SOUTH COUNTY COMMUNITY MONITORING PROJECT

San Luis Obispo County Air Pollution Control District

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Glossary of Terms

beta source	A radioactive material (typically carbon 14) that emits beta particles. In air monitoring, it is used to measure mass of particulates deposited on a filter.
coarse fraction	Airborne particulates with an aerodynamic diameter between 2.5 and 10 microns.
dust event	
-Minor event	Only one permanent monitoring site has 24-hour PM10 average greater than 50 ug/m3
-Moderate event	Two permanent monitoring sites have 24-hour PM10 average greater than 50 ug/m3, but both less than 100 ug/m3
-Significant event	Two permanent monitoring sites have 24-hour PM10 average greater than 50 ug/m3 and at least one greater than 100 ug/m3
-Very Significant event	At least one permanent monitoring site has 24-hour PM10 average greater than 150 ug/m3
FEM	Federal Equivalent Method. US EPA designation indicating a monitoring method has been determined to be equivalent to the established federal reference method for measurement of a particular pollutant.
fine fraction	Airborne particulates with an aerodynamic diameter less than 2.5 micron.
FRM	Federal Reference Method. US EPA designation for the established measurement method for a particular pollutant.
histogram	A graphical representation showing a visual impression of the distribution of data.
hi-volume sampler	A particulate sampler designated as the federal reference method for PM_{10}. The hi-volume sampler is a manual method used to measure 24 hour average concentration of PM_{10}.
nephelometer	A nephelometer measures suspended particulates by employing a light beam (source beam) and a light detector set to one side (often 90°) of the source beam.
OHV	Off-highway vehicle
Plume	The spatial pattern of airborne pollutants resulting from an emission source.
PM_{10}	Airborne particles with an aerodynamic diameter less than 10 microns.
$PM_{2.5}$	Airborne particles with an aerodynamic diameter less than 2.5 microns.
ug/m3	micrograms per cubic meter. The unit of measure typically used for airborne particle pollution representing the mass weight of particles per cubic meter of air sampled.
wind blown dust	Crustal particles entrained in the atmosphere by wind blowing across open soil and/or sand areas

Executive Summary

The San Luis Obispo County Air Pollution Control District (APCD) has been investigating elevated particulate levels on the Nipomo Mesa for the past decade. Studies performed by the APCD in the area have shown the source of the elevated particulate matter (PM) pollution to be windblown dust from the open sand areas of the Oceano Dunes State Vehicular Recreation Area (SVRA), and that emissions are increased by off road vehicle activity. Additionally, previous studies have shown elevated airborne particulates are present near Pier Avenue in Oceano.

While working to reduce the particulate emissions at the source, the APCD also recognizes the need to provide the most accurate information available to residents of the area regarding the impacts of the windblown dust to their community. That was a primary impetus behind the design and implementation of the South County Community Monitoring Project. The goal of this project was to map the spatial extent and concentration gradient of the dust plume to better understand its impacts on Nipomo Mesa and Oceano neighborhoods. The data collected was ultimately intended to facilitate the preparation of more detailed air quality forecasts for those areas and enhance the ability of local residents to individually determine if or when protective actions might be needed on high PM days. Better knowledge of the plume path and downwind concentrations would also help inform the development of dust controls at the SVRA.

A saturation monitoring approach was utilized for this project with 23 semi-portable, real time beta attenuation (EBAM) PM_{10} monitors (many equipped with wind sensors), deployed across the Nipomo Mesa, as well as near the beach and adjacent to Pier Avenue and in Oceano. These monitors gathered data during the months of March through May, 2012 to capture the period known to have the highest winds and prevalence of dust episodes.

<u>Nipomo Mesa Study Results</u>

The data gathered from the Nipomo Mesa study area provides a detailed and comprehensive picture of the path, concentration gradient and influence of different wind conditions on the dust plume. Most dust episodes showed a remarkable similarity in plume extent and concentration gradient, with the main variable being the severity of the event. Figure E-1 below presents a visualization of the typical plume pattern observed on the Mesa.

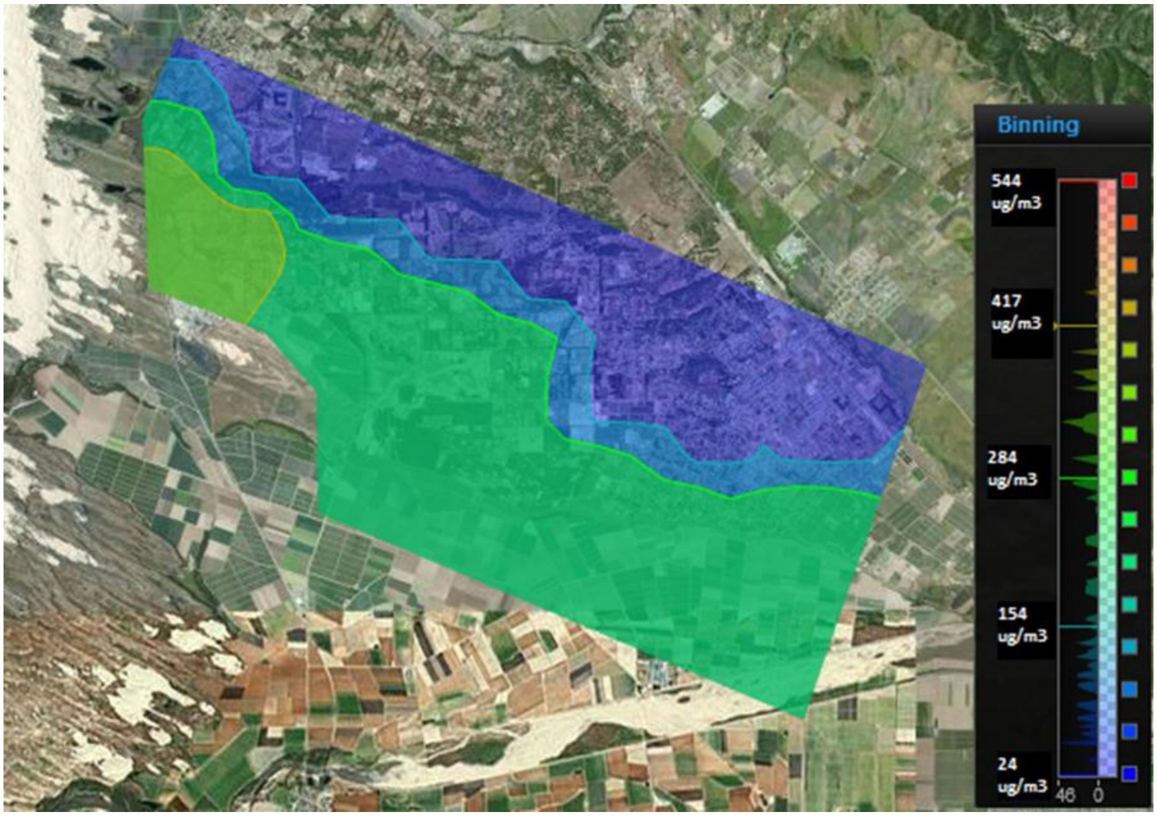


Figure E-1 – Typical Pattern of PM10 Distribution for Peak Hour of Dust Episode on the Nipomo Mesa

While the pattern of PM_{10} concentration depicted above is typical for most wind/dust events, some subtle differences were noted on specific episodes. The most significant variable in episodes appears to be changes in wind direction as the plume moves inland. Wind data shows that during the strong northwest winds when the dust events typically occur, the wind direction is quite constant near the coast, resulting in only small changes in the plume characteristics on the western portion of the Nipomo Mesa. However, the wind direction farther inland becomes much more variable, resulting in more variations in the plume path as one moves inland. For example, it is not uncommon for the wind direction five miles from the coast to shift more northerly, which results in a plume impact that is pushed in a more southerly direction with little to no impact in the northern portion of the Mesa. Conversely, particulate concentrations increase in the northerly portion of the study area when the wind direction inland is more westerly than on the coast. Analysis of the project data also demonstrated that the dust plume from the coastal dunes often extends inland to Santa Maria.

<u>Oceano Area Study Results</u>

Data gathered from the Oceano area showed elevated particulate concentrations are present during high northwesterly winds at monitors in close proximity to any area of disturbed open sand. These sand areas include the beach as well as Pier Avenue where sand commonly is tracked out of the SVRA by vehicles exiting the park. The project data showed the extent of the plume from these open sand areas to be quite small, with particulate concentrations diminishing quickly downwind. A 40% drop in PM_{10} concentration was observed just 0.1 mile downwind of the Pier Avenue monitoring site, while almost no plume presence was detectable at a site less than 0.4 miles downwind from the beach area.

Implications for Air Quality Forecasting in the South County

Detailed analysis of the study data and the particulate concentration relationships between each monitoring site under various meteorological conditions was used to generate more detailed forecast maps than previously possible for both the Nipomo Mesa and Oceano areas. Figures E-2 and E-3 below define the typical areal influence of the dust plume on each area during strong northwesterly winds. The APCD will use these maps to provide a numerical forecast of the Air Quality Index (AQI) for each forecast zone based on the approximate magnitude of the forecasted particulate concentrations. Each forecast zone is related to PM concentrations measured at the three permanent APCD monitoring stations on the Nipomo Mesa: CDF (Willow Road), Mesa2 (Guadalupe Road) and NRP (Nipomo Regional Park). Areas outside of the zones shown in these figures should use the San Luis Obispo monitoring station for particulate air quality guidance, unless otherwise noted.

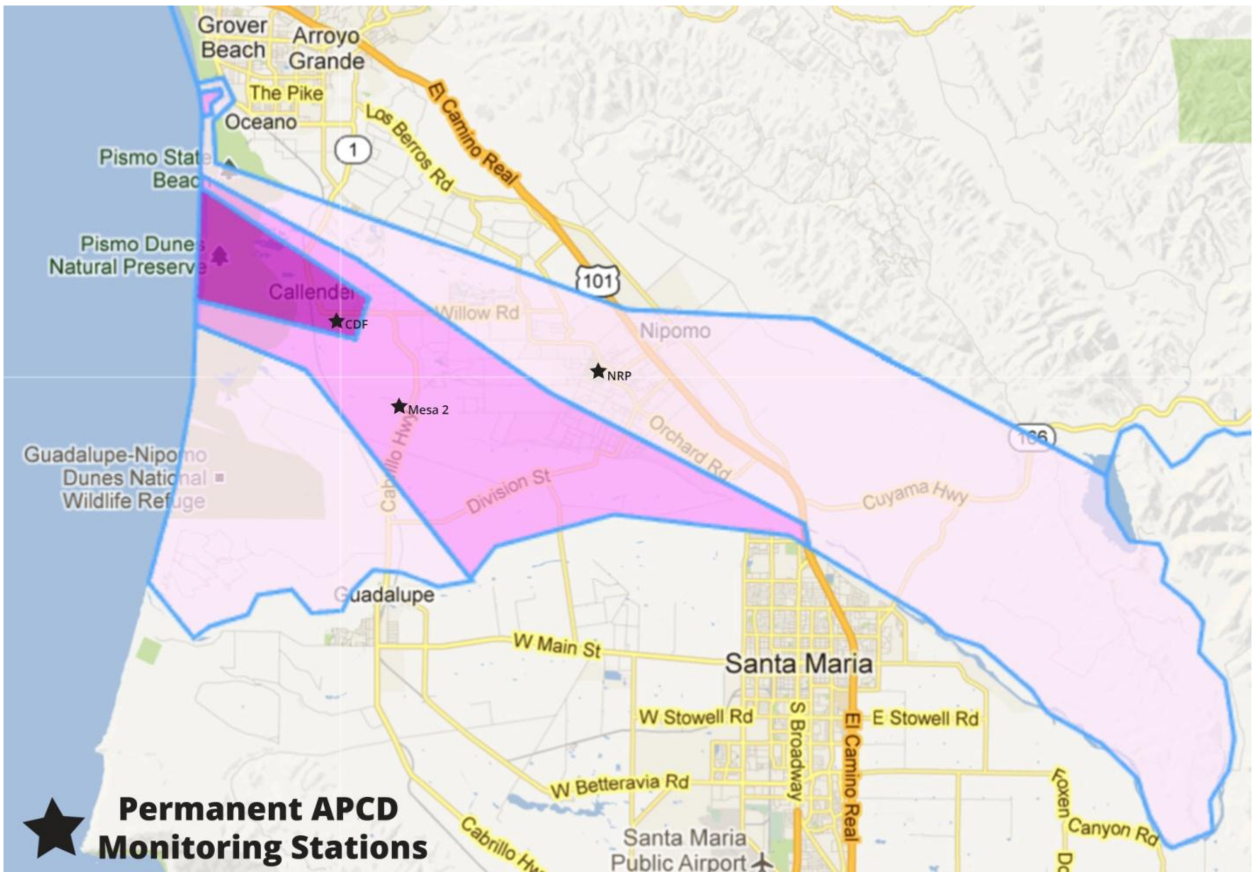


Figure E-2 - Nipomo Area Forecast Map. Forecast zones: Dark Pink = CDF, Medium Pink = Mesa2, Light Pink = NRP

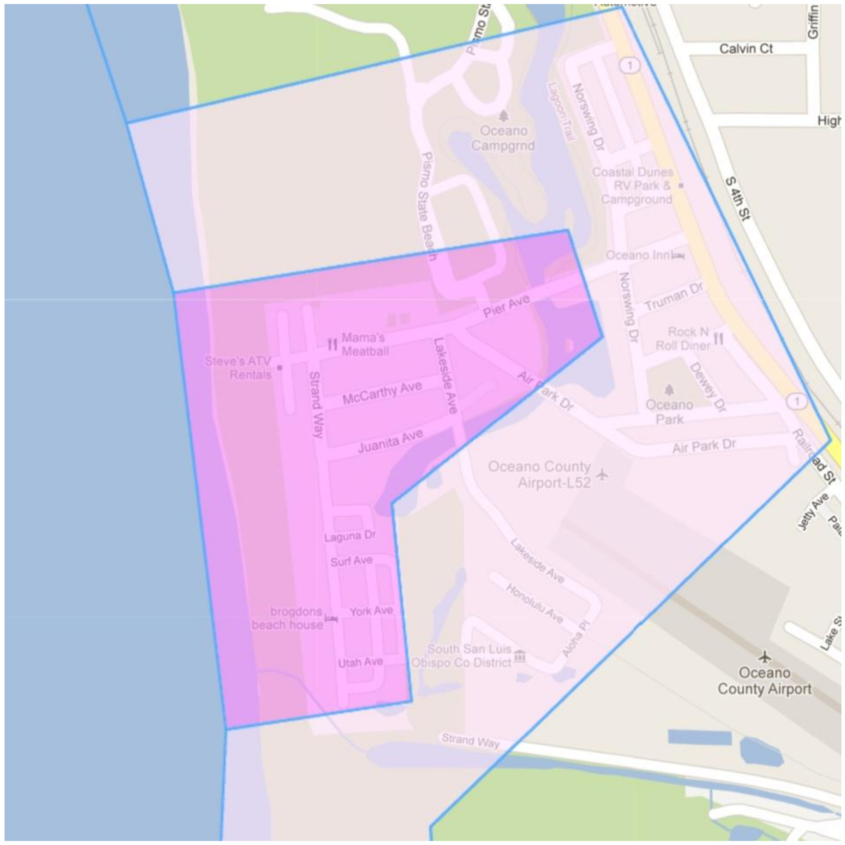


Figure E-3 – Oceano Area Forecast Map. Forecast zones: Medium Pink = Mesa2, Light Pink = NRP

It is important to note that each wind-blown dust event can have different wind and particulate concentration characteristics, so the forecast zones on these maps are based on the estimated average magnitude of the particulate concentrations observed in each area. The borders of each zone are approximate and not meant to be a rigid boundary; the plume path can vary with changes in wind direction and speed, and particulate concentrations on either side of a forecast zone border are likely to be similar. Thus, the public should use the air quality forecasts as a guide to help plan their outdoor activities and protect their health during blowing dust episodes, understanding that the forecast is our best estimate of potential maximum PM levels in each zone on a given day. The San Luis Obispo County forecast zones end at the Santa Barbara County border; however, as previously discussed, data from this study indicates impacts of the plume continue into Santa Barbara County during the more significant blowing dust events.

Introduction and Background

This report describes a special air monitoring study conducted by the San Luis Obispo County Air Pollution Control District (SLO APCD or District) to better define the spatial distribution and neighborhood impacts of the windblown dust plume that originates from the Oceano Dunes during high northwest wind conditions. The study focused on two primary impact areas in the South County: the Nipomo Mesa neighborhoods directly downwind of the dunes, and the Oceano neighborhoods adjacent to Pier Ave and the beach. The results of this study will be used to increase the accuracy of our South County air quality forecasting and the information available to affected residents and the media.

Historical ambient air monitoring conducted by the SLO APCD has recorded high airborne particulate matter (PM) concentrations in southwestern San Luis Obispo County that are much higher than those observed at other coastal areas of San Luis Obispo County and California as a whole (1). Ambient PM levels of on the Nipomo Mesa exceed State air quality standards about 60 to 70 days per year and occasionally exceed the considerably more stringent Federal standards. Of particular concern are the very high hourly PM levels that typically occur in the active hours of the day during these episodes.

To better understand the extent and source(s) of this particulate pollution, the SLO APCD has previously performed other air monitoring studies in and around the Nipomo Mesa and Oceano areas, including what are now commonly referred to as the Phase 1 and Phase 2 South County Particulate Studies (2,3). These comprehensive research efforts have documented the severity of the problem and confirmed that the high particulate levels impacting the Nipomo Mesa are associated with high winds, and that the main source area is the open sand sheets of the Oceano Dunes State Vehicular Recreation Area (SVRA). The Phase 2 study concluded that all open sand areas exposed to high winds have the potential to emit PM, but that off-highway vehicle (OHV) activity in the SVRA increases the magnitude of these emissions. Considerable analyses of airborne particulate samples collected during these studies has shown that, on high concentration days, the majority of the particle mass consists of earth crustal elements, along with 5 to 10 % sea salt, about 5% ammonium sulfate and less than 1% ammonium nitrate (2, 3).

High particulate concentrations were also measured in Oceano near Pier Avenue in the Phase 2 study during high wind events, but the source area was not clearly defined (2). While there is a small open sand area (beach) upwind from Oceano, other nearby areas with similar upwind beaches have not measured high concentrations of windblown dust (e.g., Grover Beach). Wind entrainment of sand tracked out onto the south side of Pier Avenue as vehicles exit the beach was suggested in the study as a possible source.

Figure 1 below shows the study area and air monitoring locations utilized in the Phase 2 study.

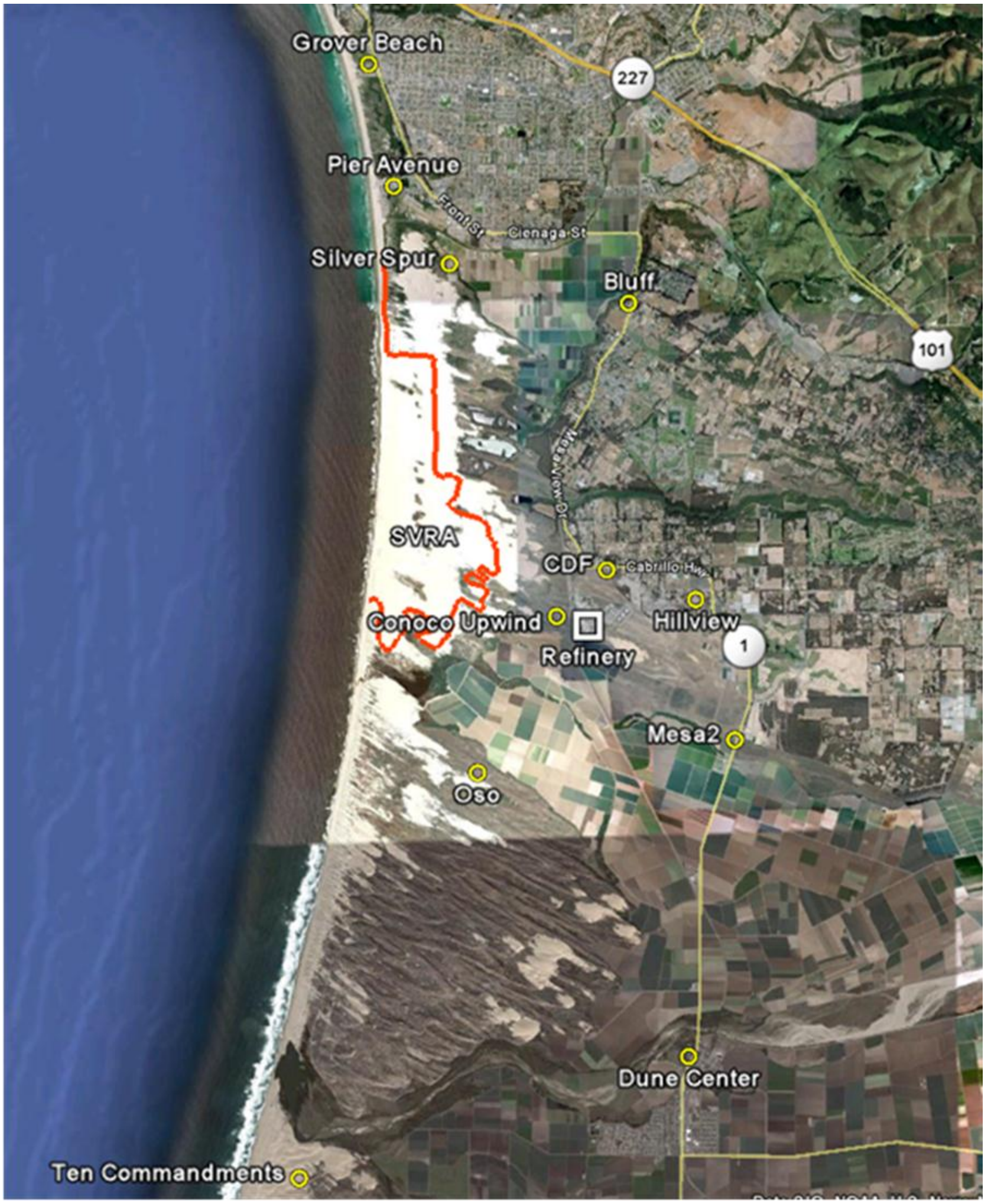


Figure 1 – South County Phase 2 Particulate Study Air Monitoring Locations

Concern over potential health impacts from these high PM levels led the District to perform short-term PM_{10} monitoring at the four public schools in the area (Figure 2, below) to better understand the PM exposure levels for local school children. The monitoring was performed sequentially from April through October 2011, one school at a time, with the goal of measuring PM levels at each location during at least 6 to 8 high northwest wind days before moving to the next school. Data from this limited monitoring project showed the following:

1. No windblown dust impacts were measured at Oceano Elementary School, indicating the extent of the dust plume affecting that community was likely confined to the area near Pier Avenue where PM was measured during the Phase 2 study.

2. There also was no significant windblown dust impacts measured at Mesa Middle School, indicating this school was likely situated to the north of the dust plume.
3. Windblown dust impacts were measured at Lopez High School, but were lower than those concurrently measured at the District's CDF monitoring site about a mile to the south. It is important to note that only one significant dust event occurred during the monitoring period for this school, so the dataset is quite limited. The wind speeds measured at this site were also considerably lower than any other wind speed measurements in the area, likely due to the thick eucalyptus groves directly upwind of the school.
4. Dust impacts were also measured at Dorothea Lange Elementary School on the south eastern portion of the Nipomo Mesa. PM levels observed there were less than measured on the western edge of the Mesa, and closely followed the PM levels concurrently measured at the District's nearby NRP monitoring station. (4)

Figure 2 – Location of District Permanent Monitors and Short Term School Monitors

In analyzing the data collected during the short-term schools monitoring projects it became clear a much better understanding was needed of the spatial extent and concentration gradients of the dust plume impacting the Nipomo Mesa, as well as the source and extent of the dust impacting the community of Oceano. Such information would enhance our air quality forecasting capabilities and enable area residents in affected areas to better determine if protective actions were needed on high PM days. Better knowledge of the plume path and downwind concentrations would also help inform the development of dust controls at the SVRA. Thus, in late 2011 the SLOAPCD initiated this Community Monitoring Project.

Community Monitoring Project

The Community Monitoring Project was designed and developed in late 2011 to provide a detailed understanding of the spatial extent and concentration gradient of the dust plume originating at the Oceano Dunes SVRA. March through May 2012 was selected as the desired timeframe for data collection to capture the period that historically has the most wind-blown dust events. The project focused on two areas of study, Oceano and the Nipomo Mesa, as depicted in Figure 3.

Figure 3 – Community Monitoring Project Study Areas

Study Design

The primary goal of the Community Monitoring Project was to better define the downwind path and concentration gradient of the dust plume originating from the Coastal Dunes. The monitoring plan developed for this study is included in Appendix B. Historical measurements in the study area show that most wind/dust events occur in the spring months from March through May, so the project was designed to have monitors deployed in the field during this period.

Saturation monitoring is a well-established method for analyzing spatial differences in concentrations and was implemented for this study using semi-portable PM_{10} monitors saturating the area downwind from the source area. Two challenges in any saturation monitoring project are:

1. To identify a measurement method that is technically and logistically feasible to apply, is semi-portable, has the necessary time resolution and operational characteristics needed to provide reliable data, and is affordable to acquire and implement.
2. To establish a sufficient density of monitors, in representative locations, to provide sufficient resolution of the plume path and concentration levels.

If these challenges can be overcome in the design of the project, the result is a very clear description of plume path and concentration gradients. One important advantage of the saturation approach is the entire pattern of data is considered, rather than placing all emphasis on a single point of measurement. Looking at the pattern of data across the study area allows data outliers to be discounted as the focus is on the common pattern of data. In essence, when similar values are measured from adjacent monitors, the adjacent monitors provide additional validation to each other's data value. Systematic bias in measurement would not be detected by comparison to adjacent monitors, but can be addressed by a robust QA/QC program that includes comparison to different monitoring methods.

<u>Selection of the Monitoring Method</u>

Because windblown dust typically has more mass in the coarse fraction (2.5-10 micron) than the fine fraction (<2.5 micron), PM_{10} was the obvious parameter to measure for this project. Including measurement of meteorological parameters across the study area provides added insight into the plume behavior.

Hourly data resolution was considered essential to understanding the short term movement of the plume; thus, traditional manual filter methods that only provide 24-hour average readings were eliminated as candidate methods. A number of PM_{10} measurement methods that provide hourly (or less) resolution were evaluated for use in this project (5). Project staff weighed the benefits and drawbacks of each method and ultimately selected the MetOne EBAM as the best available method for this study. Important considerations included the following:

- EBAMS are often configured with meteorological sensors, so in addition to gathering PM_{10} data, wind speed and direction data could also be gathered across the study area.
- Project staff is already very familiar with operation of the EBAM.
- The large number of EBAM samplers needed for this project was available on loan from other government agencies.

The MetOne EBAM is a portable PM_{10} monitor that uses beta attenuation as the sampling method. One important operational characteristic of the EBAM to be mindful about is its known tendency to respond low to PM_{10} samples when most of the mass consists of particle sizes in the coarse range above 7 microns. This characteristic was first discovered by the SLO APCD in Quality Assurance (QA) tests associated with the Phase 2 study. After investigation by the sampler manufacturer, the issue was confirmed and determined to be caused by the partial obstruction of the sample path by the beta source (6), located just above the sample filter tape (see Figure 4). EPA-approved Federal Equivalent Method (FEM) monitors with more advanced beta attenuation systems (such as the MetOne BAM 1020 used at APCD permanent monitoring sites) do not have the beta source in the sample path; instead, they have a complex shuttle mechanism that moves the filter tape between the sample path and the beta source and detector.

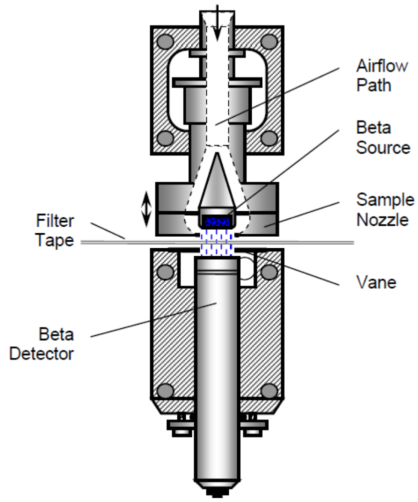


Figure 4 – EBAM Source, Detector, and Sample Path

Through extensive QA testing during the Phase 2 study, the District was able to successfully apply a correction factor developed by running side-by-side tests comparing the EBAM measurements to FEM monitors (2). The corrected EBAM data ensures PM_{10} measurements are accurately reported even when the majority of the sample mass consists of particles greater than 7 microns. In selecting the EBAM for use in this study, project staff acknowledged that extensive QA testing would be needed to ensure valid and high quality data was collected.

Quality Assurance Program

Independent quality assurance oversight for this project was performed by Mr. Karl Tupper of the San Luis Obispo County APCD. He was not involved in performing any calibrations, QC checks, maintenance or other aspects of sampler operation for this program to allow for independent oversight of QA issues. Mr. Tupper was responsible for reviewing all Quality Control (QC) check documentation for accuracy, reviewing all site selection surveys, and assuring the procedures utilized followed those outlined in the monitoring plan and the EBAM Standard Operating Procedures (SOP) manual (Appendix B). In addition, He was also responsible for review and analysis of the methods inter-comparison tests between the EBAM samplers and the federally approved monitoring method performed at the District's Mesa2 and Nipomo Regional Park (NRP) monitoring stations prior to the saturation sampling, including approval of all correction factors to the data. Finally, Mr. Tupper approved the validation of all data utilized in the analysis of data for this project.

All EBAM samplers utilized for this project were operated adjacent (collocated) to the Districts Mesa2 or NRP monitoring stations, both of which are equipped with FEM PM_{10} monitors. The FEMs are subjected to bi-annual performance audits by the California Air Resources Board (CARB) and successfully passed all audits; the last audit was in April 2012. Most of the samplers were collocated with the District's FEM

PM_{10} monitors for the approximate period of February 7, 2012 through March 7, 2012. Some samplers that needed additional repair work prior to deployment, or were received from the loaning agency at a later date, were collocated during alternative time periods.

This period of collocation of all EBAM samplers with the BAM 1020 FEMs was used to establish the relationship between each EBAM sampler and the FEM, focusing on comparisons between the two sampling methods during wind-blown dust events. The results of these comparison tests were used to calculate correction factors for the EBAM data to make it comparable to the federally equivalent PM_{10} method. Throughout most of the project measurement period at least one EBAM was collocated at both the NRP and Mesa2 sites. Cycling of EBAM samplers between the Mesa 2 site and the NRP site was performed to establish a consistent relationship between the EBAM monitors and the FEM monitors at both the Mesa2 and NRP monitoring locations.

In addition to collocation of the EBAM samplers with FEMs, the project followed a strict Quality Control protocol to ensure only valid representative data was used in analyzing the monitoring results. Details of the QC protocol, QC results, and a detailed description of the collocation tests and correction factor calculations can be found in Appendix A and Appendix B.

Nipomo Mesa Monitor Locations

A common approach in saturation monitoring is to divide the study area into a grid, siting one monitor in each grid area; this results in an almost even distribution of monitors across the study area. To achieve the project goal of describing the plume path and concentration gradient on the Nipomo Mesa, while ensuring measurements captured sensitive receptors and more populated areas, a modified grid approach was used. In this approach, a grid was used as a starting point for monitor siting, followed by a detailed examination of each grid area to identify sensitive receptors, relative population density, our current understanding of micro-meteorological patterns, and any previous monitoring performed in the area. This analysis was used to determine if, and approximately where, a monitor should be sited in each grid.

Figure 5 shows the study area downwind from the coastal dunes with an approximately 1 square mile grid aligned to the prevailing winds that occur during dust events. A resolution of 1 square mile provides an adequate description of the plume, even with the obvious topographic and other obstructions to airflow that will result in micro-meteorological conditions in some areas. The northern grid boundary was determined based on previous monitoring projects in the area that indicated this was likely the northern extent of the plume under most conditions. The southern grid boundary was set at the edge of the Nipomo Mesa, which also is the edge of the most populated areas. In addition to siting monitors based on analysis and investigation of each grid, it was determined that siting a few additional monitors outside of the populated grid area would be of value in enhancing our knowledge of the plume extent.

Figure 5 – Approximately 1 square mile Grids over Populated Area Downwind from the SVRA and Permanent District Monitoring Stations

Oceano Monitoring Locations

The situation in the Oceano study area is different due to the much smaller spatial scale being investigated (most of the community fits into a single half square mile area) and the added goal of providing a more definitive determination of the source of particulate matter impacting the community. Additionally, State Parks, in conjunction with the County of San Luis Obispo, has instituted a street cleaning program designed to minimize the accumulation of sand being tracked out of the SVRA onto Pier Avenue; thus, it was hoped that measurements in this area might also be able to determine how much reduction in ambient particulate matter has occurred due to this mitigation effort. The study design for Oceano incorporated a similar saturation approach, with one monitor located at approximately the same location where the Phase 2 study measured high particulate concentrations.

For both study areas, land owners in desirable monitoring site locations were approached to host samplers. Each potential sampler location was investigated by project staff and a formal evaluation of the suitability of the site was performed. The Project Monitoring Plan, attached as Appendix B, details the specific siting criteria and the forms and procedures used to evaluate potential site locations. In general, the sites were evaluated for:

- Minimal obstructions to air flow, particularly from the NW direction as that is the path for most windblown dust events.
- Proximity to other potential local particulate sources.
- Availability of electrical power.
- Ease of access to the site.
- Security for staff and equipment.

Following an exhaustive search and onsite evaluations for appropriate monitor locations, a set of suitable locations on the Mesa and in Oceano was finalized and formal agreements with the hosting land owners were established. One important study zone where staff was unable to secure a monitoring site was the agricultural area south of the Nipomo Mesa in the northern portion of the Santa Maria Valley (site ID S-E). As an alternative, staff utilized a sampler mounted on the bed of a truck parked on the side of the roadway from approximately 10am through 5pm on 6 days that were forecast to be episode events, and one day forecast to be a non-event day for comparison.

Figure 6 below presents the approximate location of each monitoring site in the Nipomo Mesa study area along with its assigned site ID. Note that not all sites were operational for the entire monitoring period.

Figure 6 – Nipomo Mesa Project Site Locations. Permanent SLO APCD/State Parks monitoring stations are shown with yellow pins, temporary EBAM locations with purple circles.

In the Oceano study area, a sampler (O-C) was sited across the street from a monitoring location previously used in the Phase 2 Study (the original Phase 2 location was unavailable) that had measured high PM_{10} concentrations. A second site (O-A) was selected further inland from O-C along the northwestern prevailing wind direction. A third site (O-B) was also selected approximately the same distance inland (along prevailing wind direction) as O-A, but farther south and well away from any influence of Pier Avenue. After review of preliminary data from these three sites in early May, a fourth Oceano site (O-D) was selected on the beach. Figure 7, below, shows the approximate location of these sites as well as the location of Oceano Elementary School, where monitoring in the Spring of 2011 detected no dust plume or elevated PM_{10} readings. (4) Note that for the Community Monitoring Project, no new monitoring was performed at Oceano Elementary School.

Figure 7 – Oceano Study Area Sampling Locations in Relation to Oceano Elementary School

Results and Analysis

Overall, the data from the saturation monitoring provide exceptional detail on plume extent, concentration gradient, and wind patterns across the study area. The density of monitors was more than sufficient to meet the goals of the project, even with sporadic data loss from some sampling locations.

For the Community Monitoring Project, the EBAM samplers operated quite well; occasional monitor failures did occur, as expected, both for PM_{10} and wind sensors. Some PM_{10} data loss occurred due to hardware failures (mostly pumps), out of tolerance quality control checks (mostly due to occasional nozzle leaks), and tape failures. Data loss for wind parameters was almost entirely due to failure of the internal reed relay on wind speed sensors in certain samplers; the reed relay has a finite life, and as most the EBAM samplers were used units, their age contributed to the failure rate of these sensors. During the saturation monitoring period after all monitors were installed (3/10/12 to 5/31/12) the average data recovery for PM_{10} from the EBAM saturation monitors was a respectable 81%, and the wind data recovery rate exceeded the PM_{10} data recovery. A more complete breakdown of data recovery is provided in Appendix A.

Nipomo Mesa Study Area

Plume Path and Concentration Gradient

The data gathered from the Nipomo Mesa study area provide a detailed and comprehensive picture of the dust plume path, concentration gradient, and how wind conditions influence the dust plume. Most dust episodes show a remarkable similarity in plume extent and concentration gradient, with the main variable being the severity of the dust event. Figure 8 below presents a visualization of the typical plume pattern observed on the Mesa. The colored isopleths were produced using Groundswell Technologies Waiora software.

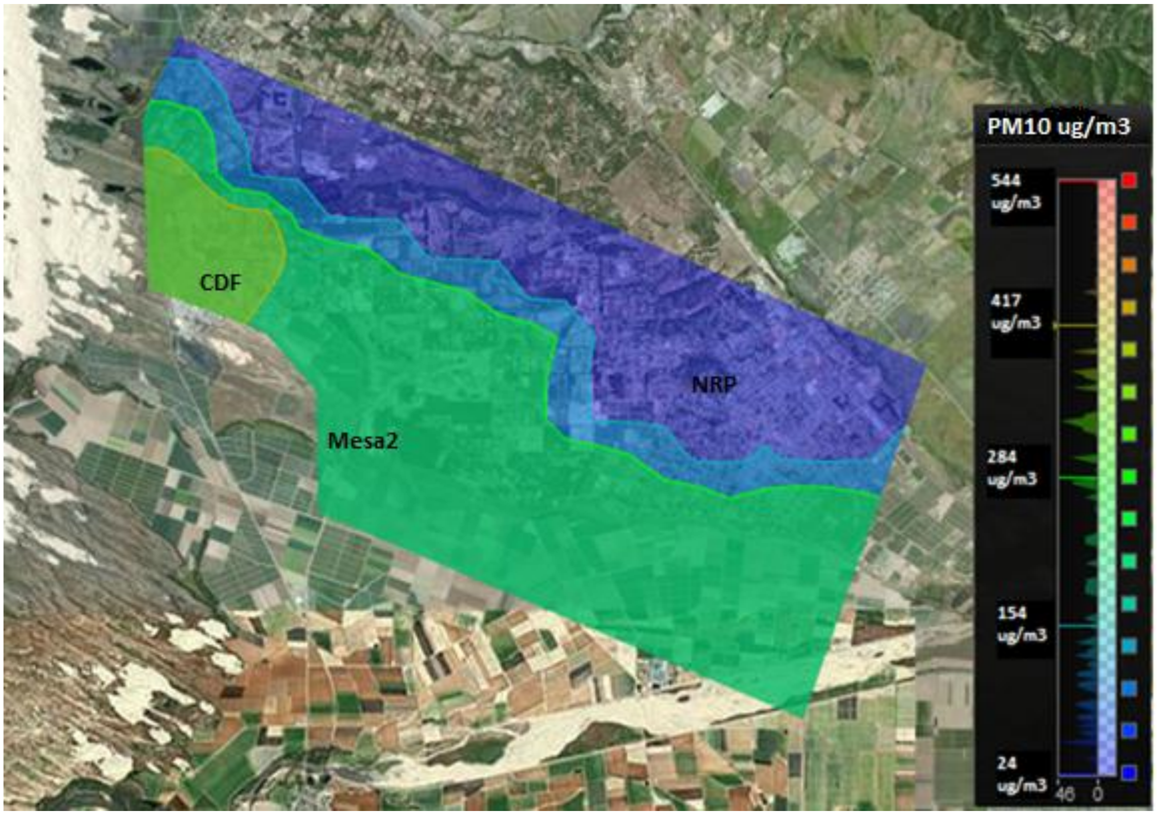


Figure 8 - Typical Pattern of PM10 Distribution for Typical Peak Hour of Dust Episode on the Nipomo Mesa

Note in Figure 8, above, that the concentrations are quite low along the entire northern and northeastern study domain. This confirms previous measurements which showed that under most wind-blown dust event conditions, the northern/northeastern edge of the plume path generally follows the northern boundary of the study domain where PM concentrations tend to be least influenced by the plume. There are some exceptions, and under extreme dust events, the concentrations along the northern study extent can be significantly higher than typical background levels; however in general, the Community Monitoring Project data confirms the study domain captured the northern extent of dust plumes from the SVRA.

Figure 8 also demonstrates the highest concentration areas are along the western and southern boundaries of the study domain. The very highest concentration areas are consistently in the vicinity of the District's permanent CDF monitoring station, with slightly lower concentrations to the north and south. PM_{10} concentrations similar to those observed at the APCD Mesa2 site occur along the southern edge of the Nipomo Mesa and the northern portion of the Santa Maria Valley, as measured by the temporary site SE. The Community Monitoring Project study domain does not extend farther south than the temporary site SE in the northern portion of the Santa Maria Valley. Thus, the southerly extent of the dust plume was estimated using the data from this study and historical data from a monitoring station previously located in Guadalupe.

A PM_{10} monitor was located in downtown Guadalupe in March 2009 as part of the Phase 2 study; the Guadalupe site was a similar distance from the coast as Mesa2, but about 3.5 miles south of Mesa2. PM_{10} concentrations at Guadalupe barely exceeded normal background levels, even during hours when Mesa2 measured 200 to 300 ug/m3. Based on this historical data, it appears the southern extent of the dust plume is somewhere between Mesa2 and Guadalupe when the winds are from the northwest.

The average 24-hour PM_{10} concentrations at all temporary sites on days with dust events compared to average concentrations at the permanent District sites on those same days provide a good gauge of typical plume impacts in areas without a permanent site. Figure 9 below shows the name and location of each temporary and permanent site, while Table 1 presents the data comparisons as a ratio of the average concentration observed at each temporary site versus each permanent site. Multiplying the ratio listed times the 24 hour average concentration from the specified permanent site provides the approximate 24-hour average concentration one would expect at the location of the temporary site. These factors can be utilized in future dust episodes to estimate the impacts at one or more temporary site location. Note that there is no 24 hour data for site S-E, but comparing the hourly concentrations gathered from S-E show that the concentrations during dust episodes at S-E are very similar to Mesa2.

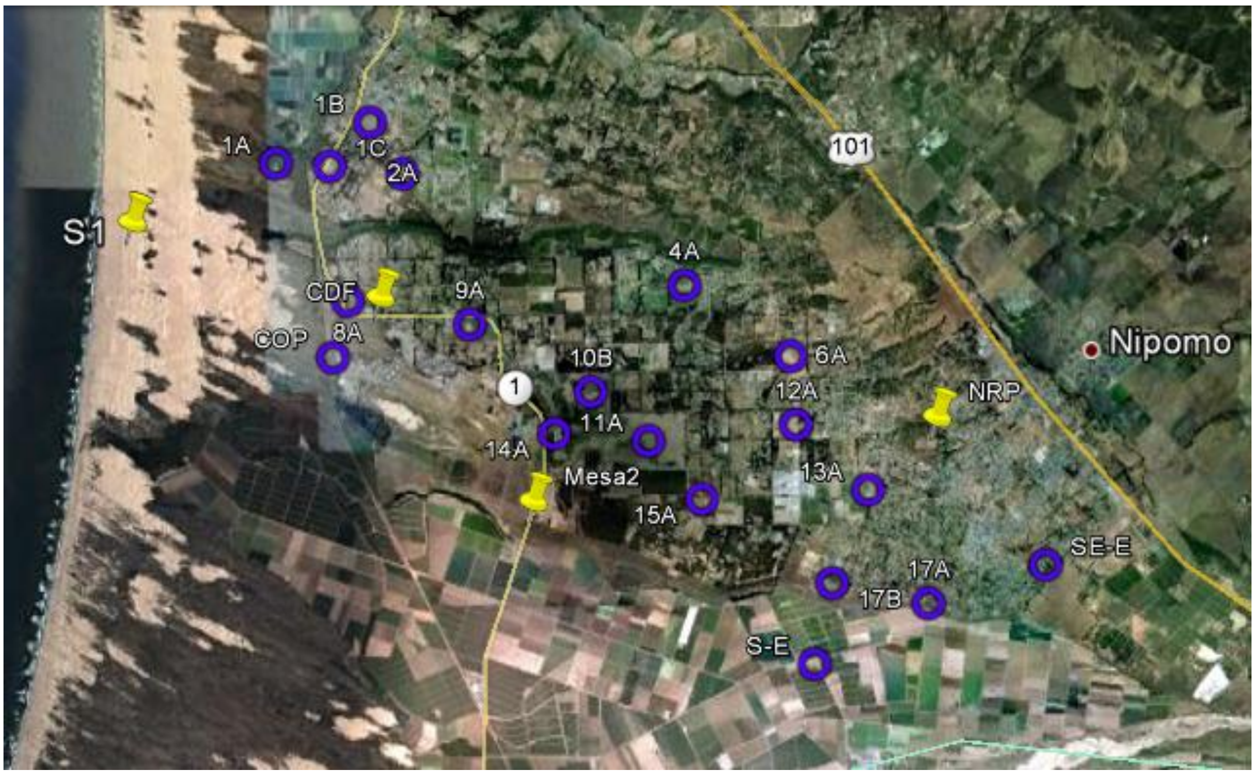


Figure 9–Temporary sites and Permanent Sites Used in Study

Table 1 – Comparison of average 24-hour PM_{10} concentrations at temporary and permanent monitoring sites on episode days during the study period

Temporary Sites	Most Comparable District Site	Ratio of Average 24-hr PM_{10} Concentration to District Site			# Episode Days Analyzed	Statistical Correlation of Episode Data to District Site		
		NRP	CDF	Mesa2		NRP	CDF	Mesa2
1A	Mesa2	1.34	0.55	0.75	26	0.41	0.82	0.80
1B	NRP	0.74	0.24	0.33	9	0.63	0.47	0.80
1C	Mesa2	1.20	0.58	0.75	14	0.46	0.89	0.88
2A	NRP	0.76	0.29	0.39	23	0.39	0.51	0.47
4A	NRP	1.08	0.49	0.64	20	0.88	0.29	0.27
6A	NRP	0.76	0.29	0.39	29	0.95	0.49	0.49
8A	CDF	2.12	0.85	1.12	23	0.36	0.93	0.93
9A	Mesa2	1.43	0.52	0.70	23	0.62	0.84	0.81
10B	Mesa2	1.59	0.62	0.82	29	0.72	0.87	0.87
11A	Mesa2	1.45	0.53	0.72	23	0.55	0.83	0.76
12A	NRP	1.19	0.46	0.63	19	0.87	0.53	0.56
13A	NRP	1.14	0.45	0.58	23	0.78	0.48	0.53
14A	Mesa2	1.75	0.72	0.98	20	0.13	0.79	0.84
15A	Mesa2	1.83	0.68	0.88	20	0.61	0.82	0.87
17B	Mesa2	1.40	0.55	0.73	26	0.68	0.87	0.85
17A	Mesa2	1.43	0.55	0.73	29	0.76	0.88	0.85
SE-E	NRP	1.10	0.43	0.56	26	0.94	0.58	0.60
COP	Mesa2	1.65	0.66	0.84	6	0.51	0.91	0.99

Based on the project data, in most cases the centerline of the dust plume follows the prevailing northwesterly wind direction centered on the CDF monitoring station and extending inland. As the plume moves inland, the wind direction may vary, resulting in subtle shifts in the plume centerline. Data analysis from the Santa Maria monitoring station and numerous visual observations indicate that the plume reaches Santa Maria during the more significant events when the inland wind direction directs the plume to this monitor.

