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Acoustics • Air Quality

Memo

To: **Paula Hartman, TRA**

Date: **March 19, 2010**

From: **James A. Reyff and Bill Popenuck**

Subject: **Comments on Meteorological Data Used for the South County Phase 2 Particulate Study**

Based on our conversations about the ambient particulate matter (PM) monitoring data presented in the South County Phase 2 Particulate Study (Phase 2 report), emission sources, methods of estimating emissions potential, and concerns about the meteorological data used in the Phase 2 report, in particular wind speeds, we have reviewed the available information on the Phase 2 meteorological data and provided below are our initial comments.

The information reviewed included the Phase 2 report and associated appendices along with a listing of the hourly meteorological data provided by the San Luis Obispo Air Pollution Control District (District) in their website (http://www.slocleanair.org). Detailed analysis of the raw data was not possible since the data provided is in an image format (Adobe Acrobat PDF file) and the District was unable to provide it in an alternate useable format (e.g., Excel format)[1].

Introduction

Understanding the meteorological conditions that affect generation of PM emissions from the sand dune areas in the State Vehicle Recreational Area (SVRA), as well as having meteorological data representative of the dune areas are critical in order to accurately represent potential sources of PM emissions.

Meteorological data used in the Phase 2 report were obtained from four meteorological monitoring stations in the study area. These stations are identified below, along with other pertinent information about the stations. Figure 1 shows the locations of these stations relative to the Oceano Dunes SVRA.

[1] Personal communication (email), 3/12/10, with Joel Craig (3/11/10) and Larry Allen (3/12/10) of the SLOAPCD. An initial request for the data in Excel format was made to Joel Craig and a response that they could not provide the data in Excel format and that the PDF format was the best that they could do was received from Larry Allen.

Meteorological Monitoring Station	Elevation[a] (feet)	Wind Sensor Height[b] (meters)	Wind Sensor Elevation (feet)	Approximate Distance from Ocean (miles)	Approximate Distance From SVRA (miles)
Oso	103	2	110	1.5	within
CDF	124	7	147	2.5	1.5[c]
Mesa 2	127	10	160	4.0	3.1[c]
Grover Beach	22	10	55	0.3	3.1[d]

[a] Approximate elevation from USGS National Elevation Dataset (NED) data.
[b] Height above local ground level.
[c] Distances obtained from Phase 2 Study report.
[d] Approximate distance to northernmost boundary of SVRA.

As part of the Phase 2 study sand flux measurements were used to investigate possible sources of wind blown PM emissions and estimate wind erosion potential in these source areas. Sand flux data were collected within the SVRA where off highway vehicle (OHV) activity is allowed, in an area south of the SVRA where OHV activity is not allowed, as well as several other areas outside of the SVRA. Wind speed data from the Oso and CDF monitoring stations were used in calculating the sand flux from three of the areas where data were collected. These were the beach dunes within the SVRA, interior dunes in the SVRA, and an undisturbed area of the Oso area.

Inappropriate Selection of Wind Speed Data for Flux Calculations

The wind speed data from the CDF site were used for flux calculations associated with the beach and interior dunes of the SVRA, and wind speed data from the Oso site were used for the undisturbed Oso area. As discussed in Appendix B of the Phase 2 report, these wind speed data were used to determine local threshold wind speeds, threshold friction velocities, and in calculating sand flux using the Gillette wind erosion model.

Although the Oso wind speed data were obtained from a location that is at a similar elevation (anemometer elevation of about 110 feet) and distance from the shoreline (1.5 miles) as the SVRA study areas, the sand flux study elected to use the wind speed data from the CDF site. The CDF site is about 2.5 miles from the shoreline, more than a mile further inland than the Oso site, and with an anemometer elevation of 147 feet, almost 40 feet higher than the Oso data. Additionally, as discussed in the Phase 2 report, the wind speeds at the Oso site were about 70% higher than those observed at the CDF site. This indicates that there is a substantial difference between the wind regimes in the lower elevation dune areas compared to the CDF site. The Phase 2 report did not provide an analysis of the representativeness of the CDF data for use in the SVRA study area and gave no justification for its selection. We believe the use of the CDF data to represent local ground level conditions in the SVRA area is inappropriate.

As detailed below in the discussion of threshold wind speeds and threshold friction velocities, wind speed data used for sand flux calculations should be obtained from site-specific wind sensors so that wind data are representative of the local areas where sand flux measurements are obtained. Use of data that are not site specific can introduce significant errors in the sand flux calculations resulting in unreliable estimates of the potential emissions generated from each of the different areas evaluated.

