# Oceano Dunes State Vehicular Recreation Area
# Dust Control Program

# 2021 Annual Report and Work Plan

*CONDITIONAL APPROVAL DRAFT*

*October 1, 2021*

**State of California**
**Department of Parks and Recreation**

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# ODSVRA Dust Control Program
# 2021 Annual Report and Work Plan

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## 2021 Annual Report and Work Plan Attachments(Separate Documents)

| **Acronym/Symbol** | **Full Phrase or Description** |
|---|---|
| $\mu g/m^3$ | Micrograms Per Cubic Meter |
| ARWP | Annual Report and Work Plan |
| ASU | Arizona State University |
| BAM | Beta Attenuation Monitor |
| BSNE | Big Springs Number Eight |
| CAAQS | California Ambient Air Quality Standards |
| CALMET | Computer-Aided Learning in Meteorology |
| CARB | California Air Resources Board |
| CCA | California Coastal Act |
| CCC | California Coastal Commission |
| CDF | California Department of Forestry and Fire Protection |
| State Parks | California Department of Parks and Recreation (also State Parks) |
| CGS | California Geological Survey |
| DEM | Digital Elevation Model |
| DRI | Desert Research Institute |
| GCD | Geomorphic Change Detection |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| MP | Megapixel |
| NAAQS | National Ambient Air Quality Standards |
| ND | Normalized Distance |
| NDRE | Normalized Difference Red-Edge Index |
| NDVI | Normalized Difference Vegetation Index |
| NSF | Normalized Sand Flux |
| ODSVRA | Oceano Dunes State Vehicular Recreation Area |
| OHMVR Commission | Off-Highway Motor Vehicle Recreation Commission |
| OHV | Off-Highway Vehicle |
| PI-SWERL | Portable In-Situ Wind Erosion Laboratory |
| $PM_{10}$ | Particulate Matter 10 |
| PMRP | Particulate Matter Reduction Plan |
| PPK | Post-Processing Kinematic GPS Positioning |
| RCD | Coastal San Luis Resource Conservation District |
| RGB | Red, Green, and Blue |
| SAG | Scientific Advisory Group |
| SB | Straw Bale |
| Scripps | Scripps Institution of Oceanography |
| SfM | Structure-From-Motion photogrammetry |
| SLOAPCD | San Luis Obispo County Air Pollution Control District |
| SM | Straw Measures |

| Acronym/Symbol | Full Phrase or Description |
|---|---|
| SOA | Stipulated Order of Abatement |
| SODAR | Sonic Detection and Ranging Instrument |
| SVRA | State Vehicular Recreation Area |
| TLS | Terrestrial Lidar Scanning |
| TV | Temporary Vehicle Exclusion |
| UAS | Uncrewed Aerial System |
| UCSB | University of California, Santa Barbara |
| USEPA | United States Environmental Protection Agency |
| VG | Vegetation |
| WF | Wind Fencing |
| WPD | Wind Power Density |

# 1 INTRODUCTION

The California Department of Parks and Recreation (State Parks) has prepared this 2021 Annual Report and Work Plan (ARWP) for the Oceano Dunes State Vehicular Recreation Area (ODSVRA) Dust Control Program to comply with the Stipulated Order of Abatement (SOA) approved by the San Luis Obispo County Air Pollution Control District (SLOAPCD) Hearing Board in April 2018 (Case No. 17-01) and amended in November 2019.[1]

The SOA, Conditions 4 and 5, as amended, requires State Parks to prepare and submit to the SLOAPCD, and the SOA Scientific Advisory Group (SAG), an ARWP, by August 1 each year from 2019 to 2022. In general, SOA Condition 4 requires the ARWP to:

- Review dust control activities implemented over the previous 12-month period and, using tracking metrics specified in the Particulate Matter Reduction Plan (PMRP), document progress towards SOA goals. For this 2021 ARWP, the previous 12-month period started on August 1, 2020, and ended on July 31, 2021.
- Identify dust control activities proposed to be undertaken or completed in the next 12-month period and, using tracking metrics specified in the PMRP, document expected outcomes and potential emission reductions for these activities. For this 2021 ARWP, the next 12-month period starts on August 1, 2021, and ends on July 31, 2022.
- Using air quality modeling, estimate the downwind benefits and anticipated reductions in respirable particulate matter ($PM_{10}$) concentrations associated with proposed dust control activities.
- Describe the budgetary considerations for the development and implementation of proposed dust control activities.
- Provide a detailed implementation schedule with deadlines associated with the physical deployment of proposed dust control actions.

Section 2 of this ARWP **reports** on dust control activities implemented in the previous 12 months (August 1, 2020 to July 31, 2021), including progress made towards SOA goals to date.

Section 3 of this ARWP **proposes** dust control program activities undertaken or completed inthe coming 12 months (August 1, 2021 to July 31, 2022), including model-predicted $PM_{10}$ mass and concentration reductions and continued progress towards meeting SOA goals.

[1] The SOA, as amended, is available for review on the following SLOAPCD website: https://www.slocleanair.org/who/board/hearing-board/actions.php

Section 4 and Section 5 of this ARWP **describe** budget considerations and implementation schedules for the proposed Dust Control Program activities to be initiated, undertaken, and/or completed in the coming 12 months.

This 2021 ARWP has been prepared under the supervision of Jon O'Brien, Environmental Program Manager, OHVMR Division, who State Parks has designated as the Project Manager for the Dust Control Program under Condition 13 of the Amended SOA. State Parks' development of the 2021 ARWP was done in close consultation and coordination with the SAG ARWP subcommittee.

# 2 DUST CONTROL PROGRAM ANNUAL REPORT (AUGUST 1, 2020 TO JULY 31, 2021)

This section of the 2021 ARWP reports on Dust Control Program activities undertaken from August 1, 2020, to July 31, 2021, estimates progress towards achieving SOA goals, and presents additional information on other activities related to the Dust Control Program undertaken by State Parks and/or the SAG.

From August 1, 2020, to July 31, 2021, State Parks installed 92.3 acres of new dust control measures at ODSVRA, converted 32.3 acres of existing, temporary dust control measures to native dune vegetation, performed as-needed maintenance and supplemental planting activities on dust control measures throughout ODSVRA, and continued robust data collection and modeling efforts intended to improve the effectiveness of State Parks' Dust Control Program. State Parks undertook the above activities in consultation and coordination with the SAG and SLOAPCD. **As of July 31, 2021, State Parks has successfully installed approximately 322.5 total acres of dust control measures at ODSVRA.** More than 80% of these measures are located within the SVRA's open riding and camping area (261.2 acres out of 322.5 acres). **The Desert Research Institute (DRI) air quality model, being used per Section 2(c) of the SOA, estimates State Parks' dust control efforts to date have resulted in a 22.3% reduction in modeled baseline $PM_{10}$ mass emissions at ODSVRA.** This cumulative reduction represents continued progress towards the SOA's goal of a 50% reduction in mass emissions from the open riding and camping area.

State Parks notes that while the SOA requires State Parks to report on activities "implemented over the previous year" by August 1, 2021, this 2021 ARWP reports on activities that were started more than one year ago (i.e., before August 1, 2020) and completed in the past year (i.e., between August 1, 2020, and July 31, 2021). It also reports on activities started in the past year, which State Parks or the SAG did not expect to complete in time for reporting in this ARWP cycle. This lag in reporting is due to the seasonal nature of data collection efforts and the time involved to process, analyze, interpret, and report the data collected for the Dust Control Program. The year 2020 ARWP actions/results that are not available to State Parks for reporting in this 2021 ARWP will be discussed in the next ARWP cycle (i.e., the 2022 ARWP).

## 2.1 REPORT ON DUST CONTROL MEASURES INSTALLED AT ODSVRA

State Parks' ODSVRA Dust Control Program is a multi-year, adaptive management program involving an iterative series of dust control projects intended to improve air quality downwind of ODSVRA.

Dust control projects are measures that State Parks puts on or into the ground to cover the ground surface or reduce surface disturbance, break the flow of wind across the landscape, and reduce or halt saltation and dust generation. The Dust Control Program includes seasonal dust control measures, temporary dust control measures, and vegetation dust control measures. A seasonal dust control measure is a project that State Parks implements to control saltation and dust generation for a defined period, usually between March 1 and October 31 of each calendar year. In contrast, temporary dust control measures control saltation and dust generation indefinitely, but not permanently.

Seasonal and temporary dust control measures generally include wind fencing, straw bales, other straw treatments, porous roughness elements, and other materials that can sometimes, but not always, be recovered and reused in subsequent dust control projects.[2] State Parks also excludes vehicles from areas (vehicle exclusion areas) and has explored, in a very limited manner, the use of soil stabilizers as a form of seasonal and/or temporary dust control at ODSVRA. In contrast to seasonal and temporary measures like wind fencing, vegetation planted by State Parks at ODSVRA is generally considered a long-term dust control measure. However, vegetation is subject to fluctuation in growing conditions, sand migration, etc.

Finally, State Parks also implements a track-out control program to prevent track-out of sand onto Grand Avenue and Pier Avenue entrances to ODSVRA.

State Parks' report on ODSVRA dust control measures as of July 31, 2021 is provided below.

### 2.1.1 Dust Control Measures Installed Between August 1, 2020, And July 31, 2021

From August 1, 2020, to July 31, 2021, State Parks installed 92.3 acres of new dust control projects at ODSVRA.[3] State Parks:

- Initiated planting of 26.6 acres of new vegetation using sterile grass seed in 3 different treatment areas.
- Installed 65.7 acres of new, temporary dust control measures in 9 different areas, including:
  - Approximately 32.5 acres of wind fencing in 2 different project areas.
  - Approximately 27.3 acres of straw treatments in 5 different project areas.
  - Approximately 5.9 acres of vehicle exclusions in 2 different project areas.

From August 1, 2020, to July 31, 2021, State Parks also converted and/or maintained

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[2] Straw bales were used for specific dust control projects and are identified as such (11-SB-01, 14-SB-01, 18-SB-01, and 18-SB-02). Other projects have employed a mix of straw mats, straw blankets, fiber rolls, and blown straw and are collectively referred to in this ARWP as "straw treatment" projects.

[3] As recommended by the SAG, the main body of this 2021 ARWP document and Attachment 01 to the 2021 ARWP report the size of dust control measures to the nearest tenth of an acre, with acreage values rounded up (values 0.05 and above) or down (values below 0.05) to the nearest tenth of an acre as necessary.

approximately 73 acres of existing dust control projects. State Parks:

- Converted 32.3 acres of existing, temporary wind fencing and straw measures to native dune vegetation.
- Conducted supplemental plantings in existing vegetation plots.
- Maintained 40.3 acres of existing wind fencing installed as part of the 2019 ARWP.

The dust control projects implemented by State Parks from August 1, 2020, to July 31, 2021, total 124.6 acres as listed in Table 2-1, shown in Figure 2-1, and briefly summarized below.[4.]

Refer to Attachment 01, 2011 to 2021 Dust Control Measures for additional maps showing historical dust control measure locations, the dust control measures installed between August 1, 2020, and July 31, 2021, and all dust control measures in place as of July 31, 2021. Refer to Section 2.3.7 and Attachment 02, Updated PMRP Evaluation Metrics, for information on dust control projects at ODSVRA, dust mitigation targets, and other indicators of dust control progress at ODSVRA.

#### 2.1.1.1 New Vegetation Measures

In late spring 2021, State Parks initiated the planting of approximately 26.6 new acres of vegetation at ODSVRA in three different project areas selected in consultation with the SAG:

- Vegetation measures 21-VG-05 (18.4 acres), 21-VG-06 (4.2 acres), and 21-VG-07 (4.0 acres) are each located in the southeastern part of the SVRA, outside the SVRA's open riding and camping area. These new plantings are located adjacent to existing dune vegetation and generally fill in and/or expand and increase the size of existing vegetated dune areas.

State Parks broadcast the treatment areas with limited seeds and sterile cereal grains. Due to the timing of the seeding (late in the growing season), germination was limited in each treatment area. State Parks will stabilize and seed these areas using locally collected native seed during the 2021/22 planting season; container plants are not currently proposed in this area for 2021 (see Section 3.1.5). State Parks' seeding methods are fully described in Chapter 6 of the June 2019 Draft PMRP.

[4] The 124.6-acre estimate of dust control measures implemented between August 1, 2020 and July 31, 2021 includes 92.3 acres of new dust control measures (i.e., land area not previously controlled) and 32.3 acres of temporary dust control measures converted to vegetation dust control measures (i.e., land area already controlled but changed to a different dust control measure). The maintenance of wind fencing, and minor supplemental vegetation planting are not included in the 124.6-acre estimate because there was no meaningful change in the type or amount of dust control occurring in these areas.

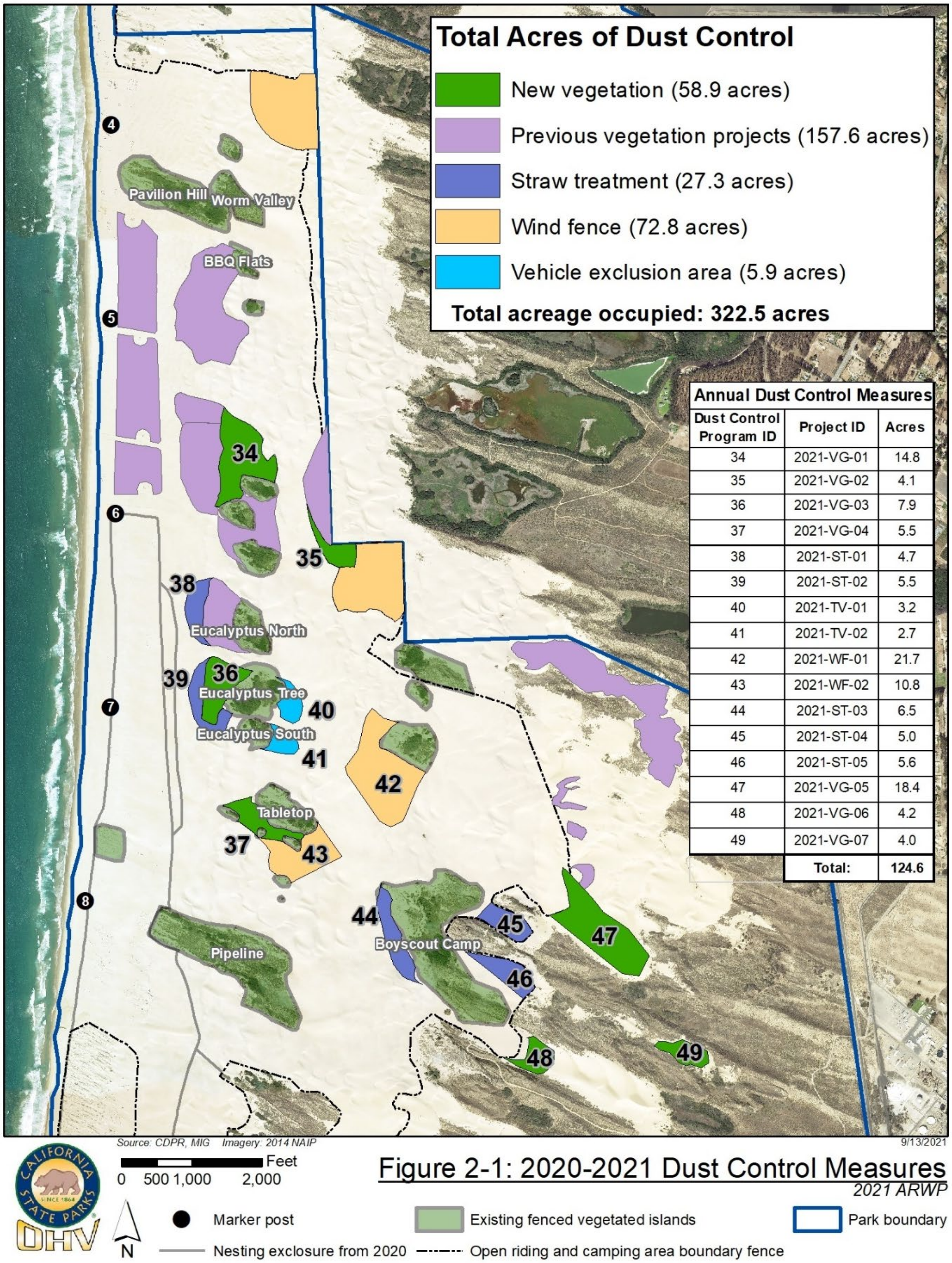
| Table 2-1. Dust Control Measures Installed from August 1, 2020, and July 31, 2021 | | | | |
|---|---|---|---|---|
| **Dust Control Program ID(A)** | **Dust Control Measure ID(B)** | **New or Converted Dust Control Measure** | **Status of Dust Control Measure** | **Dust Control Measure Size in Acres(C)** |
| **Converted Dust Control Projects** | | | | |
| 34 | 21-VG-01 | Converted to Vegetation | Long-term | 14.8 |
| 35 | 21-VG-02 | Converted to Vegetation | Long-term | 4.1 |
| 36 | 21-VG-03 | Converted to Vegetation | Long-term | 7.9 |
| 37 | 21-VG-04 | Converted to Vegetation | Long-term | 5.5 |
| *Subtotal, Converted Dust Control Projects* | | | | *32.3* |
| **New Dust Control Projects** | | | | |
| 38 | 21-ST-01 | New Straw Treatment | Temporary | 4.7 |
| 39 | 21-ST-02 | New Straw Treatment | Temporary | 5.5 |
| 40 | 21-TV-01 | New Vehicle Exclusion Area | Temporary | 3.2 |
| 41 | 21-TV-02 | New Vehicle Exclusion Area | Temporary | 2.7 |
| 42 | 21-WF-01 | New Wind Fence | Temporary | 21.7 |
| 43 | 21-WF-02 | New Wind Fence | Temporary | 10.8 |
| 44 | 21-ST-03 | New Straw Treatment | Temporary | 6.5 |
| 45 | 21-ST-04 | New Straw Treatment | Temporary | 5.0 |
| 46 | 21-ST-05 | New Straw Treatment | Temporary | 5.6 |
| 47 | 21-VG-01 | New Vegetation | Long-term | 18.4 |
| 48 | 21-VG-02 | New Vegetation | Long-term | 4.2 |
| 49 | 21-VG-03 | New Vegetation | Long-term | 4.0 |
| *Subtotal, New Dust Control Projects* | | | | *92.3* |
| **Total Dust Control Measure Acreage Installed, August 1, 2020, to July 31, 2021** | | | | **124.6** |

(A) State Parks has implemented a series of dust control projects at ODSVRA since 2011. The "Dust Control Program ID" represents the chronological order of these dust control projects, beginning with the first strawbale pilot project in 2011 (ID #01) and concluding with the final vegetation project in 2021 (ID #49). For projects installed in the same dust control year (defined from August 1st of one year to July 31st of the next year), projects are numbered from north to south.

(B) The "Dust Control Measure ID" identifies the dust control year, type of measure, and how many of the same type of measures were installed in the dust control year. For example, "21-ST-05" is the fifth straw treatment project installed in the 2021 dust control year (identified from north to south). "SB" refers to strawbale, "ST" refers to straw treatment, "WF" refers to wind fencing, "TV" refers to temporary vehicle exclusion area, and "VG" refers to vegetation.

(C) As recommended by the SAG, this 2021 ARWP document reports dust control measure acreages to the nearest tenth of an acre. See footnote 1. Refer to Figure 2-1 and Attachment 01, 2011 to 2021 Dust Control Measures for dust control measure location and acreage amounts.

**Figure 2-1. 2020 – 2021 Dust Control Measures**



#### 2.1.1.2 New Temporary Dust Control Measures

In fall 2020 and spring 2021, State Parks installed approximately 65.7 acres of new, temporary dust control measures at ODSVRA in nine different project areas selected in consultation with the SAG:

- Wind fencing measures 21-WF-01 (21.7 acres in south Boy Scout vegetation island) and 21-WF-02 (10.8 acres between the Tabletop and Willow Ridges vegetation islands) are located near the center of the SVRA's open riding and camping area. The fencing projects consisted of multiple rows of four-foot-tall porous fences (50% porosity) placed perpendicular to the prevailing sand transporting-wind direction.

- Straw treatment measures 21-ST-01 (4.7 acres west of the Eucalyptus North vegetation island), and 21-ST-02 (5.5 acres west of the Eucalyptus Tree vegetation island) are each located near the center of the SVRA's open riding and camping area. Straw measures 21-ST-03 (6.5 acres west of the Boy Scout Camp vegetation island), 21-ST-04 (5.0 acres east of the Boy Scout Camp vegetation island), and 21-ST-05 (5.6 acres east of the Boy Scout Camp vegetation island) are each located near the southeast corner of the SVRA's open riding and camping area. These new straw measures are located adjacent to existing vegetation islands and dust control vegetation projects and generally fill in and/or expand and increase the size of existing vegetated dune areas and/or treatment areas. State Parks applies straw to a depth of approximately six-to-eight inches; however, the amount of straw applied varies by treatment area due to topography.

- Vehicle exclosure measures 21-TV-01 (3.2 acres east of the Eucalyptus Tree vegetation island) and 21-TV-02 (2.7 acres east of the Eucalyptus South vegetation island) are located near the center of the ODSVRA open riding and camping area.

#### 2.1.1.3 Conversion of Existing Temporary Measures to Long-Term Vegetation Dust Control Measures

In fall 2020 and winter 2021, State Parks converted 32.3 acres of temporary windfencing and straw bale treatments to long-term vegetation dust control measures:

- Vegetation measure 21-VG-01 (14.8 acres north of the Heather and Acacia vegetation islands) is located near the center of the ODSVRA open riding and camping area. This measure replaced 14.8 acres of straw treatment installed in March 2020 (20-ST-01), which had replaced a portion of wind fencing installed in 2018 under SOA Condition 1.b. (18-WF-01 and 18-WF-02; see Attachment 01, Figures A01-09 and A01-11).

- Vegetation measure 21-VG-02 (4.1acres) is located along the eastern boundary of the ODSVRA (perpendicular to marker Post 6) in the open riding and camping area. This measure replaced approximately four acres of straw treatment installed in January 2020 pursuant to Amended SOA Condition 4 (20-ST- 02, see Attachment 01, Figure A01-11).

- Vegetation measures 21-VG-03 (7.9 acres west of the Eucalyptus Tree vegetation island) and 21-VG-04 (5.5 acres south of the Tabletop vegetation island) are located near the center of the ODSVRA open riding and camping area. These measures replaced 13.5 acres of wind fencing installed in 2018 pursuant to SOA Condition 1.b. (18-WF-04 and 18-WF-05, see Attachment 01, Figure A01-09).

#### 2.1.1.4 Supplemental Vegetation Plantings

From fall 2020 to spring 2021, State Parks planted approximately 24,800 plants. They spread approximately 46 pounds of native dune seed (and 300 pounds of sterile seed) in areas previously treated with native vegetation. In total, this supplemental planting covered approximately eight acres of previously treated areas. Supplemental planting often focuses on the west-facing portions of vegetation installations where direct wind and sand activity bury or undermine treatments. Some supplemental planting areas require straw, while others are treated with native plants and/or seeds. The areas that received supplemental plantings during the 2020/21 planting season included the Big Foot west (20-VG-04), BBQ Flats (19-VG-01), and Eucalyptus North (19-VG-02) vegetated areas (see Attachment 01, Figures A01-10, and A01-11). Refer to Attachment 03, 2020/2021 ODSVRA Dust Control Program Supplemental Vegetation Restoration Projects for a detailed breakdown of the supplemental planting treatment areas, the type of species planted, and the amount of supplemental seed (pounds applied) and planting (number of seedlings planted) activity in each treatment area.

While State Parks’ supplemental vegetation planting activities may be necessary to support the establishment and success of a vegetation project, such activities (in terms of acres of supplemental plantings) are not reported in this section or Table 2-1 because: 1) These activities take place in project areas that have already been reported on in prior ARWP documents and counted as vegetation dust control projects (see Section 2.1.2); and 2) While plant and seed quantities are known, it is difficult to track the actual surface area where supplemental planting activities occur.

#### 2.1.1.5 Maintenance of Existing Temporary Dust Control Measures

Consistent with SOA Condition 1.b., State Parks maintained 40.3 acres of existing wind fencing projects installed at ODSVRA before August 1, 2020. These include projects 20-WF-01 (20.5 acres) in the northeast corner of the open riding and camping area and 20-WF-02 (19.8 acres) along the eastern boundary of the open riding and camping area (see Attachment 01, Figure A01-11). Maintenance activities included replacing fence posts and fencing materials and installing new fence rows to maintain historical design control values for wind fencing arrays (greater than 80% to 90% control in the array's center).

### 2.1.2 Cumulative Dust Control Measures Installed As Of July 31, 2021

As of July 31, 2021, 32 dust control projects are in the ground at ODSVRA. State Parks actively manages and maintains each of these projects. In total, the 32 dust control projects occupy 322.5 acres of land at ODSVRA. The dust control measures in the ground at ODSVRA as of July 31, 2021, are listed in Table 2-2 and shown in Figure 2-2.

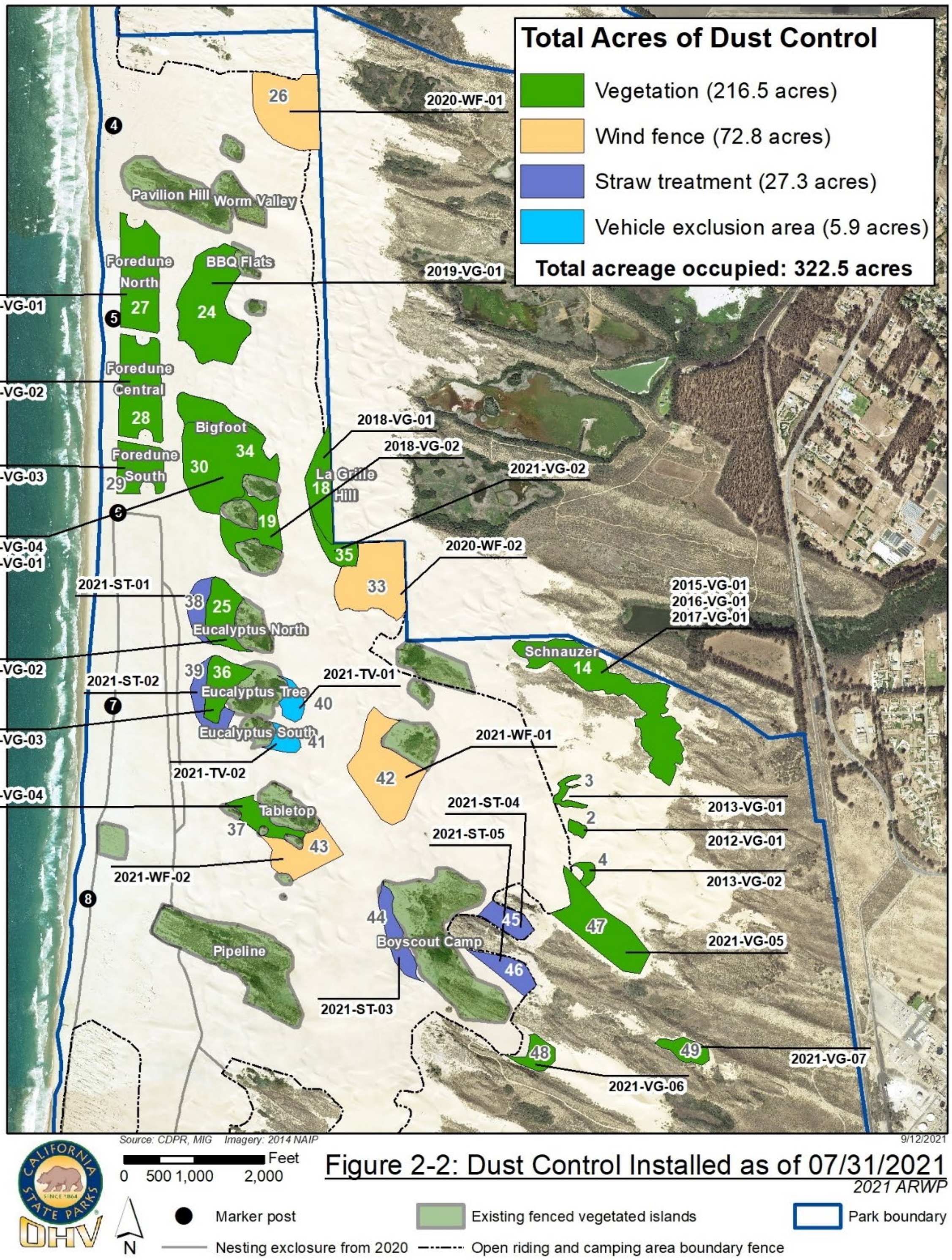
Refer to Attachment 01 for additional maps showing historical dust control measure locations and all dust control measures in place as of July 31, 2021. Refer to Section 2.3.7 and Attachment 02, Updated PMRP Evaluation Metrics, for information on dust control projects at ODSVRA, dust mitigation targets, and other indicators of dust control progress at ODSVRA.

**Table 2-2. Cumulative Dust Control Measures Installed as of July 31, 2021**

| Type of Dust Control Measure | Number of Projects[(A)] | Acres Controlled by Dust Control Measures | | |
|---|---|---|---|---|
| | | Inside Open Riding and Camping Area | Outside Open Riding and Camping Area | SVRA Total |
| **Vegetation Dust Control Measures** | | | | |
| Foredune | 3 | 48.0 | 0.0 | 48.0 |
| Backdune | 18 | 107.2 | 61.3 | 168.5 |
| Subtotal | 21 | 155.2 | 61.3 | 216.5 |
| **Seasonal and/or Temporary Dust Control Measures** | | | | |
| Straw | 5 | 27.3 | 0.0 | 27.3 |
| Wind Fencing | 4 | 72.8 | 0.0 | 72.8 |
| Vehicle Exclosure | 2 | 5.9 | 0.0 | 5.9 |
| Other[(B)] | 0 | 0.0 | 0.0 | 0.0 |
| Subtotal | 11 | 106.0 | 0.0 | 106.0 |
| **Totals** | **32** | **261.2** | **61.3** | **322.5** |

(A) Value reflects the number of projects forecast to be in the ground as of July 31, 2021 and does not consider planned activities described in Section 3 of this ARWP.
(B) Other refers to porous roughness elements, soil stabilizers, or other types of dust control measures.

**Figure 2-2. Dust Control Measures Installed as of July 31, 2022**



## 2.2 REPORT ON PROGRESS TOWARDS SOA GOALS

As amended, SOA #17-01 establishes project, emission reduction, and air quality standard requirements:

- Condition 1.a. and Item 1 of the SOA, as amended, required State Parks to fence off a foredune area (identified in Map 1 of Attachment 1 of the SOA) and install 74-acres of wind fencing projects by September 15, 2018 (referred to as initial particulate matter reduction actions, or "Initial SOA" dust control measures). Pursuant to the SOA, State Parks is to prioritize the conversion of wind fencing projects to vegetation. As amended in November 2019, the SOA also requires State Parks to finish installing perimeter fencing for a 48-acre foredune area and complete an additional 4.2 acres of vegetation in an area approved by the SAG.
- Condition 1.c. required State Parks to install SLOAPCD-approved sand track-out control devices at the Grand and Pier Avenue entrances to ODSVRA.
- Condition 2.b. required State Parks' PMRP to be designed to achieve the state and federal ambient air quality standards for $PM_{10}$. These standards are typically California Ambient Air Quality Standards (CAAQS) and National Ambient Air Quality Standards (NAAQS). The CAAQS and NAAQS for $PM_{10}$ are shown in Table 2-3. The CAAQS and NAAQS are mass concentration-based standards that required measurement and analysis of ambient air to determine compliance with the standard. Progress towards compliance with SOA Condition 2.b is measured by evaluating modeled and actual measured concentrations of $PM_{10}$ concentrations at the SLOAPCD's CDF and Mesa 2 air monitoring stations.
- Condition 2.c required the PMRP to reduce maximum 24-hour $PM_{10}$ baseline emissions by 50%. This requirement is assessed through air quality modeling to define the baseline emissions conditions from May 1, 2013, through August 31, 2013, before any major dust controls were implemented. After the issuance of the SOA, baseline emissions conditions were defined as the $PM_{10}$ mass emissions occurring within ODSVRA open riding and camping area, as averaged over the ten windiest days from May 1, 2013, to August 31, 2013. In contrast to the CAAQS and NAAQS, which are mass-concentration-based standards, this SOA requirement is a mass-emissions-based standard. Progress towards compliance with SOA Condition 2.c. is measured by modeling and identifying the maximum amount of $PM_{10}$ mass (e.g., metric tons/day) emitted by the ODSVRA open riding and camping area during the 2013 baseline period, inputting dust control measures into the model, and determining the reduction in $PM_{10}$ mass achieved by the dust control measures based on the use of the air quality model.

| Table 2-3. California and National Ambient Air Quality Standards for $PM_{10}$ | | |
|---|---|---|
| **Averaging Time** | **California Standard[(A)]** | **National Standard [(A)]** |
| 24-Hour Average | 50 µg/m$^3$ | 150 µg/m$^3$ |
| Annual Arithmetic Mean | 20 µg/m$^3$ | No standard adopted |

Source: CARB, 2016 (https://ww2.arb.ca.gov/sites/default/files/2020-07/aaqs2.pdf)
(A) µg/m$^3$ = micrograms per cubic meter

State Parks' report on the progress made towards complying with the SOA requirements identified above is provided below.

### 2.2.1 Report On Progress Towards Specific SOA Projects

State Parks achieved the following progress towards the specific projects identified in the SOA, as amended:

- **Foredune Project:** State Parks installed perimeter fencing for the 48-acre foredune project in 2019 (20-VG-01, 20-VG-02, 20-VG-03; see Attachment 01, Figure A01-11). During the 2019/20 growing season, State Parks implemented six different foredune treatment areas, including seed or seedling planting strategies, in consultation with the SAG. State Parks is monitoring foredune development in consultation with the SAG and UCSB.

- **Initial SOA Wind Fencing Projects:** State Parks installed 48.7 acres of windfencing in three different treatment areas in Summer 2018. As of July 31, 2021, State Parks has converted all 48.7 acres of Initial SOA wind fencing projects to vegetation.
    - *Heather, Acacia, and Cottonwood (aka "Paw Print" or "Bigfoot"):* State Parks installed two wind fencing arrays on 35.2 acres of land adjacent to the Heather, Acacia, and Cottonwood vegetation islands in Summer 2018 (18-WF-01and 18-WF-02, see Attachment 01, Figure A01-09). State Parks converted most of this wind fencing (20.4 acres) to dune scrub vegetation in December 2019 (20- VG-04, see Attachment 01, Figure A01-11). State Parks removed the remaining 14.8 acres of wind fencing treatments in September 2019, installed straw bales in the same area in March 2020 (20-ST-01), and converted this straw to vegetation as described in Winter 2021 (21-VG-01, see Section 2.1.1.3).
    - *Eucalyptus Tree and Eucalyptus South:* State Parks installed wind fencing arrays on 8.0 acres of land adjacent to the Eucalyptus Tree vegetation island (18-WF-04). As described in Section 2.1.1.3, State Parks converted this wind fencing to vegetation in Winter 2021 (21-VG-03).
    - *Tabletop:* State Parks installed wind fencing arrays on 5.5 acres adjacent to the Tabletop vegetation island (18-WF-05). As described in Section 2.1.1.3, State Parks converted this wind fencing to vegetation in Winter 2021 (21-VG-04).

- **Initial SOA Straw Bale Projects:** State Parks installed 36.1 acres of strawbales in two different treatment areas in Summer 2018. As of July 31, 2021, State Parks has converted all 36.1 acres of Initial SOA straw bale projects to vegetation.
  - *BBQ Flats:* State Parks installed approximately 3,630 strawbales on 27.0 acres of land adjacent to the BBQ Flats vegetation islands in the northern part of the SVRA's open riding and camping area (18-SB-01, see Attachment 01, Figure A01-09). In winter 2018, State Parks converted these strawbales to vegetation (19-VG-01, see Attachment 01, Figure A01-10).
  - *Eucalyptus North:* State Parks installed approximately 1,360 straw bales on 9.1 acres of land adjacent to the Eucalyptus North vegetation island in the SVRA's open riding and camping center area (18-SB-02, see Attachment 01, Figure A01-09). In winter 2018, State Parks planted vegetation within this treatment area that replaced the straw bales installed in Summer 2018 (19- VG-02, see Attachment 01, Figure A01-10).
- **Amended SOA 4.2-Acres of Permanent Dust Control:** As described in Section 2.1.1.3, State Parks installed straw treatment on 4.1 acres of land along the eastern edge of the open riding and camping area, perpendicular to marker post 6, in January 2020 (20-ST-02, see Attachment 01, Figure A01-11), which was subsequently converted to vegetation in winter 2021 (21-VG-02).

### 2.2.2 Report on Progress Towards 50% Mass Emissions Reduction

The DRI model estimates the maximum amount of $PM_{10}$ mass (e.g., metric tons/day) emitted by the dune surfaces in the ODSVRA open riding and camping area during the stipulated 2013 baseline period to be 182.8 metric tons/day. State Parks' progress in reducing modeled baseline mass emissions is summarized in Table 2-4. See Attachment 04, DRI Report Oceano Dunes: Status 2021 for DRI model estimates of baseline mass emission reductions by year.[5] Refer also to Attachment 02, Updated PMRP Evaluation Metrics, for information on dust control projects at ODSVRA, dust mitigation targets, and other indicators of dust control progress at ODSVRA.

[5] The estimated baseline emissions are based on 2013 Portable In-Situ Wind Erosion Laboratory (PI-SWERL) emissivity data using the $1/r^2$, 5 nearest neighbor interpolation/extrapolation methodology) and reflect the average amount of $PM_{10}$ mass emitted from the open riding and camping area on the 10 highest emitting days during the baseline period. One metric ton is equal to 1.1 short tons (U.S. tons). One metric ton is approximately 2,204.6 pounds while one U.S. Ton is 2,000 pounds.

| **Table 2-4. Modeled $PM_{10}$ Mass Emissions at ODSVRA through July 31, 2021** | | | | | |
|---|---|---|---|---|---|
| **Scenario/Evaluation** | **Cumulative Area Controlled (Acres)** | **ODSVRA – All Areas** | | **ODSVRA – Open Riding and Camping Area Only** | |
| | | **$PM_{10}$ Mass Emissions (Metric Tons/Day)** | **Percent Reduction in $PM_{10}$ Mass Emissions** | **$PM_{10}$ Mass Emissions (Metric Tons/Day)** | **Percent Reduction in $PM_{10}$ Mass Emissions** |
| 2013 Modeled Baseline Emissions from Open Riding and Camping Area (No Dust Control Measures in Place) | 0 | 182.8[A] | 0% | 182.8[A] | 0% |
| Cumulative Dust Control Measures in Place as of July 31, 2020 | 230.2 | 153.1 (-29.7)[B] | -16.2%[B] | 155.3 (-27.5) | -15.0% |
| *Incremental New Dust Control Measures Installed between August 1, 2020 and July 31, 2021* | *92.3* | *142.0 (-11.1)[C]* | *-6.1%[C]* | *145.2 (-10.1)* | *-5.5%* |
| **Cumulative Totals - All Dust Control Measures in Place as of July 31, 2021** | **322.5** | **142.0 (-40.8)[D]** | **-22.3%[D]** | **145.2 (-37.6)** | **-20.6%** |
| **SOA Condition 2.c Goal** | **--** | **91.4[E]** | **50%** | **91.4** | **50%** |

Source: DRI, 2021 (see Attachment 04), modified by State Parks.

(A) Pursuant to the SOA, the 2013 modeled baseline for mass emissions is based on emissions from the ODSVRA open riding and camping area only; however, the mass emissions reductions needed to comply with the SOA, as amended, may occur from both inside and outside the open riding and camping area.

(B) The cumulative dust control measures in place throughout the ODSVRA as of July 31, 2020 reduced 2013 modeled baseline mass emission from 182.8 metric tons per day to 153.1 metric tons per day, a reduction of 29.7 metric tons per day. This equals a 16.2% reduction in 2013 modeled baseline emissions (29.7/182.8 = 16.2%). Most of the mass emissions reductions (27.5 out of 29.7 metric tons per day, or 92.6% of mass emissions reductions) are achieved by dust control measures installed inside the open riding and camping area. Note table values for ODSVRA – All Areas may differ slightly (less than 1.0 metric ton per day) from values contained in Attachment 04 due to rounding and model tolerances.

(C) The new dust control measures installed throughout the ODSVRA between August 1, 2020 and July 31, 2021 reduced 2013 modeled baseline mass emissions from 153.1 (as of July 31, 2020) to 142.0 metric tons per day, a reduction of 11.1 metric tons per day, which equals 6.1% of 2013 modeled baseline emissions levels (11.1/182.8 = 6.1%). Most of the mass emissions reductions (10.1 out of 11.1 metric tons per day, or 91.0% of mass emissions reductions) are achieved by dust control measures installed inside the open riding and camping area. Note table values for ODSVRA – All Areas may differ slightly (less than 1.0 metric ton per day) from values contained in Attachment 04 due to rounding and model tolerances.

(D) The cumulative dust control measures in place throughout the ODSVRA as of July 31, 2021 reduced 2013 modeled baseline mass emission from 182.8 metric tons per day to 142.0 metric tons per day, a reduction of 40.8 metric tons per day, which equals a 22.3% reduction in 2013 modeled baseline emissions (40.8/182.8 = 22.3%). Most of the mass emissions reductions (37.6 out of 40.8 metric tons per day, or 92.2% of mass emissions reductions) are achieved by dust control measures installed inside the open riding and camping area. Note table values for ODSVRA – All Areas may differ slightly (less than 1.0 metric ton per day) from values contained in Attachment 04 due to rounding and model tolerances.

(E) A 50% reduction in 2013 modeled baseline mass emissions (182.8 metric tons per day) equals 91.4 metric tons per day.

As of July 31, 2020, the DRI model estimates State Parks' dust control measures reduced mass emissions by 29.7 metric tons per day, a 16.2% reduction in modeled baseline mass emissions. The new dust control measures installed by State Parks between August 1, 2020, and July 31, 2021, reduced mass emissions by an additional 11.1 metric tons per day, or 6.1% of the modeled baseline mass emissions level of 182.8 metric tons per day. In total, the DRI model estimates the cumulative reduction in modeled baseline mass emissions achieved by the 322.5 acres of dust control measures in the ground at Oceano Dunes SVRA as of July 31, 2021, is 40.8 metric tons per day, which equals a 22.3% reduction in baseline mass emissions. The DRI model also estimates that dust control projects installed outside the open riding and camping area (as of July 31, 2021) have resulted in a cumulative mass emissions reduction of 4.1 metric tons per day. Most of the estimated reductions in $PM_{10}$ mass emissions (37.6 out of 40.8 metric tons per day, or 92.2% of the modeled baseline mass emissions reductions) have been achieved by dust control measures installed inside the open riding and camping area (261.2 of the 322.5 total acres of dust control, see Table 2-2). The 22.3% cumulative reduction in modeled baseline $PM_{10}$ mass emissions represents continued progress towards achieving the 50% reduction baseline mass emissions required by SOA Condition 2.c.

### 2.2.3 Report On Progress Towards Ambient Air Quality Standards

The DRI model is also used to evaluate potential changes in downwind $PM_{10}$ concentrations at selected receptor sites such as the SLOAPCD's CDF and Mesa2 air quality monitoring stations. The model estimates the 24-hour average $PM_{10}$ concentration at CDF and Mesa2 during the stipulated 2013 baseline period to be 124.7 and 97.5 $\mu g/m^3$, respectively. Refer to Attachment 04, DRI Report Oceano Dunes: Status 2021 for DRI model estimates of $PM_{10}$ concentration reductions downwind of ODSVRA. Refer also to Attachment 02, Updated PMRP Evaluation Metrics, for information on dust control projects at ODSVRA, dust mitigation targets, and other indicators of dust control progress at ODSVRA.

#### 2.2.3.1 CDF Air Quality Monitoring Station

State Parks' progress in reducing 2013 modeled baseline $PM_{10}$ concentrations at the SLOAPCD's CDF air quality monitoring station is summarized in Table 2-5. Refer to Attachment 04 for additional information on DRI model estimates of 24-hour $PM_{10}$ concentrations at the CDF station.

| Table 2-5. Modeled Estimated Reductions of $PM_{10}$ Downwind of ODSVRA (CDF) | | | |
|---|---|---|---|
| **Scenario/Evaluation** | **Cumulative Area Controlled (Acres)** | **CDF $PM_{10}$ 24-hour Average Concentration (µg/m$^3$)** | **Percent Reduction in $PM_{10}$ Concentration** |
| 2013 Modeled Baseline (No Dust Control Measures in Place) | 0 | 124.7$^{(A)}$ | 0% |
| Cumulative Dust Control Measures in Place as of July 31, 2020 | 230.2 | 72.4 (-52.3) $^{(B)}$ | -41.9%$^{(B)}$ |
| *Incremental New Dust Control Measures Installed between August 1, 2020, and July 31, 2021* | 92.3 | 72.2 (-0.2) $^{(C)}$ | -0.2%$^{(C)}$ |
| **Cumulative Totals (All Dust Control Measures in Place as of July 31, 2021)** | **322.5** | **72.2 (-52.5) $^{(D)}$** | **-42.1%$^{(D)}$** |
| **SOA Condition 2.c. Goal** | **--** | **50.0$^{(E)}$** | **60%** |

Source: DRI, 2021 (see Attachment 04), modified by State Parks.

(A) Pursuant to the SOA, the 2013 modeled baseline for $PM_{10}$ concentration (µg/m$^3$) is based on emissions from riding and non-riding areas at ODSVRA.

(B) The cumulative dust control measures in place as of July 31, 2020 reduced modeled baseline 24-hour average $PM_{10}$ concentrations at CDF from 124.7 µg/m$^3$ to 72.4 µg/m$^3$, a reduction of 52.3 µg/m$^3$. This equals a 41.9% reduction in 2013 modeled baseline 24-hour average $PM_{10}$ concentrations (72.4/124.7 = 41.9%).

(C) The new dust control measures installed between August 1, 2020 and July 31, 2021 reduced modeled baseline 24-hour average $PM_{10}$ concentrations at CDF from 72.4 µg/m$^3$ (as of July 31, 2020) to 72.2 µg/m$^3$, a reduction of 0.2 µg/m$^3$, which equals a 0.2% reduction in 2013 modeled baseline 24-hour average $PM_{10}$ concentrations (0.2/124.7 = 0.2%).

(D) The cumulative dust control measures in place as of July 31, 2021 reduced modeled baseline 24-hour average $PM_{10}$ concentrations at CDF from 124.7 µg/m$^3$ to 72.2 µg/m$^3$, a reduction of 52.5 µg/m$^3$. This equals a 42.1% reduction in 2013 modeled baseline 24-hour average $PM_{10}$ concentrations (72.2/124.7 = 42.1%).

(E) The SOA goal is based on the CAAQS of 50 µg/m$^3$ (see Table 2-3).

As of July 31, 2020, the DRI model estimates State Parks' dust control measures reduced downwind 24-hour $PM_{10}$ concentrations at the CDF station by 52.3 µg/m$^3$, a 41.9% reduction in baseline $PM_{10}$ concentrations for this site. The new dust control measures installed by State Parks between August 1, 2020, and July 31, 2021, reduced 24-hour $PM_{10}$ concentrations at the CDF station by an additional 0.2 µg/m$^3$, or 0.2% of baseline $PM_{10}$ concentrations. This limited reduction is because dust control projects installed between August 1, 2020, and July 31, 2021, focused on air quality improvements at Mesa2 station and not the CDF station. In total, the DRI model estimates the cumulative reduction in 24-hour $PM_{10}$ concentrations at the CDF station from the 322.5 acres of dust control measures in the ground at Ocean Dunes SVRA as of July 31, 2021, is 52.5 µg/m$^3$, which equals a 42.1% reduction in baseline modeled 24-hour $PM_{10}$ concentrations. This 42.1% cumulative reduction in 24-hour $PM_{10}$ concentrations at the CDF site represents continued progress towards achieving CAAQS (50 µg/m$^3$) required by SOA Condition 2.b.

### 2.2.3.2 Mesa2 Air Quality Monitoring Station

State Parks' progress in reducing 2013 modeled baseline $PM_{10}$ concentrations at the SLOAPCD's Mesa2 air quality monitoring station is summarized in Table 2-6. Refer to Attachment 04 for additional information on DRI model estimates of 24-hour $PM_{10}$ concentrations at the Mesa2 station.

**Table 2-6. Modeled Estimated Reductions of $PM_{10}$ Downwind of ODSVRA (Mesa2)**

| Scenario/Evaluation | Cumulative Area Controlled (Acres) | Mesa2 $PM_{10}$ 24-hour Average Concentration ($\mu g/m^3$) | Percent Reduction in $PM_{10}$ Concentration |
|---|---|---|---|
| 2013 Modeled Baseline (No Dust Control Measures in Place) | 0 | 97.5 (A) | 0% |
| Cumulative Dust Control Measures in Place as of July 31, 2020 | 230.2 | 91.2 (-6.3) (B) | -6.5% (B) |
| *Incremental New Dust Control Measures Installed between August 1, 2020, and July 31, 2021* | *92.3* | *73.8 (-17.4) (C)* | *-17.8% (C)* |
| **Cumulative Totals (All Dust Control Measures in Place as of July 31, 2021)** | **322.5** | **73.8 (-23.7)** (D) | **-24.3%** (D) |
| **SOA Condition 2.c. Goal** | **--** | **50.0** (E) | **49%** |

Source: DRI, 2021 (see Attachment 04), modified by State Parks.

(A) Pursuant to the SOA, the 2013 modeled baseline for $PM_{10}$ concentration ($\mu g/m^3$) is based on emissions from riding and non-riding areas at ODSVRA.

(B) The cumulative dust control measures in place as of July 31, 2020 reduced modeled baseline 24-hour average $PM_{10}$ concentrations at Mesa2 from 97.5 $\mu g/m^3$ to 91.2 $\mu g/m^3$, a reduction of 6.3 $\mu g/m^3$. This equals a 6.5% reduction in 2013 modeled baseline 24-hour average $PM_{10}$ concentrations (6.3/97.5 = 6.5%).

(C) The new dust control measures installed between August 1, 2020 and July 31, 2021 reduced modeled baseline 24-hour average $PM_{10}$ concentrations at Mesa2 from 91.2 $\mu g/m^3$ (as of July 31, 2020) to 73.8 $\mu g/m^3$, a reduction of 17.4 $\mu g/m^3$, which equals a 17.8% reduction in 2013 modeled baseline 24-hour average $PM_{10}$ concentrations (17.4/97.5 = 17.8%).

(D) The cumulative dust control measures in place as of July 31, 2021 reduced modeled baseline 24-hour average $PM_{10}$ concentrations at Mesa2 from 97.5 $\mu g/m^3$ to73.8 $\mu g/m^3$, a reduction of 23.7 $\mu g/m^3$. This equals a 24.3% reduction in 2013 modeled baseline 24-hour average $PM_{10}$ concentrations 73.8/97.5 = 24.3%).

(E) The SOA goal is based on the CAAQS of 50 $\mu g/m^3$ (see Table 2-3).

Based on the dust controls in place as of July 31, 2020, the DRI model estimates that State Parks' dust control measures reduced downwind 24-hour $PM_{10}$ concentrations at the Mesa2 station by 6.3 $\mu g/m^3$, a 6.5% reduction in baseline $PM_{10}$ concentrations at this site. The new dust control measures installed by State Parks between August 1, 2020, and July 31, 2021, reduced 24-hour $PM_{10}$ concentrations at the Mesa2 station by an additional 17.4 $\mu g/m^3$, or 17.8% of baseline $PM_{10}$ concentrations. In total, the DRI model estimates the cumulative reduction in 24-hour $PM_{10}$ concentrations at the Mesa2 station from the 322.5 acres of dust control measures in the ground at Ocean Dunes SVRA as of July 31, 2021, is 23.7 µg/$m^3$, which equals a 24.3% reduction in modeled baseline 24-hour $PM_{10}$ concentrations.

This 24.3% cumulative reduction in modeled baseline 24-hour $PM_{10}$ concentrations at the Mesa2 station represents continued progress towards achieving the CAAQS (50 µg/$m^3$) as required by SOA Condition 2.b.

#### 2.2.3.3 Report on Progress Towards Track-Out Control

State Parks has developed engineered drawings for permanent track-out control at Grand and Pier Avenues. Those plans were finalized in 2020 and are included as Attachment 05, Sediment Track-Out Prevention Measures. The physical projects were not installed during the 2021 reporting period because control agencies had not approved funding. It is anticipated that these projects will be funded during the State of California's Fiscal Year from July 2021-June 2022, with construction possible in the first quarter of 2022. In the interim, State Parks installed temporary rubber track-out mats at the Pier Avenue exit to test the effectiveness and operational parameters of the track-out prevention measures. During the closure of ODSVRA during the 2020 COVID-19 pandemic (roughly March-October 2020), no track-out mats were in place because there was no public vehicle activity allowed on the beach. The temporary mats are in place and regularly cleaned during all periods when the beach was opened to public vehicle activity.

Ongoing street sweeping activities on Pier and Grand Avenues occur three times per week using a combination of State Parks' sweepers and a private contractor on Pier Avenue.

## 2.3 REPORT ON FIELD MONITORING AND AIR QUALITY MODELING

Chapter 3 of State Parks' PMRP provides a basic overview of dispersion modeling and presents the methodology, key inputs, data sources, and assumptions experts from the DRI Division of Atmospheric Sciences, SAG, CARB, SLOAPCD, and State Parks have incorporated into the SOA's air quality modeling. As noted in Section 3.4 of the approved PMRP:

The United States Environmental Protection Agency's (USEPA) Guideline on Air Quality Models states, "the formulation and application of air quality models are accompanied by several sources of uncertainty."

The Guideline document describes two specific sources of uncertainty. 'Irreducible' uncertainty stems from unknown conditions, which may not be explicitly accounted for in the model, and which are likely to lead to deviations from the actual, observed concentrations for any individual event. Uncertainties cause "reducible" uncertainties in the "known" input conditions (e.g., emission characteristics and meteorological data, errors in measured concentrations, and inadequate model physics and formulation).

State Parks' adaptative management approach to dust control at ODSVRA involves collecting data that supports the evaluation and improvement of model performance and dust control measure effectiveness. Incorporating new information and comparing model predictions to observations from actual air quality stations such as CDF facilitates model improvements and public understanding and confidence in the model's results.

For example, State Parks' monitoring network (see Section 2.3.1) provides data on meteorological and $PM_{10}$ conditions across the spatial domain of ODSVRA and at locations external to the SVRA. These data are important for modeling of dispersion of $PM_{10}$ for the time frame beginning with its establishment (effectively for 2017 to the present).[6] For the baseline year, the stations set up in 2013, at different locations, provided wind speed and wind direction data and $PM_{10}$ measurements across the spatial domain as input into the model. These data are used within the DRI model to verify model predicted $PM_{10}$ at the monitoring locations, adjusted to reflect the measurement if the model values diverge from those local values. The monitoring network data are also used to investigate how the dust emission system has changed through time, allowing evaluation of how dust controls have modulated the PM levels on a regional scale.

State Parks' report on field monitoring activities and progress towards improving the measurement, modeling, and evaluation of compliance with SOA goals is described below.

### 2.3.1 Meteorological and $PM_{10}$ Monitoring

State Parks installed seasonal and temporary meteorological and $PM_{10}$ monitoring sites at ODSVRA since the SLOAPCD first began evaluating $PM_{10}$ emissions on the Nipomo Mesa in 2007. The purpose of these instruments is to help assess individual project effectiveness and update and refine meteorological inputs needed for the SOA's air quality modeling.

State Parks' S1 meteorological tower (located near marker post 6) was installed in June 2010 and continues to operate and support Dust Control Program activities. In 2013, State Parks deployed a temporary network of meteorological and $PM_{10}$ monitoring equipment throughout ODSVRA. This temporary network, mostly removed in 2013, has generally informed the basis and need for subsequent meteorological and $PM_{10}$ data collection efforts and monitoring locations in subsequent years.

State Parks' meteorological and $PM_{10}$ monitoring network varies slightly from year to year depending on specific goals, objectives, and dust control measures identified in the ARWP cycle. For the 2020 monitoring effort, a new meteorological and $PM_{10}$ monitoring station was placed in the northern dunes preserve area, east of marker posts 3 and 4, to provide

[6] Wind and PM monitoring began in 2013 but the network of monitoring stations that is installed annually with MetOne 212-2 Particle Profilers began in 2017 and reached the current compliment of stations in 2019.

measurements that characterize a non-riding area. From August 1, 2020, to July 31, 2021, State Parks maintained the 2020 ARWP monitoring network shown in Figure 2-3, including:

- Six foredune (see Section 2.3.2.2) meteorological and PM monitoring sites
- Fifteen other meteorological and PM monitoring sites located throughout and downwind of ODSVRA
- One sonic detection and ranging (SODAR) instrument station

Typically, the monitoring site consists of a suite of instruments affixed to a tripod, platform, or tower located three-to-ten meters above ground level (see Figure 2-4). Instruments collect wind speed and wind direction (using two-dimensional sonic anemometry), ambient temperature, relative humidity (RH), and barometric pressure. The SODAR instrument station (originally installed in May 2019) records three-dimensional velocity vector data from approximately 40 meters to 200 meters above ground level (see Figure 2-5).

The particulate matter at each station is measured using a MetOne 212-2 Particle Profiler that measures particle counts in eight size (geometric mean diameter in micrometers, or µm) bins (0.39 µm, 0.59 µm, 0.84 µm, 1.41 µm, 2.24 µm, 3.53 µm, 7.07 µm, and 10+ µm) per sampled flow volume using an optically based measurement system. These particle count bins are used to derive a $PM_{10}$ concentration on a minute and hourly basis. The $PM_{10}$ concentration is derived from environmentally controlled and field calibration relationships between particle count data collected by the Particle Profiler and mass-based $PM_{10}$ concentration data collected by an EPA Federal Equivalent Method $PM_{10}$ monitor. DRI conducted initial, environmentally controlled calibration procedures in 2020 and concluded the consistency of the calibration relationship among the Met One 212-2 Particle Profiler units was good for particles through size bin six both before and after field deployment.[7] In addition, field calibrations indicate the MetOne Particle Profilers are not adversely affected by high wind conditions (above 5 meters per second). In April 2021, DRI repeated the environmentally controlled calibration procedures with similar results. The 2021 calibration ensures that each MetOne 212-2 Particle Profiler instrument has a specific calibration relationship to provide the best estimate of $PM_{10}$ during deployment at ODSVRA.

Refer to Attachment 06 for a detailed summary of DRI's MetOne 212-2 Particle Profiler $PM_{10}$ calibration procedures. A Sensit instrument is also deployed at/near the ground level to measure saltation activity in active sand transport areas.

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[7] As described in Attachment 06, page 1, " . . . the number of particles the number of particles in a size bin is calculated by subtracting the number of counts associated with all larger size bins.... Therefore, it is an important distinction that the cumulative mass concentration of particles through size bin six (PMbin6) in the 212-2 instrument is used for relating the PMbin6 value to the BAM-measured $PM_{10}$."

**Figure 2-3. 2020 – 2021 Monitoring Network**

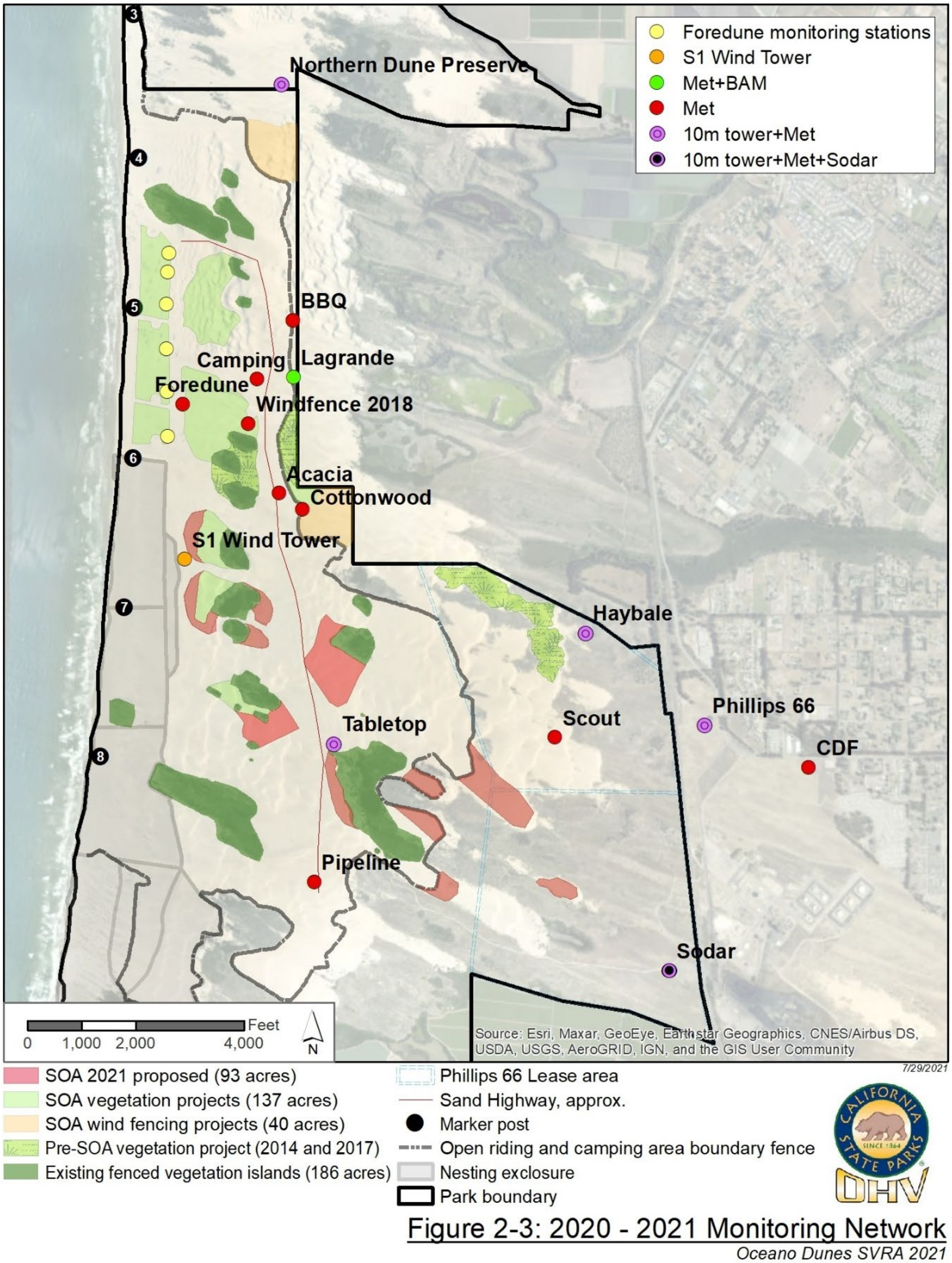


**Figure 2-4. Typical Meteorological and PM Monitoring Station at ODSVRA**

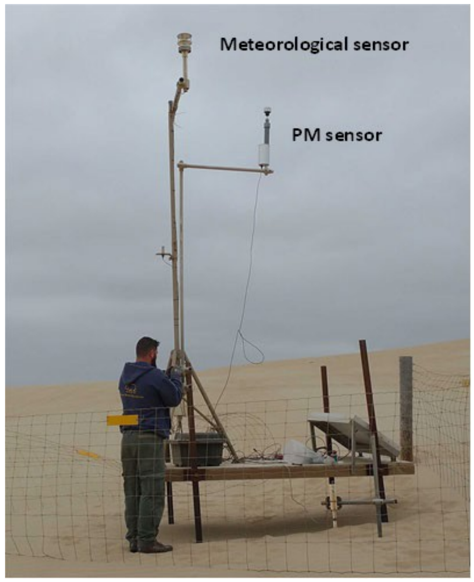



**Figure 2-4.** Typical meteorological (sonic anemometer) and PM (MetOne 212-2 Particle Profiler)monitoring site.

**Figure 2-5. SODAR Monitoring Station**

**Figure 2-5**. The SODAR upper-air measurement station is located near the southeast corner of ODSVRA. The photo shows the co-located 10-meter meteorological tower and the Phillips 66 refinery in the back left. UCSB and ASU operate the station.

### 2.3.2 Saltation Monitoring

In addition to meteorological and airborne $PM_{10}$ measurements, State Parks also operates instruments that physically collect or count the movement of sand particles when high wind events actuate the saltation process. These instruments include the Big Springs Number Eight (BSNE) dust collector and the Sensit saltation monitor. The saltation monitoring instruments help assess individual project effectiveness.

The BSNE sampling network quantifies sand flux in dust control measures. The sampling network is monitored and maintained by personnel from the Coastal San Luis Resource Conservation District (San Luis RCD) following procedures and training provided by DRI. The sampling strategy involves installing the BSNE sand trap at 15 centimeters (cm) above the ground surface before a sand transport event. After the sand transport event, sand is collected from the instrument, placed into a bag, and recorded the date and location/instrument ID. The emptied BSNE sand trap is reset to 15 cm above the ground surface to collect sand during the next sand transport event. The collected sand samples were returned to the RCD office and weighed on an electronic balance to 0.01 grams (g) precision.

#### 2.3.2.1 Wind Fence Array Saltation Flux Measurements

From August 1, 2020, to July 31, 2021, State Parks, San Luis RCD, and DRI collected and analyzed saltation flux measurements from two temporary wind fencing projects installed in 2020 (20-WF-01 and 20-WF-02, See Attachment 01, Figure A01-11). Twelve traps were placed in each wind fence project. The traps were placed between consecutive wind fence rows at a distance of six fence heights from the upwind (i.e., western) fence. The control effectiveness of the wind fencing array is defined by the Normalized Sand Flux (NSF, defined as the sand flux internal to the array divided by the sand flux upwind of the array).

The overall control effectiveness is based on the change of NSF as a function of downwind distance through a dust control measure. Within dust control measure 20-WF-01, NSF decreased rapidly between the first four sets of traps (closest to the upwind fence position) then stabilized throughout the remainder of the array except for a fence row/trap situated in an elevated position where maximum winds are likely to occur. The DRI reports the mean NSF in the general center of 20-WF-01 to be 0.28 (+0.11), indicating a mean percent reduction in the sand flux of 72% near the array's center. Within dust control measure 20-WF-02, NSF similarly decreased rapidly between the first four sets of traps (closest to the upwind fence position), then stabilized to the end of the array. The DRI reports the mean NSF in the general center of 20-WF-02 to be 0.21 (+0.08).

The mean NSF reported for 20-WF-01 was 0.28 (+0.11), which is greater than past mean NSF observations within wind fencing arrays, indicates that the effectiveness of the sand fence array at this location was not as high as has been observed with other sand fence arrays in the past.

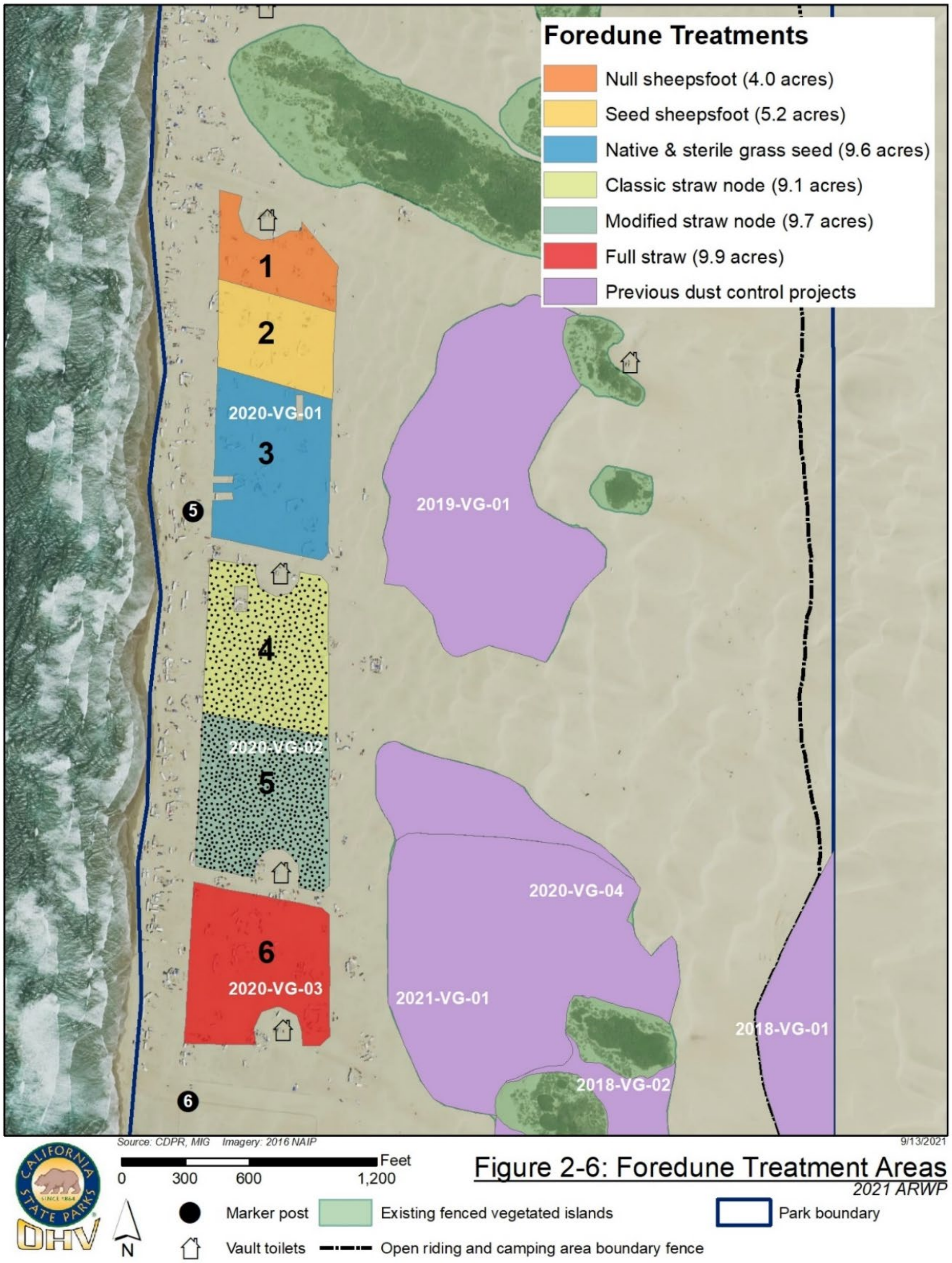
For example, the 2020 ARWP reported a mean NSF of 0.21 (+0.13) across 94% of a larger, approximately 35-acre wind fencing) array (18-WF-01 and 18-WF-02, See Attachment 01, Figure A01-09). The mean NSF value reported for 20 WF-02 (0.21+ 0.08) was observed to be similar to the mean NSF reported for 20-WF-01 (0.28 +0.11). However, direct comparisons between the 2020 wind fencing projects and those undertaken in 2018 (and reported in the 2020 ARWP) are limited due to differences in size, topography, and the area for which mean NSFs were reported (e.g., the area used to report NSF values for the 2020 wind fencing projects vs. 94% of the are used for reporting the NSF values for the 2018 wind fencing project). Refer to Attachment 07 for DRI's and UCSB's detailed report on saltation flux measurements collected and analyzed from August 1, 2020, to July 31, 2021.

#### 2.3.2.2 Foredune Restoration Area Saltation Flux Measurements

State Parks initiated the 48-acre foredune restoration treatment in 2019. The restoration treatment is based on a SAG design in which the 48-acre treatment area is sub-divided into six different treatment areas, as shown in Figure 2-6. The treatment areas include:

- Plot 1 – Foredune North (18.6 acres, 20-VG-01):
    - Treatment 1 (4.0 acres): There is no treatment other than sheep's footsurface texturing to create divots for seeds and low-level aerodynamic roughness.
    - Treatment 2 (5.2 acres): Native seed mix with sheep's foot surfacetexturing.
    - Treatment 3 (9.6 acres): Sheep's foot texturing with sterileryegrass and native seed mix.
- Plot 2 – Foredune Central (18.8 acres, 20-VG-02):
    - Treatment 4 (9.1 acres): Low-density random node planting (with a spacing derived from a natural analog site near Oso Flaco Lake) with approximately nine foredune-specific plants per node planted within a 12-foot radius zone of straw to protect seedlings.
    - Treatment 5 (9.7 acres): High-density random node planting with the same planting and straw protection strategy.
- Plot 3 – Foredune South (9.9 acres 20-VG-03):
    - Treatment 6 (9.9 acres): "Parks' Classic" restoration consisting of sheep's foot surface texturing, spread straw over the entire area, planting of foredune specific species, and seeding the area with native seed.

**Figure 2-6. Foredune Treatment Areas**



From August 1, 2020, to July 31, 2021, State Parks, San Luis RCD, DRI, and UCSB conducted meteorological and saltation flux measurements from each of the six foredune treatment areas. These measurements are intended to characterize wind changes, monitor saltation activity, and relate these data to changes in vegetation cover and dune morphology through time. The measurements were conducted with a suite of instruments on a three-meter tower on a platform deployed near the eastern edge of each treatment plot, approximately ten meters west of the eastern fence line and halfway along the north-south length of the treatment area. The foredune monitoring stations have almost the same configuration as those deployed across and exterior to ODSVRA to measure temperature, RH, wind speed, wind direction, and pressure (see Section 2.3.1 and Figure 2-4). However, the foredune monitoring stations do not measure $PM_{10}$. Sensit saltation sensors are located at each station to provide data on threshold wind speed for sand transport and relative saltation activity. A remote camera system is also deployed at each station to provide additional information on the frequency and relative magnitude of sand transport events providing a wider field of view than the point-measurement of the Sensit. The camera systems also provide qualitative data on weather conditions, sea state, plant cover changes, dune form, and development changes. Three tipping bucket rain gauges are deployed across the restoration area (north, middle, south) to provide data on precipitation across the foredune restoration zone.

Similar to wind fence and other sand flux measurements at ODSVRA, sand flux in the foredune restoration treatment areas is measured using a series of BSNE dust collectors (see Attachment 07). For the foredune treatment areas, a linear transect of five BSNE dust collectors is located at the north-south midpoint of each defined test area and oriented to the major sand-transporting wind direction in the foredune treatment area (292° west-northwest). A pair of BSNE dust collectors are placed on the western side of a treatment area approximately two meters from the perimeter fence to receive the incoming sand flux. The next four BSNE dust collector pairs in the treatment area are positioned at four meters (12 feet), 13 meters (42 feet), 45 meters (148 feet), and 160 meters (525 feet) along the 292° transect line.

The control effectiveness of the foredune treatment areas is defined by the NSF as follows:

$$\text{Foredune NSF} = (BSNE_n \text{ trap } 1 + BSNE_n \text{ trap } 2)/2)/\ (BSNE_1 \text{ trap } 1 + BSNE_1 \text{ trap } 2)/2)$$

Where:

n = BSNE dust collector position along the transect through the restoration area

$BSNE_1$ = BSNE dust collector position on the upwind leading edge of the treatment area

As the BSNE dust collectors are paired at each position 1 – 5, NSF is based on the mean value of the two traps at each position.

The DRI and UCSB completed data analysis from April 2020 to November 2020. They reported the NSF in foredune treatment areas 1, 2, and 3 remained relatively stable during this period, except for treatment area 2, which shows a considerable increase in NSF at the four interior measurement locations in November 2020. The NSF in foredune treatment areas 4, 5, and 6 remained stable, except for area 6, which showed a considerable increase in NSF at the four interior measurement locations in November 2020. This effect is likely due to the straw surface becoming inundated with sand across the width of this test plot.

The relationship between mean NSF and normalized distance (ND) is defined as:

> Foredune ND = Horizontal distance to measurement/Total distance across restoration area

For April 2020 to November 2020 period, NSD as a function of ND was relatively steady across the measurement transects in foredune treatment areas 1, 2, and 3, indicating that control efficiency did not change appreciably during the study period. In contrast, the NSF was systematically reduced as a function of ND, most clearly in foredune treatment areas 5 and 6. The change in NSF as a function of ND through time in the foredune treatment areas suggests that saltation flux increased on the eastern side of foredune treatment areas 4, 5, and 6 as time progressed from the initial treatment efforts through November 2020. This change indicates that the ability and effectiveness of these treatment areas to control sand were diminishing through time, likely due to the increasing burial of straw over time and limited plant and nebkha (type of dune that forms around vegetation) development.

Refer to Attachment 07 for the detailed report on foredune saltation flux measurements collected and analyzed from August 1, 2020, to July 31, 2021.

### 2.3.3 UAS Surveys

State Parks, in coordination with a team from Arizona State University (ASU) and UCSB, has used a Wingtra One fixed-wing uncrewed aerial system (UAS, also known as a drone) to survey and monitor changes in dune morphodynamics, vegetation cover, and sediment budgets (volumetric change) at ODSVRA since October 2019. The Wingtra One UAS is a fully autonomous drone. Flight paths are pre-programmed into the drone and monitored by an FAA-certified pilot. The drone is typically flown at altitudes over 100 m above ground level. The system is equipped with post-processing kinematic (PPK) Global Positioning System (GPS) correction capabilities referenced during data collection to a survey-grade Trimble R10 base station that operates in static collection mode. These GPS data are then used to provide precise georeferencing for each photo collected by the onboard payload within mm-scale accuracy.

Flights are coordinated with State Parks staff and wildlife monitors to ensure safety and minimal disturbance to birds and wildlife during the flight campaigns; UAS flights are not conducted during shorebird nesting periods.

The UAS surveys conducted from August 1, 2020, to July 31, 2021, covering more than 20 square kilometers in total (approximately 4-6 km2 per campaign) and involve the collection of high-resolution digital imagery using: 1) a Sony RX1RII 42-megapixel (MP) full-frame red, green, and blue (RGB) camera sensor at approximately 1.5 to 2 cm resolution, and 2) a Micasense Rededge-MX sensor that provides multispectral (RGB, rededge/RE, and near-infrared/NIR) imagery at a resolution of approximately 7 to 9 cm. The multispectral imagery provides the added benefit of allowing for vegetation to be easily extracted from the resulting imagery and, using various spectral indices, such as Normalized Difference Vegetation Index (NDVI) and Normalized Difference Red-Edge Index (NDRE), seasonal changes in vegetation cover can also be identified.

The UAS imagery datasets are then used to create four main data products:

1. Georeferenced, orthorectified aerial photo mosaics of the study site in the visual (RGB)bands,
2. Georeferenced, orthorectified multispectral maps of vegetation cover using NDVI and other spectral methods
3. Three-dimensional digital elevation models (DEMs) derived from structure-from-motion(SfM) photogrammetry,
4. Geomorphic change detection (GCD) maps from consecutive time steps show differences in elevation derived by comparing DEMs over time using spatial statistics. The GCD maps are then used to calculate volumes of sediment changebetween surveys that can be used to identify and interpret dune development, evolution, erosion/deposition patterns, and sediment budgets. In contrast to the point measurement of the BSNEs, the GCD maps provide spatial patterns of geomorphic change.

As of July 31, 2021, four UAS survey campaigns have been flown at ODSVRA (see Table 2-7). The UAS surveys occur each February and October to avoid the western snowy plover nesting season between March and September. Initial UAS survey efforts in October 2019 and February 2020 focused on mapping the 48-acre foredune treatment areas (20-VG-01, 20-VG-02, and 20-VG-03, see Attachment 01, Figure A01-11). In early 2020, State Parks and the SAG decided to expand UAS surveys to include the full extent of ODSVRA's open riding and camping area (approximately 1,500 acres). It included key reference sites of high OHV activity, protected non-riding areas, aeolian sand transport (saltation) pathways, vegetated restoration areas, natural foredune sites, and other highly emissive areas.

| Table 2-7. Summary of UAS Surveys at ODSVRA | | | | |
|---|---|---|---|---|
| **UAS Survey Campaigns** | **Survey Dates** | **Sensor Payload (spectral bands)** | **Coverage Area (square kilometers)** | **Average Altitude (meters)** |
| 1: Baseline Pre-Restoration Survey | October 1-2, 2019 | Sony RX1R II (42 Megapixel, RGB) | 3.83 | 114 |
| 2: Initial Treatment Installations | February 10-11, 2020 | Sony RX1R II (42 Megapixel, RGB) | 5.41 | 123 |
| 3: First Post-Treatment Survey | October 13-15, 2020 | Sony RX1R II (42Megapixel, RGB) | 5.98 | 121 |
| | October 16, 2020 | Micasense RedEdge-MX (RGB, RE, NIR) | 4.63 | 113 |
| 4: First Year of Treatment Response | February 17-18, 2021 | Sony RX1R II (42 Megapixel, RGB) | 5.95 | 120 |
| | February 18-21, 2021 | Micasense RedEdge-MX (RGB, RE, NIR) | 5.79 | 118 |

A pre-restoration baseline survey was flown in October 2019 before any foredune restoration activity. The second survey was flown in February 2020 during the installation of restoration treatments and before the closure of ODSVRA in March 2020 due to COVID-19. These initial surveys involved only the visual (red, green, and blue spectrum) camera payload. The third survey occurred in October 2020 and captured the first growth phase of foredune seedlings using RGB and a multispectral sensor to better detect and assess vegetation growth. The fourth survey in February 2021, also using both RGB and multispectral sensors, captured the first year of changes in vegetation cover and dune morphodynamics.

UCSB has completed initial analysis and reporting related to UAS surveys at ODSVRA. Refer to Attachment 08, UCSB-ASU 2020- 2021 ODSVRA Foredune Restoration UAS Survey Report, for UCSB's full analysis. The following is a summary of the findings of the analysis excerpted from the UCSB-ASU Foredune Restoration UAS Survey Report included as Attachment 08 to this ARWP:

> "In February 2020, six different foredune restoration treatment plots were established over a 48 acre region of the ODSVRA that was identified through a collaborative process involving [State Parks], SLOAPCD and the SAG. The treatments included (north to south):

1) a plot textured by sheepsfoot stippling only (a minimal intervention control site); 2) a plot textured by sheepsfoot with broadcast native seeds; 3) a plot textured by sheepsfoot with broadcast seeds of native foredune plants and sterile rye grass; 4) low-density planting nodes with juvenile native plants surrounded by a protective straw circle; 5) high-density planting nodes with juvenile plants; 6) complete straw cover with high density planting of juvenile plants. The performance of the treatments is assessed using five criteria that track the geomorphic and vegetation responses within the restoration areas, including: 1) maintain a positive sediment budget (volumetric gains); 2) maintain aeolian activity within the treatments (namely sand transport and open sand surfaces) to provide necessary ecological conditions for plant growth and dune development; 3) ensure plant survivorship and increased plant cover over time to some eventual equilibrium state; 4) enhance dune development; and 5) contribute to a reduction in dust emissivity.

An uncrewed aerial system (UAS) with high resolution cameras is used to detect and map both geomorphic and vegetation changes in the restoration plots and adjoining beach and back dune areas from four flights to date (Oct. 2019, Feb. 2020, Oct. 2020, Feb. 2021). Resulting datasets include georeferenced orthophoto mosaics, vegetation cover maps, three-dimensional terrain maps (DTMs), and geomorphic change detection (GCD) maps used to calculate volumes of sediment erosion/deposition across the restoration sites. These data are then used to identify and interpret dune movement, sediment budget responses, and vegetation establishment. The report provides results from the first year following implementation of the restoration treatments and also examines specific changes during the March-October 2020 COVID-19 closure to OHV activity, as requested by [State Parks].

Over the study period, sand supply to the beach has been highlight variable, as expected, due to seasonal trends in wave energy, beach erosion/rebuilding, and the movement of rip current embayments. Overall, however, sand supply to the beach declined in front of the foredune restoration site during this first year with some plots (1, 4, 6) seeing a net loss. These changes in beach width and sand supply occur independently from the restoration activities, yet they control the responses of the treatments by modulating the influx of sand by wind from the beach. Dune development occurred in four of the six plots with [approximately] 1 m tall nebkha observed in plots 3 and 5 and smaller forms ([approximately] 0.6 m) in treatment plots 4 and 6. Low, largely unvegetated [less than 0.6% coverage] protodunes and transverse ridges migrated through plots 1 and 2. All treatments showed positive net sediment budgets by the end of this first year of s, with plots 1-3 showing the greatest surpluses.

Vegetation cover generally increased for all treatment types except for the plot 1 control site, which showed negligible change. Plot 6 showed the greatest increase in plant cover, from 2.2 to 4.9%, followed by treatment plots 5, 3, 2, and 4 (in decreasing order). For context, the peak observed historical plant cover at the restoration site and in the broader foredune zone (approximately 400 meters landward of the upper beach) in the ODSVRA open riding and camping area, respectively, were about 3% and 6% in 1966.

The first year of plant growth and dune development at the foredune restoration site has shown an array of responses that are unique to each treatment plot and provides only an initial glimpse of ecosystem response. With reference to defined performance criteria:

1. All plots showed a positive sediment budget, although some treatments (2, 4) showed only marginal increases over the pre-restoration baseline survey.
2. Aeolian processes remained active in all treatments shown by rippled sand transport corridors, dune development and migration, and emergency of erosional deflation surfaces with coarse lag deposits on all sites. Erosional responses are expected during early development phases and do not necessarily reflect poor performance.
3. Initial plant survivorship was high [approximately 70%] and plant cover increased post-installation by 0.2 to 2.8% in all seeded or planted treatments (2-6). Some species, namely *Abronia latifolia,* showed rapid establishment and growth, promoting development of talker nebkhad dunes. It is too early to assess broader foredune ecosystem re-establishment, but the first year has provided promising results.
4. Enhanced dune development was observed in four of the six treatments (3-6), with the largest [approximately 1 m] nebkha dunes emerging in plots 3 (sheepsfoot + native seed + sterile grass seed) and 5 (high density planting nodes) followed by smaller [approximately 0.6 m] nebkha in plots 4 (low density nodes) and 6 (broadcast straw + plants). Compared to the disturbed, relatively flat pre-restoration surface, plots 1 and 2 also shoed limited development of largely unvegetated protodunes and transverse ridges that migrate inland.
5. Contributions to reduced dust emissivity remain to be assessed. It is too early in the establishment and development of the foredune treatments to assess their impact on dust emissivity. Continued $PM_{10}$ emissivity testing (PI-SWERL) is recommended coupled with enhanced empirical studies and modeling of aeolian transport and dust emissions within and downwind of the restoration plots to better understand the broader performance of the treatments for improving air quality."

### 2.3.4 Computational Fluid Dynamics

Computational fluid dynamics (CFD) is the science of producing fluid flow simulations using large computational resources. The CFD modeling can be used to evaluate how the evolving foredune treatment areas will modulate the boundary-layer flow (wind speed, direction, and surface shear velocity) over the foredune area, in the lee of the foredune area, and with the re-vegetation areas located east of the foredune restoration area. Currently, the DRI model only accounts for localized reductions in dust emissivity directly within dust control treatment areas. Incorporating CFD into the DRI model could provide a more accurate assessment of the effectiveness of mitigation treatments by accounting for flow changes within and downwind of treatment areas.

The CFD modeling requires inputs of monitoring data to constrain model boundary conditions. From August 1, 2020, to July 31, 2020, DRI and UCSB undertook a measurement campaign to characterize the flow over foredune treatment areas in the ODSVRA open riding and camping area and existing foredunes south of the open riding and camping area in the Oso Flaco area of ODSVRA. Monitoring consisted of three-meter towers instrumented with three-dimensional sonic anemometers to measure the three components of wind speed horizontal (u), spanwise (v), and vertical (w) at 10 hertz (Hz) at three positions on the tower: 0.25 m, 1.6 m, and 3.1 m.

The CFD data processing is ongoing. These data will be used to estimate flow quantities such as the surface Reynolds stress (a similar stress quantity as the shear velocity) and turbulence intensity. The sonic anemometry measurements combined with measurements of surface roughness parameters obtained from the UAS-derived DEMs, on-ground photogrammetry, and terrestrial lidar scanning (TLS) data collected in May 2021, will be used to understand how the evolving surface structures, such as plants and nebkha, in the foredune areas are influencing the flow and the sediment transport potential across each treatment type.

The CFD modeling is expected to result in the following benefits:

- A means to provide more realistic estimates of the aerodynamic roughness lengths (z0) for different areas of ODSVRA. This parameter plays a critical role in Computer-Aided Learning In Meteorology (CALMET) in estimating wind shear (which drives dust emissions). Currently, its representation in CALMET remains simplistic.
- Better estimates of shear velocity based on the topographic position on the dunes and in their lee will also provide better estimates of emissions.

See Attachment 09, DRI 2020/2021 CFD Report for DRI's detailed report on CFD activities completed from August 1, 2020, to July 31, 2021.

### 2.3.5 PI-SWERL/Emissivity Monitoring and the Influence of OHVs on Dust Generation

State Parks has commissioned substantial research to better understand the science of dust and emissivity at ODSVRA. Since 2013, DRI has undertaken PI-SWERL measurements of $PM_{10}$ emissivity across ODSVRA in riding and non-riding areas annually. The measurements have been repeated over time by revisiting the 2013 sampling locations. Measurements have also been made in areas deemed critical to understanding changes in emissivity throughout ODSVRA. In total, between 2013 and 2019, DRI conducted 932 individual PI-SWERL emissivity tests within the ODSVRA riding area and 317 PI-SWERL emissivity tests outside the riding area. In addition, a network of air quality and meteorological monitoring stations have been in place within and downwind of the park since 2017 (see Section 2.3.1 and 2.3.2).

Two recent DRI reports used seven years of data to explore the questions:

> 1) What effects, if any, does OHV activity have on dust emissivity at ODSVRA and $PM_{10}$ concentrations downwind?
>
> 2) Are the dust mitigation projects improving air quality downwind of ODSVRA? Summaries of DRI's reports as they relate to these two questions are provided below. These summaries are excerpted from the State Parks' Staff Report "Dust Emissions and OHV Activity at [Oceano Dunes] SVRA", presented to the Off Highway Motor Vehicle Recreation (OHMVR) Commission on August 26, 2021. Refer to Attachment 10 for State Parks' Staff Report and the two DRI reports summarized by the Staff Report: Examining Dust Emissions and OHV Activity at the ODSVRA and Increments of Progress Towards Air Quality Objectives (2013 – 2020). Attachment 10 also includes a related wind and $PM_{10}$ analysis prepared by the California Geological Survey (CGS). As noted in Section 2.4.1, the SAG reviewed and commented on this CGS analysis. The SAG's comments are contained in Attachment 12 for SAG comments on the CGS analysis.

#### 2.3.5.1 Influence of OHVs on Emissivity, $PM_{10}$, and Dune Geomorphology

In March 2020, ODSVRA and Pismo State Beach were closed to vehicular access to mitigate the spread of COVID-19. This closure lasted until the end of October, an approximately 7-month period. The COVID-19 closure of ODSVRA provided an opportunity to preliminarily evaluate changes in emissivity (i.e., PI-SWERL measurements), dune geomorphic changes, and downwind $PM_{10}$ concentrations with the absence of OHV recreation over time. Regarding the influence of OHVs on emissivity and $PM_{10}$, State Parks' staff report states:

> "The first question of how OHV may impact dust emissions at [ODSVRA] has been a point of discussion raised by the OHV Commission, the OHV community, the [SLOAPCD], and other stakeholders for several years. In addition to analyzing the impacts off-highway vehicles may have on dust emissivity at [ODSVRA], DRI also explored how any impacts on emissivity are related to observed changes in $PM_{10}$ concentrations in the

ODSVRA as well as downwind of the Park from 2017 to 2020. For clarity, emissivity is defined as how much particulate matter is released from the sand surface per unit area and time under the action of the wind. $PM_{10}$ concentration is the mass of $PM_{10}$ in a volume of air being moved by the wind and is typically measured at a downwind receptor site.

To address any impacts on emissivity, measurements of emissivity from dune sands were made using a specialized instrument (PI-SWERL®) from 2013 through to 2020 in the area with OHV activity and in areas where OHV access is not permitted. These measurements indicated that the mean emissivity of the sand inside of the riding area was two the three times higher than the mean of the non-riding areas, for wind conditions well-above the threshold where saltation begins on the dunes. In addition, emissivity data specific to the La Grande Tract from 2020 was lower than in 2019. Note that these data quantify the $PM_{10}$ emissivity of the sand, as opposed to downwind $PM_{10}$ concentrations.

In addition to analyzing the sand emissivity data, measurements of Wind Power Density (WPD), a measure of the ability of the wind to cause sand to saltate and emit dust and suspended particulate matter (concentrations of $PM_{10}$) were made at 15 monitoring stations in the riding areas (11 stations) and downwind of the riding areas (4 stations). These measurements have been made annually between May and September 2017 to 2020. In 2017, 2018, and 2019, these data indicate that $PM_{10}$ concentrations in the air at ODSVRA, increased from May through July per month for similar wind conditions. The increase was observed from May through September for 2019 . . . In 2019, that increase was approximately 12% per month for similar wind conditions . . . The increase was also observed at the four monitoring stations downwind of the riding area mentioned above . . .

Public vehicle activity was prohibited beginning in late March 2020 due to the [COVID-19] pandemic. In contrast with the 2019 data, measurements of $PM_{10}$ and WPD, April to August 2020 in [ODSVRA] indicated an approximate 11% decrease per month for similar wind conditions . . .

The cessation of OHV activity resulted in the dunes producing lower concentrations of $PM_{10}$ for similar wind conditions during sand transport (saltation) in [ODSVRA]. The decrease was also observed at the four monitoring stations downwind of the riding area . . ."

The Staff Report concludes:

"The analyses by DRI indicates that OHV activity increases emissivity and dust levels in the active dune field, in addition to $PM_{10}$ concentrations, downwind of ODSVRA. However, the dust mitigation measures in place have significantly improved air quality downwind of [ODSVRA]."

*Dune Geomorphic Changes*

In addition to emissivity and $PM_{10}$ concentrations, the results of a recent study prepared by UCSB evaluates dune geomorphic changes during the COVID-19 closure period. The results from the UAS surveys of the foredune restoration treatments indicate that all plots showed a positive sediment budget, aeolian processes remained active in all plots, initial plant survivorship was high and plant cover increased post-installation, and enhanced dune development was observed in four of the six treatments (3-6). With regards to the foredune restoration site's potential contributions to reduced dust emissivity, the UCSB report concludes it is too early in the establishment and development of the foredune treatments to assess their impact on dust emissivity and recommends continued $PM_{10}$ emissivity testing (PI-SWERL) coupled with enhanced empirical studies and modeling of aeolian transport and dust emissions within and downwind of the restoration plots to better understand the effect of the foredune treatments on air quality. Refer to Section 2.3.3 for a summary of the key findings of the UCSB report, which is presented in full in Attachment 08 to this ARWP. Refer to Section 2.3.3 for a summary of the key findings of the UCSB report, which is presented in full in Attachment 08 to this ARWP.

#### 2.3.5.2 Increments of Progress Towards Meeting Air Quality Objectives, 2013 to 2020

The second question of whether dust mitigation projects are improving air quality downwind of ODSVRA is partially answered by the results of DRI modeling presented in Section 2.2.2 and Section 2.2.3. Regarding other increments of progress towards meeting air quality objectives, the State Parks' Staff Report states:

> "Dust controls—temporary wind fences and vegetation projects—have been used within the Oceano Dunes [SVRA] to reduce $PM_{10}$ emissions originating from within the park. These controls are also expected to lower the $PM_{10}$ concentrations helping to meet the SOA requirements. Beginning in 2014, 28 acres of dust control was implemented, and the acreage had increased to 223 acres in 2020. That is approximately 15% of the available riding area. According to emission and dispersion modeling undertaken by DRI, the 223 acres reduced $PM_{10}$ measured at the Calfire monitoring station (CDF) by [approximately] 42% with respect to the values modeled for the 2013 baseline days.
>
> Using the $PM_{10}$ measurements at CDF and wind speed data from the S1 tower in [ODSVRA], DRI demonstrated that dust emission in locations where controls have been placed produces less $PM_{10}$ now than prior to these controls and that this reduction is consistent with the increase in acres of dust control. Specifically, these data indicate that emplacement of dust controls upwind of the CDF station reduced $PM_{10}$ production by 48% for similar wind conditions with the controls in place in 2020 compared with the

no-control conditions of 2011–2013. DRI's analysis of the data also agrees with model results that indicate $PM_{10}$ reduction at the CDF receptor site is due to the dust controls.

Air quality modeling and analyses of the wind and $PM_{10}$ data presented in the DRI report indicate that the actions taken by Parks to reduce dust-generated impacts within [ODSVRA] through the dust control program are demonstrable with decreased emissions of $PM_{10}$ as the size of the control areas have increased through time, and these impacts amount to a reduction of [approximately] 45% near the CDF measurement site since 2011. This has been documented by sophisticated computer modeling of concentrations at sensitive receptor sites and has been verified by measurements at EPA monitoring sites downwind of [ODSVRA]. This analysis shows that the ongoing dust control efforts have eliminated exceedances of the Federal ambient air quality $PM_{10}$ standard and are making strong progress to meet the State standard as well."

### 2.3.6 Vegetation Monitoring

From August 1, 2020, to July 31, 2021, State Parks developed and reported the vegetation sampling methods described below in consultation with SAG's vegetation working group.

#### 2.3.6.1 Line Intercept Transect Sampling Method

The line intercept method was utilized to estimate the species percent cover within each of the sixforedune treatment areas and a reference site in the North Oso Flaco foredune. A total of three30-meter transects were sampled in each treatment area. Sampling occurred in September when access to foredune areas was not limited by nesting bird activity.

The starting points for the transect lines were randomly selected within each project area using Geographic Information System (GIS). Transect directions were also randomly selected from the eight cardinal and intermediate directions (i.e., N, NE, E, SE, etc.). A measuring tape was run along the transect and secured with wooden stakes. As the vegetation canopy intersected the line, the species was noted on a data sheet along with the beginning and ending canopy measurements. When the canopies of two different species overlapped, each species was documented separately as two different canopies. A closed canopy for a given species was assumed until gaps in vegetation exceed the width of five cm. Dead vegetation was not included in the measurements unless it was clearly the result of the seasonal dieback of a perennial plant that was still viable. Once each 30-meter transect was surveyed, staff conducted a walk-around assessment within an area of ten meters from the transect line for the entire length of the transect (a "belt transect"), and all additional species observed was noted.

As expected in the first growing season, none of the foredune treatment areas approached the vegetative cover (34.2%) of the Oso Flaco reference site; however, three of the six treatment areas did have species diversity similar to the Oso Flaco reference site with at least nine species represented in the treatment area for year one of monitoring. The treatment area that achieved the highest percent cover was Area 3 with 4.02% cover, followed closely by Area 6 with 3.57% cover. Both Area 5 and Area 6 showed the highest species richness, with ten species represented in both areas. Based on the line intercept transect monitoring, it does not appear that three transects in each area were sufficient to determine the percent cover with certainty since Area 4 had greater cover than Area 5 (0.76% compared to 0.40%). At the same time, Area 4 was planted with 61% of the density of Area 5. The monitoring methods are expected to increase, and substantial vegetative growth has been observed in the second growing season. It does appear that the survey methods were sufficient to determine the species richness. Additional survey work will be necessary to evaluate if survey methods are sufficient.

State Parks notes the rapid growth of vegetation within much of the foredune treatment areas was anecdotally observed during the winter and spring months following the September 2020 monitoring. State Parks anticipates that monitoring conducted from August 1, 2021, to July 31, 2022, will indicate that vegetation cover within the foredune treatment areas is increasing significantly.

Refer to Attachment 11, Foredune Restoration Monitoring Report, for detailed results of the foredune transect monitoring conducted from August 1, 2020, to July 31, 2021.

#### 2.3.6.2 Photo Point Monitoring

State Parks conducted on-the-ground photo point monitoring of the 48-acre foredune treatment areas before project installation in February 2020 and subsequent installation in May 2020 and October 2020. Photo point monitoring is scheduled to continue each October in subsequent years. Photo points are located on all four corners of each treatment area. For each photo point, two photos are taken, each with one of the treatment area boundary lines on the outer edge of the photo with the interior of the treatment area centered in the photo. There is also one photo point overlooking the entire 48-acre foredune treatment area.

In addition to on-the-ground monitoring, drone aerial imagery photo point monitoring was conducted in May 2020 and again in December 2020. Two photo points were taken of each treatment area, including one from the east and one from the west for each area. Drone photo point monitoring is scheduled to continue an annual basis.

### 2.3.7 Evaluation Metrics

Pursuant to the SLOAPCD SOA as amended, State Parks will continue to report PMRP evaluation metrics developed in consultation with the SAG to track progress and inform adaptive management actions. However, recent discussions among the SAG, State Parks, and SLOAPCD have highlighted that the existing set of evaluation metrics does not serve their intended tracking and management purpose. Therefore, a new set of evaluation metrics is adopted in this ARWP (see Attachment 02, 2021 Updated PMRP Evaluation Metrics).

This update intends to provide a more streamlined dashboard that makes it easier to track progress and inform adaptative management. "Dust Mitigation Targets" refer to evaluation metrics with specific, measurable endpoints. "Dust Mitigation Indicators" refer to values indicating progress, but specific targets are not defined. Unlike previous reports of evaluation metrics, current and future ARWPs will report on all relevant metrics and include arecord of metrics for past years to track progress more easily.

## 2.4 REPORT ON OTHER DUST CONTROL PROGRAM-RELATED ACTIVITIES

Chapter 7 of State Parks' approved PMRP describes potential actions that State Parks, the SAG, and the SLOAPCD may undertake to further support and inform the overall adaptive management approach to dust control at ODSVRA. State Parks' report on other dust control program-related activities is provided below.

### 2.4.1 SAG Responses to Studies

During the 2021 ARWP Reporting Period (August 1, 2020, to July 31, 2021), the SAG provided formal responses/reviews to the following studies and reports:

**Report:** ODSVRA Dust Control Program 2020 Annual Report and Work Plan – Draft 8-1-2020
**Author:** California Department of Parks and Recreation
**Date:** August 1, 2020
**SAG Response Date:** August 31, 2020

**Report:** An Analysis: May and June Wind Strength Year to Year and State $PM_{10}$ Exceedances with and without OHV Recreation, ODSVRA
**Author:** W. Harris, California Geological Survey
**Date:** August 5, 2020
**SAG Response Date:** August 20, 2020

**Report:** September 2020 Scripps Supplementary Report on Particulate Matter (PM) Sources at Oceano Dunes State Vehicular Recreation Area (ODSVRA)
**Author:** L.M. Russell, Scripps Institution of Oceanography
**Date:** September 21, 2020
**SAG Response Date:** November 2, 2020

**Report:** 90 Acre Treatment Options for 2020-21 Annual Report and Work Plan
**Author:** California Department of Parks and Recreation
**Date:** November 16, 2020
**SAG Response Date:** November 20, 2020

**Report:** Oceano Dunes Coastal Development Permit 4-82-300 Review

**Author:** California Coastal Commission staff
**Date:** February 16, 2021
**SAG Response Date:** March 12, 2021

**Report:** Report to the SAG and Parks Evaluating the Potential for Developing a New Baseline Mass Emissions Rate and Target Reduction within the SOA
**Authors:** J.A Gillies, J. Mejia, and E. Furtak-Cole, Desert Research Institute
**Date:** April 27, 2021
**SAG Response Date:** April 30, 2021

In June 2021, the SAG also initiated preparing a "State of the Science" document to synthesize knowledge regarding ODSVRA dust mitigation activities. Refer to Attachment 12 for the compilation of the SAG's responses to the studies listed above and Section 3.1.8.

### 2.4.2 SAG Participation In Meetings

During the 2020-21 Annual Report period, the Scientific Advisory Group (SAG) participated in various meetings. Table 2-8 lists significant meetings of the full SAG, meetings of the SAG with other entities, and presentations by SAG members at public events. All meetings are virtual unless otherwise indicated.

**Table 2-8. SAG Participation in Meetings, August 2020 - July 2021**

| Date(s) | Meeting Name | SAG Role | Participants |
|---|---|---|---|
| August 25, 2020 | SLOAPCD meeting on ARWP | Discuss draft 2020 ARWP | SAG, State Parks, SLOAPCD, CARB |
| September 3, 2020 | State Parks meeting with SAG | Discuss approach to SOA target | SAG, State Parks |
| September 28, 2020 | SLOAPCD meeting on ARWP | Discuss draft 2020 ARWP | SAG, State Parks, SLOAPCD |
| October 19, 2020 | SLOAPCD meeting on ARWP | Prep for Public Workshop andHearing Board meeting | SAG, State Parks, SLOAPCD |
| October 23, 2020 | SLOAPCD Public Workshop and Hearing Board meeting | Present on 2020 ARWP | SAG, State Parks, SLOAPCD |
| November 12, 2020 | State Parks meeting with SAG | Discuss approach to SOA target | SAG, State Parks |
| November 19, 2020 | SAG meeting | Discuss location of control measures | SAG |
| November 23, 2020 | SLOACPD meeting on ARWP | Discuss location of control measures | SAG, State Parks, SLOAPCD |

| Table 2-8. SAG Participation in Meetings, August 2020 - July 2021 | | | |
|---|---|---|---|
| **Date(s)** | **Meeting Name** | **SAG Role** | **Participants** |
| January 21, 2021 | State Parks meeting with SAG | Discuss approach to SOA target | SAG, State Parks |
| February 23, 2021 | State Parks meeting with SAG | Provide updates on SAG activities | SAG, State Parks |
| March 2, 2021 | SLOAPCD Hearing Board prep meeting | Discuss planned presentations toSLOAPCD Hearing Board | SAG, State Parks, SLOAPCD |
| March 22, 2021 | SLOAPCD Hearing Board prep meeting | Discuss planned presentations toSLOAPCD Hearing Board | SAG, CPDR, SLOAPCD |
| March 24, 2021 | SLOAPCD Hearing Board meeting | Present updates to SLOAPCDHearing Board | SAG, State Parks, SLOAPCD |
| April 22, 2021 | DRI meeting with SAG | Discuss the approach to SOA target | SAG, DRI |
| May 18, 2021 | SAG meeting | SAG organizational discussion | SAG |
| May 19, 2021 | SAG meeting | Plan for 2021 ARWP | SAG, State Parks, SLOAPCD |
| June 18, 2021 | SAG meeting | Plan “State of the Science” report | SAG |
| July 22-23, 2021 | SAG meeting (in-person) | Discuss 2021 ARWP | SAG, State Parks, SLOAPCD |

### 2.4.3 Revisiting the SOA Target

Section 3.3 of the 2020 ARWP states:

> “All parties [i.e., SAG, DRI staff, and State Parks staff] will continue coordination on possible SOA Goal Alternatives, noting that the foremost goal is to achieve reductions in $PM_{10}$ concentrations toward attaining state and federal air quality standards while minimizingimpacts to public recreation opportunities.”

SOA provision 2.c. directs that State Parks:

> “[establish] an initial target of reducing the maximum 24-hour $PM_{10}$ baseline emissions by fifty percent (50%), based on air quality modeling based on a modeling scenario for the period May 1 through August 31, 2013.”

Whereas SOA provision 2.d. allows that:

> "[t]he estimates of emission reductions identified in 2c may be modified based on air quality modeling conducted by CARB or another modeling subject to the review of the SAG."

As directed by the 2020 ARWP, the SAG discussed possible alternatives to the existing SOA dust emissions reduction target. In its preliminary discussions, the SAG considered that the ODSVRA is a naturally dusty environment. However, OHV impacts have led to an increase in $PM_{10}$ mass emissions and airborne $PM_{10}$ concentrations relative to air quality conditions before human disturbance of the dunes. Considering these factors, the SAG agreed that a reasonable goal would be to reduce $PM_{10}$ mass emissions and airborne $PM_{10}$ concentrations to levels commensurate with naturally occurring conditions before human disturbance of the dunes.

The SAG identified two primary impacts of human disturbance that may have contributed to increases in $PM_{10}$ mass emissions relative to a pre-disturbance emissions scenario: (1) increased $PM_{10}$ emissivity of OHV-impacted dune surfaces; and (2) changed vegetation cover and related dune-stabilizing features. Impact 1 (increased $PM_{10}$ emissivity) is apparent from PI-SWERL surveys that reveal Riding Area dune surfaces are significantly more emissive than equivalent non-riding area dune surfaces. Impact 2 (decreased dune-stabilizing features) is apparent from air photos that show significantly changed vegetation coverage within the SVRA's open riding and camping area in the 2013 baseline scenario than in historical aerial surveys. Therefore, should a pre-disturbance emissions scenario be identified as the basis for setting a new SOA dust mitigation target, this scenario should account for lower $PM_{10}$ emissivity and changed dune-stabilizing vegetation coverage relative to the current impacted conditions.

As a preliminary proof of concept of the pre-disturbance emissions scenario approach, the SAG recommended that DRI staff use the DRI model to simulate a simplified scenario in which the $PM_{10}$ emissivity of riding area surfaces is replaced with a new $PM_{10}$ emissivity derived from the average emissivity of adjacent non-riding area surfaces. DRI staff performed the recommended proof-of-concept modeling, and the SAG reviewed the results and presented its findings to State Parks staff (see Attachment 12). The SAG identified the following outcomes of the proof-of-concept modeling:

1. Pre-disturbance conditions produce substantial $PM_{10}$ emissions and airborne $PM_{10}$ concentrations.
2. pre-disturbance $PM_{10}$ emissions and concentrations are significantly lower than for post-disturbance conditions.
3. the pre-disturbance emissions scenario modeling approach is a feasible way to identify a potential alternative to the current SOA target.

