

Appendix A: Meteorological Data

APPENDIX A

A.1 Hourly Surface Meteorological Data Stations

When characterizing near-field air dispersion using models such as AERMOD, representative hourly surface meteorological data inputs are required in order to characterize the atmospheric transport and dispersion in the area to be studied. AERMET, the meteorological preprocessor to AERMOD, requires certain surface meteorological parameters in order to prepare an AERMOD meteorological data input file. The minimum surface meteorological parameters required include wind speed, wind direction, temperature, and cloud cover (United States Environmental Protection Agency [USEPA] 2004b). Station pressure is also recommended, but not required, for AERMET (USEPA 2004a). This appendix discusses the availability of such surface meteorological data, the selection criteria used to choose representative surface meteorological data for the Ports and the major freeways and rail line near the Ports, and the results of this selection methodology. The methodologies employed in this selection process were previously approved by the California Air Resources Board (ARB) for air dispersion modeling purposes at the BNSF Watson/Wilmington Rail Yard (ENVIRON 2006), located within one mile of the Ports.¹ Because cloud cover data is only available from national weather service (NWS) stations, the evaluation and treatment of cloud cover data is discussed separately in Section A.5 below.

The dominant terrain features/water bodies that may influence wind patterns in this part of the Los Angeles Basin include the Pacific Ocean to the west, the hills of the Palos Verdes Peninsula to the west/southwest and the San Pedro Bay and shipping channels to the south of the study area. Although the area in the immediate vicinity of the Ports is generally flat, these terrain features/water bodies may result in significant variations in wind patterns over relatively short distances. In order to identify meteorological data stations that may be representative of operations at the Ports and out-of-port emissions on major freeways and the major rail line extending north from the Ports, a comprehensive search was conducted to identify surface meteorological data stations in the vicinity of the Ports. Databases of meteorological stations referenced by the USEPA's Support Center for Atmospheric Modeling (SCRAM) website and available from the National Climatic Data Center (NCDC 2006a,b,c) were searched. The database of stations operated by ARB or managed by local agencies and reporting to ARB was also used (ARB 2006a). Meteorological stations that contain wind speed, wind direction, temperature, and pressure data that may be appropriate for air dispersion modeling located within a 20-km radius of the studied area include four ARB stations, two NCDC/NWS stations, two South Coast Air Quality Management District (SCAQMD) stations, four stations at the Port of Los Angeles, and two stations at the Port of Long beach. Figure I-A-1 shows the locations of the fourteen meteorological stations in the vicinity of the Ports and the freeways near the Ports. Meteorological data from the most recent five years were obtained, where available, from each

¹ Personal communication, J. Yuan of ARB by e-mail to D. Daugherty of ENVIRON on August 3, 2006.

of the stations identified above. For stations that had less than five years of data available, the longest possible time period for which complete data were available was used in the evaluation. Wind flow patterns at each of the stations are shown in Figure I-A-2.

A.2 Hourly Surface Meteorological Data Selection for On-Port Emission Sources

ENVIRON evaluated the fourteen meteorological stations located within a 20-km radius of the Ports with at least one year of quality-checked meteorological data to select surface meteorological data that are representative of conditions at the Ports.^{2,3} ENVIRON evaluated the relative location of each station to the Ports, the data quality, and the wind patterns at each station as compared to the general wind patterns in the vicinity of the Ports when evaluating each station. ENVIRON also evaluated the data quality (e.g., completeness and quality assurance reports) and monitor siting against USEPA guidelines (USEPA 2000) based on available information. ENVIRON previously evaluated each of these stations based on criteria significant to dispersion modeling (e.g. representativeness, proximity to emissions sources, and proximity to terrain features) during the meteorological data selection process for the BNSF Watson/Wilmington Rail Yard (ENVIRON 2006), which was previously approved by ARB.⁴ The remainder of this section describes the results of ENVIRON's evaluation.

