San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Technical Evaluation of Sensor Technology (TEST) Program

Clarity Node Sensor
2018 –4th 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 PM2.5. 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 PM2.5 estimates based on real-time regulatory monitor readings in the area. This self-calibration process is aimed to result in more accurate PM2.5 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 PM2.5 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 PM2.5 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

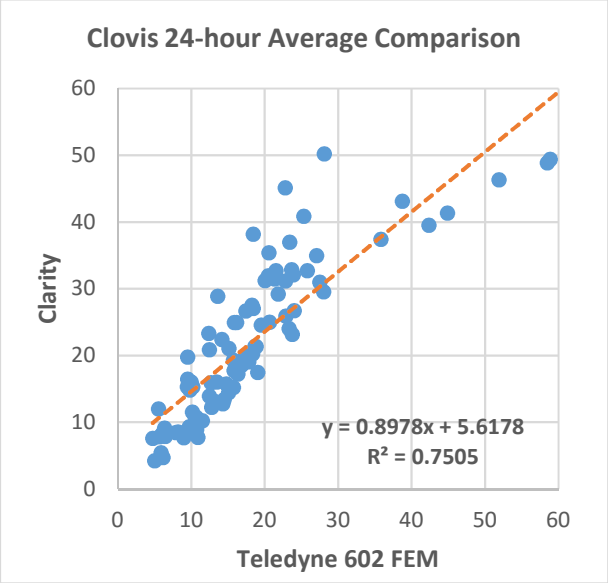
The analysis for this report covers the time period of October 2018 through December 2018 (2018 – 4th quarter). The data from the 4th quarter of 2018 were impacted by a few wildfires burning in northern and central California causing moderate to high PM readings throughout the Valley. For two weeks in November, the most destructive and largest wildfire in California recorded history, the Camp Fire, burned in northern California and smoke filled the San Joaquin Valley. During this same time, another wildfire in Tulare County resulted in elevated PM2.5 concentrations in the region. Rain at the end of November helped to extinguish the wildfires. Brief periods of high pressure resided over the Valley causing stagnation and an increase in PM2.5 concentrations. Recorded PM2.5 concentrations for both the Clarity Node sensor and regulatory monitors were highest in this period during the severe wildfire impacts in November.

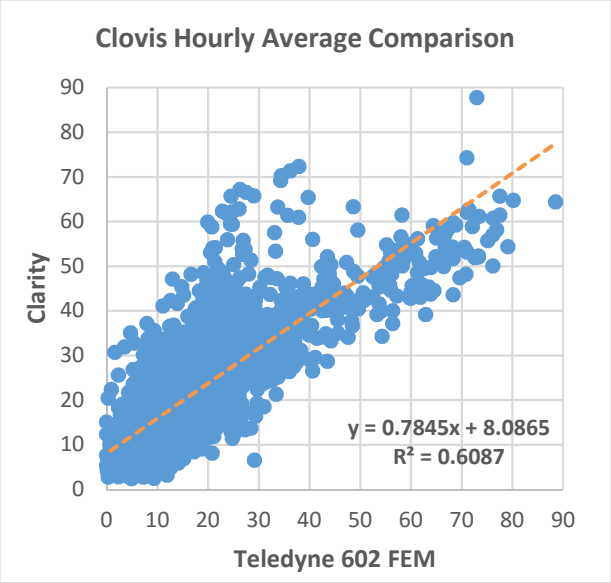
This assessment compares the Clarity Node performance against two different regulatory PM2.5 monitors operating in the District's network – the MetOne BAM-1020 and the Teledyne 602. Overall, most of the Clarity Node sensors operating during this period showed a negligible bias (both high and low) compared to the regulatory monitors, except for the Tranquillity sensor, which continues to show a more pronounced high bias. The bias was more pronounced at higher PM2.5 concentrations, as seen in the graphs below.