Variations in Dust Events

While the pattern of PM_{10} concentration depicted in Figure 8 above is typical for most wind/dust events, some subtle differences were noted on specific episodes. The most significant variable in episodes appears to be changes in wind direction as the plume moves inland. At the S1 meteorological site located on the dunes, there is very little variability in wind direction during significant dust episodes, as shown in Figure 10. This figure presents a histogram depicting the distribution of wind direction at S1 for the peak PM_{10} hour (measured at CDF) of each day during the monitoring phase of this project when the CDF site exceeded the state 24-hour PM_{10} health standard of 50 ug/m3.

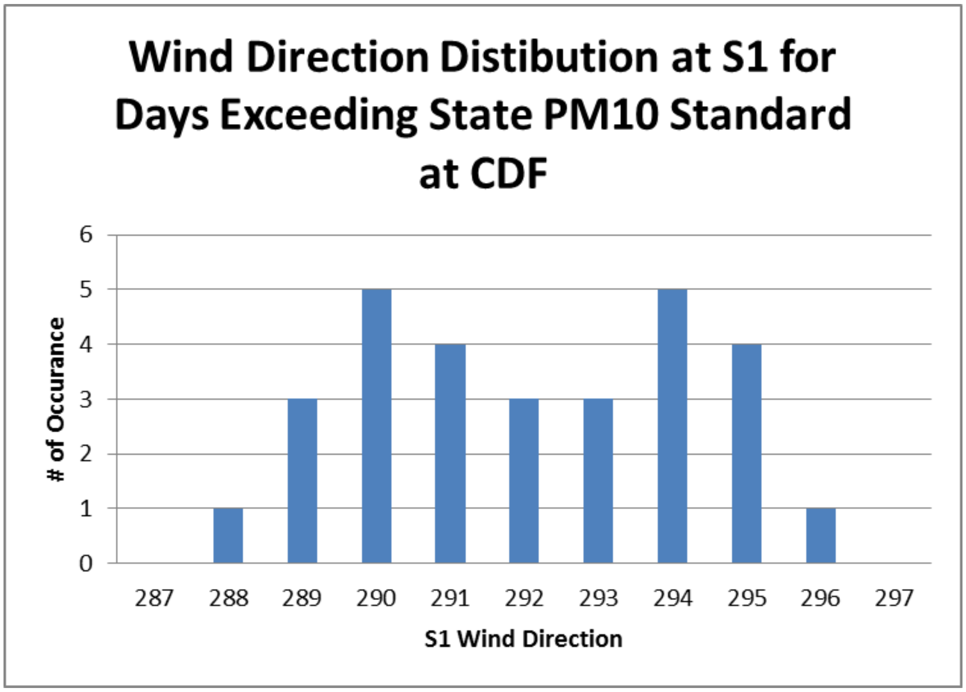


Figure 10 –S1 Wind Direction Distribution at Peak Hour of Significant Dust Events

In contrast, wind direction variability increases as you move inland as represented in Figures 11 and 12 below. Figures 11 and 12 present the same wind direction histogram as Figure 10 from monitoring stations farther inland.

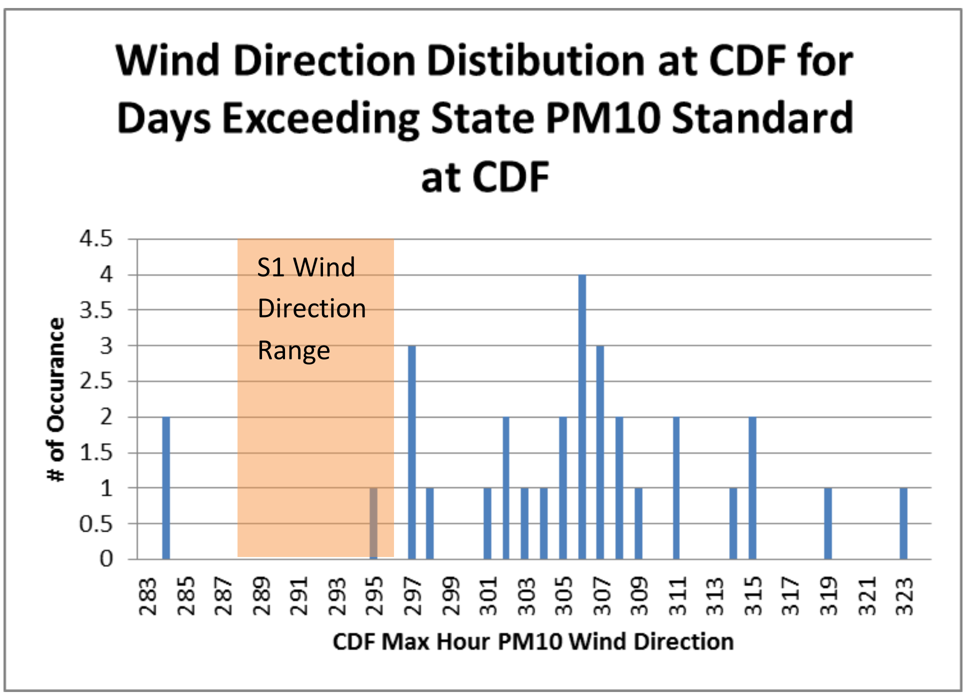


Figure 11 –CDF Wind Direction Distribution at Max Hour of Significant Dust Events

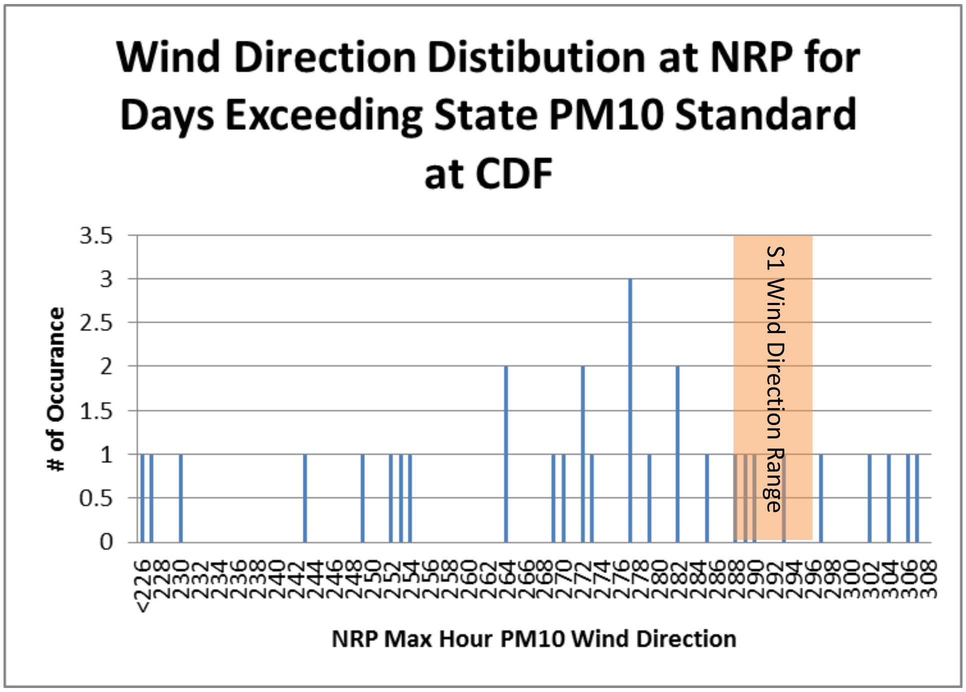


Figure 12 –NRP Wind Direction Distribution at Peak Hour of Significant Dust Events

These shifts in wind direction inland result in clear movement of the dust plume. The Community Monitoring Project wind sensors captured these shifts, showing the interaction between wind conditions and plume path. For example, Figures 13 to 15 present data from the Nipomo Study Area for hours 12 to 14 on April 19, 2012. On this day there was a moderate wind event, with wind speeds at S1 ranging from 19.6 to 23 mph for these hours. The figures show the data as interpolated by the Groundswell software, with wind direction arrows manually added for sites reporting wind conditions (arrows indicate direction only, not speed). It is important to note that wind data from the EBAM wind sensors will be more influenced by surrounding terrain due to their lower sensor height (~ 2 meters) than the permanent monitoring sites with sensors at 10 meters. It is also important to note that the only locations where PM_{10} concentrations are actually known are the monitoring sites. Elsewhere on the map concentrations are interpolations between these known points, and do not take into account local topography, surface features, meteorological data, or other complexities.

As shown in the figures, on hour 12 (Fig 13), the inland sites 6A, 13A, NRP, and SE-E all measured wind direction out of the NE to east, and at these locations, PM_{10} concentrations were near baseline values. Then on hour 13 (Fig 16), the wind direction shifted at sites 6A, 13A and NRP to a westerly wind, and PM_{10} impacts were then measured at these locations. Then on hour 14 (Fig 14) the winds shifted northerly at 6A, 13A, and NRP and PM_{10} concentrations at these sites dropped dramatically. On the next hour, sites 17A and 17B also shift northerly and the PM_{10} levels in this entire region drop to near background levels.

In addition to the displays presented below, hourly data from the spatial display is available as a video at Video link for spatial display of 4/19/12 data It is recommended that the video display be set to full screen.

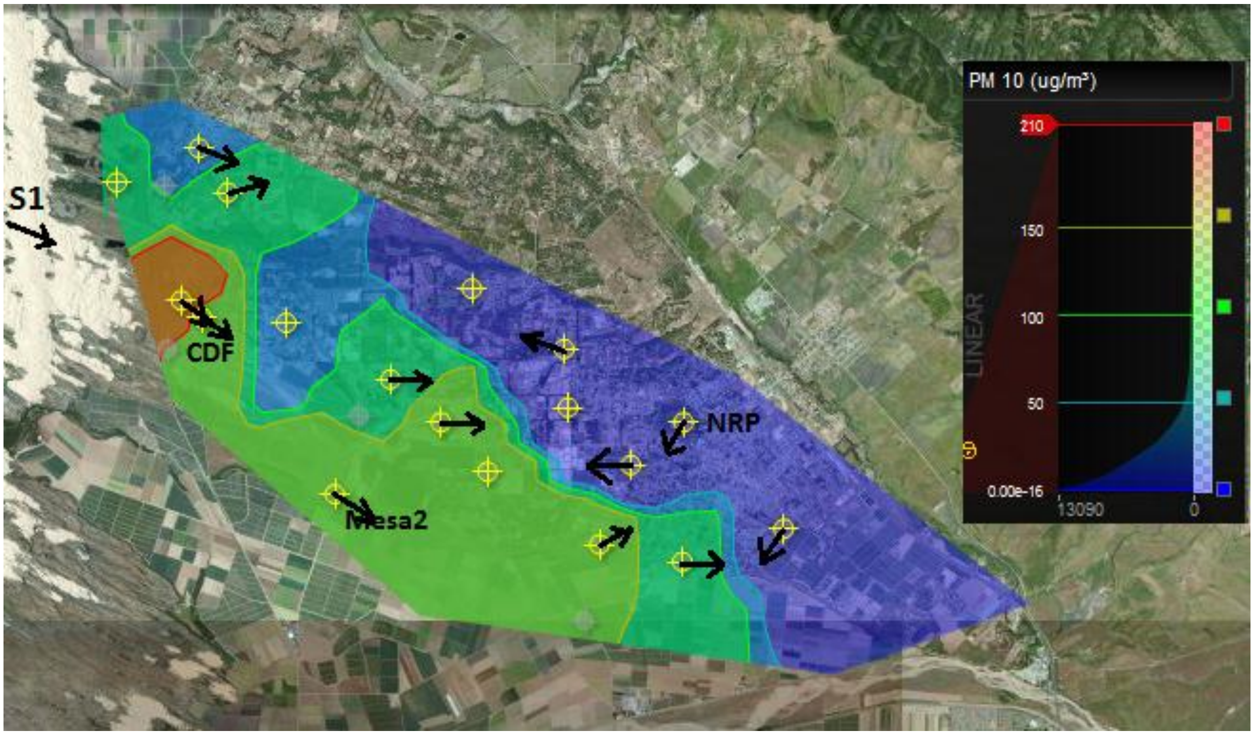


Figure 13 – PM10 and Winds for the Nipomo Study Area 4/19/12 at 12:00

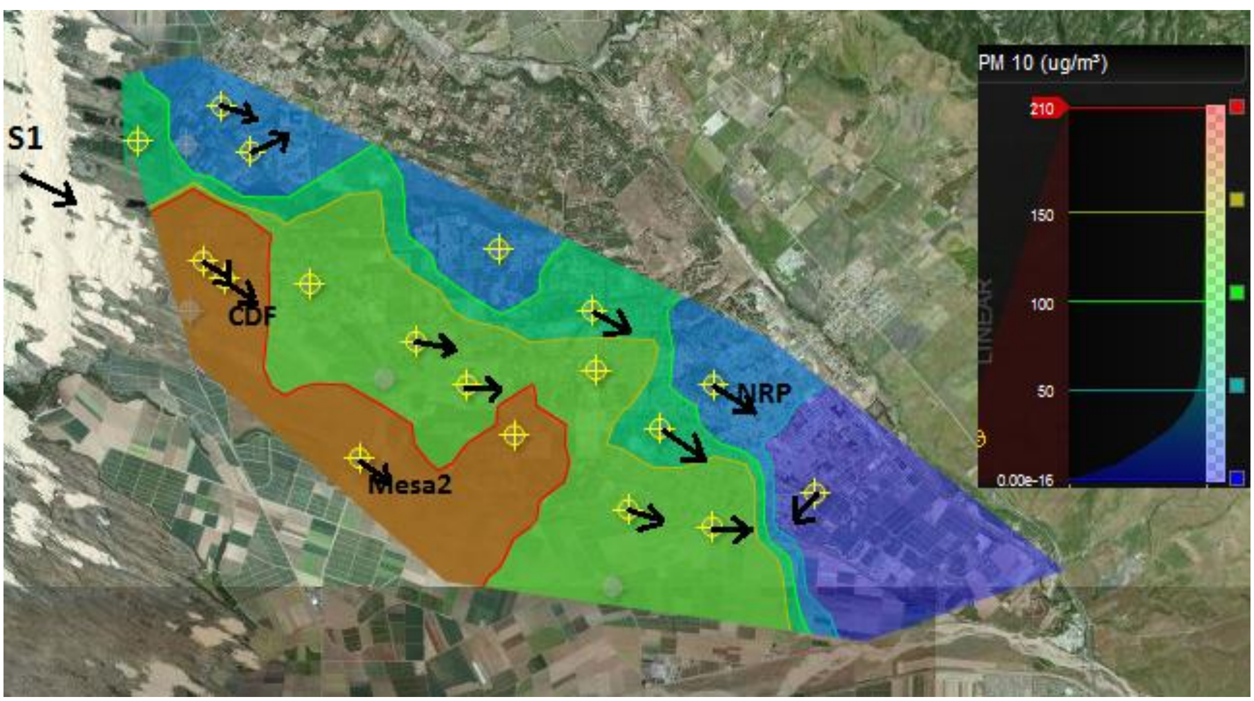


Figure 14 – PM10 and Winds for the Nipomo Study Area 4/19/12 at 13:00

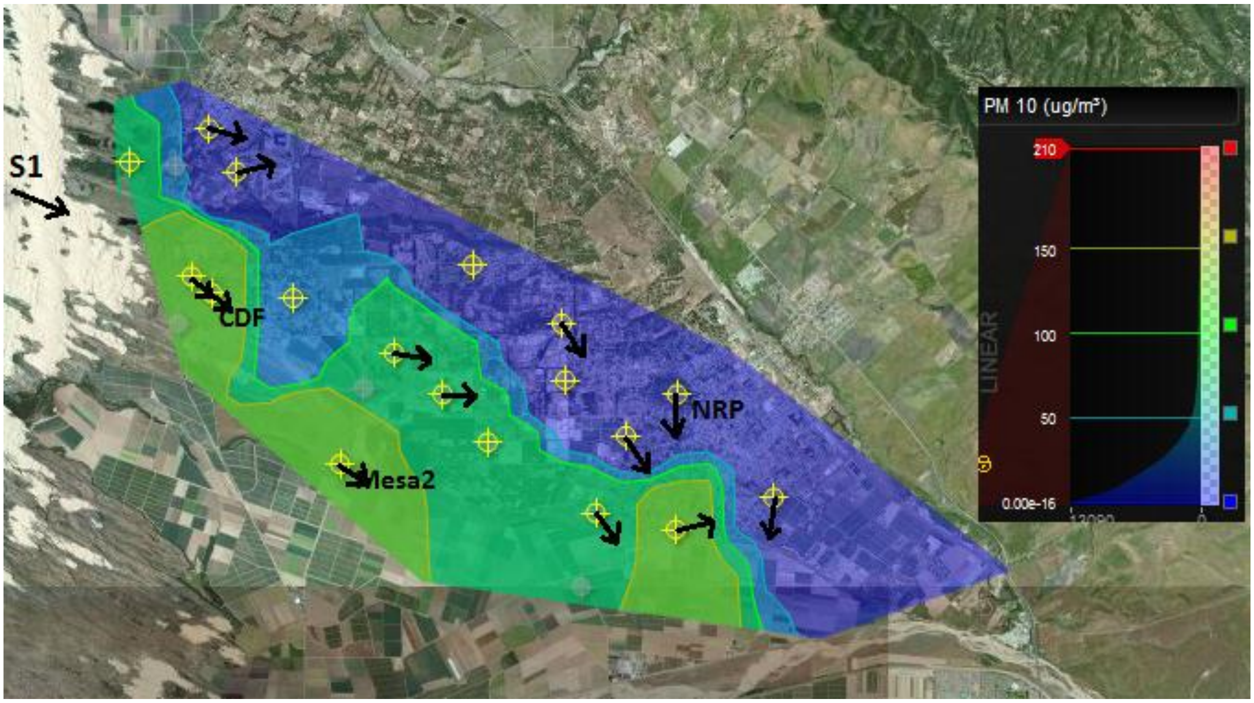


Figure 15 – PM10 and Winds for the Nipomo Study Area 4/19/12 at 14:00

Differences in inland wind direction from episode to episode also can result in downwind plume impacts. Review of the study data shows that episodes with a consistent northerly component in inland wind directions result in very little PM_{10} impacts in the vicinity of NRP (See Appendix C, day 4/4/12 for an example), but higher PM_{10} levels are often seen in Santa Maria on those days. On episodes with a consistent westerly inland wind direction, the plume appears to have little to no impact at the Santa Maria monitoring station but higher concentrations are usually measured in the vicinity of NRP (See Appendix C, day 5/17/12 for an example).

An additional observation of the Nipomo data set is that on a few occasions, some monitors appeared to be impacted by local PM_{10} sources. These rare occurrences are easily identified by looking at the overall pattern of PM_{10} measurement in the region and clearly are very localized in impact. While such anomalies are interesting to investigate and understand, they do not change the overall pattern observed in the study data, which was very consistent. A more detailed discussion of possible local source impacts is presented in Appendix A.

<u>Visual Observations of Dust Plume</u>

The particulate measurements and plume analysis performed for this project also match visual observations of the dust plume. APCD staff has observed the plume both from the ground and an aerial perspective. Figures 16-18 were taken on April 28, 2011 during a significant dust event. The 24-hour average PM_{10} level at CDF on this day was 135 ug/m3, with a peak hour concentration of 442 ug/m3. The winds were quite strong on this day, with Mesa2 recording wind speeds over 20 mph during the peak of the event. The wind direction inland at Nipomo Regional Park monitoring station was around 295 degrees during the event. As seen in the project data as well as these images, when the inland wind direction has a northerly component as seen at NRP, it appears to push the main portion of the plume more to the south, reducing its impact in the northern portion of the study area. Additionally, these images show that the plume does extend inland to Santa Maria and likely beyond. Figure 17 also shows a smaller dust plume originating from the dunes west of Guadalupe.

Figure 166 – 4/28/11 Aerial Image from above Santa Maria River and HWY101 looking to the Northwest

Figure 17 – 4/28/11 Aerial Image from above Willow Road and HWY101 looking to the Southwest

Figure 18 – 4/28/11 Aerial Image from above Arroyo Grande looking to the Southeast

Summary of Nipomo Mesa Monitoring Results

In summary, the dust plume originating in the coastal dunes most often has a centerline of highest concentration passing through the CDF site along a trajectory of the prevailing NW winds. However, variations in the wind direction can cause the plume to shift to the north or south. Spatial displays of 24 hour averaged data of each day where at least one monitor exceeded the state 24 hour PM_{10} standard of 50 ug/m3 are presented in Appendix C. Additionally, a summary of PM and wind data from all permanent monitors in the area is provided, as well as a brief description of significant conditions of each event. Links to videos of the hourly data are also provided in the data summaries for some of the more interesting days. These plots and videos are useful in understanding the areas impacted by blowing dust and will be used by District staff in forecasting the air quality and levels of PM_{10} impact on the Nipomo Mesa.

Oceano Study Area

Saturation monitoring in the Oceano study area started on March 19, 2012; initially 3 sites were installed. As depicted in Figure 19 below, site O-C was located within feet of the previous Phase2 Pier Avenue monitoring site to facilitate comparisons to that data, which showed significant PM_{10} impacts at that site. Site O-A was located about 0.1 mile downwind from O-C. Site O-B was located a similar distance inland as Site O-A, but about 0.3 mile to the south. On May 10, 2012 site O-D was installed upwind from site O-B directly on the edge of the beach (on the roof of a beachfront house).

Figure 19 – Oceano Study Area Monitoring Locations

The sampler at site O-C experienced a number of problems that resulted in the invalidation of data from installation until April 12, 2012. Additionally, there were a number of wind speed sensor failures on the Oceano samplers due to failed reed relays. While the loss of O-C PM_{10} data is unfortunate, the close proximity of these samplers allows lost wind speed data to be dealt with by referring to adjacent site values in most cases.

An additional complication in analyzing PM_{10} impacts in the Oceano area is the added influence of sea salt due to its close proximity to the ocean. To evaluate this, approximately 50 hourly particulate samples collected under a variety of conditions were selected from the Oceano sites for salt analysis. These analyses showed that samples taken during wind events typically contain between 5% and 10% salt (very similar to the salt content measured during episode days on the Nipomo Mesa during the Phase 1 and Phase 2 studies). This consistency in the data allows comparisons of PM_{10} measurements during wind events without much consideration of salt content. However, the analysis did show high salt concentrations can occur during calm periods in this area, so salt impacts during these periods must be taken into consideration in evaluating 24-hour average PM_{10} concentrations. Additional discussion of the salt analysis conducted for Oceano is provided in Appendix D.

Observations of Plume Impacts

The pattern of PM_{10} concentrations observed during wind events from April 12 through May 10, prior to the installation of site O-D, was quite consistent: O-C was always the high site, with O-A next lowest and O-B near background levels. Figure 20 below depicts the typical concentration pattern seen during this period from the three initial Oceano sites, as interpolated by the Groundswell software.

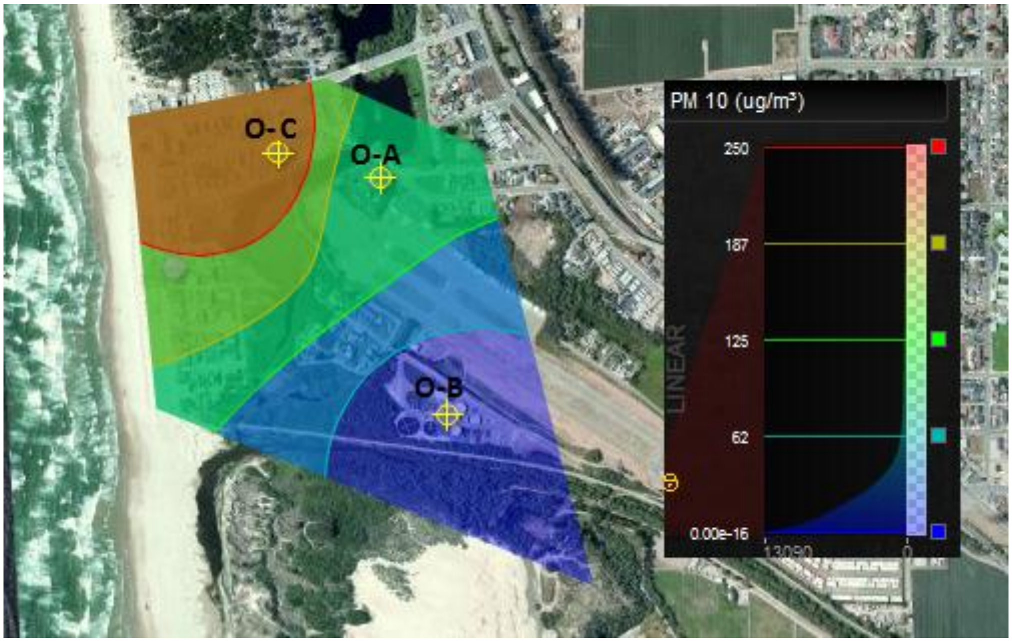


Figure 18 – Oceano Typical PM10 Concentrations Prior to Install of O-D

Review of this preliminary data showed the plume measured at O-C to be relatively small, dropping off significantly just 0.1 mile downwind at site O-A. Additionally, this data was consistent with the theory of Pier Avenue as the source, as was suggested in the Phase2 data analysis. However, this data pattern could also point to the beach itself as the source responsible for the high readings at O-C, as this site is closest to the beach of the three locations. This question was the impetus for installing the fourth monitor, O-D, directly at the beach sand edge on the roof of a home.

Review of the data set from May 10, 2012 through May 31, 2012 when all four monitors were operational showed a typical average pattern during wind events: PM_{10} levels at O-D were slightly higher (~10%) than O-C, O-A levels were significantly lower than O-C, and O-B measuring near background levels. Figure 21 below presents this typical pattern.

The first observation from analysis of the Oceano data set is that PM_{10} impacts in Oceano are much different than in Grover Beach, just one mile to the north. Phase2 PM_{10} measurements at Grover Beach showed virtually no significant PM_{10} impacts during strong (>15 mph) NW wind event hours. Yet in Oceano, significant hourly PM_{10} impacts are measured at O-A under those conditions; site O-A is a similar distance downwind from the open beach sand as Grover Beach. This indicates one or a combination of factors influencing windblown PM emissions in Oceano, such as sand track out onto Pier Avenue, OHV disturbance to the beach sand surface or other unidentified differences between the two areas is responsible for the difference in measured PM_{10} levels.

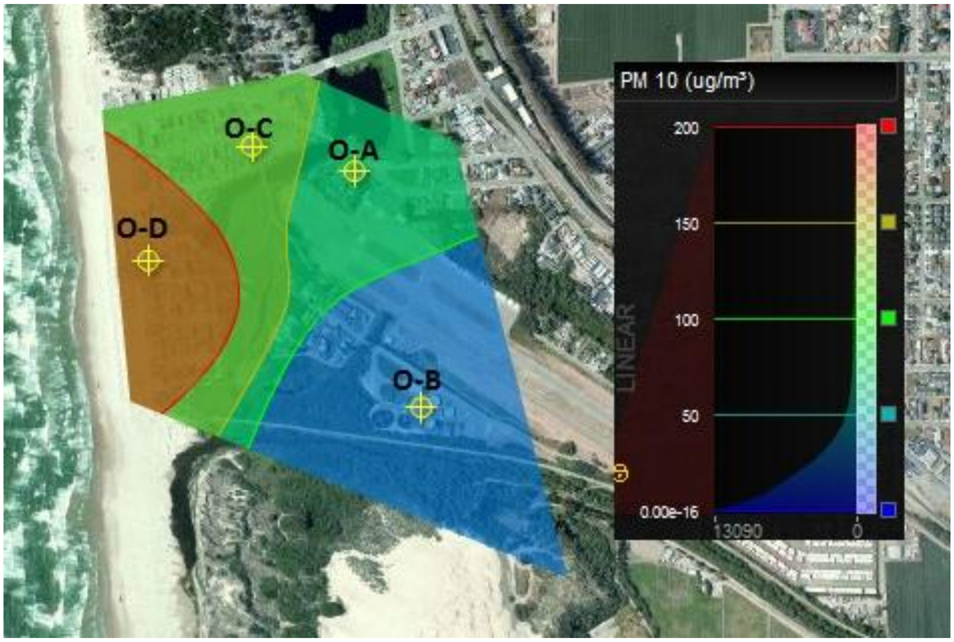


Figure 19 – Oceano Typical PM10 Concentrations with site O-D

Comparison of the average PM_{10} levels during wind/dust events between sites O-C and O-D show that on average, both sites measure similar PM_{10} concentrations, with site O-D about 10% higher. Site O-C is approximately 0.2 miles downwind from the edge of the beach sand, while O-D is just a few feet from the edge of the sand (with about 100 feet of sparse vegetation before open sand is encountered upwind). If the emission source for the Oceano area was predominately the beach sand, O-C PM_{10} measurements should be significantly lower compared to O-D because it is located further downwind from the beach sand. While the data from O-D demonstrates the beach itself is a localized source, the data from O-C suggests an additional source is impacting that site, and strongly points to the sand that accumulates on Pier Avenue as the source. The fact that site O-B rarely measured any impacts from windblown dust during the project provides additional evidence that site O-C is impacted by a source other than the beach.

Summary of Oceano Area Study Results

Data gathered from the Oceano area showed elevated particulate concentrations are present during high northwesterly winds at monitors in close proximity to any area of disturbed open sand. These sand areas include the beach as well as Pier Avenue where sand commonly is tracked out of the SVRA by vehicles exiting the park. The project data showed the extent of the plume from these open sand areas to be quite small, with particulate concentrations diminishing quickly downwind. A 40% drop in PM_{10} concentration was observed just 0.1 mile downwind of the Pier Avenue monitoring site, while almost no plume presence was detectable at a site less than 0.4 miles downwind from the beach area.

Conclusions and Recommendations

Study data from the South County Community Monitoring Project shows a relatively consistent pattern for the path of the dust plume from the Oceano Dunes that impacts the Nipomo Mesa area on high wind days. The approximate centerline of the plume typically follows a path along a line drawn through the CDF site inland following the prevailing northwesterly winds. The highest concentrations along the plume centerline occur closest to the dune source and slowly diminish inland, with lower but still significant PM_{10} levels appearing to impact the Santa Maria valley. In the Oceano area, elevated particulate concentrations are present during high northwesterly winds at monitors in close proximity to any area of disturbed open sand, but diminish very quickly a short distance downwind.

Implications for Air Quality Forecasting in the Nipomo Mesa Study Area

One of the primary reasons for determining the spatial extent and concentration gradients of the dust plume impacting the Nipomo Mesa was to provide more detailed air quality forecasts in that region and enable area residents to determine if protective actions are needed in their neighborhood on high PM days. Better knowledge of the plume path and downwind concentrations would also help inform the development of dust controls at the SVRA. Table 1 presented previously showed the relationship between average 24-hour PM_{10} concentrations measured at the temporary project sites compared to the permanent District sites, which can be used to approximate the plume impact in an area of the Mesa without a permanent site. The factors displayed in Table 1 were used to develop Figure 22 below, which presents recommendations on appropriate airborne particulate grid zones for the Nipomo Area. The name in each grid or adjacent to the grid represents the permanent monitoring station that most often is the best fit for approximating the maximum PM_{10} concentrations likely to occur in that grid square (or adjacent to the grid area) on a given day.

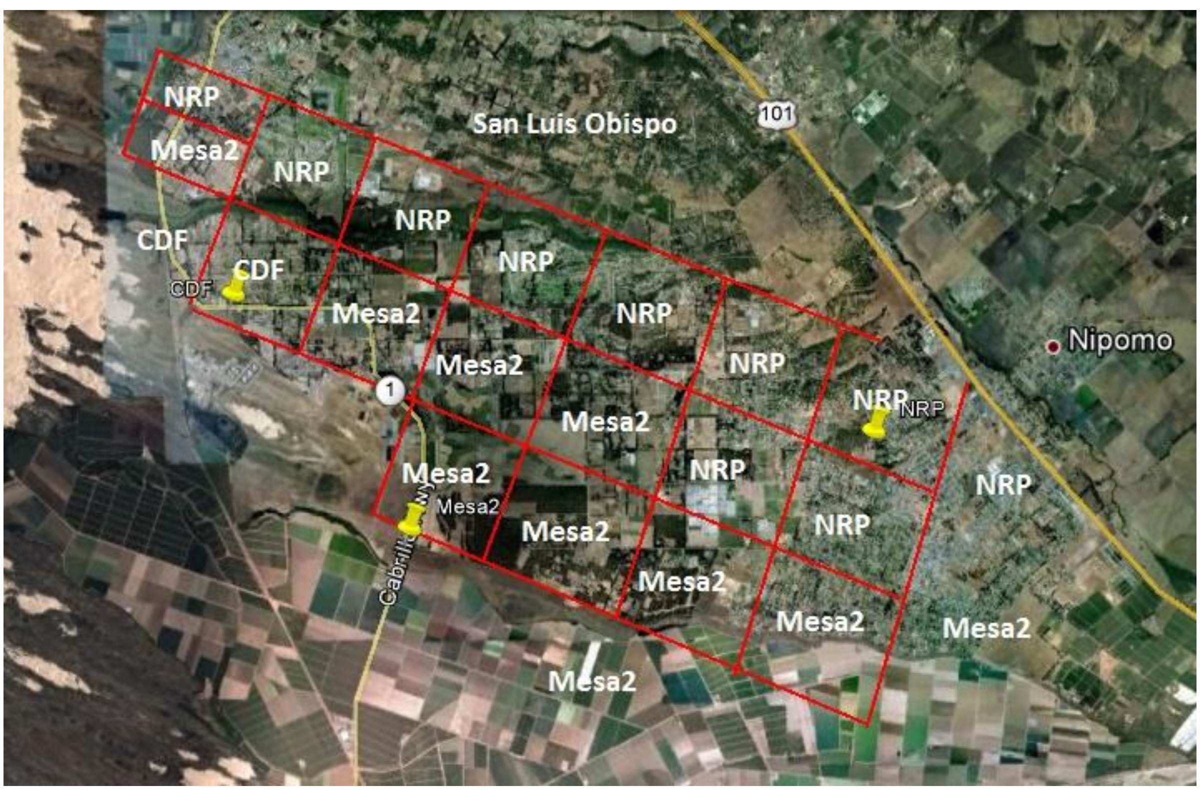


Figure 20 – Forecasting Recommendations for the Nipomo Area

Study data and the inter-site relationships identified in Table 1 were used to generate the more detailed forecast map shown in Figure 25, below. This forecast map defines the typical areal influence of the dust plume during strong northwesterly winds. The APCD will use these maps to provide a numerical forecast of the Air Quality Index (AQI) for each forecast zone based on the approximate magnitude of the forecasted particulate concentrations. Each forecast zone is related to PM concentrations measured at the three permanent APCD particulate monitoring stations on the Nipomo Mesa - CDF (Willow Road), Mesa2 (Guadalupe Road) and NRP (Nipomo Regional Park). Areas outside of the zones shown in Figure 23 should use the San Luis Obispo monitoring station for particulate air quality guidance unless otherwise noted.

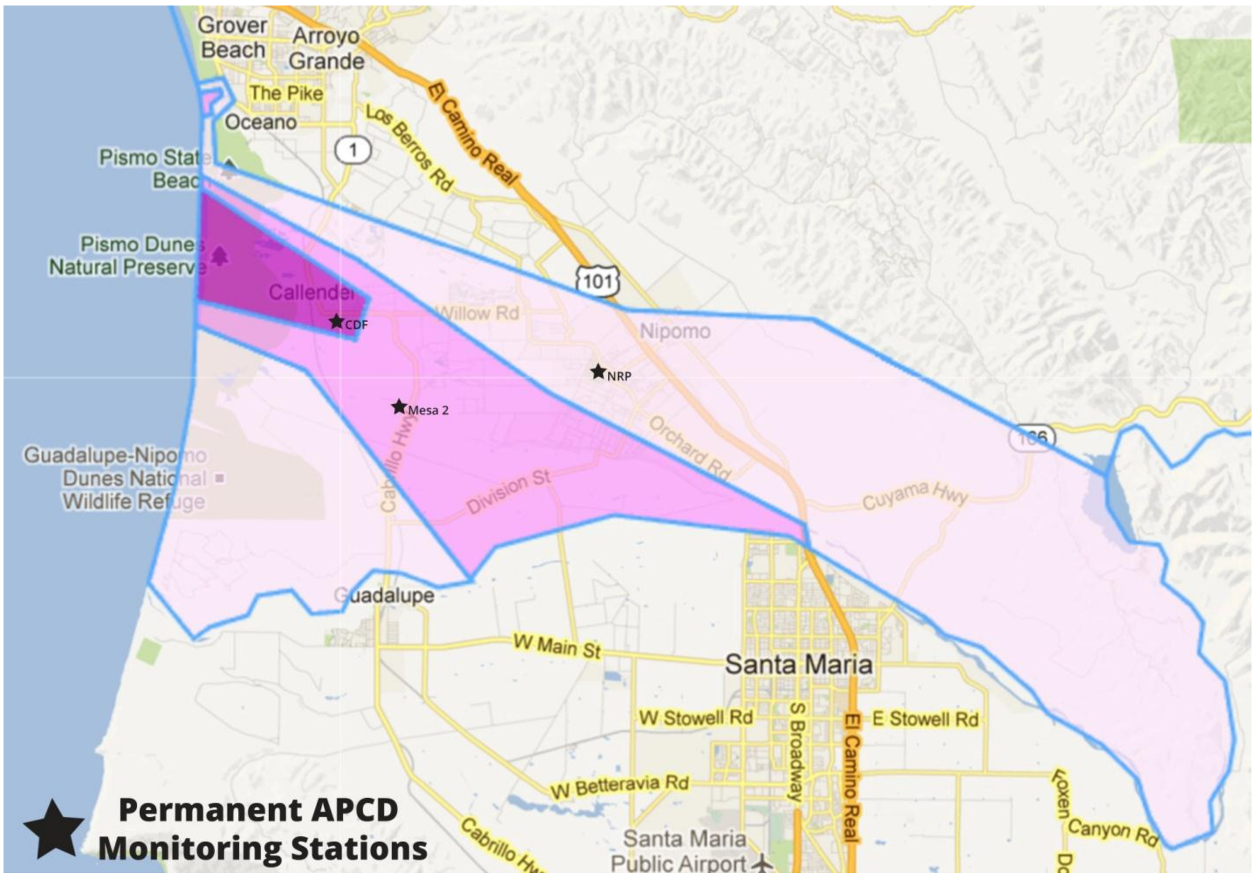


Figure 21 - Forecast map for Nipomo area. Forecast zones: Dark Pink = CDF, Medium Pink = Mesa2, Link Pink = NRP

Each wind-blown dust event can have different wind and particulate concentration characteristics, so it is important to note that the forecast zones are based on the estimated average magnitude of the particulate concentrations. The borders of each zone area are approximate and are not meant to be a rigid boundary; the plume path can vary with changes in wind direction and speed, and particulate concentrations on either side of a forecast zone border are likely to be similar. Thus, the public can use the air quality forecasts as a guide to help plan their outdoor activities and protect their health during blowing dust episodes, understanding that the forecast is our best estimate of potential maximum PM levels in each zone on a given day. The San Luis Obispo County forecast zones end at the Santa Barbara County border; however, as previously discussed, data from this study and the Santa Maria monitoring station indicate plume impacts continue into Santa Barbara County during the more significant blowing dust events.

Implications for Air Quality Forecasting in the Oceano Study Area

In the Oceano study area, proximity to open sand, whether it is sand that accumulates on Pier Avenue or sand on the beach, appears to be the best indicator of PM_{10} impacts. The data demonstrates PM_{10} levels adjacent to disturbed open sand (in the roadway or beach) during wind events can produce significant PM_{10} impacts; however, the data also shows those impacts to be quite limited in spatial extent. As depicted in Figures 20 and 22 above, there was an approximate 40% drop in PM_{10} concentration in the 0.1 mile downwind distance between sites O-C and O-A, and almost no detectable plume presence 0.37 miles downwind from site O-D.

Figure 24, below, presents a close up of the Forecast Zone Map for the Pier Avenue area of Oceano. This forecast map defines the typical areal influence of the dust plume on affected areas of Oceano during strong northwesterly winds. Each forecast zone is related to PM concentrations measured at the following permanent APCD particulate monitoring stations: Green Zone = Mesa2 (Guadalupe Road) and Blue Zone = NRP (Nipomo Regional Park). Areas outside of these zones should use the San Luis Obispo monitoring station for particulate air quality guidance unless otherwise noted.

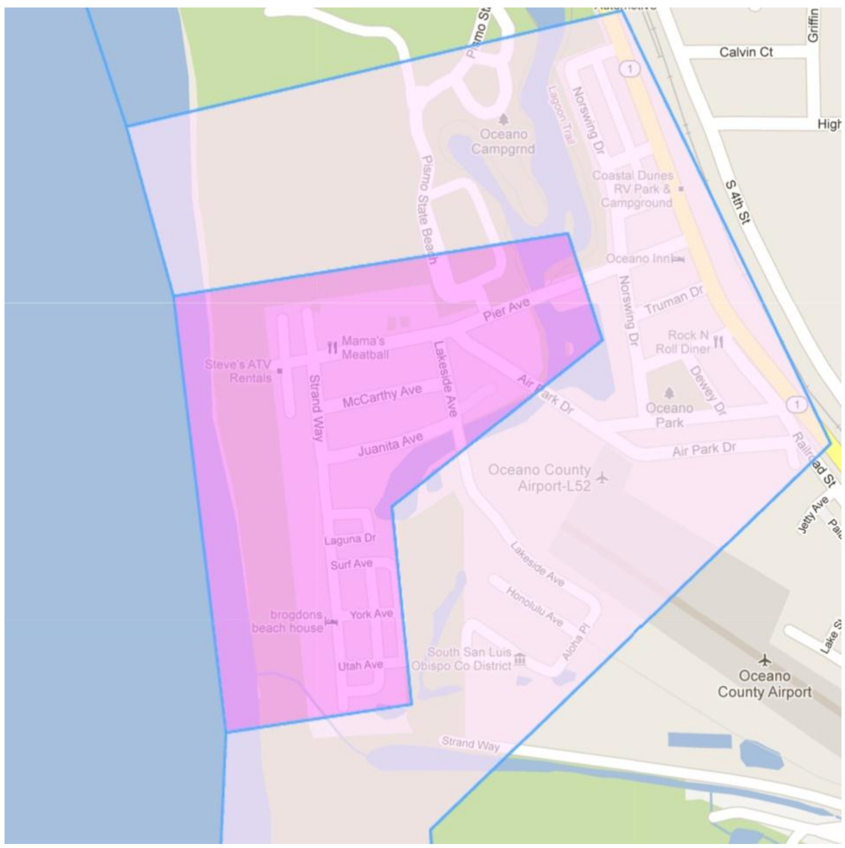


Figure 22 - Forecast map for Pier Avenue area of Oceano. Forecast zones: Medium Pink = Mesa2, Light Pink = NRP

Bibliography

1) EPA AQS Database, www.epa/ttn/aqs
2) San Luis Obispo County APCD Phase 2 Particulate Study, 2009
3) San Luis Obispo County APCD Phase 1 Particulate Study, 2004
4) San Luis Obispo County APCD 2011 School Measurements, 2011
5) Lanane, C., Johnson, D. *A Comparison of PM_{10} Survey Monitors*, Great Basin Unified Air Pollution Control District, presented at the Air & Waste Management Association Symposium on Air Quality Measurement Methods and Technology, Los Angeles, CA, November 2-4, 2010.
6) Numerous phone interviews with Dennis Hart, Design Engineer, MetOne Inc.

SOUTH COUNTY COMMUNITY MONITORING PROJECT

Appendix A – Project Quality Assurance/Quality Control

Preliminary Evaluation of EBAM Samplers

Maintaining and operating the large number of samplers with a small project staff required extensive planning and testing of samplers prior to deployment in the field to ensure adequate quality and completeness of data collected in this project. Most samplers utilized for this project were borrowed from other government agencies; in most cases, the sampler's maintenance history and performance were largely unknown. Upon receipt from the loaning organization each sampler was set up in the APCD laboratory, existing configuration documented, and thoroughly cleaned following procedures that exceeded the manufacture's recommendations. Each sampler was then configured to the standard configuration utilized by the APCD for this project, ensuring the configuration of all samplers was identical and appropriate for this application. Table A1 below presents this standard configuration with criteria not specific to each instrument highlighted.

Table A1 – EBAM Configuration

Baud: 9600
ConcRef: 0
ConcDacMode: 1
DacRefFS: 0
SamplePeriod: 3600
LogPeriod: 3600
LocID: 19
FlowSetPt: 16.7
FlowType: 0
IGain: 100
K: 1.080
Bkgd: -0.001
AbsZero: 0.350
AbsSpan: 0.976
Usw: 0.285
RHSetPt: 35
DTSetPt: 15
RHCtrl: 1
FactoryMode: 0
PumpProtect: 0
LoVacuum: 228.6
HiVacuum: 266.7
MachineType: 1
ExtSensor: 0
MinRestart: 12.50
StandardTemp: 25

While some of the configuration variables are specific to each sampler, ensuring all samplers are configured identically for the parameters not specific to each sampler was important for comparative measurements.

