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

Draft 2025 Annual Report and Work Plan

August 15, 2025



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

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Oceano Dunes State Vehicular Recreation Area Dust Control Program Draft 2025 Annual Report and Work Plan

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2025 Annual Report and Work Plan Attachments (Separate Documents)

Attachment 01: 2011 to 2025 Dust Control Projects

Attachment 02: 2024/2025 ODSVRA Dust Control Program Vegetation Restoration Projects
(State Parks' ARWP Work Product)

Attachment 03: Report of Findings: ODSVRA Meteorological and PM₁₀ Monitoring Network, 2024

- Report of Findings: ODSVRA Meteorological and PM₁₀ Monitoring Network, 2024 (DRI Document)
- SAG Review of Desert Research Institute (DRI) "Report of Findings: ODSVRA Meteorological and PM₁₀ Monitoring Network, 2024" (SAG Memo)

Attachment 04: UCSB 2024-2025 ODSVRA Foredune Restoration UAS Survey Report

- UCSB 2024-2025 ODSVRA Foredune Restoration UAS Survey Report (UCSB Report)
- SAG Review of UCSB Report "2024-2025 ODSVRA Foredune Restoration UAS Monitoring Report" (SAG Memo)

Attachment 05: ODSVRA Emissivity PI-SWERL Update Report (2013-2024)

- ODSVRA Emissivity PI-SWERL Update Report (2013-2024) (SAG Document)

Attachment 06: Evaluation of Potential Changes in Dust Emissions due to Mechanical Raking of ODSVRA Beach Areas

- Evaluation of Potential Changes in Dust Emissions due to Mechanical Raking of ODSVRA Beach Areas (DRI Document)
- SAG Review of DRI Document "Evaluation of Potential Changes in Dust Emissions due to Mechanical Raking of ODSVRA Beach Areas" (SAG Memo)

Attachment 07: Summary of Vegetation Monitoring of Restoration Sites at ODSVRA (2024)
(State Parks' ARWP Work Product)

Attachment 08: Increments of Progress Toward Air Quality Objectives, ODSVRA Dust Control 2024 Update

- Increments of Progress Toward Air Quality Objectives, ODSVRA Dust Control 2024 Update (DRI Document)
- SAG Review of DRI "Increments of Progress Toward Air Quality Objectives, ODSVRA Dust Control 2024 Update" (SAG Memo)

Attachment 09: Recent (2020-2024) Changes in Vegetation Cover within the Oceano Dunes SVRA

- Recent (2020-2024) Changes in Vegetation Cover within the Oceano Dunes SVRA (UCSB Report)
- SAG Review of UCSB “Recent 2020-2024 Changes in Vegetation Cover within the Oceano Dunes SVRA” (SAG Memo)

Attachment 10: Modeling to Determine the Condition of Excess Emissions for 2025 ODSVRA (DRI Document)

Attachment 11: 2025 PMRP Evaluation Metrics

Attachment 12: 2025/2026 ODSVRA Dust Control Program Vegetation Restoration Projects

List of Abbreviations and Acronyms	
Abbreviation or Acronym	Full Phrase or Description
°	degrees
<	less than
>	greater than
≥	greater than or equal to
u^*	shear velocity
$\mu\text{g m}^{-3}$	micrograms per cubic meter
AGL	above ground level
ARWP	Annual Report and Work Plan
ASU	Arizona State University
B	beach area used in foredune morphological change analysis
BAM	Beta Attenuation Monitor
CAAQS	California Ambient Air Quality Standard
CARB	California Air Resources Board
CDP	Coastal Development Permit
cm	centimeter(s)
DEM	digital elevation model
DTM	digital terrain model
DRI	Desert Research Institute
FAQ	Frequently Asked Questions
FD	foredune area used in foredune morphological change analysis
FEM	Federal Equivalent Method
FRA	foredune restoration area
GCD	geomorphic change detection
GIS	geographic information system
$\text{g m}^{-2} \text{d}^{-1}$	grams per square meter per day
GPS	global positioning system
GSD	ground sampling distance
kg m^{-3}	kilograms per cubic meter
km	kilometer(s)
LD	landward dune area used in foredune morphological change analysis
m	meter(s)

