Representativeness of the Oso Control Site Monitor

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Background

It is informative to review exactly how vehicular recreation within the ODSVRA contributes to PM_{10} levels on the Nipomo Mesa. A common misconception is that the PM_{10} measured at the District's monitor stations on the Mesa arises from purely natural sources, or from sand that is actively kicked up by vehicles, or is related to tailpipe emissions from these vehicles. While vehicular activity does kick up sand and generate tailpipe emissions, these sources are secondary contributors to downwind PM_{10}. The primary mechanisms by which these activities increase downwind particulate levels are:

1. Denuding dune surfaces of vegetation.
2. Disturbing sand dune surface morphology.

This is the reason ambient PM_{10} levels correlate strongly and directly with high winds blowing across the ODSVRA, but do not correlate well with daily vehicular activity. Vehicular activity increases the emissive potential of the areas where it is allowed within the ODSVRA, but high PM_{10} levels only occur under high winds conditions.

It is certainly true that large, open sand sheets which lack vegetation are a natural part of the Guadalupe-Nipomo Dunes Complex (of which the ODSVRA is a part.) For example, there exist very large areas of open sand outside of the area where riding is currently permitted. (Though, in the past many of these areas were also used for riding, so their current state may not be truly "natural".) It is also well-known that regardless of vehicular activity, open sand sheets emit PM_{10} under high wind conditions; thus, some component of the PM_{10} measured by District monitoring stations downwind of the ODSVRA is unrelated to vehicular activity. This is exactly why District Rule 1001 requires State Parks to reduce PM_{10} from the riding to only to within 20% of levels downwind of non-riding areas.

Evidence that vehicular activity has denuded the riding area of the ODSVRA include:

- Aerial photography: the current riding area is largely devoid of foredunes, while non-riding areas—both within the Park and to the south of it—have them.
- Historical photography: While it is unknown exactly how undisturbed the ODSVRA was in the 1930s, aerial photography from this era does show substantially more robust foredunes in most of the areas that are currently open to riding.
- State Parks own studies and reports state that the extant vegetated islands must be fenced off from vehicular activity to prevent further loss of vegetation. Similarly, revegetation projects must be fenced off from riding in order to be successful.

State Parks notes there are currently more vegetated acres within the ODSVRA than there were in 1930s. While true, this considers only the total acreage within the ODSVRA as a whole, neglecting to describe where those changes have occurred. In fact, substantial amounts of vegetation have been lost within the riding area and most of the gains have occurred in areas where riding is now prohibited. Furthermore, the denuded areas tend to be closer to the shore where wind speeds are higher, and where there is more potential for emissions.

Evidence that disturbing sand dune surface morphology increases emissivity is discussed below.

State Park's Studies Show that Riding Increases Emissivity

In 2013, State Parks' contractor Desert Research Institute (DRI) performed emissivity measurements on open sand throughout the ODSVRA. These measurement, made with their PI-SWERL device, were intended to quantify how much PM_{10} is emitted from the sand surface under controlled wind speed conditions. Their report[1] concludes that "[t]hese PI-SWERL measurements have made it clear that the La Grande and South West riding areas, and to a lesser extent the East riding area, are exhibiting the potential for windblown PM10 emissions that is higher than the non-riding areas that were tested." According to Table 2 of their report, on average the riding areas emit 5.2 times more PM_{10} than non-riding areas under 23 mph winds. At 32 mph, the difference is a factor 4.3, and at 36 mph, the difference is a factor 2.4. Comparing measurements from the Oso Flaco area to the La Grande tract area (which are upwind of the Oso Flaco and CDF monitors, respectively; see Figure 1, below), the differences are even larger: at **23 mph, the La Grande area emits 31.8 times as much PM_{10} as Oso Flaco, at 32 mph, 7.3 times; and at 36 mph, 4.8 times**.

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[1] Vicken Etyemezian, John Gillies, Dongzi Zhu, Ashok Pokharel, and George Nikolich, July 20, 2015. "2013 Intensive Wind Erodibility measurements at and Near the Oceano Dunes State Vehicular Recreation Area: Report of Findings." Available online at http://www.slocleanair.org/images/cms/upload/files/2013_PI-SWERL_Report%20of%20Findings_07_2015_Final.pdf.