In addition, the SAG agreed that further updates to the preliminary pre-disturbance scenario – including consideration of spatial gradients in naturally-occurring dust emissivity, an assessment of historical dune-stabilizing vegetation coverage and its effects on $PM_{10}$ emissions, and quantification of model uncertainty – are needed before the pre-disturbance scenario modeling approach may be used to determine an alternative to the current SOA target. Accordingly, UCSB has initiated an analysis of historical vegetation cover that will examine historical trends in vegetation cover and inform further discussions regarding potential changes to the SOA target. Refer to Section 3.1.8.1 for a description of the next steps for developing proposed alternatives to the current SOA target.

### 2.4.4 OTHER SOURCES OF DUST

As amended, SOA #17-01 recognizes that $PM_{10}$ concentrations measured at CDF and on the Nipomo Mesa may come from various sources external to ODSVRA (SOA pg. 6,lines 19 to 23 and SOA pg. 14, lines 13 to 15). In response, State Parks and the SLOAPCD continued studying other potential $PM_{10}$ emission sources and their relative contributions to $PM_{10}$ concentrations on the Nipomo Mesa.

#### 2.4.4.1 $PM_{10}$ Speciation Sampling

In 2020, the SLOAPCD collected 13 $PM_{10}$ samples for speciation analysis at CDF to further investigate the amount of salt, inorganic aerosols, crustal material, etc. there is in the $PM_{10}$ sampled at the CDF station. Each sample was a pair of filters, one Teflon and one quartz, exposed for 24 hours. These samples were analyzed by DRI for total $PM_{10}$ mass concentration, certain ions (sodium, potassium, chloride, ammonium, nitrate, sulfate, and methanesulfonate), various organic and elemental fractions and elements from sodium through uranium by XRF.

State Parks funded the processing of the samples, and Karl Tupper (from SLOAPCD) and Earl Withycombe (from CARB and SAG) have been analyzing the data. Three samples were collected on “normal” days, uninfluenced by wind-blown dust or other obvious sources, and these are considered background samples. Eight samples were collected on days predicted to be wind-blown dust event days. However, it should be noted that in the 2020 wind event, $PM_{10}$ concentrations were lower than in previous years, and the highest concentration of these eight samples was only 93 ug/$m^3$ (as measured by the Beta AttenuationMonitor (BAM)). One sample was collected on a day heavily influenced by wildfire smoke, and another sample was influenced by transport from the San Joaquin Valley.

A report on the results from 2020 is not yet available, but preliminary analysis indicates:

- The 13 samples are not enough to do a state-of-the-art apportionment analysis, i.e., positive matrix factorization (PMF). Attempts to run PMF with the data resulted in physically reasonable solutions; however, they were not stable. CARB’s PMF specialist indicates that 150 samples are ideal, though there are examples of successful analyses with fewer.

- The correlation between the collocated SLOAPCD BAM concentrations and the DRI filter concentrations is good ($r^2$ = 0.97) - much better than Scripps reported for their $PM_{2.5}$ filters ($r^2$ = 0.69). In 2019, the SLOAPCD collected filter samples with this same equipmentand weighed them by two different labs. There was also a good correlation with the BAM then, but with a slight bias in the opposite direction.
- The mass closure is poor. The mass closure refers to the difference between the measured total $PM_{10}$ concentration and an estimate constructed by taking the raw concentrations of the measured elements and ions in each sample and applying standard equations and assumptions to estimate how much salt, inorganic aerosol, crustal material, etc., there isin the sample, and finally summing all these constituents up. The "reconstructed mass" should be close to the mass measured on the filter. While the mass closure is never perfect, for the samples, the comparison is poor. For the four background and smoke samples, the reconstructed mass is 91 to 103% of the measured mass—which is acceptable—but for the eight wind event samples, the range is 71-98% with a mean of82%, and for the lone SJV transport day, it is only 36%.

Refer to Attachment 13, 2021 Proposal for Speciation Sampling for more detailed information on the speciation analyses completed to date and additional details related to the SLOAPCD's 2021 speciation sampling that is currently underway.

### 2.4.4.2 Scripps Institution of Oceanography Study

The Scripps Institution of Oceanography (Scripps), in collaboration with State Parks and CGS, continued into years two and three of its investigation of airborne $PM_{10}$ constituents at ODSVRA and vicinity. In August 2020, the OHMVR Commission requested an update of findings from spring 2020 air filter sampling and analysis conducted by Scripps. In response, Scripps atmospheric chemistry professor Lynn Russel prepared a September 20, 2020 report entitled "Preliminary Results from May 2020 Aerosol Measurements," which she presented to the OHMVR Commission on September 24, 2020. Data presented indicate $PM_{2.5}$ mineral dust mass measured by Scripps is less than the $PM_{2.5}$ values measured by the SLOAPCD's CDF BAM instrument. Preliminary results from air filter sampling adjacent to the dune shorelineindicate measured airborne $PM_{10}$ consists mostly of atmospheric water and contains approximately 20 percent mineral dust. The SAG and SLOAPCD have questioned the validity of the 20 percent value. Please see the SAG and SLOAPCD's response to why the 20 percent value is disputed in Attachment 12 and Attachment 14, respectively.

For 30 consecutive days, from April 27 through May 26, 2021, air filter samples were again collected at the SLOAPCD's CDF location but not along the dune shoreline. Consecutive-day sampling along the shore was not possible due to the nesting activity of protected shorebirds.

The sampling effort at CDF was expanded to include collecting $PM_{10}$ samples and collecting $PM_{2.5}$ samples using two types of particulate segregator cyclones—a sharp cut cyclone and a very sharp cut cyclone. Samples were collected on pre-weighed Teflon filters. Analyses conducted and conducted include gravimetric analysis, elemental speciation, and carbon-source identification using Fourier-transform infrared spectroscopy. Refer to Attachment 14 for the 2020 Scripps study, SLOAPCD's comments on this study, and Scripps's response to the SAG's and SLOAPCD's comments. Refer to Attachment 12 for the SAG's comments on the Scripps study.

### 2.4.5 Public Relations Campaign

According to SOA #17-01 (background statement "c"), in November 2020, State Parks prepared a draft public relations campaign for SAG review and comment. The public relations campaign intends to educate the public on regional air quality issues in southern San Luis Obispo County surrounding ODSVRA, how they are being addressed, and how they can be a part ofthe solution. State Parks' initial public relations campaign proposal focused on providing resource materials and educational videos via various public platforms, including social media, websites, outreach programs, and other forms of communication with the public. In January 2021, the SAG provided comments to State Parks on its proposed public relations campaign. State Parks is evaluating the SAG's comments and is preparing a revised public relations campaign for SAG review. Refer to Attachment 15 for State Parks' updated draft public relations campaign.

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# 3 WORK PLAN

The Work Plan proposes Dust Control Program activities between August 1, 2021, and July 31, 2022. It estimates progress towards achieving SOA goals and presents additional information on other activities related to the Dust Control Program undertaken by State Parks and/or the SAG.

## 3.1 DUST CONTROL ACTIVITIES PROPOSED FOR THE NEXT YEAR

For the period of approximately August 1, 2021, to July 31, 2022, State Parks is proposing to initiate,undertake, and/or complete the following dust control project activities:

- Install 90 acres of new dust control measures, including:
    - Initiate planting on 56.2 acres of new vegetation using sterile grass seed in 9 different treatment areas.
    - Install 26.3 acres of new, temporary straw treatments.
    - Install 7.5 acres of new temporary soil stabilizers or other experimental treatments to be determined.
- Convert 53.0 acres of existing temporary dust control measures to long-term vegetation measures, including:
    - Straw treatments (27.3 acres installed in 2021).
    - Wind fencing (19.8 acres installed in 2020).
    - Temporary vehicle exclusion areas (5.9 acres installed in 2021).
- Continue foredune monitoring and assessment.
- Dune emissivity (PI-SWERL) sampling campaign, such as within the foredune restoration zone.
- Supplemental vegetation planting in previous vegetation treatment areas (non-foredune only).
- Maintain existing wind fencing measures.
- Continue Dust Control Program field monitoring and air quality modeling activities.
- Continued SAG consultation, including updating the approach to evaluating SOA progress and requirements and facilitating adaptive management decisions based on monitoring results and assessment campaigns.
- Initiate a Dust Control Program public relations campaign in consultation with the SAG.

- Coordinate with the California Coastal Commission on 2021 ARWP permitting requirements.
- Continue Dust Control Program activities related to identifying other potential sourcesof dust and $PM_{10}$ contributing to air quality conditions.

State Parks' description of proposed Dust Control Program projects and activities is provided below.

### 3.1.1 Install 90 Acres of New Dust Control Measures

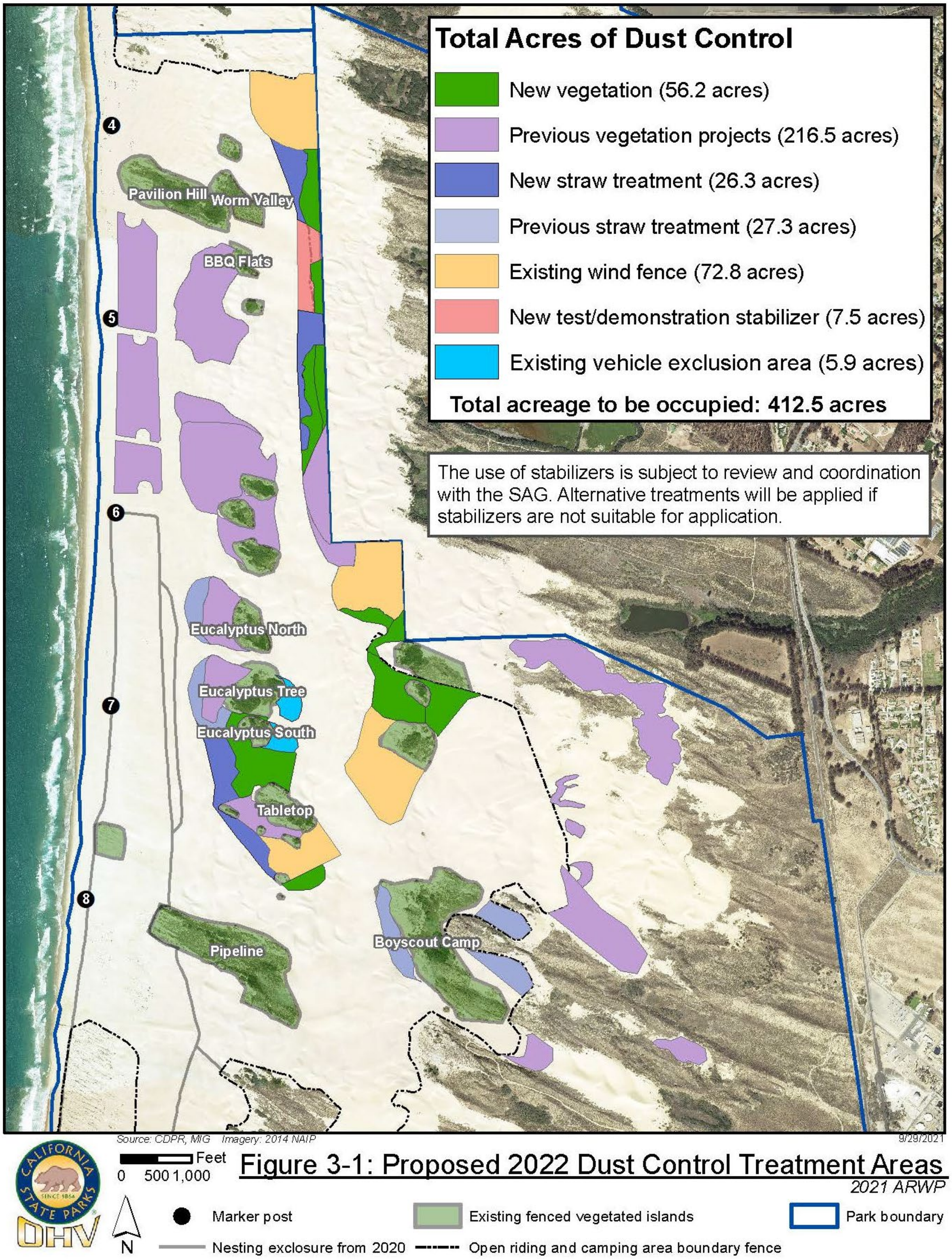
State Parks proposes to install 90 acres of new dust control measures in locations that maximize $PM_{10}$ mass emissions reductions (from within ODSVRA) and concentration reductions (at the SLOAPCD's CDF and Mesa2 air quality monitoring stations) while preserving key operation and resource protection needs of ODSVRA, such as Sand Highway. The locations for the 90 acres of new dust control measures were selected in consultation with the SAG and are shown in Figure 3-1.

The 90 acres of new dust control measures would consist of a combination of new vegetation plantings (56.2 acres) and temporary dust control measures (33.8 acres); however, the final actual type and amount of temporary dust control measures, as well as the final actual location of specific dust control projects, is contingent on the availability of materials and actual field conditions/suitability of specific project sites.

#### 3.1.1.1 Vegetation Plantings

State Parks proposes to initiate 56.2 acres of new vegetation plantings in 9 different areas that are generally located near the open riding and camping area boundary in the northern and central parts of ODSVRA, the Eucalyptus South vegetation island, and the Tabletop vegetation island. State Parks would plant 42.6 acres of vegetation within the open riding and camping area and 13.6 acres of vegetation outside of the open riding and camping area. These new plantings would be located adjacent to other existing and proposed dust control measures (e.g., straw treatments, vegetation) and generally fill in and/or expand and increase the size of existing vegetated dune areas and other dust control treatment areas. State Parks will first apply straw mulch to the selected planting areas and then broadcast treatment areas with sterile cereal grains. State Parks' seeding methods are fully described in Chapter 6 of the June 2019 Draft PMRP.

**Figure 3-1. 2021/2022 Dust Control Projects**



#### 3.1.1.2 Straw Treatments

State Parks proposes to install 26.3 acres of straw treatments near the open riding and camping area boundary in the northern part of ODSVRA, the Eucalyptus South vegetation island, and the Tabletop vegetation island. Nearly all the proposed straw treatments would be located within the open riding and camping area (25.1 acres out of 26.3 acres). The straw treatment would be located adjacent to other existing and proposed dust control measures (e.g., straw treatments, vegetation) and generally fill in and/or expand and increase the size of vegetated dune areas and other dust control treatment areas. The specific straw treatment to be applied would consist of blown straw and fiber blankets that could be used to support future vegetation planting activities.

#### 3.1.1.3 Soil Stabilizers

State Parks proposes to install, on a test or demonstration basis, up to 7.5 acres of soil stabilizer. Most of this control treatment (5.5 acres out of 7.5 acres) would be applied within the open riding and camping area.

There are several different types of soil stabilizers, including water, water-absorbing materials, clay additives, organic petroleum products, organic non-petroleum products, and synthetic polymer products. Organic petroleum, non-petroleum products, and synthetic polymer products suppress dust by binding or adhering surface particles together. Usually a proprietary chemical formula, the stabilizing compound(s) is mixed with water to provide the desired level of stabilization and then sprayed onto the receiving surface. The mixture is typically milky white but dries clear or leaves the ground surface appearing wet. Although surface particles are adhered, the stabilized surface remains permeable to water. A US EPA Environmental Technology Verification Report for one particular dust suppression product, EnviroKleen, found the product to have a dust control effectiveness between 70% to 90%. In addition, the US EPA determined, after testing for acute and chronic toxicity, that this particular product has very low aquatic toxicity and is not considered an aquatic pollutant (USEPA 2005). State Parks' review of existing, commercially available soil stabilizer products indicates most stabilizer products are non-toxic, but that synthetic polymer products may be the least toxic type of stabilizer. Once a suitable non-toxic, environmentally-friendly soil stabilization product is identified, State Parks would apply the product via a tanker truck and spray hose.

State Parks notes that the potential use of soil stabilizers has not been reviewed or approved by the SAG or the CCC. State Parks will coordinate with the SAG on the selection and use of an appropriate, effective soil stabilizer product. In addition, should the CCC decline to authorize the use of soil stabilizers as part of the CDP process (Section 3.1.11) State parks will substitute the 7.5 acres of planned soil stabilizer projects with an alternative treatment of equal size selected in coordination with the SAG and SLOAPCD.

#### 3.1.1.4 Measures to Avoid Delays in Implementation

State Park's proposes to complete installation of new dust control projects by March 31, 2022 (i.e., install perimeter fencing) and have all treatments installed by April 15, 2022. To avoid delays in implementing new dust control measures, State Parks will prioritize completing new dust control treatments in areas that have the highest potential for western snowy plover nesting activity, such as areas west of the Eucalyptus Tree and Tabletop vegetation islands. State Parks would complete dust control treatments in areas that may impacted western snowy plovers by April 15, 2022.

In addition, State Parks will maintain all mechanical straw blowing equipment in good working order. Should this equipment breakdown or fail, State Parks will distribute straw treatments with alternative equipment or means in a timely manner.

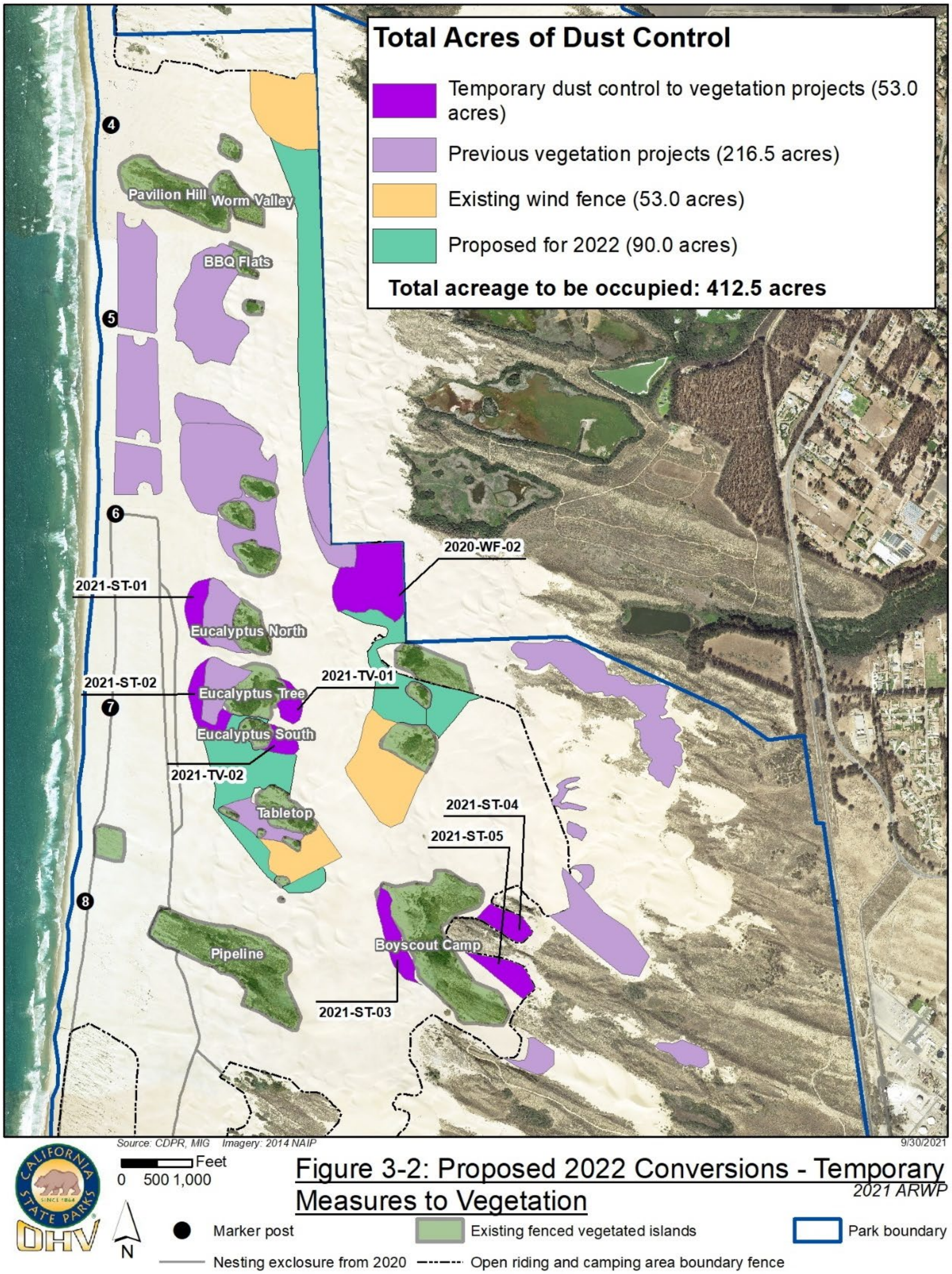
### 3.1.2 Convert Existing Temporary Dust Control Measures to Vegetation

State Parks proposes to convert a total of 53.0 acres of existing temporary dust control measures to native dune vegetation:

- **Existing Wind Fencing:** State Parks proposes to convert 19.8 acres of wind fencing installed in 2020 (20-WF-02, see Attachment 01, Figure A01-11) to native dune vegetation. This area is located along the eastern edge of the open riding and camping area, perpendicular to marker post 6.
- **Existing Straw:** State Parks proposes to convert 27.3 acres of straw treatments installed in 2021 to native dune vegetation. The straw areas that would be converted to vegetation include projects 21-ST-01 (4.7 acres), 21-ST-02 (5.5 acres), 21- ST-03 (6.5 acres), 21-ST-04 (5.0 acres), and 21-ST-05 (5.6 acres, see Figure 2-1).
- **Existing Vehicle Exclosures:** State Parks proposes to convert 5.9 acres of temporary vehicle exclusion areas installed in 2021 to native dune vegetation. This conversion would result in the permanent closure of these areas to vehicular recreation. State Parks would convert the following projects to vegetation: 21- TV-01 (3.2 acres) and 21-TV-02 (2.7 acres, see Figure 2-1). Vehicle exclosure areas that are not converted to vegetation would remain in place to provide continued dust control benefits.

The locations of State Park's proposed conversion projects (i.e., temporary dust control to vegetation) are shown on Figure 3-2.

**Figure 3-2. Proposed 2022 Conversions – Temporary Measures to Vegetation**



#### 3.1.2.1 Measures to Avoid Delays in Implementation

Following removal of existing dust control measures and/or preparation of treatment areas for vegetation plantings (e.g., reapplication of straw along upwind edges that may have become inundated with sand), State Parks will restore the project areas. State Parks' restoration methods aredescribed in Chapter 6 of the June 2019 Draft PMRP. State Parks will schedule conversion efforts (e.g., the initial removal of fencing) to occur as late as possible, given other park operations requirements and the need to ensure sufficient planting time. State Parks will also perform these restoration efforts in a manner that minimizes the delay between removing the existing wind fencing and applying straw/initiating planting activities as much as possible given potential constraints (e.g., equipment, staffing, and material availability, other park operations requirements). For restoration work, State Parks will maintain a perimeter fence to prohibit OHV activity and camping in the restoration area.

In addition, as described in Section 3.1.1.4, State Parks will also prioritize conversion areas that may be affected by western snowy plover activities and maintain equipment in good working order to avoid delays in implementation.

### 3.1.3 Planting Palette / Estimate of Plants and Seed Needed for Conversions

State Parks will coordinate with the SAG to prepare a planting palette with targets for container stock and native seed needed for dust control projects over the next year. As of August 1, 2021, State Parks estimates up to approximately 107,000 plants and 500 pounds of native seed would be required to complete the conversion of approximately 45 to 50 acres of temporary dust control projects to native dune vegetation.

Additional plants would be required for State Parks proposed supplemental planting activities (see Section 3.1.5). With this additional activity, State Parks estimates a total of up to approximately 117,000 plants and 725 pounds of native seed would be required to complete the proposed 2021 vegetation planting activities.

Refer to Attachment 16 for State Parks' proposed 2021/2022 planting projects and estimates of planting and seeding activity by the project.

### 3.1.4 Continued Foredune Monitoring and Assessment

State Parks will continue coordinating with the SAG on foredune monitoring and assessment activities from August 1, 2021, to July 31, 2022. Vegetation monitoring includes transects within each treatment plot as outlined in Section 2.3.6.1 and collaboration with UCSB on topographic and vegetation changes based on UAS monitoring outlined in Section 2.3.6.2 and analysis of images from monitoring stations within the treatment area. State Parks will coordinate with the SAG on the monitoring methods for evaluating vegetation cover and species diversity in foredune treatment areas.

### 3.1.5 Continued Supplemental Planting in Previous Treatment Areas

State Parks proposes to perform supplemental planting and seeding activities on previously installed vegetation projects near the Eucalyptus Tree North vegetation island (19-VG-02, See Attachment 01, Figure A01-10), approximately one acre near the Eucalyptus Tree vegetation island (21-VG-03), and approximately 26 acres located in the southeastern part of the SVRA, outside the SVRA's open riding and camping area (21-VG-05, 21-VG-06, and 21-VG-07). In addition, State Parks would conduct supplemental planting activities on approximately two acres of land near the Boy Scout vegetation island. This area is near an existing dust control measure (21-ST-03) but is not added to the dust control acreage values reported in this 2021 ARWP. The location of State Park's supplemental planting activities planned to occur between August 1, 2021 and July 31, 2022 is show in Figure 3-3.

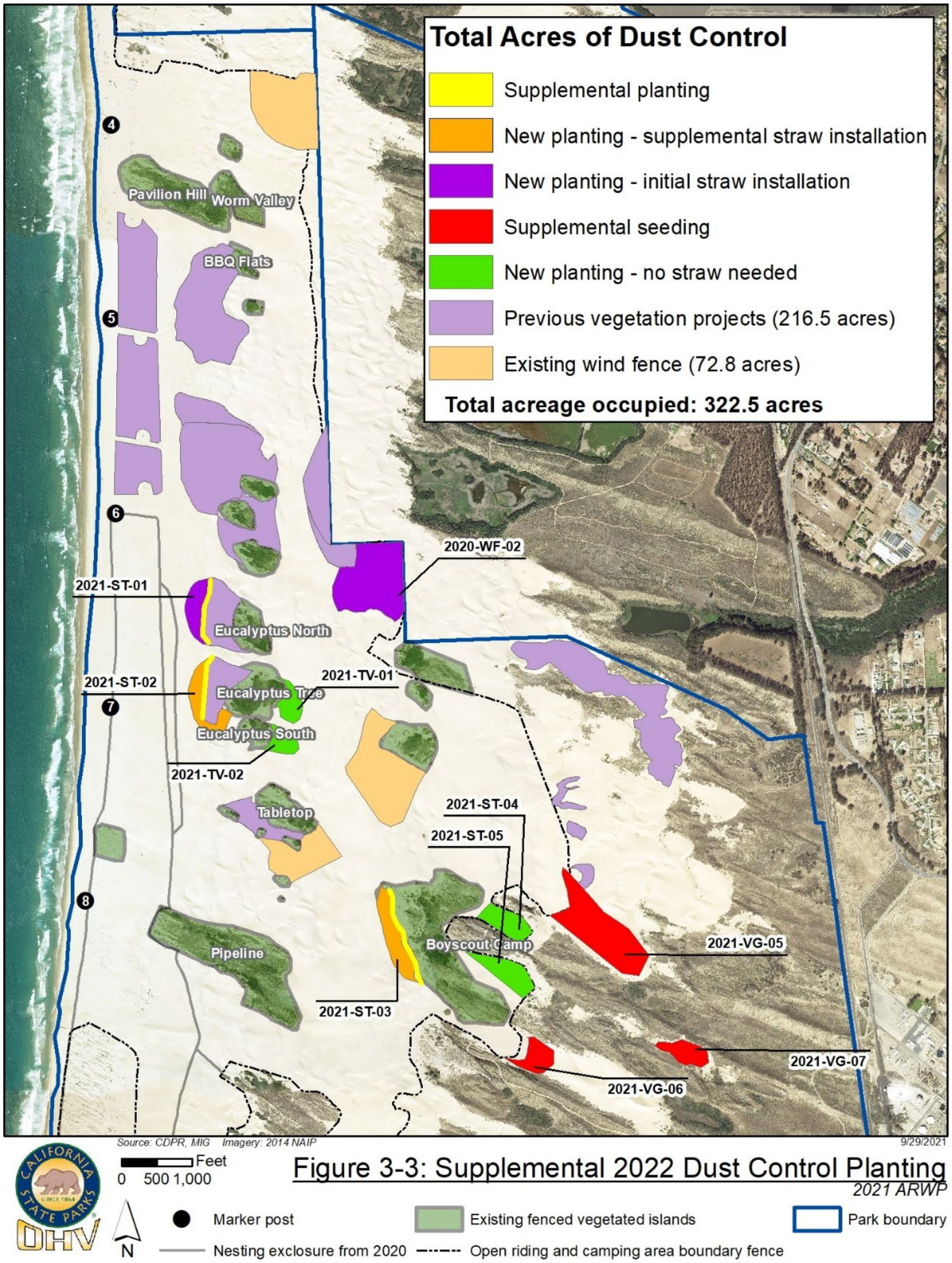
As of August 1, 2021, State Parks estimates up to approximately 10,000 plants and 225 pounds of native seed would be required to complete the supplemental planting activities on approximately 30 acres of temporary dust control projects. State Parks' supplemental planting activities would be in addition to other vegetation planting activities proposed in the 2021 ARWP (converting existing temporary dust control measures to vegetation; see Section 3.1.2). In total, State Parks estimates up to approximately 117,000 plants and 725 pounds of native seed would be required to complete all proposed 2021 vegetation planting activities identified in the2021 ARWP.

Refer to Attachment 16 for State Parks' proposed 2021/2022 planting projects and estimates of planting and seeding activity by the project.

### 3.1.6 Maintenance of Existing Wind Fencing Measures

State Parks will maintain all existing wind fencing projects installed before August 1, 2021, including projects 20-WF-01 (approximately 20 acres, see Attachment 01, Figure A01-11), 21-WF-01 (approximately 22 acres), and 21-WF-02 (approximately 11 acres). State Parks will continue to maintain these existing wind fence arrays as needed. Potential maintenance activities that may be required to maintain effective dust control in wind fencing areas include repairing and/or replacing fencing components (poles and netting) and/or installing new fence extensions or rows (if warranted due to shifting sand conditions).

**Figure 3-3. Supplemental 2022 Dust Control Plantings**



### 3.1.7 Field Monitoring and Air Quality Modeling Activities

State Parks, DRI, and the SAG propose to conduct the field monitoring and air quality modeling activities described below from August 1, 2021, to July 31, 2022.

#### 3.1.7.1 Meteorological, PM, and Saltation Monitoring

In consultation and coordination with the RCD, DRI, and UCSB, State Parks will continue to operate and maintain the existing meteorological, PM, and saltation monitoring instruments/sites described shown in Figure 2-3 and described in Section 2.3. This effort will include post-deployment calibration of MetOne Particle Profilers and continued evaluation of NSF and other key evaluation metrics. In addition, State Parks, in consultation with the RCD, DRI, and the SAG, will deploy new instruments in proposed dust control measures intended to assess and evaluate the effectiveness of newly installed dust control measures at ODSVRA.

#### 3.1.7.2 PI-SWERL Surveys

In consultation with DRI, State Parks will work with the SAG to determine if a useful PI-SWERL measurement campaign should be carried out in 2021/2022 to further the current understanding of the dustemissions system and inform air quality modeling and management of dust emissions at ODSVRA. For example, the SAG recently discussed the idea of conducting repeat PI-SWERL surveys within the foredune restoration area to quantify better the effect of the foredune restoration on dust management. State Parks, in consultation with DRI, will work with the SAG to identify the specific strategy for PI-SWERL measurement within the foredune restoration area should the SAG identify this activity as a priority for the 2021 ARWP.

#### 3.1.7.3 UAS Surveys

Consistent with previous years (see Section 2.3.3), UAS surveys for the next reporting period (August 1, 2021, to July 31, 2022) will occur in October 2021 and February 2022. Campaigns will involve flights with RGB and multispectral payloads as in the 2020-21 period. The same data products mentioned in Section 2.3.3 will be produced (georeferenced digital orthophoto mosaics, DEMs, GCD maps).

### 3.1.8 Continued SAG Consultation and Evaluation

Pursuant to the SLOAPCD SOA as amended, State Parks will continue to utilize the SAG for consultation and evaluation. Priority areas for State Parks consultation with the SAG in 2021-22 include (but are not limited to) the following:

- Update approach to evaluating SOA progress and requirements (Section 3.1.8.1).
- Adaptive management process (see Section 3.1.9).
- Provide feedback on the Public Relations Campaign (see Section 3.1.10).

- Further refine modeling to determine the effectiveness of dust mitigation activities (see Section 3.2.4).

The SAG will continue to exercise its independent advisory role by preparing scientific reports and reviews that inform the implementation and monitoring of ODSVRA dust mitigation activities. In particular, the SAG anticipates publishing a “State of the Science” reportin Fall 2021 to provide a synthesis and review of existing white papers, reports, and scientific literature relevant to dust mitigation efforts at ODSVRA. The SAG may consult with State Parks and SLOAPCD to ensure access to relevant context and information in preparing such reports and reviews. However, to ensure independence, the content and timeline for the final publication of SAG reports and reviews will be at the sole discretion of the SAG, although the SAG will consider timeline considerations from either agency.

#### 3.1.8.1 Update Approach to Evaluating SOA Progress and Requirements

Section 2.4.3 describes the initial work by the SAG, DRI staff, and State Parks staff to identify a possible alternative to the existing SOA $PM_{10}$ mass emissions reduction target. The SAG proposed an approach to modeling a $PM_{10}$ “pre-disturbance emissions scenario” based on estimated dune conditions before human disturbance through this initial work. Preliminary proof-of-concept modeling of the pre-disturbance emissions scenario revealed the promise of this approach. In the coming year, the pre-disturbance emissions scenario approach will be refined to account for several important factors not included in the proof of concept, including (1) consideration of spatial gradients in naturally occurring dust emissivity, (2) assessment of historical dune-stabilizing vegetation coverage, and its effects on $PM_{10}$ emissions, and (3) quantification of model uncertainty. These planned refinements are described below:

- **Spatial gradient in dust emissivity.** Instead of applying a uniform $PM_{10}$ emissivity curve to the riding area domain, the refined model will include a spatial (north-south) gradient in the $PM_{10}$ emissivity that reflects the concomitant spatial gradient in $PM_{10}$ emissivity in adjacent non-riding areas.
- **Historical dune-stabilizing vegetation coverage.** Historical aerial photography dating back to 1939 will be used to identify and estimate pre-disturbance coverage of vegetation and related dune-stabilizing features (e.g., nebkhas) for incorporation into modeling the pre-disturbance emissions scenario, including possible indirect effects of historical vegetation on downwind emissivity. UCSB has initiated an analysis of historical vegetation cover at ODSVRA to inform further discussion on potential revisions to the SOA target.
- **Uncertainty quantification.** Refinements in modeling $PM_{10}$ emissions and concentrations for the pre-disturbance emissions scenario will include quantification of uncertainties associated with mapping historical vegetation coverage and pre-

disturbance emissivity, along with other DRI model uncertainties.

Outcomes of the modeling of the refined pre-disturbance emissions scenario will then be used to determine if a modification to the existing SOA target is justifiable and, if so, what this revised target would look like. This work will occur in parallel with efforts (e.g., sand flux monitoring and CFD model development) to quantify additional indirect effects of dust mitigation activities, such as downwind sheltering effects and changes in sediment flux (Section 3.2.4) so that the full air quality improvement resulting from dune restoration activities is appropriately credited when determining progress toward current or potentially revised dust mitigation targets.

#### 3.1.8.2 Work Plan

The following work plan is proposed to ensure timely progress on developing proposed alternatives for effective SOA goals with a target date of January 31, 2022:

- Preliminary progress on the SOA target is reported in ARWP (see Section 2.4.3).
- In consultation with DRI, the SAG finalizes the determination of inputs for the pre-disturbance scenario model (i.e., the spatial gradient in dustemissivity, historical dune-stabilizing vegetation coverage).
- In consultation with DRI, the SAG finalizes the determination of theprocess to account for indirect effects in the DRI model.[8]
- The DRI, in consultation with SAG and State Parks, completes updates to theDRI model to account for pre-disturbance scenario and indirect effects.
- The DRI completes updated model simulations for pre-disturbance scenarios (compared to the 2013 scenario and 2021 cumulative treatments) and presents results to State Parks and SAG.
- The SAG reviews DRI model simulations and discusses the next stepsfor the SOA target with State Parks.
- The SAG presents findings and recommendations on SOA targets toState Parks and the SLOAPCD.

[8] "Indirect effects" refer to the effects of dust mitigation treatments beyond the direct reductions in $PM_{10}$ mass emissivity within treatment areas. These include downwind sheltering effects (as modeled by CFD) and changes in sediment flux.

### 3.1.9 Adaptive Management Process

The SOA implicitly recognizes the need for State Parks to update and improve its Dust Control Program as new information becomes available during each ARWP process. State Parks' The OHMVR Division 2009 Strategic Plan defines adaptive management as: "A type of natural resource management in which decisions are made as part of an ongoing science-based process.

Adaptive management involves testing, monitoring, and evaluating applied strategies and incorporating new knowledge into management approaches based on scientific findings and the needs of society. Results are used to modify management policy, strategies, and practices." The Dust Control Program involves testing modeling predictions, comparing real-world measurements to model predictions, and incorporating new information to refine model predictions and dust control strategies. State Parks, in consultation with the SAG, will use the latest information compiled in this 2021 ARWP, including the updated PMRP evaluation metrics outlined in Attachment 02, to refine the adaptive management process that will guide the Dust Control Program following the conclusion of the ARWP process outlined in SOA #17-01, as amended.

#### 3.1.9.1 SAG Meetings and Workshops

The SAG anticipates the following meeting and workshop activities in 2021-22:

- Quarterly full-day SAG meetings, with the participation of State Parks and SLOAPCD staff as needed. Public health conditions permitting, it is anticipated that Winter 2022 and Summer 2022 meetings will be held in person at ODSVRA. Fall 2021 and Spring 2022 meetings will be held via videoconference.
- Regular monthly calls among the full SAG, with State Parks and SLOAPCD staffas needed.
- Additional ad hoc calls among subgroups of the SAG to address specific work tasks with State Parks and SLOAPCD staff as needed.
- SAG presentations at public meetings and workshops, as requested by State Parks and SLOAPCD.

### 3.1.10 Public Relations Campaign

State Parks will build upon its initial public relations (PR) campaign development described in Section 2.4.5. Parks will continue to coordinate and consult with the SAG to develop a clear PR campaign that meaningfully engages ODSVRA visitors, surrounding community members, and other relevant stakeholders. The PR campaign will provide tailored information and educational content on the ODSVRA Dust Control Program in a variety of formats and for a variety of ODSVRA users (e.g., frequent visitors, infrequent visitors, etc.). The main components of this campaign include:

- A digital two-page flyer that provides an overview of air quality issues at ODSVRA, including the basics of sand movement in a dune system, how dust is generated and mobilized, and the relationship between the SOA and Dust Control Program management actions.
- Social media posts that provide short, concise statements on how ODSVRA visitors can support the ODSVRA Dust Control Program.
- An air quality specific video that provides a high-level overview of the Dust Control Program and discusses why it is key to protecting park resources, reducing dust downwind of ODSVRA< and ensuring future off-highway vehicle opportunities at the dunes. The video will present information at a level at which all viewers could understand why there are closures in the dunes, the importance of the closures, and how the public can help.
- A Frequently Asked Questions (FAQ) sheet with specific information about the Dust Control Program that the public may be seeking answers to. The FAQ may be presented in both digital and hard copy formats and would be accessible across online and social media platforms.

Refer to Attachment 15, Preliminary Public Relations Campaign, for detailed information on State Parks' updated PR campaign activities. Refer also to Table 5-8 for State Parks' timeline of PR campaign activities.

### 3.1.11 Coastal Commission Coordination

Some of State Parks' proposed Dust Control Program activities for the August 1, 2021 to July 31, 2022 period constitute development under the California Coastal Act (e.g., installing wind fencing, monitoring equipment, etc.). Therefore, these activities require a Coastal Development Permit (CDP) from the California Coastal Commission (CCC) to be installed. In September 2017, the CCC approved CDP #3-12-050 to implement a five-year adaptive management Dust Control Program at ODSVRA. This permit is subject to certain conditions, including, but not limited to, the type and amount of Dust Control Program activities, the area in which Dust Control Program activities may occur, and the need for annual review of Dust Control Program activities at ODSVRA. In general, CDP #3-12-050 authorizes Dust Control Program activities that are the same as described in State Parks' 2017 Dust Control Program EIR; however, the CDP provides authorization to undertake these activities in areas necessary to meet CARB or SLOAPCD requirements. State Parks will coordinate with CCC staff on the appropriate CDP process for the proposed 2021 ARWP projects. The appropriate CDP process may include an amendment to

CDP #3-12-050.[9]

State Parks will submit a formal CDP application to the California Coastal Commission by November 1, 2021, pending SLOAPCD approval of the ARWP by October 31, 2021. State Parks will coordinate weekly with the representative from Coastal Commission to track the progress of this application and answer questions or concerns that arise during the review of the application materials. The goal is to have an approved CDP for the 2021 ARWP projects no later than February 2022. This timeline is tentative and subject to change based on the complexity of the projects proposed in the ARWP and issues outside the control of State Parks, including Coastal Commission staff workload and other complex Coastal Act issues.

## 3.2 MODELED $PM_{10}$ MASS EMISSIONS AND CONCENTRATION REDUCTIONS

The DRI, in consultation with State Parks and the SAG, has modeled the $PM_{10}$ mass emission and concentration reductions that are estimated to be achieved by State Parks' proposed 90 acres of new, temporary dust control measures described in Section 3.1.1. The results of this modeling are summarized below. See Attachment 17 Modeled $PM_{10}$ Mass Emissions and Concentration Reductions Estimates (2021/2022) for DRI's detailed modeling results.

As explained in Section 3.1.1, State Parks has, in consultation with the SAG, selected 90 acres of new dust control measures that maximize $PM_{10}$ mass emission and concentration reductions while preserving key operations at ODSVRA. Attachment 17 also includes the results of DRI modeling for an alternative 90-acre plan that is very similar to State Parks' proposed plan but focuses only on maximizing mass emission and concentration reductions (referred to as option 1 in the modeling). The modeling for this alternative plan estimated mass emissions reductions would be approximately 0.7 metric tons per day higher than the proposed plan. Concentrations at CDF were estimated to be approximately 0.4 $\mu g/m^3$ lower for the alternative plan, compared to the proposed plan, while concentrations at Mesa2 would be approximately 0.2 $\mu g/m^3$ higher. The modeling, therefore, shows no substantial differences in mass emission and concentration reductions between State Parks' proposed plan and the alternative plan modeled by DRI.

### 3.2.1 ESTIMATED $PM_{10}$ MASS EMISSIONS REDUCTIONS

The DRI model estimates the maximum amount of $PM_{10}$ mass (e.g., metric tons/day) emitted by the dune surfaces in the ODSVRA open riding and camping area during the stipulated 2013 baseline period to be 182.8 metric tons/day.[3] State Parks' anticipated progress towards reducing baseline emissions with the 90 acres of new dust control measures described in Section 3.1.1 is summarized in Table 3-1. See Attachment 17, Modeled $PM_{10}$ Mass Emissions and Concentration Reductions Estimates (2021/2022) for DRI's detailed modeling results.

[9] In March 2021, the CCC voted to ban OHV recreation and limit street-legal vehicle use and camping at ODSVRA by 2024. This action is subject to several ongoing lawsuits. State Parks will continue to operate ODSVRA in a manner that supports OHV recreation and the Dust Control Program for the immediate future.

**Table 3-1. Modeled $PM_{10}$ Mass Emissions Reductions – 2021/2022 Dust Control Projects**

| Scenario/Evaluation | Cumulative Area Controlled (Acres) | ODSVRA – All Areas | | ODSVRA – Open Riding and Camping Area Only | |
|---|---|---|---|---|---|
| | | $PM_{10}$ Mass Emissions (Metric Tons/Day) | Percent Reduction in $PM_{10}$ Mass Emissions | $PM_{10}$ Mass Emissions (Metric Tons/Day) | Percent Reduction in $PM_{10}$ Mass Emissions |
| 2013 Modeled Baseline Emissions from Open Riding and Camping Area (No Dust Control Measures in Place) | 0 | 182.8[A] | 0% | 182.8[A] | 0% |
| Cumulative Dust Control Measures in Place as of July 31, 2021 | 322.5 | 142.0 (-40.8)[B] | -22.3%[B] | 145.2 (-37.6) | -20.6% |
| *New Dust Control Measures to be Installed between August 1, 2021 and July 31, 2022* | *90.0* | *124.9 (-17.1)[C]* | *-9.4%[C]* | *131.2 (-14.0)* | *-7.7%* |
| **Cumulative Totals - All Dust Control Measures in Place as of July 31, 2021** | **412.5** | **124.9 (-57.9)**[D] | **-31.7%**[D] | **131.2 (-51.6)** | **-28.2%** |
| **SOA Condition 2.c Goal** | **--** | **91.4**[E] | **50%** | **91.4** | **50%** |

Source: DRI, 2021 (see Attachment 17), modified by State Parks.

(A) Pursuant to the SOA, the 2013 modeled baseline for mass emissions is based on emissions from the ODSVRA open riding and camping area only; however, the mass emissions reductions needed to comply with the SOA, as amended, may occur from both inside and outside the open riding and camping area.

(B) The cumulative dust control measures in place throughout the ODSVRA as of July 31, 2021 reduced 2013 modeled baseline mass emission from 182.8 metric tons per day to 142.0 metric tons per day, a reduction of 40.8 metric tons per day, which equals a 22.3% reduction in 2013 modeled baseline emissions (40.8/182.8 = 22.3%). Most of the mass emissions reductions (37.6 out of 40.8 metric tons per day, or 92.2% of mass emissions reductions) are achieved by dust control measures installed inside the open riding and camping area. Note table values for ODSVRA – All Areas may differ slightly (less than 1.0 metric ton per day) from values contained in Attachment 17 due to rounding and model tolerances.

(C) The new dust control measures installed throughout the ODSVRA between August 1, 2020 and July 31, 2021 reduced 2013 modeled baseline mass emissions from 153.1 (as of July 31, 2020) to 142.0 metric tons per day, a reduction of 11.1 metric tons per day, which equals 6.1% of 2013 modeled baseline emissions levels (11.1/182.8 = 6.1%). Most of the mass emissions reductions (10.1 out of 11.1 metric tons per day, or 91.0% of mass emissions reductions) are achieved by dust control measures installed inside the open riding and camping area. Note table values for ODSVRA – All Areas may differ slightly (less than 1.0 metric ton per day) from values contained in Attachment 17 due to rounding and model tolerances.

(D) The cumulative dust control measures in place throughout the ODSVRA as of July 31, 2021 reduced 2013 modeled baseline mass emission from 182.8 metric tons per day to 142.0 metric tons per day, a reduction of 40.8 metric tons per day, which equals a 22.3% reduction in 2013 modeled baseline emissions (40.8/182.8 = 22.3%). Most of the mass emissions reductions (51.6 out of 57.9 metric tons per day, or 89.1% of mass emissions reductions) are achieved by dust control measures installed inside the open riding and camping area. Note table values for ODSVRA – All Areas may differ slightly (less than 1.0 metric ton per day) from values contained in Attachment 17 due to rounding and model tolerances.

(E) A 50% reduction in 2013 modeled baseline mass emissions (182.8 metric tons per day) equals 91.4 metric tons per day.

As of July 31, 2021, the DRI model estimates State Parks' dust control measures reduced modeled baseline mass emissions by 40.8 metric tons per day, a 22.3% reduction in baseline mass emissions. The new dust control measures planned for installation by State Parks between August 1, 2021 and July 31, 2022 are estimated to reduce mass emissions by an additional 17.1 metric tons per day, or 9.4% of the modeled baseline mass emissions level of 182.8 metric tons per day. In total, the DRI model estimates the cumulative reduction in mass emissions achieved by the 412.5 acres of dust control measures planned to be in the ground at Ocean Dunes SVRA by July 31, 2022, is 57.9 metric tons per day, which equals a 31.7% reduction in modeled baseline mass emissions. Most of the estimated reductions in $PM_{10}$ mass emissions (51.6 out of 57.9 metric tons per day, or 89.1% of modeled baseline mass emissions reductions) are achieved by dust control measures installed inside the open riding and camping area. The 31.7% cumulative reduction in modeled baseline $PM_{10}$ mass emissions represents continued progress towards achieving the 50% reduction in baseline mass emissions required by SOA Condition 2.c.

### 3.2.2 Estimated $PM_{10}$ Concentration Reductions at CDF and MESA2

#### 3.2.2.1 CDF Air Quality Monitoring Station

The DRI model estimates the 24-hour average $PM_{10}$ concentration at the SLOAPCD's CDF air quality monitoring stations during the stipulated 2013 baseline to be 124.7 $\mu g/m^3$. State Parks' anticipated progress towards achieving ambient air quality standards at the CDF station with the 90 acres of new dust control measures described in Section 3.1.1 is summarized in Table 3-2. See Attachment 17, Modeled $PM_{10}$ Mass Emissions and Concentration Reductions Estimates (2021/2022) for DRI's detailed modeling results.

| Table 3-2. Modeled $PM_{10}$ Concentration Reductions at CDF (2021/2022 Dust Control Projects) | | | |
|---|---|---|---|
| **Scenario/Evaluation** | **Cumulative Area Controlled (Acres)** | **CDF $PM_{10}$ 24-hour Average Concentration ($\mu g/m^3$)(A)** | **Percent Reduction in $PM_{10}$ Concentration** |
| 2013 Modeled Baseline $PM_{10}$ Concentrations (No Dust Control Measures in Place) | 0 | 124.7(A) | 0% |
| Cumulative Dust Control Measures in Place as of July 31, 2021 | 322.5 | 72.2 (-52.5)(B) | -42.1%(B) |
| *New Dust Control Measures to be Installed between August 1, 2021 and July 31, 2022.* | *90* | *66.4 (-5.8)*(C) | *-4.7%*(C) |
| **Cumulative Totals (All Dust Control Measures to be In Place as of July 31, 2022)** | **412.5** | **66.4 (-58.3)**(D) | **-46.8%**(D) |
| **SOA Condition 2.c Goal** | **--** | **50.0**(E) | **60.0%** |

Source: DRI, 2021 (see Attachment 17), modified by State Parks.

(A) Pursuant to the SOA, the 2013 modeled baseline for $PM_{10}$ concentration ($\mu g/m^3$) is based on emissions from riding and non-riding areas at ODSVRA.

(B) The cumulative dust control measures in place as of July 31, 2021 reduced modeled baseline 24-hour average $PM_{10}$ concentrations at CDF from 124.7 $\mu g/m^3$ to 72.2 $\mu g/m^3$, a reduction of 52.5 $\mu g/m^3$. This equals a 42.1% reduction in 2013 modeled baseline 24-hour average $PM_{10}$ concentrations (72.2/124.7 = 42.1%).

(C) The new dust control measures planned to be installed between August 1, 2021 and July 31, 2022 are anticipated to reduce modeled baseline 24-hour average $PM_{10}$ concentrations at CDF from 72.2 $\mu g/m^3$ (as of July 31, 2021) to 66.4 $\mu g/m^3$, a reduction of 5.8 $\mu g/m^3$, which equals a 4.7% reduction in 2013 modeled baseline 24-hour average $PM_{10}$ concentrations (5.8/124.7 =4.7%).

(D) The cumulative dust control measures planned to be in place as of July 31, 2022 are anticipated to reduce modeled baseline 24-hour average $PM_{10}$ concentrations at CDF from 124.7 $\mu g/m^3$ to 66.4 $\mu g/m^3$, a reduction of 58.3 $\mu g/m^3$. This equals a 46.8% reduction in 2013 modeled baseline 24-hour average $PM_{10}$ concentrations (58.3/124.7 = 46.8%).

(E) The SOA goal is based on the CAAQS of 50 $\mu g/m^3$ (see Table 2-3).

As of July 31, 2021, the DRI model estimates State Parks' dust control measures have reduced 24-hour $PM_{10}$ concentrations at the CDF station by 52.5 $\mu g/m^3$, a 42.1% reduction in baseline $PM_{10}$ concentrations for this site. The new dust control measures planned for installation by State Parks between August 1, 2021 and July 31, 2022 are estimated to reduce 24-hour $PM_{10}$ concentrations at the CDF station by an additional 5.8 $\mu g/m^3$, or 4.7% of baseline $PM_{10}$ concentrations. In total, the DRI model estimates the cumulative reduction in 24-hour $PM_{10}$ concentrations at the CDF station from the 412.5 acres of dust control measures planned to be in the ground at Ocean Dunes SVRA by July 31, 2022 to be 58.3 $\mu g/m^3$, which equals a 46.8% reduction in baseline modeled 24-hour $PM_{10}$ concentrations. This 46.8% cumulative reduction in 24-hour $PM_{10}$ concentrations at the CDF site represents continued progress towards achieving the CAAQS (50 µg/m$^3$) required by SOA Condition 2.b.

Figure 3-4 visually depicts the relative $PM_{10}$ concentration reductions achieved by the dust control measures implemented through July 31, 2021 and the additional progress to be gained by July 31, 2022.

**Figure 3-4. Relative $PM_{10}$ Concentration Reductions as of July 31, 2021 and July 31, 2022**

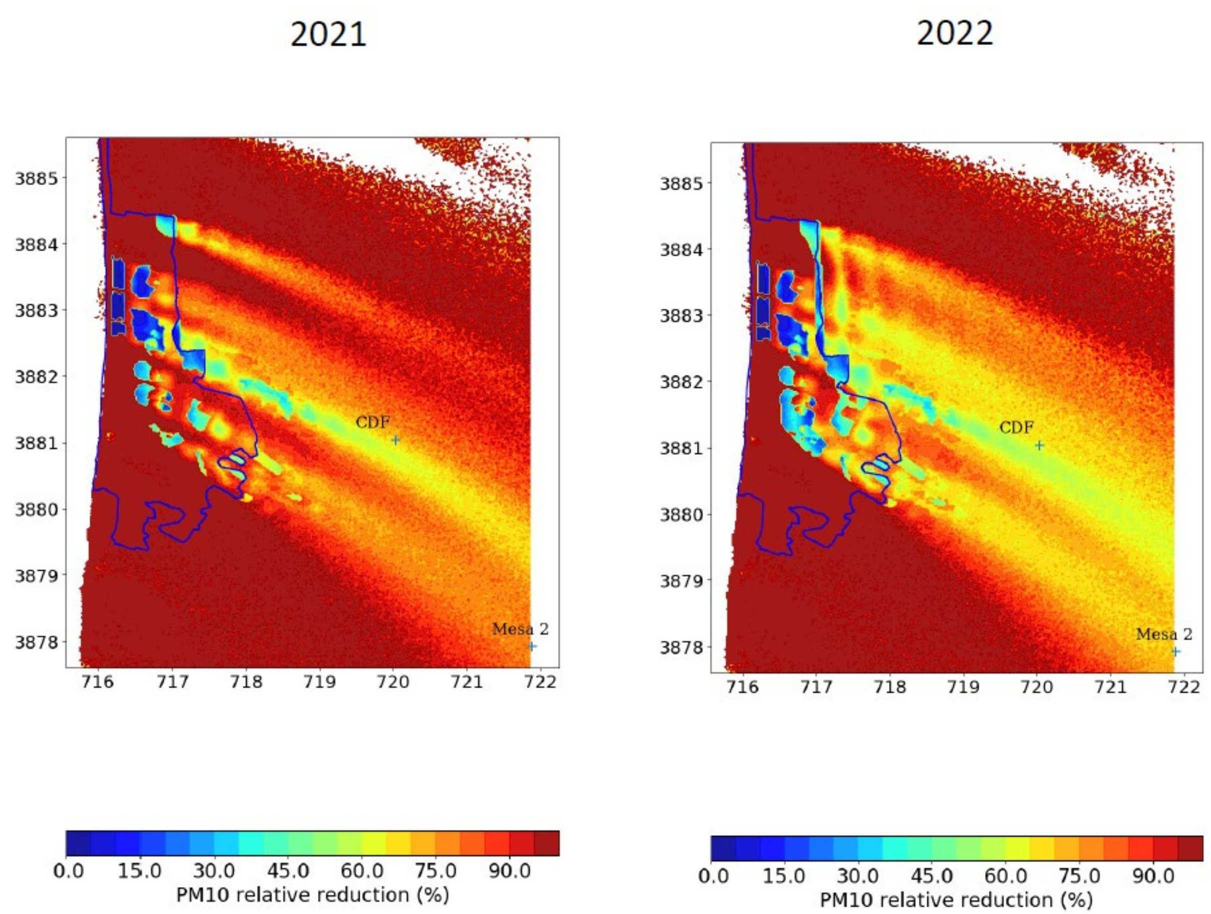



**Figure 3-4.** The relative $PM_{10}$ concentration reductions achieved by the dust control measures implemented through July 31, 2021 (left panel) and relative $PM_{10}$ concentration reductions to be gained by July 31, 2022 with State Parks' 90 acres of new dust control measures. (Image Source: DRI, 2021, see Attachment 17).

As shown in Figure 3-4 (left panel), the greatest relative $PM_{10}$ concentration reductions achieved by State Parks dust control measures in place as of July 31, 2021 are generally concentrated in the area upwind of CDF, with several other bands of relative reductions present both above and below CDF. Figure 3-4 (right panel) also shows that State Parks' 90 acres of new dust control measures planned for installation in 2021 and 2022 are anticipated to result in further $PM_{10}$ concentration reductions in areas that already experience some of the highest relative reductions (as of July 31, 2021) and expand the overall geographic area where $PM_{10}$ concentration reductions are anticipated to occur.

### 3.2.2.2 Mesa2 Air Quality Monitoring Station

The DRI model estimates the 24-hour average $PM_{10}$ concentration at the SLOAPCD's Mesa2 air quality monitoring stations during the stipulated 2013 baseline period to be 97.5 µg/m$^3$. State Parks' anticipated progress towards achieving ambient air quality standards at the Mesa2 station with the 90 acres of new dust control measures described in Section 3.1.1 is summarized in Table 3-3. See Attachment 17, Modeled $PM_{10}$ Mass Emissions and Concentration Reductions Estimates (2021/2022) for DRI's detailed modeling results.

**Table 3-3. Modeled $PM_{10}$ Concentration Reductions at Mesa2 (2021/2022 Dust Control Projects)**

| Scenario/Evaluation | Cumulative Area Controlled (Acres) | Mesa2 $PM_{10}$ 24-hour Average Concentration (µg/m$^3$)$^{(A)}$ | Percent Reduction in $PM_{10}$ Concentration |
|---|---|---|---|
| 2013 Modeled Baseline $PM_{10}$ Concentrations (No Dust Control Measures in Place) | 0 | 97.5$^{(A)}$ | 0% |
| Cumulative Dust Control Measures in Place as of July 31, 2021 | 322.5 | 73.8 (-23.7)$^{(B)}$ | -24.3%$^{(B)}$ |
| *New Dust Control Measures to be Installed between August 1, 2021 and July 31, 2022.* | 90 | 65.5 (-8.3)$^{(C)}$ | -8.5%$^{(C)}$ |
| **Cumulative Totals (All Dust Control Measures to be In Place as of July 31, 2022)** | 412.5 | 65.5 (-32.0)$^{(D)}$ | -32.8%$^{(D)}$ |
| **SOA Condition 2.c Goal** | - | **50.0$^{(E)}$** | **48.8%** |

Source: DRI, 2021 (see Attachment 17), modified by State Parks.

(A) Pursuant to the SOA, the 2013 modeled baseline for $PM_{10}$ concentration (µg/m$^3$) is based on emissions from riding and non-riding areas at ODSVRA.

(B) The cumulative dust control measures in place as of July 31, 2021 reduced modeled baseline 24-hour average $PM_{10}$ concentrations at Mesa2 from 97.5 µg/m$^3$ to 73.8 µg/m$^3$, a reduction of 23.7 µg/m$^3$. This equals a 24.3% reduction in 2013 modeled baseline 24-hour average $PM_{10}$ concentrations (23.7/97.5 = 24.3%).

(C) The new dust control measures planned to be installed between August 1, 2021 and July 31, 2022 are anticipated to reduce modeled baseline 24-hour average $PM_{10}$ concentrations at Mesa2 from 73.8 µg/m$^3$ (as of July 31, 2021) to 65.5 µg/m$^3$, a reduction of 8.3 µg/m$^3$, which equals an 8.5% reduction in 2013 modeled baseline 24-hour average $PM_{10}$ concentrations (8.3/97.5 = 8.5%).

(D) The cumulative dust control measures planned to be in place as of July 31, 2022 are anticipated to reduce modeled baseline 24-hour average $PM_{10}$ concentrations at Mesa2 from 97.5 µg/m$^3$ to 65.5 µg/m$^3$, a reduction of 32.0 µg/m$^3$. This equals a 32.8% reduction in 2013 modeled baseline 24-hour average $PM_{10}$ concentrations (65.5/97.5 = 32.8%).

(E) The SOA goal is based on the CAAQS of 50 µg/m$^3$ (see Table 2-3).

As of July 31, 2021, the DRI model estimates State Parks' dust control measures have reduced 24-hour $PM_{10}$ concentrations at the Mesa2 station by 23.7 $\mu g/m^3$, a 24.2% reduction in baseline $PM_{10}$ concentrations for this site. The new dust control measures planned for installation by State Parks between August 1, 2021, and July 31, 2022, are estimated to reduce 24-hour $PM_{10}$ concentrations at the Mesa2 station by an additional 8.3 $\mu g/m^3$, or 8.5% of baseline $PM_{10}$ concentrations. In total, the DRI model estimates the cumulative reduction in 24-hour $PM_{10}$ concentrations at the Mesa2 station from the 412.5 acres of dust control measures planned to be in the ground at Ocean Dunes SVRA by July 31, 2022, to be 32.0 $\mu g/m^3$, which equals a 32.8% reduction in baseline modeled 24-hour $PM_{10}$ concentrations. This 32.8% cumulative reduction in 24-hour $PM_{10}$ concentrations at the Mesa2 site represents continued progress towards achieving the CAAQS (50 $\mu g/m^3$) required by SOA Condition 2.b.

Refer to Figure 3-4 for the graphic depicting the relative $PM_{10}$ concentration reductions achieved by the dust control measures implemented through July 31, 2021, and the further progress to be gained by July 31, 2022.

### 3.2.3 Additional Dust Controls Needed to Achieve SOA Goals

State Parks' June 2019 PMRP included a preliminary compliance analysis, or sensitivity analysis, based on a series of hypothetical dust control modeling scenarios (prepared by DRI) that evaluated the approximate size, scale, and level of effort necessary to comply with the SOA's air quality objectives. The preliminary PMRP modeling conducted by DRI indicated that approximately 500 acres of dust control measures could be needed to achieve SOA air quality objectives.

The dust control strategy identified in the PMRP was always envisioned as and continues to be an iterative, adaptive management process that would be updated over time to incorporate the latest science and data collected as part of the PMRP and ARWP processes. The ARWP process, in particular, functions as a mechanism to not only present the results and findings from prior year's work, but to also summarize the latest advances in the science and understanding of the physical processes that lead to dust generation at ODSVRA. Each ARWP, therefore, also provides an opportunity to update and refine previous information reported by State Parks in its PMRP and ARWPs.

For this 2021 ARWP, DRI has developed an updated estimate of the amount of dust control measures that may be required to achieve SOA air quality objectives. The updated modeling takes into account the anticipated, modeled progress to be made in reducing $PM_{10}$ mass emissions and concentrations with the 412.5 acres of dust control measures State Parks has already installed or plans to install by July 31, 2022. The results of DRI's updated sensitivity analysis indicate that an additional 189.6 acres of dust control measures may be needed to achieve a 50% reduction in 2013 baseline $PM_{10}$ mass emissions from the riding area. Refer to Attachment 18, DRI Estimate of Additional Treatment Area to Reach the Stipulated Order of

Abatement 50% Goal for detailed results of DRI's updated sensitivity analysis.

To achieve the 50% reduction in baseline $PM_{10}$ mass emissions levels, State Parks would need to locate additional dust control measures in areas with the highest remaining emissivity. In general, most of the 189.6 acres of dust control measures modeled by DRI in the updated sensitivity analysis are located in the La Grande Tract or the central portion of ODSVRA (between marker posts 6 and 8).

The updated sensitivity analysis increases the estimate of the amount of dust control measures necessary to comply with SOA Condition 2.C, up from 500 acres (as preliminary estimated in the PMRP) to 602 acres.[10] This level of dust control (approximately 602 acres) would result in 24-hour $PM_{10}$ concentrations at the SLOAPCD's CDF and Mesa2 air quality monitoring stations of 38.4 and 54.8 $\mu g/m^3$, respectively in comparison to the CAAQS of 50.0 $\mu g/m^3$.

The updated sensitivity analysis conducted by DRI for this 2021 ARWP must also be considered a preliminary evaluation that will be updated over time to incorporate new information on the ODSVRA Dust Control Program. Future data collection efforts such as updated PI-SWERL measurements, LIDAR data, etc., are sources of information that could be incorporated into future modeling efforts. In addition, model refinements, including the CFD analysis currently underway (see Sections 2.3.4 and 3.2.4), could result in additional emission reductions that are not currently accounted for. These ongoing activities are likely to change the anticipated amount of area that needs to be controlled to meet SOA objectives. Finally, all model predictions should be considered against actual observed conditions at the CDF and Mesa2 sites to identify additional model adjustments or refinements of the sensitivity analysis contained in this 2021 ARWP.

### 3.2.4 Further Refinement Of Modeled Reductions In $PM_{10}$ Emissions

DRI will continue to evaluate CFD applications for the DRI air quality model's treatment of the foredune restoration area and, potentially, other dust control measures at ODSVRA.

The purpose of this evaluation will be to quantify the indirect effects of dust mitigation activities, such as downwind sheltering effects (as modeled by CFD) and changes in sediment flux. This evaluation is anticipated to be complete by October 31, 2021.

### 3.2.5 Increments of Progress Towards Air Quality Objectives, 2013 to 2021

The DRI will provide an updated evaluation regarding the incremental progress made toward achieving SOA air quality objectives based on dust control projects installed as of July 31, 2021 and July 31, 2022. This evaluation is expected to be reported on in State Parks' 2022 ARWP.

[10] 602 acres is derived from: 412.5 acres in place (as of 07/31/22) + 189.6 additional acres = 602.1 total acres. Estimates assume all dust control measures are 100% effective.

## 3.3 ADDITIONAL ASSESSMENTS

As described in 2.4.5, SOA #17-01, as amended, recognizes that $PM_{10}$ concentrations measured at CDF and on the Nipomo Mesa may come from various sources external to ODSVRA. Accordingly, State Parks and the SLOAPCD proposed to continue studying other potential $PM_{10}$ emission sources and their relative contributions to $PM_{10}$ concentrations on the Nipomo Mesa, including the potential contribution of marine sources to measured $PM_{10}$ levels.

### 3.3.1 CHEMICAL SPECIATION

While data analysis of the 2020 samples is still ongoing, the SLOAPCD, with CARB, is currently undertaking a more ambitious speciation sampling plan for the 2021 ARWP reporting cycle (August 1, 2021, to July 31, 2022). The SLOAPCD's and CARB's sampling plan is designed to generate enough data to run a successful PMF analysis and address some of the questions noted in the preliminary review of the data. The 2021 plan includes a greater sampling frequency, possible quantitative elemental results for chlorine, sodium, and magnesium (components of ODSVRA sand), possible sampling for the actual mineral composition of sand at ODSVRA, and improved data quality assurance procedures. The SLOAPCD is leading the proposed sampling and data analysis with analytical support provided by CARB and DRI and funding support provided by State Parks.

Refer to Attachment 13, 2021 Proposal for Speciation Sampling for more detailed information on the speciation analyses completed to date and SLOAPCD/CARB's proposal for 2021 speciation sampling that provides more details on the activities that are underway.

### 3.3.2 SCRIPPS STUDY

The analytical work related to the Scripps' spring 2021 sampling will be completed by late summer/early fall 2021. Data analysis and preparation of a report of findings will continue through 2021. The report of findings is due to State Parks in February 2022.

Preparation of a related document to be submitted for scientific journal publication will begin subsequently and continue through June 2022.

### 3.3.3 SCIENTIFIC REVIEW PROCESS

State Parks will coordinate with the SAG on developing a process for how scientific data collected for or related to the ODSVRA Dust Control Program is reviewed and reported on by State Parks and its representatives. This document will include an anticipated timeline and process for SAG review.

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# 4 BUDGETARY CONSIDERATIONS

The State Parks' estimated budget to develop and implement the 2021/2022 dust control actions described in Section 3 is $2,924,727. A detailed breakdown of this estimated budget is provided in Table 4-1. This budget covers all activities from July 1, 2021, through June 30, 2022, including existing contracts with SAG members. The approximately $2.92 million budget shown in Table 4-1 is slightly higher than the costs State Parks identified in proposed activities in the 2020 ARWP ($2.64 million).

| Table 4-1. Estimated 2021 Work Plan Budget | | | |
|---|---|---|---|
| **Dust Control Activity** | **3rd Party Contract Costs** | **Other Costs** | **Total Costs(A)** |
| **Vegetation Plantings (Conversion of Wind Fencing, Foredune, and Supplemental Plantings)** | | | |
| Labor | $298,000.00 | $124,000.00 | $422,000.00 |
| Materials | $0 | $135,000.00 | $135,000.00 |
| Equipment | $70,000.00 | $0 | $70,000.00 |
| Greenhouse Facilities | $190,000.00 | $0 | $190,000.00 |
| Subtotals | $558,000.00 | $259,000.00 | $817,000.00 |
| **Maintenance and Installation of Wind Fencing** | | | |
| Labor | $297,000.00 | $96,000.00 | $393,000.00 |
| Materials | $0 | $120,000.00 | $120,000.00 |
| Equipment | $135,000.00 | $0 | $135,000.00 |
| Subtotals | $432,000.00 | $216,000.00 | $648,000.00 |
| **Monitoring (Sand Flux, Air Quality, Meteorological, and Other Monitoring) and Modeling** | | | |
| Instrument Operations | $165,000.00 | $29,000.00 | $194,000.00 |
| Data Analysis | $300,000.00 | $0 | $300,000.00 |
| Subtotals | $465,000.00 | $29,000.00 | $494,000.00 |
| **Dust Control Project Design and Technical Assistance** | | | |
| Scientific Expertise | $228,000.00 | $0 | $228,000.00 |
| Subtotals | $228,000.00 | $0 | $228,000.00 |
| **Other Items of Expense** | | | |
| Miscellaneous | $737,727.00 | $0 | $737,727.00 |
| Subtotals | $737,727.00 | $0 | $737,727.00 |
| **TOTAL COSTS** | **$2,420,727.00** | **$504,000.00** | **$2,924,727.00** |

(A) The cost estimate does not include permanent State Parks staff positions assigned to these duties but includes seasonalstaff time and overtime for permanent staff.

(B) Miscellaneous costs include SAG contracts for greenhouse assistance, fuel costs, equipment repairs, purchases, andother Dust Control Program support costs.

# 5 IMPLEMENTATION SCHEDULE

The tables below present schedules for implementing the dust control activities identified in Section 3. The tables cover an approximately 14-month period from June 2021 to July 2022.

**Table 5-1. Install 90 Acres of New Dust Control Measures**

| CDPR Task/Activity | 2021 | | | | | | | 2022 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **June** | **July** | **Aug.** | **Sept.** | **Oct.** | **Nov.** | **Dec.** | **Jan.** | **Feb.** | **Mar.** | **Apr.** | **May** | **June** | **July** |
| Consult with SAG ondust control measure locations | O | → | X | | | | | | | | | | O | → |
| Obtain Amendmentto Coastal Development Permit #3-12-50 | | | | | | O | → | → | X | | | | | |
| Install perimeter fence around new,temporary dust control measures | | | | | | | | | O | X | | | | |
| Install new straw mulch measures | | | | | | | | | O | → | X | | | |
| Install new vehicle exclusion measures | | | | | | | | | O | → | X | | | |
| Apply soil stabilizers | | | | | | | | | O | → | X | | | |
| KEY: | O | Task Start | | | → | Task In Progress | | | | X | Task Complete | | | |

**Table 5-2. Convert Existing Temporary Dust Control Measures to Vegetation**

| CDPR Task/Activity | 2021 | | | | | | | 2022 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July |
| Consult with SAG on project selection | | O | → | → | X | | | | | | | | O | → |
| Collect native seed and plants, cultivate growth, procure additional plants from nurseries | → | → | → | → | → | X | | | | | | | | |
| Remove existing wind fences | | | | O | X | | | | | | | | | |
| Distribute straw mulch | | | | | O | → | X | | | | | | | |
| Initiate seeding and planting | | | | | | | O | → | → | X | | | | |
| Table Key: | O | Task Start | | | → | Task In Progress | | | | X | Task Complete | | | |

**Table 5-3. Continued Foredune Monitoring and Assessment**

| CDPR Task/Activity | 2021 | | | | | | | 2022 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July |
| Consult with SAG on monitoring | | O | → | X | | | | | | | | | O | → |
| Transect sampling | | | | O | → | → | → | → | X | | | | | |
| Photo point monitoring | | | | | O<br>X | | | | | | | | | |
| Data analysis | | | | | | | | | | O | → | X | | |
| Table Key: | O | Task Start | | | → | Task In Progress | | | | X | Task Complete | | | |

**Table 5-4. Supplemental Planting in Previous Treatment Areas**

| CDPR Task/Activity | 2021 | | | | | | | 2022 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July |
| Collect native seed and plants, cultivate growth, procure additional plants from nurseries | → | → | → | → | → | X | | | | | | | | |
| Initiate seeding and planting | | | | | | | O | → | → | X | | | | |
| Table Key: | O | Task Start | | | → | Task In Progress | | | | X | Task Complete | | | |

**Table 5-5. Maintenance of Existing Wind Fencing Measures**

| CDPR Task/Activity | 2021 | | | | | | | 2022 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July |
| Repair and/or replace fencing components, add new fence extensions or rows if needed | | | | | | | | | O | → | → | X | | |
| Table Key: | O | Task Start | | | → | Task In Progress | | | | X | Task Complete | | | |

**Table 5-6. Field Monitoring and Air Quality Modeling Activities**

| CDPR Task/Activity | 2021 | | | | | | | 2022 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July |
| Meteorological, PM, and saltation data acquisition | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| PI-SWERL Surveys | To be performed as necessary and in consultation with the SAG | | | | | | | | | | | | | |
| UAS Surveys | | | | | O<br>X | | | | O<br>X | | | | | |
| Improve DRI air quality model performance | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| KEY: | O | Task Start | | | → | Task In Progress | | | | X | Task Complete | | | |

**Table 5-7. Continued SAG Consultation and Evaluation**

| CDPR Task/Activity | 2021 | | | | | | | 2022 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July |
| Consult with SAG on 2021 ARWP | O | → | → | → | X | | | | | | | | | |
| Update approach to evaluating SOA progress | | | O | → | → | → | → | X | | | | | | |
| SAG quarterly meetings | | | X | | | X | | | X | | | X | | |
| Prepare 2022 ARWP outline for SAG review | | | | | | | | | | | | O X | | |
| Consult with SAG on 2022 ARWP | | | | | | | | | | | | O | → | → |
| Table Key: | O | Task Start | | | → | Task In Progress | | | | X | Task Complete | | | |

**Table 5-8. Public Relations Campaign**

| CDPR Task/Activity | 2021 | | | | | | | 2022 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July |
| Consult with SAG onPublic Relations Campaign | → | → | → | → | → | → | → | → | → | → | → | → | → | → |
| Digital two-page flyer | → | → | → | → | → | → | → | → | → | X | | | | |
| Social Media Posts | → | → | → | → | → | → | → | → | → | X | | | | |
| Air Quality Specific Video | → | → | → | → | → | → | → | X | | | | | | |
| FAQ Sheet | → | → | → | → | → | X | | | | | | | | |
| Table Key: | O | Task Start | | | → | Task In Progress | | | | X | Task Complete | | | |

**Oceano Dunes State Vehicular Recreation Area**

**Dust Control Program**

**Conditional Approval Draft**

**2021 Annual Report and Work Plan**

**October 1, 2021**

## ATTACHMENTS

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**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

# ATTACHMENT 01

## 2011 to 2021 Dust Control Measures

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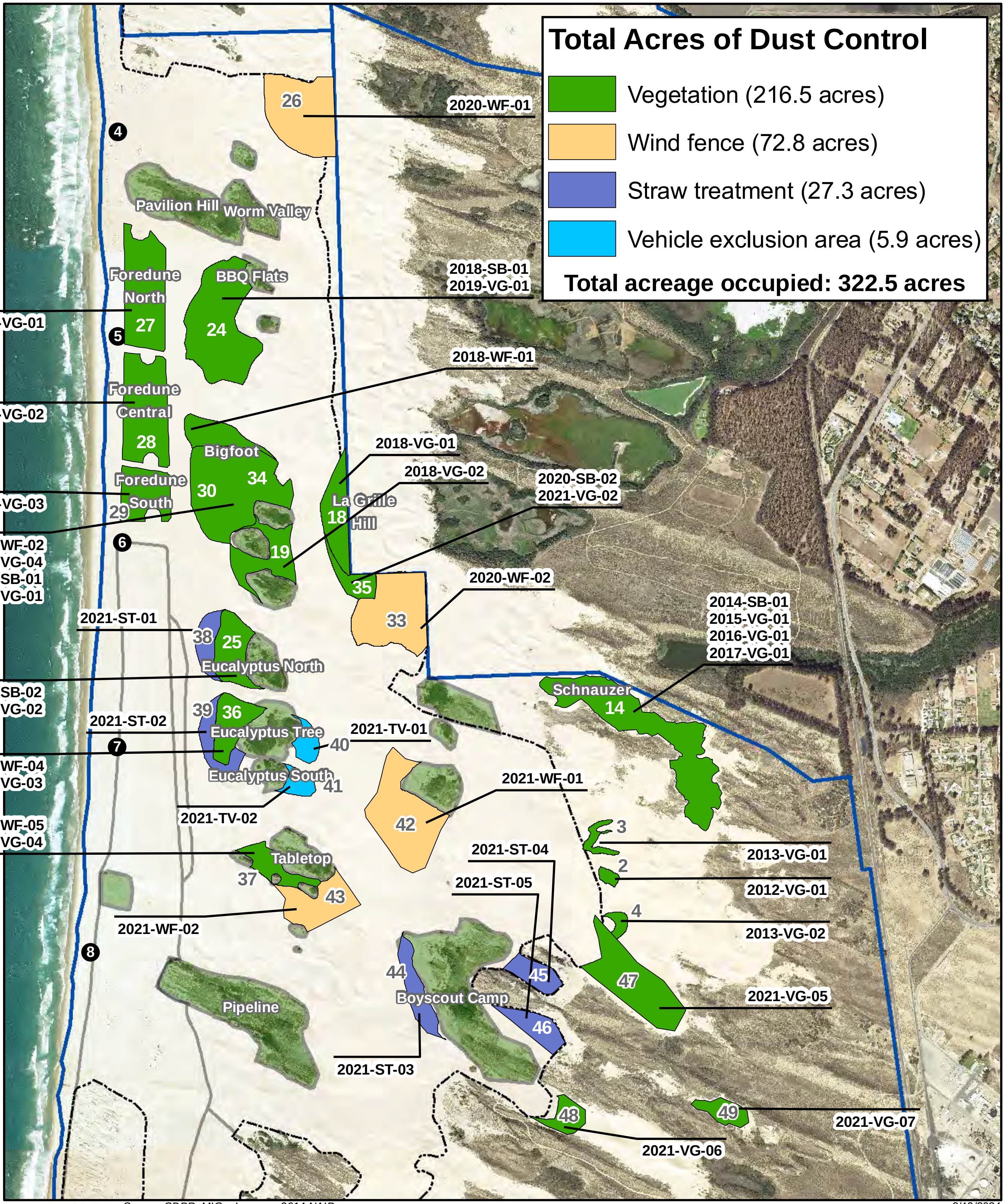



Source: CDPR, MIG Imagery: 2014 NAIP

9/13/2021

0 500 1,000 2,000 Feet

# A01-01: Cumulative Dust Control as of 7/31/21

*2021 ARWP*

Marker post

Existing fenced vegetated islands

Park boundary

Nesting exclosure from 2020

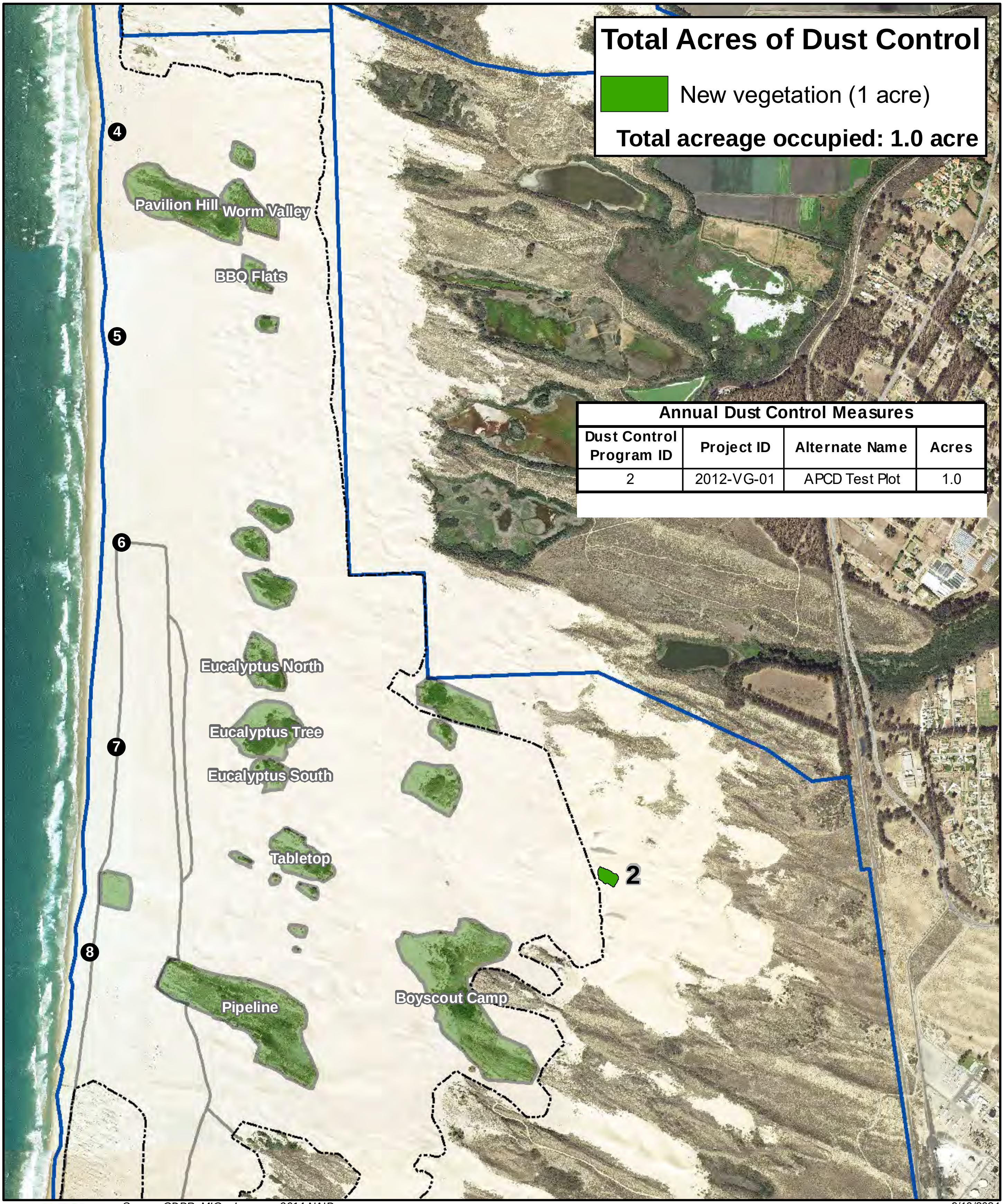
Open riding and camping area boundary fence


| Total Acres of Dust Control |
|---|
| Straw bales (1 acre) |
| **Total acreage occupied: 1.0 acre** |

| Annual Dust Control Measures | | | |
|---|---|---|---|
| Dust Control Program ID | Project ID | Alternate Name | Acres |
| 1 | 2011-SB-01 | - | 1.0 |

# A01-02: 2011 Dust Control Treatment Areas

*2021 ARWP*




**Annual Dust Control Measures**

| Dust Control Program ID | Project ID | Alternate Name | Acres |
|---|---|---|---|
| 2 | 2012-VG-01 | APCD Test Plot | 1.0 |

Source: CDPR, MIG   Imagery: 2014 NAIP

9/13/2021

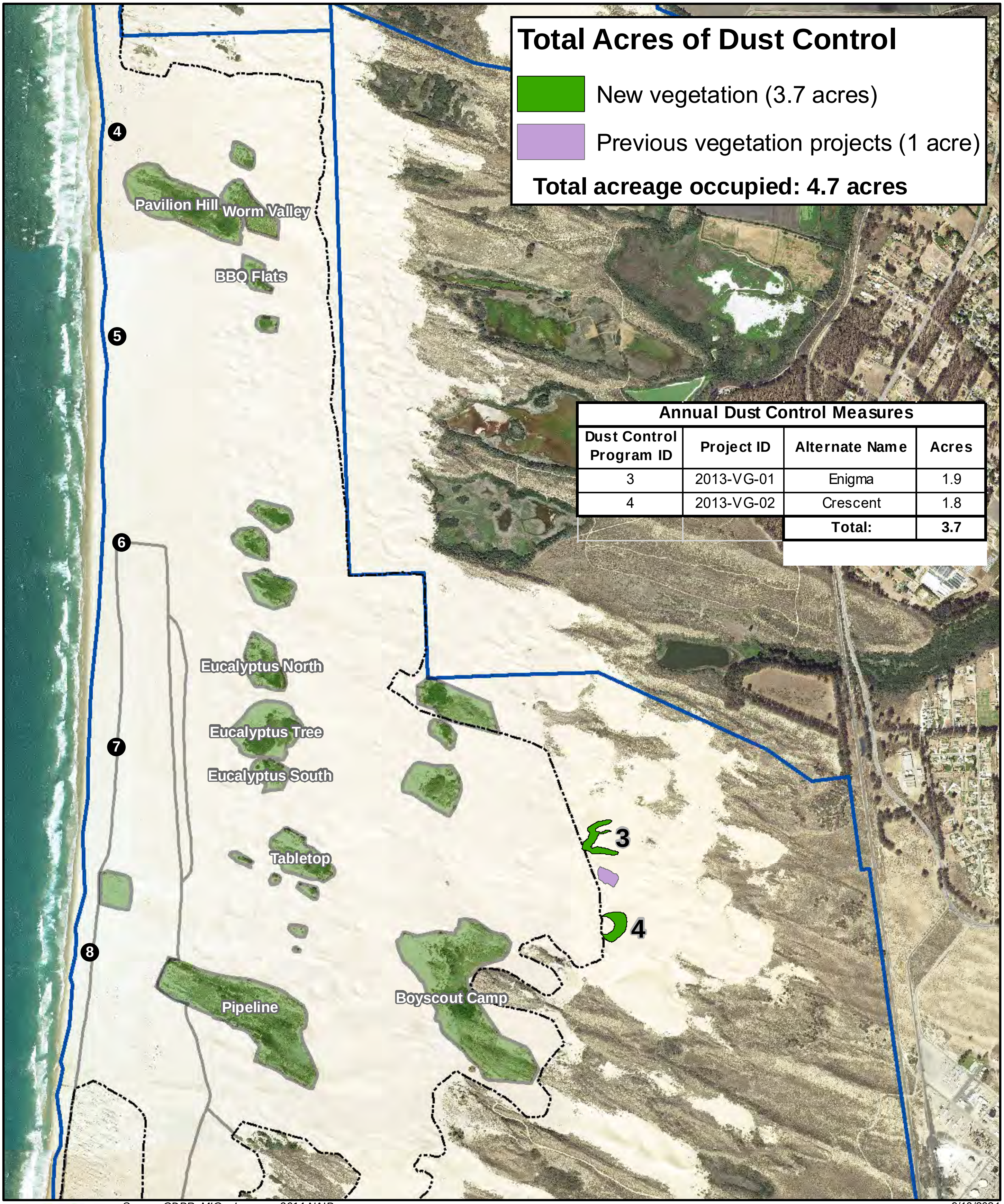
Feet
0 500 1,000 2,000

# A01-03: 2012 Dust Control Treatment Areas

*2021 ARWP*

N

- Marker post
- Nesting exclosure from 2020
- Existing fenced vegetated islands
- Open riding and camping area boundary fence
- Park boundary

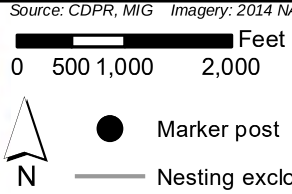



**Annual Dust Control Measures**

| Dust Control Program ID | Project ID | Alternate Name | Acres |
|---|---|---|---|
| 3 | 2013-VG-01 | Enigma | 1.9 |
| 4 | 2013-VG-02 | Crescent | 1.8 |
| | | **Total:** | **3.7** |

Source: CDPR, MIG Imagery: 2014 NAIP

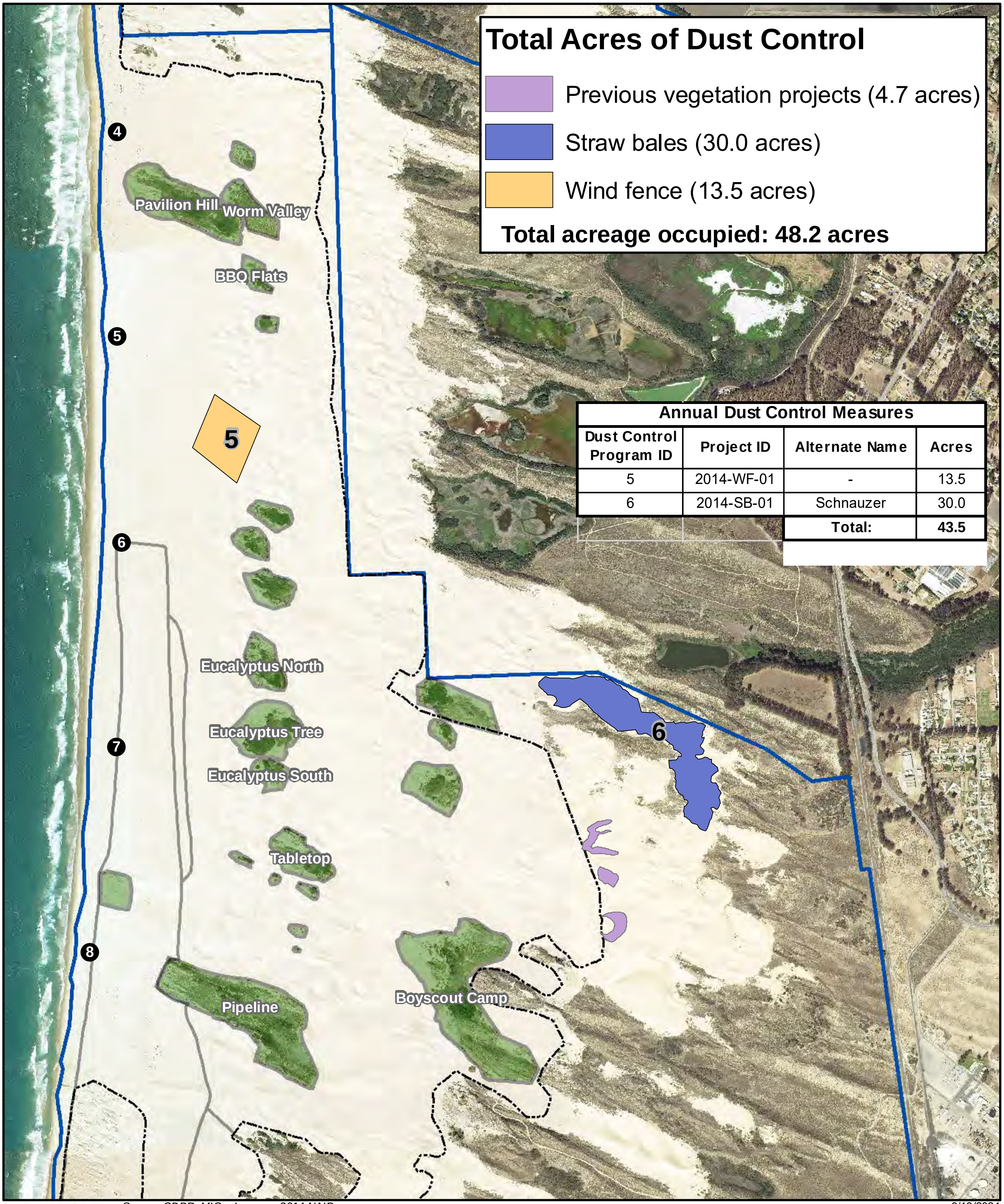
9/13/2021




# A01-04: 2013 Dust Control Treatment Areas

*2021 ARWP*

Marker post
Existing fenced vegetated islands
Park boundary
Nesting exclosure from 2020
Open riding and camping area boundary fence




| Annual Dust Control Measures | | | |
|---|---|---|---|
| Dust Control Program ID | Project ID | Alternate Name | Acres |
| 5 | 2014-WF-01 | - | 13.5 |
| 6 | 2014-SB-01 | Schnauzer | 30.0 |
| | | Total: | 43.5 |

Source: CDPR, MIG Imagery: 2014 NAIP

9/13/2021

0 500 1,000 2,000 Feet

N

# A01-05: 2014 Dust Control Treatment Areas

*2021 ARWP*

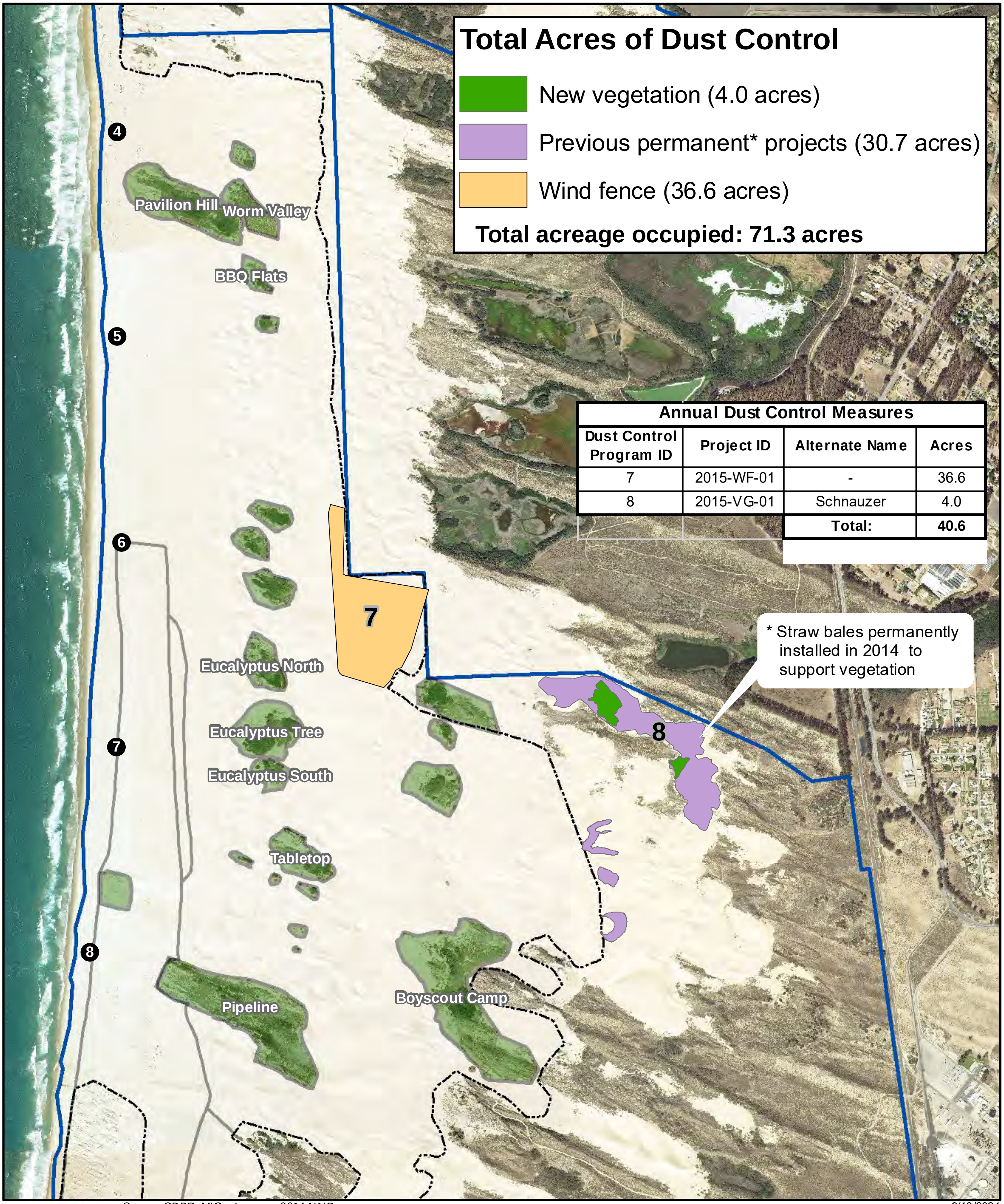
Marker post

Nesting exclosure from 2020

Existing fenced vegetated islands

Open riding and camping area boundary fence

Park boundary




**Annual Dust Control Measures**

| Dust Control Program ID | Project ID | Alternate Name | Acres |
|---|---|---|---|
| 7 | 2015-WF-01 | - | 36.6 |
| 8 | 2015-VG-01 | Schnauzer | 4.0 |
| | | **Total:** | **40.6** |

Source: CDPR, MIG Imagery: 2014 NAIP

9/13/2021

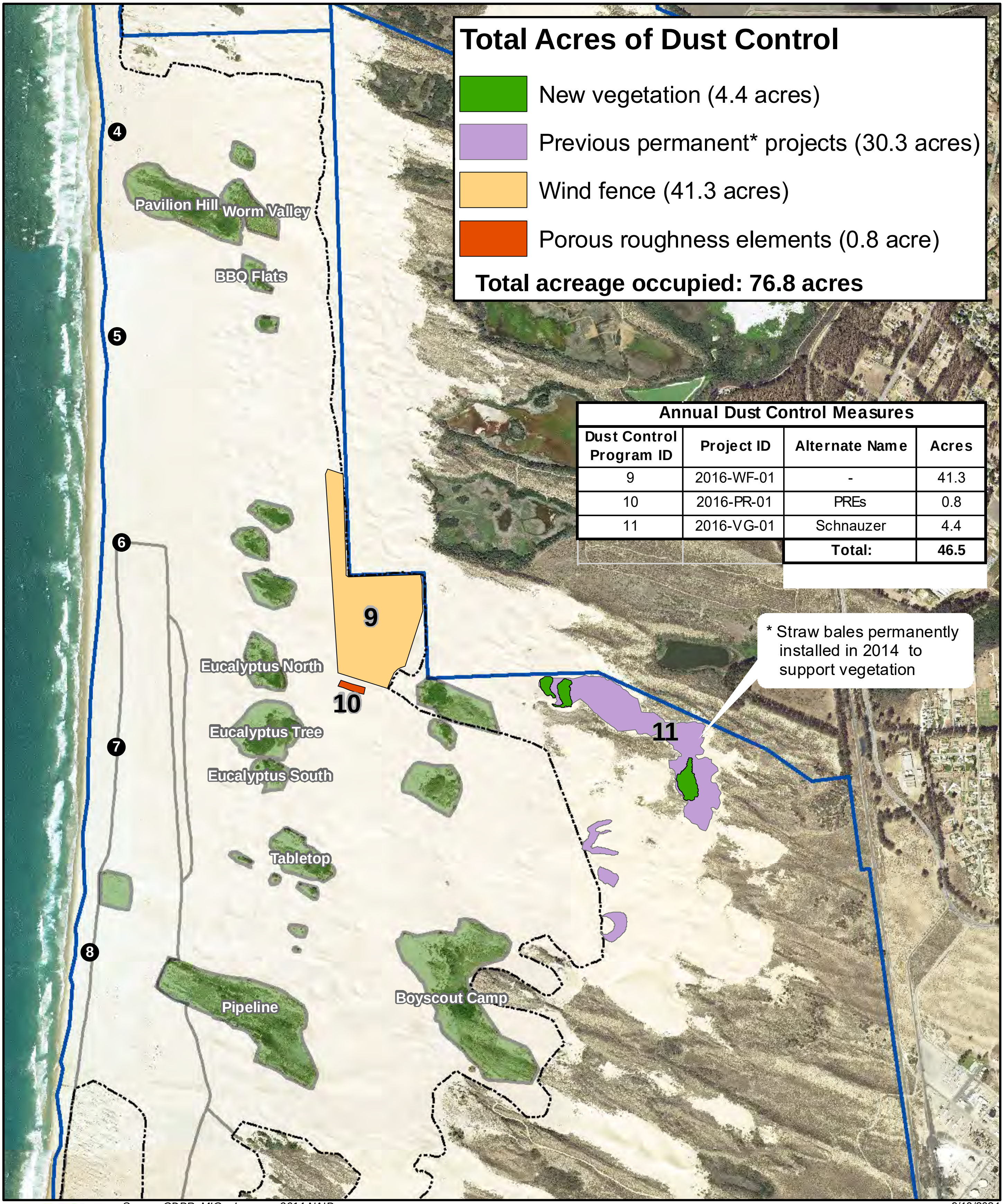
Feet
0 500 1,000 2,000

N

# A01-06: 2015 Dust Control Treatment Areas

*2021 ARWP*

Marker post
Nesting exclosure from 2020
Existing fenced vegetated islands
Open riding and camping area boundary fence
Park boundary




Annual Dust Control Measures

| Dust Control Program ID | Project ID | Alternate Name | Acres |
|---|---|---|---|
| 9 | 2016-WF-01 | - | 41.3 |
| 10 | 2016-PR-01 | PREs | 0.8 |
| 11 | 2016-VG-01 | Schnauzer | 4.4 |
| | | Total: | 46.5 |

Source: CDPR, MIG Imagery: 2014 NAIP

9/13/2021

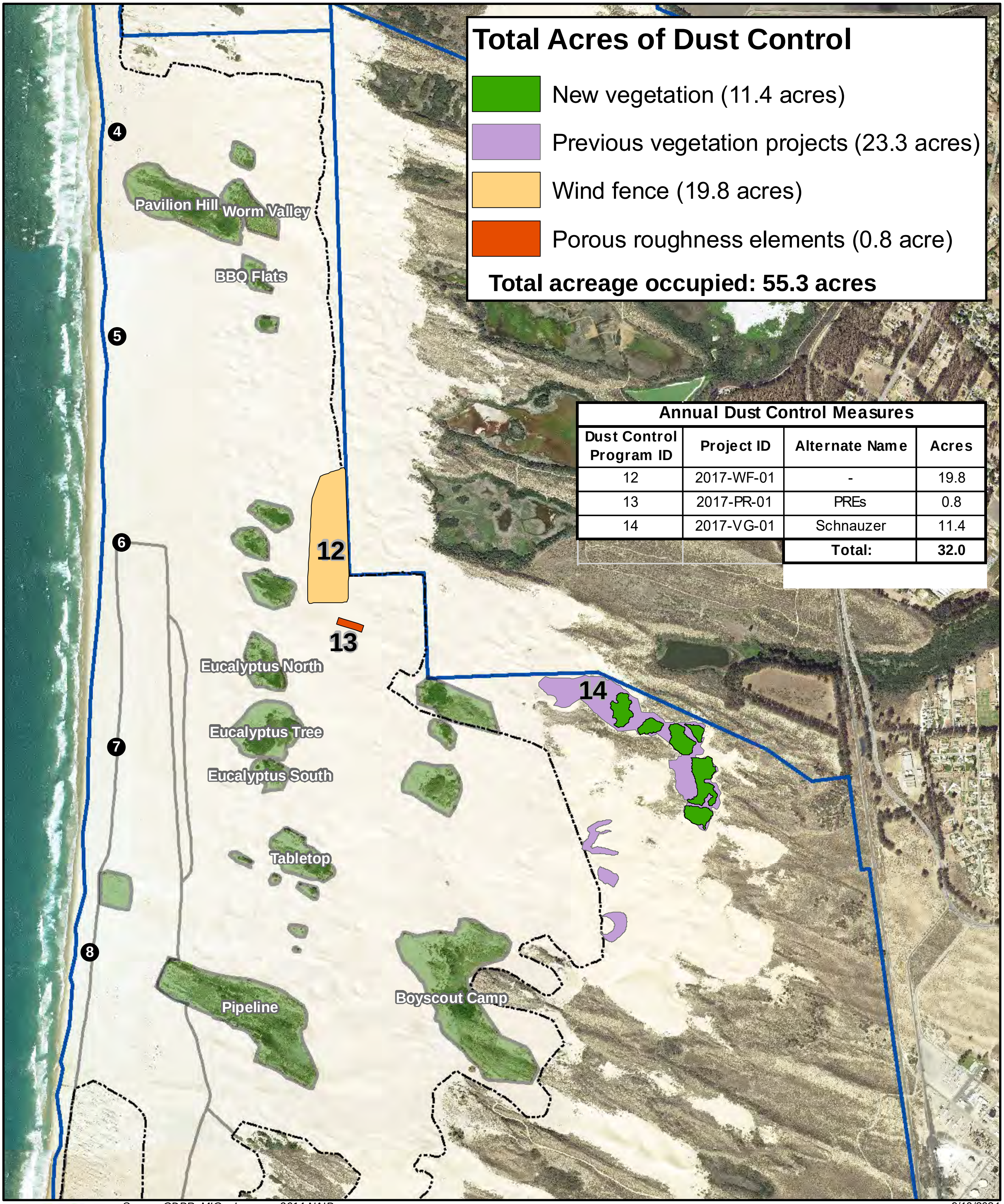
Feet
0 500 1,000 2,000

N

# A01-07: 2016 Dust Control Treatment Areas

*2021 ARWP*

Marker post
Nesting exclosure from 2020
Existing fenced vegetated islands
Open riding and camping area boundary fence
Park boundary




| Annual Dust Control Measures | | | |
|---|---|---|---|
| Dust Control Program ID | Project ID | Alternate Name | Acres |
| 12 | 2017-WF-01 | - | 19.8 |
| 13 | 2017-PR-01 | PREs | 0.8 |
| 14 | 2017-VG-01 | Schnauzer | 11.4 |
| | | Total: | 32.0 |

Source: CDPR, MIG Imagery: 2014 NAIP

9/13/2021

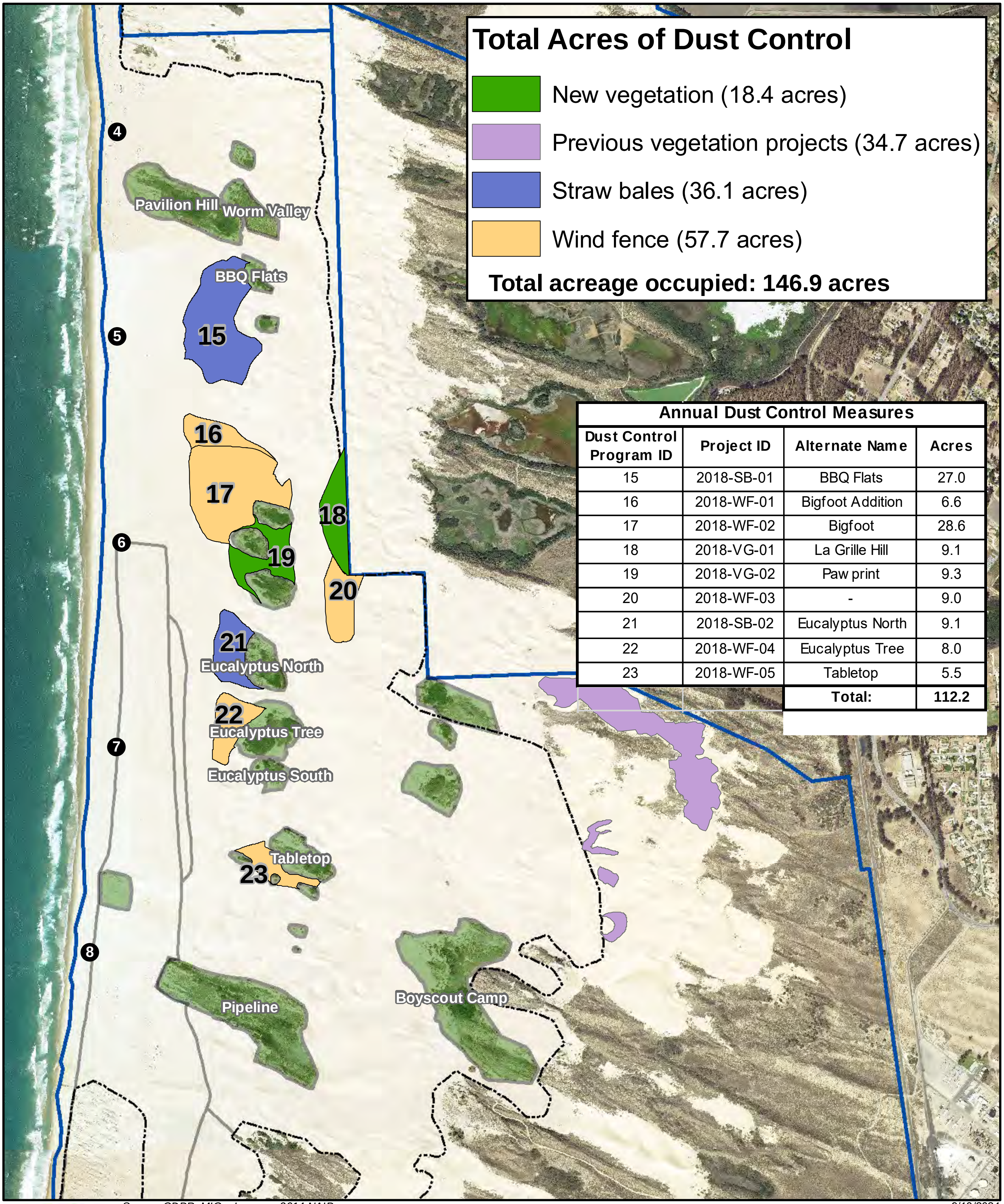
0 500 1,000 2,000 Feet

N

# A01-08: 2017 Dust Control Treatment Areas

*2021 ARWP*

Marker post
Nesting exclosure from 2020
Existing fenced vegetated islands
Open riding and camping area boundary fence
Park boundary




