San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Technical Evaluation of Sensor Technology (TEST) Program

Clarity Node Sensor
2019 – 2nd 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, on February 28, 2018, five Clarity sensors were installed at five District air monitoring stations; Clovis, Manteca, Merced, Tracy, and Tranquillity.

The analysis in this report compare PM2.5 data collected from Clarity sensors to PM2.5 data collected from the Federal Equivalent Method (FEM) monitors that are collocated at the District air monitoring sites. 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

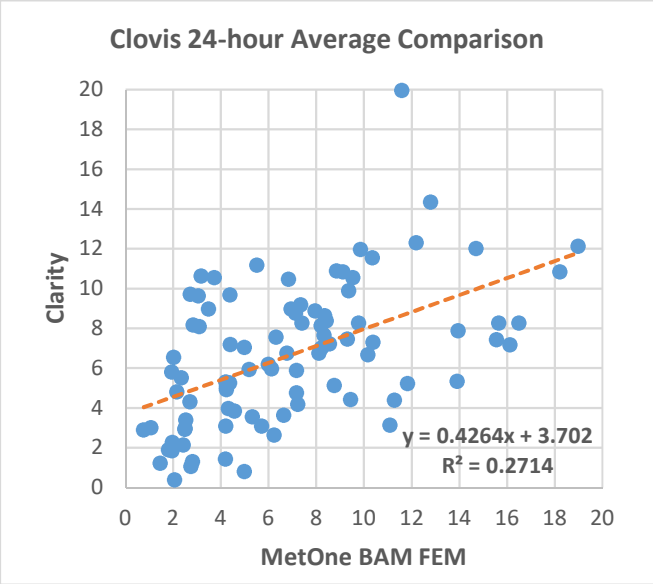
This assessment compares the Clarity Node performance against two different regulatory PM2.5 monitors operating in the District's network – the MetOne BAM-1020 (Clovis, Merced, Tracy, Tranquility) and the Teledyne 602 (Manteca). The analysis for this report covers the time period of April 2019 through June 2019 (2019 – 2nd quarter). For this second quarter analysis, the Clarity sensor at the Clovis site was compared to data from the BAM since it was more available than the 602, which was used in previous quarterly analyses. During this 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.

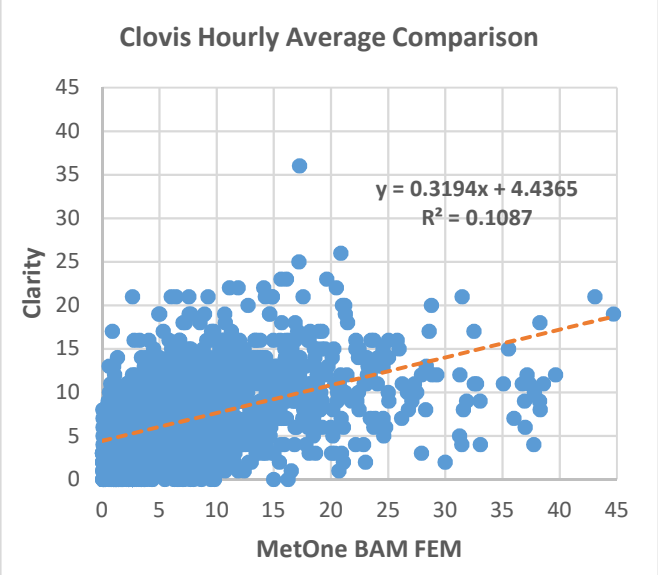
The data from the 2nd quarter of 2019 were impacted by a mixture of both troughs and ridges traversing the region. Periods of high pressure resided over the Valley causing increased stability and an increase in PM2.5 concentrations; however, 24-hour average concentrations remained under 25 µg/m³ at all sites for the period. As PM2.5 concentrations were lower during this period, the bias remained below 1 µg/m³ at all stations, except for Tranquillity where the Clarity sensor averaged 1.3 µg/m³ higher than the FEM for both the hourly and 24-hour averages.