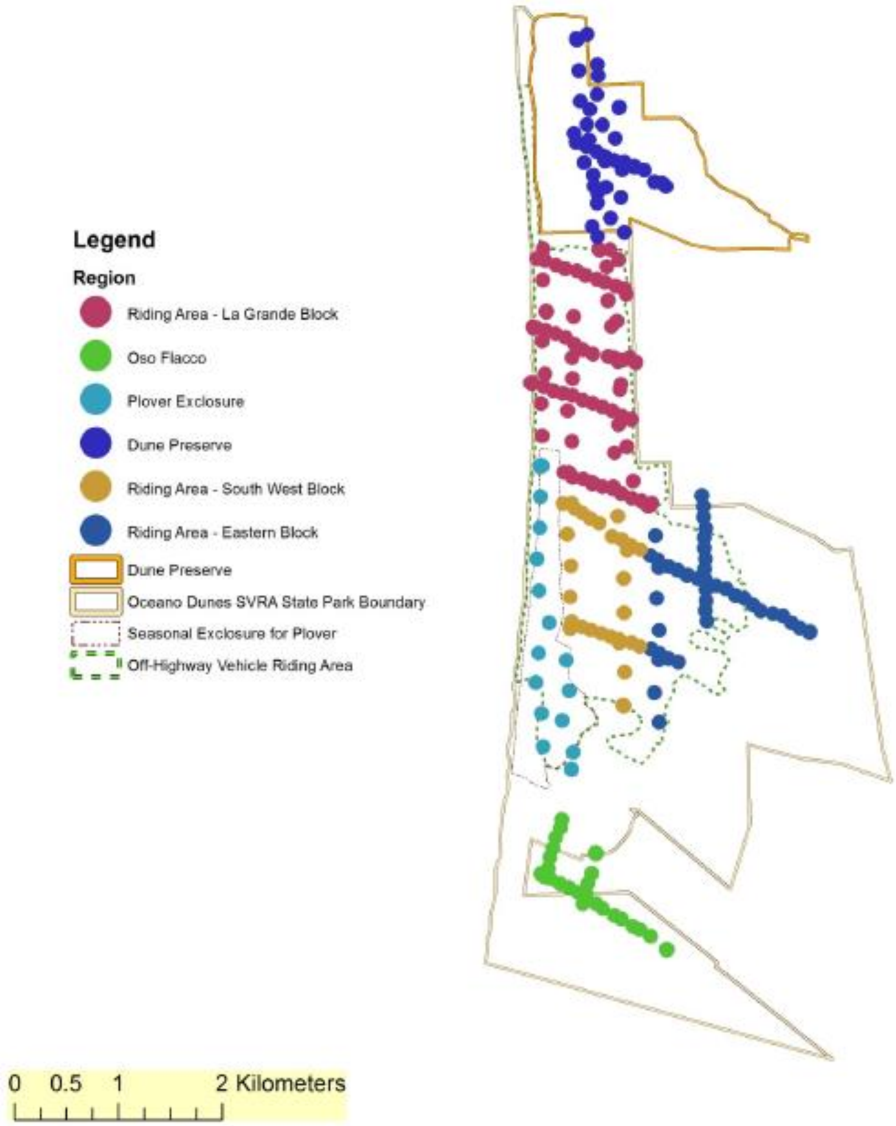

Figure 8. Delineation of Regions summarized in Table 2.

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Figure 1: Figure 8 from the DRI PI-SWERL report, showing the locations of the PI-SWERL measurements.

Also in 2013, PM_{10} and wind measurements were made along several transects *within* the ODSVRA, in both riding and non-riding areas, as shown in Figure 2, below. Also shown are 15-degree arcs of influence, showing the areas of the ODSVRA upwind of the CDF and Oso monitors during high wind events. DRI's analysis of the data[2] shows that for the same wind speeds, PM_{10} level are consistently higher in riding areas than in non-riding areas. This is shown most clearly in Figure 47 of the report. The site labeled 1C in the figure was located on open sand in a non-riding area, specifically the Dune Preserve. Site T4B was in the Oso Flaco area, approximately upwind of where the Oso Flaco monitor was later established. Site T2C and T3C were on the edge of the riding area, in open sand, and approximately upwind of CDF.

Using the power law equations that DRI derived for the curves in Figure 47 (displayed in the upper left corner of the figure) the expected PM_{10} concentration for a site can be calculated for a given wind speed. Using such PM_{10} estimates, the ratio of PM_{10} at one site versus another can be calculated at various wind speeds. The tables, below, summarize these ratios at 10 and 14 m/s (22 mph and 31mph), with each cell giving the ratio of riding area PM_{10} to non-riding area PM_{10}, i.e. how many times higher is PM_{10} at a riding area monitor vs a non-riding area monitor.

As shown in Table 1, for 10 m/s winds PM_{10} concentrations downwind of the riding areas are calculated to be 1.3 to 2.9 times higher than concentrations downwind of non-riding areas, depending on the riding/non-riding pair being considered. At 14 m/s (Table 2), a riding area monitor is calculated to measure 1.3 to 4.6 as much PM_{10}.

