DEPARTMENT OF CONSERVATION

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CALIFORNIA GEOLOGICAL SURVEY

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Subject: In consideration of Draft Rule 1001 proposed by the San Luis Obispo County Air Pollution Control District: An analysis of Wind, Soils, and Open Sand Sheet and Vegetation Acreage in the Active Dunes of the Callender Dune Sheet, San Luis Obispo County, California.

Introduction

In September 2011, the San Luis Obispo County Air Pollution Control District (SLOAPCD) issued "Coastal Dunes Dust Control" Draft Rule 1001 (Draft Rule). The Draft Rule pertains to the active dunes of the Callender Dune Sheet where the Off-Highway Motor Vehicle Recreation Division (Division) of California State Parks (CSP) manages the Oceano Dunes State Vehicular Recreation Area (Oceano Dunes SVRA) and related facilities, in south San Luis Obispo County (Figures 1 and 2).

The SLOAPCD developed the Draft Rule based on findings presented in its February 2010 report, "South County Phase 2 Particulate Study" (Phase 2 report). From the Phase 2 data, the SLOAPCD concluded that when strong seasonal winds blow from the northwest, saltation-generated PM10 is a significant source of particulate impacting the Nipomo Mesa area of San Luis Obispo County and that saltation (defined below) happens more readily (with less wind) in the dunes where off-highway vehicle (OHV) recreation occurs.

In a coastal dune environment, after tides and waves bring sand and finer sediment to the shore, wind is the primary means of sediment transport. The wind-driven migration of sand, where grains bounce and creep along beach and dune surfaces, is called saltation. Smaller dust-sized particles can be released in the saltation process when a grain impacts a sandy surface. Some of this smaller material has a diameter of 10 microns or less. Material of this size range is generically called PM10. PM10 is generally not visible to the eye and can become entrained in the air with sufficient wind.

At the May 2010 meeting of the SLOAPCD Board, the Division acknowledged that PM10 impacts the Nipomo Mesa when strong, seasonal winds blow, and also that PM10 can be generated by the saltation process as dunes form and migrate landward. But based on three independent reviews of the Phase 2 report data (California Geological Survey (CGS), 2010A; Illingworth and Rodkin, Inc. (I&R), 2010; and TRA Environmental Sciences, Inc. (TRA), 2010), the Division maintained that the SLOAPCD position—that more saltation and more PM10 results from OHV recreation in the dunes—is unfounded

Purpose

This document was prepared by CGS at the request of the Division. It is to examine the primary mechanism that forms the dunes—the wind. The purpose is to consider wind speeds measured within the OHV riding area of the Callender Dunes with the foundation of the Draft Rule, the Phase 2 report, which claims saltation in the OHV riding area occurs with lighter winds than in other areas of the dunes and so produces more PM10.

Additionally, the compositions of soils mapped in south San Luis Obispo County by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) are examined. Specifically, the distribution of these soils based on their clay content is presented as a consideration of other sources which contribute to PM10 detected on the Nipomo Mesa.

Finally, CGS examines the earliest aerial photographs of the Callender Dunes, taken in 1930 and 1939, and compares that imagery with 2010 aerial imagery of the dunes. The intent is to document change in two natural features of the dunes which influence the degree to which saltation in a coastal dune environment occurs, namely vegetation and open sand sheet acreage.

Background

At the May 2010 SLOAPCD Board meeting, the Division expressed a willingness to work cooperatively with San Luis Obispo County representatives (SLO County) and SLOAPCD to better quantify and potentially mitigate occurrences of elevated PM10 concentrations detected on Nipomo Mesa. This initiated the development of a Memorandum of Agreement (MOA) between the agencies. Through the MOA process the Division, SLO County, and the SLOAPCD were to develop pilot projects which would examine possible variations in the potential to emit PM10 within the dunes and to determine the effectiveness of different strategies for minimizing saltation. This was a first step to collaboratively develop a Particulate Matter Reduction Plan (PMRP).

