Action: Mobile monitoring to identify air pollution hotspots and to assess the impact of traffic related emissions on community exposure

Background & Objective

The San Bernardino, Muscoy (SBM) community is intersected by a multitude of highly congested public and freeway roads with high traffic volumes and a high fraction of diesel truck traffic due to the presence of warehouses and railyards, and associated goods movement. The SBM community steering committee (CSC) identified traffic emissions from idling and moving trucks operated on freeways and local neighborhood streets as a major air quality concern in SBM. The CSC concerns related to emissions from railyards and warehouses are addressed in separate progress reports. The focus of this report is truck traffic on major roadways and freeways, and in specific areas identified by the CSC.

The monitoring strategy to study and characterize this air quality priority includes comprehensive mobile measurements with a focus on black carbon (BC), particulate matter (PM), ultrafine particles (UFP), and nitrogen dioxide (NO_2). Mobile monitoring was first conducted near areas with high density of moving and idling trucks within the local neighborhood streets. These measurements will extend to other areas within the SBM community to support the implementation of emission reduction strategies and track their progress; identify air pollution hotspots; and assess the impact of truck emissions on community exposure. These measurements can be used to identify areas where traffic emissions are a concern and to support the implementation of Automated License Plate Readers (ALPR), which is currently being explored by South Coast AQMD staff in collaboration with the California Air Resources Board (CARB). For more information please refer to the SBM Community Emissions Reduction Plan (CERP Ch. 5b).

Method

Air monitoring was conducted near areas identified by the CSC using a mobile platform capable of measuring a wide range of particulate and gaseous pollutants, including PM, BC, UFP, and NO_2. Figure 1 shows truck idling hotspots (yellow circles) and the locations where truck traffic is of particular concern (red stars) within SBM. Locations where truck traffic is of particular concern were identified by the CSC through a prioritization activity during the January 2019 CSC meeting, whereas truck idling hotspots were identified by the CSC through a separate prioritization activity during the October 2019 CSC meeting.

The South Coast AQMD maintains an air monitoring station in the SBM community where some of the major diesel emission tracers (BC, NO_2, and UFP) are measured. This site has been operational since 1986 and will provide an opportunity to observe long-term trends in air pollution levels and track the progress of the emissions reduction strategies described in the CERP for this community.

Results
• As of August 2020, a total of 8 days of mobile monitoring has been carried out to identify, study and characterize truck idling hotspots and the locations where truck traffic is of particular concern • Mobile monitoring results indicate the presence of elevated concentrations of NO_2, UFP, and BC on major freeways and roadways (see Attachment A for details) • NO_2, UFP, and BC concentrations were found to be generally lower in residential communities, especially near Cajon Wash, as compared to those measured in and around major streets and freeways (Attachment A) • The residential area between the Interstate I-215, I-210 and Route 259 showed higher concentration for NO_2, UFP, and BC (Attachment A)
Next steps
• Continue mobile monitoring with a focus on specific areas with elevated levels of pollution to determine if they are persistent • Continue to assess mobile measurements and fixed monitoring data/results to support the implementation of emission reduction strategies and track their progress, and support the implementation of ALPR