Table 1: Calculated ratio of PM_{10} for riding vs non-riding area at 10 m/s (22 mph)

	T1C – non-riding area	**T4C – non-riding area**
T2C – riding area	2.9	2.5
T3C – riding area	2.4	1.3

Table 2: Calculated ratio of PM_{10} for riding vs non-riding area at 14 m/s (31 mph)

	T1C – non-riding area	**T4C – non-riding area**
T2C – riding area	4.6	2.3
T3C – riding area	2.7	1.3

These calculated ratios should be considered very rough estimates of how much more ambient PM_{10} is expected downwind of riding vs non-riding areas. They represent only the comparison among these four sites—other downwind locations may receive more or less PM_{10}. It should also be noted

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[2] J.A. Gillies and V. Etyemezian, 9, 22, 2014. "Wind and PM10 Characteristics at the ODSVRA from the 2013 Assessment Monitoring Network." Available online at http://www.slocleanair.org/images/cms/upload/files/DRI_Oceano-Dune-Wind%20-PM-Conditions_09-22-2014%281%29.pdf

that the curves displayed in Figure 47 of DRI report are idealized—the are fit to field data which is very scattered. (See Figures 43 through 46 of the DRI report for plots similar to 47 which contain error bars). So even among these 4 sites, the “true” ratios likely differ at least a little from these calculated values.

Figure 2: Locations of PM_{10} monitors during 2013 study, along with CDF and Oso Flaco monitoring stations and their 15-degree arcs of influence.

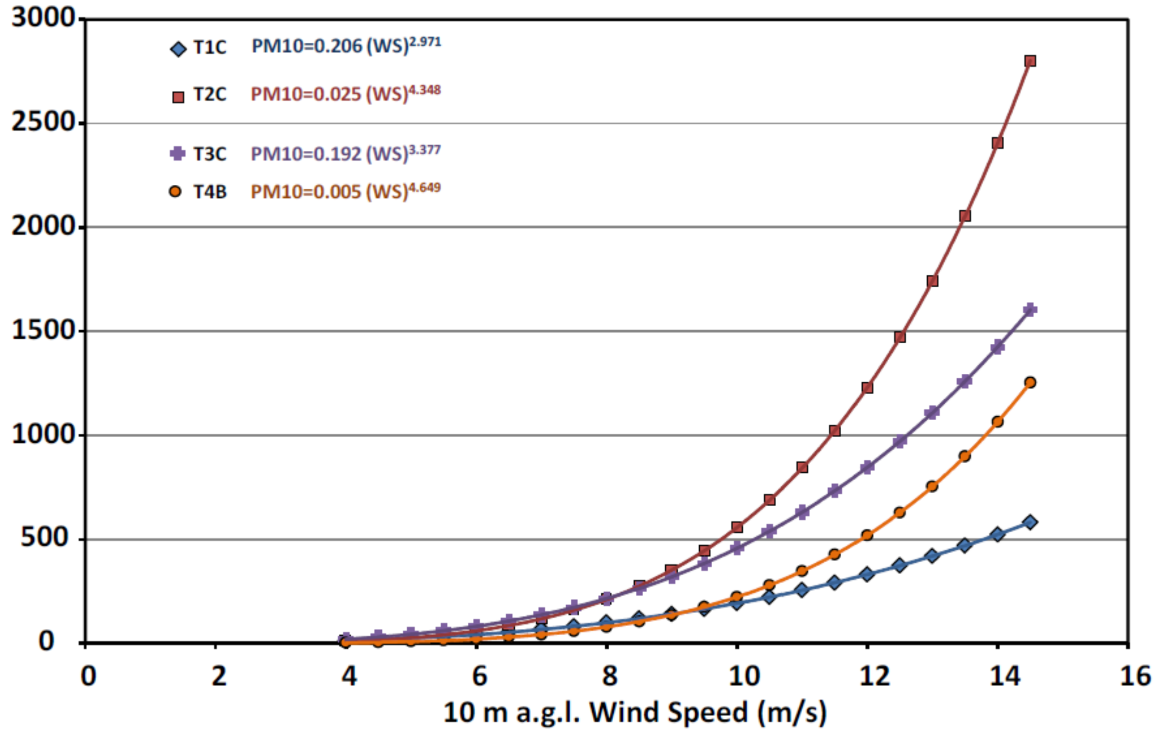

Figure 47. Relationships between mean 10 m hourly wind speed and PM_{10} for the four e-Bam measurement positions for the 292° winds (NB: no 10 m wind speed measured at position T3B).