As agreed by all parties, a consultant, the Desert Research Institute (DRI), was contracted to assist in the pilot project design and to implement the pilot projects.

In its September 15, 2011 Final Project Report, DRI issued its findings from the pilot project work, indicating that there is very little variation in the potential to emit PM10 in the dunes, whether inside the OHV riding area or in areas where OHV riding is prohibited (DRI, 2011).

DRI also examined how sand movement—and therefore saltation—was affected by vegetation and by the patterned placement of hay bales. Both the vegetation and the hay bales were found to effectively limit sand movement, though quantifying an effect on downwind PM10 concentrations could not be determined (DRI, 2011).

Concurrent but independent of the pilot project work, SLOAPCD staff developed the Draft Rule. The Draft Rule was presented at a September 7, 2011 public workshop in Grover Beach and at the Board's September 28, 2011 meeting.

The Draft Rule calls for the development of a PMRP, as was discussed in the earlier MOA process.

The Draft Rule also calls for PM10 monitoring directly downwind of the OHV riding area and downwind of at least one "control" location—open sand sheets where OHV riding is restricted. Through a PM10 concentration comparison process between a "control" PM10 monitoring station and a PM10 monitoring station downwind of the OHV riding area, compliance with the Draft Rule would be determined. If the PM10 concentration comparison process indicated the Division was not in compliance, daily fines could be imposed on the State of California by SLOAPCD until the Division demonstrated that it had returned to compliance with the Draft Rule.

The information presented in the following sections was prepared in consideration of the Draft Rule.

<u>Wind Over the Dunes and Emissivity</u>

Comparing Peak Wind Speeds

In June 2010, Sonoma Technologies, Inc. (STI), installed a tower scaffold equipped with three anemometers and wind vanes in the OHV riding area of the Oceano Dunes SVRA. The wind measuring devices were positioned on the tower at 2, 7, and 10 meters above the sand surface. The location of the tower, called S1, and the OHV riding area at Oceano Dunes SVRA are shown in Figure 2, attached.

The S1 Tower was one of four wind monitoring stations to be installed in the Callender Dunes as part of a scope of work prepared jointly by CGS and TRA (CGS, 2010B) for the Division. The installation of the S1 Tower was permitted by SLO County, but due to permitting constraints that extended to the California Coastal Commission, the other towers have not been installed.

The intent of installing the wind stations is to more comprehensibly understand the effects of terrain on wind speed within the dunes and to measure winds where saltation occurs. Wind data from the S1 Tower was essential for the pilot project work conducted by DRI, and the continued collection and analysis of S1 wind data is to inform the PMRP development process.

The S1 Tower was positioned in the foredune area of the OHV riding area, in approximate alignment along the prevailing wind direction line with two downwind air monitoring stations operated by the SLOAPCD, stations CDF and Mesa 2 (Figure 2). The S1 location also approximately coincides with sand mass measurements made as part of the SLOAPCD's Phase 2 investigation to correlate sand movement in the OHV riding area with wind speed measured at the CDF station.

A second tower, S2, was planned for the interior dunes, near the eastern boundary of the OHV riding area and in alignment with S1 and Mesa 2. However, as indicated above, that tower has yet to be installed due to permitting constraints.

The northwest prevailing winds that have created the Callender Dunes are strongest in the spring months, and so the potential for saltation is greatest during this time. Accordingly, wind data from March, April, and May of this year, as measured at the S1 Tower, and from the CDF and Mesa 2 stations, are examined herein. Specifically, peak hourly-averaged wind speeds for each day during the three spring months were examined (Note: Data from the CDF and Mesa 2 stations were acquired via a link to the California Air Resources Board website provided on the SLOAPCD website: http://www.slocleanair.org/air/stations.php. Data from S1 was provided by STI).

The plots of the peak wind speed data—in miles per hour (mph)—from each station are displayed together on Figures 3, 4, and 5. The figures display March, April, and May 2011 data, respectively. The figures also indicate the days of the respective spring month, the hour of the day when the peak wind occurred, and the direction from which the hourly-averaged peak wind originated. A break in a plotted line indicates data were unavailable for that day, presumably due to equipment calibration and/or repair.