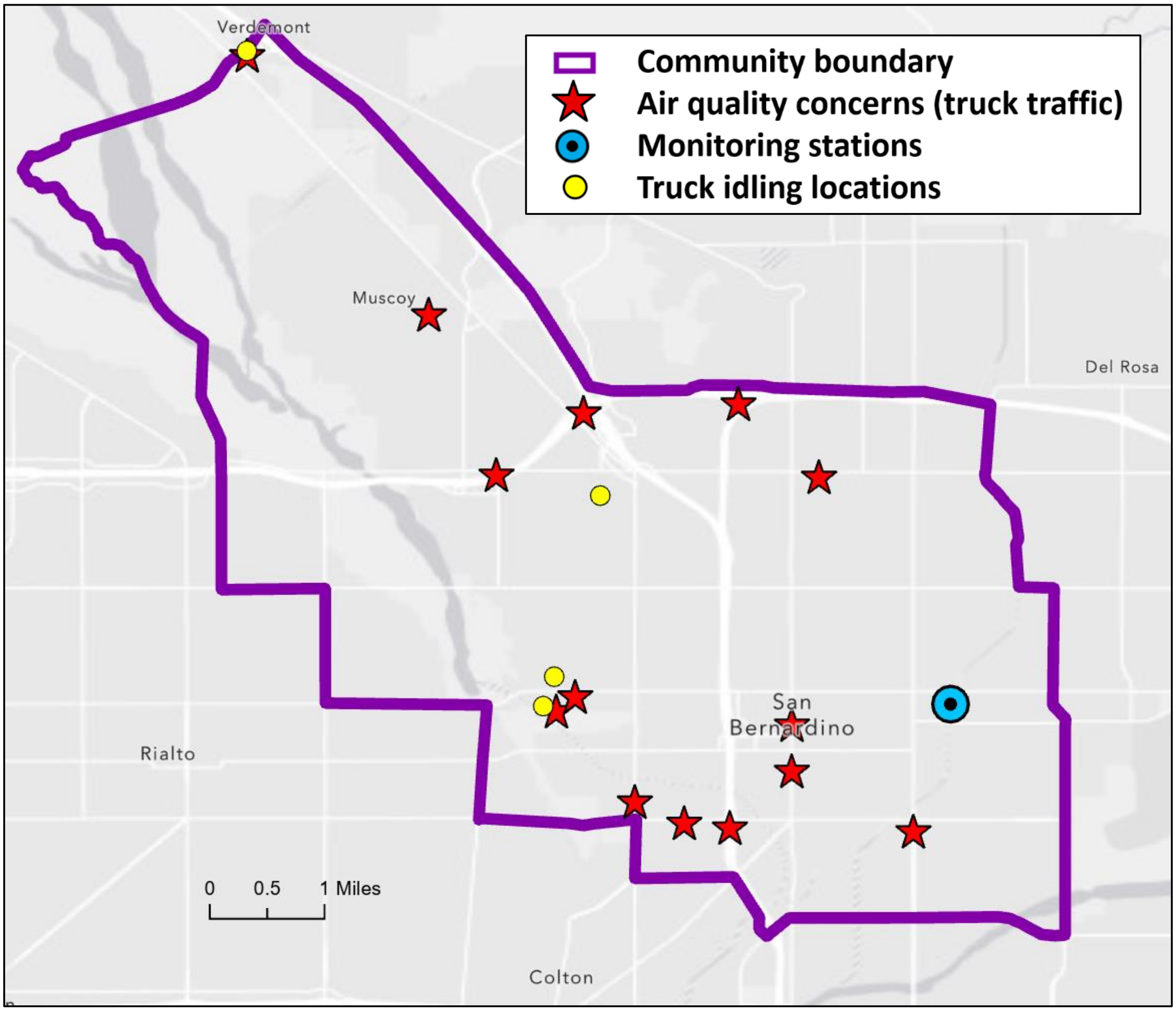

Figure 1. Map of the SBM community showing the locations identified by the CSC where truck idling hotspots (shown as yellow circles) and truck traffic are of particular concern (shown as red stars). The location of the monitoring station for baseline measurements operated by the South Coast AQMD

Attachment A

As of August 2020, a total of 8 mobile monitoring surveys have been conducted in the San Bernardino Muscoy (SBM) community to measure diesel emissions. Diesel engines emit a complex mixture of air pollutants, including both gaseous and solid material. The solid material in diesel exhaust is known as diesel particulate matter (DPM), which is a component of fine particulate matter (PM2.5). There is no technique to directly measure DPM (a major contributor to health risk); therefore, indirect measurements for surrogates of diesel exhaust are used, specifically black carbon (BC). DPM is typically composed of carbon particles ("soot", also called BC) and numerous organic compounds. Diesel exhaust also contains gaseous pollutants, including volatile organic compounds (VOC) and nitrogen oxides (NOx).

Mobile measurements were conducted using a mobile platform capable of monitoring a wide range of particulate and gaseous pollutants, including PM, BC, ultrafine particles (UFP), and nitrogen dioxide (NO_2), as part of the area-wide surveys. The routes traversed by the mobile platform were selected to perform monitoring in and around major roadways and freeways, as well as near specific truck traffic and idling locations identified by the community steering committee (CSC) through prioritization activities conducted during the January 2019 and October 2019 CSC meetings.