Zero Background Test

Next each sampler was set up for a zero background test in an enclosed area to prevent drastic temperatures changes and exclude ambient dust. The zero background test is performed by allowing the instrument to sample in normal mode with a HEPA filter attached to the inlet. The filter prevents any particulate matter greater than 0.3 micrometers from entering the sampler's sample path, which results in the sampler sampling ambient air containing essentially a concentration of zero. The zero background test is useful in identifying samplers with a noisy response. The EBAM samplers, even under perfect conditions are known to have a higher signal to noise ratio than similar federally approved permanent beta attenuation monitors such as the MetOne BAM1020 due to the greater distance between the beta source and detector. In addition to the EBAM source/detector distance contributing to greater variability in response, other aspects of the EBAM design can also contribute to higher variability in readings. For example, the beta source being located in the sample path has been shown to accumulate particulate and at some point as more and more particulate is deposited on the source; particles of the size of a grain of sand will fall off, depositing on the filter tape, resulting in a spike in the PM_{10} data for that hour. Additionally, due to the very small size of the sampler's inlet heater (40 watts as compared to 250 watt in the BAM1020), in moist environments, it is possible for water to condense on the filter tape, again resulting in a positive spike in the PM_{10} data for that hour.

The zero background test is run over at least 3 days. The data from the test is downloaded and the first few hours discarded. The remaining next 72 hours are evaluated for mean value as well as variability. Figure A1 below presents the results of the zero background tests for each sampler used in this project. The green marker on each vertical line is the mean zero value and the top and bottom of each line represents two standard deviations on each side of the mean as a measure of variability. Most samplers' results show that the typical variability is approximately +/- 5 to 10 ug/m3. When looking at data from the EBAMs, one needs to keep these estimates of the sampler's inherent variability in addition to other mentioned variables in mind. It is also important to note that the EBAM cannot measure less than -5 and most samplers had readings of -5 for some hours of the zero background test, so these estimates of variability are likely somewhat lower than reality. There were two samplers with significantly higher variability, indicating a noisy sampler. These two samplers were cleaned and serviced prior to deployment for the collocation measurement period.

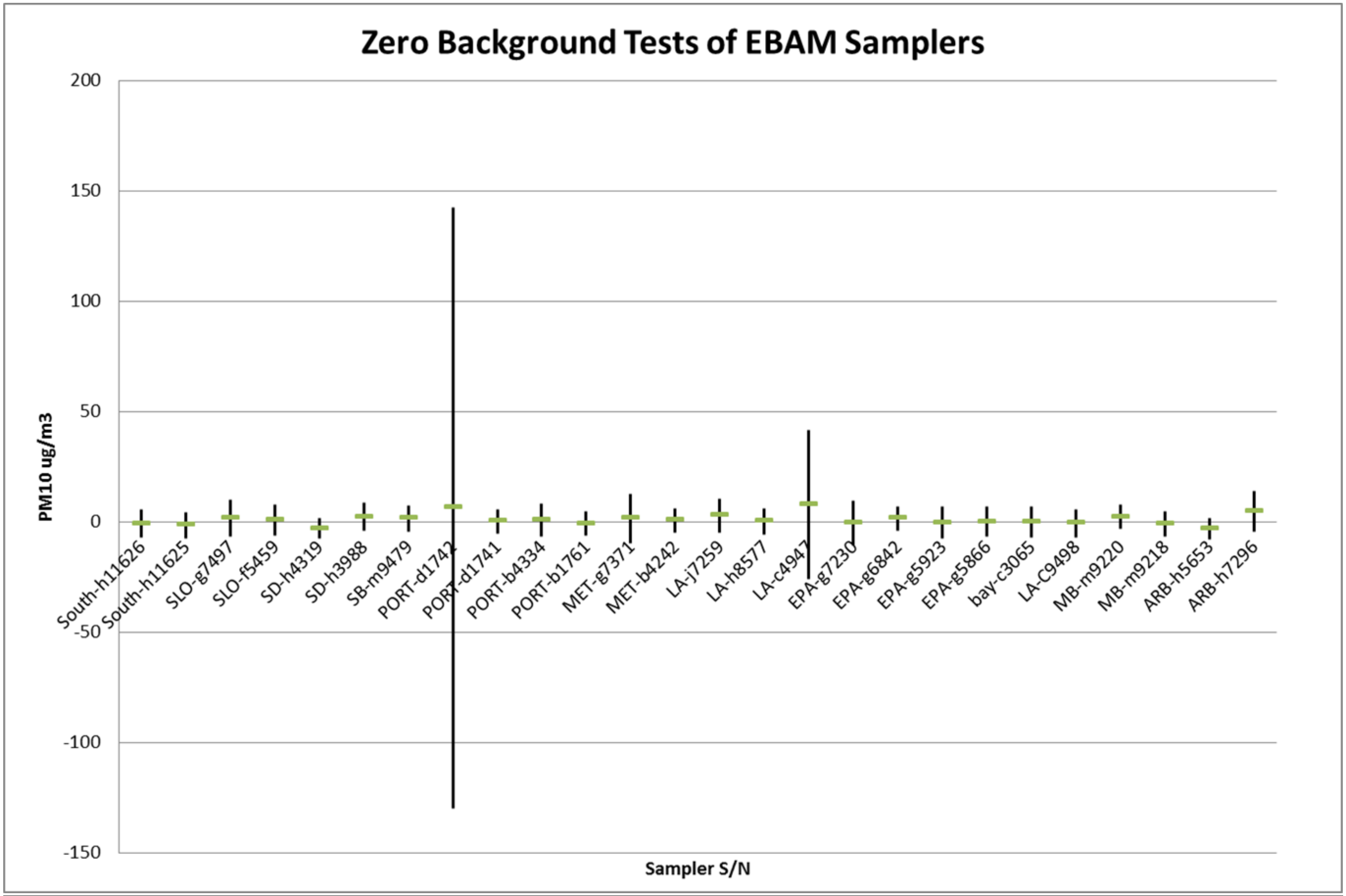


Figure A1 – Zero Background Test Results

Evaluation During Collocation Period

EBAMs were then collocated with BAM 1020 PM monitors at APCD permanent monitoring stations for several weeks. The main purpose of the collocation period was to establish the relationship between each EBAM and the federally approved beta attenuation samplers An additional important benefit of the collocation period is to further investigate any sampler problems and correct these issues. The two main problems with samplers that were identified during the collocation period were inlet heater problems and noisy response by some samplers that were not identified by the zero background tests.

The initial review of collocated data from the EBAM samplers identified a few samplers that had more problems of controlling the inlet humidity than other samplers. Further investigation identified that these samplers were manufactured with a slightly different configuration, to allow for an external AC powered pump, rather than the standard internal DC pump. In discussions with MetOne design engineers, project staff discovered that the samplers with internal pumps were designed to utilize the waste heat from the internal DC pump to help in heating the inlet, to better control the humidity of the sample. Without the waste heat from the pump, the samplers with external pumps were unable to provide adequate control of sample humidity. In consultation with MetOne, project staff designed an add-on inlet heater to provide a substitute source of heat for the missing pump. After installing these added heater assemblies, these samplers sample humidity control was improved.

The initial review of collocated data from the EBAM samplers also identified four samplers that had a noisy response. It is quite interesting that these four samplers (g5866, g7230, h3988, and g7497) had good results in the zero background test, designed to identify samplers with a noisy response. But, once these samplers were deployed for the collocation period, the ambient data clearly identified them as having excessive variability in their response. Discussions with MetOne failed to positively identify why these samplers exhibited normal variability on the zero tests, yet when sampling ambient sample had excessive variability. It is possible that because the zero test was performed indoors, with less variations in humidity, or the presence of particulate on ambient sampling contributed to this difference. Regardless, others should use caution on relying on the zero background test to identify noisy samplers. Figures A2 and A3 below present example data comparing a typical EBAM response to one of these noisy samplers with the trace from the Mesa2 permanent monitor as reference.

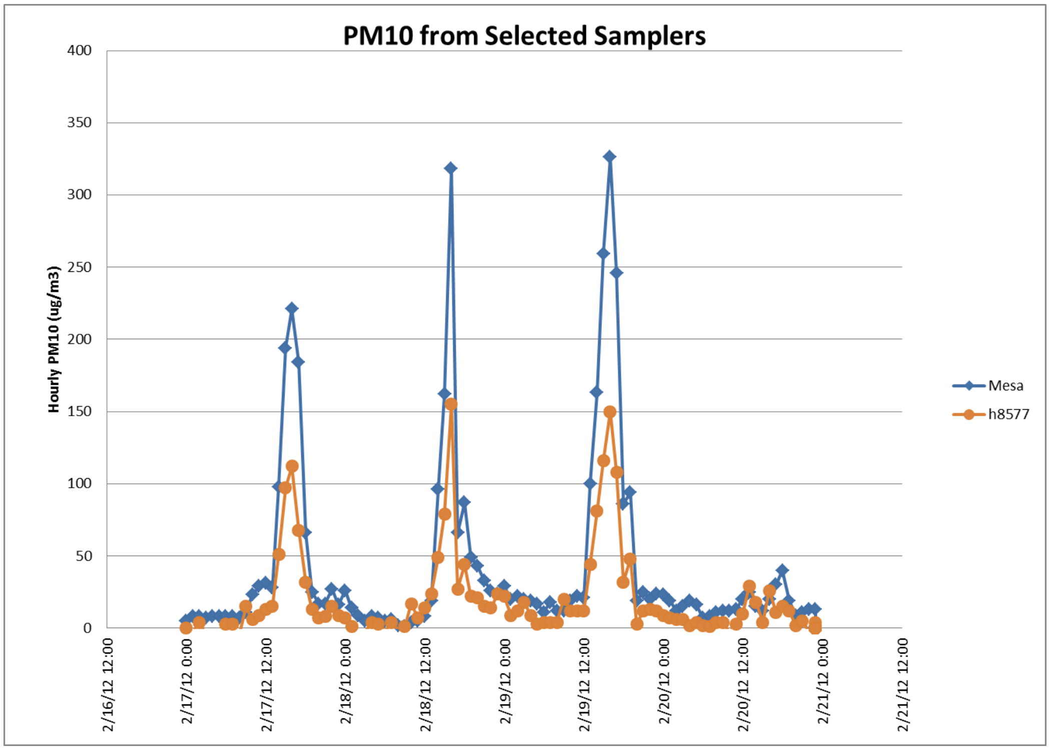


Figure A2 – Example of an EBAM with Typical Variability

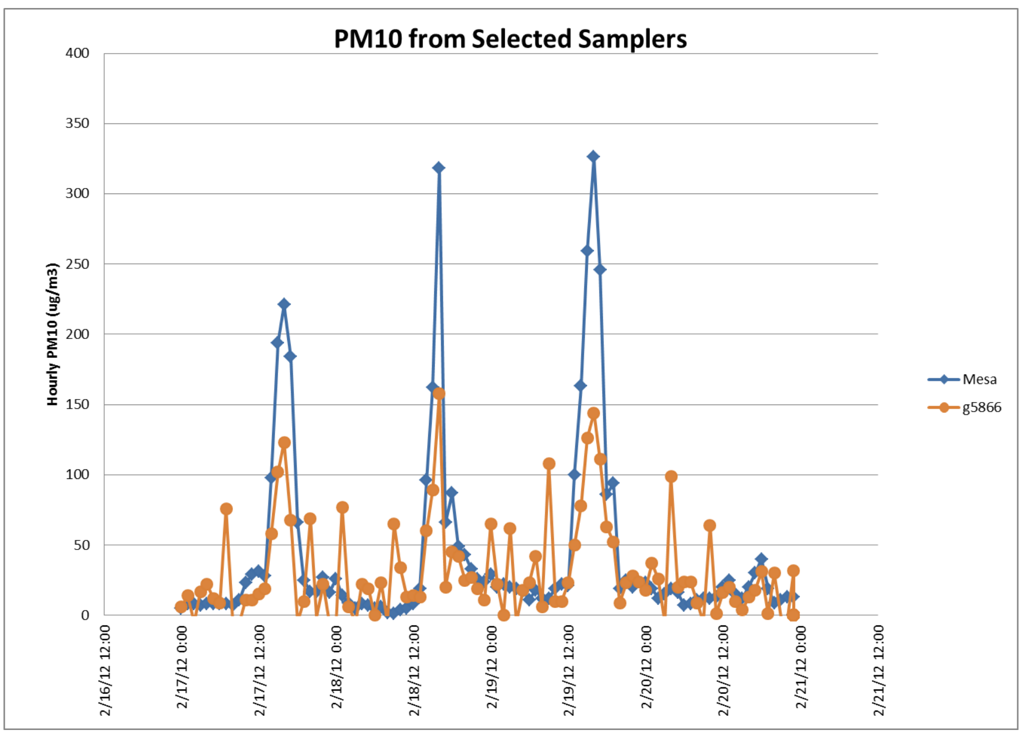


Figure A3 – Example of an EBAM with Excessive Variability

Note also in Figures A2 and A3 that the EBAM sampler's response to the dust events (peaks) is lower than the Mesa2 BAM1020 readings. This is due to the operational differences between the BAM 1020 sampler and the EBAM sampler that causes the EBAM to read lower when measuring sample with most mass in the >7 micron region, and is why a correction factor is needed to make the EBAM samplers measure windblown dust accurately.

The samplers with excessive variability were serviced and found that the beta source was extremely dirty. Following a cleaning of the beta source, all of these units exhibited typical variability in their readings.

In addition to the two above main issues identified and corrected during the collocation period, numerous additional problems were found with many of the samplers. These issues included dirty beta detectors, bad o-ring seals, and weak pumps.

Sampler Operations

Operation of all samplers followed the San Luis Obispo County APCD standard operating procedures for EBAM samplers as well as the Community Monitoring Project Monitoring Plan (See Appendix E). In general, these procedures required bi-weekly quality control checks to be performed on each sampler throughout the entire sampling program. These checks involved the following tasks:

- General Inspection of sampler, noting any issues that might influence sampler operations.
- Verification that sampler external temperature, pressure, and sample flowrate are within allowable limits. Certified standards traceable to National Institute of Standards and Technology (NIST) standards were utilized for these verifications.
- Verification that met sensor boom is aligned to true north.
- Verification that wind speed and direction sensors are reading correctly.
- Performance of any maintenance required such as replacing filter tape.
- Correct any malfunctions or other problems with the sampler.
- Download data from sampler (performed weekly).

In addition to performing the bi-weekly QC checks, a full calibration of the sampler was performed at the beginning and end of the project, following re-location or any major repairs. The procedures for the full calibration are contained in Appendix E. Records of all QC checks, calibrations, or other activity with each sampler were documented on paper forms that were later transcribed to electronic records.

After each data download, project staff reviewed all data looking for indications of possible problems with each sampler. Whenever a possible problem was identified in the data after download, investigation and corrective action were taken.

Validation Criteria

PM_{10} data from all EBAMs were first automatically validated based on the sampler's internal recordings for each hour. The criteria utilized for the preliminary automated validation is listed below:

- Sample Flowrate recorded by sampler for each hour must be within +/-5% of design value of 16.7 l/min
- No internal sampler alarms that could influence validity can be present for that hour

Following the preliminary validation, sampler logs and quality control records were reviewed by project staff for final validation of data. Any period of data not bracketed in time by QC checks showing the sampler to be within tolerance, or periods where tape punching occurred were invalidated.

Data Completeness

Identifying and responding to sampler failures from 25 deployed samplers proved to be quite a challenge. An additional problem was that none of the samplers were equipped with any data telemetry. Without telemetry, a sampler could be offline for as much as a week before staff could know of the problem (samplers were visited once a week). Regardless, the overall data recovery for PM_{10} data from the EBAM samplers during the period the samplers were deployed for saturation monitoring exceeded 80%, the typical data recovery rate goal for monitoring ambient pollutants.

Unfortunately, as luck would have it, the distribution of lost data was not uniform across time and location. Figure A4 below presents the data recovery rate for the monitoring period.

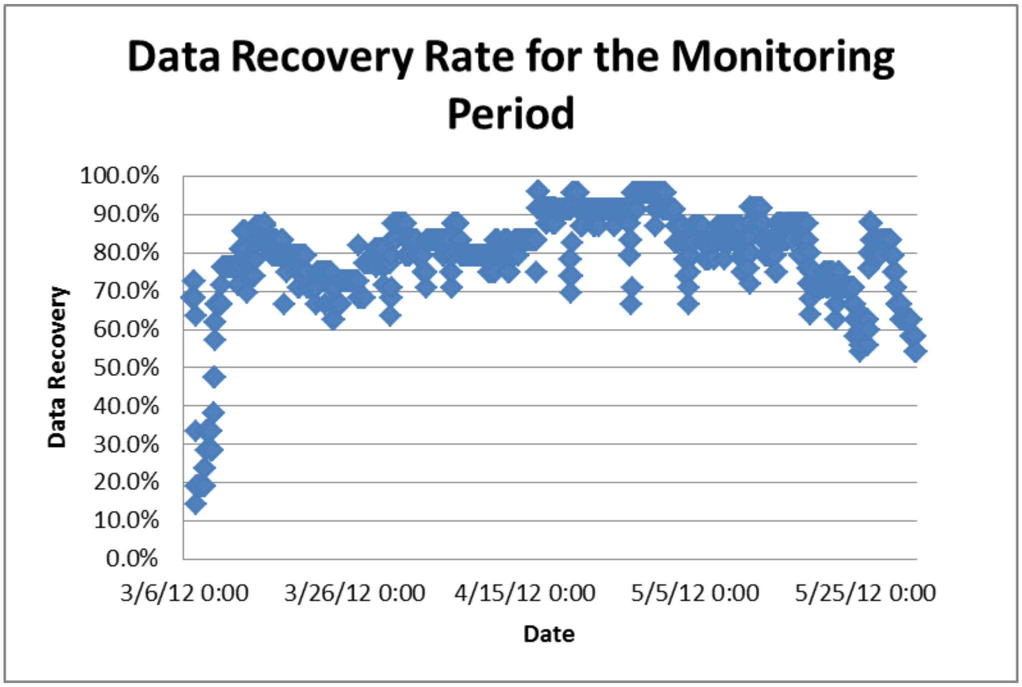


Figure A4 – PM_{10} Data Recovery for Monitoring Period

Figure A4 shows the data recovery rising in early March as samplers are being deployed to their respective monitoring locations. The data recovery averages approximately 80% through mid April where it increases to above 90%. Then in mid-May a string of failures drops the recovery rate to approximately 70%. Most unfortunately on May 23-25th, a series of additional failures drops the recovery rate below 60%. This is one of the most unfortunate times for these failures to occur as this is during a period of extreme dust events, including two days that exceeded the 24 hour federal PM_{10} health standard. The sampler failures in this period do not appear connected to the extreme winds or PM concentrations, rather just unlucky timing.

Data recovery for the meteorological parameters was higher than for PM_{10}. However, there were a string of wind speed sensor failures, mostly on the samplers located in the Oceano study area in the second half of the monitoring period. The wind speed sensor failures were a result of the failure of the internal reed switch in the sensor. Reed switches have a finite number of times they can open and close and it appears these sensors reed switches were near the end of their life.

Determining and Applying Correction Factors for EBAM PM_{10} Measurements

Previous studies performed by the San Luis Obispo County APCD first identified a design issue with EBAM samplers that causes them to read low when sampling a particle size distribution where most of the particle mass in greater than 7 microns. Because windblown dust generally has most mass in this particle size, utilizing EBAM samplers for this application requires developing a strategy to account for this problem. In the Phase2 study, development and use of a correction factor worked successfully by collocating the sampler at the District's Mesa2 monitoring site that is equipped with a federally approved monitor that does not exhibit this bias in measurement. A wind speed "trigger" was used to identify periods when it was likely the sampler would be measuring windblown dust. This "trigger" was used to identify periods during collocation when windblown dust was likely present, as well as during the monitoring period. This system worked well for the Phase2 study as both Mesa2 and the Oso site where the EBAM was utilized were close to the source with few obstructions upwind.

For this Community Monitoring Project it became clear the method utilized to correct EBAM data for the Phase2 study would not work as well for this project. Sampling locations for this project were quite varied, with some directly on the beach and others quite far inland. Previous monitoring had identified that inland site wind speeds were quite variable, depending on proximity to obstructions and distance from the coast. So a simple wind speed trigger would be very inaccurate at predicting if the sample contained windblown dust.

Other ideas were explored to identify a trigger that would be reliable in predicting the presence of windblown dust that would be workable for this project. The "trigger" that appears to work the best is a combination of a PM_{10} value above a threshold and sand movement in the source area.

State Parks has installed a sensor designed to detect sand movement by the wind at their S1 meteorological station in the source area. This sensor, called a Sensit, essentially counts how many sand particles impact the sensing element each hour. For accurate measurements of sand flux, the sensor must be "calibrated" by maintaining the sensor height above the sand surface. In this location, this requires daily adjustments to the sensor height to account for shifts in the sand surface, which State Parks does not perform. However, even though the sensor is "uncalibrated", review of the data shows it to be a very reliable method for detecting periods of sand movement, or lack thereof, in the dunes.

Analysis of the effect of particle size distribution on EBAM response

Previous work demonstrated that when compared to FEM BAM 1020s, EBAMs systematically yield low readings during windblown dust events. This bias may be caused by design differences between the BAM 1020 and the EBAM, specifically the arrangement of beta source/beta detector assembly and the sample path. In the BAM 1020, the beta source/beta detector assembly is beside the sample path, and the tape shuttles between the two. In the EBAM, the beta source and beta detector are in line with the sample path, and particles must pass around the source before being deposited on the tape. Such an obstacle in the sample path should have a greater effect on larger particles than smaller ones. Specifically, large particles would be expected to be diverted toward the edges of the sample path more so than smaller particles. This effect may account for the donut shaped spots observed on EBAM tapes during wind-blown dust events, which tend to have a large fraction of coarse PM (see Figures A-5 and A-6 below). Since the beta-particle emissions are focused through the middle of the tape—i.e. through the donut hole—this effect could explain the low EBAM readings during wind-blow dust events.

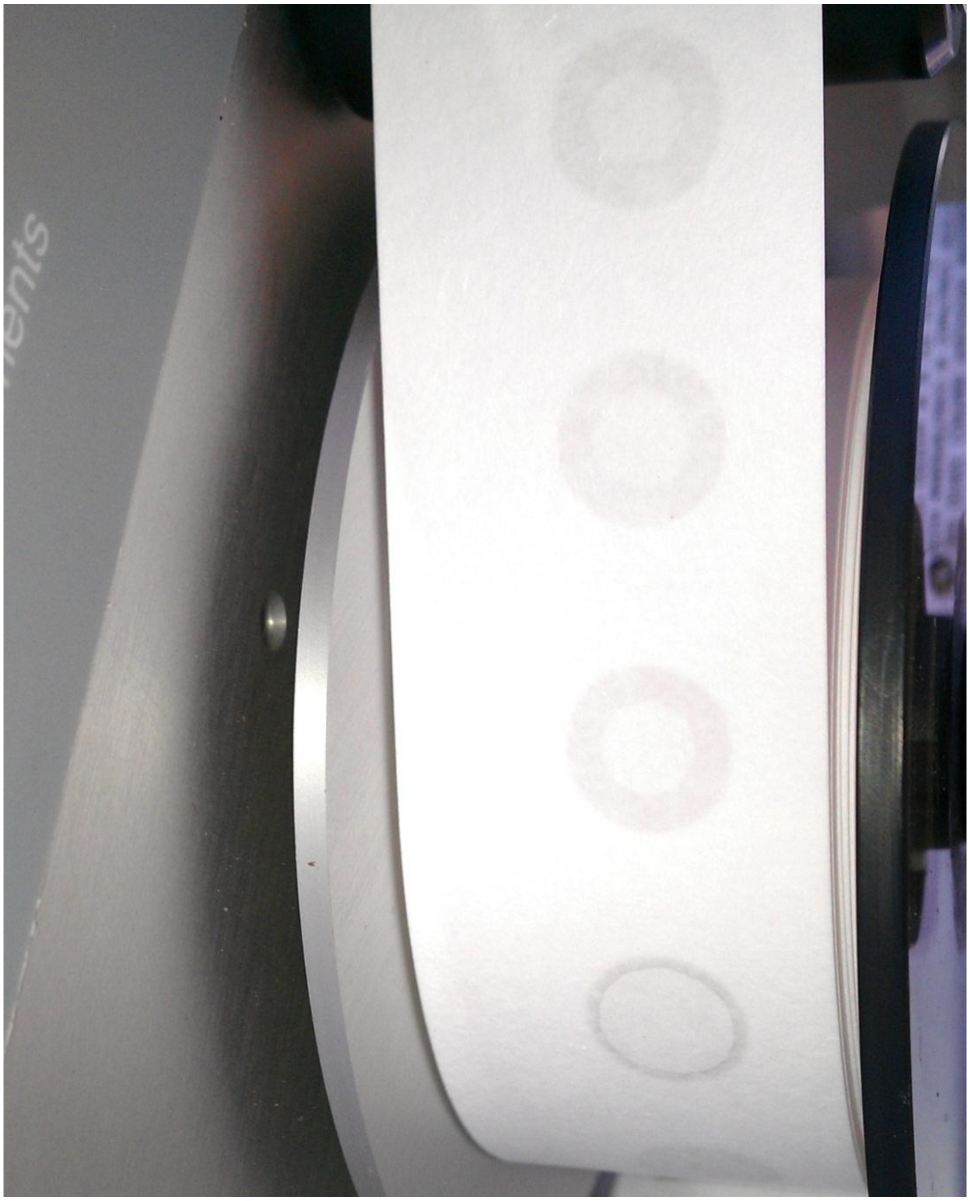


Figure A-5 Example of "doughnut" pattern of tape deposit

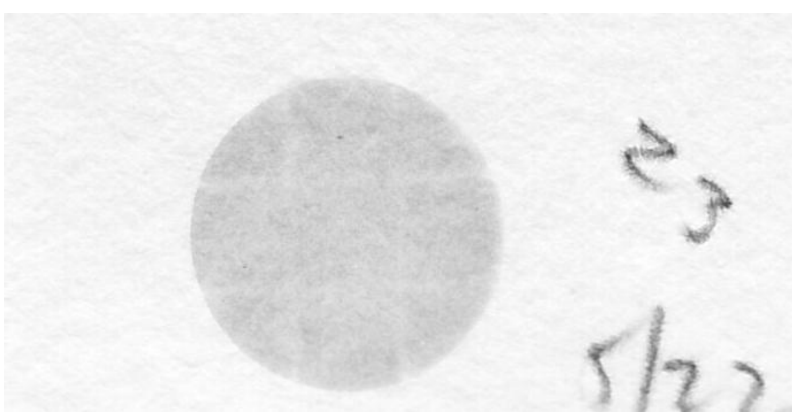


Figure A-6 Example of normal tape deposit

This theory predicts that as particle size increases (or as the fraction of large particles increases), EBAM readings should be increasingly biased low. While the specialized technology to fully characterize particle size distribution was not available for this project, the Mesa2 site does have BAM 1020s continuously monitoring both PM_{10} and $PM_{2.5}$. Thus the masses of particles in the 0 to 2.5 micron and 2.5 to 10 micron ranges are known, and a limited analysis of the effect of particle size distribution on EBAM response is possible. This analysis is presented below.

By definition, PM_{10} is the sum of $PM_{2.5}$ and PM_{coarse}, where PM_{coarse} is the mass of particles in the 2.5 to 10 micron size range. If the FEM BAMs at Mesa2 are considered to provide "true" $PM_{2.5}$ and PM_{10} values, and if the EBAM does indeed attenuate the mass of large particles more than small, it is expected that for a collocated EBAM:

$$EBAM_{10} = c_1 * PM_{coarse} + c_2 * PM_{fine} + c_3 \quad \text{(Eq. 1)}$$

then

$$c_1 < c_2$$

where

$$EBAM_{10} = EBAM\ PM_{10}\ reading$$
$$PM_{coarse} = PM_{10}\ BAM\ reading - PM_{2.5}\ BAM\ reading$$
$$PM_{fine} = PM_{2.5}\ BAM\ reading$$

and c_1 and c_2 are coefficients and c_3 is an intercept term that ideally should be zero. The coefficients c_1 and c_2 should also be less than or equal to one.

To test this, collocation data from Mesa2 was analyzed by least squares linear regression, and parameters c_1–c_3 where derived for each EBAM. Each EBAM was analyzed separately, and only hours with valid EBAM, PM_{10} BAM, and $PM_{2.5}$ BAM readings were included in the analysis. The results are shown in Table A2 below.

Table A2 - Regression analysis results for $EBAM_{10}$ vs PM_{coarse} PM_{fine}

EBAM serial number	c_1	c_2	c_3	r^2	n
g5866	0.39 **	1.41 **	1.62 *	0.65	409
g5923	0.33 **	1.14 **	3.68 **	0.87	478
g7230	0.39 **	1.20 **	0.13 (n.s.)	0.88	404
g6842	0.38 **	0.75 **	-0.46 (n.s.)	0.92	285
c4947	0.55 **	0.69 **	6.49 **	0.82	698
h8577	0.43 **	0.97 **	-1.25 **	0.93	696
j7259	0.45 **	1.07 **	-0.51 (n.s.)	0.87	612
b4242	0.31 **	1.41 **	3.80 **	0.85	698
g7371	0.48 **	0.77 **	2.14 **	0.84	779
b1761	0.44 **	1.00 **	0.87 (n.s.)	0.92	699

EBAM serial number	c_1	c_2	c_3	r^2	n
b4334	0.43 **	1.42 **	6.10 **	0.85	698
d1741	0.38 **	1.01 **	2.60 **	0.89	699
d1742	0.46 **	1.04 **	-3.08 **	0.91	559
m9479	0.44 **	1.19 **	2.59 **	0.91	698
h3988	0.38 **	1.41 **	-1.55 (n.s.)	0.83	213
h4319	0.42 **	1.10 **	2.60 **	0.87	779
f5459	0.41 **	1.00 **	-0.45 (n.s.)	0.90	696
g7497	0.33 **	1.57 **	11.24 **	0.66	430
h11625	0.36 **	0.97 **	0.07 (n.s.)	0.90	473
h11626	0.39 **	1.01 **	0.59 (n.s.)	0.88	699
m9220	0.47 **	0.96 **	2.11 **	0.91	779
m9218	0.55 **	0.76 **	-2.29 *	0.75	145
h5653	0.48 **	0.78 **	3.59 **	0.92	741
h7296	0.50 **	0.63 **	6.66 **	0.93	432

n = Number of observations in analysis.
r^2 = Coefficient of determination for the regression.
** = Statistically significant. P-value for coefficient ≤ 0.05.
* = Borderline significant. P-value for coefficient between 0.05 and 0.1.
n.s. = Not statistically significant. P-value for coefficient > 0.1.

As shown in Table A2 above, in all cases regression analyses yielded statistically significant c_1 and c_2 coefficients. The intercept term, c_3, was only significant sometimes. The coefficient of determination, r^2, was above 0.80 in all but three cases, indicating that PM_{fine} and PM_{coarse} are good predictors of EBAM PM_{10} concentrations.

Critically, in every case $c_1 < c_2$, demonstrating that as the fraction of coarse particulates increases, EBAM readings are increasingly biased low. Furthermore, c_1 and c_2 are less than one in all but a few cases and the intercept term, c_3, is generally close to zero. These data support the theory that an obstructed flow path is the cause of the EBAM's downward bias in observed PM concentration. These data also support the use of correction factors during events with high fractions of coarse particulates.

Since EBAMs will be used to predict "true" PM_{10} concentrations in the field, it is useful to rearrange Eq. 1 into a form in which the EBAM reading is the independent variable, such as:

$$truePM_{10} = m * EBAM_{10} + b \quad \text{(Eq. 2)}$$

where *m* is a slope term and *b* is an intercept term, which is ideally equal or close to zero.

Rearranging Eq. 1 into the form of Eq. 2 yields:

$$PM_{10}\ BAM\ reading = \frac{EBAM_{10}}{c_1 + (c_2 - c_1) * \gamma} - \frac{c_3}{c_1 + (c_2 - c_1) * \gamma} \quad \text{(Eq. 3)}$$

where

$$\gamma = \frac{PM_{2.5}\,BAM\,reading}{PM_{10}\,BAM\,reading} \quad \text{(Eq. 4)}$$

and thus

$$m = \frac{1}{c_1 + (c_2 - c_1) * \gamma} \quad \text{(Eq. 5)}$$

and

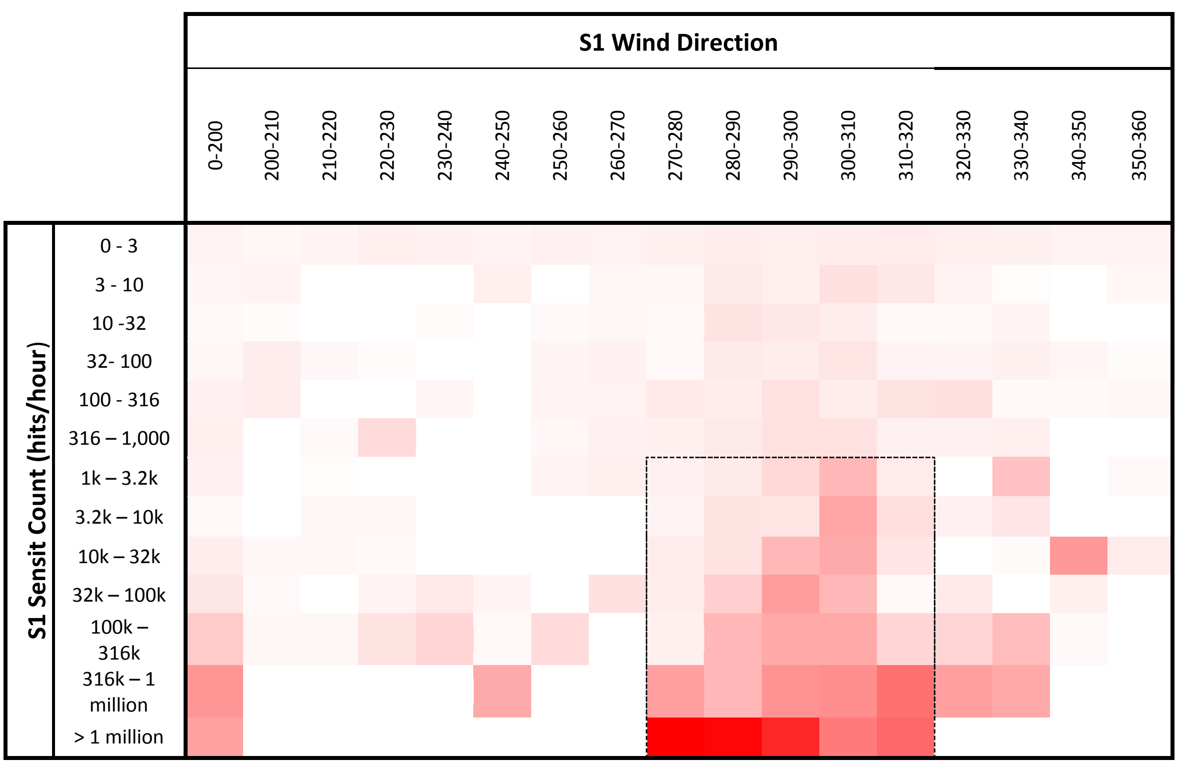
$$b = -\frac{c_3}{c_1 + (c_2 - c_1) * \gamma} \quad \text{(Eq. 6)}$$

This form explicitly shows that the slope term, *m*, needed to scale EBAM readings to "true" PM_{10} values depends on γ, the $PM_{2.5}/PM_{10}$ ratio. Since c_1 is less than c_2 and by definition the ratio γ must be between zero (no $PM_{2.5}$) and one (all $PM_{2.5}$), then the correction factor *m* increases as the $PM_{2.5}/PM_{10}$ ratio γ, decreases. In other words, the higher the fraction of coarse PM, the greater the correction factor, as predicted.

Analysis of Particle Size During Wind-Blow Dust Events

Since EBAM readings tend to be biased low when sampling air with a large fraction of coarse particulate, this suggests that their readings during such events ought to be corrected. As shown in the Table A3 below, PM_{10} at Mesa2 (as measured by the permanent FEM BAM at that site) is highest when the wind direction measured at S1 is between 270 and 320 degrees, and Sensit counts are greater than 1000/hr.

Table A3 - Average Mesa2 PM_{10} vs S1 Wind Direction and Sensit Count*



*During the colocation period, 3/16/12 through 5/31/12. Cells corresponding to Wind Direction/Sensit Count combinations that were not observed are set to zero (i.e. unshaded). The area corresponding to a Sensit count >1000/hr and wind direction between 270 and 320 is marked by the dashed line.

Color coding:

0 ug/m^3
50 ug/m^3
100 ug/m^3
150 ug/m^3
200 ug/m^3
250 ug/m^3
300 ug/m^3

Under these conditions, the average ratio of $PM_{2.5}$ to PM_{10} at Mesa2 during the colocation period was 27%. The average ratio for other conditions was 49%.[1] This shows that the hours when PM_{10} levels at Mesa2 are most elevated tend to correspond to hours when sand is moving on the dunes and the wind direction on the dunes favors transport in the direction of Mesa2. Furthermore, this shows that the particle size distribution during these hours has a higher fraction of coarse particulate. Taken together, this implies that the use of a correction factor during under these conditions is warranted.

Application of correction factor

Since the $PM_{2.5}/PM_{10}$ ratio during wind-blown dust events is lower than the ratio during other times, and since an EBAM's response varies with this ratio (see above), it was desirable to account for this dependency. Two methods were considered: applying, to each hour of each EBAM's dataset, a variable correction factor that depends on that hour's $PM_{2.5}/PM_{10}$ ratio, or using a static, unvarying correction factor that is applied only during hours believed to be influenced by wind-blown dust.

The first method, equivalent to using Eqs. 3-6, is appealing since it does not require identifying hours likely to be influenced by wind-blow dust. The drawback is that this method requires a $PM_{2.5}/PM_{10}$ ratio, γ, for each measurement being corrected, but this ratio is only available for measurements made at Mesa2 and CDF—the only sites in the study area with collocated $PM_{2.5}$ and PM_{10} samplers. If it could be assumed that for each hour γ was constant across the study area, then Eqs. 3-6 could be applied. This assumption does not, however, appear to be valid, since the correlation between the $PM_{2.5}/PM_{10}$ ratio at CDF versus that at Mesa2 for all measurements is very poor (however the correlation between the average episode ratio between the two sites is good).

This leaves the second method, which introduces the complication of needing to determine a trigger for when to apply the correction factor. Fortunately, as discussed above, elevated PM_{10} levels at Mesa2 tend to occur under certain conditions, specifically when the S1 winds are from 270° to 320° and are fast enough to get sand moving, as indicated by a sensit reading greater than 1000. While these criteria are useful for indicating when dust is likely to become aloft and transported to Mesa2, conditions resulting in the transport of dust to the various EBAM field sites may be different. For example, while conditions at S1 may result in elevated PM_{10} at Mesa2, other sites in the study area may be unaffected by the event. It would be undesirable to apply a correction factor to data from these unaffected sites. The converse is also possible: Mesa2 could be unaffected by an event while other sites in the study area are

[1] For the calculation of these average ratios, hours with negative $PM_{2.5}$ or PM_{10} values and/or PM_{10} values of zero were omitted. If $PM_{2.5} > PM_{10}$, a value of 100% was used.

impacted, perhaps because an S1 wind direction of 270° to 320° is optimal only for transporting dust to Mesa2, and other sites may be most affected at other wind directions.

To strike a balance between these competing interests, a trigger based on both S1 conditions and the EBAM's PM_{10} reading was used. Specifically, the sensit reading for the hour must be greater than 1000 and the EBAM's reading must be over a threshold concentration. As discussed in greater detail below, a regression analysis was performed on each EBAM's collocation dataset in order to determine the optimum correction factor and application threshold.

Derivation of Correction Factors

As noted earlier, EBAMs were collocated with FEM BAM 1020s for several weeks in order to collect data from which correction factors could be derived. EBAMs were collocated at Mesa2 or NRP once pre-deployment checks were completed, and they were removed as they were needed in the field. Many EBAMs had some periods of collocation data invalided due to failed QC checks, power failures, and other issues. Therefore, each EBAM had a unique, final collocation dataset. In all cases only hours with both a valid EBAM reading and valid collocated BAM reading were used.

Most EBAMs were collocated only at Mesa2 (22 units) or NRP (one unit, c3056), but two units (h4319 and g7491) were moved between NRP and Mesa2 for the entire project. In these cases the collocation periods were first analyzed separately. After determining that results with the NRP-only dataset did not differ significantly from those using only the Mesa2 data (see below for more details), NRP and Mesa2 collocation data was combined, and the analyses re-run on the merged dataset. Across the 25 collocation datasets, the average number of paired EBAM/BAM hourly values was 653.

For each EBAM, a subset of "criteria data" was then selected from the collocation dataset, to be used in regression analysis. Criteria data were those hours with a sensit count greater than 1000 and an S1 wind direction between 270° to 320°. (Note that S1 wind direction is not included in the criteria for correcting field data, since the optimal S1 wind direction ranges for transporting dust from the dunes to the various EBAM deployment sites is not known. In contrast, 270° to 320° is optimal for transporting dust to Mesa2.) The number of observations in the criteria datasets ranged from 43 to 242.

Measurements were not evenly distributed across the EBAM's measurement range of -5 to 1000 $\mu g/m^3$, but rather were clustered toward the low end. Therefore, a weighting scheme was applied to the criteria data. The EBAM range was divided into 10 $\mu g/m^3$ bins from -10 to 480 $\mu g/m^3$ plus a bin for >480 $\mu g/m^3$, and the number of points in each bin was determined. Each observation in the criteria data set was then assigned a weight equal to the reciprocal of the number of points in its bin. The intent of this weighting scheme was to ensure that the influence of the large number of measurements clustered at the low end of the EBAM's range did not overwhelm the influence of the few points at higher concentrations. This weighting scheme reduces error on the high end of the scale at the expense of increased error on the low end and slightly higher error overall.

Previous experience with the EBAM suggested that it gives a very noisy response to background levels of PM_{10}. Scatterplots of collocation data confirmed that at the low end of the EBAM's range (~<50 $\mu g/m^3$), there was high degree of scatter. Therefore, a segmented linear regression approach was pursued. It was anticipated that below some threshold EBAM concentration, the correlation would be poor and/or not significantly different from a slope of 1 and intercept of 0, while the data above the threshold would yield a good fit and a slope different from 1, and possibly a non-zero intercept. (A slope of 1 and intercept of 0 would indicate that no correction of the EBAM data was necessary). The threshold would be optimized to give the best overall fit, and would be used as the trigger (along with the S1 sensit count) for when to apply the correction factor(s) derived from the analysis to EBAM field data.

Therefore for each EBAM, the criteria data was analyzed by the following segmented weighted regression:

$$\begin{cases} PM_{10}BAM\ reading = m_U * PM_{10}EBAM\ reading + b_U & \text{for } PM_{10}EBAM\ reading \geq T \\ PM_{10}BAM\ reading = m_L * PM_{10}EBAM\ reading + b_L & \text{for } PM_{10}EBAM\ reading < T \end{cases} \qquad \text{Eq. 7}$$

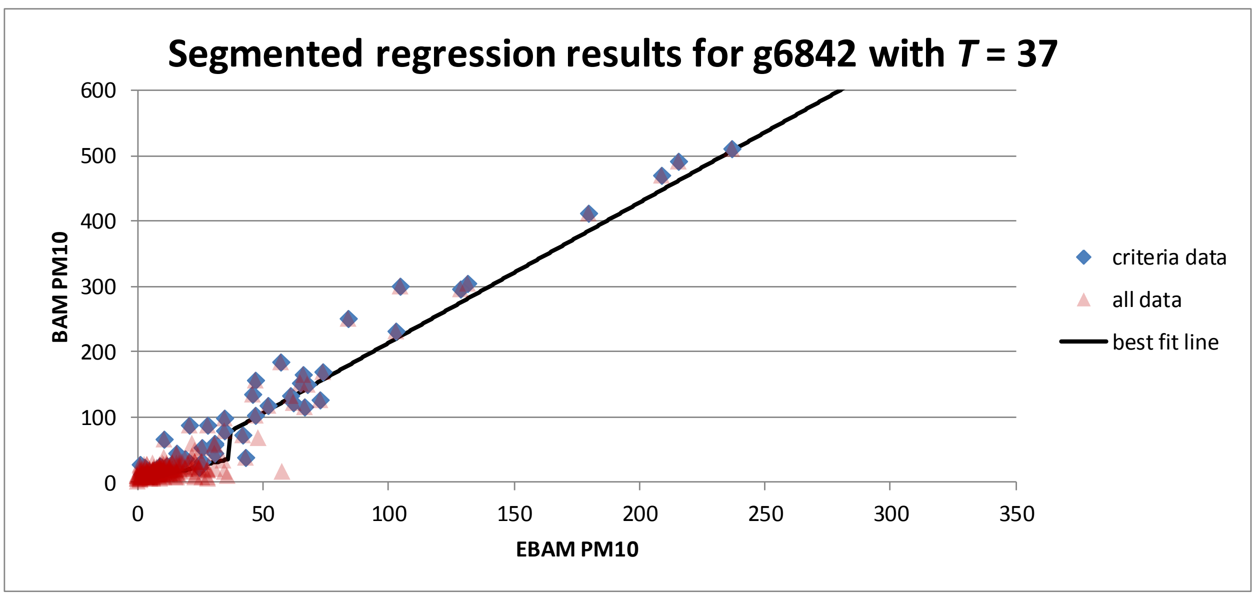
where

$$T = \text{EBAM threshold concentration}$$
$$m_U = \text{slope of weighted linear regression for data above T}$$
$$b_U = \text{intercept of weighted linear regression for data above T}$$
$$m_L = \text{slope of weighted linear regression for data below T}$$
$$b_L = \text{intercept of weighted linear regression for data below T}$$

An arbitrary threshold, *T*, was selected, and all EBAM values below *T* were regressed against their corresponding BAM values. Thus preliminary correction factors m_L and b_L for the lower part of the EBAM range were derived. At the same time, a regression was performed on data points above the threshold, *T*, yielding correction factors m_U and b_U for the upper part of the range. Coefficients of determination, r^2_U and r^2_L, were calculated for the two regressions, and an overall coefficient of determination for the model, r^2_{All}, was also determined.

Table A4 below shows the results of these regressions with *T* optimized, and Figure A-7 shows the results for a typical EBAM. (The method for optimizing *T* is discussed later.) With the exception of c3056 (which was collocated at NRP) in all cases r^2_{All} was greater than 0.90, indicating the model derived from segmented linear regression fits the data well. As expected, the lower end regressions (i.e. the regressions on data with EBAM readings less than the thresholds) yielded poorer results than the upper end regression. This is indicated by the fact r^2_U is greater than r^2_L for almost all EBAMs and by the larger standard errors of m_L as compared to m_U. For most EBAMs, values of m_L and b_L are not statistically significantly different from 1 and 0, respectively, as expected.