From May 2001 through July 2002, ARB operated a Wilmington station (Wilmington North Mahar) as part of a Special Community Air Quality Monitoring Study (ARB 2003a). ARB used the meteorological data from this station in their diesel exhaust particulate matter (DPM) Exposure Assessment for the port area (ARB 2006a). [Note that data from the Port of Los Angeles sites were not available at the time for use in the ARB (2006a) study.] This report states that the Wilmington North Mahar station was chosen rather than the North Long Beach station because it is closer to the combined ports area and the data is more recent. It should be noted that the ENVIRON analyses described above (ENVIRON 2006) chose not to recommend the Wilmington North Mahar station because requested wind speed data for this station was provided in vector-averaged format and this format is discouraged by USEPA and ARB Memorandum of Understanding (MOU) modeling guidelines (USEPA 2000; ARB 2006b).

The Torrance Municipal Airport station, located approximately eight kilometers west of the Ports is situated at the eastern edge of the Palos Verdes Hills. The wind flow patterns at the Torrance Municipal Airport station appear to reflect channeling of the winds parallel to these hills. Therefore, the Torrance Municipal Airport station was eliminated from further consideration.

² The SCAQMD Lynwood and Compton-MATES stations were not evaluated as part of the meteorological data evaluation for the on-port emission sources as these stations are located more than 10 km from the Ports.

³ The two meteorological stations operated by the Port of Long Beach – Gull Park and Super Block-east began collecting data since September 1, 2006. Current evaluation of these two stations was based on data collected between September 1, 2006 and June 30, 2007. An updated evaluation will be performed once a complete year of data has arrived for these two stations.

⁴ Personal communication, J. Yuan of ARB by e-mail to D. Daugherty of ENVIRON on August 3, 2006.

Of the four remaining NCDC/NWS stations and ARB stations, all of the stations except the North Long Beach station exhibited a significant component of the winds (20% to 35%) blowing from the northwest. The North Long Beach Station wind rose shows only a small component of winds blowing from the northwest (approximately 3%), with predominant winds from the west and southwest. According to USEPA meteorological monitoring guidance (USEPA 2000), sensors for wind speed and wind direction should be located at a distance at least ten times the height of nearby obstructions. An inspection of photographs^{5,6} of this meteorological station indicated that buildings located approximately 100 meters to the northwest of the station and 90 meters to the south/southwest of the building may be obstructing winds from the northwest and south/southwest, respectively. Figure I-A-3 shows the location of the North Long Beach station and the outline of these two buildings in the vicinity of the station. Based on this evaluation, the North Long Beach station was eliminated from further consideration.

NCDC recommended the Long Beach Daugherty Field station as the most complete NCDC station in the vicinity of the Wilmington Yard⁷, located within one mile of the Ports. However, the Long Beach Daugherty Field wind rose exhibited almost twice as many hours with calm winds (approximately 28% of all hours for the five year period 2000 plus 2002 to 2005) when compared to the other stations under consideration (approximately 2% for Wilmington-North Mahar, 3% for Wilmington-Multiple Air Toxics Exposure Assessment (MATES), 4% for Long Beach-East Pacific Coast Highway, and 3% for SPPS stations). In addition, the wind speed distribution for the Long Beach Daugherty Field station appeared to show a higher frequency of high-speed winds than the other stations under consideration. Most importantly, the Long Beach Daugherty Field station is much farther from the Ports than the other stations considered in this evaluation. Therefore, wind patterns and speeds at the Long Beach Daugherty Field station are likely to be the least representative of the conditions at the Ports. Based on the station's relative distance from the Ports, the relatively high percentage of calms and higher frequency of high-speed winds at the Long Beach Daugherty Field, this station was eliminated from further consideration for all surface measurements except cloud cover.