Typically, measurements from a mobile platform at a given location are relatively short, ranging from seconds to a few minutes when the platform is moving. Therefore, given the high temporal variability of most air pollutants, mobile survey measurements do not necessarily capture the typical air quality conditions of a specific location. One way to address this limitation is to increase the number of measurement runs (passes, or transects) to obtain a more representative and consistent map of the spatial and temporal variability of the measured air pollutants. Figure A-1 shows the routes traversed by the mobile monitoring in and around major roadways and freeways within the SBM community. In this figure, the number of passes, that is a measure of representativeness of the measured concentrations, is shown as a white-to-green color gradient, with darker green representing areas where more passes/measurements were conducted/taken.

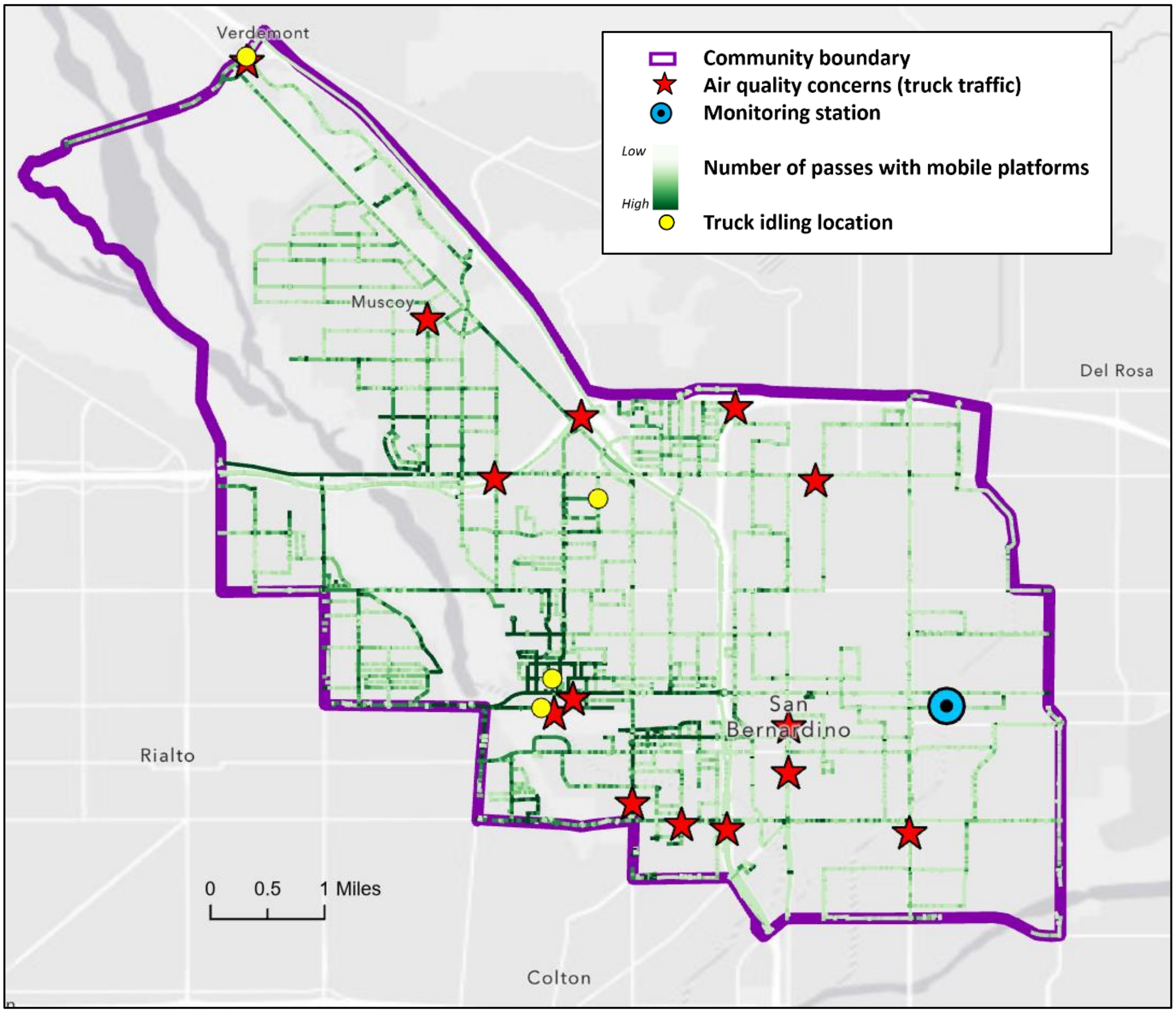