## Total Acres of Dust Control

- New vegetation (18.4 acres)
- Previous vegetation projects (34.7 acres)
- Straw bales (36.1 acres)
- Wind fence (57.7 acres)

**Total acreage occupied: 146.9 acres**

**Annual Dust Control Measures**

| Dust Control Program ID | Project ID | Alternate Name | Acres |
|---|---|---|---|
| 15 | 2018-SB-01 | BBQ Flats | 27.0 |
| 16 | 2018-WF-01 | Bigfoot Addition | 6.6 |
| 17 | 2018-WF-02 | Bigfoot | 28.6 |
| 18 | 2018-VG-01 | La Grille Hill | 9.1 |
| 19 | 2018-VG-02 | Paw print | 9.3 |
| 20 | 2018-WF-03 | - | 9.0 |
| 21 | 2018-SB-02 | Eucalyptus North | 9.1 |
| 22 | 2018-WF-04 | Eucalyptus Tree | 8.0 |
| 23 | 2018-WF-05 | Tabletop | 5.5 |
| | | **Total:** | **112.2** |

Source: CDPR, MIG Imagery: 2014 NAIP

9/13/2021

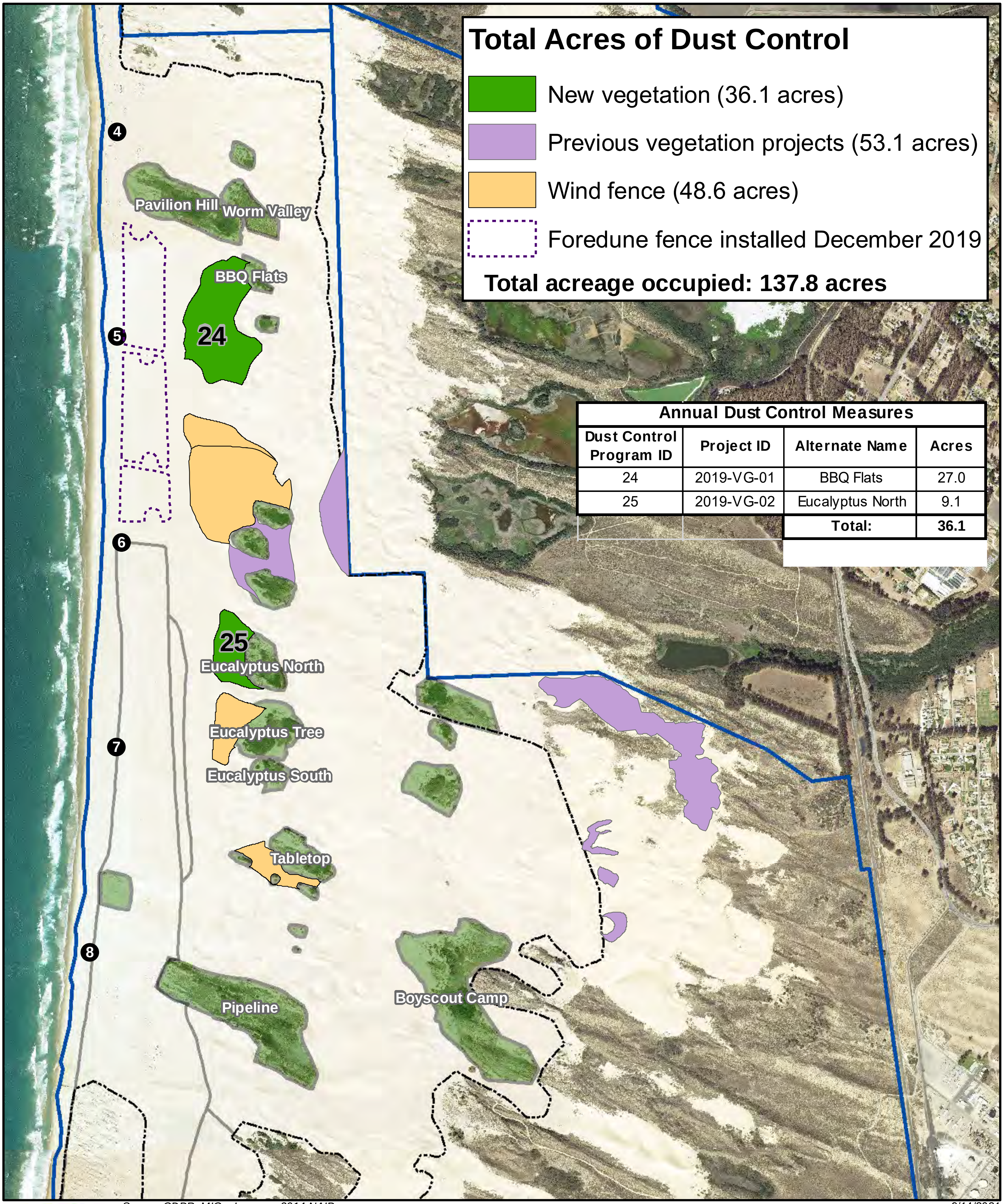
Feet
0 500 1,000 2,000

N

# A01-09: 2018 Dust Control Treatment Areas

*2021 ARWP*

- Marker post
- Nesting exclosure from 2020
- Existing fenced vegetated islands
- Open riding and camping area boundary fence
- Park boundary




| Annual Dust Control Measures | | | |
|---|---|---|---|
| Dust Control Program ID | Project ID | Alternate Name | Acres |
| 24 | 2019-VG-01 | BBQ Flats | 27.0 |
| 25 | 2019-VG-02 | Eucalyptus North | 9.1 |
| | | **Total:** | **36.1** |

Source: CDPR, MIG Imagery: 2014 NAIP

9/14/2021

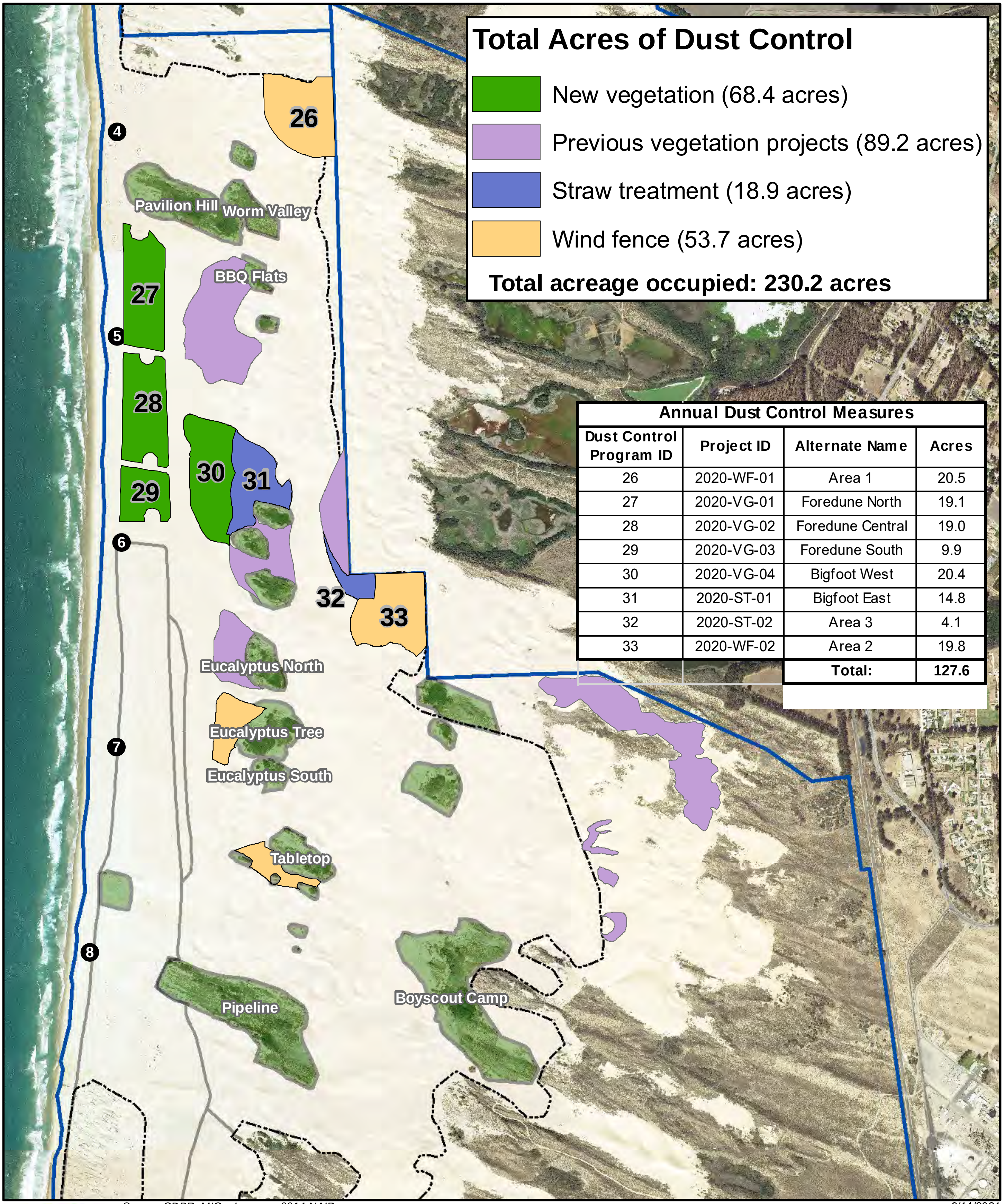
Feet
0 500 1,000 2,000

# A01-10: 2019 Dust Control Treatment Areas

*2021 ARWP*

N

Marker post
Existing fenced vegetated islands
Park boundary
Nesting exclosure from 2020
Open riding and camping area boundary fence




**Annual Dust Control Measures**

| Dust Control Program ID | Project ID | Alternate Name | Acres |
|---|---|---|---|
| 26 | 2020-WF-01 | Area 1 | 20.5 |
| 27 | 2020-VG-01 | Foredune North | 19.1 |
| 28 | 2020-VG-02 | Foredune Central | 19.0 |
| 29 | 2020-VG-03 | Foredune South | 9.9 |
| 30 | 2020-VG-04 | Bigfoot West | 20.4 |
| 31 | 2020-ST-01 | Bigfoot East | 14.8 |
| 32 | 2020-ST-02 | Area 3 | 4.1 |
| 33 | 2020-WF-02 | Area 2 | 19.8 |
| | | Total: | 127.6 |

Source: CDPR, MIG Imagery: 2014 NAIP

9/14/2021

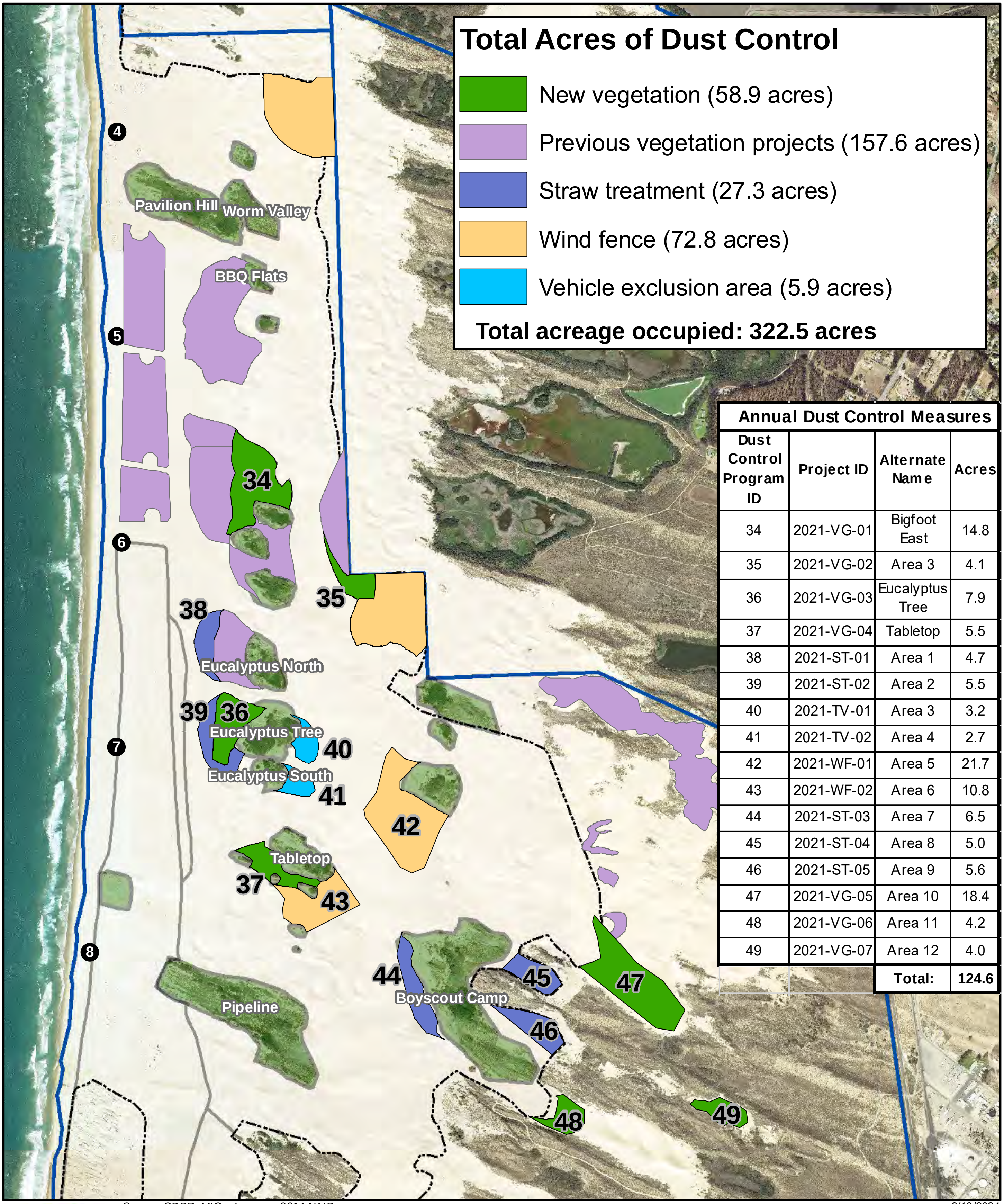
Feet
0 500 1,000 2,000

# A01-11: 2020 Dust Control Treatment Areas

*2021 ARWP*

N

Marker post
Existing fenced vegetated islands
Park boundary
Nesting exclosure from 2020
Open riding and camping area boundary fence




| Annual Dust Control Measures | | | |
|---|---|---|---|
| Dust Control Program ID | Project ID | Alternate Name | Acres |
| 34 | 2021-VG-01 | Bigfoot East | 14.8 |
| 35 | 2021-VG-02 | Area 3 | 4.1 |
| 36 | 2021-VG-03 | Eucalyptus Tree | 7.9 |
| 37 | 2021-VG-04 | Tabletop | 5.5 |
| 38 | 2021-ST-01 | Area 1 | 4.7 |
| 39 | 2021-ST-02 | Area 2 | 5.5 |
| 40 | 2021-TV-01 | Area 3 | 3.2 |
| 41 | 2021-TV-02 | Area 4 | 2.7 |
| 42 | 2021-WF-01 | Area 5 | 21.7 |
| 43 | 2021-WF-02 | Area 6 | 10.8 |
| 44 | 2021-ST-03 | Area 7 | 6.5 |
| 45 | 2021-ST-04 | Area 8 | 5.0 |
| 46 | 2021-ST-05 | Area 9 | 5.6 |
| 47 | 2021-VG-05 | Area 10 | 18.4 |
| 48 | 2021-VG-06 | Area 11 | 4.2 |
| 49 | 2021-VG-07 | Area 12 | 4.0 |
| | | Total: | 124.6 |

*Source: CDPR, MIG    Imagery: 2014 NAIP*

9/13/2021

0  500 1,000  2,000 Feet

N

# A01-12: 2021 Dust Control Treatment Areas

*2021 ARWP*

Marker post
Existing fenced vegetated islands
Park boundary
Nesting exclosure from 2020
Open riding and camping area boundary fence

**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

## ATTACHMENT 02

**2021 Updated PRMP Evaluation Metrics**

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**PMRP Evaluation Metrics – Annual Record 2020-21**

The 2021 Annual Report and Work Plan (ARWP) includes an updated set of PMRP evaluation metrics developed in consultation with the Scientific Advisory Group (SAG). The intention of this update is to provide a more streamlined dashboard that makes it easier to track progress and to inform adaptative management. "Dust Mitigation Targets" refer to evaluation metrics with specific measurable endpoints. "Dust Mitigation Indicators" refer to values indicating progress but for which specific targets are not defined. Table notes are provided at the end of this document.

| **DUST MITIGATION TARGETS** | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Dust mitigation treatments*** | | **2013 (baseline)** | **2019** | **2020** | **2021** | **2022 (planned)** | **Current target**[1] |
| A. Cumulative area under treatment within ODSVRA, as of July 31 of current year, relative to 2013 baseline (acres) | A1. Total | 0 | 137.8 | 230.2 | 322.5 | 412.5 | N/A |
| | A2. Back dunes inside Riding Area | 0 | 103.1 | 195.5 | 213.2 | 286.4 | |
| | A3. Back dunes outside Riding Area | 0 | 34.7 | 34.7 | 61.3 | 78.1 | |
| | A4. Foredunes | 0 | 0 | 48.0 | 48.0 | 48.0 | |
| ***$PM_{10}$ mass emissions*** | | **2013 (baseline)** | **2019** | **2020** | **2021** | **2022 (planned)** | **Current target**[2] |
| B. Riding Area mean $PM_{10}$ emissions for 10 baseline days - modeled[3] | B1. Mass emissions (metric tons / day) | 182.8 | 160.8[4] | 153.1 | 142.0 | 124.9 | 91.4 |
| | B2. Relative to 2013 | 100% | 88.0%[4] | 83.8% | 77.7% | 68.3% | 50% |
| ***$PM_{10}$ concentrations*** | | **2013 (baseline)** | **2019** | **2020** | **2021** | **2022 (planned)** | **Current target**[5] |
| C. CDF mean $PM_{10}$ concentration for 10 baseline days (µg/m$^3$) - modeled[3] | | 124.7 | 99.7[4] | 72.4 | 72.2 | 66.4 | N/A |
| D. Mesa2 mean $PM_{10}$ concentration for 10 baseline days (µg/m$^3$) - modeled[3] | | 97.5 | N/A[4] | 91.2 | 73.8 | 65.5 | |

| DUST MITIGATION INDICATORS | | | | | |
|---|---|---|---|---|---|
| ***Air quality indicators*** | | **2013 (baseline)** | **2019** | **2020** | **2021** |
| 1. Actual number of high wind event days[6] | | 59 | 30 | 55 | 51 |
| 2. Actual number of exceedances of California air quality standard[7] | 2a. at CDF | 58 | 16 | 30 | 28 |
| | 2b. at Mesa2 | 43 | 14 | 28 | 30 |
| 3. Actual number of exceedances of Federal air quality standard[8] | 3a. at CDF | 1 | 0 | 0 | 0 |
| | 3b. at Mesa2 | 0 | 0 | 0 | 0 |
| ***Foredune restoration*** | | **2013 (baseline)** | **2019** | **2020** | **2021** |
| 4. Foredune plant fractional cover, at time of spring survey (%) | 4a. Treatment 1 | N/A | N/A | N/A | 0 |
| | 4b. Treatment 2 | | | | 0.1 |
| | 4c. Treatment 3 | | | | 4.02 |
| | 4d. Treatment 4 | | | | 0.76 |
| | 4e. Treatment 5 | | | | 0.4 |
| | 4f. Treatment 6 | | | | 3.57 |
| 5. Foredune species richness index relative to Oso Flaco site[9] | 5a. Treatment 1 | N/A | N/A | N/A | 0 |
| | 5b. Treatment 2 | | | | 33 |
| | 5c. Treatment 3 | | | | 50 |
| | 5d. Treatment 4 | | | | 100 |
| | 5e. Treatment 5 | | | | 110 |
| | 5f. Treatment 6 | | | | 110 |
| 6. Foredune sand volume, current spring survey relative to previous fall survey ($m^3$ $m^{-2}$ $month^{-1}$) | 6a. Treatment 1 | N/A | N/A | N/A | 0.0011 |
| | 6b. Treatment 2 | | | | 0.0006 |
| | 6c. Treatment 3 | | | | 0.0022 |
| | 6d. Treatment 4 | | | | 0.0009 |
| | 6e. Treatment 5 | | | | 0.0020 |
| | 6f. Treatment 6 | | | | 0.0031 |
| ***Back dune stabilization*** | | **2013 (baseline)[10]** | **2019** | **2020** | **2021** |
| 7. Cumulative area of back dune stabilization within ODSVRA, as of July 31 of current year (acres) | 7a. Planting area | TBD | 89.2 | 109.6 | 168.5 |
| | 7b. Fencing area | TBD | 48.6 | 53.7 | 72.8 |
| | 7c. Straw bales area | TBD | 0 | 18.9 | 27.3 |
| | 7d. Temporary vehicle exclusion areas | TBD | 0 | 0 | 5.9 |
| | 7e. Stabilized vegetation surface area[11] | TBD | 137.8 | 182.2 | 274.5 |
| 8. Native seed harvest for all plants during current ARWP reporting period (kg/year) | | N/A | 203.2 | 417.2 | 330 |
| 9. Plant species cultivation for all plants during current ARWP reporting period (#/year) | | | 106,350 | 96,600 | 116,986 |

**EVALUATION METRIC TABLE NOTES**

[1] The current dust mitigation treatment area target is defined in the Particulate Matter Reduction Plan (PMRP). This target may be revised in the future based on further modeling of dust mitigation effectiveness and monitoring of actual air quality improvements.

[2] The current $PM_{10}$ mass emissions target is defined according to Stipulated Order of Abatement (SOA) provision 2c, which "…establish[es] an initial target of reducing the maximum 24-hour $PM_{10}$ baseline emissions by fifty percent (50%), based on air quality modeling based on a modeling scenario for the period May 1 through August 31, 2013." The air quality modeling approach is described in the PMRP. The 10 baseline days for this scenario are defined in the 2020 Annual Report and Work Plan (ARWP), Attachment 6. Ongoing efforts to revisit the SOA target may result in changes to these values.

[3] The values reported here account only for "direct effects" resulting from changes in emissivity for areas directly under treatment. Future model refinements to account for downwind effects of treatments, such as through use of computational fluid dynamics (CFD) approaches, may result in changes to these values.

[4] The estimate of mass emission reductions come from State Parks 2020 ARWP, Attachment 3 (Oceano Dunes Emission, Dispersion, and Attribution Model Results and Treatment Assessment (DRI, 2020). The estimate of CDF concentration reductions (25.0 $\mu g/m^3$) comes from State Parks' 2019 ARWP, p. 2-6 (dated December 31, 2019). The 2019 ARWP did not provide a modeled concentration reduction for Mesa2.

[5] SOA provision 2b states that "…the [Particulate Matter Reduction] Plan shall be designed to achieve state and federal ambient $PM_{10}$ air quality standards." However, it does not designate a specific $PM_{10}$ airborne concentration target for the baseline modeling scenario. Ongoing efforts to revisit the SOA target may result in establishing new targets based on modeled $PM_{10}$ concentrations for the baseline scenario.

[6] Values are determined using the SLO Air Pollution Control District (APCD) definition of "high wind event day" as any day when the 3 p.m. PST hourly wind speed at CDF exceeds 8 mph and the 1 p.m. PST hourly wind direction is between 290 and 360°. The period of consideration is January 1 - June 28.

[7] CA air quality standard is a mean value of 50 $\mu g/m^3$ over a 24-hour period. The period of consideration is January 1 - June 28.

[8] Federal air quality standard is a mean value of 150 $\mu g/m^3$ over a 24-hour period. The period of consideration is January 1 - June 28.

[9] Number of native plant species recorded for each treatment area as compared to reference site at Oso Flaco. Long term goal is to have a stable or increasing richness value versus reference site.

[10] Baseline 2013 values for back dune stabilization will be estimated from UCSB's upcoming historic vegetation report.

[11] Area based on actual vegetation coverage determined from aerial imagery.

**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

**ATTACHMENT 03**

**2020/2021 ODSVRA Dust Control Program Supplemental Vegetation Restoration Projects**

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| 2020/2021 ODSVRA Dust Control Program Supplemental Vegetation Restoration Projects | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Treatment Areas | | | | | |
| | | Totals | | Bigfoot (Program ID: 30, Project ID: 20-VG-04) | | BBQ Flats (Program ID: 24, Project ID: 2019-VG-01) | | Eucalyptus Tree North (Program ID: 25, Project ID: 19-VG-02) | |
| | Area (Acres) | **8.3** | | 4.6 | | 2.6 | | 1.1 | |
| Scattered Straw | Bales (3X4X8 foot) | **75** | | 37 | | 27 | | 11 | |
| Native Seed | Weight (lbs) | **45.6** | | 23 | | 17 | | 5.6 | |
| Triticale (Sterile) Seed | Weight (lbs) | **300** | | 160 | | 100 | | 40 | |
| Species | Common Name | **Total Plants** | **Total Seed** | Plants | Seed (lbs) | Plants | Seed (lbs) | Plants | Seed (lbs) |
| *Abronia latifolia* | Yellow sand verbena | | **0.177** | | | | 0.13 | | 0.047 |
| *Abronia maritima* | Sticky sand verbena | | **3.53** | | | | 2.6 | | 0.93 |
| *Achillea millefolium* | Common yarrow | **1568** | **4.518** | 784 | 2.4 | 490 | 1.56 | 294 | 0.558 |
| *Acmispon glaber* | Deerweed | **686** | **0.377** | 392 | 0.2 | 245 | 0.13 | 49 | 0.047 |
| *Ambrosia chamissonis* | Beach bur | **882** | **12.4** | 392 | 6.6 | 490 | 4.3 | | 1.5 |
| *Camissoniopsis cheiranthifolia* | Beach evening-primrose | **2401** | **1.106** | 1372 | 0.4 | 735 | 0.52 | 294 | 0.186 |
| *Corethrogyne filaginifolia* | Common sandaster | **980** | **0.16** | 392 | 0.16 | 490 | | 98 | |
| *Ericameria ericoides* | Mock heather | **1054** | **4.142** | 588 | 2.2 | 368 | 1.43 | 98 | 0.512 |
| *Erigeron blochmaniae* | Blochman's leafy daisy | **2107** | **0.377** | 1176 | 0.2 | 735 | 0.13 | 196 | 0.047 |
| *Eriogonum parvifolium* | Coastal buckwheat | **686** | **4.142** | 392 | 2.2 | 245 | 1.43 | 49 | 0.512 |
| *Eriophyllum staechadifolium* | Seaside golden yarrow | **637** | **1.883** | 196 | 1 | 245 | 0.65 | 196 | 0.233 |
| *Erysimum suffrutescens* | Suffrutescent wallflower | **1421** | **0.075** | 784 | 0.04 | 490 | 0.026 | 147 | 0.009 |
| *Lupinus chamissonis* | Dune bush lupine | **5096** | **1.506** | 2744 | 0.8 | 1470 | 0.52 | 882 | 0.186 |
| *Malacothrix incana* | Dunedelion | **441** | **0** | 196 | | 245 | | | |
| *Monardella undulata ssp crispa* | Crisp monardella | **2793** | **3.765** | 1568 | 2 | 980 | 1.3 | 245 | 0.465 |
| *Phacelia ramosissima* | Branching phacelia | **2156** | **6.36** | 1176 | 5 | 735 | 1.36 | 245 | |
| *Senecio blochmaniae* | Dune ragwort | **1887** | **1.236** | 980 | | 613 | 0.91 | 294 | 0.326 |
| **Total** | | **24795** | **45.754** | **13132** | **23.2** | **8576** | **16.996** | **3087** | **5.558** |

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**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

**<u>ATTACHMENT 04</u>**

**Desert Research Institute (DRI) Oceano Dunes: Status 2021**

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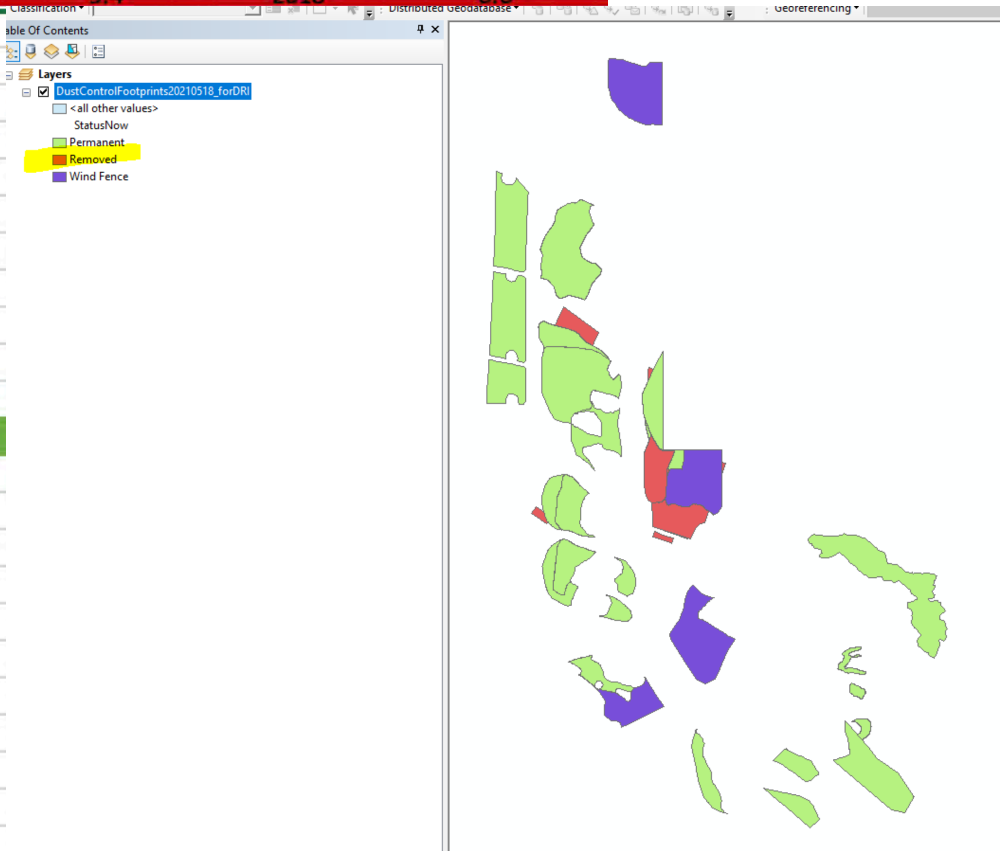
Desert Research Institute

# Oceano Dunes: Status 2021

| Scenario | Polygon ID | Name area | Description | Year Implem | Year Removed | Status | Area Polygon [Acres] | Area Model [Acres] | Year Implem | Area treated [Acres] |
|---|---|---|---|---|---|---|---|---|---|---|
| Pre2020 | 55 | straw bales ne | Removed | 2011 | | Removed | 1.0 | 1.1 | 2011 | 1.1 |
| Pre2020 | 53 | APCD Test Plot | APCD Test Plot | 2012 | | Permanent | 1.1 | 1.1 | 2012 | 0.0 |
| Pre2020 | 54 | Enigma | Enigma | 2013 | | Permanent | 2.0 | 2.0 | 2013 | 0.3 |
| Pre2020 | 52 | Crescent | Crescent | 2013 | | Permanent | 1.8 | 1.9 | 2013 | 0.1 |
| Pre2020 | 3 | '14 | Removed | 2014 | 2014 | Removed | 13.5 | 13.5 | 2014 | 0.0 |
| Pre2020 | 47 | Trial area 2014 | Schnauzer | 2014 | | Permanent | 30.1 | 29.9 | 2014 | 28.0 |
| Pre2020 | 2 | '15 | Removed | 2015 | 2015 | Removed | 36.6 | 37.2 | 2015 | 0.0 |
| Pre2020 | 4 | '16 | Removed | 2016 | 2016 | Removed | 41.3 | 42.2 | 2016 | 0.0 |
| Pre2020 | 5 | | PREs | 2016 | | Removed | 0.7 | 0.8 | 2016 | 0.0 |
| Pre2020 | 8 | | PREs | 2017 | | Removed | 0.7 | 0.8 | 2017 | 0.0 |
| Pre2020 | 45 | Dust reduction | La Grille Hill | 2017 | | Permanent | 9.1 | 8.8 | 2017 | 2.6 |
| Pre2020 | 44 | Dust reduction | Pawprint | 2017 | | Permanent | 9.3 | 9.4 | 2017 | 9.4 |
| Pre2020 | 48 | SAO installed a | Removed | 2018 | 2018 | Removed | 9.0 | 9.4 | 2018 | 0.0 |
| Pre2020 | 46 | Dust reduction | Bigfoot | 2018 | | Permanent | 28.6 | | | |
| Pre2020 | 40 | Stipulated Aba | Bigfoot Addition | 2018 | | Permanent | 6.6 | | | |
| Pre2020 | 42 | Stipulated Aba | Eucalyptus Tree | 2018 | | Permanent | 7.9 | | | |
| Pre2020 | 41 | Stipulated Aba | Eucalyptus North | 2018 | | Permanent | 9.1 | | | |
| Pre2020 | 39 | Stipulated Aba | BBQ Flats | 2018 | | Permanent | 27.0 | | | |
| Pre2020 | 43 | Stipulated Aba | Tabletop | 2018 | | Permanent | 5.5 | | | |
| Pre2020 | 51 | Foredune Dece | Foredune North | 2019 | | Permanent | 19.1 | | | |
| Pre2020 | 49 | Foredune Dece | Foredune South | 2019 | | Permanent | 9.9 | | | |
| Pre2020 | 50 | Foredune Dece | Foredune Central | 2019 | | Permanent | 19.0 | | | |
| Pre2020 | 11 | Wind Fence | Wind Fence 2020 | 2020 | | Wind Fence | 20.5 | | | |
| Pre2020 | 10 | Wind Fence | Wind Fence 2020 | 2020 | | Wind Fence | 19.8 | | | |
| Pre2020 | 9 | Vegetation | Permanent 2020 | 2020 | | Permanent | 4.1 | | | |
| 2021 | 71 | Actual GPSd 3/ | Temporary Vehicl | 2021 | | Permanent | 2.8 | | | |
| 2021 | 56 | Proposed shap | Wind Fence | 2021 | | Wind Fence | 10.8 | | | |
| 2021 | 57 | Proposed shap | Wind Fence | 2021 | | Wind Fence | 21.7 | | | |
| 2021 | 63 | Proposed shap | Straw | 2021 | | Permanent | 5.6 | | | |
| 2021 | 64 | Proposed shap | Straw | 2021 | | Permanent | 5.0 | | | |
| 2021 | 65 | Proposed | Seed | 2021 | | Permanent | 4.2 | | | |
| 2021 | 66 | Proposed | Seed | 2021 | | Permanent | 4.0 | | | |
| 2021 | 67 | Proposed | Seed | 2021 | | Permanent | 18.4 | | | |
| 2021 | 68 | Actual GPSd 3/ | Straw | 2021 | | Permanent | 4.7 | | | |
| 2021 | 69 | Actual GPSd 3/ | Straw | 2021 | | Permanent | 5.5 | | | |
| 2021 | 70 | Actual GPSd 3/ | Temporary Vehicl | 2021 | | Permanent | 3.2 | | | |
| 2021 | 72 | Actual GPSd 3/ | Straw | 2021 | | Permanent | 6.5 | | | |




Tamar Carmonia, Parks

# 2013 Emissions Grid: reduction per treatment area - 10 baseline days

| | | Riding and non-riding areas | | | | Riding areas only | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year Implem | Area treated [Acres] | Emissions [Metric Tons/day] | Abatement [Metric Tons/day] | Cumulative Abatement [Met | Cumulative Abatement [%] | Emissions [Metric Tons/day] | Abatement [Metric Tons/day] | Cumulative Abatement [Metric Tons/day] | Cumulative Abatement [%] |
| 2011 | 1.1 | 243.5 | 0.0 | 0.0 | 100.0 | 182.8 | 0.0 | 0.0 | 100.0 |
| 2012 | 0.0 | 243.5 | 0.0 | 0.0 | 100.0 | 182.8 | 0.0 | 0.0 | 100.0 |
| 2013 | 0.3 | 243.5 | 0.0 | 0.0 | 100.0 | 182.8 | 0.0 | 0.0 | 100.0 |
| 2013 | 0.1 | 243.5 | 0.0 | 0.0 | 100.0 | 182.8 | 0.0 | 0.0 | 100.0 |
| 2014 | 0.0 | 243.5 | 0.0 | 0.0 | 100.0 | 182.8 | 0.0 | 0.0 | 100.0 |
| 2014 | 28.0 | 242.2 | 1.3 | 1.3 | 99.5 | 182.8 | 0.0 | 0.0 | 100.0 |
| 2015 | 0.0 | 242.2 | 0.0 | 1.3 | 99.5 | 182.8 | 0.0 | 0.0 | 100.0 |
| 2016 | 0.0 | 242.2 | 0.0 | 1.3 | 99.5 | 182.8 | 0.0 | 0.0 | 100.0 |
| 2016 | 0.0 | 242.2 | 0.0 | 1.3 | 99.5 | 182.8 | 0.0 | 0.0 | 100.0 |
| 2017 | 0.0 | 242.2 | 0.0 | 1.3 | 99.5 | 182.8 | 0.0 | 0.0 | 100.0 |
| 2017 | 2.6 | 240.8 | 1.5 | 2.8 | 98.9 | 182.8 | 0.0 | 0.0 | 100.0 |
| 2017 | 9.4 | 239.4 | 1.3 | 4.1 | 98.3 | 181.4 | 1.4 | 1.4 | 99.2 |
| 2018 | 0.0 | 239.4 | 0.0 | 4.1 | 98.3 | 181.4 | 0.0 | 1.4 | 99.2 |
| 2018 | 23.5 | 234.9 | 4.5 | 8.7 | 96.4 | 176.7 | 4.7 | 6.1 | 96.7 |
| 2018 | 2.2 | 233.8 | 1.0 | 9.7 | 96.0 | 175.6 | 1.1 | 7.1 | 96.1 |
| 2018 | 8.0 | 232.9 | 1.0 | 10.6 | 95.6 | 174.7 | 1.0 | 8.1 | 95.6 |
| 2018 | 8.8 | 231.9 | 1.0 | 11.6 | 95.2 | 173.7 | 1.0 | 9.1 | 95.0 |
| 2018 | 26.8 | 228.0 | 4.0 | 15.6 | 93.6 | 169.6 | 4.1 | 13.2 | 92.8 |
| 2018 | 5.4 | 227.0 | 1.0 | 16.6 | 93.2 | 168.5 | 1.0 | 14.2 | 92.2 |
| 2019 | 19.3 | 223.7 | 3.3 | 19.8 | 91.9 | 165.2 | 3.4 | 17.6 | 90.4 |
| 2019 | 9.9 | 221.9 | 1.8 | 21.7 | 91.1 | 163.3 | 1.9 | 19.5 | 89.3 |
| 2019 | 19.4 | 218.7 | 3.2 | 24.8 | 89.8 | 160.0 | 3.3 | 22.8 | 87.5 |
| 2020 | 21.0 | 216.4 | 2.3 | 27.1 | 88.9 | 158.0 | 2.1 | 24.8 | 86.4 |
| 2020 | 2.6 | 214.4 | 2.0 | 29.1 | 88.1 | 155.9 | 2.1 | 26.9 | 85.3 |
| 2020 | 0.2 | 213.9 | 0.6 | 29.7 | 87.8 | 155.3 | 0.6 | 27.5 | 85.0 |
| 2021 | 2.9 | 213.2 | 0.7 | 30.3 | 87.5 | 154.6 | 0.7 | 28.2 | 84.6 |
| 2021 | 10.7 | 211.1 | 2.1 | 32.5 | 86.7 | 152.4 | 2.2 | 30.4 | 83.4 |
| 2021 | 21.5 | 208.3 | 2.8 | 35.3 | 85.5 | 149.6 | 2.9 | 33.2 | 81.8 |
| 2021 | 5.8 | 207.7 | 0.6 | 35.9 | 85.3 | 148.9 | 0.6 | 33.9 | 81.5 |
| 2021 | 5.1 | 207.1 | 0.6 | 36.4 | 85.0 | 148.3 | 0.6 | 34.5 | 81.1 |
| 2021 | 4.4 | 206.9 | 0.2 | 36.7 | 84.9 | 148.3 | 0.0 | 34.5 | 81.1 |
| 2021 | 4.0 | 206.7 | 0.2 | 36.9 | 84.9 | 148.3 | 0.0 | 34.5 | 81.1 |
| 2021 | 17.9 | 205.8 | 0.9 | 37.8 | 84.5 | 148.3 | 0.0 | 34.5 | 81.1 |
| 2021 | 4.2 | 205.3 | 0.5 | 38.2 | 84.3 | 147.9 | 0.5 | 34.9 | 80.9 |
| 2021 | 5.4 | 204.4 | 1.0 | 39.2 | 83.9 | 146.9 | 1.0 | 35.9 | 80.3 |
| 2021 | 3.2 | 203.6 | 0.8 | 39.9 | 83.6 | 146.1 | 0.8 | 36.7 | 79.9 |
| 2021 | 6.0 | 202.8 | 0.8 | 40.8 | 83.3 | 145.2 | 0.8 | 37.6 | 79.4 |

Riding and non-riding Area: 83.3%

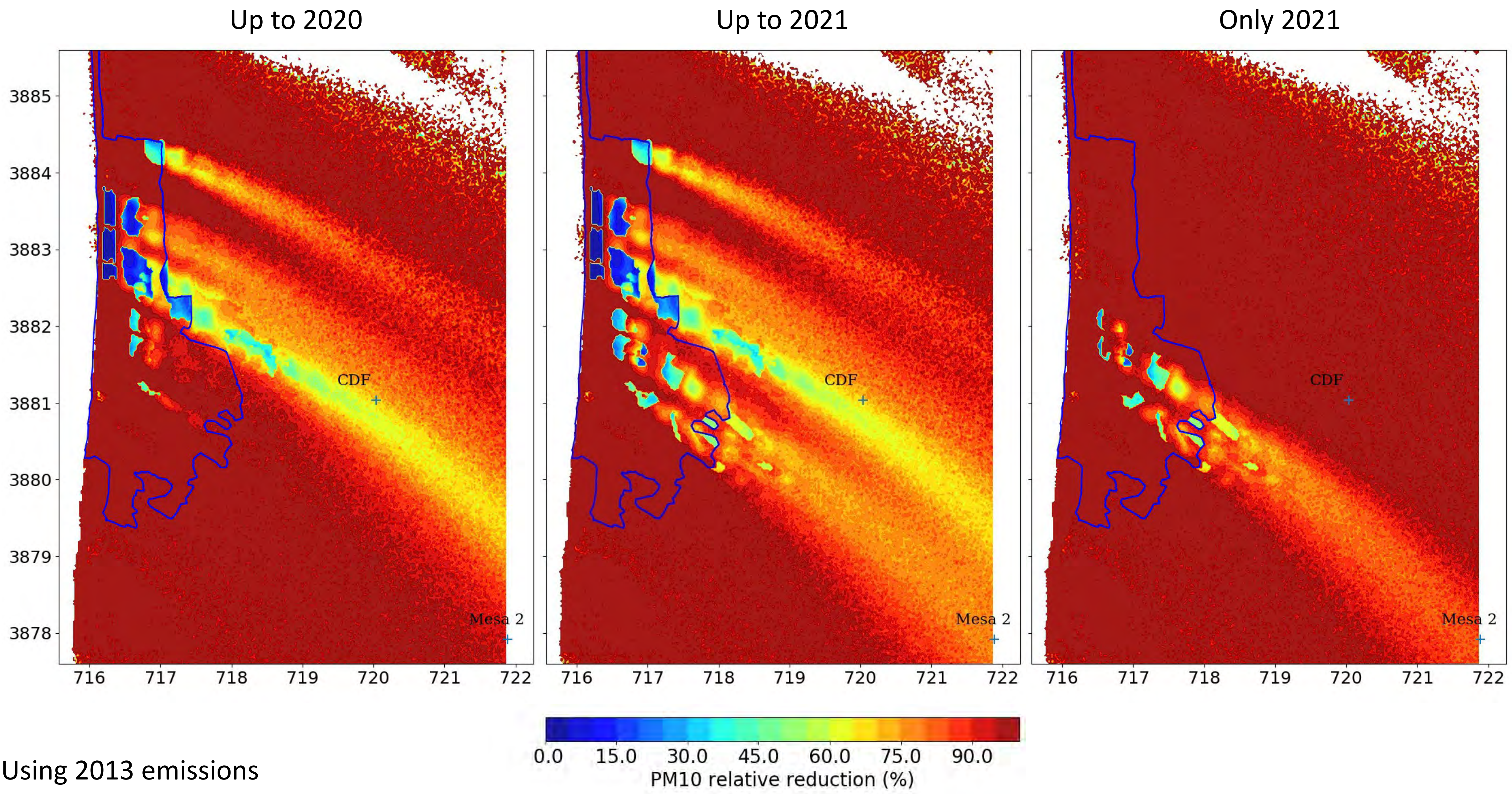
Riding area: 79.4%

# 2019 Emissions Grid: reduction per treatment area - 10 baseline days

| | | Riding and non-riding areas | | | | Riding areas only | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year Implemented | Area treated [Acres] | Emissions [Metric Tons/day] | Abatement [Metric Tons/day] | Cumulative Abatement [Metric Tons/day | Cumulative Abatement [%] | Emissions [Metric Tons/day] | Abatement [Metric Tons/day] | Cumulative Abatement [Metric Tons/day] | Cumulative Abatement [%] |
| 2011 | 1.1 | 227.73 | 0.000 | 0.000 | 100.000 | 159.71 | 0.000 | 0.000 | 100.000 |
| 2012 | 0.0 | 227.73 | 0.000 | 0.000 | 100.000 | 159.71 | 0.000 | 0.000 | 100.000 |
| 2013 | 0.3 | 227.70 | 0.026 | 0.026 | 99.988 | 159.71 | 0.000 | 0.000 | 100.000 |
| 2013 | 0.1 | 227.69 | 0.007 | 0.034 | 99.985 | 159.71 | 0.000 | 0.000 | 100.000 |
| 2014 | 0.0 | 227.69 | 0.000 | 0.034 | 99.985 | 159.71 | 0.000 | 0.000 | 100.000 |
| 2014 | 28.0 | 226.39 | 1.302 | 1.336 | 99.413 | 159.71 | 0.000 | 0.000 | 100.000 |
| 2015 | 0.0 | 226.39 | 0.000 | 1.336 | 99.413 | 159.71 | 0.000 | 0.000 | 100.000 |
| 2016 | 0.0 | 226.39 | 0.000 | 1.336 | 99.413 | 159.71 | 0.000 | 0.000 | 100.000 |
| 2016 | 0.0 | 226.39 | 0.000 | 1.336 | 99.413 | 159.71 | 0.000 | 0.000 | 100.000 |
| 2017 | 0.0 | 226.39 | 0.000 | 1.336 | 99.413 | 159.71 | 0.000 | 0.000 | 100.000 |
| 2017 | 2.6 | 225.01 | 1.384 | 2.720 | 98.806 | 159.71 | 0.000 | 0.000 | 100.000 |
| 2017 | 9.4 | 223.19 | 1.819 | 4.539 | 98.007 | 157.83 | 1.878 | 1.878 | 98.824 |
| 2018 | 0.0 | 223.19 | 0.000 | 4.539 | 98.007 | 157.83 | 0.000 | 1.878 | 98.824 |
| 2018 | 23.5 | 218.22 | 4.964 | 9.503 | 95.827 | 152.70 | 5.126 | 7.004 | 95.614 |
| 2018 | 2.2 | 217.11 | 1.118 | 10.621 | 95.336 | 151.55 | 1.154 | 8.158 | 94.892 |
| 2018 | 8.0 | 216.52 | 0.588 | 11.209 | 95.078 | 150.94 | 0.607 | 8.766 | 94.511 |
| 2018 | 8.8 | 215.27 | 1.243 | 12.452 | 94.532 | 149.66 | 1.283 | 10.049 | 93.708 |
| 2018 | 26.8 | 212.04 | 3.237 | 15.689 | 93.111 | 146.31 | 3.342 | 13.391 | 91.615 |
| 2018 | 5.4 | 211.44 | 0.597 | 16.286 | 92.849 | 145.70 | 0.617 | 14.007 | 91.229 |
| 2019 | 19.3 | 208.71 | 2.734 | 19.020 | 91.648 | 142.87 | 2.823 | 16.830 | 89.462 |
| 2019 | 9.9 | 207.28 | 1.423 | 20.443 | 91.023 | 141.41 | 1.469 | 18.299 | 88.542 |
| 2019 | 19.4 | 204.83 | 2.453 | 22.896 | 89.946 | 138.87 | 2.533 | 20.832 | 86.956 |
| 2020 | 21.0 | 203.29 | 1.538 | 24.434 | 89.270 | 137.55 | 1.321 | 22.154 | 86.128 |
| 2020 | 2.6 | 201.53 | 1.757 | 26.191 | 88.499 | 135.74 | 1.814 | 23.967 | 84.993 |
| 2020 | 0.2 | 201.04 | 0.496 | 26.687 | 88.281 | 135.23 | 0.512 | 24.479 | 84.672 |
| 2021 | 2.9 | 200.68 | 0.357 | 27.043 | 88.125 | 134.86 | 0.368 | 24.847 | 84.442 |
| 2021 | 10.7 | 199.16 | 1.520 | 28.564 | 87.457 | 133.29 | 1.570 | 26.417 | 83.459 |
| 2021 | 21.5 | 196.93 | 2.227 | 30.791 | 86.479 | 130.99 | 2.300 | 28.717 | 82.019 |
| 2021 | 5.8 | 196.41 | 0.522 | 31.313 | 86.250 | 130.45 | 0.539 | 29.256 | 81.681 |
| 2021 | 5.1 | 195.88 | 0.531 | 31.844 | 86.017 | 129.90 | 0.548 | 29.804 | 81.338 |
| 2021 | 4.4 | 195.62 | 0.258 | 32.102 | 85.903 | 129.90 | 0.000 | 29.804 | 81.338 |
| 2021 | 4.0 | 195.32 | 0.303 | 32.405 | 85.770 | 129.90 | 0.000 | 29.804 | 81.338 |
| 2021 | 17.9 | 194.32 | 0.998 | 33.403 | 85.332 | 129.90 | 0.000 | 29.804 | 81.338 |
| 2021 | 4.2 | 193.68 | 0.647 | 34.050 | 85.048 | 129.23 | 0.668 | 30.472 | 80.920 |
| 2021 | 5.4 | 193.31 | 0.365 | 34.415 | 84.888 | 128.86 | 0.377 | 30.849 | 80.684 |
| 2021 | 3.2 | 192.74 | 0.575 | 34.990 | 84.635 | 128.26 | 0.594 | 31.442 | 80.312 |
| 2021 | 6.0 | 192.22 | 0.517 | 35.507 | 84.408 | 127.73 | 0.534 | 31.976 | 79.978 |

Riding and non-riding Area: 84.4%

Riding area: 79.9%




Using 2013 emissions

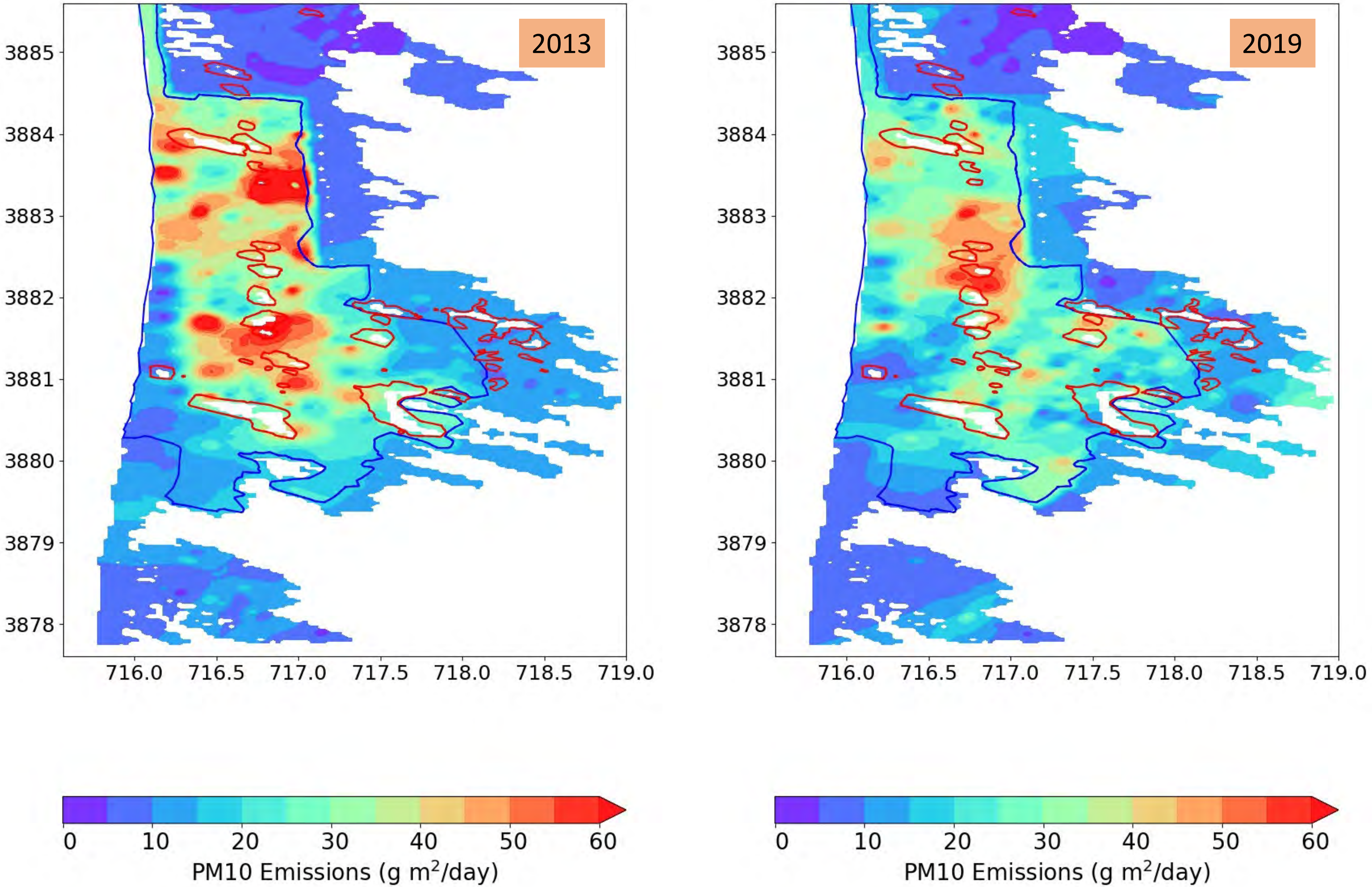
# Concentration reductions (2013 emissions) Mean 15 May- 15 July & 10 baseline days

CDF

| Concentration at CDF (24-hour means) | PM10 [microg/m^3] | % left after Removing |
|---|---|---|
| Observations | 52.4 | |
| Modeled Baseline | 51.1 | 100.0 |
| Modeled Removing 2011-2020 | 33.8 | 62.5 |
| Modeled Removing 2011-2021 | 33.5 | 65.5 |
| | | |
| 10 Highest Emission Days | PM10 [microg/m^3] | % left after Removing |
| Observations | 128.2 | |
| Modeled Baseline | 124.7 | 100 |
| Modeled Removing 2011-2020 | 72.4 | 58.1 |
| Modeled Removing 2011-2021 | 72.2 | 57.9 |

Mesa 2

| Concentration at Mesa 2 (24-hour means) | PM10 [microg/m^3] | % left after Removing |
|---|---|---|
| Observations | 39.7 | |
| Modeled Baseline | 34.4 | 100.0 |
| Modeled Removing 2011-2020 | 32.2 | 93.6 |
| Modeled Removing 2011-2021 | 27.1 | 78.8 |
| | | |
| 10 Highest Emission Days | PM10 [microg/m^3] | % left after Removing |
| Observations | 95.4 | |
| Modeled Baseline | 97.5 | 100.0 |
| Modeled Removing 2011-2020 | 91.2 | 93.6 |
| Modeled Removing 2011-2021 | 73.8 | 75.8 |

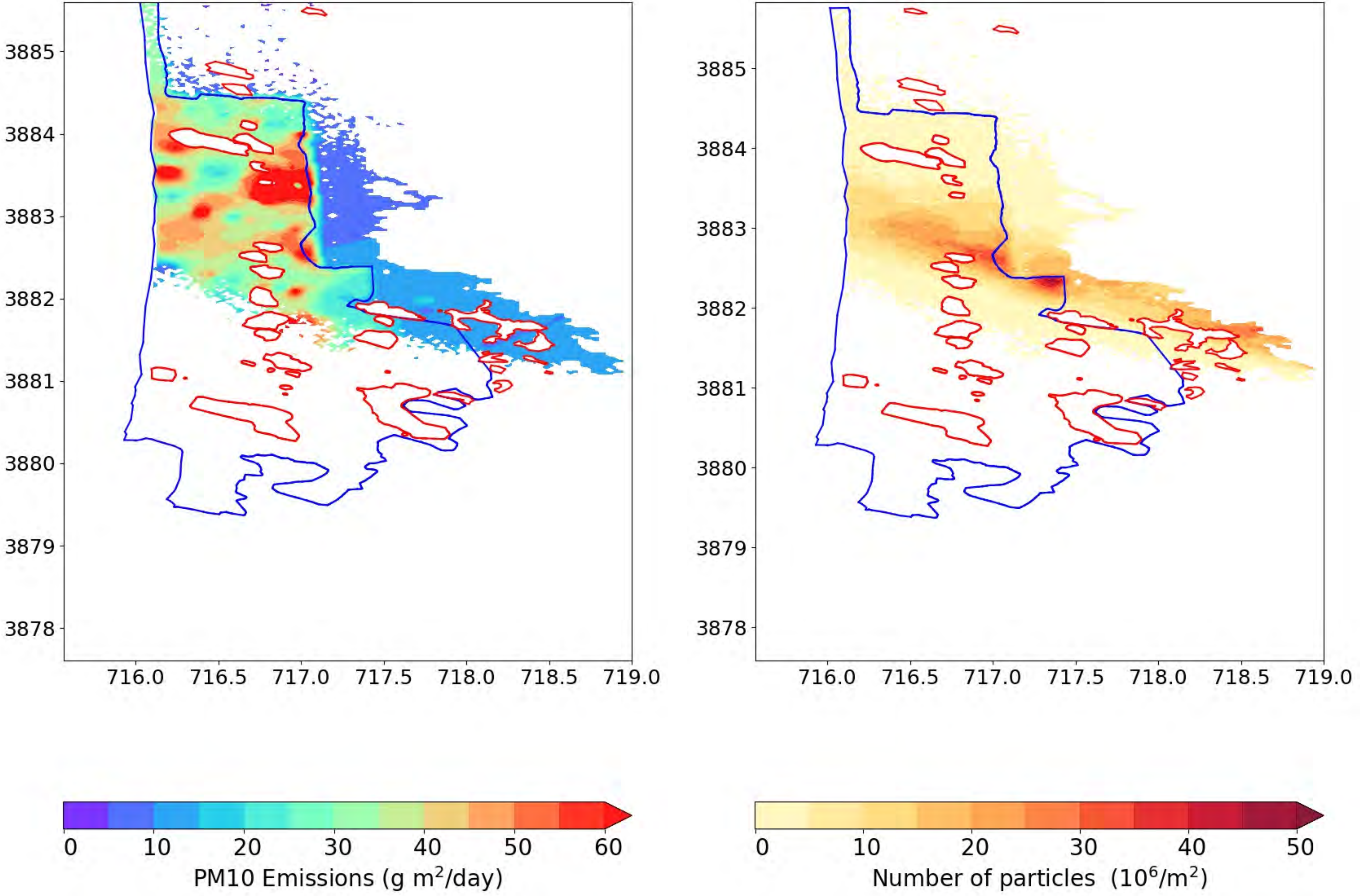


2013
2019
3885
3884
3883
3882
3881
3880
3879
3878
716.0
716.5
717.0
717.5
718.0
718.5
719.0
0
10
20
30
40
50
60
PM10 Emissions (g m$^2$/day)

Baseline

2013 Emissions

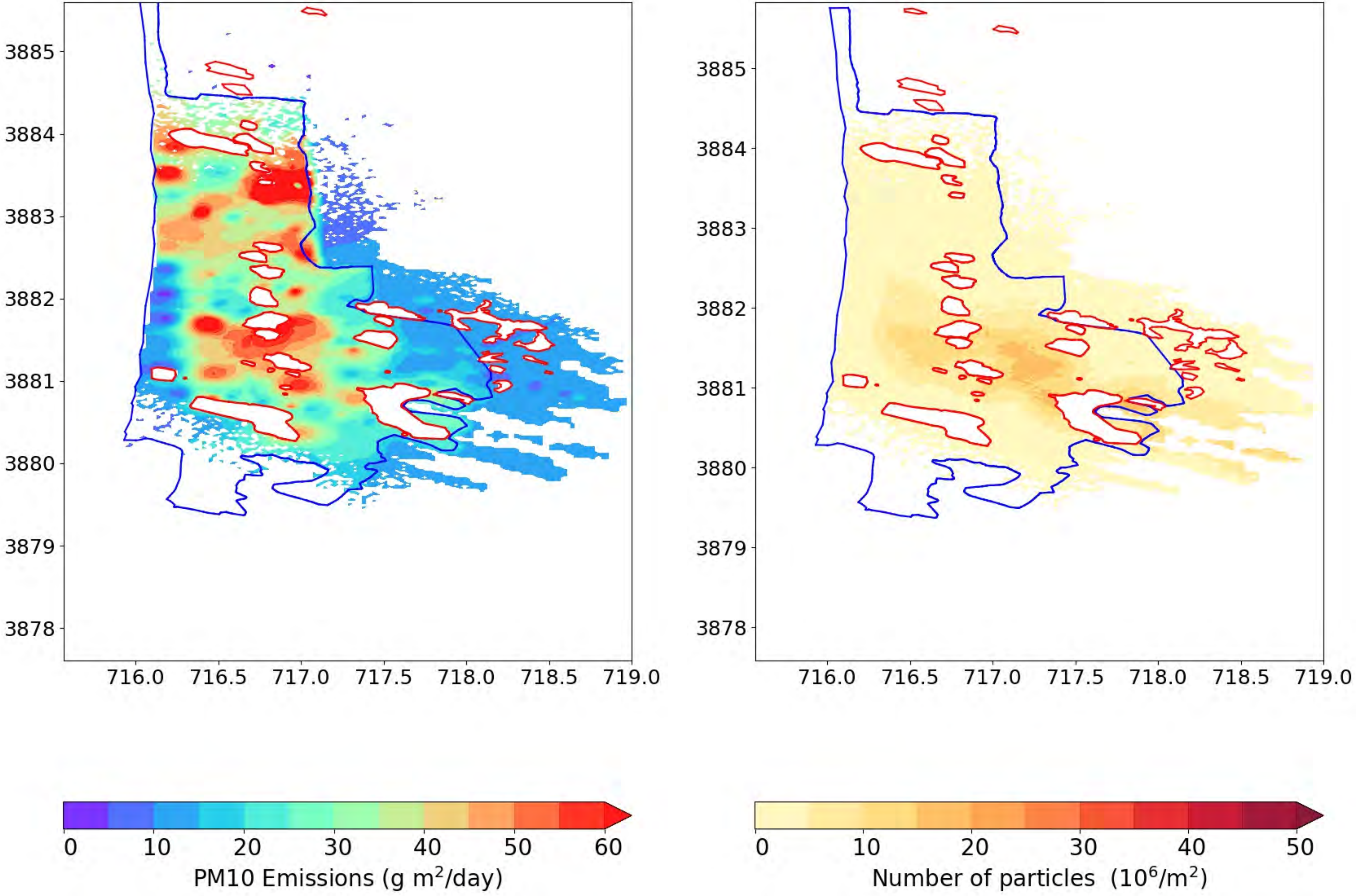
CDF



Baseline

2013 Emissions

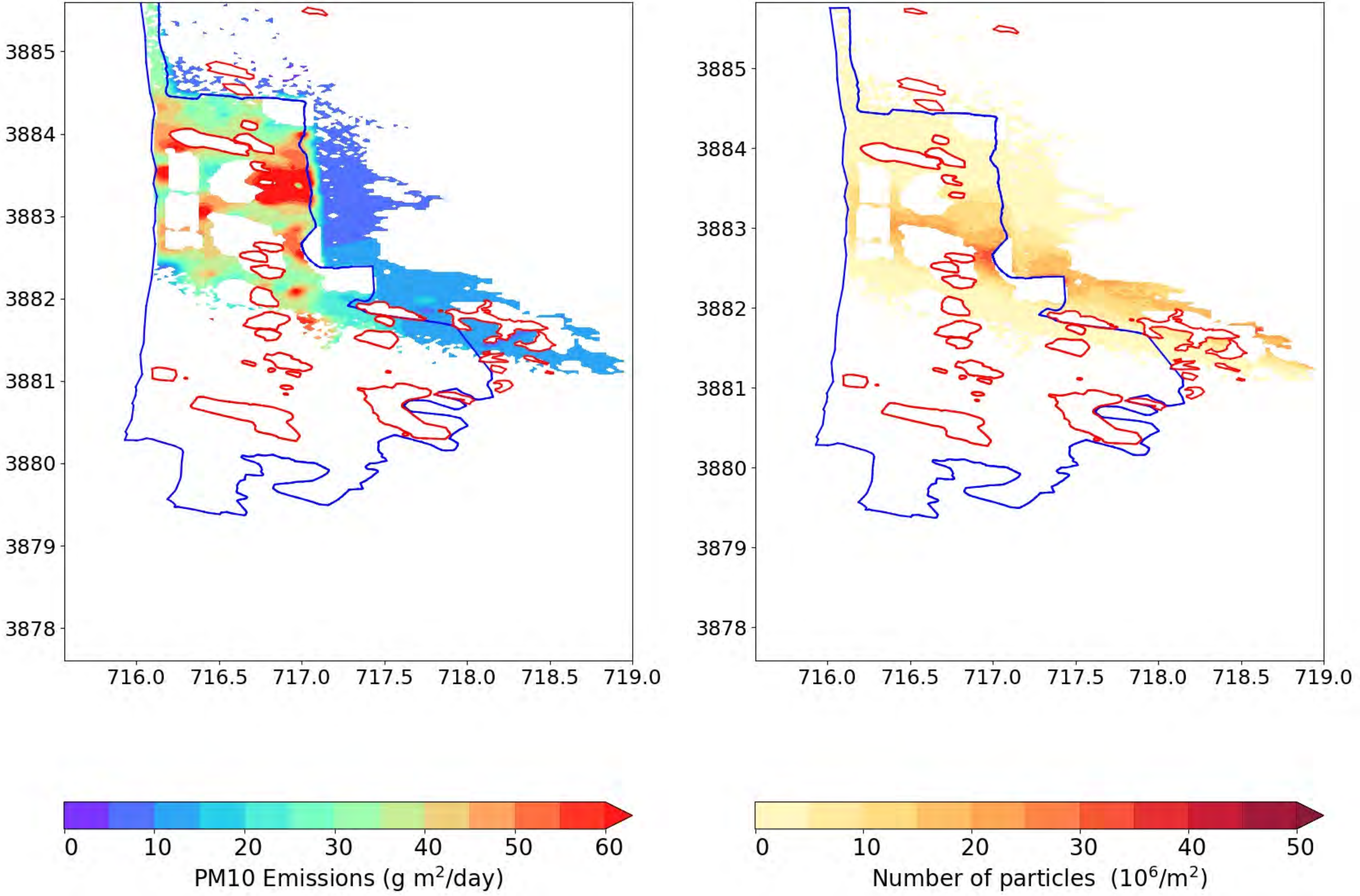
Mesa 2



2021 treatment

2013 Emissions

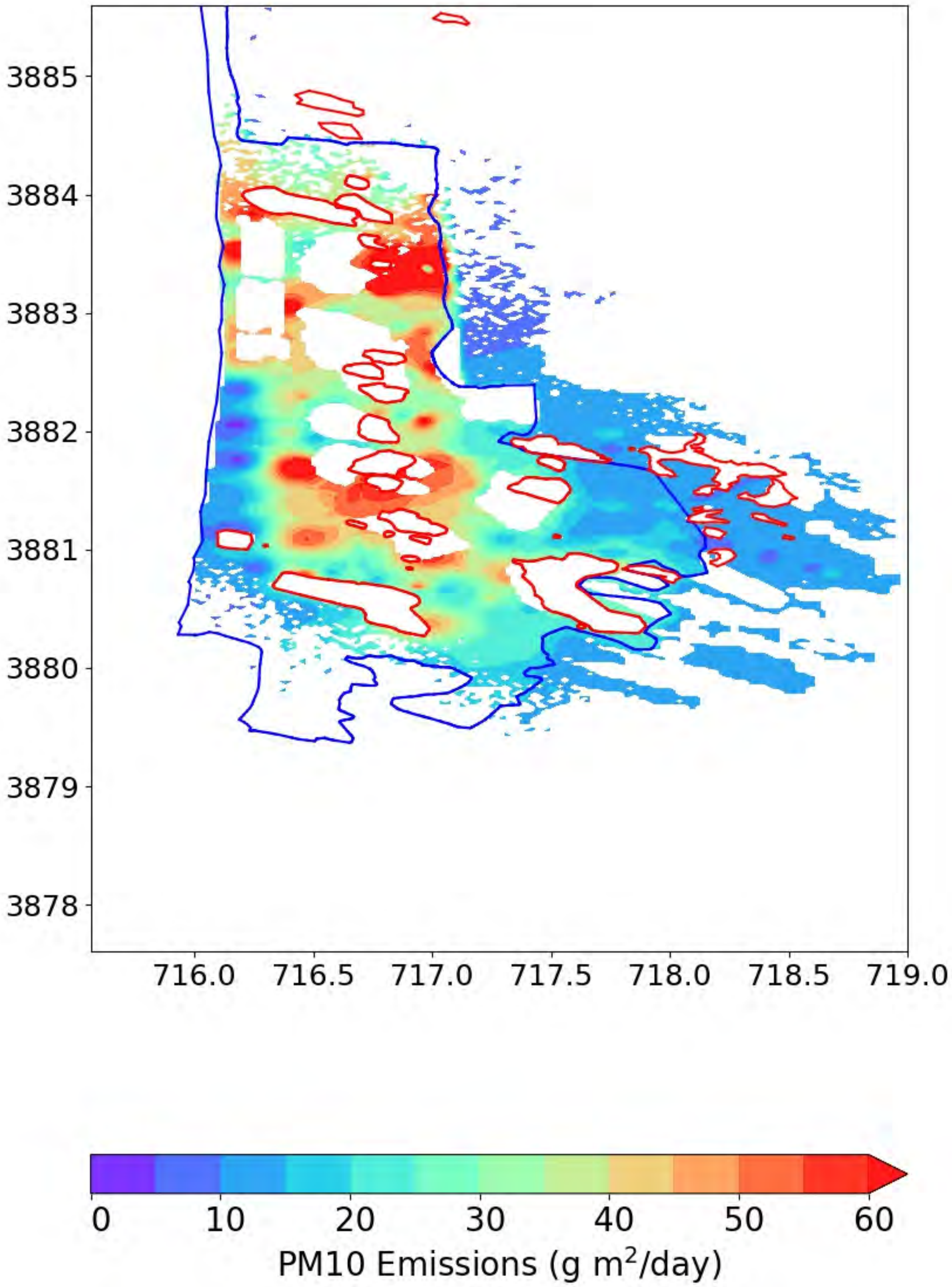
CDF

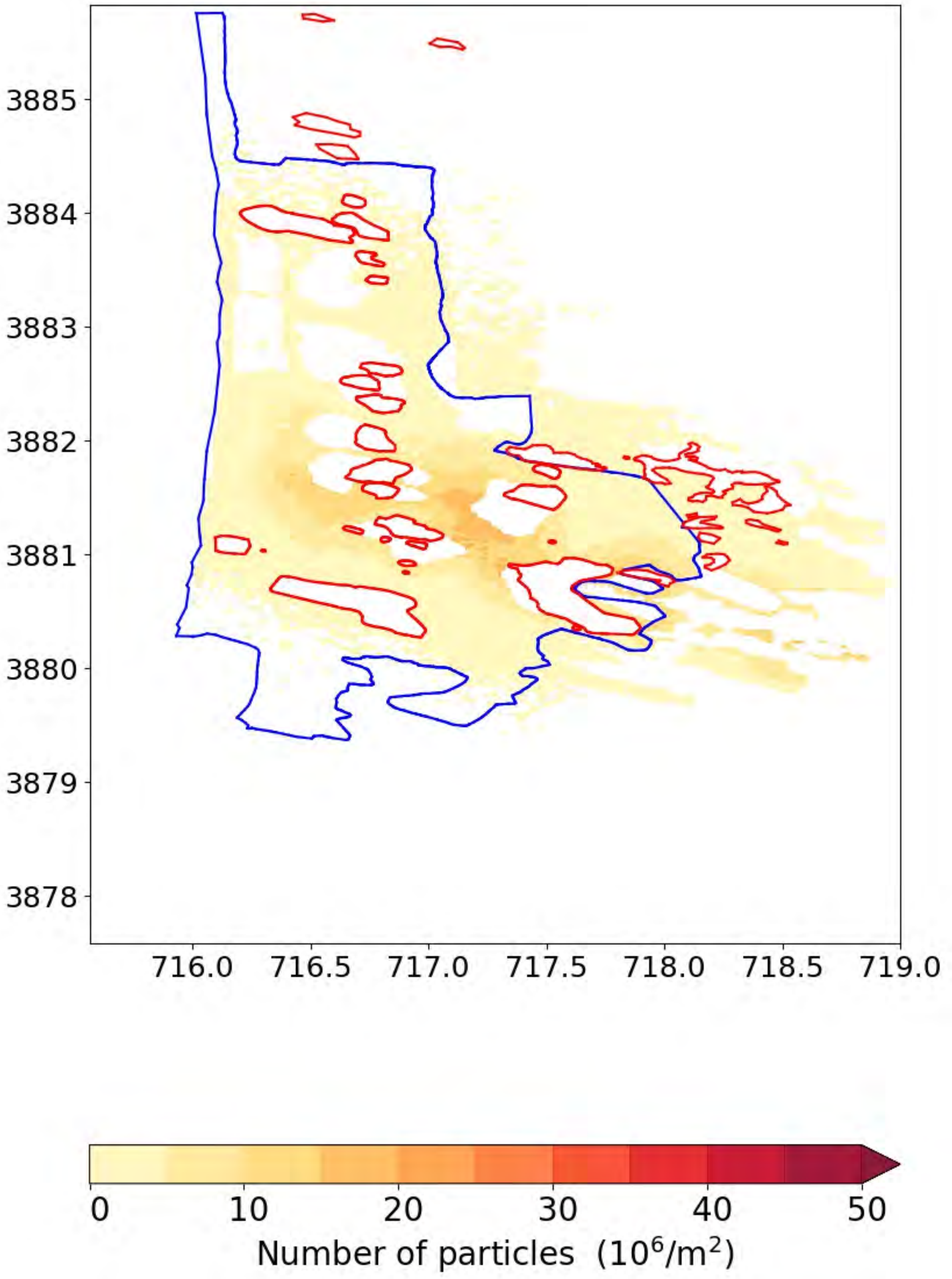


2021 treatment

2013 Emissions

Mesa 2



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**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

**ATTACHMENT 05**

**Sediment Trackout Prevention Measures**

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100% SUBMITTAL

# CALIFORNIA DEPARTMENT OF PARKS AND RECREATION
# FACILITIES AND DEVELOPMENT DIVISION
# OCEANO DUNES SVRA
# SEDIMENT TRACK-OUT PREVENTION MEASURES

SFM PERMIT APPLICATION NUMBER: 20-S-1574-CP-NW

## SCOPE OF WORK

THIS PROJECT INCLUDES THE CONSTRUCTION OF TWO CONCRETE V-GROOVED SEDIMENT TRAP TO PREVENT SEDIMENT TRACK-OUT AT TWO ENTRANCES TO OCEANO DUNES STATE VEHICULAR RECREATION AREA (PARK). THE PROJECT SITES ARE LOCATED AT THE ENTRANCES TO THE PARK AT GRAND AVENUE AND PIER AVENUE IN THE CITY OF OCEANO. THIS PROJECT ALSO INCLUDES MINOR ACCESSIBILITY WORK IN THE PARKING LOT OF PIER AVENUE.

## GENERAL NOTES

1. ALL MATERIALS SHOWN OR NOTED ON THE PLANS ARE NEW UNLESS CALLED OUT OTHERWISE.
2. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY ALL EXISTING CONDITIONS SHOWN OR DIMENSIONED HERE. ANY DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE STATE'S REPRESENTATIVE FOR RESOLUTION BEFORE PROCEEDING WITH THAT PORTION OF THE WORK.
3. ALL WORK SHALL COMPLY WITH THE CURRENT EDITION OF THE FOLLOWING LISTED CODES, AND ALL OTHERS HAVING JURISDICTION OVER THE WORK.

   TITLE 19, CCR, PUBLIC SAFETY, SFM REGULATIONS.
   2019 CA ADMINISTRATIVE CODE TITLE 24, PT 1.
   2019 CA BUILDING CODE (CBC) TITLE 24, PT 2.
   2019 CA ELECTRICAL CODE (CEC) TITLE 24, PT 3.
   2019 CA MECHANICAL CODE (CMC) TITLE 24, PT 4
   2019 CA PLUMBING CODE (CPC) TITLE 24, PT 5.
   2019 CA ENERGY CODE CCR TITLE 24, PT 6.
   2019 CA GREEN BUILDING STANDARDS TITLE 24, PT 11.
   2019 CA REFERENCED STANDARDS TITLE 24, PT 12.
   2010 ADA STANDARD FOR ACCESSIBLE DESIGN.
   THE SECRETARY OF THE INTERIOR'S STANDARDS FOR THE TREATMENT OF HISTORIC PROPERTIES.
4. CONDUCT ALL WORK IN ACCORDANCE WITH THE LATEST SAFETY RULES AND REGULATIONS OF ALL AUTHORITIES AND AGENCIES HAVING JURISDICTION OVER THE WORK.
5. ALL WORK SHALL BE IN ACCORDANCE WITH THE CONSTRUCTION DOCUMENTS. WHERE DETAILED INFORMATION OR CLARIFICATION IS REQUIRED, THE MATTER SHALL BE REFERRED TO THE STATE'S REPRESENTATIVE FOR WRITTEN RESOLUTION.
6. THE CONTRACTOR SHALL NOT SCALE THE DRAWINGS, BUT SHALL RELY ONLY ON THE WRITTEN DIMENSIONS GIVEN. IF A DISCREPANCY OCCURS OR NO DIMENSION IS GIVEN, THE CONTRACTOR SHALL NOTIFY THE STATE'S REPRESENTATIVE FOR WRITTEN CLARIFICATION BEFORE PROCEEDING WITH THAT PORTION OF THE WORK.

## SURVEY NOTES

THIS SURVEY IS BASED ON NAD83 (CSRC) EPOCH 2011 STATE PLANE COORDINATE SYSTEM ZONE 05, AND NAVD88 (GEOID12A) VERTICAL DATUM. USING GPS REAL-TIME NETWORK (CSDS RTN). THE FOLLOWING STATION gb1f HELD FIXED:

STATION Gb1f
N: 2239594.403
E: 5779296.013
EL: 89.804

UNITS ARE US SURVEY FEET, GRID DISTANCES. TO OBTAIN GROUND DISTANCES, DIVIDE DISTANCES BY THE PROJECT AVERAGE COMBINED SCALE FACTOR OF 0.99994575

THE UTILITIES SHOWN HAVE BEEN LOCATED FROM FIELD OBSERVATIONS ONLY. NO GUARANTEE THAT THE UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. NO WARRANT IS MADE THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED AS THEY WERE NOT PHYSICALLY LOCATED.

## ABBREVIATIONS

| | |
|---|---|
| AB | AGGREGATE BASE |
| AC | ASPHALT CONCRETE |
| CLR | CLEAR |
| DIA. | DIAMETER |
| (E) | EXISTING |
| ISA | INTERNATIONAL SYMBOL OF ACCESS |
| MAX | MAXIMUM |
| MIN | MINIMUM |
| NAD | NORTH AMERICAN DATUM |
| NAVD | NORTH AMERICAN VERTICAL DATUM |
| NTS | NOT TO SCALE |
| O.C. | ON CENTER |
| OSHA | OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION |
| (P) | PROPOSED |
| SF | SQUARE FEET |
| TYP. | TYPICAL |

## SYMBOLS LEGEND

A / A-1 — SECTION NUMBER / SHEET NUMBER

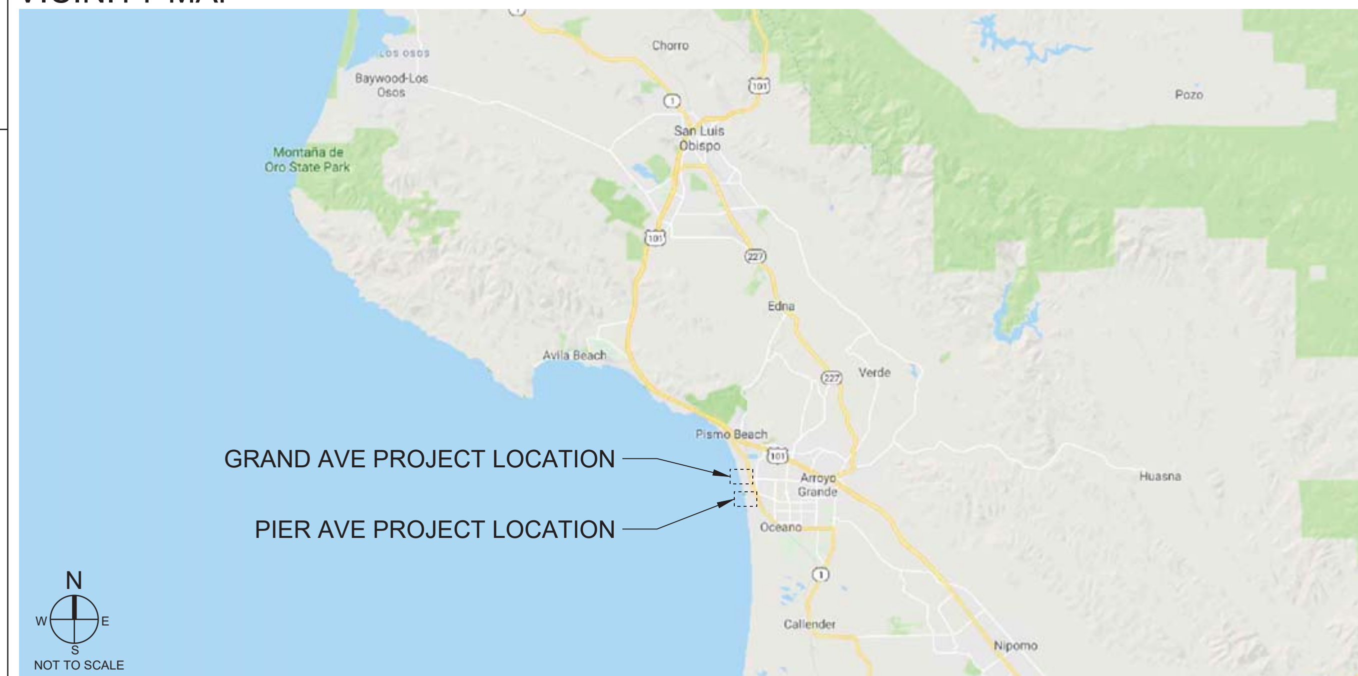
1 / A-1 — DETAIL NUMBER / SHEET NUMBER

1 — REVISION NUMBER

X' — DIMENSION LINE CENTER LINE

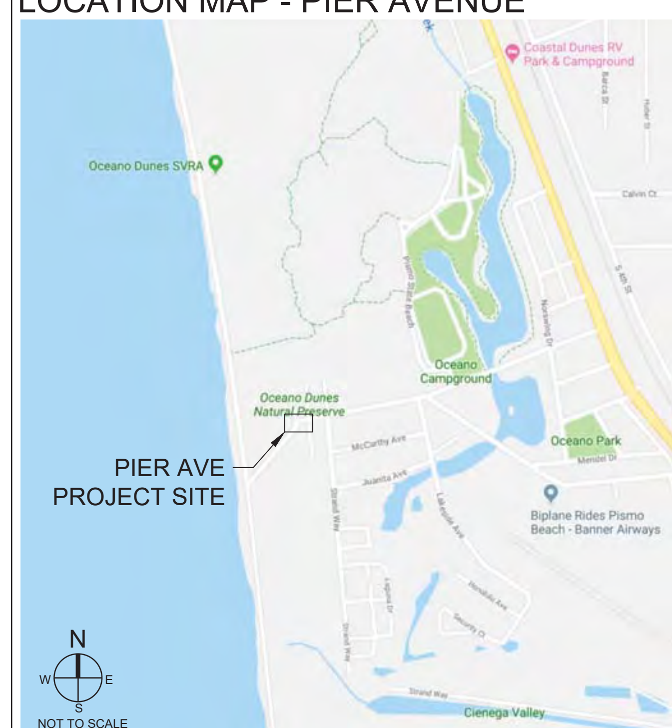
X' — DIMENSION LINE FACE OF MATERIAL

## VICINITY MAP




## LOCATION MAP - GRAND AVENUE


## LOCATION MAP - PIER AVENUE




## SHEET INDEX



UNDERGROUND SERVICE ALERT
811
CALL BEFORE YOU DIG

SHEET SIZE: 22X34

CALIFORNIA STATE PARKS SINCE 1864

FACILITIES & DEVELOPMENT
One Capitol Mall
Sacramento, CA 95814

REGISTERED PROFESSIONAL ENGINEER VINH LE No. 84125 SIGNED: 05/28/20 CIVIL STATE OF CALIFORNIA

OFFICE OF THE STATE FIRE MARSHAL APPROVED FIRE AND PANIC ONLY
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.
Reviewed by Date

DPR ACCESS COMPLIANCE REVIEW ACCESSIBILITY SECTION
Certification #
Reviewed by Date

ACCESSIBILITY COMPLIANCE AND STATE FIRE MARSHAL SIGNED ORIGINALS ARE ON FILE AT THE DEPARTMENT OF PARKS AND RECREATION, NORTHERN SERVICE CENTER

| | |
|---|---|
| DESIGNED: | VL |
| DRAWN: | VL |
| CHECKED: | KR |
| DATE: 05-28-2020 | |

REVISIONS

| | DATE |
|---|---|

OCEANO DUNES SVRA
SEDIMENT TRACK-OUT PREVENTION MEASURES
TITLE SHEET

DRAWING NO. 04535P.1

SHEET NO. G-1

1 OF 8

File: C:\Users\vinh.le\Desktop\Corna Virus\Oceano Dunes Trackout\05_Drawings\Sheet Set\G-1 TITLE SHEET.dwg Layout: G-1 TITLE SHEET Date: May 28 2020 - 1:42 pm User: Vinh.Le

## GENERAL NOTES:

1. CONTRACTOR SHALL, AT ALL TIMES, KEEP THE PREMISES FREE FROM ACCUMULATION OF WASTE MATERIALS OR RUBBISH CAUSED BY HIS WORK. AT THE COMPLETION OF THE WORK REMOVE ALL RUBBISH, TOOLS, AND SURPLUS MATERIALS, AND LEAVE THE JOB IN A BROOM CLEAN CONDITION.

2. SELECTIVE DEMOLITION SHALL BE DONE IN ACCORDANCE WITH THE CONSTRUCTION DOCUMENTS. REPAIR ANY DEMOLITION PERFORMED IN EXCESS OF THAT REQUIRED. RETURN STRUCTURES AND SURFACES TO THE CONDITION PRIOR TO COMMENCEMENT OF SELECTIVE DEMOLITION. REPAIR ADJACENT CONSTRUCTION OR SURFACES, SOILED OR DAMAGED, BY SELECTIVE DEMOLITION WORK.

3. A LOCATION FOR THE CONTRACTOR'S CORPORATION YARD WILL BE DESIGNATED WITHIN THE SITE BY THE STATE'S REPRESENTATIVE. CONTRACTOR IS PERMITTED TO FENCE THIS AREA TO PROTECT OFFICES, STORED MATERIAL AND EQUIPMENT. CONTRACTOR IS RESPONSIBLE FOR SECURING HIS/HER EQUIPMENT FROM THEFT OR VANDALISM.

4. THESE DRAWINGS DO NOT CONTAIN THE NECESSARY COMPONENTS FOR CONSTRUCTION SAFETY. WORKER AND PEDESTRIAN PROTECTION SHALL BE PROVIDED AND MAINTAINED BY THE CONTRACTOR AT THE CONTRACTOR'S EXPENSE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COMPLIANCE WITH ALL CURRENTLY APPLICABLE SAFETY LAWS OF ANY JURISDICTIONAL BODY, INCLUDING BUT NOT LIMITED TO OSHA REQUIREMENTS.

5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING THE EXACT LOCATION OF ALL EXISTING UTILITIES AND FOR THE PROTECTION AND REPAIR OF DAMAGE TO THEM. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING ALL UTILITIES AS TO THE LOCATION OF ALL UNDERGROUND FACILITIES CALL "UNDERGROUND SERVICE ALERT" 811, 48 HOURS BEFORE DIGGING. ALSO CALL THE NOTIFY THE STATE'S REPRESENTATIVE 48 HOURS PRIOR TO DIGGING.

6. THE CONTRACTOR IS RESPONSIBLE FOR SITE CONDITIONS CONTINUALLY DURING WORKING HOURS, INCLUDING PUBLIC SAFETY, DUST CONTROL, AND EROSION AND SEDIMENT CONTROL.

7. THE CONTRACTOR IS FINANCIALLY RESPONSIBLE FOR THE MAINTENANCE OR REPAIR OF OFFSITE STREET SURFACES WHERE DAMAGE HAS BEEN SUSTAINED BECAUSE OF THE CONSTRUCTION TRAFFIC.

8. CONSTRUCTION NOISE SHALL BE IN COMPLIANCE WITH CONSTRUCTION DOCUMENTS FOR SPECIFIC RESTRICTIONS AND HOURS OF OPERATION.

9. THE CONTRACTOR SHALL MAINTAIN AN ACCURATE RECORD OF ALL APPROVED DEVIATIONS FROM THE PLANS BEFORE AND DURING CONSTRUCTION. UPON COMPLETION OF WORK, ONE SET OF RED-LINED AS-BUILT PLANS SHALL BE SUBMITTED TO THE STATE'S REPRESENTATIVE FOR REVIEW AND ACCEPTANCE.

10. REFER TO GEOCON'S GEOTECHNICAL INVESTIGATION REPORT TITLED "OCEANO DUNES SRVA" PROJECT NUMBER S9030-05-72 FOR SUBSURFACE CONDITIONS. THE CONTRACTOR IS RESPONSIBLE FOR REVIEWING THE GEOTECHNICAL INVESTIGATION REPORT PRIOR TO BIDDING.

11. THE TYPES, LOCATIONS, SIZES, AND/OR DEPTHS OF EXISTING UNDERGROUND UTILITIES AS SHOWN ON THESE IMPROVEMENT PLANS WERE OBTAINED FROM SOURCES OF VARYING RELIABILITY. THE CONTRACTOR IS CAUTIONED THAT ONLY ACTUAL EXCAVATION WILL REVEAL THE TYPES, EXTENT, SIZES, LOCATIONS, AND DEPTHS OF SUCH UNDERGROUND UTILITIES. A REASONABLE EFFORT HAS BEEN MADE TO LOCATE AND DELINEATE ALL KNOWN UNDER-GROUND UTILITIES. HOWEVER THE STATE CAN ASSUME NO RESPONSIBILITY FOR THE COMPLETENESS OR ACCURACY OF ITS DELINEATION OF SUCH UNDERGROUND UTILITIES NOR FOR THE EXISTENCE OF OTHER BURIED OBJECTS OR UTILITIES WHICH MAY BE ENCOUNTERED BUT WHICH ARE NOT SHOWN ON THESE DRAWINGS.

12. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING THE STATE'S REPRESENTATIVE 48-HOURS PRIOR TO COMMENCING WORK AND 24-HOURS PRIOR TO RESUMPTION AFTER INTERRUPTION. REQUESTS FOR INSPECTION SHALL BE GIVEN 72-HOURS IN ADVANCE, AND BE PERFORMED BY THE STATE'S AUTHORIZED REPRESENTATIVE.

13. IT IS POSSIBLE THAT PREVIOUS ACTIVITIES HAVE OBSCURED SURFACE EVIDENCE OF CULTURAL RESOURCES OR THAT PREVIOUSLY UNDISCOVERED CULTURAL RESOURCES ARE LOCATED ON THE SITE. IF PREVIOUSLY UNIDENTIFIED CULTURAL RESOURCES ARE ENCOUNTERED DURING EARTH-MOVING ACTIVITIES, ALL CONSTRUCTION ACTIVITY WITHIN 100 FEET OF THE RESOURCES SHALL BE HALTED IMMEDIATELY, AND THE APPROPRIATE AUTHORITIES NOTIFIED. IF SUSPECTED HUMAN REMAINS ARE ENCOUNTERED, THE COUNTY CORONER AND THE DEPARTMENT PARKS AND RECREATION SHOULD BE NOTIFIED IMMEDIATELY. IF PREHISTORIC OR HISTORIC-ERA RESOURCES ARE ENCOUNTERED, THE DEPARTMENT PARKS AND RECREATION AND A QUALIFIED ARCHAEOLOGIST SHOULD BE NOTIFIED IMMEDIATELY.

14. THE CONTRACTOR SHALL BE RESPONSIBLE FOR REPORTING ALL CONFLICTS, ERRORS, OMISSIONS, ETC. TO THE STATE'S REPRESENTATIVE IMMEDIATELY UPON DISCOVERY. IF SO DIRECTED BY THE STATE'S REPRESENTATIVE, THE CONTRACTOR SHALL STOP WORK UNTIL MITIGATION CAN BE MADE. AND COSTS INCURRED RESULTING FROM THE CONTRACTOR'S FAILURE TO STOP WORK AS DIRECTED SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

15. APPROVAL OF THESE PLANS DOES NOT AUTHORIZE OR APPROVE ANY OMISSION OR DEVIATION FROM APPLICABLE REGULATIONS. FINAL APPROVAL IS SUBJECT TO FIELD INSPECTION. ONE SET OF APPROVED PLANS AND SPECIFICATIONS SHALL BE AVAILABLE ON THE PROJECT SITE AT ALL TIMES.

## V-GROOVE NOTES:

1. PRIOR TO BEGINNING CONCRETE WORK ON THE ACTUAL SEDIMENT TRAP, THE CONTRACTOR SHOULD BE REQUIRED TO MAKE 4' x 8' x 4" V-GROOVE CONCRETE TEST PANELS ON FLAT GROUND AT THE CONSTRUCTION SITE. UPON APPROVAL OF A TEST PANEL BY THE STATE'S REPRESENTATIVE, THE PANEL WILL DEMONSTRATE THE CONTRACTOR'S ABILITY TO FORM SATISFACTORY V-GROOVES AND WILL SERVE AS AN OBJECTIVE STANDARD ON THE SITE FOR JUDGING THE ACCEPTABILITY OF THE V-GROOVES FORMED ON THE ACTUAL SEDIMENT TRAP.

2. USE A CONCRETE CREW OF NOT LESS THAN 5 WORKERS INCLUDING AT LEAST 2 FINISHERS.

3. ALL TOOLS, SUPPLIES, EQUIPMENT AND MATERIALS ARE TO BE ON SITE BEFORE BEGINNING PLACEMENT OF CONCRETE.

4. FOR MULTIPLY LANE, PLACE CONCRETE AND FINISH ONE LANE AT A TIME.

5. START EARLY IN THE DAY WITH ATTENTION TO:

    5.1. TIME OF YEAR
    5.2. ALTITUDE
    5.3. HAUL DISTANCE
    5.4. TEMPERATURE
    5.5. WIND
    5.6. DESIGN MIX
    5.7. WEATHER FORECAST
    5.8. CLIMATE
    5.9. SIZE OF CREW

6. LIMIT PLACEMENT OF CONCRETE TO THE FOLLOWING MAXIMUM RATES PER HOUR:

    8-10 CY/HOUR FOR 6" THICK SECTIONS
    11-13 CY/HOUR FOR 8" THICK SECTIONS

    THIS WILL RESULT IN A PRODUCTION RATE OF ABOUT 30-35 LINEAR FEET OF 15' WIDE LANE PER HOUR, OR AN AREA OF ABOUT 450-525 SQUARE FEET.

7. ADEQUATELY VIBRATE THE CONCRETE EVERY 12" ON CENTER WITH INTERNAL VIBRATORS TO ELIMINATE AIR POCKETS, AND TO INSURE FULL CONTACT WITH THE REBAR AND CONSTRUCTION FORMS. DO NOT OVER-VIBRATE AS THE AGGREGATE WILL SETTLE TO THE BOTTOM AND WEAKEN THE CONCRETE SLAB.

8. IF NECESSARY, SCREED THE WET CONCRETE TO THE TOP OF THE FORMS USING A VIBRATORY POWER SCREED, WORKING UPHILL VIA HAND OR GASOLINE POWERED WINCHES.

9. WOOD FLOAT THE CONCRETE AS NECESSARY TO TOUCH UP AND REPAIR THE SCREEDED SURFACE.

10. BEGINNING AT THE APPROPRIATE LOWER CORNER, BEGIN FORMING V-GROOVES AT AN SPECIFIED ANGLE (SEE PLAN) FROM THE LONGITUDINAL AXIS OF THE SEDIMENT. INITIALLY, THERE WILL BE A TRIANGULAR AREA AT THE VERY BOTTOM OF THE SEDIMENT TRAP WITHIN WHICH IT WILL BE AWKWARD TO USE THE V-GROOVE TOOL HOWEVER, AFTER PROGRESSING UP THE SEDIMENT TRAP TO THE POINT WHERE THE V-GROOVE TOOL CAN BE USED OVER THE FULL WIDTH OF THE LAUNCHING LANE, THE GROOVING OPERATION WILL BE MUCH EASIER. CARE MUST BE TAKEN TO INSURE THAT THE ANGLES ON THE FRONT AND REAR OF THE V-GROOVE TOOL FIT SNUGLY AGAINST THE FORMS ON EACH PASS OF THE TOOL ACROSS THE WET CONCRETE. IT IS OFTEN HELPFUL TO FABRICATE A COUPLE OF SMALLER V-GROOVE HAND TOOLS TO USE IN THE TIGHT CORNERS ARE THE TOP AND BOTTOM FOR THE RAMP. FOR A 15' WIDE LANE, THE USE OF A STRAIGHT 20' LENGTH OF 2" x 6" LUMBER WILL BE OF GREAT ASSISTANCE IN MAINTAINING THE CORRECT ALIGNMENT AND PROVIDES A GUIDE FOR RUNNING THE V-GROOVE TOOL ACROSS THE WET CONCRETE. WHEN DONE PROPERLY, CRISP V-GROOVES CAN BE FORMED WITH ONLY ONE OR TWO PASSES OF THE TOOL. VIBRATE, SCREED AND V-GROOVE ONE HOURLY PLACEMENT OF CONCRETE BEFORE ALLOWING THE NEXT PLACEMENT. IF UNEXPECTED DELAYS OCCUR BETWEEN HOURLY PLACEMENTS DUE TO EQUIPMENT PROBLEMS, TRAFFIC, ETC., LEAVE THE ROUGH EDGE ALONG THE UPPER SIDE FOR THE LAST PLACEMENT GENERALLY ALONG THE SAME ANGLE ALIGNMENT OF THE V-GROOVES. THIS WILL ELIMINATE MOST OF THE PROBLEMS OF TRYING TO FINISH BOTH "OLD" AND "NEW" CONCRETE ON THE SAME PASS OF THE FINISH TOOL. TO ASSIST CONTRACTORS AND OTHERS IN THE CONSTRUCTION OF V-GROOVE SURFACES, THE DIVISION OF BOATING AND WATERWAYS HAS PRODUCED AN EIGHT MINUTE VIDEO WHICH ILLUSTRATES THE INFORMATION PRESENTED ABOVE. THE VIDEO CAN BE ORDERED BY CONTACTING THE STATE'S REPRESENTATIVE AS PER THE INFORMATION AT THE END OF THE INTRODUCTION TO THE LAYOUT, DESIGN AND CONSTRUCTION HANDBOOK BY THE DEPARTMENT OF BOATING AND WATERWAYS.

## TESTING REQUIREMENTS:

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL EARTHWORK COMPACTION TESTING. THE STATE'S REPRESENTATIVE SHALL BE NOTIFIED AT LEAST 72-HOURS IN ADVANCE OF ANY SCHEDULED COMPACTION TESTING BEING PERFORMED ON THE SITE. ALL COMPACTION TESTING SHALL BE PERFORMED BY A REGISTERED SOIL ENGINEER IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS AND SHALL BE PAID FOR BY THE CONTRACTOR. RESULTS OF THESE TESTS SHALL BECOME THE PROPERTY OF THE STATE. ANY RE-TESTING DEEMED NECESSARY BY THE STATE'S REPRESENTATIVE SHALL BE PAID FOR BY THE CONTRACTOR.

2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL AGGREGATE BASE COMPACTION TESTING. THE STATE'S REPRESENTATIVE SHALL BE NOTIFIED AT LEAST 72-HOURS IN ADVANCE OF ANY SCHEDULED COMPACTION TESTING BEING PERFORMED ON THE SITE. ALL COMPACTION TESTING SHALL BE PERFORMED BY A REGISTERED SOIL ENGINEER IN ACCORDANCE WITH THE WITH THE PROJECT SPECIFICATIONS AND SHALL BE PAID FOR BY THE CONTRACTOR. RESULTS OF THESE TESTS SHALL BECOME THE PROPERTY OF THE STATE. ANY RE-TESTING DEEMED NECESSARY BY THE STATE'S REPRESENTATIVE SHALL BE PAID FOR BY THE CONTRACTOR

3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY AGGREGATE CONCRETE TESTING IF DEEMED NECESSARY BY THE STATE'S REPRESENTATIVE. THE STATE'S REPRESENTATIVE SHALL BE NOTIFIED AT LEAST 72-HOURS IN ADVANCE OF ANY SCHEDULED PAVING OPERATION BEING PERFORMED ON THE SITE.

4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR EMPLOYING A TESTING AGENCY TO PERFORM CONCRETE TESTING AT THEIR EXPENSE. ALL RESULTS OF THE CONCRETE TESTING SHALL BECOME PROPERTY OF THE STATE. THE CONTRACTOR SHALL SUPPLY ONE (1) SET OF FOUR (4) STANDARD CYLINDERS FOR EVERY 20 CUBIC YARDS OF CONCRETE PLACED, OR FOR EACH MAJOR PLACEMENT DURING THE DAY. ONE SPECIMEN SHALL BE TESTED AT SEVEN (7) DAYS, TWO (2) SPECIMENS TESTED AT 28 DAYS, AND ONE (1) SPECIMEN RETAINED IN RESERVE FOR LATER TESTING IF REQUIRED. COMPRESSIVE STRENGTH TESTS SHALL BE PERFORMED AS PER REQUIREMENTS SET FORTH IN THE PROJECT SPECIFICATIONS. THE STATE'S REPRESENTATIVE SHALL BE NOTIFIED AT LEAST 72-HOURS IN ADVANCE OF ANY SCHEDULED CONCRETE POURING BEING PERFORMED ON THE SITE. PRIOR TO ANY CONCRETE PLACEMENT, FORMWORK AND REBAR PLACEMENT MUST BE INSPECTED AND APPROVED BY THE STATE'S REPRESENTATIVE. FAILURE RECEIVE APPROVAL BY THE STATE'S REPRESENTATIVE ON FORMWORK AND REBAR PLACEMENT PRIOR TO POURING CONCRETE MAY RESULT IN THE CONTRACTOR DEMOLISHING IMPROVEMENTS AT THEIR EXPENSE.

## ACCESSIBILITY NOTES:

1. ALL FLATWORK AND CURBS SHALL BE CONSTRUCTED TO COMPLY WITH CURRENT TITLE 24 ADA ACCESSIBILITY LAWS. THIS REQUIRES "EXTRA EFFORT" IN ACHIEVING THE ACCURACY OF THE GRADES AND SLOPES REQUIRED (FINISHED GRADES OF CONCRETE IN TITLE 24 AREAS SHALL BE WITHIN A TOLERANCE OF ±1/8" OF PROPOSED GRADES). PRIOR TO POURING ANY CURB OR FLATWORK AROUND THE PERIMETER OF ANY BUILDING, THE CONCRETE CONTRACTOR SHALL VERIFY THAT THE GRADE OF THE FINISHED FLOOR AND THE FLATWORK/CURB FORMS ARE IN THE PROPER GRADE DIFFERENTIAL PRIOR TO POURING CONCRETE ON ANY TITLE 24 ROUTE OF ACCESS. IF ANY DIFFERENCES ARE FOUND, NOTIFY THE STATE'S REPRESENTATIVE IMMEDIATELY PRIOR TO PROCEEDING.
2. PARKING
    2.1. SURFACE SLOPES FOR PARKING SPACES AND ACCESS AISLES SERVING THEM SHALL NOT EXCEED 2% IN ANY DIRECTION.

SHEET SIZE: 22X34


FACILITIES & DEVELOPMENT
One Capitol Mall
Sacramento, CA 95814

REGISTERED PROFESSIONAL ENGINEER
VINH LE
No. 84125
SIGNED: 05/28/20
CIVIL
STATE OF CALIFORNIA


OFFICE OF THE STATE FIRE MARSHAL
APPROVED FIRE AND PANIC ONLY

Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.