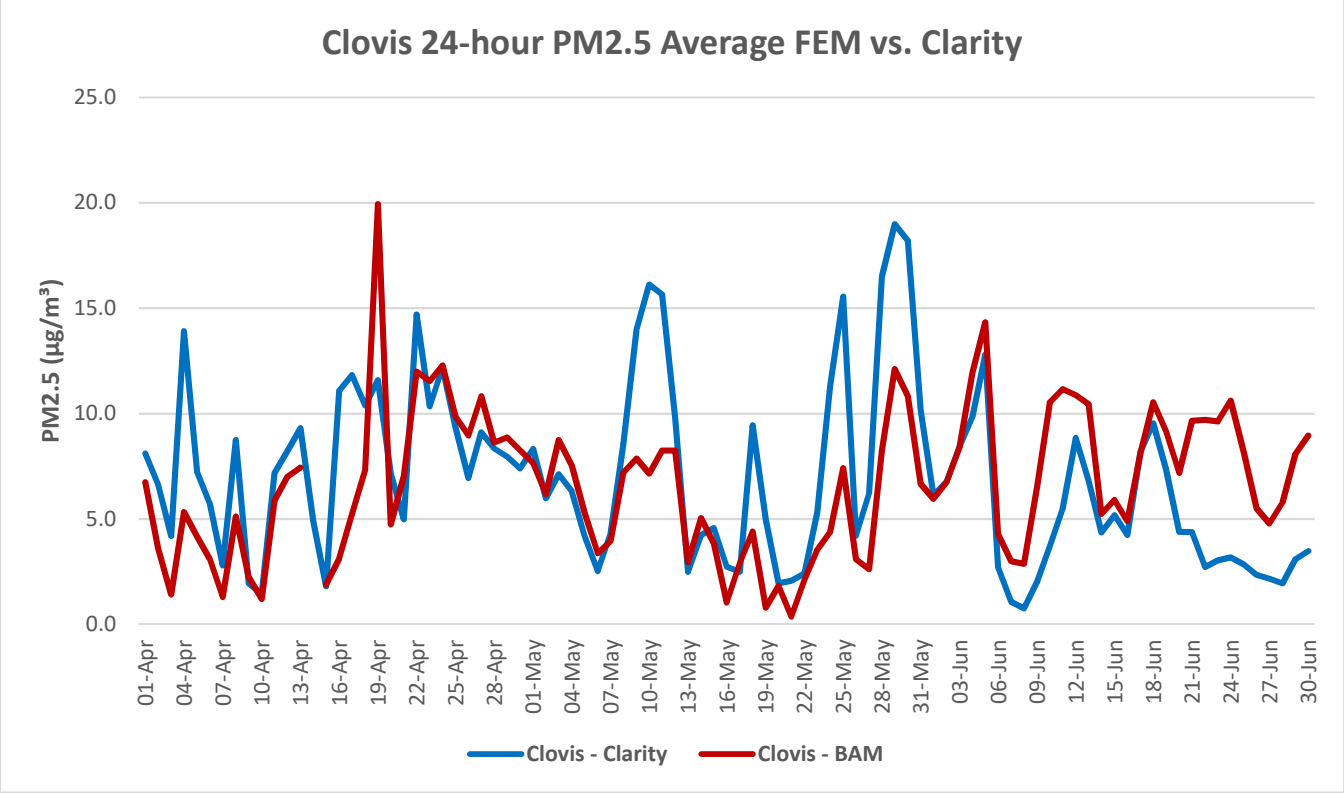
Site Specific Analysis of Clarity-Node Sensor Performance

Clovis-Villa

For the 24-hour average, Clarity data had a 0.3 µg/m^3 high bias during the April 2019 through June 2019 period. For the hourly average, Clarity data had a 0.3 µg/m^3 high bias over the same period.