List of Abbreviations and Acronyms	
Abbreviation or Acronym	Full Phrase or Description
m s ⁻¹	meters per second
m ³ m ⁻²	cubic meters per square meter
m ³ m ⁻² mo ⁻¹	cubic meters per square meter per month
mg m ⁻² s ⁻¹	milligrams per square meter per second
NAAQS	National Ambient Air Quality Standard
NDP station	Northern Dune Preserve station
NDVI	Normalized Difference Vegetation Index
NIR	near-infrared
NOF	North Oso Flaco (foredune)
ODSVRA	Oceano Dunes State Vehicular Recreation Area
OHMVR Division	Off-Highway Motor Vehicle Recreation Division
OHV	off-highway vehicle
P66	Phillips 66
Pan	panchromatic
PE	Plover Exclosure
PI-SWRL	Portable In-Situ Wind Erosion Laboratory
PM ₁₀	particulate matter with an aerodynamic diameter of 10 microns or less
PMRP	Particulate Matter Reduction Plan
PPK	post-processing kinematic
PST	Pacific Standard Time
QA/QC	quality assurance/quality control
RE	red edge
RGB	red, green, and blue
RH	relative humidity
RPM	revolutions per minute
SAG	Scientific Advisory Group
SE	Seasonal Exclosure
SLOAPCD	San Luis Obispo County Air Pollution Control District
SOA	Stipulated Order of Abatement
SODAR	sonic detection and ranging
State Parks	California Department of Parks and Recreation

List of Abbreviations and Acronyms	
Abbreviation or Acronym	Full Phrase or Description
SVRA	State Vehicular Recreation Area
TP	treatment plot
TPM ₁₀	Total Hourly PM ₁₀
TWPD	Total Wind Power Density
UAS	uncrewed aerial system
UCSB	University of California, Santa Barbara
USEPA	United States Environmental Protection Agency
W m ⁻²	Watts per square meter
WPD	wind power density

1 INTRODUCTION

The California Department of Parks and Recreation (State Parks) has prepared this 2025 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, October 2022, and October 2024.¹

State Parks' 2025 ARWP is the seventh document summarizing the status and overall progress of the ODSVRA Dust Control Program in meeting SOA requirements.² Each ARWP has applied the best available scientific methods, involving both field data collection and air quality modeling, to prioritize and control emissions of particulate matter with an aerodynamic diameter of 10 microns or less (PM₁₀) from the ODSVRA. Each ARWP has also been prepared in coordination with the SOA Scientific Advisory Group (SAG) and in accordance with SOA requirements; however, the SOA's requirements have changed over time and, accordingly, the contents and information presented in each ARWP have changed over time as well. Each ARWP's introductory chapter has summarized the specific content and information requirements in effect at the time the ARWP was prepared, and the introduction to State Parks' 2024 ARWP provides a succinct discussion of how ARWP information has changed over time.³ Currently, the SOA requires the ODSVRA Dust Control Program to eliminate emissions in excess of naturally occurring emissions from the ODSVRA that contribute to downwind violations of the state and federal PM₁₀ air quality standards. As described in the 2024 ARWP, State Parks has made substantial progress in reducing PM₁₀ emissions, and modeling conducted in accordance with SOA requirements showed the ODSVRA was not in a condition of excess emissions as of July 31, 2024, and was not predicted to be in a condition of excess emissions on July 31, 2025.

This 2025 ARWP describes the continued progress made in reducing PM₁₀ emissions from the ODSVRA. The modeling conducted for this 2025 ARWP shows the ODSVRA is not in a condition of excess emissions as of July 31, 2025, and is not predicted to be in a condition of excess emissions as of July 31, 2026.

¹ The SOA, as amended, is available on the following SLOAPCD website:

<https://www.slocleanair.org/who/board/hearing-board/actions.php>.

² State Parks' 2019 to 2024 ARWP documents are available on the following SLOAPCD website:

<https://www.slocleanair.org/air-quality/oceano-dunes-efforts>.