Reviewed by Date

DPR ACCESS COMPLIANCE REVIEW
ACCESSIBILITY SECTION

Certification #

Reviewed by Date

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| | |
|---|---|
| DESIGNED: | VL |
| DRAWN: | VL |
| CHECKED: | KR |
| DATE: 05-28-2020 | |

| REVISIONS | |
|---|---|
| △ | DATE |
| | |

OCEANO DUNES SVRA
SEDIMENT TRACK-OUT PREVENTION MEASURES

# GENERAL NOTES

DRAWING NO.
04535P.2

SHEET NO.
G-2

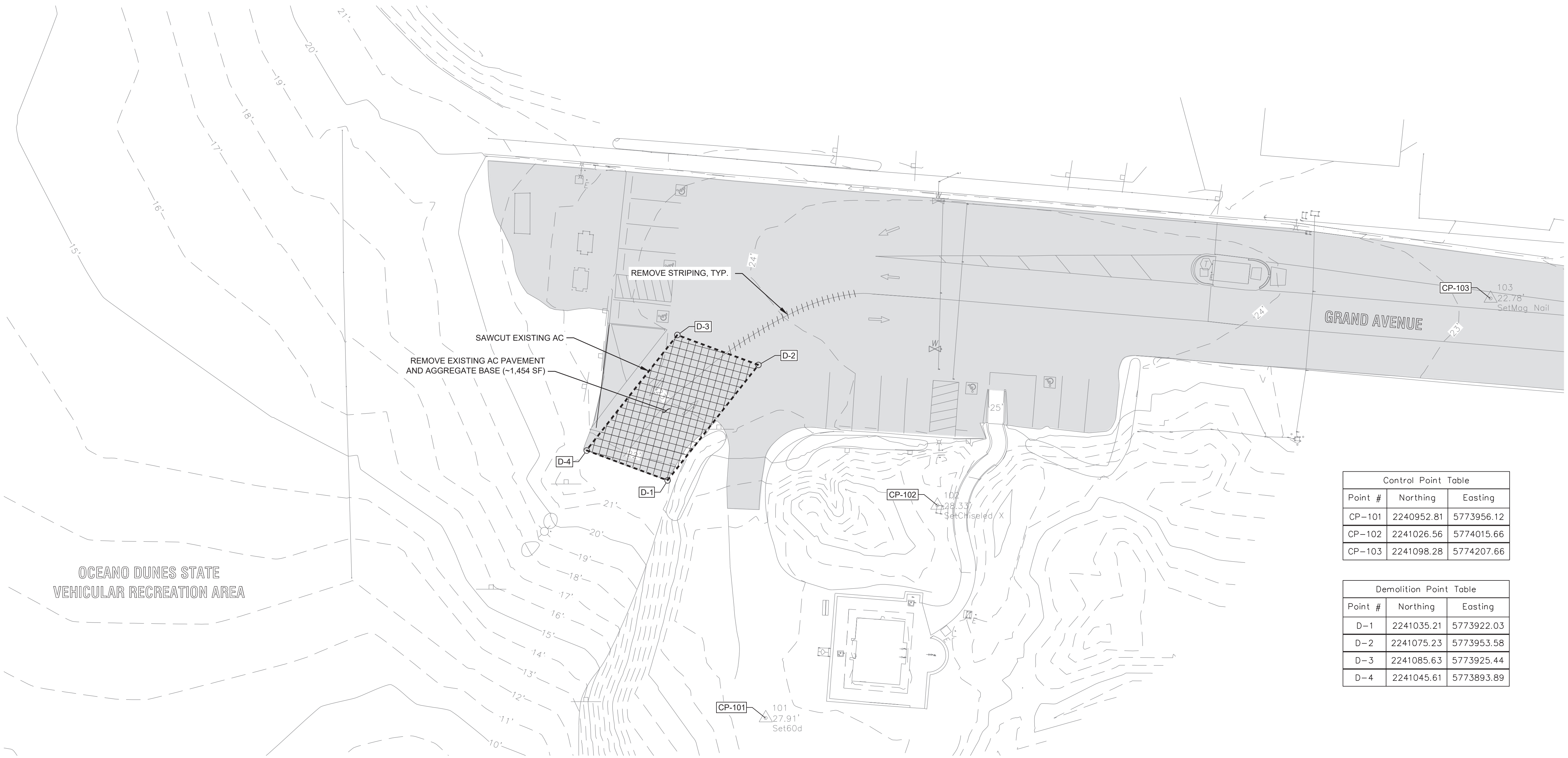


100% SUBMITTAL


File: C:\Users\vinh.le\Desktop\Corna Virus\Oceano Dunes Trackout\05_Drawings\Engineering\G-2 GENERAL NOTES.dwg Layout: G-2 GENERAL NOTES Date: May 28 2020 - 1:48 pm User: Vinh.Le

100% SUBMITTAL






EXISTING SITE AND DEMOLITION PLAN - GRAND AVENUE

SCALE: 1" - 20'

Control Point Table

| Point # | Northing | Easting |
|---|---|---|
| CP-101 | 2240952.81 | 5773956.12 |
| CP-102 | 2241026.56 | 5774015.66 |
| CP-103 | 2241098.28 | 5774207.66 |

Demolition Point Table

| Point # | Northing | Easting |
|---|---|---|
| D-1 | 2241035.21 | 5773922.03 |
| D-2 | 2241075.23 | 5773953.58 |
| D-3 | 2241085.63 | 5773925.44 |
| D-4 | 2241045.61 | 5773893.89 |

## LEGEND

- EXISTING AC TO BE DEMOLISHED AND REMOVED (~1,454 SF)
- EXISTING AC ROADWAY TO REMAIN UNDISTURBED
- SAWCUT LINE
- REMOVE STRIPING

## DEMOLITION NOTES

1. CONSTRUCTION SITE SHALL BE KEPT CLEAR FROM THE DEBRIS AND CONSTRUCTION MATERIAL.
2. CONTRACTOR SHALL LEGALLY DISPOSE OF CONSTRUCTION DEBRIS OFFSITE.
3. CONTRACTOR SHALL WORK ON ONE LOCATION AT A TIME TO ENSURE THAT VEHICULAR ACCESS TO THE BEACH IS AVAILABLE.

N W E S

1"=20'

0 10 20 40

SHEET SIZE: 22X34

CALIFORNIA STATE PARKS SINCE 1864

FACILITIES & DEVELOPMENT
One Capitol Mall
Sacramento, CA 95814

REGISTERED PROFESSIONAL ENGINEER VINH LE No. 84125 SIGNED: 05/28/20 CIVIL STATE OF CALIFORNIA

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DESIGNED: VL
DRAWN: VL
CHECKED: KR
DATE: 05-28-2020

REVISIONS

DATE

OCEANO DUNES SVRA
SEDIMENT TRACK-OUT PREVENTION MEASURES

EXISTING SITE AND DEMOLITION PLAN - GRAND AVENUE

DRAWING NO. 04535P.3

SHEET NO. C-1

100% SUBMITTAL


EXISTING SITE AND DEMOLITION PLAN - PIER AVENUE

SCALE: 1" - 20'

Control Point Table

| Point # | Northing | Easting |
|---|---|---|
| CP-101 | 2235048.32 | 5775134.55 |
| CP-102 | 2234788.17 | 5775151.13 |
| CP-103 | 2234986.22 | 5775015.77 |
| CP-104 | 2235051.30 | 5774928.89 |
| CP-105 | 2235061.78 | 5775016.38 |
| CP-106 | 2235210.12 | 5774918.51 |

Demolition Point Table

| Point # | Northing | Easting |
|---|---|---|
| D-1 | 2234962.4681 | 5774941.13 |
| D-2 | 2234980.2073 | 5774950.31 |
| D-3 | 2234994.9965 | 5774947.81 |
| D-4 | 2234993.2313 | 5774937.49 |
| D-5 | 2235019.9554 | 5774916.01 |
| D-6 | 2234979.4819 | 5774899.48 |

## LEGEND

- EXISTING AC TO BE DEMOLISHED AND REMOVED (~1,897 SF)
- EXISTING AC ROADWAY TO REMAIN UNDISTURBED
- SAWCUT LINE
- REMOVE STRIPING

## DEMOLITION NOTES

1. CONSTRUCTION SITE SHALL BE KEPT CLEAR FROM THE DEBRIS AND CONSTRUCTION MATERIAL.
2. CONTRACTOR SHALL LEGALLY DISPOSE OF CONSTRUCTION DEBRIS OFFSITE.
3. CONTRACTOR SHALL WORK ON ONE LOCATION AT A TIME TO ENSURE THAT VEHICULAR ACCESS TO THE BEACH IS AVAILABLE.

N W E S

1"=20'

0 10 20 40

SHEET SIZE: 22X34

File: C:\Users\vinh.le\Desktop\Corna Virus\Oceano Dunes Trackout\05_Drawings\Engineering\C-2 EXISTING SITE AND DEMOLITION PLAN - PIER AVENUE.dwg Layout: C-2 EXISTING SITE AND DEMOLITION PLAN - PIER AVENUE Date: May 28 2020 - 1:45 pm Use $(++)

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FACILITIES & DEVELOPMENT
One Capitol Mall
Sacramento, CA 95814

REGISTERED PROFESSIONAL ENGINEER VINH LE No. 84125 SIGNED: 05/28/20 CIVIL STATE OF CALIFORNIA

OFFICE OF THE STATE FIRE MARSHAL APPROVED FIRE AND PANIC ONLY

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OCEANO DUNES SVRA
SEDIMENT TRACK-OUT PREVENTION MEASURES

# EXISTING SITE AND DEMOLITION PLAN - PIER AVENUE

DRAWING NO. 04535P.4

SHEET NO. C-2

4 OF 8

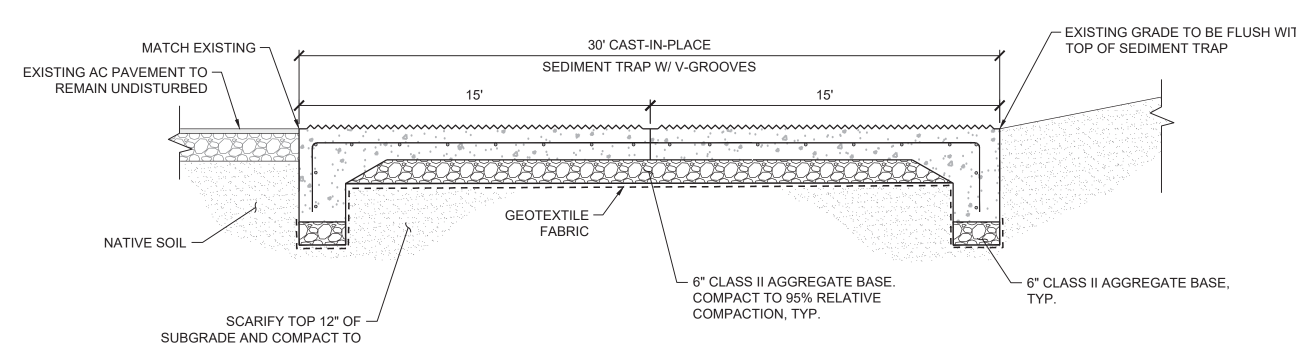
100% SUBMITTAL


## SITE IMPROVEMENT PLAN - GRAND AVENUE

SCALE: 1" - 20'

## LEGEND

- PROPOSED CONCRETE SEDIMENT TRAP WITH V-GROOVES
- PROPOSED CONCRETE
- PROPOSED CLASS II AGGREGATE BASE
- EXISTING AC ROADWAY TO REMAIN UNDISTURBED
- EXISTING AGGREGATE BASE
- NATIVE SOIL
- PROPOSED GEOTEXTILE FABRIC
- PROPOSED CENTERLINE STRIPING




## SECTION A

NOT TO SCALE

N W E S

1"=20'

0 10 20 40

SHEET SIZE: 22X34

FACILITIES & DEVELOPMENT
One Capitol Mall
Sacramento, CA 95814

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VINH LE
No. 84125
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OCEANO DUNES SVRA
SEDIMENT TRACK-OUT PREVENTION MEASURES

# SITE IMPROVEMENT PLAN - GRAND AVENUE

DRAWING NO.
04535P.5

SHEET NO.
C-3

5 OF 8

File: C:\Users\vinh.le\Desktop\Corna Virus\Oceano Dunes Trackout\05_Drawings\Engineering\C-3 SITE IMPROVEMENT PLAN - GRAND AVENUE.dwg Layout: C-3 SITE IMPROVEMENT PLAN - GRAND AVENUE Date: May 28 2020 - 2:10 pm User: Vinh.Le

100% SUBMITTAL

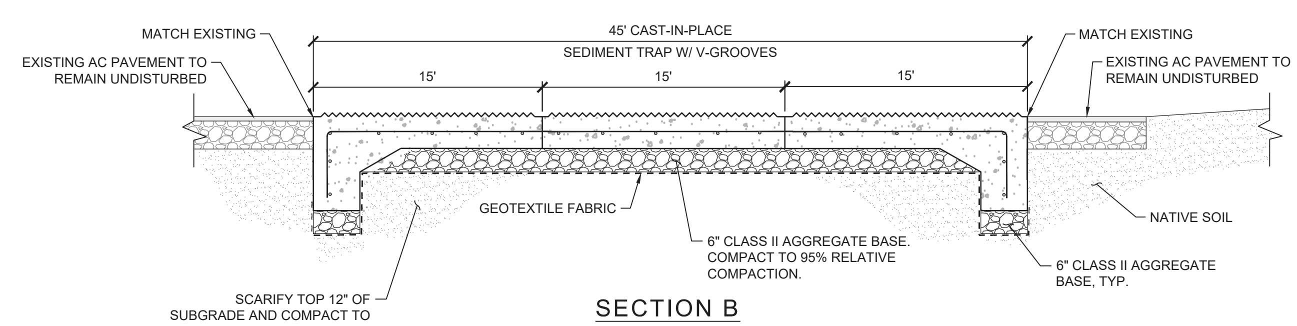
File: C:\Users\vinh.le\Desktop\Corna Virus\Oceano Dunes Trackout\05_Drawings\Engineering\C-4 SITE IMPROVEMENT PLAN - PIER AVENUE.dwg Layout: C-4 SITE IMPROVEMENT PLAN - PIER AVENUE Date: May 28 2020 - 2:10 pm User: Vinh.Le


## SITE IMPROVEMENT PLAN - PIER AVENUE

SCALE: 1" - 20'

## LEGEND

| | |
|---|---|
| | PROPOSED CONCRETE SEDIMENT TRAP WITH V-GROOVES |
| | PROPOSED CONCRETE |
| | PROPOSED CLASS II AGGREGATE BASE |
| | EXISTING AC ROADWAY TO REMAIN UNDISTURBED |
| | EXISTING AGGREGATE BASE |
| | NATIVE SOIL |
| - - - - - - | PROPOSED GEOTEXTILE FABRIC |




## SECTION B

NOT TO SCALE

N S W E

1"=20'

0 10 20 40

SHEET SIZE: 22X34

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One Capitol Mall
Sacramento, CA 95814

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VINH LE
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OCEANO DUNES SVRA
SEDIMENT TRACK-OUT PREVENTION MEASURES

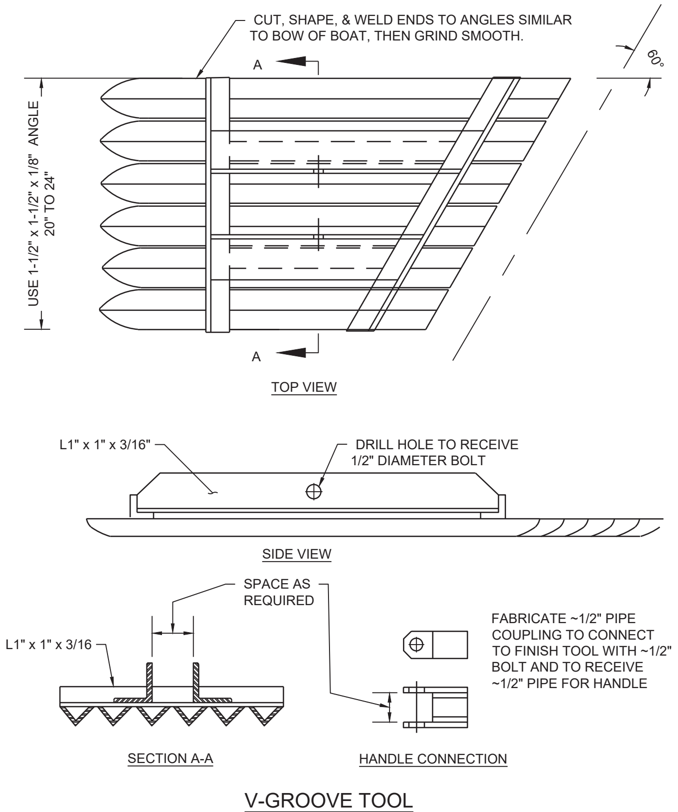
# SITE IMPROVEMENT PLAN - PIER AVENUE

DRAWING NO.
04535P.6

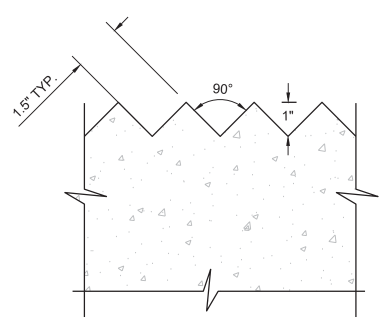
SHEET NO.
C-4

6 OF 8

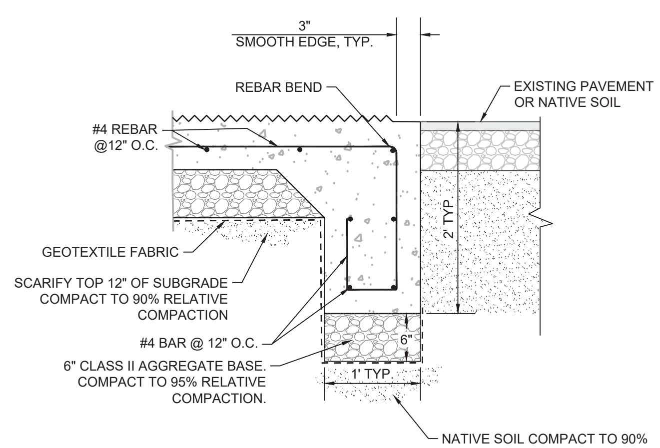
100% SUBMITTAL



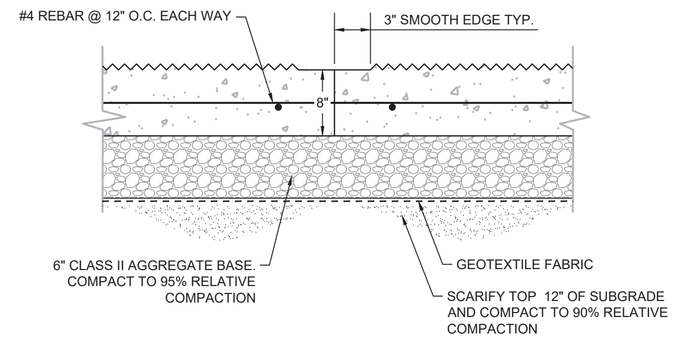

1 V-GROOVE LAYOUT & TOOL
NTS



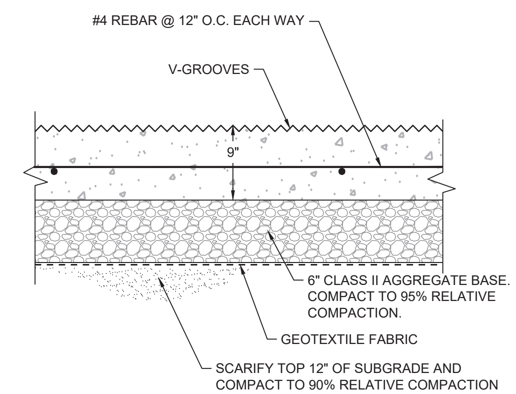

2 V-GROOVES
NTS



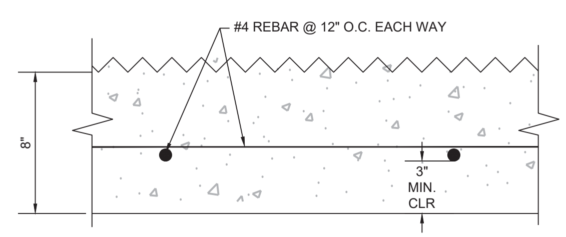

3 TURNDOWN FOOTING
NTS



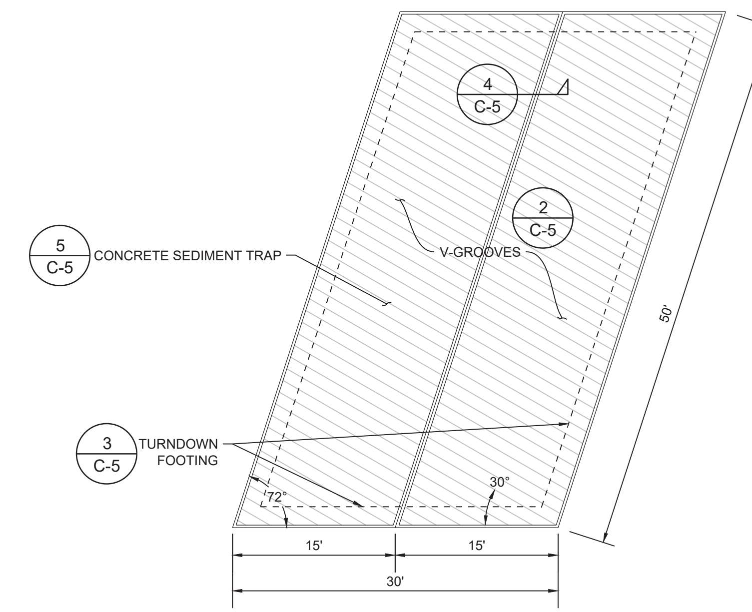

4 CONTROL JOINT
NTS



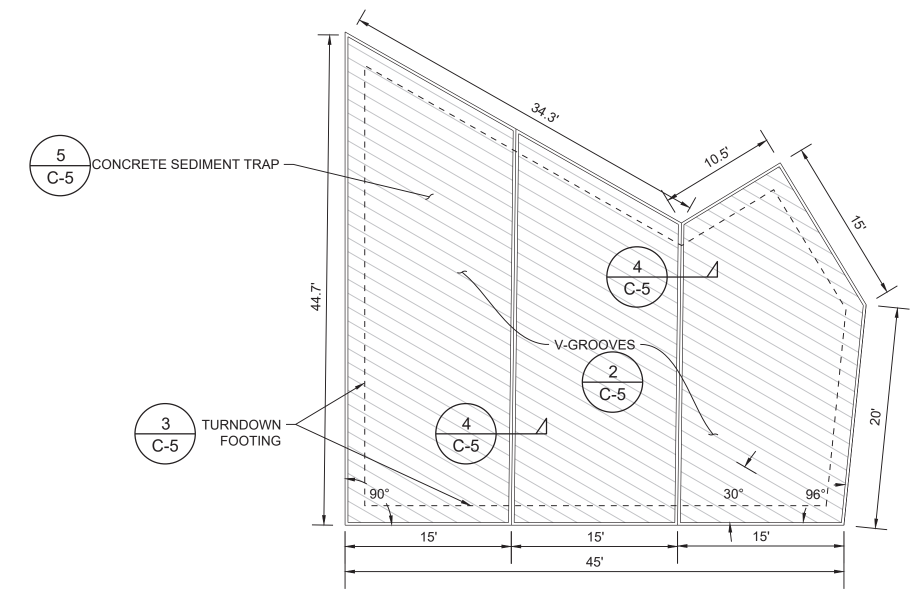

5 CONCRETE SEDIMENT TRAP
NTS




6 REBAR CLEARANCE
NTS




7 SEDIMENT TRAP LAYOUT - GRAND AVENUE
NTS




8 SEDIMENT TRAP LAYOUT - PIER AVENUE
NTS

File: C:\Users\vinh.le\Desktop\Corna Virus\Oceano Dunes Trackout\05_Drawings\Engineering\C-5 CONSTRUCTION DETAILS.dwg Layout: C-5 CONSTRUCTION DETAILS Date: May 28 2020 - 2:11 pm User: Vinh.Le

SHEET SIZE: 22X34

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No. 84125
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OCEANO DUNES SVRA
SEDIMENT TRACK-OUT PREVENTION MEASURES
# CONSTRUCTION DETAILS

DRAWING NO.
04535P.7

SHEET NO.
C-5
7 OF 8

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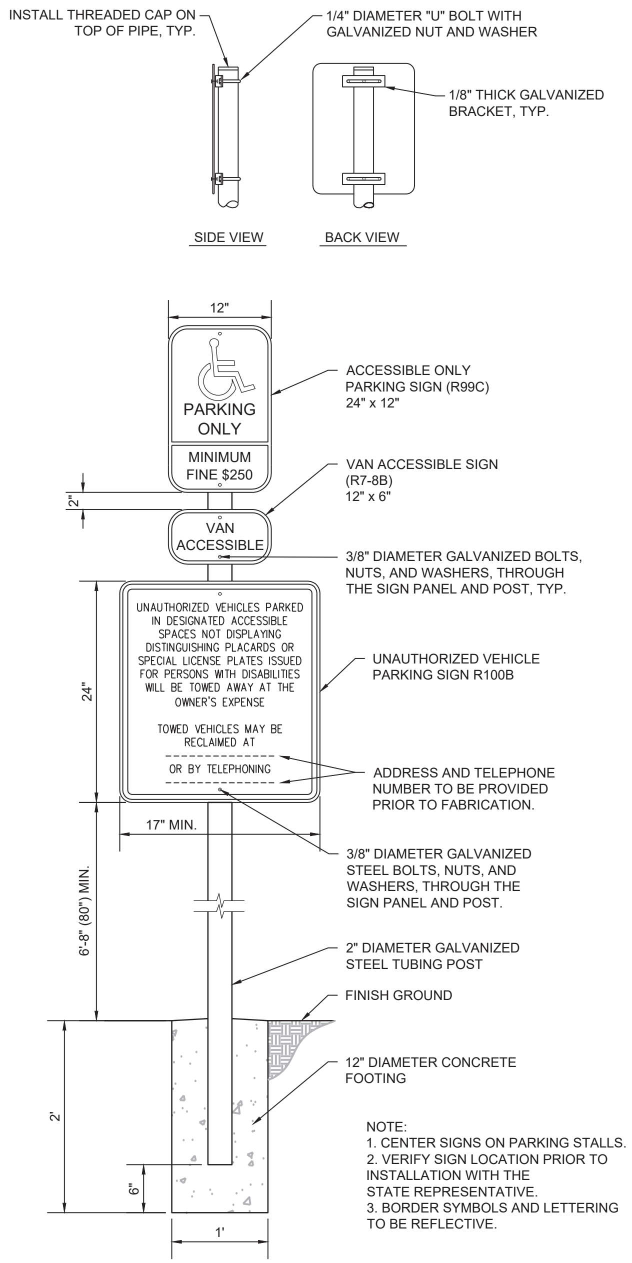
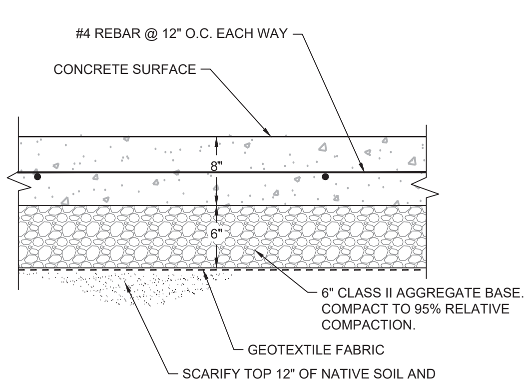
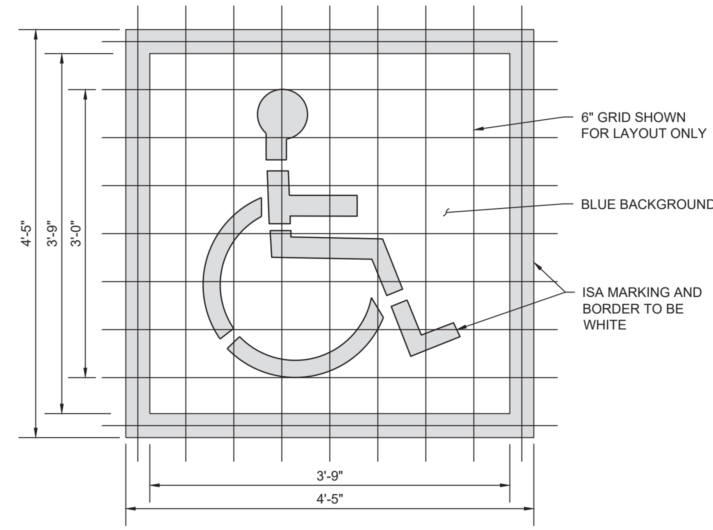


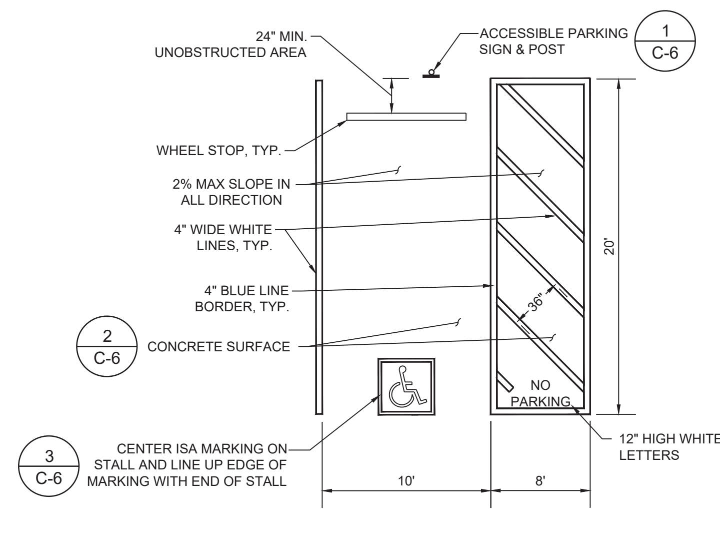

1 ACCESSIBLE PARKING SIGN & POST
NTS



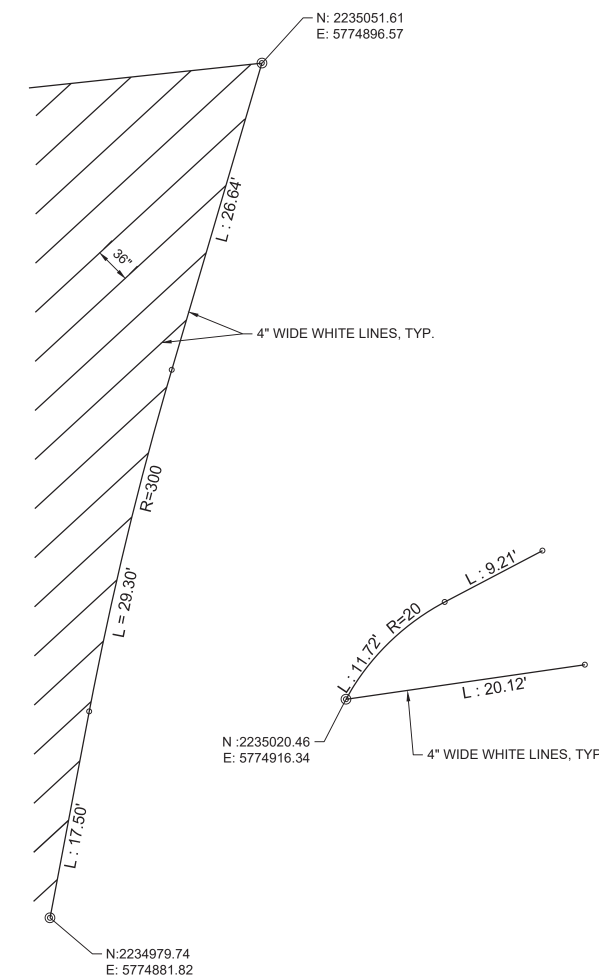

2 ACCESSIBLE PARKING STALL SECTION
NTS




3 INTERNATIONAL SYMBOL OF ACCESS MARKING
NTS




4 VAN ACCESSIBLE PARKING STALL
NTS




5 STRIPING - PIER AVENUE
NTS

File: C:\Users\vinh.le\Desktop\Corna Virus\Oceano Dunes Trackout\05_Drawings\Engineering\C-6 ACCESSIBILITY DETAILS.dwg Layout: C-6 ACCESSIBILITY AND STRIPING DETAILS Date: May 28 2020 - 2:16 pm User: Vinh.Le

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OCEANO DUNES SVRA
SEDIMENT TRACK-OUT PREVENTION MEASURES
ACCESSIBILITY AND STRIPING DETAILS

DRAWING NO.
04535P.8

SHEET NO.
C-6
8 OF 8

**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

# ATTACHMENT 06

## DRI MetOne 212-2/BAM Calibration Procedures

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**2020 Pre and Post Deployment Calibrations of MetOne 212-2 Instruments with a BAM**

In order to achieve a measure of $PM_{10}$ from the MetOne 212-2 instrument that can be compared between stations and to the $PM_{10}$ measured by an EPA Federal Equivalent Method a calibration procedure was developed to convert the particle count data to an equivalent mass based $PM_{10}$ concentration. Cross-calibration of each 212-2 instrument with a Beta Attenuation Monitor (BAM-1022, MetOne Instruments, Grants Pass, OR) was achieved by collocating them in an environmentally controlled chamber and establishing a unit-specific calibration relation. The instruments are rack-mounted in the chamber beside the BAM and a filter-based sampler (cyclone-style sampler). Under controlled temperature and humidity conditions dust is created by simulated saltation of Oceano

Dune sand and mixed thoroughly within the chamber exposing all instruments to the same PM10 concentrations. The data stream (particle counts in each bin size per unit time) from the 212-2 units and the BAM (μg $m^{-3}$) are recorded by a datalogger.

Each 212-2 outputs a data string corresponding to the counts of particles that are greater than a given diameter in a given volume. The geometric mean diameter of the eight size bins in micrometers (μm) are: 0.39 μm, 0.59 μm, 0.84 μm, 1.41 μm, 2.24 μm, 3.53 μm, 7.07 μm, and 10+ μm. In order to translate this into a mass-equivalent concentration: 1) the number of particles in a size bin is calculated by subtracting the number of counts associated with all larger size bins, 2) a diameter representing all the particles within a size bin is estimated (taken to be the geometric mean of the minimum and maximum of the size bin), 3) the volume of an individual particle of the characteristic diameter of the size bin is calculated assuming particles are spheres, 4) the total volume of particles in a volume of air is calculated by multiplying the volume of a single particle by the number of particles in the size bin in the known volume of air, and 5) a particle density of 2600 kg $m^{-3}$ is used to estimate the mass concentration of particles in the size bin. The cumulative mass concentration of particles through size bin 6 is denoted as PMbin6. A calibration relationship between the BAM and the PMbin6 value is defined through the paired values of BAM-measured $PM_{10}$ and calculated PMbin6 for each 212-2 instrument.

An example of this relation is shown in Figure A. The consistency of the calibration relations among the 212-2 units prior to deployment in 2020 was good. The mean slope value for all units combined was 0.238 (±0.063) and mean intercept was 4.704 (±0.869). The mean correlation coefficient was 0.950 (±0.013).

In addition to the chamber testing, an in-Park calibration station was established in 2020. This station consisted of a BAM, mounting hardware for two 212-2 units, wind speed, wind direction and RH instruments, and datalogging with modem telemetry. The purpose of the in-Park calibration was to determine the performance of the 212-2 and BAM instruments under ambient conditions at the ODSVRA. Of concern was their ability to perform under high wind conditions and whether this resulted in a bias in the measurement compared to the BAM. In 2020, 10 of the 212-2 units were collocated with the in-Park BAM.

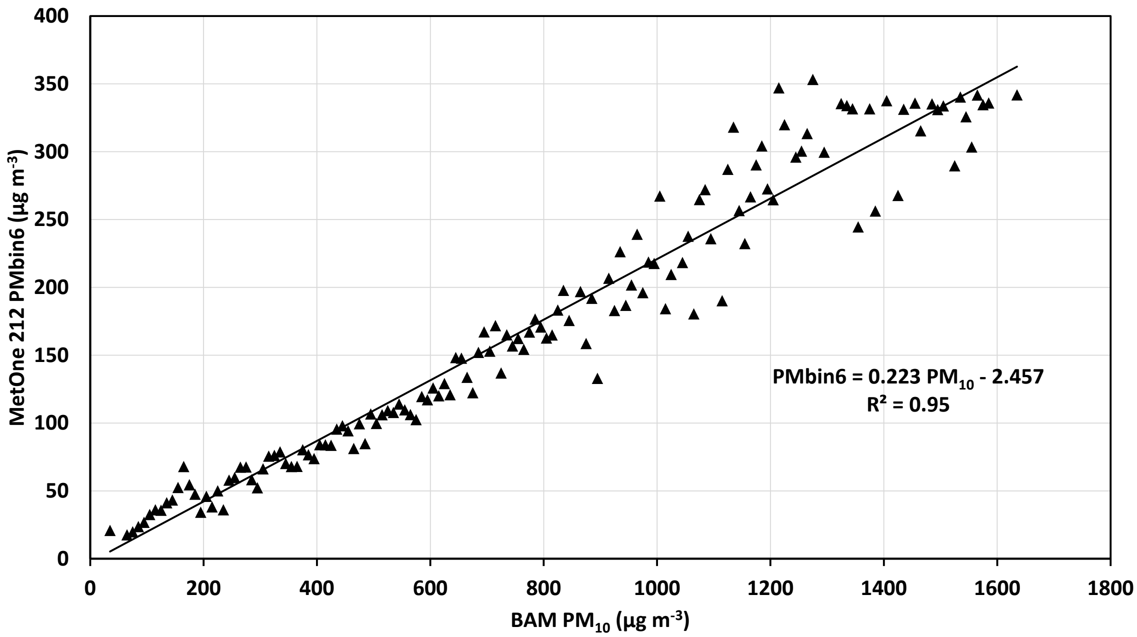


**Figure A**. An example of the calibration relationship between BAM and PMbin6 from chamber testing for the MetOne 212 instrument deployed at the BBQ site (Fig. 4).

The available data from the in-Park calibration testing indicated that the 212-2 units were not adversely affected by wind speeds that exceeded 5 m s-1 compared to the chamber conditions (i.e., no wind). The mean slope value and intercept values were 0.224 (±0.042) and 5.096 (±3.437), respectively. The mean correlation coefficient was 0.917 (±0.119). The differences in slope, intercept, and correlation coefficient are due to the dynamic nature of the field environment, but the degree of change indicates that under these conditions the correlation between the two instruments remained high.

An example of the post-deployment calibration (January 2021) relation is shown in Figure B. The consistency of the calibration relations among the 212-2 units post-deployment was good. The

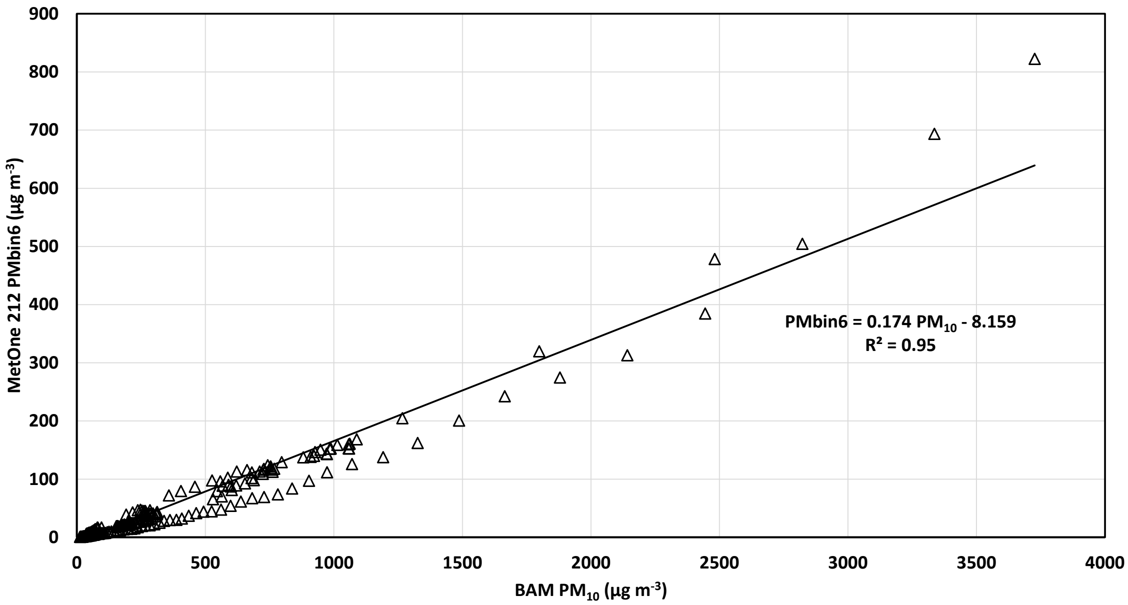


**Figure B**. An example of the calibration relationship between BAM and PMbin6 from chamber testing for the MetOne 212 instrument deployed at the BBQ site (Fig. 4) following removal from the field.

mean slope value for all units combined was 0.238 (±0.082) and mean intercept was -8.254 (±3.018). The mean correlation coefficient was 0.966 (±0.011). The post-deployment calibrations compare very favorably with the pre-deployment calibrations in terms of the slopes of the relation between the MetOne 212 (dependent variable) and the BAM (independent variable). The change in the mean intercept from 0.238 to -8.254 suggests a systematic change did occur, but overall the effect on the calculated $PM_{10}$ values is less than 10 µg $m^{-3}$.

The data acquired from these stations are used to evaluate the state of the dust emission system within the ODSVRA across space and through time. The developing database is used to compare various metrics (e.g., monthly total Wind Power Density [W $m^{-2}$], Total $PM_{10}$ [µg $m^{-3}$]) between months and between years. Examples of the continuous data collected for the in-Park Station Moymell and the out-of-Park Station CDF for May 2020 are shown in Figure C.

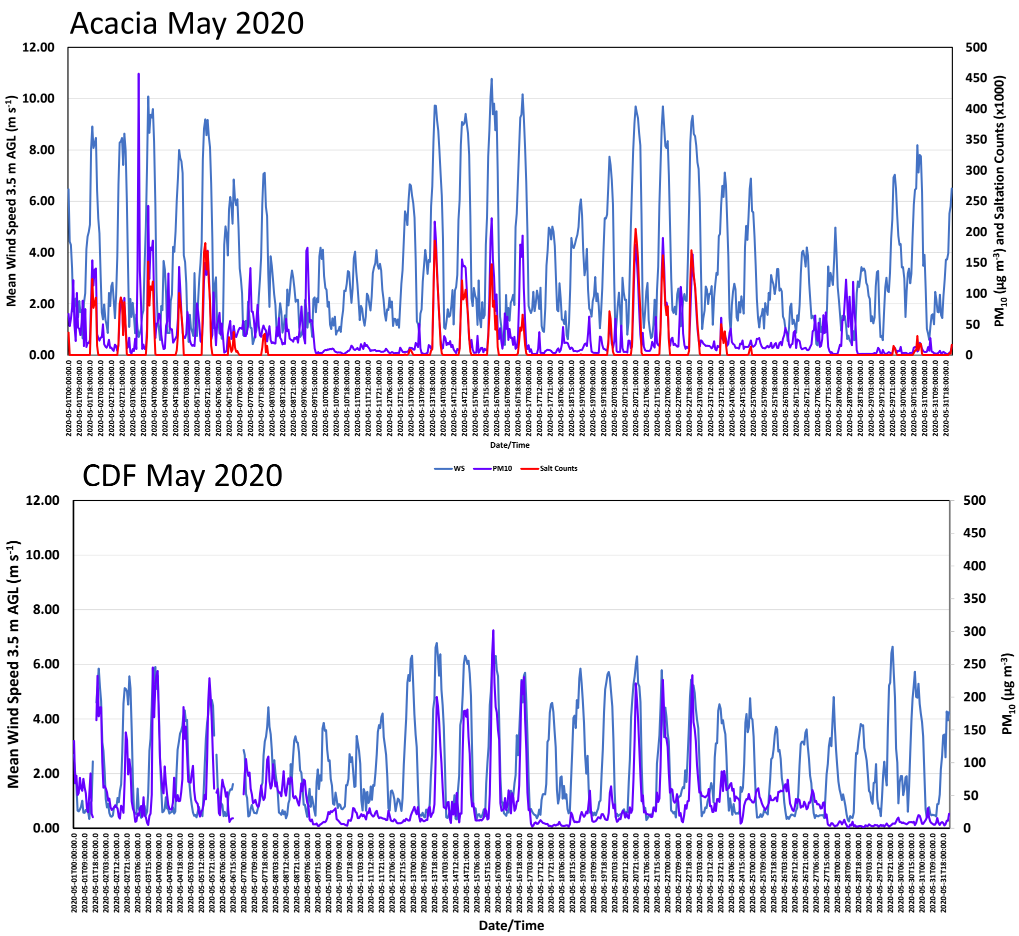


**Figure C**. Examples of mean hourly wind speed, $PM_{10}$, and Sensit particle counts from the network stations Acacia and CDF (see 2021 ARWP Figure 2-6 for locations). Note the Acacia station has a Sensit whereas CDF does not.

## 2021 Pre Deployment Calibrations of MetOne 212-2 Instruments with a BAM

The MetOnes deployed in spring 2021 were calibrated against a BAM in the DRI environmental chamber in Las Vegas in April 2021. An example of the relation between PMbin6 and Bam-measured $PM_{10}$ is shown in Figure D. for unit #8. For the instruments calibrated in April 2021, relation between the MetOnes and the BAM had a mean correlation coefficient ($R^2$) of 0.982 (±0.005) between the calculated PMbin6 values and the BAM-measured $PM_{10}$ values. The mean slope value for all units combined was 0.490 (±0.132) and mean intercept was -4.060 (±0.989). The values of the slope and intercept have changed each year for each instrument, which is likely due to the reconditioning each unit goes through at the annual factory maintenance. The in-chamber and in-Park calibrations are necessary to ensure that each instrument has a specific calibration to provide the best estimate of $PM_{10}$ during deployment at the ODSVRA.

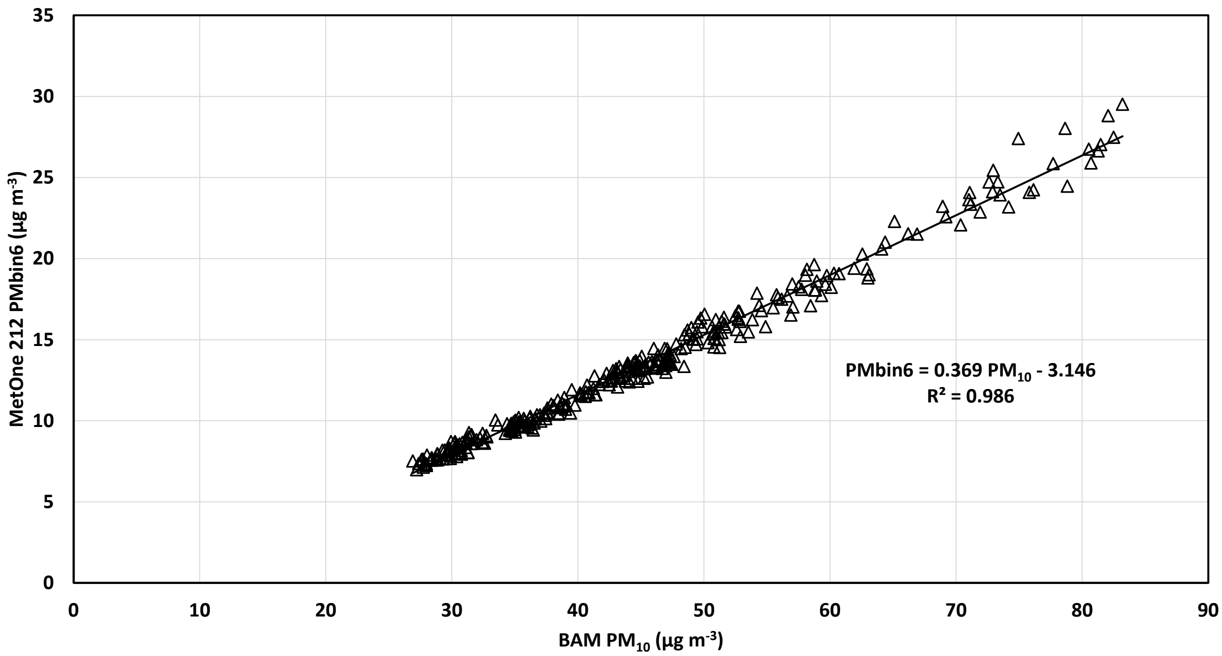


**Figure D**. The relation between PMbin6 and $PM_{10}$ for unit #8, April 2021 in-chamber calibration prior to deployment.

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**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

# ATTACHMENT 07

**DRI and UCSB 20 – 21 Sand Flux Report**

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**Saltation flux measurements –**

**Temporary Sand Fences Arrays and Foredune Restoration Areas**

The operation of the BSNE sampling network that quantifies sand flux in dust control and foredune restoration areas was carried out by personnel from the Coastal San Luis Resource Conservation District following training received from DRI personnel. The sampling strategy is to have the traps installed, the opening set at 15 cm above the surface, prior to a sand transport event. Following an event (typically the next morning), each BSNE is visited and the collected sand is put into Ziploc bags with the date of collection and the unique identifier for the BSNE. The empty BSNE is returned to its holder and the height set to 15 centimeters (cm) making it ready for the next collection. The sample bags are returned to the RCD office for latter weighing on an electronic balance to a precision of 0.01 grams (g).

**Temporary Sand Fence Arrays**

Saltation flux measurements were made in the two temporary sand fence arrays established in spring 2020. In 2020, 12 traps were placed in each array area and 20 in the re-vegetation area. In 2020, 12 traps were placed in each of the fence arrays and the BSNE traps were placed between consecutive sand fences at a distance of 6 fence heights from the upwind (western) fence based on the positioning shown in Table 1.

**Table 1**. The positions of BSNE sand traps within the two temporary sand fence arrays, 2020

| Row # | Distance (m) | D/H | BSNE* (Area 1, 43 rows) | BSNE (Area 2, 36 rows) |
|---|---|---|---|---|
| 0 | 0 | 0 | X X | X X |
| 2-3 | 16 | 13 | X X | X X |
| 3-4 | 24 | 20 | | X |
| 4-5 | 33 | 27 | X X | X X |
| 8-9 | 67 | 55 | X | X |
| 12-13 | 101 | 90 | X | X |
| 18-19 | 144 | 118 | X X | X X |
| 30-31 | 255 | 209 | X | X |
| 38-39 | 323 | 272 | X | |

*X X indicates 2 BSNEs spaced 2 m apart, N-S

Control effectiveness of the array to reduce sand flux is defined by the Normalized Sand Flux (NSF):

NSF=sand flux internal to the array/sand flux upwind of the array

The overall control effectiveness is based on the change of NSF as a function of downwind distance through a dust control area (sand fence array or vegetation).

In the temporary sand fence array Area 1 in 2020, the NSF decreased rapidly between the first four sets of traps (upwind to between rows 12 and 23) to normalized distance (ND)=33 (40.3 m) (Figure A). The NSF then stabilized to a relatively constant value to the end of the array (323 m), except at ND=91.2 where a high degree of variability in the flux was observed. This is due to its elevated position where maximum wind speeds are likely to occur. This has been observed at elevated positions in other fence arrays in previous years. The mean NSF between ND=33 and ND=188.6 in Area 1, excluding the measurement at ND=91.2 was 0.28 (±0.11), indicating that the effectiveness of this sand fence array was not as high as has been observed in the past.

In the temporary sand fence array Area 2 in 2020, the NSF decreased rapidly between the first four sets of traps (upwind to between rows 8 and 9) to ND=44.8 (54.7 m) (Figure B). The NSF then stabilized to a relatively constant value to the end of the measurements (255 m). A high degree of variability in the flux was observed at all the measurement positions ND≥67.7. The mean NSF between ND=44.8 and ND=171.2 in Area 2, was 0.21 (±0.08), similar to Area 1.

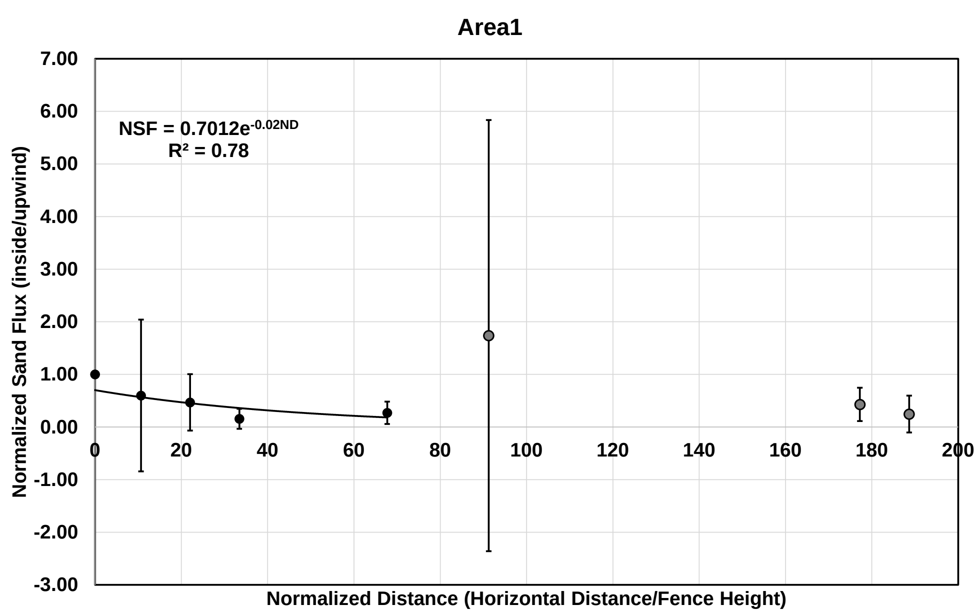


**Figure A**. Mean normalized sand flux as a function of normalized distance for the fence array Area 1 in 2020. The regression represents the change in NSF as a function of ND between ND 0 to 66.7 (black circles).

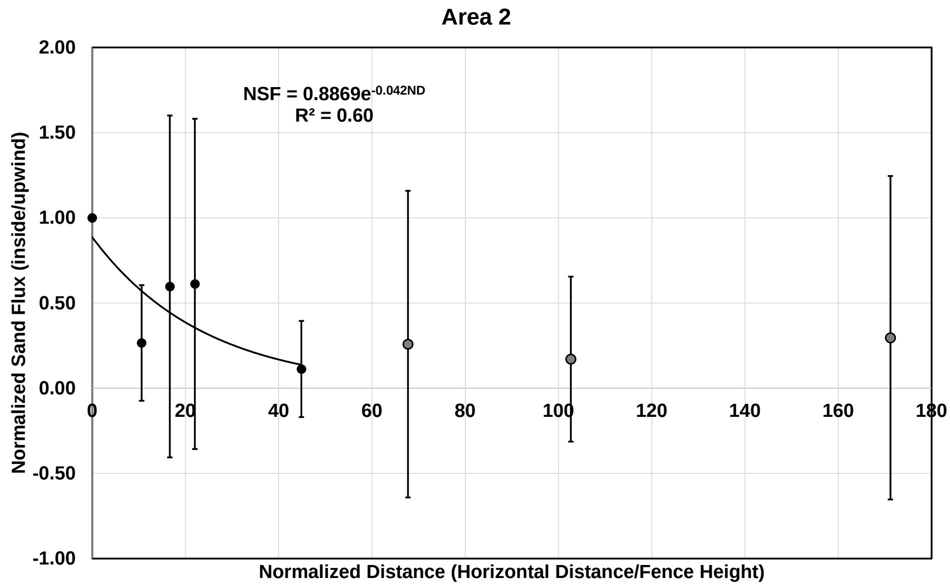



**Figure B**. Mean normalized sand flux as a function of normalized distance for the fence array Area 2 in 2020. The regression represents the change in NSF as a function of ND between ND 0 to 44.9 (black circles).

## Foredune Restoration Areas

To characterize the changes in wind and to monitor saltation activity and changes in vegetation cover and dune morphology through time, a suite of instruments on a 3 m tripod on a platform was deployed near the eastern edge of each treatment plot, approximately 10 m west of the eastern fence line and halfway along the north-south length of the treatment area. These monitoring stations have almost the same configuration as those deployed across and exterior to the Oceano Dunes SVRA to measure temperature, RH, wind speed, wind direction, and pressure (ClimaVue500). The restoration area stations, however, do not have PM measurements.

Sensit saltation sensors are located at each station to provide data on threshold wind speed for sand transport. A remote camera system is also deployed at each station to provide additional information on the frequency and relative magnitude of sand transport events providing a wider field of view than the point-measurement of the Sensit. The camera systems also provide qualitative data on weather conditions, sea state, changes in plant cover, and changes in dune form and development. Three tipping bucket rain gauges are deployed across the restoration area (north, middle, south) to provide data on precipitation across the foredune restoration zone.

Sand flux in the 6 foredune restoration treatment areas is measured using BSNE-style sand traps. A linear transect consisting of 5 BSNEs oriented with the major sand transporting wind direction, i.e., 292° at the north-south midpoint of each defined test area was established in April 2020. A BSNE is placed on the western side of a treatment area approximately 2 m from the security fence to receive the incoming sand flux. The next 4 traps in a treatment area are positioned at 4 m (12 feet), 13 m (42 feet), 45 m (148 feet), and 160 m (525 feet) along the 292° transect line. A map of the BSNE locations in the foredune restoration area is shown in Figure D.

The temporal trends for each of the BSNE transects in foredune restoration areas 1 to 3 and 4 to 6 are shown in Figure E and Figure F, respectively, for the time interval April to November 2020. For the foredune restoration areas normalized sand flux is defined as:

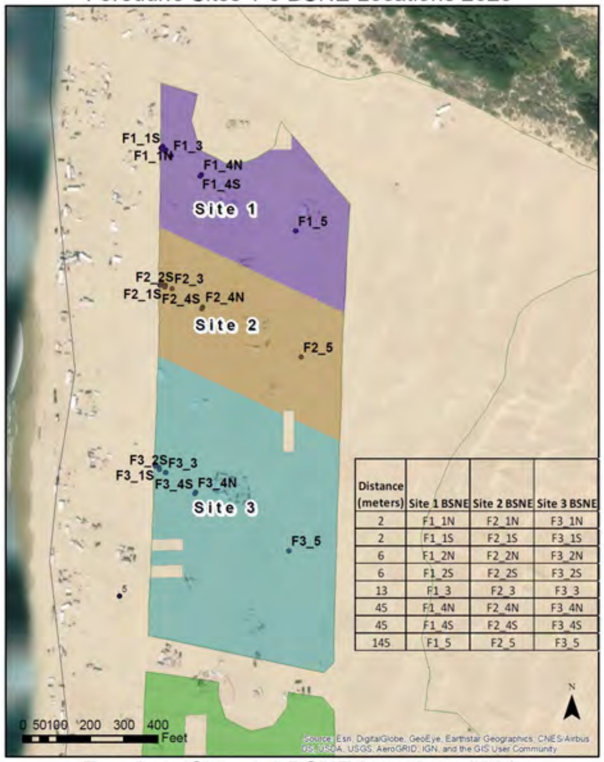
$$NSF=((BSNE_n \text{ trap } 1 + BSNE_n \text{ trap } 2)/2)/((BSNE_1 \text{ trap } 1 + BSNE_1 \text{ trap } 2)/2)$$

where subscript *n* indicates trap position along the transect through the restoration area. $BSNE_1$ indicates the traps on the upwind leading edge of the area. BSNE traps are paired at each position, 1-5, and NSF is based on the mean value of the 2 traps at each position.

For areas 1 through 3 the normalized sand flux (NSF) remains in a relatively stable range of values through this time interval except for area 2, which shows a considerable increase in NSF at the four interior measurement locations in November 2020. For areas 4 through 6, stable ranges of NSF are observed at the interior monitoring positions through this time interval except for area 6, which shows a considerable increase in NSF at the four interior measurement locations in November 2020. This is likely due to the straw surface becoming inundated with sand across the width of this test plot.

The relations between mean NSF and normalized distance (ND=Horizontal Distance to measurement position/Total distance across restoration area) are shown for foredune restoration areas 1 to 3 and 4 to 6 are shown in Figure G and Figure H, respectively, for the time interval .

Foredune Sites 1-3 BSNE Locations 2020




Foredune Sites 4-6 BSNE Locations 2020

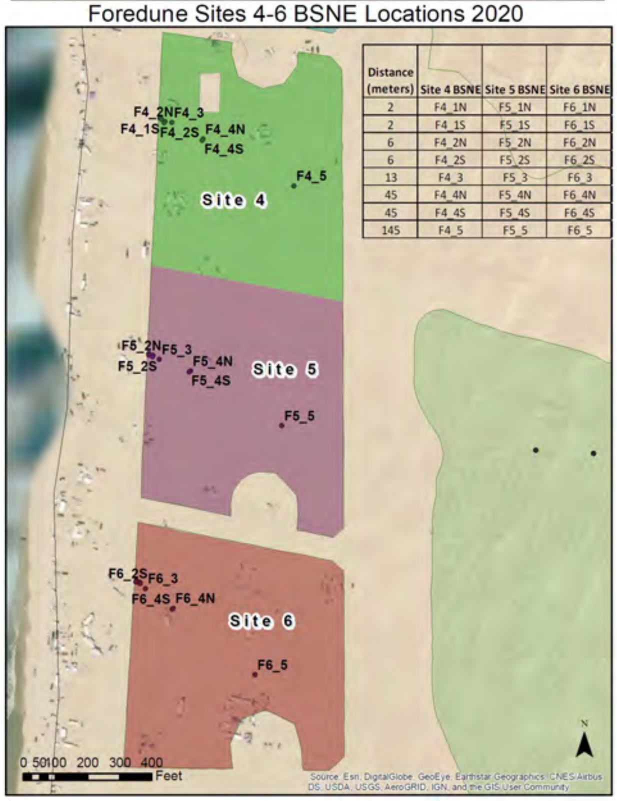


**Figure D**. Locations of the BSNE samplers in the foredune restoration areas.

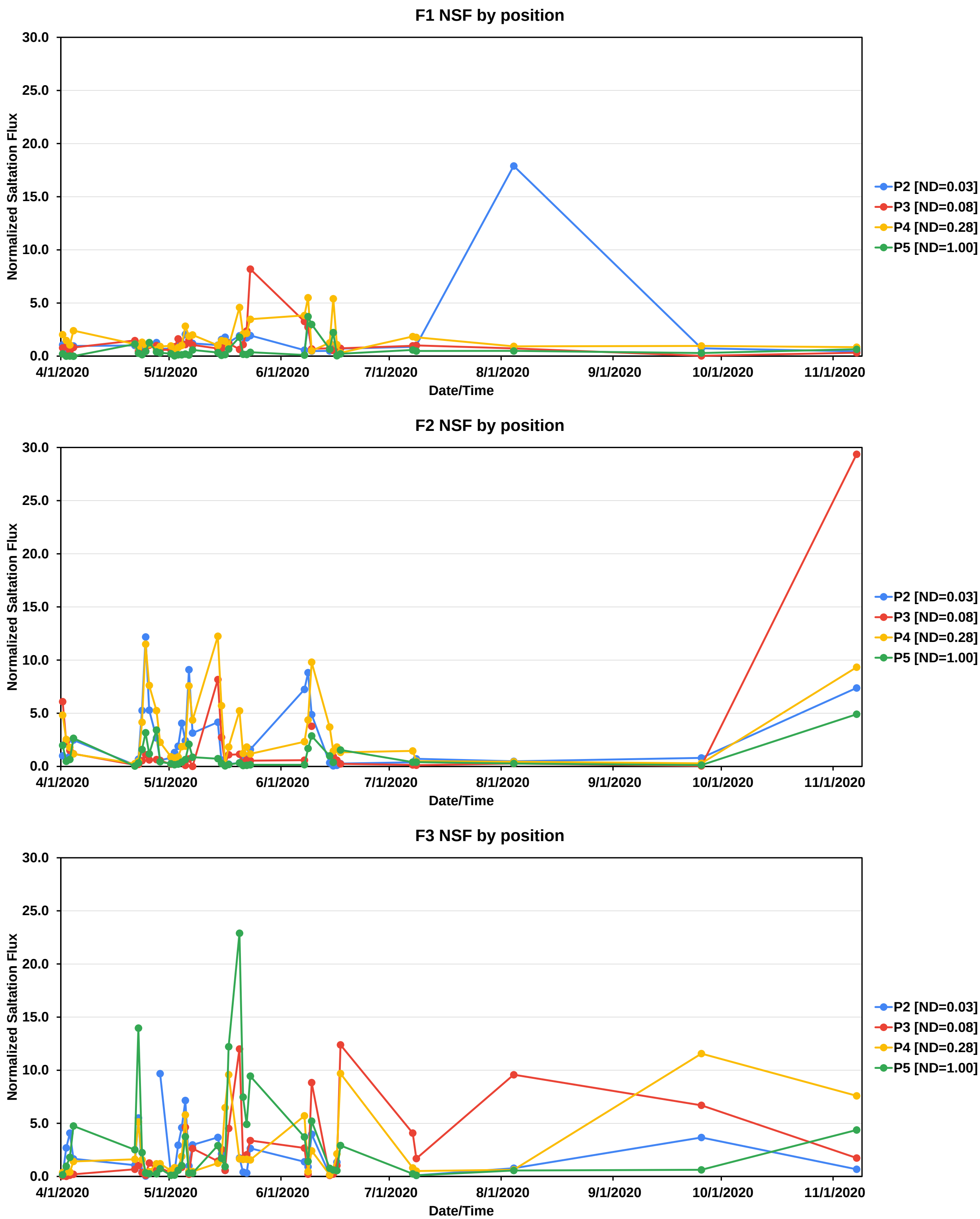
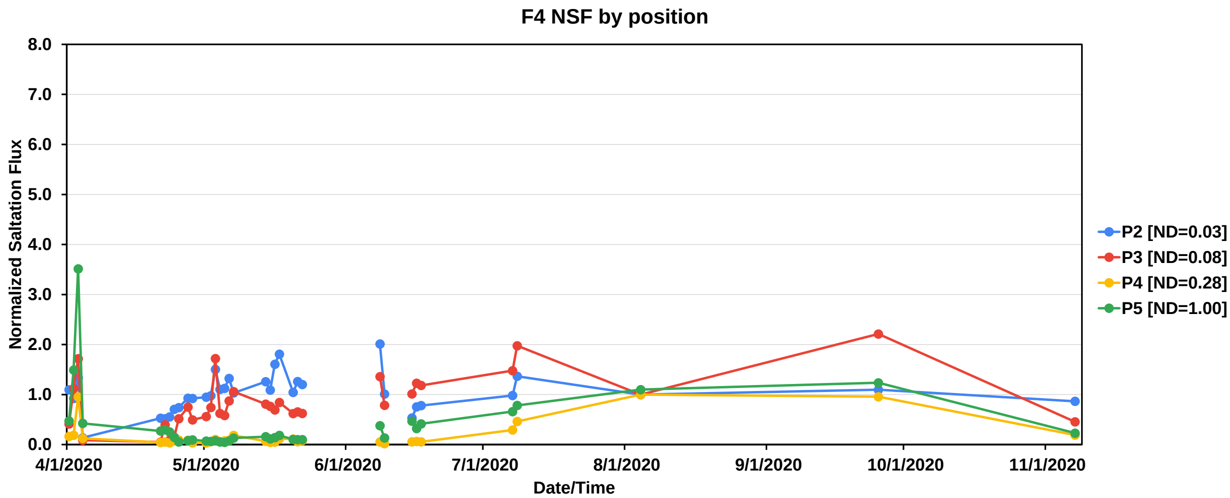
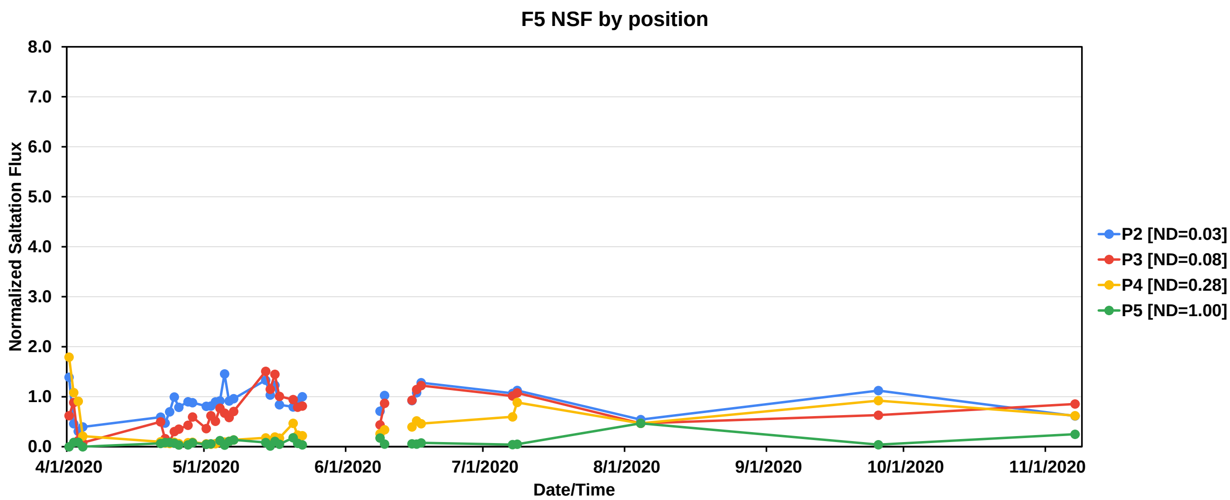



**Figure E**. The change in NSF at the interior measurement positions restoration areas 1 through 3 for the time interval April to November 2020.



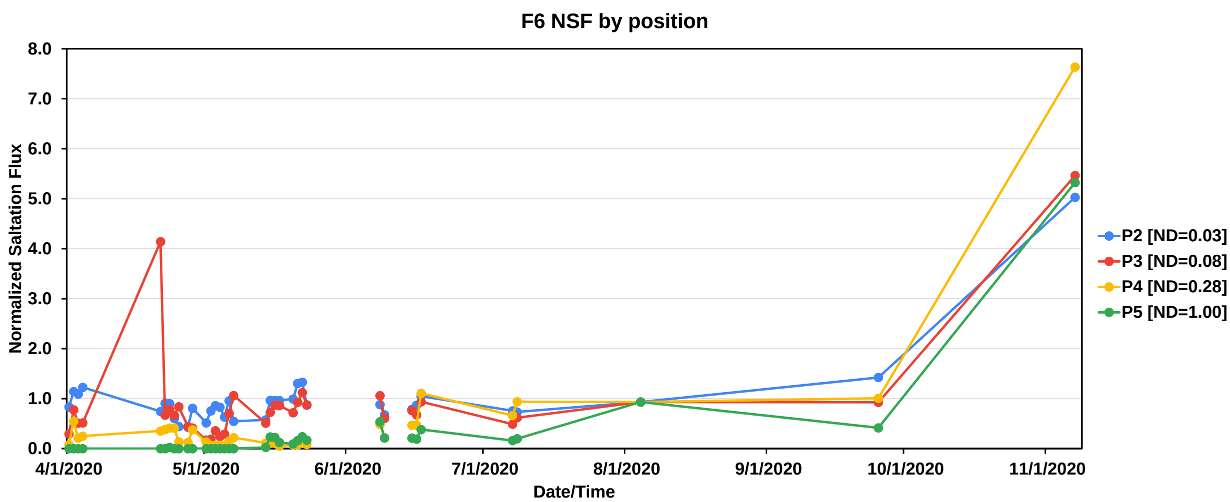




**Figure F.** The change in NSF at the interior measurement positions restoration areas 4 through 6 for the time interval April to November 2020.

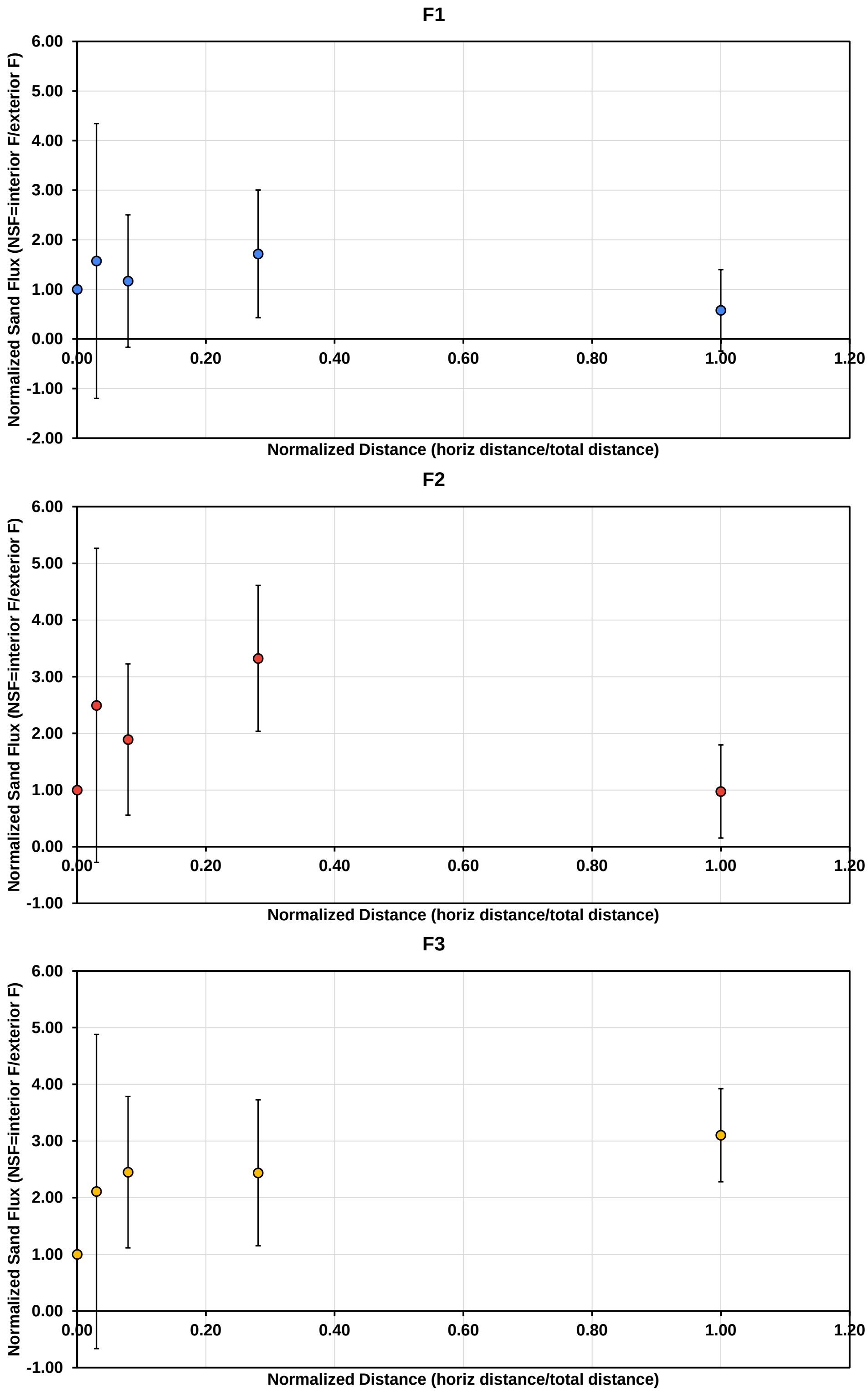



**Figure G**. The change in NSF as a function of ND for restoration areas 1 through 3 for the time interval April to November 2020.

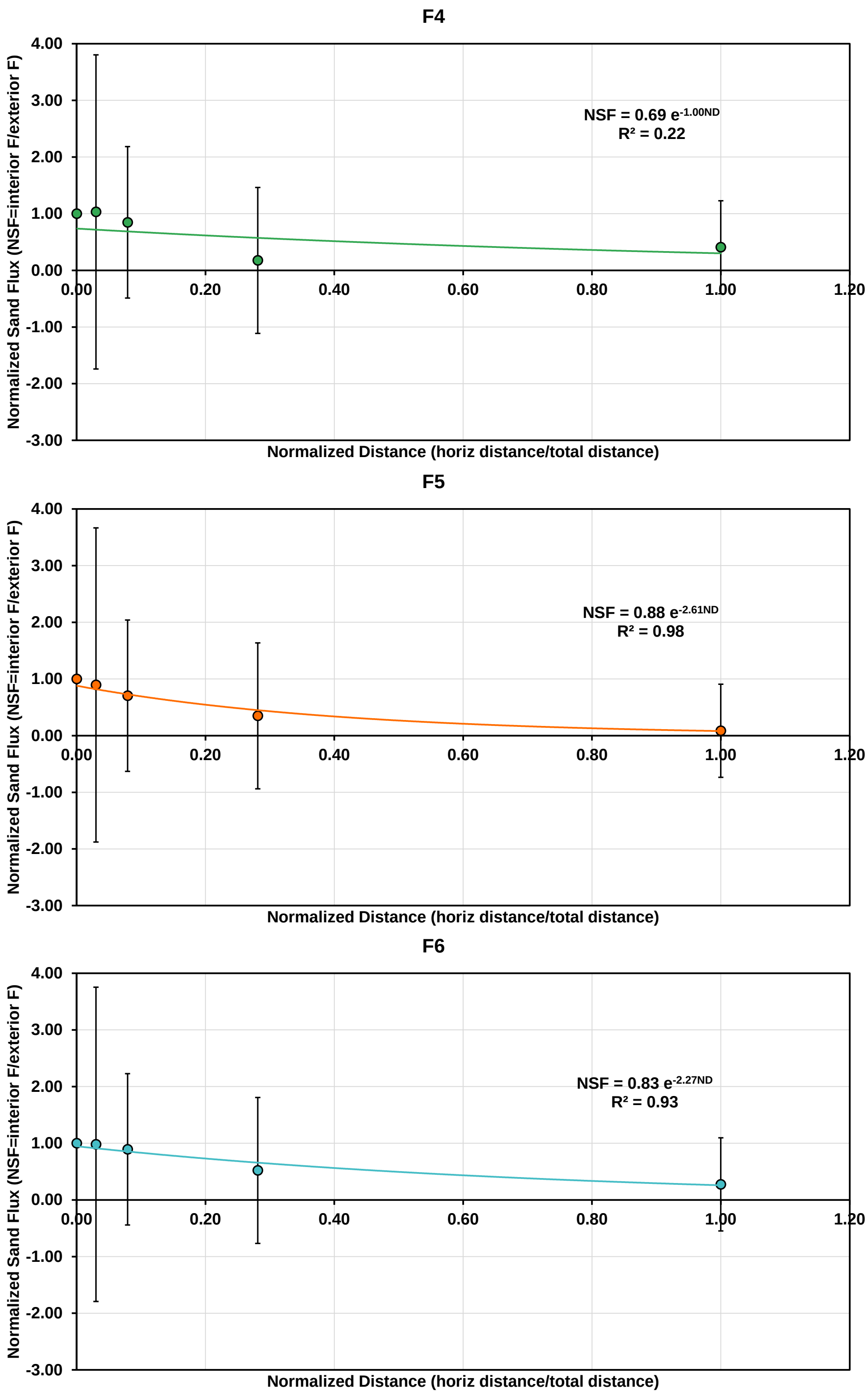



**Figure H.** The change in NSF as a function of ND for restoration areas 3 through 6 for the time interval April to November 2020.

April to November 2020. For areas 1 through 3 the normalized sand flux (NSF) as a function of ND shows a relatively limited range of variability across the measurement transect. For areas 4 through 6, NSF was systematically reduced as a function of ND for this time interval. This is observed most clearly in areas 5 and 6, although there is high degree of variability in NSF at each measurement position. The reduction in NSF as a function of ND is preserved at these restoration areas even as the magnitude of the overall flux increased in November 2020.

April to November 2020. For areas 1 through 3 the normalized sand flux (NSF) as a function of ND shows a relatively limited range of variability across the measurement transect. For areas 4 through 6, NSF was systematically reduced as a function of ND for this time interval. This is observed most clearly in areas 5 and 6, although there is high degree of variability in NSF at each measurement position. The reduction in NSF as a function of ND is preserved at these restoration areas even as the magnitude of the overall flux increased in November 2020.

Change in NSF through time in the restoration areas, suggest that saltation flux was increasing towards the eastern side of treatment areas 4, 5, and 6 as time progressed from the initial installation through to November 2020. This suggests that the effectiveness to control sand flux was diminishing through time, likely because of the increasing burial of the straw through time and the limited plant and nebkha development. For treatment areas 1, 2, and 3, NSF remained variable at all locations through time indicating that the control efficiency did not change appreciably through the April to November time interval.

**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

**ATTACHMENT 08**

**UCSB-ASU 2020-2021 ODSVRA Foredune Restoration UAS Survey Report**

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# UCSB-ASU 2020-2021 ODSVRA

# Foredune Restoration UAS Survey Report

**Prepared by: Zach Hilgendorf[1], Ian Walker[2,3], and Craig Turner[1]**

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[2] Department of Geography, University of California, Santa Barbara
[3] Member of the ODSVRA Scientific Advisory Group

September 2021

**List of Acronyms:**

Arizona State University – ASU
California Department of Parks and Recreation – CDPR
Desert Research Institute – DRI
Digital Terrain Model – DTM
Geomorphic Change Detection – GCD
Ground Sampling Distance – GSD
Light Detection and Ranging - LIDAR
Near Infrared – NIR
Normalized Difference Red-Edge Index – NDRE
Normalized Difference Vegetation Index – NDVI
Oceano Dunes State Vehicular Recreation Area – ODSVRA
Off-Highway Vehicles – OHV
Particulate Matter – PM
Particulate Matter Reduction Plan - PMRP
Portable In-Situ Wind Erosion Laboratory – PI-SWERL
Post-Processing Kinematic - PPK
Red-Edge – RE
Red-Green-Blue Spectral Bands – RGB
San Luis Obispo Air Pollution Control District – SLO-APCD
Scientific Advisory Group – SAG
Structure-from-Motion – SfM
Stipulated Order of Abatement - SOA
Uncrewed Aerial Platform – UAS
University of California Santa Barbara – UCSB

**EXECUTIVE SUMMARY**

In February 2020, six different foredune restoration treatment plots were established over a 48 acre region of the ODSVRA that was identified through a collaborative process involving CDPR, SLOAPCD and the SAG. The treatments included (north to south): 1) a plot textured by sheepsfoot stippling only (a minimal intervention control site); 2) a plot textured by sheepsfoot with broadcast native seeds; 3) a plot textured by sheepsfoot with broadcast seeds of native foredune plants and sterile rye grass; 4) low-density planting nodes with juvenile native plants surrounded by a protective straw circle; 5) high-density planting nodes with juvenile plants; 6) complete straw cover with high density planting of juvenile plants. The performance of the treatments is assessed using five criteria that track the geomorphic and vegetation responses within the restoration areas, including: 1) maintain a positive sediment budget (volumetric gains); 2) maintain aeolian activity within the treatments (namely sand transport and open sand surfaces) to provide necessary ecological conditions for plant growth and dune development; 3) ensure plant survivorship and increased plant cover over time to some eventual equilibrium state; 4) enhance dune development; and 5) contribute to a reduction in dust emissivity.

An uncrewed aerial system (UAS) with high resolution cameras is used to detect and map both geomorphic and vegetation changes in the restoration plots and adjoining beach and back dune areas from four flights to date (Oct. 2019, Feb. 2020, Oct. 2020, Feb. 2021). Resulting datasets include georeferenced orthophoto mosaics, vegetation cover maps, three-dimensional terrain maps (DTMs), and geomorphic change detection maps (GCD) maps used to calculate volumes of sediment erosion/deposition across the restoration sites. These data are then used to identify and interpret dune development, sediment budget responses, and vegetation establishment. The report provides results from the first year following implementation of the restoration treatments and also examines specific changes during the March-October 2020 Covid-19 closure to OHV activity, as requested by CDPR.

Over the study period, sand supply to the beach was highly variable, as expected, due to seasonal trends in wave energy, beach erosion/rebuilding, and the movement of rip current embayments. Overall, however, sand supply to the beach declined in front of the restoration site during this first year with some plots (1, 4, 6) seeing a net loss. These changes in beach width and sand supply occur independently from the restoration activities, yet they control the responses of the treatments by modulating the influx of sand by wind from the beach. Dune development occurred in four of the six plots with ~1 m tall nebkha observed in plots 3 and 5 and smaller forms (~0.6 m) in treatments 4 and 6. Low, largely unvegetated (< 0.6%) protodunes and transverse ridges migrated through plots 1 and 2. All treatments showed positive net sediment budgets by the end of this first year, with plots 1-3 showing the greatest surpluses.

Vegetation cover generally increased for all treatment types except for the plot 1 control site, which showed negligible change. Plot 6 showed the greatest increase in plant cover, from 2.2 to 4.9%, followed by treatments 5, 3, 2, and 4 (in decreasing order). For context, the peak observed historical plant cover at the restoration site and in the broader foredune zone (~400m landward of the upper beach) in the OHV riding area, respectively, were about 3 and 6% in 1966[see footnote 3].

The first year of plant growth and dune development at the foredune restoration site has shown an array of responses that are unique to each treatment plot and provides only an initial glimpse of ecosystem response. With reference to the defined performance criteria:

1. **All plots showed a positive sediment budget**, although some treatments (2, 4) showed only marginal increases over the pre-restoration baseline survey.

2. **Aeolian processes remained active in all treatments** shown by rippled sand transport corridors, dune development and migration, and emergence of erosional deflation surfaces with coarse lag deposits on all sites. Erosional responses are expected during early development phases and do not necessarily reflect poor performance.

3. **Initial plant survivorship was high (~70%) and plant cover increased post-installation** by 0.2 to 2.8% in all seeded or planted treatments (2-6). Some species, namely *Abronia latifolia*, showed rapid establishment and growth, promoting development of taller nebkha dunes. It is too early to assess broader foredune ecosystem re-establishment, but this first year has provided promising results.

4. **Enhanced dune development was observed in four of the six treatments** (3-6), with the largest (~1 m) nebkha dunes emerging in plots 3 (sheepsfoot + native seed + sterile grass seed) and 5 (high density planting nodes) followed by smaller (~0.6 m) nebkha in plots 4 (low density nodes) and 6 (broadcast straw + plants). Compared to the disturbed, relatively flat pre-restoration surface, plots 1 and 2 also showed limited development of largely unvegetated protodunes and transverse ridges that migrate inland.

5. **Contributions to reduced dust emissivity remain to be assessed**. It is too early in the establishment and development of the foredune treatments to assess their impact on dust emissivity. Continued $PM_{10}$ emissivity testing (PI-SWERL) is recommended coupled with enhanced empirical studies and modelling of aeolian transport and dust emissions within and downwind of the restoration plots to better understand the broader performance of the treatments for improving air quality.

**1. Introduction:**

To monitor and assess the performance of the foredune restoration dust emissions mitigation project at the ODSVRA, a team from UCSB and ASU, in collaboration with the CDPR, have been conducting UAS flights biannually since October 2019 through the present. The UAS imagery datasets are then used to create the following main data products:

1. Georeferenced, orthorectified **aerial photo mosaics** of the study site in the visual (RGB) spectral bands,
2. Georeferenced, orthorectified **maps of vegetation cover** derived from RGB and multispectral imagery using NDVI and other spectral methods,
3. Three-dimensional **DTMs**[1] derived from the RGB imagery using SfM photogrammetry,
4. **GCD maps** from consecutive time steps showing differences in elevation derived by comparison of DTMs using spatial statistics. The GCD maps are then used to calculate volumes of sediment change between surveys that can be used to identify and interpret dune development, evolution, erosion/deposition patterns, and sediment budgets.

Data collected during these flights allows for high resolution, three-dimensional surfaces to be constructed and compared over time to quantify sand volume changes and dune dynamics throughout the park. Other data collected allow for examination of the growth of vegetation and the development of dune forms within the foredune treatment plots. This report details the methods used for data collection, processing, as well as initial results for data collected prior to the implementation of the restoration treatments (October 2019, a baseline survey) through to February 2021 (one year following the installation of restoration treatments in February 2020).

Generally, the performance or 'success' of the restoration treatments at ODSVRA can be assessed using criteria that track the geomorphic, sediment transport, and vegetation characteristics and responses within the treatment areas. Walker et al. (2013)[2] identified several key indicators that can be used to assess the performance of coastal dune restoration projects using an approach that encourages re-establishment of dynamic ecological and geomorphic conditions that improve dune ecosystem form and function and promote a more resilient and sustainable landform. It is

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[1] DTMs differ from Digital Elevation Models (DEMs) in that they can include other elements on top of the surface, such as vegetation or structures. For the purposes of change detection modelling in this report, any structures (e.g., restroom buildings, fences, etc.) or other elements (e.g., vehicles) were removed during processing.

[2] Walker, I. J., Eamer, J. B., & Darke, I. B. (2013). Assessing significant geomorphic changes and effectiveness of dynamic restoration in a coastal dune ecosystem. Geomorphology, 199, 192-204. https://doi.org/10.1016/j.geomorph.2013.04.023

important to note that the Walker et al. (2013) study was developed for restoring dune landscapes that have been altered by invasive plants that have stabilized existing dune surfaces and reduced active aeolian processes, whereas the ODSVRA restoration project is designed to develop new dunes on a previously disturbed, flat, unvegetated surface.

Key indicators identified by Walker et al. (2013) include: 1) increased aeolian activity (i.e., windblown sand transport, erosion, deposition) within the treatment areas, 2) enlarged active sand surface area (for systems densely vegetated with non-native and/or invasive species), 3) positive sediment budgets (i.e., continued gains in sediment volumes over time), 4) increased dune morphodynamics (i.e., enhanced development and activity of dune forms involving erosion and/or deposition of sediment in the landscape), 5) improved geomorphic diversity (i.e., an increase in the number and/or types of dune forms in the landscape), and 6) enhanced geomorphic resilience (i.e., improved ability of the dune system to recover from disturbance events, such as coastal erosion or flooding, to a pre-disturbance state).

As above, not all of these indicators are suitable for the ODSVRA site, which had essentially no vegetated foredune ecosystem prior to the start of the project, although historical aerial photography shows the presence of sparse vegetation and scattered nebkha foredunes in the decades following the 1930s before widespread vehicle use (as documented in an independent report by Swet et al. 2021[3]). Hence, indicators 2 and 6 from the list above could not be assessed for ODSVRA. The Walker et al. (2013) list also does not include any aspect of vegetation monitoring or dust emissions mitigation. For the purposes of the ODSVRA project, we define the following key indicators from which system performance can be assessed:

1. **Establish and maintain a positive sediment budget** (i.e., continued gains in sediment volume over time). This is particularly important during the first phase of foredune development in which small incipient nebkha dunes (mounds of windblown sand trapped in vegetation) establish and related downwind shadow dunes grow. Eventually, as nebkha and shadow dunes grow and coalesce and, in turn, alter onshore wind and sand transport patterns, volumetric gains may slow and/or plateau once the system reaches its fully developed state. Based on nearby natural foredune sites (e.g., Oso Flaco), this could take as long as several decades to occur.

2. **Maintain aeolian activity, namely sand transport (saltation) and open sand surfaces, within the treatments**. Saltation of sand, and related erosion and deposition patterns, are critical processes required for dune development and maintenance. In addition, these

[3] Swet, N., Hilgendorf, Z., & Walker, I. J. (2021). UCSB Historical Vegetation Cover Change Analysis (1939-2020) within the Oceano Dunes SVRA. Report commissioned by CDPR OHV Division ODSVRA. In review.

processes create fundamental ecological disturbances (abrasion, burial, exhumation, nutrient transport, etc.) and gradients required to maintain healthy foredune plant communities. Plant species found in backdune scrub ecosystems, however, are not necessarily well adapted to the same disturbance processes or gradients and, thus, care must be used in selecting appropriate plants for foredune vs. backdune restoration settings. Natural foredunes in this region are not characterized by a uniform foredune ridge with high plant cover, as is often the case further north in California and Oregon. Rather, a more hummocky, discontinuous form with active sand surfaces is the preferred ecosystem form.

3. **Increase foredune plant cover and survivorship**. Where a new foredune ecosystem is being developed, it is imperative that plants establish and survive to initiate sedimentation during the early stages of dune development. Eventually, however, plant cover density might plateau at an amount that is in balance with dune form/position, aeolian activity, soil nutrients, and regional climate conditions. As ecosystem re-establishment occurs, it is also anticipated that species richness would improve and, accordingly, initial planting palettes should reflect the range of species present in neighboring natural foredune ecosystems, such as the Oso Flaco reference site.

4. **Enhanced dune development**. The establishment and growth of foredunes and related dune forms (e.g., nebkha, blowouts, transverse or barchanoid ridges, parabolic dunes, etc.) and morphodynamics involving erosion and/or deposition of sediment in the landscape is a key sign of improved performance. Important feedback mechanisms exist between wind flow, sand transport, vegetation cover, and dune form that are required to build and maintain natural foredunes. As the system develops and evolves, the variety of dune forms is expected to change and will organize toward a morphology that reflects plant cover, aeolian activity, and regional climate controls.

5. **Contribute to a reduction in dust emissivity**. The main impetus for the foredune restoration project at ODSVRA was to implement a sustainable, nature-based dust emissions mitigation treatment that had both onsite and downwind impacts. The location for the project was determined by CDPR-ODSVRA staff and the SAG to target a highly emissive area of sand surface as identified by extensive Pi-SWERL testing by DRI. Prior to restoration, the ~48 acre site had been used for intensive camping and OHV activity close to the high water line, where a foredune system would naturally exist. The new terrain and vegetation roughness is designed to disrupt boundary layer airflow and surface shear stress patterns that drive saltation and dust emissions in this area. Due to secondary lee-side flow effects, it is anticipated that the new foredune will also have downwind benefits on reduced shear stress and dust emissions.

**2. Methods:**

UAS platforms and SfM photogrammetry have experienced widespread and rapid advancements in the last decade[4,5]. SfM photogrammetry refers to the reconstruction of a three-dimensional landscape from highly overlapped (70% frontal and side overlap) images. The quality and resulting products are dependent on the camera used, methods for georectification, and, in the case of UAS platforms, flight altitude, shutter speed, and stability[6]. UAS-SfM datasets have been used in a wide variety of landscapes and ecosystems, including those along the coast. Advantages for using such datasets for coastal monitoring and detecting change include the relative ease and low cost of data collection, compared to aerial LIDAR, and the high accuracy (mm-cm resolution) of the resulting maps.

A fixed-wing, fully autonomous UAS platform was used at the ODSVRA from October 2019 to February 2021 to monitor and characterize changes in sediment volumes, geomorphic responses, and vegetation cover within and beyond the restoration treatments. The WingtraOne UAS is typically flown at altitudes over 100 m above ground level and is equipped with on board, survey-grade GPS with PPK correction capabilities. During data collection, a Trimble R10 base station is operated in static collection mode, which is then used to refine photo point locations from the UAS to within millimeters of their real-world location. As of the date of this report, four collection campaigns have been flown at ODSVRA (Table 1) with multispectral data collected in October 2020 and February 2021. The multi-spectral campaigns used a 5-band camera payload that captures not only visual RGB, but also red edge (RE) and near-infrared (NIR) bands. Data from this payload allow for improved vegetation extraction. NDVI and NDRE are also produced to assess vegetation differences between seasons.

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[4]Anderson, K., Westoby, M. J., & James, M. R. (2019). Low-budget topographic surveying comes of age: Structure from motion photogrammetry in geography and the geosciences. Progress in Physical Geography: Earth and Environment, 43(2), 163–173. https://doi.org/10.1177/0309133319837454

[5] James, M. R., Chandler, J. H., Eltner, A., Fraser, C., Miller, P. E., Mills, J. P., Noble, T., Robson, S., & Lane, S. N. (2019). Guidelines on the use of structure-from-motion photogrammetry in geomorphic research. Earth Surface Processes and Landforms, 44(10), 2081–2084. https://doi.org/10.1002/esp.4637

[6] Singh, K. K., and A. E. Frazier. (2018). A meta-analysis and review of unmanned aircraft system (UAS) imagery for terrestrial applications. International Journal of Remote Sensing, 39(15–16), 5078–5098. https://doi.org/10.1080/01431161.2017.1420941

*Table 1. Collection specifications for the four RGB UAS campaigns and the two multispectral (RGB, RE, and NIR) campaigns.*

| UAS Survey Campaign | Survey Date | Sensor Payload (spectral bands) | Coverage Area ($km^2$) | Average Altitude (m) | Average Wind ($m\ s^{-1}$) |
|---|---|---|---|---|---|
| 1: Baseline pre-restoration survey | Oct. 1-2, 2019 | Sony RX1R II (42 MP, RGB) | 3.83 | 114 | 7.00 |
| 2: Initial treatment installations | Feb. 10-11, 2020 | Sony RX1R II (42 MP, RGB) | 5.41 | 123 | 4.29 |
| 3: First post-treatment survey | Oct. 13-15, 2020 | Sony RX1R II (42 MP, RGB) | 5.98 | 121 | 4.16 |
| | Oct. 16, 2020 | Micasense RedEdge-MX (RGB, RE, NIR) | 4.63 | 113 | 5.70 |
| 4: First year of treatment response | Feb. 17-18, 2021 | Sony RX1R II (42 MP, RGB) | 5.95 | 120 | 3.35 |
| | Feb. 18-21, 2021 | Micasense RedEdge-MX (RGB, RE, NIR) | 5.79 | 118 | 6.68 |

The primary camera payload, a Sony RX1RII 42 MP full-frame sensor, is used to produce high resolution (<2 cm) orthomosaic imagery that, in turn, is used with SfM to create three-dimensional point clouds of the underlying surface that can be compared between campaigns to quantify volumetric change (Table 2). Point clouds between campaigns are aligned to one another using static features in the landscape (e.g., structures, roads, etc.) and then the dataset is averaged to 10 cm point spacing. This point cloud is then used to create a gridded (rasterized) DTM that represents the surface topography. Successive DTMs are imported into the GCD toolset, developed by Riverscapes Consortium, which calculates volumes of change between collocated raster grid cells (pixels) and then applies a statistical filter to remove volumes of change that fall below a threshold uncertainty value with 95% confidence[7,8]. The threshold for realistically measurable change is determined by developing an uncertainty budget that includes the inherent accuracy of the GNSS station, the calculated uncertainty of the point cloud, and the root mean square error from the alignment of each point cloud with static features in the

[7] Wheaton, J. M., Brasington, J., Darby, S. E., & Sear, D. A. (2009). Accounting for uncertainty in DEMs from repeat topographic surveys: improved sediment budgets. Earth Surface Processes and Landforms, 35(2), 136-156. https://doi.org/10.1002/esp.1886

[8] Hilgendorf, Z., Marvin, M. C., Turner, C. M., & Walker, I. J. (2021). Assessing Geomorphic Change in Restored Coastal Dune Ecosystems Using a Multi-Platform Aerial Approach. Remote Sensing, 13(3), 354. https://doi.org/10.3390/rs13030354

landscape. The uncertainty between two campaigns is propagated and pixels that exceed the minimum level of detection threshold (typically around 5 cm) are included. The results can be subset by specified units to monitor plot-based change over time.

*Table 2. SfM specifications for the RGB and multispectral UAS campaigns. GSD refers to the distance between the center of adjacent pixels and describes the cell size of each pixel in centimeters (i.e., pixel resolution). The RGB camera takes a single image per capture point, while the multispectral camera takes a picture in each band, hence the difference between RGB and multispectral images used. The Total Uncertainty column refers to the calculated vertical uncertainty for datasets used in DEM development and volumetric change detection mapping. As the multispectral datasets were not used for this purpose, a value of "NA" is shown.*

| UAS Survey Campaign | Survey Date | Images Used | GSD (cm/pix) | Total Uncertainty (m) |
|---|---|---|---|---|
| 1: Baseline pre-restoration survey | Oct. 1-2, 2019 | 5,954 | 1.45 | 0.038 |
| 2: Initial treatment installations | Feb. 10-11, 2020 | 6,186 | 1.56 | 0.033 |
| 3: First post-treatment survey | Oct. 13-15, 2020 | 6,998 | 1.54 | 0.037 |
| | Oct. 16, 2020 | 25,085 | 7.53 | NA |
| 4: First year of treatment response | Feb. 17-18, 2021 | 7,312 | 1.52 | 0.030 |
| | Feb. 18-21, 2021 | 57,315 | 7.89 | NA |

**3. Results:**

*3.1. UAS Photogrammetry: Visible (RGB) imagery*

Figures 1-2 show the extent of the four UAS RGB orthophoto campaigns between October 2019 and February 2021. The February 2020 campaign included the collection of an eastward (landward) extending panhandle swath to monitor the rate of change of the landward dunes, as well as another eastward stretching extent immediately north of Oso Flaco Lake and landward of more established foredunes. The only other change in the imagery collection domain came in October 2020, which involved filling in the area between the southern landward extent and the eastern extent, south of the panhandle. These changes were made to monitor restoration efforts and the behavior of dunes, landward of the established foredune to the south, as an analog to compare against the foredune treatment plots to the north.

The initial October 2019 orthophoto mosaic represents the pre-restoration "baseline" map of the restoration site prior to any restoration treatments, which were implemented during the February 2020 campaign as evident by the partial straw coverage in treatment plots 5 and 6 (see also Figure 3). The October 2020 collection represents a full first growing season for the treatments, but also captures eight months of park closure (no OHV activity) during the COVID-19 global pandemic. Finally, the February 2021 collection captures conditions after the first full year of plant growth and geomorphic response within the treatment plots.

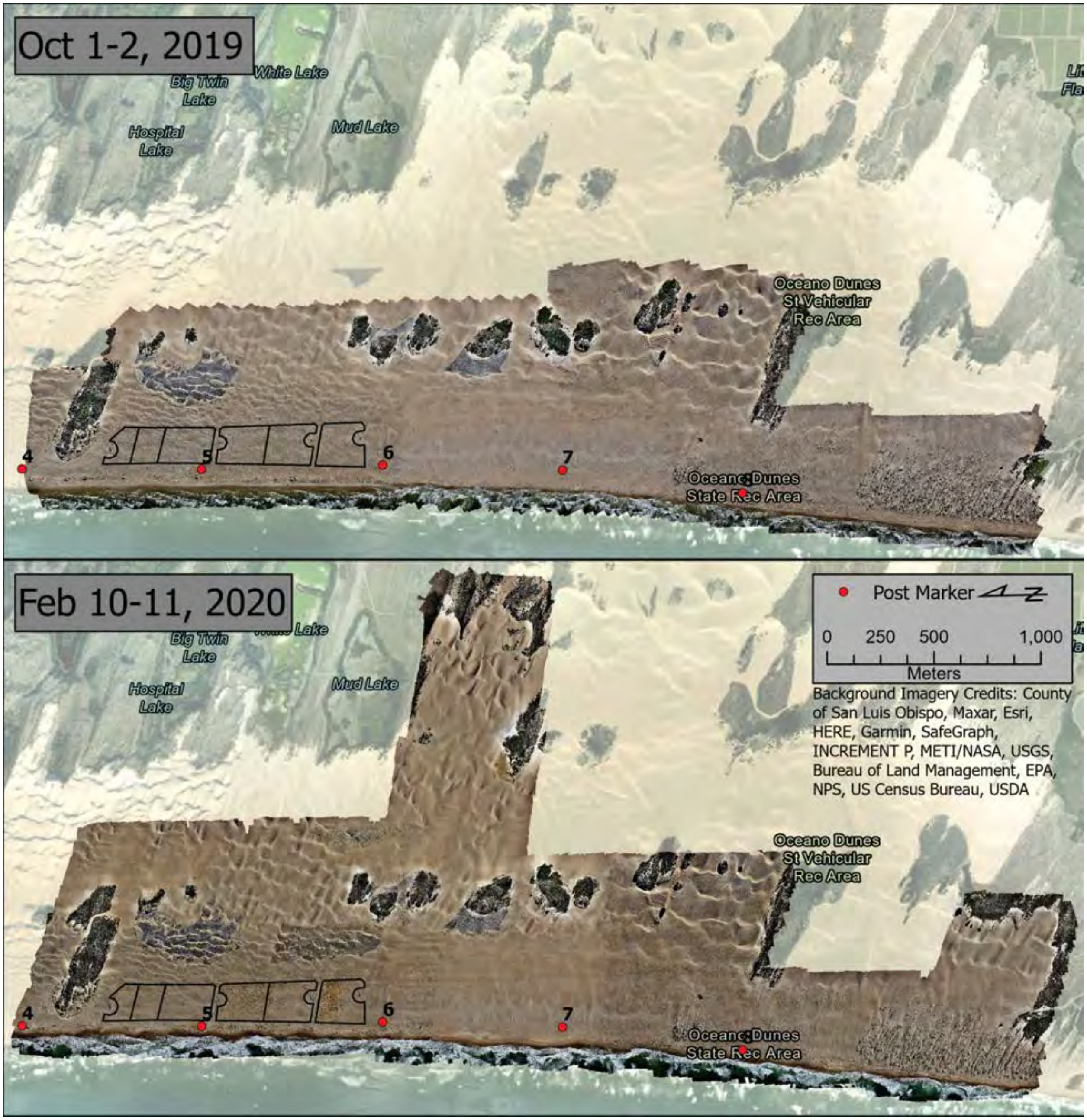


*Figure 1. UAS orthophoto mosaic showing the extent of the October 2019 and February 2020 UAS mapping campaigns. North is oriented towards the left of the image. The polygons along the shore to the north indicate the six foredune treatment plots. Numbered red dots indicate the location of navigation post markers.*

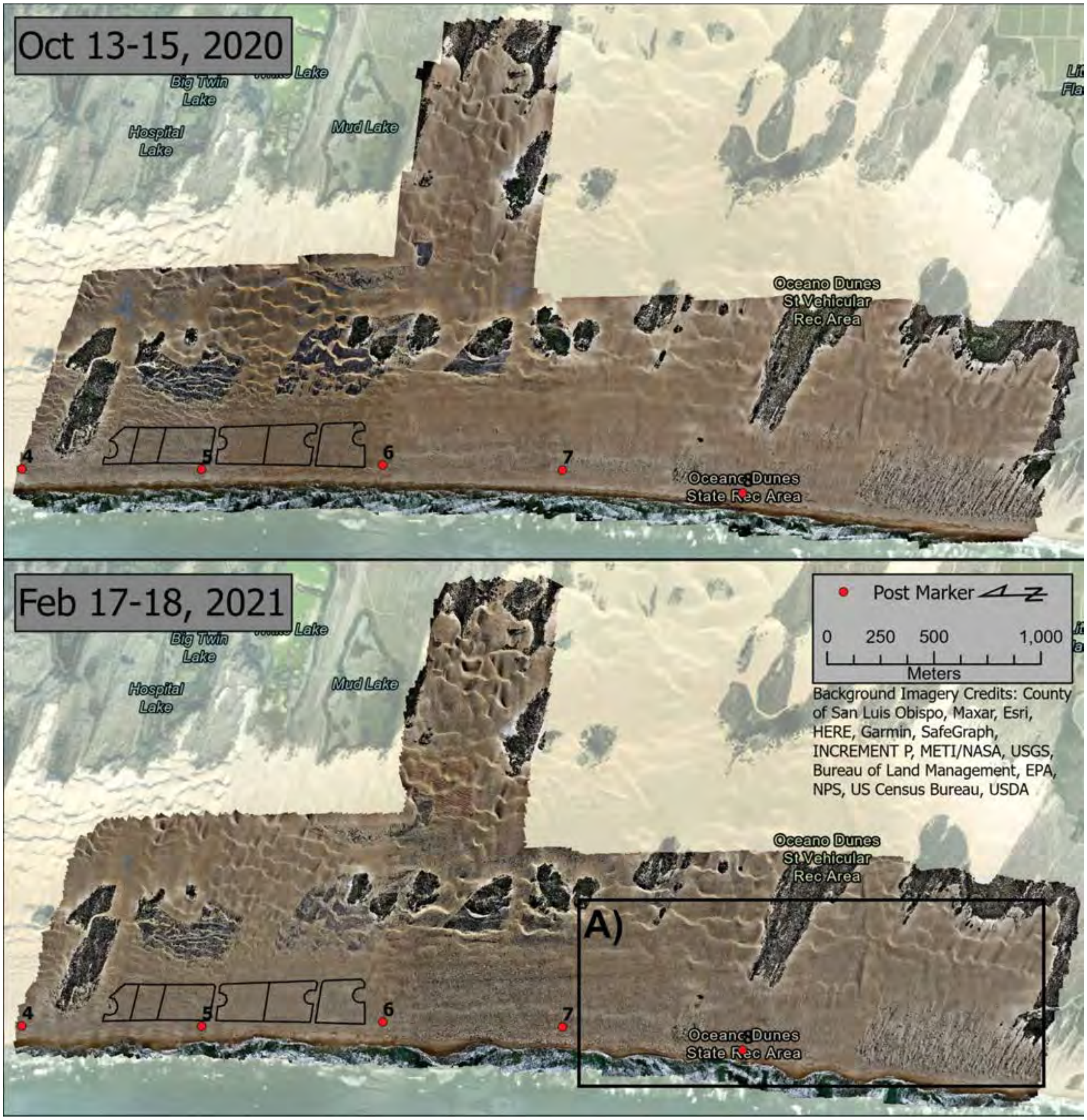


*Figure 2. UAS orthophoto mosaic showing the extent of the October 2020 and February 2021 UAS mapping campaigns. North is oriented towards the left of the image. The polygons along the shore to the north indicate the six foredune treatment plots. Numbered red dots indicate the location of navigation post markers. Inset A) Extent of the DSM used in Figure 13.*

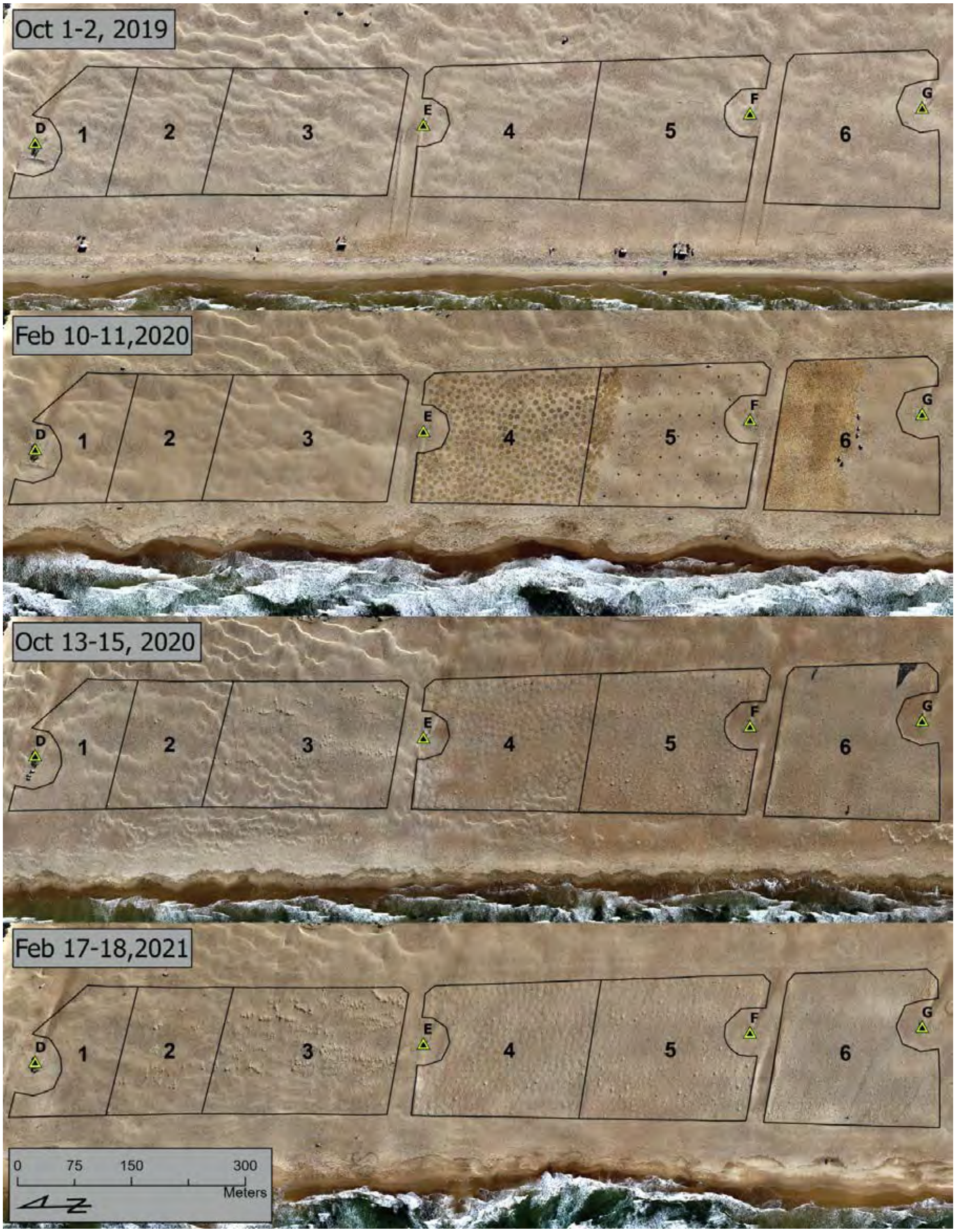


*Figure 3. A view of the foredune treatment plots from each of the four RGB UAS mapping campaigns. Numbers correspond to the following restoration treatments: 1) Sheepsfoot stippling only (control site), 2) Sheepsfoot + native seeds, 3) Sheepsfoot + native seeds + sterile ryegrass seed, 4) Low density straw planting nodes, 5) High density planting nodes, and 6) Broadcast straw with randomly planted seedlings and broadcast seed (aka "Parks Classic").*

*3.2. UAS Photogrammetry: Multispectral (RGB, RE, NIR) and Vegetation Indices*

To enhance the detection and monitoring of vegetation at the landscape scale in the restoration treatment areas, multispectral imagery was collected in October 2020 and February 2021 (Figure 4). The October 2020 collection primarily focused on the seaward extent of the site, including the foredune treatment zones, seasonal Western Snowy Plover exclosure, and established foredunes to the south near Oso Flaco Lake. The February 2021 collection covered a larger extent to match that of the concurrent RGB campaign. All data are calibrated using a pre- and post-flight calibration panel so that, while the orthomosaics in Figure 4 may appear to have variable contrast, individual pixels are properly scaled so that the extracted indices are accurate.

