

PM2.5 Monitoring at the San Ysidro Port-of-Entry

Prepared for the:

U.S. Environmental Protection Agency

By:

**The San Diego Air Pollution Control District
Monitoring and Technical Services Division**

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Executive Summary

A special purpose PM_{2.5} (particulate matter of 2.5 micrometers and less in aerodynamic diameter) analyzer was installed and operated at the San Ysidro Port-of-Entry (POE) to address community concerns about vehicular traffic impacts on air quality. The POE was chosen to measure PM_{2.5} concentrations in the area expected to have the maximum impact from vehicles crossing the border in both directions; especially where a large number of vehicles are idling while waiting for inspection and permission to cross the border.

PM_{2.5} concentrations were measured at two different locations at the San Ysidro POE. The PM_{2.5} concentrations were found to exhibit seasonal, diurnal, and spatially-consistent patterns found at other continuous PM_{2.5} monitoring locations in San Diego county. Although idling vehicles add to local PM_{2.5} concentrations, regional background concentrations from the Tijuana metropolitan area were found to be the predominant source of particulate matter in the border region.

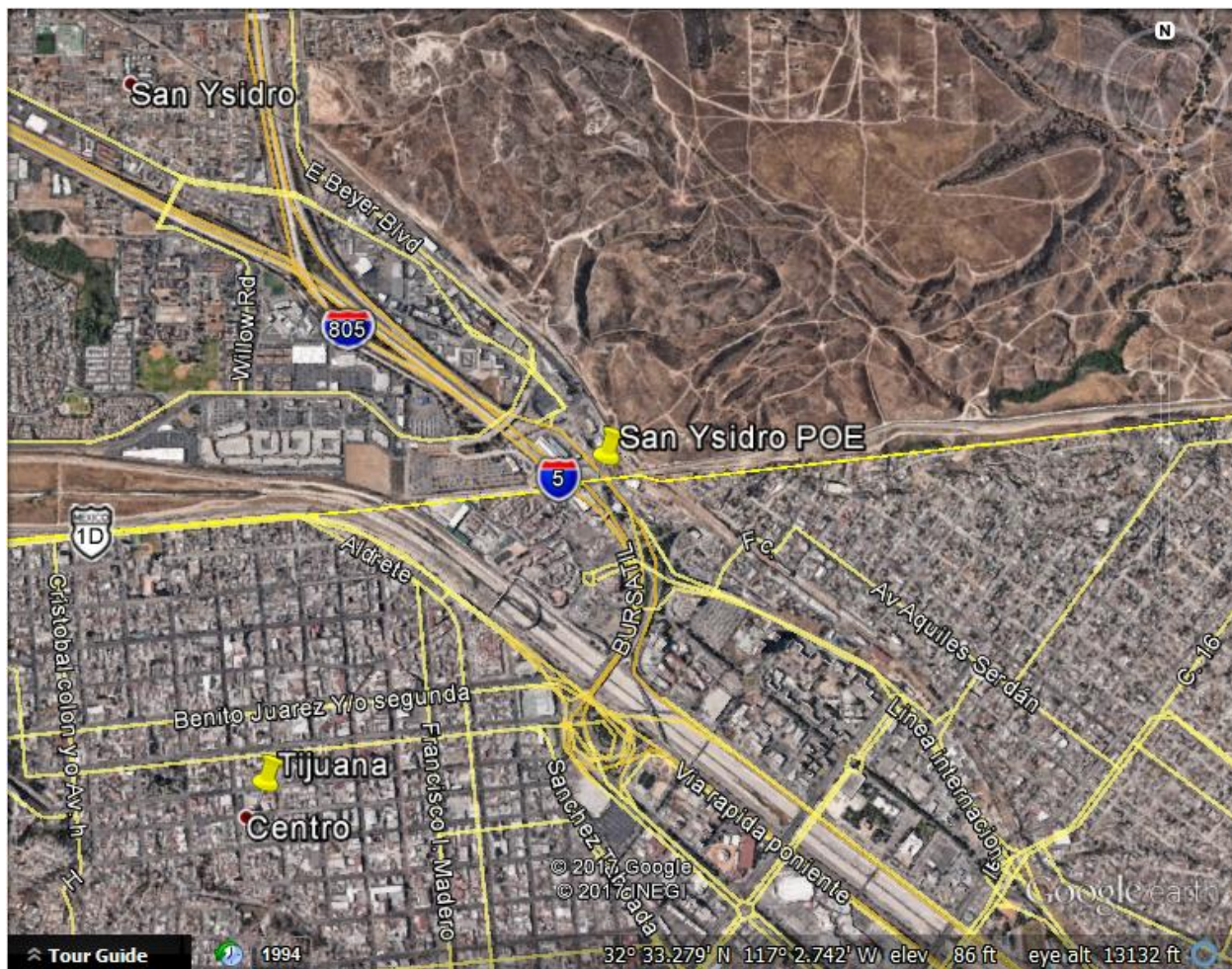
This study has demonstrated that, on average, the border region has higher PM_{2.5} concentrations than other areas of San Diego county. This is primarily due to higher particulate emissions south of the border. Additional PM_{2.5} monitoring in the border area of San Diego county will help determine the degree and extent of the PM_{2.5} impacts in this area, and will help in the development of emissions reduction strategies to reduce particulate pollution in this area.

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Introduction

The San Ysidro border crossing is the busiest land Port-of-Entry (POE) in the Western Hemisphere (<https://www.gsa.gov/about-us/regions/pacific-rim-9/land-ports-of-entry/san-ysidro-land-port-of-entry>). Northbound crossings into the United States average about 1.5 million vehicle and 750,000 pedestrian crossings per month, or roughly 50,000 vehicle and 25,000 pedestrian crossings per day. The community of San Ysidro and nearby communities have longstanding concerns about air quality impacts resulting from the vehicular traffic moving through the region. The San Ysidro POE, surrounding environment, and other features mentioned in this report are shown in Figure 1.

Figure 1. San Ysidro Port-of-Entry (POE) and surrounding environment.



To address community concerns, the U.S. Environmental Agency (EPA) Region 9 funded the San Diego Air Pollution Control District (District) to locate a continuous PM_{2.5} (particulate matter of 2.5 micrometers and less in aerodynamic diameter) analyzer as close to the San Ysidro border crossing as possible to document the impacts of vehicular emissions on the local air

quality. In January 2015, the District deployed a non-regulatory Beta Attenuation Monitor (BAM) PM_{2.5} sensor on the rooftop of a 3-story building overlooking the San Ysidro POE (about 19 meters from the closest traffic lane into the United States). The location of the analyzer was also roughly 16 meters above the level of vehicle lanes. This analyzer became operational on January 27, 2015 (a photo of the rooftop PM_{2.5} monitoring site, designated as SAY, is shown in Figure 2). To help characterize the PM_{2.5} data collected, a portable meteorological station was added in April 2015. Unfortunately, the building's scheduled demolition was moved up, and the District had to remove the analyzer on March 22, 2016.

Figure 2. San Ysidro Port-of-Entry (POE) rooftop location (SAY) of PM_{2.5} analyzer.



In an attempt to meet all monitoring goals, a new location was found about 180 meters to the southwest in a street-level parking lot, which is just west of the exit point out of the United States (just west of the nearest southbound lane of Interstate 5 – see Figure 3). Operations resumed there on June 6, 2016 (designated as SAY2). However, this location was short-lived as planned construction was once again moved forward. This forced the District to discontinue monitoring on August 24, 2016. Figure 3 shows the location of both sites in relation to the northbound POE. With no other immediate border sites available, this concluded the PM_{2.5} monitoring at the POE. The monitoring dates for each site are summarized in Table 1.

Figure 3. Location of the initial rooftop (SAY) PM_{2.5} monitoring site and the ground-level (SAY2) site at the San Ysidro POE.

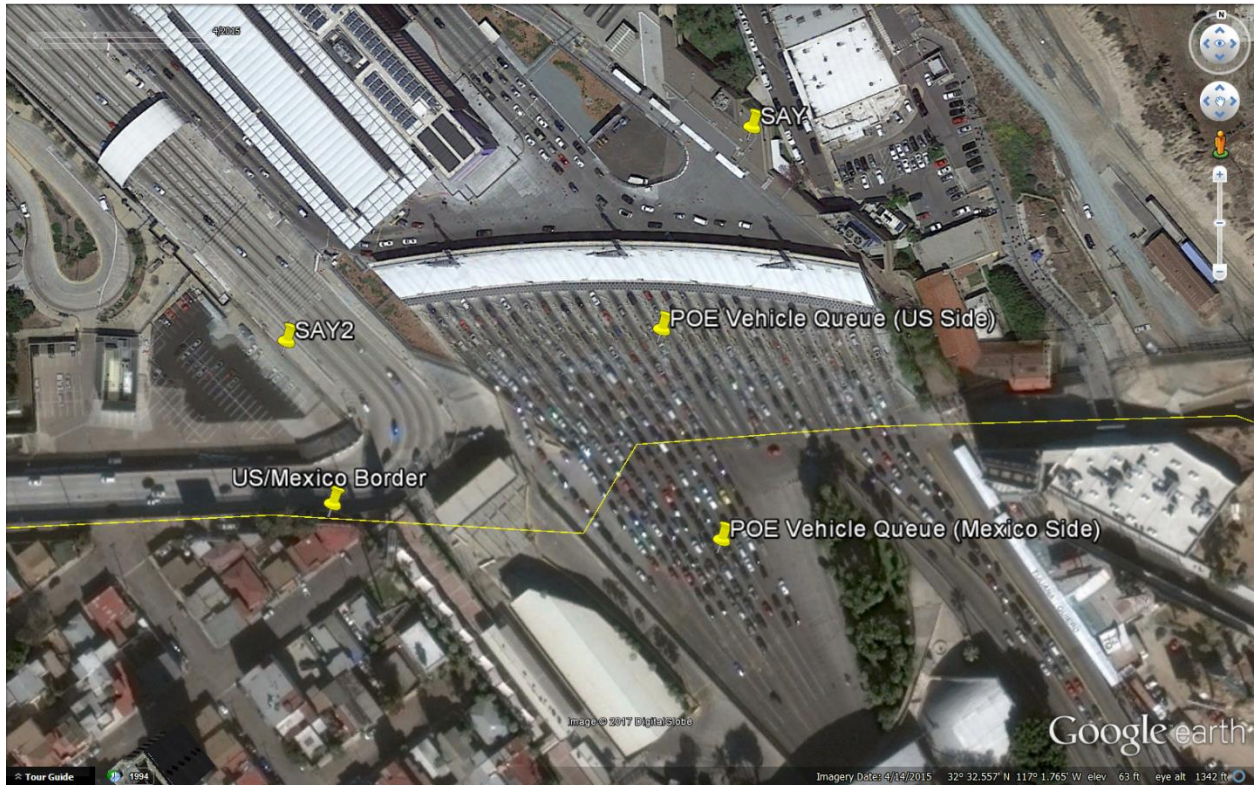


Table 1. Monitoring dates, including meteorological monitoring for the two POE monitoring sites.

Site	PM _{2.5} Monitoring Dates	Meteorological Monitoring Dates
SAY	January 28, 2015 through March 21, 2016	April 15, 2015 through March 21, 2016
SAY2	June 7, 2016 through August 23, 2016	June 7, 2016 through August 23, 2016

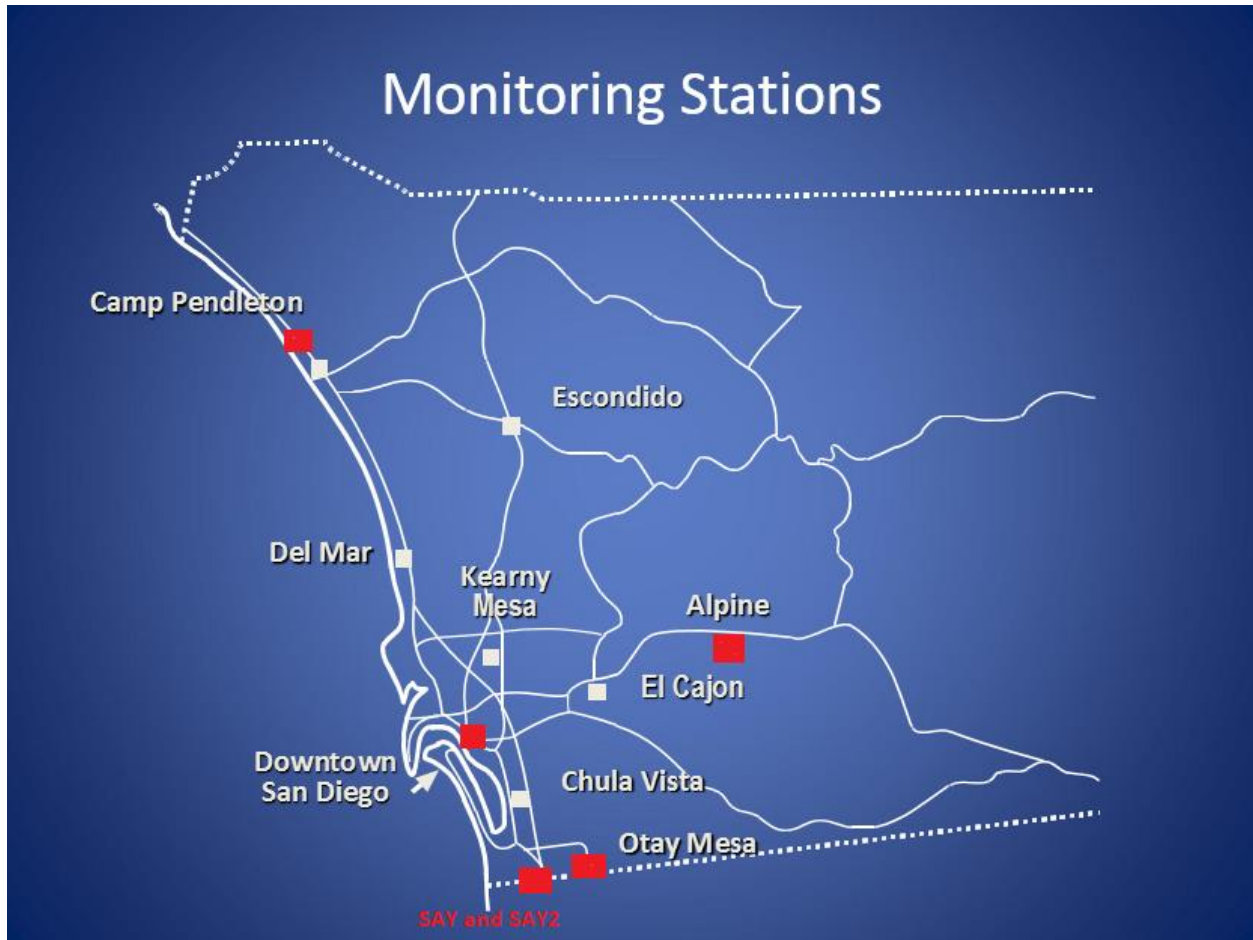
Additionally, this PM_{2.5} monitoring supplemented the Border 2020 Environment Program – a binational collaborative effort with a mission to protect human health and the environment along the U.S. – Mexico border.

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Data Analysis

The District operates a network of air quality monitoring stations located in the major population centers of the county. These stations monitor for criteria pollutants (i.e., ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, particulate matter (including $PM_{2.5}$ and PM_{10}), lead (Pb)), toxic metals, and a wide-variety of toxic and photochemical precursor gases. Four of these monitoring stations included non-regulatory BAM units (shown in red in Figure 4). [Note: The inland valley Escondido site (ESC) also operated a non-regulatory BAM at the beginning of the POE monitoring project but was discontinued due to a property repurpose/renovation. The inland valley El Cajon sites were also not measuring continuous $PM_{2.5}$ during the POE monitoring project due to numerous site relocations.]

Figure 4. Map showing locations of continuous $PM_{2.5}$ monitoring site locations referenced in this report (marked in red).



The countywide continuous $PM_{2.5}$ data averages for the period when the rooftop San Ysidro POE site (SAY) was operational are compared against the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ in Figure 5. The data shows that the highest average $PM_{2.5}$ concentration occurred at the sites nearest the border. SAY was the highest, followed by the Donovan (DVN –

in Otay Mesa) site. The coastal sites – Perkins Elementary School (PES – in Downtown San Diego) in Barrio Logan (an Environmental Justice (EJ) community) and Camp Pendleton (CMP – north of Oceanside) were lower and almost identical. The foothills site in Alpine (ALP), which has the fewest local emissions sources and is frequently above the marine layer, had the lowest average concentration. Detailed monitoring site information for SAY are included in Table 2.

Figure 5. Average PM_{2.5} concentrations by site for the entire monitoring period (January 28, 2015 through March 21, 2016) at the initial San Ysidro POE site (SAY). The annual PM_{2.5} NAAQS is represented by a horizontal purple line.