However, given that site-specific wind speed data were not obtained as part of the study, the next best alternative would have been to use the Oso wind data for all sand flux calculations and acknowledge the limitations of its use. Additionally, the actual wind speed data from the Oso site at 2 meters should have been used in calculating the threshold wind speeds and friction velocities. The majority of sand flux typically occurs very near the ground, with the majority of the flux occurring within 1 meter of the surface[2]. Thus, actual wind speeds closest to the flux zone where saltation, creep, and the suspension of particles occur best represent the effect the winds have on the physical processes occurring and should be used rather than an adjusted wind speed at 10 meters that was based on an actual 2 meter wind speed measurement.

Use of the Oso adjusted wind speed data at 10 meters for purposes of calculating threshold wind speeds and friction velocities introduces unnecessary additional error since there is an inherent error in the procedures used to extrapolate wind speeds from 2 meters to 10 meters. If it is desired to reference the threshold wind speeds and friction velocities to 10 meter winds for comparison purposes, the average threshold wind speeds and friction velocities determined from the actual 2 meter wind data can be extrapolated to equivalent 10 meter values.

If the Oso wind speed data rather than the CDF data were used as being representative of all SVRA dune areas the threshold wind speeds for the beach and interior dune areas could be 70% higher than reported. This would potentially result in threshold wind speeds for the beach and interior dune areas being the same or greater than that of the undisturbed Oso area.

Threshold Wind Speeds and Threshold Friction Velocities

The threshold wind speed (u_t) and threshold friction velocity (u_t*) are parameters commonly used in assessing sand flux from an area. The threshold wind speed is the wind speed needed to initiate sand movement at the ground surface. Since the wind speed typically increases with height (especially very near the surface), the threshold wind speed is a function of height. Thus, it is important to know what height the wind speed is referenced to when evaluating threshold wind speeds.

Friction velocity is a measure of the shear stress in the surface boundary layer and, unlike the wind speed, is assumed to be constant with height in the surface boundary layer and is used, for among other things, in mathematically describing the wind velocity profile[3]. The threshold friction velocity is the friction velocity corresponding to the wind speed threshold. Under neutral atmospheric conditions the threshold friction velocity can be calculated knowing the threshold wind speed and the surface roughness (z_0) of the surrounding ground area[4], where the surface roughness is a measure of the aerodynamic roughness of the surface.

Threshold friction velocities for the Phase 2 report were calculated using an assumed surface roughness of 0.1 centimeters (cm). The basis for selection of this surface roughness value was not provided. Accurate estimates of local surface roughness values are important in correctly calculating the threshold friction velocities since these velocities are subsequently used to estimate sand flux. Without knowledge of the actual surface roughness, significant errors can be introduced into the sand flux calculations. For example, reported surface roughness values for different areas of Owens Lake[2] range from 0.01 cm to 0.6 cm. As an example of the degree of potential error introduced by incorrectly characterizing the surface roughness, for a 10 meter per second threshold wind speed and a surface roughness of 0.01 cm the threshold friction velocity is 15.5 cm/sec. With surface roughness values of