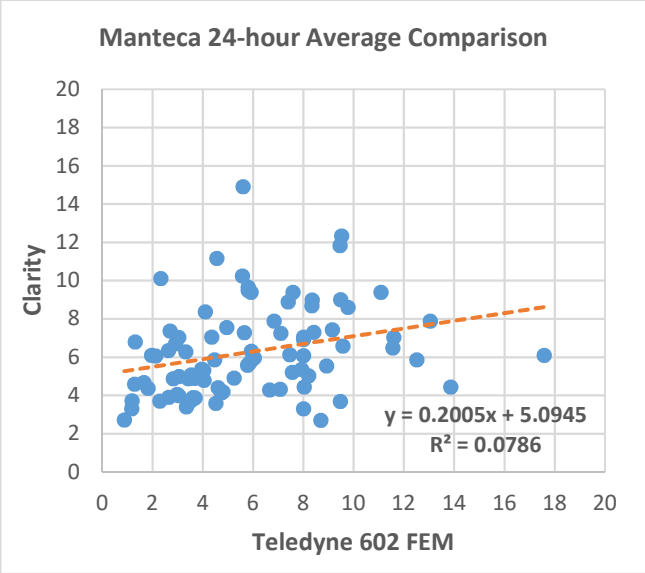


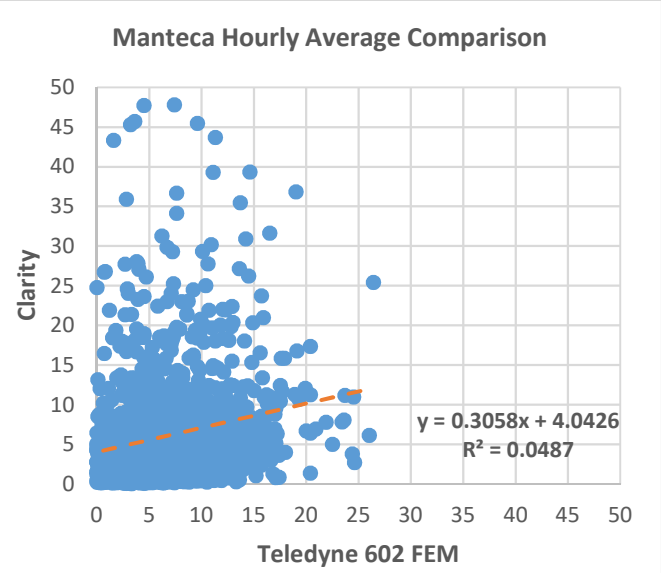


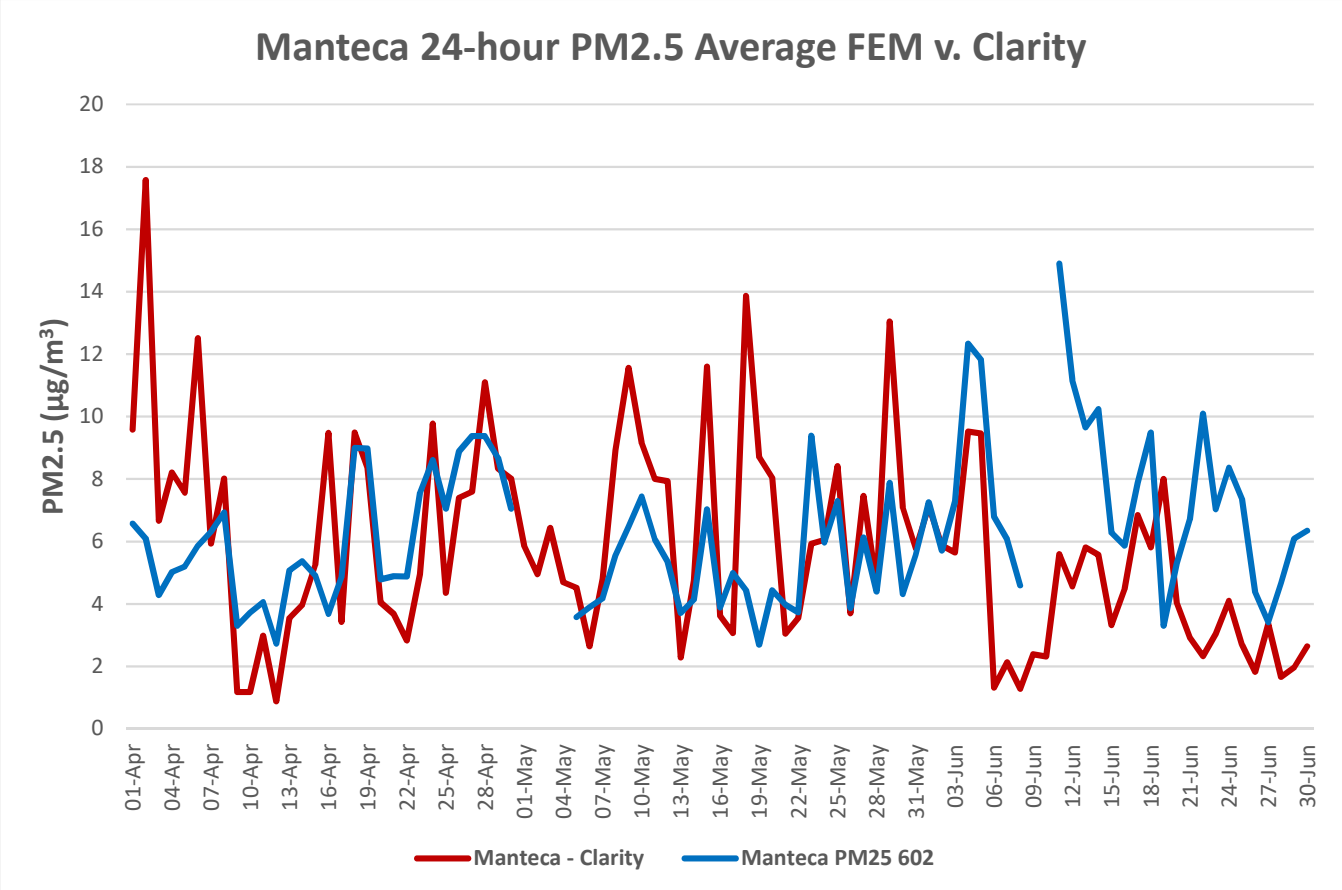


Manteca

For the 24-hour average, Clarity data had a 0.3 µg/m^3 low bias during the April 2019 through June 2019 period. For the hourly average, Clarity data had a 0.2 µg/m^3 low bias over the same period.