According to SCAQMD, meteorological data collected at the Wilmington-MATES and Long Beach-East Pacific Coast Highway stations have not been quality-assured/quality-checked by ARB or SCAQMD. In addition, wind speed data for the Wilmington-MATES station were provided in vector-averaged format, which is discouraged by USEPA modeling guidelines (USEPA 2000). Because the meteorological data at these two stations have not been quality-assured, and vector-averaged format is not recommended by USEPA or ARB, the Wilmington-MATES and Long Beach-East Pacific Coast Highway stations were eliminated from further consideration.

⁵ http://www.arb.ca.gov/qaweb/photo_view.php?file=0570072-tationw.jpg&site_no=70072&date=05&caption=Looking%20West%20from%20the%20probe.

⁶ http://www.arb.ca.gov/qaweb/photo_view.php?file=0470072-stations.jpg&site_no=70072&date=04&caption=Looking%20South%20from%20the%20probe.

⁷ Personal Communication. William Brown of NCDC by telephone to C. Mukai of ENVIRON on May 5, 2006.

Four air quality monitoring stations operated by the Port of Los Angeles collect meteorological data in the vicinity of the Port of Los Angeles (POLA) as part of the POLA Terminal Improvement Project monitoring program.⁸ The Port of Long Beach also operates two meteorological stations.⁹ The wind flow patterns at each of these six meteorological monitoring stations are displayed as period-average wind roses in Figure I-A-4. The period-average wind roses for the four POLA stations are based on the most complete one year of data since the stations began operating in 2005. The period-average wind roses for the two Port of Long Beach (POLB) stations are based on data collected between September 1, 2006 and June 30, 2007. There may be differences once a full year of data have been collected due to potential seasonal differences. As shown in Figure I-A-4, the “SPPS”, “TITP”, “Liberty Hill Plaza”, “Super Block” stations are all located in the central or northern area of the harbor. The SPPS, TITP, and Super Block stations are located on flat terrain, and wind patterns at these stations may be representative of winds at Port leaseholders inland or in the mid-harbor. The “Liberty Hill Plaza” station, located on the eastern edge of the Palos Verdes Hills, may be representative of winds at Port leaseholders very close to this station.

Two other potentially important stations are the Port of Los Angeles “Berth 47” station, and the Port of Long Beach “Gull Park” station, which are both situated in the outer harbor and may be representative of meteorology affecting plumes of ships entering and leaving the port. Outer harbor wind patterns are very different than wind patterns closer to the port-area and port-area receptors. As seen in Figure I-A-4, the wind rose for Berth 47 indicates different wind patterns than those at the other four Port of Los Angeles and Port of Long Beach stations but similar to the Port of Long Beach Gull Park Station. Specifically, the wind rose indicates that patterns characterized by higher wind speeds and less variation in direction than patterns further inland. Further discussion of these two stations is provided in Section A.4

Based on the ENVIRON’s review of available meteorological data near the Ports, discussed above and in ENVIRON’s meteorological analysis for the BNSF Wilmington Yard (ENVIRON 2006), six meteorological stations were selected as candidates to represent meteorological conditions for on-Port sources:

- Port of Los Angeles- SPPS
- Port of Los Angeles-Liberty Hill Plaza
- Port of Los Angeles- TITP
- Port of Los Angeles-Berth 47
- Port of Long Beach-Gull Park
- Port of Long Beach-Super Block

⁸ Los Angeles Harbor Department. http://www.portoflosangeles.org/AQ_Monitoring/Workplan.pdf

⁹ Port of Long Beach. http://www.polb.com/environment/air_quality/air_monitoring.asp

A.3 Hourly Surface Meteorological Data Selection for Land-Side Out-of-Port Emission Sources

Due to the increase in air dispersion modeling uncertainty associated with the use of multiple meteorological stations with different predominant wind directions, ENVIRON evaluated the geographical area over which Port-representative meteorological data (e.g., data from SPPS and TITP) were also representative of out-of-port emissions from trucks on major freeways (i.e., Interstates 110 and 710 and Highways 47 and 103) and the major rail line (i.e., the Alameda Corridor) extending north from the Ports. As part of this evaluation, two additional stations north of the Ports, Compton-MATES and Lynwood, operated by SCAQMD, were identified and evaluated in addition to the twelve meteorological stations described above. The period-average wind roses for Lynwood and Compton-MATES stations are displayed in Figure I-A-2.

