

Technical Review of DRI report “Chemical Speciation and Source Attribution of PM10 Samples Collected in 2021 at the CDF Monitoring Site.” (report undated)

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Introduction

On March 16, 2023, State Parks posted a report by the Desert Research Institute (DRI) on the website for the California Off-Highway Motor Vehicle Recreation Commission (Commission).

The report title is “Chemical Speciation and Source Attribution of PM10 Samples Collected in 2021 at the CDF Monitoring Site.” It is written by Dr. Jack Gillies and three of his DRI colleagues. The report is undated and does not have listed page numbers. The electronic record on the document indicates it was “created” on February 10, 2023 and “modified” on March 16, 2023, the day it was posted to the Commission website.

Dr. Gillies is a member of the Scientific Advisory Group (SAG), which is a board of technical advisors formed as part of the Stipulated Order of Abatement (SOA) that was imposed on State Parks by the San Luis Obispo County Air Pollution Control District (SLOAPCD) in 2018.

The SLOAPCD provided the equipment and labor for the air-sampling effort described in the report. State Parks paid for the laboratory analyses of collected samples and for the report preparation by DRI.

Study Focus: Confirm or Deny Scripps Findings

The focus of this study was to determine if this 2021 sampling effort by the SLOAPCD was in general agreement or not with recently published findings by the Scripps Institution of Oceanography (Scripps).

The Scripps findings show that the Mesa PM10 contains 14% dust.

The 14% dust findings bear significance because the SLOAPCD has up until this point assumed all PM10 on the Mesa is dust from Oceano Dunes. Similarly, the computer modeling conducted by the SAG as part of the SOA process assumes all PM10 on the Mesa is dust from the dunes. The SAG computer modeling calculates where and how much of the dunes are to be covered with plastic fences, hay, and/or vegetation so that dust from dune saltation is minimized, which, per the all-dust assumption, should reduce PM10 concentrations on the Mesa. A finding of 14% dust in the PM10 effectively invalidates the SAG computer modeling as well as the SLOAPCD’s long-held premise that dust created indirectly from off-highway vehicle (OHV) recreation at Oceano Dunes is the cause of the PM10 on the Mesa.

The DRI report alludes to the Scripps findings but does not state them outright. Nor does the report cite the Scripps publication in its list of references though the publication was available for review online approximately two months before the DRI report was prepared. This is difficult to reconcile

because for all the references DRI does cite, none seem more relevant to the DRI/SLOAPCD investigation than the Scripps publication.

Air Sampling Apparatus and the BAM monitor

For this particular study, the SLOAPCD set up air sampling equipment at their CDF air monitoring station on the Nipomo Mesa (Mesa). The CDF air monitoring station is about a mile or so east of the Oceano Dunes State Vehicular Recreation Area (Oceano Dunes). The samples were collected by the SLOAPCD using pre-weighed filters provided by DRI and filter holders (samplers) provided by the SLOAPCD.

The air sampling equipment used by the SLOAPCD for this investigation is called a Partisol sampler. Though it was set up at the CDF monitoring site, it is not the same equipment the SLOAPCD uses to record hourly measurements of PM10 and PM2.5. That device is called a Beta Attenuation Monitor (BAM), and the PM data it records become part of the official air quality record archived by the California Air Resources Board (CARB). The BAM equipment is audited regularly by the SLOAPCD and CARB to ensure accuracy. Data recorded by the equipment are used to determine if there have been violations of PM standards. The California State PM10 standard, which is relevant to this discussion, is a PM10 concentration of 50 micrograms per cubic meter of air averaged over a 24-hour period—using the hourly PM10 data collected by the BAM. Any 24-hour averaged PM10 concentration recorded by the BAM that is at or over 50 micrograms per cubic meter of air is considered a violation of the State's PM10 standard.

In its report, DRI did not make a distinction between the Partisol sampler used for the SLOAPCD investigation and the BAM instrument. The BAM instrument was not mentioned at all.