³ The October 2024 amendments were made after State Parks' 2024 ARWP was submitted to, and conditionally approved by, the SLOAPCD. These amendments extended the term of the SOA through December 2028 but did not materially change ARWP content or information requirements.

The SOA, as amended, generally requires State Parks' ARWP to include a review of dust control progress made over the previous year, a work plan and estimates of progress anticipated to be made for the coming year, and summary budget and schedule information.⁴ Accordingly, this 2025 ARWP is organized as follows:

- **Chapter 2, Annual Report (August 1, 2024, to July 31, 2025)**, describes Dust Control Program activities implemented in the previous 12 months, including progress made toward SOA goals.
- **Chapter 3, Work Plan (August 1, 2025, to July 31, 2026)**, describes the Dust Control Program activities to be undertaken in the coming 12 months, including activities related to the excess emissions compliance framework established by the SOA.
- **Chapter 4, Budgetary Considerations**, describes the estimated budget to develop and implement the 2025/2026 Work Plan.
- **Chapter 5, Implementation Schedule**, presents schedules for the Dust Control Program activities to be initiated, undertaken, and/or completed in the coming 12 months.
- **Attachments 01 – 12** present, in their entirety, important documents that are summarized and/or referenced in this 2025 ARWP. Some of these documents have undergone the scientific review process agreed upon by State Parks and the SAG and, therefore, the SAG's review of these documents is included with this 2025 ARWP.

This 2025 ARWP has been prepared under the supervision of Ronnie Glick, Senior Environmental Scientist, and Jon O'Brien, Environmental Program Manager, Off-Highway Motor Vehicle Recreation Division (OHMVR Division), whom State Parks has designated as the Project Manager for the Dust Control Program pursuant to the SOA, as amended. State Parks developed the 2025 ARWP in consultation and coordination with the SAG Chair, Dr. Bernard Bauer. State Parks acknowledges changes in SAG membership to account for current and future Dust Control Program needs, and thanks Carla Scheidlinger and Mike Bush for their many years of service with the SAG.

⁴ The specific content to be included in the ARWP and the SAG and SLOAPCD process for reviewing and approving the ARWP are described in the original 2018 SOA, specifically, conditions 4 and 5, as modified by the 2019 SOA amendments (modifications 7 and 8); 2022 SOA amendments (modification 6); and 2024 SOA amendments (modification 3).

2 ANNUAL REPORT (AUGUST 1, 2024, TO JULY 31, 2025)

This chapter reports on Dust Control Program activities undertaken between August 1, 2024, and July 31, 2025, and the corresponding progress made toward achieving air quality objectives during this time.

As a general overview, the ODSVRA Dust Control Program is a comprehensive, multi-year, adaptive management program designed to reduce saltation and dust generation within the ODSVRA and improve air quality downwind of the ODSVRA.⁵ State Parks initiated the program in 2011 as a series of studies and pilot projects. Over time, the program has adapted to become an iterative series of dust control-related activities that are evaluated and modified as necessary to meet the evolving requirements of the SOA. Typical annual Dust Control Program activities include the following:

- **Dust control projects** are control measures that reduce or stop saltation and dust generation at the ODSVRA. These measures may be seasonal, temporary, or permanent in nature.⁶ State Parks' report on dust control projects is provided in Section 2.1. Refer to Attachment 01 for maps of dust control projects implemented at the ODSVRA each year since 2011.
 - Seasonal and temporary projects generally include wind fencing, straw bales and broadcast surface straw treatments, and use of other materials that can sometimes, but not always, be recovered and reused in subsequent dust control projects. State Parks has also excluded motor vehicles from areas (vehicle exclusion areas) and has explored, in a very limited manner in 2014, the use of soil stabilizers as a form of seasonal and/or temporary dust control at the ODSVRA.
 - Permanent dust control consists of vegetation plantings, including foredune, backdune, and supplemental planting efforts (i.e., replanting or maintaining vegetation coverage in previously planted projects).