A common index used to identify vegetation is NDVI, which expresses the difference between the reflectance values of NIR light (reflected strongly by plants) and red (R) light (absorbed by plants). NDVI values range from -1 to +1 and areas with dense vegetation will typically have positive values (~+0.3 to 0.8) while water surfaces or fog (that absorb both bands) will tend to have low positive to slightly negative values. Soil surfaces also tend to be characterized by small positive NDVI values (say 0.1 to 0.2), depending on colour and moisture content.

NDVI indices were calculated for the October 2020 and February 2021 datasets in order to detect pixels of vegetation cover from the imagery and monitor changes over time. After examining the histograms for each NDVI output, a threshold was used to remove pixels with high index values (representative of vegetation) (Figure 5). Initial results highlight a general increase in the percent cover (vegetation cover normalized by total treatment plot area) across most treatment types (Figure 6) between October 2020 and February 2021. Treatment 6 (broadcast straw/Parks Classic) exhibited the highest vegetation cover change, increasing from 2.2 to 4.9%, followed by treatment 5 (high density nodes) increasing from 1.5 to 2.4%, and treatment 3 (Sheepsfoot+Native Seed+Ryegrass), increasing from 2.4 to 3.2%. Negligible vegetation change was detected for the control site (treatment 1), and very slight increases (+0.2% and +0.5%) for treatment plots 2 and 4, respectively.

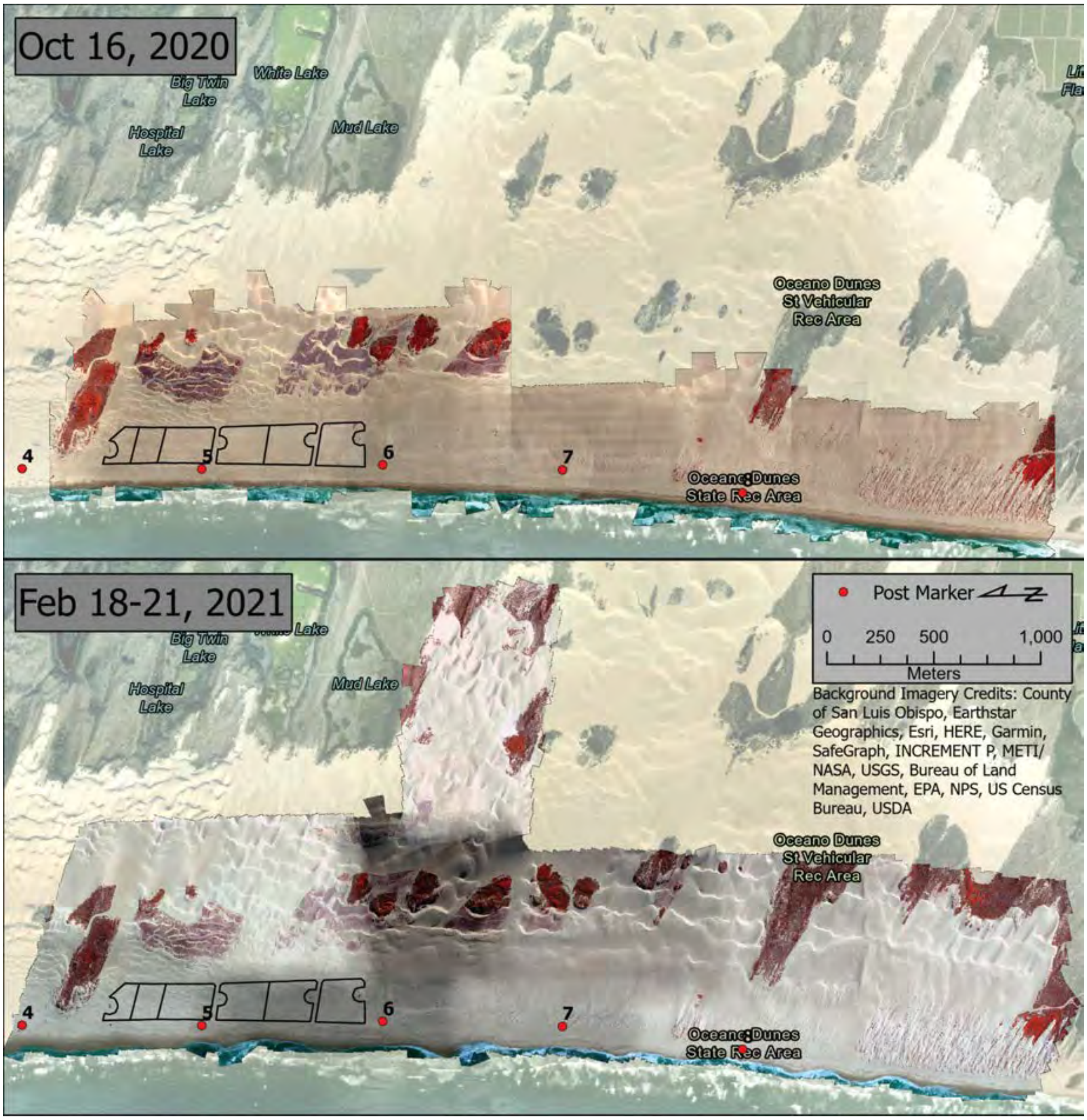


*Figure 4. False-color (G+B+NIR) UAS orthomosaic of multispectral imagery captured from a Micasense RedEdge-MX 5-band sensor (R, G, B, RE, NIR) showing the extent of the two collection campaigns. Contrast differences are only visual and do not impact the indices calculated from the values of compared bands.*

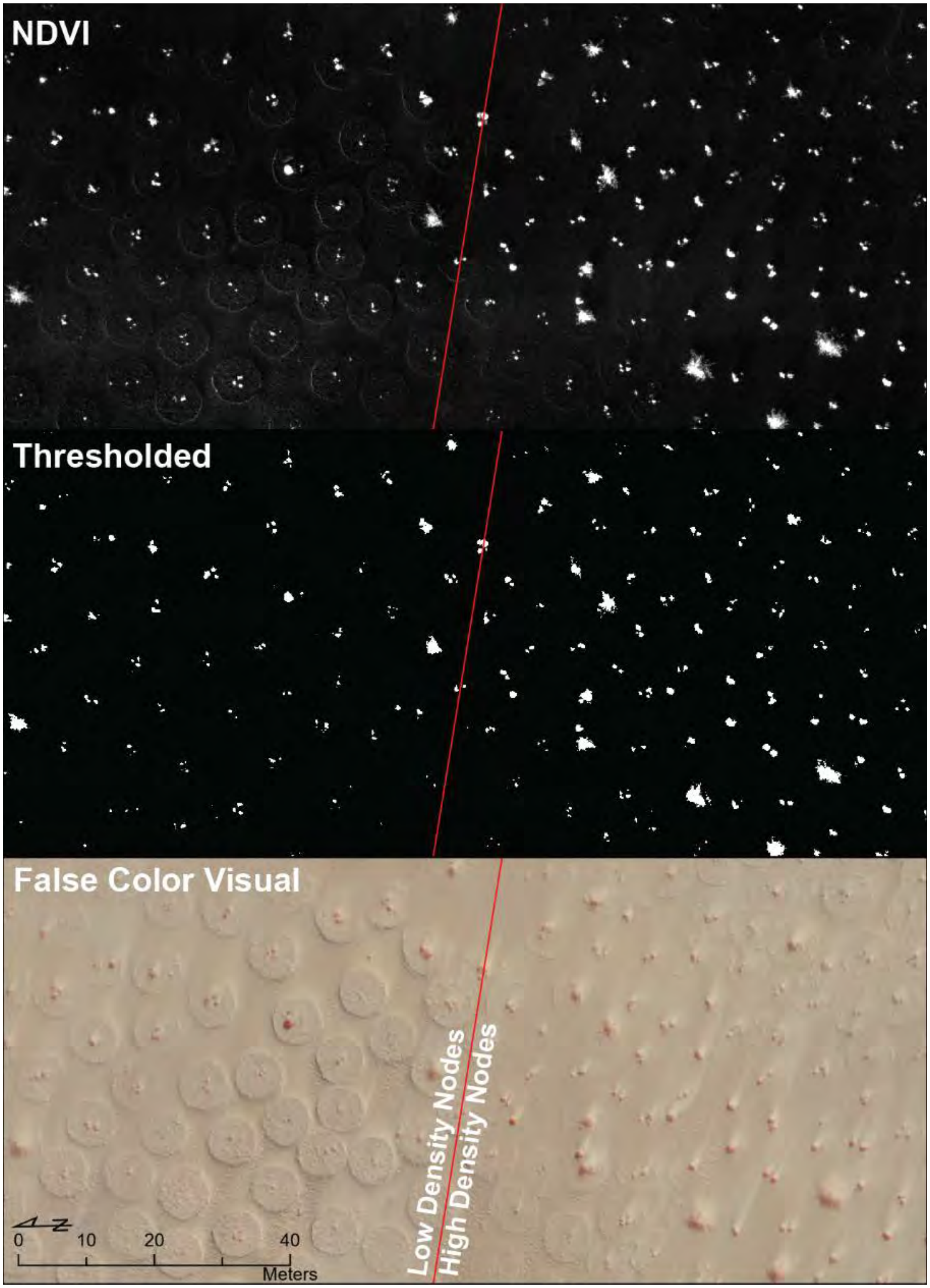


*Figure 5. Example of the NDVI output, thresholded NDVI used to extract distinct vegetation pixels, and false color visual outputs (vegetation as red pixels) along the boundary of the low density planting node (treatment 4) and high density node (treatment 5) plots.*

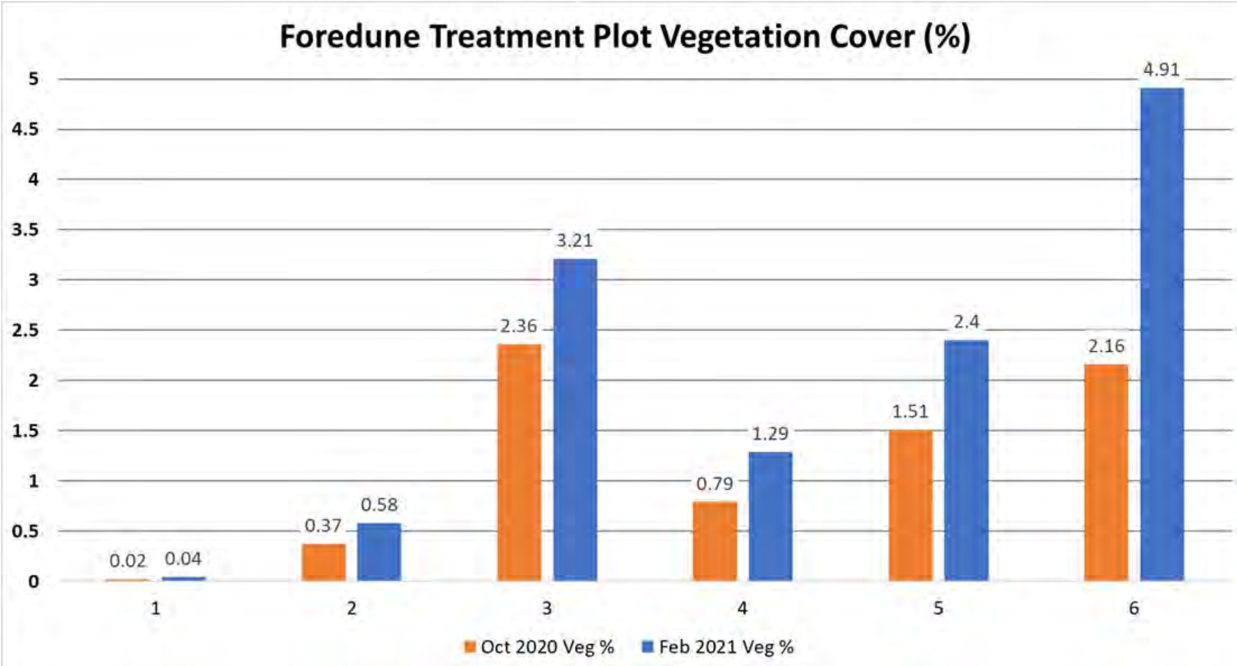


*Figure 6. Bar graph showing changes in percent cover of vegetation per treatment plot (as described in Figure 3) derived from the multi-spectral UAS datasets from October 2020 and February 2021.*

At this point, vegetation cover estimates derived from the UAS campaigns do not identify particular plant species, only the presence/absence of plant cover. Coordination with CDPR vegetation transect monitoring datasets coupled with ground truthing of distinct species against corresponding imagery and multi-spectral signatures is planned to improve species-level identification.

*3.3. Topographic Differencing and Volumetric Change Trends*

Repeat DTMs derived from the UAS imagery are compared through time using spatial statistics to detect pixels of statistically significant elevation change (topographic differencing) and broader geomorphic changes (Figure 7). The resulting GCD maps show areas and quantities of significant change that are then used to calculate volumes of sediment erosion or deposition between surveys in cubic metres ($m^3$) or normalized by area ($m^3$ $m^{-2}$), which is effectively an average depth of change (m) over the entire area. The raster grid positioning and size (0.10 x 0.10 m) is fixed across all surveys, so the volume estimates are determined by changes in depth above/below the grid. Pixels of insignificant change are not shown in the resulting change detection maps (i.e., they are transparent) but they are still included in the uncertainty estimates for each interval.

Quantities of surface elevation (normalized volume) change can be used to identify and interpret dune development and evolution, erosion/deposition patterns, and sediment budgets for the restoration treatments and other areas within ODSVRA. Typically this is done by identifying distinct zones (e.g., the foredune treatment polygons) and interpreting changes relative to upwind (e.g., fronting segments of beach) areas, which provide sand supply, and downwind areas landward of the foredune treatments.

Figure 8 shows the GCD maps for each survey interval between October 2019 and February 2021 with corresponding pixels of significant elevation (i.e., normalized volume) change. Figure 9 shows results for each UAS mapping campaign relative to the October 2019 baseline. As such, Figure 9 provides an indication of relative aeolian activity for each survey campaign normalized by the baseline (pre-restoration) condition as well as a picture of cumulative change at each survey. In both figures, foredune treatment polygons are identified as well as adjoining beach and landward backdune zones for each treatment plot.

The first interval (October 2019 to February 2020) characterizes a baseline reference condition of site geomorphology prior to implementation of the restoration treatments. The second interval (February 2020 to October 2020) shows the response of the treatments to the initial installation (February 2020), first wind season, and first season of vegetation growth. The third interval (October 2020 to February 2021) shows the responses associated with the first winter season (plant dormancy, increased rainfall and storms).

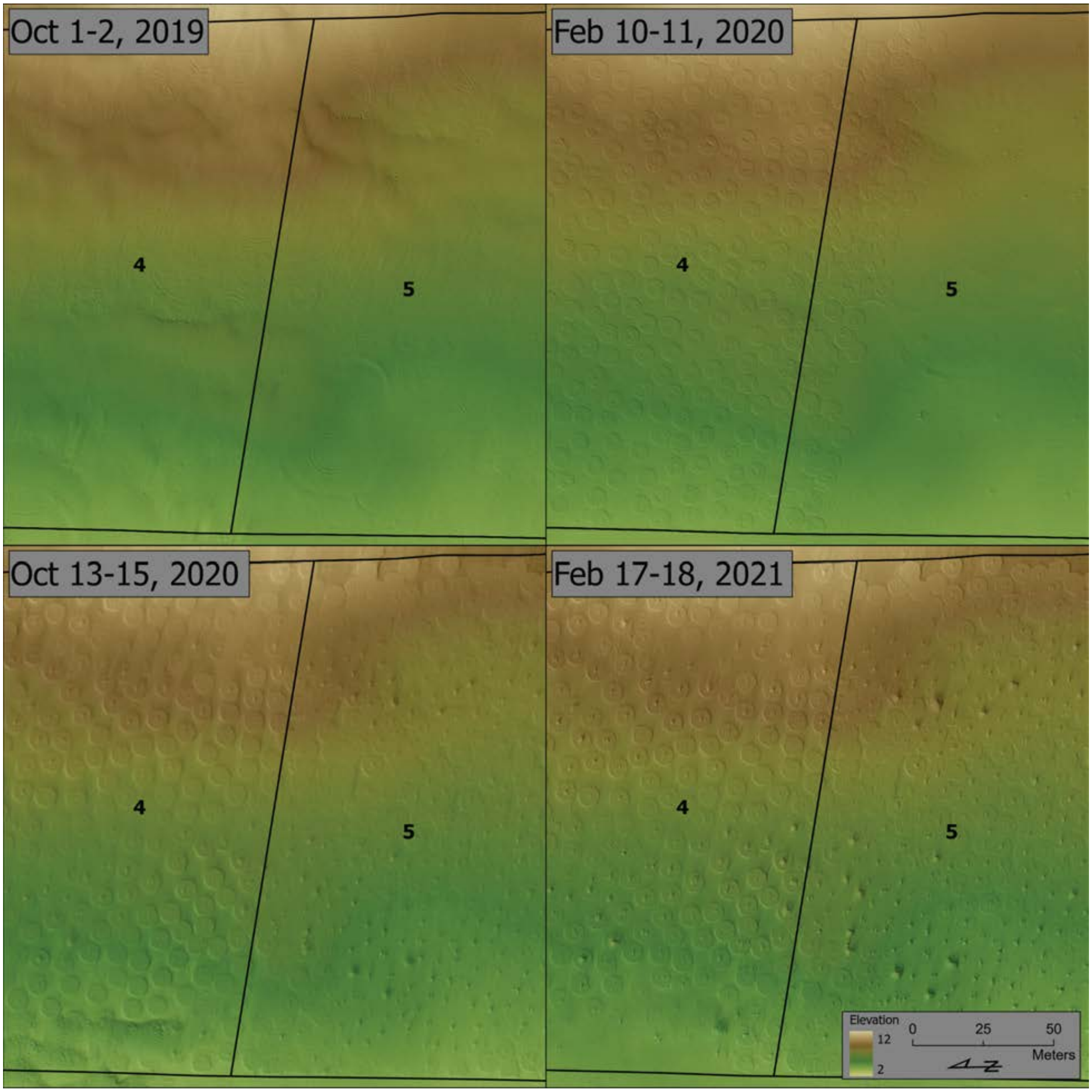


*Figure 7. Example DTMs of the boundary region between the low and high density node (4-5) treatment plots from all campaigns. Straw planting circles are evident in the February 2020 collection. Developing nebkha can be seen in October 2020 and February 2021 collections. These differences are then detected and quantified using the Geomorphic Change Detection toolset.*

To date, one full year (February 2020 to February 2021) of geomorphic and sediment volume changes have been observed following restoration. As in Figure 8, the restoration treatments each exhibited distinctly different signals of geomorphic response and sediment volume change in the first year following treatment (February 2020 to February 2021). Figure 10 provides a time series of normalized volumetric changes for each geomorphic unit and Figure 11 shows the total volume change quantities in $m^3$ within each plot for each change interval.

Treatment plots 1 (Sheepsfoot, control site) and 2 (Sheepsfoot+Native Seed) were the least altered by vegetation-induced sedimentation and maintained similar change patterns across all intervals. Aeolian sand transport in treatment plots 1-2 generated low-lying (0.4-0.6 m), slowly migrating semi-continuous transverse and barchanoid dune ridges and protodunes. Very little vegetation became established, except for near the seaward edge of the plots. Some shadow dunes were present in the landward half of these plots, but these were not nebkha as they were initiated by nodes of cemented sand, anthropogenic debris, and exhumed campfire charcoal remnants within interdune areas.

One of the key controls on the sedimentation response of all treatments is the amount of sand that enters the upwind beach unit, which effectively provides the incoming supply of sand that could enter the treatment between survey intervals. Treatment plots 1 and 2 experienced similar decreasing trends in supply to the beach from October 2019 to February 2021, as well as lesser volumetric inputs compared to the other four beach units to the south. Accordingly, the foredune unit for treatment plots 1 and 2 exhibited some of the lowest rates of accumulation, suggesting that most sediment is bypassing the treatment zone (Figure 8). This said, both treatment plots have shown positive responses in sand accumulation since installation by approximately 9 and 4.4 times the baseline (October 2019 to February 2020) condition (Table 3) and vegetation cover has increased very slightly (+0.2%) in treatment 2 (Figure 6).

Treatment 3 (Sheepsfoot + native seed + sterile rye grass seed) developed significantly through seed establishment, subsequent plant growth, and nebkha development predominantly with *Abronia latifolia*. Inputs to the beach were positive in every interval and this plot recorded the second highest cumulative input to the beach between October 2019 to February 2021. Nebkha dunes quickly coalesced in the plot to form ridges to just over 1 m tall. As a result, this plot exhibited the highest normalized surface change per month, across all treatment plots, during the October 2020 to February 2021 interval. Net sediment volume change remained positive across all intervals, except for the landward dunes landscape unit during the February 2020 to October 2020 interval (Table 3). Generally, changes in the landward units for all treatments are somewhat decoupled from those within the upwind foredune treatment plots due to the influence of OHV traffic in later surveys and landscape scale secondary flow patterns that are generated by larger dunes (e.g., Pavilion Hill or larger barchanoid and transverse dunes inland).

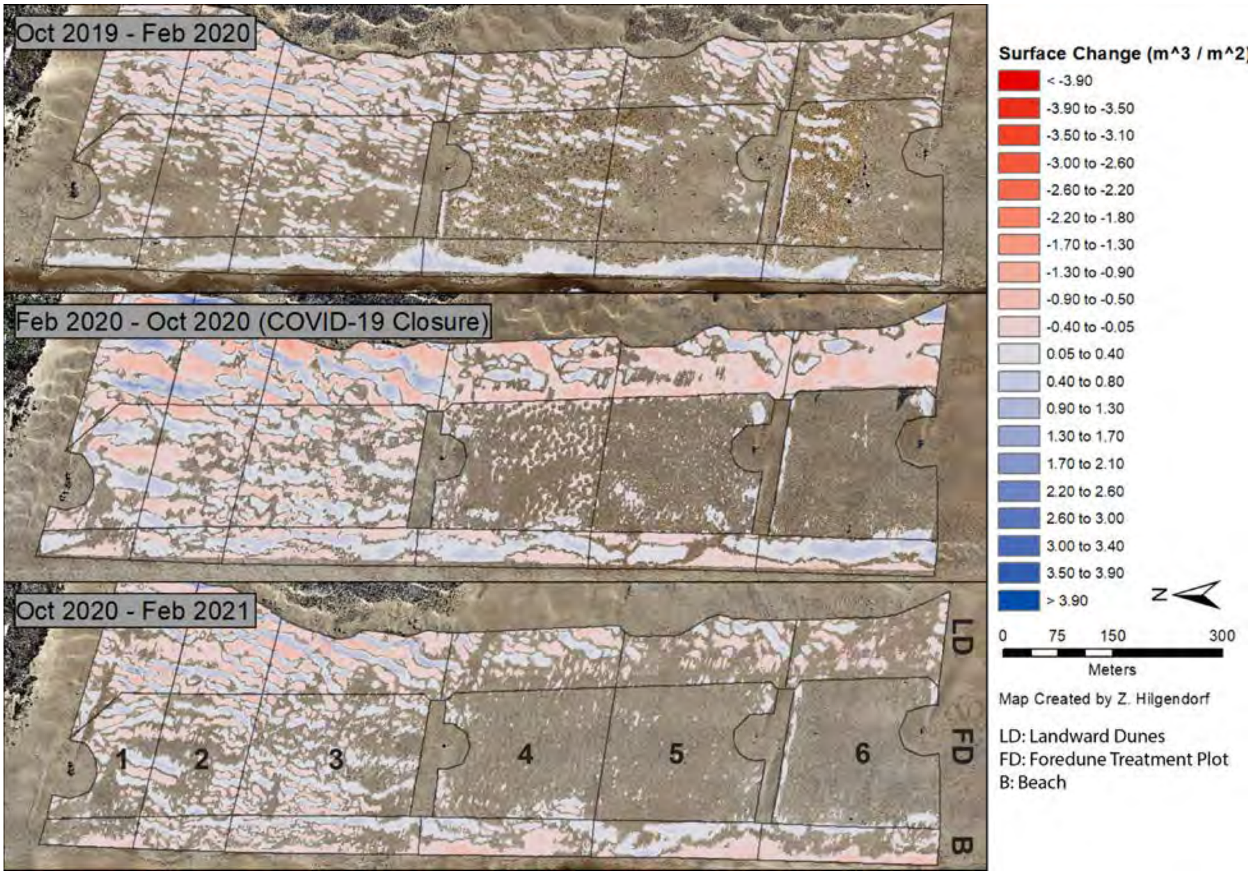


*Figure 8. GCD maps with corresponding pixels of significant elevation change indicated (reds = erosion, blues = deposition, insignificant change = transparent) for each survey interval between October 2019 and February 2021 overlain on the UAS photomosaics for the second time step in each interval. Foredune treatment polygons are outlined and numbered. Intervening transportation corridors, found between treatment plots 3 and 4 and 5 and 6, are not included in the analysis. Also included are the beach and landward backdune zones adjacent to each treatment plot. The underlying orthomosaic image is for the later date of each interval.*

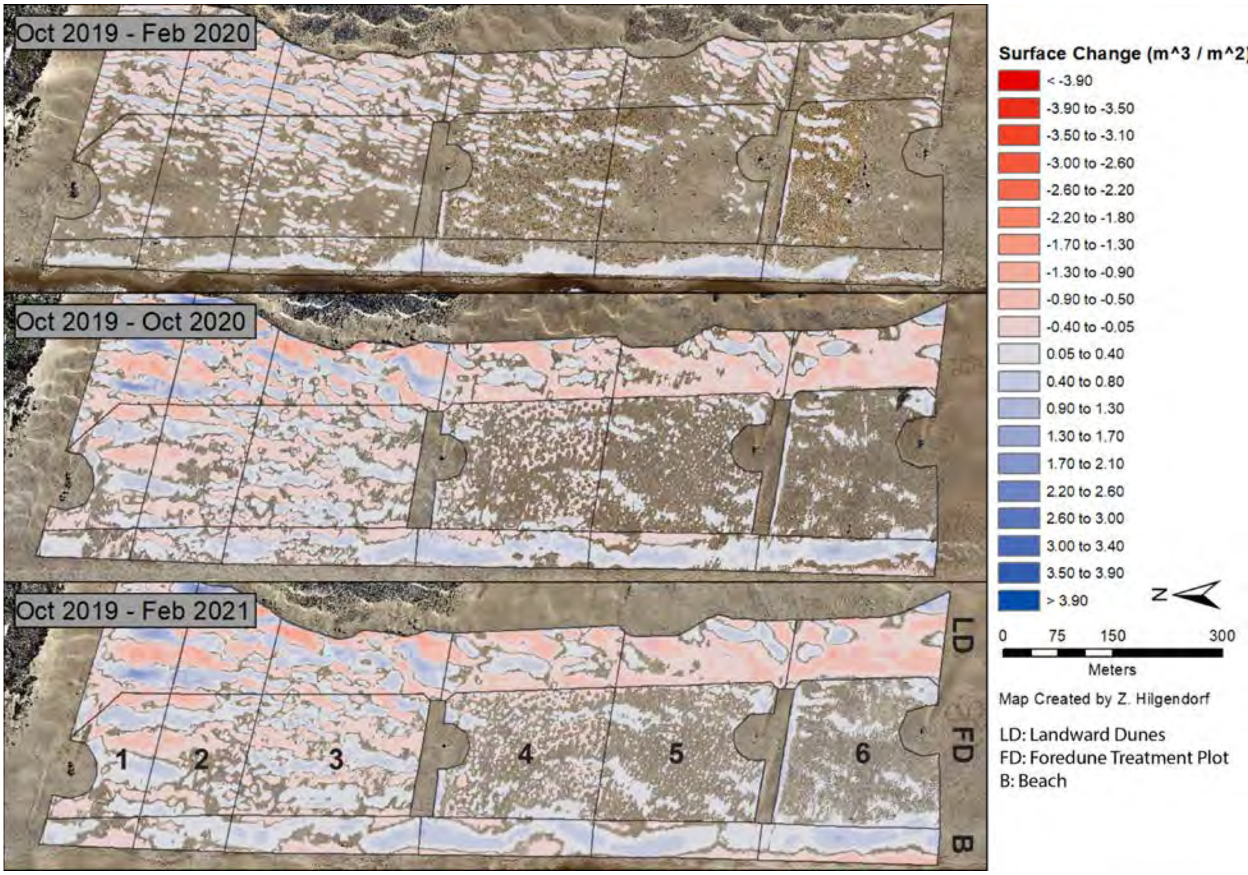


*Figure 9. GCD maps for each UAS mapping campaign (reds = erosion, blues = deposition, insignificant change = transparent) relative to the October 2019 baseline overlain on the UAS photomosaics for the latter time step. Also included are the beach and landward backdune zones adjacent to each treatment plot. The underlying orthomosaic image is for the later date of each interval.*

*Table 3. Normalized surface volumetric (depth) changes for the foredune treatment plots (FD, bold values) and adjoining beach (B) and landward dune (LD) zones. Blue cells indicate sand accumulation, red cells show erosion. The net change column represents change between the baseline (Oct 2019) and most recent (Feb 2021) intervals. Uncertainty values associated with individual measurement campaigns are provided in Table 2.*

| Normalized Volumetric Change by Total Area ($m^3$ / $m^2$) | | | | | |
|---|---|---|---|---|---|
| Treatment Plot | Landscape Zone | Oct 2019 – Feb 2020 | Feb 2020 – Oct 2020 | Oct 2020 – Feb 2021 | *Net Change (Oct 2019 – Feb 2021)* |
| Sheepsfoot (1) | B | 0.075 | -0.013 | -0.045 | *0.013* |
| | **FD** | **0.002** | **0.006** | **0.018** | ***0.019*** |
| | LD | -0.004 | 0.020 | 0.024 | *0.031* |
| Sheepsfoot+ Seed (2) | B | 0.050 | 0.052 | 0.005 | *0.097* |
| | **FD** | **0.005** | **-0.014** | **0.022** | ***0.009*** |
| | LD | 0.008 | 0.050 | 0.020 | *0.070* |
| Sheepsfoot+ Seed+Rye (3) | B | 0.088 | 0.043 | 0.017 | *0.140* |
| | **FD** | **0.012** | **0.008** | **0.027** | ***0.037*** |
| | LD | 0.010 | -0.039 | 0.029 | *-0.009* |
| Low Density (4) | B | 0.155 | 0.096 | -0.029 | *0.216* |
| | **FD** | **0.017** | **-0.016** | **0.010** | ***0.014*** |
| | LD | 0.004 | -0.104 | -0.002 | *-0.113* |
| High Density (5) | B | 0.148 | -0.008 | 0.026 | *0.176* |
| | **FD** | **0.008** | **0.008** | **0.006** | ***0.034*** |
| | LD | -0.005 | -0.147 | 0.005 | *-0.158* |
| Parks Classic (6) | B | 0.068 | 0.188 | -0.058 | *0.160* |
| | **FD** | **0.010** | **0.016** | **0.013** | ***0.052*** |
| | LD | -0.003 | -0.172 | -0.013 | *-0.215* |

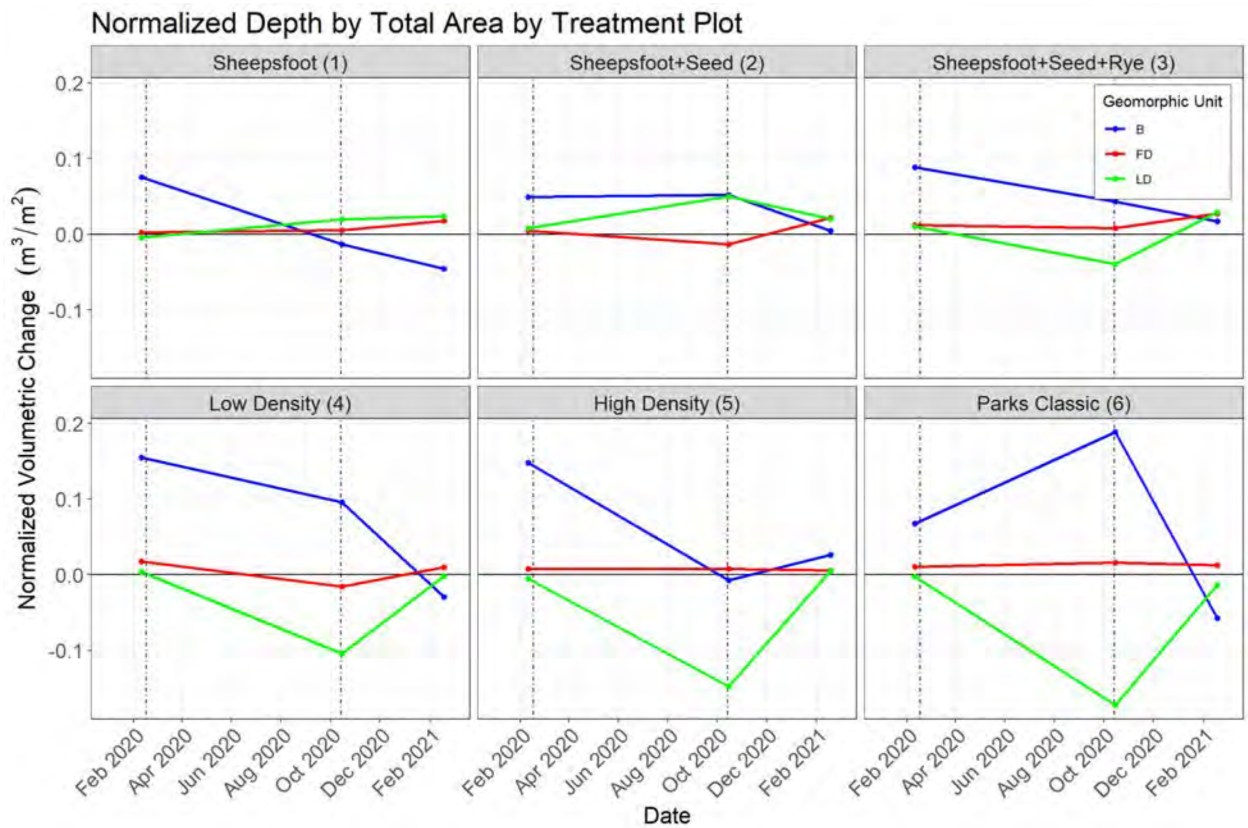


*Figure 10. Time series of normalized volumetric changes (total volumetric change divided by total plot area) derived by successive change intervals for each restoration treatment plot. Responses are shown for the foredune (FD), adjacent beach (B), and landward dune (LD) landscape units. Each point on the plot represents net results of volumetric change for the preceding interval (e.g., the first point represents net change between October 2019 and February 2020, etc.). Dashed lines delimit the COVID-19 closure period (March 2020 through October 2020).*

Treatment plots 4 and 5 (low and high density nodes) were established by estimating the plant density and shadow dune coverage for more established nebkha fields to the south in both the seasonal Western Snowy Plover exclosure as well as in the Oso Flaco foredune complex. The two different densities are comparable to the spacing of earlier stage (treatment 4) and more developed nebkha foredunes (treatment 5), respectively, although on install they both lacked the associated depositional topography.

The beach units fronting treatments 4 and 5 experienced the highest normalized rates of sediment input during the pre-installation monitoring interval (October 2019 to February 2020) (Figures 10, 11). During this same initial interval, the treatment 4 plot experienced the highest volumetric gain. However, following treatment installation (February 2020 to October 2020) erosion dominated due to the development of erosional streets between the straw nodes. Trends for the most recent interval showed that, despite a net loss of sediment from the beach, net deposition occurred throughout the adjoining treatment plot as nebkha established and grew to a height of approximately 0.6 m. This indicates that, despite initial erosion, treatment 4 is acting as a depositional sink for sediment.

The beach unit fronting treatment 5 (high density nodes) recorded net deposition in the first two monitoring intervals (October 2019 to February 2020 baseline, October 2020 to February 2021) and net erosion in the February 2020 to October 2020 interval. In the treatment plot itself, each interval experienced net deposition with cumulative inputs averaging over 3 cm, plotwide. Nebkha dunes within treatment 5 were larger than in the treatment 4 plot and closer in height to the larger dunes in treatment 3, with some dunes over 1 m tall. Meanwhile, the landward dunes behind treatment 5 experienced the second greatest net erosion next to that of treatment 6. Minor erosion (-0.005 m) occurred landward of the treatment in the first two monitoring intervals, with the greatest erosion in the February 2020 to October 2020 interval (-0.157 m). Erosional streets and erosion of the windward side of the straw circles were not as common in this plot compared to the adjacent low density node treatment.

Treatment 6 (Parks Classic) featured complete straw coverage and the highest planting density on installation. Currently, it has the highest vegetation coverage post-installation (Figure 6). This site saw the largest volumetric inputs to the beach in the two surveys following installation (Figure 10), so much of the depositional response within the treatment plot is a response to this enhanced upwind supply. Despite this, large nebkha were not present in this plot, as in treatments 3 or 5, but the treatment shows consistent accretion with high deposition along the windward margins upwind on the beach and on the north fenceline, which was lined with sand fencing for most of the period of study. The sand fence promotes the development of a sand drift immediately downwind, within the treatment plot in this case. The same fence-drift pattern is also observed on the north fence line of treatment 4. Downwind of treatment 6, the largest amounts of erosion were observed in the landward dunes in the later two intervals (February 2020 through February 2021) and cumulatively (-0.215 m).

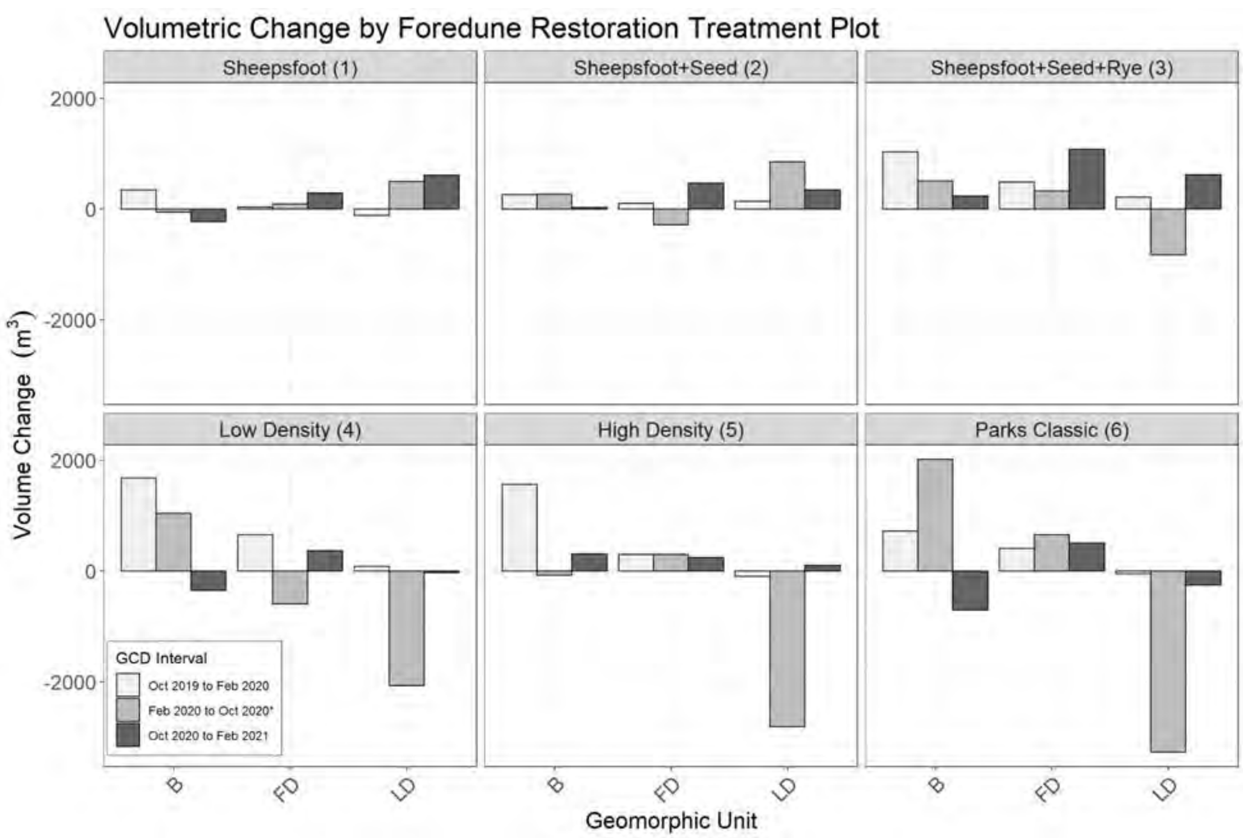


*Figure 11. Bar graph of observed volumetric changes (m$^3$) within the beach (B), foredune treatment plot (FD), and landward dunes (LD), for each treatment, across each GCD interval. Asterisk in the legend indicates the February 2020 to October 2020 COVID-19 closure period that occurred between March 2020 and October 2020.*

## 4. Discussion

### *4.1. Topographic Differencing and Volumetric Change Trends*

Geomorphic change within the treatment plots showed both seasonal and treatment related responses. In addition to seasonal changes in moisture/precipitation (a supply-limiting factor) and the frequency of transporting winds (highest in April through June), two other key factors control the variability in treatment responses over time, including: 1) variations in sand supply to the beach (inputs to the system), and 2) the extent of initial modifications of the treatment strategies and their influence on vegetation development and subsequent sediment accretion. Although the absolute volumes of sediment inputs to the beach fronting the restoration plots (upwind sand supply) differ (Figure 11), the area-normalized values of change were comparable between all plots and intervals (Figure 10), with a generally decreasing trend over time in 2021.

The seasonal establishment and movement of rip current embayments and resulting changes in beach width, which controls the available sand fetch for aeolian transport, consequently alters the supply of sand into the landward foredune treatment plots. These rip embayments are noticeable in the two February orthomosaics in Figures 1-2. As above, beach width (and area) and resulting sand supply variations can have an appreciable and variable impact on geomorphic and sediment budget responses of the foredune treatments at this scale of observation. Such variations, as well as other beach erosion events, are natural, difficult to predict, and should be considered accordingly during interpretation of restoration responses and future adaptive management decisions at this time scale of observation.

The impacts of the variability in beach width and sand supply to the restoration plots was most evident in treatments 4-6. Prior to the installation of the treatments, these plots saw a pulse of sediment supply to the beach in the October 2019 to February 2020 interval. Following this, supply to the beach from February 2020 to October 2020 was much lower fronting treatment plots 4-5 compared to a higher amount on the beach at treatment 6 (Parks Classic). As the supply to the beach during this first interval occurred prior to the treatment installation, it is effectively part of the baseline signal and, coincidentally, it is the highest normalized volumetric change for all treatment plots, except for treatment 6 (Figure 10).

Treatment 6 was the only plot to experience an increase in sand supply to the beach over two change intervals, with the February 2020 to October 2020 interval being the highest measured influx of sand of all treatment sites post installation. This increased supply was timed with the onset of the windy season during which an appreciable amount of sand was transported landward into the treatment plots. This inundation of sand during the first wind season began within a month following installation, between March and May of 2020, as shown in the satellite imagery sequence in Figure 12. Although this figure appears to show complete inundation for treatments 4 and 5 during this interval, they actually experienced less net volumetric change than treatment 6 due to erosional streets that developed between the planting nodes, as shown in Figures 8 and 9, which are not captured in the satellite imagery.

In contrast, treatment plots 1 and 2 were the least modified and had very low volumetric change rates following installation. Both sites also showed close relationships between normalized volumetric changes within the treatment plot and landward plots, suggesting that the treatments are not greatly affecting sedimentation trends (i.e., they are not yet acting as an appreciable sediment sink that would modulate sand supply further landward, Figure 10). Treatment plots 3 and 4 exhibited similar trends, whereas treatments 5 and 6 experienced the greatest deviation between inputs to the treatment plot and erosion within the landward plots.

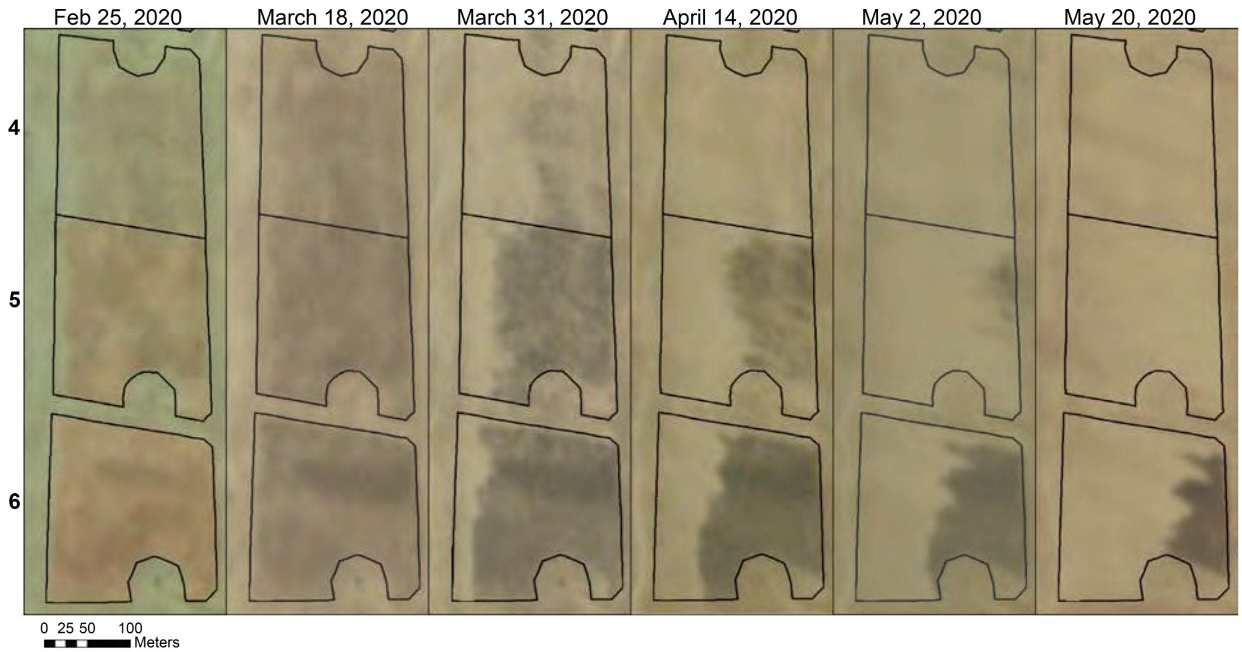


*Figure 12. PlanetScope (3 meter) imagery showing sand inundation in treatment plots 4-6 (low density, high density, Parks classic) over a month and a half. Imagery is oriented with north up and the Pacific Ocean on the left. Sand burial progresses with onshore winds (from left to right).*

The erosion/deposition trends in the landward dunes are somewhat decoupled from the ongoings in the foredune restoration plots for two main reasons. First, OHV traffic in the corridor behind the restoration plots has been active during the observation period with the exception of the March 2020 to October 2020 COVID-19 closure. OHV traffic can displace sediment over time on beaches, modify or disrupt sand supply from beaches to landward foredunes, reorganize pre-existing dunes and protodunes, and enhance localized erosion[9,10].

Second, as dunes evolve and protrude more into the planetary boundary layer, their roughness generates secondary flow patterns downwind that can have appreciable influence on shear

[9] Defeo, O., McLachlan, A., Schoeman, D. S., Schlacher, T. A., Dugan, J., Jones, A., Lastra, M., & Scapini, F. (2009). Threats to sandy beach ecosystems: A review. Estuarine, Coastal and Shelf Science, 81(1), 1–12. http://dx.doi.org/10.1016/j.ecss.2008.09.022

[10] Houser, C., Labude, B., Haider, L., & Weymer, B. (2013). Impacts of driving on the beach: Case studies from Assateague Island and Padre Island National Seashores. Ocean & Coastal Management, 71, 33–45. http://dx.doi.org/10.1016/j.ocecoaman.2012.09.012

stress, sand transport, and dune form[11,12]. At some distance downwind, varying typically from 4-10 dune heights (for continuous dune ridges, not nebkha) wind flow reattaches to the surface and velocity increases (known as the flow separation zone). Within 30-100 dune heights downwind, surface shear stress can approach upwind values[13]. Thus, there is often a downwind 'sheltering' (i.e., shear stress reduction) effect within the separation zone behind dunes that should experience reduced sand transport and dust emissions. Therefore, the restored foredune is expected to have dust emission mitigation effects that extend further downwind beyond the treatment area itself. Downwind of the separation zone, as the boundary layer redevelops and other deflected flow patterns converge, transport of fine-grained sands and surface deflation (erosion and lowering) can occur and coarsening and armoring of this downwind zone is possible on undisturbed surfaces over time. In situations where replenishment of fine particles to the surface is limited, progressive coarsening can make the entrainment of fines more difficult over time.

The established foredune landscape near Oso Flaco Lake and areas with larger nebkha and shadow dunes within the seasonal bird nesting exclosure provide local analogues for what the foredune restoration site will evolve towards. The established Oso Flaco foredunes tend to be between 5-7 m tall. A deflation plain also exists downwind of the Oso Flaco foredune complex (see Figure 13 "A") as well as landward of the "7.5 Reveg" plot, near post marker 8 (Figure 13 "B") and, while this site has not had as long to develop as the Oso Flaco foredunes, it exhibits a similarly spaced foredune-deflation plain relationship. To the north in the seasonal nesting exclosure, nebkha can be up to 2 m tall and, toward the southern end of this exclosure, they are much more densely arranged and a small deflation plain can be seen (see immediately south of post marker 7 in Figure 13 "C"). Based on these observed geomorphic trends, it is very likely that the more densely vegetated and faster evolving treatment plots 3-6 will evolve toward these neighbouring stages of landscape development.

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[11] Walker, I. J., & Hesp, P. A. (2013). 11.07 Fundamentals of Aeolian Sediment Transport: Airflow Over Dunes. In Treatise on Geomorphology, ed. J. F. Shroder, 109–133. Elsevier https://linkinghub.elsevier.com/retrieve/pii/B9780123747396003006

[12] Walker, I. J., & Shugar, D. H. (2013). Secondary flow deflection in the lee of transverse dunes with implications for dune morphodynamics and migration. Earth Surface Processes and Landforms, 38(14), 1642–1654. https://doi.org/10.1002/esp.3398

[13] Walker, I.J., & Nickling, W.G. (2002). Dynamics of secondary airflow and sediment transport over and in the lee of transverse dunes. Progress in Physical Geography, 26(1), 47-75. https://doi.org/10.1191%2F0309133302pp325ra

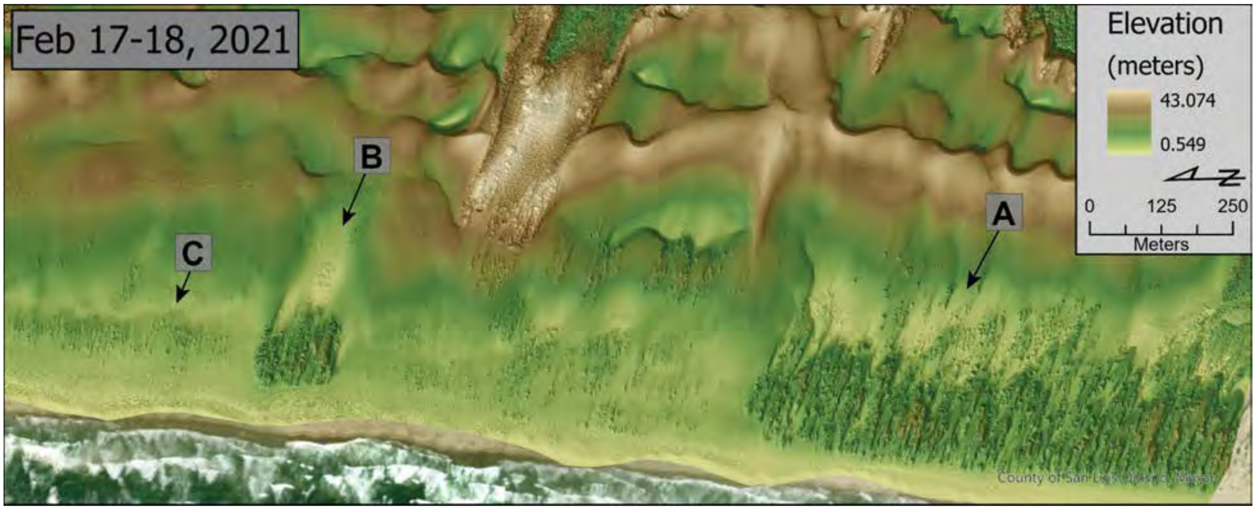


*Figure 13. DTM from the February 2021 UAS campaign located south of the foredune restoration plots near the Oso Flaco foredune reference site. Elevations range from 0.55 m (1.8 ft) to 43 m (141 ft) above sea level in the landward dunes. Downwind (leeward) deflation plains are common behind dune topography as seen at A) leeward of the northern Oso Flaco foredune complex, B) leeward of the "7.5 Reveg" plot, and C) leeward of the nebkha field within the seasonal Western Snowy Plover nesting exclosure. Figure 2 includes an inset box (A), to highlight the extent of area in Figure 13.*

*4.2. Landscape responses in the absence of OHV activity during the COVID-19 closure*

During the COVID-19 pandemic, the ODSVRA was closed to camping and OHV access from mid-March through October 2020. Restoration treatment installations finished in late February 2020 just prior to the closure. As such, the February 2020 through October 2020 surveys capture changes within the landscape without widespread vehicular disturbance. The SAG was asked by CDPR to explore the impacts of this closure on landscape change and dust emissions during this time. This report addresses observed changes in geomorphology and sediment budgets in the vicinity of the foredune restoration zone.

The February 2020 to October 2020 interval experienced the most extensive patterns of geomorphic change of the three periods measured to date (Table 3, Figures 8-11). In terms of volumetric change, many of the treatments and landward plots recorded erosion or little to no net change (which does not imply minimal geomorphic change). Nebkha and shadow dune growth and the expansion of vegetation cover were noted in treatment plots 3-6. In total, 2 of 6 beach plots, 2 of 6 treatment plots, and 4 of 6 landward plots recorded net erosion, while 5 of 10 of the sites with net deposition recorded normalized volumetric change less than 0.02 $m^3m^{-2}$ (<2 cm average depth) during the pandemic closure. These responses are not unexpected and are explained largely by the following factors.

First, the February 2020 to October 2020 interval was the first wind season captured by the surveys since installation of the restoration treatments, so the extent and amounts of change are expected to be greater than the preceding October 2019 to February 2020 interval. As shown in Figure 12, the restoration plots were quickly inundated with a pulse of sediment between March and May of 2020 in the early months of this first wind season.

Second, surfaces subjected to repeat OHV traffic in ODSVRA are highly disturbed with little to no stabilizing vegetation. Samples of surface and subsurface sands from ODSVRA collected and analysed by UCSB and ASU contain an expected mixture of sand and dust-sized particles. Over time, and depending on grain size distributions and replenishment or mixing within sand deposits, wind action can preferentially remove surface fines via a process called 'winnowing'. In areas where the supply of fine sediments to the surface is limited or episodic, winnowing can result in coarsening of the surface as larger particles are left behind as a lag deposit. Where this persists, saltation rates and dust emissions from the surface may eventually decline as progressively fewer fine particles are available for aeolian transport. Provided that the surface is not mixed to bring fines to the surface, or replenished with a new supply of fine sediment, the development of coarse lag surfaces can eventually inhibit aeolian transport on previously active surfaces.

At ODSVRA, it is hypothesized that vehicle action frequently mixes sediments in riding areas, bringing finer particles to the surface that are more readily transported by wind action. Combined with the destruction of vegetation in riding areas, it is likely that OHV activity produces surfaces that are more susceptible to wind erosion and dust emissions, as evidenced also by the higher dust emissivity values within the riding areas shown in the DRI PI-SWERL testing results[14,15].

Even though vehicle activity had ceased during the COVID-19 closure period, the levels of sand transport and dust emissions from surfaces disturbed by OHV activity could persist for months or longer following the OHV restrictions. The winnowing and deflation response of previously disturbed surfaces within the foredune restoration area was evident throughout the treatment plots and was most pronounced in plots 1-4 (Figure 14), as well as in landward dune (LD) areas, where erosion values were greatest downwind of treatment plots 3-6.

*Figure 14. Deflation of sand surfaces in ODSVRA following vehicle access restrictions. Fine sediments on formerly disturbed surfaces have been removed by wind action leaving behind coarser sediments and anthropogenic debris. A) Close-up ground level view of the underlying*

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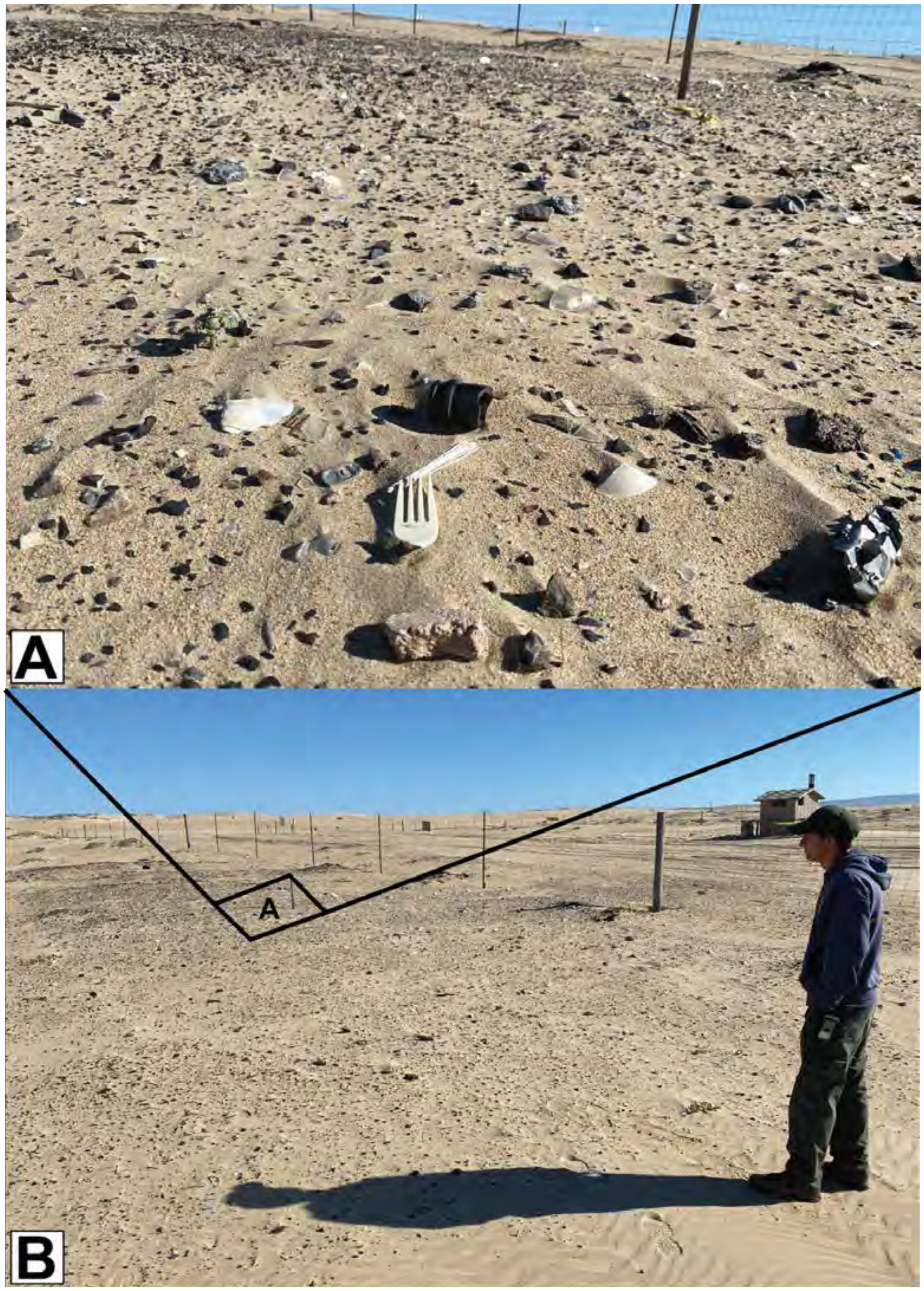
[14] Gillies, J.A., Furtak-Cole, E., Nikolich, G., & Etyemezian, V. (2021). "Examining Dust Emissions and OHV Activity at the ODSVRA" Report from DRI to CDPR.

[15] Gillies, J.A., Furtak-Cole, E., Nikolich, G., & Etyemezian, V. (2021). "The role of off highway vehicle activity in augmenting dust emissions at the Oceano Dunes State Vehicular Recreation Area, Oceano CA." In review with Atmospheric Environment.




*coarser sediments and debris common throughout the exclosed restoration sites. B) View showing the extent of the debris with the viewing area of panel A highlighted.*

Third, repeat vehicle traffic is an appreciable agent of geological change, as evidenced not only by the destruction of vegetation cover, particularly on the upper beach and foredune zones, but also by formation of direct traffic corridors in other areas that flatten surfaces, disrupt natural geomorphic processes (e.g., foredune formation, dune migration, beach sand supply), displace appreciable volumes of sediment[9,16], and create new erosional and depositional patterns. Historically, although vegetation cover has gradually increased in both the larger ODSVRA area and in the less disturbed foredunes at Oso Flaco over time, aerial photographs dating back to 1939[3] show that plant cover within the riding area itself has generally declined from a historic high in 1966.

OHV traffic in the corridor behind the foredune restoration zone was active prior to the COVID-19 closure. During the OHV closure period, this area reorganized into larger dunes with greater interdune corridors behind treatment plots 1-3, and larger deflation surfaces developed downwind of treatment plots 4-6 (Figures 8, 9). This is partly a response to enhanced sand transport during the wind season and related surface winnowing, but is also a morphological response and reorganization of the preceding disturbed surface to limited vehicle activity.

Fourth, as discussed in the previous section, as the foredune restoration treatments develop and dunes evolve, they protrude more into the boundary layer and resulting secondary flow patterns can have appreciable influence on shear stress, sand transport, and dune form both within the treatments and for significant distances downwind. Although the February 2020 to October 2020 interval experienced the most erosion across all treatment plots and adjoining landscape units (Table 3, Figure 8), this is not unexpected in the windy season. Similarly, leeward deflation downwind of modified (roughened) surfaces is anticipated, although the extent of this is expected to be limited given the relatively low roughness and varying extents of surface modification (e.g., straw cover that limits saltation development downwind) during the early stages of treatment establishment.

Given the independent, yet connected effects of the foredune restoration treatments, and the delayed adjustment of OHV-disturbed surfaces during the first observed wind season, it is difficult to disentangle the roles of either OHVs or the windy season on the observed morphodynamic and sediment budget responses. The restoration zone and adjoining landscape units responded expectedly, yet it is also evident that prolonged vehicular disturbance and recreational activities have impacted not only vegetation cover and the composition and response of surface sediments, but also the morphology and function of aeolian dunes in the riding area. Multiple measurement campaigns since 2013 by DRI have shown that areas subjected to the most intensive OHV activity also have the highest $PM_{10}$ dust emissivity[14]. In contrast, undisturbed locations like at Oso Flaco and the northern dune preserve are less emissive. In short, the results of this report and others indicate that the sediments and dunes within the ODSVRA

[16] Anders, F. J., & Leatherman, S. P. (1987). Disturbance of beach sediment by off-road vehicles. Environmental Geology and Water Sciences, 9(3), 183–189. https://doi.org/10.1007/BF02449950

riding areas are more disturbed, have experienced significant changes in historical vegetation cover, and in many areas have become more susceptible to wind erosion, sand transport, and dust emissions compared to neighbouring undisturbed dunes.

Emission of fine particulate dust is a natural consequence of aeolian activity in dune landscapes. Windblown dust from the Oceano Dunes is the predominant air quality challenge affecting southern San Luis Obispo County and each year dozens of exceedances of the state $PM_{10}$ standard are recorded in communities downwind of the ODSVRA[17]. The current landscape at ODSVRA has been altered by decades of human activities, including OHV recreation, that have altered stabilizing vegetation cover and landforms, such as foredunes, that help reduce dust emissions. Although vegetation cover within the broader ODSVRA and in undisturbed dunes at Oso Flaco has gradually increased historically, plant cover within the riding area and the foredune zone in particular have shown steady declines since 1966[3], which corresponds with an era of increasing recreational OHV activity in the region that began in the 1950s[18]. In addition to the foredune restoration project examined here, other revegetation efforts have been implemented by CDPR in recent years, particularly in response to the 2018 SOA and related PMRP in 2019.

The Callendar dune system, within which the ODSVRA operates, has been present and active since at least the mid-late Holocene period (i.e., within the last ~12,000 years)[19,20] and is part of the larger and older (late Pleistocene, ~70,000 to 13,000 yrs ago[21]) Santa Maria dune system that includes the neighbouring southerly Guadalupe and Vandenberg dunefields. The Callendar dune system has been maintained by an onshore supply of sand by wind of roughly 60,400 $m^3$ $yr^{-1}$ between Pismo Pier and Oso Flaco Creek[22], which translates to ~5.1 $m^3$ $m^{-1}$ beach width per year. Our research to date shows that the area of the dunes in the vicinity of the foredune restoration site (combined beach, foredune, and landward dune units) received approximately 8000 $m^3$ $yr^{-1}$ of sand by wind during the period of study, which converts to about 4.7 $m^3$ $m^{-1}$ beach width per

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[17] SLOAPCD, 2020. "Annual Air Quality Report for 2019". Available online at: https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/2019aqrt-FINAL.pdf.

[18] Guiton-Austin, L. (2011). As cited by Harris, W. California Geological Survey Report, 1 November 2011. "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 Callendar Dune Sheet, San Luis Obispo County, California"

[19] Orme, A. R. (1992). Late Quaternary deposits near Point Sal, south-central California: A time frame for coastal dune emplacement. SEPM Special Publication No. 48, 7.

[20] Barrineau, P., & Tchakerian, V. P. (2021). Geomorphology and dynamics of a coastal transgressive dune system, central California. Physical Geography, 1-23.

[21] Peterson, C. D., Ryan, C., Meyer, J., Price, D., & Hostetler, S. W. (2018). Origins of the Santa Maria and Vandenberg coastal dune sheets (~100-0 ka) under changing sea levels, shoreline orientations and wave directions: Long-term records of coastal sand supply in south-central California, USA. Journal of Geography and Geology, 10(1), 33–68.

[22] Bowen, A. J., & Inman, D. L. (1966). Budget of littoral sands in the vicinity of Point Arguello, California. Coastal Engineering Research Center, US Army Corps of Engineers Technical Memorandum 19: Vicksburg, MS. Table 5.

year. This value is comparable to that of Bowen and Inman (1966) and only reflects supply delivered to the first 300 to 400 m of the system in the area of the restoration site. As such, there is significant onshore sand supply to maintain dune development at the site and related aeolian processes of saltation and fine dust emissions.

Given the geological time scales over which these dune systems operate (decades to millennia) and recognizing the extent of anthropogenic disturbance imprinted upon the dunes in recent decades, it is highly unlikely that a few months of OHV riding restrictions would have a substantial impact on $PM_{10}$ emissions from ODSVRA. It is expected that it would take much longer than this short closure interval, likely years to decades, for surfaces and landforms (e.g., foredunes) to re-establish or recover and become self-sustaining. This said, CDPR-OHV Division has implemented significant dust control measures in the ODSVRA since 2005 including other vegetation restoration treatments that, collectively, are having substantial impacts on improving air quality. According to direct measurements and modelling conducted by DRI, summarized in a 2021 report on "Increments of progress towards air quality objectives…", dust control measures implemented from 2011 to 2020, in particular, have reduced $PM_{10}$ from the ODSVRA by approximately 45%. This occurred while much of the riding areas remained open to OHV activity and camping, which indicates encouraging progress toward mitigating the dust emissions and air quality challenges as required by the 2018 SOA and subsequent PMRP in 2019.

To date, the development of the foredune restoration areas overall is very encouraging. It is anticipated that the progressive development of the foredune will play an important role in dust emissions mitigation not only by reducing emissivity of surfaces within the treatment areas, but also by: 1) extending a shelter zone of reduced shear stress and dust emissions for some distance (that is a function of dune height and surface roughness) downwind, and 2) reducing landward sand flux from the beach into the larger transgressive dunes, thereby moderating dust emissions by altering saltation activity at the leading edge of the system. Continued monitoring is required to detect and assess how the restoration site is performing per the stated criteria and the results will continue to be used for ARWP reporting and future adaptive management decisions.

**5. Summary and Conclusions:**

To monitor and assess the performance of the foredune restoration dust mitigation project at the ODSVRA, a team from UCSB and ASU, in collaboration with CDPR, has been conducting biannual UAS surveys of the foredune restoration treatment site from October 2019 through to February 2021. Primary data products, gathered with a WingtraOne fixed-wing UAS platform, include:

1. Four high resolution (~1.5 cm) visual (RGB) aerial orthomosaic images encompassing ongoing foredune restoration efforts and sites of landward interest between Pavilion Hill and Oso Flaco Lake,
2. Two high resolution (~7.5 cm) multispectral (RGB-RE-NIR) orthomosaic images collected concurrently with the October 2020 and February 2021 visual orthomosaics.
3. Two (per multispectral orthomosaic) high resolution (~7.5 cm) NDVI and NDRE orthomosaics for assessing vegetation extent and change,
4. Four high resolution (10 cm) three-dimensional point clouds reconstructing surface topography,
5. Three GCD change maps, including a baseline (October 2019 to February 2020) collection, pre-restoration map, and two (February 2020 to October 2020, October 2020 to February 2021) post-treatment installation intervals.

Prior to installation of the treatment plots (October 2019 to February 2020), little to no vegetation was present in the foredune restoration treatment plots and change was primarily driven by: i) aeolian processes moving sand landward by saltation and low transverse dune migration, and ii) the impacts of vehicle activity and camping. Supply to the beach was variable, but net positive as all beach plots recorded net deposition. Deposition within the treatment plots and landward dune plots was low to negligible initially, as the eventual treatment plots were largely barren sand surfaces with little to no roughness elements to increase deposition.

Following installation of the treatment plots (February 2020 to October 2020), sediment supply to the beach declined or was negligible, partly due to the setup and migration of seasonally established rip embayments. Treatment plots 1-2 experienced very little deposition, as their treatment regimes did not involve planting seedlings or broadcast straw to quickly add roughness. Treatment 3 was seeded with native plants and a sterile rye grass, which sprouted and generated ample roughness to stimulate dune growth. Treatments 4-6 involved combined straw cover with plant seedlings. Treatments 3, 5, and 6 recorded the highest cumulative volumetric inputs during this interval, as nebkha began to develop and trap increasing volumes of sediment. Treatment plot 4 (low density nodes), however, recorded net erosion, due to the development of erosional streets between planting nodes that offset the growth of nebkha within the plot. Treatments 3-6 all recorded the highest rates of net erosion of the adjacent landward plots during this interval. Coupled with the growth of vegetation during the first growing season after treatment installation, and the closure of the park to OHV traffic and camping during the COVID-19 pandemic, this interval provided a unique look at early stage nebkha growth and development and decreased anthropogenic activities within the riding area.

The most recent interval (October 2020 to February 2021), captures the end of a full year of response to the restoration treatments. Sediment budgets to the beach plot remained low or erosive. The establishment of ~1 m tall nebkha was observed in treatment plots 3 and 5, while smaller nebkha (~0.6 m) were observed in treatments 4 and 6. All treatments recorded positive sediment budgets by the end of this first year, with treatment 3 showing the greatest rate of increase. Very little vegetation cover (< 0.6% coverage) established in treatment plots 1 and 2, and migrating protodunes and low transverse ridges were responsible for observed changes. Treatments 1 and 2 did record higher volumes of change, but these inputs came during the first windy season, post-treatment installation. Furthermore, despite the positive sediment budget, sediment bypassing is much more prevalent in these plots, given the general lack of vegetation.

Observed trends in vegetation growth, dune evolution, and sediment budget responses in the foredune restoration zone at ODSVRA provide an opportunity to study and assess the effectiveness of the restoration project and, in turn, eventually inform adaptive management strategies. The first year of vegetation growth and dune evolution after implementation of the restoration treatments has shown an array of responses that are unique to each treatment. However, the extent and nature of the longer term evolution of the foredune in this disturbed setting has yet to be fully realized. As the system continues to develop, it will be necessary to consider the indicators outlined in Section 1 to understand and quantify the impact that the foredune restoration treatment plots are having on landscape evolution and dust mitigation. Those indicators are revisited and assessed, following the first year of system response, as follows:

1. **All plots showed a positive sediment budget** over this first year following the implementation of restoration treatments, although some treatments (2, 4) showed only marginal increases over the pre-restoration baseline survey. This is not surprising as only one wind season has been captured in the observations to date and it will take time for the treatments to establish and evolve. Treatment 2 received only surface texturing and native seed, compared to other treatments with introduced straw and plant roughness. The planting node spacing of treatment 4, though randomized, resulted in development of erosional streets between the nodes, which was anticipated to a certain extent and does not mean that this treatment is underperforming, given positive responses in some of the other indicators, including dune development and increasing plant cover.

2. **Aeolian processes remained active in all treatments** shown by rippled sand transport corridors, dune development and migration, and emergence of erosional deflation surfaces with coarse lag deposits on all sites. Erosional responses are expected during early development phases and do not necessarily reflect poor performance. Generally, maintenance of aeolian processes is required to provide needed ecological disturbance gradients and processes required for plant growth and dune development.

3. **Initial plant survivorship was high (~70%) and plant cover increased post-installation** by a modest 0.2 to 2.8% in all seeded or planted treatments (2-6). Some species, namely

*Abronia latifolia*, showed rapid establishment and growth, promoting development of taller nebkha dunes. It is too early to assess broader foredune ecosystem re-establishment, but this first year has provided promising results.

4. **<u>Enhanced dune development was observed in four of the six treatments</u>** (3-6), with the largest (~1 m) nebkha dunes emerging in plots 3 (sheepsfoot + native seed + sterile grass seed) and 5 (high density planting nodes) followed by smaller (~0.6 m) nebkha in plots 4 (low density nodes) and 6 (broadcast straw + plants). Compared to the disturbed, relatively flat pre-restoration surface, plots 1 and 2 also showed limited development of largely unvegetated protodunes and transverse ridges that migrate inland. With limited vegetation and nebkha development, however, it is possible that these plots could progressively fall behind the performance of the other treatments as they evolve. This said, it is also probable that sites with lesser amounts of initial restoration intervention might require longer time intervals to develop. Accordingly, the data collected to date, which includes only one growth season, is probably insufficient to assess performance trajectories. With this in mind, it is recommended that no adaptive management interventions occur for at least one more full growth season.

5. **<u>Contributions to reduced dust emissivity remain to be assessed</u>**. It is too early in the establishment and development of the foredune treatments to assess their impact on dust emissivity. Continued $PM_{10}$ emissivity testing (PI-SWERL) is recommended coupled with enhanced empirical studies and modelling of aeolian transport and dust emissions within and downwind of the restoration plots to better understand the broader performance of the treatments for improving air quality.

**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

**ATTACHMENT 09**

**DRI 2020/2021 Computational Fluid Dynamics (CFD) Report**

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**2020/2021 Computation Fluid Dynamics (CFD) Report**

Computational fluid dynamics (CFD) is the science of producing simulations of fluid flow using large computational resources. For applications at the Oceano Dunes, and in particular the Oso Flaco foredune, the incompressible Navier-Stokes equations will be solved as the model governing fluid flow. This is a set of partial differential equations, which will be solved using a computational method called the Finite Volume Method (FVM). The FVM method decomposes the domain of interest, in our case a zone of air flow above the foredune, into discrete computational cells (finite volumes) which are used to compute a solution. This solution arrives in the form of a massive set of linear equations, which can be solved by a computer. The shape and number of computational cells has a direct effect on the quality of the solution, and the amount of computing power that is required. DRI is using a software implementation of the FVM called openFOAM (open field operations and manipulation), which has been installed on the University of California, Santa Barbara computing cluster. DRI expects that the simulations will be done on the UCSB computing cluster through the support of Dr. I.J. Walker.

The domain of the simulations can be visualized as a rectangular box placed over the dune surface (see the left pane of Figure A for an example). The governing equations and FVM method together produce a solution inside the box, however boundary conditions for air velocity, pressure, and turbulence quantities must be specified on the boundaries of the box. DRI will use a k-epsilon turbulence model in openFOAM to produce steady-state simulations of the flow field over a portion of the Oso Flaco foredune. This helps to mitigate the very large computational resources needed to produce simulations over a large three-dimensional space. Steady state solutions also provide a time-averaged view of the flow, which is appropriate for the time scales of large wind events. The solution of the flow will produce detailed fields of velocity and pressure throughout the study area, including downwind of foredune, as well as quantification of turbulence production and decay caused by the interaction of the flow with the dune topography. From the velocity and pressure fields quantities such as the surface shear stress on the dune surface, flow path lines, and turbulence intensity can be resolved. Surface shear stress in particular is very important to characterize as it is a primary driver of emissions of dust via the shear-driven saltation process. An example of velocity magnitude patterns inside a domain along a transect across a dune is shown in the right pane of Figure A.

Sonic anemometer data from the spring 2021 field campaign will be indispensable in the setup and validation of the simulations. As mentioned earlier, the flow on the interior of the domain is dictated by the boundary conditions, which need to be specified. It is particularly important the character of the velocity entering the inlet boundary is as realistic as possible. Here, the sonic anemometry data from the towers placed near the high tide mark will be used to set the inlet boundary flow conditions. These data will be time averaged to provide inlet profiles of the wind velocity. Turbulent fluctuations will also be calculated from the dataset, providing inlet turbulence boundary conditions. Towers with sonic anemometers placed along transects within the Oso Flaco foredune and within the foredune restoration areas to characterize the local flow conditions will serve as important validation points for the output of the flow model.

The coding of the simulation in openFOAM has been drafted and is operational for generating shear stress on the foredune topography. A preliminary image of the shear stress developed on a portion of the Oso Flaco dune surface is shown in Figure B. The next phases of development are to obtain the digital elevation data that corresponds with the measurement transect made in May and that extends downwind of the easternmost location of the measurements. The sonic anemometry data are being QA-QCed to ensure that they do not contain any irregularities (e.g., lowest anemometers returned bad data due to dust on the transducers). Following this the sonic data will be used to provide the input boundary flow conditions as well as estimates of shear stress on the surface at the leading edge and at the measurement positions along the transect.

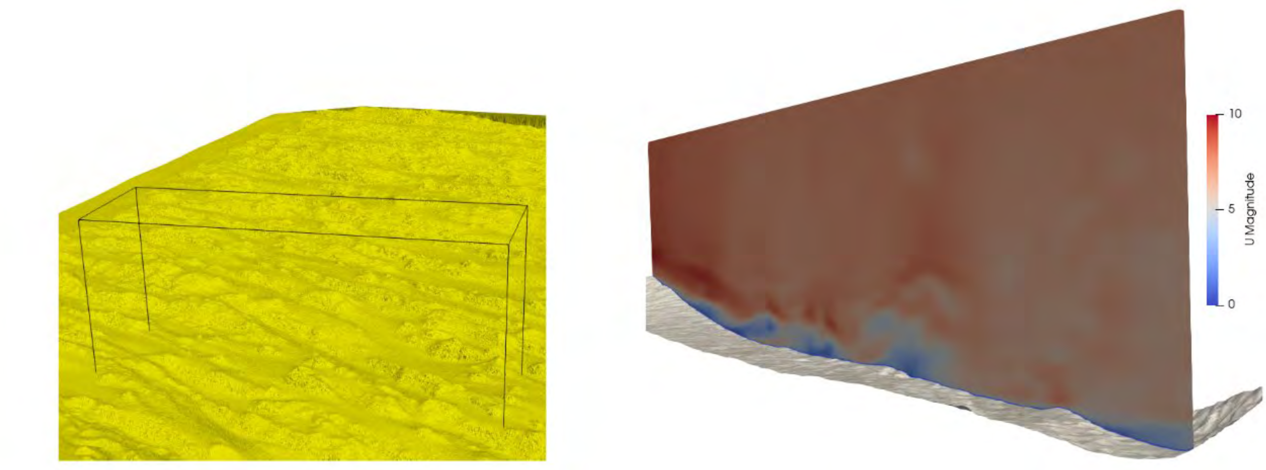


**Figure A**. **Left**: An example of a small computational domain placed over the Oso Flaco topography. **Right**: An example of velocity magnitude pattern across a portion of the dune from a preliminary simulation inside the domain.

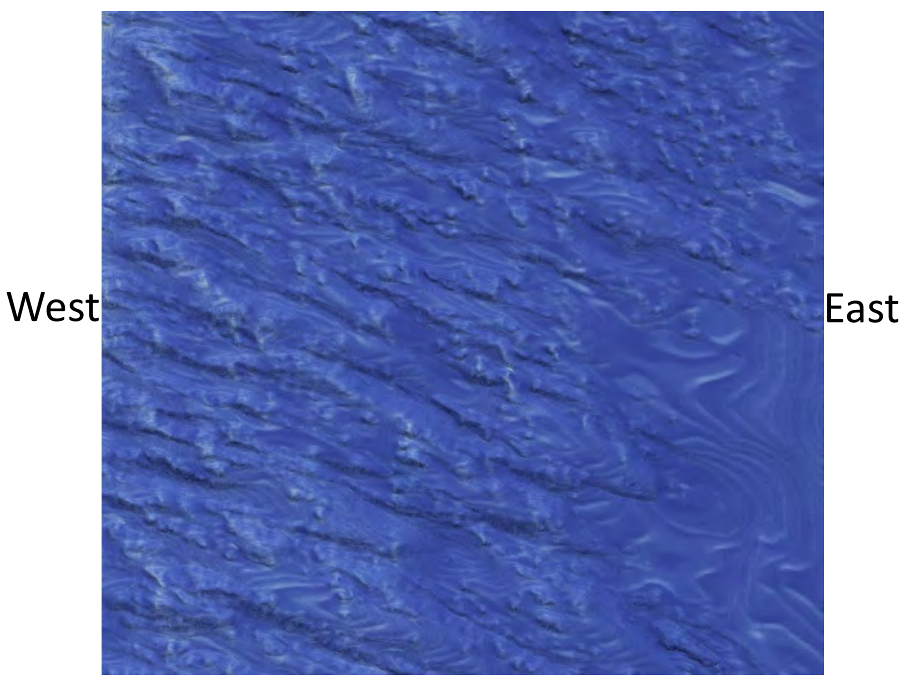


**Figure B** Preliminary simulation of shear stress distribution across an area of the Oso Flaco foredune. The lighter the color the greater the surface shear stress.

The simulation data will be interrogated to examine the pattern of shear stress distribution through and in the lee of the Oso Flaco foredune. The expectation is that a zone of shear stress reduction behind the foredune is defined with shear stress increasing with increasing distance from the foredune. The defined gradient will be used to modify the shear stress calculated by the CALMET wind field model in the DRI emission and dispersion model using this scaling relation. CALMET cannot resolve the fine scale effects of the complex foredune topography so the scaling relation can be applied after CALMET resolves shear stress, or friction velocity ($u_*$) in the grid cells representing a foredune area and in the lee of the foredune.

**Flow Dynamics over Foredune and Oso Flaco**

In May 2021, DRI and UCSB undertook a measurement campaign to characterize the flow over the foredune treatment areas. This was accomplished using 3 m towers instrumented with three 3-D sonic anemometers to measure the three components of wind speed horizontal (*u*), spanwise (*v*), and vertical (*w*) at 10 Hz at three positions on the tower: 0.25 m, 1.6 m, and 3.1 m. These data are used to estimate flow quantities such as the surface Reynolds stress (RS, which is a similar stress quantity as the shear velocity, $u_*$, e.g., Klipp, 2018), RS component stresses, such as $u'^2$ (e.g., Baddock et al., 2011; Weaver and Wiggs, 2011) and turbulence intensity (TI, e.g., Li and McKenna Neuman, 2012; Gillies et al., 2021). As the incoming wind from the ocean passes up the beach and across the foredune restoration areas these quantities are modulated by the surface roughness as it interacts with the flow.

The incoming flow to the restoration areas was determined by having one of the 3 m towers positioned upwind of restoration area 1 (northernmost treatment). This tower remained at this position for the duration of the measurements. The second tower was positioned at the downwind edge of five of the treatments (1 to 5) to measure the flow after it had passed over the treatments. No measurements were made on the downwind side of treatment 6 (Parks classic) due to the presence of two broods of Snowy plovers that required the restriction of access to the site.

The sonic anemometry measurements combined with measurements of surface roughness parameters obtained from the UAS-derived DEMS, on-ground photogrammetry, and terrestrial lidar scanning (TLS) data collected in May 2021, will be used to understand how the evolving surface structures, such as plants and nebkha, in the foredune areas are influencing the flow and the sediment transport potential across each treatment type.

Table1 provides an accounting of the measurement periods for the five treatment areas and the transect through the Oso Flaco dune. These data are currently being organized and quality assured/quality controlled. Following this analysis will be carried out to characterize the flow conditions and then link these data with the surface roughness measurements.

**Table 1**. The locations and observation periods of flow over the foredune restoration areas and a cross section through the Oso Flaco foredune.

| Name | Longitude | Latitude | Day | Start** | End |
|---|---|---|---|---|---|
| Restoration Upwind* | -120.6291 | 35.073815 | 17-05-2021 | 15:16:51 | 17:41:21 |
| Restoration Upwind | -120.6291 | 35.07383 | 21-05-2021 | 10:46:34 | 24:00:00 |
| T1 | -120.6274 | 35.0726004 | 17-05-2021 | 16:34:28 | 17:36:07 |
| T2 | -120.6273 | 35.0716462 | 18-05-2021 | 9:59:38 | 11:36:09 |
| T3 | -120.6272 | 35.0701377 | 18-05-2021 | 12:12:04 | 12:45:20 |
| T4 | -120.6272 | 35.0678638 | 19-05-2021 | 8:59:41 | 10:42:52 |
| T5 | -120.6272 | 35.0656751 | 21-05-2021 | 11:14:45 | 24:00:00 |
| Oso Flaco Upwind | -120.6329 | 35.0378334 | 20-05-2021 | 8:45:00 | 24:00:00 |
| Oso Flaco Transect P1 | -120.6319 | 35.0380164 | 20-05-2021 | 9:40:46 | 10:51:25 |
| Oso Flaco Transect P2 | -120.6309 | 35.0374855 | 20-05-2021 | 11:18:00 | 11:49:20 |
| Oso Flaco Transect P3 | -120.6301 | 35.0372208 | 20-05-2021 | 12:09:29 | 12:41:16 |
| Oso Flaco Transect P4 | -120.6296 | 35.0367 | 20-05-2021 | 13:08:02 | 13:46:00 |
| *Multiple collection periods at this location | | | | | |
| **times in UTC -8 with no adjustment for daylight savings | | | | | |

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**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

# ATTACHMENT 10

**State Parks Staff Report Dust Emissions and OHV Activity at ODSVRA**

**DRI Report: Examining Dust Emissions and OHV Activity at ODSVRA**

**DRI Report: Increments of Progress Towards Air Quality Objectives, 2013 – 2020**

**California Geological Survey Analysis of May and June Wind Strength Year to Year and State PM10 Exceedances with and without OHV Recreation, ODSVRA**

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State of California • The Natural Resources Agency
Gavin Newsom, *Governor*

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Armando Quintero, *Director*

**OHMVR COMMISSION MEETING**
**Sacramento, CA**

**8/26/21**

**STAFF REPORT:** **Dust Emissions and OHV Activity at ODSVRA**

**STAFF:** Jon O'Brien, Environmental Program Manager, OHMVR Division

**SUBJECT:** Update on the Oceano Dust Program and Recent Research

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## Summary


- State Parks has been working with the San Luis Obispo County Air Pollution Control District since 2011 on dust issues downwind of Oceano Dunes SVRA (ODSVRA)
- State Parks entered into a Stipulated Order of Abatement with the APCD in 2018, with an aim of reducing particulate matter (PM10) in the Oceano Dunes area
- There have been substantial dust mitigation efforts at ODSVRA, in addition to research aimed at better understanding the science around dust at Oceano. Two recent Desert Research Institute reports used seven years of data to explore the questions:
  - What effects, if any, does OHV activity have on dust emissivity at the ODSVRA and PM10 concentrations downwind?
  - Are the dust mitigation projects improving air quality downwind of ODSVRA?
- Dust emissivity measurements at ODSVRA indicate that the dunes within the riding area are two to three times more emissive than the dunes in the non-riding area
- In addition, PM10 concentrations within, and downwind, of ODSVRA decreased through the spring and summer during the COVID closure of ODSVRA in 2020. In 2019, the PM10 concentrations increased through the spring and summer
- However, due to the substantial dust mitigation efforts at ODSVRA since 2014, there have been significant reductions over time in PM10 concentrations downwind of ODSVRA
- These reductions in PM10 concentrations indicate that, even though the riding area is more emissive than the non-riding area, the dust mitigation efforts at ODSVRA are improving air quality in south San Luis Obispo County
- These results show that improved air quality and OHV activity can coexist at ODSVRA, and more dust mitigation projects will be needed to meet the targets of the Stipulated Order of Abatement

## Discussion

Oceano Dunes State Vehicular Recreation Area (ODSVRA) is located on the central coast of California south of the town of San Luis Obispo in the 'five cities' area. It is the only coastal State Vehicular Recreation Area (SVRA), and one of the most popular Park Units in the state with over 2 million visitors annually. ODSVRA is 3,600 acres and is part of the greater Nipomo-Guadalupe Dunes Complex that encompasses approximately 18,000 acres. The riding area within ODSVRA is approximately 1,000 acres. The Nipomo-Guadalupe Dune Complex is characterized by high winds and dusty conditions. Dust, or particulate matter (PM10), is created through a natural process called saltation where the wind causes sand grains to bounce across the dune surface thereby emitting PM10 into the air.

California State Parks (Parks) has been working with the San Luis Obispo County Air Pollution Control District (APCD) on managing PM10 emissions from the riding area since 2011. Concerning air quality at ODSVRA, the APCD imposed Air District Rule 1001 in 2011, requiring Parks to reduce particulate matter; a Consent Decree was signed between Parks and the APCD in 2014. Parks then entered into a Stipulated Order of Abatement (SOA) with the APCD in 2018. The Order was amended in 2019. The SOA has three air quality targets:

1. To meet the State ambient air quality standard for PM10
2. To meet the Federal ambient air quality standard for PM10
3. To reduce the maximum 24-hour PM10 baseline mass emissions by 50% (initial target; based on 2013 mass emission estimate)

Air quality modeling is required, as per the SOA, to determine the change in PM10 mass emissions through time from the baseline year of 2013 for 10 specified days. Mass emissions quantifies the metric tons of PM10 emissions per day. This quantity is derived from a computer model that also predicts PM10 concentrations (μg $m^{-3}$) at downwind locations. As of 2021, Parks had installed over 300 acres of dust mitigation projects at ODSVRA.

Parks has commissioned substantial research at ODSVRA aimed at better understanding the science of dust and emissivity in the area. As part of this effort, the Desert Research Institute (DRI), has been collecting dust emissivity data at ODSVRA since 2013. In addition, a network of air quality and meteorological monitoring stations have been in place within, and downwind, of the park since 2017. Parks also works with a Scientific Advisory Group (SAG) on scientific issues at the park. The SAG was established by the SOA and is comprised of scientists with expertise in atmospheric science, dune geomorphology, botany, and horticulture.

Part of this research has been to answer two fundamental questions:
1. What effects, if any, does OHV activity have on dust emissivity at, and downwind, of ODSVRA?
2. Are the dust mitigation projects in place improving air quality downwind of ODSVRA?

***Does OHV have an impact on dust emissions at ODSVRA (see attachment 1)*?**

The first question of how OHV may impact dust emissions at ODSVRA has been a point of discussion raised by the OHV Commission, the OHV community, the San Luis Obispo County Air Pollution Control District, and other stakeholders for several years. In addition to analyzing the impacts off-highway vehicles may have on dust emissivity at ODSVRA, DRI also explored how any impacts on emissivity are related to observed changes in PM10 concentrations in the ODSVRA as well as downwind of the Park from 2017 to 2020. For clarity, emissivity is defined as how much particulate matter is released from the sand surface per unit area and time under the action of the wind. PM10 concentration is the mass of $PM_{10}$ in a volume of air being moved by the wind and is typically measured at a downwind receptor site.

To address any impacts on emissivity, measurements of emissivity from dune sands were made using a specialized instrument (PI-SWERL®) from 2013 through to 2020 in the area with OHV activity and in areas where OHV access is not permitted. These measurements indicated that the mean emissivity of the sand inside of the riding area was two the three times higher than the mean of the non-riding areas, for wind conditions well-above the threshold where saltation begins on the dunes. In addition, emissivity data specific to the La Grande Tract from 2020 was lower than in 2019. Note that these data quantify the PM10 emissivity of the sand, as opposed to downwind PM10 concentrations.

In addition to analyzing the sand emissivity data, measurements of Wind Power Density (WPD), a measure of the ability of the wind to cause sand to saltate and emit dust and suspended particulate matter (concentrations of PM10) were made at 15 monitoring stations in the riding areas (11 stations) and downwind of the riding areas (4 stations). These measurements have been made annually between May and September 2017 to 2020. In 2017, 2018, and 2019, these data indicate that $PM_{10}$ concentrations in the air at ODSVRA, increased from May through July per month for similar wind conditions. The increase was observed from May through September for 2019 (Figures 17 and 18). In 2019, that increase was approximately 12% per month for similar wind conditions (Figure 17). The increase was also observed at the four monitoring stations downwind of the riding area mentioned above (see slide 19 from DRI 'Examining Dust Emissions and OHV Activity at ODSVRA' presentation).

Public vehicle activity was prohibited beginning in late March 2020 due to the SARS-CoV-2 pandemic. In contrast with the 2019 data, measurements of $PM_{10}$ and WPD, April to August, 2020 in the ODSVRA indicated an approximate 11% decrease per month for similar wind conditions (Figure 20).

The cessation of OHV activity resulted in the dunes producing lower concentrations of $PM_{10}$ for similar wind conditions during sand transport (saltation) in the ODSVRA. The decrease was also observed at the four monitoring stations downwind of the riding area (see slide 19 from DRI 'Examining Dust Emissions and OHV Activity at ODSVRA' presentation).

***Are the dust mitigation projects improving air quality downwind of ODSVRA (see attachment 2)?***

Dust controls—temporary wind fences and vegetation projects—have been used within the Oceano Dunes State Vehicular Recreation Area to reduce PM10 emissions originating from within the park. These controls are also expected to lower the PM10 concentrations helping to meet the SOA requirements. Beginning in 2014, 28 acres of dust control was implemented, and the acreage had increased to 223 acres in 2020. That is approximately 15% of the available riding area. According to emission and dispersion modeling undertaken by DRI, the

223 acres reduced PM10 measured at the Calfire monitoring station (CDF) by ≈42% with respect to the values modeled for the 2013 baseline days.

Using the PM10 measurements at CDF and wind speed data from the S1 tower in the ODSVRA, DRI demonstrated that dust emission in locations where controls have been placed produces less PM10 now than prior to these controls and that this reduction is consistent with the increase in acres of dust control. Specifically, these data indicate that emplacement of dust controls upwind of the CDF station reduced PM10 production by 48% for similar wind conditions with the controls in place in 2020 compared with the no-control conditions of 2011–2013. DRI's analysis of the data also agrees with model results that indicate PM10 reduction at the CDF receptor site is due to the dust controls.

Air quality modeling and analyses of the wind and PM10 data presented in the DRI report indicate that the actions taken by Parks to reduce dust-generated impacts within the ODSVRA through the dust control program are demonstrable with decreased emissions of PM10 as the size of the control areas have increased through time, and these impacts amount to a reduction of ≈45% near the CDF measurement site since 2011. This has been documented by sophisticated computer modeling of concentrations at sensitive receptor sites and has been verified by measurements at EPA monitoring sites downwind of ODSVRA. This analysis shows that the ongoing dust control efforts have eliminated exceedances of the Federal ambient air quality PM10 standard and are making strong progress to meet the State standard as well.

***Conclusion:***

***The analyses by DRI indicates that OHV activity increases emissivity and dust levels in the active dune field, in addition to PM10 concentrations, downwind of ODSVRA. However, the dust mitigation measures in place have significantly improved air quality downwind of ODSVRA.*** Parks continues to implement projects to mitigate dust emissions, monitor changes in emissivity and PM10 due to the dust control projects, and refine the DRI dust emission-dispersion model to better understand the relationships between OHV activity and sensitive receptors on the Nipomo Mesa.

In compliance with the SOA, more dust mitigation projects will be installed, which are expected to further reduce PM10 emissions from ODSVRA thereby improving air quality downwind of the Park. Both the SAG and the APCD have stated that they believe that it is possible to meet the requirements of the SOA while maintaining off-highway vehicle recreation at ODSVRA. In a letter to the California Coastal Commission on March 12th, 2021 (see attachment 3), the SAG wrote, "…from an air quality perspective the work of the SAG thus far indicates that there is a workable approach to achieving the targets set by the SOA while retaining some level of off-highway vehicular activity at the ODSVRA."

Improved air quality and continued OHV activities are compatible at ODSVRA. The ongoing research and analyses continue to help Parks refine dust control efforts and activities. Parks will continue to work with the APCD and the SAG towards meeting the goals of the SOA and improving air quality, while maintaining high quality off-highway vehicle recreational opportunities at ODSVRA.

**Commission Action**

For information only.

**Attachments**

1. Examining Dust Emissions and OHV Activity at ODSVRA. Desert Research Institute. February 2021
2. Gillies, J.A, E. Furtak-Cole, V. Etyemezian. Increments of Progress Towards Air Quality Objectives-ODSVRA Dust Controls. Desert Research Institute. December 2020
3. Letter from the SAG to the CA Coastal Commission. March 12th, 2021

**Examining Dust Emissions and OHV Activity at the ODSVRA**

J.A. Gillies, E. Furtak-Cole, G. Nikolich, and V. Etyemezian

## Introduction

California State Parks has undertaken ambitious dust control efforts at the ODSVRA to move towards meeting the Stipulated Order of Abatement targets for reducing the mass emissions of $PM_{10}$ from the ODSVRA and lowering the $PM_{10}$ concentrations at key monitoring sites CDF and Mesa2. It is assumed that lowering the total mass emissions and the $PM_{10}$ levels at these two sites indicates that air quality across the Mesa is being improved for all residents.

A recent Report to Parks from DRI (Gillies et al., 2020) presents analysis based on modeling and empirical data, that suggests $PM_{10}$ levels have been lowered by approximately 45% in the vicinity of the CDF monitoring site since dust controls have been emplaced within the riding area of the ODSVRA beginning in 2014. This has been achieved by controlling in 2020, 223 acres using vegetation and temporary wind fencing to reduce dust emissions.

A question that has been posed by stakeholders is: if OHV activity augments the emissivity of the dunes, what fractional increase may this represent? Here we present several lines of evidence that this increase can be defined. The analyses to be reported uses the available PI-SWERL data collected between 2013 through 2020, and the wind and $PM_{10}$ data from the in-Park monitoring network in 2019 and 2020.

## PI-SWERL

Since 2013 DRI has undertaken PI-SWERL measurements of $PM_{10}$ emissivity (E, mg $m^{-2}$ $s^{-1}$) across the ODSVRA in riding and non-riding areas on an annual basis. Measurements have been repeated through time by revisiting locations that were established in 2013, which defined west to east and north to south transects. In addition, over the same period PI-SWERL measurements were also made in the Plover exclosure area during periods when it was and was not accessible. Measurements have also been made in areas where it was deemed critical to obtain data that could be used to, for example, define the change in emissivity as a function of distance past the riding-nonriding boundary on the eastern side of the ODSVRA.

In 2020 OHV activity ceased in April due to restrictions based on health concerns for the transmission of COVID19. The cessation of OHV activity provided an opportunity to investigate how emissivity may change through time due to the absence of OHV. A program was undertaken to repeatedly measure emissivity using the PI-SWERL in the Lagrande Tract at the same geographic positions (30 in number) from April through October (Fig. 1). The positions within the Lagrande Tract selected for repeat measurements were selected from the 2013 transects. A subset of sample locations (62 in number) was also selected that represented the wider riding area domain of the ODSVRA (Fig. 2) to allow comparison with the same locations measured in 2019. The measurement protocols for PI-SWERL have remained the same since 2013 and the testing sequence of RPM and ramping between RPM values used has been the Hybrid3500.

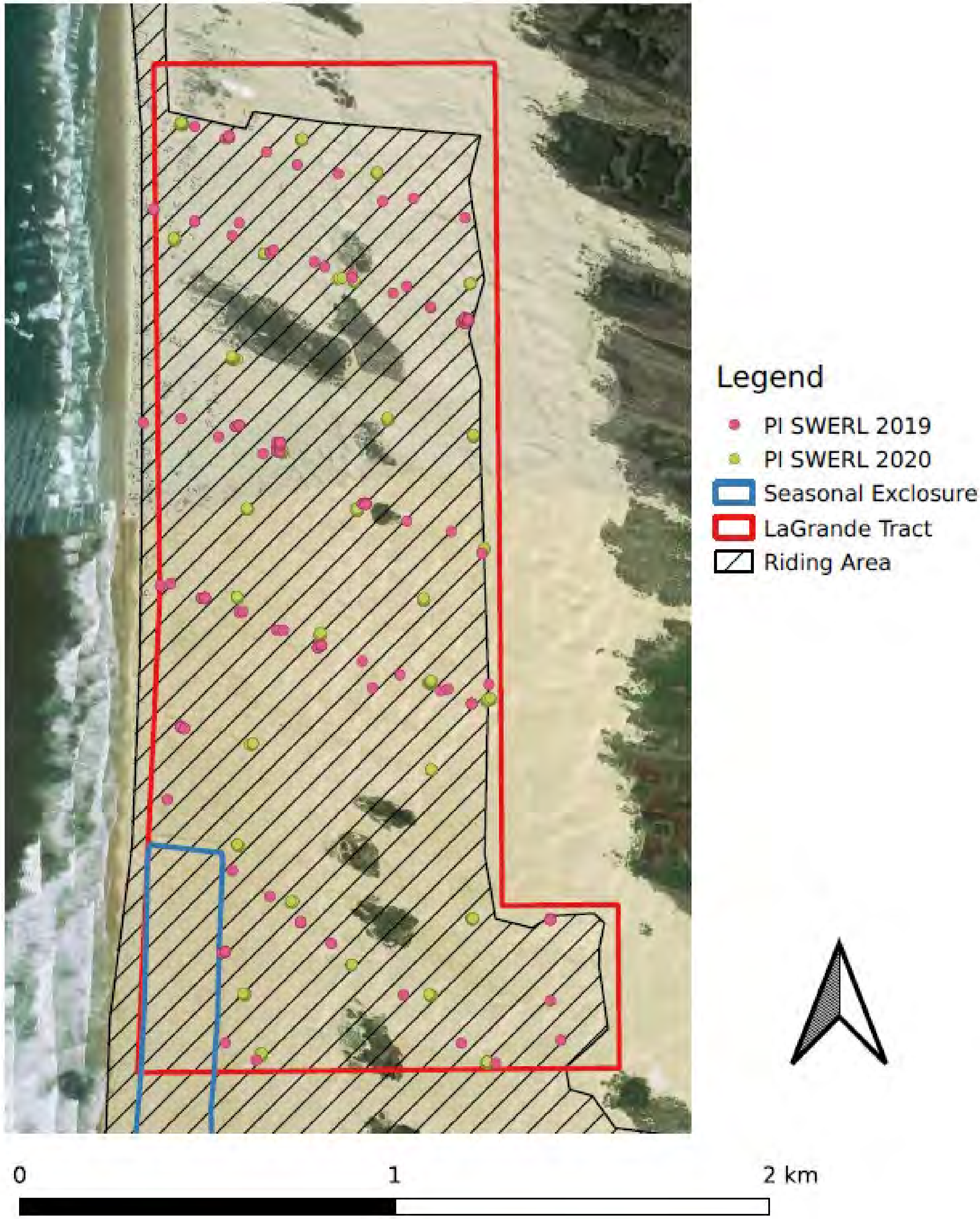


**Figure 1**. Locations of PI-SWERL tests in the Lagrande Tract in 2019 (pink circles) and in 2020 (green circles).

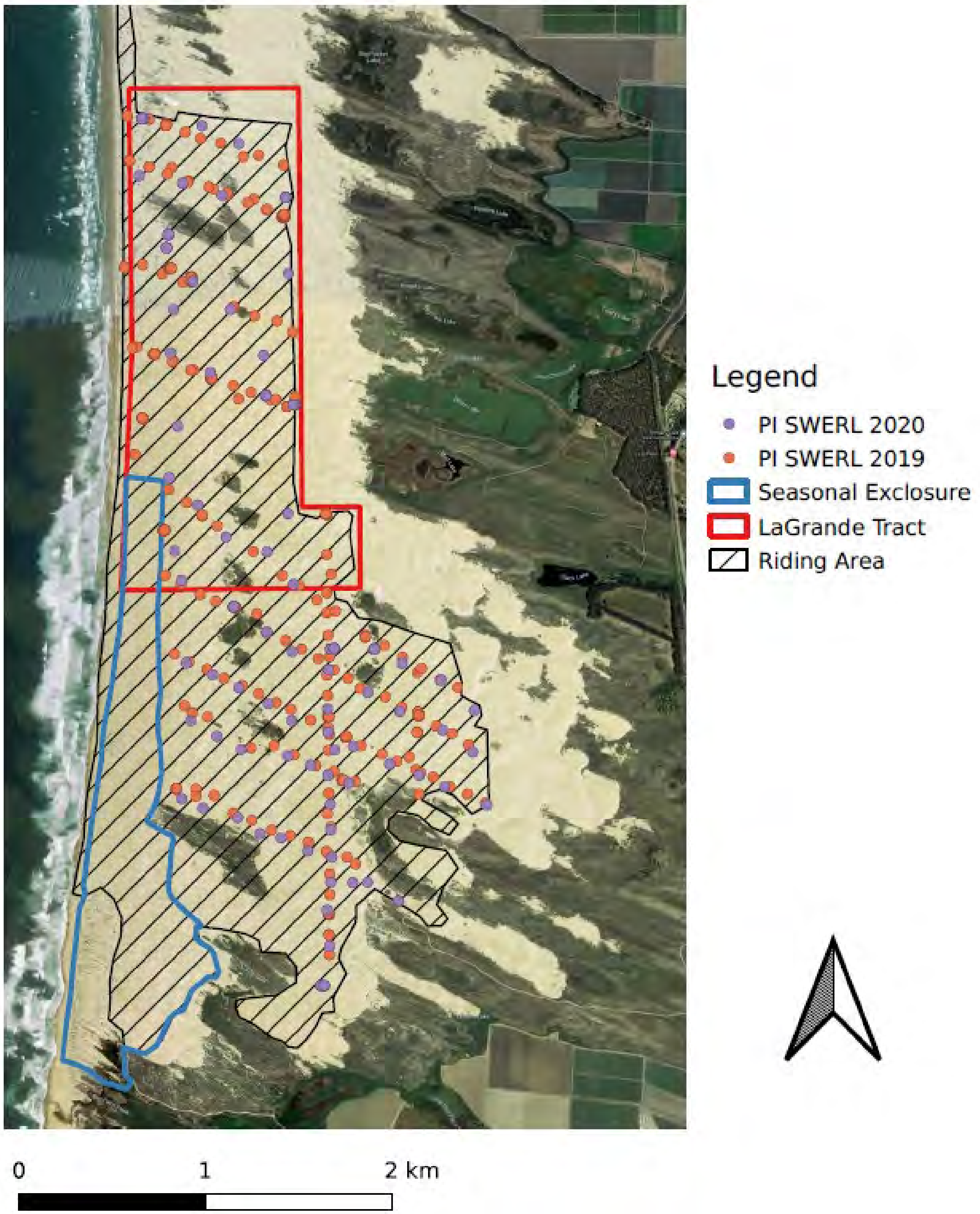


**Figure 2**. The PI-SWERL test locations for 2020 (purple circles) and 2019 (orange circles).

**2013-2019**

At the broadest level of comparison of emissivity between riding and non-riding areas the data for all years (2013-2019) can be aggregated together to produce an emissivity and $u_*$ relation for each. For the riding area approximately 932 individual PI-SWERL tests representing the three RPM set points in the Hybrid 3500 test are available. In the same period approximately 317 PI-SWERL tests were made in non-riding areas. These tests do not include those made in the Plover exclosure area between 2013 and 2019.