Air Sampling Effort

The SLOAPCD collected one 24-hour PM10 filter sample from its Partisol sampler every three days, beginning on April 20, 2021 and ending October 25, 2021. A total of 52 samples were collected of which 47 were considered valid.

Collected samples were stored by the SLOAPCD for an unspecified time and then sent to DRI for analyses.

Of the 47 valid samples collected, 8 samples were considered relevant because they were collected on days when the sampling equipment recorded PM10 readings that met or exceeded the State PM10 standard. Also, on those days strong afternoon winds came from the west, blowing over Oceano Dunes to the Mesa.

For the remaining 39 samples DRI concluded, "The non-exceedance day source attribution does not provide much useful information in terms of air quality management with respect to PM10" coming from the west.

Equipment and Sampling Methodology Different from Scripps Investigation

The once-every-three-days sampling method used by the SLOAPCD is not the same as that used by Scripps, nor is the equipment the same.

The Scripps study focused on worst-case scenario conditions. Sampling was conducted during the windiest part of the spring and fall (late April through May and September/October), during the windiest time of day (late morning to early evening). These are the times when the westerly prevailing winds are at their strongest, and most importantly, when hourly BAM PM10 readings at the CDF station are at their highest. If saltation-driven dust from the dunes is causing high PM10 on the Mesa, these are the times when dust content in the PM10 would be the greatest.

The sampling equipment used by Scripps partitions air flow at constant specified velocities to ensure capture of particles of a particular size (namely 10 microns) or smaller on a cassette-held air filter. Conceptually, this is the same as the equipment used by the SLOAPCD.

But the Scripps sampling apparatus was engineered so that PM10 could be collected in increments of time during the day—not all day. That enabled sampling during the worst case scenario conditions described above. Additionally, this methodology, which is widely used in atmospheric chemistry research, was not disputed whatsoever during the peer-review process that led to the scientific journal publication of the Scripps study.

The Scripps study deemed “high PM10 days” as any day during the sampling effort in which hourly BAM-recorded PM10 values exceeded 140 micrograms per cubic meter at least once during the sampling time. In this way, only samples collected on “high PM10 days” were analyzed to determine dust content.

For the Scripps work, there were 23 PM10 samples collected on “high PM10 days,” and of those, 19 were also on days when the State PM10 standard was exceeded at the BAM CDF monitoring station.

Analyzing PM10 Samples

To determine the dust content of the PM10, as well as the proportional amount of other constituents in the PM10, DRI, as directed by the SLOAPCD, conducted gravimetric, chemical speciation, and x-ray fluorescence analyses. These analyses, in general terms, are the same as the analyses used by Scripps.

Gravimetric analysis determines the weight of the PM10 on the air filter in the sampler, and speciation determines the proportional mass of oxidized elements in the PM10. Most elements oxidize, that is, bond with oxygen, and oxidized elements are associated with minerals, particularly minerals from the earth’s crust. Broadly speaking, specific oxidized elements identified together in speciation analysis define the mineral dust content of a PM10 sample, and the combined oxidized mass of those elements define the weight of the dust in the sample.

Discrepancies in 24-hour PM10 Data

DRI and the SLOAPCD identified their 8 “exceedance day” samples based on when their sampling equipment recorded a 24-hour PM10 measurement that was at or above the State PM10 standard of 50 micrograms. As stated above, the sampling equipment is not the same as the SLOAPCD’s official BAM monitor, data from which determines if the State PM10 standard has been violated.

This would not be an issue if the data between the instruments compared favorably. But in terms of defining an “exceedance day” that coincides with a recorded violation of the State PM10 standard, using the sampler PM10 reading and not the BAM reading is problematic for one of the 8 “exceedance day” samples.

The DRI report states that for the sample collected on May 4, 2021, the sampling equipment recorded a 24-hour PM10 value of 50 micrograms, which would at least be a violation of the State PM10 standard if not an exceedance. But the BAM equipment for that day recorded a 24-hour PM10 value of 47.4 micrograms—very much not a violation. By that official measurement, the DRI/SLOAPCD dataset of relevant samples is reduced to 7.