⁵ State Parks and the SLOAPCD have conducted and continue to conduct substantial research to better understand the science of dust emissions, dust controls, and dune restoration at the ODSVRA. While the SAG does not directly conduct research, it does evaluate existing knowledge, assess recent research conducted by State Parks and its third-party contractors, and, in limited instances, analyze data collected by State Parks and its third-party contractors (e.g., surface emissivity data). In February 2023, the SAG independently published a comprehensive report (entitled "Oceano Dunes: State of the Science") that defines key terms like saltation and synthesizes information relevant to understanding dust generation and mitigation at the ODSVRA. This report is available on the following SLOAPCD website (under "Winter 2023 Update, State of the Science Final Report"):
<https://www.slocleanair.org/air-quality/oceano-dunes-efforts>.

⁶ Seasonal dust control projects are installed for a defined period, usually between approximately March 1 and October 31 of each calendar year. In contrast, temporary projects are installed indefinitely, but not permanently.

- o Two related but independent activities that provide dust control benefits are State Parks' long-term closure of the ODSVRA Western Snowy Plover and California Least Tern nesting enclosure and the seasonal closure of certain beach and transportation corridors.⁷ These closures, which protect nesting shorebirds, prohibit vehicular and non-vehicular recreation from occurring, which has been shown to reduce saltation and dust generation at the ODSVRA. It is noted that State Parks manages the nesting enclosure area for multiple purposes.
- **Field monitoring** collects the data identified by State Parks, the SAG, and the SLOAPCD necessary to support State Parks' adaptive management approach to dust control at the ODSVRA. Field monitoring activities vary by year to meet the specific needs of the Dust Control Program. Not all types of data are collected each year; however, field monitoring generally includes the installation, operation, and/or maintenance of ground and aerial equipment that collects data on one or more of the following: meteorological conditions, PM₁₀ concentrations, surface emissivity characteristics, foredune deposition and erosion rates, and vegetation coverage. The data that are collected are verified, evaluated, and used to improve the effectiveness of dust control projects and the performance of the air quality models used to assess Dust Control Program progress. State Parks' report on field monitoring activities is provided in Section 2.2.
- **Air quality and emissions modeling** is the method stipulated by the SOA, as amended, for evaluating compliance with the SOA, which, as of October 2024, is "to eliminate emissions in excess of naturally occurring emissions from the ODSVRA that contribute to downwind violations of the state and federal PM₁₀ air quality standards." Modeling is also used, in part, to demonstrate progress in meeting other evaluation metrics developed by State Parks, the SAG, and the SLOAPCD. State Parks' report on modeling activities is provided in Section 2.3.
- **Track-out control** is a program required by the SOA to prevent track-out of sand onto the Grand Avenue and Pier Avenue entrances to the ODSVRA. State Parks' report on track-out control activities is provided in Section 2.3.

⁷ For the purposes of this ARWP, the terms "Western Snowy Plover and California Least Tern nesting enclosure" "nesting enclosure area", and "Plover Enclosure" refer to the same geographic area (see Figure 2-1). In general, depending on context, this ARWP uses the term Plover Enclosure or "PE" to refer to this geographic area, which is also a specific zone in the excess emissions model (see Section 2.3.2). Similarly, for the purposes of this ARWP, the term "seasonal foredune beach and transportation corridors" is used to refer to a general geographic area (e.g., see Figure 2-1), while the term "Seasonal Enclosure" or "SE" is used to refer to the specific zone used in the excess emissions model (see Section 2.3.2)..

- **Other Dust Control Program activities** include actions that State Parks, the SAG, and the SLOAPCD may undertake to support and inform the overall adaptive management approach to dust control at the ODSVRA, such as, but not limited to, SAG, SLOAPCD, or other entity preparation and/or review of independent studies. State Parks' report on other activities related to the Dust Control Program is provided in Section 2.4.

State Parks notes that while the SOA requires State Parks to report on activities implemented over the previous year by August 1, 2025, this 2025 ARWP reports on activities that were started more than one year ago (i.e., before August 1, 2024) and completed in the past year (i.e., between August 1, 2024, and July 31, 2025). It also reports on activities started in the past year that State Parks, its contractors, and/or the SAG could not 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 in processing, analyzing, interpreting, reviewing, and reporting the data collected for the Dust Control Program.