From the plots, it is evident that the S1 Tower records the strongest winds, with some measurements exceeding 30 miles per hour (mph). The lightest peak winds were recorded at the CDF station, with most measuring between 5 and 10 mph, for all three months.

There appears to be some wind speed correlation between the S1 Tower and Mesa 2 station based on the charted lines, where a similar pattern of peaks and troughs is apparent. The pattern can be faintly discerned in the plot of CDF data as well. However, time of day for the recorded peak wind at each location does not correlate. For example, on April 6, the hourly-averaged peak wind at S1 was nearly 30 mph (29.75 mph), averaged during the 1700 hour (from 5 to 6 PM) (Figure 4). At Mesa 2, the wind peak on that day was 18.9 mph, averaged during the 1400 hour (from 2 to 3 PM). And the peak wind speed at CDF occurred during the 1100 hour (11 AM to 12 PM) and measured 9 mph.

Examination of other peaks yield the same conclusion: the times of the peak winds are not the same—with one exception. Peak winds measured on March 24, 2011 all occurred during the 1500 hour (from 3 to 4 PM), but these winds came from the south-southeast (Figure 3).

Because the times of the peak winds do not coincide, and because the figures show only the recorded peak wind at each station for a given spring day, it appears that the observed correlation pattern only reflects the regional fluctuation in wind speed, illustrating when winds in general are strong or calm in the south county. It is beyond the scope of this analysis to determine why the times of peak prevailing winds recorded at each station do not coincide. Because some of the peaks are separated by as much as six hours, such as those recorded on April 6, 2011, and then at other times the difference is less, though still significant, it seems unlikely that the recording clocks at each station are not in general synchronicity.

Wind and Emissivity

As stated earlier, the DRI pilot project study used S1 wind data in its analysis of sand movement in the OHV riding area. Additionally, as part of its investigation, DRI positioned a 2-meter high anemometer upwind of an area where the Division had successfully reintroduced native vegetation. The anemometer was approximately 1.5 miles south of the S1 Tower, outside of the OHV riding area, and located about the same distance from the shore as the S1 Tower. DRI noted, based on nearly three weeks of recorded wind measurements (from April 15 to May 4, 2011) that the wind data recorded at that anemometer are “very similar in magnitude and frequency” to the wind data collected at the two meter high anemometer positioned on the S1 Tower (DRI, 2011). This is an indication that wind from the prevailing wind direction advances over the dunes at approximately the same speed, with some variance for localized topography. From its pilot project testing at different locations within Oceano Dunes SVRA, DRI (2011) also found that the emissivity of a dune surface—its potential to emit PM10— shows little variability, whether the dune is inside or outside the OHV riding area.

Based on the wind and emissivity consistencies within the dunes, it appears that the potential for sand saltation to generate PM10 is the same throughout the active dunes, whether the saltation occurs inside or outside the OHV riding area.

<u>Clay Fines</u>

The NRCS defines clay fines as mineral soil particles less than 2 microns in diameter (NRCS, 2008). As a soil textural classification, clay contains 40 percent or more clay fines.

As part of an earlier analysis to assess potential sources of PM10, CGS examined the percent clay component of soils in south San Luis Obispo County (CGS, 2011A and 2011B). To do this, CGS illustrated the soils mapped by the NRCS based on their percent clay content (presented in CGS 2011A and Figure 6, herein). Soil groupings were made for soils containing 0 to 1% clay, 1 to 10% clay, 10 to 20% clay, and 20 to 50% clay (Figure 6).

A quick review of Figure 6 shows that the beach and active dune sands, marked by their NRCS soil unit number designations, 107 and 134, respectively, contain the least amount of clay, and so are grouped in the 0 to 1 percent clay class. These materials actually contain no more than 0.5% clay, per the NRCS (2008), which is in agreement with grain size analyses of these sediments conducted by CGS (2011A) and DRI (2011).