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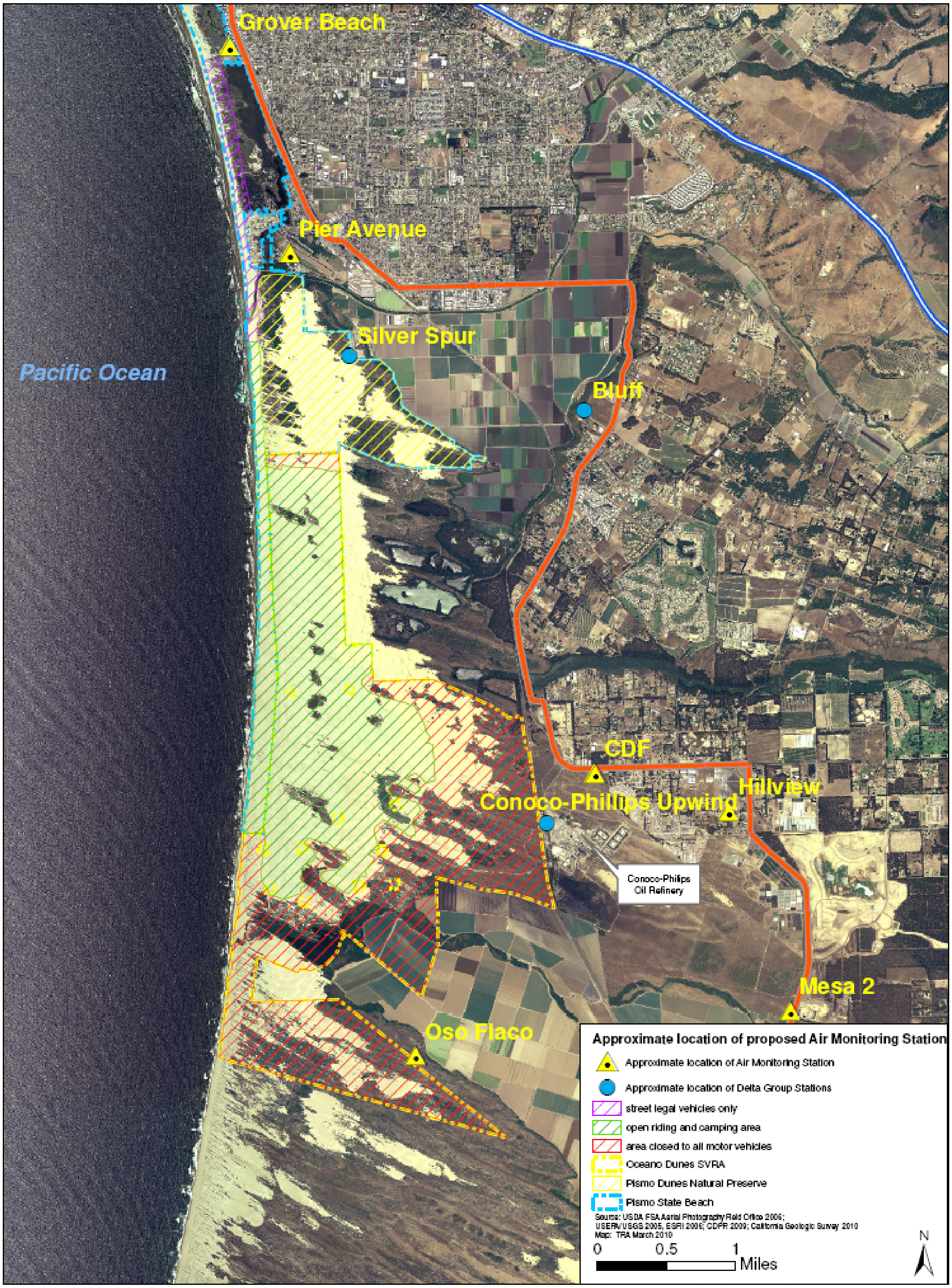
[2] Ono, 2006. *Application of the Gillette model for windblown dust at Owens Lake, CA*. Atmospheric Environment, Volume 40, 3011-3021, 2006.
[3] Lumley, J. and Panofsky, H.,1964, *The Structure of Atmospheric Turbulence*, John Wiley & Sons, Inc.,.
[4] Plate, E., 1971, *Aerodynamic Characteristics of Atmospheric Boundary Layers*, U.S. Department of Energy.

0.1 cm, 0.5 cm and 1.0 cm the threshold friction velocities are 19.4 cm/sec, 23.5 cm/sec, and 25.9 cm/sec, respectively. Thus, an error of 67% or more can be introduced into the sand flux calculations solely due to mischaracterization of the local surface roughness values.

Conclusions

The Phase 2 report's reliance on the use of wind data from the CDF site for evaluating sand flux in the SVRA is not appropriate, resulting in unfounded conclusions regarding sand flux from the different study areas. In order to more accurately characterize the meteorological conditions affecting local sand flux in different dune areas, individual anemometers should be used for each area. With site-specific wind speed measurements the local surface roughness, threshold wind speeds, and threshold friction velocities can be uniquely determined for each area.

Figure 1


Grover Beach
Pier Avenue
Silver Spur
Pacific Ocean
Bluff
CDF
Hillview
Conoco-Phillips Upwind
Conoco-Philips Oil Refinery
Mesa 2
Oso Flaco
Approximate location of proposed Air Monitoring Station
Approximate location of Air Monitoring Station
Approximate location of Delta Group Stations
street legal vehicles only
open riding and camping area
area closed to all motor vehicles
Oceano Dunes SVRA
Pismo Dunes Natural Preserve
Pismo State Beach
Source: USDA FSA Aerial Photography Field Office 2006;
USEPA/USGS 2005, ESRI 2006; CDPR 2009; California Geologic Survey 2010
Map: TRA March 2010
0
0.5
1
Miles
N