2.1 REPORT ON DUST CONTROL PROJECTS

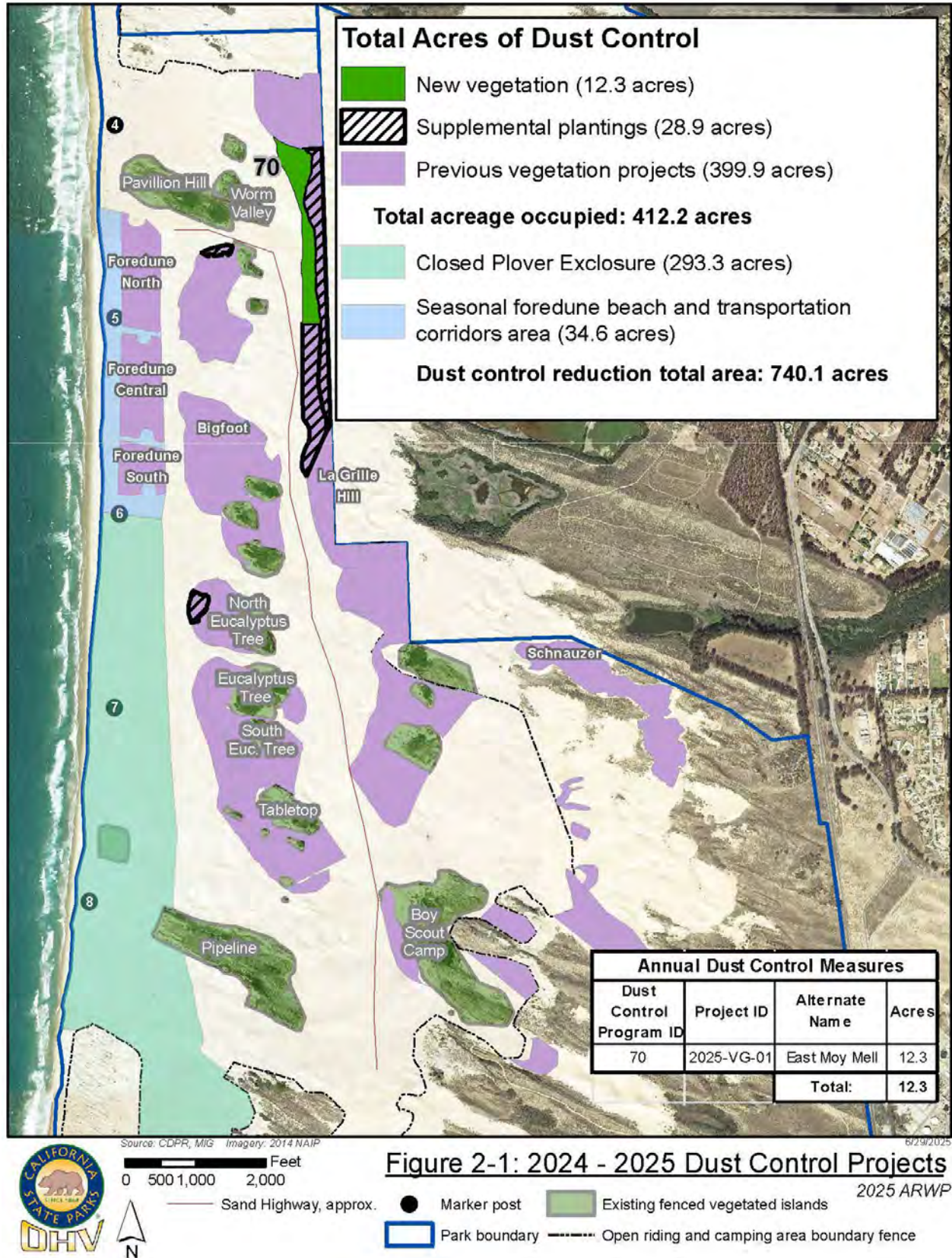
From August 1, 2024, to July 31, 2025, State Parks completed the following dust control projects:

- **Converted 12.3 acres of temporary projects to vegetation.**⁸ State Parks converted the last remaining temporary straw treatment at the ODSVRA to vegetation. This 12.3-acre project (2022-ST-01) was in the northeast corner of the ODSVRA open riding and camping area (see Figure 2-1).^{9,10} State Parks planted a total of 35,554 plants and spread a total of 152 pounds of native dune seed and 300 pounds of sterile seed in this vegetation conversion project. Refer to Attachment 02 for information on the species list, number of seedlings planted, and pounds of seed applied for this conversion project.

