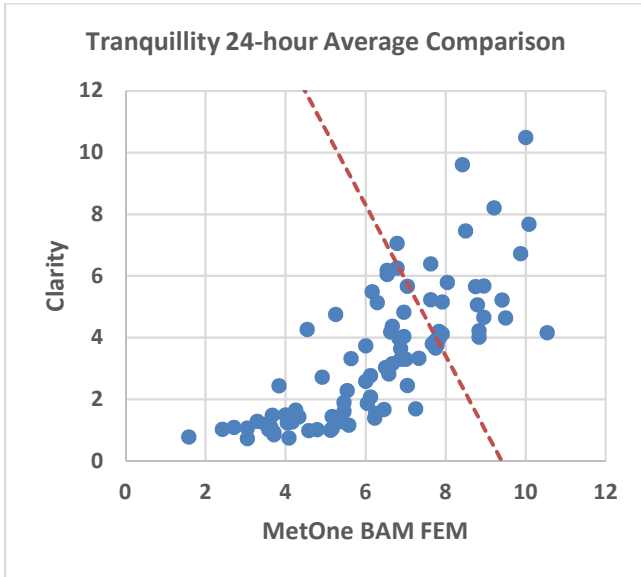
Tracy-Airport

For the 24-hour average, Clarity data had a 1.0 µg/m³ low bias during the July through September 2019 period. For the hourly average, Clarity data had a 1.0 µg/m³ low bias over the same period.



Tranquillity

For the 24-hour average, Clarity data had a 1.6 $\mu\text{g}/\text{m}^3$ high bias during the July through September 2019 period. For the hourly average, Clarity data had a 1.7 $\mu\text{g}/\text{m}^3$ high bias over the same period.



Statistical Summary

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

Statistic	Clovis	Manteca	Merced	Tracy	Tranquillity
FEM Avg	6.0	7.6	6.7	5.3	6.3
Sensor Avg	5.1	5.3	5.0	4.2	7.8
FEM 1-hr Max	122.0	47.4	116.0	42.0	26.0
Sensor 1-hr Max	436.1	67.1	55.6	39.8	3302.6
FEM 24-hr Max	6.0	15.0	17.1	11.8	10.5
Sensor 24-hr Max	28.7	13.6	13.6	12.6	316.0
1-hr R ²	0.4084	0.2365	0.4493	0.3442	0.0014
1-hr Slope	1.0534	0.4614	0.6417	0.6305	-1.0947
1-hr Intercept	4.2486	1.9643	0.6864	0.9416	14.605
24-hr R ²	0.3252	0.6504	0.6959	0.5996	0.0208
24-hr Slope	0.5731	0.7045	1.0757	0.8576	-2.4402
24-hr Intercept	6.0010	3.7202	-2.2290	-0.2683	22.939