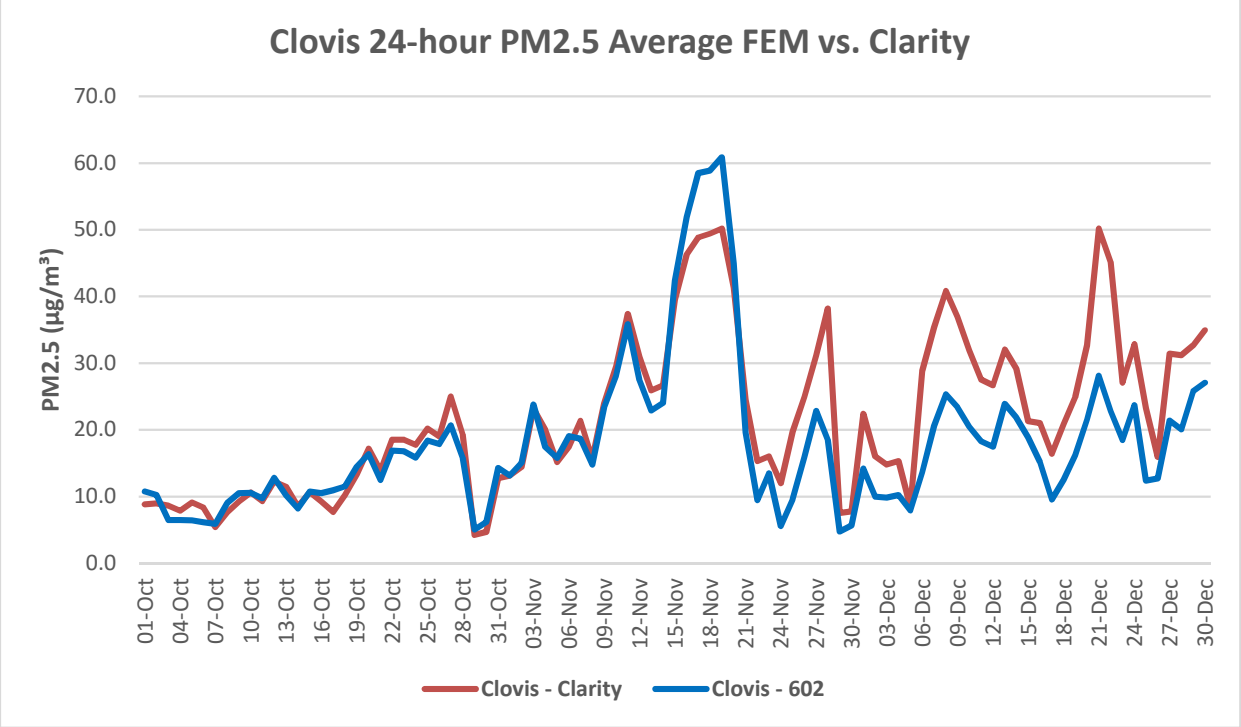
Site Specific Analysis of Clarity-Node Sensor Performance

Clovis-Villa

For the 24-hour average, Clarity data had a 4.1 µg/m^3 high bias during the October 2018 through December 2018 period. For the hourly average, Clarity data had a 4.2 µg/m^3 high bias over the same period.