Figure A-1. Map of the SBM community showing the routes traversed by the mobile platforms with respect to the locations identified by the CSC where truck idling hotspots and truck traffic are of particular concern. As of August 2020, a total of eight days of mobile monitoring has been carried out in SBM

Figure A-2 shows the duration and time window for the area-wide mobile measurements performed within the SBM community in and around freeways, major roadways, and near truck idling hotspots, and locations where truck traffic is of particular concern. As shown in this figure, mobile monitoring was performed at different times of day during the eight weekdays.

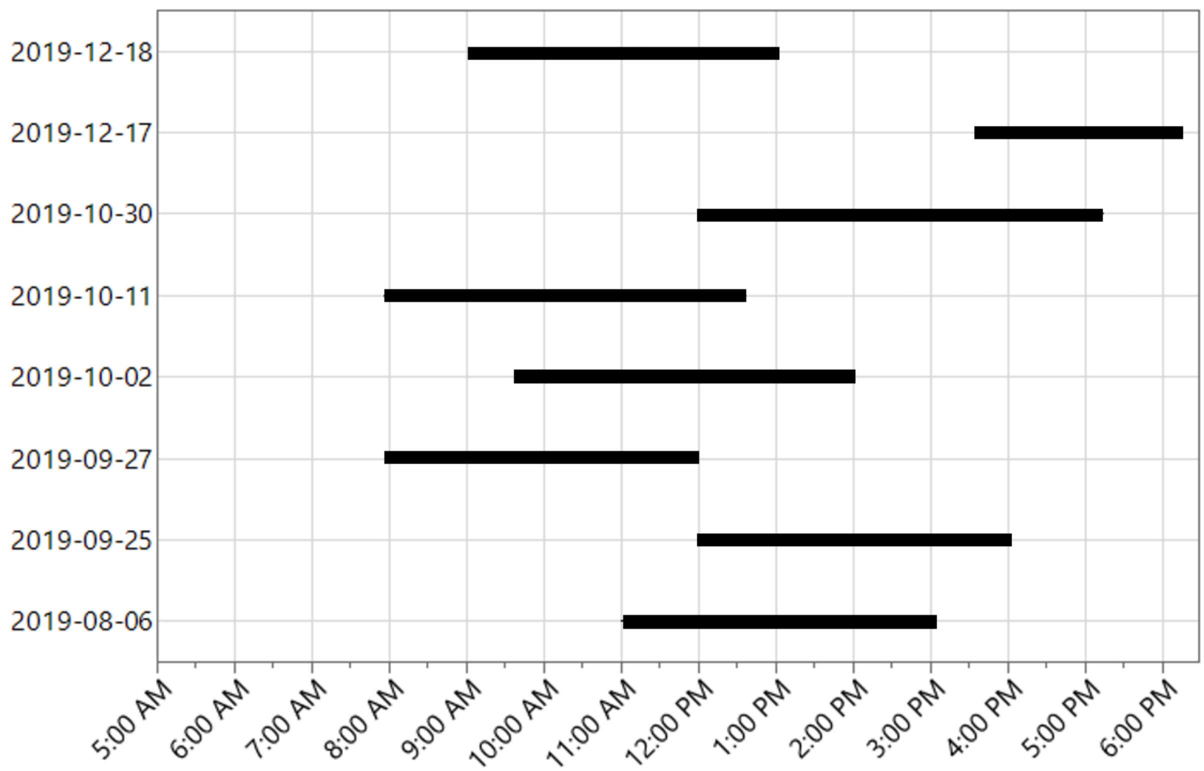

Figure A-2. The duration and time window for the area-wide mobile measurements performed in the SBM community in and around freeways and major roadways, and near locations where truck idling hotspots and truck traffic are of particular concern. The time windows only include hours of active mobile measurements within the community, excluding the commute time between the South Coast AQMD Headquarters and SBM