All other materials downwind of the Callender Dune Sheet contain much more clay, including flood plain sediments from Arroyo Grande Creek, which lie north, northwest, and west of the Nipomo Mesa and contain more than 30% clay (Figure 6). Additional clay-rich and silt-rich flood plain and alluvial sediments are found northwest, and southerly adjacent to, the Mesa 2 air monitoring station.

Dirt roads traverse these deposits, allowing access for agricultural workers and their equipment to till, plant, and harvest row crops grown in fields composed of these sediments. Wind over barren fields and general agricultural and earth-moving operations on these soils have the potential to stir PM10, making it difficult to discount these soils of the south county as a potential PM10 source impacting the Nipomo Mesa, particularly given their reservoir of PM10-sized particles.

Open Sand Sheet Acreage

The imagery displayed in Figure 2, included herein, displays 2010 aerial photography acquired from the National Agricultural Imagery Program (NAIP). This imagery was compared to the earliest aerial photographs available of the active dunes of the Callender Dune Sheet to discern changes in vegetation and open sand sheet acreage over time.

Digital scans of aerial photographs from a 1930 flight survey of the dunes (Fairchild, 1930) were combined with scans of a 1939 aerial survey of the dunes conducted by the United States Army (US Army, 1939) to give a complete picture of the active dunes in the 1930's. The resolution of 1939 photographs is relatively good, but these photos did not cover the easternmost portions of the active dunes. The resolution of 1930 photographs is comparatively poor, but these images did capture the eastern edge of the active dunes.

Using geographic information system software (GIS), the images were sized to a common scale, spliced together, and geographically referenced so that the imagery from the 1930's could be draped over the 2010 NAIP imagery (Figure 7).

The extent of open sand sheet and dune vegetation acreage displayed in the 1930's imagery was digitized using GIS, as was that displayed in the 2010 NAIP imagery, so that changes in open sand sheet acreage and vegetation coverage could be quantified.

It is important to note that vehicle recreational activity along the coast in the south county in the 1930's was limited to the hard-pack sand near the shore. According to Linda Guiton-Austin, who, as curator of the Oceano Railroad Depot Museum, has chronicled the history of the dunes in the south county, the recreational use of vehicles equipped with the technology to traverse inland, onto the active dunes, did not grow until 1950's (Guiton-Austin, 2011). Ms. Guiton-Austin also notes that in the early 1900's fast-growing European beach grasses and ice plant were planted in the foredunes where Oceano Dunes SVRA is presently. This was done in an effort to stabilize sand underneath and around the La Grande Beach Pavilion, a structure built at the time to draw tourists and potential land investors. The pavilion ultimately collapsed in ruin due to shifting sands (Guiton-Austin, 2011).

Despite these and other limited anthropogenic influences, the 1930's imagery is a reasonable representation of the dunes previous to the influence of OHV activity and the Division management of Oceano Dunes SVRA, which began in 1983.

The acreage changes are illustrated in Figure 8, attached. The yellow shading displays the area of open sand that has remained the same for 70 years. The green shading indicates where dune vegetation has encroached onto open sand as of 2010. Blue shading indicates where vegetation in the 1930's is not present in 2010.

Between the southernmost and northernmost boundaries of Oceano Dunes SVRA, including the Pismo Dune Preserve, the amount of open sand sheet acreage has decreased approximately 650 acres since the 1930's (Figure 8), which conversely represents an increase in vegetation acreage by the same amount.

When 1930's to 2010 acreage changes are examined from south of the Pismo Dune Preserve and north of Oso Flaco Lake, which approximately delineates the northern and southern limits of the majority of the OHV riding area (see dashed lines on Figure 8), the decrease in open sand sheet acreage, and corresponding increase in vegetation, is approximately 196 acres.