Figure A-7



Scatter Plot for the segmented regression for g6842, with *T* at its optimum value of 37. Blue squares indicate criteria data used in the regression analysis. The best fit line from the upper and lower regressions is shown in black. Every collocation data point, whether used in the regression analysis or not, is shown with a red triangle.

Table A-4: Result of Segmented Regression of Criteria Data

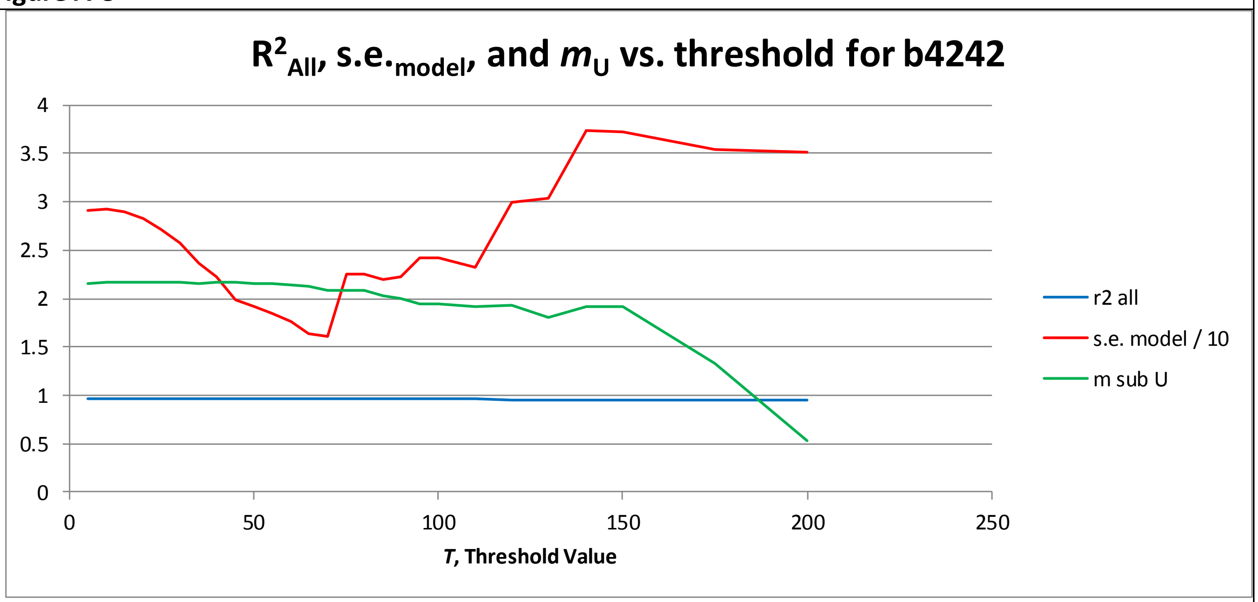
EBAM Serial number	Threshold, *T* (ug/m^3)	Lower regression on data with EBAM observations <*T*				Upper regression on data with EBAM observations ≥ *T*				Overall Model	
		r^2_L	N_L	m_L (s.e.) [a]	b_L (s.e.) [a]	r^2_U	N_U	m_U (s.e.) [a]	b_U (s.e.) [a]	R^2_{All}	N_{All}
g5866	36	0.82	33	0.84 (0.41) (n.s.)	13 (8) (n.s.)	0.98	13	2.22 (0.16) **	-39 (14) **	0.95	46
g5923	39	0.95	34	1.39 (0.93) (n.s.)	8 (20) (n.s.)	0.95	45	2.02 (0.11) **	11 (17) (n.s.)	0.95	79
g7230	57	0.96	30	0.98 (0.28) (n.s.)	13 (9) (n.s.)	1.00	7	1.92 (0.09) **	10 (19) (n.s.)	0.99	37
g6842	37	0.96	23	1.81 (0.64) (n.s.)	9 (13) (n.s.)	0.96	24	2.14 (0.15) **	21 (21) (n.s.)	0.96	47
c4947	76	0.84	80	0.96 (0.34) (n.s.)	12 (14) (n.s.)	0.93	33	1.52 (0.15) **	26 (29) (n.s.)	0.91	113
h8577	30	0.96	47	0.75 (0.67) (n.s.)	20 (10) *	0.96	66	1.76 (0.08) **	20 (12) *	0.96	113
j7259	51	0.89	67	1.22 (0.39) (n.s.)	13 (10) (n.s.)	0.95	35	1.85 (0.19) **	-1 (22) (n.s.)	0.93	102
b4242	70	0.91	86	1.55 (0.33) (n.s.)	3 (13) (n.s.)	0.98	29	2.09 (0.13) **	-1 (21) (n.s.)	0.96	115
g7371	54	0.80	96	1.07 (0.48) (n.s.)	17 (14) (n.s.)	0.94	36	1.89 (0.15) **	-17 (26) (n.s.)	0.91	132
b1761	70	0.93	81	1.55 (0.26) **	4 (10) (n.s.)	0.97	32	1.81 (0.12) **	9 (21) (n.s.)	0.96	113
b4334	85	0.86	86	1.13 (0.26) (n.s.)	11 (12) (n.s.)	0.97	28	1.60 (0.12) **	22 (25) (n.s.)	0.94	114
d1741	42	0.94	62	1.65 (0.79) (n.s.)	3 (18) (n.s.)	0.96	52	1.97 (0.11) **	7 (16) (n.s.)	0.95	114
d1742	34	0.95	49	1.28 (0.60) (n.s.)	13 (10) (n.s.)	0.97	39	1.65 (0.08) **	23 (14) (n.s.)	0.96	88
m9479	44	0.97	57	1.44 (0.52) (n.s.)	3 (12) (n.s.)	0.96	58	1.82 (0.08) **	-11 (13) (n.s.)	0.97	115
h3988	30	0.97	14	1.31 (0.86) (n.s.)	6 (15) (n.s.)	0.94	29	1.99 (0.16) **	-9 (17) (n.s.)	0.95	43
h4319 [b]	64	0.98	177	1.35 (0.22) (n.s.)	11 (7) (n.s.)	0.98	122	1.85 (0.08) **	-7 (13) (n.s.)	0.98	299
f5459	34	0.94	57	1.21 (0.65) (n.s.)	15 (11) (n.s.)	0.97	56	2.05 (0.09) **	-7 (12) (n.s.)	0.97	113
g7497 [b]	87	0.85	216	1.28 (0.16) *	6 (7) (n.s.)	0.99	26	1.71 (0.12) **	-16 (17) (n.s.)	0.95	242
h11625	32	0.97	25	0.64 (0.85) (n.s.)	21 (13) (n.s.)	0.92	52	2.11 (0.14) **	5 (19) (n.s.)	0.93	77
h11626	48	0.91	70	1.46 (0.54) (n.s.)	13 (13) (n.s.)	0.96	45	2.12 (0.12) **	-14 (18) (n.s.)	0.95	115
m9220	56	0.95	81	1.25 (0.32) (n.s.)	9 (10) (n.s.)	0.99	59	1.78 (0.09) **	-3 (12) (n.s.)	0.97	140
m9218	25	0.80	16	0.58 (0.65) (n.s.)	16 (8) *	0.99	5	1.67 (0.20) **	3 (15) (n.s.)	0.95	21
h5653	48	0.99	47	1.19 (0.33) (n.s.)	14 (8) *	0.97	82	1.85 (0.09) **	-7 (12) (n.s.)	0.98	129
h7296	65	0.98	23	1.14 (0.31) (n.s.)	5 (10) (n.s.)	0.96	39	1.89 (0.14) **	-11 (19) (n.s.)	0.97	62
c3056 [c]	6	0.68	28	-0.70 (2.63) (n.s.)	18 (9) **	0.81	83	1.65 (0.19) **	-2 (10) (n.s.)	0.80	111

Notes and Abbreviations:
[a] The format for these columns is as follows: parameter value (standard error) statistical significance. ** = Statistically significant (p-value < 0.05), * = Borderline significant (p-value between 0.05 and 0.1), (n.s.) = not significant (p-value > 0.1).
[b] Data from collocation at both Mesa2 and NRP.
[c] Data from NRP collocation only.
T = Threshold from Eq. 7. N = Number of observations in analysis. Subscripts "U", "L", and "All" indicate, respectively, whether the parameter applies to the upper range regression on data above the threshold, the lower range regression on data below the threshold, or the application of the model to all the criteria data.

To determine the optimum value for the threshold *T* for each EBAM, the correction factors derived with Eq. 7 were applied to each EBAM's entire collocation dataset, including both criteria and non-criteria data, however only slopes that differed significantly from 1 and intercepts that differed significant from 0 were used. Non-significant slopes and intercepts were set to 1 and 0, respectively. Statistical significance was assessed using two-tailed T-tests and selecting a p-value of 0.05 as the threshold for significance. Using these slopes and intercepts, predicted BAM values were calculated from the observed EBAM values. Predicted BAM values were subtracted from the observed BAM values to yield residuals. From the sum of squared residuals, statistics assessing how well the model fit the data were calculated, including the coefficient of determination for the model, r^2_{Model}, and the standard error for the model, $s.e._{Model}$.

Typically, r^2_{All}—the combined r^2 for the upper and lower end regressions on criteria data—did not vary much as *T* increased, but $s.e._{Model}$ decreased gradually before rising sharply. *T* was optimized when $s.e._{Model}$ was at its minimum. The results for a typical EBAM are shown in Figure A-8, below.

Figure A-8



Graph showing how r^2_{All}, $s.e._{Model}$, and m_U vary with the threshold, *T*. Note that $s.e._{Model}$ has been divided by 10 to bring its values on scale with those of r^2_{All} and m_U. In this case, the optimum value for *T* is 70, which is where $s.e._{Model}$ is minimized. Also note that m_U, the slope of the regression on criteria data greater than *T*, does not change much until $s.e._{Model}$ starts to rise.

Table A5 below summarizes the results. For each EBAM, the optimized value for *T*, along with the final upper and lower end slopes and intercepts is shown. (These slopes and intercepts are denoted with the subscript "Model", to differentiate them from slopes and intercepts derived from Eq. 7 and displayed in the previous table. Since in this part of the analysis only statistically significant slopes and intercepts were used, $m_{L,Model} = m_L$ if m_L was significant, otherwise it was set to 1. The m_Us were treated the same way. Intercepts were treated similarly, except non-significant intercepts were set to 0.) The table also provides statistics describing the goodness of fit of the model, r^2_{Model}, and the standard error for the model, $s.e._{Model}$.

Table A5 – EBAM Threshold and Correction Factors

EBAM serial number	Threshold, *T* (ug/m^3)	$m_{L,Model}$	$b_{L,Model}$	$m_{U,Model}$	$b_{U,Model}$	N_{Model}	r^2_{Model}	$s.e._{Model}$
g5866	36	1.00	0	2.22	-39	409	0.75	11.5
g5923	39	1.00	0	2.02	0	478	0.90	19.4
g7230	57	1.00	0	1.92	0	404	0.94	12.7
g6842	37	1.00	0	2.14	0	285	0.93	18.3
c4947	76	1.00	0	1.52	0	698	0.87	18.6
h8577	30	1.00	0	1.76	0	696	0.92	14.8
j7259	51	1.00	0	1.85	0	612	0.87	14.1
b4242	70	1.00	0	2.09	0	698	0.91	16.1
g7371	54	1.00	0	1.89	0	779	0.87	17.2
b1761	70	1.55	0	1.81	0	699	0.93	14.1
b4334	85	1.00	0	1.60	0	698	0.90	16.5
d1741	42	1.00	0	1.97	0	699	0.92	15.4
d1742	34	1.00	0	1.65	0	559	0.90	16.7
m9479	44	1.00	0	1.82	0	698	0.92	15.1
h3988	30	1.00	0	1.99	0	213	0.79	22.3
h4319[a]	64	1.00	0	1.85	0	1816	0.89	19.8
f5459	34	1.00	0	2.05	0	696	0.92	15.2
g7497[a]	87	1.00	0	1.71	0	1305	0.61	21.5
h11625	32	1.00	0	2.11	0	473	0.91	18.9
h11626	48	1.00	0	2.12	0	699	0.90	16.9
m9220	56	1.00	0	1.78	0	779	0.94	12.3
m9218	25	1.00	0	1.67	0	145	0.75	11.4
h5653	48	1.00	0	1.85	0	741	0.94	16.2
h7296	65	1.00	0	1.89	0	432	0.96	13.3
c3056[b]	6	1.00	18	1.65	0	603	0.48	11.5

[a]Data from collocation at both NRP and Mesa2. [b]Data from collocation at NRP only.

As mentioned earlier, the slopes and intercepts for the lower end regressions were usually not significantly different 1 and 0, and thus most values for $m_{L,Model}$ and $b_{L,Model}$ are 1 and 0, respectively. This is equivalent to leaving the data that is less than the threshold uncorrected. Most values for $b_{U,Model}$ are also 0, as most b_L were non-significant. In contrast, all of the values of the slope for the upper end regression, m_L, were significant. The average m_L was 1.88, indicating that during windblown dust events the EBAM is low by a factor of almost 2.

These final correction factors were applied to the data as follows: when the sum of the previous and current hourly S1 sensit reading is above 1500, then EBAM's reading was multiplied by $m_{U,Model}$ if it's value equaled or exceeded *T*. If $b_{U,Model}$ was non-zero, this term was also applied. If the EBAM reading was less than *T*, then $m_{L,Model}$ and $b_{L,Model}$ were applied, but with two exception these are always equal to 1 and 0, respectively, so the application of these lower end correction factors leaves the data unchanged.

The figures below demonstrate the application of the correction factors to a typical EBAM. In Figure A-9, Mesa2 PM_{10} BAM data and uncorrected S/N b1761 EBAM data from the collocation period are plotted on the same graph. Figure A-10 presents the same data but with correction factors applied to the EBAM data. Note how the corrected EBAM data tracks the Mesa2 BAM data much more closely that the uncorrected data.

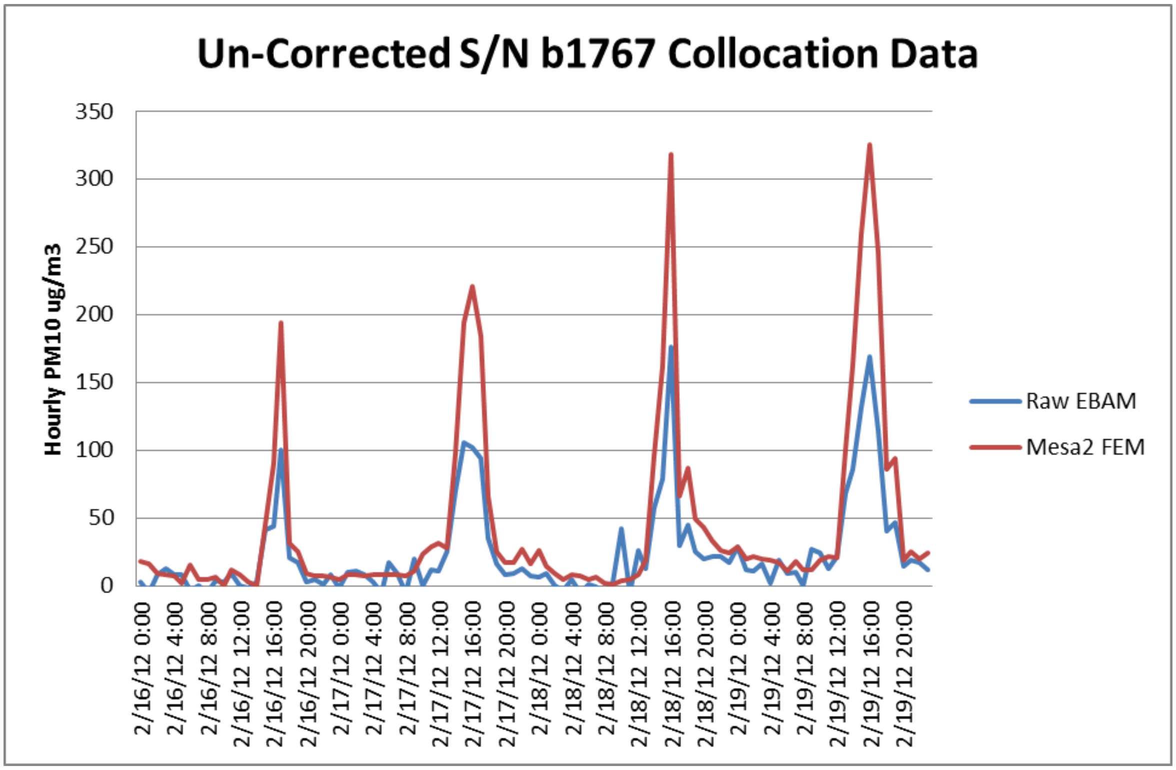


Figure A9 – Uncorrected EBAM S/N b1767 Data Compared to Mesa2 FEM

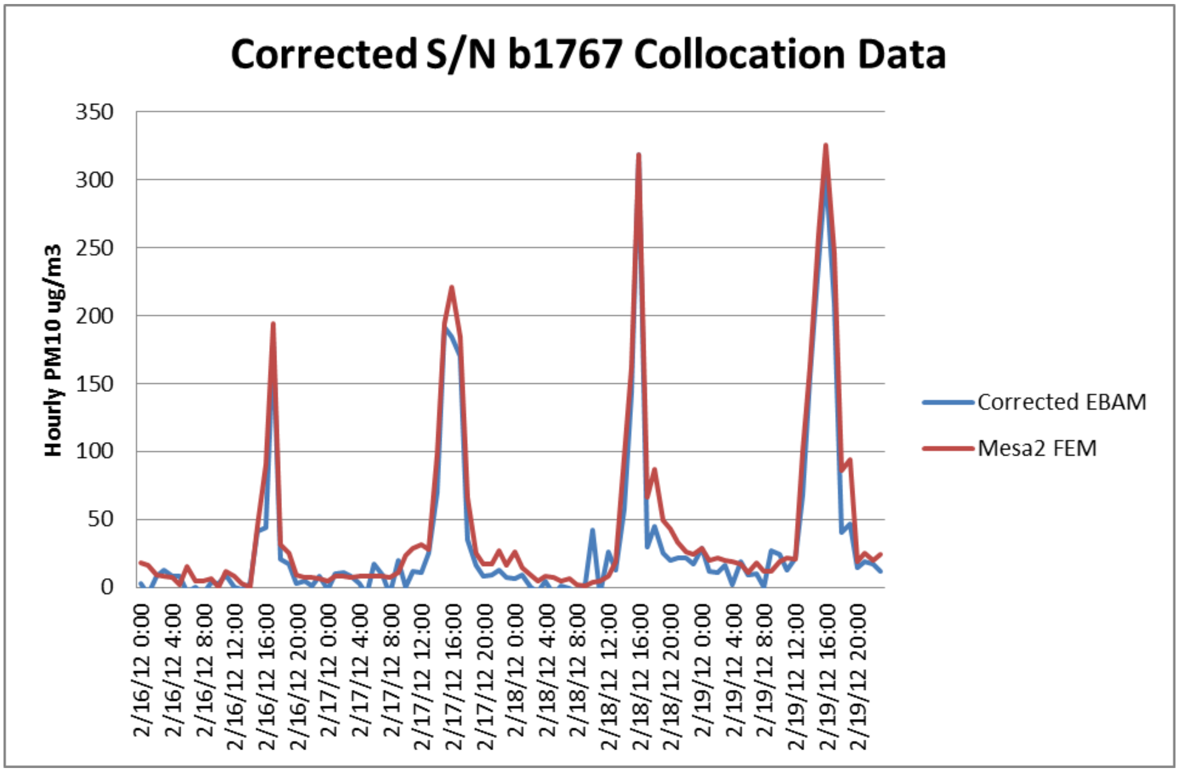


Figure A10 – Corrected EBAM S/N 1767 data Compared to Mesa2 FEM

Collocation at Mesa2 vs NRP

EBAMs h4319 and g7497 were moved between Mesa2 and NRP, and the final correction factors in the Table A5 above are derived from data collected at both sites. As the $PM_{2.5}/PM_{10}$ ratio at NRP was not likely to be exactly the same as that at Mesa2, it was thought that correction factors derived from NRP collocation data might differ from those derived using Mesa2 data. Therefore, prior to merging the data from Mesa2 and NRP, the collocation periods were analyzed separately to determine whether the location of collocation was important.

EBAM h4319 was first installed at Mesa2, then moved to NRP, then reinstalled at Mesa2. Examining the two Mesa2 collocation periods individually yielded nearly identical results: both had an optimum threshold of 52 and insignificant $m_{L,Model}$, $b_{L,Model}$, and $b_{U,Model}$. The upper end slopes, $m_{U,Model}$, for the first and second Mesa2 to collocation periods were 1.93 (with a standard error of 0.09) and 1.85 (with a standard error of 0.08), respectively. An analysis of covariation (ANCOVA) showed no significant difference between the upper end slopes and yielded a merged $m_{U,Model}$ of 1.88 (s.e. 0.06).

Regression analysis of h4319's NRP colocation period by itself yielded non-significant results at all values of *T*, with all slopes and intercepts non-significant. A likely cause of this was the narrow range of the NRP data—the highest EBAM reading at the site was only 89 $\mu g/m^3$. In contrast, this EBAM registered PM_{10} values as high as 343 $\mu g/m^3$ during collocation at Mesa2. When analyzed together, ANCOVA showed no significant difference between the merged Mesa2 collocation periods and the NRP collocation period. The correction factors derived from the merged dataset (shown in the table above) are nearly identical to those derived from the Mesa2-only dataset. The main difference is that including the NRP data increases $s.e._{Model}$—with NRP data excluded, $s.e._{Model}$ = 15.1, with it included $s.e._{Model}$ = 19.8.

EBAM g7497 had one period each of collocation at Mesa2 and NRP. When analyzed individually, the datasets yielded nearly identical optimum cutoffs of 71 and 70, respectively. The corresponding $m_{U,Model}$ values were 1.53 (s.e. 0.19) and 2.13 (s.e. 0.15), respectively, both of which were statistically significant. In addition, $b_{U,Model}$ for the regression of the Mesa2 dataset was also significant, with a value of -83.4 (s.e. 21.71). When analyzed jointly, ANCOVA showed no significant difference between the two collocation periods, so the dataset were merged and the segmented regression rerun. Only $m_{U,Model}$ was statistically significant, and at 1.71 (s.e. 0.12), it was nearly the average of the NRP-only and Mesa2-only slopes.

Finally, EBAM c3056 was collocated at NRP only. The instrument had the lowest r^2_{All}, with a value of 0.80 and also the worst r^2_{Model}, 0.48. A likely explanation for this the correlation is the narrow spread of the NRP data. The highest PM_{10} value recorded by the EBAM during the collocation period was only 83. In contrast, EBAMs collocated at Mesa2 experienced much higher PM_{10} levels.

Additional Corrections to the Dataset

On a few occasions, EBAM flow modes were accidently temporarily changed from “actual” to “STP”. Both the SLOAPCD EBAM SOP and the EPA FEM designation for the BAM 1020 call for flow regulation to be set to the actual mode. In this mode, the EBAM maintains a constant sample flow of 16.7 LPM during the sample collection period. When set to STP, the EBAM maintains a sample flow of 16.7 SLPM (Standard Liters Per Minute); the difference being that under STP, flows are adjusted to standard temperature and pressure of 25 °C and 760 mmHg. Under the temperature and pressure conditions encountered during this study, LPM and SLPM flow can differ by as much as 5%.

Inspection of EBAM settings files (which were downloaded along with data files at least 2 weeks) revealed the three instances when EBAMs inadvertently had their flow modes set to STP. In these cases, equations 8 and 9 were used to correct EBAM flow and PM_{10} concentration back to actual conditions.

$$flow\ corrected\ PM_{10} = raw\ PM_{10} * \frac{P}{760} * \frac{298}{T + 273} \qquad \text{(Eq. 8)}$$

$$corrected\ EBAM\ flow = raw\ flow * \frac{760}{P} * \frac{T + 273}{298} \qquad \text{(Eq. 9)}$$

where

P = actual atmospheric pressure in mmHg, estimated from sampler altitude
T = actual temperature recorded by the EBAM for the hour

In all cases, raw EBAM PM_{10} values were corrected by Eq. 8 before the collocation correction factor was applied or before being used in the derivation of correction factors.

In addition to flow modes being improperly set, site checks and the review of QC data revealed some occasions when EBAM wind direction sensors were misaligned, causing measured wind directions to be off. If the beginning and end of the period of improper alignment could be accurately identified, then the wind direction data was corrected, otherwise it was invalidated. Table A6 below summarizes these corrections.

Table A6 - Additional Corrections Applied to the Dataset

Sampler S/N	Site	Begin Adjustment	End Adjustment	Parameter Adjusted	Adjustment Amount	Reason for Adjustment
g5866	O-D	5/10/2012 17:00	5/23/2012 9:00	Flow, PM10	STP to Actual	Accidently set to STP Mode
g5923	1A	3/8/2012 12:00	3/23/2012 10:00	WD	13	Boom Alignment Error
g7230	O-B	3/19/2012 14:00	3/23/2012 11:00	WD	-100	Boom Alignment Error
g7230	O-B	3/23/2012 12:00	5/31/2012 23:00	WD	-26	Boom Alignment Error
c4947	1B	3/8/2012 15:00	3/23/2012 11:00	WD	13	Boom Alignment Error
h8577	8A	3/9/2012 14:00	3/23/2012 11:00	WD	-16	Boom Alignment Error
j7259	6A	3/8/2012 14:00	3/23/2012 13:00	WD	56	Boom Alignment Error
g7371	O-C	4/12/2012 16:00	5/24/2012 8:00	Flow, PM10	STP to Actual	Accidently set to STP Mode
f5459	17A	3/9/2012 14:00	3/16/2012 15:00	WD	180	Boom Alignment Error
m9218	O-A	3/21/2012 14:00	4/3/2012 11:00	WD	180	Boom Alignment Error
h7296	COP	5/3/2012 15:00	5/23/2012 10:00	Flow, PM10	STP to Actual	Accidently set to STP Mode

Salt Analysis of Oceano Samples

Approximately 50 hourly EBAM samples were selected from Oceano EBAM filter tapes for chloride ion analysis in order to better understand the widely fluctuating influence of sea salt on the data collected in Oceano. Previous studies have demonstrated that locations in such close proximity to the ocean can have a widely variable influence from sea salt, while these same studies have demonstrated a relatively consistent, low level of sea salt in samples collected from the Nipomo Mesa.

Performing chloride ion analysis from particulate filters is quite common; however, few if any analytical laboratories have ever performed this analysis on BAM filter media. Project staff worked with Desert Research Institute's (DRI) analytical laboratory to investigate the feasibility of performing this analysis on samples collected using this filter media.

Prior to initiation of sampling, blank filter media was analyzed by DRI to test the methodology as well as determine if the un-exposed BAM filter media contained any chloride. These tests by DRI proved the analytical method adapted to this filter media was workable and also that the un-exposed BAM tapes did contain a small quantity of chloride. Numerous samples of blank tape analyses, from both unopened filter tape as well as blank filter tape punches from the same Oceano sampler demonstrated that the blank BAM tapes chloride concentration was quite consistent at a level that translates to a salt concentration of between 1-2 ug/m3. These consistent blank concentrations were subtracted from the actual field samples to yield the final chloride concentration utilized.

Sample handling of the selected filter sections followed established good laboratory practices including use of gloves, storage of filter samples in glassine envelopes, sealing each sample with EPA sample seals, as well as use of chain of custody documentation. A detailed discussion of the results of the salt analyses for Oceano is provided in Appendix D.

Influence of Local Sources

In the review and analysis of the project data a very small number of data values were identified that do not fit the typical spatial pattern or PM_{10} concentrations seen on the overwhelming majority of measurements. While these outliers do not change any of the conclusions and findings supported by the vast majority of data, they are interesting to examine, and may provide added insight into PM measurements and PM issues in the region.

There are a variety of possible causes of these data outliers. As previously discussed, when sampling coarse particulate, over time the EBAM samplers will accumulate dust on the beta source that will eventually drop off and land on the filter tape. Once on the tape, it gets measured as mass and causes a large positive bias in that one hour's PM_{10} measurement; these positive artifacts occur infrequently and somewhat randomly, usually affecting a single hour.

Another possible cause of these outliers is potential local activity in close proximity to the sampler that is emitting large amounts of particulate for a short period. Examples would be a barbeque, idling vehicle, or active disturbance to the soil next to the sampler (e.g. - plowing a field, farm animal activity, or driving on a dirt road).

A final possible cause could be wind entrainment of soil particles from an open disturbed area directly upwind from a sampler. Most of the study area is covered by thick vegetation, some of which is irrigated, and many groves of eucalyptus trees that will dramatically lower the downwind wind speed; thus, windblown emissions from these areas are very unlikely. However, there are a few small areas of open, disturbed soil in some portions of the study area. Because of their small size, however, the impact of any emissions from these potential sources would be small and very localized, especially on a significant episode day where emissions from the Oceano Dunes dust plume overwhelm those from small local sources.

The largest potential alternative dust source in the area is the agricultural fields in the Santa Maria Valley. Data analysis does show these fields can occasionally be a moderate source of airborne particulate pollution for short periods under some high wind conditions. As discussed in detail in Appendix B, however, detailed analysis of the particle size distribution downwind from these fields indicates that on the northwest wind events that produce the dust plume episodes from the dunes, the agricultural fields have a minor, if any, impact. Additionally, while manning the temporary sampling site (S-E) in the Santa Maria Valley, project staff observed no visible dust emissions on any day except for 5/25/12.

Table A-7 below presents a listing of all identified data values that do not fit the surrounding data pattern and/or appear to be caused by something other than windblown dust originating from the coastal dunes. The majority of outliers listed are from site 13A; this site is located just downwind from a large agricultural field with an upwind fetch of about ½ mile across the planted fields. The fields also have a grid of dirt roads for worker access to them. The fields upwind from site 13A were planted using plastic mulch covering most of the ground surface area during the project. It is interesting that excluding the 5/25/12 day where it is clear there were some windblown dust sources in the area, all but one outlier from site 13A occurred on the weekend.

Table A-7 – Listing of All Outlier Data Values Identified in the Project Data Set

Day of Week	Date	Site	Hour	Comment	Likely Cause
Thursday	4/5/2012	14A	13-14	Site 14a ~100 ug/m3 above CDF, other hours look normal. WS in region are high.	Local disturbance, sampler artifact, or local wind blown dust
Friday	4/6/2012	10B	5	Single hour ~160 ug/m3, low WS	Sampler artifact
Friday	4/27/2012	12A	13	Single hour outlier ~200 ug/m3 above nearby sites. WS at 13A and 6A increase on hour 14, yet PM_{10} at12A drops	Local disturbance or local windblown dust
Friday	5/4/2012	13A	12-13	Both hours ~100 ug/m3 above nearby sites. Hour 13 to 14 WS goes from 12.3-12.1 but PM_{10} drops to below surrounding sites levels on hour 14	Local disturbance or local wind blown dust
Saturday	5/5/2012	15A	9	Single hour spike ~175 ug/m3, low wind speed	Sampler artifact or local disturbance
Sunday	5/6/2012	13A	11	Very low WS from north, single hour spike >1000ug/m3	Sampler artifact or local disturbance
Saturday	5/12/2012	SE-E	11	Winds low in region, single hour spike >550 ug/m3	Sampler artifact or local disturbance
Tuesday	5/15/2012	12A	16	Winds low in region, single hour spike >800 ug/m3	Sampler artifact or local disturbance
Tuesday	5/15/2012	14A	17	Winds lower than typical at 14A for wind event, single hour spike >500 ug/m3	Sampler artifact or local disturbance
Saturday	5/19/2012	13A	11-14	Winds during period low and PM does not correlate with wind speed.	Local disturbance
Tuesday	5/22/2012	13A	15	Single hour >1800 ug/m3. Following hour WS increases from 11 - 12.1 and PM_{10} drops to levels in surrounding sites	Sampler artifact, local disturbance, or local wind blown dust
Friday	5/25/2012	S-E, 17A, 13A, 12A	13-15	Unusual meteorological pattern, higher WS inland than on the coast. Wind speeds in vicinity of affected sites highest of project. Santa Maria PM2.5/10 ratio indicates impacts from ag. fields.	Local windblown dust

These outliers have been retained in the study data set, so anyone interested can examine them in further detail. While interesting to investigate, the outlier values represent only a tiny fraction (0.07%) of the large amount of data gathered and evaluated for this project and thus do not change, or significantly affect, the overall findings.

APPENDIX B

SAN LUIS OBISPO COUNTY
AIR POLLUTION CONTROL DISTRICT

2012 COMMUNITY PARTICULATE
MONITORING PROJECT

MONITORING PLAN

JANUARY 2012

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1.0 Project Description and Timeline

The San Luis Obispo County Air Pollution Control District (District) is undertaking a project to better understand the spatial distribution of the plume of particulates that originate from the Oceano Dunes State Vehicle Recreational Area (SVRA). The District plans to utilize saturation monitoring downwind from the OHV riding area and downwind from the Pier Avenue park entrance, focused on sensitive receptors and populated areas to map the spatial extent and concentration gradient of the windblown dust plume. Past studies by the District have clearly documented the plume presence immediately downwind from the riding area of the SVRA as well as the Pier Avenue area near the park entrance, this project will provide additional data that will be used by the District to better inform the public of the air quality impacts in sensitive receptors such as schools, environmental justice areas, and other populated areas downwind from the source.

Study Design

The core concept of saturation monitoring is siting monitors in a grid across the expected path of the plume being investigated. Data from the array of monitors is used to characterize the plume path and concentration gradient. Previous District studies have demonstrated that the plume of windblown particulate being investigated only occurs under conditions of strong northwesterly winds with the primary plume impacting the Nipomo Mesa. However, these studies have also documented high levels of particulate just downwind from the SVRA entrance on Pier Avenue, also when high northwesterly winds are present.

Therefore, for this project, there will be two saturation monitoring areas utilized, a large area in the populated portion of the Nipomo Mesa and a much smaller area in the community of Oceano. These general areas are depicted in Figure 1 below:

Figure 1 - Areas of Saturation Monitoring and Permanent Monitoring Stations

MetOne E-BAM samplers configured for PM-10 measurements will be utilized as saturation monitors for this project. The E-BAM measures PM-10 by beta attenuation and is capable of generating hourly PM-10 data. Most E-BAMs utilized will also be equipped with wind speed and direction sensors, allowing wind conditions across the study area to be characterized and related to the particulate values measured. The E-BAM is not a federally approved method for PM-10, so part of the study design is to document the relationship between federally approved monitors and the E-BAM monitors to allow data from the E-BAM to be compared to health standards as well as the data from the District permanent monitoring stations in the area that utilize federally approved methods.

Because sampling in the Oceano area is so close to the ocean, there is a high likelihood that the PM-10 mass measurements from the E-BAM samplers will be biased due to high salt conditions. Data from the Phase 2 study showed the highest bias of samples taken adjacent to the ocean due to salt under calm conditions and lower, but significant, contributions under high wind event periods. Therefore, the tape from approximately five wind events (comprising 4-5 hours in length each) from E-BAM samplers in the Oceano area will be analyzed for chloride ion to allow for sea salt contributions to the mass measurements to be calculated. These salt mass calculations will be used in analyzing all mass data for wind event periods collected in the Oceano area to account for sea salt contributions. Additionally, approximately 2-3 hours of high mass measurements while wind conditions are calm will also be analyzed for chloride ion to demonstrate the contribution of sea salt to the periods of calm, but high PM mass measurements.

Project Timeline

District monitoring in the area has shown that the windblown dust from the SVRA occurs during periods of strong northwesterly winds that tend to occur most often in the Spring season. In order to capture as many wind/dust events as possible, the sampling period for this project is proposed to be March 2012 through May 2012. The table below presents the major project milestones and expected timeline.

Task/Milestone	Expected Time Period
Site Selection and Equipment Acquisition	Expected period to be November 1, 2011 through February 1, 2012
QA Collocation of Samplers	February 1, 2012 through February 21, 2012
Sampler Installations	February 22, 2012 through February 29, 2012
Saturation Monitoring Period	March 1, 2012 through May 31, 2012
Analysis of Data and Final Report	June 1, 2012 through August 31, 2012

2.0 Monitoring Locations

Selecting appropriate locations such that a grid with sufficient density of monitors to characterize the plume as well as locations that are representative of the area around the monitor are essential in a successful saturation monitoring project. Siting of the individual monitors following guidelines to assure that the monitors are not unduly influenced by local sources and are representative of the general area the monitor location is described in Section 3 of this document. Selecting the appropriate general locations for the monitors is described below for each of the two saturation monitoring areas.

Nipomo Mesa Saturation Monitoring Area

Previous studies have demonstrated the northern boundary of the typical plume path over the Nipomo Mesa area to be south of Mesa Middle School. The southern boundary has not previously been defined, but the populated area stops just north of the Santa Maria River. The eastern boundary appears to be near to the District's Nipomo Regional Park permanent monitoring station, based on historical data.

With these approximate plume boundaries, the saturation monitoring area can be divided into approximately one square mile grids, as depicted in Figure 2 below. Locating a monitor in each grid will provide sufficient density to adequately define the plume extent and concentration gradient. It may not be possible to find a suitable location in each grid, but the overall goal should be to find a suitable location in as many grids as possible. Additionally, should it be impossible to find a suitable location in one grid, every effort possible should be made to ensure that a monitor is sited in grids adjacent to the grid without a monitor.

In addition to siting a monitor in each grid, it may be advantageous to locate at least one monitor in the populated area southeast of the grid area to demonstrate the eastern extent of the plume. Similarly, it would be advantageous to locate at least one monitor south of the grid area to demonstrate the southern extent of the plume.

As preliminary data is reviewed it may be advantageous to add or move one or more monitors to alternate locations based on the preliminary data. This flexibility will be utilized as a means of providing additional data that may be more representative of the plume rather than more localized conditions. If possible, it is advantageous to keep all monitors installed at the initial monitoring location to ensure that variations in plume path, that may not be apparent from the initial 6-10 dust events, are clearly documented. There may be situations where one or more site's data appears to not fit the overall plume pattern based on the grid of monitor's readings. In this case, if possible, a second monitor will be installed at an alternate location in the grid to confirm or disprove that the original monitor's data is not a representative measurement of the plume. Should there not be a spare monitor to perform this added monitoring, movement of an existing monitor to accomplish this second measurement can be considered.

The evaluation of moving site(s) will be made after at least 6-10 significant dust events have been captured by the original network of monitors. A site will only be moved if the data from the site to be moved either does not show any plume impact for any of the dust events, or the readings show a clear relationship to nearby permanent monitors. For a saturation site to show a clear relationship to a nearby permanent monitor, the correlation coefficient of a linear regression of the hourly averages during all dust events to date should approach 0.9 or greater.

Figure 2 – Nipomo Mesa Monitoring Area with Grids Defined

Figures 3 through 21 presented below present a close up of each grid by number with a discussion of potential monitoring locations and considerations in selecting an appropriate site for that grid. Note that these figures have been rotated about 20 degrees such that north is no longer up, but have been positioned so that the prevailing northwesterly wind direction moves from left to right across the grid. These figures will be used by project staff in searching for appropriate monitoring site locations.

Figure 3– Grid 1

Previous District monitoring in the Fall of 2011 at Lopez High School showed the plume presence at Lopez High School, but at PM-10 levels approximately ¼ of the PM-10 levels measured just over one mile south at the CDF station. The wind speeds at Lopez High were also 2 to 3 times lower than measured at the CDF station. It is possible that the dense eucalyptus trees upwind from the school were responsible for both the lower winds and PM-10 concentrations measured at the school.

Two general areas should be considered for this grid, and it may be a grid where two monitors should be located. Locating a monitor to the west of the eucalyptus groves would show whether the plume concentration is actually lower than the levels measured at CDF prior to encountering the dense trees, or whether the trees are responsible for the lower PM-10 measured at Lopez High School. A second potential location would be away from the groves of trees in the neighborhood in the northern section of the grid.

Figure 4 – Grid 2

The predominant feature of this grid is the Cypress Ridge residential development. This residential development is the most populated and is a location with citizens concerned about air quality. The best potential site would be in an open area or around the residential development.

Figure 5 – Grid 3

This grid has very little population and is mostly heavily vegetated open space and agricultural land. This grid may be a grid that does not get a monitoring location due to the lack of population as well as the lack of good potential locations. It may be possible to locate a monitor at one of the agricultural operations in the northern portion of the grid.

Figure 6 – Grid 4

The predominant feature in this grid is the Black Lake Golf Course and adjacent housing development. Unfortunately there are lots of trees surrounding many of the parts of this grid. The residential area near Woodgreen Way is quite dense and has a row of eucalyptus trees upwind making siting difficult in this area. The most likely potential sites in this grid would be one of the residences adjacent to the golf course or in the golf course itself.

Figure 7 – Grid 5

The most likely area in this grid for a suitable site is in the residential areas in the north or west portion of the grid. The areas with dense vegetation will likely be too obstructed to meet siting goals.

Figure 8 – Grid 6

This grid is mostly covered by low density residential areas, except the agricultural operations in the north. The most likely site in this grid would be in the open rural residential area.

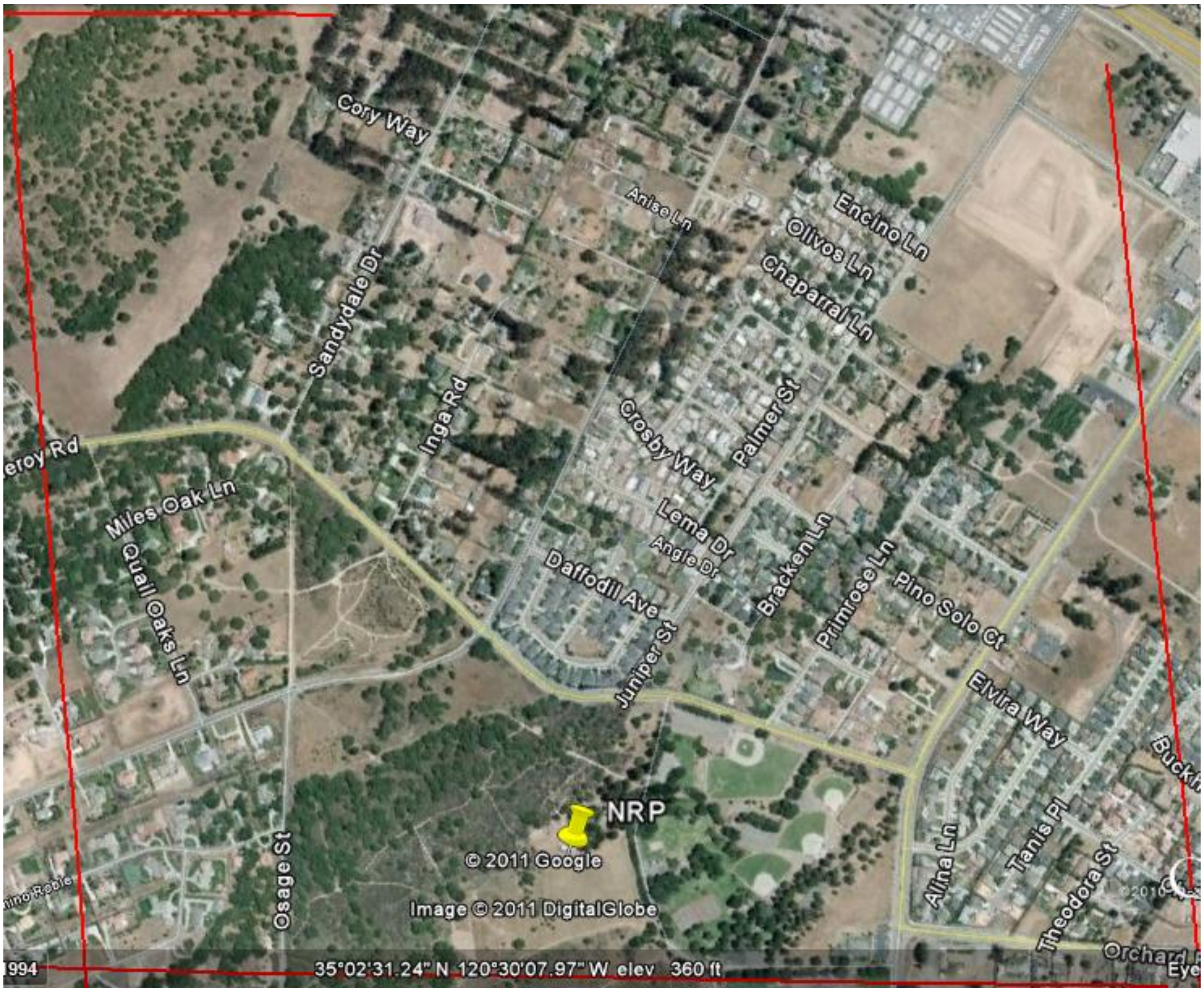


Figure 9 - Grid 7

This grid contains the District's Nipomo Regional Park permanent monitoring station. Data from this station shows it is only slightly impacted by the dust plume. Because there is a permanent monitoring station in this grid, there may be no need to locate a saturation monitor.