The mean emissivity (E, mg $m^{-2}$ $s^{-1}$) as a function of shear velocity ($u_*$, m $s^{-1}$) relation for the riding and non-riding areas are shown in Fig. 3. The shear velocity is estimated from the RPM value of the PI-SWERL Hybrid 3500 test sequence using the conversion equation of Etyemezian et al. (2014). An Analysis of Variance (ANOVA) test was conducted on the E values for each of the three sets of $u_*$ values to test whether they are statistically different at the 0.05 level of confidence (i.e., the set P value). The nonparametric ANOVA test was used because these data are not normally distributed. For each of the three $u_*$ values the difference in E between the riding and non-riding tests is statistically significant based on the calculated P values being $<0.05$ and the F value being greater than the F critical value (generated by the ANOVA test). This demonstrates that the long term mean emissivity of the entire riding area is greater than the long term mean emissivity of the non-riding area for the aggregated data from 2013 to 2019.

These aggregated data sets indicate at the broadest level that, all else being equal, the riding area has a higher emissivity than the non-OHV impacted surfaces, providing some suggestion as to the impact of OHV activity on emissivity. Because the relationship between E and $u_*$ is non-linear (i.e., a power function) the scaling of the OHV effect on emissivity cannot be quantified as a single value. At lower shear velocities (e.g., 0.38 m $s^{-1}$) emissivity of OHV-impacted sand is enhanced by a factor of 3.6 while at the higher value of 0.61 m $s^{-1}$ it is enhanced by a factor of 1.9 (Fig. 3). OHV activity exerts mechanisms of anthropogenic influence on the dunes throughout the area designated for active riding. The mechanisms consist of rotating vehicle tires that: 1) create a shearing force between sand particles at and near the surface, 2) mix the surface layer of sand, and 3) displace sand particles away from the path of vehicle travel. We hypothesize that these three mechanisms (and perhaps other unidentified near-surface mechanisms) related to OHV activity have the potential to augment the emissivity of the dune sand creating higher concentrations of dust in the air than would occur if this dune system was not impacted by OHV activity.

The mean emissivity relationship for riding and non-riding areas can be disaggregated to examine for geographic influence on the emissivity across space (Fig. 4). For the non-riding area the emissivity data can generally be grouped as: northern dune preserve, areas east of the riding/non-riding boundary in the middle zone of the ODSVRA, and the southern dune preserve. For each of the three zones an ANOVA test was done on the paired data for each PI-SWERL test $u_*$. The ANOVA tests indicated that the mean emissivity values for each test $u_*$ are significantly different between the geographic locations, with the north having higher emissivity than the east and the south, and east higher than the south (Fig. 5).

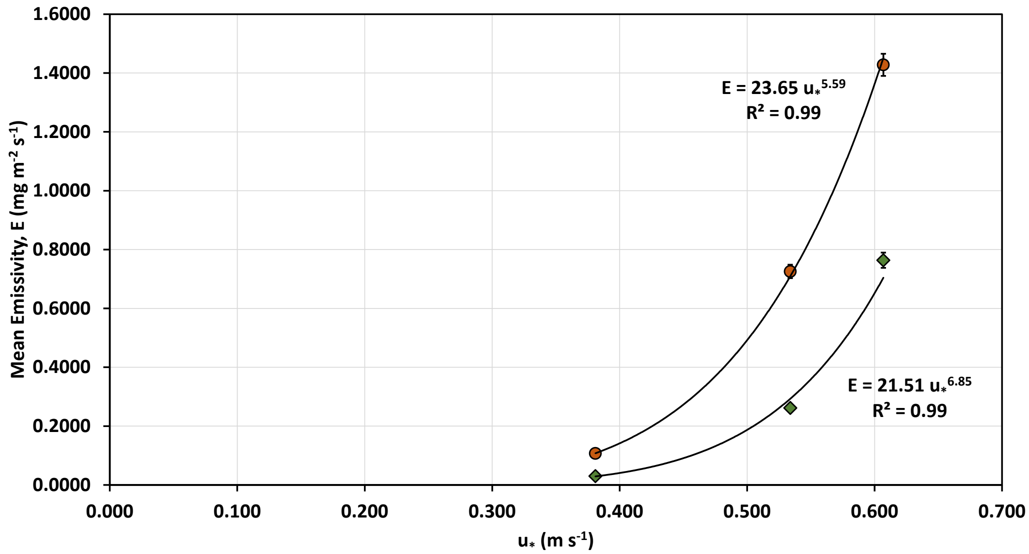


**Figure 3**. The relation between mean E (mg $m^{-2}$ $s^{-1}$) and $u_*$ (m $s^{-1}$) for the amalgamated data from 2013 to 2019 for the riding (orange circles) and non-riding areas (green diamonds). Error bars represent the standard error of the estimate (standard deviation/(#observations-1)$^{0.5}$).

The gradient of increasing emissivity towards the north in the non-riding area also is observed in the emissivity data for the riding area of the ODSVRA. This is demonstrated in Fig. 6, which shows the increase in mean emissivity as a function of latitude bins of 0.005 (decimal) degrees expressed as the factorial increase in emissions when normalized to the southern-most measurement group for all available data (i.e., mean emissivity in latitude bin/mean emissivity in southern-most latitude bin) from 2013 to 2019. This holds for each of the three test $u_*$ values (Fig. 6). In each latitude bin for each test $u_*$, the emissivity represents the mean of all tests that fall within the bin. This emissivity gradient is a function, in large part, of the gradient in mean grain diameter increasing from north to south. The emission of dust from the dune sands due to saltation is more efficient for sand of smaller mean grain diameter than larger mean grain diameter. This was observed in the analysis of the mean grain size and emissivity data from measurements made in 2013 (Fig. 7).

As identified previously, at the broadest scale the emissivity of the riding area was between 3.6 and 1.9 times greater than the non-riding area for the three PI-SWERL test $u_*$ values. The available data can be interrogated further by pairing specific regions of the riding and non-riding area based on the latitude of the tests. Keeping the non-riding groupings as shown in Fig. 4 and grouping the riding area tests closest in latitude to the non-riding tests, the difference in emissivity can be examined between them along the north to south axis of the ODSVRA. The factorial difference between the riding and non-riding emissivity (i.e., E riding/E non-riding) as a function of north, middle, and southern non-riding latitudinal ranges is shown in Fig. 8. This figure suggests that the difference between the riding and non-riding areas along the north to south gradient is similar for each PI-SWERL test $u_*$ regardless of distance along the gradient. For the lowest test $u_*$ (0.381 m $s^{-1}$) the difference in emissivity between riding and non-riding is, on average, riding emissivity is 4.3 times greater. For test $u_*$=0.534 m $s^{-1}$ the factor is 2.7, and for test $u_*$=0.607 m $s^{-1}$ the factor is 2.0. The lower emissivity of the non-riding area across the north-south

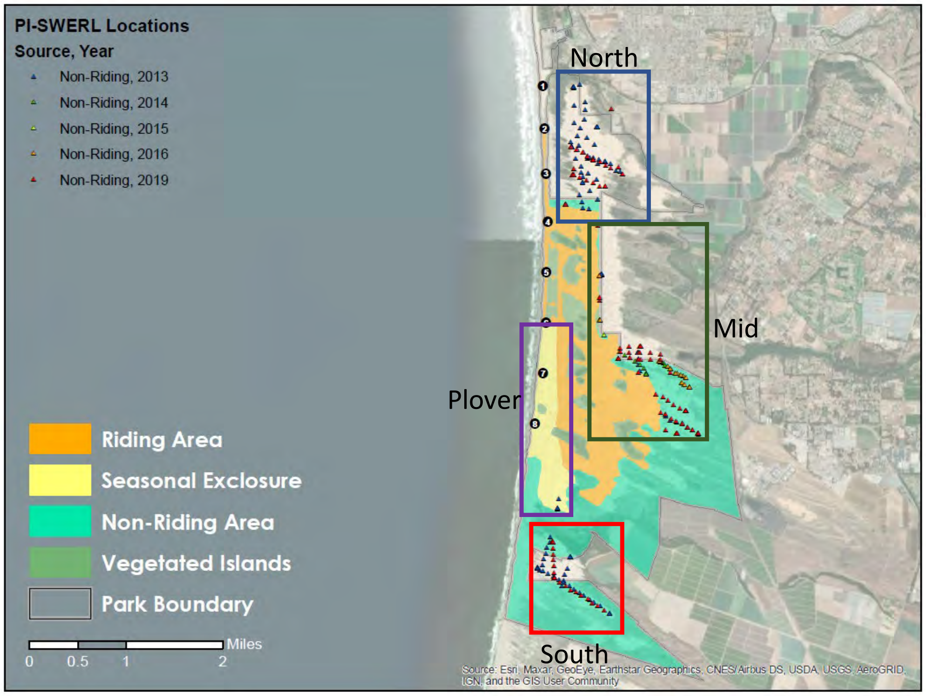


**Figure 4**. The grouping of the PI-SWERL tests by geographic position in the ODSVRA. In the north west quadrant of the Mid zone, the area east of the non-riding in the ODSVRA is private land and inaccessible for measurements.

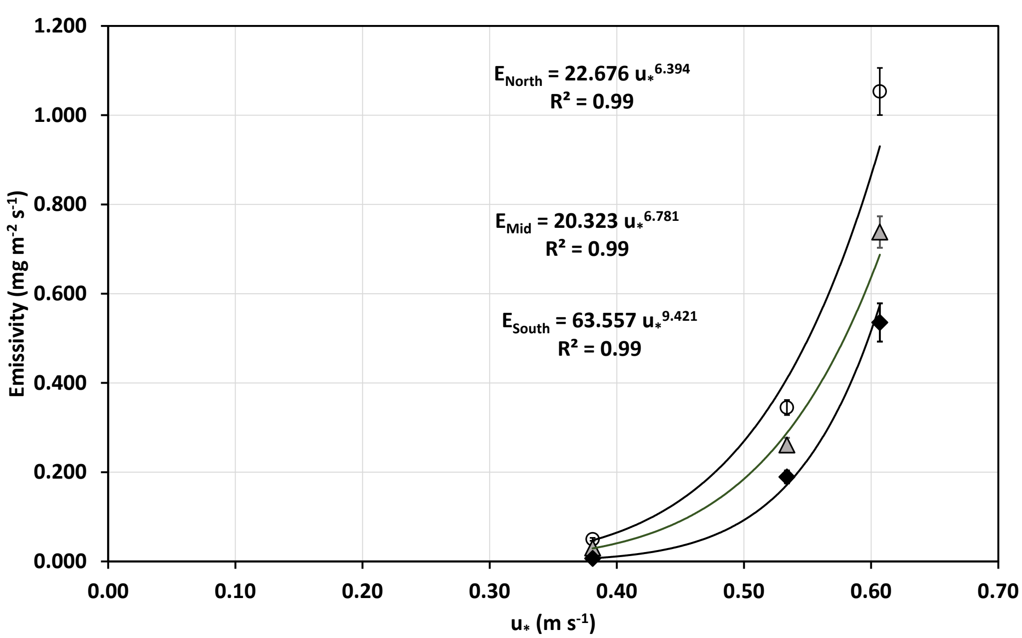


**Figure 5**. The relation between mean E (mg m$^{-2}$ s$^{-1}$) and $u_*$ (m s$^{-1}$) compared by geographic position for the non-riding areas: white circle, north; grey triangle, middle, black diamond, south. Error bars represent the standard error of the estimate (standard deviation/(#observations-1)$^{0.5}$).

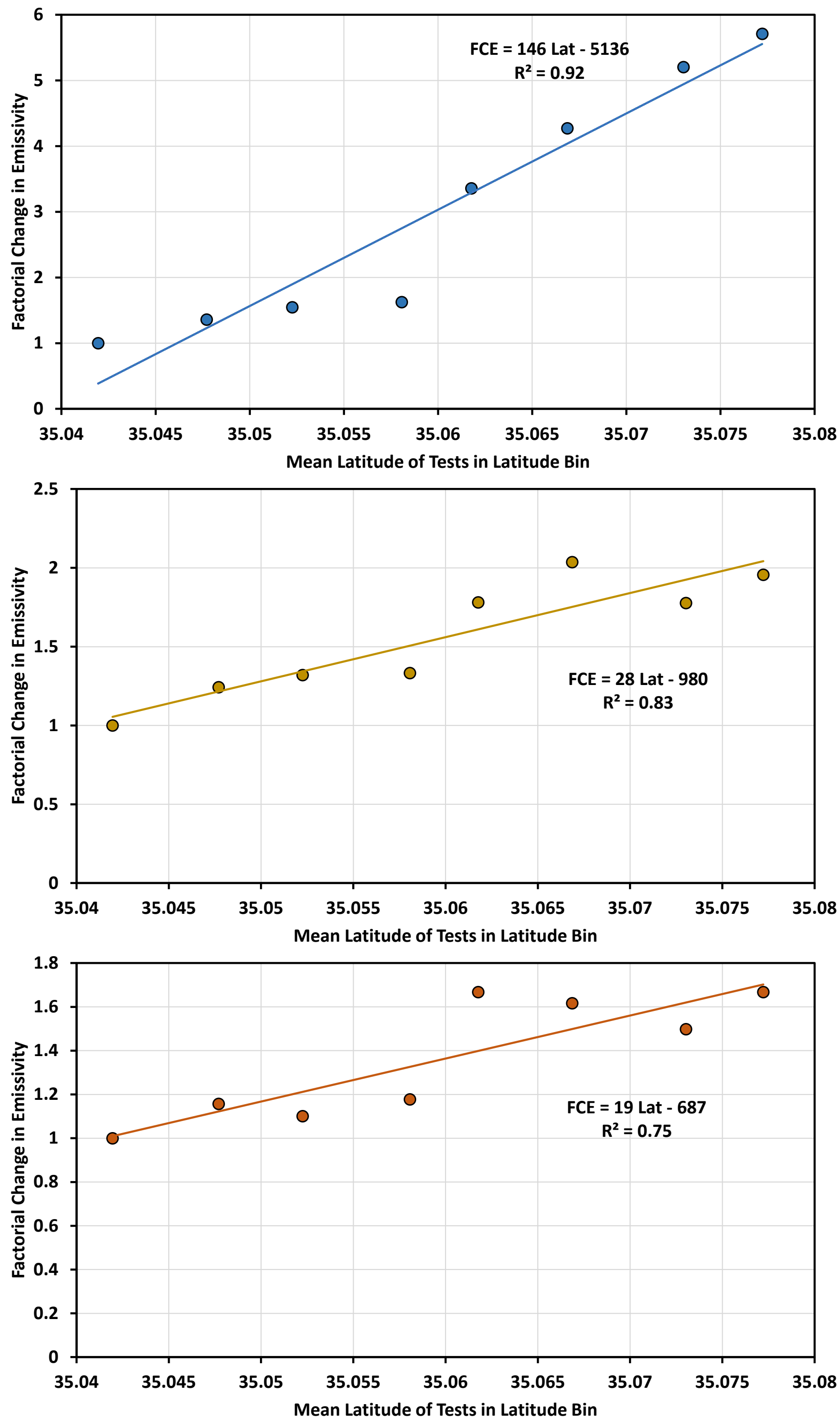


**Figure 6**. The factorial increase in emissivity as a function of position along the north (35.08 decimal degrees) to south (35.04 decimal degrees) gradient of the PI-SWERL tests in the ODSVRA riding area. Data represent mean emissivity in each latitudinal bin normalized to the mean emissivity in the southern-most latitude bin for the three PI-SWERL $u_*$ values: 0.381 m $s^{-1}$ (top panel), 0.534 m $s^{-1}$ (middle panel), and 0.607 m $s^{-1}$ (bottom panel).

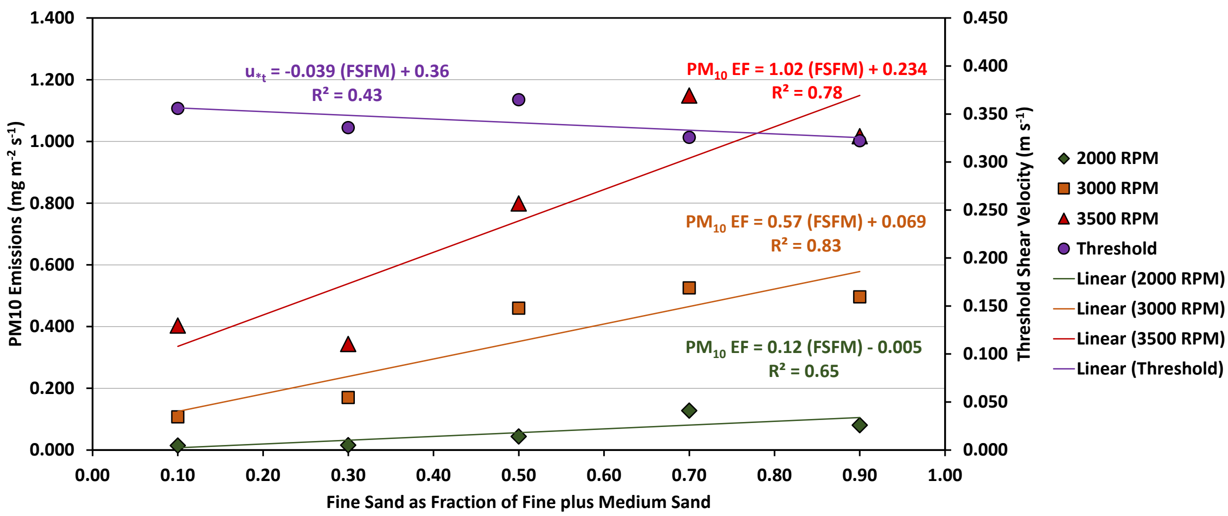


**Figure 7**. Relationships between $PM_{10}$ emissions and the ratio of fine sand as a fraction of fine sand +medium sand. Data are from 2013 as reported in "Addendum to the Pi-SWERL Report" (Etyemezian et al., 2014, refer to Fig. 15).

distance of the ODSVRA, and the fact that this difference scales consistently as a function of latitude and $u_*$, suggests this represents, in part, the augmentation of dune sand emissivity due to OHV activity. Unfortunately, there are no data to evaluate if there is a north-south gradient in vehicle activity, which could also be influencing the relation shown in Fig. 8.

**2020 Lagrande Tract Repeated PI-SWERL Survey**

PI-SWERL tests were repeated within the Lagrande Tract area from April to October 2020 during which time OHV activity was largely prohibited (NB, no measurements were made in August). The locations of the tests remained constant during that time (Fig. 1). It must be recognized that although the positions of the tests remained the same, the sand was intermittently being transported by the wind. The wind redistributes the sand and the bedforms (ripples and dunes) migrate in the direction of the sand transporting wind during transport events. Although the tests were conducted at the same locations, clearly the sand at those locations was not the same sand from the previous tests. The wind essentially randomizes the surface with each transport event and makes comparison of emissivity at a particular position questionable. For these data it is more reasonable to aggregate them by creating a mean emissivity for the tests made during set periods of time, for example by month.

In addition to the randomization of the surface by the wind, moisture conditions due to precipitation dew and fog varied across space and through time during the PI-SWERL testing. This creates a degree of difficulty for comparing emissivity as a function of time and requires that some aggregation of the data be undertaken to try and account for the variability, particularly due to moisture effects. Ideally the data would be aggregated by a moisture-based criterion, but a reliable metric and measurement method remains to be developed.

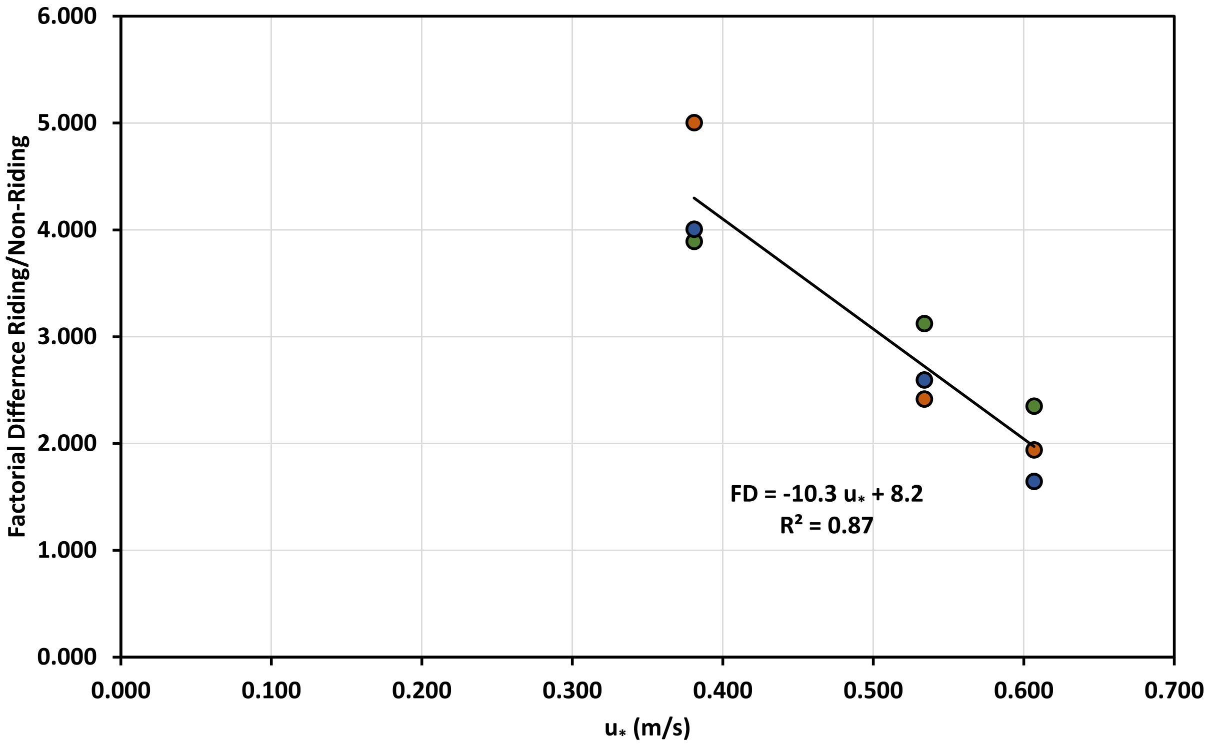


**Figure 8**. The factorial difference in emissivity between riding and non-riding areas as a function of PI-SWERL test $u_*$ and as a function of the latitudinal range of the northern (blue circles), middle (green circles) and southern (orange circles) non-riding area groupings.

The mean emissivity and $u_*$ relations for the Lagrande Tract for April, May, June, and July are represented by color-coded circles in Fig. 9. For comparison they are plotted along with the mean emissivity and $u_*$ relations for the Lagrande Tract in 2019 (for tests in the same area as 2020), all riding area tests (2013-2019), and all non-riding tests (2013-2019). These data show that in April 2020, the emissivity is most similar to the mean non-riding area relationship, likely due to moisture effects linked with precipitation events in April 2020. In May and June 2020, the emissivity is similar to the emissivity in the same general area as was measured in 2019, differing by less than a factor of 1.5 for the two highest shear velocities in the PI-SWERL test. In July 2020, the emissivity is most like the mean non-riding area relationship based on PI-SWERL testing between 2013 to 2019. The factorial difference (i.e., E-2019/E-2020 for the same test $u_*$ values) between emissivity for 2019 and 2020 for April through October for the same area of the Lagrande Tract where measurements were made in 2020 is shown in Fig. 10. In general, the emissivity of the Lagrande Tract in 2020 was less than in 2019. The month to month pattern of change in emissivity illustrated in Fig. 10, could, in part, be due to moisture effects from precipitation, fog and dew events. The lower emissivity in 2020 may also be indicative of changes in the sand due to the cessation of riding, caused by, for example, removal of the $PM_{10}$ source material by winnowing, coarsening of the sand near the surface due to wind-driven sorting processes, and the cessation of the mixing of the surface sand by vehicle tires.

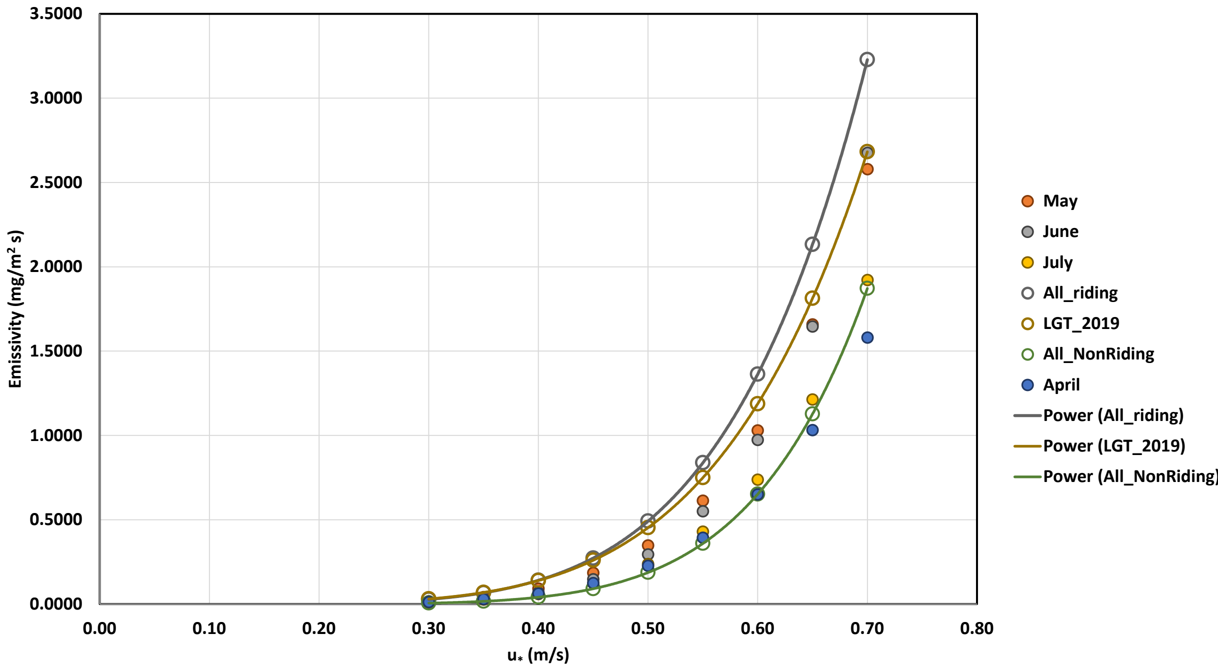


**Figure 9**. The mean emissivity and u* relations for the Lagrande Tract for April, May, June, and July 2020 compared with Lagrande Tract 2019, all riding area (2013-209), and all nonriding area (2013-2019).

**2020 Compared to 2019 for Areas Outside the Lagrande Tract**

In May 2020 PI-SWERL measurements were made across the ODSVRA riding area that represent a sub-set of the sampling grid that was established in 2013 (Fig. 2). These measurements were made between May 12 to May 17. The mean emissivity measured in 2020 for the three test u* values were compared to the emissivity data from PI-SWERL testing in May 2019 to evaluate if a significant change in emissivity had occurred across a larger spatial domain than just the Lagrande Tract. An ANOVA test for each of the test u* values between the two years was carried out and the results show that the mean emissivity in 2020, E=0.064 mg $m^{-2}$ $s^{-1}$ for u*=0.381 m $s^{-1}$ (RPM=2000), was not different than the mean value of E=0.075 mg $m^{-2}$ $s^{-1}$ for 2019. For the higher test u* values of 0.534 m $s^{-1}$ (RPM=3000) and 0.607 m $s^{-1}$ (RPM=3500), the mean E values in 2020 were 0.324 mg $m^{-2}$ $s^{-1}$ and 0.831 mg $m^{-2}$ $s^{-1}$, respectively, while for the 2019 data they were 0.503 mg $m^{-2}$ $s^{-1}$ and 1.037 mg $m^{-2}$ $s^{-1}$, respectively. ANOVA testing for each pair indicate that the E values are significantly different for the higher u* test values between the two years. This indicates that the mean emissivity of the riding area as a function of u* in May 2020 (Fig. 11) was lower than in 2019, as was also observed for the Lagrande Tract repeat survey area. This could be a result of the cessation of OHV activity, but it could also be due to the effects noted in the previous section.

Due to constraints due to weather and accessibility, PI-SWERL measurements in the nonriding areas were extremely limited in 2020. Comparison with 2019 measurements could not be made.

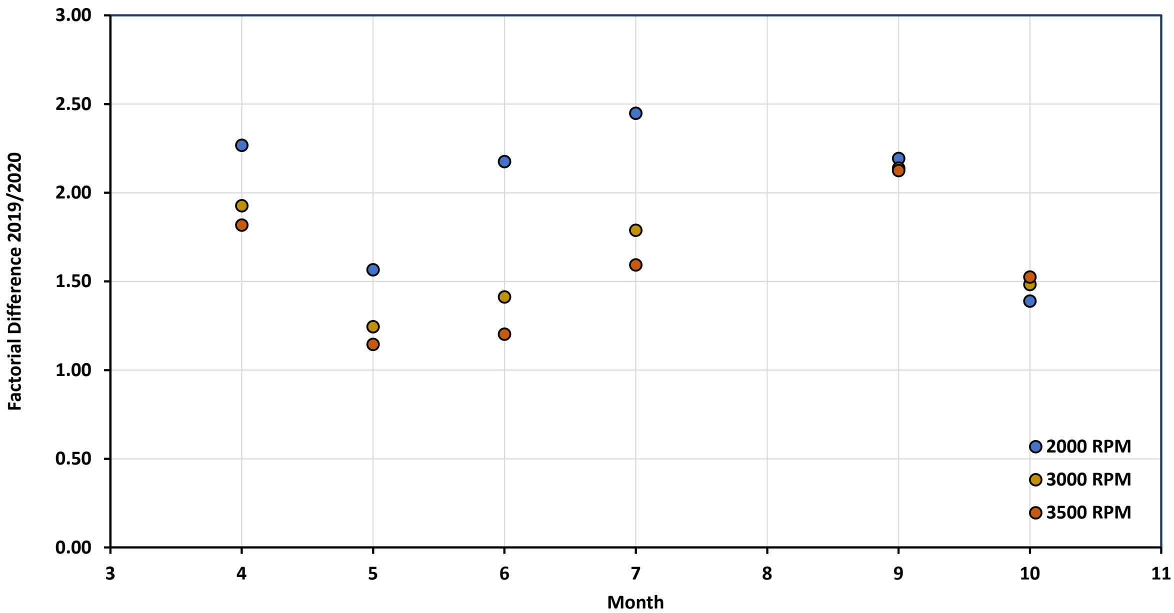


**Figure 10**. The factorial difference in mean emissivity between 2019 and 2020 for each PI-SWERL test u* (RPM) from April (month 4) through September (month 10).

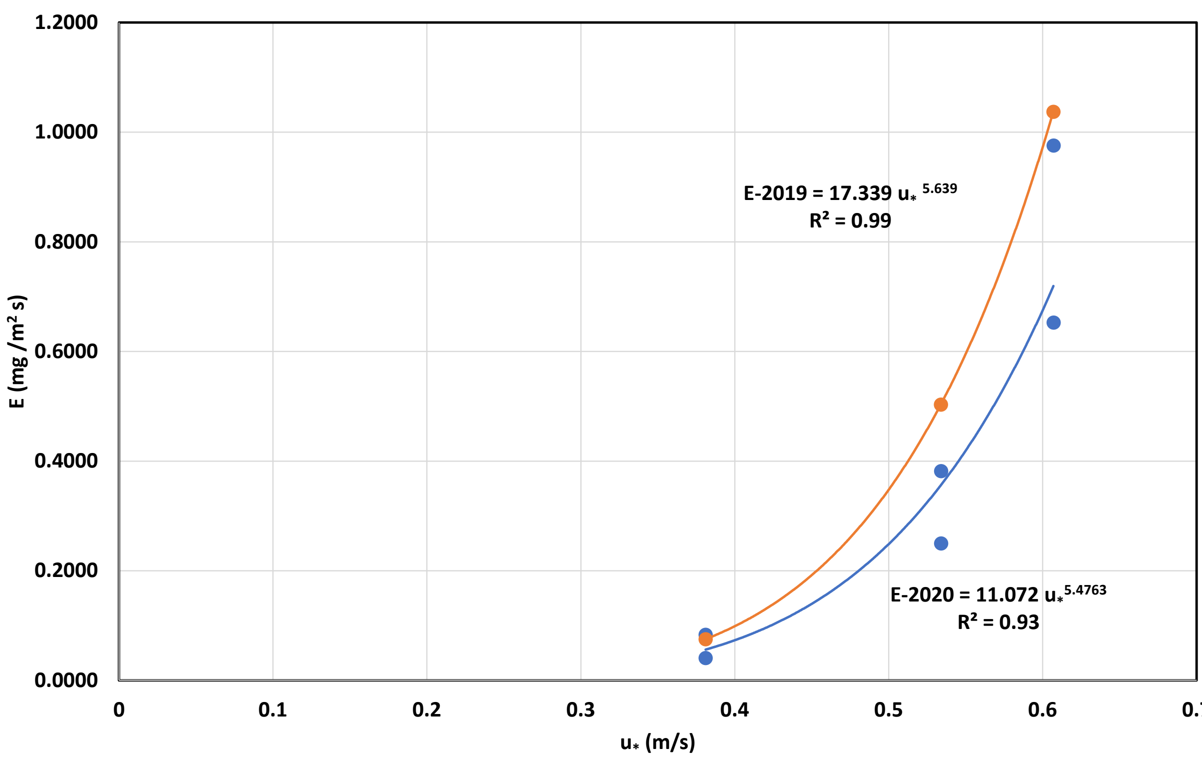


**Figure 11**. The mean emissivity and u* relations for the ODSVRA in May 2019 (orange circles) and May 2020 (blue circles).

**PM Concentration and Wind Data from the In-Park Monitors, 2019-2020**

During 2019 and 2020, a meteorological and airborne dust monitoring network (Fig. 12) consisting of 15 monitoring locations was installed at the ODSVRA in active riding areas, at the eastern border of the Park, and exterior to the Park on Philips 66 land and at the CDF monitoring site. These monitoring networks served to characterize wind conditions and the distribution of airborne particulate matter (PM) during wind events exceeding the threshold wind speed for saltation that contribute to elevated concentrations of $PM_{10}$ (particulate matter ≤10 micrometers in aerodynamic diameter). Data from 2019 and 2020 derived from the in-Park monitoring network allow for an examination of $PM_{10}$ and wind relations across a wide area of the ODSVRA and to examine for changes in the dust emission system through time.

The wind speed and direction data at these sites are measured with the MetSense instrument, which uses 2-D sonic anemometry to derive these parameters. Particulate matter at each station is measured using a MetOne Instruments 212-2 Particle Profiler that measures particle counts in eight size bins. These particle count bins are used to derive a $PM_{10}$ concentration on a minute and hourly basis. In order to achieve a measure of $PM_{10}$ from this instrument that can be compared between stations and to the $PM_{10}$ measured by an EPA Federal Equivalent Method Beta Attenuation Monitor (BAM), a calibration procedure has been developed to convert the MetOne particle count data to a BAM-equivalent $PM_{10}$ concentration.

The BAM equivalent $PM_{10}$ concentration for each 212-2 instrument is achieved by collocating the 212-2 instruments in an environmentally controlled chamber in a lab at DRI's campus in Las Vegas, NV, and establishing a unit-specific calibration relation. The instruments are rack-mounted in the chamber beside a BAM and a filter-based sampler (US EPA approved cyclone-style sampler). Under controlled


**Figure 12**. Locations of the meteorological and airborne dust monitoring stations at the ODSVRA and exterior to the ODSVRA.

temperature and humidity conditions dust created by simulated saltation of Oceano Dune sand is generated in the chamber that all instruments are exposed to simultaneously. The data stream (particle counts in each bin size) from the 212-2 units and the BAM (µg $m^{-3}$) are recorded by a datalogger.

Each 212-2 outputs a data string corresponding to the counts of particles that are greater than a given size in a given volume (0.01667 liters). In order to translate this into a $PM_{10}$ concentration: 1) the number of particles in a size bin is calculated by subtracting the number of counts associated with all larger size bins, 2) a diameter representing all the particles within a size bin is estimated (taken to be the geometric mean of the minimum and maximum of the size bin), 3) the volume of an individual particle of the characteristic diameter of the size bin is calculated assuming particles are spheres, 4) the total volume of particles in a volume of air is calculated by multiplying the volume of a single particle by the number of particles in the size bin in the known volume of air, and 5) a particle density of 2600 kg $m^{-3}$ is used to estimate the mass concentration of particles in the size bin. The cumulative mass concentration of particles through size bin 6 is denoted as PMbin6. A calibration relationship between the BAM and the PMbin6 value is defined through the paired values of BAM-measured $PM_{10}$ and calculated PMbin6 for each 212-2 instrument. Hereafter the measurements made with the 212-2 and corrected with the calibration relationships will be identified as 212-$PM_{10}$. An example of this relationship is shown in Fig. 13. The consistency of the calibration relations among the 212-2 units as measured in March 2020 was quite good. The mean slope value for all units combined was 4.106 (±1.100) and mean intercept was -4.741 (±3.514). The mean correlation coefficient was 0.950 (±0.013).

In addition to the chamber testing, an in-Park calibration station was established in 2020. This station consisted of a BAM, mounting hardware for two 212-2 units, wind speed, wind direction and RH instruments, and datalogging with modem telemetry. The purpose of the in-Park calibration was to determine the performance of the 212-2 and BAM instruments under ambient conditions at the ODSVRA. Of concern was their ability to perform under high wind conditions and whether this resulted in a bias in the measurement compared to the BAM. In 2020, 10 of the 212-2 units were collocated with the in-Park BAM. The available data from the in-Park calibration testing indicates that the 212-2 units were not adversely affected by wind speeds that exceeded 5 m $s^{-1}$ compared to the chamber conditions (i.e., no wind). The mean slope value and intercept values were 4.481 (±0.889) and -8.332 (±24.605), respectively. The mean correlation coefficient was 0.917 (±0.119). The differences in slope, intercept, and correlation coefficient are due to the dynamic nature of the field environment, but the degree of change indicates that under these conditions the correlation between the two instruments remained high and provides confidence that the 212-2 performs well at the ODSVRA. In this report, because we do not have in-Park calibrations for all relevant stations, the PMbin6 data are converted to 212-$PM_{10}$ using the March 2020 chamber derived relationships for each 212-2 unit. The analysis to be presented is based largely on the use of ratio values so the absolute values of 212-$PM_{10}$ may not match the actual values. Using the 212-2 chamber-derived calibration coefficients ensures the inter-comparisons among the different units can be made with confidence, as differences in 212-$PM_{10}$ measurements are not due to a mixing of calibration methods, i.e., in-lab versus in-Park.

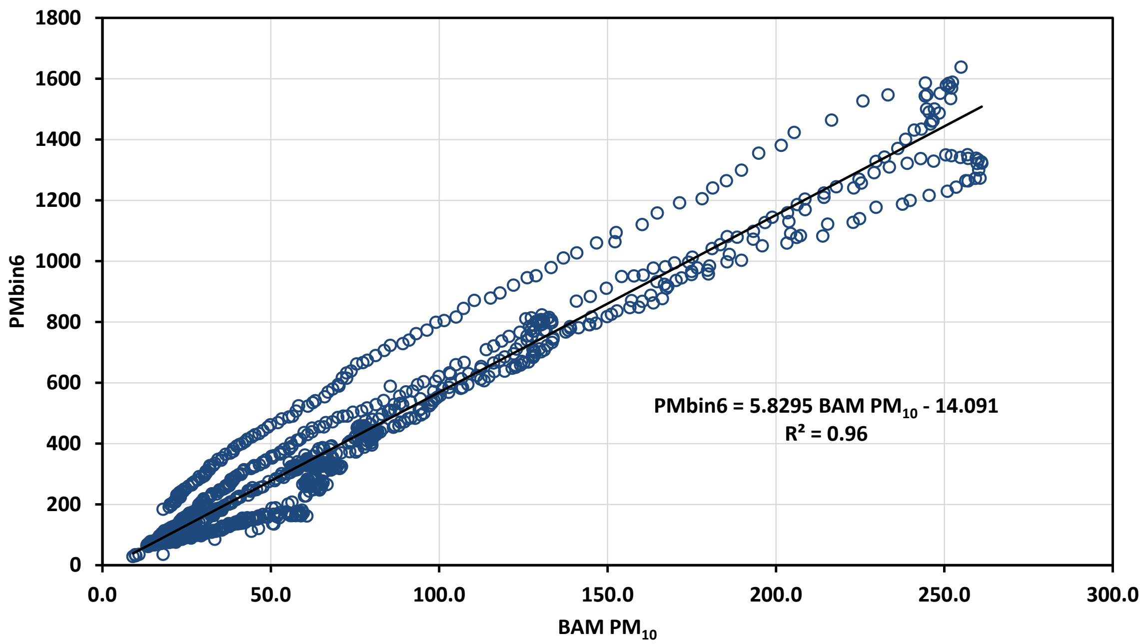


**Figure 13**. An example of the calibration relationship between BAM and PMbin6 from chamber testing.

Of key interest in 2020 due to the closure of the riding area to OHV activity is whether a change in the observed $PM_{10}$ levels as measured by the in-Park monitoring network is observed for similar wind conditions through time. As previously reported in Etyemezian et al. (2019), the in-Park $PM_{10}$ monitoring data suggest a changing pattern in the emissions between April and August based on analysis of the 2017-2018 data. These data suggested that the magnitude of the wind speed that was required to reach the observed concentrations of dust decreased as the months progressed from April to August. That is, for comparable wind speeds, $PM_{10}$ concentrations were higher during later months (August) than earlier in the season (May-July), which suggests the emissivity of the surface had increased with time in this period.

Based on recent reports by Furtak-Cole and Gillies (2020) and Gillies et al. (2020), a different analytical approach than was used by Etyemezian et al. (2019) was used for the 2019 and 2020 in-Park monitor data (i.e., stations located on sand) to evaluate if the pattern of $PM_{10}$ concentrations through time as described by Etyemezian et al. (2019) was repeated in 2019 and 2020. The list of these stations and their latitude/longitude are provided in Table 1. In this report the method of Furtak-Cole and Gillies (2020) and Gillies et al. (2020) using total of wind power density (WPD, W $m^{-2}$) and total 212-$PM_{10}$, and the calculation of the T212-$PM_{10}$:TWPD ratio has been adopted. This ratio can be used as a metric to evaluate changes in the dust emission system across the sampling domain and through time. Recall, WPD is defined as (e.g., Kalmikov, 2017):

$WPD=0.5\ \rho_a\ u^3$ (1)

where $\rho_a$ is air density (kg $m^{-3}$), and u (m $s^{-1}$) is wind speed at a given height above ground level (AGL) common to all sites. For the in-Park monitors the wind speed measurement height was 3 m. The ratio of total $PM_{10}$:total WPD serves as a metric to evaluate how the dust emission system is changed by

**Table 1**. The station names and position data for the PM and met monitoring stations. Stations shaded gray are not surrounded by sand or are outside the ODSVRA.

| Station Name | Latitude | Longitude |
|---|---|---|
| Moymell | 35.0751 | -120.6199 |
| BBQ | 35.0700 | -120.6197 |
| Lagrande | 35.0664 | -120.6197 |
| Camping | 35.0662 | -120.6218 |
| Foredune | 35.0650 | -120.6264 |
| Windfence | 35.0644 | -120.6221 |
| Acacia | 35.0605 | -120.6205 |
| Cottonwood | 35.0597 | -120.6190 |
| Haybale | 35.0535 | -120.6016 |
| Phillips66 | 35.0489 | -120.5939 |
| Scout | 35.0482 | -120.6032 |
| Tabletop | 35.0478 | -120.6168 |
| CDF | 35.0467 | -120.5877 |
| Pipeline | 35.0406 | -120.6180 |
| Sodar | 35.0368 | -120.5962 |

changes to or in the landscape. With no changes to the surface where the emissions originate from, this ratio will reflect the efficiency of the wind and saltation system to produce $PM_{10}$ for the prevailing environmental conditions during the period of interest. If, however, the surface from which the emissions are originating from is changing, for example, by removal of the $PM_{10}$ source material or coarsening of the surface sand (i.e., increasing mean grain diameter), the ratio should diminish as dust production by saltation processes becomes less efficient in producing $PM_{10}$ dust. There is a limit to the explanatory power of this ratio, which is that if winds are at or close to the designated threshold speed either at the monitoring location or in the source area for a large part of the record, the value becomes unstable due to a potential paucity of data but also because as wind speed diminishes the strength of the coupling between the wind and the saltation-generated $PM_{10}$ weakens and is subject to influence of $PM_{10}$ from other sources.

In the analysis presented here only one filter is applied to the data, that wind speed measured at 3 m above-ground-level be ≥5 m $s^{-1}$, which for most cases will be above the wind speed across the domain that will cause the sand to saltate and emit dust-sized particles. Total WPD for a month is the sum WPD for all hours that meet the wind speed filter criterion. Total 212-$PM_{10}$ for the month is the sum of T212-$PM_{10}$ for each hour that met the wind speed criterion. This was done to produce a stable ratio of total $PM_{10}$:total WPD. As the in-Park stations of interest are surrounded by sand that can emit dust whenever the wind exceeds the threshold for transport regardless of wind direction, we chose not to filter for wind direction.

For each of the in-Park stations (see Table 1) the relation between T212-$PM_{10}$ and TWPD as a function of month was derived for 2019 (May/June through September) and 2020 (April through August). For all stations in both years this relation was highly correlated. Examples of this relation for stations Moymell, Windfence, Scout, and Tabletop for 2019 are shown in Fig. 14. Examples of this relationship for the same stations for 2020 are shown in Fig. 15. These examples span the north-south distance of the in-Park stations. As the T212-$PM_{10}$ and TWPD relation is highly correlated for all stations in both years the T212-$PM_{10}$:TWPD ratio can be used to examine if the dust production due to wind-driven saltation changes across space and through time. The mean number of hours in each month above the threshold WPD of 77 W $m^{-2}$ for calculating TWPD and T212-$PM_{10}$ ranged from 72 (April 2019) to 116 (September 2019).

In 2019 the in-Park stations did not all begin collection in the same month with stations coming on line in either May or June. To demonstrate how the T212-$PM_{10}$:TWPD ratio changed through time in 2019, this ratio as a function of month for the same four stations shown in Fig. 14 is shown in Fig. 16. The examples of the change in the T212-$PM_{10}$:TWPD ratio as a function of month shown in Fig. 16, suggest that, as Etyemezian et al. (2019) noted, higher $PM_{10}$ concentrations are observed in the late summer month of August compared with previous months for similar wind conditions. These plots indicate that as time progressed the dunes were producing higher concentrations of $PM_{10}$ for lower, but above threshold wind speed because the T212-$PM_{10}$:TWPD ratio increased through time. To compare among all the in-Park sites and to account for the different time intervals the stations were operational, the T212-$PM_{10}$:TWPD ratio for each month the station operated was normalized to the ratio estimated for its beginning month of operation for each station (i.e., [T212-$PM_{10}$:TWPD-month-n]/[T212-$PM_{10}$:TWPD-month-1]). The mean normalized T212-$PM_{10}$:TWPD ratio for each increment of month is shown in Fig. 17. When all in-Park stations are considered, the normalized mean T212-$PM_{10}$:TWPD ratio shows an incremental increase from spring through to fall across the span of the monitoring stations in 2019. In general, the data in Fig. 17 indicate that in 2019, when OHV activity was not restricted, from May to September concentrations of $PM_{10}$ for equivalent WPD increased by ≈48%, or 12% per month.

A further demonstration of the change in concentrations of $PM_{10}$ for equivalent WPD for the Park as a function of time can be demonstrated using the 2017 and 2018 data from the available Met/PM stations operating in those years and calculating the $TPM_{10}$ and TWPD for each available month.

The monthly normalized mean T212-$PM_{10}$:TWPD ratio (normalized to the initial month of monitoring) for these years is shown in Fig. 18. In both year there is an increase in this ratio from spring to summer, for the in-Park and out-of-Park stations, followed by a decrease into the fall months, similar to the patterns shown for the example stations for 2019 shown in Fig. 14. Note that for the out-of-Park stations compared to the in-Park stations the pattern of change through time is similar, but the absolute value range is not. This is because the height of wind speed measurement at those locations is 10 m, not 3 m, so they are not directly comparable.

The same analyses were carried out for the available 2020 in-Park station data, which operated from April through to early September 2020. The measurement record in September 2020 was not deemed sufficiently long for allowing comparisons with the previous months, so it was not used (# hours >77 W $m^{-2}$ ranged between 3 and 26). The mean number of hours in each month, April to August, above the threshold WPD of 77 W $m^{-2}$ for calculating TWPD and T212-$PM_{10}$ ranged from 69 (August 2020) to 173 (May 2020). Examples of the T212-$PM_{10}$:TWPD relation for stations Moymell, Windfence, Scout, and Tabletop for 2020 as a function of month are shown in Fig. 19. The plots in Fig 19 suggest that in 2020, concentrations of $PM_{10}$ due to saltation of dune sand within the ODSVRA changed substantially compared to 2019, and the general pattern of emissions increasing incrementally through the summer months first noted by Etyemezian et al. (2019) and repeated again in 2019 does not hold. Using all the available in-Park stations (Table 1) for 2020, the mean normalized T212-$PM_{10}$:TWPD ratio was estimated by normalizing to the ratio for April (Fig. 20). The relation shown in Fig. 20 indicates that across the spatial domain of the PM and meteorological monitoring network, the concentrations of Total $PM_{10}$

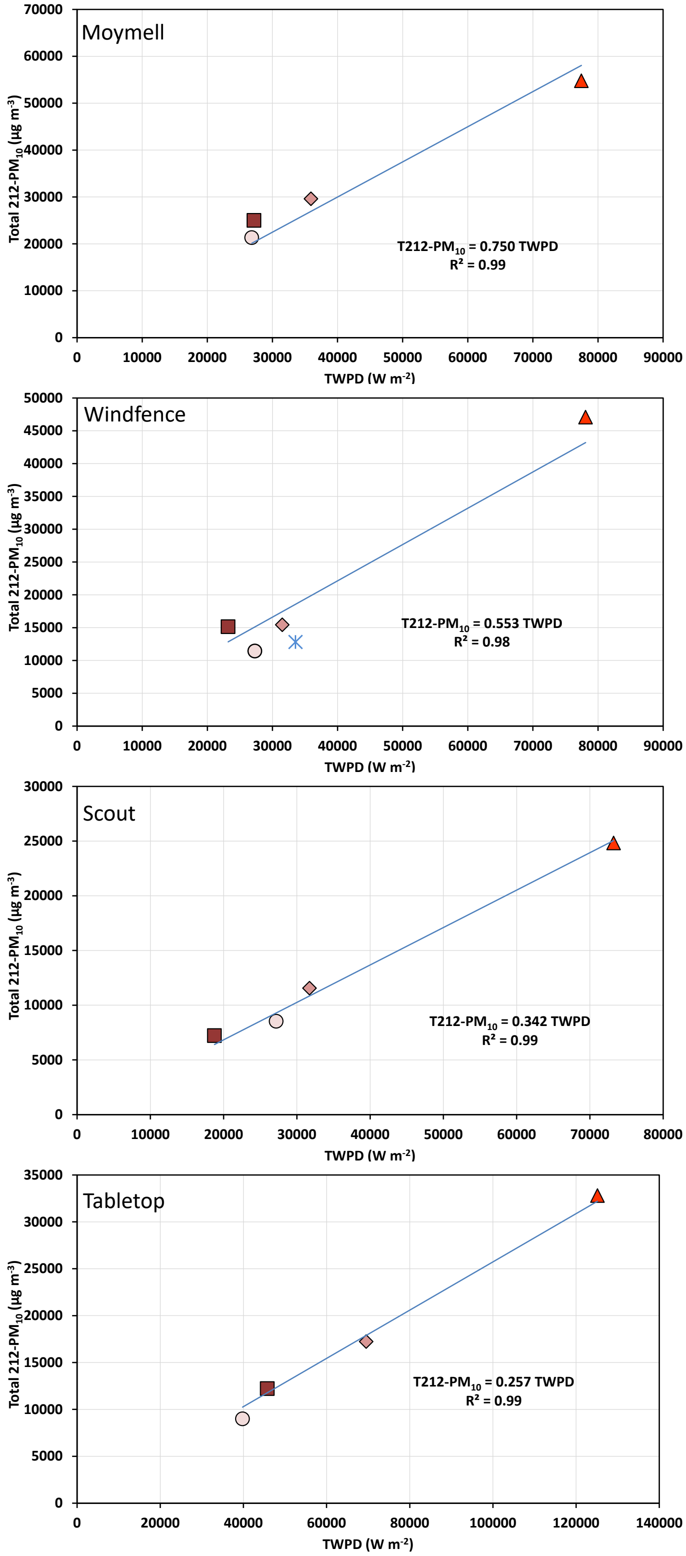


**Figure 14**. Examples of the T212-PM$_{10}$ and TWPD relation for stations Moymell, Windfence, Scout, and Tabletop for 2019. Shape/color indicates the months; light red circle, June; medium-red diamond, July: dark red square, August; orange triangle, September.

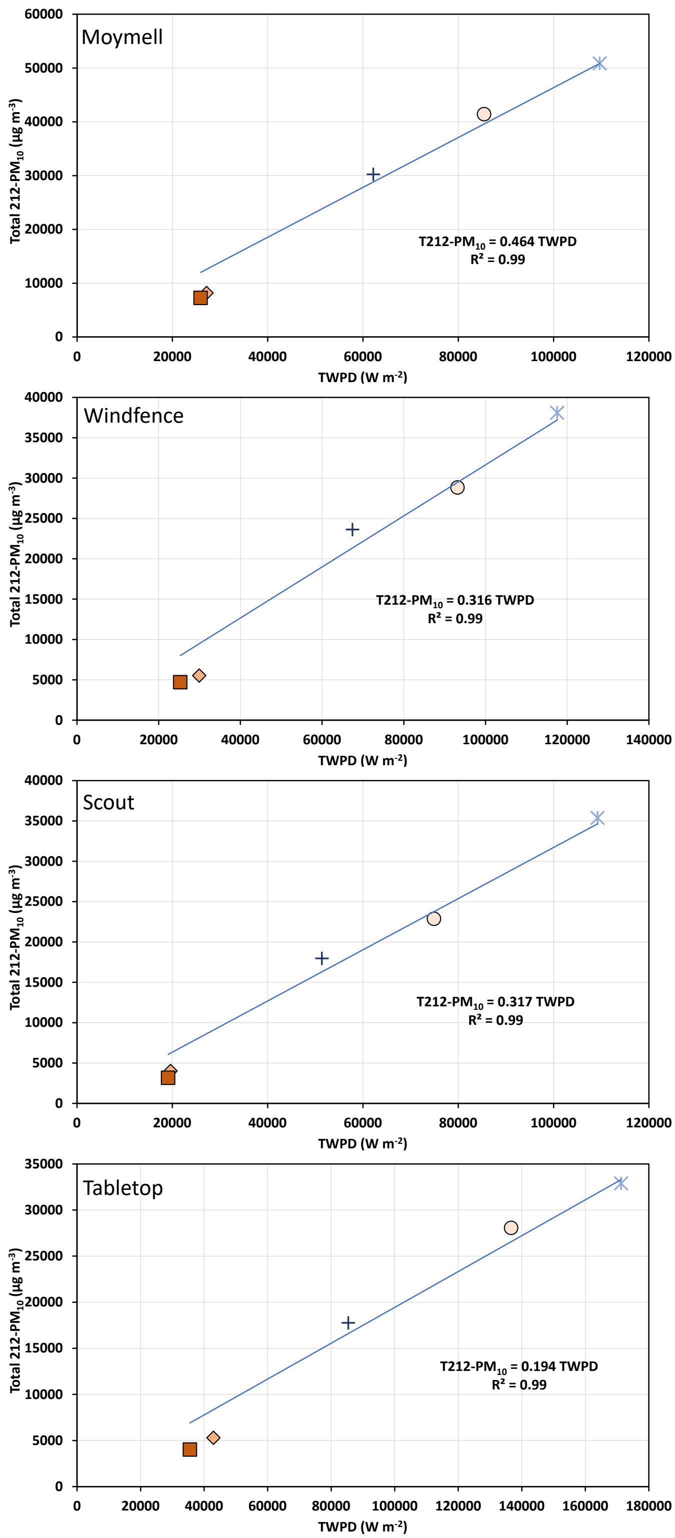


**Figure 15**. Examples of the T212-$PM_{10}$ and TWPD relation for stations Moymell, Windfence, Scout, and Tabletop for 2020. Shape/color indicates the month; dark blue +, April; light blue ✳, May; light red circle, June; medium-red diamond, July; dark red square, August.

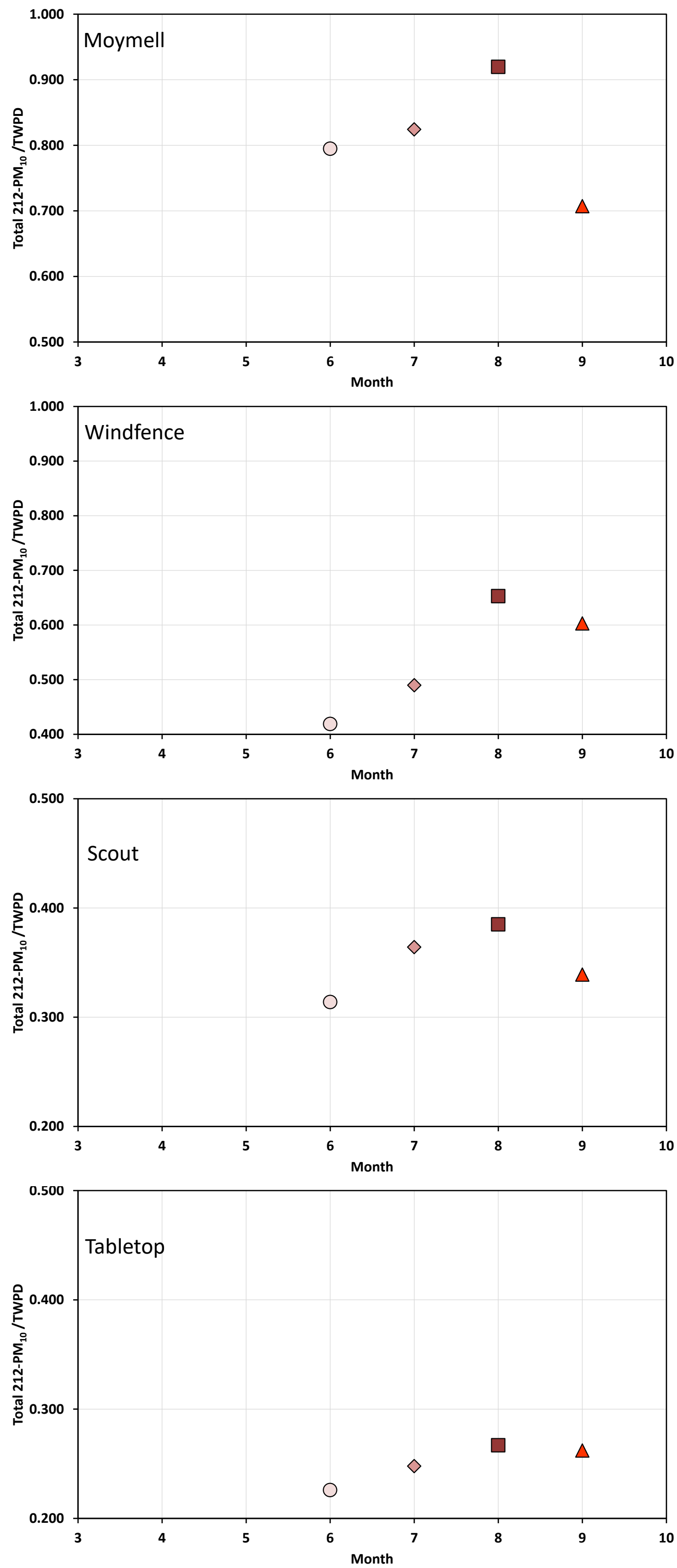


**Figure 16**. Examples of the T212-$PM_{10}$:TWPD relation for stations Moymell, Windfence, Scout, and Tabletop for 2019. X-axis number represent month of the year by number, e.g., 6=June.

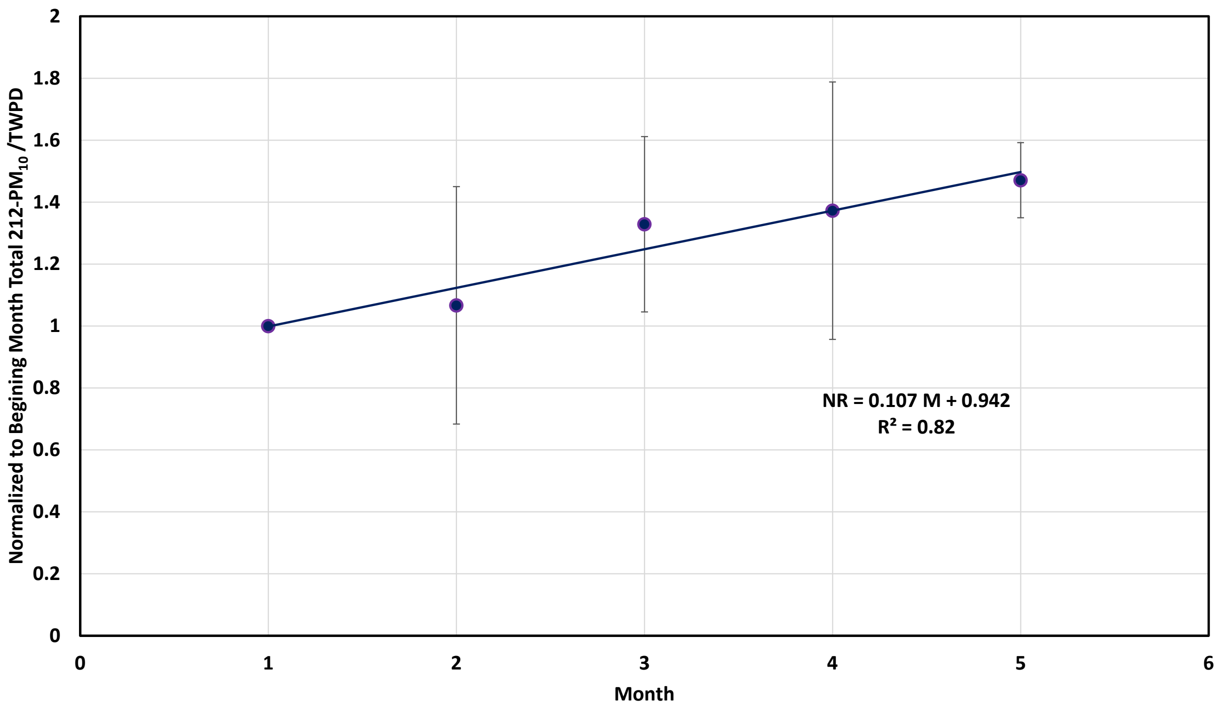


**Figure 17**. The mean normalized T212-$PM_{10}$:TWPD ratio as a function of month-long increments of time. Data represent the period from May to September 2019 and include all in-Park stations (see Table 1). Note number on the X-axis does not represent month of the year, as the starting month for the normalization may be May or June.

resulting from saltation created emissions decreased by 46.5% (% change from T212-$PM_{10}$:TWPD=1 to T212-$PM_{10}$:TWPD=0.535) between April and August for equivalent conditions of Total WPD, approximately 11.6% each month. This suggests that the cessation of OHV activity has likely allowed the dust emission system to evolve towards a new state representing a less impacted dune system.

The T212-$PM_{10}$:TWPD values as a function station latitude for 2019 and 2020 are shown in Fig. 21. These data show that the northern stations (latitude >35.005) produced greater concentrations of 212-$PM_{10}$ in 2019 than in 2020, for equivalent WPD values. Of note is the T212-$PM_{10}$:TWPD ratio for the Lagrande station in 2020 (red circle datum in Fig. 21). This monitoring location has the highest ratio value among all the monitoring stations for all months from April to August, with the mean value, T212-$PM_{10}$:TWPD=0.805, which is between 2 to 8 times greater than the other stations (Fig. 21). Unfortunately, there was a failure of the MetOne 212-2 unit in 2019 at the Lagrande monitoring station so a direct comparison between 2019 and 2020 is not possible. However, in 2020 the mean T212-

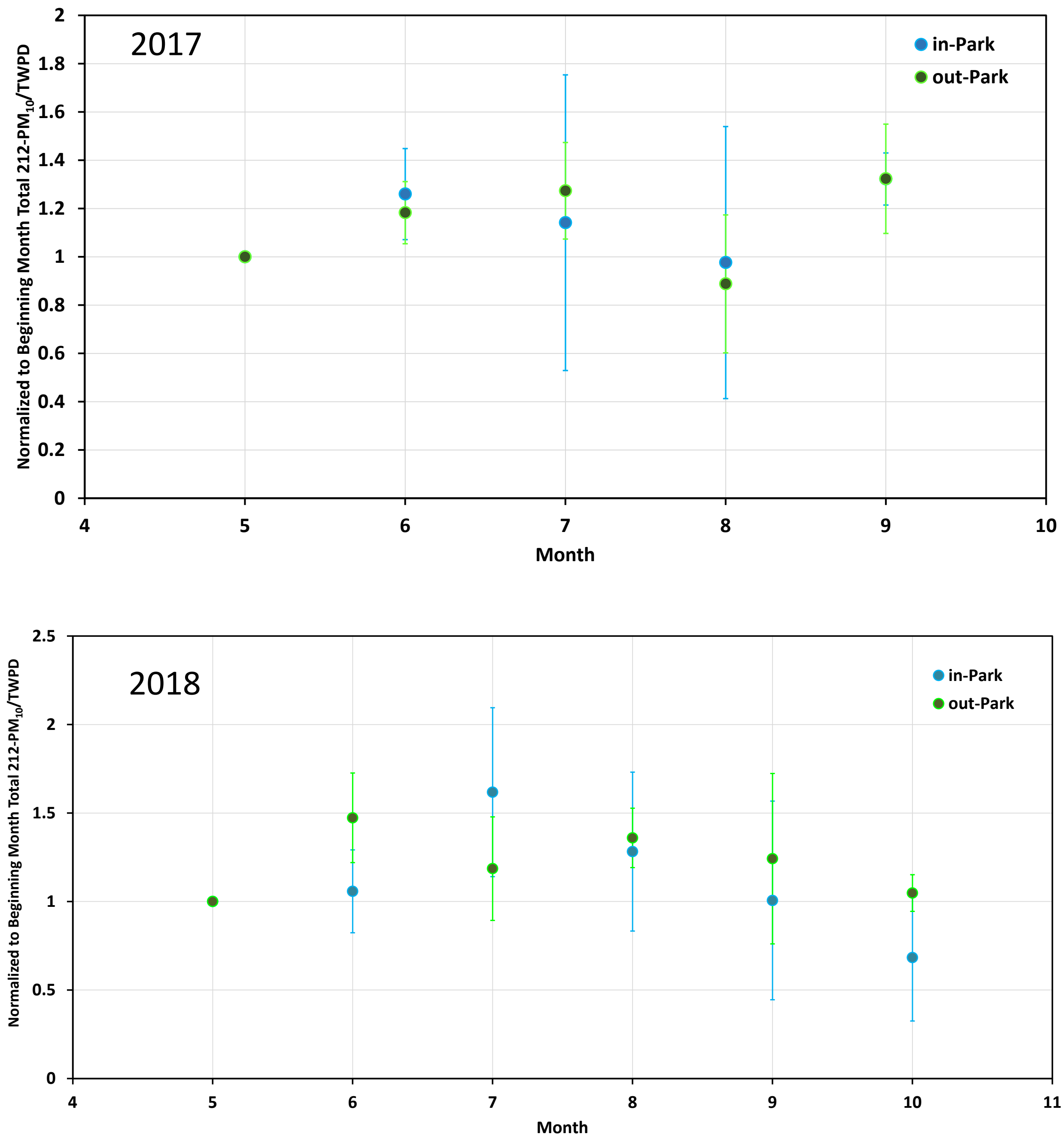


**Figure 18**. The mean normalized T212-$PM_{10}$:TWPD ratio (normalized to the starting month of monitoring) as a function of month-long increments of time. Data represent the period from May to September/October in either year. Out-of-Park stations are SODAR, P66, and CDF.

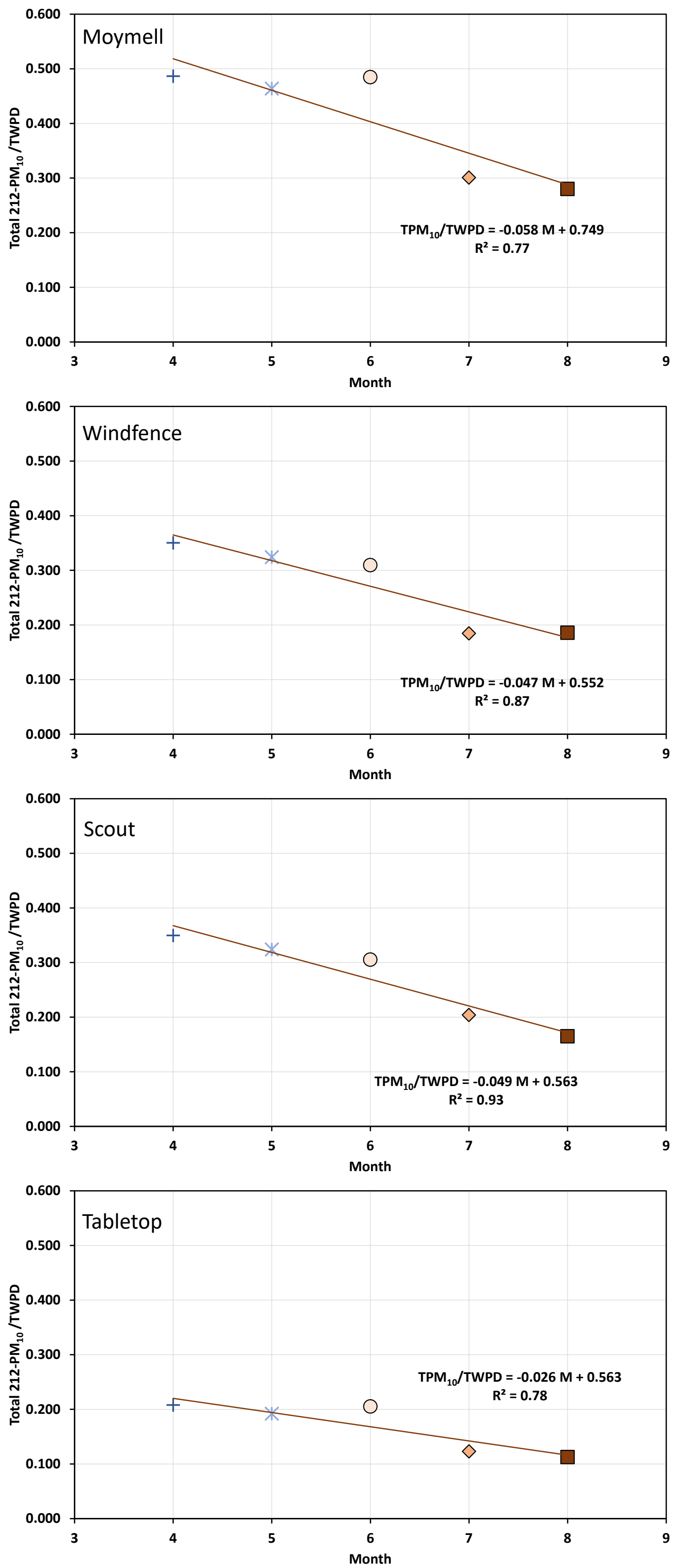


**Figure 19**. Examples of the T212-$PM_{10}$:TWPD relation for stations Moymell, Windfence, Scout, and Tabletop for 2020. X-axis number represents month of the year by number, e.g., 4=April.

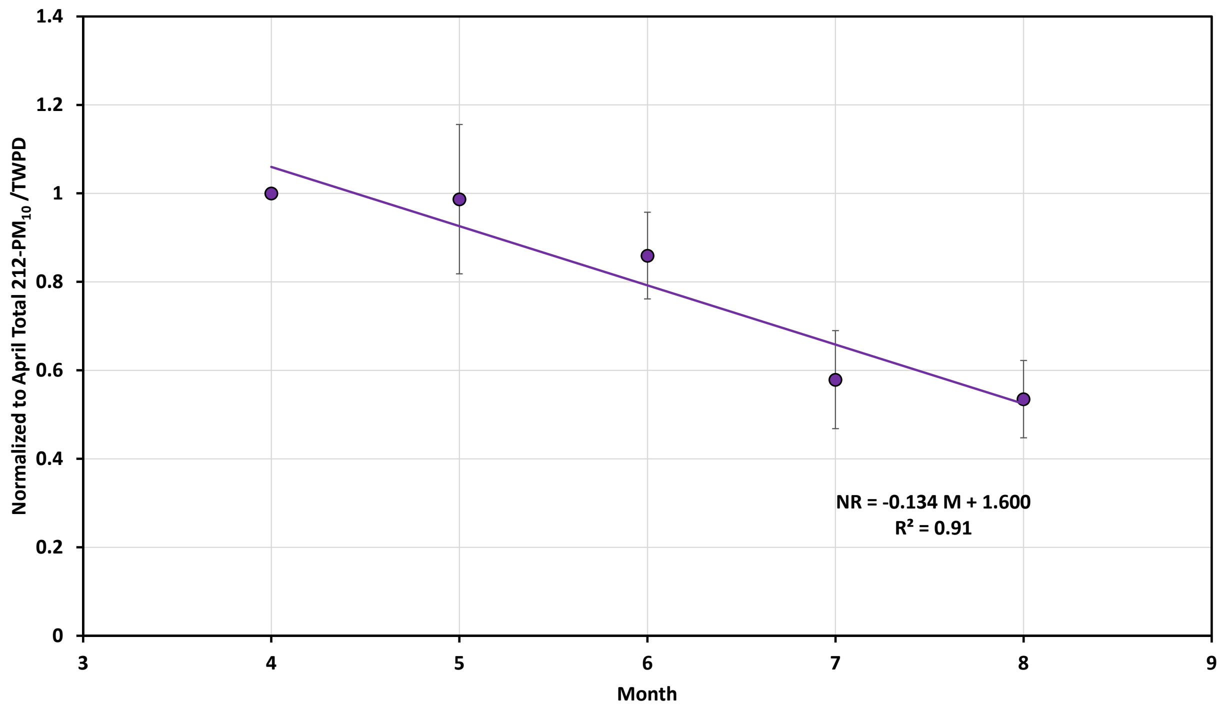


**Figure 20**. The mean normalized T212-$PM_{10}$:TWPD ratio as a function of a month-long increments of time. Data represent the period from April to August 2020 and include all in-Park stations (see Table 1).

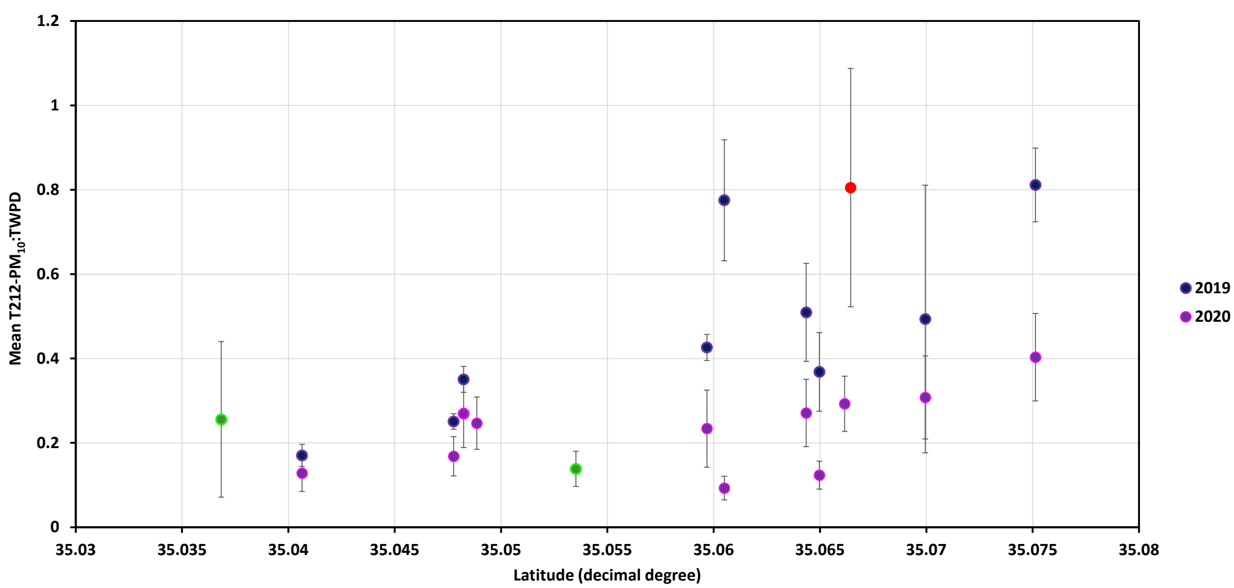


**Figure 21**. The mean T212-$PM_{10}$:TWPD ratio for each of the in-Park stations as a function of latitude in 2019 (May or June-Sept) and 2020 (April-Aug). Error bars represent the standard deviation of the mean ratio for the available months of data. The red circle datum marks the Lagrande Tract value in 2020. The green circles are the out-of-Park stations. Green circles are out-of-Park stations (SODAR [35.03684] and Haybale [35.05352], 2020)

$PM_{10}$:TWPD value for the Lagrande station was in the range reported by nearby stations in 2019. This indicates that the areas upwind of this monitoring station were much more emissive than other parts of the Park in 2020. This is important as emissions from the Lagrande tract impact, to a high degree, the CDF monitoring site.

Since there are no comparable data to define the pattern of $TPM_{10}$:TWPD across space or through time prior to 2017 and hence for times before OHV activity periods, it is not possible to unambiguously declare the absolute effect of OHV activity on increasing the dune emissivity above a pre-impact condition. The station data from 2019 suggest that on the seasonal time frame May to August, OHV activity increased the saltation-generated $PM_{10}$ concentrations from the dunes by approximately 50% for similar values of WPD (Fig. 17). Upon restriction of OHV activity in 2020, the station data indicate the saltation-generated $PM_{10}$ concentrations from the riding area decreased by approximately 50% from April through to the end of August for similar values of WPD (Fig. 20).

**Conclusions**

Based on the record of PI-SWERL measurements from 2013 to 2020, and the in-Park monitoring of meteorologic and 212-$PM_{10}$ in 2019 and 2020, it appears that the cessation of OHV activity in 2020 had a demonstrable effect on the emissivity of the dune surfaces in the riding area. In 2019 as OHV activity was unrestricted the PI-SWERL data from across the ODSVRA riding area and the Lagrande Tract, in particular, indicate that emissivity was higher in 2019 than 2020. Although variable through time, due likely to moisture effects on emissivity, the emissivity of the Lagrande Tract by September 2020 was ≈50% less emissive than it was in 2019, according to the PI-SWERL measurements.

The in-Park met-PM stations provide a more continuous record of the dust emissions system across the spatial domain of the ODSVRA than can be obtained with periodic PI-SWERL measurements of emissivity. The instrument network enables characterization of the $PM_{10}$ concentrations through a broad range of environmental conditions in which dust emissions occur. Data from the network indicates that the emissivity of the riding area decreased between April and August in 2020 because $PM_{10}$ concentrations were lower for similar values of WPD. This holds across the entire spatial domain of the monitoring network. It is noted, however, that the Lagrande station, located downwind of the Lagrande Tract, produced much higher $PM_{10}$ concentrations for equivalent WPD values than all the other in-Park stations in 2020. This suggests that the Lagrande tract remained a rich source area for $PM_{10}$ from April-to August 2020. Although the T212-$PM_{10}$:TWPD ratio for this station did decline through time from April to August similar to all the other stations. The station data from 2020 suggest that the removal of OHV activity in April allowed the dune system to move to a different emissive state that was approximately 50% lower following the passage of four months of time. This correlates with the observed reduction in emissivity in 2020 as measured with the PI-SWERL.

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# Increments of Progress

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January 5, 2021

DRI
Desert Research Institute

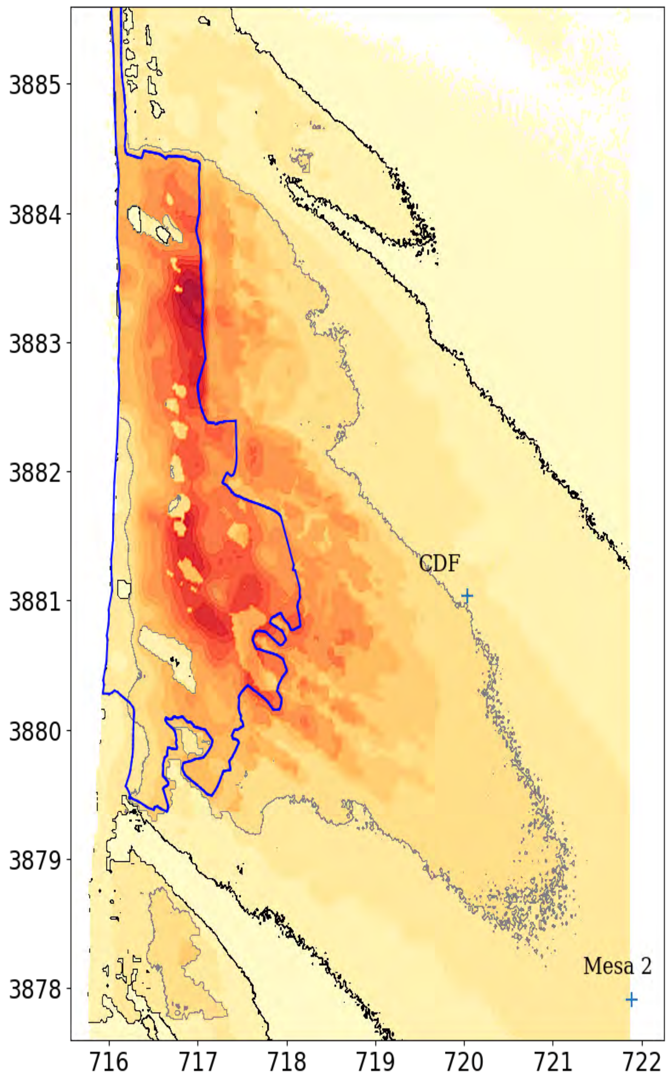
# Increments of Progress Demonstrating Progress to Achieving SOA Goals

Reduce $PM_{10}$ mass emissions (mg $m^{-2}$ $s^{-1}$) by 50%

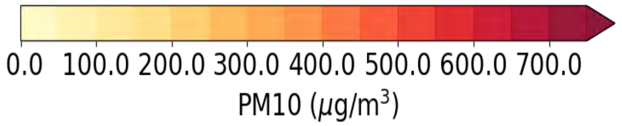
Reduce $PM_{10}$ levels across the area downwind of the ODSVRA and exceedances of the Federal and State 24-hour mean $PM_{10}$ standards

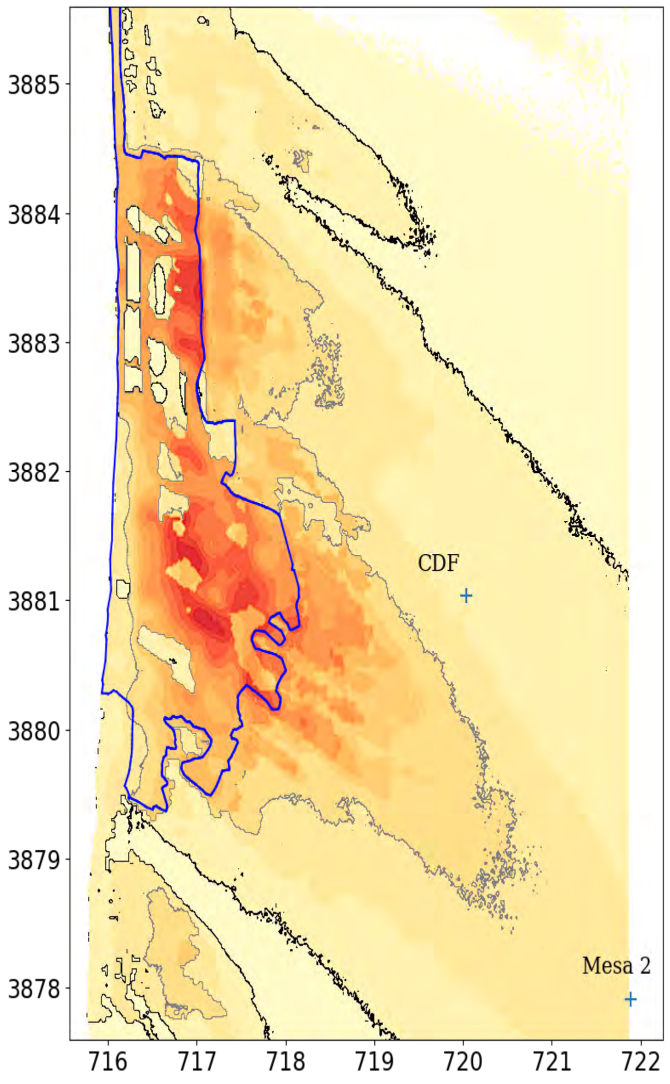
Beginning in 2014, 28 acres of dust controls were implemented, and the acreage has increased to 223 acres in 2020.

According to emission and dispersion modeling undertaken by DRI, the 223 acres reduces $PM_{10}$ measured at the CDF monitoring station

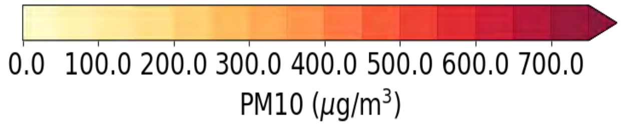


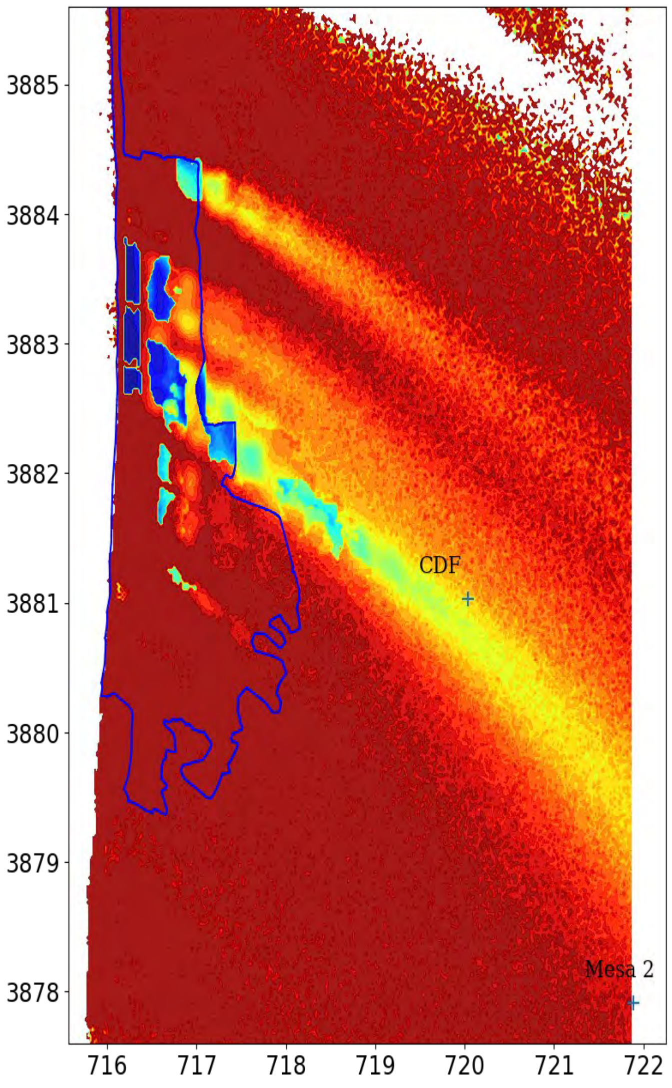

2013 No controls



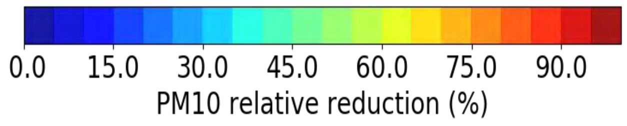




2020 Controls




$PM_{10}$ percent change between 2013 and 2020



Do air quality and meteorological data corroborate the model results?

Can incremental progress in improved air quality be demonstrated from 2013 to 2020 from the dust control actions?

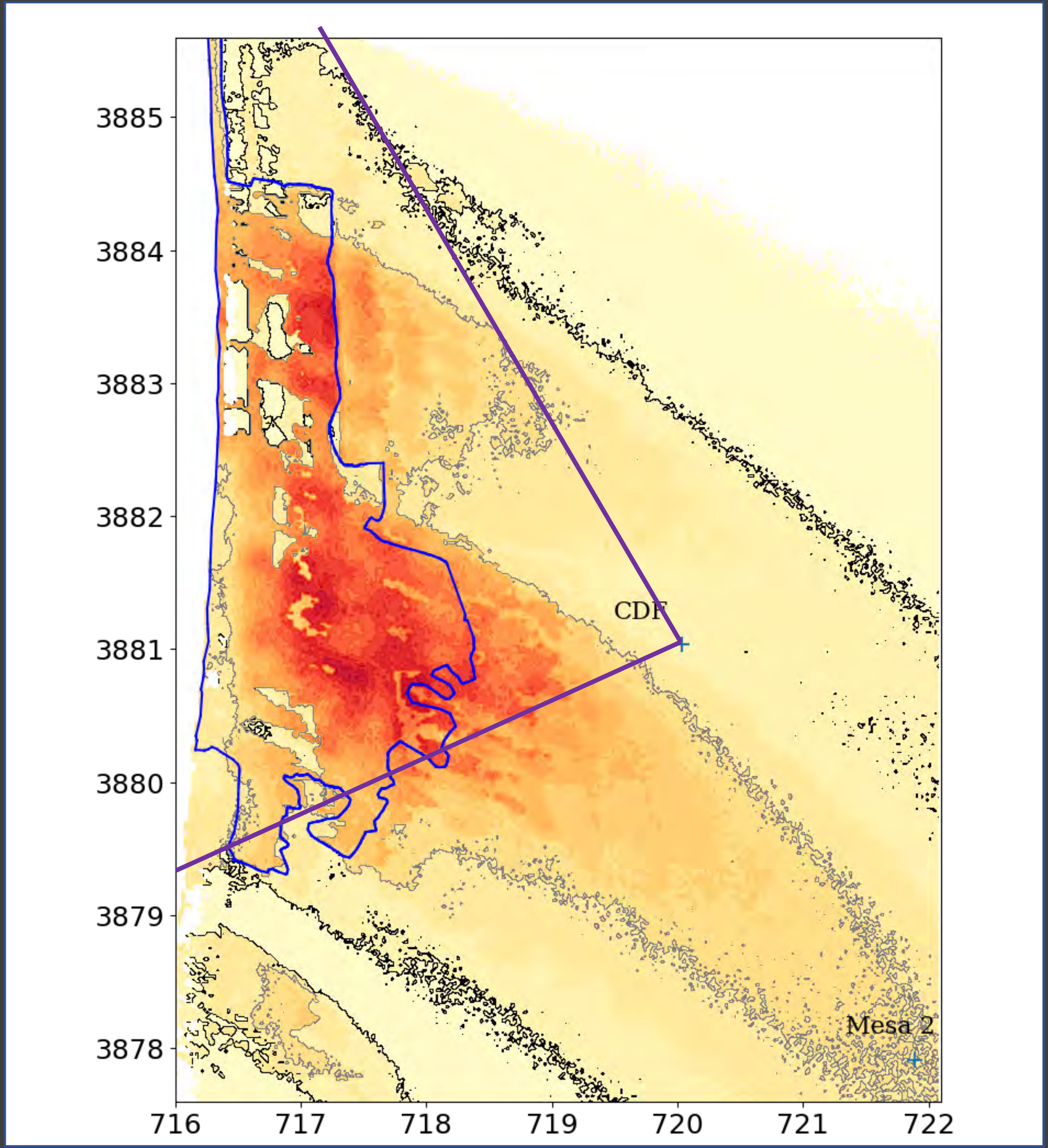
Available data:

Hourly mean $PM_{10}$ from CDF and Mesa2

Hourly meteorological data (hourly mean wind speed and wind direction) from CDF, Mesa2, and S1 tower (within the ODSVRA)

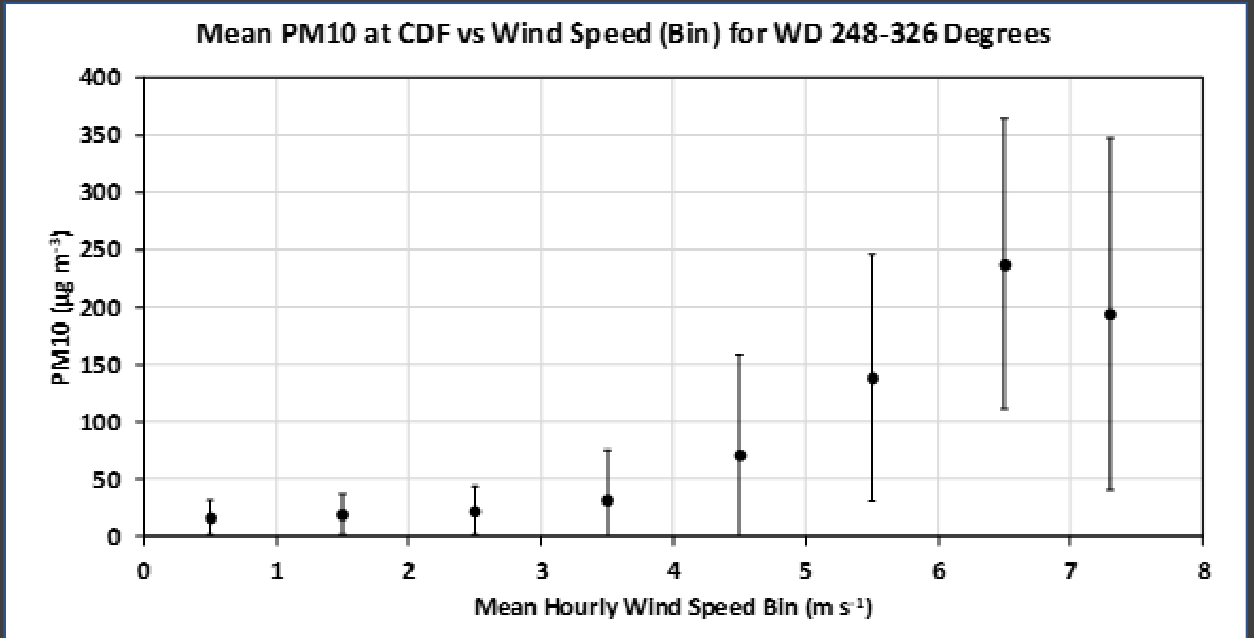
# Methods

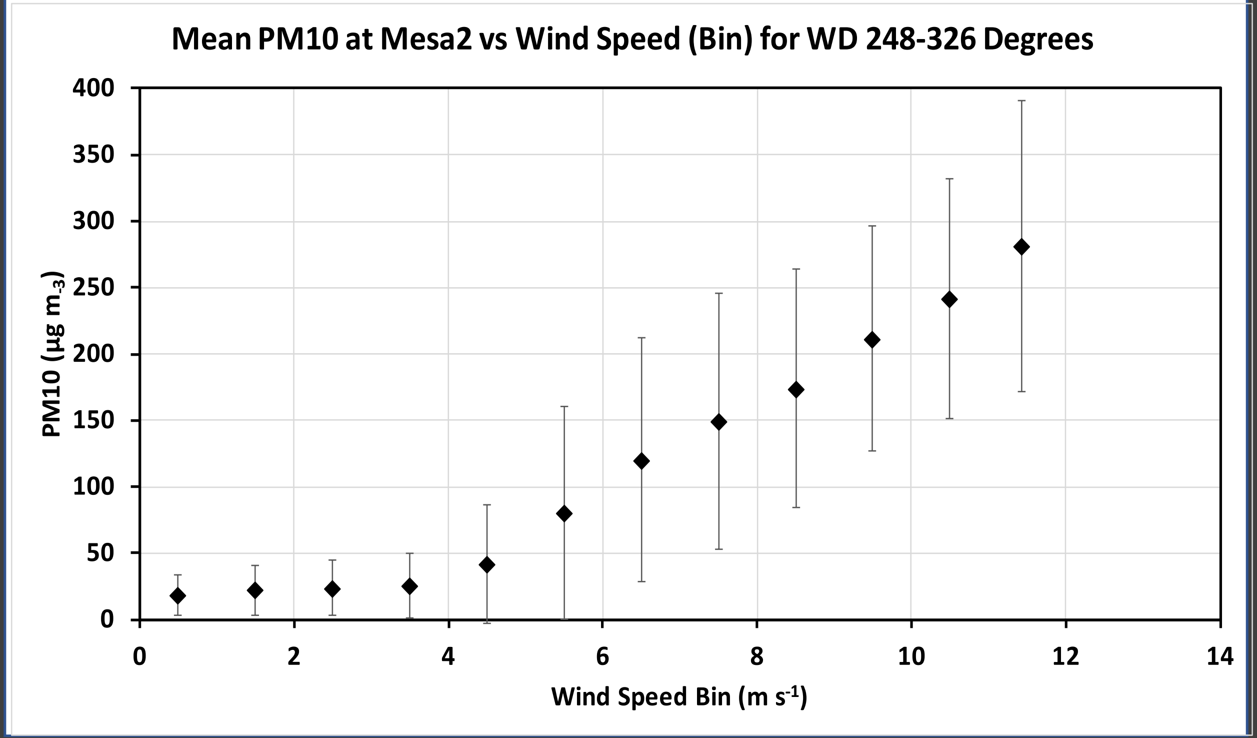
- **Assumptions:**
- **1) Winds from 248° to 326 ° are used to ensure, conservatively, that the air flow that reaches CDF and Mesa2 has most likely travelled from the ODSVRA**



## Methods

- **Assumptions:**
- **2) A wind speed filter is applied based on screening for the conditions where it is most likely that the $PM_{10}$ reaching CDF and Mesa2 is due to the generation of dust by the saltation process within the ODSVRA.**
- **CDF and Mesa2: ≥4.5 m/s; S1 ≥8 m/s**



## Methods

- **Assumptions:**
- **3) Eliminate hourly wind speed and the corresponding $PM_{10}$ data for that hour if there has been a precipitation event from one to three days prior to the measurement**

## Analysis

- **Calculate Wind Power Density (WPD) for each (filtered) hour**

**WPD = air density (kg/m$^3$) x wind speed$^3$ (m/s)=Watts/m$^2$**

## Analysis

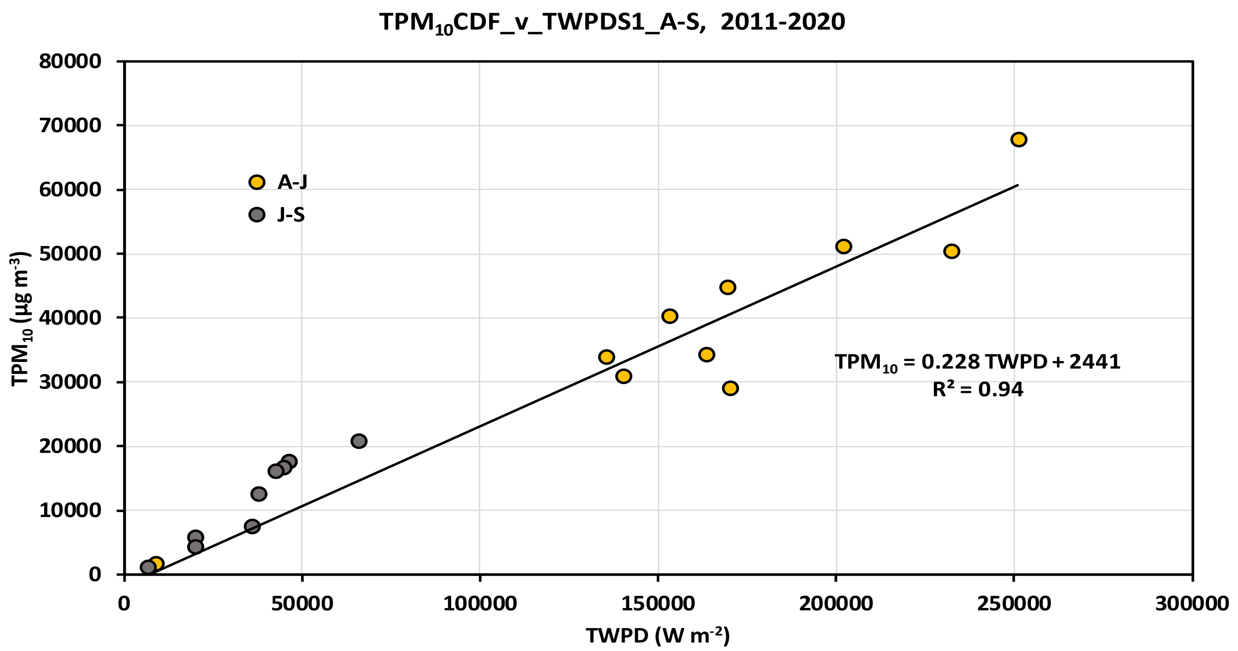
**Calculate the sum of hourly WPD for the periods of interest (April-June and July-September [filters applied])**

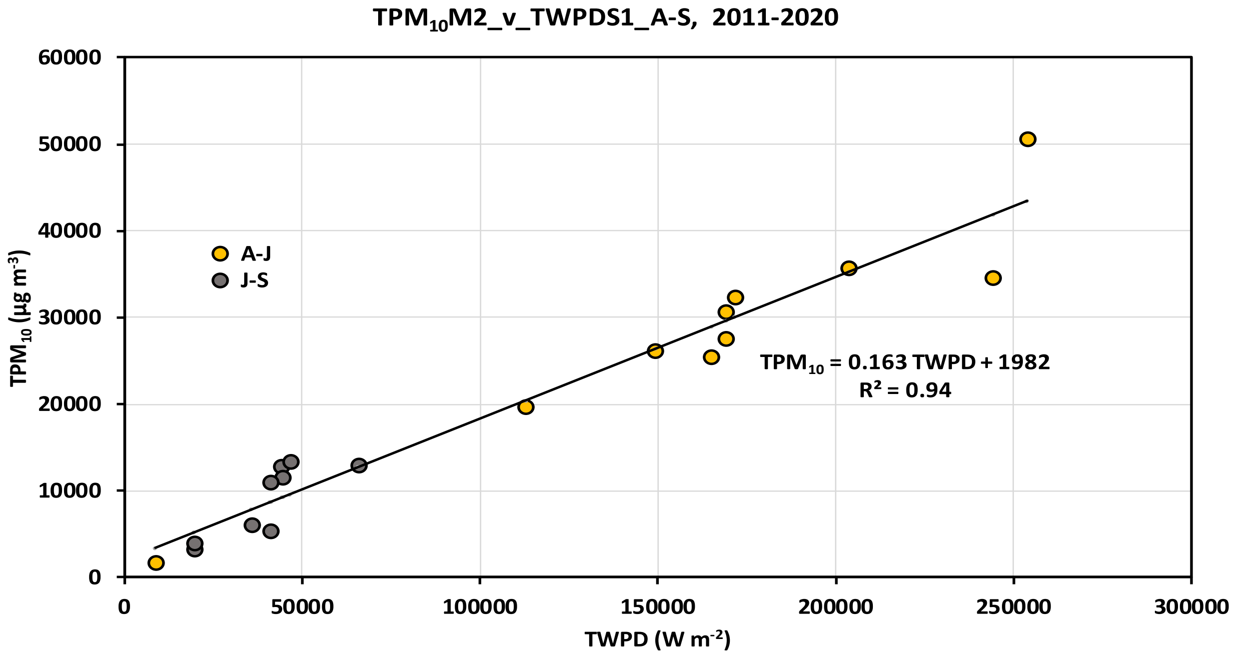
**Calculate the sum of $PM_{10}$ hourly concentration for the matching hours in the same periods of interest**

$$Total\ WPD = \sum_{End\ Hour}^{Begin\ Hour} Hourly\ WPD$$

$$Total\ PM_{10} = \sum_{End\ Hour}^{Begin\ Hour} Hourly\ PM_{10}$$

# Results


TPM10CDF_v_TWPDS1_A-S, 2011-2020
A-J
J-S
TPM10 = 0.228 TWPD + 2441
R² = 0.94
TPM10 (µg m-3)
TWPD (W m-2)
0
10000
20000
30000
40000
50000
60000
70000
80000
0
50000
100000
150000
200000
250000
300000


TPM10M2_v_TWPDS1_A-S, 2011-2020
A-J
J-S
TPM10 = 0.163 TWPD + 1982
R² = 0.94
TPM10 (µg m-3)
TWPD (W m-2)
0
10000
20000
30000
40000
50000
60000
0
50000
100000
150000
200000
250000
300000

## Results

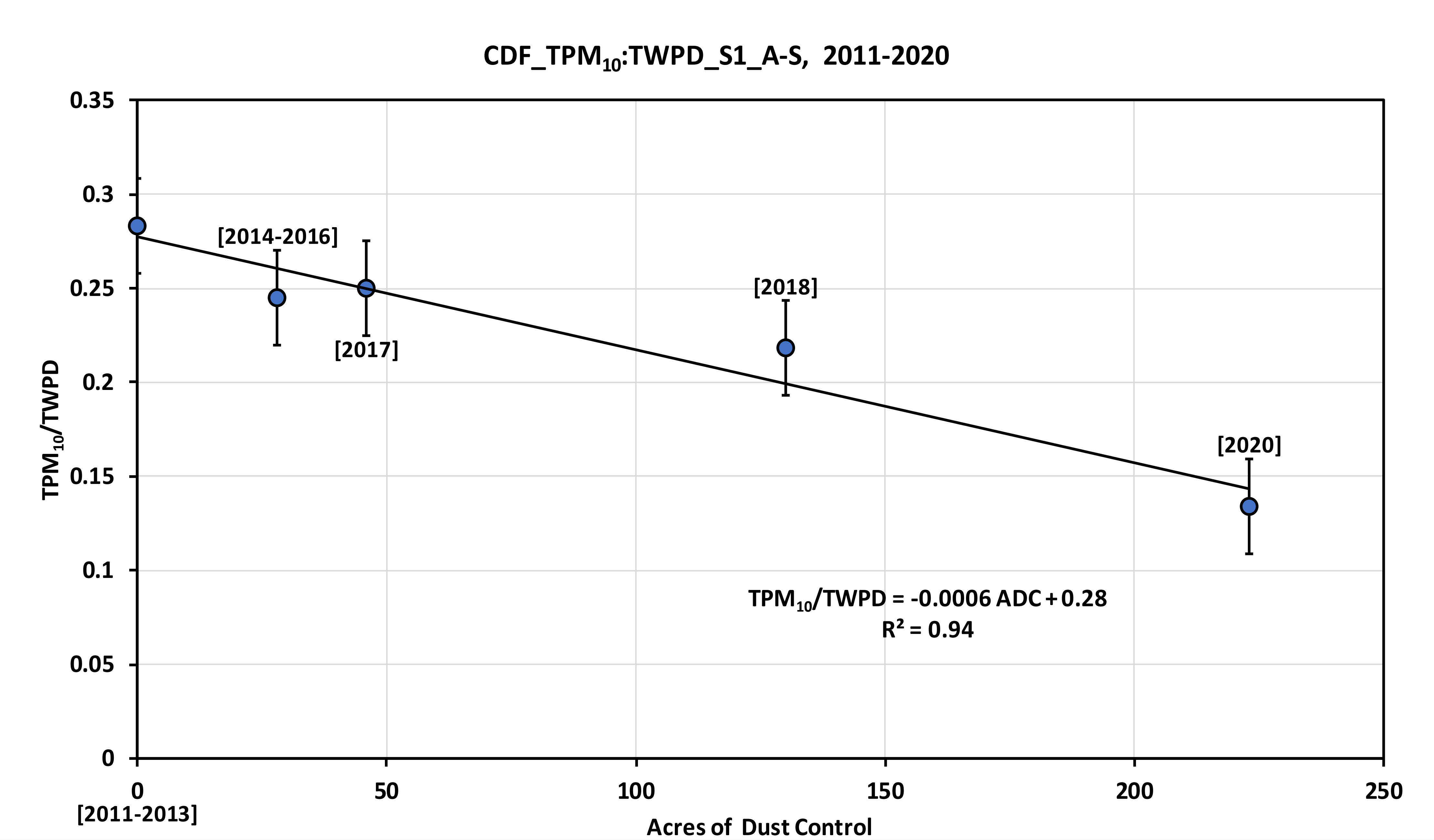
**Because of the strength of the relation between $TPM_{10}$ and TWPD, their ratio can serve as a metric to evaluate how the dust emission system is changed by landscape changes.**

**Constant ratio through time: no change in dust emission system**

**Changing ratio through time: change in dust emission system through time**

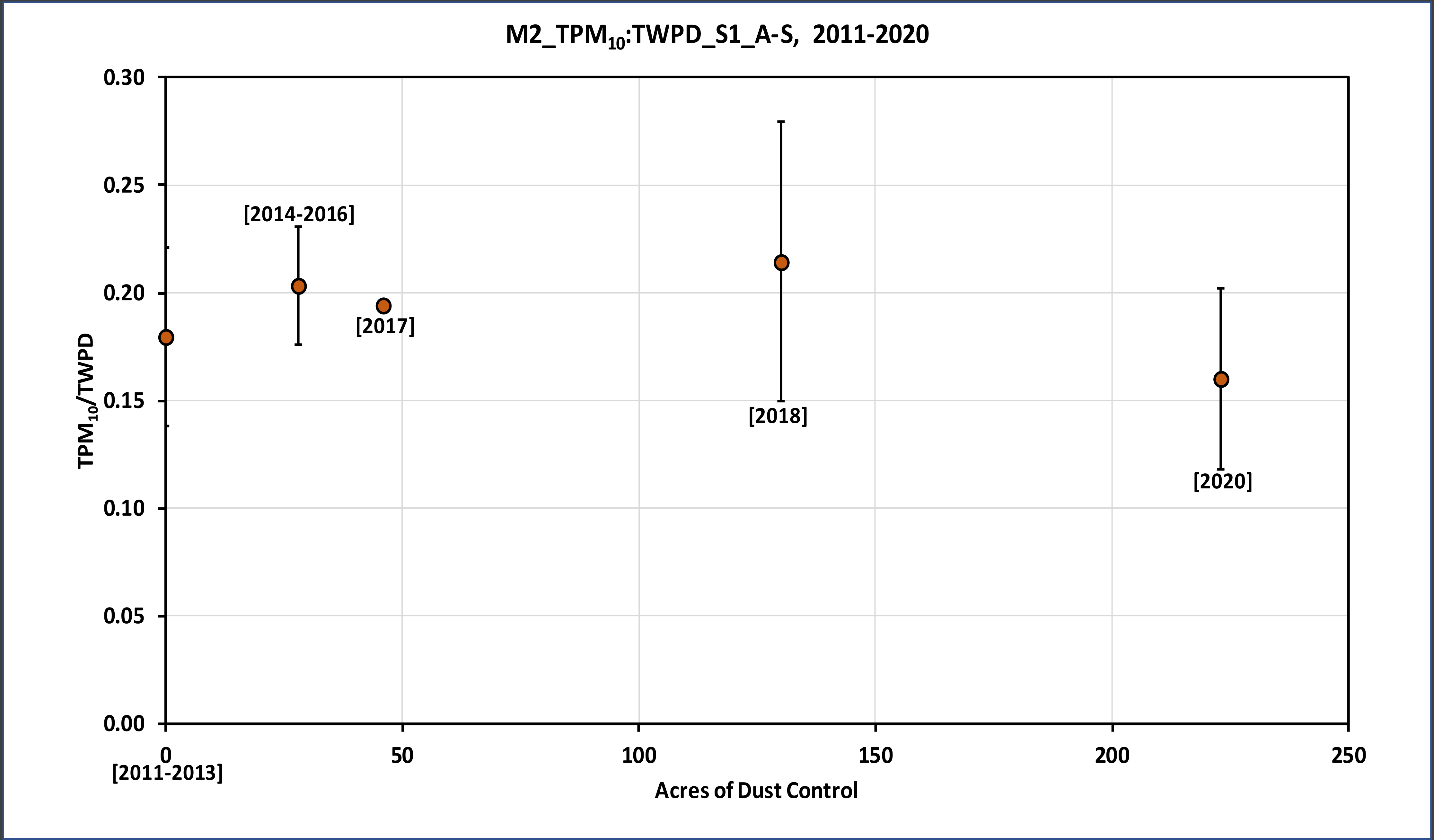
**Why change?: 1) reduction in area emitting, or 2) change in surface emissivity**

# Results



CDF_TPM10:TWPD_S1_A-S, 2011-2020
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
TPM10/TWPD
[2014-2016]
[2017]
[2018]
[2020]
TPM10/TWPD = -0.0006 ADC + 0.28
R² = 0.94
0
[2011-2013]
50
100
150
200
250
Acres of Dust Control

# Results



M2_TPM10:TWPD_S1_A-S, 2011-2020
TPM10/TWPD
0.30
0.25
0.20
0.15
0.10
0.05
0.00
[2014-2016]
[2017]
[2018]
[2020]
0
50
100
150
200
250
[2011-2013]
Acres of Dust Control

# Summary

- DRI's emission/dispersion modeling suggests $PM_{10}$ at CDF is reduced by 42% due to controls in place in 2020 (i.e., 223 acres)
- Sequential decline in $TPM_{10}$:TWPD ratio for CDF/S1 tower from 2011-2013 to 2020 indicate that with increased area of dust controls the production of $PM_{10}$ has decreased through time
- Reduction in 2020 is 48% for equivalent WPD since 2011-2013 (no controls in place)
- (Possible) Decline in $TPM_{10}$:TWPD ratio for Mesa2/S1 tower between 2011-2013 and 2020 indicates dust controls have reduced the production of $PM_{10}$ by 11% for equivalent WPD since 2011-2013 (no controls in place), model results suggest 7% decrease

State of California • The Natural Resources Agency
Gavin Newsom, ***Governor***
DEPARTMENT OF PARKS AND RECREATION
Lisa Ann L. Mangat***, Director***
Off-Highway Motor Vehicle Recreation Division
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**Memorandum**

# An Analysis: May and June Wind Strength Year to Year and State PM10 Exceedances with and without OHV Recreation, Oceano Dunes SVRA.