Upon extensive screening and pre-processing of the data, UFP and NO_2 measurements were found to be the most robust and reliable set of diesel exhaust markers measured, with 8 and 7 (out of 8) valid days of measurements, respectively, and minimum instrument down time, followed by BC measurements, with 6 days of measurements. Figures A-3, A-4, and A-5 illustrate "aggregated" maps of the spatial patterns (or concentration gradients) of NO_2, UFP, and BC concentrations in and around freeways, major roadways, truck idling hotspots, and locations where truck traffic are of particular concern within the SBM community, as measured by the mobile monitoring platform during those 8 days. To ensure that the concentration gradient map is representative of the variations in the pollutant concentrations, individual measurements taken within each 30-meter street segment in different passes and on different days were "aggregated", by calculating their arithmetic average, and shown as colored bins on the map. Therefore, each segment on the map represents multiple measurements taken at different passes. In addition, it should be noted that mobile measurements taken on different days and hours cannot be directly compared, mainly because of the day-by-day and diurnal (i.e., hour-of-the-day) variability in pollutant concentrations as a result of changes in meteorology and source emission strengths. Therefore, in order to account for the day-by-day as well as diurnal variability in the pollutant concentrations, the mobile monitoring data need to be normalized with stationary data from a fixed air monitoring station, according to a commonly used method in the literature. To achieve this, hourly data from the San Bernardino air monitoring station (which is part of the South Coast AQMD air monitoring network) was collected for the time period when mobile monitoring was conducted (Figure A-2). For example, on August 6th, 2019, mobile monitoring was performed from 11 am PST to 3 pm PST; therefore, a total of 4 hourly averages were calculated for each pollutant from the San Bernardino air monitoring station. Subsequently, the mobile monitoring data with 1- and 3-second time resolution were divided by the hourly averaged stationary data that corresponded to the hour in which that measurement was taken.

As shown in Figure A-3, the mobile monitoring results indicate elevated NO_2 concentrations on freeways, including the Interstate I-215 and I-210, and the streets around them. These instantaneous spikes in concentration, lasting from seconds to minutes, were occasionally higher than the U.S. EPA's short-term (i.e., 1-hour) standard for NO_2 (i.e., 100 ppb). However, the comparison of instantaneous measured concentrations with hourly standard must be interpreted with caution, as instantaneous measurements conducted by the mobile platform represent levels measured every few seconds, whereas the NO_2 short-term standard is based on a 1-hour average concentration. The purpose of this comparison is to help with the identification of persistent elevated levels of NO_2 and potential pollution hotspots. NO_2 concentration is low in the areas near Cajon Wash which runs on the west side of the SBM community. Most of the residential areas also show relatively low NO_2 concentrations. It should also be noted that NO_2 concentrations in the residential area between the I-215, I-210 and Rout 259 were relatively high. Measurements near traffic idling hotspots and at locations where truck traffic is of concern show a wide variability in concentration levels for NO_2.