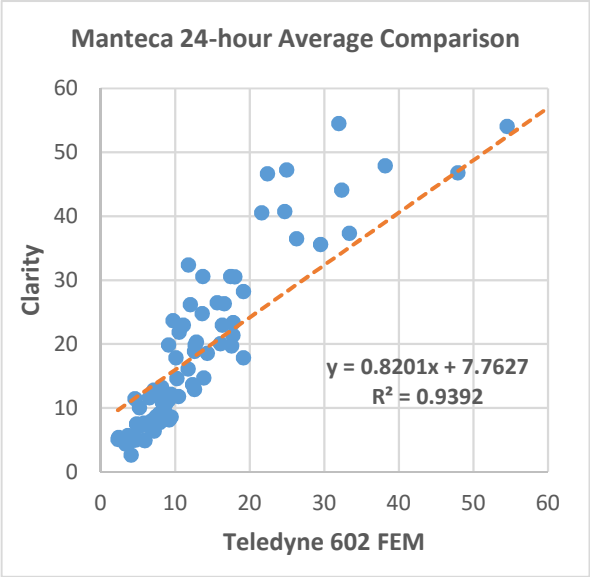


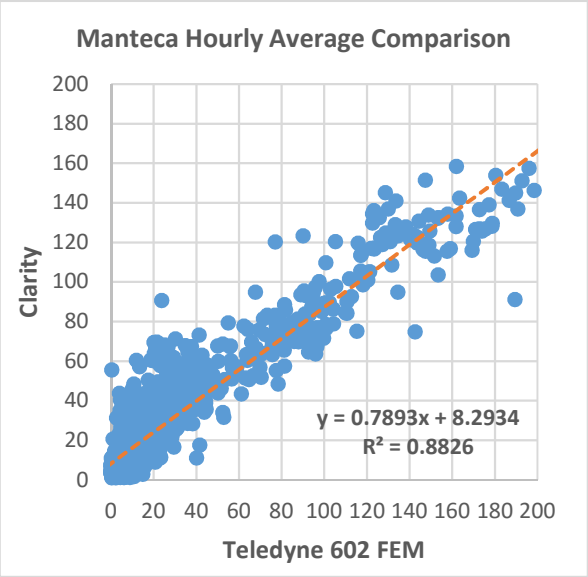


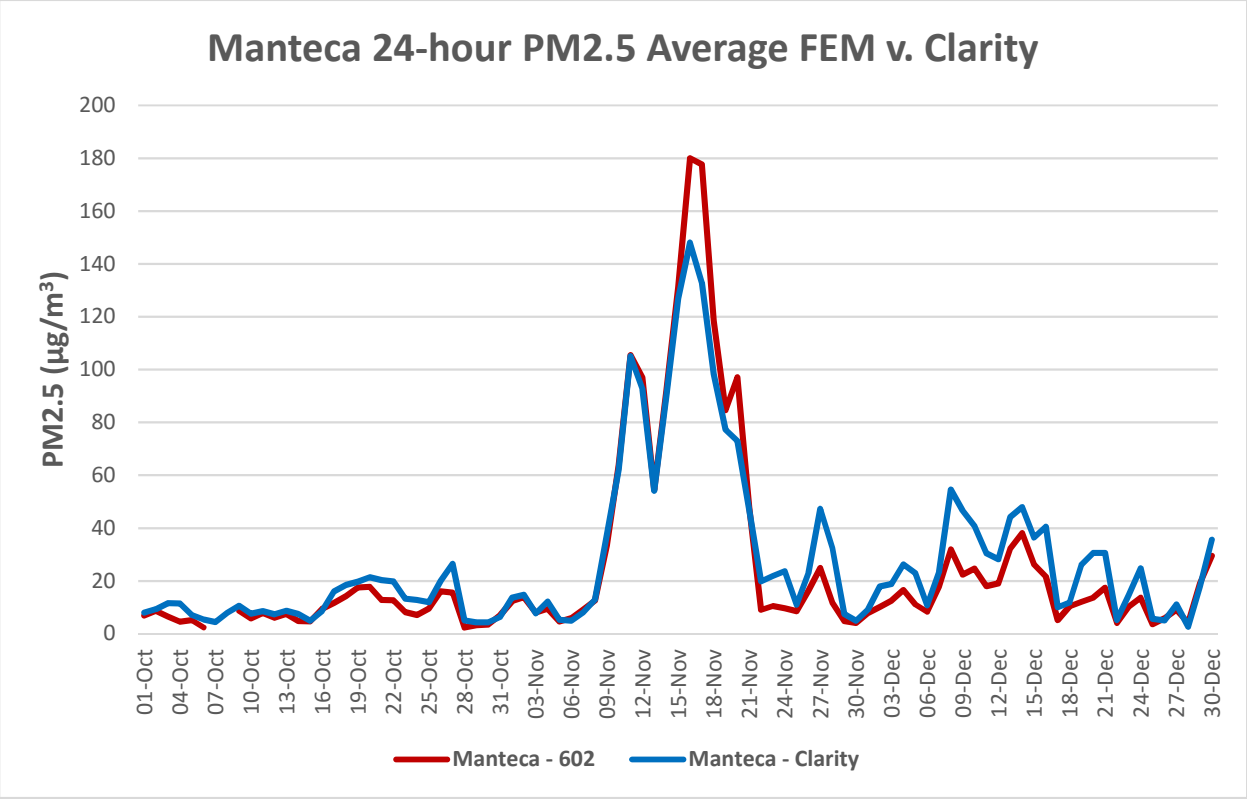


Manteca

For the 24-hour average, Clarity data had a 3.6 µg/m^3 high bias during the October 2018 through December 2018 period. For the hourly average, Clarity data had a 3.1 µg/m^3 high bias over the same period.