⁸ As recommended by the SAG, the main body of this ARWP and Attachment 01 to this ARWP report the size of dust control projects 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.

⁹ State Parks has implemented dust control projects at the ODSVRA since 2011. The "Dust Control Program ID" shown in Figure 2-1 represents the chronological order of dust control projects, beginning with the first straw treatment project in 2011 (ID #01) and concluding with the final vegetation project in 2025 (ID #70). For projects installed in the same dust control year (defined as August 1 of one year to July 31 of the next year), projects are numbered from north to south. In some instances, temporary projects have been converted to vegetation, resulting in two distinct projects in the same geographic area. Thus, while State Parks has implemented 70 different projects over time, only 40 projects are active as of July 31, 2025. Refer to Attachment 01 for annual maps of individual dust control projects and dust control project areas.

¹⁰ The "Project ID" shown in Figure 2-1 identifies the year the project was undertaken, the type of project it was, and how many of the same type of project were installed in the dust control year (defined as August 1 of one year to July 31 of the next year). Projects are defined as straw treatment (ST), wind fencing (WF), temporary vehicle exclusion (TV), and vegetation (VG). For example, "2024-VG-03" is the third vegetation project installed in the 2024 dust control year.



- **Conducted supplemental vegetation plantings.** Supplemental planting and seeding activities often focus on the west-facing portions of vegetation installations where direct wind and sand activity bury or otherwise compromise treatments. During the 2024-2025 reporting period, State Parks planted 85,469 plants and spread approximately 343 pounds of native dune seed and 650 pounds of sterile seed over 28.9 acres of previously treated areas. The areas that received supplemental plantings during the 2024-2025 reporting period included 1.0 acre near the BBQ Flats vegetation island (2019-VG-01), 2.0 acres near the North Eucalyptus Tree vegetation island (2022-VG-04), 14.6 acres east of Sand Highway (2022-VG-01), and 11.3 acres west of Sand Highway (2022-VG-02; see Figure 2-2). Refer to Attachment 02 for information on the species list, number of seedlings planted, and pounds of seed applied for each supplemental planting project.
- **Seasonally closed 34.6 acres of foredune beach and transportation corridors area.** State Parks' installation of a 48-acre foredune at the end of 2019 resulted in a narrow beach area to the west of the foredune project and transportation corridors in between different foredune treatment areas, as well as a small corridor to the south of the foredune project, neighboring the Plover Exclosure (see Figure 2-1). These areas are subject to Western Snowy Plover and California Least Tern nesting activity during the breeding season. Consistent with management activities since 2020, State Parks installed seasonal fencing around these areas to protect potential nest sites. In total, State Parks seasonally closed 34.6 acres for approximately seven months from March 1, 2024, to September 30, 2024. The foredune beach and transportation corridors area were again seasonally closed on March 1, 2025, and will reopen on October 1, 2025.
- **Maintained closure of the Plover Exclosure (PE).** In October 2021, State Parks closed the approximately 300-acre PE area to vehicular and non-vehicular recreation.¹¹ Since then, State Parks has maintained the closed status of this area, installing and maintaining perimeter fencing as necessary.

As of July 31, 2025, State Parks actively manages and maintains 40 different dust control projects.¹² In total, these 40 dust control projects, plus the PE and seasonally closed foredune beach and transportation corridors area, occupy 740.1 acres of land at the ODSVRA. The ODSVRA's dust control projects are summarized in Table 2-1 and shown in Figure 2-2. Refer to Attachment 01 for additional maps showing historical dust control project locations and all dust control projects in place as of July 31, 2025.