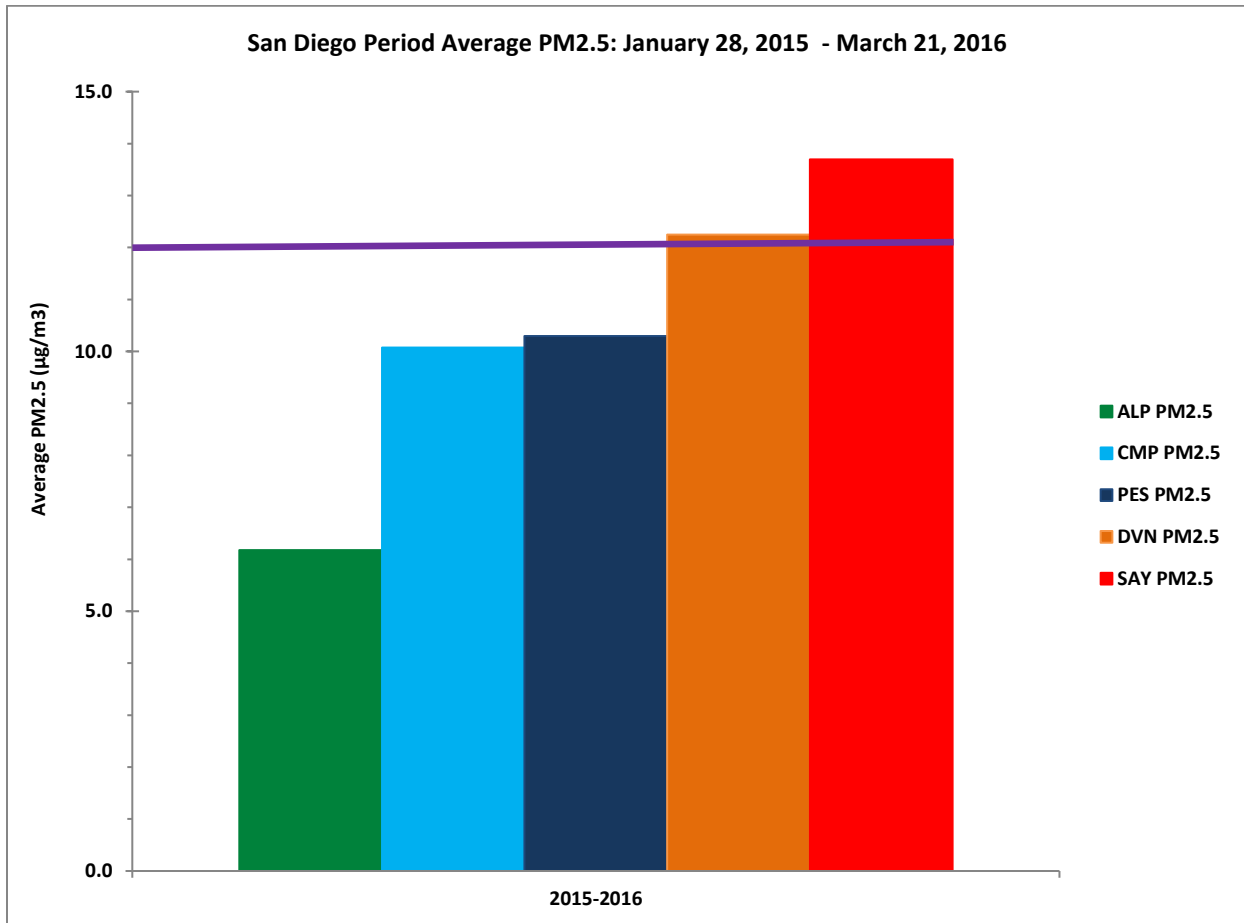
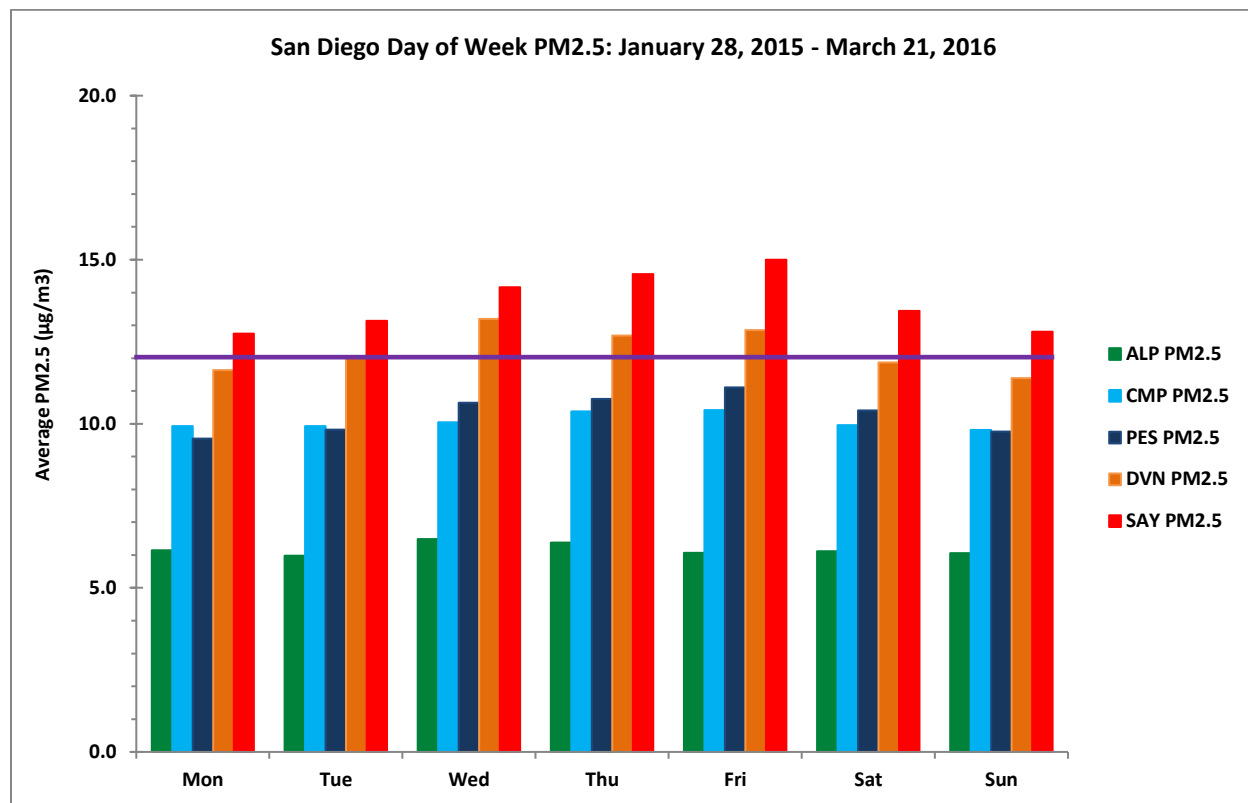


Table 2. San Ysidro site (SAY) information for the initial rooftop location at the San Ysidro POE.

County:	San Diego
Representative Area:	San Diego MSA
Site Name:	San Ysidro
Year Established:	1/27/2015
Site Address:	795 East San Ysidro Blvd.
Site Name Abbreviation:	SAY
AQS Number:	06-073-1019
Latitude:	32.543475 ^o
Longitude:	-117.029028 ^o
Elevation above Sea Level:	20 m
General Location:	Rooftop of Federal detention facility
Ground Cover:	Paved
Distance to Road:	19 meters (Border Crossing lanes)
Traffic Count (2010 AADT):	AADT= 39, 691 (from border crossing)
Site Description:	On the rooftop of the Federal detention facility overlooking the San Ysidro Border Point of Entry (POE)/border crossing. This site is intended for the EPA Border 2020 program and is to measure the PM _{2.5} contributions from the POE.
Monitoring Objectives:	To quantify airborne particulates from the San Ysidro POE
Planned Changes:	Relocation about 180 meters east-southeast, due to demolition of the building on which the sampler is located.

The majority of PM_{2.5} measured at San Diego sites is directly emitted into the atmosphere (known as primary PM_{2.5}; secondary particulates are formed through chemical reactions in the atmosphere). Therefore, PM_{2.5} generally builds up throughout the County during the week and is lowest on weekends. This is confirmed in the day-of-week averages for all continuous PM_{2.5} monitoring sites shown in Figure 6. The Alpine site (ALP), which is further from emission sources, does not reflect the day-of-week pattern of the other sites.

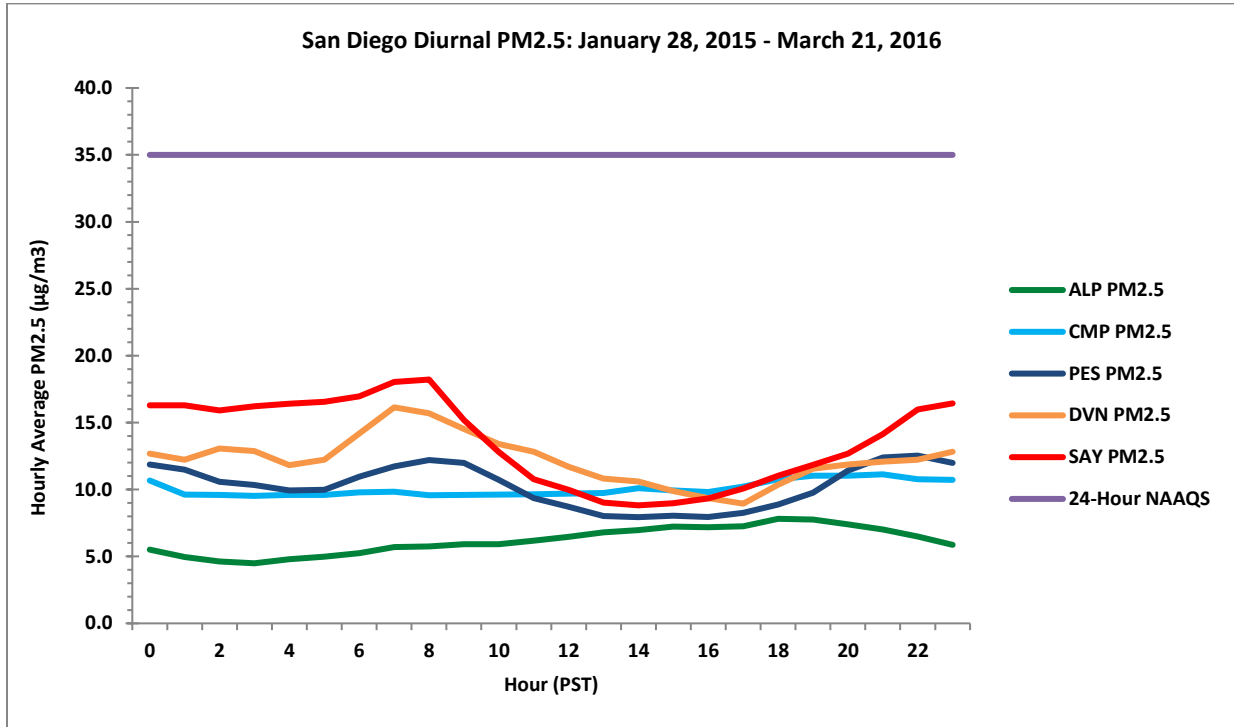
Figure 6. Average PM_{2.5} concentrations by day-of-week and site for the entire monitoring period (January 28, 2015 through March 21, 2016) at the rooftop San Ysidro POE site (SAY). The annual PM_{2.5} NAAQS is represented by a horizontal purple line.



Since the majority of pollutant emissions in San Diego county come from mobile sources, we can expect that a diurnal pattern will be found in the continuous PM_{2.5} data. As shown in Figure 7, this is indeed the case. The pattern is most exaggerated at SAY, with a peak during the morning commute when the atmosphere is most stable. This is followed by a steady decrease in PM_{2.5} concentrations as temperatures increase, atmospheric stability decreases, and sea breeze circulations develop during the day. As the evening commute begins and atmospheric stability again increases, there is a steady climb in PM_{2.5} concentrations, which continues throughout the night.

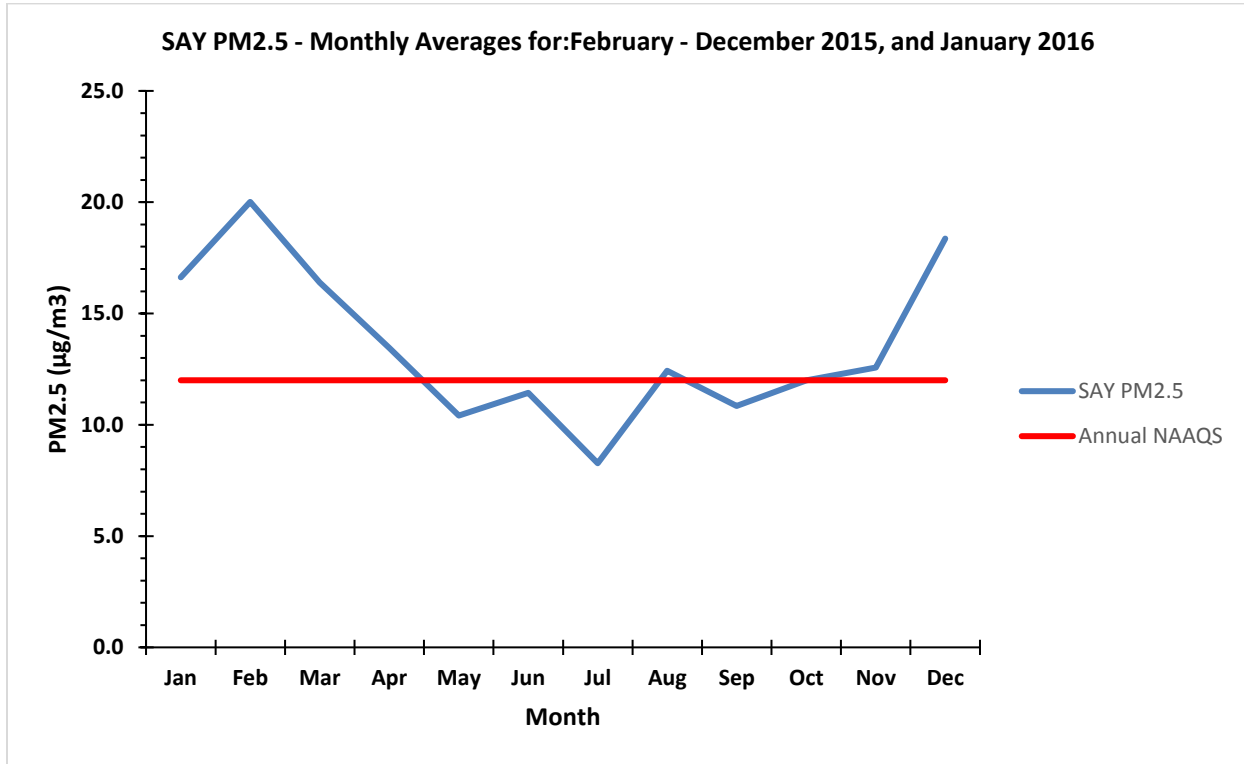
While this pattern is similar at PES and DVN, there is a minimum late at night before the morning commute starts. This is the result of fewer emissions occurring late at night in these areas. CMP and ALP both show less diurnal variation, with an evening maximum coinciding with or just after the evening commute. It is also apparent that for much of the daylight hours, DVN has higher PM_{2.5} concentrations than SAY. This indicates that regional PM_{2.5} concentrations are higher than emissions directly associated with the San Ysidro POE.

Figure 7. Average diurnal PM_{2.5} concentrations by site for the entire monitoring period (January 28, 2015 through March 21, 2016) at the rooftop San Ysidro POE site (SAY).



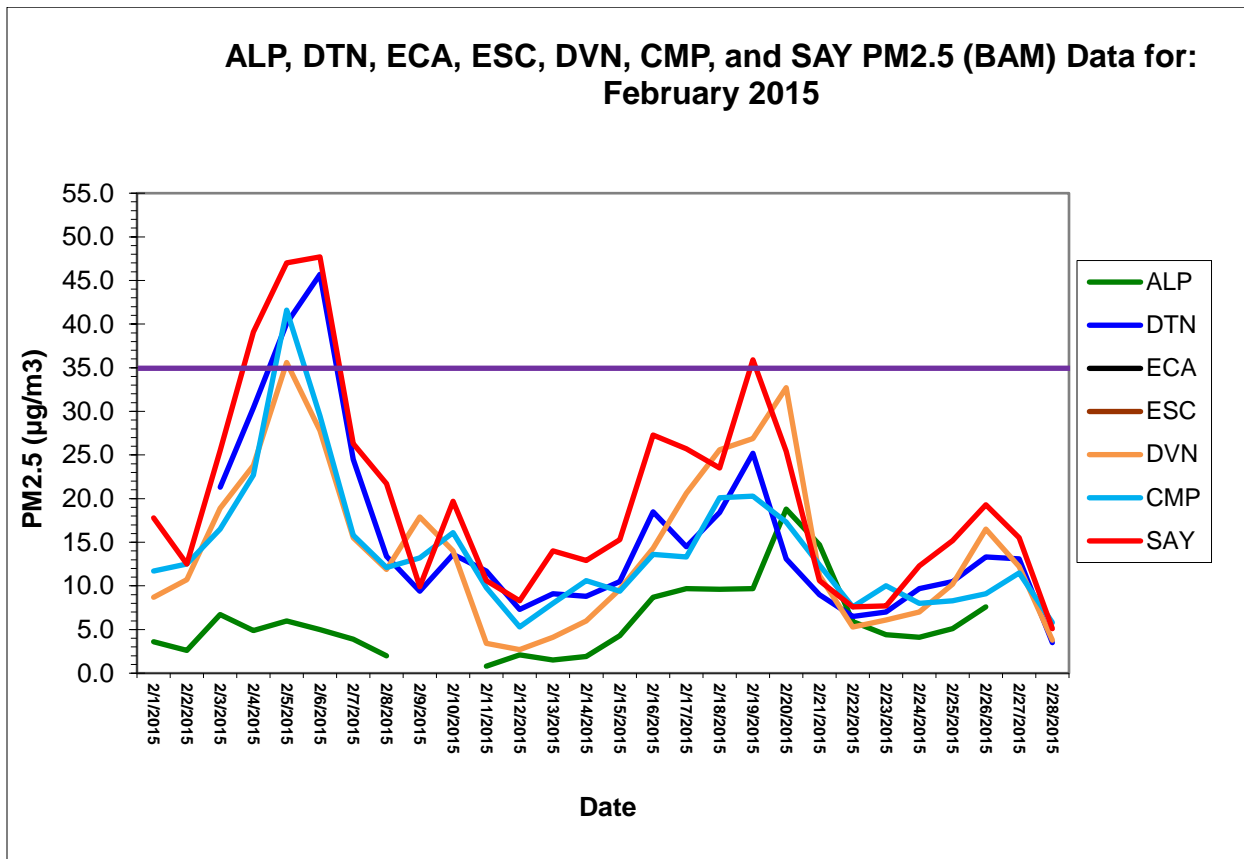
Under usual conditions, PM_{2.5} concentrations tend to be highest in the winter months. This is primarily due to increased atmospheric stability caused by surface cooling and the subsequent development of surface-based nocturnal inversions during the long nights of winter. This was indeed the case for the rooftop SAY monitoring site. Figure 8 shows the monthly average PM_{2.5} concentrations for each month of the year, which clearly shows higher monthly averages during winter months and lower values during summer months (longer days/shorter nights, reduced atmospheric stability, and stronger, more pronounced sea breezes).

Figure 8. Monthly average PM_{2.5} concentrations at the rooftop San Ysidro POE site (SAY).