As indicated by the 1930's imagery displayed in Figure 7 and by some of the blue shading in Figure 8, foredune vegetation has diminished within the Oceano Dunes SVRA boundaries. This is probably due to increased recreational activity in the dunes, including OHV recreation, which became increasing popular starting in the 1950's (Guiton-Austin, 2011), as well as natural dune forming processes. Despite this loss, it is important to note that the greater vegetation acreage gains shown in Figure 8 represent in part successful native vegetation planting projects like those undertaken by the Division. A vegetation analysis performed by CSP staff shows that the amount of vegetation within and near the OHV riding area, as measured between the years 1985 and 2003, increased approximately 80 acres (CGS, 2007) (Note: The dashed lines on Figure 8 also correspond to the approximate northern and southern limits of this survey). Additionally, at current staffing levels, Division personnel plant between 10 and 25 acres of native vegetation within the boundaries of Oceano Dunes SVRA annually (Glick, 2011).

Overall, the 1930's to 2010 aerial imagery comparison shows open sand sheet acreage in the dunes has been significantly reduced (Figure 8), resulting in a significant net reduction in the amount of saltation that occurs naturally in this dune setting.

Conclusions

The comparative PM10 monitoring proposed as part of the Draft Rule is based on an incorrect calculation. The calculation, presented in the Phase 2 report, implies that sand saltation, and therefore PM10 generation, occurs more readily (with less wind) in that portion of the coastal dunes disturbed by OHV recreation. This was determined by coupling sand movement measurements made in the foredunes of the OHV riding area with wind data collected at the CDF station, approximately 2.5 miles from the shoreline. That error was previously presented to the SLOAPCD Board in reviews of the Phase 2 report (CGS, 2010 and I&R, 2010) and has been reconfirmed by the S1/CDF wind data comparison made herein. Wind data collected at the S1 Tower, located in the foredunes of the OHV riding area where sand saltation occurs, does not correlate with CDF wind data. Winds measured at S1 are significantly stronger than at CDF, and the timing of daily peak winds at S1 do not temporally correlate with much weaker peak winds recorded at CDF. Based on these inconsistencies and the incorrect conclusion presented in the Phase 2 report regarding saltation in the OHV riding area, comparative PM10 monitoring conducted for enforcement purposes is not warranted and should be removed from the Draft Rule language.

Winds measured at different locations within the dunes, though at about the same distance from the shore, compare similarly (DRI, 2011). The potential of a dune surface to emit PM10—whether the dune is inside or outside the OHV riding area—shows little, mostly insignificant variability (DRI, 2011). Given these consistencies, it appears that the potential for wind to generate PM10 from saltation is the same throughout the dunes, and it appears that the potential results from natural dune formation and migration processes.

Vegetation coverage of open sand sheet acreage has increased significantly since the 1930's. In turn, this has caused a significant reduction in sand grain saltation, and a corresponding, though undetermined, reduction in the potential to generate PM10. Quantifying how vegetation and other saltation-reducing measures taken in the dunes will influence PM10 concentrations on the Nipomo Mesa will be complex, and at best, only an estimate, which will be difficult to verify because other PM10 sources impacting the Nipomo Mesa have not been characterized.

Continued native vegetation planting projects undertaken annually by Division staff will continue to reduce saltation and potential PM10 emissions.

Should you have any questions regarding this evaluation, please feel free to call.

Respectfully submitted,

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Figures attached:

Figure 1: Coastal Dunes of Central California
Figure 2: Oceano Dunes State Vehicular Recreation Area and Vicinity
Figure 3: S1, Mesa 2, and CDF Wind Data, March 2011
Figure 4: S1, Mesa 2, and CDF Wind Data, April 2011
Figure 5: S1, Mesa 2, and CDF Wind Data, May 2011
Figure 6: Clay Fraction of Soils Surveyed by NRCS, Oceano Dunes SVRA and Vicinity
Figure 7: 1930’s Aerial Imagery, Oceano Dunes SVRA and Vicinity
Figure 8: Comparative Analysis of 1930’s and 2010 Aerial Imagery, Oceano Dunes SVRA and Vicinity

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