**August 5, 2020**

**From:**
Will Harris
Senior Engineering Geologist
California Geological Survey

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*Background*
Since March 28, 2020, due to coronavirus concerns, off-highway vehicle (OHV) recreation has been prohibited at the Oceano Dunes State Vehicular Recreation Area (Oceano Dunes) in south San Luis Obispo (SLO) County California. Oceano Dunes remains closed to OHV recreation due to concerns related to endangered and threatened shorebirds.

The SLO County Air Pollution Control District (APCD) has suggested that OHV recreation causes the dune saltation process to be enhanced in some way, leading to more dust that blows downwind—an additional amount of dust beyond what is emitted naturally from the dune saltation process. As yet, the OHV-enhanced saltation value and related added dust amount has not been determined by the APCD nor by the Scientific Advisory Group (SAG), a collection of advisors and scientists formed as a result of the May 2018 Stipulated Order of Abatement (SOA) issued to DPR by the APCD.

A commonly expressed idea to determine if OHV recreation truly does increase saltation-generated dust downwind of Oceano Dunes is to prohibit OHV use for a period of time to see what happens. The coronavirus shut down of Oceano Dunes has created that opportunity.

The closure to vehicles has allowed for an examination of changes in the emission of saltation-generated dust from the dunes that may be due to the absence of OHV recreation. It is for this reason that the Desert Research Institute (DRI), consultant to the California Department of Parks and Recreation (DPR), has been conducting weekly testing of dune surface dust-emissive potential within Oceano Dunes. Thus far, DRI has not provided any preliminary findings from the testing.

But in the context of the SOA, which requires that violations of the state PM10 standard recorded downwind of Oceano Dunes be reduced, comparing the number of PM10 violations by specific month in any given year offers a simple metric.

A local news publication did such a comparison for the month of May and found that in May 2020, when there was no OHV recreation, there were more violations of the state's PM10 standard than for the same month in the previous six years (https://calcoastnews.com/2020/05/coronavirus-shutdown-shows-dust-on-the-nipomo-mesa-science-is-flawed/).

The violations were recorded at the APCD's CDF and Mesa 2 air monitoring sites located on Nipomo Mesa (Mesa), approximately two miles downwind (easterly) of Oceano Dunes.

In an attempt to explain this unanticipated finding, the APCD posted a Frequently Asked Questions (FAQ) document to its website (https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/June2020FAQ-42.pdf). The second question in the document reads, "Why have there been more exceedances [of the state's PM10 standard] in 2020 than by this point last year?" In answer the APCD states, "In simple terms, it was a very windy spring. 2020 is by far the windiest of the last 6 years, while 2019 was the least windy."

This claim is based on wind data recorded at the CDF site on the Mesa. For individual years from 2015 through 2020, data from January through June were combined to represent spring wind speeds for a respective year.

However, that comparison is not germane to specific months when, in 2020, there was no OHV recreation at Oceano Dunes. Also, the comparison does not represent "a very windy spring" since the comparison uses data from January, February, and the first half of March. In other words, the first half of 2020 may indeed be the windiest half-year of the last six years, but that does not necessarily mean May 2020 has been the windiest May of the last six years.

Examining wind speed in May, and to a lesser extent, June, is more relevant because these are the months, in any given year, when the most violations of the state PM10 standard have been recorded. It is for this reason the SAG, in conducting SOA-required computer modeling of dust emission, uses wind and PM10 data recorded from May and June 2013 to inform their computer model.

*Analysis*

To that end, here is an examination of the APCD's CDF wind speed data from May and June for the years 2013 through 2020. The purpose of this data analysis is to determine which year had the windiest May and the windiest June, and if those windiest months in a particular year recorded the most violations of the state's PM10 standard.

The CDF site records hourly resultant wind speed in miles per hour (mph) and wind direction (the direction the wind is coming from). Days on the Mesa when elevated concentrations of PM10 are recorded coincide with strong prevailing winds from the northwest. The winds occur seasonally, predominantly in the late spring. The winds build in strength daily, beginning in the late morning, peaking in mid to late afternoon, and calming by early evening. Accordingly, to make this examination relevant to high PM10 recorded on the Mesa, the wind data were culled based on wind speed, wind direction, and time of day: Only data for winds above 5 mph, coming from the northwest quadrant, recorded between the hours of 11:00AM and 7:00PM were used for the analysis.

Hourly wind speed for each day from those segregated data were then added up and averaged. Those daily averages were then used to calculate the monthly wind speed average for each May and June from 2013 to 2020. Additionally, the recorded state PM10 violations for

May and June of each year were tallied to determine if wind speed and lack of OHV recreation in 2020 correlated with the number of PM10 violations.

*Results and Discussion*
The results are summarized in the table below.

| **Wind Speed and State PM10 Exceedances Recorded at CDF for May and June, 2013 to 2020** | | | | | |
|---|---|---|---|---|---|
| ***May*** | | | ***June*** | | |
| **Year***** | **Averaged Wind Speed (mph)**** | **Exceedances of State PM10 Standard** | **Year***** | **Averaged Wind Speed (mph)**** | **Exceedances of State PM10 Standard** |
| 2013 | 10.529 | 20 | 2017 | 9.012 | 9 |
| 2014 | 10.036 | 19 | 2018 | 8.787 | 9 |
| 2015 | 9.842 | 5 | 2015 | 8.715 | 5 |
| 2019 | 9.391 | 6 | 2014 | 8.627 | 6 |
| 2016 | 9.376 | 4 | 2020* | 8.615 | 7 |
| 2020* | 9.375 | 12 | 2016 | 8.602 | 10 |
| 2018 | 9.351 | 9 | 2013 | 8.464 | 7 |
| 2017 | 9.123 | 10 | 2019 | 7.834 | 2 |

*No OHV recreation occurring within Oceano Dunes SVRA.

**Wind speed averages determined using data for winds above 5 mph, coming from the northwest quadrant, recorded between the hours of 11:00AM and 7:00PM.

***Ordered from most to least windy years.

Most broadly, the CDF data show northwest winds are stronger in May than June, an expected result.

Regarding May, averaged northwest wind speeds year to year show variability within 1.4 mph. May 2013 had the highest average wind speed (10.05 mph), and May 2017 had the lowest wind speed (9.12 mph). May 2020 wind speed (9.38 mph) was the third least windy May of the eight years examined. Additionally, May 2020, when no OHV recreation occurred in the dunes, had the most violations of the state's PM10 standard (12) since 2014.

For June, averaged northwest wind speeds year to year show variability within 1.2 mph. June 2017 had the highest average wind speed (9.01 mph), and June 2019 had the lowest (7.83 mph). June 2020 wind speed (8.61 mph) was the fourth least windy June of the eight years examined. In comparing violations of the state's PM10 standard year to year, June 2020, with no OHV recreation in the dunes, recorded 7 violations. The most violations were recorded in June 2016 (10), which was the third least windy June (8.60 mph) for the eight years examined.

It should be noted that since 2017, DPR has installed approximately 230 acres of saltation-reducing treatments in the dunes. Most of these treatments consist of planted dune vegetation, and most have been in the OHV riding area of Oceano Dunes. Despite this effort, despite that May and June 2020 were less windy than most other years going back to 2013, and despite that there was no OHV recreation occurring at Oceano Dunes, the number of violations of the state's PM10 standard, particularly in May 2020, appears exceptionally high. It appears the geologic processes of the dunes system, in the broader context of the dust concentrations measured on the Mesa, are far from understood. Accordingly, attempts to accurately assign those recorded dust concentrations to a specific recreational activity within a specific area of the dunes are premature at best and may even be unachievable.

*Conclusions*

The review of the data shows that northwest wind speeds in May 2020 and June 2020 were not exceptionally elevated. In fact, May 2020 and June 2020, respectively, had lighter winds than most of the correlating months and years examined. From these data, the months of May and June in 2020 were not very windy.

Additionally, the comparatively lower wind speeds of May 2020 and June 2020 do not correlate to the high number of state PM10 violations concurrently recorded during these months in 2020, when OHV recreation was not present. This finding is at odds with the referenced APCD FAQ document that stated, "more exceedances [of the state PM10 standard] are expected in a windier year than in a less windy year." This may be because the APCD analysis to determine the strength of spring winds year to year as a means to explain PM10 exceedances in 2020 incorporates data from months that are not in spring (January, February, the first half of March), and does not consider the specific months in 2020 when there was no OHV recreation occurring in the dunes.

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**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

# ATTACHMENT 11

**State Parks Foredune Restoration Monitoring Report**

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# Summary of Vegetation Monitoring of Restoration Sites at ODSVRA

# (Aug 2020-July 2021)

**Line Intercept Transect Sampling**

Methods

Line Intercept method (Line intercept: % cover =distance a+b+c+d+e+f/total transect length, where a, b, c, etc. are the intercept lengths of vegetation canopy) was used to estimate percent cover of species within each treatment area of the 48 acre Foredune Project and a reference site in the North Oso Flaco Foredune. A total of three transects of 30-meters each were sampled in each treatment area and a total of three 30-meter reference transects were sampled. Sampling occurred in September when access to Foredune areas were not limited by nesting bird activity.

Starting points for the transect lines will be randomly selected within each project area using GIS software. Transect directions were randomly selected from the eight cardinal and intermediate directions (i.e. N, NE, E, SE, S, SW, W, and NW).

A measuring tape was run along the transect and secured with wooden stakes. As the vegetation canopy intersected the line, the species was noted on the datasheet along with the beginning and ending measurements of the canopy under “Start” and “Stop”. When the canopies of two different species overlapped, each species was documented separately as two different canopies. A closed canopy for a given species was assumed until gaps in vegetation exceed the width of 5-centimeters. Dead vegetation was not included in the measurements unless it was clearly the result of seasonal dieback of a perennial plant that was still viable.

Once each 30-meter transect was surveyed, a walk around assessment within an area of 10-meters from the transect line was conducted and all addition species observed were noted.

Results

As expected in the first growing season, for year one of monitoring, none of the treatment areas met the vegetative cover of the reference site at 34.22% vegetative cover. However, three of the six treatment areas did meet the species diversity of the reference site with at least

9 species represented. The treatment area that saw the highest percent cover was Area 3 with 4.02% cover followed closely by Area 6 with 3.57% cover. Both Area 5 and Area 6 showed the highest level of species diversity with 10 species represented in both areas. Based on on-the-ground observations, it does not appear that total of three transects in each area were sufficient to determine the percent cover with certainty as it appeared that Area 4 had greater cover than Area 5 (0.76% compared to 0.40%) while Area 4 was planted with 61% of the density of Area 5. The monitoring methods are expected to become increasingly accurate as the vegetative cover continues to increase and substantial vegetative growth has already been observed in the second growing season. It does appear that the survey methods were sufficient to determine the species richness. Additional survey work will be needed to be sure.

Rapid growth of vegetation within much of the project area was observed during the winter and spring months following the September 2021 monitoring. It is anticipated that the 2021 monitoring with show a significant increase in vegetation cover within the project area.

**Photo Point Monitoring**

On-the-ground photo point monitoring was conducted for the 48 Acre Foredune project prior to project installation in February 2020 and following project installation in in May 2020 and October 2020. Photo point monitoring is scheduled to continue in October in subsequent years. Photo points are located on all four corners of each treatment area. For each photo point two photos are taken, each with one of the treatment area boundary lines on the outer edge of the photo with the interior of the treatment area centered in the photo. There is also one photo point overlooking the entire 48 Acre Foredune project from a distance.

In addition to on the ground monitoring, drone aerial imagery photo point monitoring was conducted in May 2020 and again in December 2020. Two photo points were take of each treatment area, including one from the east and one from the west for each area. Drone photo point monitoring is scheduled to continue on an annual basis.

Figure 1. Results from 48 Acre Foredune Project transect monitoring.

| | North Oso Flaco Fordune Reference (3-30m transects) | | 2020 Foredune Project (3-30m transects per area) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Accounts for overlapping cover<br>**Non-native species<br>***Includes species present within 10m of transect<br>P=Present within 10m of transect | **Percent Cover** | **Percent of Transects with species present***** | **Total Percent Cover** | **Percent of Transects with species present***** | **Area 1 Control** | **Area 2 Native Seed** | **Area 3 Native Seed & Grain Seed** | **Area 4 Low Density Nodes** | **Area 5 High Density Nodes** | **Area 6 Parks Classic** |
| **All species*** | **34.22%** | | **1.58%** | | **0.00%** | **0.10%** | **4.02%** | **0.76%** | **0.40%** | **3.57%** |
| Abronia maritima | 20.89% | 100% | 0.80% | 83.3% | | P | 3.51% | 0.18% | P | 1.09% |
| Ambrosia chamissonis | 11.03% | 100% | 0.61% | 83.3% | | 0.10% | 0.77% | 0.50% | 0.40% | 1.90% |
| Camissoniopsis cheiranthifolia | 0.86% | 100% | 0.10% | 55.6% | | | P | 0.43% | P | 0.19% |
| Cakile maritima** | 5.04% | 100% | 0.06% | 44.4% | | | P | P | P | 0.39% |
| Abronia latifolia | | 67% | | 66.7% | | P | P | P | P | P |
| Eriophyllum staechadifolium | | | | 33.3% | | | | P | P | P |
| Malicothrix incana | | 67% | | 33.3% | | | | P | P | P |
| Atriplex leucophylla | | | | 22.2% | | | | P | P | P |
| Achillea millefolium | | | | 16.7% | | | | P | P | P |
| Abronia umbellata | | | | 5.6% | | | P | | | |
| Eriogonum parvifolium | | | | 5.6% | | | | | | P |
| Monardella undulata crispa | | | | 5.6% | | | | | P | |
| Carpobrotus chilensis** | 0.73% | 100% | | | | | | | | |
| Calystegia soldanella | | 33% | | | | | | | | |
| Cuscuta subinclusa | | 33% | | | | | | | | |
| **Species Richness***** | | **9** | | **12** | | **3** | **6** | **9** | **10** | **10** |

| Present only in reference | Present only in treatment | Present in both reference and treatment |
|---|---|---|

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**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

# ATTACHMENT 12

**Compilation of Scientific Advisory Group (SAG) Responses to Comments and Studies from 08/01/20 to 07/31/21**

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**08-20-2020**

## Memorandum: SAG Critique of W. Harris Memorandum of 08-05-2020

**From**: Science Advisory Group

**To:** J. O'Brien, Environmental Program Manager, OHMVR

**RE:** SAG Critique of W. Harris Memorandum:

*An Analysis: May and June Wind Strength Year to Year and State PM10 Exceedances with and without OHV Recreation, Oceano Dunes SVRA. August 5, 2020*.

Dear Mr. O'Brien,

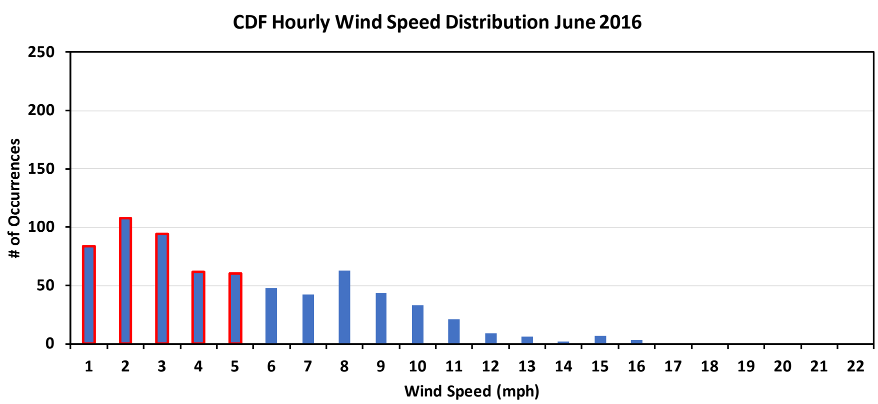
It is part of the SAG's purview to review scientific and technical issues related to the research, development and implementation of windblown $PM_{10}$ controls and prepare technical specifications and analyses of proposed mitigation measures (See SOA item 3c). The SAG therefore has prepared a response to California Geological Survey employee Mr. W. Harris's memo of August 5, 2020, wherein he presents analysis of wind speed and $PM_{10}$ data pertinent to the Oceano Dunes State Vehicular Recreation Area (ODSVRA) to Parks and other stakeholders (e.g., SLOCAPCD).

In Mr Harris's memo of August 5, 2020, he provides an analysis of wind speed and $PM_{10}$ data from the CDF monitoring station for the months of May and June from 2013 to 2020. His purpose appears to be to contextualize or rebut the claim made by SLOCAPCD in their Frequently Asked Questions (FAQ) document (https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/June2020FAQ-42.pdf), in particular the second question in this document that reads: "Why have there been more exceedances [of the state's $PM_{10}$ standard] in 2020 than by this point last year?" In response, the APCD states: "In simple terms, it was a very windy spring. 2020 is by far the windiest of the last 6 years, while 2019 was the least windy." Mr. Harris contends via his analysis that: "The review of the data shows that northwest wind speeds in May 2020 and June 2020 were not exceptionally elevated. In fact, May 2020 and June 2020, respectively, had lighter winds than most of the correlating months and years examined. From these data, the months of May and June in 2020 were not very windy."

The SAG would like to comment for the record on several aspects of his analysis as we feel that this analysis is poorly conceived and based on faulty statistical analysis. This comment is supported by significant expertise of SAG members in wind erosion, dust emissions, air quality monitoring, data analysis, and modelling.

Mr. Harris challenges the APCD's statement that some periods of 2020 can be judged to be windier than earlier periods. There are several fundamental problems with this approach and related arguments. First, to make a valid comparison the same metric should be used. He chose to calculate mean values of hourly wind speed over month-long intervals after applying a lower limit threshold filter of 5 mph to wind speed, an unspecified directional filter "coming from the northwest quadrant", and a temporal filter restricting the data to between 11:00 am and 7:00 pm as a means of estimating longer period (i.e., monthly) mean wind speeds. He then makes the claim that this mean filtered monthly wind speed links to exceedance of the State $PM_{10}$ Standard (50 $\mu g\ m^{-3}$). In contrast, the metric used by the APCD is a "High Wind Event Day" defined as "any day when the 3:00 p.m. PST hourly wind speed at CDF exceeds 8 mph and the 1:00 pm PST hourly wind direction is between 290° and 360°". The main flaw in the approach is that no definition is provided to allow comparison for the determination of when one period is “windier” than another. It is also important to note that neither filtering method makes reference to any accepted metric of “windiness”.  Direct comparison of the metrics from the two approaches cannot be made regarding the ambiguous term “windier”.  Moreover, flaws in the analysis render it meaningless.

The second flaw in the analysis relates to the comparison of the means of filtered time-series.  By removing wind speeds less than 5 mph, means are taken over different time intervals within each month.  A simple and extreme example of why this is a problem is provided in reference to the CDF hourly mean wind speed dataset.  Consider the wind speed histograms of June 2016 and November 2018 shown in Figure 1.  Without defining what “windy” means, it is clear that there are more hours of wind above the threshold of 5 mph in June 2016 (278 hours) compared to November of 2018 (149 hours).  Average values from all (unfiltered) data shows that June 2016 has a higher true average windspeed of 4.7 mph compared to November 2018 with a true average of 3.5 mph.  However, after the threshold filter is applied, the mean wind speed for June 2016 increases to 8.2 mph, while the mean of November of 2018 increases to 8.6 mph.  Thus, the assertion that November 2018 is “windier” because it has a higher filtered mean speed is clearly flawed.  This is a result, in part, because the filtering of low wind speeds biases the distribution by changing the number of data points.  Thus, the filtered mean is not statistically representative of the month for which it was computed.  This approach completely ignores the effect of duration of the filtered wind data on the response of the dust emission system.



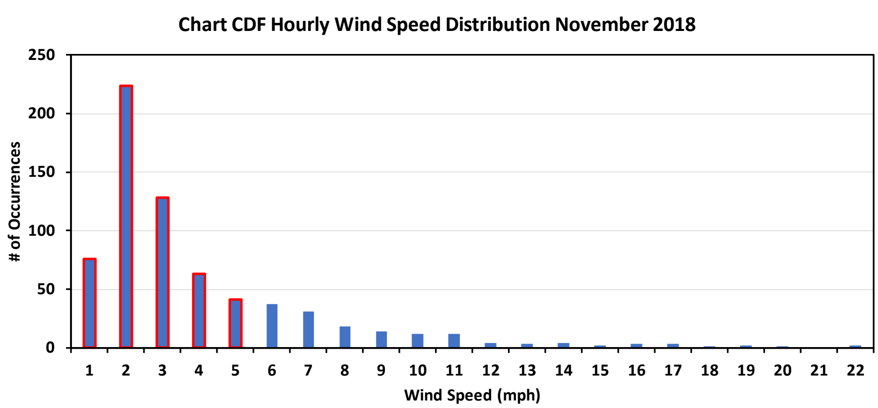




**Figure 1**. Hourly wind speed distributions for CDF representing June 2016 and November 2018.  Red borders indicate the wind speed distribution of winds ≤5 mph.

A third flaw in the analysis is the use of means as a measure of central tendency for wind speed distributions and making conjectures about $PM_{10}$ violations based on the mean. Wind speed distributions are not normally distributed (Hennessey, 1977). Instead, wind distributions are often 'skewed', with greater frequency of lower speed observations and comparatively lower frequency of higher speed events. As such, it is a fundamental statistical violation to use the mean as a measure of central tendency for highly skewed data. In the meteorological literature, wind speed distributions are typically characterized by the Weibull distribution (e.g., Corotis et al., 1978; Hennessy, 1977; Christofferson and Gillette, 1986; Garcia et al., 1998). The distribution begins at zero and has a long tail of high magnitude winds of low frequency (Fig. 2).

Figure 2 shows two hypothetical wind speed distributions with the same number of observations and having the same mean value of 4.1 mph. By comparison of means alone, they would be judged to be of the same level of "windiness" per Mr. Harris's approach. A more appropriate metric, for example, is the percentage of winds over a threshold for sand transport and dust emissions. The observed response of increased $PM_{10}$ concentration at CDF typically occurs when measured hourly wind speed meets and exceeds 10 mph. Windspeed distribution 2, shown in Fig. 2, more frequently exceeds 10 mph and would be judged to be "windier" and produce more dust than distribution 1. In fact, distribution 1 fails to exceed this critical threshold and, under these conditions would produce no saltation and, thus, negligible dust emissions. The use of means to describe central tendency of skewed distributions is fundamentally flawed, especially for estimating the propensity for saltation-induced dust emissions.

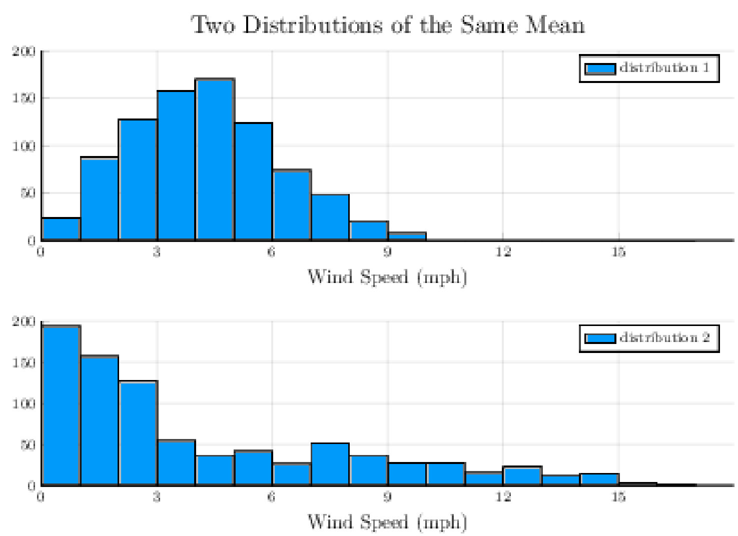



**Figure 2**. Two hypothetical wind speed distributions that have the same mean wind speed.

Relating dust emissions to wind speed is better understood using: i) probability density functions (Christofferson and Gillette, 1986), ii) measures of wind erosivity (Shao, 2000) or, iii) erosive wind power density (WPD, W $m^{-2}$) (e.g., Hagen et al., 1999). These metrics are more appropriate and useful to compare wind erosion and dust emission potential between measurement locations or for the same location for different time periods than mean wind speeds. This is because these methods can account for both wind magnitude and duration, whereas the monthly mean of hourly wind speed cannot. In that wind speeds are not normally distributed (e.g., distribution 2, Fig. 2) it is typically the case that quantifying changes or differences in the tails of the wind speed distribution are more important to characterize the influence of wind on dust emissions (and ambient particle concentration levels) than measures of central tendency, e.g., mean values. The metric developed by the APCD accounts, in part, for the importance of the heavy tail of the wind speed distribution in affecting dust emissions.

If evaluating wind and its relation to ambient $PM_{10}$ dust is deemed a germane contribution to the discussions on why the number of air quality exceedances increased in spring 2020 as observed at the CDF monitoring site, the SAG recommends that the framework for analysis be wind power (as developed by meteorologists and wind energy engineers) or erosive wind power density metrics (as developed by, for example, agricultural scientists and aeolian geomorphologists). These provide unambiguous metrics that link the wind speed distribution to the response of the dust emission system. The SAG is concerned that Mr. Harris's analysis creates the opportunity for a false narrative to be generated that can be incorrectly championed. Decisions that will have to be made to best manage the ODSVRA, as it relates to dust emissions and air quality exceedances, must be informed by the most accurate representation and interpretation of the available data, and in this case would have been served by making use of the available scientific literature related to analyses of wind speed distributions.

Respectfully,

Science Advisory Group

**References**

Christofferson, R. D., and D. A. Gillette (1987), A simple estimator of the shape factor of the two-parameter Weibull distribution, *Journal of Climate and Applied Meteorology*, 26(2), 323-325.

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**August 31, 2020**

## Memorandum: SAG Review of Draft ARWP 8-1-2020

**From**:
Scientific Advisory Group (SAG)

**To:**
Gary Willey, San Luis Obispo Air Pollution Control District (SLO APCD)
Jon O'Brien, California Department of Parks and Recreation, Off-Highway Motor Vehicle Recreation Division (OHMVR)

**Summary statement:**

The Scientific Advisory Group (SAG) is generally pleased with the draft 2020-21 Annual Report and Work Plan (ARWP). The ARWP demonstrates tangible progress on dust mitigation treatments during the 2019-20 work year, including initiation of the 48-acre foredune restoration project. The draft ARWP also sets forth a comprehensive 2020-21 work plan, which includes continuing progress on existing and new dust mitigation treatments, as well as advancements on modeling and monitoring capabilities to inform adaptive management. The SAG is also pleased with how OHMVR has displayed a spirit of cooperation with SAG through ongoing consultation in the ARWP drafting and writing process.

The SAG is aware that the draft ARWP proposes to add only 40 acres of additional dust mitigation treatments in the 2020-21 work year, which may be insufficient to achieve the level of dust mitigation required by the Stipulated Order of Abatement (SOA) in a timely manner. The SAG therefore recommends that the 2020-21 ARWP plan for an increase in the amount of new dust mitigation treatment areas beyond the 40 acres stated in the draft ARWP to at least double this amount. To inform this recommendation, the SAG reviewed a map of existing (to February 2020) dust mitigation treatments as well as the most current Desert Research Institute (DRI) dust emission attribution maps (based on 2013 winds and the PI-SWERL testing grid) for both the CDF and Mesa2 monitoring stations. Noting extensive recent dust mitigation efforts in the north-central portion of the Oceano Dunes State Vehicular Recreation Area (ODSVRA) (e.g., BBQ Flats, Bigfoot, Eucalyptus) the SAG recommends that OHMVR focus on installing new mitigation "islands" in the south-central region of the ODSVRA, as shown in the attached Figure 1. Such areas could have additional emissions reductions benefits for Mesa2, in particular.

The SAG recognizes the challenges imposed by the terrain and other site logistics, such as maintaining safety, restroom access, and vehicle transport corridors, and indicates three general areas for consideration. Although these areas do not correspond with the most highly emissive surfaces attributed to PM10 concentrations at either Mesa2 or CDF (see attached Figures 2 and 3), such as the "sand highway," they would provide dust mitigation benefit not only within their footprint areas but also by a sheltering effect that would reduce surface shear stress, sand saltation, and resulting dust emissions downwind of the treatment areas. Possible locations for transportation/access corridors to accompany these mitigation islands are also indicated in the attached Figure 1.

In making a final selection among these possible treatment areas, the SAG urges OHMVR to consider the full available scientific evidence to determine the relative effectiveness of possible treatment alternatives. Notably, the draft ARWP includes significant activities in the 2020-21 work year to improve DRI dust model predictions by assimilating improved emissivity maps (from recent PI-SWERL surveys) and meteorological data (from the recently-installed SODAR station). In addition, planned fluid dynamic modeling during the 2020-21 work year will help to quantify secondary effects on dust emissions reductions downwind of the foredune treatment area. Therefore, as such modeling improvements are made, the SAG recommends that OHMVR revisit the specific scope and placement of planned dust mitigation treatment areas.

In addition, the SAG recommends that OHMVR engage with a subset of SAG members to seriously consider scientifically-justified alternatives to the current 50% emissions reduction target that may more directly reflect the impact of dust mitigation treatments on downwind airborne dust concentrations.

Members of the SAG offer additional specific comments on the draft ARWP below. Three figures are also attached with this review.

Respectfully,
Scientific Advisory Group (SAG)

**Additional comments from SAG members**

Carla Scheidlinger:

1. Typo: page 2-2, paragraph 2 line 2: remove the word "be"
2. Typo: page 2-2, remove last empty bullet from Plot 1
3. For Plot 2 description on page 2-2, indicate what the densities of "high" and "low" are in terms of nodes/acre.
4. Page 2-3, specify planting density for Parks Classic.
5. Typo: Page 2-7, capitalize the M in PM in the heading for section 2.3.1
6. Page 3-2, section 3.1.1. If the information on the foredune is not acquired before summer of 2021, there will be no opportunity to carry out planting during the current work year. The statement about planting in this section then conflicts with the timeline shown in Table 5-1 on page 5-1.
7. In Table 5-3 on page 5-2, the schedule for removing the sand fence and then replanting leaves a pretty long time between fence removal and planting; this time period should be shortened.

Raleigh Martin:

1. **Project Manager.** Please identify the name of the current project manager, as per item 13 in the amended SOA. I assume this is Jon O'Brien, but please confirm this within the ARWP text.
2. **Sec. 2.2. Statement of Progress Achieved.** Please also provide a value for the modeled concentration change at Mesa2.
3. **Sec. 2.3.1. Monitoring Activities Conducted Over the Previous Year: Meteorological, Pm, and Saltation Monitoring.** It appears that many Normalized Sand Flux (NSF) values reported here are from the 2018-19 ARWP period, not the 2019-20 ARWP period that is the subject of this report. Please provide NSF values specifically for each of the 2019-20 control measures listed in Table 2-1, as available. Please also make it clear how the reported NSF values relate to each of the specific treatment areas. (For example, does Table 2-3 refer to the 2019-WF-01 and 2019-WF-02 treatments?)
4. **Table 2-3.** Please clarify what treatment area the "two temporary sand fence arrays" are referring to – are these 2019-WF-01 and 2019-WF-02?
5. **Attachment 6. "Defining the SOA 10 Baseline Days."** The current attachment does not actually define the SOA 10 baseline days. It instead performs an analysis to justify an existing choice that is not described anywhere in the ARWP. The SAG provided a preliminary definition of the SOA 10 Baseline Days, which was included as Attachment 5 for the revised 2019-20 ARWP issued on December 31, 2020. To reflect changes that were agreed to at the February 2020 SAG meeting and which were incorporated into subsequent DRI modeling, I provided OHMVR with an update to this file on March 1, 2020. I strongly recommend including this as an attachment with the 2020-21 ARWP. This would formally settle the lingering matter over selection of the 10 baseline days.
6. **Table 3-6.** Please replace the "tbd" entries with "Consult with SAG on selection of specific dust control treatment" and "Install dust control treatment."
7. **Sec. 3.2.3.** Planned Field Measurements: Baseline Sand Flux Measurements. This subsection as currently written is not helpful, because it only describes the theory of BSNEs without any specific plans. It would be much more useful to describe the actual

plan for BSNE data collection and analysis in 2020-21, following on the deployment of BSNE arrays described in Sec. 2.3.1.

8. **Sec. 3.2.3.** Planned Field Measurements: PM10 Measurements. This subsection as currently written is also not helpful. Please provide more specific detail on expected PM10 Measurements in 2020-21.
9. **Exhibit 2.** Please update the numbering of foredune treatment areas to match what is in the report.
10. **Attachments 1 & 2: 2019-20 and 2020-21 metrics.** These need to be updated. For 2019-20 (Attachment 1), many of the values (i.e., P7-P16) are listed as “TBD – 2020 ARWP.” Please provide these values or give an explanation for why the values are not included. For 2020-21 (Attachment 2), many of the target values (i.e., P4-P16) are listed as “TBD.” Will an attempt be made to define these targets? If OHMVR is unable to provide these values now, could it commit to a target date for consultation with SAG on these items? In addition, to avoid confusion, I suggest removing “TBD – 2020 ARWP” in the Attachment 2 “Value” column, as well as updating or removing the items in the “Notes / Plan” column of this file.

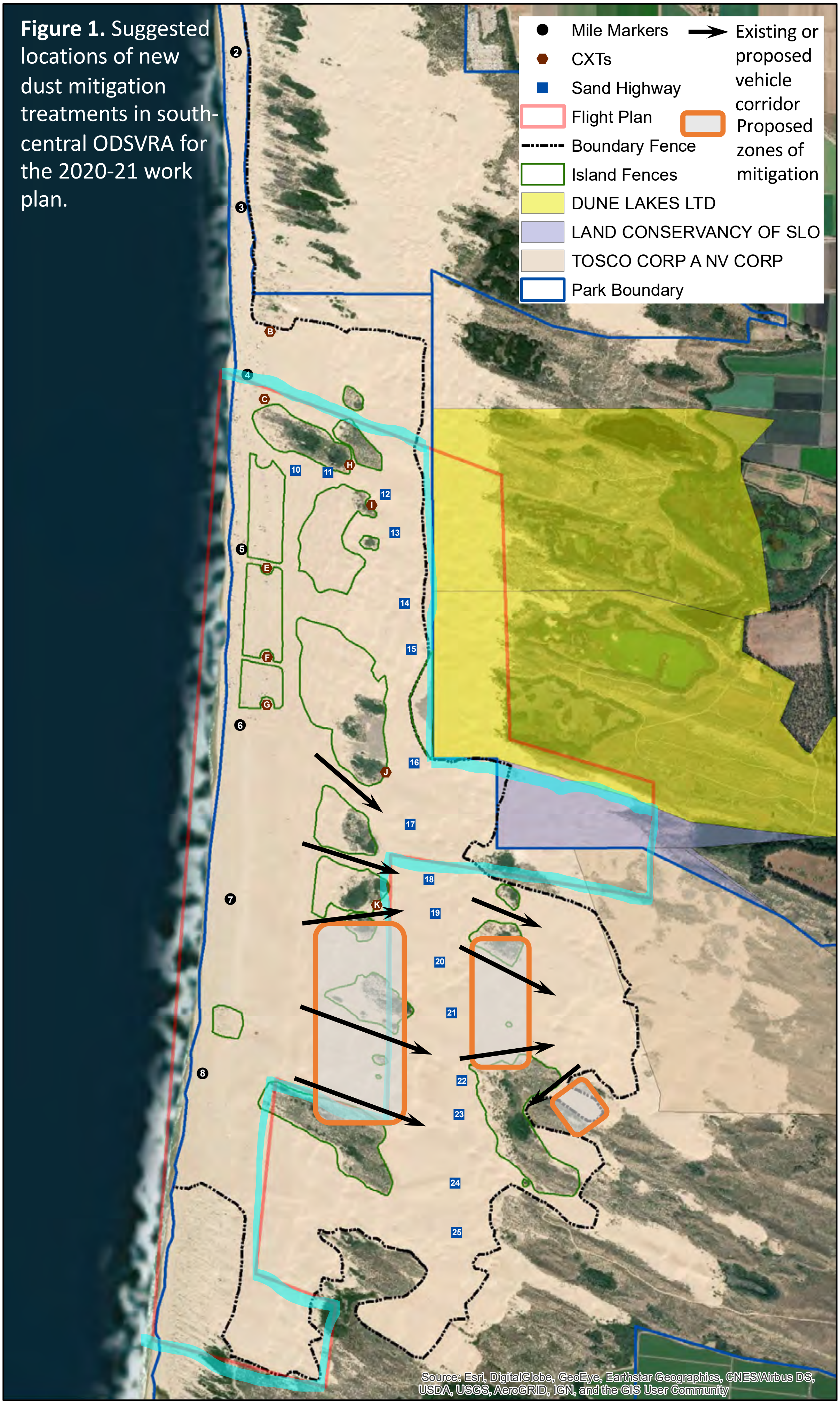


**Figure 1.** Suggested locations of new dust mitigation treatments in south-central ODSVRA for the 2020-21 work plan.

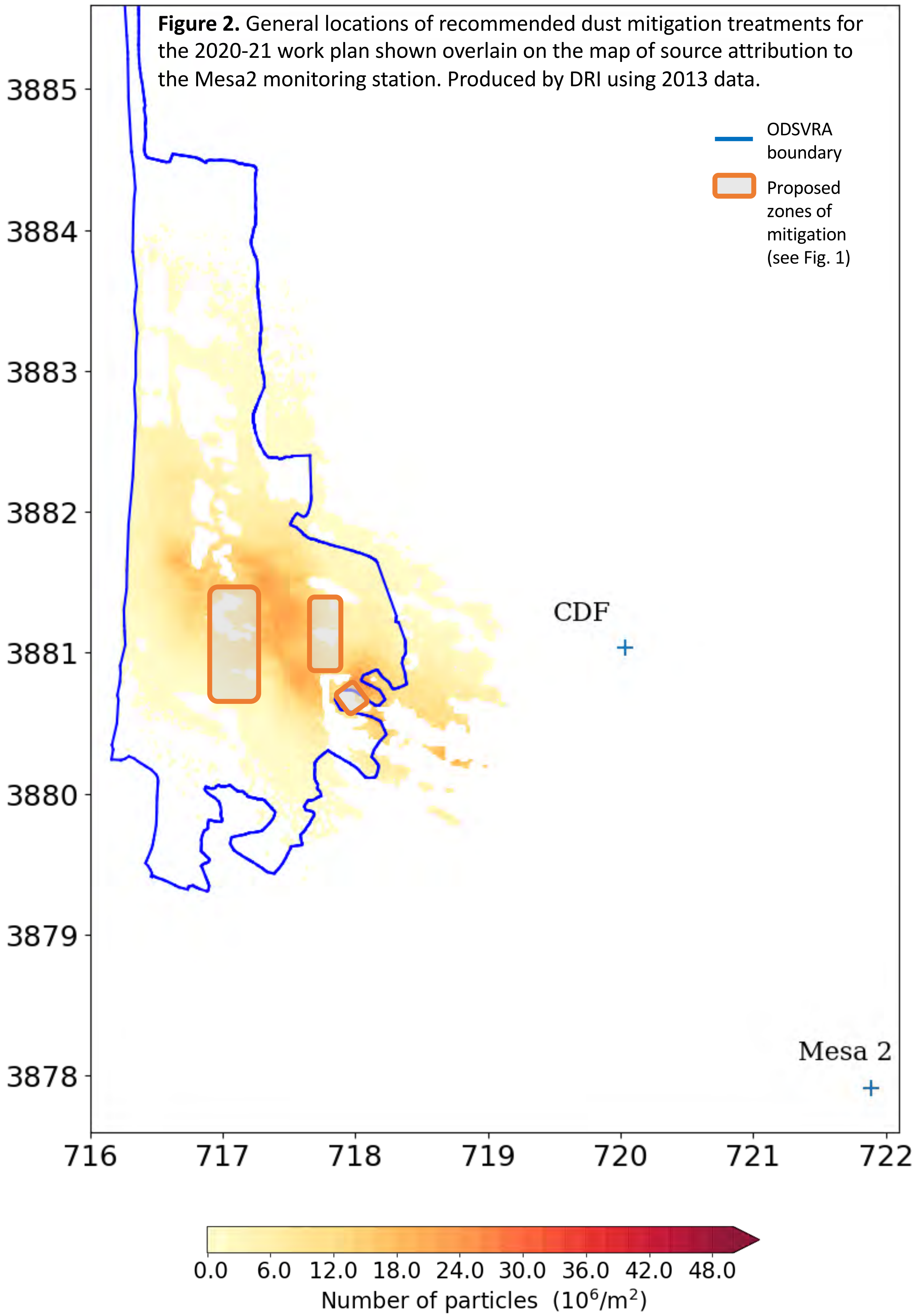


**Figure 2.** General locations of recommended dust mitigation treatments for the 2020-21 work plan shown overlain on the map of source attribution to the Mesa2 monitoring station. Produced by DRI using 2013 data.

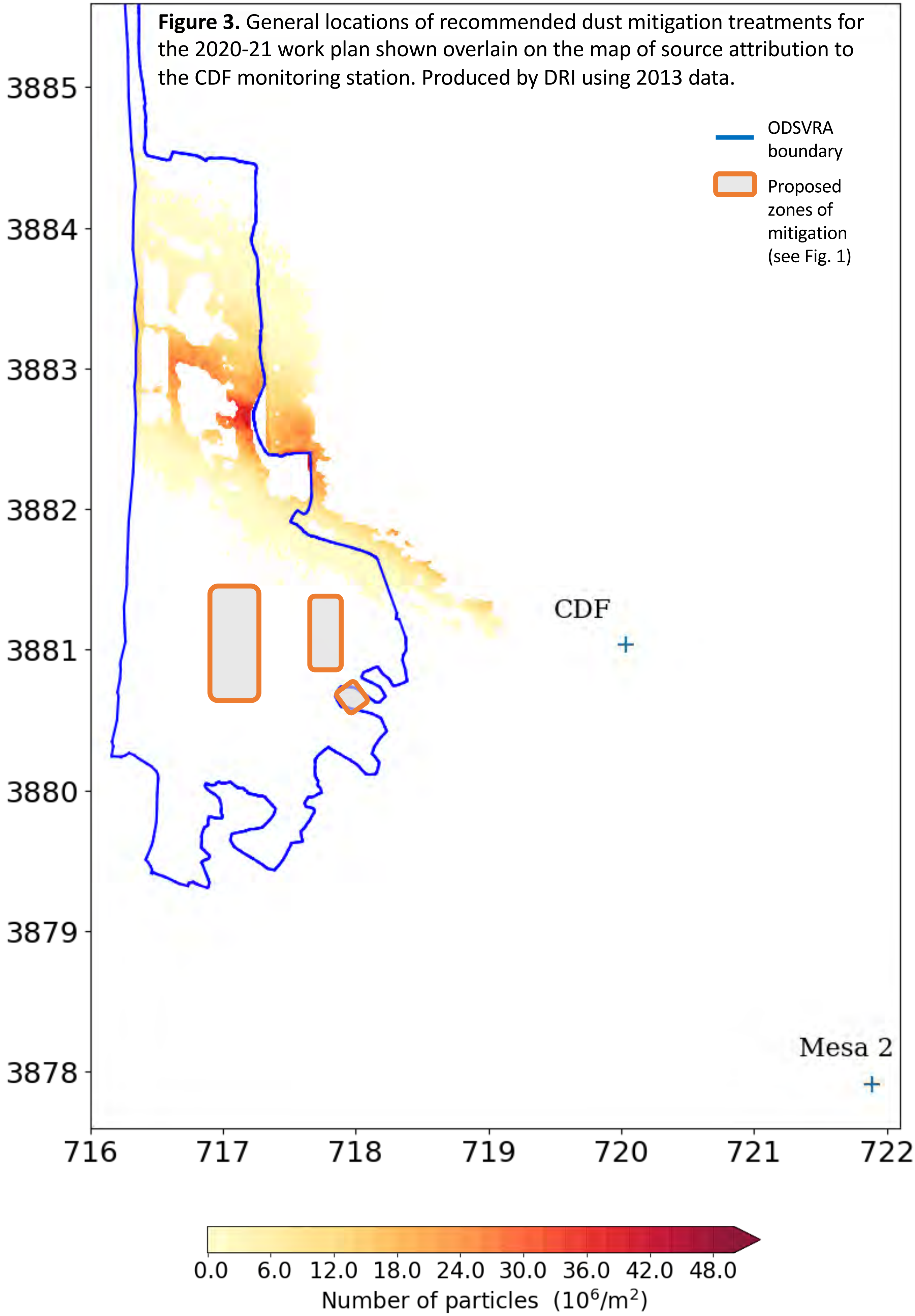


**Figure 3.** General locations of recommended dust mitigation treatments for the 2020-21 work plan shown overlain on the map of source attribution to the CDF monitoring station. Produced by DRI using 2013 data.

November 2, 2020

**Memo:** Scientific Advisory Group (SAG) Review of September 2020 Scripps Supplementary Report on Particulate Matter (PM) Sources at Oceano Dunes State Vehicular Recreation Area (ODSVRA)

**From**: The Scientific Advisory Group (SAG)

**To**: Jon O'Brien, California Department of Parks and Recreation

**Background**

In February 2020, Dr. Lynn Russell and colleagues from the Scripps Institution of Oceanography at the University of California, San Diego (UCSD) submitted a report, "First Year (2019) Summary Report: Investigation of Aerosol Particulates in a Coastal Setting, South San Luis Obispo County, California." Four individual members of the Scientific Advisory Group (SAG) prepared reviews of the Scripps study, which were published as Attachment 7 of the 2020-21 Annual Report and Work Plan (ARWP). Here is a summary of some of the main critiques offered by members of the SAG in their review of the Feb. 2020 Scripps report:

1. The Feb. 2020 Scripps report focused its analysis on $PM_{2.5}$ dust, whereas the Stipulated Order of Abatement (SOA) for dust mitigation at the Oceano Dunes State Vehicular Recreation Area (ODSVRA) is concerned with emissions and airborne concentrations of $PM_{10}$.
2. The Feb. 2020 Scripps report underestimated the contribution of mineral dust within the overall suite of $PM_{2.5}$ constituents. This underestimation by Scripps appears to be based on the use of a non-standard filter sampler that systematically underestimates $PM_{2.5}$ concentration relative to the San Luis Obispo Air Pollution Control District (SLOAPCD) BAM $PM_{2.5}$ samplers, which use U.S. EPA approved Federal Equivalent Method (FEM) regulatory methods. Furthermore, the Scripps $PM_{2.5}$ filters appear to have been sampled only for certain elements and constituents, whereas SLOAPCD measurements describe total dust mass. A SAG reviewer recommended that, in future sampling campaigns, the Scripps researchers analyze filters for total mass by gravimetry prior to further analysis.
3. The Feb. 2020 Scripps report misleadingly describes dust emitted through "natural saltation processes" as unrelated to OHV activity, when in fact areas of intensive OHV activity have been clearly associated with higher surface dust emissivity than protected areas, regardless of the presence of OHVs at the specific time of dust emissions.
4. The Feb. 2020 Scripps report baselessly dismisses the negative health effects of airborne mineral dust.

In August 2020, the Off-Highway Motor Vehicle Commission requested that Scripps prepare an updated report to describe refined analyses for determining the fraction of airborne particulate matter (PM) that are dust. In response to this request, Scripps prepared a supplementary report on September 20, 2020. The Sept. 2020 Scripps supplementary report describes gravimetric and elemental analyses of Teflon filters collected during a sampling period from April 27, 2020, to May 17, 2020. The analyses describe $PM_{2.5}$ measurements at the CDF monitoring station and $PM_{10}$ measurements at a location near the mean high tide line serving as a benchmark for non-dune ocean sources. The subject of this current SAG review is this Sept. 2020 Scripps supplementary report.

**SAG review of Sept. 2020 Scripps supplementary report**

A key claim of the Scripps supplementary report is that mineral dust constitutes only 20% of the overall mass of $PM_{2.5}$ measured by the SLOAPCD BAM at CDF on high PM days. This claim implies that mineral dust emitted from the ODSVRA and associated with intensive OHV activity is not the most important cause of exceedance of state air quality standards with respect to $PM_{2.5}$ and $PM_{10}$. Though the SAG recognizes that mineral dust is not the sole contributor to $PM_{2.5}$ and $PM_{10}$ measured at CDF and at other nearby air quality monitors, the SAG finds serious problems with the claim that mineral dust accounts for only a small fraction of measured PM. Similar to the concerns expressed in its review of the Feb. 2020 Scripps report, the SAG remains critical of two key aspects of Scripps' current 20% claim.

1. The Scripps work is framed with respect to the measurement of $PM_{2.5}$, whereas the air quality concern with respect to the ODSVRA PM contributions and the basis of the SOA is in the regulation of $PM_{10}$. A large proportion of mineral dust emissions at Oceano Dunes are known to be associated with particle sizes greater than measured in the Scripps study (i.e., in the range from 2.5-10 $\mu$m).[1] Thus, it is likely that consideration of only $PM_{2.5}$ provides an underestimate of the true contribution of mineral dust to airborne PM at ODSVRA.
2. SAG is critical of the Scripps measurement methods with respect to four main points:
    a) use of a non-Federal Reference (FRM) or Equivalent (FEM) filter sampler for measuring airborne PM
    b) lack of information on how the $PM_{2.5}$ filters were handled and analyzed
    c) computation of elemental mass from XRF, and
    d) assumption of adsorbed water effects on particle concentration mass measurements.

Combined, these technical issues, which are described in further detail in Appendix 1 below, most likely result in further underestimation of the contribution of mineral dust to airborne PM.

In addition to questioning Scripps' 20% claim, the SAG also remains critical of two additional claims about the effects of mineral dust on airborne PM, which are also repeated from the Feb. 2020 Scripps report:

1. The report claims that elevated PM during the pandemic closure proves that OHV activities do not affect the dust emission system of the ODSVRA. This claim is speculative at best and is not supported by the analysis provided. This claim also neglects direct observations (i.e., PI-SWERL emissivity measurements) obtained by the Desert Research Institute (DRI) that show distinctly higher surface dust emissivity in OHV riding areas compared to adjacent protected areas. This indicates a clear and long-lasting association between OHV activity and elevated surface dust emissivity that persists even when OHV activity is not occurring. The SAG addressed this matter in its April 6, 2020, letter on the COVID-19 closure, which is included as Attachment 8 in the 2020-21 ARWP. The mechanisms that link OHV activity to enhanced dust emissivity of dune sands are an important proposed topic of future investigation.
2. The Scripps report ignores a very large body of peer-reviewed literature related to the health effects of mineral dust. The Scripps report baselessly claims that because mineral dust is "natural," its emission has no adverse air quality health impacts. Appendix 2 of

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[1] Huang Y, Kok JF, Martin RL, Swet N, Katra I, Gill TE, Reynolds RL, Freire LS (2019). Fine dust emissions from active sands at coastal Oceano Dunes, California, *Atmospheric Chemistry and Physics, 19*(5), 2947-2964. dx.doi.org/10.5194/acp-19-2947-2019

this review provides further information from the peer-reviewed literature on mineral dust and its health impacts.

Finally, the SAG notes that, as originally contracted by State Parks, Scripps was charged with quantifying the link between marine phytoplankton blooms and airborne PM measured at and downwind of the ODSVRA. The Feb. 2020 Scripps report indicated only a very minor contribution of marine phytoplankton to airborne PM, and the current Sept. 2020 Scripps supplementary report seems to completely ignore the issue of marine phytoplankton, despite this being the original motivation for this study.

In summary, the SAG rejects Scripps' claim that mineral dust constitutes only a small percentage of airborne PM at and downwind of the ODSVRA, and it further rejects Scripps claims about the role of OHV activities on PM emissions and the effects of airborne mineral dust PM on adverse health outcomes. As described below, the SAG recommends continuation of source apportionment studies for airborne PM described in the 2020-21 ARWP. Additional detail on the SAG's methodological concerns with the Scripps' Sept. 2020 supplementary report follows in Appendix 1 below. In Appendix 2 below, the SAG provides a rebuttal to baseless claims made by Scripps regarding mineral dust and its health effects.

**SAG recommendations for quantifying airborne PM sources**

The SAG has already recommended that additional measurement be made to improve quantification of airborne PM sources. As described in Sec. 3.1.7 of the 2020-21 ARWP, the Desert Research Institute (DRI) is planning to perform chemical analyses on 13 pairs of filters collected by the SLOAPCD from 2020 sampling days. The samples were collected using a Partisol sampler that has designation as a U.S. EPA FEM for sampling PM (i.e., equivalent to a Federal Reference Monitor) with a $PM_{10}$ size-selective inlet. The chemically-speciated data will then be delivered to SLOAPCD and the California Air Resources Board (CARB) for PM source apportionment analysis. Results from the Scripps study will be considered as part of this analysis. Sec. 3.1.7 of the 2020-21 ARWP also describes how the SAG and Parks are engaged in ongoing meteorological, PM, and saltation measurements to more accurately quantify the effect of the temporary absence of OHV activity on airborne PM emission.

**SAG position on SLOAPCD review of the Scripps supplementary report**

On October 30, 2020, the SLOAPCD submitted to State Parks its own independent review of the Scripps Supplementary Report.[2] The SAG has reviewed this SLOAPCD review. The SAG fully supports the findings of the SLOAPCD review, noting that SLOAPCD raised many of the same concerns expressed by the SAG in this letter.

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[2] SLOAPCD (October 30, 2020), San Luis Obispo County Air Pollution Control District Review of September 2020 Scripps Report.

**Appendix 1: Issues with Scripps analytical techniques and suggestions for improvement**
There are many uncertainties in the Scripps Sept. 2020 supplementary report, leading the SAG to question the claim that only about 20% of airborne $PM_{2.5}$ is attributable to mineral dust on high PM days, and that $PM_{2.5}$ is the appropriate metric, when the SOA is concerned with $PM_{10}$. The SAG details some of these concerns below.

(p. 3-4, Section 1.a.*)* *"The lower gravimetric mass concentrations are consistent with the expectation that the BAM method included more water than the gravimetric reference method".*

> The $PM_{2.5}$ Beta Attenuation Monitor (BAM) at CDF, like the $PM_{10}$ BAM, is equipped with a heater in the intake tube. The heater is programmed to turn on when the relative humidity (RH) exceeds 35%. Absent measurements of the RH of the inlet and outlet flows through a BAM, this "expectation" cannot be conclusively confirmed.

(p. 4, Section 1.a.) *It is likely that the 38% difference in mass on high $PM_{10}$ days is due to water evaporating, although other semivolatile compounds (ammonium nitrate and organic mass) could also be included in the BAM method and not in the gravimetric method."*

> Studies of the loss of semivolatile compounds from $PM_{2.5}$ Federal Reference Method (FRM) filters report up to a 40% loss of $PM_{2.5}$ mass from filters collected at two sites in Southern California.[3]

(p. 5, Section 2.a.) *"This suggests that at least 28% of the EBAM mass concentration was water."*

> (see responses to p. 3-4, Section 1.a. and p. 4, Section 1.a.)

(p. 5, last paragraph) *"The breakdown by weight and by component of the BAM concentrations measured at the CDF and Beach sites are summarized in Figure 9, where we have interpreted the difference between BAM and gravimetric mass as the evaporated fraction that is likely water and illustrated the measures mass component contributions from Dust, Salt, and Other."*

> It would very helpful if the report described the specific methods used in handling and analyzing the $PM_{2.5}$ filters. It is incongruous that 25% to 35% of filter mass is assumed to be water without the inclusion of any laboratory analysis to support this assumption. It is also incongruous that if XRF were used to identify the elemental composition of the solid mass collected, the remaining XRF results are not reported. There is also no description of how elemental mass results from the XRF analysis were used to compute the "sand" fraction of mass. Were elemental results converted to predominant geological species mass, for example?

Rough correlation of mineral content in $PM_{2.5}$ and $PM_{10}$:

> The Scripps Supplemental Report states that 20% of $PM_{2.5}$ monitored at the CDF monitor was mineral in origin. The Report also states that 36% of $PM_{2.5}$ monitored on the 10 afternoons with 24-hour $PM_{10}$ concentrations exceeding 140 $\mu g/m^3$ was mineral in origin. Unfortunately, the Report does not specify the hours of "afternoon" operation to enable

[3] Final Report: Continuous Measurement of PM2.5 and Associated Semi-Volatile Particulate Species, Eatough D.J., U.S. EPA Grant R825367, 1999, https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/520/report/F

an analysis of the equivalent mineral content of hourly $PM_{10}$ concentrations recorded during the 10 afternoons.

Daily average $PM_{2.5}$ and $PM_{10}$ concentrations recorded at the CDF monitor are available at CARB's AQMIS website.[4] The $PM_{2.5}$ and $PM_{10}$ 24-hour concentrations recorded at CDF on April 27 through May 17, 2020 – the period of monitoring conducted by UCSD – average 11.0 and 47.1 $\mu g/m^3$, respectively. The Report states that 20% of $PM_{2.5}$ collected on filters during this monitoring period was of mineral derivation. This would equate to an average of 2.2 $\mu g/m^3$ of $PM_{2.5}$ being composed of mineral contributions. Analyses published over the past two decades indicate that the fraction of windblown dust in $PM_{10}$ samples that is smaller than $PM_{2.5}$ is about 10%. Using this ratio, the equivalent mass concentration of mineral origin in $PM_{10}$ samples would be about 22 $\mu g/m^3$ (=2.2 $\mu g/m^3$ / 10%). This value is about 50% of the average $PM_{10}$ concentration measured by SLOAPCD at CDF (47.1 $\mu g/m^3$) during the same time period. On the basis of this rough correlation, I think we can assume that the mineral content of $PM_{10}$ measured at the CDF monitor is at least 50%, which is a substantially higher fraction than is assumed in the Report.

Definition of "mineral dust":

Figure 9 attributes a large proportion of CDF $PM_{2.5}$ and $PM_{10}$ to the nebulous category of "other," which "may include additional water, ammonium, nitrate, sulfate and organic compounds." Scripps should further clarify how it is using the elemental analysis to distinguish between percentages of "mineral dust" and "other," noting that mineral dust emissions at Oceano include a significant fraction of feldspar and clay- and iron-rich sand grain coatings.[5] In addition, Scripps should also report contributions of mineral dust and other constituents as a percentage of non-water components, in addition to its existing descriptions of these components as a fraction of total $PM_{2.5}$ measured by the SLOAPCD sampler.

[4] Air Quality and Meteorological Information System, California Air Resources Board, https://www.arb.ca.gov/aqmis2/aqmis2.php

[5] Swet N, Elperin T, Kok JF, Martin RL, Yizhak H, Katra I (2019). Can active sands generate dust particles by wind-induced processes? *Earth and Planetary Science Letters, 506*, 371-380. dx.doi.org/10.1016/j.epsl.2018.11.013

**Appendix 2: Mineral dust and its health impacts**

The statement that airborne mineral dust has not been associated with health effects in humans is unsupported and contra to published literature. Investigation of health effects due to the inhalation of mineral dust PM extends from *in vitro* and epigenotoxicity studies that have shown that mineral dust PM can cause distinct cellular, molecular, genetic and epigenetic alterations in cells (e.g., Miousse, et al., 2015) to observations of increased admissions to hospitals due to respiratory related ailments during dust outbreaks from the Sahara/Sahel (e.g., Uduma and Jimoh, 2013), the deserts of Asia (e.g., Kanatani et al., 2010), as well dust from North American deserts such as the Chihuahuan (e.g., Rodopoulo et al., 2014). Morman and Plumlee (2014) provide a good overview of dust and human health.

<u>References Cited</u>:


Kanatani, K., et al. (2010). Desert dust exposure is associated with increased risk of asthma hospitalization in children. *Am J. Respir Crit Care Med 182*, 1475-1481.

Miousse, I.R. et al. (2015). *In vitro* toxicity and epigenotoxicity of different types of ambient particulate matter. *Toxicological Science, 148* (2), 473-487, doi: 10.1093/toxsci/kfv200.

Morman, S.A. and Plumlee, G.S (214). Dust and human health. In *Mineral Dust: A Key Player in the Earth System*, Knippertz, P. and J.-B.W. Stuut (Eds.), Springer, Dordrecht, 385-410.

Rodopoulo, S., et al. (2014). Air pollution and hospital emergency room and admissions for cardiovascular and respiratory diseases in Doña Ana County, New Mexico. *Environmental Research, 129*, 39-46, doi: 10.1016/j.envres.2013.

Uduma, A.U. and Jimoh, W.L.O. (2013). High incidence of asthma, bronchitis, pneumonia and sinusitis in Kano State, north west Nigeria during Saharan dust events. *American Journal of Environment, Energy and Power Research, 1*(8), 174 – 185.


Additional references are easily gleaned using search engines such as Google Scholar.

November 20, 2020

**Memo:** Scientific Advisory Group (SAG) Review of 90 Acre Treatment Options for 2020-21 ARWP

**From**: The Scientific Advisory Group (SAG)

**To**: Jon O'Brien, California Department of Parks and Recreation

In its conditional approval of the 2020-21 Annual Report and Work Plan (ARWP), the San Luis Obispo Air Pollution Control District (SLOAPCD) directed Parks, in consultation with the SAG, to identify approximately 90 acres within the ODSVRA for new temporary/seasonal dust controls and their expected impacts on dust emissions and downwind $PM_{10}$ consultations. Parks presented four treatment options to the SAG, along with dust emissions modeling analysis prepared by the Desert Research Institute (DRI).

**Among the options presented, the SAG recommends Option 2 as the most effective for dust emissions reduction, but the SAG also supports Option 1 as potentially achieving a similar level of dust emissions reduction.**

The SAG finds that **Option 2** is likely to provide the greatest reduction in dust emissions and downwind $PM_{10}$ concentrations among the options presented. The effectiveness of Option 2 is supported by the DRI model, which predicts a greater net emissions reduction for Option 2 than for any of the other options presented. In addition, the vast majority of acreage for Option 2 is contained within the Riding Area, which is known to be (on average) more emissive than Non-Riding Areas. All of the other options presented place a substantial fraction of dust mitigation treatments in Non-Riding Areas. Thus, the Option 2 treatments are likely to provide a greater per-acre reduction in $PM_{10}$ dust emissions as compared to these other options.

The SAG also supports **Option 1.** Though the DRI model predicts smaller emissions reductions for Option 1 than for Option 2, the SAG notes that the modeled difference between these two options is within the margin of uncertainty between modeled and observed values for the DRI model (see 2020-21 ARWP, Sec. 2.3.3.1). Thus, the SAG cannot unambiguously state that Option 2 will necessarily reduce dust emissions by more than Option 1.

*Nickling Environmental Ltd*
*Air quality and wind erosion specialists*

**March 12, 2021**

Mr. Jack Ainsworth, Executive Director, California Coastal Commission
Mr. Steve Padilla, Chair of the California Coastal Commission
455 Market Street, Suite 300
San Francisco, CA. 94105

**Re: Oceano Dunes State Vehicular Recreation Area**

Dear Mr. Ainsworth and Mr. Steve Padilla,

The Scientific Advisory Group (SAG) was established in April 30, 2018 through a Stipulated Order of Abatement (SOA) to advise California State Parks on potential methodologies to reduce dust emissions at Oceano Dunes State Vehicular Recreation Area (ODSVRA), California, to comply with State and Federal Air Quality $PM_{10}$ Standards. SAG is comprised of 7 well published research scientists (geomorphologists, air quality engineers and biologists) whose primary expertise is directly related to sediment transport by wind, wind erosion control methodologies and air quality issues.
Since its inception it has been SAG's goal to reduce dust emissions at ODSVRA using environmentally sustainable techniques that attempt to mimic or enhance natural dune processes and landforms that tend to slow down near surface wind speeds and trap sediment (e.g., planting of natural vegetation, promoting the development of dune forms near the coast where sediment is deposited by wave action). Importantly the SAG has always been focused on finding the most effective ways to improve air quality with the least possible disruption to existing uses.

Over the past 3-5 years the control strategies and field trials that have been implemented at ODSVRA have been very promising with significant sand deposition behind sand fences and within planted vegetation. Of particular importance is the development of the 48 acre (0.19 $km^2$) "proto" foredune that was established using different forms of roughness (tillage, addition of straw mulch and planting of different varieties and densities of vegetation). In the past 2 years small dunes (nebhkas) have now begun to form, providing evidence that they will continue to grow, trapping sand moving down wind, thereby reducing dust emissions and PM10 concentrations.

…cont'd

Although we understand that the Coastal Commission and Parks must weigh a variety of factors in their decisions, from an air quality perspective the work of the SAG thus far indicates that there is a workable approach to achieving the targets set by the SOA while retaining some level of off-highway vehicular activity at the ODSVRA. We would like to make sure that these scientifically informed findings, which are reflected in multiple Parks reports in response to the SOA, are appropriately considered within broader debates about management of the ODSVRA.

Yours Sincerely,

W.G. Nickling PhD
Special Master
Chair, Science Advisory Group

**Science Advisory Group**
W.G. Nickling PhD, Chair
M. Bush MS
J.A. Gillies PhD
R. Martin PhD
C. Scheidlinger MS
I.J. Walker PhD
Earl Withycombe MEng

cc: Gavin Newsom, Governor
Wade Crowfoot, Secretary for Natural Resources Agency
Armando Quintero, Director DPR
Sarah Miggins, Deputy Director OHMVR Division
OHMVR Commissioners
Coastal Commissioners

April 30, 2021

**Memo:** Scientific Advisory Group (SAG) Review of *Report to the SAG and Parks Evaluating the Potential for Developing a New Baseline Mass Emissions Rate and Target Reduction within the SOA*, by J.A Gillies, J. Mejia, and E. Furtak-Cole, Desert Research Institute (DRI), Reno, NV

**From**: The Scientific Advisory Group (SAG)

**To**: Jon O'Brien, California Department of Parks and Recreation

**Background.** The 2020 Annual Report and Work Plan (ARWP) states, "All parties will continue coordination on possible SOA Goal Alternatives, noting that the foremost goal is to achieve reductions in PM10 concentrations toward attaining state and federal air quality standards while minimizing impacts to public recreation opportunities." Following approval of the 2020 ARWP, the SAG initiated a process of reviewing the existing Stipulated Order of Abatement (SOA) target of reducing PM10 mass emissions by 50% relative to the 2013 baseline and examining scientifically-informed alternatives. The SAG is exploring an alternative approach that, unlike the current target, defines a "pre-disturbance" reference scenario of dust emissions prior to OHV disturbance, and then models the differences in PM10 mass emissions and airborne concentrations relative to the SOA "baseline" of 2013 dust emissions.

To inform this alternative approach, the SAG requested (and California State Parks agreed) that the Desert Research Institute (DRI) use the extensive available PI-SWERL emissivity data collected from 2013 to 2019 and the DRI emission/dispersion model (Mejia et al., 2019) to perform a preliminary implementation of the SAG's proposed alternative approach. DRI's report seeks to answer the following questions. First, what is the effect on PM10 mass emissions from the Oceano Dunes State Vehicular Recreation Area (ODSVRA) for the SOA-defined 10 baseline days of 2013 if the emissivity of the riding area is represented by the mean emissivity relationship for all non-riding (i.e., undisturbed) areas. Second, what is the effect of such a change in emissions on downwind PM10 concentrations?

SAG's intention in requesting this analysis from DRI was to provide a *preliminary* sense of the feasibility of identifying an alternative to the existing SOA target that is referenced to an emissions scenario that reflects conditions prior to OHV activity. Based on DRI's report, the SAG would then advise Parks on how to move forward (if at all) on use of this alternative approach to defining the SOA dust mitigation target and related progress in attaining the SOA goals of improved air quality. Below, the SAG provides a review of the DRI report and offers its recommendations for next steps.

**Technical Review.** The SAG affirms that the analyses described in the DRI report fulfill SAG's request for modeling to determine the feasibility of an alternative approach to the SOA target based on modeling a scenario representative of dust emissions prior to OHV disturbance, and that the methodology deployed to pursue this analysis is scientifically sound. The approach to mapping PM10 emissivity based on PI-SWERL measurements is justified by extensive scientific literature, as is the method for modeling emissions and downwind transport of PM10 using the DRI model (Mejia et al., 2019). Furthermore, DRI correctly identifies the limitations of their current modeling of the pre-disturbance emissions scenario, which does not yet consider the effects of spatial gradients of PM10 emissivity and/or historical differences in vegetation coverage. Given the preliminary nature of this analysis, and the complication of accounting for these factors, the SAG advised DRI not to include these factors in their initial modeling efforts.

**Key Findings of DRI Report.**

1. Independent of the question of the specific SOA target, the DRI report demonstrates the unambiguous impact of OHV activity on increased PM10 emissions within the ODSVRA. In terms of emissivity, under strong winds (~u*=0.61m/s), the emissivity of Riding Area surfaces appears to be roughly double that of Non-Riding Area surfaces, and this ratio is even more pronounced for weaker winds (e.g., Figs. 4 and 9). Furthermore, there is also an unambiguous impact of OHVs on increased downwind airborne PM10 concentrations, especially at the CDF monitoring site and, to a lesser degree, at the Mesa2 site. Also notable is the fact that, even for the modeled scenario without OHV disturbance, these monitoring sites experience exceedances of the 50 μg $m^{-3}$ California PM10 air quality standard on the windiest days. Therefore, the key question is not whether OHVs have an impact on PM10 emissions, but rather how big that impact is.
2. Preliminary modeling of a pre-disturbance emissions scenario indicates that Riding Area PM10 mass emissions for the 2013 baseline days would be 37.6% lower in the absence of OHV activity than in the presence of OHVs (i.e., 118.2 metric tons/day versus 189.4 metric tons/day). It is probable that the preliminary DRI model analysis overestimates pre-disturbance PM10 emissivity in the southern portion of the Riding Area (e.g., right panel in Fig. 5) and underestimates historical vegetation cover, so the SAG expects that refinement of the pre-disturbance emissions scenario to account for a spatial emissions gradient and/or historical vegetation cover would likely decrease overall PM10 mass emissions further. Though it is hard to predict what exact effect these model refinements might have, it is plausible that they would reduce PM10 mass emissions for the pre-disturbance emissions scenario to the point where emissions could approach or exceed 50% lower than the 2013 baseline scenario, in line with the existing SOA target.

**Recommendations.** The SAG finds that the approach of modeling PM10 emissions and concentration for a pre-disturbance emissions scenario, and then comparing this to a scenario of OHV disturbance, is highly instructive for understanding the effect of OHVs on PM10 mass emissions and airborne concentrations. The current SOA-defined target does not consider these realities. Therefore, the SAG advises that Parks consider use of this modeling approach in the future as a valuable tool for understanding the effects of dust control treatments on reducing PM10 dust emissions and concentrations to levels commensurate with the absence of OHV impacts. However, based on the DRI report, the SAG questions whether it is worthwhile to revisit the SOA 50% mass emissions reduction target. Already, the preliminary model analysis shows a 37.6% reduction in PM10 mass emissions for the pre-disturbance scenario relative to the 2013 baseline scenario of OHV-impacted dunes, and model refinements to account for a spatial gradient in PM10 emissions and historical vegetation coverage are likely to yield further reductions approaching the existing SOA 50% reduction target. In any case, any further use of the pre-disturbance emissions scenario modeling approach should incorporate refinements to account for spatial emissivity gradient and historical vegetation coverage, and it should also include a robust treatment of model uncertainty.

**References**

Mejia, J. F., Gillies, J. A., Etyemezian, V. R., Glick, R. (2019). A very-high resolution (20 m) measurement-based dust emissions and dispersion modeling approach for the Oceano Dunes, California, Atmospheric Environment, 218, https://doi.org/10.1016/j.atmosenv.2019.116977

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**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

# ATTACHMENT 13

**Proposal for 2021 Speciation Sampling**

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# Proposal for 2021 Speciation Sampling

## Background

In 2020, APCD collected 13 $PM_{10}$ samples for speciation analysis at CDF. Each sample was a pair of filters, one Teflon and one quartz, exposed for 24 hours. These samples were analyzed by DRI for total $PM_{10}$ mass concentration, certain ions (sodium, potassium, chloride, ammonium, nitrate, sulfate, and methanesulfonate), various organic and elemental fractions, and elements from sodium through uranium by XRF. State Parks funded the analysis, and Karl Tupper (APCD) and Earl Withycombe (CARB/SAG) have been analyzing the data.

Three sample were collected on "normal" days, uninfluenced by wind blown dust or other obvious sources, and these are considered background samples. Eight samples were collected on days predicted to be wind blown dust event days, though it should be noted that in 2020 wind event $PM_{10}$ concentrations were lower that in previous years, and the highest concentration of these 8 samples was only 93 ug/$m^3$ (as measured by the BAM). One sample was collected on day heavily influenced by wildfire smoke, and another sample on a day influenced by transport from the San Joaquin Valley.

A report on the results from 2020 is not yet available, but a preliminary analysis indicates:

- The 13 samples are not enough to do a state-of-the-art apportionment analysis, i.e., positive matrix factorization (PMF). Attempts to run PMF with the data resulted in physically reasonable solutions; however, they were not stable. CARB's PMF specialist indicates that 150 samples are ideal, though there are examples of successful analyses with fewer.
- The correlation between the collocated APCD BAM concentrations and the DRI filter concentrations is good ($r^2$ = 0.97)—much better than what Scripps reported for their PM2.5 filters ($r^2$ = 0.69)—but there is a slight bias between the two. In 2019, the District collected filter samples with this same equipment and had them weighed by two different labs. There was also a good correlation with the BAM then, but with a slight bias in the *opposite* direction.

- The mass closure is poor. This refers to the difference between the measured total $PM_{10}$ concentration and an estimate constructed by taking the raw concentrations of the measured elements and ions in each sample and applying standard equations and assumptions to estimate how much salt, inorganic aerosol, crustal material, etc., there is in the sample, and finally summing all these constituents up. The "reconstructed mass" should be close to the mass measured on the filter. While the mass closure is never perfect, for our samples the comparison is poor. For the 4 background and smoke samples, the reconstructed mass is 91 to 103% of the measured mass—which is acceptable—but for the 8 wind event samples the range is 71-98% with a mean of 82%, and for the lone SJV transport day, it is only 36%.

## Proposal for 2021

In light of these preliminary results, we would like to propose a more ambitious sampling plan for 2021. This plan is designed to generate enough data to hopefully run a successful PMF analysis and to also address some of the questions noted in the preliminary review of the data.

- 1-in-3 day sampling (so ~10 samples per month) from (ideally) mid-March through at least June and possibly through October. This would yield 35 to 75 pairs of samples, with DRI doing at least the same suite of analyses as in 2020 (and thus, at least the same cost per sample). *If possible,* we would like to get quantitative elemental analysis for chlorine. DRI typically does the analysis (XRF) under vacuum, which causes volatilization loss for choline, but it can be done under ambient pressure and thus yield quantitative results. Similarly*, if possible*, it would be preferable to get quantitative—as opposed to qualitative—XRF results for sodium and magnesium, since these elements are present in feldspar and clay minerals, which are major components of ODSVRA sand.
- *If possible*, we would also like add XRD analysis to a subset of samples to determine what minerals are present. A possible explanation for the poor mass closure is that the mass closure algorithm determines the geological contribution by multiplying the concentrations of certain elements by coefficients derived from the average contributions of those elements to the Earth’s crust. The actual composition of ODSVRA

sand is likely much different, so comparing the minerology of the collected dust to the standard assumptions may explain some of the poor mass closure.

- For QA purposes, in addition to the 1-in-3 day speciation samples, we would like to also collect collocated samples on 1-in-6 day schedule to be weighed (total mass only, no speciation) by an independent lab. Thus, in addition to the 35 to 75 speciation samples, there will also be half as many QA samples. We would rotate which sampler is used for each filter, in order to detect/rule out biases due to the samplers themselves.
- For QA purposes, it would be preferable to include blank samples in the analyses. One or two blanks for each field sample would be adequate.

## Responsibilities

- **APCD:** As in 2020, the APCD would be responsible for the field work—setting and collecting the samples, storing and shipping the samples, maintaining the samplers and performing QC/QC checks. APCD Senior Scientist Karl Tupper would collaborate with Earl Withycombe on analyzing the data.
- **SAG/DRI:** DRI would provide analysis of the 1-in-3 day sample pairs and associated blanks. They would also provide pre-weighed sample cassettes to the APCD. Assuming a mid-March thru mid-October sampling period, this would be about 85 sample pairs (75 field samples plus 10 field blanks). The analyses provided would include anions (including methanesulfonate), elemental/organic carbon, elements by XRF (sodium through uranium, with quantitative Cl, Na, and Mg, if possible). A subset of samples (10-12?) would also undergo XRD analysis to identify specific minerals. Earl Withycombe (CARB) would collaborate with Karl Tupper (APCD) on analyzing the results.
- **Third Party Lab:** Provide pre-weighed sample cassettes and gravimetric analysis of 1-in-6 day QA samples. Assuming mid-March thru mid-October sampling, this would result in approximately 40 to 45 samples, including blanks. Previously, Bay Area AQMD, South Coast AQMD, and CARB have been able to provide these services to the District at no cost; however, recent conversations with these agencies have indicated that they would

be unable to do this now, due to resource constraints related to COVID-19. Thus, a contract lab would likely have to provide these services.

- **State Parks:** Provide funding for DRI and third-party lab activities.

**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

# ATTACHMENT 14

**Scripps Study Information**

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UNIVERSITY OF CALIFORNIA, SAN DIEGO UCSD

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21 September 2020

The Off-Highway Motor Vehicle Recreation Commission
c/o
Off-Highway Motor Vehicle Recreation Division
California Department of Parks and Recreation
1725 23rd Street, Suite 200
Sacramento, CA 95816

Dear Commissioners,

Please find attached my supplemental report of findings regarding gravimetric and elemental analyses of airborne particle samples collected at the Oceano Dunes State Vehicular Recreation Area and on the Nipomo Mesa. My colleagues and I are in the second year of a three-year investigation to determine marine and terrestrial sources contributing to airborne particulate matter (PM) detected seasonally on Nipomo Mesa (Mesa). The San Luis Obispo County Air Pollution Control District (APCD) operates equipment on the Mesa at a location called CDF that monitors PM10 and PM2.5 (PM that is 10 microns or less in diameter and 2.5 microns or less in diameter, respectively) with an instrument called a beta attenuation monitor (BAM).

This supplemental report was prepared in response to your request made at your August 6, 2020 meeting. As I understand it, your request was prompted by our February 20, 2020 report, which detailed a difference between the PM2.5 mass of the chemical components that we measured and the PM2.5 mass measured by the APCD BAM. Those findings prompted us to use additional techniques to more accurately determine what fraction of airborne particles are dust. As detailed in this report, I have found that mineral dust, on average on high PM days, accounts for 20% of the overall mass of the PM2.5 measured by the APCD BAM at CDF. On lower PM days, the mineral dust mass is lower still. This shows that it is incorrect to assume that all PM2.5 measured at CDF monitors is mineral dust.

I would like to extend our appreciation to the California Geological Survey and to the California Department of Parks and Recreation for their assistance and access that has made our investigation possible. I look forward to continued collaboration as this project continues.

Sincerely,

Lynn M. Russell
Professor of Atmospheric Chemistry

# UCSD Supplemental Report 2020:

## Preliminary Results from May 2020 Aerosol Measurements

Lynn M. Russell
20 September 2020

### Introduction

Building upon the results of the UCSD Report of 5 February 2020, this project has undertaken additional quantitative chemical sampling to improve the understanding of the sources of airborne particles in the Oceano Dunes area. This supplemental report covers the gravimetric and elemental analyses of the teflon filters collected during the most recent sampling period from 27 April 2020 to 17 May 2020. The objectives of this part of the research were to

1) Quantify the gravimetric mass and elemental component mass of PM2.5 aerosol particles at CDF;
2) Quantify the gravimetric mass and elemental component mass of PM10 aerosol particles at a near-beach site just beyond high tide, designated as the "Beach" site.

It is important to note that recreational vehicles were not allowed during this period because of COVID-19 restrictions that had been in place since March 2020. Vehicles for park services including habitat restoration continued essential activities.

### Background

The particle concentration in the Oceano Dunes region is expected to be a mixture of organic and inorganic components from natural and man-made sources. Its seaside location means that sea spray from breaking waves in the ocean will contribute particles with salt (NaCl as well as some trace additional salts) and organic components (from nutrients and exudates that are produced and consumed by marine biota) [Russell et al., 2010]. Another proximate natural source is mineral dust from sand-covered areas. Both sea spray and sand (or mineral) dust are increased by wind speed as well as coverage and proximity, both have substantial supermicron mass contributions with short atmospheric lifetimes, and neither is associated with evidence of chronic respiratory effects (since they are removed by impaction in the nasal passages and upper airways and since the salt and mineral components have not been associated with toxicity). In addition to these natural sources, local emissions associated with motor vehicles [Russell et al., 2011], residential and commercial activities (including use of personal care products [McDonald et al., 2018], food preparation [Chen et al., 2018], and heating), and seasonal agricultural harvesting and fertilizing, wildfires, and long-range transport from high-population areas also contribute both organic and inorganic particle mass to PM2.5 and PM10, with the contribution from each varying with wind direction as well as other conditions.

PM2.5 and PM10 are regulated by U.S. clean air standards because of their known association with degraded visibility and detrimental health effects [US Clean Air Act (https://www.epa.gov/laws-regulations/summary-clean-air-act); Dockery et al., 1993; Pope et al., 2009; Apte et al., 2018]. Recently Apte et al., calculated the U.S. average life expectancy decrement to be 0.38 yr for PM2.5, which is 3 times lower than that of countries with higher PM2.5 (e.g. China, India). While the widespread availability of PM2.5 measurements often makes it the best proxy for epidemiological studies of populations, physiological studies of health effects have shown that the causes of cell degradation are most likely from specific toxic compounds, which are also regulated and include such compounds as polycyclic aromatic hydrocarbons that are associated with fossil fuel combustion and black carbon. Recent evidence also suggests that nanoparticles (less than 100 nm diameter) and transition metals, which are also associated with fossil fuel combustion, may also play an important role [Knol et al., 2009; Oberdorster et al., 2007; Gwinn and Vallyathan, 2006; Janssen et al., 2003; Hoek et al., 2002]. Since the association of PM2.5 with toxics is likely responsible for the association of PM2.5 with health effects, the use of PM2.5 as a health indicator assumes it co-occurs with toxics.

However, it is worth noting that there is no evidence that toxic compounds are associated with the two major PM2.5 sources (dune dust and sea spray) during windy conditions at Oceano Dunes, so association of PM2.5 with detrimental health effects may be without foundation. In urban locations that serve as the basis for epidemiological health studies, the large population density means that PM2.5 is largely associated with emissions from motor vehicles that include high amounts of toxics, nanoparticles, and transition metals. In areas where PM2.5 is dominated by natural emission sources rather than man-made combustion activities, the causal link between toxics and health effects would not hold. For this reason, assessing whether health effects are associated with PM2.5 requires identifying what fraction of PM2.5 is from natural (non-toxic) sources and what fraction is from combustion emissions.

The chemical composition provides the first critical step to identifying how much of total particle mass is associated with each of these different sources. In the 5 February 2020 UCSD Report, we used Fourier Transform Infrared (FTIR) spectroscopy and X-ray Fluorescence (XRF) to provide a first cut at these sources, using elemental composition to provide tracers for sea spray, mineral dust, and combustion emissions. This report builds on those results to examine the substantial difference between the chemical measurements of dust components and the BAM PM2.5 measurements regularly measured by the San Luis Obispo County Air Pollution Control District (APCD) at its CDF air monitoring station on the Nipomo Mesa, approximately 3.2 kilometers (2 miles) inland from Oceano Dunes. First, gravimetric measurements (at partially dried conditions of 35% relative humidity (RH)) are used to provide a lower bound on the water fraction of the particle mass. Then dust components from XRF measurements are used to assess the fraction of the remaining mass that is associated with dust.

Results

Samples were collected at CDF site and the Beach site for the period of 27 April to 17 May 2020. The CDF site was co-located with the ongoing APCD sampling by BAM, which provides a metric representing the PM2.5 (and PM10) concentration at modified ambient conditions, which means that water and other semi-volatile organic and inorganic components (notably ammonium nitrate) are included. The number of sampling days was maximized to document the day-to-day variability in the aerosol and to capture multiple days with high PM2.5 (and PM10) concentration. The Beach site was sampled from 28 April to 16 May 2020, with more limited samples targeting only high wind (high PM) afternoons. The number of samples at this site was limited by the lack of sufficient power for 24-hr operation and the lack of support personnel due to access restrictions (and COVID-19). The Beach site was selected to provide a benchmark for non-dune ocean sources, since it is estimated to be approximately 100 meters from the mean high tide line. Notably, the days with high PM at CDF were often predicted successfully from short-term forecasts of high-wind conditions, consistent with prior studies.

The results addressing the objectives of the research are summarized below. We note that all of the results may differ by season, and their variability may be larger than could be captured in this short study.

1. <u>Quantify the gravimetric mass and elemental component mass of PM2.5 aerosol particles at CDF.</u>
    a. The time series of SIO gravimetric mass, EBAM, and APCD BAM PM2.5 concentration measurements tracked reasonably well (Figure 1) and

showed a moderate correlation ($R^2$~0.7). The offline gravimetric method is 26% lower on average than the online BAM instrument for all 26 afternoon and overnight samples at CDF (Figure 2). If only the 10 afternoons with 24-hr PM10 exceeding 140 μg $m^{-3}$ are averaged (https://ww3.arb.ca.gov/qaweb/site.php?s_arb_code=40853), then the gravimetric method is 38% lower than BAM. The lower gravimetric mass concentrations are consistent with the expectation that the BAM method includes more water than the gravimetric reference method. The PM2.5 sampling reference method (https://www3.epa.gov/ttn/amtic/files/ambient/pm25/qa/m212.pdf) requires that samples be stored at 35% relative humidity for 24 hr in order to partially dry the particles. In contrast, BAM and EBAM measurements are made very close to ambient relative humidity (although there may be some heating in the instrument). At CDF relative humidity frequently exceeded 35%, meaning that the BAM and EBAM measurements were wetter (that is, contained more water than the gravimetric measurements). It is likely that the 38% difference in mass on high PM10 days is due to water evaporating, although other semivolatile components (ammonium nitrate and organic mass) could also be included in the BAM method and not in the gravimetric method. It is unlikely that any dust was lost by the gravimetric method. The water contribution could be assessed by repeating the gravimetric method at higher relative humidities.

b. The time series of dust from elemental composition by XRF frequently tracked gravimetric mass (Figure 3). The scatter plot showed that dust accounted for ~17% of PM2.5 gravimetric mass on average and salt accounted for ~11% for all 26 afternoon and overnight samples (Figure 4). If only the 10 afternoons with 24-hr PM10 exceeding 140 μg $m^{-3}$ are averaged, then the dust accounted for 33% and the salt for 7%. Dust and PM2.5 were strongly correlated with $R^2$~0.8, whereas salt and PM2.5 were only weakly correlated with $R^2$~0.3. The correlation of dust and PM2.5 could be explained by the lofted dust including a proportionate amount of water that contributes to the PM2.5. Other semi-volatile components that may associate with the higher surface area provided by the dust would also proportionately increase the PM2.5 concentration. The weak correlation between salt and PM2.5 is consistent with salt being a small fraction of PM2.5 that is affected by factors other than local wind speed (including offshore winds and whitecap coverage).

2. Quantify the gravimetric mass and elemental component mass of PM10 aerosol particles at the Beach site.

a. The time series of gravimetric mass and EBAM PM10 concentration measurements tracked reasonably well (Figure 5) and showed a moderate correlation ($R^2$~0.5), with the offline gravimetric method being on average ~28% lower than the online EBAM instrument for the 7 afternoons sampled (Figure 6). The poor correlation is limited by the small number of samples (7). The lower gravimetric mass concentrations are consistent with the expectation that the EBAM method includes more water than the gravimetric reference method, which requires 35% relative humidity even though ambient relative humidity at the Beach site frequently exceeded this value. This means that the gravimetric mass concentration includes less water than the EBAM measurement, although other semivolatile components (ammonium nitrate and organic mass) could also be included in the EBAM method. This suggests that at least 28% of the EBAM mass concentration was water. It is unlikely that any dust was lost by the gravimetric method. The water contribution could be assessed by repeating the gravimetric method at higher and lower relative humidities.
b. The elemental composition showed that dust accounted for ~16% of PM10 gravimetric mass on average and salt accounted for ~7%. Both dust and salt were strongly correlated with PM10 and $R^2$~0.9. The correlations of dust, salt, and PM10 is likely caused by wind speed serving as the primary driver of all three. The lofted dust and salt may also bring with them water proportionate to their hygroscopicity, a property determined by the chemical composition of the suspended salt mixture. Other semi-volatile components that may associate with the higher surface area provided by the dust may also increase the PM10 concentration.

The breakdown by weight and by component of the BAM concentrations measured at the CDF and Beach sites are summarized in Figure 9, where we have interpreted the difference between BAM and gravimetric mass as the evaporated fraction that is likely water and illustrated the measured mass component contributions from Dust, Salt, and Other. The gravimetric fraction of BAM PM2.5 is lower at 62% on high PM10 afternoons compared to 74% for all samples measured. Dust accounts for 33% of gravimetric PM2.5 at CDF on high PM10 afternoons compared to only 17% for all samples measured. Combining the gravimetric and dust measurements, the end result is that on days with high 24-hr PM10 at CDF, the combination of the gravimetric mass as 62% of the BAM PM2.5 mass and the dust accounting for ~33% of gravimetric PM2.5 mass means that dust accounts for on average 20% of the BAM PM2.5 at CDF on high PM10 days. This means that on average one fifth of the BAM-based PM2.5 at CDF can be attributed to dust during the ten high PM10 days sampled in April-May 2020.

## Conclusions

PM2.5 mass concentrations at CDF show large contributions of sea spray and mineral dust during high wind episodes. This result means that a substantial fraction of PM2.5 was not associated with fossil-fuel combustion emissions, so that PM2.5 is not a good predictor of toxic emissions or health effects for this location in high wind conditions. For this reason, direct measurements of toxics would be needed in order to associate PM2.5 with health effects at this location.

The association of high PM10 and PM2.5 with high wind conditions, even when recreational vehicles were not allowed at Oceano Dunes, indicates that dune-derived mineral dust is more likely to be caused by natural forces (i.e. wind) rather than human activities. While the short duration of this study provides only limited statistics in support of this result, the longer records provided by APCD provide additional confirmation. For this reason, the high dust concentrations measured on high wind days in and downwind of Oceano Dunes are likely dominated by natural saltation processes associated with the indigenous geomorphological dune structure.

The correlation between the online BAM and EBAM measurements with filter-based gravimetric measurements indicated good correspondence of the metrics given the limited sampling and differences in relative humidity. The moderate correlation of the gravimetric PM2.5 with the BAM PM2.5 ($R^2$=0.7) at CDF provides general support for the BAM PM2.5 calibration and operation with the moderate correlation being consistent with expected differences in relative humidity between the methods. The fact that the mass concentrations of the gravimetric PM2.5 (CDF) and PM10 (Beach) were consistently lower (by 26-38% and 28%, respectively) than the corresponding CDF BAM measurements supports the idea that a third or more of the BAM mass is likely water at coastal locations like the APCD CDF BAM site. The most probable reason for this is that the gravimetric measurements are partially dried by equilibrating at 35% relative humidity whereas the BAM measurements vary with ambient conditions. The more consistent fractions of PM10 (i.e. $R^2$>0.95) would be consistent with the remaining mass being controlled by the components present, which would be the case for water.

To remove the contributions of the additional water in the BAM measurements, the chemical mass fractions are compared on the basis of the gravimetric mass. Relative to the partially dried gravimetric mass, the chemical mass measurements show that on average less than 33% of PM2.5 at CDF and less than 16% of PM10 at the Beach site can be attributed to dust. About 7-11% can be attributed to sea salt at both sites for the sizes measured. The remaining 60-72% of gravimetric PM2.5 at CDF and 77% of gravimetric PM10 at the Beach is likely from additional water (beyond the 26-38% included in the BAM), organic components, ammonium, nitrate, and other semi-volatile chemical species.

On days with high 24-hr PM10 at CDF, the combination of the 38% water in the BAM method relative to the gravimetric method (leaving 62% of the BAM PM2.5 mass as non-water) and the dust accounting for ~33% of gravimetric PM2.5 means that dust accounts for on average 20% of the BAM PM2.5 at CDF (on high PM10 days). This means that on average one fifth of the BAM-based PM2.5 at CDF can be attributed to dust during the ten high PM10 days sampled in April-May 2020.

Since the sampling reported here was limited by resources because of other activities at Oceano Dunes, additional offline chemical and gravimetric analysis are planned in order to provide additional evidence of the variability of the fraction of PM2.5 that is dust on high PM2.5 days.

## Methods

Aerosol particle sampling used sharp-cut cyclones operated with calibrated flows to collect particles for analysis at ambient diameters with a calibrated cut at 2.5 μm (SCC 2.229 operated at 7.5 lpm, BGI Inc., Waltham, MA) and a sampling head with nominal cut at 10 μm (16.7 lpm, provided by State Parks). Teflon filters were used as substrates and have shown negligible adsorption of volatile organic compounds (VOCs) on duplicate back filters collected simultaneously with each sample [Maria et al., 2003; Gilardoni et al., 2007]. Blank filters provided a measure of adsorption during sampling and contamination during handling (loading and unloading) and storage.

Simultaneous sampling by BAM, EBAM, and filters were used to check for sampling consistency by comparing gravimetric mass on filters to co-located BAM measurements. The hourly BAM and EBAM concentrations reported between the start and stop times for the filters were averaged (without interpolation) to provide approximate comparison points. Further refinement would be provided by a more exact integration and interpolation of beginning and ending hours.

All filters were weighed prior to sampling to provide filter-specific tare weights. After sampling, filters were weighed again, and the difference between the sampled weight and the tare was the reported gravimetric mass. The weighing procedure (Chester LabNet) for all samples used the PM2.5 reference method of 35%+/-5% for the 24 hr period (logged every 5 min), making the samples potentially drier or wetter than the ambient conditions in which they were collected. BAM and EBAM may also be drier than ambient humidity due to heating of the air when it is drawn into the instrument. Other differences may result from the hour-to-hour differences in the online measurements compared to the offline storage at constant conditions.

Each sample (and associated blank filters) were non-destructively analyzed by X-ray Fluorescence (XRF) measurements conducted by Chester LabNet (Tigard, OR) on the same filters used for gravimetric measurements. XRF analysis provided trace metal concentrations for elements heavier than Na [Maria et al., 2003]. Elemental concentrations were above detection for 30% to 100% of the ambient teflon filters collected.

Acknowledgments

The principal investigators are grateful for the insight, advice and assistance of Will Harris with the California Geological Survey, California Department of Parks and Recreation Oceano Dunes District personnel, CalFire Arroyo Grande Station staff, APCD personnel, and UCSD student Savannah Lewis.

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Figures

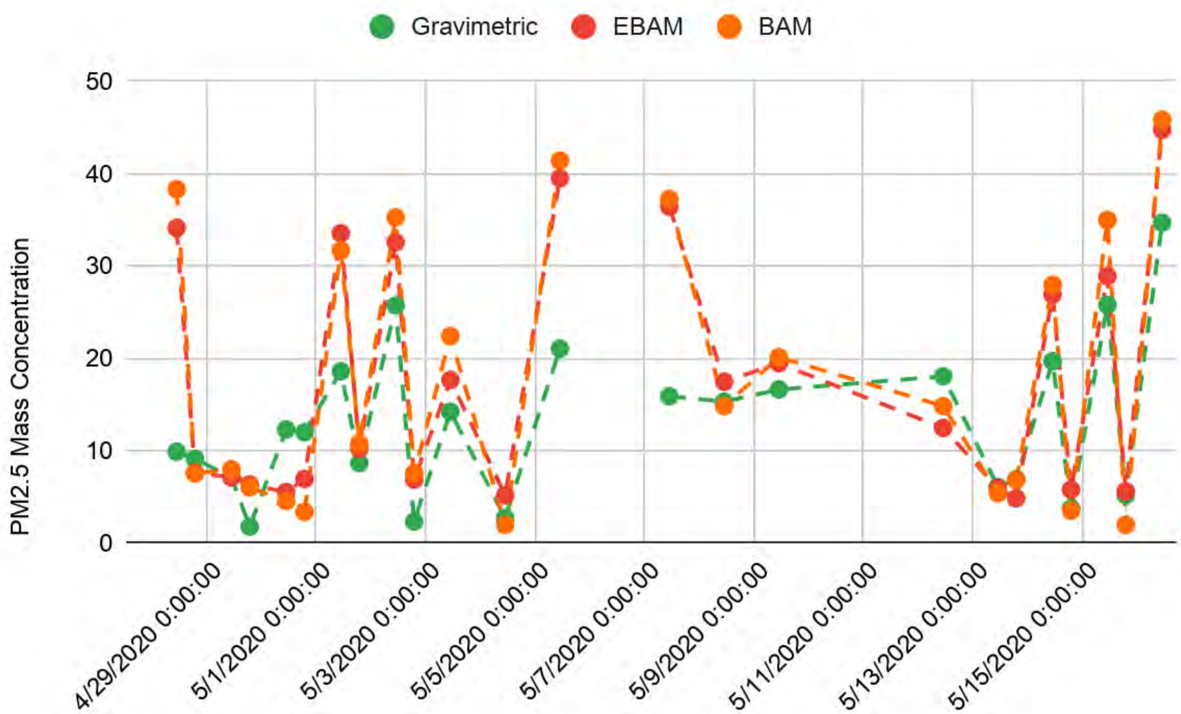


Figure 1. Time series of PM2.5 mass concentrations [μg $m^{-3}$] by Gravimetric, EBAM, and BAM methods at CDF for sampling from 27 April to 17 May 2020.

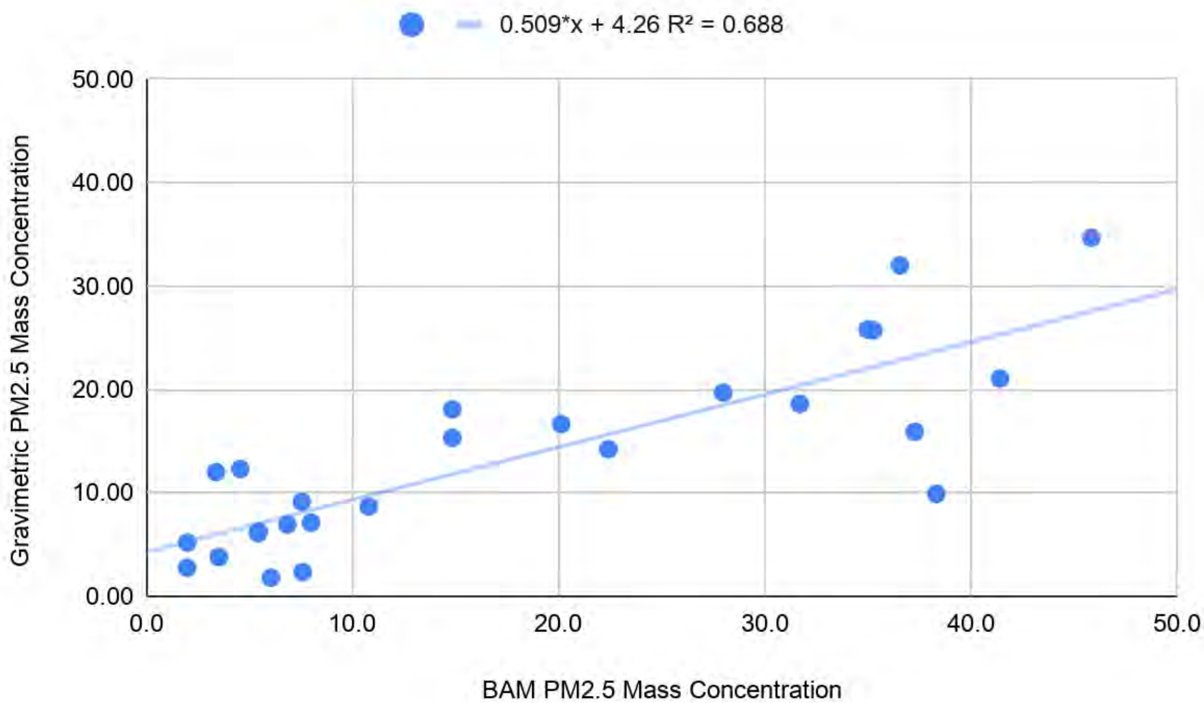


Figure 2. Scatter plot of PM2.5 mass concentrations [µg $m^{-3}$] by Gravimetric and BAM methods at CDF for sampling from 27 April to 17 May 2020. The fitted trendline indicates that the Gravimetric concentrations correlate to BAM concentrations with $R^2$=0.687.