¹¹ The decision to close this area was an operational choice that was made independently of Dust Control Program requirements.

¹² While State Parks has implemented 70 different dust control projects over time, only 40 projects are active and in the ground as of July 31, 2025. Refer to footnotes 10 and 10 for additional details on State Parks' system for identifying dust control projects implemented over time.

Table 2-1. Cumulative Dust Control Projects Installed as of July 31, 2025				
Type of Dust Control Project	Number of Projects ^(A)	Acres Controlled by Dust Control Projects		
		Inside Open Riding and Camping Area	Outside Open Riding and Camping Area	ODSVRA Total
Vegetation				
Foredune	3	48.0	0.0	48.0
Backdune	37	288.3	75.9	364.2
<i>Subtotal</i>	<i>40</i>	<i>336.3</i>	<i>75.9</i>	<i>412.2</i>
Seasonal and/or Temporary Project				
Straw treatment	0	0.0	0.0	0.0
Wind fencing	0	0.0	0.0	0.0
Temporary vehicle enclosure	0	0.0	0.0	0.0
Other ^(B)	0	0.0	0.0	0.0
<i>Subtotal</i>	<i>0</i>	<i>0.0</i>	<i>0.0</i>	<i>0.0</i>
Other Operational Activity				
Closed Plover Exclosure	-	293.3 ^(C)	0.0	293.3 ^(C)
Seasonally closed foredune beach and transportation corridors area	-	34.6	0.0	34.6
<i>Subtotal</i>	-	<i>327.9</i>	<i>0.0</i>	<i>327.9</i>
Totals^(D)	40	664.2	75.9	740.1
(A) Value reflects the number of projects in the ground as of July 31, 2025, and does not consider planned activities described in Chapter 3 of this ARWP.				
(B) “Other” refers to porous roughness elements, soil stabilizers, or other types of dust control projects.				
(C) Historically, the size of the Plover Exclosure fluctuated annually with changes in sand topography and fencing installation. The average annual size of the PE was 294 acres for the 19-year period from 2004 to 2022. For the purposes of the ODSVRA Dust Control Program, the size of the Plover Exclosure is consistently reported as 293.3 acres, which was the size of the Plover Exclosure when the dust control benefit was first credited to this area.				
(D) Without the closed Plover Exclosure and seasonally closed foredune beach and transportation corridors area, there are 336.3 acres of dust control inside the open riding and camping area and 412.2 total acres of dust control at the ODSVRA.				