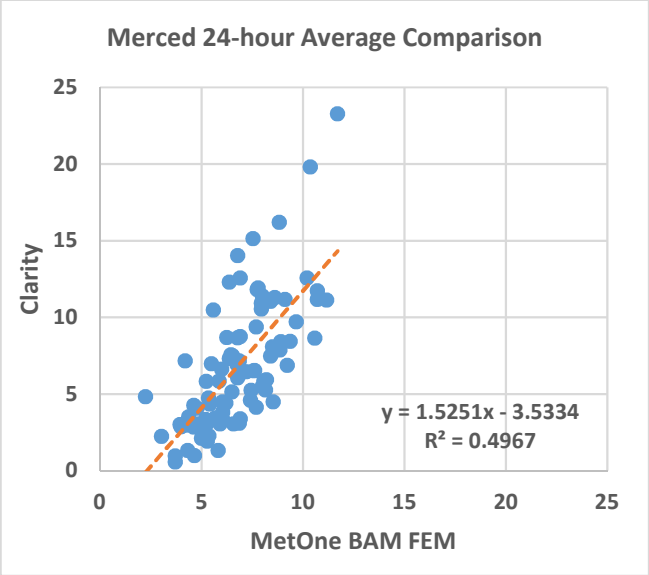


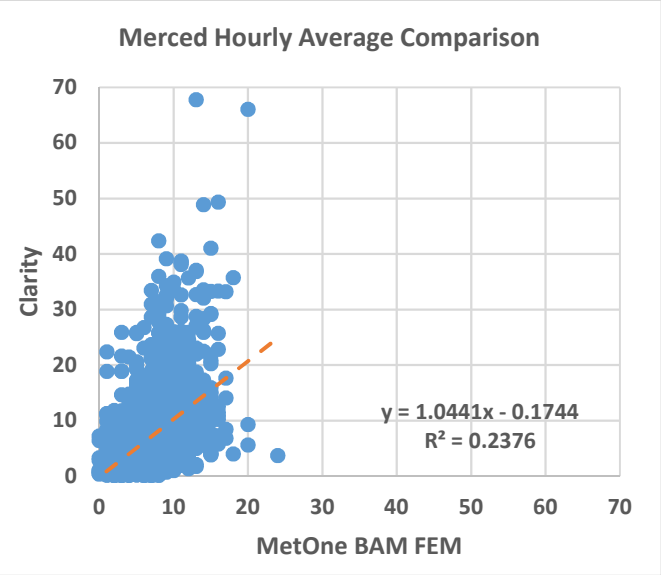


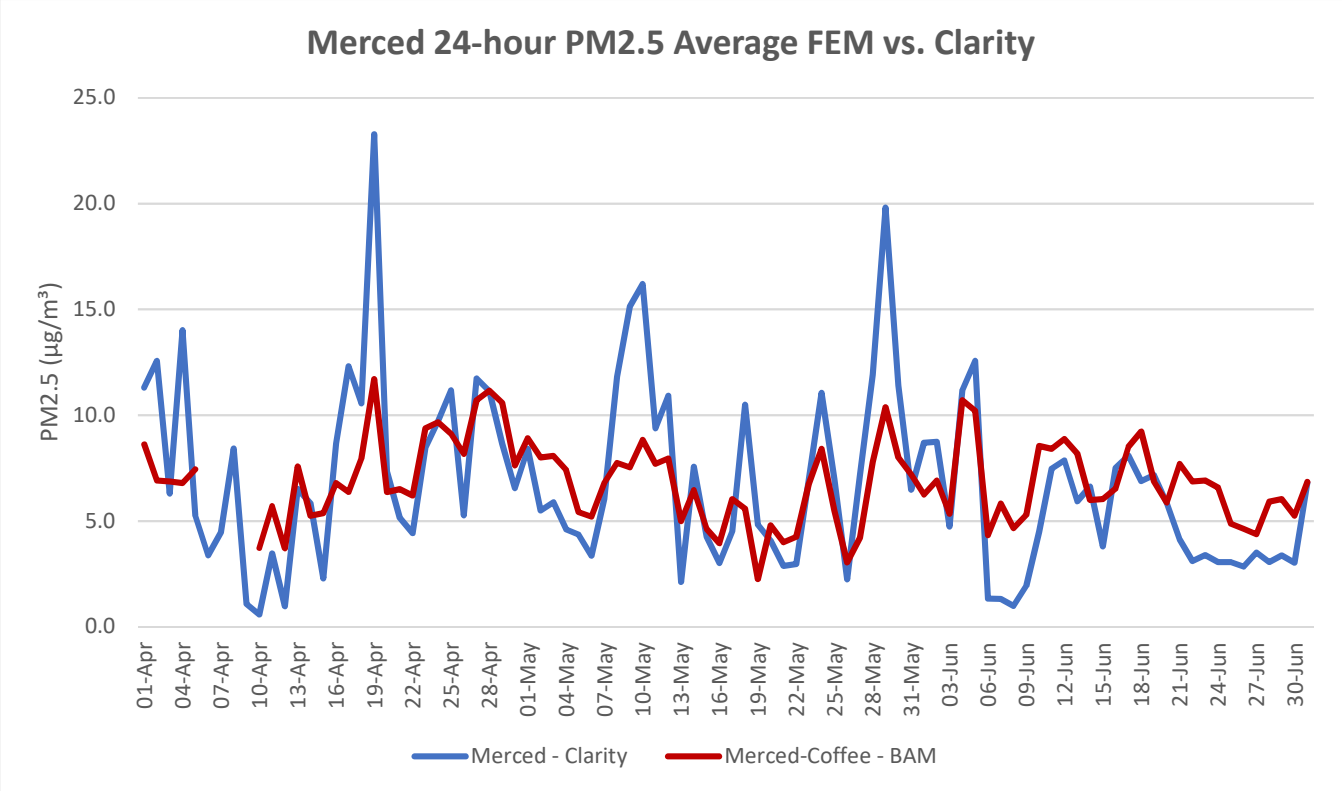


Merced-Coffee

For the 24-hour average, Clarity data had a 0.1 µg/m^3 high bias during the April through June 2019 period. For the hourly average, Clarity data had a 0.1 µg/m^3 high bias over the same period.