Since PM_{2.5} particles are so small, they can remain airborne for days to weeks at a time, depending upon weather conditions and atmospheric stability conditions. This leads to regional patterns of PM_{2.5} concentrations more influenced by large-scale atmospheric conditions than simply by localized emissions. This can be seen in the daily 24-hour averages for all BAM units operational during February 2015 shown in Figure 9. This plot shows regional PM_{2.5} concentrations going up and down in response to atmospheric conditions (higher during stable atmospheric conditions and lower during less stable conditions). This plot also shows how the Alpine site (ALP) can have much lower PM_{2.5} concentrations when atmospheric conditions isolate this elevated site above the atmospheric boundary layer where most emissions occur.

Figure 9. 24-hour PM_{2.5} averages measured by BAM units in the San Diego Air Basin during February 2015. The 24-hour NAAQS for PM_{2.5} is represented by a horizontal purple line.



Wind roses are a convenient way to summarize the wind speed and direction values measured at a given location. They are also useful to indicate the direction that pollutants will move with the prevailing winds. A wind rose plot for the entire monitoring period when meteorological data were collected (April 15, 2015 through March 21, 2016) at the rooftop location (SAY) is shown in Figure 10. The winds are predominantly out of the west-northwest to northwest (wind rose plot points in the direction that the wind blows from, the percent of time for that direction, and the speed is color-coded in ranges), with a smaller peak out of the east-southeast. During the overnight hours (hours 0000 to 0700 Pacific Standard Time (PST)), the winds are predominantly from the east-southeast (Figure 11). Figures 12 and 13 show that during the daytime (hours 0800 to 1500 PST) and evening (hours 1600 to 2300 PST), respectively, the winds are overwhelmingly out of the west-northwest and northwest. This analysis shows that the highest diurnal PM_{2.5} values (overnight) are when the wind is predominantly out of the ESE, blowing from Tijuana and across the traffic lanes at the POE.

Figure 10. Wind rose at SAY for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 0000 to 2300 PST.

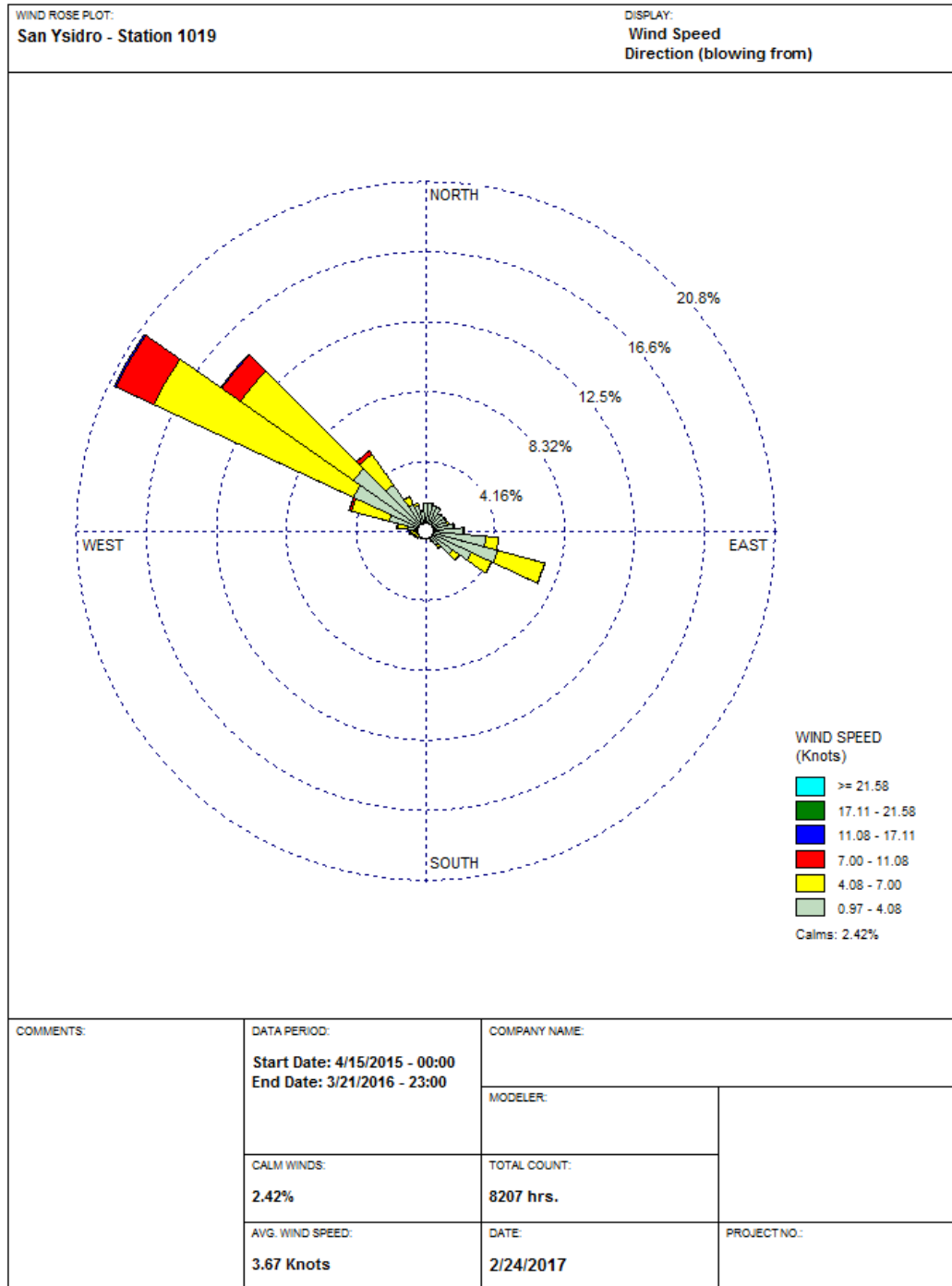


Figure 11. Wind rose at SAY for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 0000 to 0700 PST.

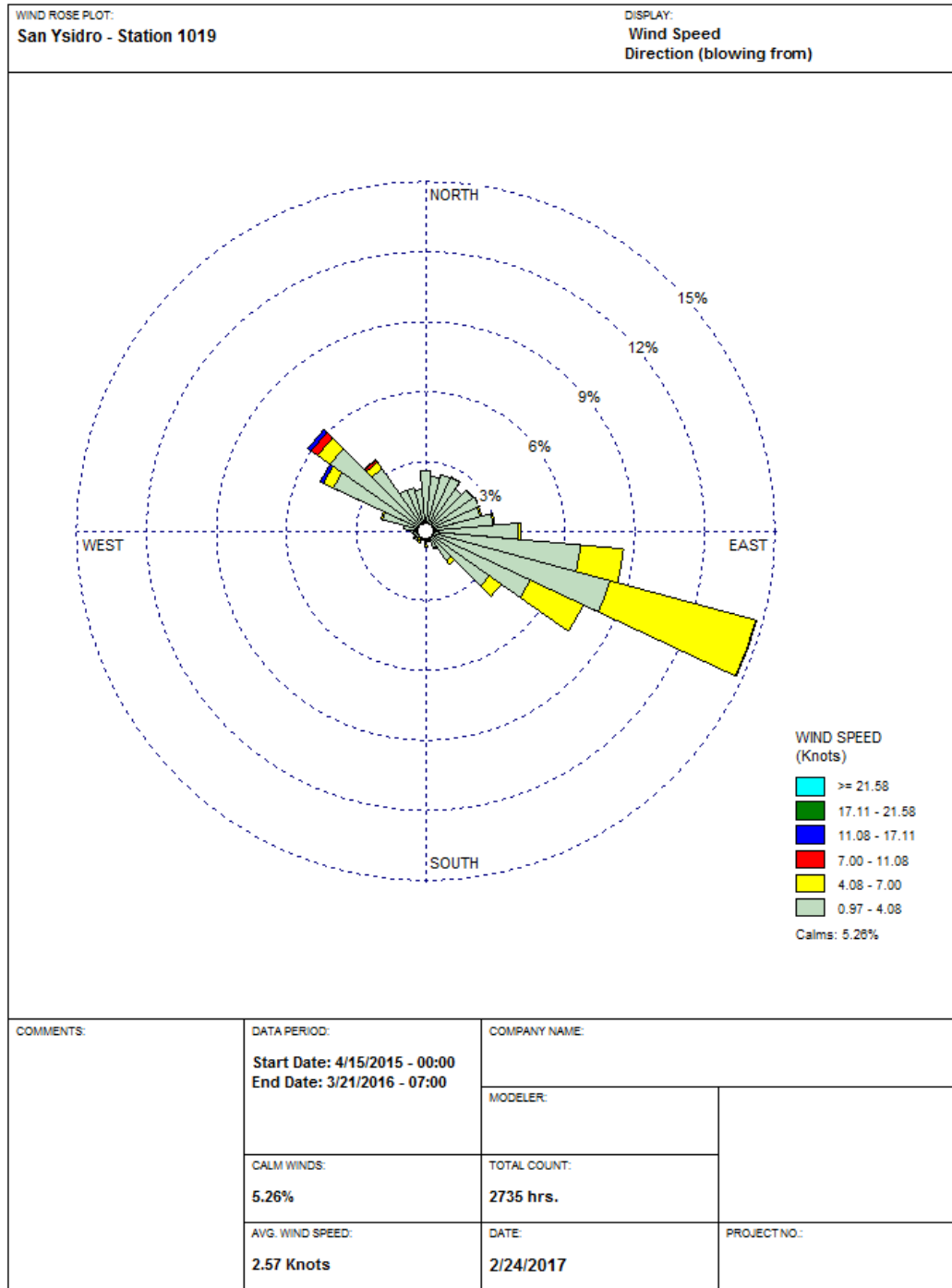


Figure 12. Wind rose at SAY for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 0800 to 1500 PST.

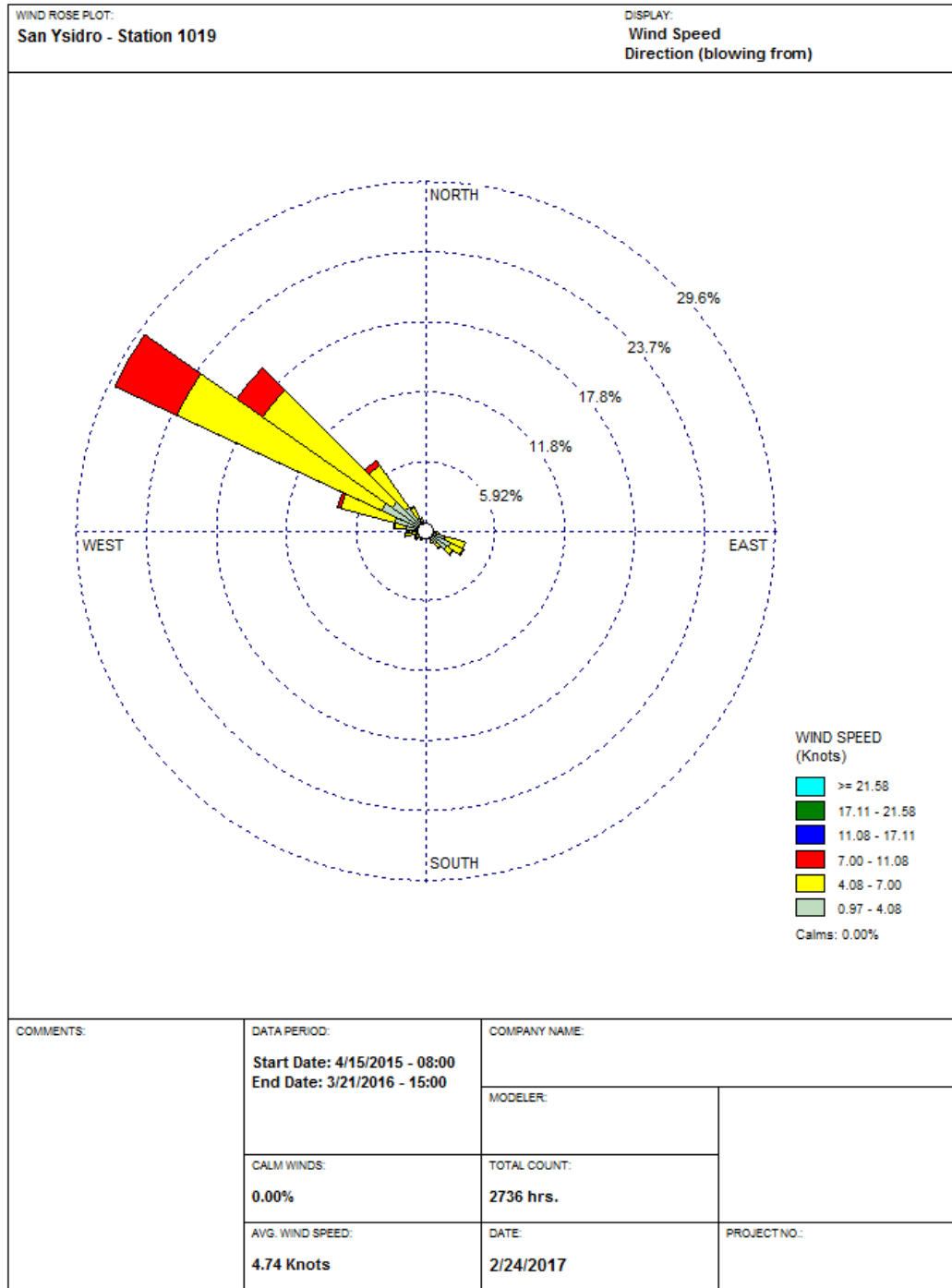
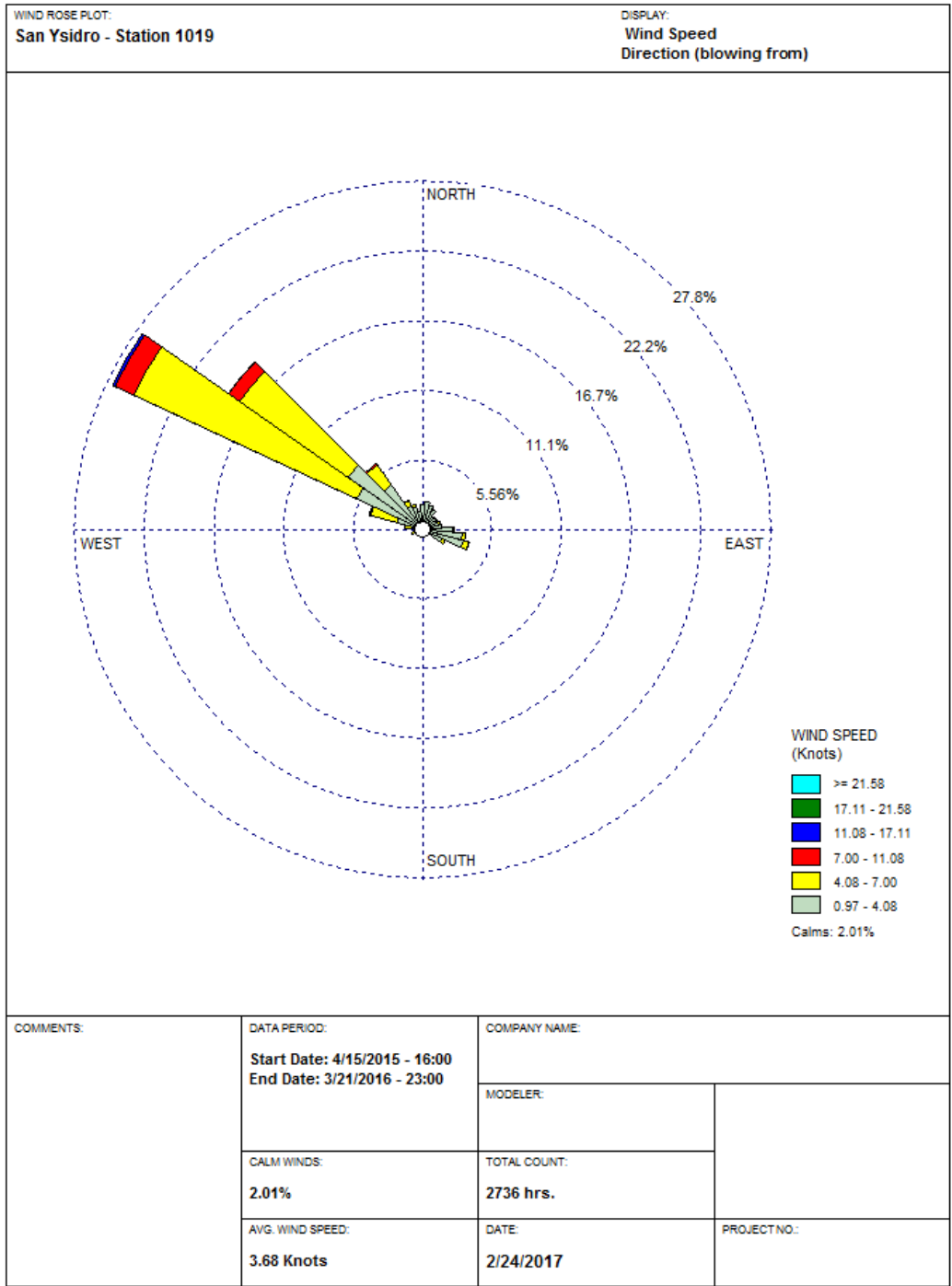


Figure 13. Wind rose at SAY for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 1600 to 2300 PST.



A pollutant rose is a variation of a wind rose, where the pollutant of interest is plotted against the wind direction. Color-coding is used to show the hourly pollutant concentrations based on the 24-hour NAAQS for PM_{2.5} Air Quality Index (AQI) in the pollutant roses in this report (green for Good (hourly concentrations 0.0 to 12.0 µg/m³; yellow for Moderate (12.1 to 35.4); orange for Unhealthy for Sensitive Groups (35.5 to 55.4); and red for Unhealthy (≥ 55.5)). In the PM_{2.5} pollutant roses, the wind barbs show the direction the wind blows from, and length of the barbs indicates the percentage of time that PM_{2.5} concentrations are within the indicated range of values. A PM_{2.5} pollutant rose for SAY is shown in Figure 14, which clearly shows the highest PM_{2.5} concentrations occur when the wind is blowing from the east-southeast (i.e., from Tijuana region and traffic waiting to cross the border). Figure 15 shows the hours 0000 to 0700 PST at SAY, which further confirms that the highest PM_{2.5} concentrations occur overnight, when the winds are predominantly from the east-southeast and the atmosphere is most stable. For the daytime period (0800 to 1500 PST – see Figure 16) the pollutant rose shows the lowest values when the wind is overwhelmingly from the west-northwest to northwest. Figure 17 shows what was seen in the diurnal plot of PM_{2.5} concentrations (Figure 7), where concentrations increase in the evening hours as the winds begin to shift offshore and from the east-southeast.