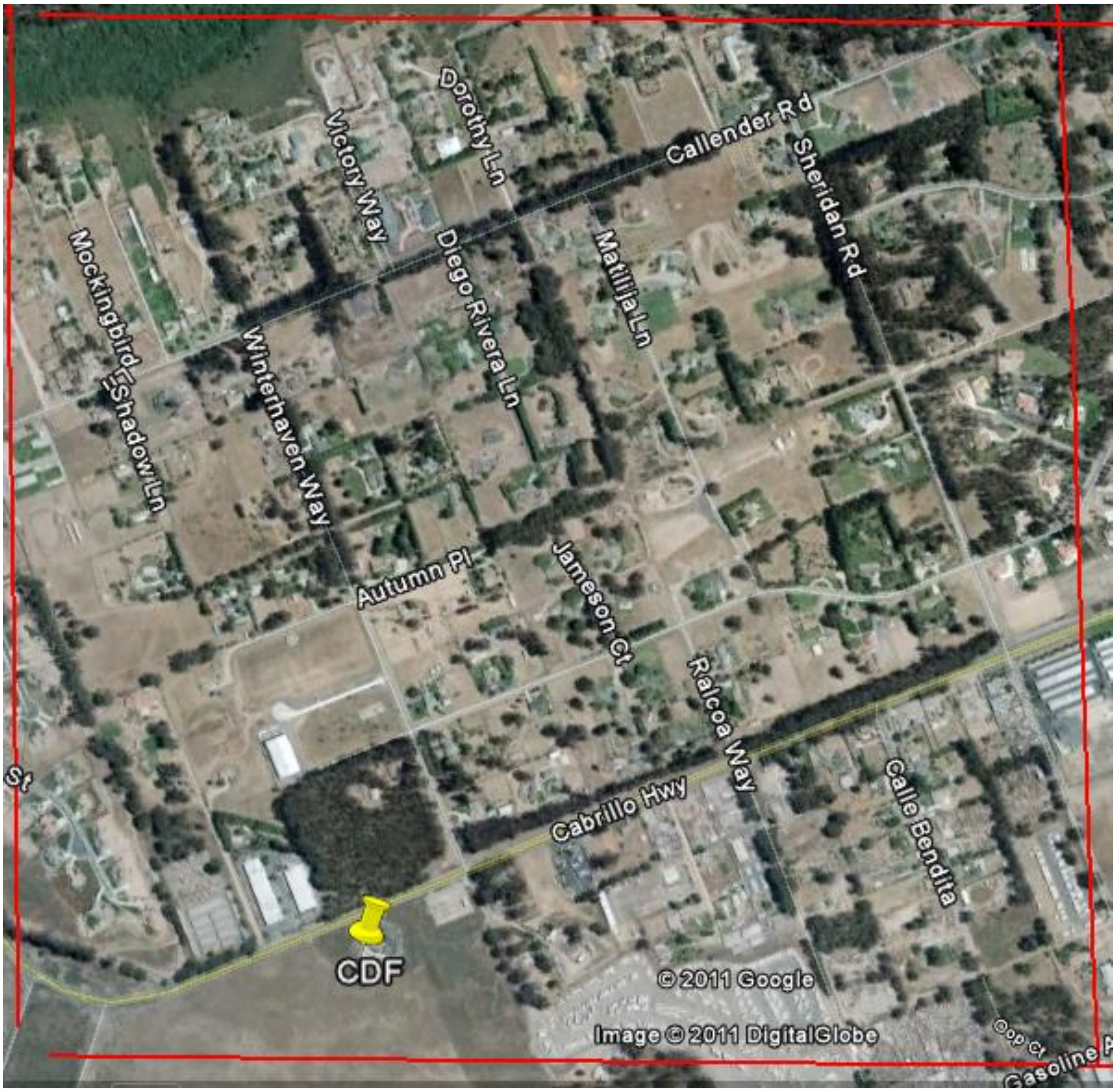


Figure 10 - Grid 8

This grid contains the District's CDF permanent monitoring station. The Phase 1 PM study had a monitor located on Calle Bendita that showed slightly lower concentrations than were measured at CDF. Even with the CDF monitor present in the grid, it would be advantageous to locate a monitor in the rural neighborhood north of the CDF site.

Figure 11 - Grid 9

This grid contains the location where the District's old Hillview site was located. Historical data from this site showed high concentrations of PM-10, but also appeared to be influenced by the dirt road running next to the monitoring site. This grid monitor should be located away from dirt roads and active agricultural operations to avoid the influence of local sources.

Figure 12 - Grid 10

This grid contains the northern portion of the Woodlands development. This residential development and the adjacent golf course is the preferred location for a monitor in this grid.

Figure 13 - Grid 11

The southwestern portion of this grid has the open area for the planned Woodland development that has yet to be built, with the exception of a few houses in the open area. Another area would be near the agricultural operations in the northern portion of this grid or the rural areas in the eastern area.

Figure 14 - Grid 12

The potential monitoring locations in this grid are the residential area in the north or non-active agricultural areas.

Figure 15 - Grid 13

This grid is just south of the grid with the Nipomo Regional Park (NRP) site. The NRP site is near the southern border of Grid 7, so it would be best to locate a monitor in the southerly portion of this grid.

Figure 16 - Grid 14

The predominant feature in this grid is the Woodlands development. Due to the population center of Woodlands and the concern of residents, a monitor should be located within the Woodlands development or the adjacent golf course. Care should be used to avoid any open un-vegetated areas yet to be developed as these areas could be localized windblown dust sources and areas downwind from eucalyptus trees.

Figure 17 - Grid 15

This grid is covered in many areas by thick dense vegetation that should be avoided. The best potential locations in this grid would be an open area in the rural neighborhoods of this grid or the extreme southern areas on the bluff overlooking the Santa Maria Valley.

Figure 18 - Grid 16

The western portion of this grid is densely vegetated and should be avoided. The only potential locations appear to be in the open areas of the rural neighborhood. Monitoring was performed in the Fall of 2011 at Lange Elementary School that is located on the eastern border of this grid. Data from Lange showed plume presence similar or slightly higher than at the Nipomo Regional Park permanent monitoring site.

Figure 19 - Grid 17

Lange Elementary School is located on the western border of this grid. Locating a site on the ridge overlooking the farmland would be a good location.

Figure 20 - Easterly Extent Grid

The best potential site location in this grid is the southern portion of the residential areas.

Figure 21 - Southerly Extent Grid

Most of this grid is composed of active agricultural fields. Locating a monitor in this location will require that the fields upwind of the location be planted to avoid the possibility of the upwind fields being a possible local source. Additionally, as the site is serviced, records will need to be maintained documenting that the upwind fields continue to be planted ensuring that they don't become a local source. The Bonita School was used as a monitoring site by Santa Barbara County APCD in the early 1990's. Wind data from the school site showed wind speeds significantly higher than measured at Mesa2.

Oceano Saturation Monitoring Area

Data from the Phase 2 monitoring site located at the Elks Lodge adjacent to Pier Avenue showed high 24 hour PM-10 concentrations on days with significant northwesterly wind events. Additionally, high values were also measured on days with calm winds. However, after analyzing the sample filters for chloride and subtracting out the contribution from sea salt, it was only days with high northwesterly wind events that recorded high 24 hour PM-10 values.

The region around the Oceano Saturation Monitoring Area is presented in Figure 22 below.

Figure 22 – Region Surrounding Oceano Saturation Area

District monitoring in the late Spring of 2011 at the Oceano Elementary School showed no detectable plume presence at the school. The plume of windblown dust appears to be present at high concentrations at the Phase 2 site on Pier Avenue, but undetectable less than a mile downwind at Oceano Elementary School. This suggests the possibility that the Phase 2 monitor was measuring a localized source in the area, possibly the sand tracked out onto Pier Avenue.

Monitoring locations in the Oceano Saturation Area should begin with a monitor at the same location as was used in the Phase 2 study at the Elks Lodge. Initially, two additional monitors could be deployed with one located to the south (Southerly #1) and one downwind (Downwind #1) as depicted in Figure 23 below. Note that the locations of these southerly and downwind monitors are only approximate; the exact location will need to be determined by availability as well as on site surveys. The Southerly #1 site will provide initial data demonstrating if the PM-10 concentration falls off quickly to the south of Pier Avenue. The Downwind #1 site will provide initial data demonstrating how far downwind from the Phase 2 site the plume of high concentration extends inland. After 5-10 strong wind events have been measured, the preliminary data will be evaluated and decisions on if moving any of the monitors is advantageous. Should the initial data show similarly high PM-10 concentration at either the Southerly #1 site and/or the Downwind #1 site as compared to the Phase 2 site, the two monitors could be moved to the Southerly #2 and Downwind #2 sites. Additionally, it may be advantageous to move one or more monitors in the dense residential areas adjacent to the beach to assess the levels of PM-10 present in this populated area in order to document the PM10 concentrations in the most populated portion of this area.

Figure 23 – Oceano Saturation Area and Potential Monitoring Sites

3.0 Monitor Siting Guidelines

These siting guidelines will assist in the selection of the approximately 20 specific monitoring locations that will be used for this study. The goal in siting the monitors in the populated area of the Nipomo Mesa, will be to select a location that is representative of the average particulate concentration of the surrounding area of approximately 1 square mile. The goal in siting the monitors in Oceano is to select monitoring locations that will help understand the source area/mechanism as well as the spatial extent of the area of high particulate concentration. Because the entire community of Oceano is approximately one square mile, the monitors' area of representativeness will be smaller than the monitors on the Nipomo Mesa.

EPA provides ample guidance for adequate siting criteria for locating an ambient air monitor. For this special purpose monitoring project, we are defining the guidelines based on EPA guidance and the manufacturer's recommendations, but with flexibility to accommodate the sampling needs according to the goals of this project. The proposed spatial distribution of the E-BAMs on the Nipomo Mesa is approximately 1 mile apart, and will aim to measure PM10 and meteorological conditions that are as representative as possible for the majority of the one square mile area covered by each monitor. For these reasons, it is appropriate to incorporate EPA 40CFR Appendix E guidelines for the middle scale (100 meters to 0.3 miles) and neighborhood scale (0.3 to 2.5 miles). The spatial distribution of the E-BAMs in Oceano will be much smaller, so the microscale to middle scale guidelines should be utilized for this portion of the project. In addition, for this project, the optimal location for ambient monitoring is where the E-BAM is near the breathing zone and based on EPA guidance if at all possible between 2-5 meters above ground level.

There are other practical considerations such as prevention of vandalism, security, accessibility, availability of electricity that should be noted when selecting final location for the sampler. Because previous studies have clearly demonstrated that windblown dust and sea salt are the overwhelming particulate sources in this area siting should focus on representative measurements of these sources. So while every attempt will be made to adhere to EPA guidance, it may be necessary for some monitors to be sited in locations that do not exactly meet the EPA criteria. For all locations whether or not the EPA criteria is met, the site conditions will be documented on the site evaluation checklist.

SAFETY NOTE: IF THE SAMPLER IS TO BE PLACED ABOVE GROUND LEVEL, THE SAMPLER MUST BE POSITIVELY SECURED TO PREVENT IT FROM FALLING. IF A SAMPLER IS DROPPED OR FALLS FROM HEIGHTS ABOVE 3 METERS, MET ONE RECOMMENDS HAVING THE SAMPLERS SENT BACK FOR RADIATION LEAK TESTING.

Spacing from Obstructions

In general, the E-BAM should be placed in an area free of obstructions; also, there must be unrestricted arc airflow of no less that than 270 degrees around the E-BAM. Under any circumstances, no part of the prevailing (northwesterly) wind direction should be obstructed.

If the E-BAM is placed within an enclosure, the sampler must be at least 2 meters away from wall(s), parapets, etc. The sampling inlet head must be at least 1 meter above the highest point of wall(s) or parapet.

Vegetation (trees or shrubs that protrude above the height of the sampler inlet) provide surfaces for particulate deposition and also restrict flow; therefore the sampler should be at least 20 meters away from the vegetation drip line and/or at a distance equivalent to two and half times the maximum height of the vegetation or the structure protrudes above the sampler inlet.

Spacing From Roads

In general, ambient monitors should be placed beyond the concentrated particle plume generated by the traffic. However, for this project attention must be paid not to be in the path of other potential sources like roads, chimneys, fire places, exhaust of any kind, boilers, combustion engines, air conditioners, dirt roads, etc. If the selected location is upwind of the road, the distance to the edge of the road should be greater than 5 meters. However, if the location is downwind of a road, the distance to the edge of the road should be no less than 20 meters. Under well documented circumstances flexibility will need to be utilized in siting monitors near roads. Considerations can be made based on the typical traffic count and whether the roadway is paved or not. It is important to remember that the windblown dust source is only present under high northwesterly winds and these same high winds will cause a dramatic decrease to near-roadway PM concentrations due to increase atmospheric mixing.

Other Considerations

The sampler is not to be placed in an unpaved area, unless there is sufficient material(s) in place to help with dust mitigation.

Site Evaluation

The attached form presented below as Figure 23 is used to summarize the applicable site conditions needed to evaluate, approve, or reject each potential monitoring location. In addition to prompting the evaluation of the most important site conditions, the form and attached photographs will be useful in evaluating the data from each monitoring site.

SITE EVALUATION CHECK LIST

Notes by:				Date:	
Grid #		Address:		Latitude:	
Site ID#		Contact Name:		Longitude :	

DESCRIPTION	NOTES		
Safe Access to Location: (Good, Excellent, Not Sure)			
Recommended EBAM Location: (ground, scaffold)			
Location's Ground Cover: (dirt, grass, asphalt, etc.)			
Wind Flow Arc: (270°, >270°, <270°)			
Height of Tallest Obstruction above proposed sampler inlet:		Describe:	
Distance from closest Vegetation(s):			
Distance from Closest Structure:			
Closest Traffic Description:		Road Type:	
Distance to Closest Edge of Road:		Traffic Count < 30,000 AADT:	
Identify Potential nearby PM Sources: Yes NO		Describe:	
Distance to Potential PM Source:			
Photos Taken of site and in the four cardinal directions?	YES/NO		
Site Recommended:	YES/NO		
Comments:			

Figure 23 – Site Evaluation Form

4.0 Sampler Operation and Quality Control Procedures

The specific details of sampler operation are contained in the SLO APCD Standard Operating Procedures (SOP) for MetOne E-BAM a sampler that is attached as Appendix A of this document. This SOP will be followed for the Community Monitoring Project.

The general protocol for sampler operation including quality control checks for this project is as follows:

Task	Interval
Review Data	Daily
Flow, Temp, Press Verification	Bi-Weekly
Confirm Operation of auxiliary sensors	Bi-Weekly
Review overall sampler set-up	Bi-Weekly
Clean Inlet and SCS if used	Monthly
Pump Test	Bi-Monthly
Replace Tape	Bi-Monthly
Clean inlet tube and cabinet	Semi-Annually
Perform Mass Calibration/Verification	Semi-Annually
Perform Full Calibration	Annually

The specific procedures for these tasks are presented in Appendix A.

The table below presents an approximate timeline for performing these checks for this project:

TASK	APPROXIMATE DATE PERFORMED	COMMENT
Initial Check out and Full Calibration of EBAM including Mass calibration, configuration and cleaning.	1/25/12 to 2/1/12	Performed at District Office
Install at Mesa2/NRP for Collocation. Perform verification and overall sampler checkout	2/1/12	Upon installation at Mesa2/NRP for QA comparison
Verifications, confirm operation of aux sensors	2/14/12	While Samplers are at Mesa2/NRP
Verification, clean inlet, and confirm overall operation	2/21/12	Just prior to shutdown
Verifications, confirm operation of aux sensors, overall sampler set up. Begin saturation monitoring.	3/1/12	Upon installation for saturation monitoring
Verifications, confirm operation of aux sensors, overall sampler set up, clean inlet, perform pump test and replace BAM tape	3/14/12	While sampler is installed for saturation sampling.

TASK	APPROXIMATE DATE PERFORMED	COMMENT
Verifications, confirm operation of aux sensors, overall sampler set up	3/28/12	While sampler is installed for saturation sampling.
Verifications, confirm operation of aux sensors, overall sampler set up, and clean inlet	4/11/12	While sampler is installed for saturation sampling.
Verifications, confirm operation of aux sensors, overall sampler set up	4/25/12	While sampler is installed for saturation sampling.
Verifications, confirm operation of aux sensors, overall sampler set up, perform pump test, clean inlet, and replace BAM tape	5/9/12	While sampler is installed for saturation sampling.
Verifications, confirm operation of aux sensors, overall sampler set up	5/23/12	While sampler is installed for saturation sampling.
Verifications, confirm operation of aux sensors, overall sampler set up. Perform Mass Calibration.	6/1/12	Just prior to shut down
Equipment shutdown calibration and sampler removal	6/1/12 to 6/5/12	Bring samplers and equipment to District office for final cleaning and EBAM reconfiguration for return to owner

In addition to performing the QC checks on the approximate schedule presented above, any time a verification QC check shows an out of tolerance condition or following a major repair of the sampler, a full calibration will be performed on the sampler.

The initial checkout and full calibration performed prior to deployment in the District laboratory will include operating all samplers for a few days and analyzing the data from each sampler to identify problems or issues such as noisy detectors or other sampling problems not identified in the initial evaluation and calibration of the samplers. Additionally, each sampler will be given a unique two digit sampler ID and this ID shall be input into the samplers memory following the procedure described in section 3.2 of the E-BAM SOP. Note that some samplers borrowed from other agencies may not allow changing the ID due to data acquisition issues, in these cases keep the original ID and ensure that no other sampler used for the project is configured with this ID. After each sampler has been assigned a unique ID, a listing of all samplers ID shall be entered into a spreadsheet that will be utilized to keep track of each sampler's location over the course of the project.

A paper form, presented below as Figure 24 will be attached to the inside of each E-BAM door and will be utilized to keep track of both the E-BAM location over the course of the project as well as QC checks. In addition to the records on Figure 24, the details and results of each check of the sampler will be documented on a paper form in the field that is later entered into a spreadsheet as described in the E-BAM SOP.

SAN LUIS OBISPO COUNTY APCD
COMMUNITY MONITORING PROJECT
EBAM RECORD OF LOCATION AND QUALITY CONTROL CHECKS

EBAM SAMPLER ID	

SAMPLER LOCATION		INSTALLATION		REMOVAL	
Street Name:		Date:		Date:	
Grid#		Time:		Time:	
Street Name:		Date:		Date:	
Grid#		Time:		Time:	
Street Name:		Date:		Date:	
Grid#		Time:		Time:	

QUALITY CONTROL VERIFICATIONS																
QC PERFORMED BY:																
QC ITEMS	**DATE**		**DATE**		**DATE**		**DATE**		**DATE**		**DATE**		**DATE**		**DATE**	
	As-is	Final	As-is	Final	As-is	Final	As-is	Final	As-is	Final	As-is	Final	As-is	Final	As-is	Final
LEAK CHECK																
SAMPLE FLOW																
AMB. TEMP.																
AMB. PRESS.																
WD 180˚ & AMB.																
WS 0 & AMB.																
VERTICAL																
PUMP TEST																
ERRORS DETECTED																

COMMENTS

ADDITIONAL QUALITY CONTROL								
QC PERFORMED BY:								
QC ITEMS	**DATE**	**DATE**	**DATE**	**DATE**	**DATE**	**DATE**	**DATE**	**DATE**
2-W SELF TEST								
4-W INLET CLEAN								
4-W CABINET CLEAN								
8-W TAPE CHANGE								
8-W CABINET CLEAN								
8-W MASS CALIB.								
#-W FULL CALIB.								
COMMENTS								

Figure 24 – Field Record of EBAM Location and QC checks

As mentioned in section 1 of this document, quartz tapes from samplers operated in the Oceano Saturation Area will have some of the tape deposits analyzed for chloride ion. In order to be able to accurately identify the specific deposition spot on the tape and relate it to the corresponding mass measurement performed by the E-BAM sampler, the quartz tape on all E-BAM samplers used for this project shall be annotated with site name as well as date and time. This annotation will be performed when a new quartz tape is installed, whenever the E-BAM sampler is visited, and when the quartz tape is removed. Exposed quartz tapes will be stored in the plastic bag and box from the original unexposed tape. The box will be labeled with the sampler ID, beginning date/time of tape, and ending date/time of the tape. Exposed tapes shall be stored in a designated location in the District laboratory at room temperature prior to selection of tapes to be analyzed. Annotating and storing tapes from all samplers will allow both the chloride analysis of selected portions of tapes from the Oceano Saturation area but visual inspection of tapes from all locations. Tape section to be analyzed shall be sent for analysis with the laboratory chain of custody form utilized by the analyzing laboratory.

In order to account for trace levels of chloride present in the quartz tape a series of field and trip blanks will be taken and analyzed by the laboratory. A field blank will be performed by replacing the E-BAM sampler's inlet with a HEPA filter and allowing the sampler to sample normal ambient air for at least 5 hours. The first 3 hours tape deposits will be discarded and one or more of the remaining tape deposits will be utilized as field blanks. Trip blanks will simply be portions of the quartz tape that were not sampled, but were present in the sampler while the sampler was deployed.

5.0 Project Quality Assurance and Methods Inter-Comparisons

Independent quality assurance oversight for this project will be performed by separate QC-staff of the San Luis Obispo County APCD. QC-staff will review all QC check documentation for accuracy as well as assuring that the procedures utilized follow those outlined in this document as well as the E-BAM SOP. In addition, QC-staff will review and approve the analysis of the methods inter-comparison between the E-BAM samplers and the federally approved monitoring method that will be performed at the District's Mesa2 and Nipomo Regional Park (NRP) monitoring stations prior to the saturation sampling, including approval of any correction factors to the data. And finally, QC-staff will review and approve the validation of all data utilized in the analysis of data for this project.

All E-BAM samplers utilized for this project will be operated adjacent to the District's Mesa2 or NRP monitoring stations for the approximate period of February 1, 2012 through February 21, 2012. This period of collocation of all E-BAM samplers with the Met One BAM 1020 (Federal Equivalent Method FEM) will establish the relationship between each E-BAM sampler and the FEM. This comparison will focus on the relationship between the two methods when dust events are being measured. The results of the comparison will be used to calculate correction factor(s) to E-BAM data to make the E-BAM data equivalent to the federally approved PM-10 method.

Initially two E-BAM samplers will be collocated at the NRP monitoring site with the remainder of E-BAM samplers collocated at the Mesa2 monitoring site. After sufficient wind events have occurred to see a consistent relationship between the monitors at the NRP and Mesa 2 sites, the two E-BAM samplers at NRP will be replaced with two samplers from the Mesa 2 monitoring site. Cycling of E-BAM samplers between the Mesa 2 site and the NRP site will be performed to establish a consistent relationship between the E-BAM monitors and the FEM monitors at both the Mesa2 and NRP monitoring locations.

6.0 Data Processing, Validation and Analysis

After the saturation sampling begins, as the raw data from the EBAM samplers is collected it will be reviewed in a routine basis seeking to assess normal instrumentation operation and to identifying and documenting values of concern. A more in depth data processing and validating will begin as soon as feasible and will continue as more EBAM data is retrieved. The data processing and validation steps are outlined below:

1) Validate sampler data using the results of QC checks, operational data from the EBAM data file and other documentation that describes sampler operation.
   a. Any data not bracketed by checks showing the sampler to be operating within allowable tolerance shall be invalidated. Should the data be bracketed by one valid check and a clear failure of the sampler that can be documented, the data is validated (up to the point of failure of the sampler) only if the analyst has no reason to question if the sampler was operating within tolerance just prior to the failure.
   b. Any data with a raw data file demonstrating that the sampler was operating outside allowable tolerances shall be invalidated.
   c. Any data that shows unrealistic or unusual values will be investigated and a determination made as to the likely validity of the data in question.
2) Apply any needed correction factor(s) identified in the methods comparison discussed in Section 5 of this document.

After thorough data analysis from the saturation monitoring that contains sufficient wind events has been validated, analysis of the relationship between the array of saturation monitors (and as well the permanent monitors) in the area will begin. This preliminary analysis will be utilized to:

1) Identify any monitoring locations that do not conform to the overall spatial distribution of particulates across the study area. Should these “outliers” be observed in the preliminary data analysis, an investigation will be made of those locations to try and understand the cause of the outlying data. If the cause is likely due to siting deficiencies, every attempt will be made to correct that deficiency and/or locate an additional monitor in a more suitable location.
2) Identify monitors that have served their purpose at the initial location to describe the plume and would better serve the overall study goals to be moved to a new location.
3) For the Oceano study area, determine if moving the southerly or downwind monitors farther to the south or downwind to help determine the extent of the plume.

As this “on the fly” analysis is being performed, some monitors may be moved to new site locations or additional spare monitors may be sited. See the discussion on adding/moving monitors in Section 2.0.

Following completion of the saturation monitoring and validation of the entire data set, the following analysis steps will be performed for the Nipomo Mesa saturation area sampler data:

1) Analyze the data to identify if different wind events produce significantly different spatial distribution of particulate concentrations. If possible, determine what factors cause the different distribution of particulate concentrations.

2) Explore the influence of factors other than the normal dispersion of particulates. For example, investigate the influence of dense groves of trees on wind speeds, and particulate concentrations.
3) Produce graphs of each sampler's data in relation to nearby permanent District particulate concentrations.
4) Produce plots of maximum particulate concentrations from each sampler and approximated isopleths on a map of the study area.

Following completion of the saturation monitoring and validation of the entire data set, the following analysis steps will be performed for the Oceano saturation area sampler data:

1) Calculate the sea salt contribution from chloride analysis performed on selected wind event periods from the Oceano monitoring area. Evaluate the sea salt data in relation to all wind event data, calculating the levels and variability of the sea salt contribution. If possible, calculate and apply a correction factor to all wind event PM-10 data from the Oceano study area that subtracts the approximate sea salt contribution from the total mass. Note this correction factor will only be utilized if the results of the sea salt measurements demonstrate a low variability of the salt concentration between the samples analyzed.
2) Perform an analysis of the data from the area to identify the typical spatial distribution, and spatial variability of PM-10 concentrations in the area.
3) Based on the analysis in step #2 above, attempt to determine the source or sources of the PM-10 impacting the area.

7.0 Final Report

Following analysis of data, a final report will be produced that summarizes the results of the project. This main body of the report will include:

1) Summary of Project and Study Design
2) Results of the data analysis (including graphs and plots)

    a. Discussion on how different wind events produce different spatial distribution of plume concentrations or if the data shows little difference between events.
    b. Discussion of any observations from the data on other factors influencing concentration distributions such as trees.
    c. Graphs of each saturation monitor in relation to nearby permanent monitor.
    d. Plots of data including isopleths.

3) Discussion on the major findings of the project.

The report will also have Appendices that include:

1) Documentation of the conditions at each monitoring site utilized for the project.
2) A summary of the analysis of the methods inter-comparison and any correction factors that were used in the project.
3) Summary of all QC checks and other sampler operation documentation from all samplers utilized for the project.
4) Complete listing of the validated data from each sampler used in the saturation monitoring portion of the study.

SOUTH COUNTY COMMUNITY MONITORING PROJECT

Appendix C – Nipomo Study Area 24 hour plots and Summary Data

This document presents spatial data displays of the 24 hour average PM_{10} concentrations for the Nipomo study area for each day of the study period where at least one site in that area exceeded the state 24 hour health standard of 50 ug/m3; the 24-hour averages were calculated from the hourly PM_{10} data measured at each site. For a 24 hour average to be valid, at least 20 of the 24 hours from that sampler must be valid (>80%). If a sampler's 24 hour value did not meet this validation criterion, the 24-hour average for that sampler is not shown and the site name/number at the top of the bar graph is replaced with OFF, indicating no data for that monitor. The scale for each bar graph is the same. Each segment represents 25 ug/m3, with a full scale reading equal to a 24 hour average of 175 ug/m3. Bar graphs for permanent monitors are presented in red.

Below each spatial data display is a table containing summary data from all permanent monitors in the area. The second row of the table presents the 24 hour PM_{10} average from the sites listed in the first row; PM_{10} is not measured at either the Grover Beach or S1 sites shown in the table, so only wind speed and wind direction data are presented for those sites. The third row presents the maximum hourly PM_{10} value for the day (no PM_{10} at Grover, S1). The fourth row presents the wind speed in miles per hour and the fifth row presents the corresponding wind direction, for the hour of the day where the maximum PM_{10} value was measured. For sites without PM_{10} (Grover, S1), the wind data presented is for the hour of the day where the maximum PM_{10} value was measured at CDF. The sixth row presents the average PM2.5/10 ratio for the day; this ratio is only calculated when the PM_{10} concentration is greater than 70 ug/m3 to allow examination of the ratio during dust events and exclude periods where measurements represent non-dust periods. The seventh row presents the PM2.5/10 ratio for the hour when the maximum PM_{10} value was recorded. The eighth row presents the number of hours with PM_{10} >70 ug/m3 that were used for the average PM2.5/10 ratio calculation.

To the right of the summary table is a text box with notes about any significant observations from the individual hourly data. Each day's dust event intensity is categorized using the following protocol:

Category	Criteria
Minor Event	Only one permanent monitoring site 24 hour average>50 ug/m3
Moderate Event	Two permanent monitoring sites 24 hour average>50 ug/m3, but both less than 100 ug/m3
Significant Event	Two permanent monitoring sites 24 hour average>50 ug/m3 and at least one>100 ug/m3
Very Significant Event	At least one permanent monitoring site 24 hour average>150 ug/m3

For some of the higher PM days or days with an unusual data pattern, a link to a video of the hourly spatial display is provided in the text box. To view the video, simply hold down the "ctrl" key and click the link; it is recommended for best viewing to select the full screen display on the video. The video can be stopped on any particular hour to examine the data for that hour, and specific hours can be selected to be displayed by moving the progress bar at the bottom of the video. ***Note that the scale on the PM_{10} bar graphs on the 24 hour plots is different than the hourly display on the video graphs. Each segment***

on the 24 hour bar graphs presented in this document below is 25 ug/m3, while each segment on the hourly bar graphs presented in the video links is 100 ug/m3.

Below is a table of URL's for each linked hourly spatial display video that can be manually entered into your internet browser to access the videos:

Spatial Display Hourly Video	URL
4/1/12	http://youtu.be/pghpRsUkNLg
4/4/12	http://youtu.be/I6a7RWnaV68
4/18/12	http://youtu.be/K7UKMpB6aac
4/19/12	http://youtu.be/iMBx8yb5s0I
4/28/12	http://youtu.be/JrSN1SURFBM
5/15/12	http://youtu.be/VP7TxuRWl0I
5/22/12	http://youtu.be/FyJecCEEeLc
5/23/12	http://youtu.be/NEFoarZPlOM
5/24/12	http://youtu.be/OVtE0HbDg4Y
5/25/12	http://youtu.be/GTWC6T4LrTk

Below is a guideline for interpreting the hourly spatial display when viewing a video link:

1) *Bar Graph presents hourly PM-$_{10}$ concentration with each segment of graph=100ug/m3, full scale=500ug/m3*
2) *Circle "pie graph" presents hourly wind data. Ignore the north segment; wind direction is from other segment toward center. Wind speed in mph is presented as text below each circle.*
3) *Approximate location of monitors configured with wind sensors is the center of circle. Approximate location of monitors without wind sensors (and therefore without circle graph) is the bottom of bar graph.*
4) *Red Monitors are District/State Parks permanent monitors with wind sensors at 10 meter height.*
5) *Black Monitors are temporary EBAM monitors with wind sensors at approximately 2 meters to 5 meters height.*
6) *If a monitor's PM_{10} value is invalid or offline for the hour presented, "OFF" will be present at top of bar graph. For hours with valid PM_{10} values, the site name/number is presented on the top of the bar graph.*
7) *If a monitor's wind data is invalid or offline for the hour presented, Circle graph will not be presented and #Value will appear where the wind speed is normally located.*

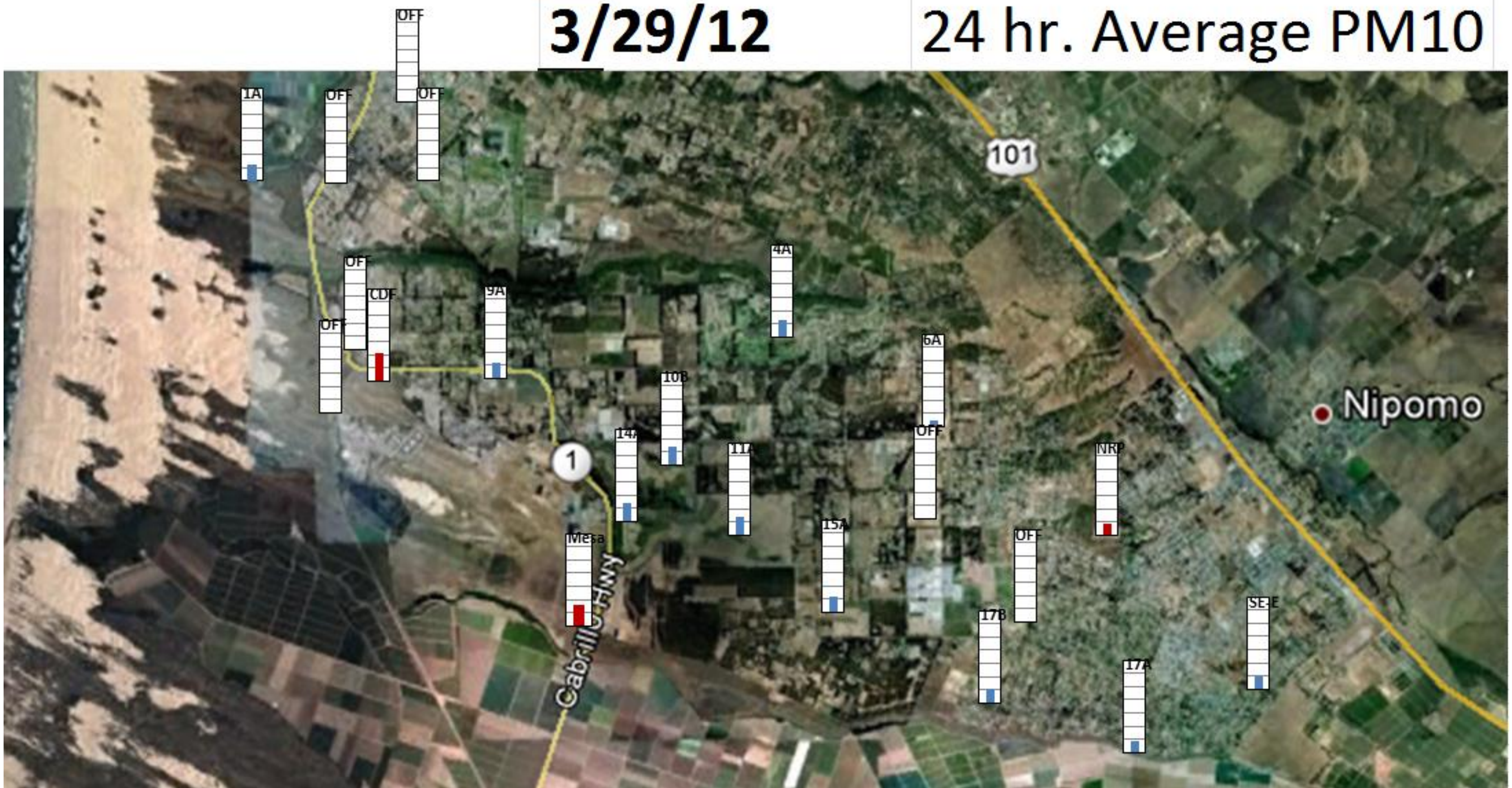
As discussed above, presented below are the spatial data displays of the 24 hour average PM_{10} concentration at each monitoring site in the Nipomo study area for each day of the project where at least one site in that area exceeded the state 24 hour health standard of 50 ug/m3. Each line on the bar graphs shown in the figures represents 25 ug/m3, with a full scale reading equal to a 24 hour average of 175 ug/m3. For reference purposes, the bar graphs for the 3 APCD permanent monitoring sites (CDF, Mesa2 and NRP) are colored red, and the bar graphs for each temporary project site are in blue.

3/19/12 24 hr. Average PM10

DATE	3/19/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		56.3	30.1		20.6	21.3
Hr. Max	PM10		279.0	166.0		92.0	86.0
at Max	WS	16.3	15.5	19.7	27.3	9.9	8.1
at Max	WD	296.0	306.0	303.0	293.8	277.0	290.0
Average	2.5/10 ratio		13.8%	16.8%			17.3%
at Max	2.5/10 ratio		12.9%	17.5%			22.1%
Count	2.5/10 ratio		5	4			2

Minor event. CDF is the only site over state standard.

3/29/12 24 hr. Average PM10

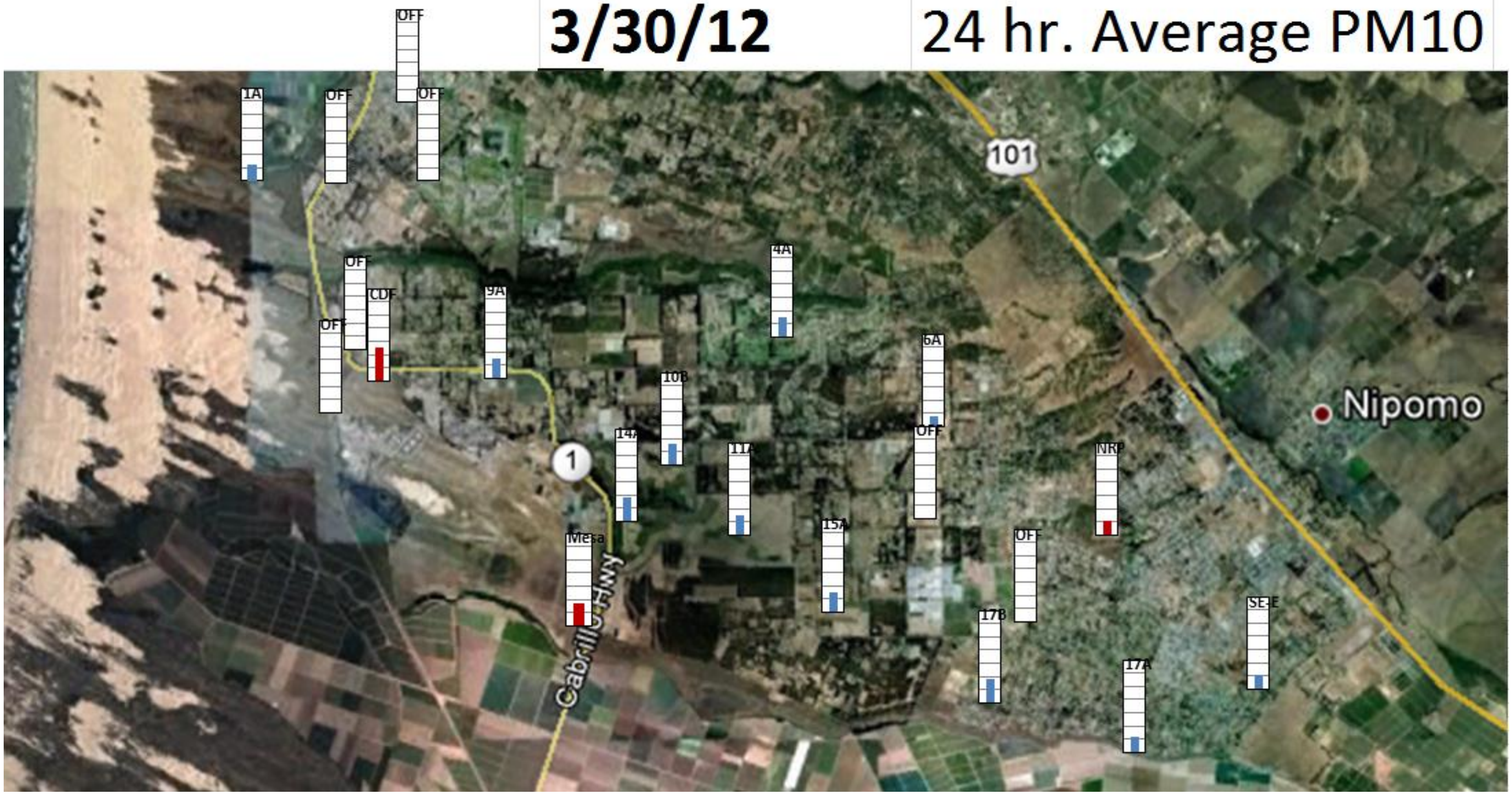


DATE	3/29/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		54.3	39.5		22.8	20.5
Hr. Max	PM10		242.0	189.0		59.0	39.0
at Max	WS	9.5	12.1	14.2	21.8	7.5	8.5
at Max	WD	289.0	309.0	312.0	289.5	273.0	279.0
Average	2.5/10 ratio		17.7%	18.1%			#DIV/0!
at Max	2.5/10 ratio		18.6%	19.6%			0.0%
Count	2.5/10 ratio		5	5			0

Minor event. CDF is the only site over state standard.

3/30/12

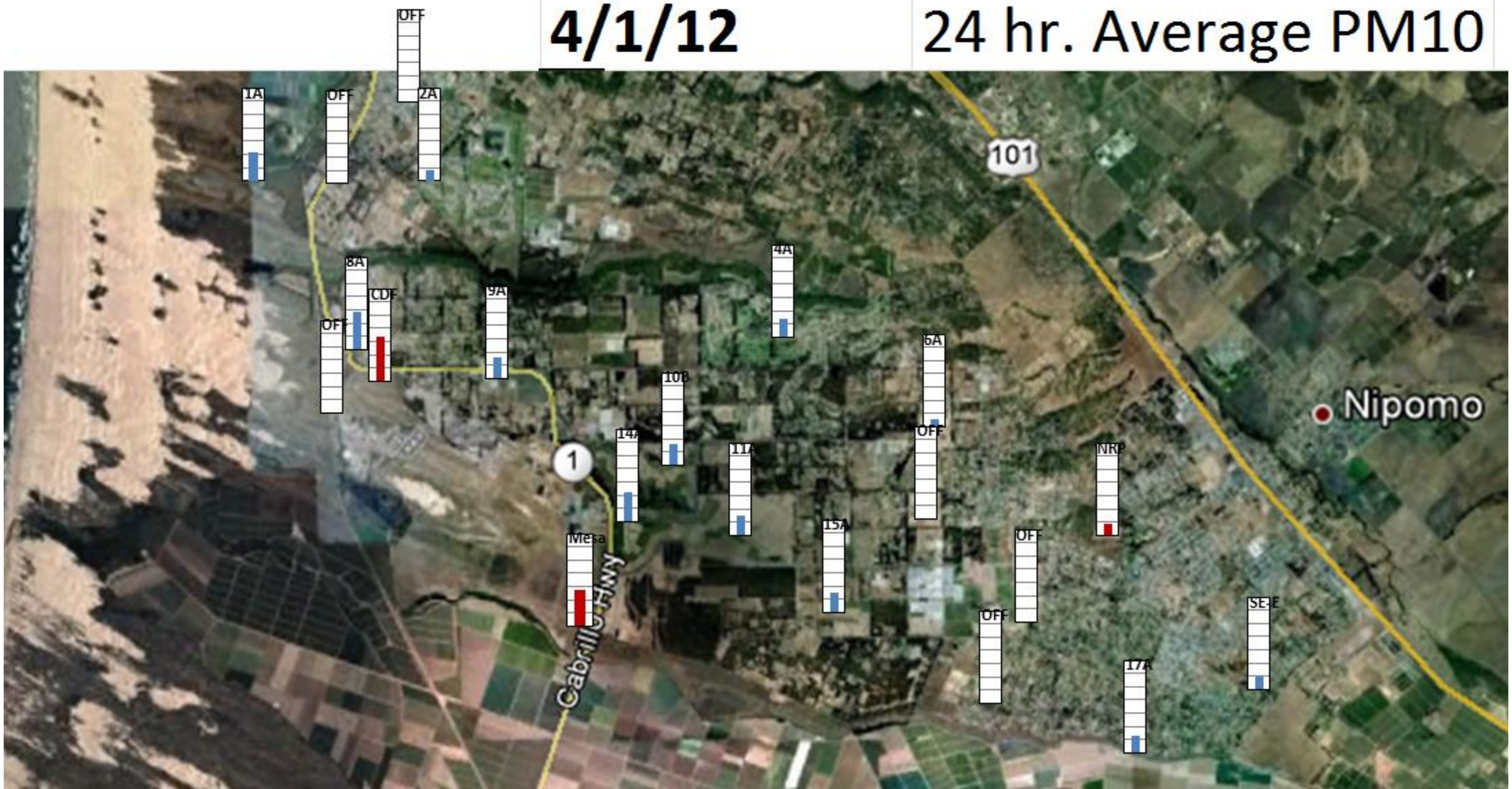
24 hr. Average PM10



DATE	3/30/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		64.0	42.8		27.7	19.7
Hr. Max	PM10		303.0	218.0		90.0	44.0
at Max	WS	11.4	14.6	15.2	25.8	7.0	11.4
at Max	WD	289.0	311.0	303.0	289.0	272.0	278.0
Average	2.5/10 ratio		20.1%	19.0%			#DIV/0!
at Max	2.5/10 ratio		19.1%	17.0%			0.0%
Count	2.5/10 ratio		6	4			0

Minor event. CDF is the only site over state standard.

4/1/12 24 hr. Average PM10

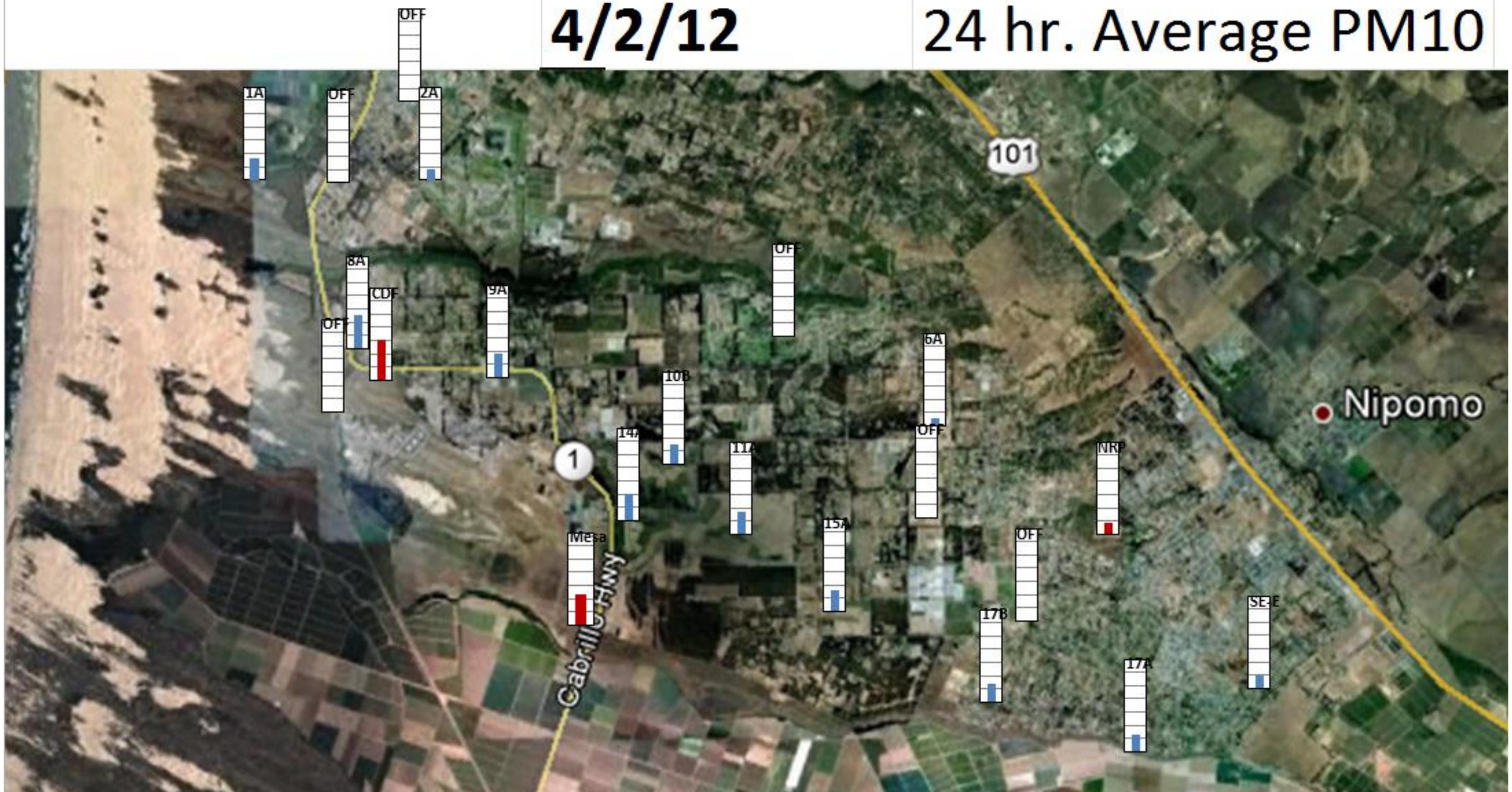


DATE	4/1/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		83.8	68.0		22.4	36.4
Hr. Max	PM10		410.0	296.0		59.0	134.0
at Max	WS	14.3	17.2	22.9	31.4	7.1	9.0
at Max	WD	298.0	306.0	304.0	294.5	307.0	313.0
Average	2.5/10 ratio		15.3%	16.3%			22.9%
at Max	2.5/10 ratio		14.4%	15.9%			24.7%
Count	2.5/10 ratio		7	7			4

Moderate Event. Winds more northerly inland resulting in impacts in Santa Maria.