Also of relevance is that the DRI report gives the sampler’s 24-hour PM10 values in whole numbers only. There are no decimal numbers given, unlike the BAM data which are given to a tenth of a microgram (for example, 47.4 micrograms for May 4, 2021). This is of merit because even a 24-hour PM10 value of 49.9 micrograms is not deemed a violation of the State PM10 standard.

Finally, the data between the sampling instrument and the BAM was off by as much as 8.2 micrograms for the DRI/SLOAPCD-identified “exceedance days.” And, as noted before, the BAM monitor is not referenced at all in the DRI report.

Reported Results

DRI summarizes the “exceedance day” findings as averaged percentages of constituents that make up the overall PM10 sampled. Their findings are:

- Dust: 43.1%
- Sea Salt: 25.0% (Note: they strenuously differentiate between “fresh sea salt” and “aged sea salt” though the purpose of this is unclear. “Fresh sea salt” dominates in the samples, but it is a distinction without a difference.)
- Undefined: 20.4%
- Combined: 11.5% (Note: I created this category by combining their results for Organic Matter (8%), “Others” (1.8%), Sulfate (1.3%), and Elemental Carbon (0.4%). I quantified these constituents for clarity to show that still more PM10 is not dust.)

Discussion: Results and Sampling Relative to the Scripps Investigation

The DRI/SLOAPCD results show mineral dust to be a minority fraction of the PM10. This in and of itself is damning to the SLOAPCD/SAG/DRI assumption that all PM10 is dust because it shows

mineral dust to be a minority fraction of the PM₁₀. The finding that 25% of the PM₁₀ is sea salt further damns the all-dust assumption.

DRI theorizes that their “undefined” percentage should be thrown into their dust bucket. But that paragraph of justification has so many caveats leading to the phrase, “It is our opinion,” that it is difficult to give their exposition any merit beyond conjecture. Also, Dr. Russell, the author of the Scripps publication, reviewed this section and found it lacking, particularly with regard to what she perceived as inexperienced use of the cited reference, McInnes et al, 1996.

In the end, it seems DRI did not believe their own postulation because it is not illustrated in their graph of results, which is presented as Figure 28 in their report.

But regardless of the DRI/SLOAPCD results, the dataset they are using to draw conclusions is vanishingly small. To recap, they took 52 total samples and found only 8 of them useful—with one of those very much sliding off the bubble of relevance because there was not an actual exceedance of the PM₁₀ standard on that particular day, May 4, 2021.

In contrast, the Scripps study collected 23 “High PM₁₀ Day” samples, of which 19 were from days when the State PM₁₀ standard was officially exceeded at the CDF station. The samples were collected under worst-case scenario conditions, in a timeframe when hourly PM₁₀ readings were at their highest and westerly winds were at their strongest. This ensures that the content of dust in the PM₁₀ would be at its greatest.

Sampling the air throughout the day on one filter, as the SLOAPCD did, dilutes the amount of dust coming from the west because the sampler is also filtering air for approximately 18 hours of the day when the winds blow from other directions, become very light, or stop altogether.

Discussion: Relevance of Data Collected in the Month of May

Section 2c of the SLOAPCD’s SOA states that the goal of reducing PM₁₀ emissions shall be “calculated using the meteorology of the 10 highest emissions days for the period May 1 through August 31, 2013.”

It turns out that the highest emission days for that timeframe are in May because May is generally the windiest month in this geographic setting.

Of the 8 “exceedance days” identified in the DRI report, three days are in May, and on only two of those days was the State PM₁₀ standard officially exceeded.

For the Scripps work, PM₁₀ samples were collected on 13 days in May when the PM₁₀ standard was violated—a significantly larger PM₁₀ dataset for May.