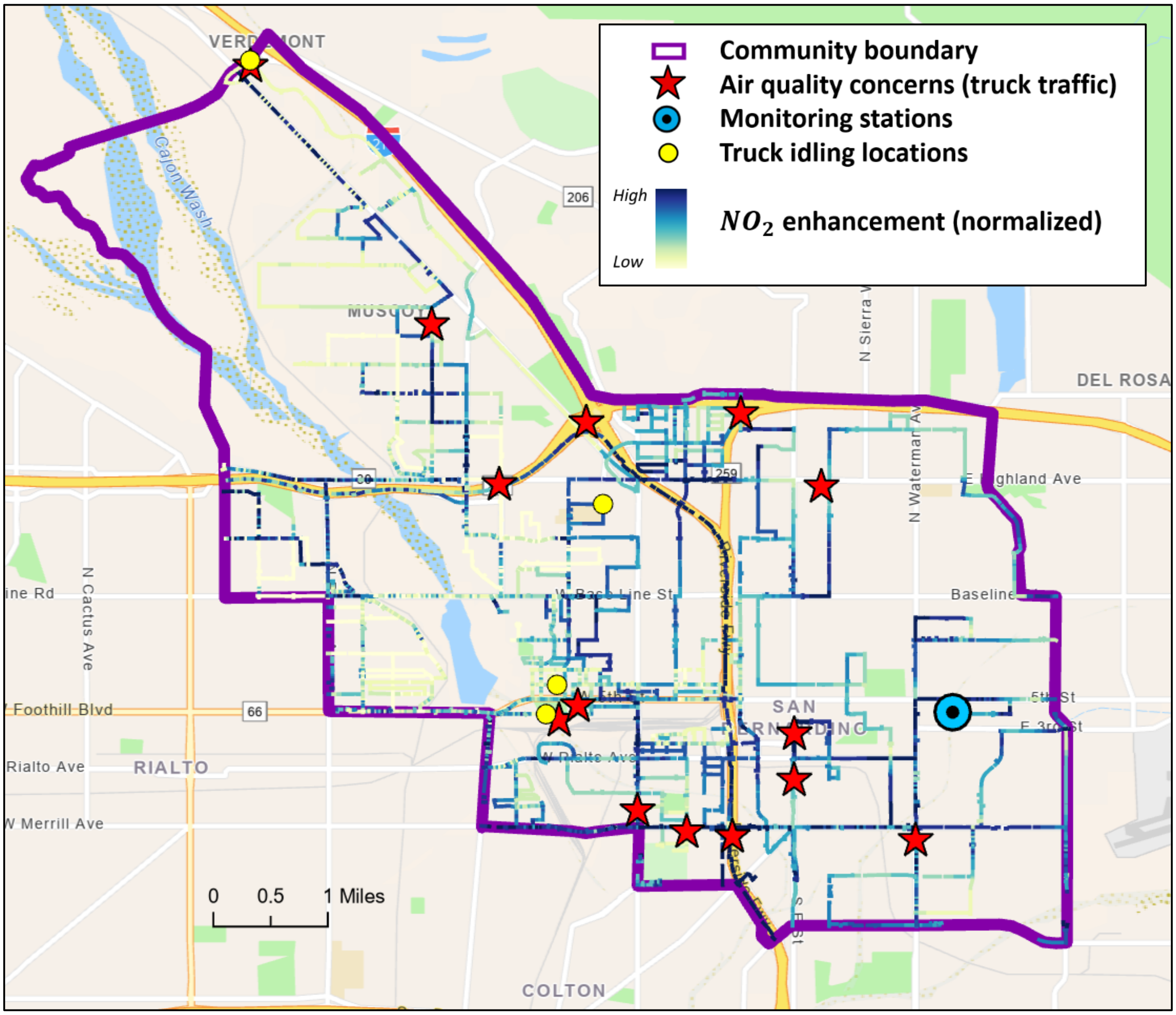

Figure A-3. Aggregated map showing the spatial variability of NO_2 concentration in and around freeways and major roadways, and near truck idling hotspots and at locations where truck traffic is considered to be a concern

For UFP (Figure A-4), the most elevated concentrations were observed on the I-215 freeway. As expected, and similarly to NO_2, UFP concentrations were generally lower in residential communities and areas around Cajon Wash compared to those measured in and around freeways and major roadways within the SBM community. As for NO_2, UFP levels varied at locations where truck traffic was identified as a concern and near truck idling hotspot locations. UFP levels were higher on the west of the I-215 freeway compared to the eastside. As shown in Figure A-5, BC concentrations also showed the highest elevations on the I-215 and I-210 freeways and Muscupiabe neighborhood in San Bernardino. BC levels were also generally higher to the west of the I-215 freeway compared to those measured in the communities across Cajon Wash. Since valid BC data were available for only 6 measurement days, BC measurements spanned a smaller part of the WCWLB community, compared to NO_2 and UFP. It is also noteworthy that even though the spatial patterns of these DPM tracers did not exactly match, the general trends were fairly consistent, showing elevated levels near and on major freeways and streets. This is an important observation since a large fraction of personal exposure to DPM occurs while traveling on roadways. According to the California Air Resource Board[1], although Californians spend a relatively small proportion of their time in enclosed vehicles (about 7% for adults and teenagers, and 4% for children under 12), 30 to 55% of daily DPM exposure typically occurs while driving.