Figure 3: Figure 47 from the DRI report. Sites T1C and T4B were in non-riding areas (the Dune Preserve north of the riding area and the Oso Flaco area south of the riding area), while T2C and T3C were within the riding area. T2C was somewhat north—and T3C south—of the open sand area presumed to be influencing CDF.

Differences in PM_{10} at CDF and Oso Flaco Are as Expected

The CDF to Oso Flaco PM_{10} ratio can be calculated from field data in a manner like that discussed in the previous section, however it is complicated by several factors, the biggest being that measured wind speeds at CDF (and presumably Oso Flaco) are greatly attenuated versus when measured close to the shore. For this reason, wind speeds measured at the S1 tower were used instead of onsite values for both monitors. Also, the Oso Flaco site was not established until mid-2015, while the DRI monitors only operated in 2013. Thus, a true “apples-to-apples” comparison using data from the same set of wind events is precluded.

Analyzing 2016-data from CDF and Oso Flaco analogously to the analysis presented in Figure 47 of the DRI report yields Figure 4, below. The calculated PM_{10} ratios for CDF to Oso Flaco are 3.4 at 10 m/s and 4.2 at 14 m/s. The actual ratios are likely to be somewhat higher, as a north-south wind speed gradient exists along the ODSVRA coast, so using S1 to represent Oso Flaco likely underestimates wind speeds there. While these ratios are greater than those calculated in the DRI report, they appear reasonable especially considering that Oso Flaco receives dust from an area with a more representative mix of vegetation and open sand than the T1A and T1D monitors in the DRI study.

In other words, the T1C and T4C non-riding monitors were downwind of large open-sand sheets in non-riding areas. The ratios presented in Tables 1 and 2 above, estimate how much vehicular activity increases the emissivity of an already denuded area. The area upwind of Oso Flaco is more typical of non-riding areas: it contains open sand areas as well as vegetation islands and vegetated foredunes.

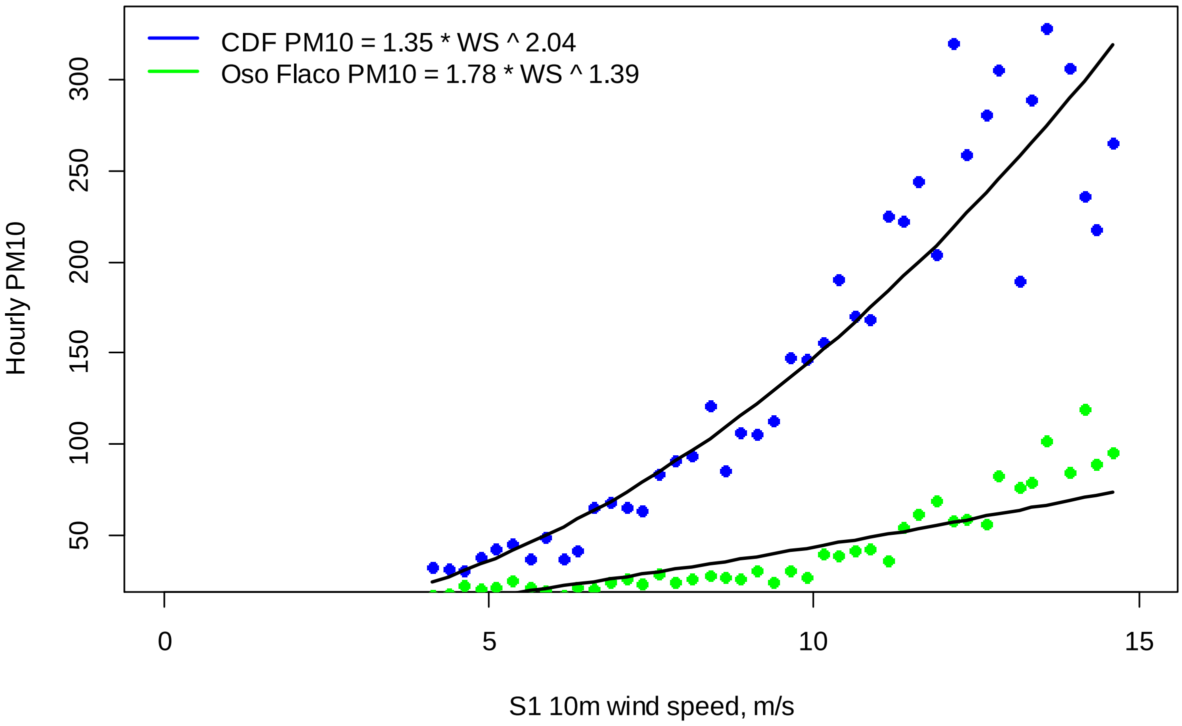

Figure 4: Relationship between mean hourly wind speed at S1 and hourly PM_{10} at CDF and Oso Flaco for 2016. Data filtered analogously to Figure 3.