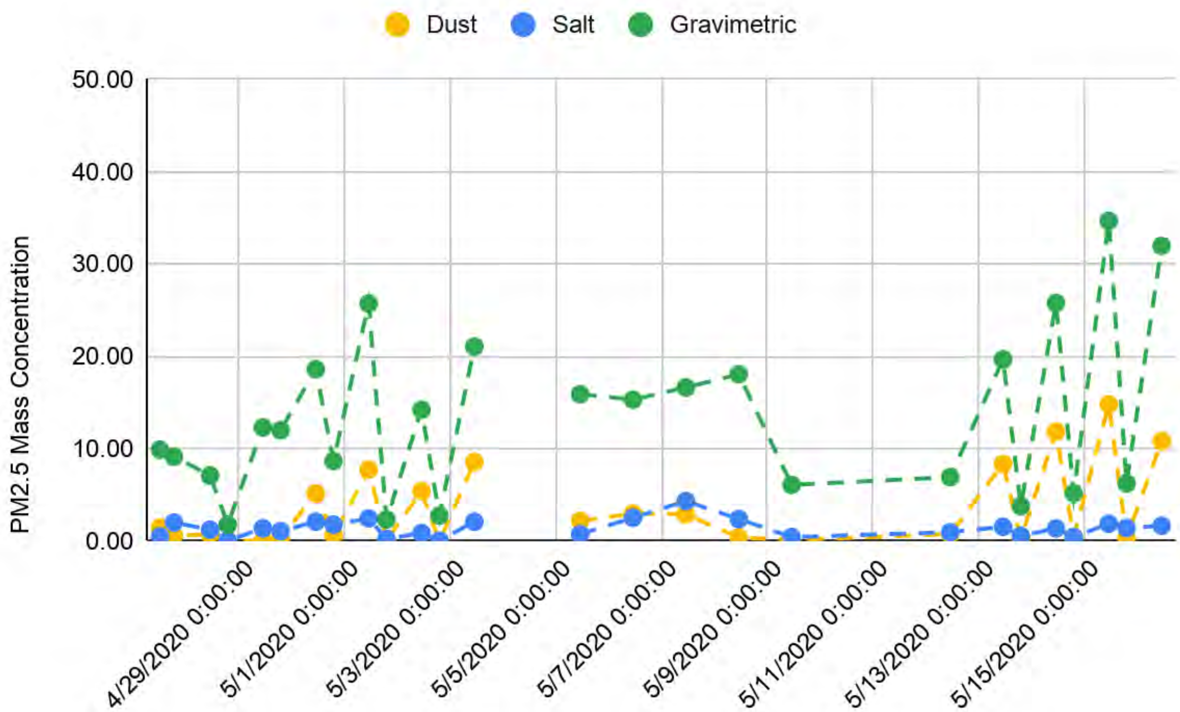


Figure 3. Time series of PM2.5 mass concentrations [$\mu g\ m^{-3}$] for Dust, Salt and Gravimetric (total) concentrations at CDF for sampling from 27 April to 17 May 2020.

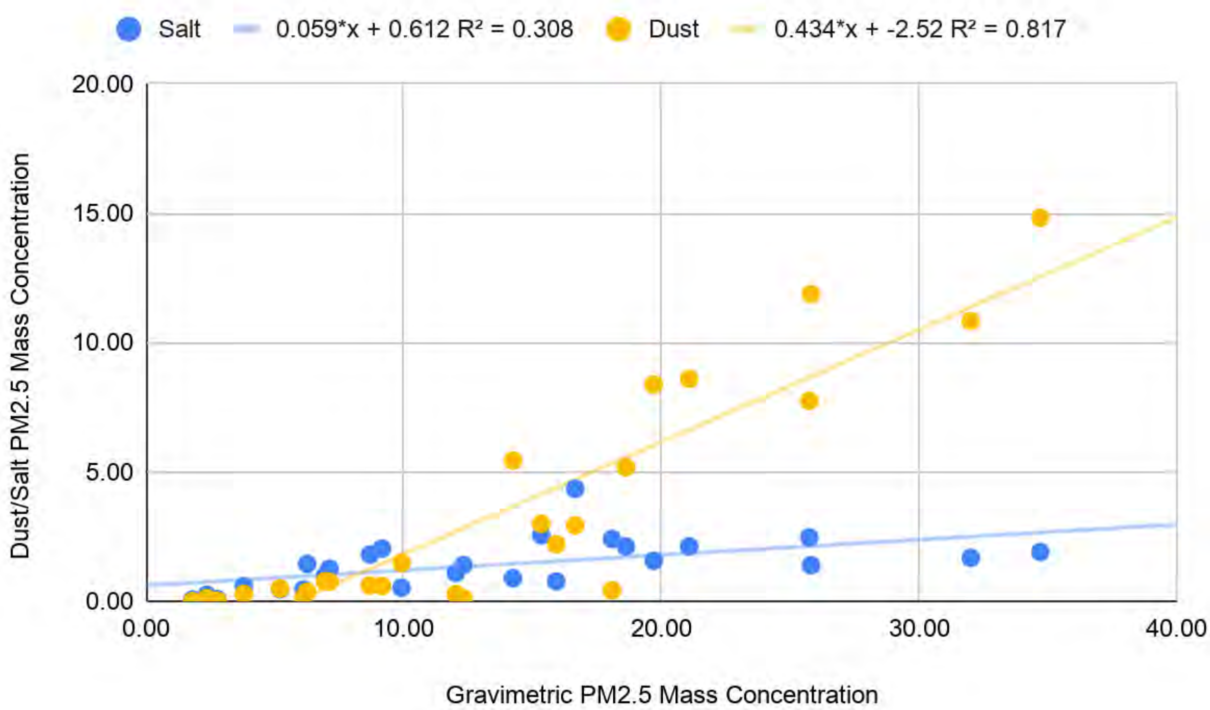


Figure 4. Scatter plot of PM2.5 mass concentrations [μg $m^{-3}$] for Dust, Salt and Gravimetric (total) concentrations at CDF for sampling from 27 April to 17 May 2020. The fitted trendline indicates that for this limited data set the Dust concentrations correlate to Gravimetric concentrations with $R^2$=0.817 and the Salt concentrations correlate to Gravimetric concentrations with $R^2$=0.308.

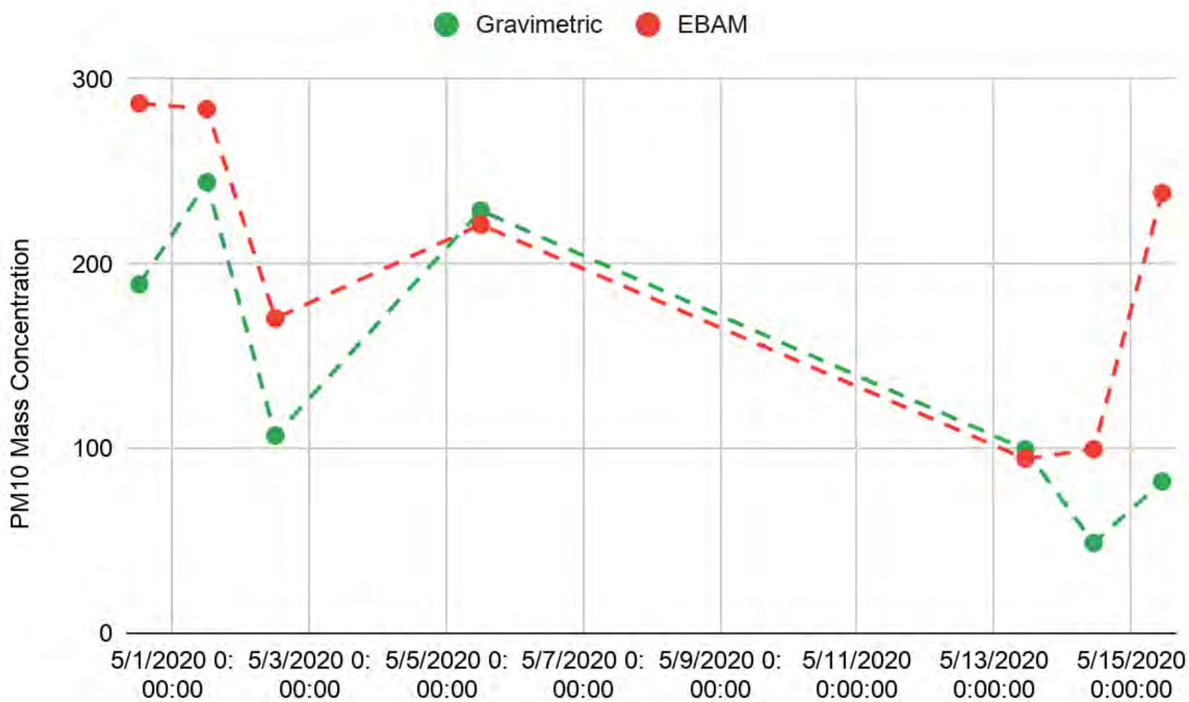


Figure 5. Time series of PM10 mass concentrations [µg $m^{-3}$] by Gravimetric and EBAM methods at Beach for sampling from 27 April to 17 May 2020.

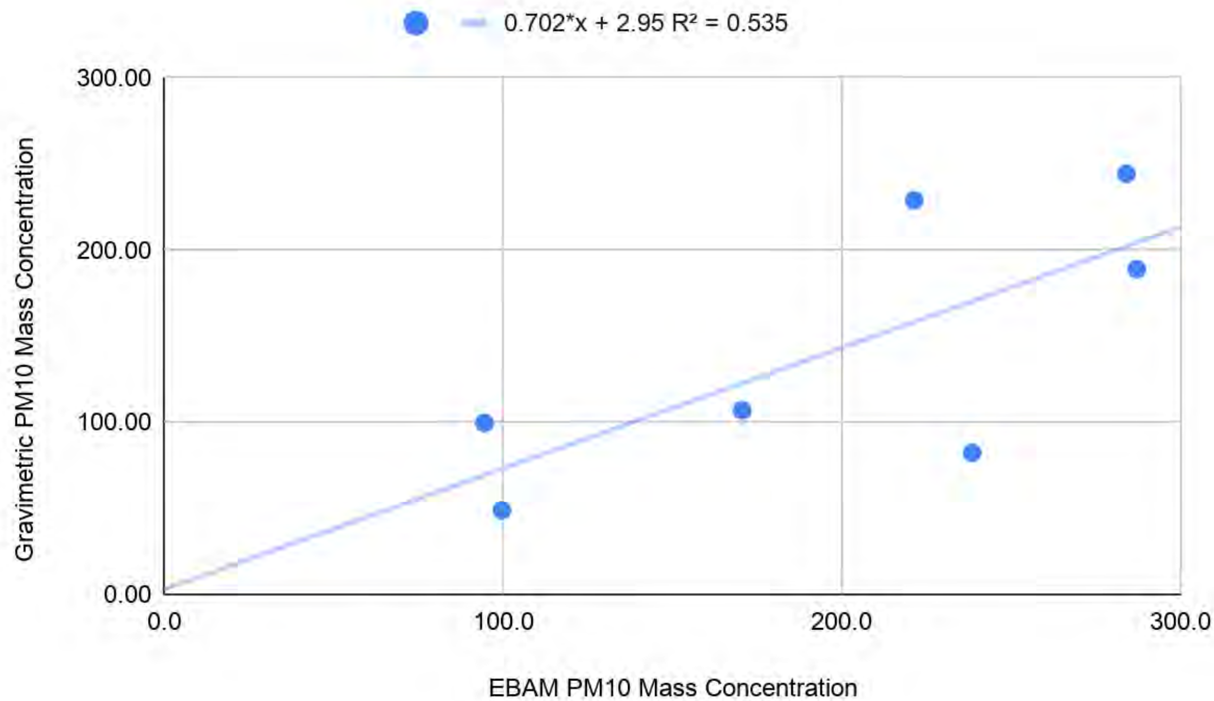


Figure 6. Scatter plot of PM10 mass concentrations [μg $m^{-3}$] by Gravimetric and EBAM methods at Beach for sampling from 27 April to 17 May 2020. The fitted trendline indicates that for this limited data set the Gravimetric concentrations correlate to EBAM with $R^2$=0.535.

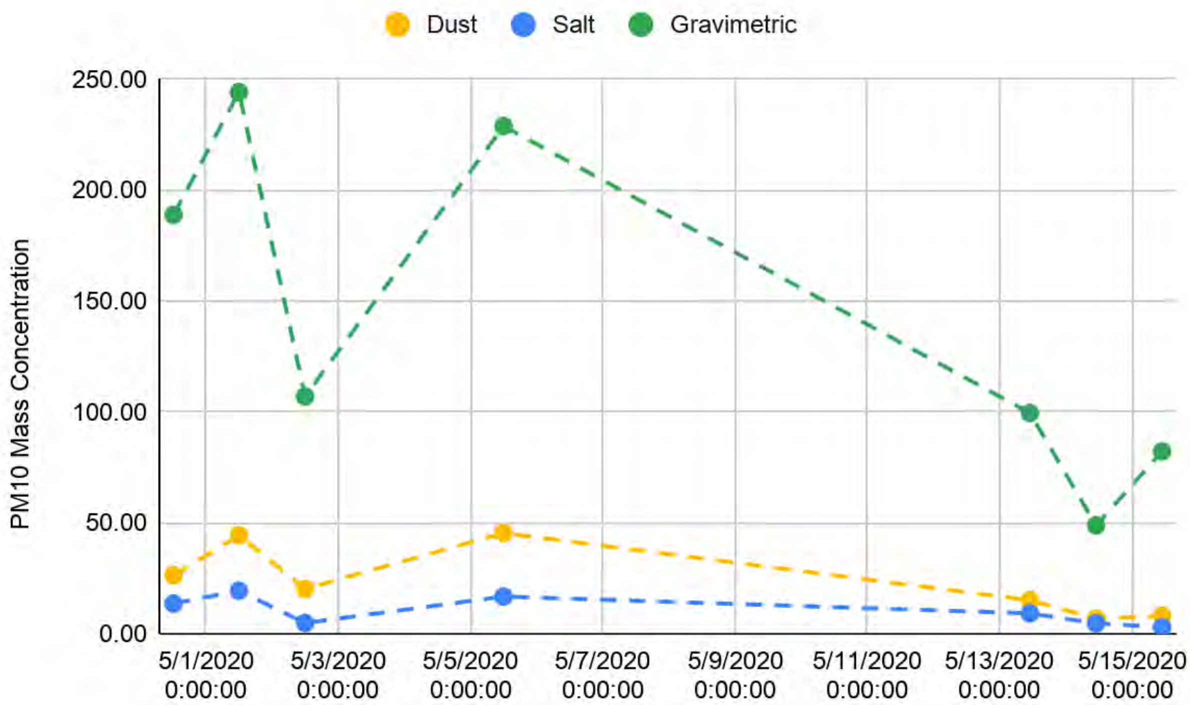


Figure 7. Time series of PM10 mass concentrations [μg $m^{-3}$] for Dust, Salt and Gravimetric (total) concentrations at Beach for sampling from 27 April to 17 May 2020.

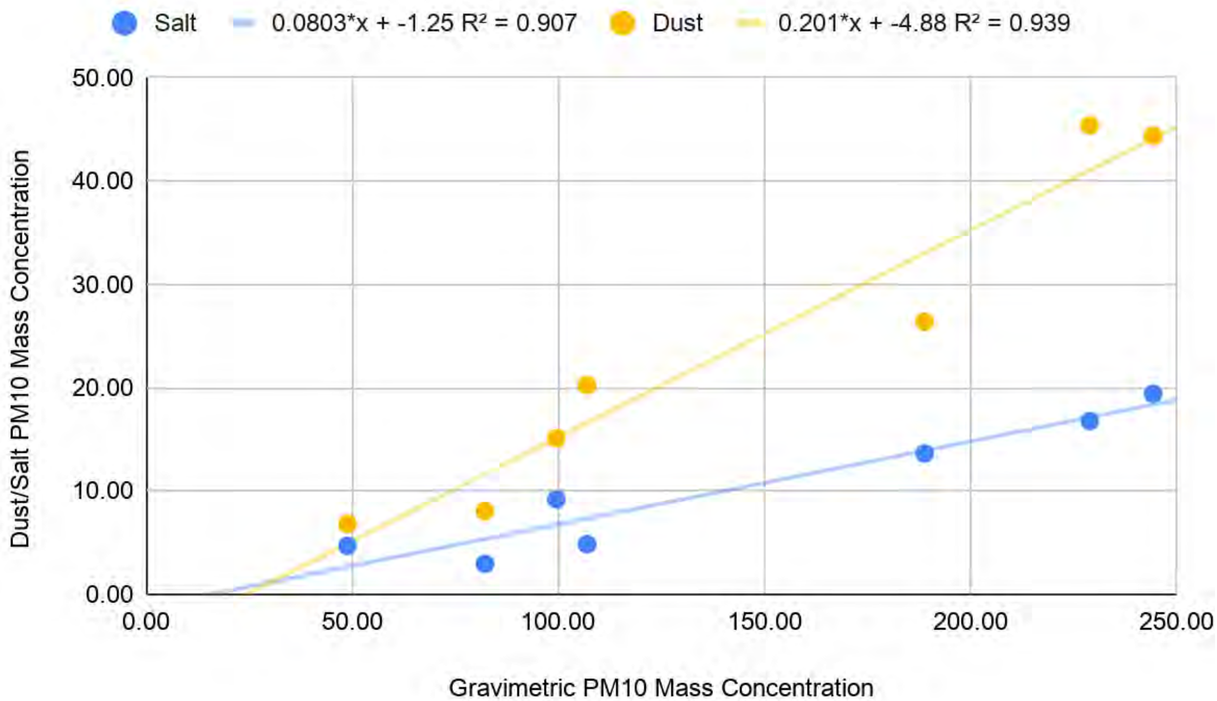


Figure 8. Scatter plot of PM10 mass concentrations [µg $m^{-3}$] for Dust, Salt and Gravimetric (total) concentrations at Beach for sampling from 27 April to 17 May 2020. The fitted trendline indicates that for this limited data set the Dust concentrations correlate to Gravimetric concentrations with $R^2$=0.939 and the Salt concentrations correlate to Gravimetric concentrations with $R^2$=0.907.

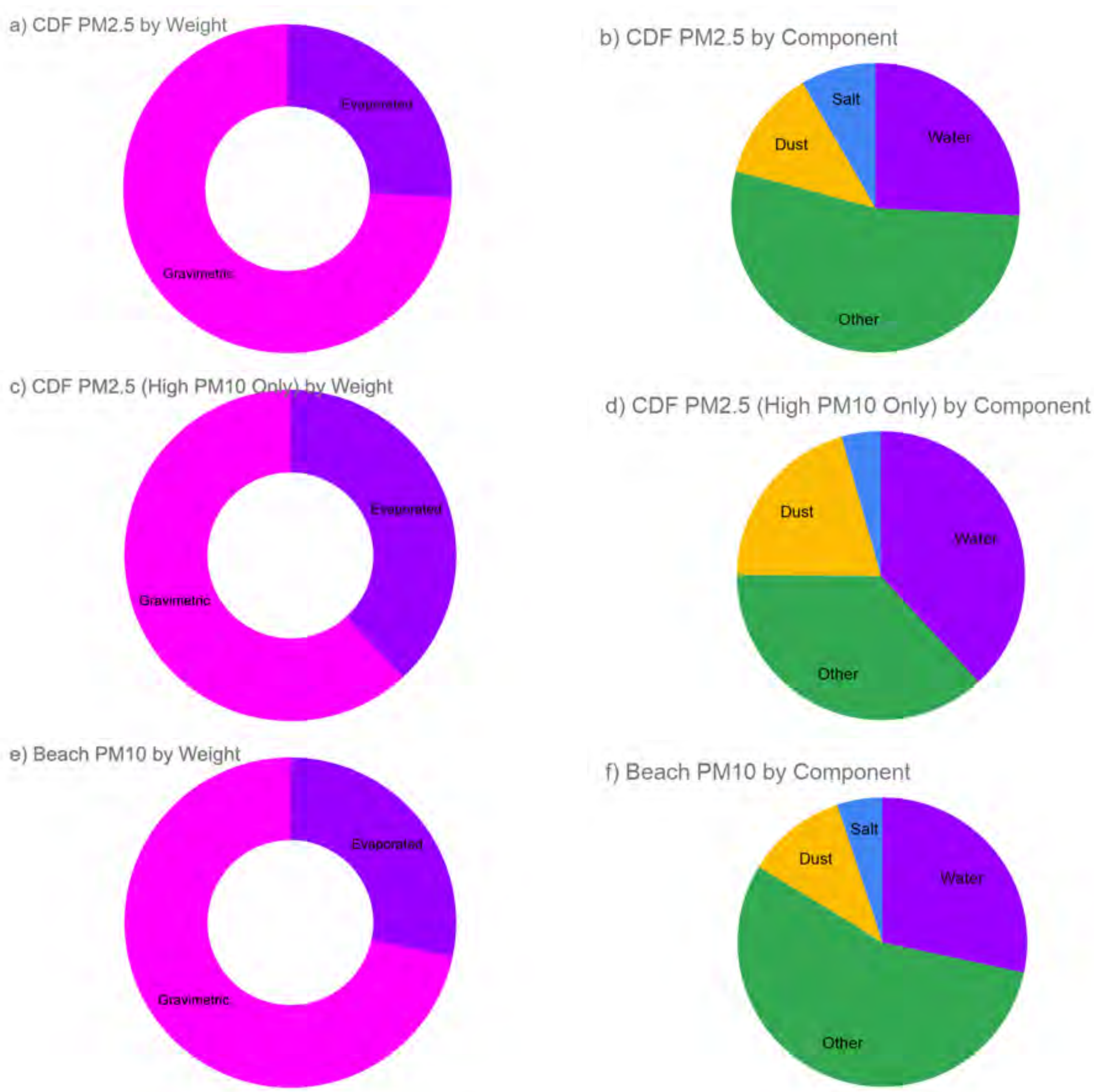


Figure 9. Summary of apportionment of BAM mass concentrations by Weight (a,c,e) and by Component (b,d,f) for (a,b) all CDF BAM2.5 (26 afternoon and overnight samples), (c,d) high PM10 day CDF BAM2.5 (10 afternoon samples), and (e,f) Beach PM10 (7 afternoon samples). High PM10 day samples are those with 24-hr PM10 exceeding 140 μg $m^{-3}$. The category labeled “Other” (green) may include additional water, ammonium, nitrate, sulfate and organic components, and trace metals.

# APCD Review of September 2020 Scripps Report

## Executive Summary

The most recent Scripps Report asks the wrong question and then uses the wrong tools to answer that question. Therefore, nothing in it alters our understanding of the dust issue on the Nipomo Mesa, which is built on more than a decade of study by several independent researchers.

The Oceano Dunes dust issue is driven by the dozens of exceedances of the $PM_{10}$ standard that occur each year downwind of the ODSVRA, yet the Scripps study measured $PM_{2.5}$, the standards for which are only rarely exceeded. Therefore, even if their samples had been collected with the right tools, their results would only be of very limited relevance to the issue.

Scripps collected their $PM_{2.5}$ samples using a novel sampler, which is not EPA-approved for $PM_{2.5}$ sampling and to our knowledge has never been tested; in fact, we are unaware of any other $PM_{2.5}$ studies using this method. Scripps's measurements are systematically lower than and correlate poorly with our BAM measurements taken at the same site (the District's CDF monitoring station downwind of the ODSVRA). Scripps argues this is due to water evaporating from their $PM_{2.5}$ filters prior to them being weighed by the EPA-approved gravimetric method. The District finds explanation unlikely, since samples collected and weighed according the full EPA-approved method generally show good correlation with collocated BAM measurements. The major difference between what Scripps did and the full EPA method is Scripps's sampling apparatus; their filter analysis was reportedly done according to the EPA protocol. Thus, the discrepancy between their $PM_{2.5}$ measurements and the District's is likely due to their sampling method. This may also explain why the Scripps speciation results are different from previous speciation studies of Oceano Dunes dust.

The District also identified several inconsistencies in the graphs and figures in the report. For example, from one figure to the next, some samples are depicted as starting at different times. One figure shows concentrations from the District's $PM_{2.5}$ BAM instrument, but some of the values depicted do not appear to match the values we actually measured.

Finally, the author appears to misunderstand how OHV activity contributes to the dust issue, writing: "The association of high PM10 and PM2.5 with high wind conditions, even when recreational vehicles were not allowed at Oceano Dunes, indicates that dune-derived mineral dust is more likely to be caused by natural forces (i.e. wind) rather than human activities. … [T]he high dust concentrations measured on high wind days in and downwind of Oceano Dunes are likely dominated by natural saltation processes associated with the indigenous geomorphological dune structure." As the District has stated elsewhere, "it is not the dust kicked up by OHV activity (i.e. 'rooster tails') that causes poor air quality downwind, nor is it their tailpipe emissions. Rather, it is the secondary effects to

vegetation and dune shapes that leads to greater wind erosion and more dust when the wind blows." And as the SAG noted in a letter shortly after the ODSVRA was closed to OHV activity, "decades of OHV activity have fundamentally altered the natural beach-dune landscape, making the dunes significantly more susceptible to PM emissions than they would be in a natural state. The SAG does not expect a few weeks or months of temporary OHV restrictions to substantially alter the balance of human versus natural contributions to PM emissions at ODSVRA."

# Introduction and Background

The subject of this review is the "Scripps Report" released on September 23, titled "UCSD Supplemental Report 2020: Preliminary Results from May 2020 Aerosol Measurements."[1] Prof. Lynn Russell, the report's author, discussed its findings at the OHMVR Commission's meeting the following day.[2] The report describes sampling conducted at CDF and within the ODSVRA in April and May 2020.

The current report follows up on two previous reports, the most recent of which described sampling conducted in 2019 and is titled "First Year (2019) Summary Report: Investigation of Aerosol Particulates in a Coastal Setting, South San Luis Obispo County, California."[3] Members of the Scientific Advisory Group (SAG) and APCD staff previously reviewed that report, and the reviews are compiled in Attachment 7 of State Parks' 2020 Annual Report and Work Plan.[4] Those reviews noted several methodological and other issues with the study and its findings, and they provided suggestions for improving future sampling campaigns.

The first report in the series, "Marine Contributions to Aerosol Particulates in a Coastal Environment,"[5] described the results of DNA analysis of E-BAM filter tapes. While the report was touted in some circles as evidence that OHV activity is not the cause of the $PM_{10}$ issue, the District did not find the study to be relevant to the issue, as we described in a June 2019 FAQ[6] and a

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[1] L. Russell (2020). "UCSD Supplemental Report 2020: Preliminary Results from May 2020 Aerosol Measurements," September 20, 2020. Available online at https://ohv.parks.ca.gov/pages/1140/files/03-Scripps%20Report.pdf.

[2] Video of September 24 OHMVR Commission meeting—including Prof. Russell's presentation and responses to questions from Commissions—is available online at https://cal-span.org/unipage/?site=cal-span&owner=OHMVR&date=2020-09-24.

[3] L. Russell, M. Kahru, B. Palenik (2020). "First Year (2019) Summary Report: Investigation of Aerosol Particulates in a Coastal Setting, South San Luis Obispo County, California," February 21, 2020. Not online.

[4] State of California. Department of Parks and Recreation, Off-Highway Motor Vehicle Recreation Division (2020). "Oceano Dunes State Vehicular Recreation Area Dust Control Program 2020 Annual Report and Work Plan (Draft)," August 2020. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/2020%20Draft%20ARWP%208-1-2020%20w%20exhibits.pdf (main document) and https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/2020%20ARWP%20Attachments%208-1-2020%20%28002%29.pdf (attachments).

[5] B. Palentik, M. Nagarkar (2018). "Report: Marine Contributions to Aerosol Particulates in a Coastal Environment," March 3, 2018. Not online.

[6] SLOCAPCD (2019). "Response to Comments on the May 1st Workshop Version of the Draft Particulate Matter Reduction Plan Required by Stipulated Order of Abatement 17-01," June 12, 2019. Available online at

comment letter to State Parks.[7] The District also offered suggestions for how future investigations along the same lines could be made more relevant to the $PM_{10}$ issue.

## Relevance of $PM_{2.5}$ vis-à-vis $PM_{10}$

The dust issue in south San Luis Obispo County is a $PM_{10}$ issue. The California $PM_{10}$ standard is exceeded dozens of times per year on the Nipomo Mesa,[8] including on 51 occasions in 2019 at CDF. While some of these exceedances are due to wildfire smoke, regional dust transport, and other sources, the bulk are due to windblown dust from the ODSVRA. In contrast, exceedances of the $PM_{2.5}$ standards are rare (most years have none) and often occur in association with wildfires rather than windblown dust events.[8]

The latest Scripps study, like the last one, did not measure $PM_{10}$ at CDF but instead measured $PM_{2.5}$. In her presentation to the OHMVR Commission, Prof. Russell explained that they focused on $PM_{2.5}$ because it is associated with more deleterious health impacts than $PM_{10}$. We agree that $PM_{2.5}$ is generally a greater health hazard than $PM_{10}$, but if the research goal is inform the dust mitigation process (as it seems to be, since the study was commissioned by the OHMVR Division, paid for out of the OHV Trust Fund, and presented in this context), then sampling $PM_{10}$ would have been far more informative. During windblown dust events $PM_{2.5}$ is only about 21% of $PM_{10}$, and the chemical composition of the $PM_{10-2.5}$ fraction may be very different from the composition of the $PM_{2.5}$ fraction.

Several reviewers of the previous Scripps report made this same point.[4] In her comments to the OHMVR Commission, Prof. Russell mentioned that they had also planned to conduct $PM_{10}$ sampling at CDF this spring, but due to the global COVID-19 pandemic they were unable to. Nonetheless, they were able to accomplish other elements of their sampling plan, so clearly $PM_{10}$ was not the priority.

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https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/Response%20to%20Comments_FINAL_PostedJune122019.pdf.

[7] Gary E Willey to Dan Canfield (2019). “California Department of Parks and Recreation’s February 1, 2017 Oceano Dunes SVRA Concept Draft Particulate Matter Reduction Plan in Response to Stipulated Order of Abatement Number 17-01,” February 25, 2019. Available online at: https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/Feb%2025%202019%20APCD%20Response%20to%20SP-Feb%201%202019%20PMRP%20%28Signed%29%20%281%29.pdf

[8] SLOCAPCD (2019). “2018 Annual Air Quality Report,” November 2019. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/2018aqrt-FINAL.pdf.

## Evaporative Loss Does Not Explain the Discrepancy in $PM_{2.5}$ Mass

The Scripps researchers collected 26 multi-hour $PM_{2.5}$ filter samples at CDF, a short distance from the District's regulatory $PM_{2.5}$ monitor, which is a continuous BAM 1020 instrument. The report states that the "concentration measurements tracked reasonably well … and showed a moderate correlation (R2~0.7). [Scripps's] offline gravimetric method is 26% lower on average than the [the District's] online BAM instrument" and even lower (38%) during wind events. These results are plotted in Figure 2 of the report, shown below. The report argues that "[i]t is likely that the 38% difference in mass on high $PM_{10}$ days is due to water evaporating, although other semi-volatile components (ammonium nitrate and organic mass) could also be included in the BAM method and not in the gravimetric method."

The District does not agree that evaporative loss is the likely cause of the discrepancy. While the gravimetric method is known to be subject to losses of water and semi-volatiles, the BAM 1020 instrument was designed to mimic this effect and thus produce comparable results. This was accomplished by incorporating an inlet heater which maintains the relative humidity of the incoming air flow at or below 35%. Through rigorous field trials at geographically diverse test sites around the

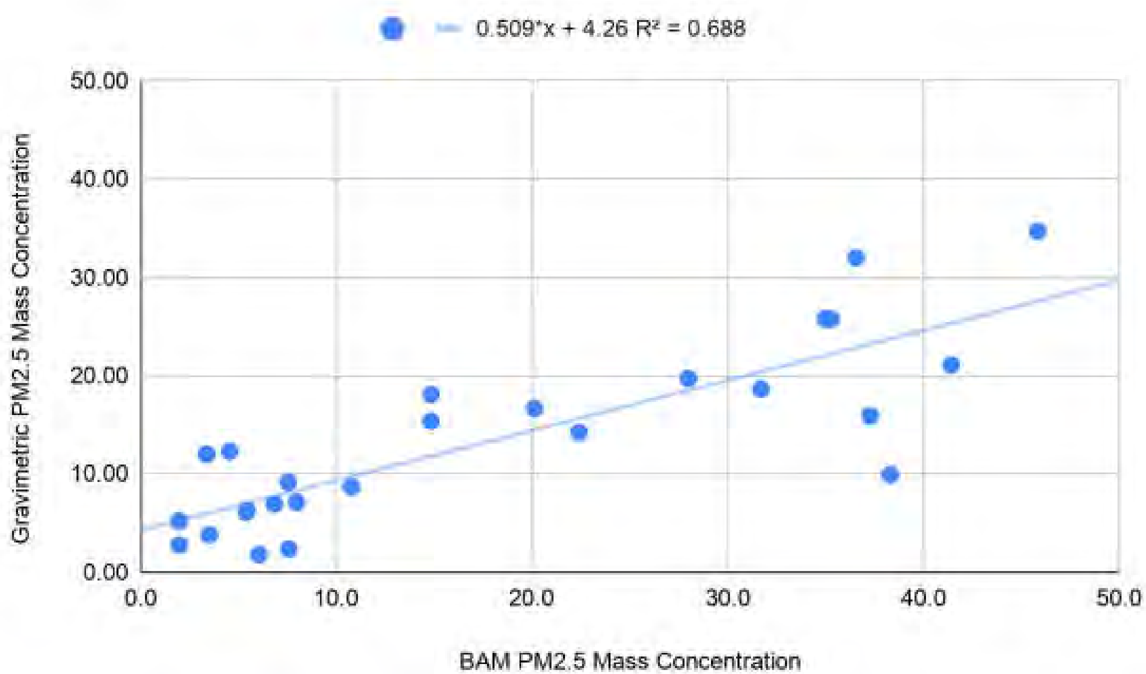
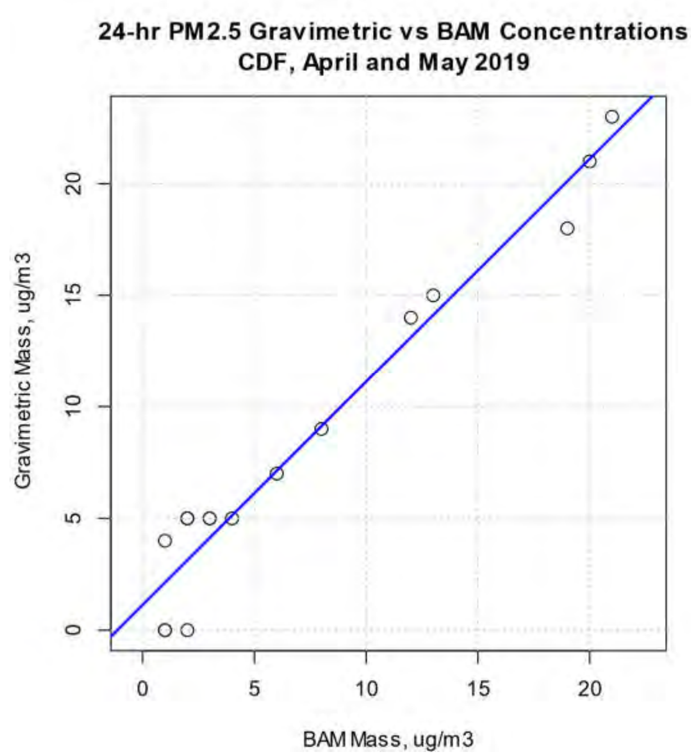



Figure 2. Scatter plot of PM2.5 mass concentrations [μg $m^{-3}$] by Gravimetric and BAM methods at CDF for sampling from 27 April to 17 May 2020. The fitted trendline indicates that the Gravimetric concentrations correlate to BAM concentrations with $R^2$=0.687.

county, the BAM 1020 was demonstrated to yield very comparable results to the established gravimetric method, and it was thus designated a Federal Equivalent Method by the EPA.[9] Today, BAM 1020 instruments measure $PM_{2.5}$ at hundreds of regulatory sites across the United States.

Numerous studies and trials have run BAM instruments alongside gravimetric samplers, and in general these have shown much better correlation and much less bias that what Scripps reports. In fact, the District collocated a filter-based $PM_{2.5}$ sampler with the BAM 1020 at CDF in the spring of 2019, and the results are plotted below.[10] For these data, the least squares fit (shown in blue) has slope = 0.999, intercept = 1.13, and $R^2$ = 0.955; the Scripps results are significantly poorer with slope = 0.509, intercept = 4.26, and $R^2$ = 0.688. The Scripps samples were shorter in duration (8 or 16 hours vs 24 hours), so somewhat more scatter is expected in their results; however, this difference in sample duration cannot account for the marked difference in $R^2$ values or for Scripps's low slope and high intercept.

Other examples abound. For example, the EPA hosts a "PM2.5 Continuous Monitor Comparability Assessments" webpage which facilitates comparisons between collocated BAM and gravimetric

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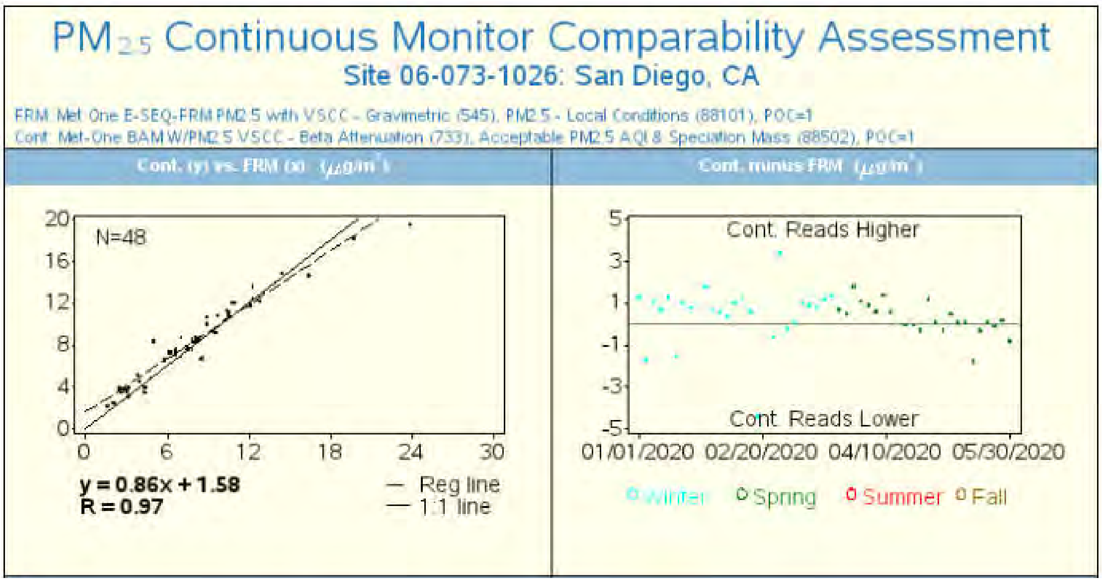
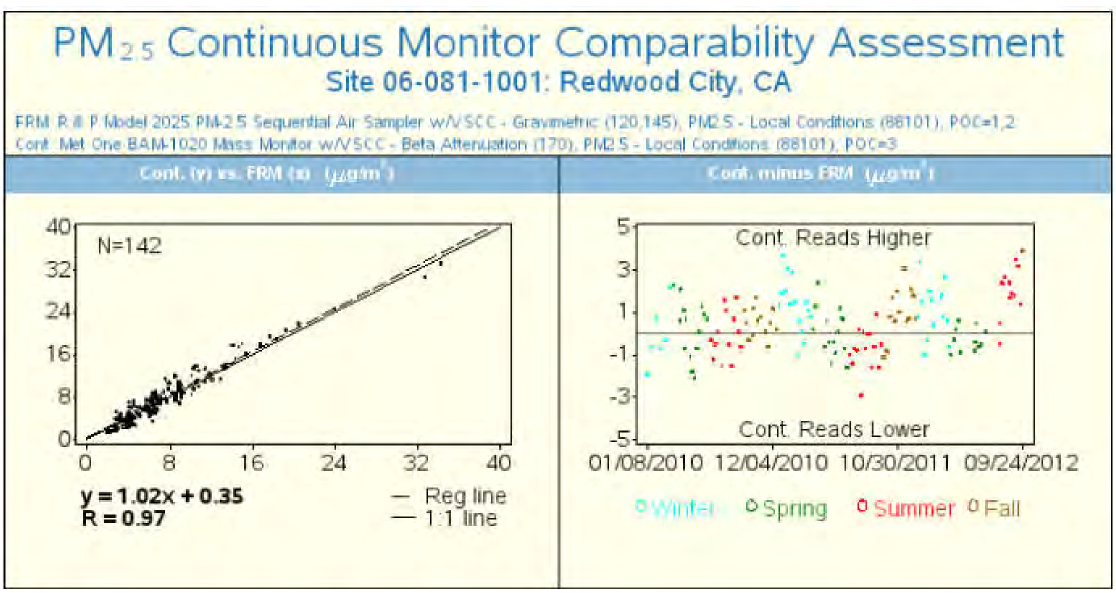
[9] Environmental Protection Agency, Office of Research and Development (2008). "Ambient Air Monitoring Reference and Equivalent Methods: Designation of One New Equivalent Method," 73 Fed. Reg. 13224, March 12, 2008. Available online at https://www.govinfo.gov/content/pkg/FR-2008-03-12/pdf/E8-4905.pdf.

[10] These are unpublished data. The BAM data are from the regulatory instrument at the site, and the gravimetric samples were collected with a Rupprecht & Pataschnick Partisol-FRM Model 2025i. Gravimetry was performed by the Bay Area Air Quality Management District according to the FRM method.

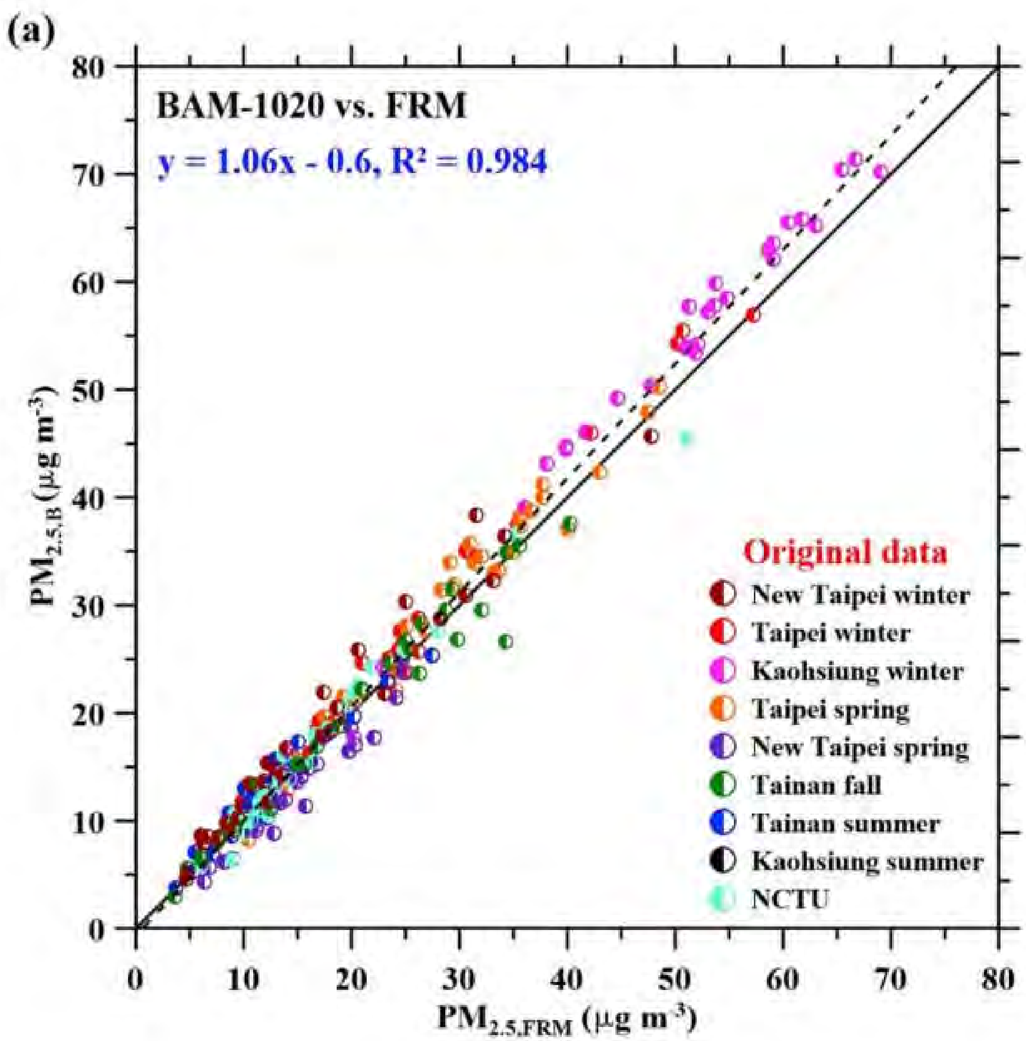
monitors.[11] Shown below are plots comparing $PM_{2.5}$ results from collocated BAM and gravimetric samplers in San Diego and Redwood City. These sites were chosen because like CDF they are coastal California sites hosting BAM monitors using VSCC cyclones (the same method used at CDF); however, unlike CDF they were operated independently of the District. The most recent year with available data is shown for each. Note that the axes are switched in these plots compared to how the data are presented in the figure above and Figure 2 of the Scripps report. These examples also show much better correlation and less bias than the Scripps results.



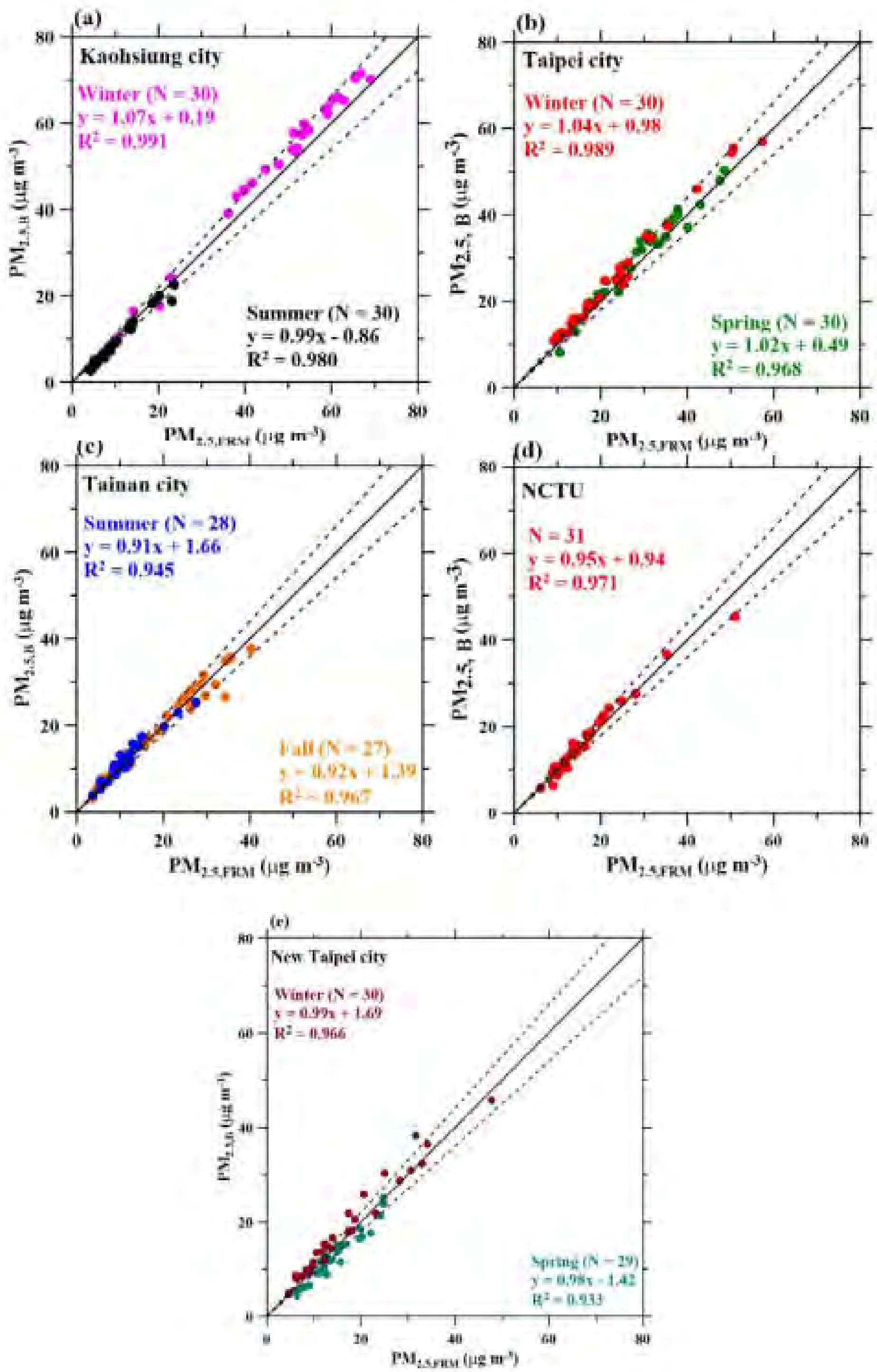

[11] Online at https://www.epa.gov/outdoor-air-quality-data/pm25-continuous-monitor-comparability-assessments. In browsing these assessments, care should be taken to ensure that the continuous monitor being assessed is a BAM-1020 with a VSCC rather than SCC.

A recent academic study, Le 2020,[12] investigated the differences between BAM and gravimetric $PM_{2.5}$ measurements in Taiwan. While the researchers did find systematic differences between collocated BAM and gravimetric measurements, which they attributed "mainly … to the aerosol water content," the bias they observed was much smaller than that reported by Scripps and more in line with the collocation studies mentioned above. Figure 2a from the study is shown below. It plots 24-hr $PM_{2.5}$ BAM concentrations from all sites in the study against the corresponding collocated gravimetric concentrations. As shown in the figure, the $R^2$ was 0.984, the slope was close to one and the intercept close to zero.




[12] T.-C. Le, K. K. Shukla, Y.-T. Chen, *et al.*, (2020). "On the concentration differences between PM2.5 FEM monitors and FRM samplers," Atmospheric Environment, 222, 117138. Available online at https://doi.org/10.1016/j.atmosenv.2019.117138.

Le 2020 found that differences between the BAM and gravimetric concentrations were influenced by ambient temperature and relative humidity, and that some sites had greater average differences than others. This is depicted in Figure S3 of the study's supplemental information, shown below. Even breaking the data down by site and season, all the individual correlations (as indicated by the $R^2$ values) and biases (as indicated by the slopes and intercepts) are much better than those reported by Scripps.



Finally, if evaporative loss was the primary cause of the mass discrepancy, then we would expect the BAM masses to always exceed the gravimetric masses, or at least to only observe BAM masses less than gravimetric masses on days when the ambient relative humidity was less than 35% (the humidity level that the Scripps samples were equilibrated at prior to weighing). This is not what is observed. According to Figure 1of the Scripps Report, there are at least 5 samples where the gravimetric mass exceeds the BAM measurement, but ambient relatively humidity did not vary much during the sampling campaign, and hourly average relative humidity was never less than 40%.

In summary, while evaporative loss is a known source of bias between BAM and gravimetric methods, this cannot explain the large difference between the Scripps gravimetric masses and the District's BAM measurements. Many researchers and regulators across the United States and around world have run BAMs and gravimetric methods side by side and obtained much better correlations with much less bias.

## The Discrepancy in $PM_{2.5}$ Mass is Likely Due to Scripps's Sampling Methodology

If evaporative loss does not explain the discrepancy in $PM_{2.5}$ mass between the District's measurements and Scripps' samples, then what does? The District believes sampling methodology is the most likely explanation—specifically differences in the $PM_{2.5}$ size separators and flow rates used by the District and Scripps. The District operates its BAM 1020 at CDF in full accordance with state and federal requirements, including the use if a BGI VSCC as the $PM_{2.5}$ size separator,[13] operated at a flow of 16.7 L/min. In contrast, Scripps employed a BGI SCC 2.229 operated at 7.5 L/min as their $PM_{2.5}$ size separator.[14] The SCC 2.229 was designed for sampling $PM_1$ at a flow rate of 16.7; while it can achieve a nominal 2.5 micron cut point when operated at 7.5 L/min,[15] it was not designed for $PM_{2.5}$ sampling and it not a part of any EPA-approved $PM_{2.5}$ measurement method.[16]

As we wrote in our critique of the previous Scripps report, "These differences in methodology are not mere technicalities. While many cyclones can achieve a 2.5 micron cut point, only the VSCC operated at 16.7 lpm has been approved for regulatory sampling since other parameters in addition to the cut point are important. … [P]articulate sampling can be biased in windy conditions, but the EPA-approved methods have been shown to be unbiased in high wind conditions like those seen at CDF." The District suspects that Scripps method is under sampling particulates from the ambient air,

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[13] BGI, Inc. (2014). "VERY SHARP CUT CYCLONE VSCC® INSTRUCTIONS FOR USE AND MAINTENANCE." Available online at https://bgi.mesalabs.com/wp-content/uploads/sites/35/2014/10/vscc_manual.pdf.
[14] BGI, Inc. (2001). "SHARP CUT CYCLONE - SCC-2.229 FOR PM1 NSTRUCTIONS FOR USE AND MAINTENANCE." Available online at https://bgi.mesalabs.com/wp-content/uploads/sites/35/2014/10/SCC-2.229_PM1_MANUAL.pdf.
[15] BGI, Inc. (2014). "BGI Cyclone Selector Chart." Available online at https://bgi.mesalabs.com/wp-content/uploads/sites/35/2014/12/BGI_CycloneSelectorChart_2.pdf
[16] EPA (2020). "LIST OF DESIGNATED REFERENCE AND EQUIVALENT METHODS," June 15, 2020. Available online at https://www.epa.gov/sites/production/files/2019-08/documents/designated_reference_and-equivalent_methods.pdf.

particularly when winds are high, and that this effect is much important than evaporative loss in explaining why the gravimetric masses are consistently lower than the BAM masses. This is consistent with Scripps's observation that "[t]he gravimetric fraction of BAM PM2.5 is lower at 62% on high PM10 afternoons [i.e. when winds are high] compared to 74% for all samples measured."

The $PM_{2.5}$ method employed by the District is used at hundreds of regulatory sites across the United States and even more around the world. In contrast, we know of no examples of the use of the SCC 2.229 at 7.5 L/min for $PM_{2.5}$ sampling, other than the recent Scripps studies at CDF. The District has requested the author to provide other examples, but we have not yet received any such examples.

# Inconsistencies in the Scripps Report

In reviewing the Scripps Report, the District has noticed several inconsistencies in the figures:

- **Figures 1 & 3: Sample Dates of Gravimetric Masses.** Figure 1 is a timeseries plotting Scripps's gravimetric masses and EBAM results along with the District's BAM measurements. Figure 3 is a timeseries plotting those same gravimetric masses along with the speciation results for "dust" and "salt". In both, the gravimetric masses are shown in green. Figure 1 shows data for 24 sampling periods, while Figure 3 shows data for 26, and each figure

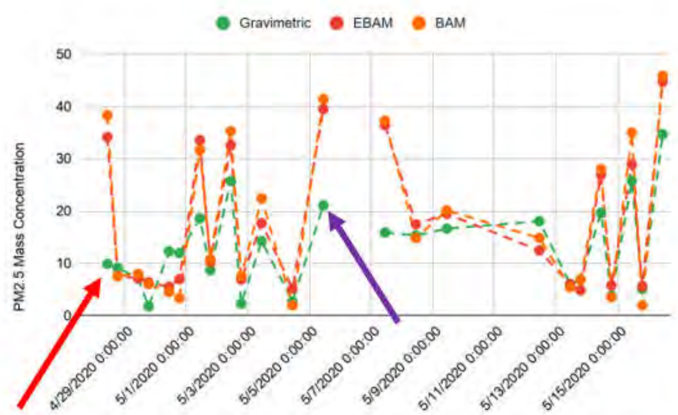


Figure 1. Time series of PM2.5 mass concentrations [µg $m^{-3}$] by Gravimetric, EBAM, and BAM methods at CDF for sampling from 27 April to 17 May 2020.

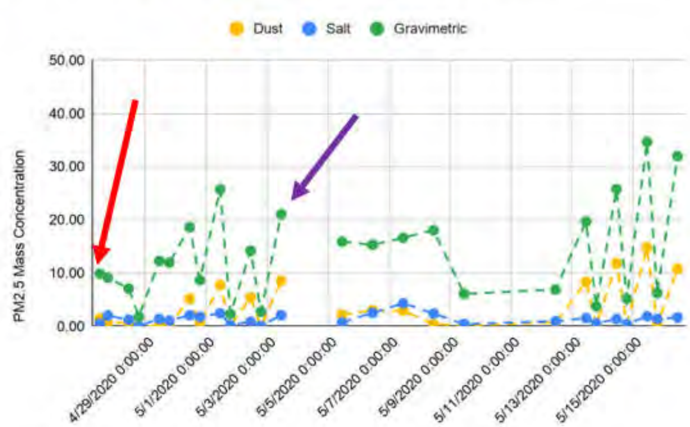


Figure 3. Time series of PM2.5 mass concentrations [µg $m^{-3}$] for Dust, Salt and Gravimetric (total) concentrations at CDF for sampling from 27 April to 17 May 2020.

contains at least a couple samples not included in the other. It is not explained why some samples are included in one figure but not the other. More critically, **the same samples are shown as starting at different times in the figures.** For example, the first sample in Figure 1, which has a gravimetric mass about 10 μg/m$^3$, is shown as starting in the afternoon of April 28$^{th}$. In Figure 3, this same sample is show as starting on the afternoon of April 27$^{th}$. See red arrows in the figure above. Similarly, in Figure 1 the last sample before the discontinuity in the middle of the graph has a gravimetric mass of about 21 or 22 μg/m$^3$ and appears to start in the afternoon of May 5$^{th}$. The corresponding sample in Figure 3 is shown as starting in the afternoon of May 3$^{rd}$. (Purple arrows).

- **Figure 1: BAM Masses.** Values from the District's BAM at CDF are shown in orange in this figure and presumably they were downloaded from the CARB website; however, at least some of these values are incorrect. For example, the very first BAM concentration in Figure 1 is depicted as about 38 or 39 μg/m$^3$, but there are not six to eight consecutive hours on April 27$^{th}$ or 28$^{th}$ which average to this value. Similarly, the figure depicts a BAM value about 36 μg/m$^3$ for a sample starting on the afternoon of May 3, but there are not six to eight consecutive hours on May 2$^{nd}$ through 5$^{th}$ which average to this value.

- **Figure 2: Gravimetric Masses and $R^2$.** Figure 2 is a scatter plot of Scripps's gravimetric masses plotted against the District's BAM masses. Figure 1 shows only one sample in which the gravimetric mass exceeded 30 μg/m$^3$ yet Figure 2 shows two samples with gravimetric masses greater than 30 μg/m$^3$. Also, according the figure legend, the $R^2$ of the correlation is 0.688, but the caption says it 0.687.

- **Figure 5: Sample Dates.** According to the text, "[t]he Beach site was sampled from 28 April to 16 May 2020;" however, Figure 5 shows the first sample as starting on April 30$^{th}$.

In addition to these inconsistencies with certain figures, we note that the report's References section lists 29 references, but only 13 of them are cited in the report.

# Reconciling the Scripps Results with Previous Studies

The Scripps Study is not the first to speciate $PM_{2.5}$ samples collected downwind of the Oceano Dunes, and its results are inconsistent with previous studies. The District's "Phase 1 Study,"[17] speciated $PM_{2.5}$ samples collected at three sites in 2004 and 2005. While none were collected at CDF, the Bendita and Mesa2 sites were nearby. On days with high wind and high $PM_{10}$ levels, speciation of $PM_{2.5}$ samples from these sites indicated that about half of the $PM_{2.5}$ mass was from crustal materials, consistent with being derived from sand or soil. On the day with the highest $PM_{2.5}$ mass in the study (May 9, 2004), 60 to 70% of the $PM_{2.5}$ mass at these sites was from crustal materials, and

[17] SLOCAPCD (2007). "NIPOMO MESA PARTICULATE STUDY." Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/APCD%20Exhibit%201%20-%20APCD_Phase1_SouthCountyPMStudy-2007%281%29.pdf.

less than 20% was from sulfate, nitrate, and sea salt. In contrast, on non-windy days with low $PM_{10}$ concentrations, the crustal contribution to $PM_{2.5}$ mass was low to nonexistent, and on an annual average basis, crustal materials contributed about 20 to 25% of $PM_{2.5}$ mass.

The District's "Phase 2 Study,"[18] released in 2010, found similar results: "Elemental analysis from drum sampler data … showed a preponderance of earth crustal elements during episode periods, similar to the Phase 1 analysis; sea salt was also present in the samples."

When describing their elemental analysis results, the Scripps Study uses the term "dust", while the District studies use the term "crustal." Presuming these terms refer to the same thing—namely, particulates derived from sand and/or soil—the Scripps results are inconsistent with these previous studies. As discussed in the report, they found dust contributes only 20% of $PM_{2.5}$ mass on high wind days. In fact, these results appear to be at odds even with the previous Scripps Report, which reported that "[f]or those sample collection days in May 2019, when the BAM PM2.5 exceeded 20 µg m-3, … dust [varied] from 4.1 to 14.4 µg m-3, corresponding to 26% to 46% of BAM PM2.5."[3]

# Miscellaneous Issues

- The cover letter states their results show "that it is incorrect to assume that all PM2.5 measured at CDF monitors is mineral dust." The District has never assumed nor stated that 100% of $PM_{2.5}$ measured at CDF (or anywhere else) is dust. On the contrary and as discussed above, the District has published studies showing that non-crustal materials contribute to $PM_{2.5}$ mass at CDF even on windy days.

- The introduction states that "It is important to note that recreational vehicles were not allowed during this period because of COVID-19 restrictions that had been in place since March 2020." Later, in the conclusions it states, "The association of high PM10 and PM2.5 with high wind conditions, even when recreational vehicles were not allowed at Oceano Dunes, indicates that dune-derived mineral dust is more likely to be caused by natural forces (i.e. wind) rather than human activities. … [T]he high dust concentrations measured on high wind days in and downwind of Oceano Dunes are likely dominated by natural saltation processes associated with the indigenous geomorphological dune structure."

  The author appears to misunderstand how OHV activity contributes to the high $PM_{10}$ levels measured downwind of the ODSVRA. As the District has stated elsewhere, "it is not the dust kicked up by OHV activity (i.e. 'rooster tails') that causes poor air quality downwind, nor is it their tailpipe emissions. Rather, it is the secondary effects to vegetation and dune shapes that leads to greater wind erosion and more dust when the wind blows. It is true that without wind, there would be no significant dust, but changes to key vegetation areas and

[18] SLOCAPCD (2010). "SOUTH COUNTY PHASE 2 PARTICULATE STUDY," February 2010. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/PM2-final_report_with_appendices.pdf.

dune structures caused by OHVs result in more sand movement and more dust emissions when the wind blows."[19]

The ODSVRA closed to OHV activity on March 27th, just one month before Scripps began sampling, so it unlikely that surface emissivity during their study differed significantly from when OHV activity is allowed. As the SAG noted in a letter dated April 5th, "decades of OHV activity have fundamentally altered the natural beach-dune landscape, making the dunes significantly more susceptible to PM emissions than they would be in a natural state. The SAG does not expect a few weeks or months of temporary OHV restrictions to substantially alter the balance of human versus natural contributions to PM emissions at ODSVRA."[20]

Additionally, if—as the Scripps Report seems to suggest—the dust downwind of the ODSVRA is simply a natural phenomenon unrelated to the long history of OHV activity, this does not explain the observed spatial pattern of $PM_{10}$ in the region. Specifically, the $PM_{10}$ levels observed downwind of the riding area of the ODSVRA (i.e. at the CDF and Mesa2 monitoring stations) are systematically higher than the levels observed downwind of non-riding areas (i.e. at the District's current Oso Flaco site or previous Morro Bay site.)[8,21] This pattern was also documented in the District's "South County Community Monitoring Project"[22] which blanketed the Nipomo Mesa in $PM_{10}$ samplers, as well as in the previously mentioned Phase 1 and Phase 2 studies.[17,18]

- The report discusses 7 $PM_{10}$ samples collected on at the "Beach" site, and states that the collocated gravimetric and E-BAM samples showed a moderate correlation. As discussed in the report for the South County Community Monitoring Project, E-BAMs are known to be biased when sampling $PM_{10}$. Therefore, both District and State Parks have always applied an empirical correction factor to $PM_{10}$ E-BAM data. No correction factor seems to have been applied by Scripps to their E-BAM data.

[19] SLOCAPCD (2020). "Frequently Asked Questions: Air Quality and the Temporary Closure of Oceano Dunes," June 30, 2020. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/June2020FAQ-42.pdf.
[20] Scientific Advisory Group, "Memo: SAG comments on the temporary closure of Oceano Dunes State Vehicular Recreation Area (ODSVRA) and impacts on particulate matter (PM) emissions," April 6, 2020. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/SAG%20Letter.pdf.
[21] SLOCPACD (2013). "Air Quality Trends: San Luis Obispo County: 1991-2011," March 2013. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/Final%20AQ%20Trends%282%29.pdf
[22] SLOCPACD (2013). "South County Community Monitoring Project," January 2013. Available online at https://storage.googleapis.com/slocleanair-org/images/cms/upload/files/Final%20Report.pdf.

UNIVERSITY OF CALIFORNIA, SAN DIEGO
SCRIPPS INSTITUTION OF OCEANOGRAPHY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

14 November 2020

Sarah Miggins, Deputy Director
Off-Highway Motor Vehicle Recreation Division, California Department of Parks and Recreation
1725 23rd Street, Suite 200, Sacramento, CA 95816

Dear Deputy Director Miggins,

I have received a copy of the 30 October 2020 transmittal from Gary Willey of the San Luis Obispo County Air Pollution Control District (APCD) to you regarding my 23 September 2020 report, "UCSD Supplemental Report 2020: Preliminary Results from May 2020 Aerosol Measurements." The transmittal includes reviews of my report by the APCD and the APCD's Scientific Advisory Group (SAG) that make two unsubstantiated claims: (1) that PM2.5 concentrations are not of concern because the focus of regulatory actions by the APCD is PM10; (2) that the instrument I used to segregate PM2.5, a sharp cut cyclone (SCC), is "unconventional and unproven," that the ACPD is "not aware of any other studies" using the SCC to sample PM2.5, per Mr. Willey's transmittal letter. My comments on these claims are:

1) When overall PM measurements were elevated at the APCD CDF site during our May 2020 sampling, hourly concentrations of PM2.5 averaged approximately 25% of the corresponding hourly PM10 concentrations. This 25% is a substantial fraction of overall PM10, and it included only 20% mineral dust. For example, if a PM10 reading is 100 μg $m^{-3}$, the PM2.5 reading would then be 25 μg $m^{-3}$. But based on our findings, only 20% of the PM2.5, or 5 μg $m^{-3}$, is mineral dust and the remaining 20 μg $m^{-3}$ is not mineral dust from the dunes. This means that at most 80 μg $m^{-3}$ of the PM10 value of 100 μg $m^{-3}$ was dune dust. The next priority should be quantitative chemical speciation of PM10 with corresponding gravimetric measurements to identify the mineral dust portion of the remaining 75 μg $m^{-3}$, as to date, to my knowledge, APCD has not considered it a priority to provide this.
2) There are several different cyclone designs for PM size cuts at different flow rates by different manufacturers. The APCD has not documented any measurable differences between the cyclone I used ("SCC") and the cyclone used by the APCD ("VSCC"). An APCD staff member confirmed to me that he has no documentation of the difference. Yet the APCD's primary reason for critiquing my report is that these two instruments, designed and widely used for the same purpose, operate somewhat differently. Also, contrary to Mr. Wiley's letter, the low-flow use of the SCC for PM2.5 sampling is readily documented, both in the specifications of standard PM sampling equipment (https://www3.epa.gov/ttnamti1/files/spectraining/MetOneSASSFOM.pdf) and in CARB-reviewed scientific reports (https://ww2.arb.ca.gov/sites/default/files/classic//research/apr/past/13-330.pdf).

There are also a variety of other minor misinterpretations and misrepresentations of my work in these "reviews" that are too numerous to discuss here, including misreading of simple graphics, misattribution of my motives, and misdirection to cited literature. If Parks would like to contract with me to document these errors, please let me know. Please do not hesitate to contact me if you have any questions (lmrussell@ucsd.edu).

Sincerely,

Lynn M Russell

Professor Lynn M. Russell (858-534-4852)

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**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

# ATTACHMENT 15

**Preliminary Public Relations (PR) Campaign**

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**ODSVRA Air Quality Public Relations Campaign Proposal**
**Proposal for the Science Advisory Group Review**
**September 2021**



The Off-Highway Motor Vehicle Recreation (OHMVR) Division together with Oceano Dunes SVRA are proposing a multi-faceted public relations campaign with the intent of providing messaging to the public and park users about various aspects of the Park's air quality management program.

Previously, an educational video series was proposed to the SAG for review and comment. This proposal has been developed to address comments, to incorporate ideas proposed by the SAG, and to better deliver messaging related to Oceano Dunes' air quality management program across multiple platforms to reach the largest audience. The following proposal includes the potential project, the intended audience, the desired messaging, an estimated timeline for completion, and a short description of the project.

## 1. Digital Two-Page Flyer

*Estimated Timeline to Completion:* Verbiage development and approval by November 10th. Graphic design first draft by January 14th. Department reviewed content and final product by March 1st, 2022.

*Audience:* The digital flyer is intended for Oceano Dunes SVRA park visitors, both long-time and first time-users. The content will be presented at an easily understood level and focus on the main facts of the air quality issues and what Oceano Dunes SVRA is doing to improve air quality downwind of the SVRA.

*Message:* The digital flyer is intended to explain the basics about sand movement in a dune system, how dust is generated and mobilized, explains the Stipulated Order of Abatement in simple terms, and how it translates to management actions implemented at the SVRA.

Following content suggestions by the SAG on the initial PR Campaign proposal, we aim to develop a digital flyer that addresses the points below. A digital flyer is preferable to hard copies to prevent trash accumulation in the park. Additionally, park staff feel that a digital flyer has more opportunity to reach a greater audience given it can be posted across multiple platforms, used during outreach events, and can be tied to existing and future outreach efforts. We plan to post this flyer on the Oceano Dunes SVRA website and across multiple social media accounts that are managed by park staff. The digital flyer could also be converted into hard copies when needed and distributed at events and to visitors who ask for more information on the air quality management program.

The following bullets reflect the content to be included in the digital flyer.

Title: Oceano Dunes SVRA Air Quality Program and Efforts to Minimize Dust

- Oceano Dunes SVRA is located within the Guadalupe-Nipomo Dunes, a large complex of naturally occurring sand dunes spanning 18 miles of the Central Coast of California (Display image showing streams/rivers that transport sediment to bay, display ocean currents, highlight SVRA, and prevailing wind direction).

- Regional air quality monitors have detected high levels of dust downwind of Oceano Dunes SVRA that exceed state standards, which prompted an agreement between San Luis Obispo Air Pollution Control District and California State Parks called a Stipulated Order of Abatement (Insert image of dunes on a windy day/insert image of dust monitor).
- A coordinated effort between Oceano Dunes SVRA staff, researchers, the Science Advisory Group, and other agencies is underway to determine specific areas that generate dust.
- When emissive areas are identified, measures to reduce dust are implemented such as planting native vegetation and fencing the area off to prevent vehicle access (Insert image of dust control project/other vegetated islands).
- Oceano Dunes SVRA staff continues to work with the Scientific Advisory Group and other experts to study the dune system and identify projects to reduce dust downwind of the park.
- Visitors to Oceano Dunes SVRA can help in the following ways:
    - Observe all park signage
    - Respect fences and closed areas – These closed, vegetated areas are the primary means by which the park can reduce dust emissions, and
    - Understand the importance of the air quality program and how it helps protect riding and recreational opportunities at Oceano Dunes SVRA

**2. Social Media Posts**

*Estimated Timeline to Completion:* Subject to approval of final language in other proposed PR products, March 1st.

*Audience:* All park visitors.

- *Message:* Short, concise statements of how the park's visitors can help support Oceano Dunes air quality management program. "Help support Oceano Dunes SVRA through the following actions: Observe signage, respect fences and closed areas, understand the importance of the air quality program and how it helps protect riding and recreational opportunities at Oceano Dunes SVRA."

Direct social media posts that are synthesized from other PR products discussed in this proposal can be posted across multiple social media platforms managed by Parks at a given time.

**3. Air Quality Specific Video**

*Estimated Timeline to Completion:* By November 10th, have final version of script ready for filming. Final video by the end of December 2021. Deploy video via social media by January 14th, 2022.

*Audience:* The air quality specific video would be intended to reach all park visitors as well as the general public in communities around Oceano Dunes SVRA.

*Message:* The air quality specific video will provide a broad overview of the Oceano Dunes' air quality management program, delivered in a short 30 second to a one-minute video. This video is intended to be a high-level synopsis of the program and discuss why it is key to protecting park resources, reducing dust downwind of the SVRA, and ensuring future off-highway vehicle opportunities at the dunes.

The air quality program specific video will discuss the actions Oceano Dunes SVRA is taking towards compliance with the Stipulated Order of Abatement and would cover similar topics discussed in the digital flyer. The following are proposed main points of the video:

- Introduce the air quality program, brief discussion of the issue at hand, introduce the SOA, and highlight the importance of compliance with the SOA (protecting park resources, improving downwind air quality, and keeping OHV recreation available).
- Introduce dune stabilization concept to reduce dust from the dunes, provide a high-level overview of how projects are identified, and introduce the Science Advisory Group.
- What visitors can do to help? (observe signage, respect fences and closed areas, and understand the importance of the air quality program).

Key to the success of this video is to keep it concise and high-level. The information will be presented at a level at which all viewers could understand why there are closures in the dunes, the importance of the closures, and how the public can help.

**4. Frequently Asked Questions Sheet**

*Estimated Timeline to Completion:* Final, reviewed FAQs and answers developed by November 10th. Post FAQs on website by November 30th. Use as an additional resource to post on social media by March 1st.

*Audience:* Park visitors seeking specific information regarding operations at the SVRA and the public seeking answers specific to management actions aimed at improving downwind air quality.

*Message:* The message would be delivered in a simple question and answer format and would be intended to answer the 'why' questions the public may have. Information, presented in the form of answers, will provide greater detail than what is presented in other proposed PR products.

A FAQ sheet will be developed with specific information about the air quality management program that the public may be seeking answers to. The FAQ sheet could be presented in both digital and hard copy formats. Similar to the digital flyer, the fact sheet would be accessible across online and social media platforms.

Potential Examples include:

*What is the Stipulated Order of Abatement and what does it mean for Oceano Dunes SVRA?*
*Why are there dust concerns?*

*What is causing the dust?*

*Why is there less riding available on the dunes?*

*Is the dust generated from the dunes natural?*

*What areas of the park are contributing to the dust?*

*What steps are taken to reduce dust emissions?*

*How do OHVs contribute to dust?*

*What can the public do to help?*

*Who is the Science Advisory Group and how are they involved?*

*Are the closures reducing dust?*

**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

# ATTACHMENT 16

**2021/2022 Planting Projects List**

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| FY2021/2022 Project List (subject to change) | | | | | | |
|---|---|---|---|---|---|---|
| **Project Name** | **Project Acreage** | **Total Plants** | **Plants Per Acre** | **Native Seed (lbs)** | **Native Seed (lbs) per Acre** | **Large Bales** |
| **New Planting Areas** | | | | | | |
| **1. Eucalyptus Tree North** | 4.7 | 11745 | 2499 | 55.93 | 11.90 | 51.70 |
| **2. Eucalyptus Tree (western)** | 5.8 | 14494 | 2499 | 69.02 | 11.90 | 63.80 |
| **3. Eucalyptus Tree (eastern)** | 3.2 | 1632 | 510 | 27.04 | 8.45 | |
| **4. South Eucalyptus Tree (eastern)** | 2.7 | 1377 | 510 | 22.82 | 8.45 | |
| **5. APCD Area 2/LaGrille** | 20 | 51360 | 2568 | 176.60 | 8.83 | 220.00 |
| **6. Boy Scout Camp** | 6.4 | 15994 | 2499 | 56.51 | 8.83 | 70.40 |
| **7. Orion Northern** | 5 | 4900 | 980 | 44.15 | 8.83 | |
| **8. Orion Southern** | 5.6 | 5488 | 980 | 49.45 | 8.83 | |
| **Subtotal** | 53.40 | 106990 | | 501.52 | 9.39 | 406 |
| **Supplemental Areas** | | | | | | |
| **9. Boy Scout Camp (non-APCD Area)** | 2.0 | 4998 | 2499 | 17.66 | 8.83 | 22.00 |
| **10. Eucalyptus Tree North** | 1.0 | 2499 | 2499 | 8.45 | 8.45 | 11.00 |
| **11. Eucalyptus Tree** | 1.0 | 2499 | 2499 | 8.45 | 8.45 | 11.00 |
| **12. APCD Area 10** | 18.4 | | | 131.42 | 7.15 | |
| **13. APCD Area 11** | 4.2 | | | 29.82 | 7.15 | |
| **14. APCD Area 12** | 4.0 | | | 28.74 | 7.15 | |
| **Subtotal** | 30.6 | 9996 | | 224.5 | 7.34 | 44 |
| **Totals** | **84.0** | **116986** | | **726** | **8.65** | **450** |
| **Updated 24 June 2021** | | | | | | |

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**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

# ATTACHMENT 17

**Modeled PM10 Mass Emissions and Concentration Reductions Estimates (2021/2022)**

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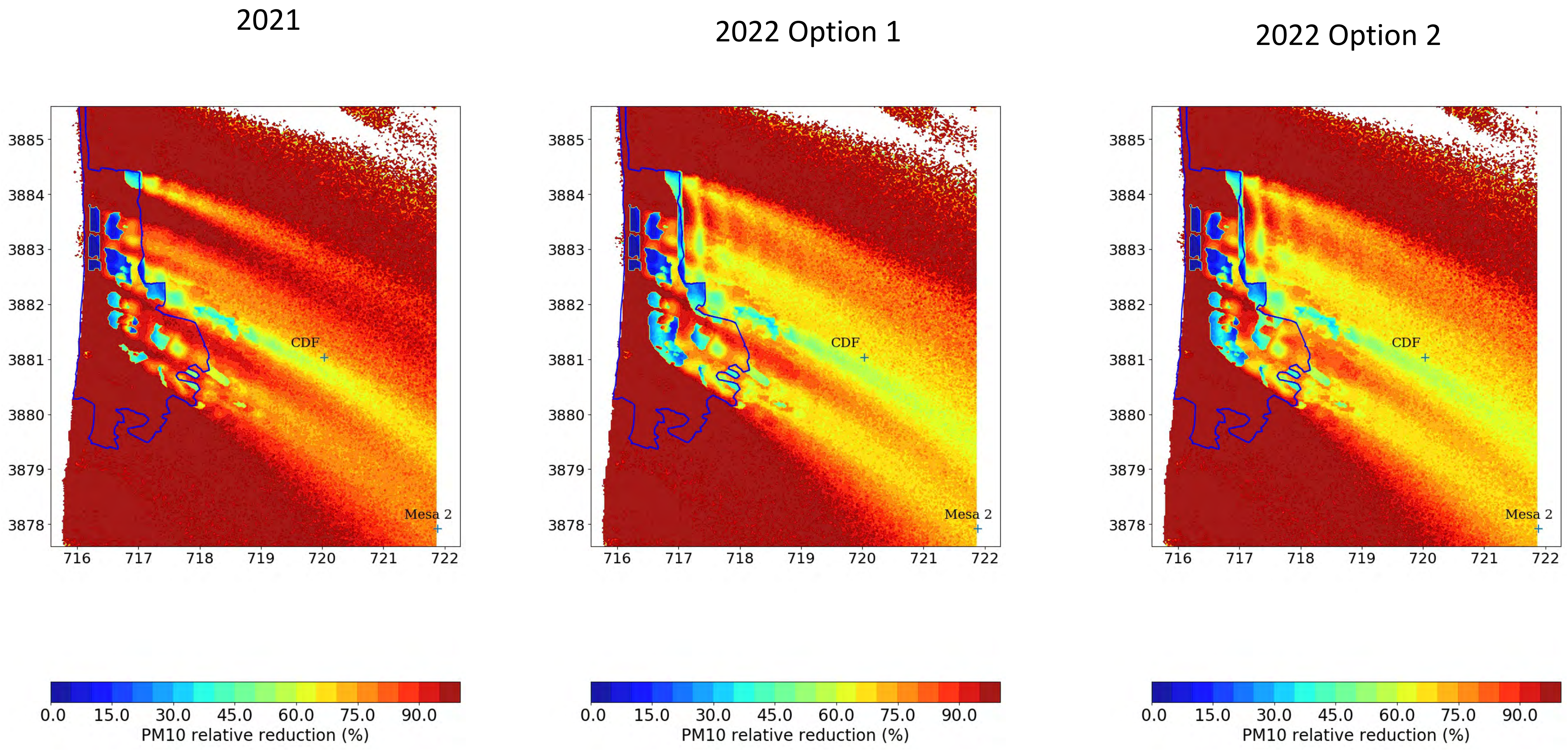
| Scenario | Polygon ID | Name area | Description | Year implemented | Year Removed | Status | Area Polygon [Acres] | Area Model [Acres] | Area treated [Acres] | Riding and non-riding areas | | | | Riding areas only | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Emissions [Metric Tons/day] | Abatement [Metric Tons/day] | Cumulative Abatement [Metric Tons/day] | Cumulative Abatement [%] | Emissions [Metric Tons/day] | Abatement [Metric Tons/day] | Cumulative Abatement [Metric Tons/day] | Cumulative Abatement [%] |
| Pre2020 | 55 | straw bales n | Removed | 2011 | | Removed | 1.0 | 1.1 | 1.1 | 243.5 | 0.0 | 0.0 | 100.0 | 182.8 | 0.0 | 0.0 | 100.0 |
| Pre2020 | 53 | APCD Test Plo | APCD Test Plot | 2012 | | Permanent | 1.1 | 1.1 | 0.0 | 243.5 | 0.0 | 0.0 | 100.0 | 182.8 | 0.0 | 0.0 | 100.0 |
| Pre2020 | 54 | Enigma | Enigma | 2013 | | Permanent | 2.0 | 2.0 | 0.3 | 243.5 | 0.0 | 0.0 | 100.0 | 182.8 | 0.0 | 0.0 | 100.0 |
| Pre2020 | 52 | Crescent | Crescent | 2013 | | Permanent | 1.8 | 1.9 | 0.1 | 243.5 | 0.0 | 0.0 | 100.0 | 182.8 | 0.0 | 0.0 | 100.0 |
| Pre2020 | 3 | '14 | Removed | 2014 | 2014 | Removed | 13.5 | 13.5 | 0.0 | 243.5 | 0.0 | 0.0 | 100.0 | 182.8 | 0.0 | 0.0 | 100.0 |
| Pre2020 | 47 | Trial area 201 | Schnauzer | 2014 | | Permanent | 30.1 | 29.9 | 28.0 | 242.2 | 1.3 | 1.3 | 99.5 | 182.8 | 0.0 | 0.0 | 100.0 |
| Pre2020 | 2 | '15 | Removed | 2015 | 2015 | Removed | 36.6 | 37.2 | 0.0 | 242.2 | 0.0 | 1.3 | 99.5 | 182.8 | 0.0 | 0.0 | 100.0 |
| Pre2020 | 4 | '16 | Removed | 2016 | 2016 | Removed | 41.3 | 42.2 | 0.0 | 242.2 | 0.0 | 1.3 | 99.5 | 182.8 | 0.0 | 0.0 | 100.0 |
| Pre2020 | 5 | | PREs | 2016 | | Removed | 0.7 | 0.8 | 0.0 | 242.2 | 0.0 | 1.3 | 99.5 | 182.8 | 0.0 | 0.0 | 100.0 |
| Pre2020 | 8 | | PREs | 2017 | | Removed | 0.7 | 0.8 | 0.0 | 242.2 | 0.0 | 1.3 | 99.5 | 182.8 | 0.0 | 0.0 | 100.0 |
| Pre2020 | 45 | Dust reductior | La Grille Hill | 2017 | | Permanent | 9.1 | 8.8 | 2.6 | 240.8 | 1.5 | 2.8 | 98.9 | 182.8 | 0.0 | 0.0 | 100.0 |
| Pre2020 | 44 | Dust reductior | Pawprint | 2017 | | Permanent | 9.3 | 9.4 | 9.4 | 239.4 | 1.3 | 4.1 | 98.3 | 181.4 | 1.4 | 1.4 | 99.2 |
| Pre2020 | 48 | SAO installed | Removed | 2018 | 2018 | Removed | 9.0 | 9.4 | 0.0 | 239.4 | 0.0 | 4.1 | 98.3 | 181.4 | 0.0 | 1.4 | 99.2 |
| Pre2020 | 46 | Dust reductior | Bigfoot | 2018 | | Permanent | 28.6 | 28.0 | 23.5 | 234.9 | 4.5 | 8.7 | 96.4 | 176.7 | 4.7 | 6.1 | 96.7 |
| Pre2020 | 40 | Stipulated Ab | Bigfoot Addition | 2018 | | Permanent | 6.6 | 7.0 | 2.2 | 233.8 | 1.0 | 9.7 | 96.0 | 175.6 | 1.1 | 7.1 | 96.1 |
| Pre2020 | 42 | Stipulated Ab | Eucalyptus Tree | 2018 | | Permanent | 7.9 | 8.0 | 8.0 | 232.9 | 1.0 | 10.6 | 95.6 | 174.7 | 1.0 | 8.1 | 95.6 |
| Pre2020 | 41 | Stipulated Ab | Eucalyptus North | 2018 | | Permanent | 9.1 | 8.8 | 8.8 | 231.9 | 1.0 | 11.6 | 95.2 | 173.7 | 1.0 | 9.1 | 95.0 |
| Pre2020 | 39 | Stipulated Ab | BBQ Flats | 2018 | | Permanent | 27.0 | 26.8 | 26.8 | 228.0 | 4.0 | 15.6 | 93.6 | 169.6 | 4.1 | 13.2 | 92.8 |
| Pre2020 | 43 | Stipulated Ab | Tabletop | 2018 | | Permanent | 5.5 | 5.4 | 5.4 | 227.0 | 1.0 | 16.6 | 93.2 | 168.5 | 1.0 | 14.2 | 92.2 |
| Pre2020 | 51 | Foredune Dec | Foredune North | 2019 | | Permanent | 19.1 | 19.3 | 19.3 | 223.7 | 3.3 | 19.8 | 91.9 | 165.2 | 3.4 | 17.6 | 90.4 |
| Pre2020 | 49 | Foredune Dec | Foredune South | 2019 | | Permanent | 9.9 | 9.9 | 9.9 | 221.9 | 1.8 | 21.7 | 91.1 | 163.3 | 1.9 | 19.5 | 89.3 |
| Pre2020 | 50 | Foredune Dec | Foredune Centra | 2019 | | Permanent | 19.0 | 19.4 | 19.4 | 218.7 | 3.2 | 24.8 | 89.8 | 160.0 | 3.3 | 22.8 | 87.5 |
| Pre2020 | 11 | Wind Fence | Wind Fence 202( | 2020 | | Wind Fence | 20.5 | 21.0 | 21.0 | 216.4 | 2.3 | 27.1 | 88.9 | 158.0 | 2.1 | 24.8 | 86.4 |
| Pre2020 | 10 | Wind Fence | Wind Fence 202( | 2020 | | Wind Fence | 19.8 | 19.9 | 2.6 | 214.4 | 2.0 | 29.1 | 88.1 | 155.9 | 2.1 | 26.9 | 85.3 |
| Pre2020 | 9 | Vegetation | Permanent 2020 | 2020 | | Permanent | 4.1 | 4.0 | 0.2 | 213.9 | 0.6 | 29.7 | 87.8 | 155.3 | 0.6 | 27.5 | 85.0 |
| 2021 | 71 | Actual GPSd | Temporary Vehic | 2021 | | Permanent | 2.8 | 2.9 | 2.9 | 213.2 | 0.7 | 30.3 | 87.5 | 154.6 | 0.7 | 28.2 | 84.6 |
| 2021 | 56 | Proposed shap | Wind Fence | 2021 | | Wind Fence | 10.8 | 10.8 | 10.7 | 211.1 | 2.1 | 32.5 | 86.7 | 152.4 | 2.2 | 30.4 | 83.4 |
| 2021 | 57 | Proposed shap | Wind Fence | 2021 | | Wind Fence | 21.7 | 21.8 | 21.5 | 208.3 | 2.8 | 35.3 | 85.5 | 149.6 | 2.9 | 33.2 | 81.8 |
| 2021 | 63 | Proposed shap | Straw | 2021 | | Permanent | 5.6 | 5.8 | 5.8 | 207.7 | 0.6 | 35.9 | 85.3 | 148.9 | 0.6 | 33.9 | 81.5 |
| 2021 | 64 | Proposed shap | Straw | 2021 | | Permanent | 5.0 | 5.1 | 5.1 | 207.1 | 0.6 | 36.4 | 85.0 | 148.3 | 0.6 | 34.5 | 81.1 |
| 2021 | 65 | Proposed | Seed | 2021 | | Permanent | 4.2 | 4.4 | 4.4 | 206.9 | 0.2 | 36.7 | 84.9 | 148.3 | 0.0 | 34.5 | 81.1 |
| 2021 | 66 | Proposed | Seed | 2021 | | Permanent | 4.0 | 4.0 | 4.0 | 206.7 | 0.2 | 36.9 | 84.9 | 148.3 | 0.0 | 34.5 | 81.1 |
| 2021 | 67 | Proposed | Seed | 2021 | | Permanent | 18.4 | 18.3 | 17.9 | 205.8 | 0.9 | 37.8 | 84.5 | 148.3 | 0.0 | 34.5 | 81.1 |
| 2021 | 68 | Actual GPSd | Straw | 2021 | | Permanent | 4.7 | 4.6 | 4.2 | 205.3 | 0.5 | 38.2 | 84.3 | 147.9 | 0.5 | 34.9 | 80.9 |
| 2021 | 69 | Actual GPSd | Straw | 2021 | | Permanent | 5.5 | 5.4 | 5.4 | 204.4 | 1.0 | 39.2 | 83.9 | 146.9 | 1.0 | 35.9 | 80.3 |
| 2021 | 70 | Actual GPSd | Temporary Vehic | 2021 | | Permanent | 3.2 | 3.3 | 3.2 | 203.6 | 0.8 | 39.9 | 83.6 | 146.1 | 0.8 | 36.7 | 79.9 |
| 2021 | 72 | Actual GPSd | Straw | 2021 | | Permanent | 6.5 | 6.5 | 6.0 | 202.8 | 0.8 | 40.8 | 83.3 | 145.2 | 0.8 | 37.6 | 79.4 |
| 2022 | 53 | Option 1 | Area 2 | 2022 | | Planned | 18.5 | 18.7 | TBD | 201.3 | 1.4 | 42.2 | 82.7 | 143.9 | 1.4 | 38.9 | 78.7 |
| 2022 | 54 | Option 1 | Area 3 | 2022 | | Planned | 34.9 | 35.2 | TBD | 194.3 | 7.0 | 49.3 | 79.8 | 136.6 | 7.3 | 46.2 | 74.7 |
| 2022 | 56 | Option 1 | Area 1 | 2022 | | Planned | 38.2 | 37.5 | TBD | 187.6 | 6.7 | 55.9 | 77.0 | 131.9 | 4.7 | 50.9 | 72.2 |
| 2022 | 57 | Option 1 | Area 4 | 2022 | | Planned | 2.8 | 2.6 | TBD | 187.0 | 0.6 | 56.5 | 76.8 | 131.3 | 0.6 | 51.5 | 71.8 |
| 2022 | 60 | Option 1 | Area 3 | 2022 | | Planned | 3.2 | 2.9 | TBD | 186.3 | 0.8 | 57.3 | 76.5 | 130.5 | 0.8 | 52.2 | 71.4 |
| 2022 | 56 | Option 2 | Area 1 | 2022 | | Planned | 38.2 | 37.5 | TBD | 196.1 | 6.7 | 47.4 | 80.5 | 140.5 | 5.5 | 43.1 | 76.9 |
| 2022 | 57 | Option 2 | Area 4 | 2022 | | Planned | 2.8 | 2.6 | TBD | 195.5 | 0.6 | 42.8 | 80.3 | 140.0 | 0.6 | 43.7 | 76.6 |
| 2022 | 58 | Option 2 | Area 3 | 2022 | | Planned | 32.4 | 32.6 | TBD | 188.9 | 6.6 | 55.9 | 77.6 | 133.1 | 6.8 | 50.5 | 72.8 |
| 2022 | 59 | Option 2 | Area 2 | 2022 | | Planned | 24.7 | 25.1 | TBD | 186.9 | 2.0 | 57.9 | 76.7 | 131.2 | 1.9 | 52.5 | 71.8 |



2021
2022 Option 1
2022 Option 2
3885
3884
3883
3882
3881
3880
3879
3878
716
717
718
719
720
721
722
CDF
Mesa 2
0.0
15.0
30.0
45.0
60.0
75.0
90.0
PM10 relative reduction (%)

# Concentration reductions (2013 emissions) Mean 15 May- 15 July & 10 baseline days

## CDF

| Concentration at CDF (24-hour means) | PM10 [microg/m^3] | % left after Removing |
|---|---|---|
| Mean 15 May-15 July | | |
| Observations | 52.4 | |
| Modeled Baseline | 51.1 | 100.0 |
| Modeled Removing 2011-2020 | 33.8 | 62.5 |
| Modeled Removing 2011-2021 | 33.5 | 65.5 |
| 2022 Option 1 | 30.9 | 60.5 |
| 2022 Option 2 | 30.9 | 60.4 |
| | | |
| 10 Highest Emission Days | PM10 [microg/m^3] | % left after Removing |
| Observations | 128.2 | |
| Modeled Baseline | 124.7 | 100.0 |
| Modeled Removing 2011-2020 | 72.4 | 58.1 |
| Modeled Removing 2011-2021 | 72.2 | 57.9 |
| 2022 Option 1 | 66.0 | 52.9 |
| 2022 Option 2 | 66.4 | 53.2 |

## Mesa 2

| Concentration at Mesa 2 (24-hour means) | PM10 [microg/m^3] | % left after Removing |
|---|---|---|
| Mean 15 May-15 July | | |
| Observations | 39.7 | |
| Modeled Baseline | 34.4 | 100.0 |
| Modeled Removing 2011-2020 | 32.2 | 93.6 |
| Modeled Removing 2011-2021 | 27.1 | 78.8 |
| 2022 Option 1 | 24.3 | 70.7 |
| 2022 Option 2 | 24.4 | 71.1 |
| | | |
| 10 Highest Emission Days | PM10 [microg/m^3] | % left after Removing |
| Observations | 95.4 | |
| Modeled Baseline | 97.5 | 100.0 |
| Modeled Removing 2011-2020 | 91.2 | 93.6 |
| Modeled Removing 2011-2021 | 73.8 | 75.8 |
| 2022 Option 1 | 65.7 | 67.5 |
| 2022 Option 2 | 65.5 | 67.2 |

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**Oceano Dunes State Vehicular Recreation Area Dust Control Program**

**Conditional Approval Draft 2021 Annual Report and Work Plan**

**ATTACHMENT 18**

**DRI Estimate of Additional Treatment Area to Reach the Stipulated Order of Abatement 50% Goal**

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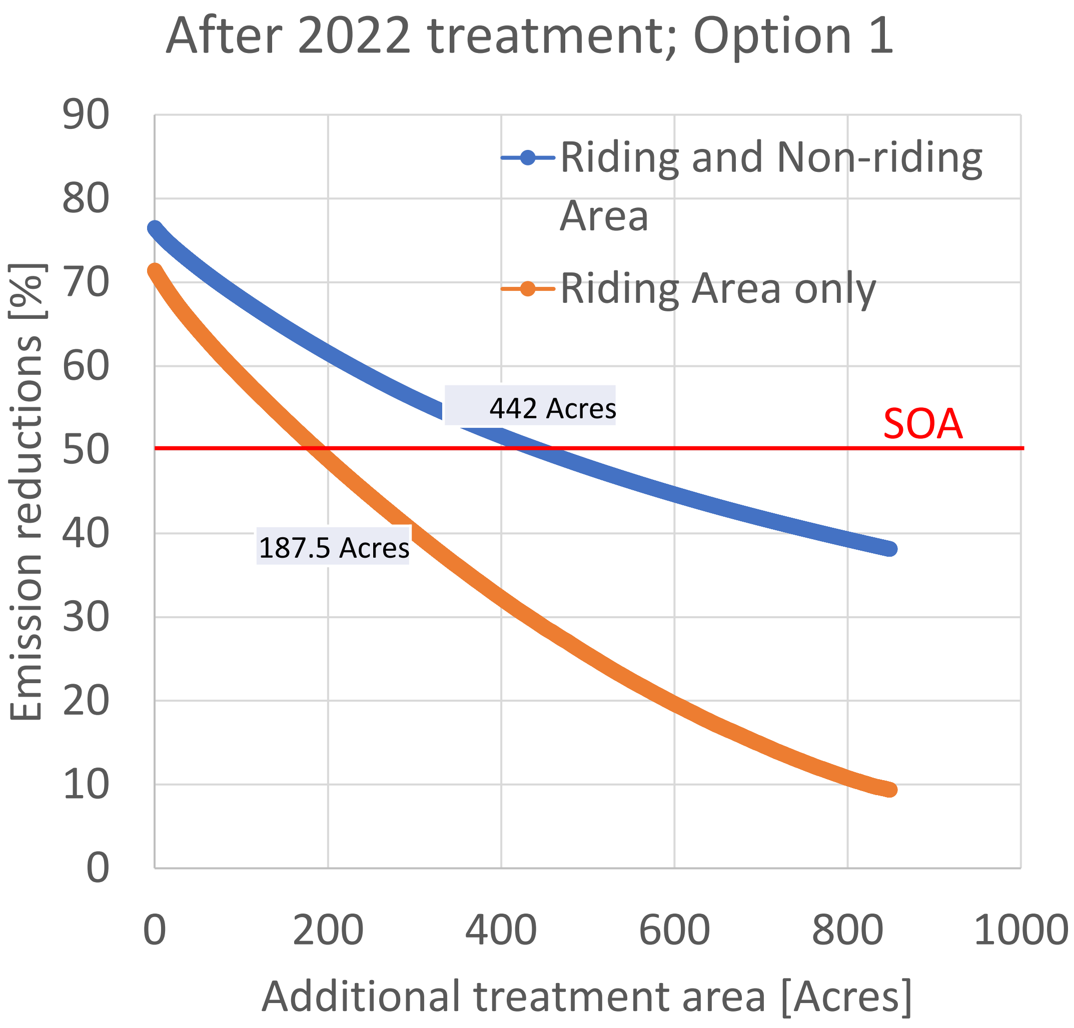
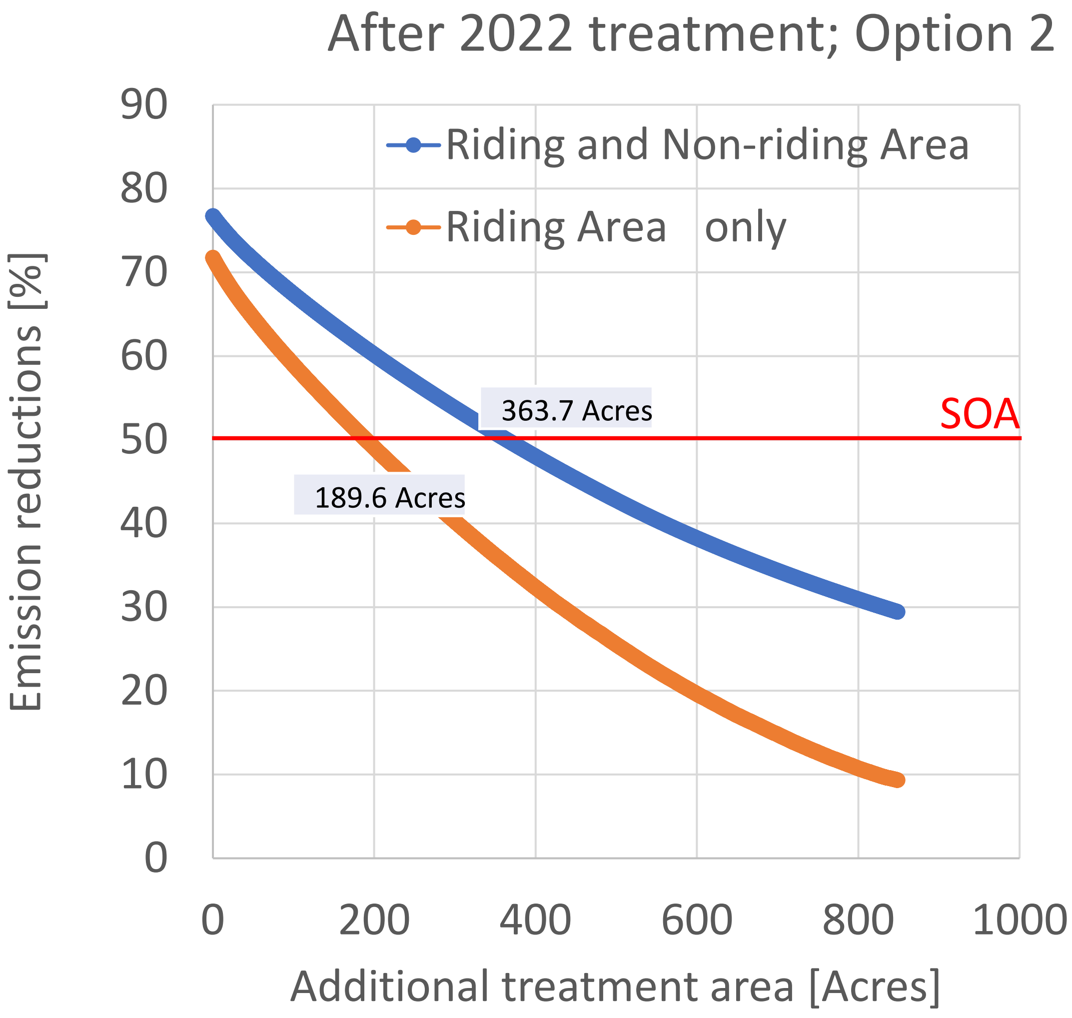
# Additional treatment area to reach the Stipulated Order of Abatement (SOA) 50% goal



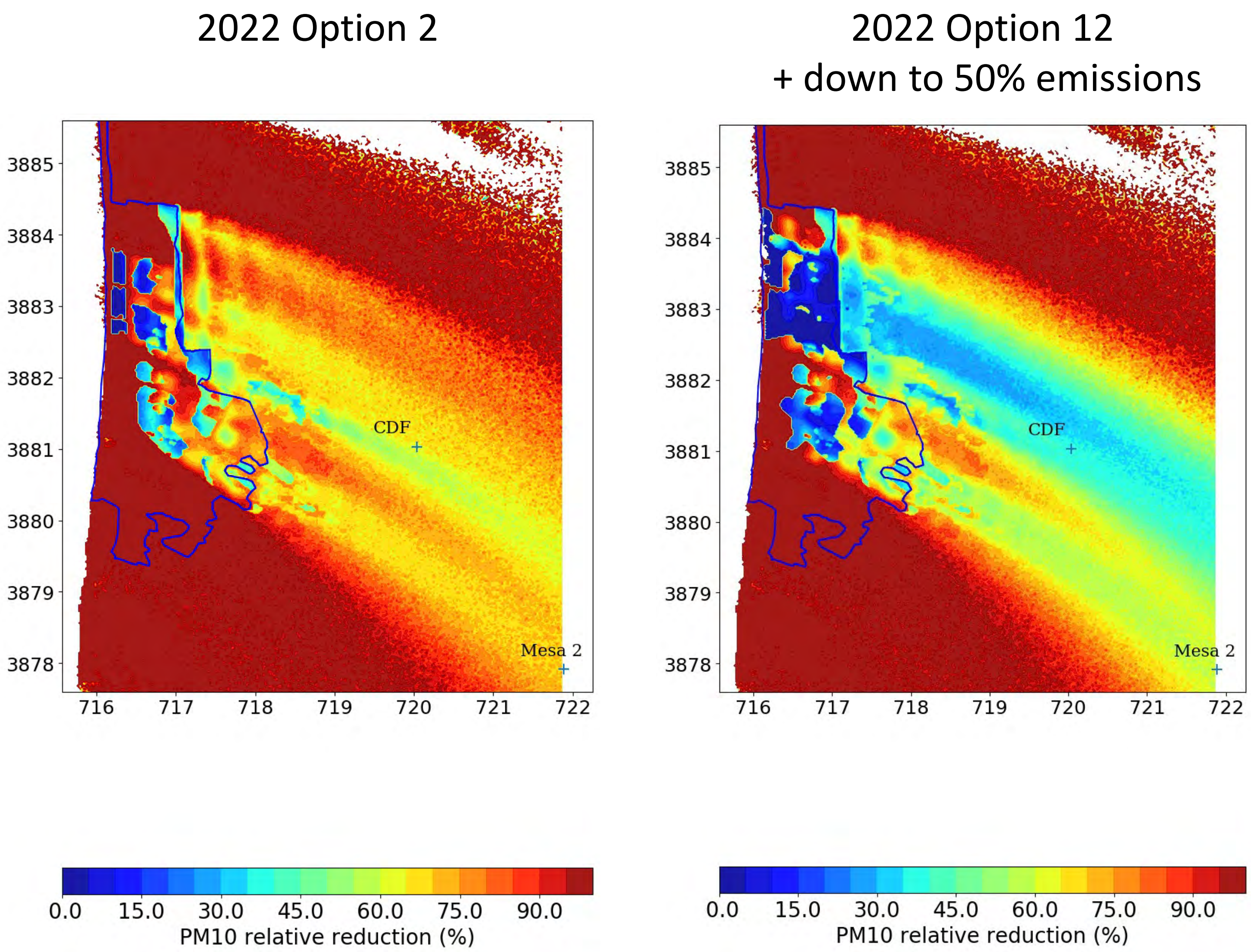
# Concentration reductions (2013 emissions) Mean 15 May- 15 July & 10 baseline days

## CDF

| Concentration at CDF (24-hour means) | PM10 [microg/m^3] | % left after Removing |
|---|---|---|
| Mean 15 May-15 July | | |
| Observations | 52.4 | |
| Modeled Baseline | 51.1 | 100.0 |
| Modeled Removing 2011-2020 | 33.8 | 62.5 |
| Modeled Removing 2011-2021 | 33.5 | 65.5 |
| 2022 Option 1 | 30.9 | 60.5 |
| 2022 Option 2 | 30.9 | 60.4 |
| 2022 Option 2 + Down to 50% mass emissions | 21.3 | 41.8 |
| | | |
| 10 Highest Emission Days | PM10 [microg/m^3] | % left after Removing |
| Observations | 128.2 | |
| Modeled Baseline | 124.7 | 100 |
| Modeled Removing 2011-2020 | 72.4 | 58 |
| Modeled Removing 2011-2021 | 72.2 | 58 |
| 2022 Option 1 | 66.0 | 52.9 |
| 2022 Option 2 | 66.4 | 53 |
| 2022 Option 2 + Down to 50% mass emissions | 38.4 | 30.8 |

## Mesa 2

| Concentration at Mesa 2 (24-hour means) | PM10 [microg/m^3] | % left after Removing |
|---|---|---|
| Mean 15 May-15 July | | |
| Observations | 39.7 | |
| Modeled Baseline | 34.4 | 100.0 |
| Modeled Removing 2011-2020 | 32.2 | 93.6 |
| Modeled Removing 2011-2021 | 27.1 | 78.8 |
| 2022 Option 1 | 24.3 | 70.7 |
| 2022 Option 2 | 24.4 | 71.1 |
| 2022 Option 2 + Down to 50% mass emissions | 20.9 | 60.8 |
| | | |
| 10 Highest Emission Days | PM10 [microg/m^3] | % left after Removing |
| Observations | 95.4 | |
| Modeled Baseline | 97.5 | 100.0 |
| Modeled Removing 2011-2020 | 91.2 | 93.6 |
| Modeled Removing 2011-2021 | 73.8 | 75.8 |
| 2022 Option 1 | 65.7 | 67.5 |
| 2022 Option 2 | 65.5 | 67.2 |
| 2022 Option 2 + Down to 50% mass emissions | 54.8 | 56.2 |



2022 Option 2
2022 Option 12
+ down to 50% emissions
3885
3884
3883
3882
3881
3880
3879
3878
716
717
718
719
720
721
722
CDF
Mesa 2
0.0
15.0
30.0
45.0
60.0
75.0
90.0
PM10 relative reduction (%)

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