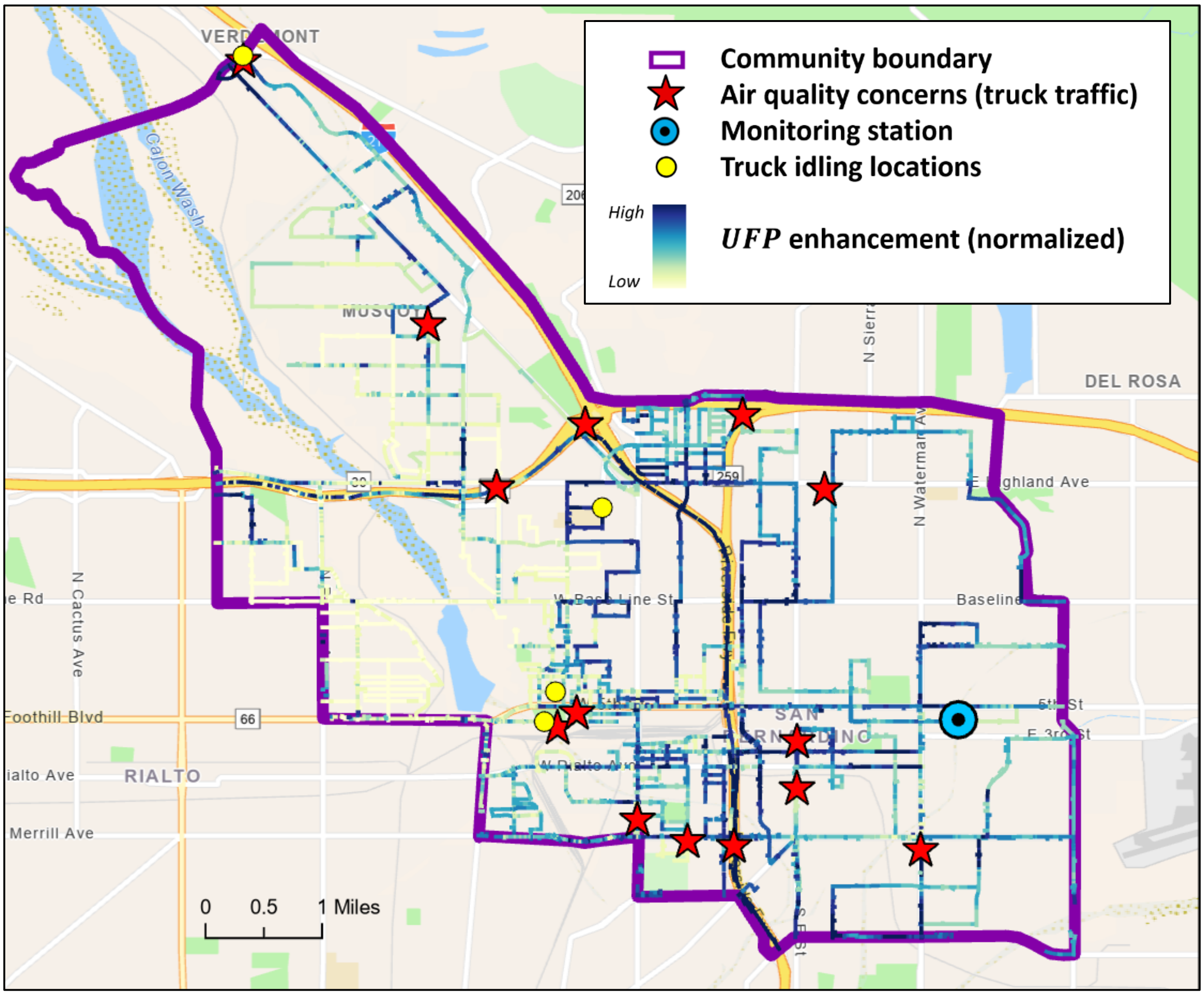

Figure A-4. Aggregated map showing the spatial variability of ultrafine particles (UFP) concentration in and around freeways and major roadways, and near truck idling hotspots and at locations where truck traffic is considered to be a concern