Video Link for 4/1/12 hourly spatial display

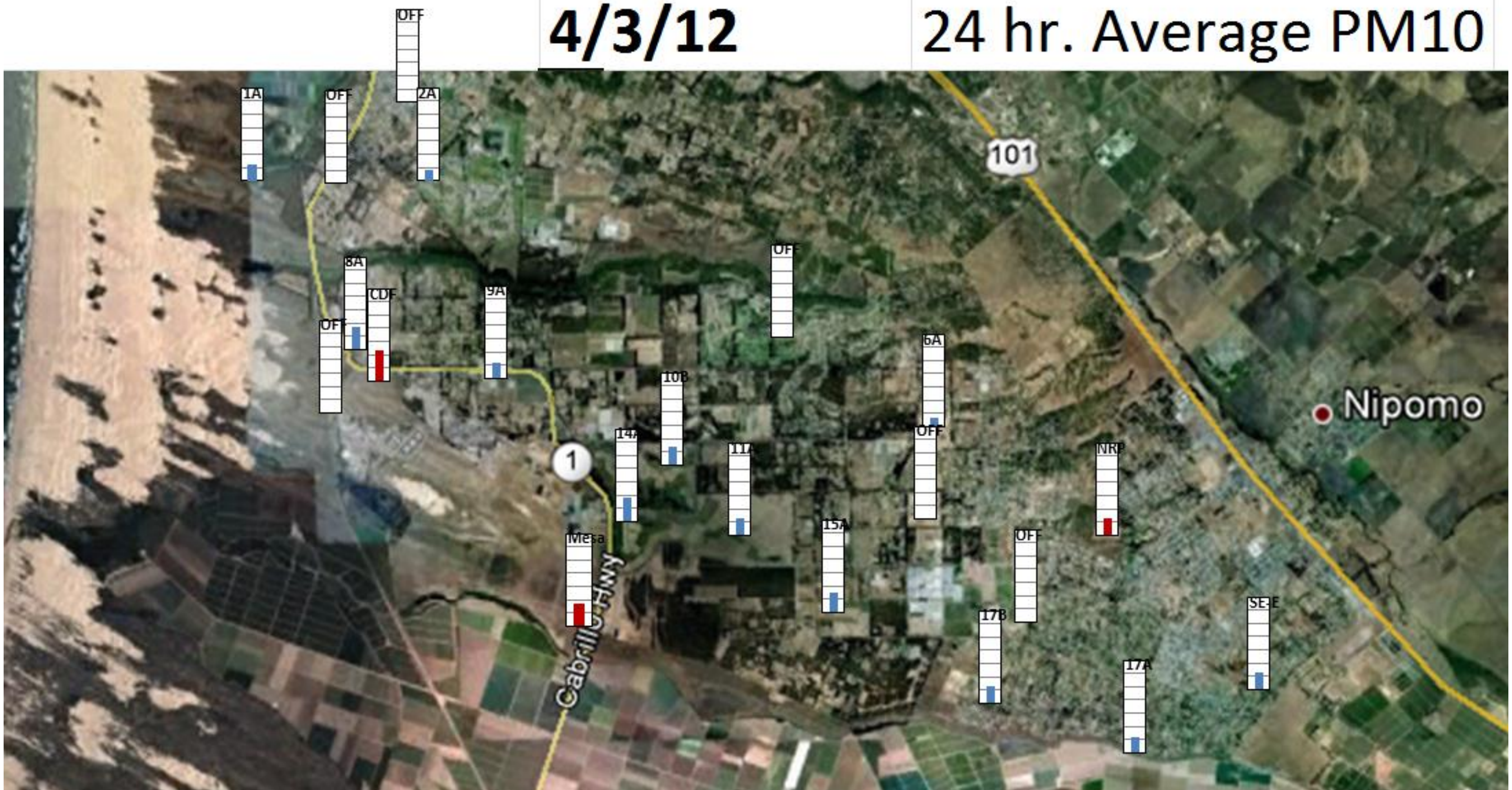
4/2/12 24 hr. Average PM10



DATE	4/2/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		76.0	58.0		22.0	27.4
Hr. Max	PM10		427.0	307.0		166.0	72.0
at Max	WS	8.1	12.9	15.0	25.7	8.0	10.1
at Max	WD	345.0	304.0	298.0	290.3	277.0	275.0
Average	2.5/10 ratio		20.4%	20.3%			25.0%
at Max	2.5/10 ratio		19.9%	18.6%			25.0%
Count	2.5/10 ratio		6	5			1

Moderate Event. Winds inland at beginning of event northerly, no impacts in vicinity of NRP. Hour 15, NRP winds shift due west, significant impacts at NRP measured. Hour 16, winds at NRP shift back to NW and levels drop at NRP.

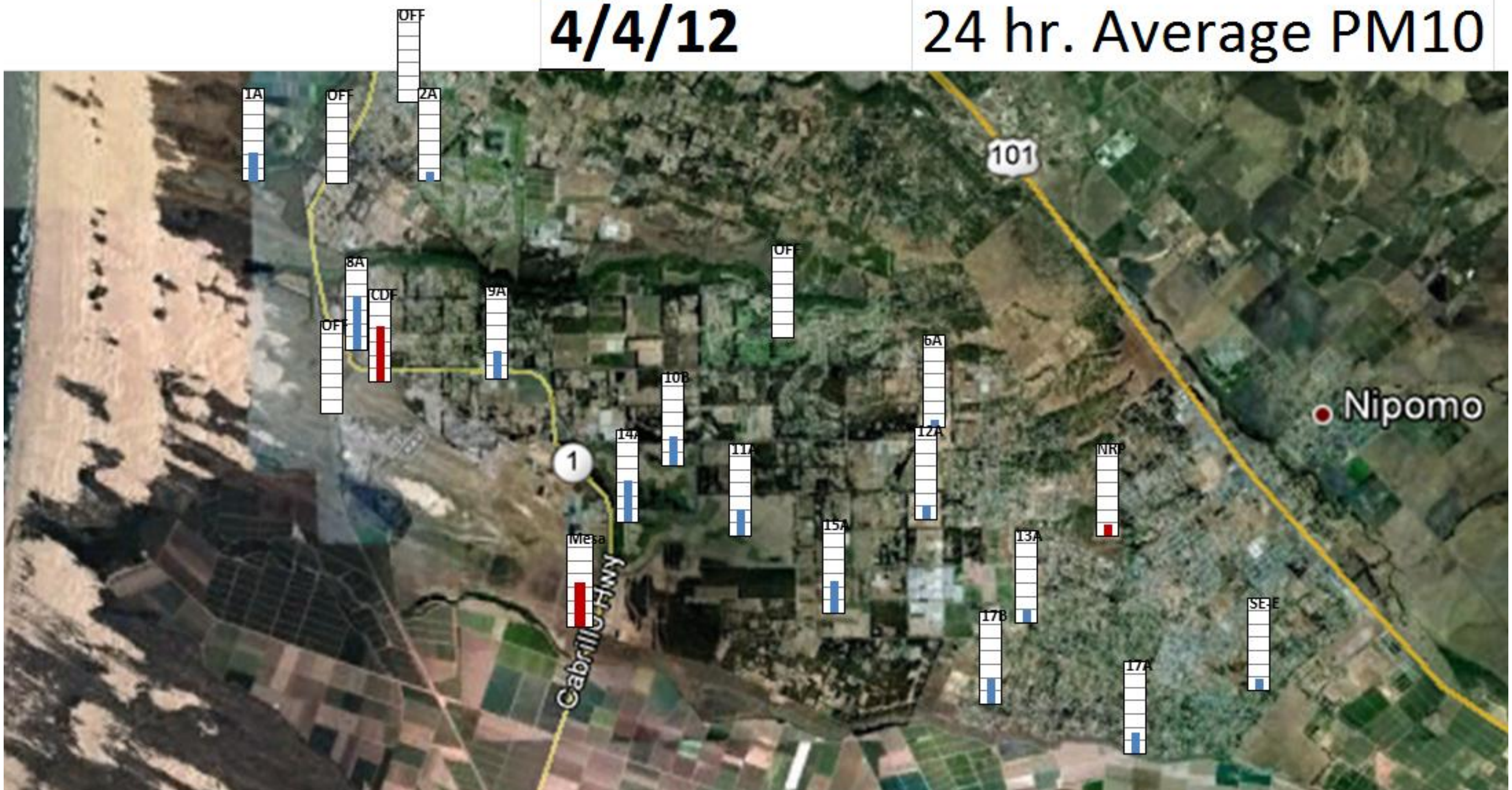
4/3/12 24 hr. Average PM10



DATE	4/3/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		57.1	43.9		32.3	32.7
Hr. Max	PM10		197.0	150.0		93.0	46.0
at Max	WS	9.0	11.3	11.1	20.7	5.8	2.0
at Max	WD	292.0	308.0	311.0	288.6	264.0	175.0
Average	2.5/10 ratio		20.0%	21.5%			#DIV/0!
at Max	2.5/10 ratio		21.3%	20.7%			0.0%
Count	2.5/10 ratio		6	5			0

Minor Event.

4/4/12 24 hr. Average PM10

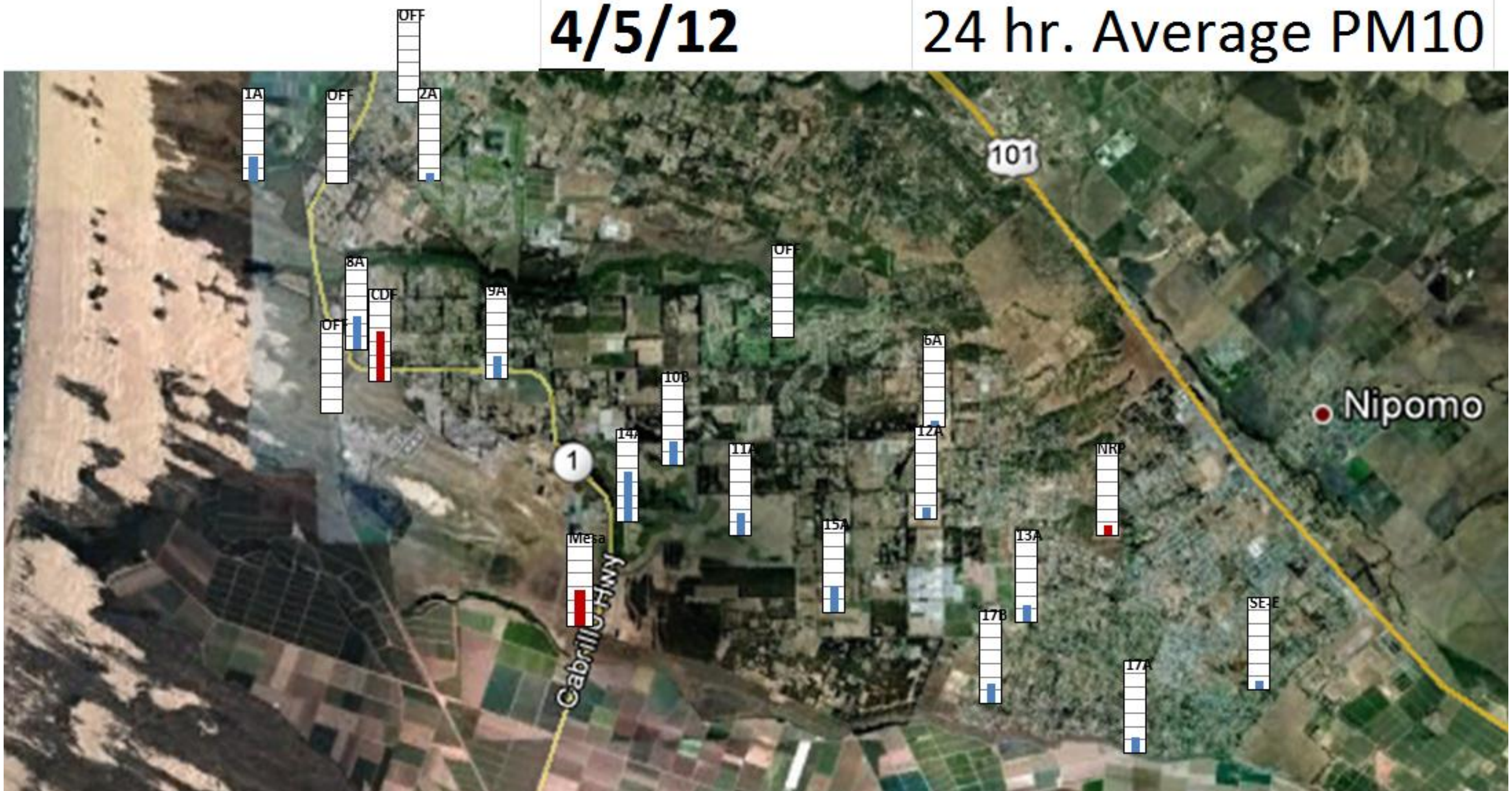


DATE	4/4/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		105.6	85.4		22.5	55.3
Hr. Max	PM10		545.0	378.0		62.0	215.0
at Max	WS	12.1	16.0	23.2	29.7	9.3	14.3
at Max	WD	300.0	307.0	313.0	295.1	297.0	292.0
Average	2.5/10 ratio		18.5%	20.2%			18.8%
at Max	2.5/10 ratio		19.4%	19.0%			23.3%
Count	2.5/10 ratio		6	6			7

Significant Event. Winds shift more and more northerly as event progresses. The northerly shift pushes plume south resulting in significant impacts in Santa Maria.

Video Link for 4/4/12 hourly spatial display

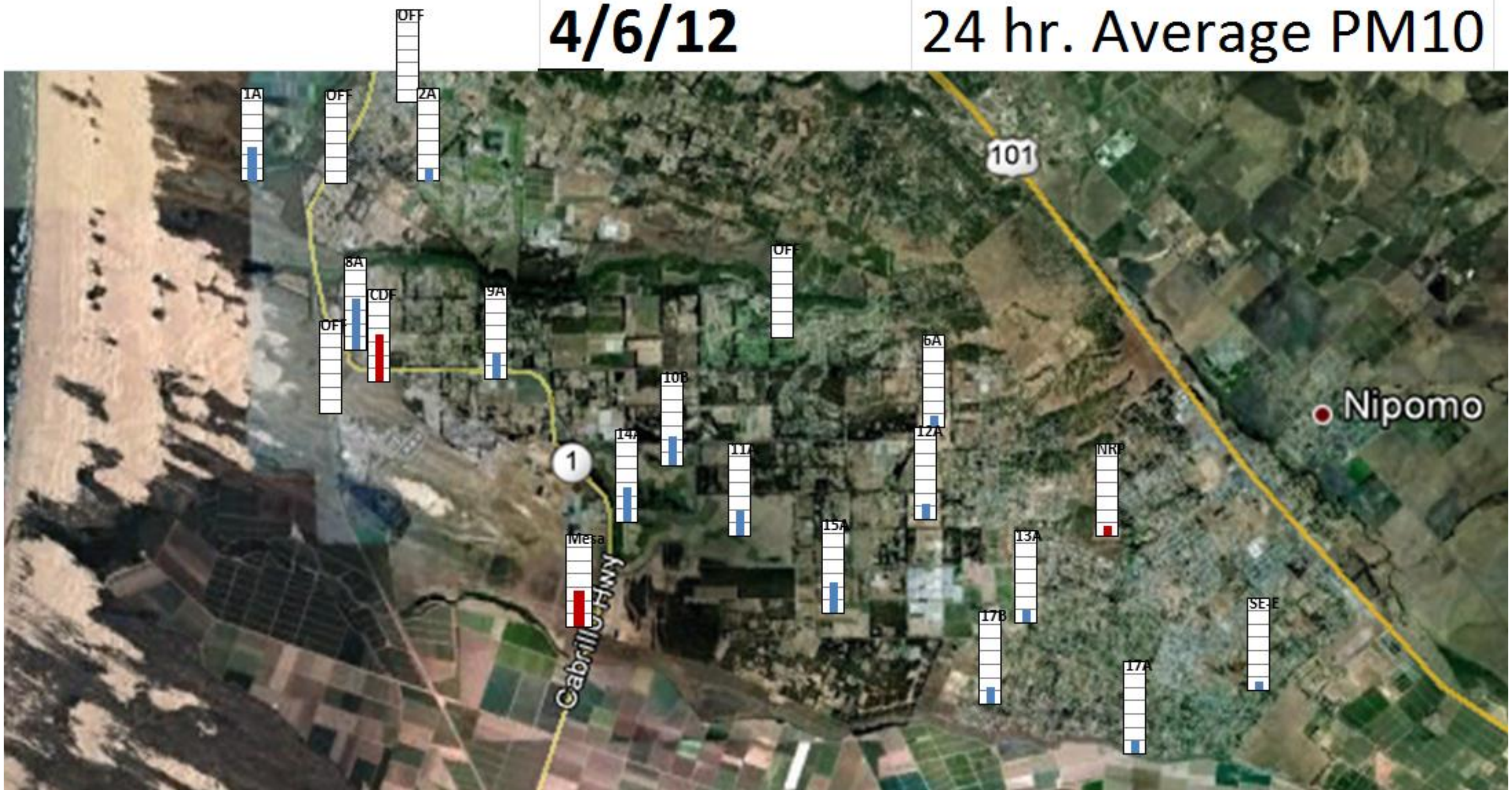
4/5/12 24 hr. Average PM10



DATE	4/5/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		94.5	69.0		18.9	41.8
Hr. Max	PM10		466.0	299.0		72.0	129.0
at Max	WS	13.8	18.1	24.5	30.6	10.1	14.1
at Max	WD	291.0	305.0	302.0	294.7	293.0	298.0
Average	2.5/10 ratio		18.8%	20.6%			17.2%
at Max	2.5/10 ratio		18.5%	18.1%			22.5%
Count	2.5/10 ratio		8	8			6

Moderate Event. Possible local influence to 14A from ag. operations upwind, or is it just in plume centerline? When winds shift more north on hour 15 14A approaches Mesa2 reading.

4/6/12 24 hr. Average PM10



DATE	4/6/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		90.0	67.5		18.4	32.5
Hr. Max	PM10		499.0	342.0		86.0	132.0
at Max	WS	8.0	14.3	18.2	27.5	5.1	8.3
at Max	WD	337.0	307.0	305.0	294.2	306.0	270.0
Average	2.5/10 ratio		19.8%	20.5%			17.1%
at Max	2.5/10 ratio		20.8%	19.9%			19.7%
Count	2.5/10 ratio		7	7			4

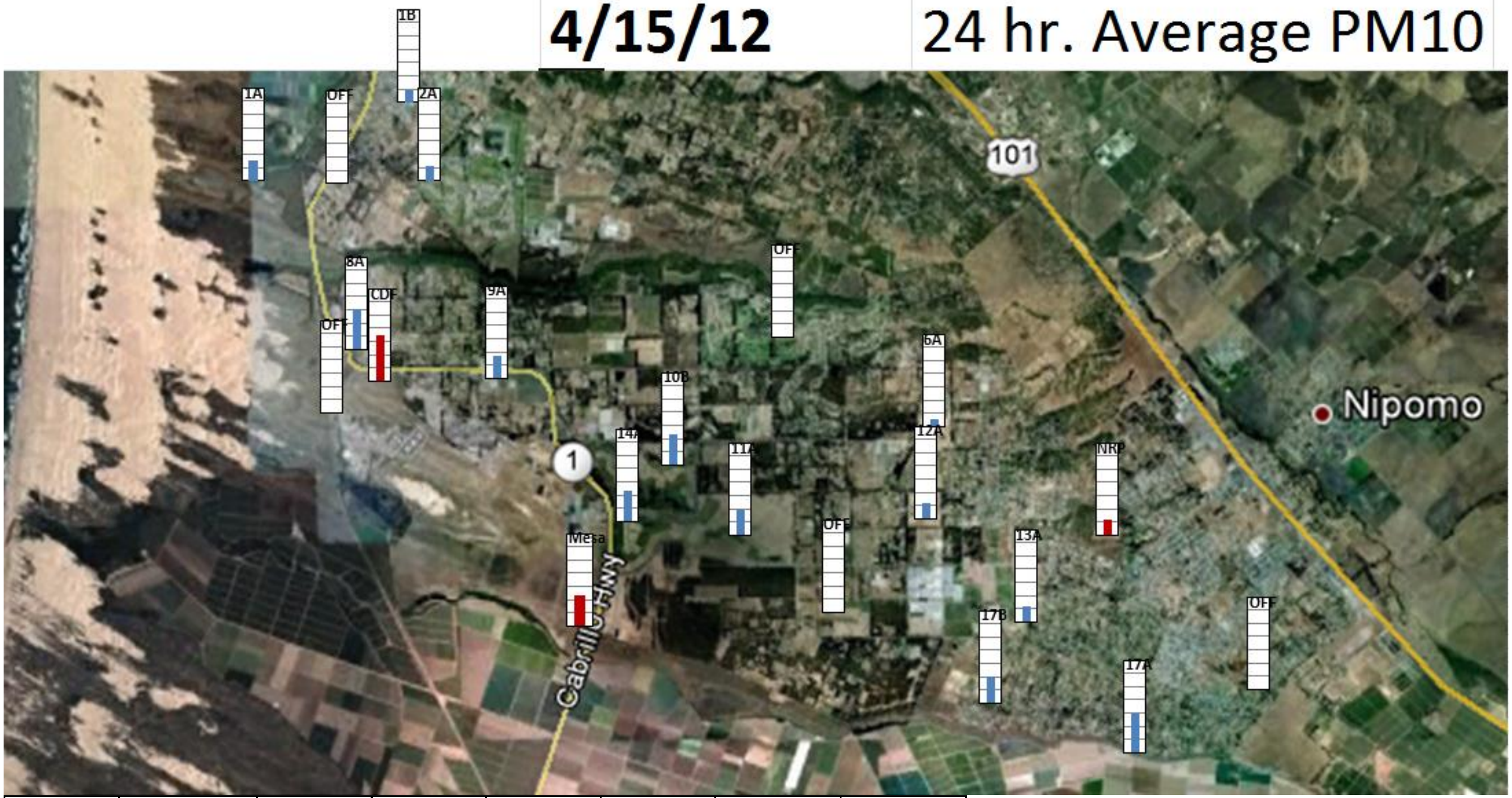
Moderate Event. Unusual spike in data at 10B on hour 5 with low winds at the time. Significant Impacts at 6A and other sites in region on hour 15 as winds shift from NE to NNW.

4/14/12 24 hr. Average PM10

DATE	4/14/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		102.5	54.0		28.5	28.1
Hr. Max	PM10		368.0	185.0		78.0	57.0
at Max	WS	16.1	15.9	20.8	28.4	9.0	9.6
at Max	WD	283.0	302.0	301.0	293.4	285.0	283.0
Average	2.5/10 ratio		14.6%	17.4%			#DIV/0!
at Max	2.5/10 ratio		14.9%	15.7%			0.0%
Count	2.5/10 ratio		7	7			0

Significant Event. Event begins earlier than most (Hr. 11).

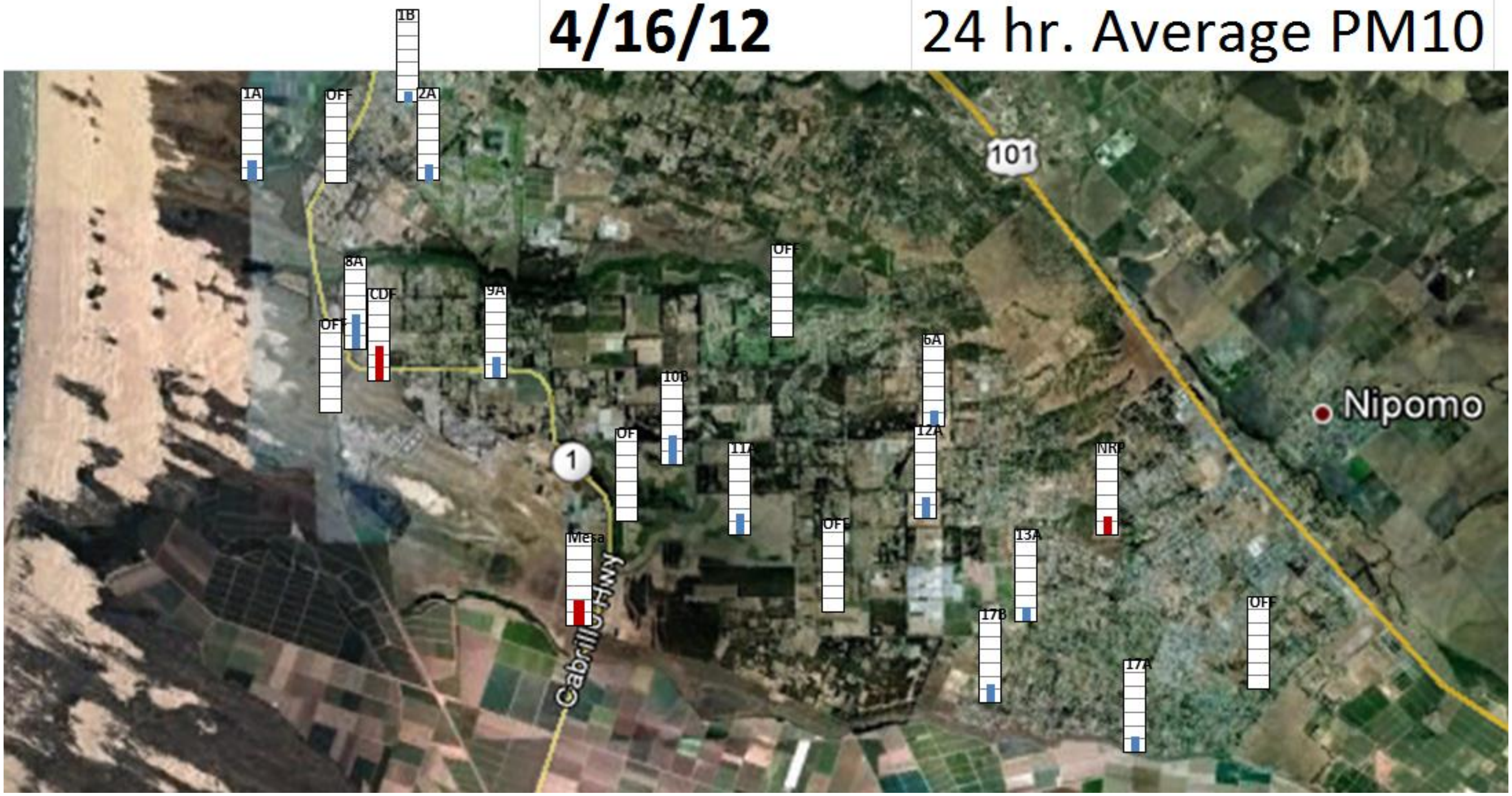
4/15/12 24 hr. Average PM10



DATE	4/15/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		86.5	59.2		29.9	23.5
Hr. Max	PM10		387.0	227.0		158.0	36.0
at Max	WS	15.7	12.7	13.8	25.4	7.2	11.9
at Max	WD	274.0	305.0	309.0	289.4	272.0	283.0
Average	2.5/10 ratio		18.0%	20.8%			#DIV/0!
at Max	2.5/10 ratio		18.3%	21.1%			0.0%
Count	2.5/10 ratio		7	7			0

Moderate Event. Inland winds out of west, resulting in impacts in the vicinity of NRP. Hour 15, winds shift northward, shifting plume to the south.

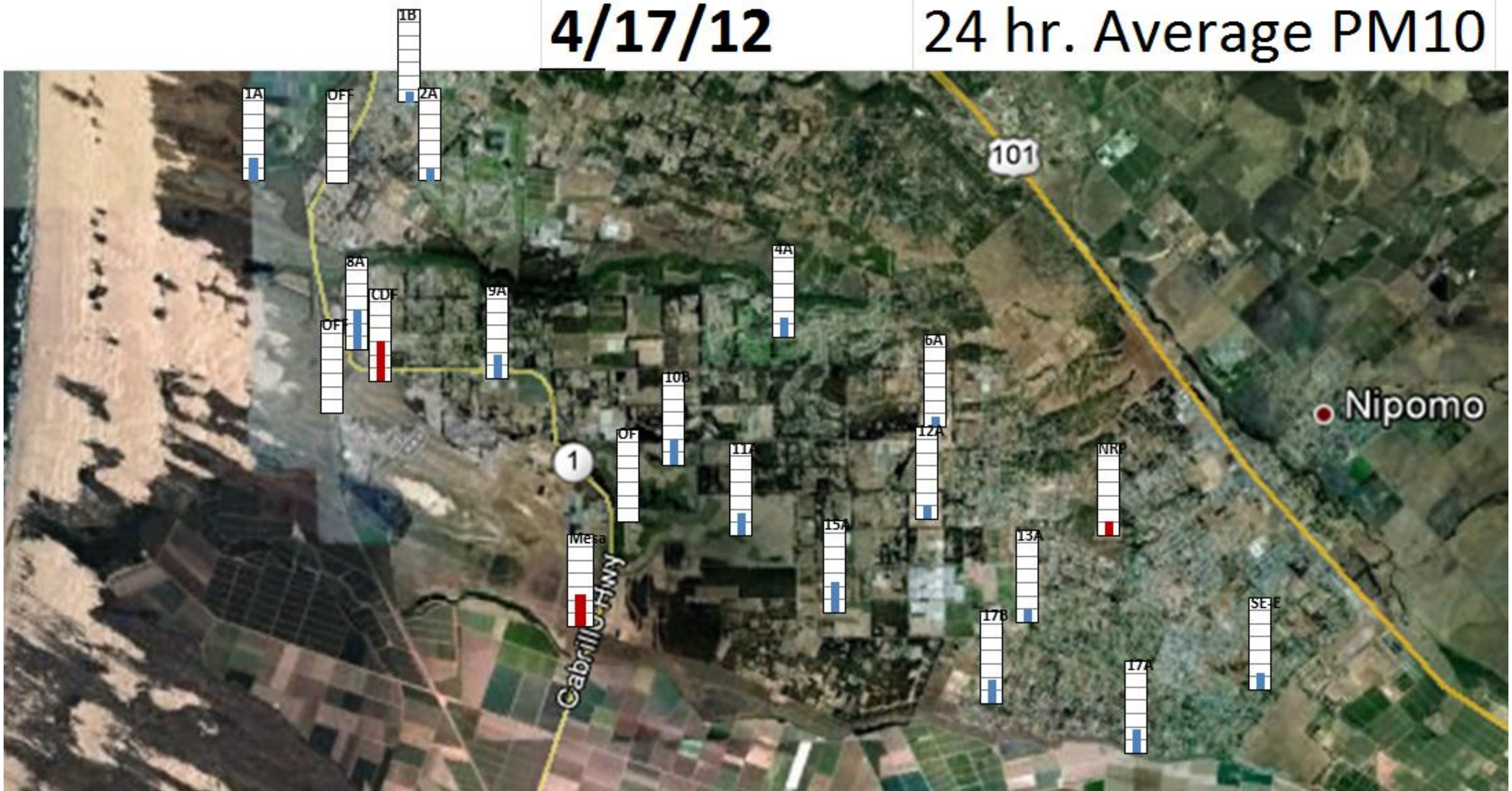
4/16/12 24 hr. Average PM10



DATE	4/16/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		67.3	48.3		35.7	27.7
Hr. Max	PM10		296.0	204.0		133.0	44.0
at Max	WS	8.2	9.4	13.3	25.1	7.2	4.7
at Max	WD	310.0	319.0	300.0	289.7	270.0	297.0
Average	2.5/10 ratio		23.3%	24.6%			#DIV/0!
at Max	2.5/10 ratio		22.0%	21.6%			0.0%
Count	2.5/10 ratio		6	5			0

Minor Event. Consistent westerly winds result in increased impacts in northeastern portion of study area.

4/17/12 24 hr. Average PM10



DATE	4/17/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		77.4	60.1		27.2	28.6
Hr. Max	PM10		333.0	265.0		85.0	62.0
at Max	WS	9.9	11.2	15.6	24.5	7.0	11.2
at Max	WD	301.0	323.0	318.0	291.0	282.0	281.0
Average	2.5/10 ratio		#DIV/0!	24.0%			#DIV/0!
at Max	2.5/10 ratio			25.7%			0.0%
Count	2.5/10 ratio		0	6			0

Moderate Event. Missing hours at Mesa2 and CDF due to maintenance.

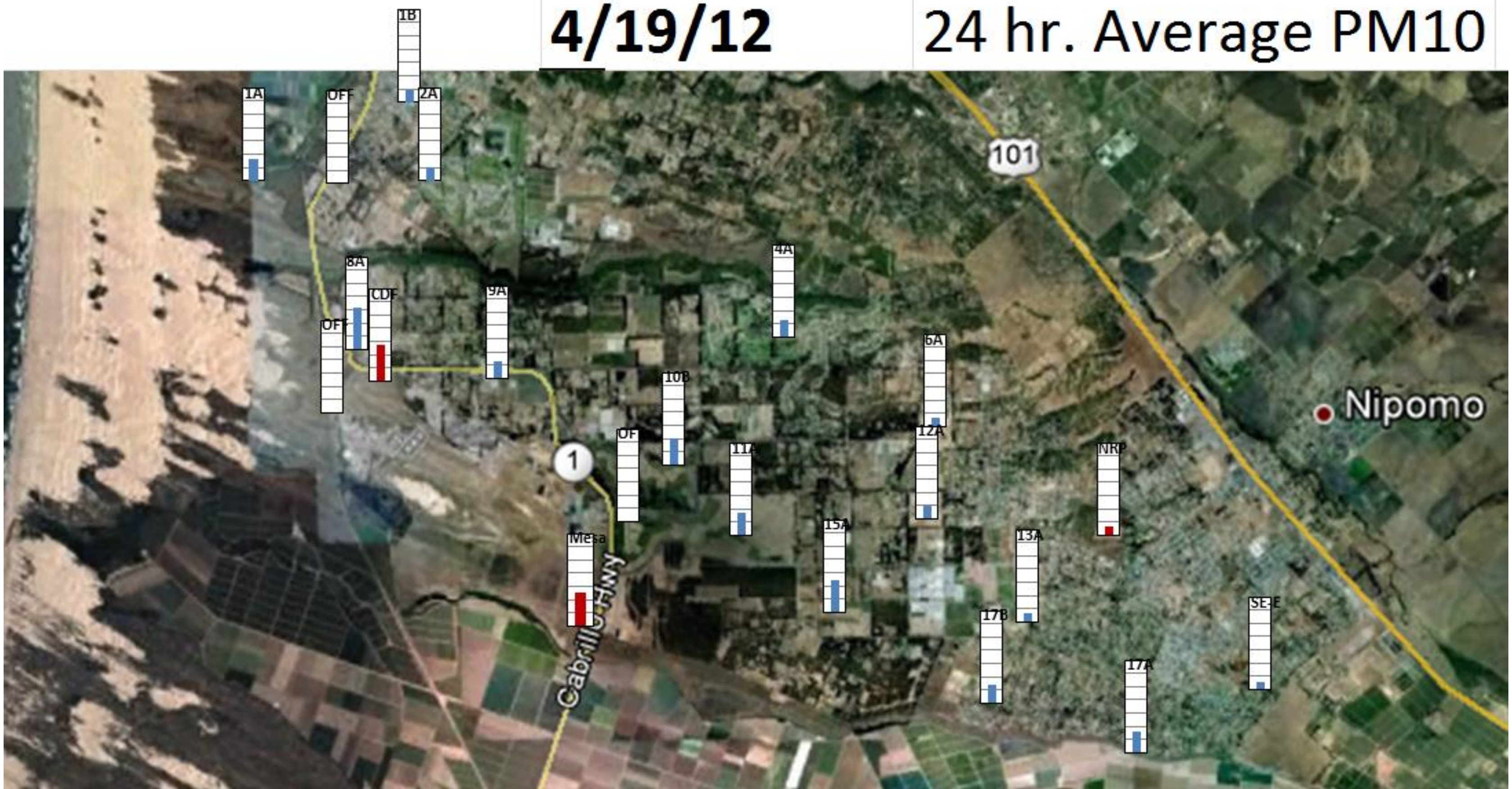
4/18/12 24 hr. Average PM10

DATE	4/18/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		90.8	76.3		28.8	33.5
Hr. Max	PM10		480.0	427.0		76.0	91.0
at Max	WS	11.5	13.9	17.8	27.6	8.6	10.5
at Max	WD	296.0	315.0	317.0	293.7	304.0	272.0
Average	2.5/10 ratio		23.0%	23.1%			26.2%
at Max	2.5/10 ratio		21.0%	21.5%			29.7%
Count	2.5/10 ratio		7	7			2

Moderate Event. Wind shift at hour 15 pushes plume to south. Hour 11 at S-E influenced by local activity on roadway, as observed by staff and obvious in data (data from S-E not presented as does not meet representativeness for 24 hour sample)

Video link for 4/18/12 hourly spatial display

4/19/12 24 hr. Average PM10



DATE	4/19/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10	[redacted]	69.8	63.5	[redacted]	16.8	31.4
Hr. Max	PM10	[redacted]	248.0	222.0	[redacted]	66.0	66.0
at Max	WS	8.8	10.2	12.0	23.0	1.8	9.9
at Max	WD	291.0	308.0	307.0	292.6	289.0	282.0
Average	2.5/10 ratio	[redacted]	22.5%	26.5%	[redacted]		#DIV/0!
at Max	2.5/10 ratio	[redacted]	25.0%	26.1%	[redacted]		0.0%
Count	2.5/10 ratio	[redacted]	8	6	[redacted]		0

Moderate Event. Early in event winds out of east for 6A, 13A, and NRP. Hour 12 winds in this region shift to westerly, impacts in this region present, Hour 13 winds in this area shift north and no impacts.

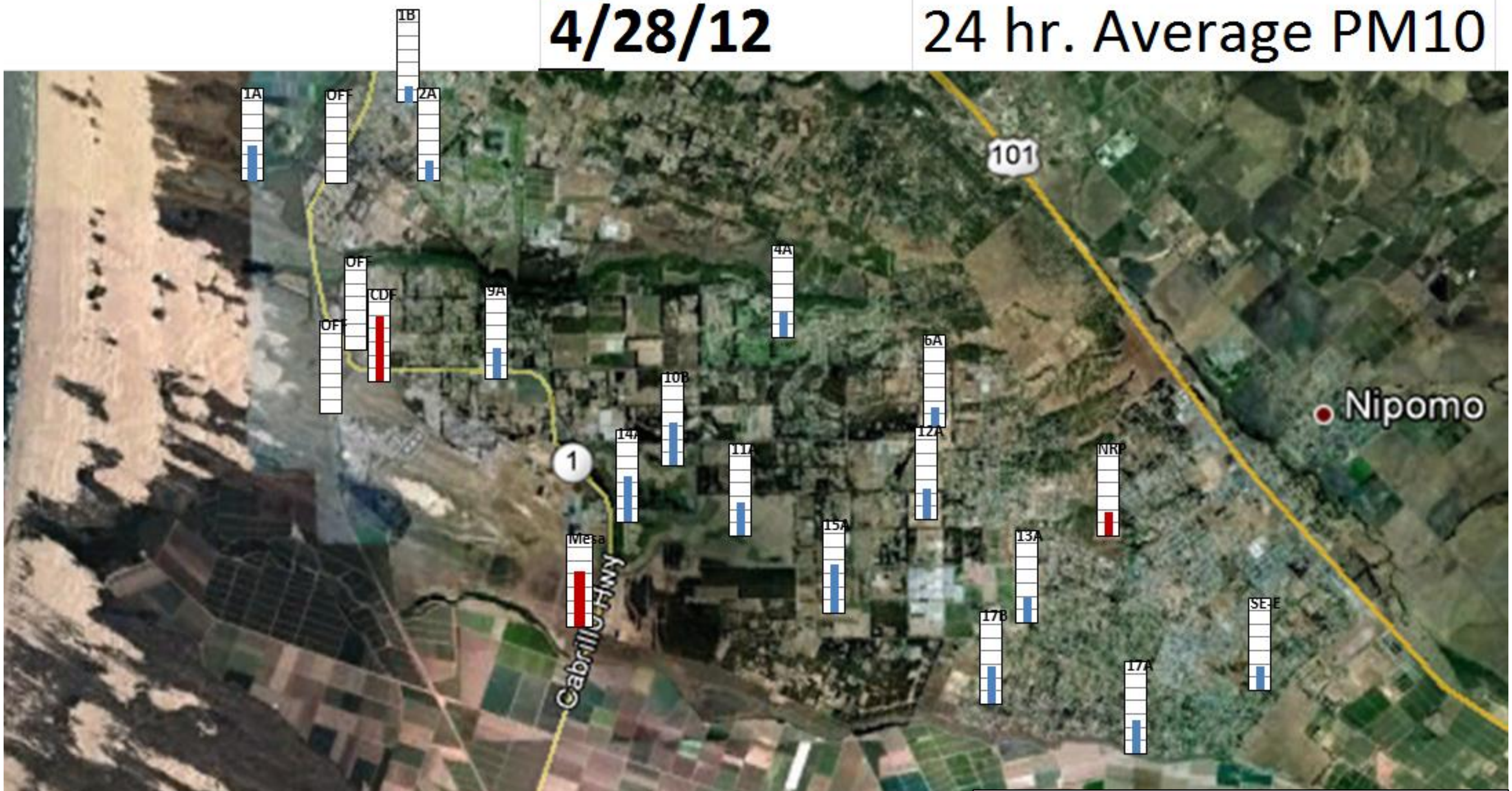
Video link for 4/19/12 hourly spatial display

4/27/12 24 hr. Average PM10

DATE	4/27/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		102.5	72.5		20.2	49.5
Hr. Max	PM10		471.0	342.0		73.0	228.0
at Max	WS	11.0	16.8	21.8	28.4	5.1	12.5
at Max	WD	307.0	306.0	312.0	295.5	302.0	287.0
Average	2.5/10 ratio		17.6%	20.8%			20.8%
at Max	2.5/10 ratio		17.6%	18.7%			24.0%
Count	2.5/10 ratio		7	7			5

Moderate Event. Unexplained spike in data for 2A hour 17. Spike in data for 12A hour 13, possibly due to activity on adjacent dirt road, wind speed in area lower on hour 13 than other hours of day. Northerly component of winds push plume south impacting Santa Maria.

4/28/12 24 hr. Average PM10

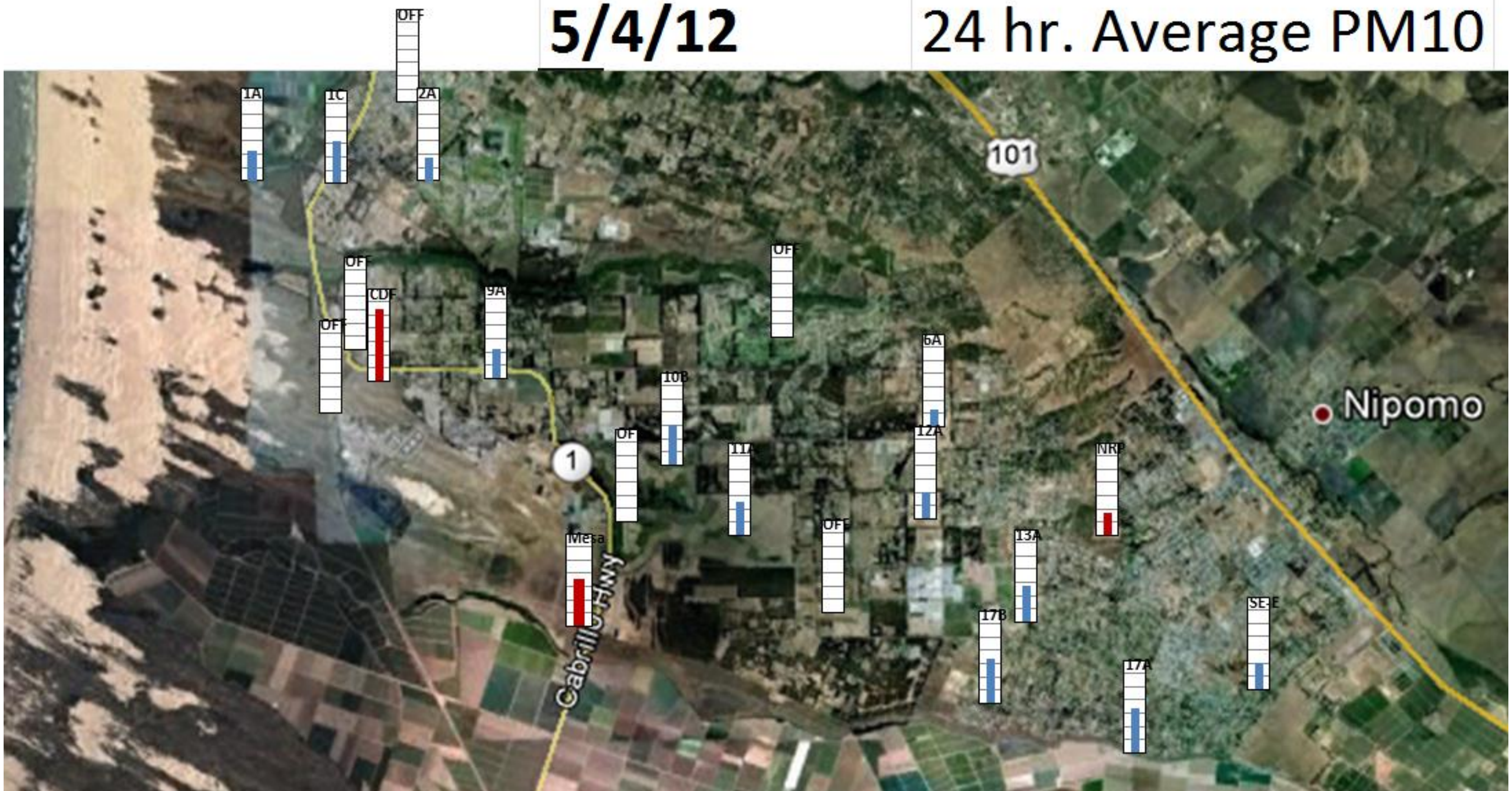


DATE	4/28/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		123.9	104.4		45.4	38.3
Hr. Max	PM10		469.0	374.0		112.0	72.0
at Max	WS	12.6	13.0	16.2	28.2	4.9	13.0
at Max	WD	296.0	314.0	315.0	290.7	243.0	290.0
Average	2.5/10 ratio		19.0%	20.5%			13.9%
at Max	2.5/10 ratio		18.1%	22.2%			13.9%
Count	2.5/10 ratio		9	8			1

Significant Event. Lower PM2.5/10 at Santa Maria as compared to Mesa2 and CDF could indicate significant contribution from ag. fields at Santa Maria. However, wind speeds lower than many days where ratio indicates little impact from fields. Most likely ratio due to only one hour over threshold for calculation.