Discussion: Presentation of PM₁₀ Data—Use of Whole Numbers for PM₁₀ and a Shortened Y-axis

The Partisol sampler used for the DRI/SLOAPCD sampling effort is manufactured by ThermoScientific, which makes a variety of air quality monitoring and sampling equipment used extensively by

regulatory agencies and scientists. It seems unlikely this equipment would give output in whole numbers, particularly when violating an air quality standard is defined by 0.1 of a microgram.

This begs the question as to whether the PM₁₀ data collected by the SLOAPCD was rounded up so that an “exceedance day” value of 50 micrograms was met, increasing their dataset of relevance from 7 samples to 8. An explanation for DRI/SLOAPCD’s use of whole numbers for reporting PM₁₀ values is warranted.

Regarding Figure 28 which presents the percentage of constituents identified in the 8 PM₁₀ samples, I’d like to point out what may be confusing unless attention is given to the Y axis of the graph. I’ve copied the figure/graph below for reference.

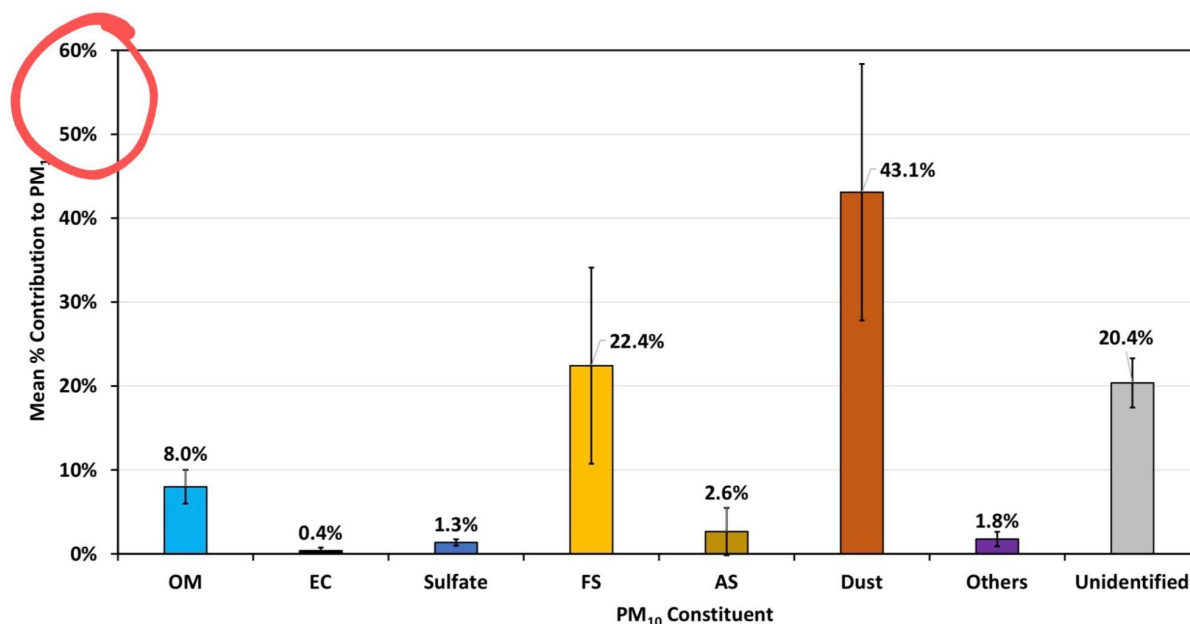


Figure 28. The mean source attribution of PM₁₀ representing the eight exceedance days between May and October 2021.

The Y axis refers to the percentage of the overall PM₁₀. Given that, one might expect the axis to extend to 100%, but, as indicated by the red circle I drew over the graph image, the axis only extends to 60%. On one hand this is understandable—it allows small contributors to the PM₁₀, like elemental carbon (“EC”) and sulfate, to register on the graph. On the other hand, an undiscerning glance makes it appear that the dust fraction of the PM₁₀ is about 75% of the PM₁₀—a gross misinterpretation. Overall, this could have been avoided by using a Y axis that extends to 100% and grouping the small contributors into a “combined” category, like I did, to show an 11.5% contribution of those constituents to the PM₁₀.