Figure 14. PM_{2.5} pollutant rose at SAY for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 0000 to 2300 PST.

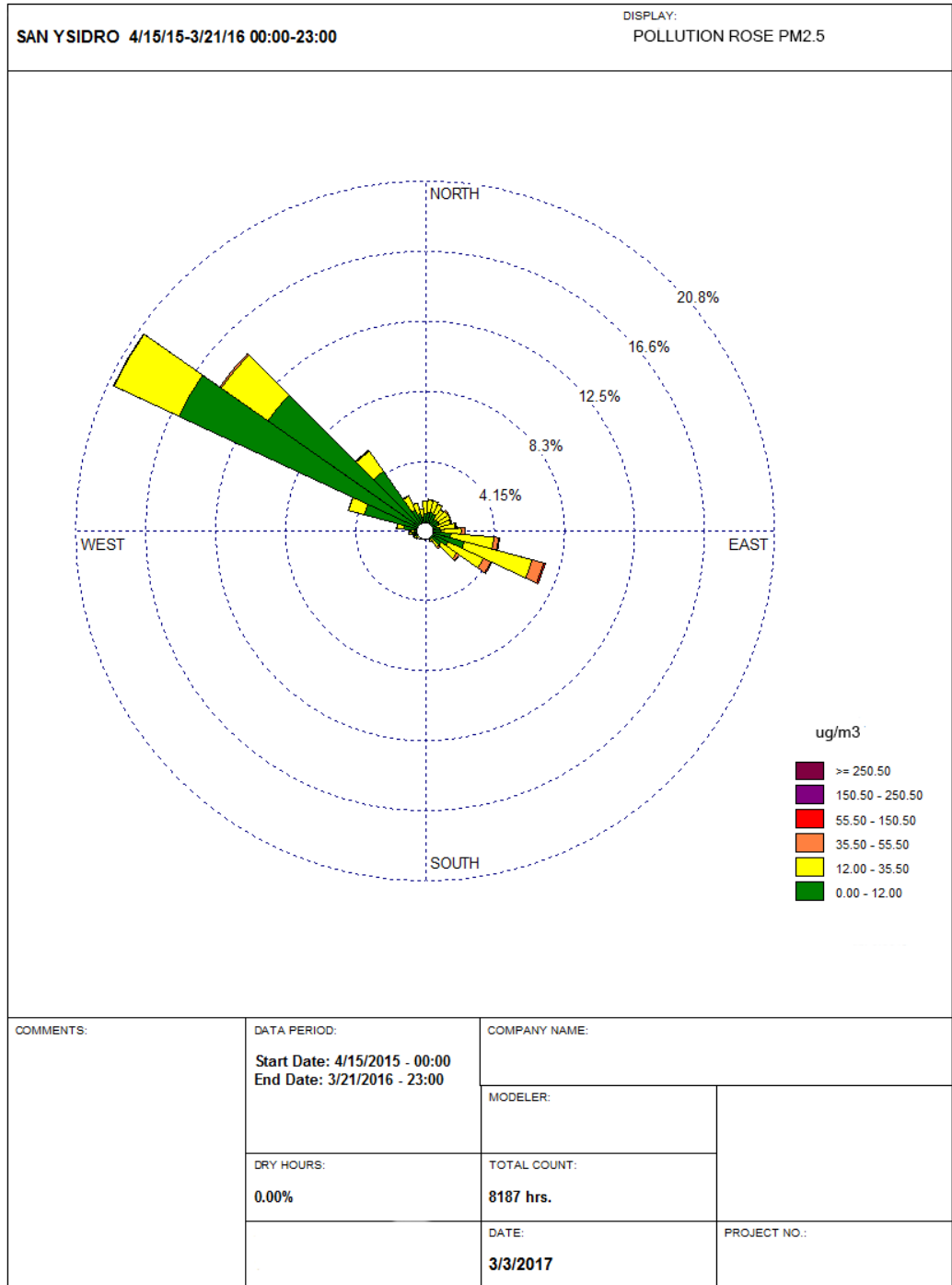


Figure 15. PM_{2.5} pollutant rose at SAY for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 0000 to 0700 PST.

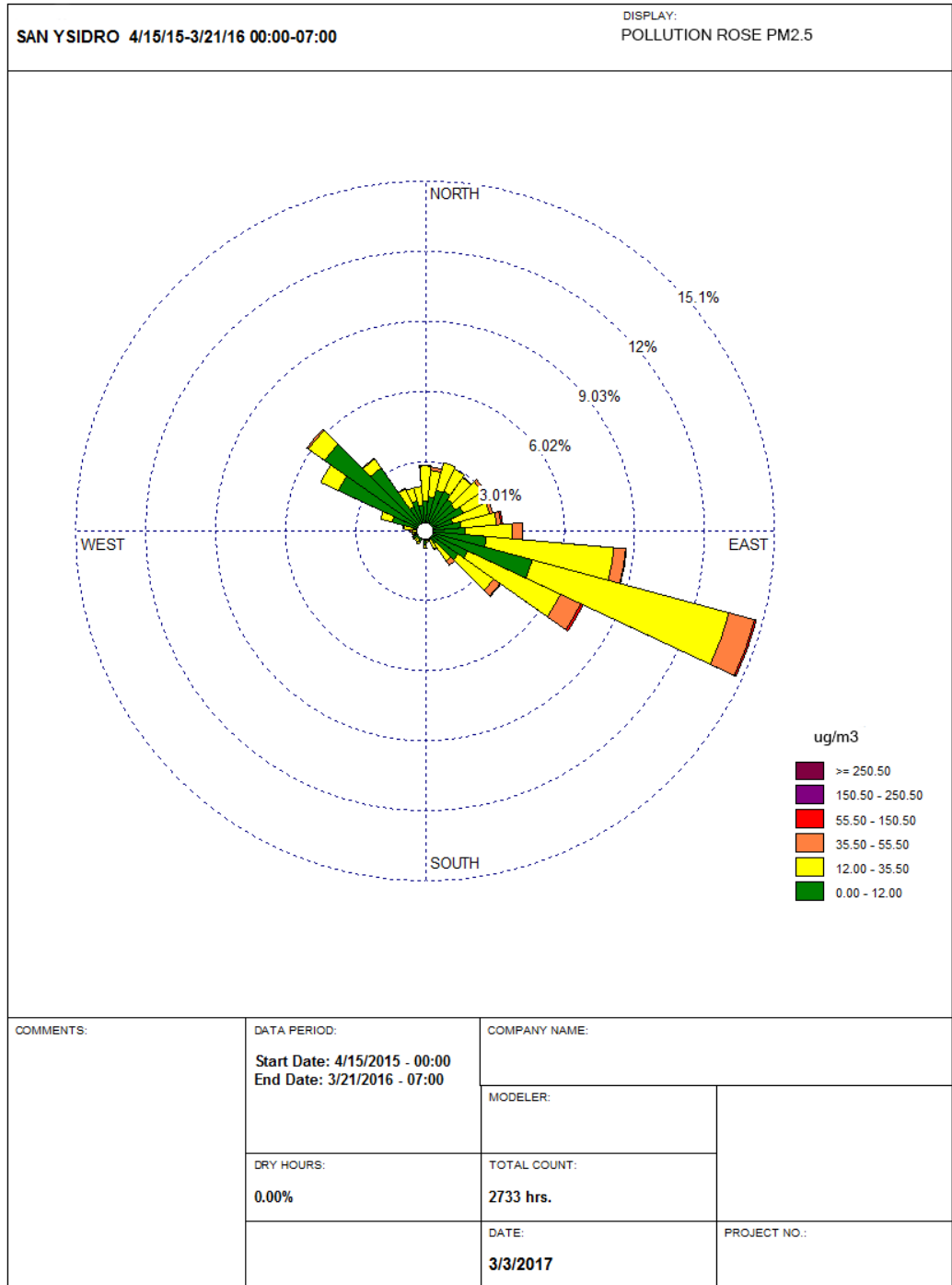


Figure 16. PM_{2.5} pollutant rose at SAY for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 0800 to 1500 PST.

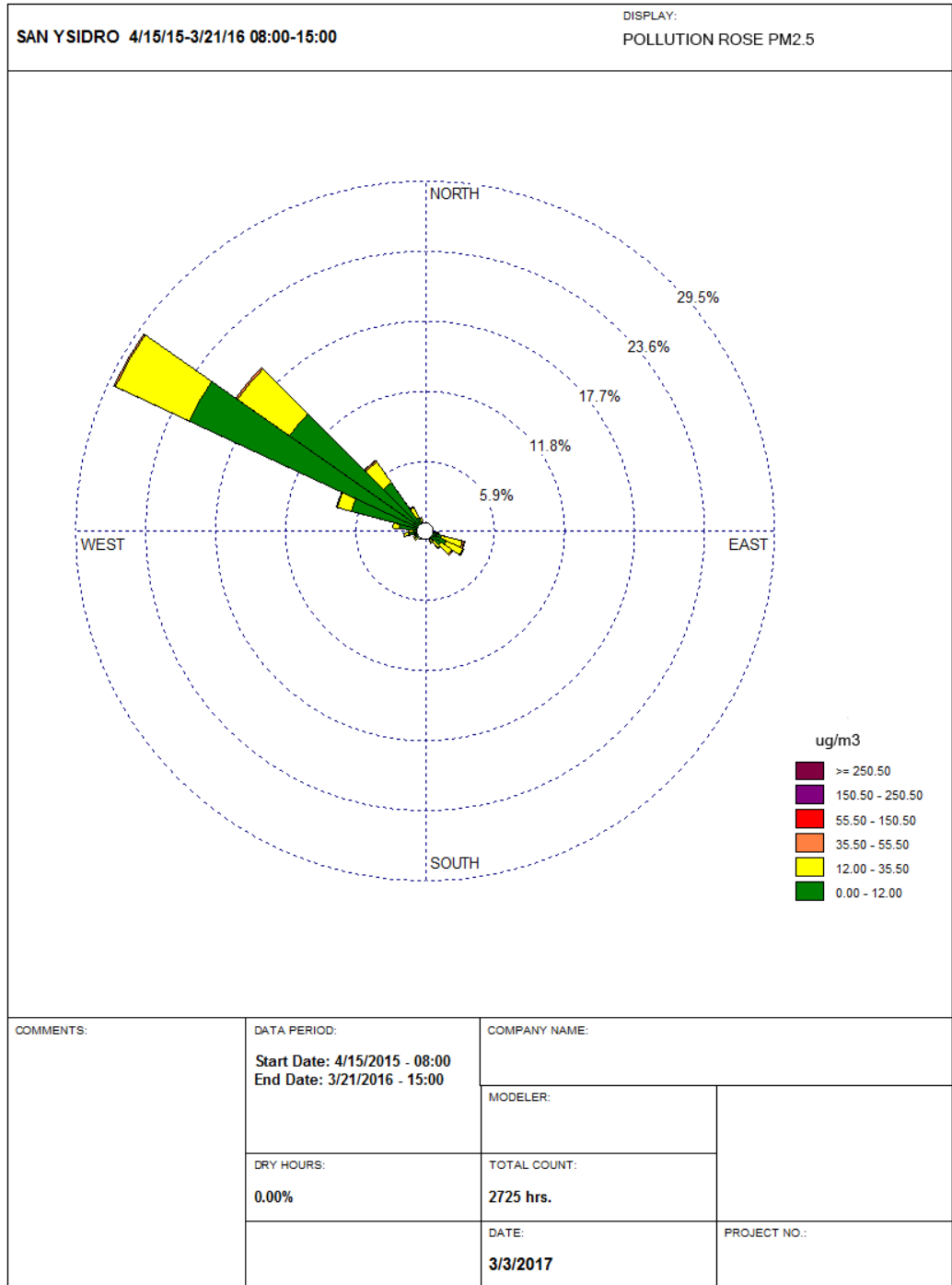
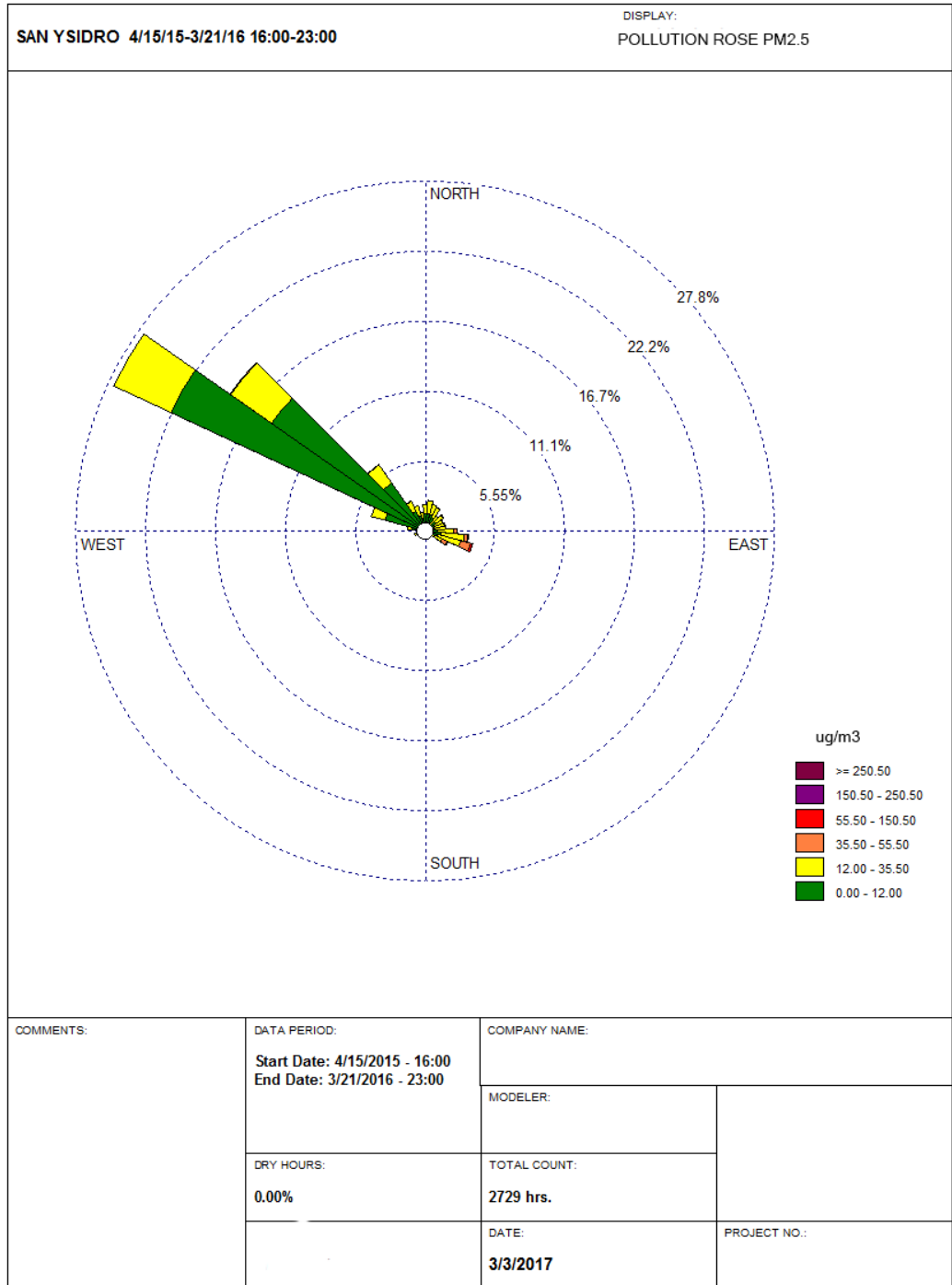


Figure 17. PM_{2.5} pollutant rose at SAY for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 1600 to 2300 PST.



At the Otay Mesa – Donovan site (DVN), the PM_{2.5} pollutant roses show very similar patterns to the SAY location. The wind direction again is predominantly from the west-northwest and the maximum PM_{2.5} concentrations coincide with the winds from the southeast at night (Figure 18). However, the winds are a bit more varied at the DVN site. This is due to differences in topography between the sites as well as the 10m height above ground level for the meteorological tower at DVN. The highest PM_{2.5} concentrations occur during the 0000 to 0700 PST time period when the winds are from the southeast (Figure 19). There are occasionally elevated concentrations during the day as well (0800 to 1500 PST), although these generally occur early in the time period – recirculated from earlier southerly winds (Figure 20). Finally there are also some elevated concentrations in the evening hours (1600 to 2300 PST - Figure 21) when the winds shift (from the southeast). This again resembles what was seen at the SAY site. This adds further evidence that the source of higher PM_{2.5} concentrations is from south of the border, and not simply due to local traffic at the POE.

Figure 18. PM_{2.5} pollutant rose at DVN for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 0000 to 2300 PST.