Video link to 4/28/12 hourly spatial display

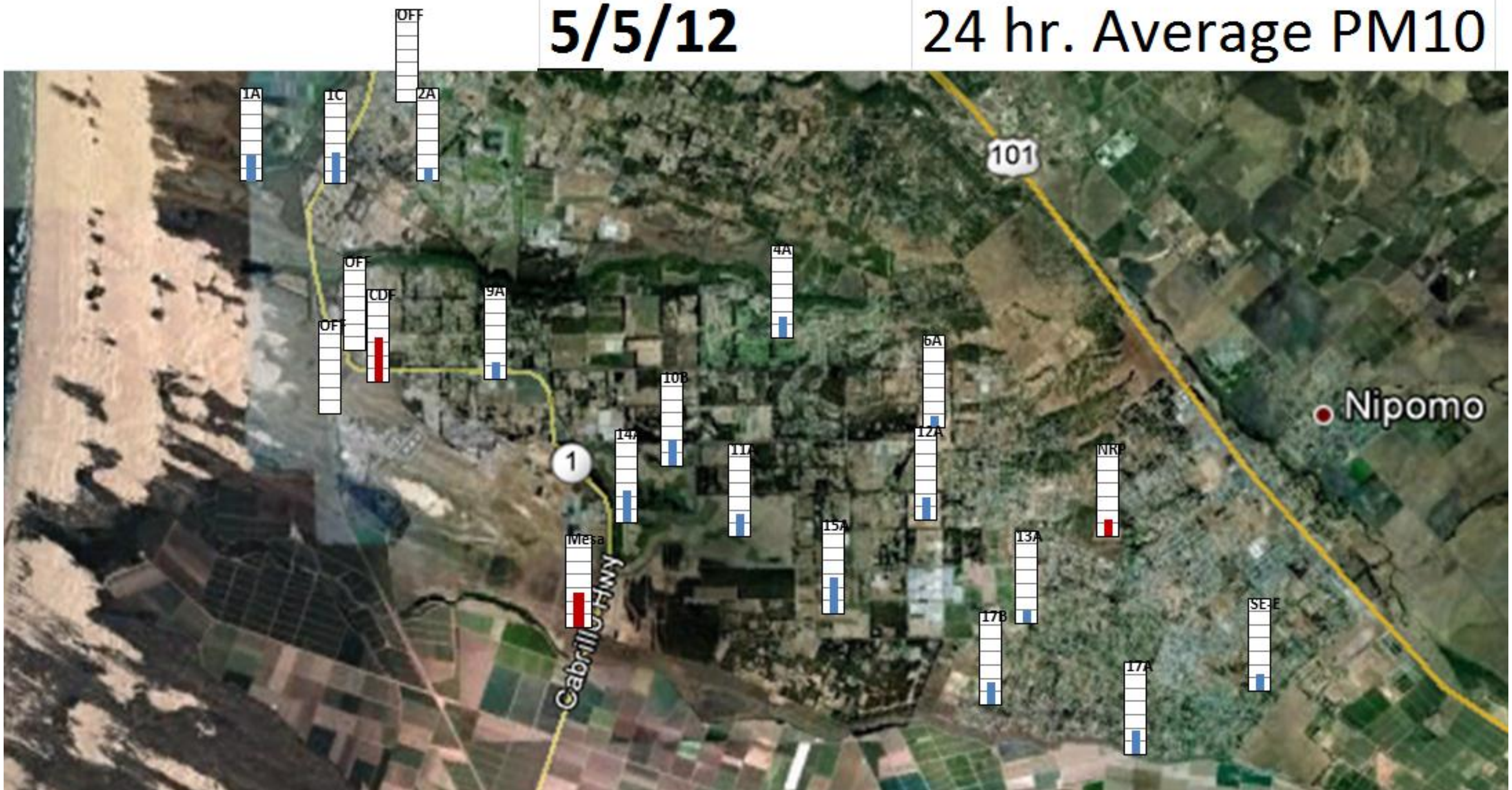
5/4/12 24 hr. Average PM10



DATE	5/4/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		136.7	90.0		43.7	34.1
Hr. Max	PM10		477.0	312.0		120.0	81.0
at Max	WS	15.2	15.3	20.1	31.3	8.4	12.8
at Max	WD	296.0	311.0	301.0	291.5	277.0	289.0
Average	2.5/10 ratio		18.9%	20.2%			19.8%
at Max	2.5/10 ratio		19.7%	18.6%			21.1%
Count	2.5/10 ratio		10	9			4

Moderate Event. Possible minor influence from local source at 13A for hours 12-13.

5/5/12 24 hr. Average PM10



DATE	5/5/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		84.7	67.1		33.3	45.3
Hr. Max	PM10		274.0	226.0		65.0	82.0
at Max	WS	8.2	13.1	16.4	N/A	4.2	12.1
at Max	WD	298.0	310.0	308.0	N/A	2.0	288.0
Average	2.5/10 ratio		26.2%	26.5%			24.4%
at Max	2.5/10 ratio		25.2%	23.0%			24.4%
Count	2.5/10 ratio		12	7			1

Moderate Event. Minor unexplained spike in data for site 15A hour 9, with low wind speed in area.

5/6/12 24 hr. Average PM10

DATE	5/6/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10	[redacted]	71.7	55.4	[redacted]	54.3	43.5
Hr. Max	PM10	[redacted]	247.0	157.0	[redacted]	111.0	56.0
at Max	WS	7.8	10.8	12.8	N/A	7.5	1.8
at Max	WD	320.0	315.0	296.0	N/A	282.0	272.0
Average	2.5/10 ratio	[redacted]	27.5%	27.5%	[redacted]	[redacted]	#DIV/0!
at Max	2.5/10 ratio	[redacted]	26.7%	24.8%	[redacted]	[redacted]	0.0%
Count	2.5/10 ratio	[redacted]	6	4	[redacted]	[redacted]	0

Moderate Event. Site 13A experiences a series of hours that appear to be influenced by local source. Hour 11 PM10>1000 ug/m3 at 13A while winds insufficient (3.8 mph) to entrain particles. Likely due to activity on roads/fields upwind.

5/7/12 24 hr. Average PM10

DATE	5/7/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		43.3	40.0		40.3	45.2
Hr. Max	PM10		69.0	77.0		71.0	83.0
at Max	WS	3.8	2.6	1.6	N/A	5.7	5.6
at Max	WD	224.0	239.0	204.0	N/A	267.0	282.0
Average	2.5/10 ratio		#DIV/0!	36.3%			25.4%
at Max	2.5/10 ratio			33.8%			26.7%
Count	2.5/10 ratio		0	2			2

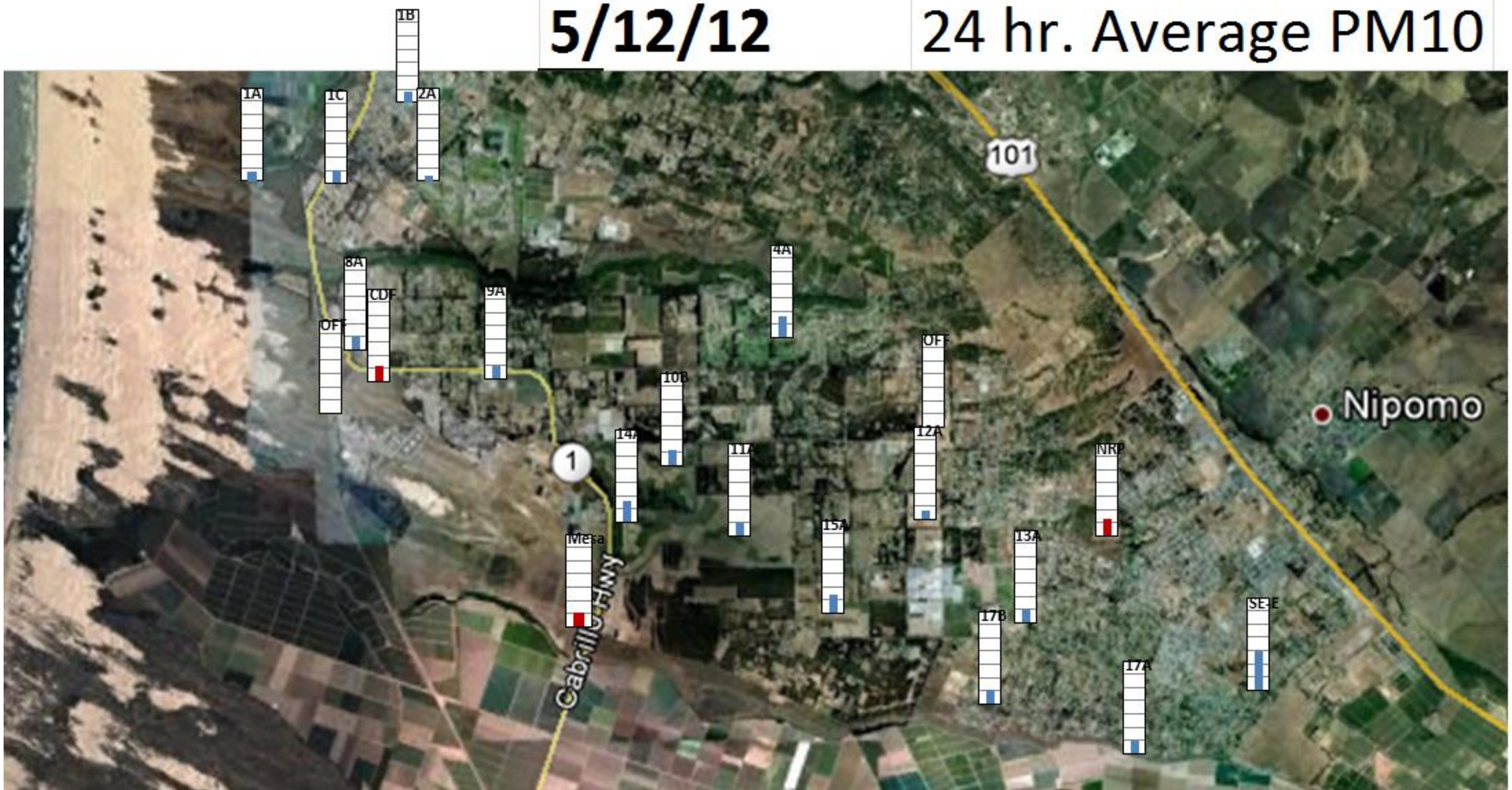
No significant contribution from dunes. Only site that exceeded state standard was SE-E. Low wind speed most of day with some southerly flow.

5/11/12 24 hr. Average PM10

DATE	5/11/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		36.1	29.5		35.5	39.7
Hr. Max	PM10		63.0	50.0		60.0	60.0
at Max	WS	2.4	2.0	3.2	6.5	4.7	1.6
at Max	WD	267.0	203.0	130.0	250.2	259.0	86.0
Average	2.5/10 ratio		#DIV/0!	#DIV/0!			#DIV/0!
at Max	2.5/10 ratio						0.0%
Count	2.5/10 ratio		0	0			0

No significant contribution from dunes. Very low wind speed across most of study area. Stagnation likely responsible for most elevated readings.

5/12/12 24 hr. Average PM10



DATE	5/12/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		28.7	27.8		31.7	43.3
Hr. Max	PM10		42.0	43.0		42.0	55.0
at Max	WS	1.3	2.7	1.3	2.5	5.1	1.8
at Max	WD	224.0	269.0	294.0	251.5	298.0	245.0
Average	2.5/10 ratio		#DIV/0!	#DIV/0!			#DIV/0!
at Max	2.5/10 ratio						0.0%
Count	2.5/10 ratio		0	0			0

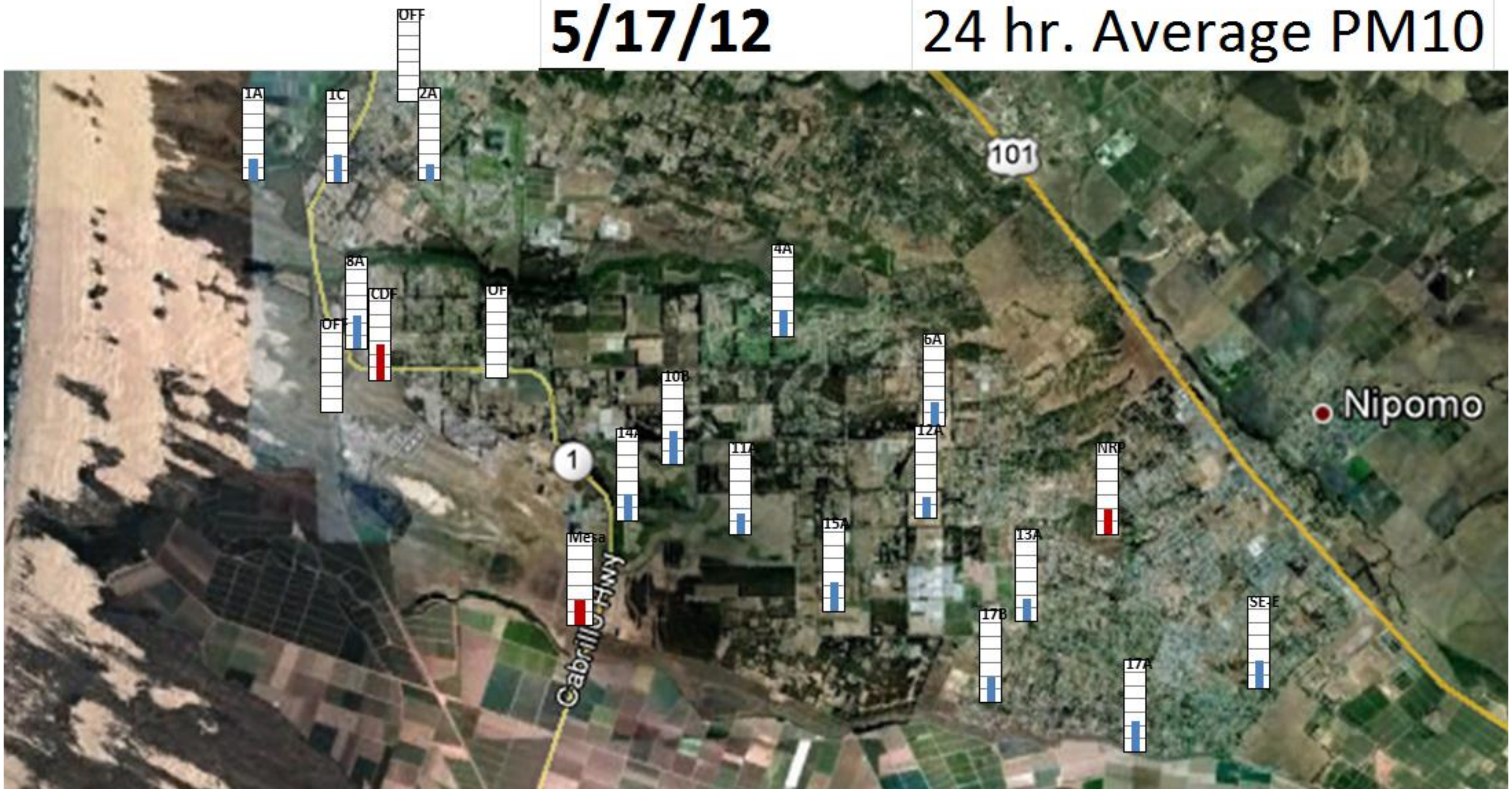
No Significant contribution from dunes. Stagnant wind conditions across region. Spike at SE-E of >500ug/m for hour 11, likely due to localized activity.

5/15/12 24 hr. Average PM10

DATE	5/15/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		89.8	73.0		49.0	No Data
Hr. Max	PM10		338.0	274.0		131.0	0.0
at Max	WS	8.4	9.7		26.3	7.6	#N/A
at Max	WD	306.0	303.0		288.3	288.0	#N/A
Average	2.5/10 ratio		22.7%	#VALUE!			#DIV/0!
at Max	2.5/10 ratio		23.4%	22.3%			0.0%
Count	2.5/10 ratio		9	7			0

Moderate Event. Hour 16, site 12A >800 ug/m3 with moderate winds, likely due to local activity, other hours at 12A do not show local influence. Hour 17, site 14A >500 ug/m3, likely due to local influence, other hours at 14A match nearby sites indicating no local influence on other hours. Video link to 5/15/12 hourly spatial display Note:Mesa2 offline hrs 11-13.

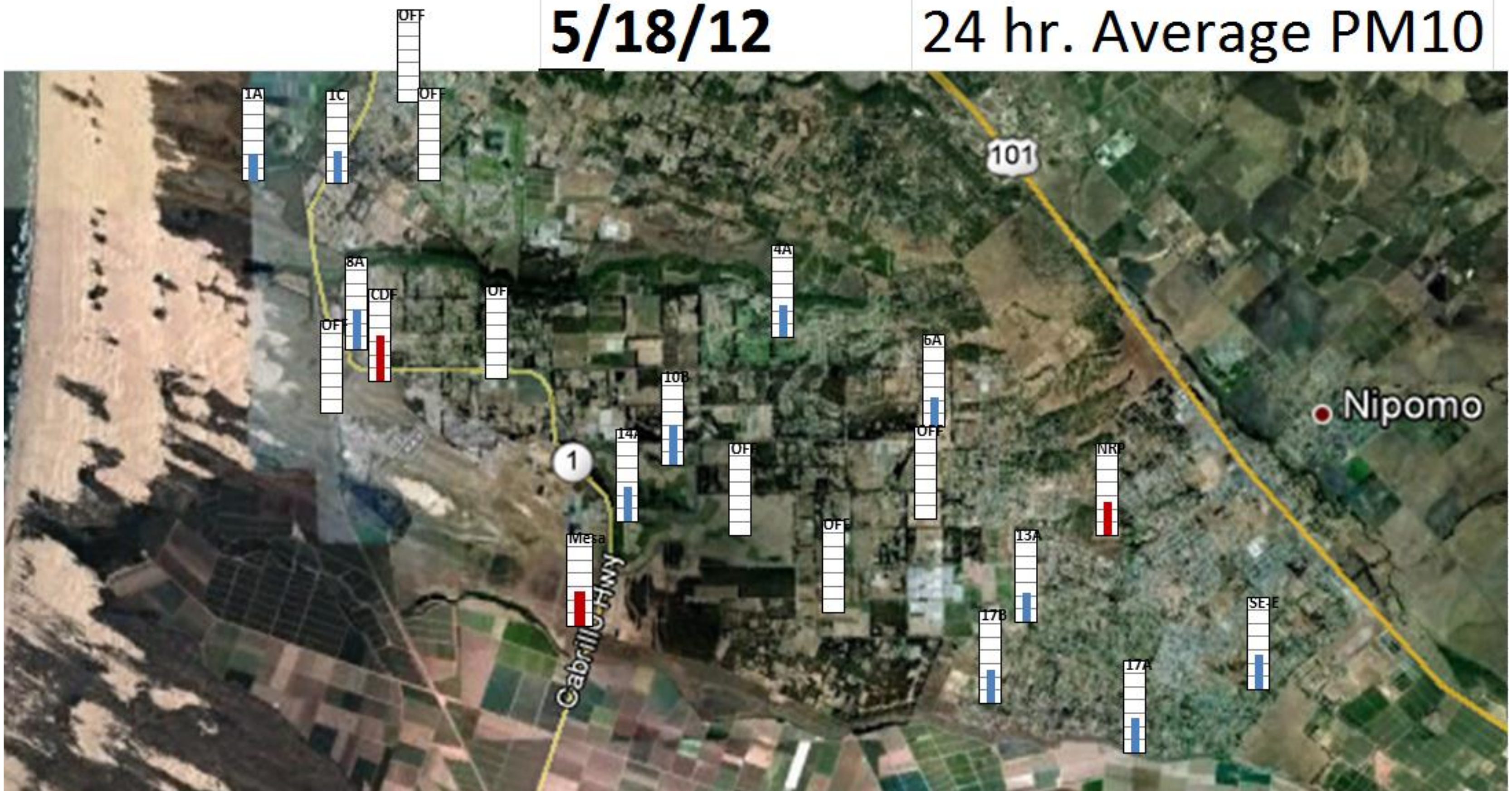
5/17/12 24 hr. Average PM10



DATE	5/17/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		69.7	47.7		47.5	No Data
Hr. Max	PM10		228.0	127.0		132.0	65.0
at Max	WS	8.6	11.1	14.5	22.3	5.9	10.1
at Max	WD	283.0	295.0	294.0	290.3	252.0	278.0
Average	2.5/10 ratio		25.6%	30.5%			#DIV/0!
at Max	2.5/10 ratio		19.3%	29.9%			0.0%
Count	2.5/10 ratio		7	5			0

Minor Event. Lack of northerly component to winds in area. This results in higher than typical values in the northern portion of study area relative to southern portion.

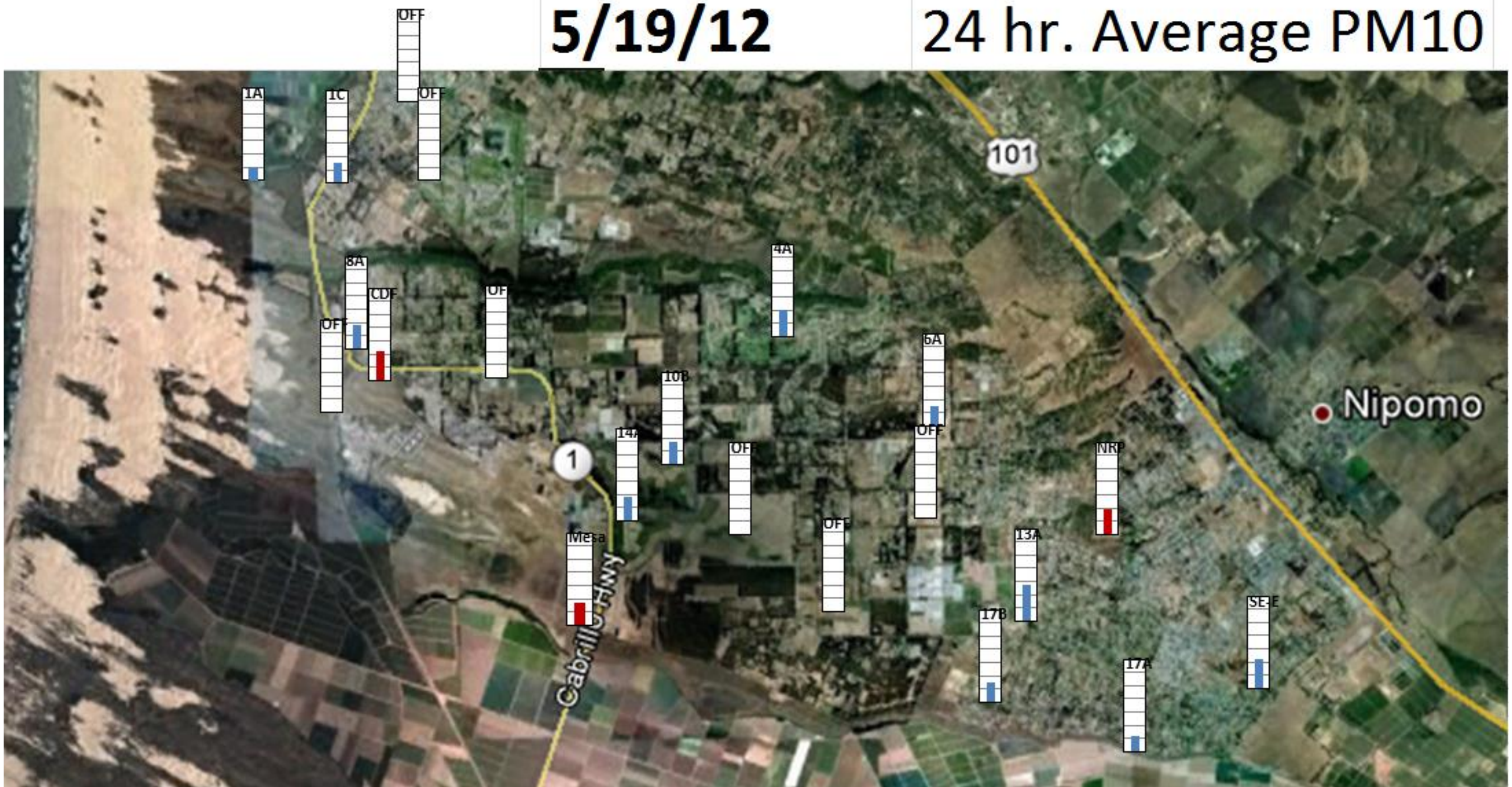
5/18/12 24 hr. Average PM10



DATE	5/18/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10	[redacted]	85.9	65.2	[redacted]	62.3	49.2
Hr. Max	PM10	[redacted]	229.0	170.0	[redacted]	134.0	69.0
at Max	WS	8.0	8.6	13.4	22.2	5.3	9.0
at Max	WD	290.0	297.0	309.0	294.1	254.0	287.0
Average	2.5/10 ratio	[redacted]	26.3%	30.6%	[redacted]	[redacted]	#DIV/0!
at Max	2.5/10 ratio	[redacted]	20.5%	29.4%	[redacted]	[redacted]	0.0%
Count	2.5/10 ratio	[redacted]	9	7	[redacted]	[redacted]	0

Moderate Event. Westerly winds inland cause higher inland reading in north as compared to south than typical pattern.

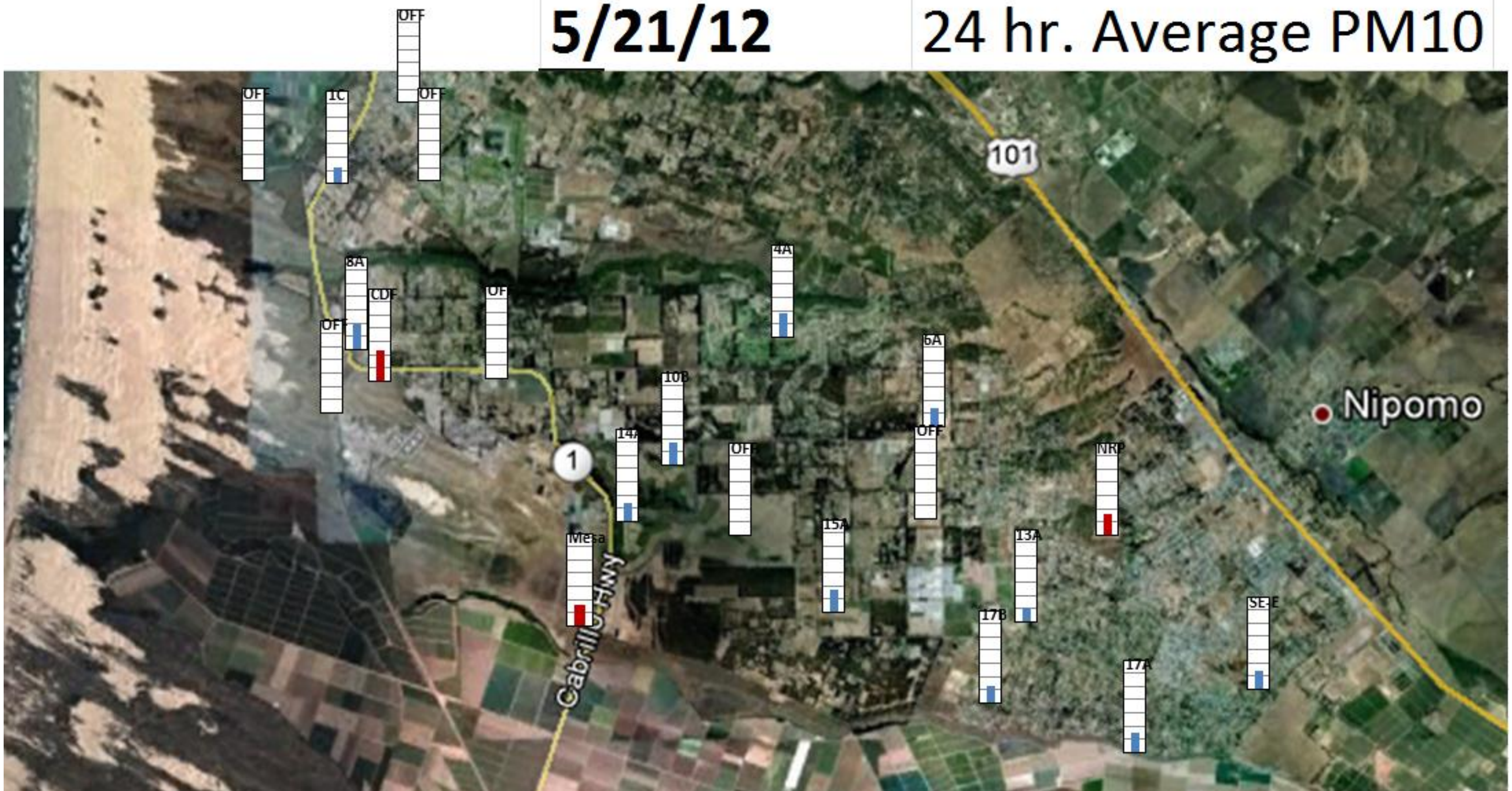
5/19/12 24 hr. Average PM10



DATE	5/19/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		54.7	43.3		47.3	46.2
Hr. Max	PM10		99.0	85.0		81.0	68.0
at Max	WS	4.9	8.3	6.4	16.3	5.6	9.0
at Max	WD	273.0	284.0	273.0	290.9	227.0	288.0
Average	2.5/10 ratio		25.4%	34.1%			#DIV/0!
at Max	2.5/10 ratio		24.2%	34.1%			0.0%
Count	2.5/10 ratio		4	1			0

Minor Event. Higher than normal background levels of PM10 and only minor contributions from dunes. Site 13A experiences a series of hours with higher than nearby site PM10 readings. Winds at 13A moderate, PM10 readings at 13A do not correlate to wind speed, indicating local activity.

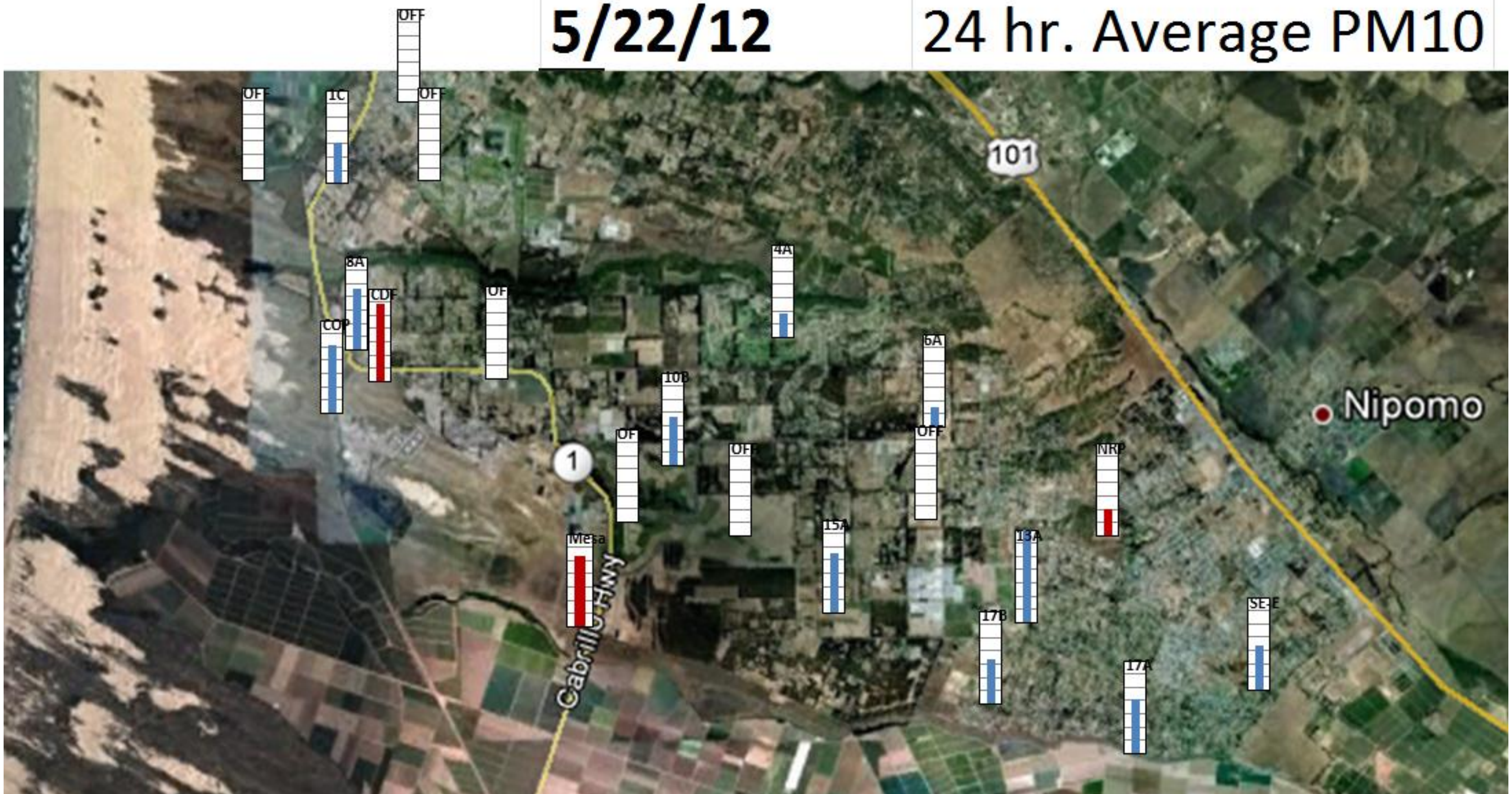
5/21/12 24 hr. Average PM10



DATE	5/21/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		58.5	40.4		40.7	24.0
Hr. Max	PM10		217.0	136.0		110.0	57.0
at Max	WS	7.5	11.2	8.9	23.4	4.9	9.4
at Max	WD	289.0	297.0	287.0	290.8	230.0	274.0
Average	2.5/10 ratio		21.2%	25.3%			#DIV/0!
at Max	2.5/10 ratio		22.6%	25.0%			0.0%
Count	2.5/10 ratio		6	5			0

Minor Event.

5/22/12 24 hr. Average PM10



DATE	5/22/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		146.8	133.7		51.0	54.9
Hr. Max	PM10		604.0	398.0		138.0	121.0
at Max	WS	15.3	11.8	15.8	28.7	3.1	13.2
at Max	WD	286.0	297.0	305.0	293.5	100.0	293.0
Average	2.5/10 ratio		21.8%	23.5%			14.7%
at Max	2.5/10 ratio		22.8%	22.9%			20.7%
Count	2.5/10 ratio		13	10			7

Significant Event. Winds have more northerly component inland, pushing plume south of NRP region. Single hour spike PM10>1800 ug/m3 hour 15 at 13A, clearly due to upwind local activity. Other hours at 13A match nearby sites, indicating unaffected by local influence.

Video link to 5/22/12 hourly spatial display

5/23/12 24 hr. Average PM10

DATE	5/23/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		186.5	143.5		53.7	70.9
Hr. Max	PM10		593.0	449.0		135.0	166.0
at Max	WS	10.5	17.2	19.9	30.8	6.8	15.7
at Max	WD	281.0	301.0	305.0	295.2	279.0	285.0
Average	2.5/10 ratio		22.4%	22.5%			19.8%
at Max	2.5/10 ratio		20.2%	18.9%			23.5%
Count	2.5/10 ratio		14	13			7

Very Significant Event. Federal 24 hour standard of 150 ug/m3 exceeded at CDF and 8A.

Video link for 5/23/12 hourly spatial display

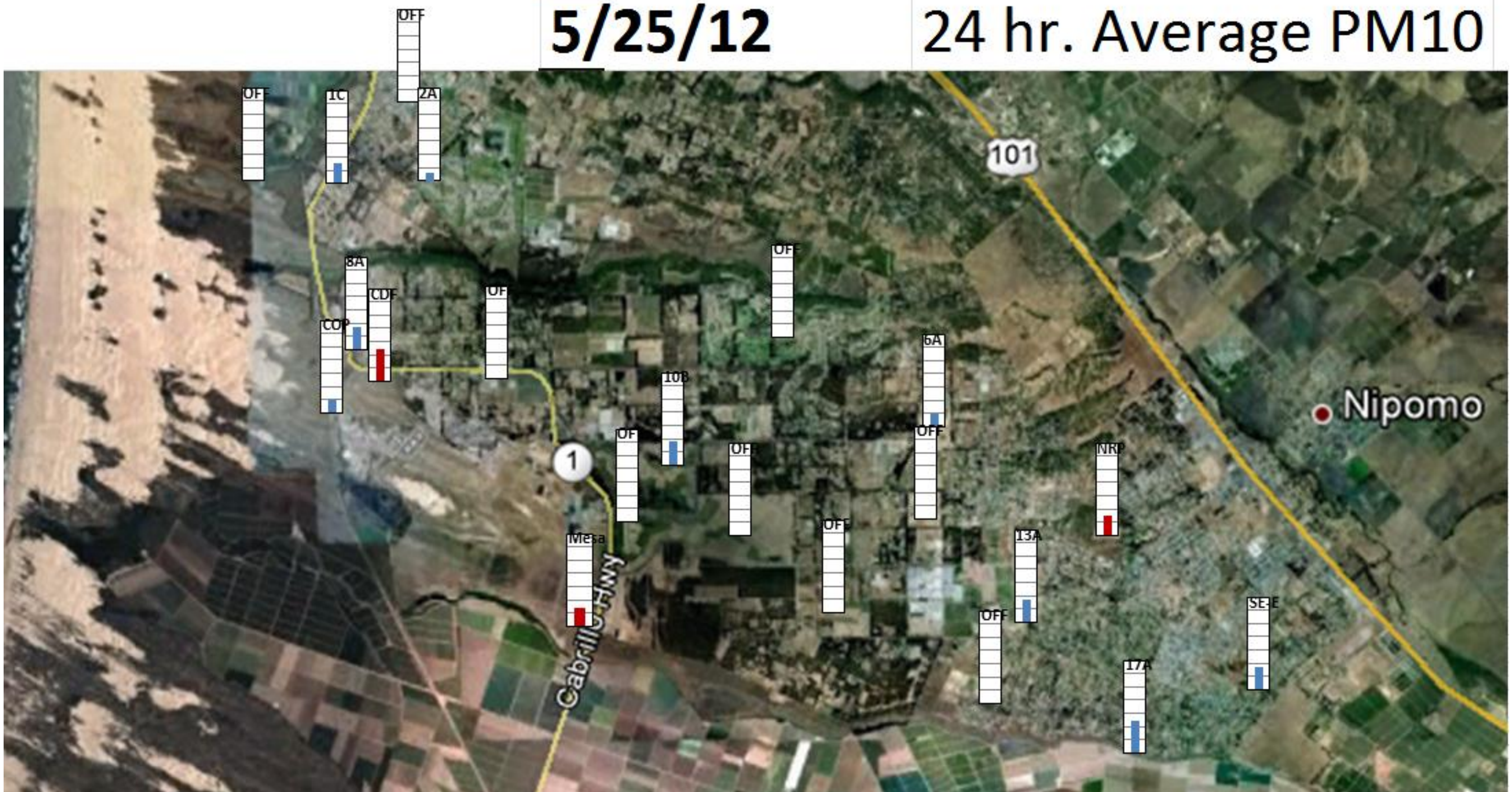
5/24/12 24 hr. Average PM10

DATE	5/24/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		167.1	138.7		66.5	56.1
Hr. Max	PM10		506.0	401.0		165.0	117.0
at Max	WS	13.0	14.1	18.0	33.3	6.9	13.7
at Max	WD	305.0	302.0	315.0	291.5	249.0	279.0
Average	2.5/10 ratio		22.6%	22.4%			24.5%
at Max	2.5/10 ratio		20.9%	22.4%			28.0%
Count	2.5/10 ratio		11	10			6

Very Significant Event. Federal 24 hour standard of 150 ug/m3 exceeded at CDF. Less northerly component to inland winds results in higher relative impacts at NRP and lower relative impacts at Santa Maria than on 5/23/12.

Video link to 5/25/12 hourly spatial display

5/25/12 24 hr. Average PM10

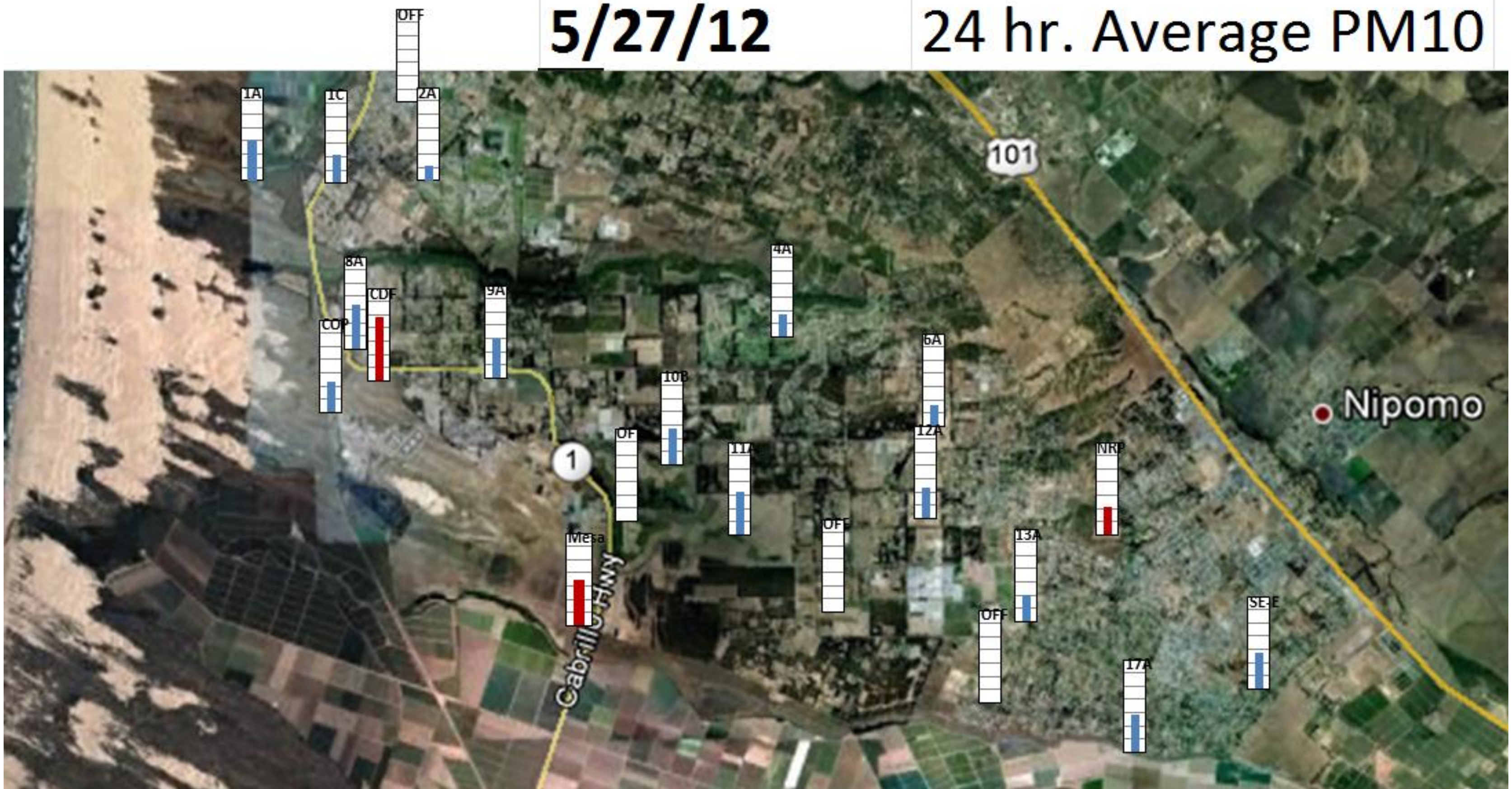


DATE	5/25/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		62.0	35.8		38.4	37.2
Hr. Max	PM10		132.0	72.0		83.0	80.0
at Max	WS	16.3	16.2	18.8	22.0	11.1	14.8
at Max	WD	282.0	284.0	291.0	287.4	290.0	290.0
Average	2.5/10 ratio		23.2%	18.1%			7.5%
at Max	2.5/10 ratio		26.5%	18.1%			7.5%
Count	2.5/10 ratio		8	1			1

Minor Event. Very unusual meteorological conditions. Winds inland higher than typical and significantly stronger than winds on the dunes. Appears sites S-E and 17A impacted by blowing dust from ag. fields and sites 13A and 12A were impacted by local sources. PM2.5/10 ratio at Santa Maria confirms non-dune sources impacting Santa Maria. See Appendix B for more discussion of this unusual day. Video link for 5/25/12 hourly spatial display

5/27/12

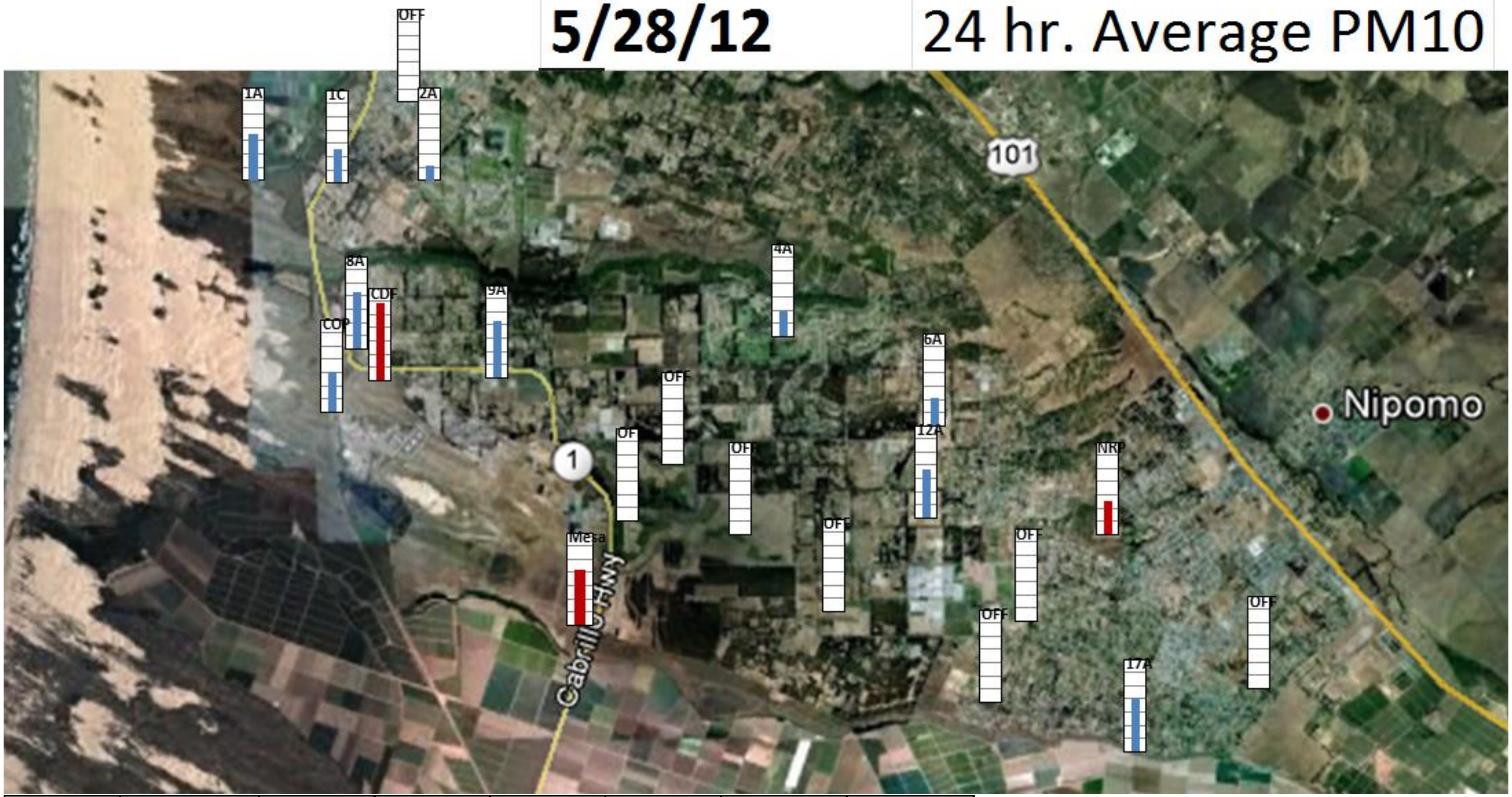
24 hr. Average PM10



DATE	5/27/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		121.2	86.0		53.7	24.2
Hr. Max	PM10		461.0	380.0		172.0	55.0
at Max	WS	11.5	12.8	16.6	29.9	5.3	12.5
at Max	WD	302.0	306.0	306.0	292.5	253.0	272.0
Average	2.5/10 ratio		18.0%	19.3%			#DIV/0!
at Max	2.5/10 ratio		20.0%	21.8%			0.0%
Count	2.5/10 ratio		9	7			0

Significant Event. Lack of northerly component on inland winds increased relative impacts at region around NRP.