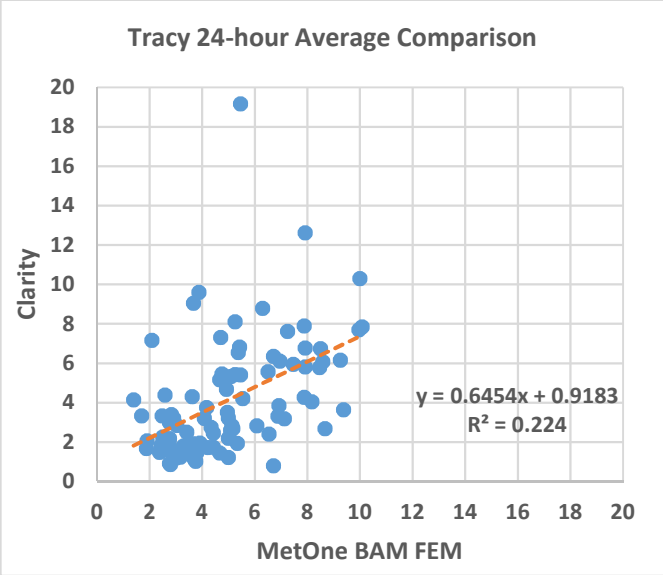


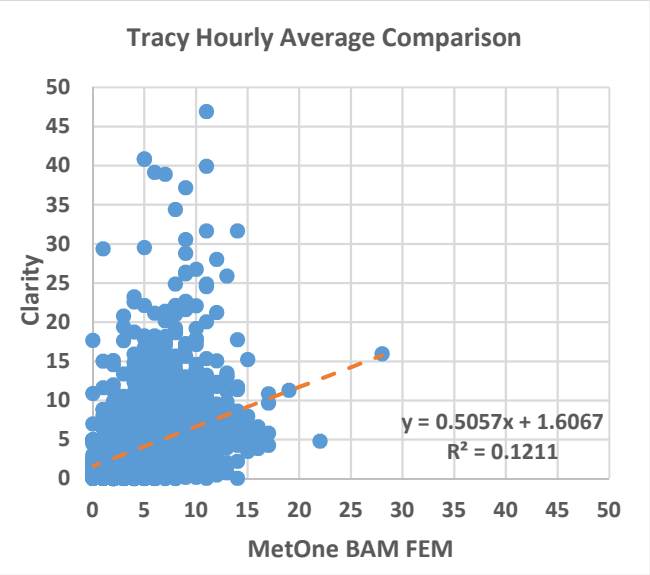


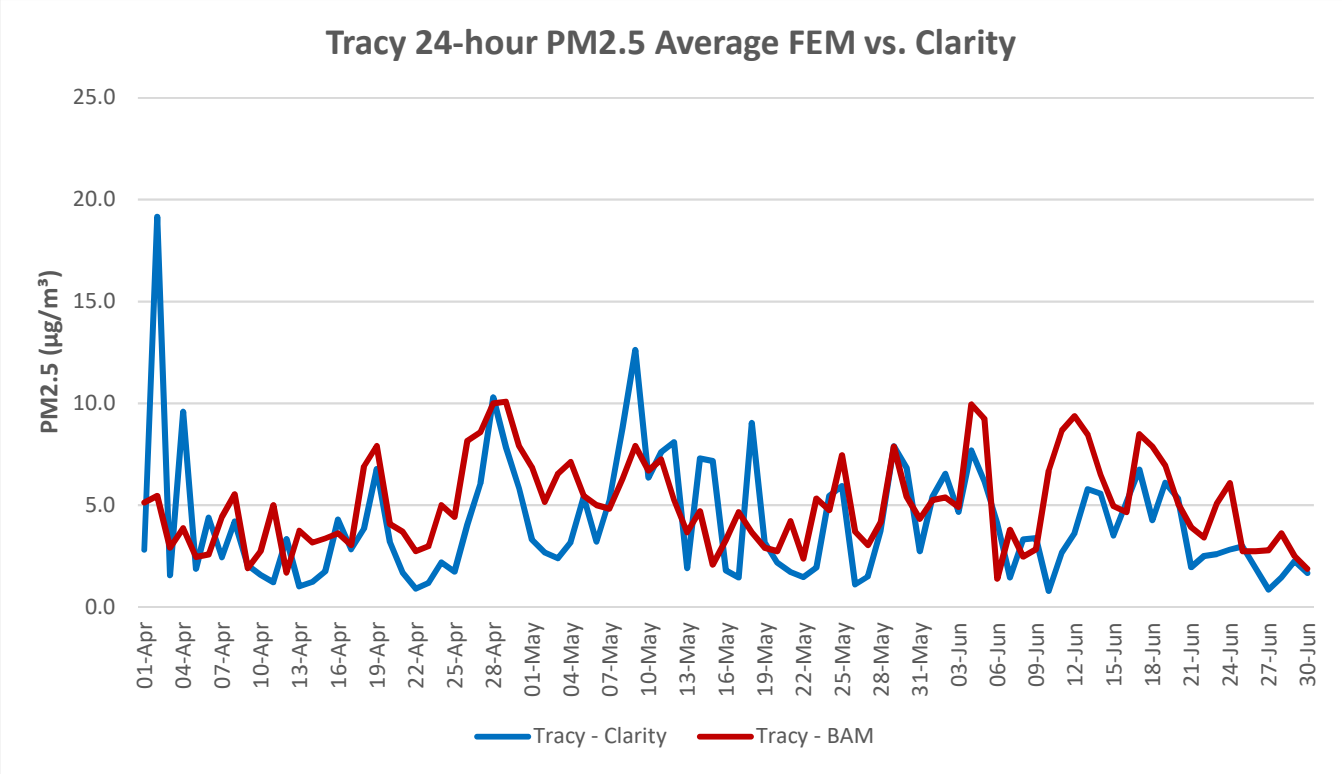


Tracy-Airport

For the 24-hour average, Clarity data had a 0.9 µg/m^3 low bias during the April through June 2019 period. For the hourly average, Clarity data had a 0.9 µg/m^3 low bias over the same period.