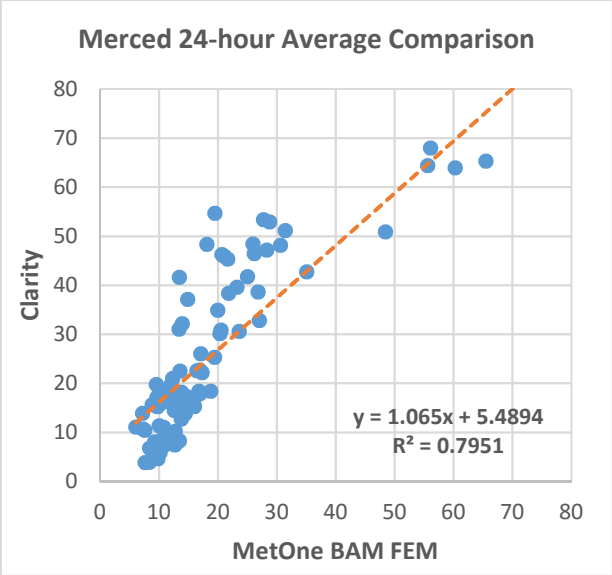


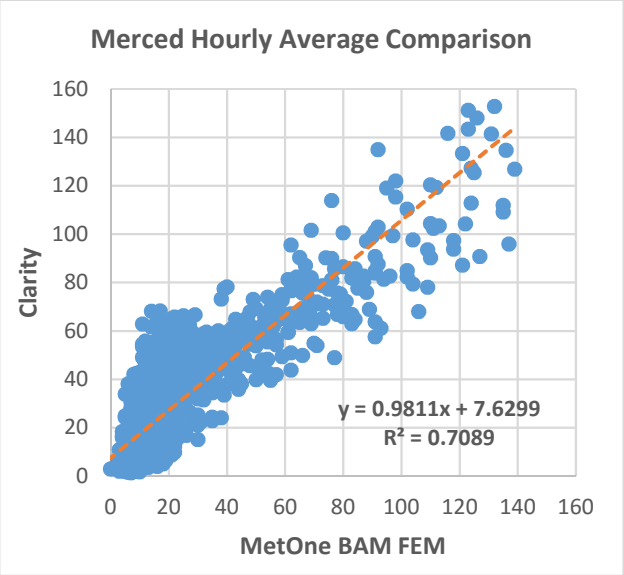


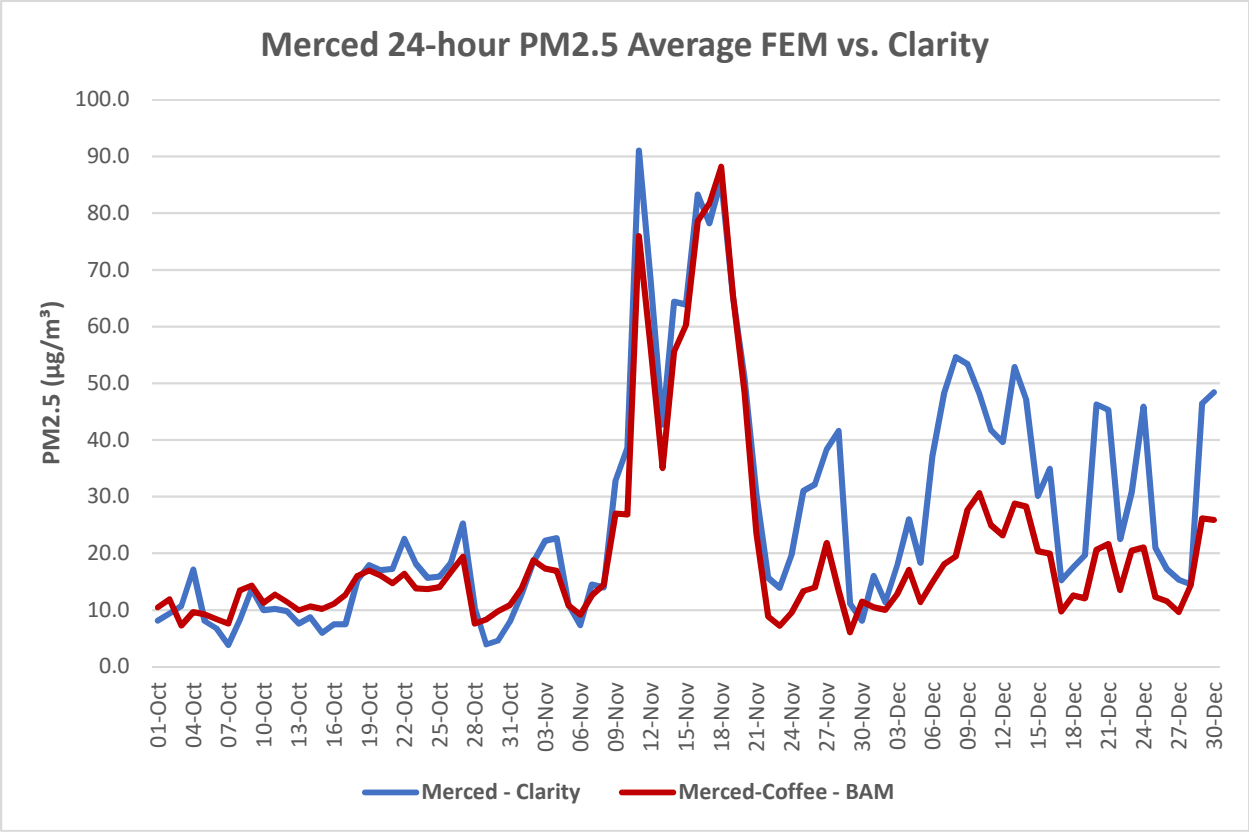


Merced-Coffee

For the 24-hour average, Clarity data had a 7.2 µg/m^3 high bias during the July through September 2018 period. For the hourly average, Clarity data had a 7.6 µg/m^3 high bias over the same period.