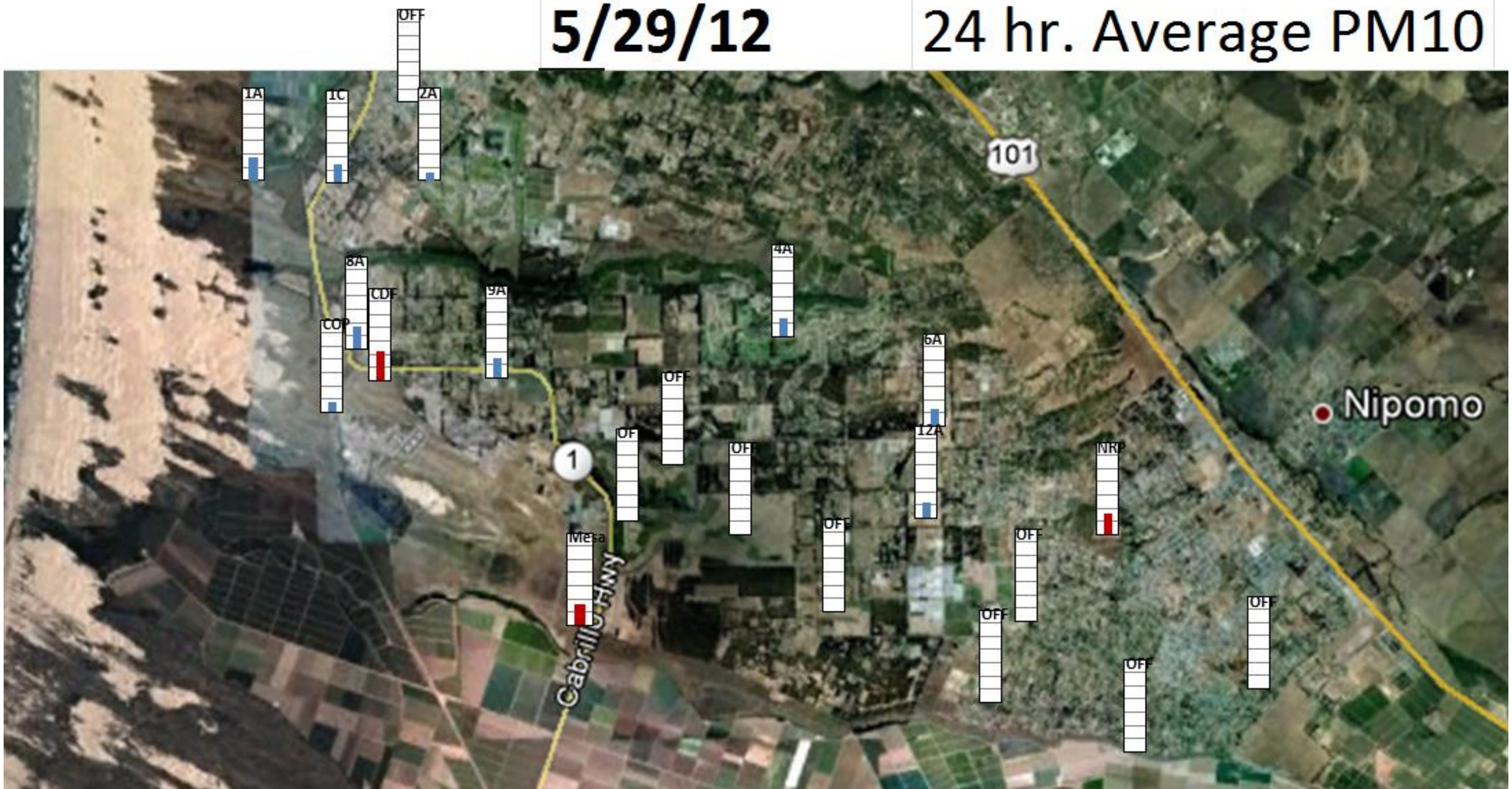
5/28/12 24 hr. Average PM10



DATE	5/28/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		147.8	105.5		64.4	29.7
Hr. Max	PM10		545.0	342.0		231.0	52.0
at Max	WS	12.1	10.8	14.6	28.1	6.9	11.2
at Max	WD	297.0	307.0	302.0	290.2	269.0	272.0
Average	2.5/10 ratio		18.2%	22.5%			#DIV/0!
at Max	2.5/10 ratio		21.8%	22.5%			0.0%
Count	2.5/10 ratio		9	8			0

Significant Event. Lack of northerly component to inland winds keeps plume impacts northerly, with almost no impacts in Santa Maria.

5/29/12 24 hr. Average PM10



DATE	5/29/2012	Grover	CDF	Mesa2	S1	NRP	S.Maria
24 AVG	PM10		55.4	40.5		41.3	29.8
Hr. Max	PM10		168.0	85.0		99.0	43.0
at Max	WS	8.0	10.1	12.4	22.5	3.9	9.2
at Max	WD	294.0	298.0	307.0	291.6	264.0	277.0
Average	2.5/10 ratio		22.1%	19.1%			#DIV/0!
at Max	2.5/10 ratio		20.2%	21.2%			0.0%
Count	2.5/10 ratio		7	3			0

Minor Event. Westerly winds inland.

SOUTH COUNTY COMMUNITY MONITORING PROJECT

Appendix D – Exploring Other Aspects of the Data Set

ADDITIONAL ANALYSIS OF OCEANO DATA

Analysis of Oceano PM_{10} Data Before and After Expanded Street Sweeping

Comparisons of the Community Monitoring Project data to the Phase2 data in theory could be used to measure the effectiveness of the street sweeping efforts of State Parks and San Luis Obispo County in reducing PM_{10} concentrations impacting the area; this comparison, however, is not so straightforward. The Phase2 Oceano data was collected with a hi-volume sampler that measured 24-hour average concentrations on a one in six day schedule for an entire year. The Community Monitoring Project data is composed of hourly concentrations measured continuously with an EBAM during the 3-month spring windy season when the highest concentrations would likely occur. Salt analysis was performed on all of the Phase 2 hi-volume filters; as mentioned previously, performing salt analysis on all hourly filter samples from the Community Monitoring Project would be prohibitively expensive. Additionally, the Phase2 site was located on the east side of Lakeside Avenue, while the Community Monitoring Site O-D was located directly across Lakeside Avenue due to unavailability of the old Phase2 location. These differences between the Phase2 data and the Community Monitoring Project data make definitive comparisons between the two data sets very difficult.

One approach to evaluating any potential changes in PM_{10} levels in Oceano between the two measurement projects is to look at the relationship between PM_{10} measurements performed at Oceano, CDF and the Mesa2 monitoring stations. The data shows a strong relationship between high PM_{10} at Oceano (from windblown sand, not salt) and high PM_{10} measured at CDF and Mesa2. This relationship is likely due to wind being the driving force behind the high concentrations in both areas.

As discussed earlier, salt content in PM_{10} samples is low and quite consistent in the numerous measurements from the Nipomo Mesa, but PM_{10} measurements from Oceano vary widely in salt concentrations; these differences alter the relationship in the PM_{10} data between the two areas. The ideal way to deal with this problem would be to analyze and subtract out the salt from all samples, but that is not feasible. As an alternative, the data from both studies was evaluated and any days with a high contribution from salt was excluded. Data from Phase 2 was evaluated based on the actual salt analysis from the Oceano filters; data from the Community Monitoring Project was evaluated by looking at PM_{10} levels in relation to wind speed. This comparative analysis identified three days with a high salt contribution in both data sets; those days were excluded from this analysis.

A simple comparison is to average the highest dust events from both sampling periods under the same conditions and compare the data relationship between Oceano, CDF and Mesa2. These data will also likely be the least influenced by sea salt. The Table D-1 below presents this data.

Table D-1 – Data Comparison between Phase2 Study and Community Monitoring Project

Phase 2 Data			
Site	Oceano	CDF	Mesa2
Top 5 24 Hr. Avg.	92.6	100.7	90.2
% diff. Oceano Vs Nipomo Site		8%	-3%
Community Monitoring Data			
Site	Oceano	CDF	Mesa2
Top 5 24 Hr. Avg.	86.9	156.9	122.3
% diff. Oceano Vs Nipomo Site		57%	34%
% Change from Phase2 to Community Monitoring Data		49%	37%

A more complex analysis is to calculate the least square linear regression of the relationship between Oceano and each Nipomo Mesa site for both the Phase2 and Community Monitoring data sets (with the three days identified as being heavily influenced by sea salt excluded) and comparing these regressions. Figure D-1 below presents the comparison of Oceano PM_{10} to CDF PM_{10} from both the Phase2 and Community Monitoring Project. Figure D-2 below presents the comparison of Oceano PM_{10} to Mesa2 PM_{10} from both the Phase2 and Community Monitoring Project.

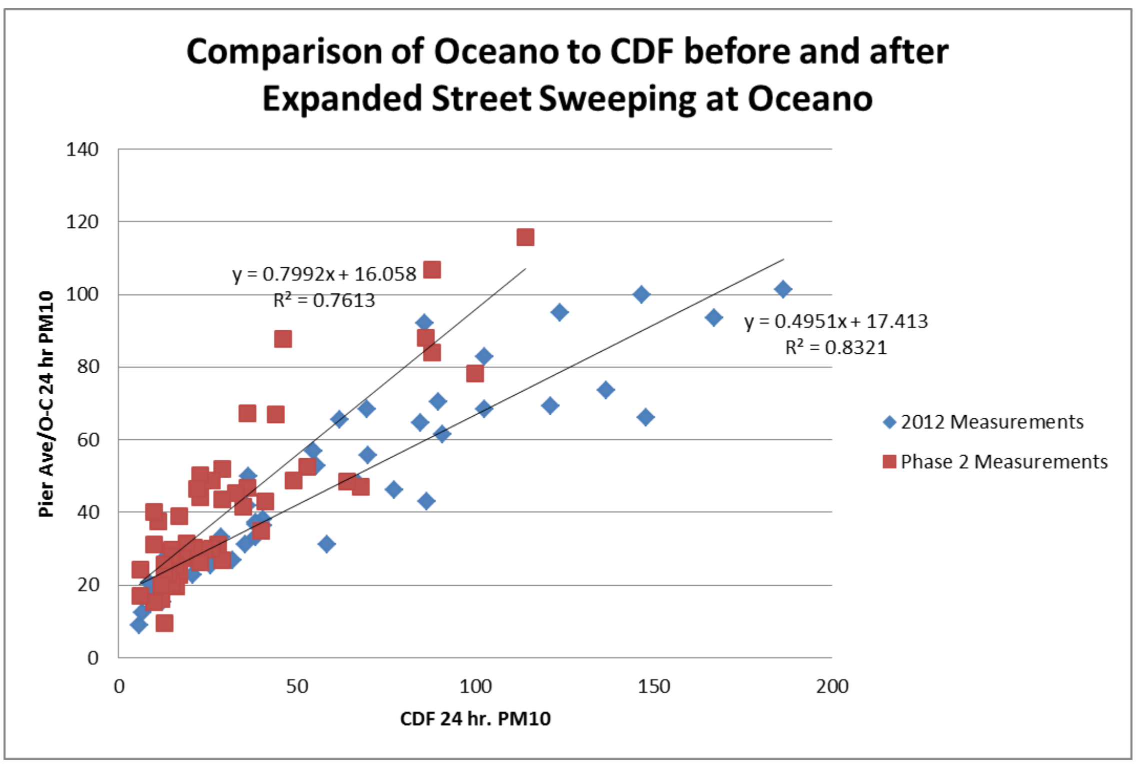


Figure D-1 – Change in PM_{10} Relationship Between Oceano and CDF

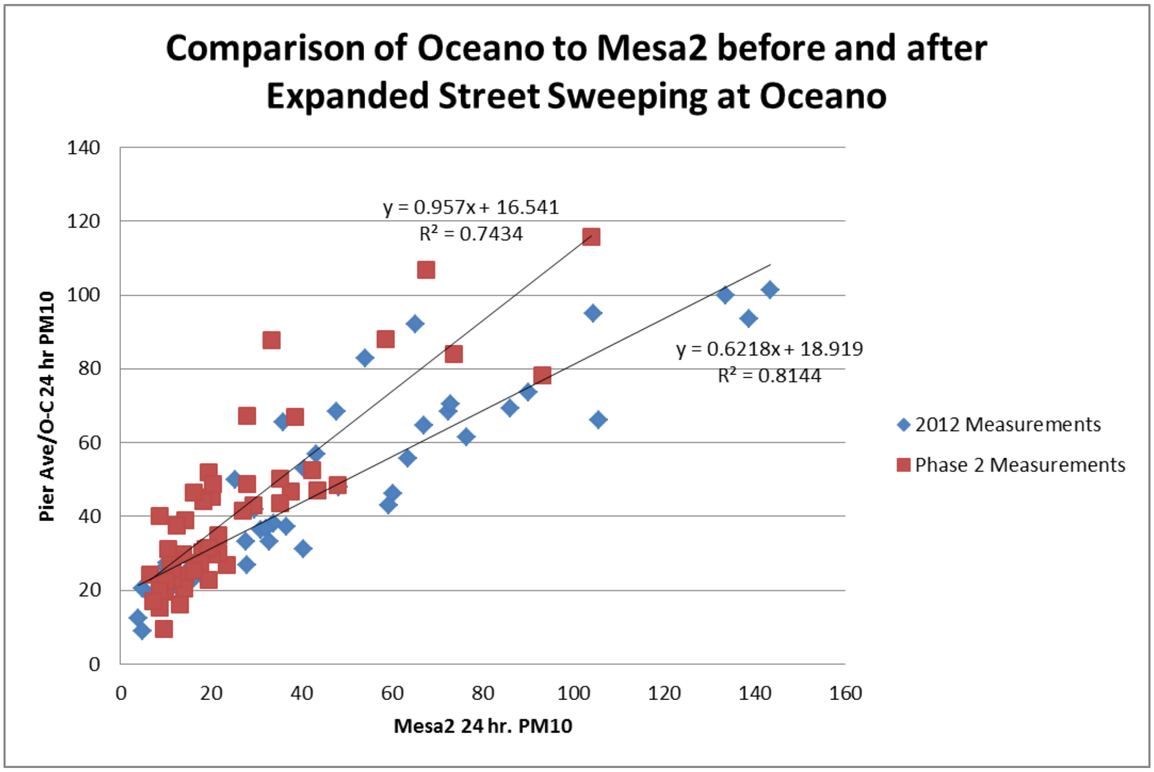


Figure D-2 – Change in PM_{10} Relationship Between Oceano and Mesa2

Both Figures D-1 and D-2 show a clear reduction in PM_{10} concentrations in Oceano relative to the PM_{10} levels on the Nipomo Mesa when comparing the two monitoring programs. Due to the scatter in the data (likely due to the influence of salt and other variables) the exact magnitude of the relative reduction is unclear, but it appears to be greater than 30%. This apparent change could be due to a variety of reasons. For instance, it is possible, but unlikely, there has been no improvement in Oceano, but instead degradation in Nipomo. Given, however, that the enhanced street cleaning effort on Pier Avenue in Oceano is the only known significant factor that has changed between the two monitoring projects makes this a more logical cause.

As noted above, there are numerous differences in the two measurement programs that could possibly account for the observed improvement, so this analysis should not be considered conclusive and is only presented as the best attempt with the limited data to evaluate the influence of the street sweeping program. Further investigation by comparing periods with and without street sweeping, using the exact same sampling location and measurement method would be needed to provide a more definitive conclusion. In addition, it is clear, even with the lower relative PM_{10} levels measured in Oceano since enhanced street sweeping efforts began, that the state 24-hour PM_{10} health standard is still exceeded occasionally in the areas closest to Pier Avenue and the disturbed beach sand.

Influence of Sea Salt in Oceano

Oceano's close proximity to the ocean makes understanding the PM_{10} impacts there considerably more complicated than in the Nipomo area due to the added influence of sea salt. Detailed measurements of salt in PM samples from the Nipomo Mesa area in the APCD Phase1 and Phase2 studies demonstrate the salt content in PM_{10} samples collected in that area is quite consistent, typically comprising between

5-10% of the sample. However, measurements at the Pier Avenue site during the Phase2 study, as well as measurements at Grover Beach about one mile to the north and a similar distance from the ocean, both showed wide fluctuations in salt content. The Grover Beach measurements were hourly and occasionally showed PM_{10} concentration spikes above 400 ug/m3; chemical analysis confirmed these spikes to be salt. As one would expect, data from Grover Beach showed the highest salt content under calm conditions when dispersion was poor. The 24-hour samples taken from Pier Avenue as part of the Phase2 study also showed wide variations in salt content, with over 50% salt content found in some samples while others contained only trace amounts.

For the Community Monitoring Project, the cost of performing salt analysis on every hourly filter sample from Oceano was prohibitive. As a compromise, approximately 50 hourly samples under a variety of conditions were selected from the Oceano sites for salt analysis, to be used to better understand the role of salt in the entire data set.

The salt data is presented in Table D-2 below. Note that samples taken during wind events typically contain between 5% and 10% salt. This consistency in the data allows comparisons of PM_{10} measurements during wind events without much consideration of salt content. However, because the high salt concentrations occur during calm periods, comparing non-wind event hours and 24-hour average concentrations requires more care and must take potential salt impacts into consideration.

Table D-2 – Summary of Oceano Sea Salt Analysis

Oceano Sea Salt Data	Site O-C			Site O-D			Site O-A			Site O-A	
Sample	EBAM PM10	Salt		EBAM PM10	Salt		EBAM PM10	Salt		Wind Speed	
Time	ug/m3	ug/m3	% Salt	ug/m3	ug/m3	% Salt	ug/m3	ug/m3	% Salt	mph	Comment
4/16/12 14:00	176	14.1	8.0%							12.3	wind event
4/17/12 14:00	205	19.3	9.4%							11.2	wind event
4/18/12 15:00	271	21.3	7.8%							12.5	wind event
4/20/12 7:00	186	108.0	58.2%							1.8	Calm Condition Salt Event
5/22/2012 11:00	141	11.0	7.8%	108	10.5	9.7%				11.4	wind event
5/22/2012 12:00	412	13.1	3.2%	235	10.9	4.6%	235	10.1	4.3%	15.0	wind event
5/22/2012 13:00	345	15.3	4.4%	342	11.1	3.2%	164	11.4	7.0%	15.9	wind event
5/22/2012 14:00	313	15.3	4.9%	400	12.5	3.1%	177	11.5	6.5%	13.9	wind event
5/22/2012 15:00	180	17.3	9.7%	319	12.3	3.9%				11.2	wind event
5/22/2012 16:00	123	15.8	12.9%	170	13.7	8.1%				10.5	wind event
5/22/2012 17:00				173	14.6	8.4%				7.8	Wind Event ending
5/22/2012 18:00	103	20.4	19.8%							6.0	Wind Event ending
5/22/2012 23:00	75	72.5	96.7%							1.6	Calm Condition Salt Event
5/23/2012 10:00	104	21.3	20.4%							13.2	Wind Event beginning
5/23/2012 12:00	223	25.2	11.3%	229	21.8	9.5%				14.1	wind event
5/23/2012 13:00	245	23.8	9.7%	276	22.7	8.2%				14.1	wind event
5/23/2012 14:00	257	24.5	9.5%	269	22.6	8.4%				13.9	wind event
5/23/2012 15:00	196	28.2	14.4%	238	21.3	8.9%				13.0	wind event
5/23/2012 16:00	155	26.2	16.9%	189	22.6	11.9%				13.0	wind event
5/23/2012 17:00	108	31.7	29.3%	169	23.2	13.7%				7.2	Wind Event ending
5/23/2012 18:00	138	31.9	23.2%	100	28.6	28.5%				5.2	Wind Event ending
5/23/2012 19:00				158	39.2	24.8%				4.7	Wind Event ending
5/23/2012 21:00	107	60.8	57.0%							2.5	Calm Condition Salt Event
5/24/2012 9:00				109	25.4	23.2%				9.0	Wind Event beginning
5/24/2012 10:00	140	25.2	18.0%	158	29.3	18.5%				11.0	Wind Event beginning
5/24/2012 13:00	307	21.0	6.9%	211	20.7	9.8%				14.8	wind event
5/24/2012 14:00	197	20.5	10.4%	265	19.7	7.4%				13.2	wind event
5/24/2012 15:00	199	23.1	11.6%	223	17.7	7.9%				12.1	wind event
5/24/2012 16:00	119	26.5	22.2%	191	17.4	9.1%				12.1	wind event
5/24/2012 17:00	51	27.9	54.6%	189	21.9	11.6%				10.1	Wind Event ending
5/24/2012 19:00	123	32.1	26.1%	120	25.2	20.9%				6.0	Wind Event ending

Variations in Oceano Plume Impacts

Looking at the hourly data from various wind/dust episodes for the Oceano study area, a more complex pattern is revealed than the average measurements between site O-C and O-D. There are episodes where site O-C PM_{10} measurements are higher than O-D and other episodes where the opposite is true. Figure D-3 below is the peak hour of an episode where O-C consistently measured higher PM_{10} values than O-D. Figures D-4 through D-8 below present consecutive hours of the main portion of a wind/dust event that demonstrates how variable the relationship between the PM_{10} concentrations at O-C and O-D are. Figure D-4 begins at 11:00 with the event just beginning. On hour 12, site O-C recorded over 400 ug/m3, twice the PM_{10} value from site O-D. Then on hour 13, sites O-C and O-D measured similar PM_{10} concentrations. However, on hour 14, the relationship between the two sites PM_{10} values reverses, with O-D measuring about 100 ug/m3 higher than O-C. On hour 15 nearing the end of the episode, O-D continues to record significantly higher PM_{10} than O-C.

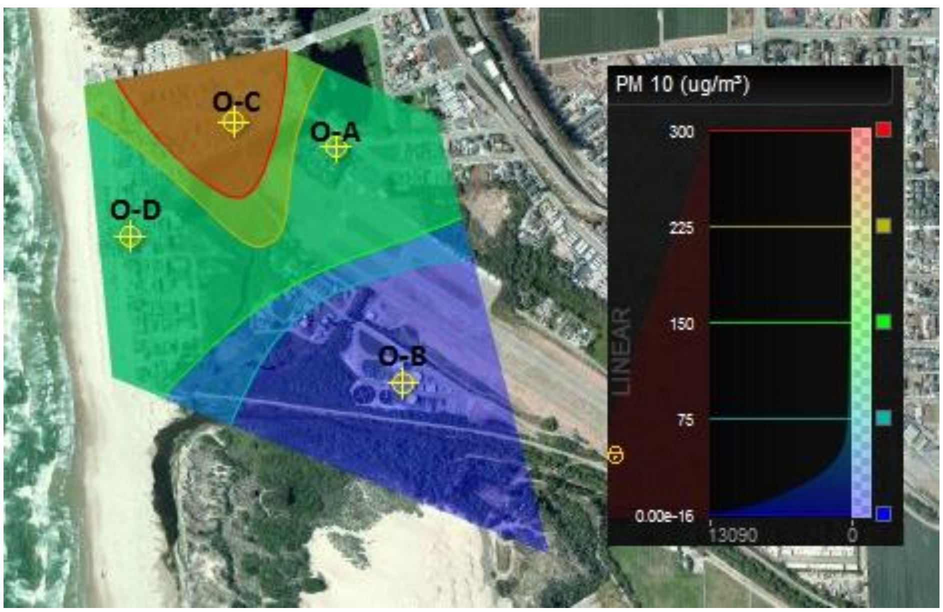


Figure D-3 – Oceano 5/28/12 hour 13

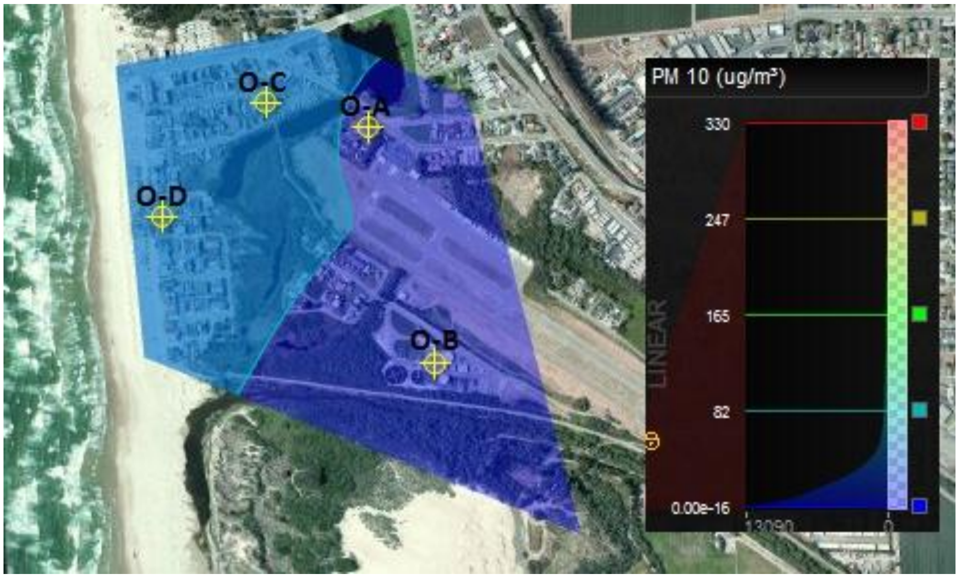


Figure D-4 – Oceano 5/22/12 11:00

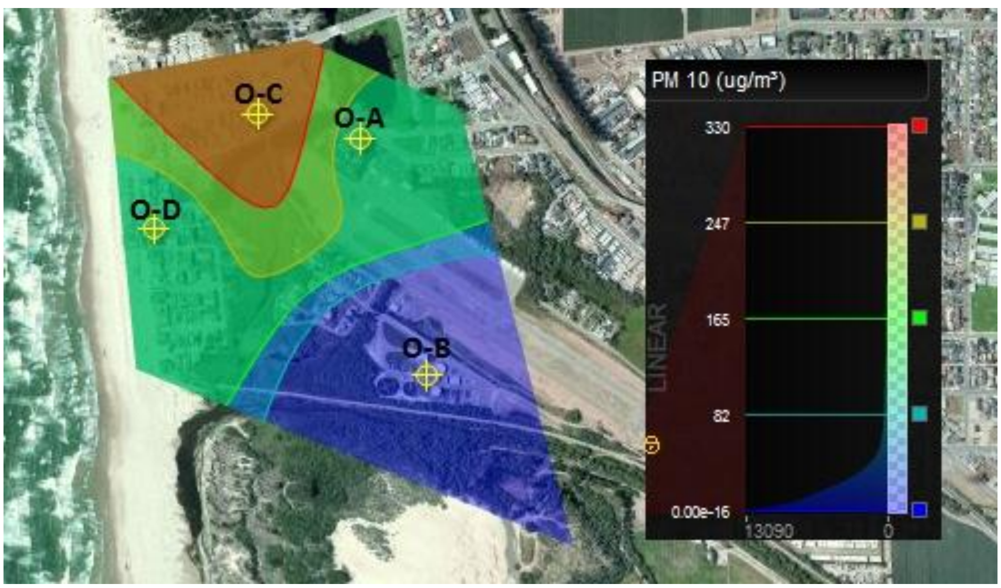


Figure D-5 – Oceano 5/22/12 12:00

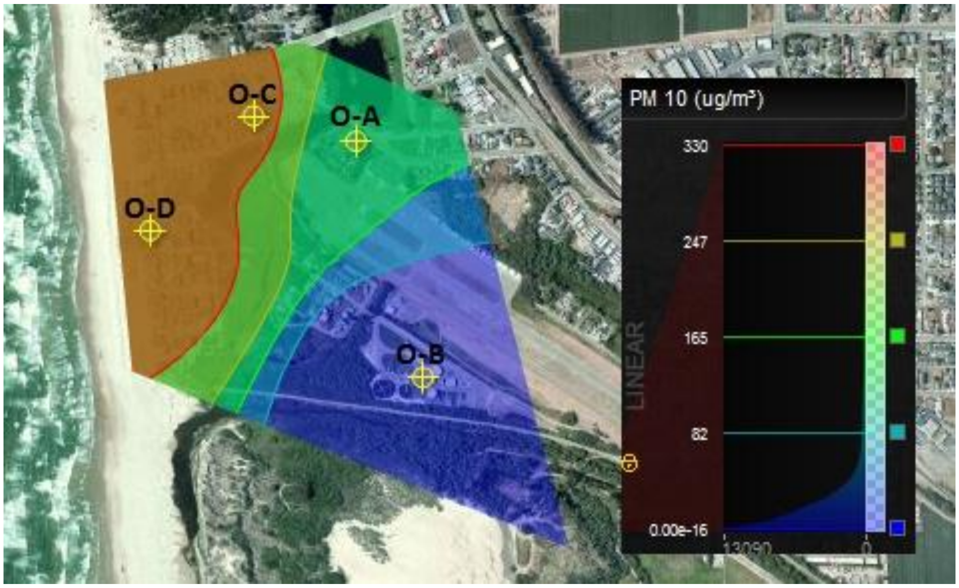


Figure D-6 – Oceano 5/22/12 13:00

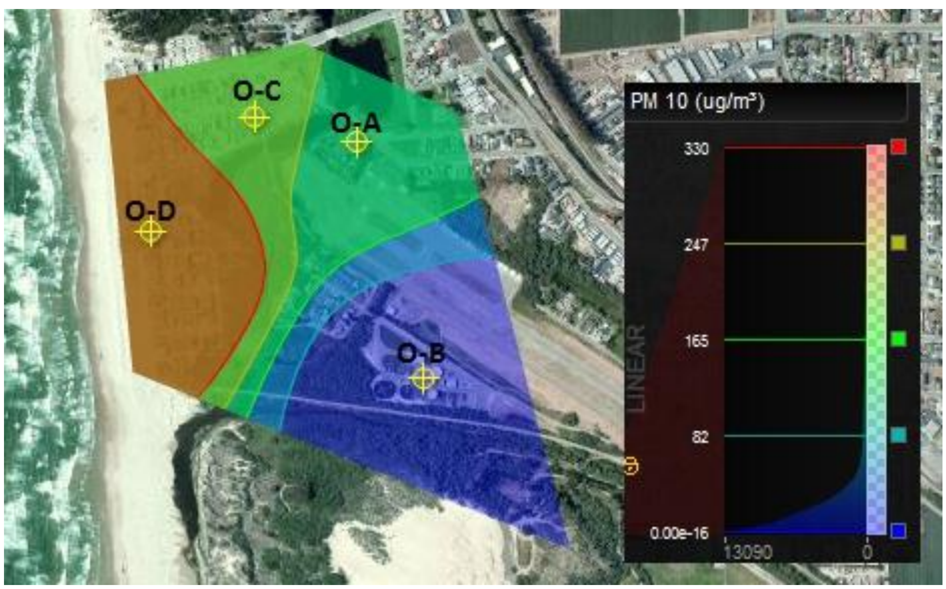


Figure D-7 – Oceano 5/22/12 14:00

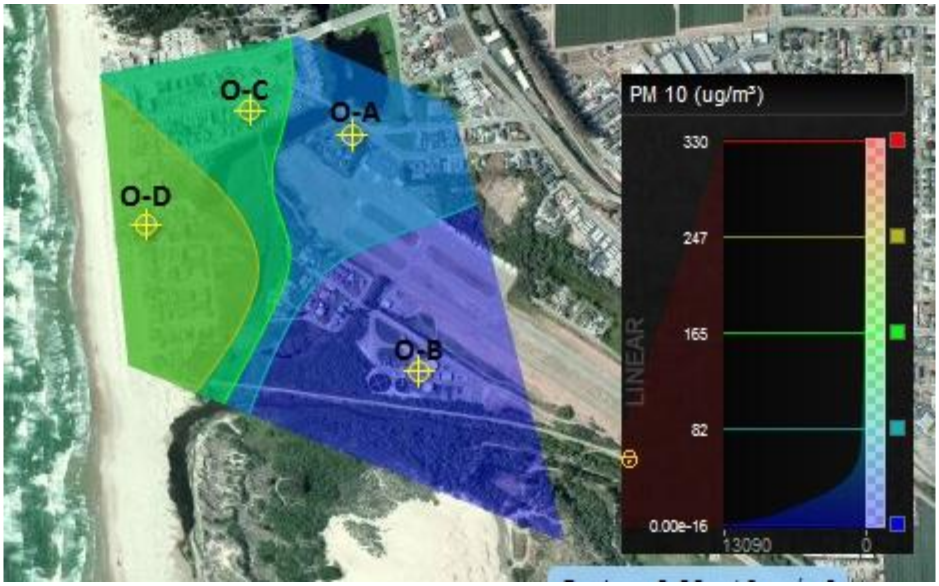


Figure D-8 – 5/22/12 15:00

The cause(s) of the shifting relationship in PM_{10} concentration between site O-C and O-D is unresolved. State Parks in coordination with San Luis Obispo County has increased the street sweeping of Pier Avenue as a potential mitigation effort. The sweeping is a possible variable in the changing relationship of PM_{10} concentrations between sites O-C and O-D. Another potential variable is that State Parks periodically moves large quantities of sand that build up next to wind fences. This sand movement is a routine maintenance activity that takes place by the wind fences right in front of the houses on Strand Way (where site O-D is located). State Parks personnel, using large earth moving equipment, moves the built up sand away from the wind fences and dumps the sand on the beach upwind of these fences. This activity causes significant disturbance to the sand surface, which could also be a factor in the changing relationship in PM_{10} readings between these two sites. Attempts to correlate shifts in the PM_{10} gradient between these two sites with the sparse records available for these activities were inconclusive in identifying any consistent pattern. It is worth noting, however, that State Parks records show sand moving activities to maintain the wind fencing occurred on the day depicted in the series of data plots above in Figures D-4 to D-8, when a significant shift in the relationship between the PM_{10} concentrations at these sites also occurred.

<u>Discussion of Peer Review Comment</u>

In supporting the major conclusions of the study, one of the project peer reviewers theorized that, in addition to direct PM impacts on the Nipomo Mesa from the Oceano Dunes, there may be a secondary impact where particles deposited along the plume path from previous episodes are re-entrained by later strong episodes. One piece of data the reviewer cited in making this comment is from the May 23 episode, which had the highest PM concentrations measured at CDF during the project. In this episode, the reviewer notes that the PM_{10} concentration at Site 15A was almost as high as the value measured at CDF for the peak hour of the event. Seeing little drop in concentration between the CDF site and the further downwind 15A site for this one hour, the reviewer postulated that particles deposited along the plume path from previous dust events might be re-entrained on subsequent events, leading to the higher than expected concentration at 15A for that hour. Close examination of the May 23 event, presented in Figure D-9 below, shows that indeed the site 15A concentration for the peak hour of the episode was only slightly lower than the corresponding value from the CDF site. However, PM_{10} concentrations at site 15A during all other hours of the episode were significantly lower than the corresponding measurements at CDF.

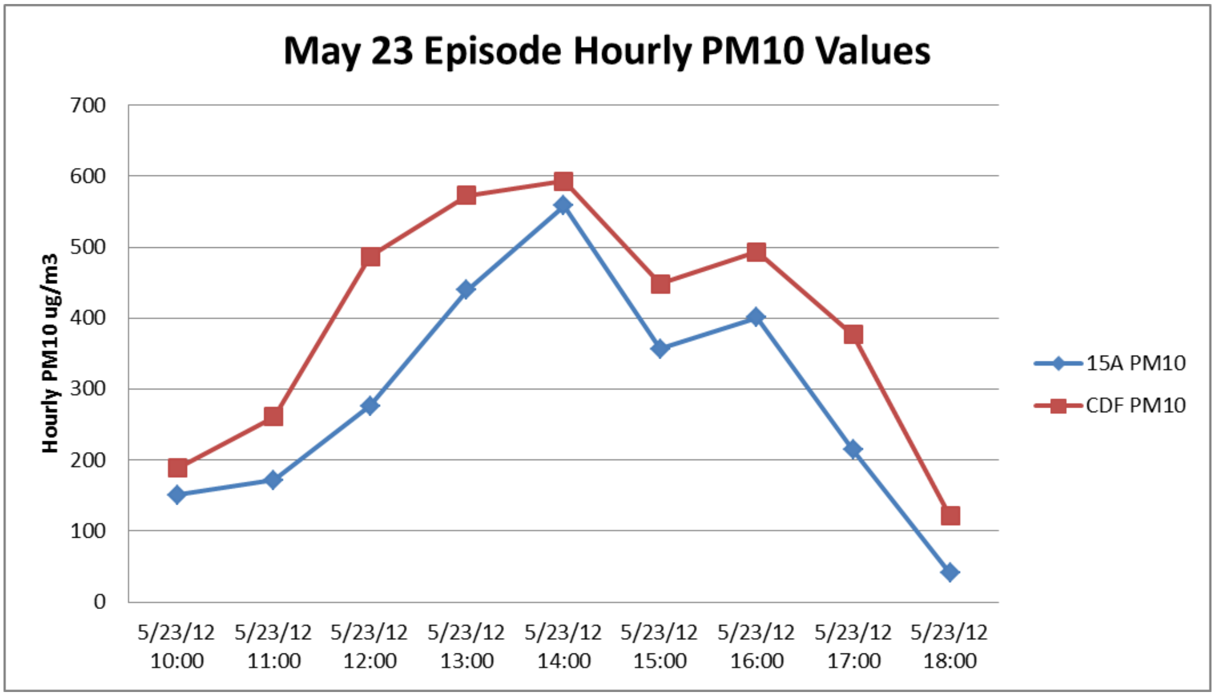


Figure D-9 – Relationship between hourly PM10 at CDF and Site 15A for 5/23/12 Episode

The hourly data set of wind event hours for the entire project period is compared in Figure D-10 below for both the CDF and 15A sites, with the 5/23/12 episode peak hour (hour 14) highlighted. This figure clearly shows that the peak hour of the 5/23/12 episode does not fit with the vast majority of the data. Indeed, when one looks at the average relationship between these sites, an expected pattern of decreasing concentration as the plume moves downwind is apparent. These average relationships between sites for episode days are presented in Table 1 in the main portion of this report.

It is not completely clear why the one peak hour of the highest episode of the study exhibited such a different pattern between the CDF and 15A sites. It is certainly possible, as the reviewer suggests, that the particle deposition that occurs during an episode can be followed by re-entrainment of those particles in subsequent strong wind events. However, the data set suggests the possibility of this having a measurable effect on local PM levels during an episode to be a rare event. Another possibility is that a local disturbance or emissions from a localized source at or near site 15A caused this one hour to be biased high. Such local influence has been noted on a handful of other data values from other sites in the study network. Site 15A was located just a few feet downwind from disturbed soil in a livestock area, and about 0.15 miles downwind from a dirt road. These two small, local sources could potentially emit PM due to both mechanical disturbance and/or wind re-entrainment. However, as noted in the detailed discussion of local sources in Appendix A, such sources have a very limited spatial influence due to their small size, and the PM emissions they might generate will be significant only a tiny fraction of the time. Regardless of the mechanism that caused this outlier value, the data set demonstrates it is a rare occurrence, not the typical or average pattern of the data.

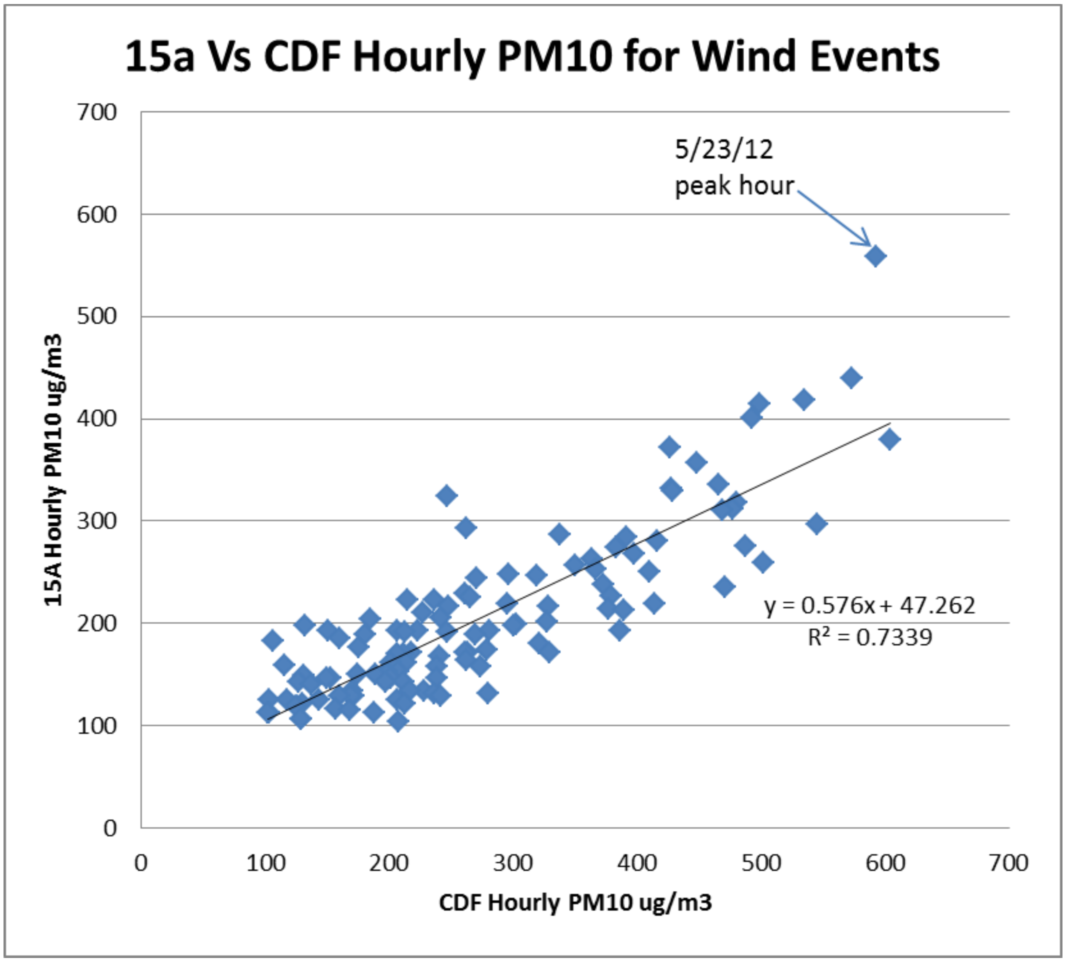


Figure D-10 – Comparison of hourly PM_{10} concentrations at CDF vs. Site 15A for all wind event hours