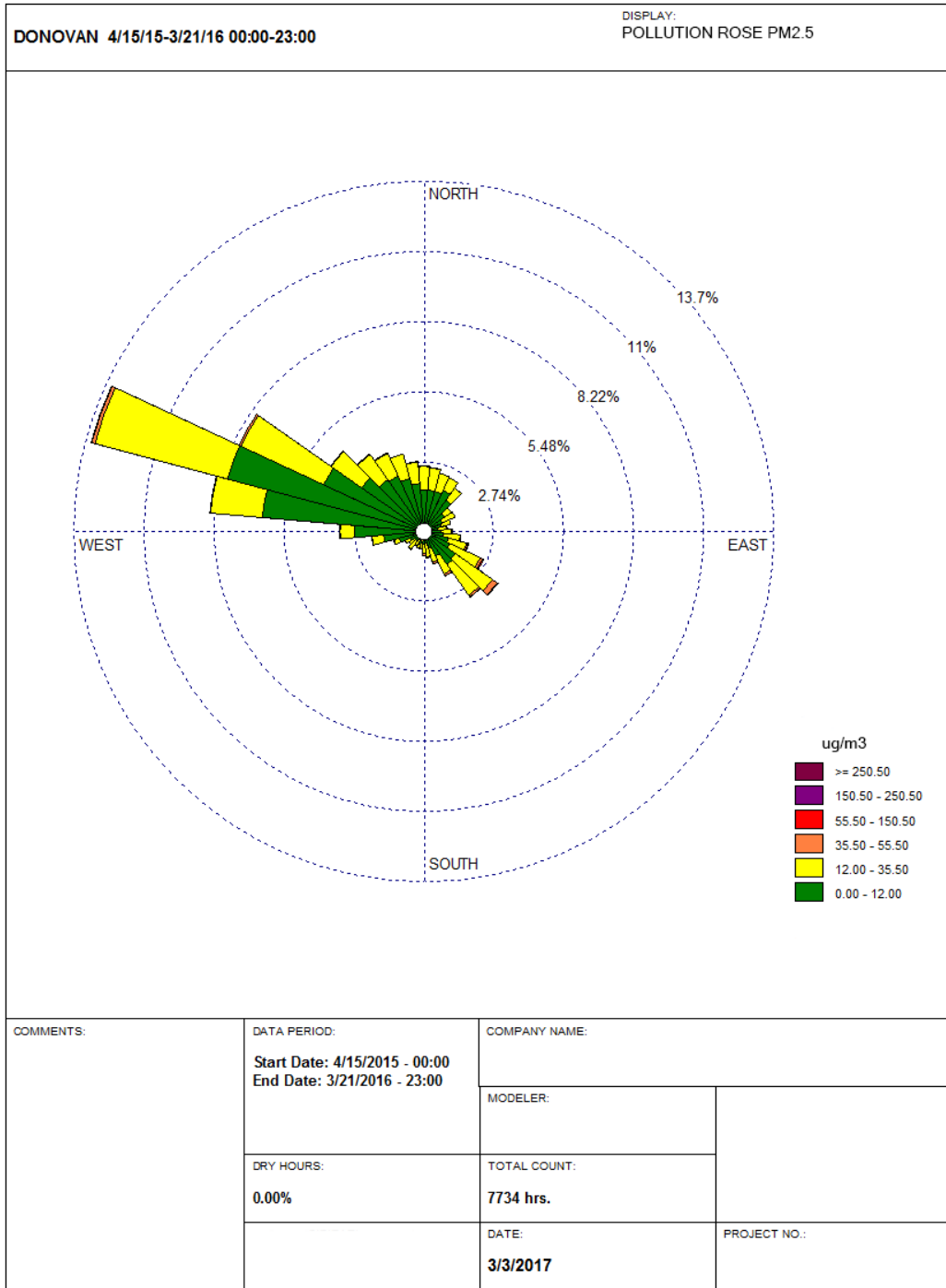


Figure 19. PM_{2.5} pollutant rose at DVN for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 0000 to 0700 PST.

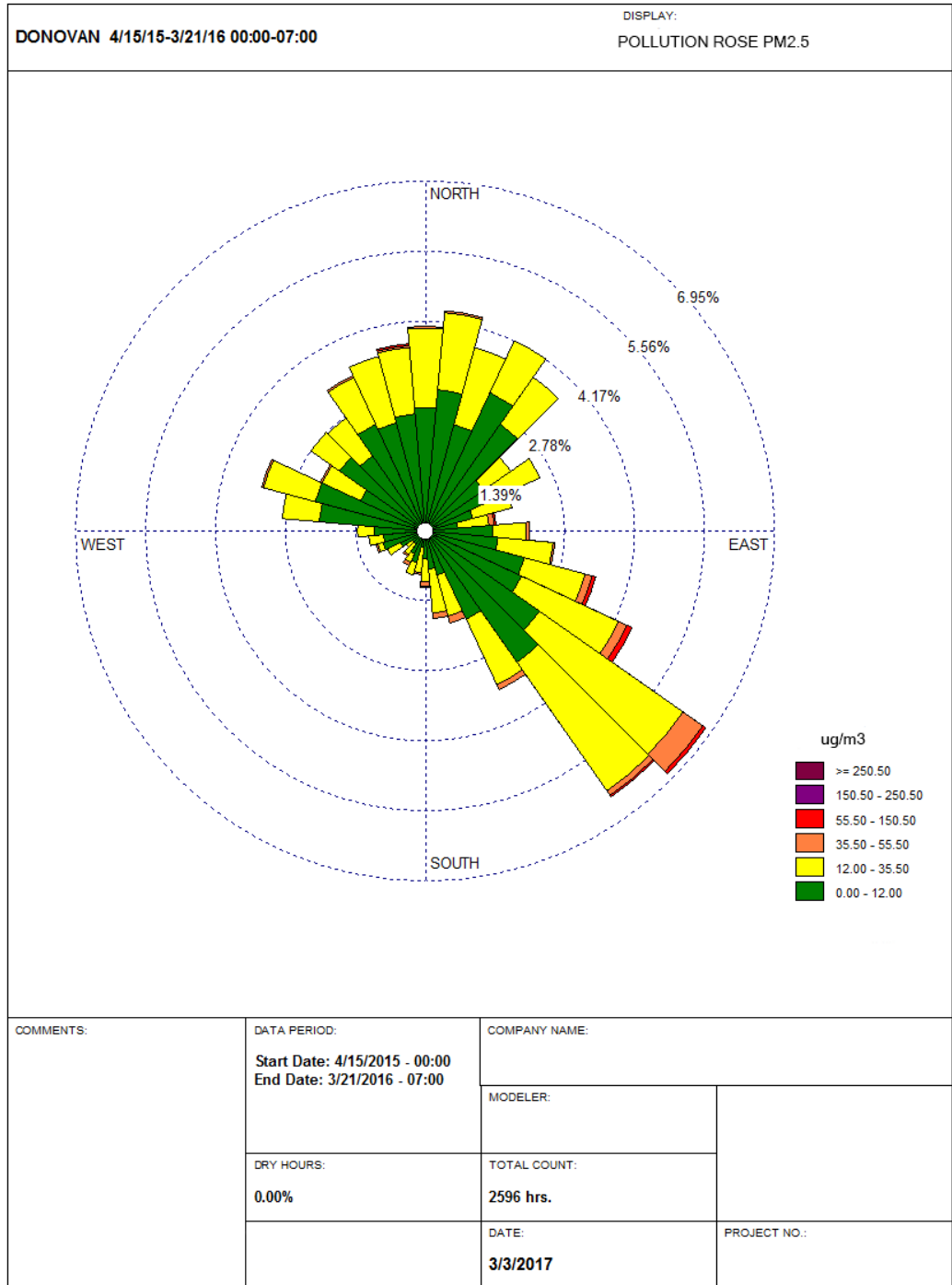


Figure 20. PM_{2.5} pollutant rose at DVN for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 0800 to 1500 PST.

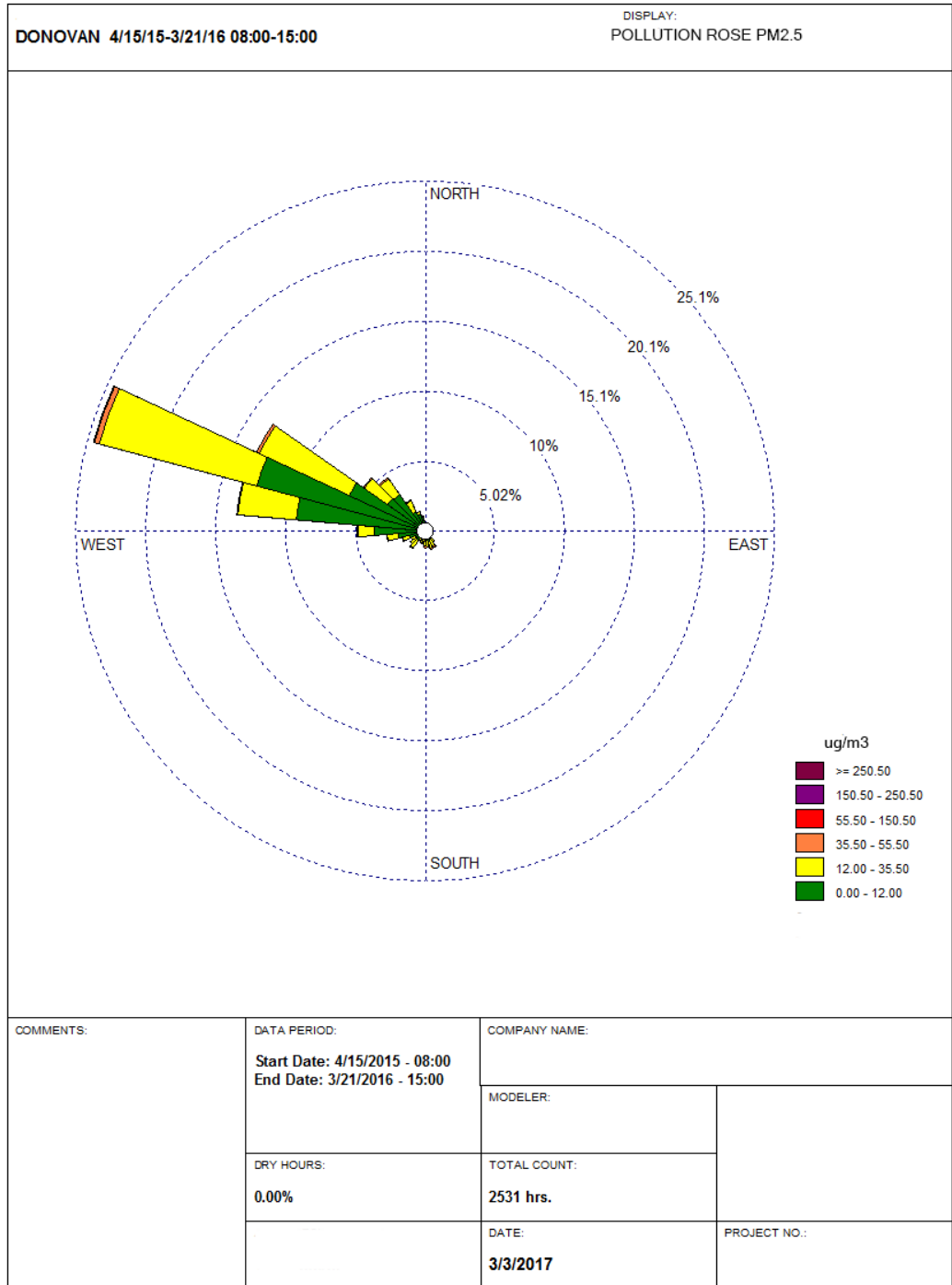
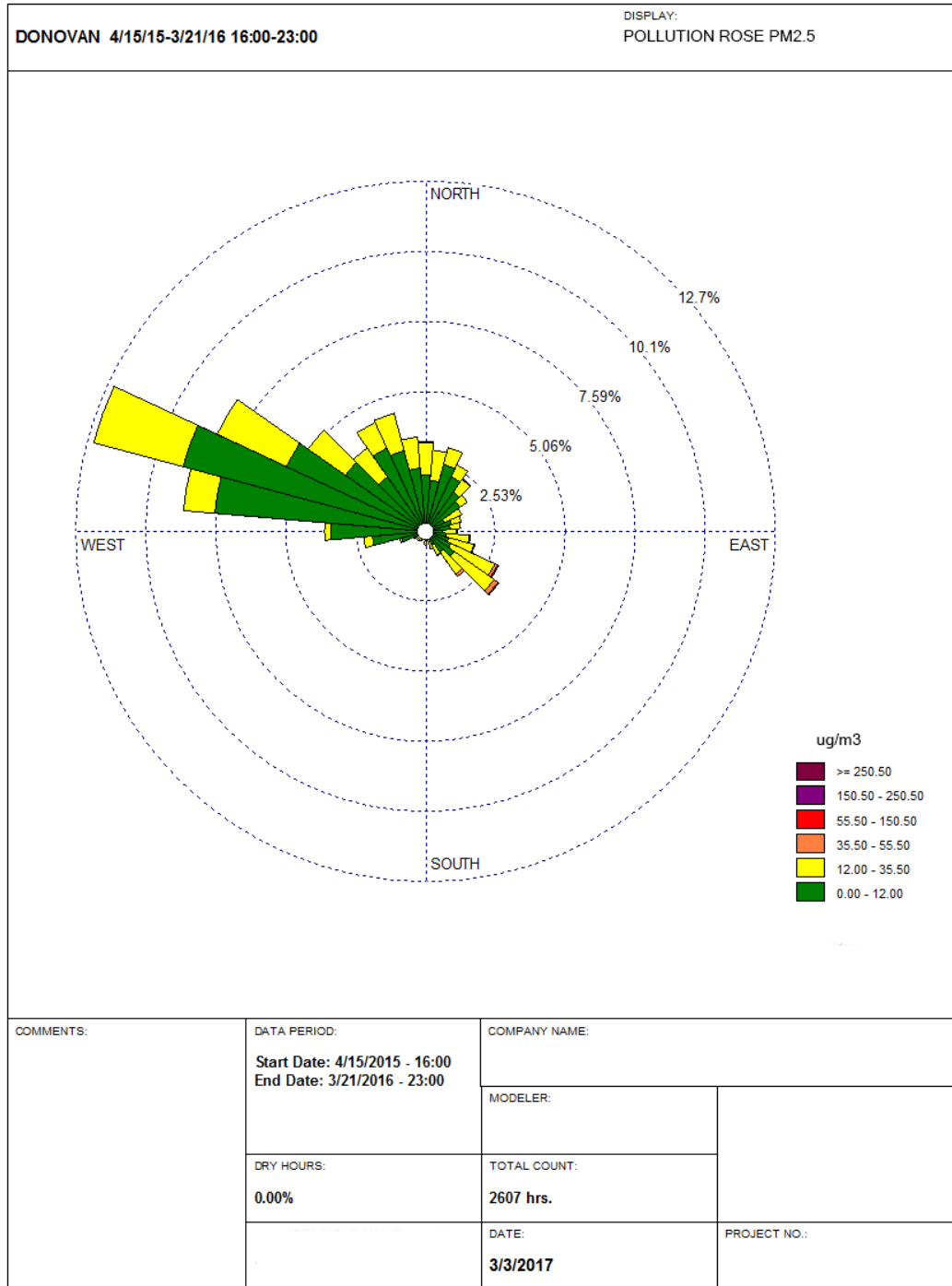


Figure 21. PM_{2.5} pollutant rose at DVN for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 1600 to 2300 PST.



Other sites in the San Diego PM_{2.5} monitoring network are cleaner and show different wind patterns compared to those near the border. At the Camp Pendleton site (CMP), the wind direction is somewhat evenly split between the west-southwest and the east-northeast, with neither direction clearly producing the highest PM_{2.5} concentrations (Figure 22). At the downtown Perkins Elementary School site (PES), the winds are predominantly from the west, with additional peak directions from the south-southwest and northeasterly directions. The highest concentrations are when the winds are light and from the northeast, which generally occurs at night (nighttime drainage – see Figure 23).

Figure 22. PM_{2.5} pollutant rose at CMP for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 0000 to 2300 PST.