As discussed above, the dominant terrain features/water bodies that may influence wind patterns in this part of the Los Angeles Basin include the Pacific Ocean to the west, the hills of the Palos Verdes Peninsula to the west/southwest, and the San Pedro Bay and shipping channels to the south. As indicated in Figure I-A-2, the meteorological data stations to the west of the Palos Verdes Hills and within approximately 5 kilometers of the San Pedro Bay (i.e., SPPS, TITP, Wilmington-North Mahar, Wilmington-MATES, Long Beach-East Pacific Coast Highway, and Long Beach Airport) generally exhibit predominant winds from the northwest and from the south or southeast. The consistency of the predominant winds among these stations indicate that the Palos Verdes Hills are channeling the winds from the northwest and that the San Pedro Bay and shipping channels influence the winds from the south and southeast. As discussed above, other nearby stations that do not show these patterns may be influenced by additional factors. For instance, the Torrance Airport station is located within one kilometer (km) of the Palos Verdes Hills and on the north side of the hills (i.e., the influence of the San Pedro Bay is blocked by the hills), thus the predominant winds are only from the northwest. The Berth 47 station is located at the southern tip of the POLA, where the winds appear to be heavily influenced by the San Pedro Bay and predominant winds are from the southwest. At the North Long Beach station, two buildings located to the northwest and south/southwest of the buildings may be obstructing winds from these directions, as described in Section A.2.

As indicated in Figure I-A-2, the Lynwood and Compton-MATES stations, located further to the north and out of the region of influence of the both the Palos Verdes Hills and the San Pedro Bay, exhibit different wind patterns than those stations that are within approximately 10 kilometers of these terrain features/water bodies. The predominant wind directions at these two stations are from the west and southwest, indicating that on-shore flow is the dominant influence on the wind patterns in the area around these stations.

As indicated in Figure I-A-2, there is a large geographical area between the Long Beach area meteorological stations, which exhibit predominant winds from the northwest and south/southeast, and the Lynwood and Compton-MATES meteorological stations which exhibit predominant winds from the west and southwest, where there are no meteorological data stations. Thus, the transition region where wind patterns shift from the northwest and

south/southeast (i.e., in the Long Beach area) to the west/southwest (i.e., the Compton/Lynwood area) is currently not well defined. However, the locations of the meteorological data stations, aerial photographs, and topographical maps may be used to approximate the northern and southern extents of this transition region. As shown in Figure I-A-5, the southern boundary of this transition region may be approximated by the Long Beach Airport meteorological data station (i.e., just to the north of the north edge of the Palos Verdes Hills), and the northern boundary of the transition region may be approximated by the location of the Compton-MATES meteorological station. The boundaries of this transition region are likely conservative (i.e., the transition region is likely not as wide as indicated in Figure I-A-5).

As discussed above, due to the absence of surface meteorological data stations between the northern edge of the Palos Verdes Hills and the City of Compton, a more precise determination of the area over which the predominant wind directions change cannot be made. Therefore, ENVIRON has assumed that a shift in wind patterns likely occurs in a transition area north of the approximate east-west line created by Interstate 405 and 223rd Street in the northern part of Long Beach (see Figure I-A-5). Because all of the Long Beach area stations indicate the same general wind patterns (i.e., predominant winds from the northwest and south/southeast), and due to the data quality issues identified for most of the other stations identified in Section A.2, ENVIRON has assumed that the Port of Los Angeles-SPPS meteorological station or Port of Long Beach-Super Block may be used as a representative meteorological data set for the out-of-Port truck emissions on major freeways and locomotive emissions on the Alameda Corridor to the south of the east-west line approximated by Interstate 405 and 223rd Street in the northern part of Long Beach.