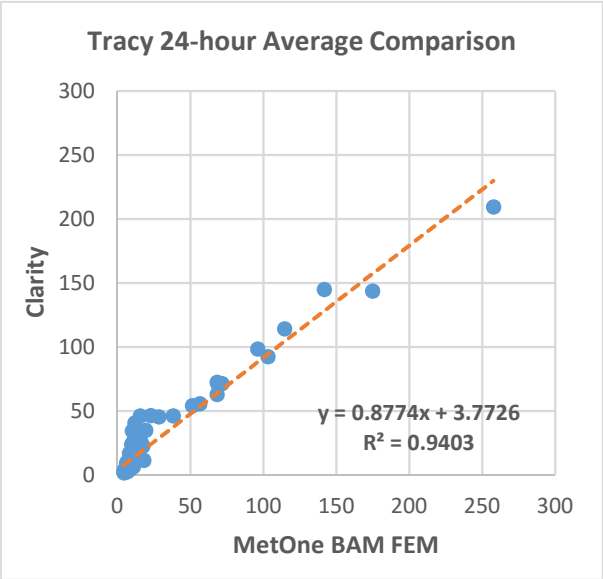


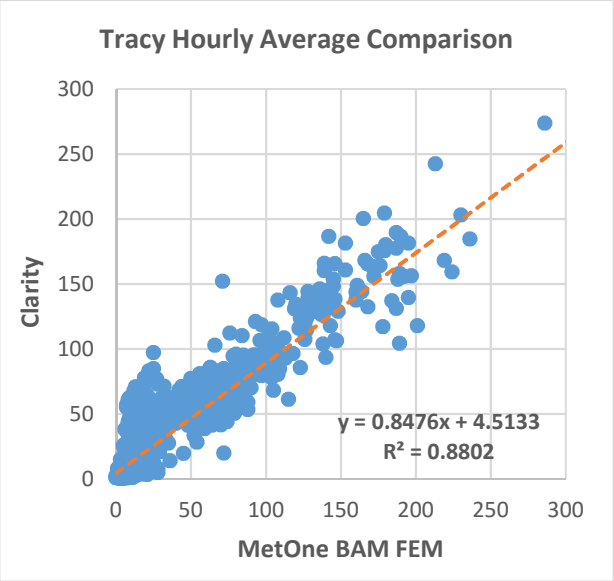


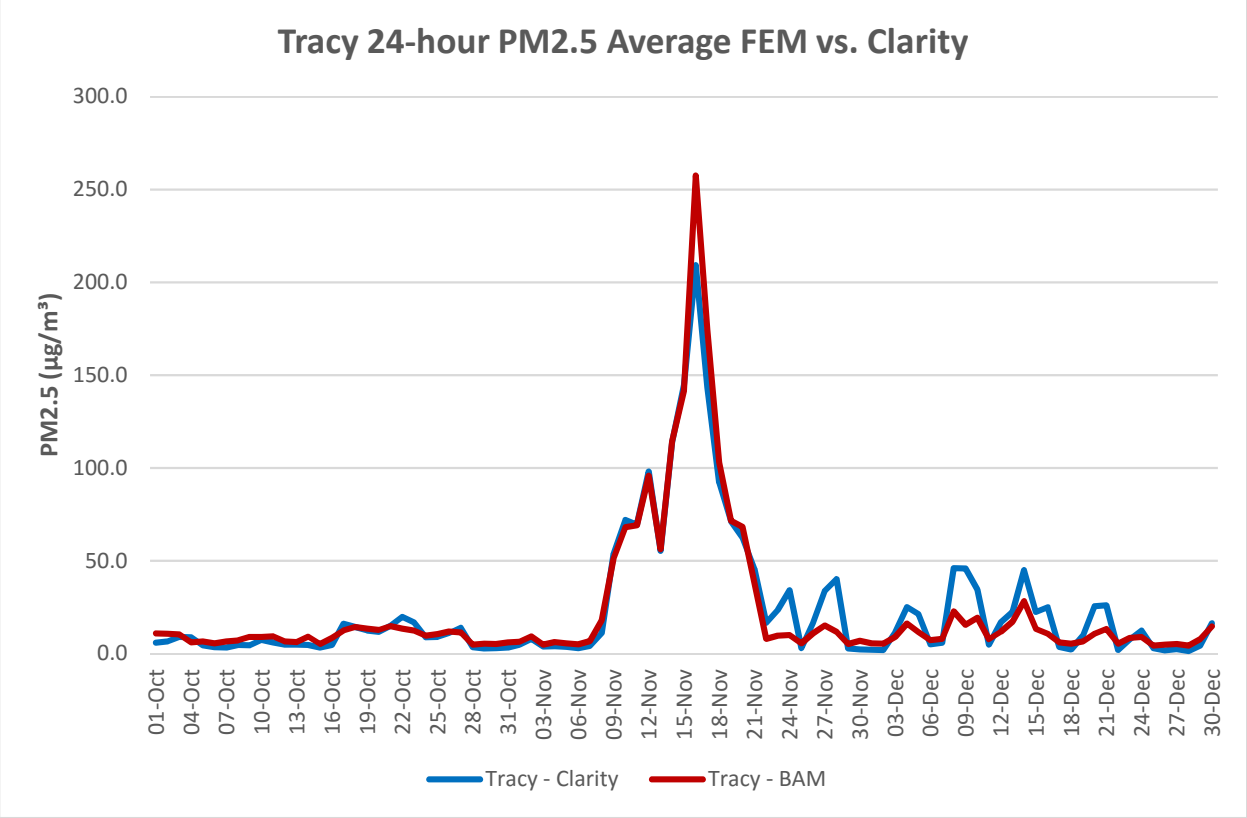


Tracy-Airport

For the 24-hour average, Clarity data had a 1.0 µg/m^3 high bias during the October through December 2018 period. For the hourly average, Clarity data had a 1.1 µg/m^3 high bias over the same period.