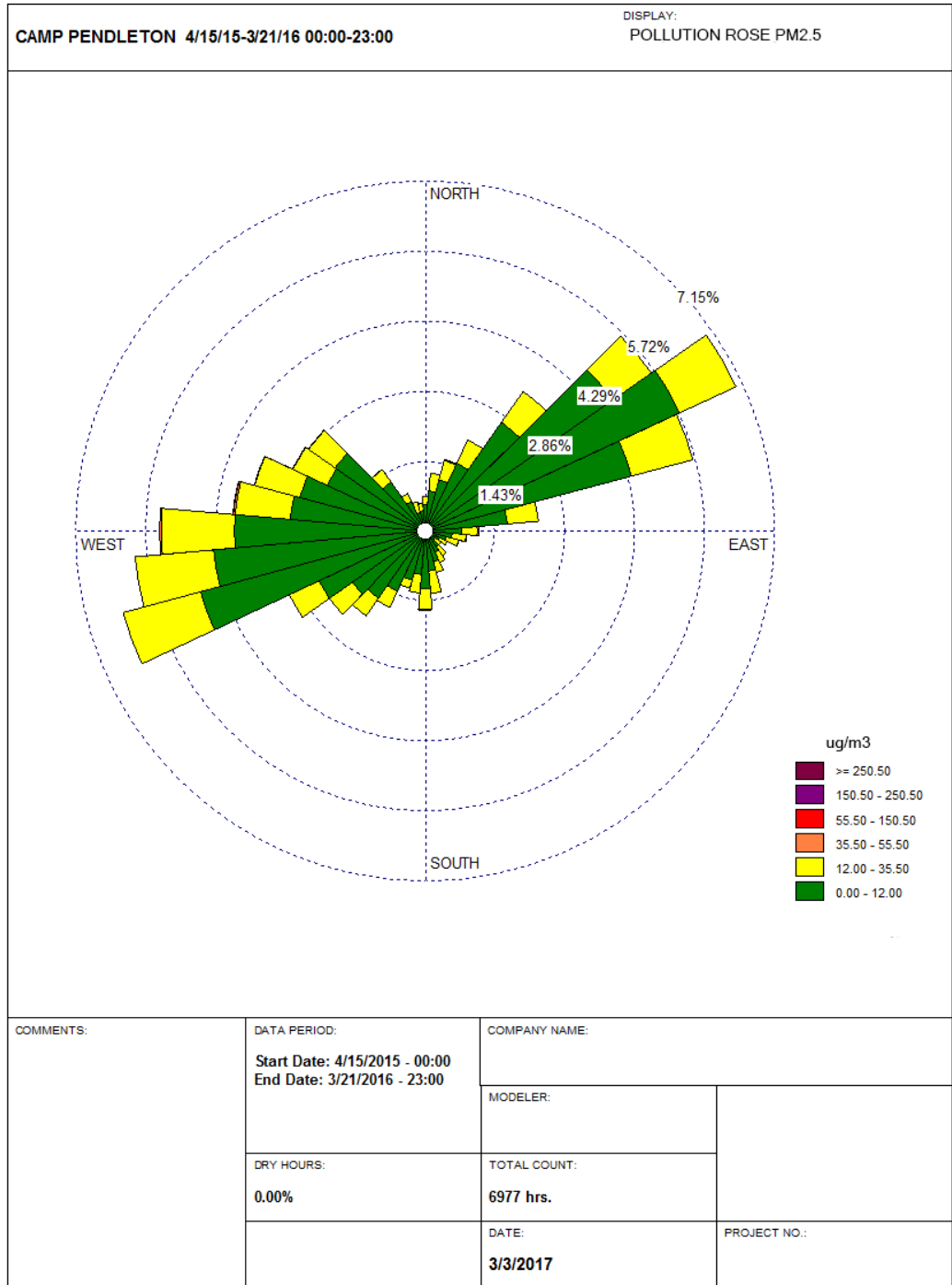
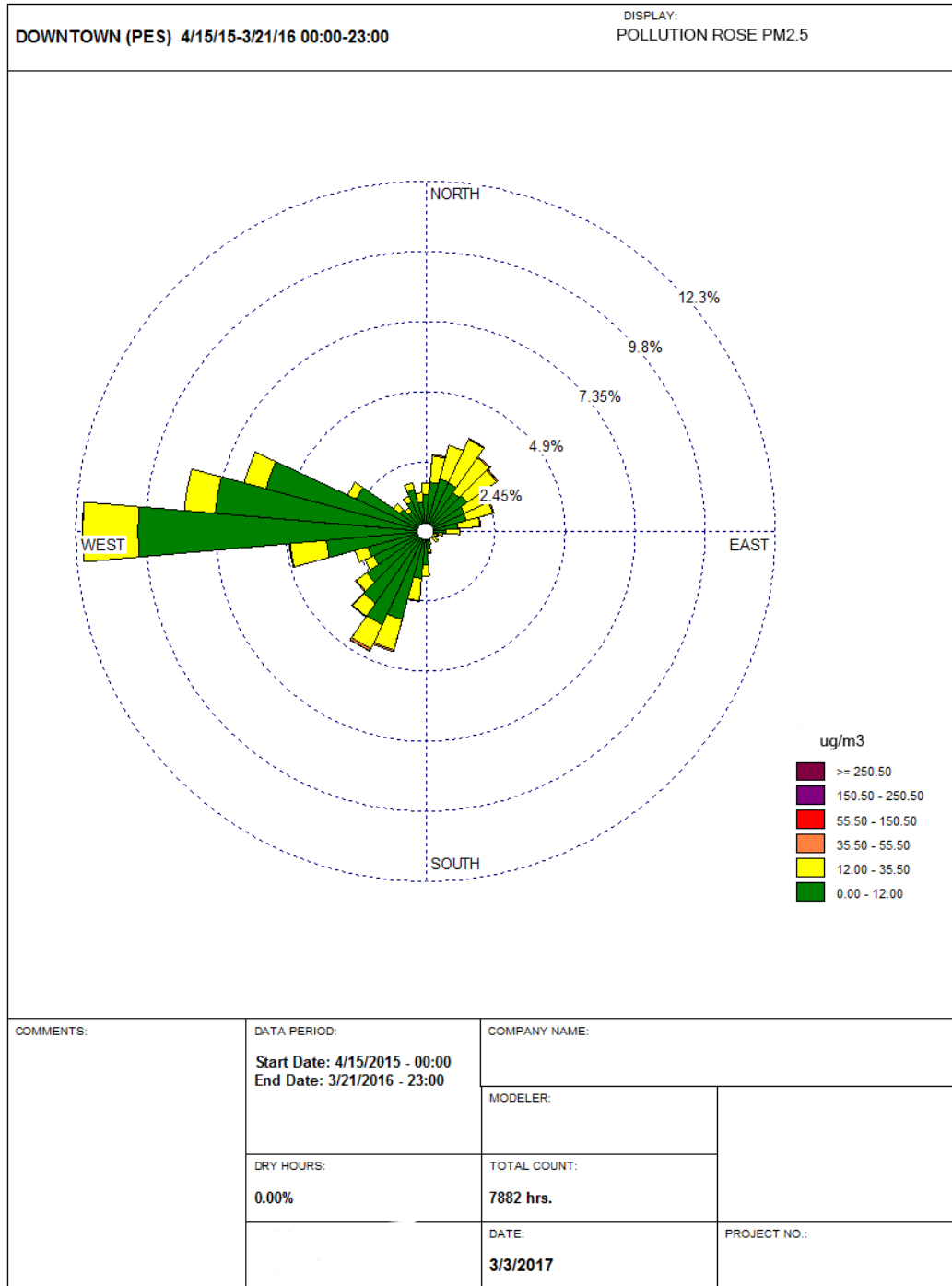


Figure 23. PM_{2.5} pollutant rose at PES for the entire meteorological monitoring period (April 15, 2015 through March 21, 2016), hours 0000 to 2300 PST.



Due to a change in the construction schedule at the POE, the District was asked to remove the rooftop monitoring equipment with very little advanced notice. This left the project short of its original monitoring goal and provided no opportunity for parallel monitoring at the POE. After the rooftop monitoring was terminated the District was able to relocate the BAM to a ground level location about 180m west-southwest of the rooftop location (SAY). This ground level location was located on the upwind side of the United States POE, immediately adjacent to the southbound traffic into Mexico. This new, ground level site was designated SAY2 (see photo in Figure 24). Table 3 describes the pertinent site information for this location.

Figure 24. San Ysidro Port-of-Entry (POE) ground level location (SAY2) of PM_{2.5} analyzer.



Table 3. San Ysidro site information for the ground level location at the San Ysidro POE (SAY2).

County:	San Diego
Representative Area:	San Diego MSA
Site Name:	San Ysidro
Year Established:	6/6/2016
Site Address:	720 East San Ysidro Blvd.
Site Name Abbreviation:	SAY2
AQS Number:	06-073-1024
Longitude:	32.542679°
Longitude:	-117.030749°
Elevation above Sea Level:	19 m
General Location:	Customs Parking lot
Ground Cover:	Paved
Distance to Road:	10 meters (Border Crossing lanes)
Traffic Count (2013 AADT):	AADT= 70, 000 (from border crossing)
Site Description:	In the Customs parking lot by the fence adjacent to traffic entering San Ysidro
Monitoring Objectives:	To quantify airborne particulates from the San Ysidro POE
Planned Changes:	Removed due to construction on 8/24/2016

SAY2 was active for roughly two-and-a-half months before the District was forced to discontinue monitoring due to construction that was unexpectedly moved forward. The SAY2 site was generally upwind of the POE during daytime hours. In general, lower PM_{2.5} concentrations were measured at the ground level SAY2 site compared to the rooftop SAY location. Although the two sites were only 180 meters apart, the difference in elevation and proximity to idling versus moving vehicles was quite different. The short monitoring time duration at the SAY2 site further complicates attempts to compare the data from the two POE sites.

Since no parallel monitoring between SAY and SAY2 was possible, we must use data from other sites in the network to see how the two sites compare. The BAM data from the DVN site collected in 2015 was compared to the 2016 data for the same dates (June 7 through August 23). This comparison showed the 2016 data to be higher than the 2015 data for the same time period (15.0 µg/m³ vs. 12.4 µg/m³, respectively). This implies that meteorological conditions in 2016 were more conducive to higher PM concentrations than in 2015. Indeed, the 2016 PM_{2.5} concentrations at SAY2 were slightly higher than the 2015 concentrations for the same date range (i.e., June 7 through August 23) at SAY (12.1 µg/m³ versus 10.5 µg/m³, respectively – see Figure 25). A comparison of average PM_{2.5} concentrations from the District’s BAM network for the SAY2 monitoring period (June 7 through August 23, 2016) is shown in Figure 26. This comparison shows that the highest PM_{2.5} concentrations were measured at the Donovan site (DVN) in the Otay Mesa area (15.0 µg/m³), followed by CMP (12.5 µg/m³), ALP (12.2 µg/m³),

SAY2 ($12.1 \mu\text{g}/\text{m}^3$), and PES ($10.3 \mu\text{g}/\text{m}^3$). This shows that the SAY2 site generally follows regional patterns for $\text{PM}_{2.5}$ concentrations.

Figure 25. Average $\text{PM}_{2.5}$ concentrations for SAY vs. SAY2 in a year-to-year comparison for the SAY2 monitoring dates (i.e., June 7 through August 23). The annual $\text{PM}_{2.5}$ NAAQS is represented by a horizontal purple line.

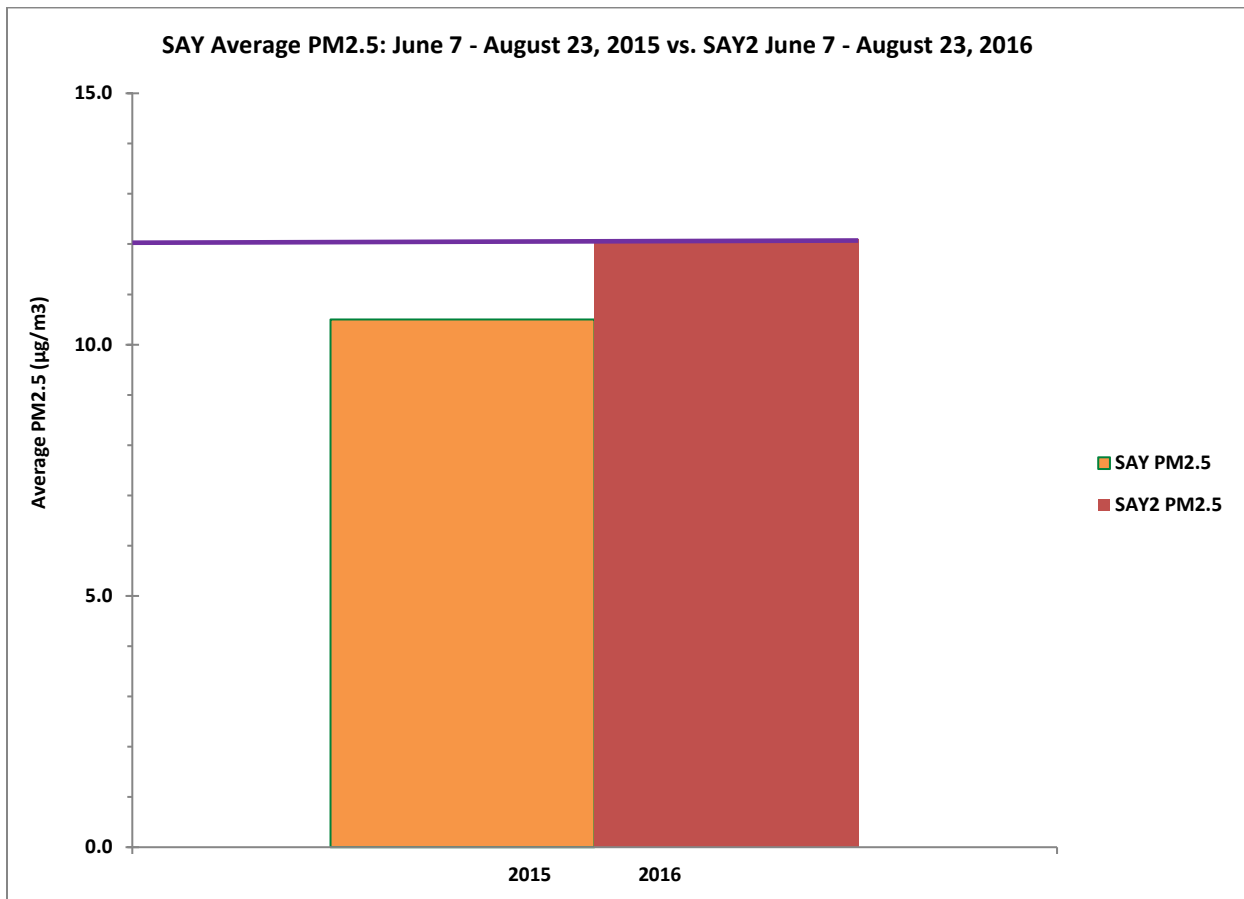


Figure 26. Average PM_{2.5} concentrations by site for the entire SAY2 monitoring period (June 7 through August 23, 2016). The annual PM_{2.5} NAAQS is represented by a horizontal purple line.

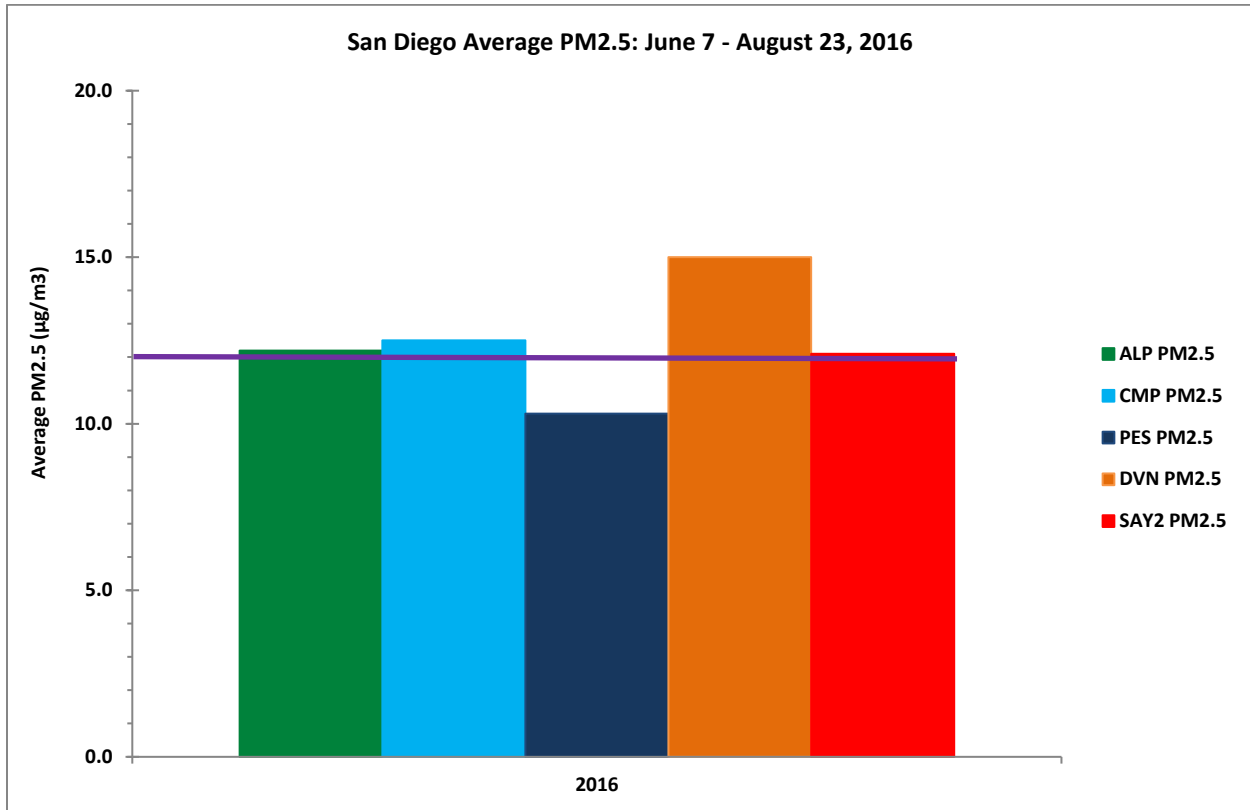
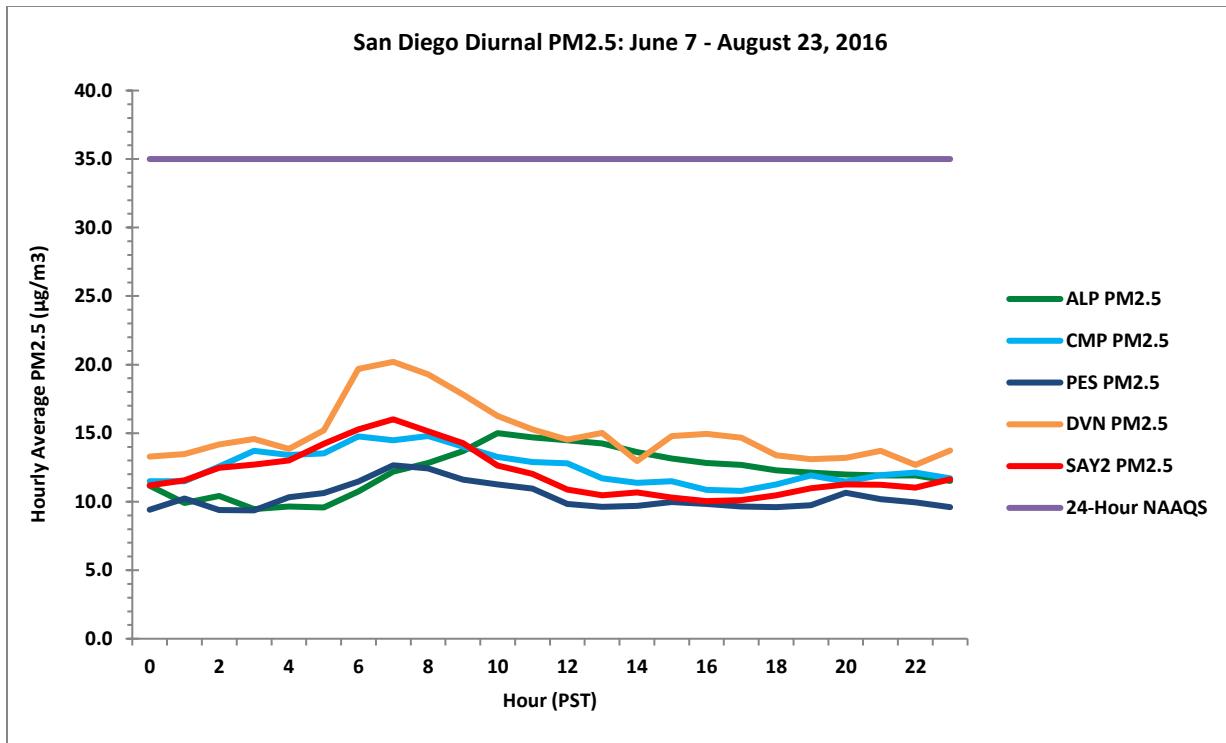


Figure 27 shows a diurnal plot of hourly averages from all sites with BAM analyzers during the time period when the SAY2 unit was operational (i.e., June 7 through August 23, 2016). This plot shows that the highest average PM_{2.5} concentrations were measured at the DVN site. The SAY2 data show a morning peak, when there is traffic waiting to cross northbound into the United States and when the atmosphere is most stable.