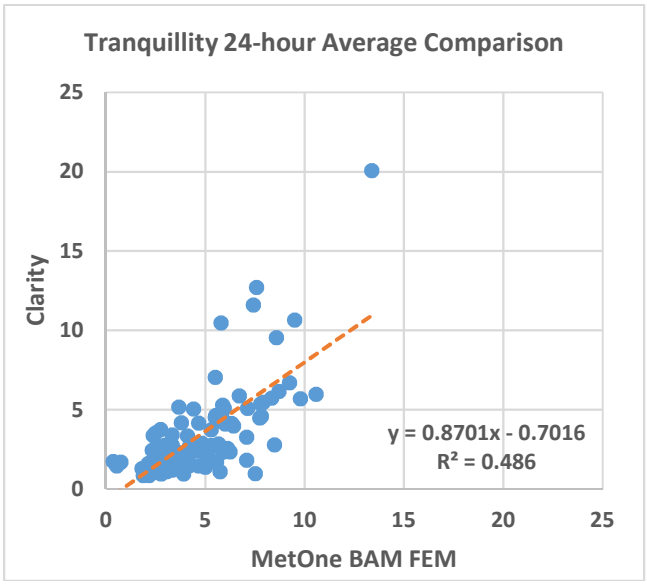


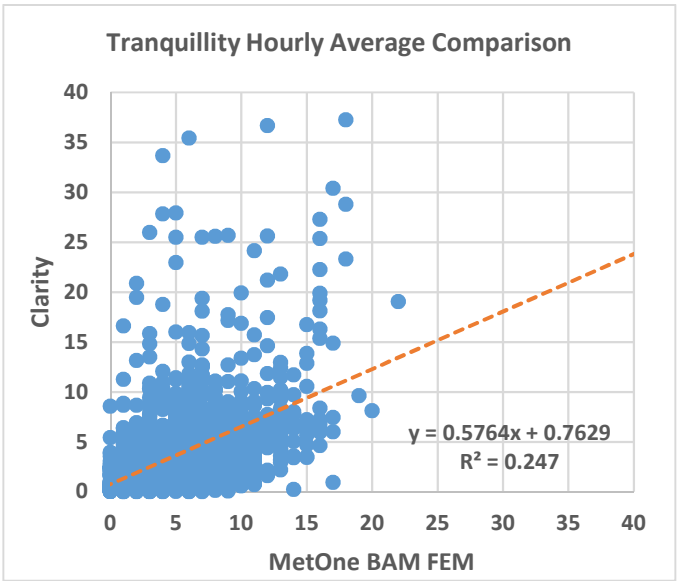


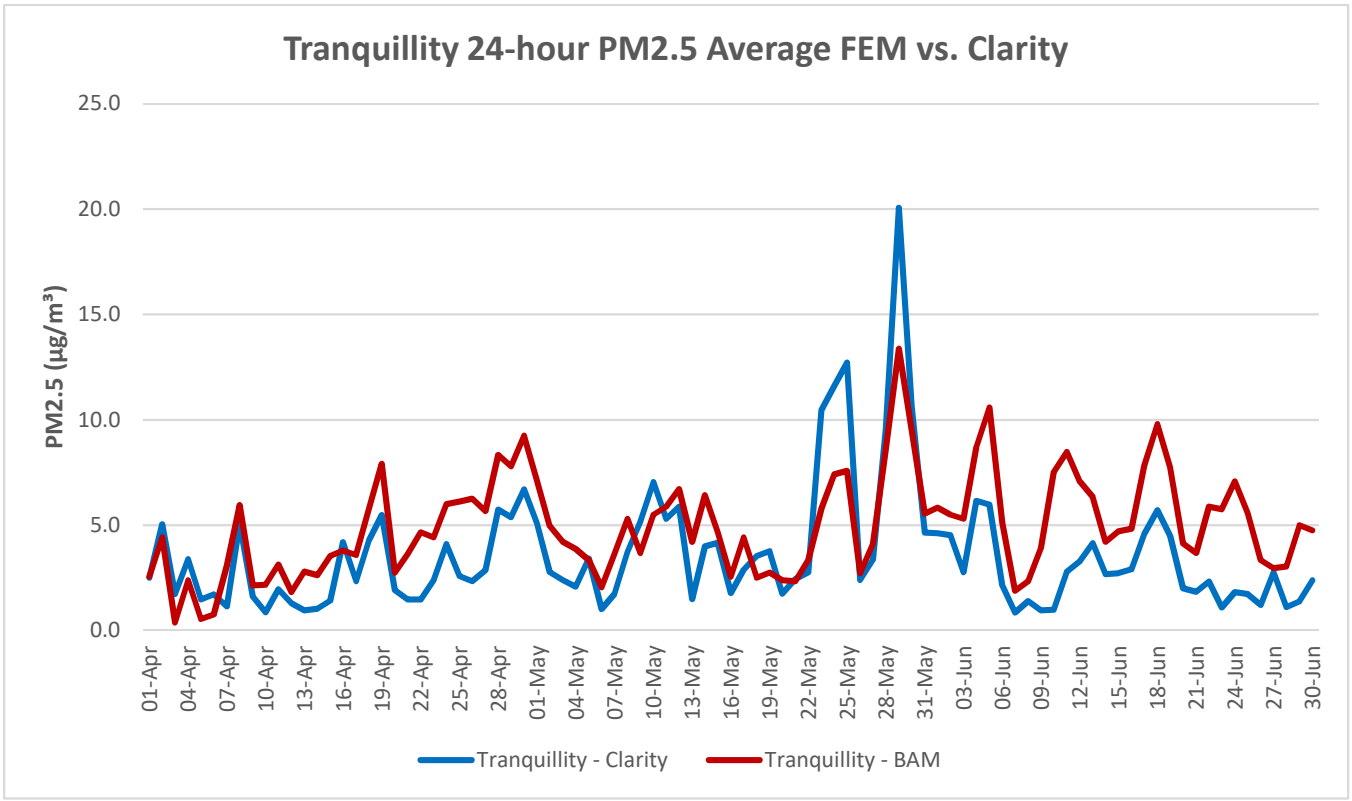


Tranquillity

For the 24-hour average, Clarity data had a 1.3 µg/m^3 low bias during the April through June 2019 period. For the hourly average, Clarity data had a 1.3 µg/m^3 low 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	6.8	6.3	6.9	5.0	4.9
Sensor Avg	6.9	5.8	6.8	4.2	3.6
FEM 1-hr Max	212.0	26.4	24.0	28.0	40.0
Sensor 1-hr Max	44.7	54.9	67.8	46.9	48.9
FEM 24-hr Max	6.8	14.9	11.7	10.1	13.4
Sensor 24-hr Max	19.0	17.6	23.3	19.2	20.1
1-hr R^2	0.1087	0.0487	0.2376	0.1220	0.2470
1-hr Slope	0.3194	0.3058	1.0441	0.5088	0.5764
1-hr Intercept	4.4365	4.0426	-0.1744	1.5862	0.7629
24-hr R^2	0.2714	0.0786	0.4967	0.2240	0.4860
24-hr Slope	0.4264	0.2005	1.5251	0.6454	0.8701
24-hr Intercept	3.7020	5.0945	-3.5334	0.9183	-0.7016