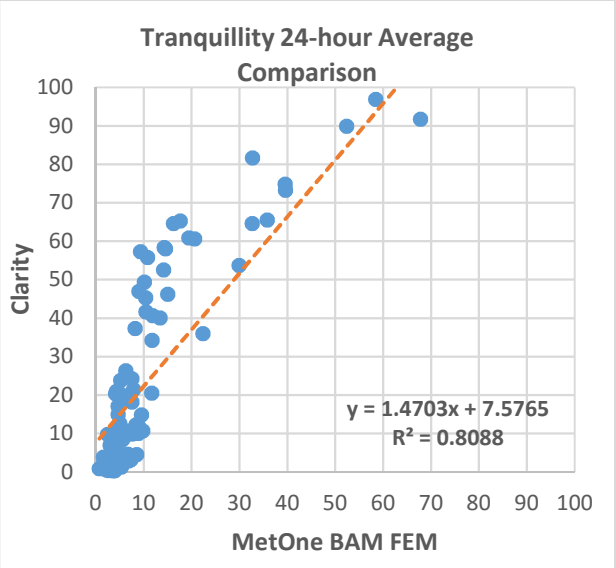


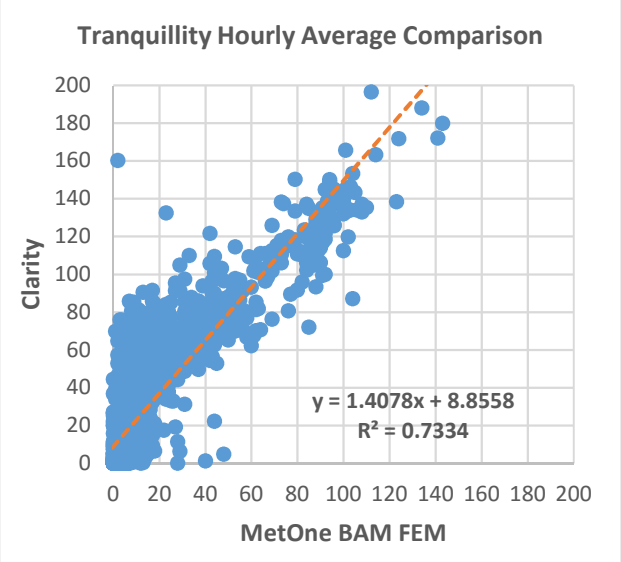


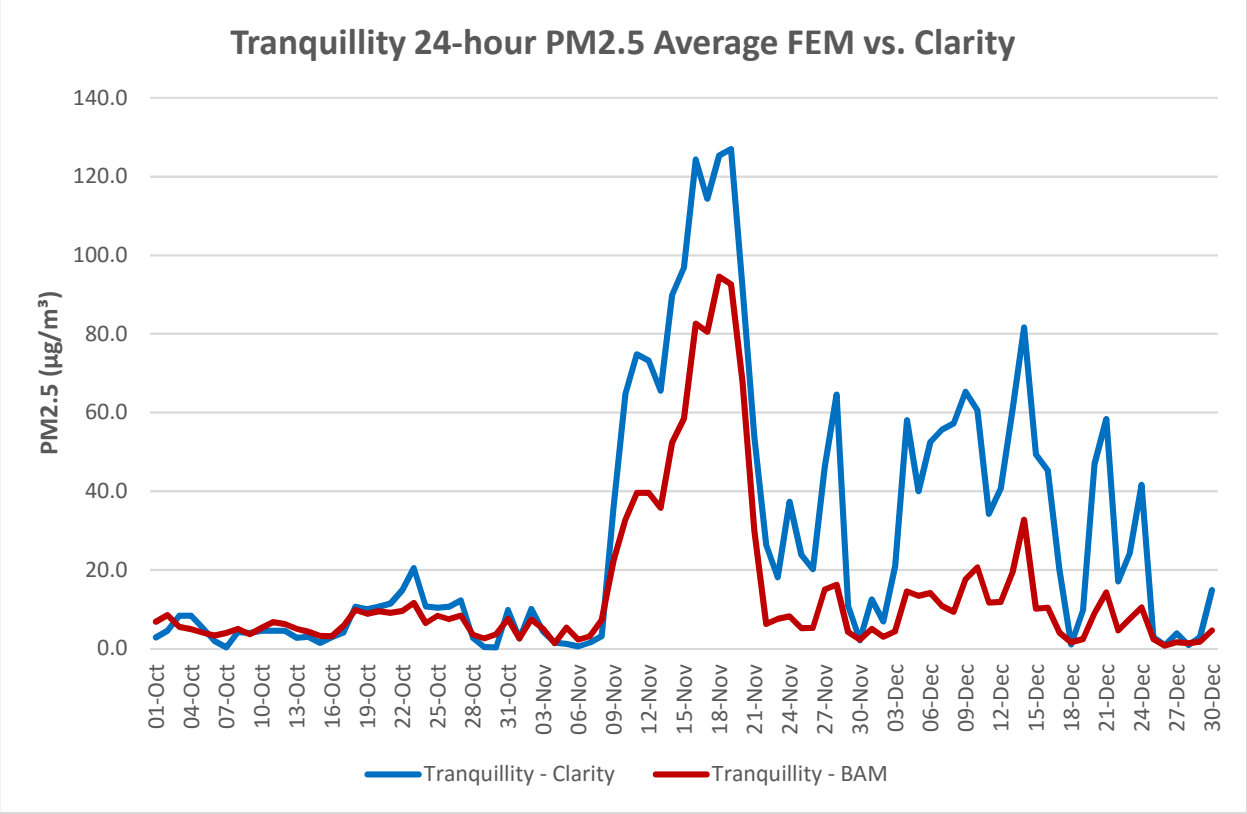


Tranquillity

For the 24-hour average, Clarity data had a 15.4 µg/m^3 high bias during the October through December 2018 period. For the hourly average, Clarity data had a 15.8 µg/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	18.3	28.2	20.9	22.5	14.3
Sensor Avg	23.2	23.1	28.6	24.2	31.1
FEM 1-hr Max	88.5	262.6	139.0	458.0	143.0
Sensor 1-hr Max	87.8	191.5	152.8	348.5	221.3
FEM 24-hr Max	60.9	148.1	88.2	257.6	94.6
Sensor 24-hr Max	50.2	180.0	91.1	209.3	127.0
1-hr R^2	0.6087	0.8826	0.7089	0.8802	0.7334
1-hr Slope	0.7845	0.7893	0.9811	0.8476	1.4078
1-hr Intercept	8.0865	8.2934	7.6299	4.5133	8.8558
24-hr R^2	0.7505	0.9392	0.7951	0.9403	0.8088
24-hr Slope	0.8978	0.8201	1.0650	0.8774	1.4703
24-hr Intercept	5.6178	7.7627	5.4894	3.7726	7.5765