Figure 27. Average diurnal PM_{2.5} concentrations by site for the entire SAY2 monitoring period (June 7 through August 23, 2016).



A diurnal plot of hourly averages for June 7 through August 23 for SAY (2015) and SAY2 (2016) is shown in Figure 28. This plot shows a nearly identical pattern in hourly averages, with the ground level SAY2 site showing slightly higher values than the SAY rooftop site. As noted above, this difference is most likely due to variability in meteorological conditions between 2015 and 2016. We can therefore conclude that the two monitoring locations are similar in terms of air quality from regional influence and impacts from local traffic.

Based on the close proximity of the rooftop and ground level sites (SAY and SAY2, respectively), we can expect very similar wind patterns at the two locations. We can also expect some variability due to influence from the large building on which SAY was located. The wind rose for the entire SAY2 monitoring period (June 7 through August 23, 2016) is shown in Figure 29. This plot shows predominately light winds out of the west to northwest. It should be noted that neither POE monitoring site was ideal for meteorological monitoring.

Figure 28. Average diurnal PM_{2.5} concentrations for SAY (2015) vs. SAY2 (2016) in a year to year comparison for the SAY2 monitoring dates (June 7 through August 23).

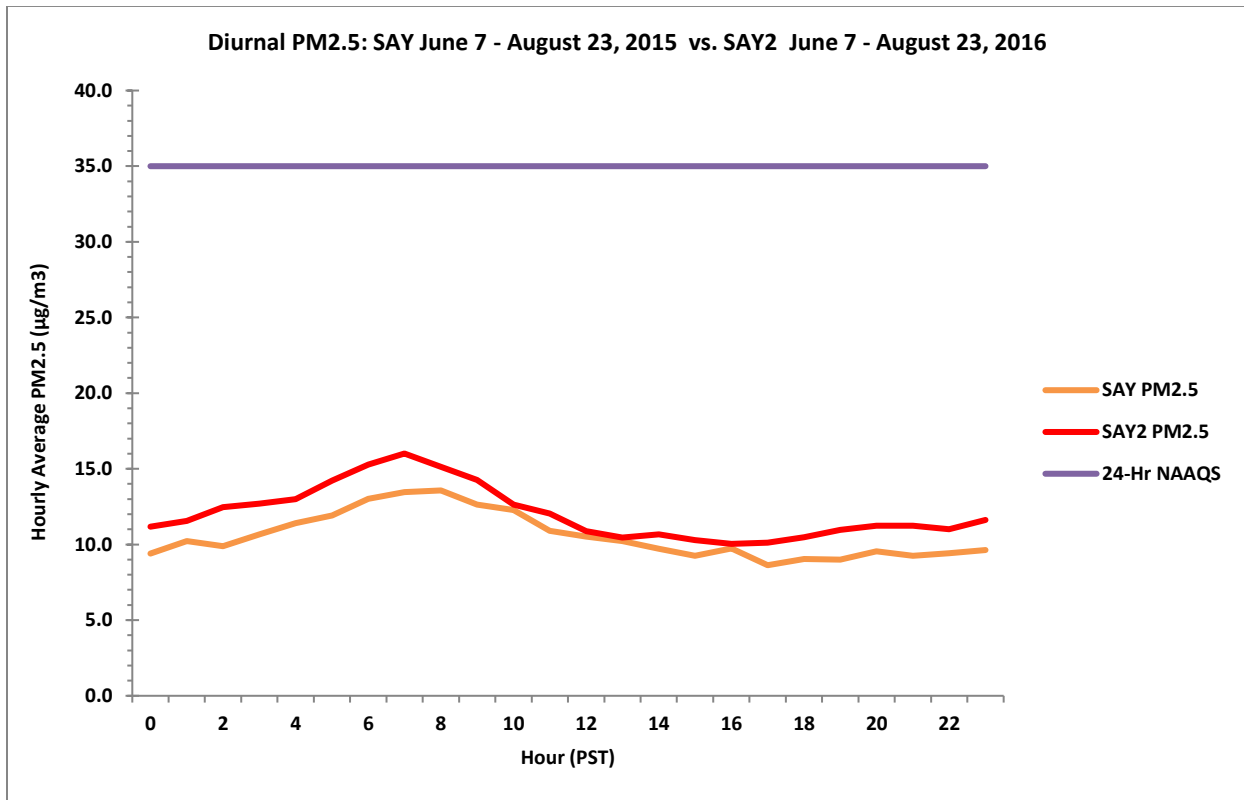
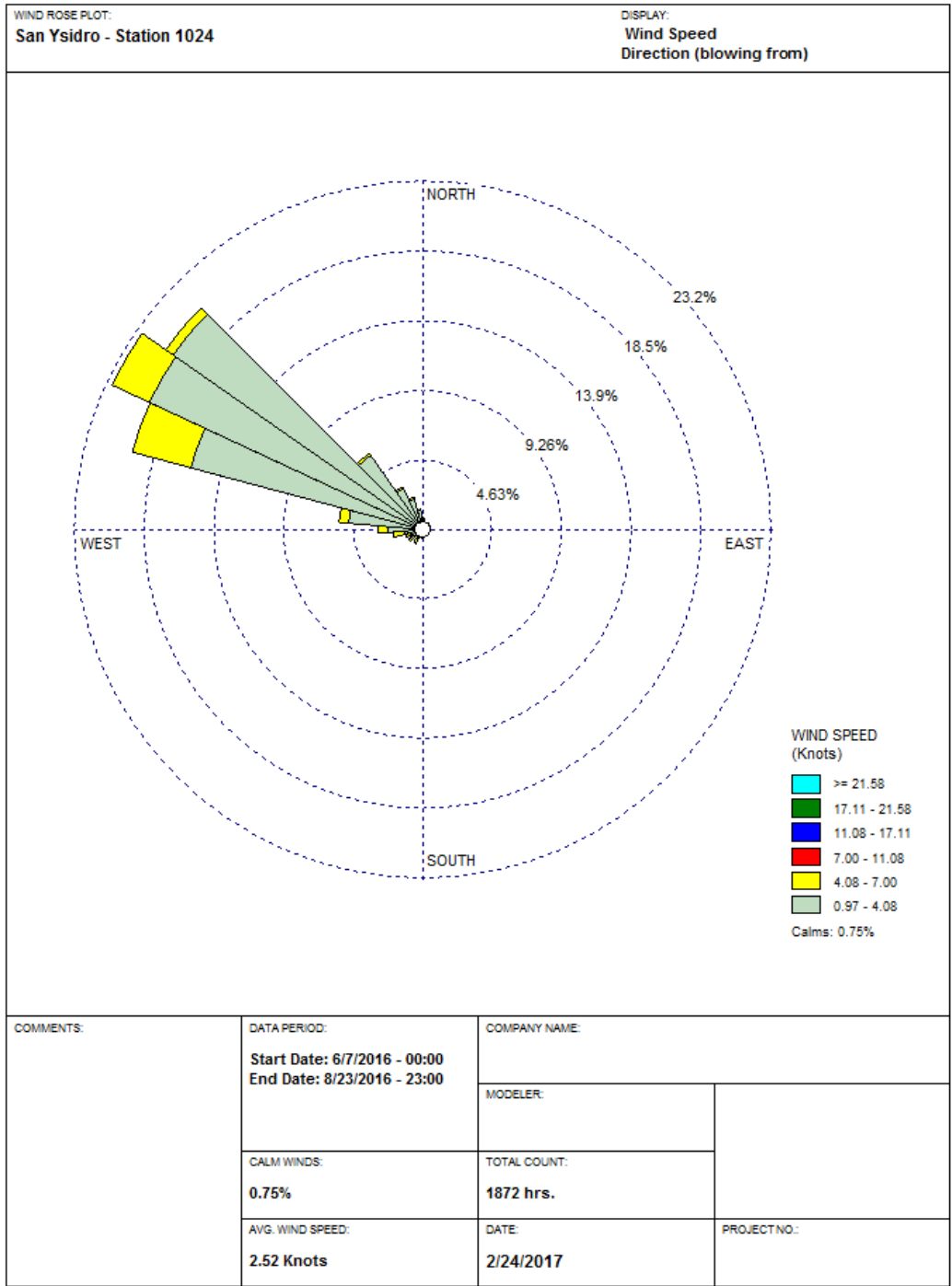


Figure 29. Wind rose at SAY2 for the entire meteorological monitoring period (June 7 through August 23, 2016), hours 0000 to 2300 PST.



The PM_{2.5} pollutant rose for the entire SAY2 monitoring period (June 7 through August 23, 2016) is shown in Figure 30, which shows that hourly values were consistently in the Good (green) to Moderate (yellow) ranges. This is consistent with the pollutant rose for the same set of dates in 2015 for the rooftop SAY location (see Figure 31). This confirms the relative consistency between the two POE monitoring locations. [Note: a few hourly values in the Unhealthy for Sensitive Groups (orange) are in the datasets but are not clearly evident due to the low frequency of occurrence.]

Figure 30. PM_{2.5} pollutant rose for the entire monitoring period at SAY2 (June 7 through August 23, 2016), hours 0000 to 2300 PST.

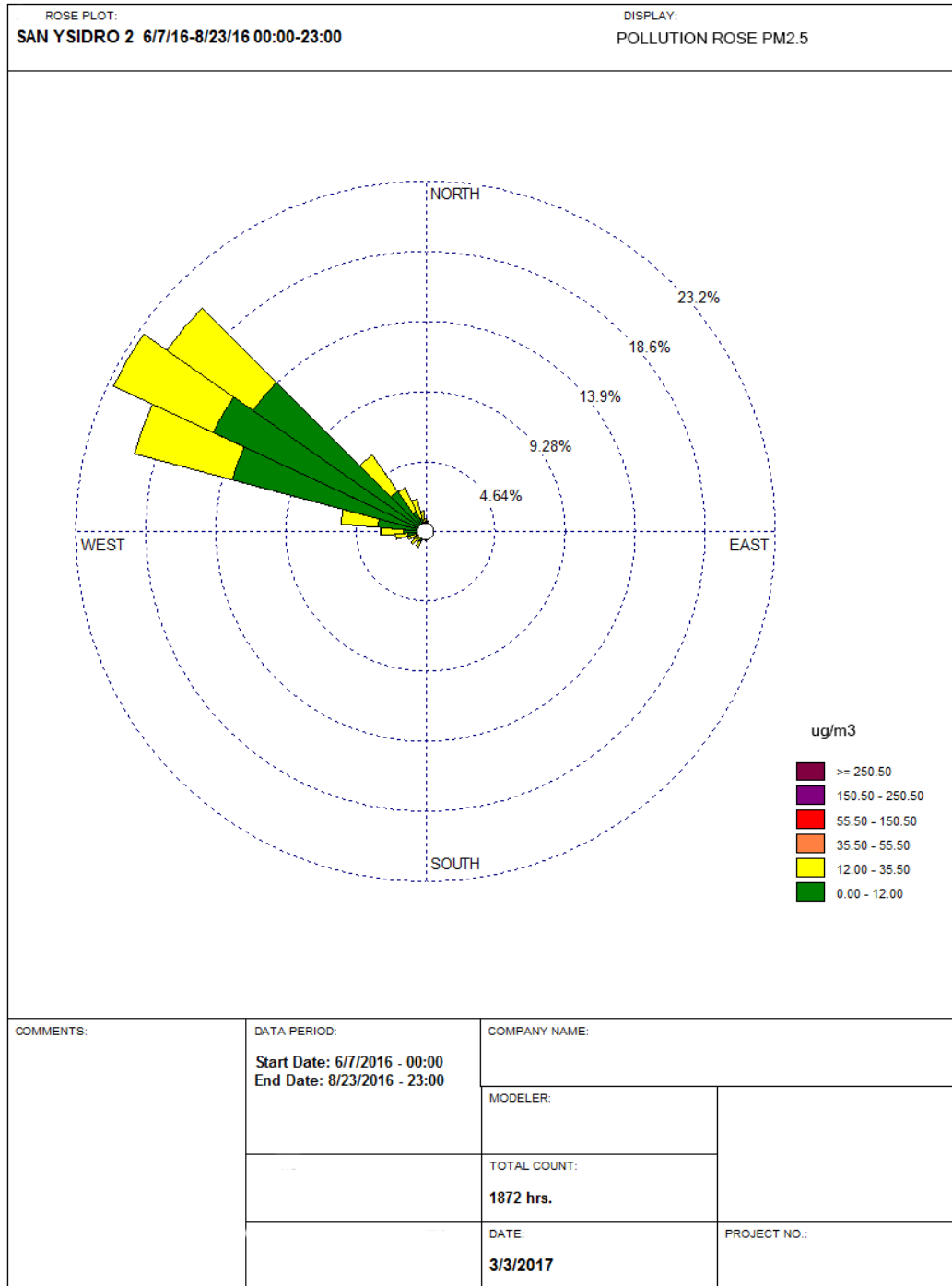
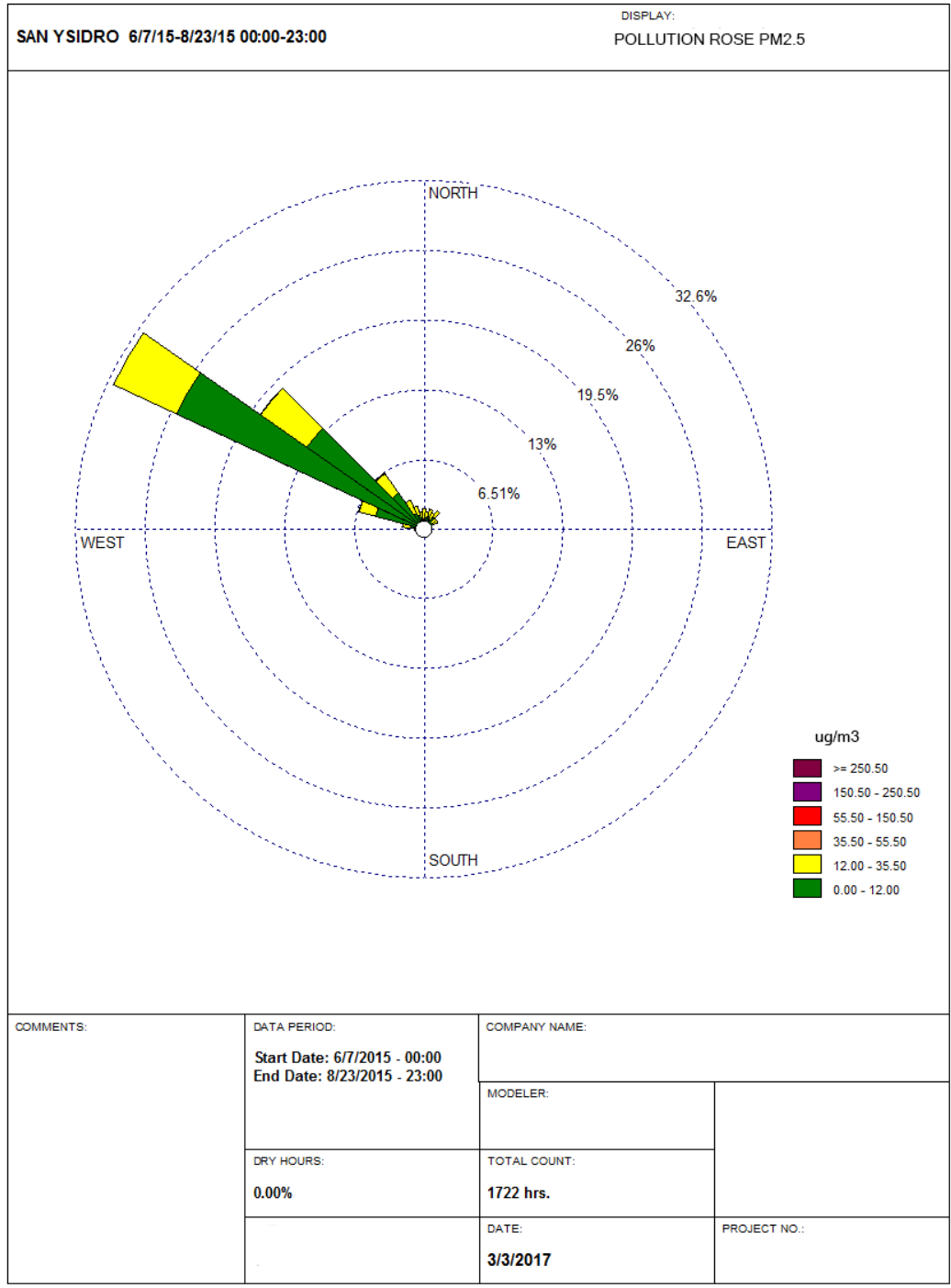


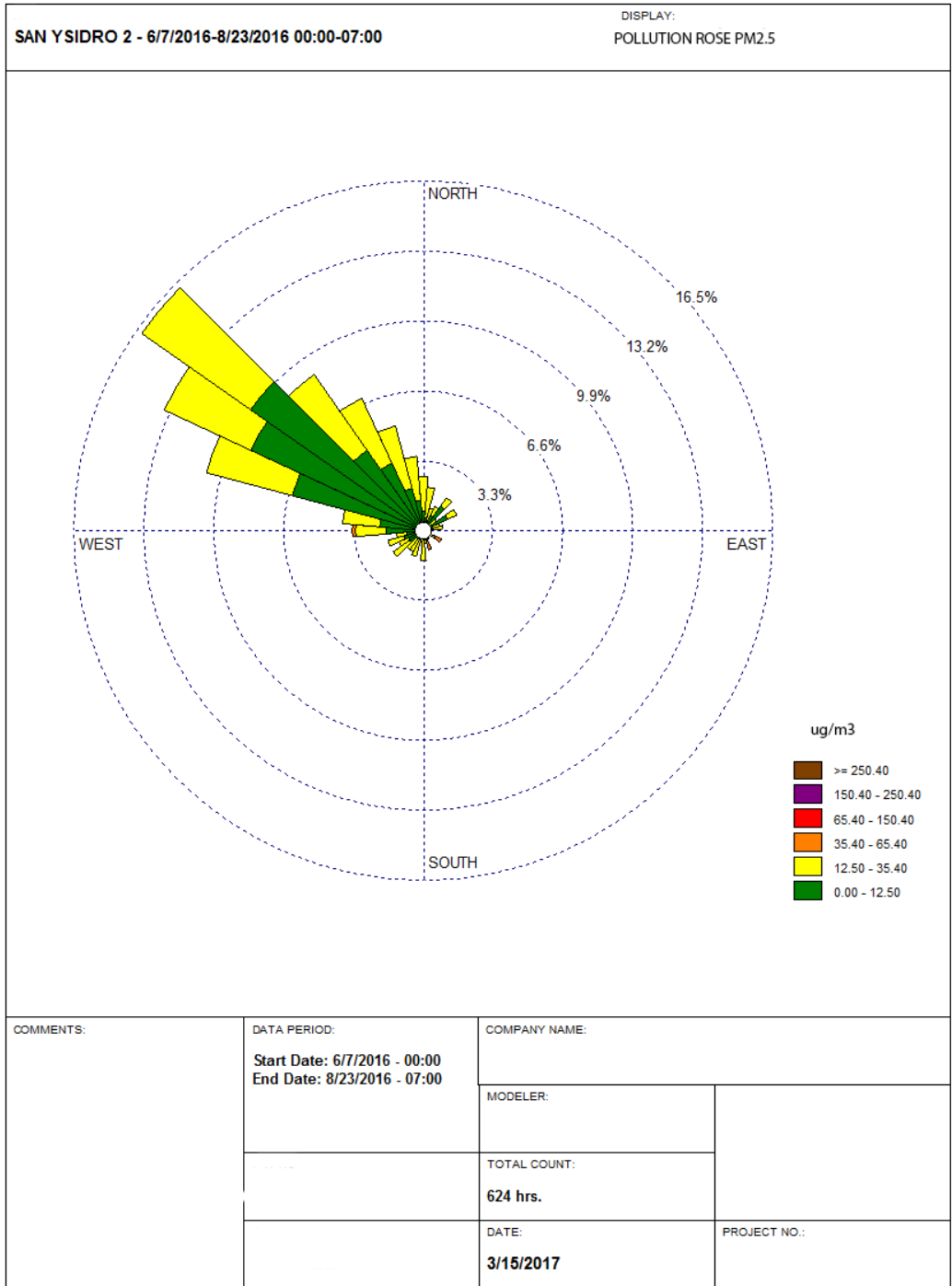
Figure 31. PM_{2.5} pollutant rose for SAY for the same monitoring time period (June 7 through August 23) in 2015 as the 2016 SAY2 monitoring period, hours 0000 to 2300 PST.