Discussion: 2020 Sampling by the SLOAPCD Not Considered in this Report

The SLOAPCD began a PM₁₀ sampling effort in 2020, after they learned of the initial 14% dust findings by Scripps. The SLOAPCD has not released those data publicly though State Parks paid for

the analyses. When Dr. Russell submitted to State Parks her draft report regarding the third-year findings of the Scripps investigation, State Parks gave the draft to the SLOAPCD to review.

In disputing the Dr. Russell's findings, the SLOAPCD claimed that their data from the 2020 sampling proved the Scripps conclusions of 14% dust to be incorrect. Dr. Russell requested a copy of the data, reviewed it, and responded that their 2020 PM10 sampling data did not disprove her work but corroborated it. In response, the SLOAPCD asked that their data be returned, and they told State Parks that the 2020 data could not be referenced in writing because the SLOAPCD had deemed the data to be "confidential."

Regardless of how intriguing that is, relevant data are relevant data, and DRI and SAG members were aware of the 2020 data. Yet, the DRI report, authored by a SAG member, makes no mention of the 2020 data.

Conclusions: Weight of Evidence Lacking

It is difficult to grant any significance to findings presented in the DRI report. Shortcomings of the report include:

- Inefficient PM10 sampling. SLOAPCD collected 52 samples over a 6 month time period, only to find that 8 samples were of value because those samples were collected on days when 24-hour PM10 measurements from their sampler were at or above 50 micrograms. The other samples were deemed either invalid or that they "not provide much useful information" relevant to the study.
- Scripps publication ignored: The most relevant reference that could have been used in this study was the Scripps publication, which demonstrated 14% dust content of the PM10. Yet the report authors did not cite it.
- No mention or correlation with the CDF BAM monitor. The BAM monitor officially records violations of PM standards, yet the authors chose to not acknowledge the existence of the monitor or its relevance.
- Discrepancies between sampler PM10 data vs BAM PM10 data. Twenty-four hour PM10 readings from the sampler were as much as 8.2 micrograms off when compared to the BAM data. DRI/SLOAPCD deemed the May 4, 2021 sample an "exceedance day" sample. But on that day, the BAM 24-hour PM10 reading was 47.4 micrograms, and so it was not an official exceedance of the State PM10 standard.
- Sampler PM10 data presented using whole numbers. It is unlikely the sampling equipment used by SLOAPCD would give output in whole numbers, particularly when violating an air quality standard is determined by 0.1 of a microgram. This begs the question as to whether PM10 data was rounded up to increase the size of the SLOAPCD's relevant dataset from 7 to 8 samples.
- Data from the month of May is relevant. The month of May generally exhibits the strongest westerly winds of the year. PM10 and meteorological data from this month are used to dictate SOA PM10 reduction requirements. Demonstrating the dust content of PM10 during May with data collected in May is relevant to demonstrating whether or not the SOA is viable. The Scripps study has PM10 data from 13 days in May when the State PM10 standard was

violated. Data from those samples show that dust content in the PM10 was 14%. The DRI/SLOAPCD study has data from only two days in May when the State PM10 standard was officially exceeded. Conclusions regarding the viability of the SOA can be drawn from the 13 May data points collected by Scripps (the SOA is not viable due to extremely low dust content in May). Very little can be discerned from the two data points provided by the SLOAPCD.

- PM10 data from 2020 not considered. The SLOAPCD sampled PM10 at the CDF location beginning in 2020 to determine dust content of the PM10. Dr. Russell from Scripps looked at these data and found they corroborated her findings. The SLOAPCD then deemed the data “confidential.” The SAG was aware of the 2020 sampling, and the DRI report was authored by a SAG member, but the DRI report makes no mention of the 2020 data.

Given these inefficiencies, omissions, discrepancies, and vagaries, it appears nothing definitive can be discerned from the DRI report.

END