[1] https://ww2.arb.ca.gov/resources/overview-diesel-exhaust-and-health

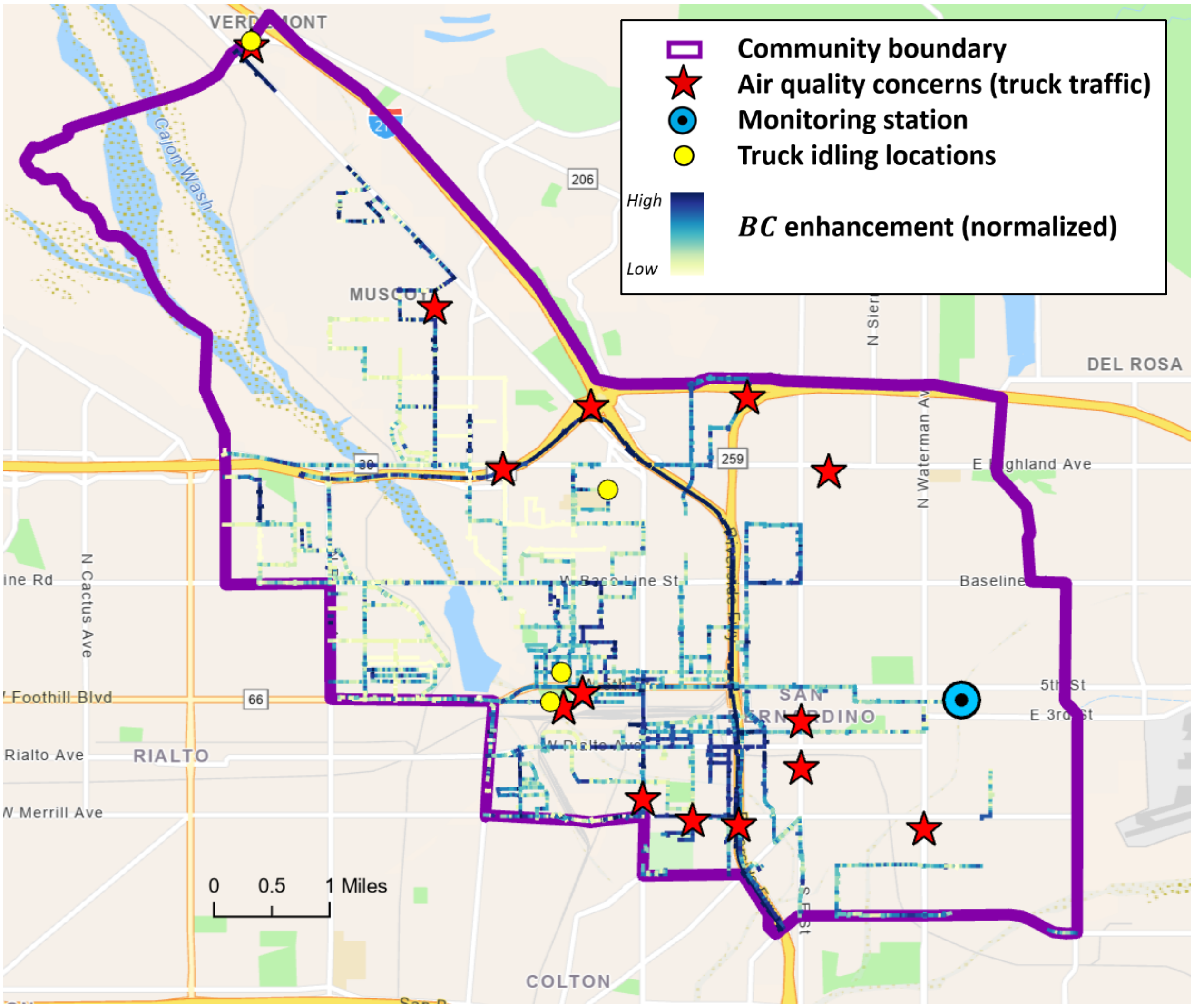

Figure A-5. Aggregated map showing the spatial variability of black carbon (BC) concentration in and around freeways and major roadways, and near truck idling hotspots and at locations where truck traffic is considered to be a concern