It can be instructive to compare the two San Ysidro POE sites by looking at pollutant roses for different times of the day. For example, the early morning (0000 to 0700 PST) PM_{2.5} pollutant rose (Figure 32) for the ground level site (SAY2) shows a similar pattern as the full-day pollutant rose for this site (Figure 30). Figure 32 also shows a few “equivalent” (using hourly values as 24-hour equivalent averages) PM_{2.5} values in the Unhealthy for Sensitive Groups (orange) range. These values, with winds from the south-southeast and southeast point back to the adjacent roadway (leading south into Mexico), the POE waiting area for vehicles entering the U.S. from Mexico, and to the greater metropolitan Tijuana area. One hour of Unhealthy for Sensitive Groups equivalent points back to the west of the monitoring location, which resulted from recirculated air that previously passed by the POE and adjacent roadway.

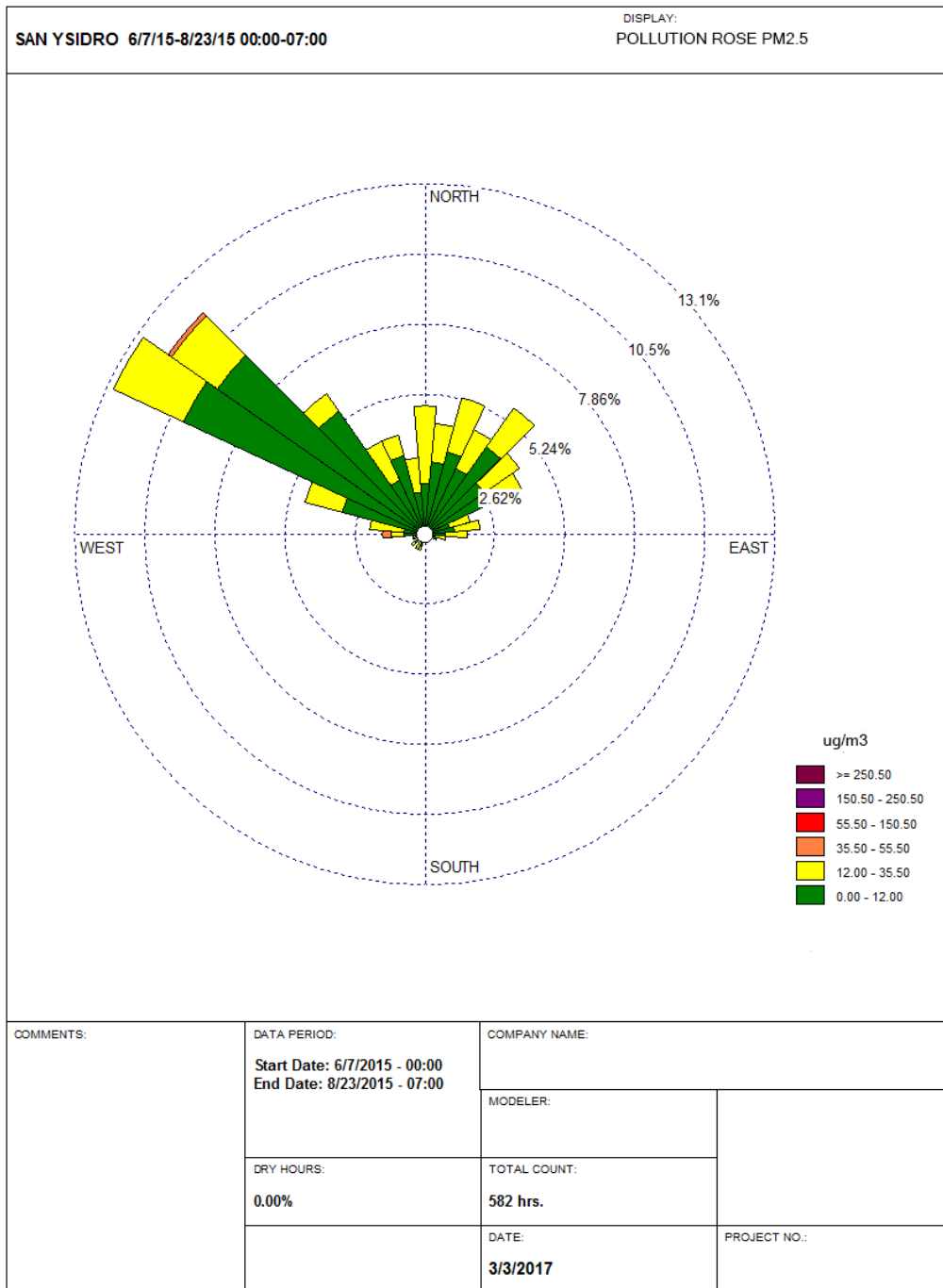
The morning time PM_{2.5} pollutant rose for rooftop SAY location for the same time period (June 7 through August 23) shown in Figure 33 shows a similar pattern. The hourly values in the equivalent Unhealthy for Sensitive Groups range during this time period that point back to the west and northwest were also the result of recirculated air near the POE. This adds additional evidence for impacts from Tijuana, as well as from local traffic and idling vehicles at the POE.

Figure 32. PM_{2.5} pollutant rose for the entire monitoring period at SAY2 (June 7 through August 23, 2016), hours 0000 to 0700 PST.



WRPLOT View - Lakes Environmental Software

Figure 33. PM_{2.5} pollutant rose for SAY for the same monitoring time period (i.e., June 7 through August 23) in 2015 as the 2016 SAY2 monitoring period, hours 0000 to 0700 PST.



WRPLOT View - Lakes Environmental Software

As noted earlier in this report, the Otay Mesa Donovan site (DVN) data showed impacts from regional sources of PM_{2.5}, with the source of higher concentrations originating south of the border. The DVN PM_{2.5} pollutant rose for data collected during the SAY2 monitoring period (June 7 through August 23, 2016) is shown in Figure 34. This PM_{2.5} pollutant rose shows a small frequency of Unhealthy for Sensitive Groups (orange) equivalent hourly values when the winds were out of the west-northwest to northwest. From previous analyses, these hourly values occur during periods of recirculation, with the predominant source being south of the border, which generally occurs during morning hours. This is confirmed in the DVN early morning PM_{2.5} pollutant rose shown in Figure 35, where a higher percentage of hours with Unhealthy for Sensitive Groups (orange) and Unhealthy (red) equivalent values originate from south of the DVN monitoring station.

Figure 34. PM_{2.5} pollutant rose for DVN for the entire SAY2 monitoring period (i.e., June 7 through August 23, 2016), hours 0000 to 2300 PST.

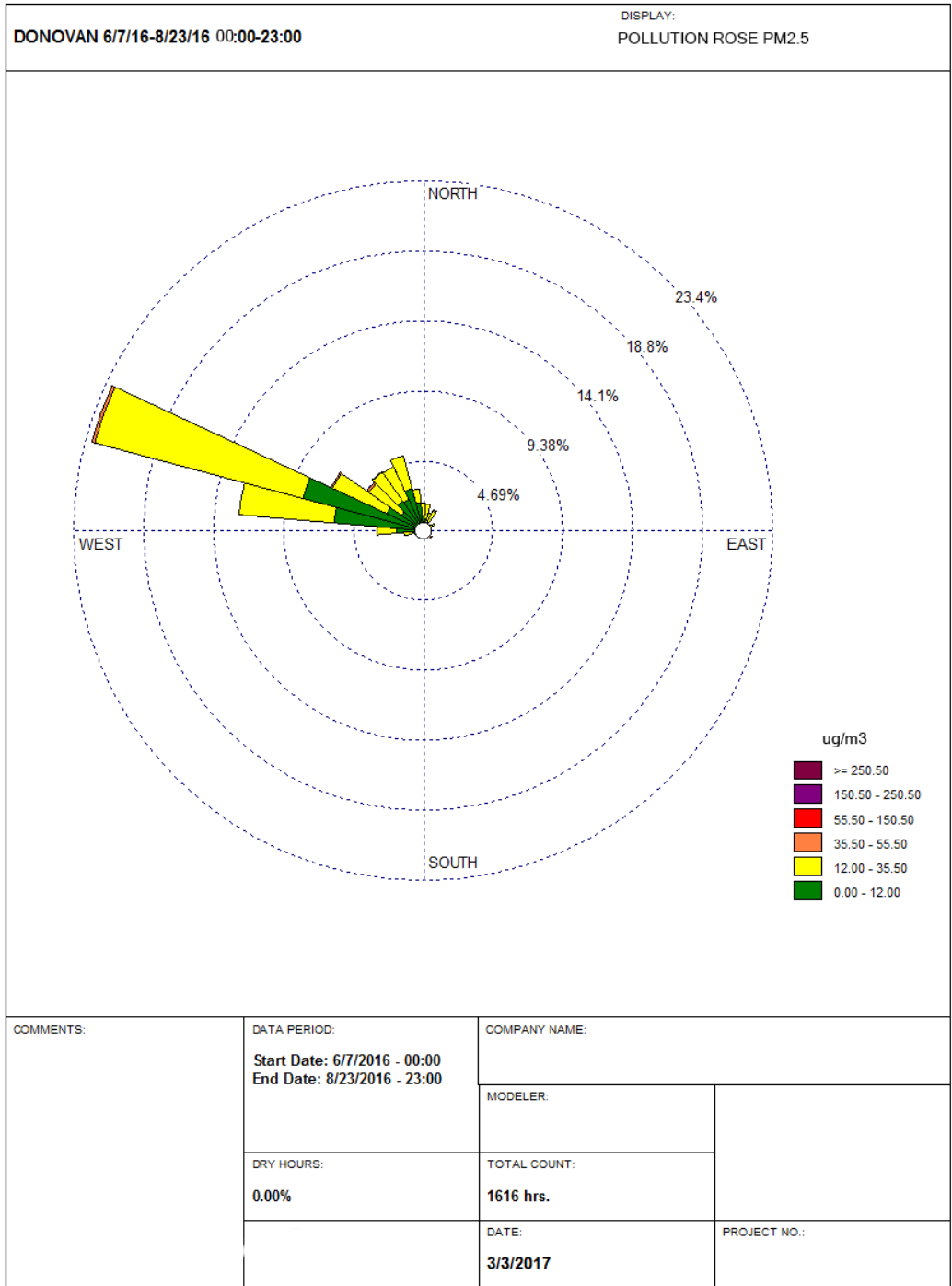
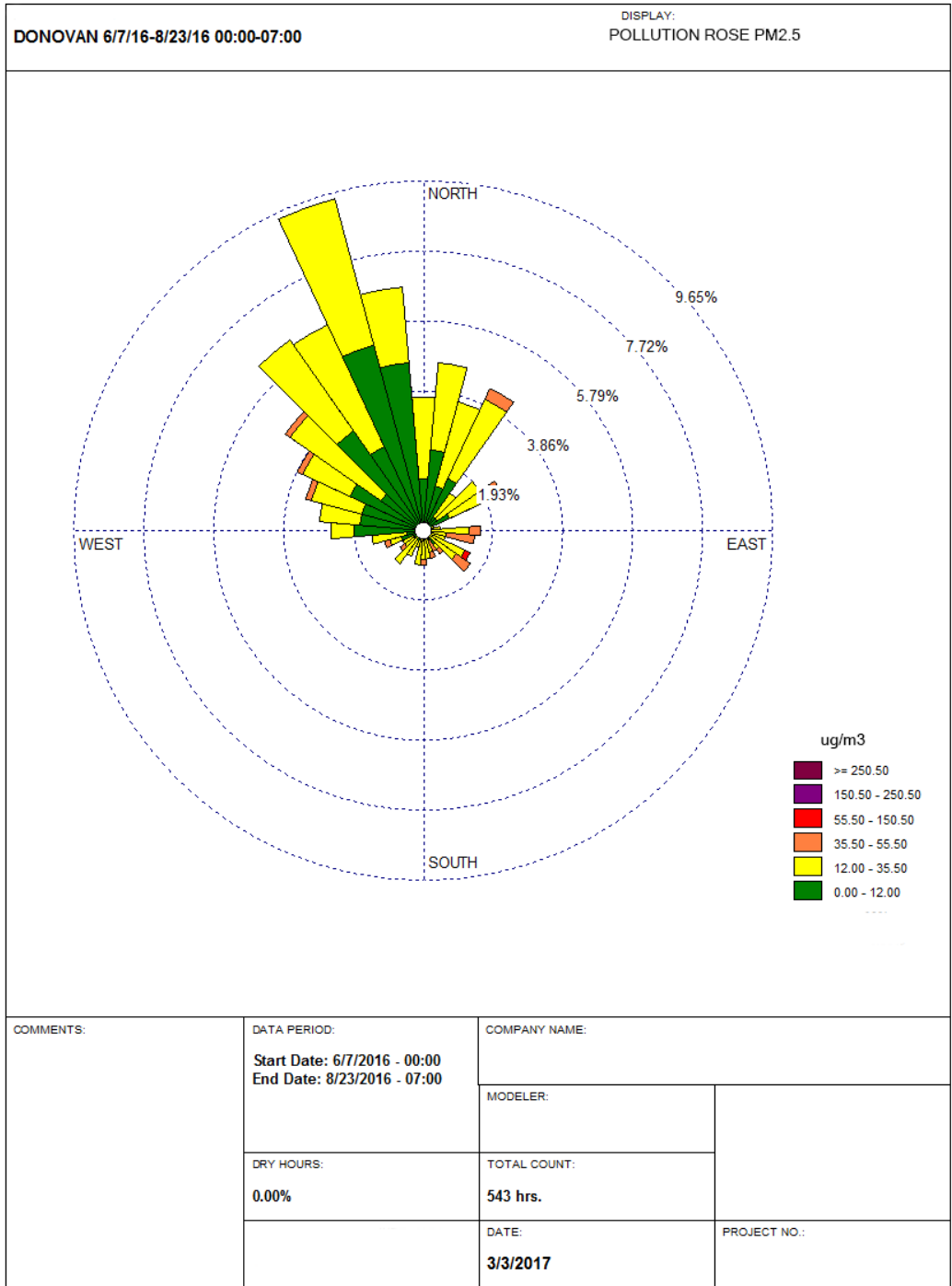


Figure 35. PM_{2.5} pollutant rose for DVN for the entire SAY2 monitoring period (i.e., June 7 through August 23, 2016), hours 0000 to 0700 PST.



Conclusions

The initial San Ysidro POE monitoring site (SAY) did measure the highest average PM_{2.5} concentration of all continuous analyzers in San Diego county during the time it was operational. The highest concentrations were generally measured during the night and early morning hours when the atmosphere was most stable and winds were out of the southeast. This showed that PM_{2.5} concentrations at the San Ysidro POE are influenced by emissions from the entire Tijuana metropolitan area, not just the local traffic traveling to and from Mexico. This is further evidenced by the PM_{2.5} measurements at the District's border region site near Otay Mesa (DVN).

Changes to the construction schedule at the POE reduced the planned rooftop monitoring. However, over a year's worth of valid data were collected at this site (SAY). An attempt was made to collect additional data at the POE. Unfortunately, further changes to the POE construction schedule necessitated leaving this site as well. A little more than two months of valid data were collected at the ground level site (SAY2). These data were collected during summer months, when lower PM_{2.5} concentrations are expected due to warmer temperatures, stronger sea breeze winds, and less atmospheric stability than during winter months.

The measurements at SAY2 further confirmed that the greater Tijuana metropolitan area has a larger impact on PM_{2.5} concentration than local traffic alone. This influence from Tijuana is also seen at the Otay Mesa area Donovan site (DVN), showing that the impacts from Tijuana are frequent, widespread, and extend at least several miles north of the border.

Communities alongside major roadways in San Diego county continue to express concerns over vehicular emissions impacting health on their residents. This is especially true for the border regions of the county where there is not a long history of air quality measurements. It would therefore be appropriate to attempt to find another representative site in a residential community along a major roadway running through the border region that has significant cross-border traffic. Measurements at the Otay Mesa POE would also be useful to document the higher particulate matter concentrations expected from this major truck-crossing (primarily heavy-duty diesel engines).