Analyzing PM_{10} 24-hour averages from CDF and Oso Flaco, rather than hourly data, shows that, on Rule 1001 violation days Oso Flaco is 2.5 times higher than CDF, and 1.4 times higher on non-violation days (See Figure 5 below).

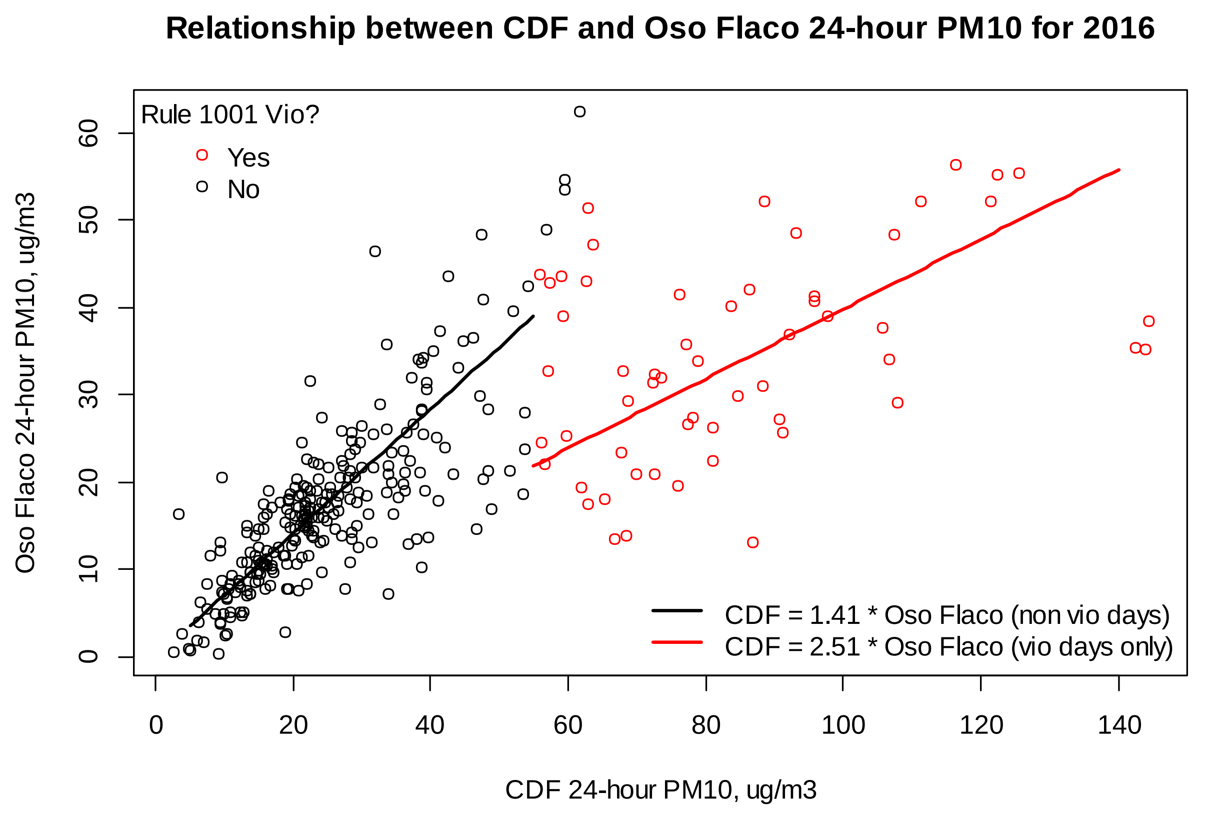

Figure 5: 24-hour PM_{10} averages at Oso Flaco vs CDF (2016 data). CDF values are 2.51 times higher than Oso Flaco on Rule 1001 violation days. These best fit lines were calculated using “Deming Regression” and forcing the lines to pass through the origin.

These ratios are very close to the riding area/nonriding area ratios measured by DRI in comparing soil emissivity and ambient PM10 levels between the riding and nonriding areas in the studies as described above and represented in Tables 1 and 2. This indicates the Oso Control site monitor is indeed appropriately sited to represent concentrations downwind of the nonriding areas for use in determining compliance with the performance standard in Rule 1001, Section C.3.