A.4 Hourly Surface Meteorological Data Selection for Ocean-Side Emission Sources

ENVIRON also evaluated off-shore meteorological stations which might be representative of ocean-side emission sources. The stations considered in this evaluation were the Berth 47 Station, located at the southern tip of the Port of Los Angeles in the outer harbor, the Santa Monica Station, located in open ocean approximately 70 kilometers west of the Ports, and the Avalon Catalina Airport, located on Catalina Island as shown in Figure I-2. Figure I-4 shows wind flow patterns for these three stations. As discussed in section A.3, the Berth 47 station appears to be strongly influenced by the San Pedro Bay. The wind patterns observed there differ in both characteristic direction and wind speed from the nearby stations further inland and are characterized by higher wind speeds and directional consistency. The wind rose for the Avalon Catalina station also indicates high wind speeds generally blowing from west-southwest. Although five years of meteorological data were available from the Avalon Catalina Airport Station, the data do not meet the minimum completeness criteria for air dispersion modeling purposes. However, the wind-rose for the Avalon Catalina Station confirms that the Berth 47 wind patterns are representative of those seen by ocean-side sources between Catalina Island and the Ports. An examination of the wind-rose for the Santa Monica Station indicates that the wind is more variable in direction than the pattern at the Berth 47 Station with

a higher frequency of winds blowing parallel to or away the shoreline. Since the Santa Monica Station has a higher frequency of winds that are parallel or away from the shoreline, air dispersion modeling using meteorological data from the Santa Monica Station may result in lower concentrations at over-land receptors. In addition, the Santa Monica station is far from the Ports. However, the higher wind speeds at this buoy confirms the expectation of higher wind speeds in the area outside of the Ports breakwater. In cases in which the modeling domain extends into the area near to this buoy, further project-specific consideration could be given to this station. Based on the above evaluation, ENVIRON selected the Port of Los Angeles Berth 47 station as representative of the wind patterns at off-shore locations outside of the Ports breakwater.

A.5 Cloud Cover Data Selection

In general, most non-NWS stations do not collect cloud cover, but AERMET, the meteorological preprocessor to AERMOD, requires cloud cover data. Therefore, since cloud cover data was not available for the station identified as the most representative for the Ports area in the other required surface parameters, the nearest available cloud cover data from an NWS station was selected for use. The substitution of data from a nearby NWS station into an incomplete set of otherwise more representative data is an option in the AERMET preprocessor algorithm (USEPA 2004a). In addition, substitution of nearby cloud cover data was approved by ARB.¹⁰

The nearest NCDC/NWS stations with available cloud cover data are located at Torrance Airport and Long Beach Daugherty Field. Figure I-A-1 shows the locations of these two stations with respect to the Ports area. The Long Beach Daugherty Field station is located approximately twelve kilometers to the northeast of the Ports, and the Torrance Municipal Airport station is located approximately ten kilometers to the northwest of the Ports at the eastern edge of the Palos Verdes Hills. Due to the potential for coastal fog conditions and the effects of the Palos Verdes Hills at the Torrance Airport, measurements of cloud cover at Long Beach Daugherty Field are likely more representative of cloud cover conditions in the vicinity of the Ports. NCDC also recommended the use of surface meteorological data from Long Beach Daugherty Field over Torrance Municipal airport due to the completeness and quality of the Long Beach Daugherty Field data.¹¹ Based on NCDC's recommendation and the potential for coastal fog conditions at the Torrance Municipal Airport, cloud cover data from the Long Beach Daugherty Field station should be merged with the surface data from the surface meteorological data stations identified above.

¹⁰ Personal communication, J. Yuan of ARB by e-mail to D. Daugherty of ENVIRON on August 3, 2006.

¹¹ Personal communication. William Brown of NCDC by telephone to Catherine Mukai of ENVIRON. 2006.

A.6 References

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