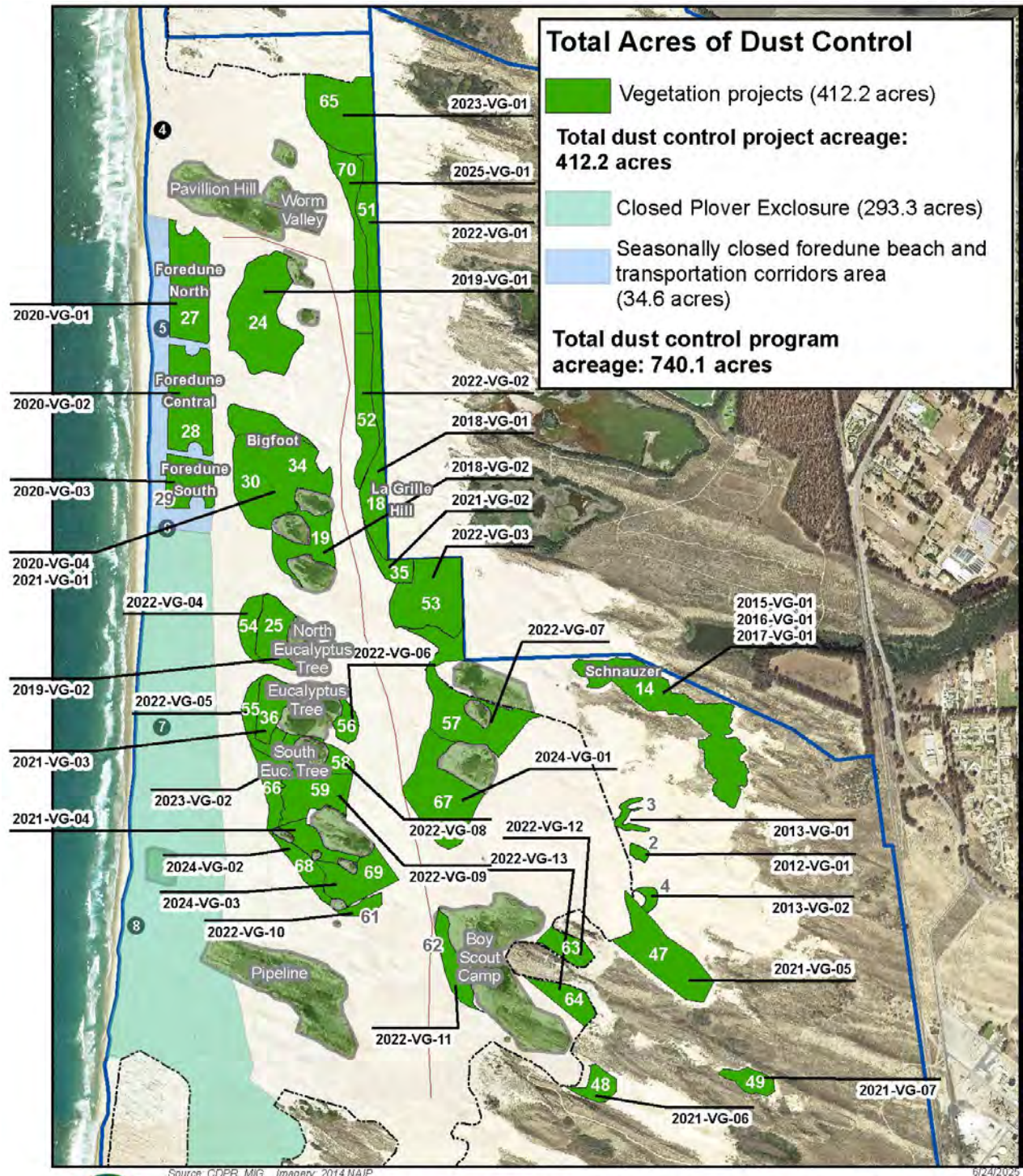


Figure 2-2: Dust Control Projects Installed as of 7/31/2025



0 500 1,000 2,000 Feet

Sand Highway, approx.



Marker post



Existing fenced vegetated islands



Park boundary



Open riding and camping area boundary fence

2.2 REPORT ON FIELD MONITORING

State Parks and the SLOAPCD have collected data on the conditions that lead to dust generation at the ODSVRA for almost two decades, with more recent efforts undertaken in coordination with the SAG. State Parks' field monitoring activities support the scientific investigation and adaptive management of dust control at the ODSVRA, provide context and in-situ observations vital to assessing individual dust control project effectiveness and air quality model performance, and support the evaluation of overall Dust Control Program success. Some monitoring activities, such as data collection at State Parks' S1 meteorological tower, have been occurring near-continuously for more than a decade or are repeated annually to provide a record of the change in conditions at the ODSVRA.¹³ Other monitoring activities are seasonal or temporary in nature and may address more specific data needs identified by State Parks, the SAG, and the SLOAPCD. In general, State Parks' field monitoring activities include the following:

- **Meteorological monitoring** to measure wind speed, wind direction, temperature, and humidity throughout the ODSVRA. Meteorological monitoring coupled with PM₁₀ monitoring provides important information on the dispersion characteristics of PM₁₀ through the ODSVRA.
- **PM₁₀ monitoring** to measure PM₁₀ concentrations in the air. State Parks' PM₁₀ monitoring is conducted primarily within the ODSVRA using instruments that go through rigorous installation procedures and data validation processes¹⁴. The SLOAPCD also conducts PM₁₀ monitoring downwind of the ODSVRA in accordance with state and federal Clean Air Act requirements. The measurements of actual airborne PM₁₀ concentrations are used to calibrate, verify, and improve confidence in required SOA modeling methodologies. The measurement of changes in PM₁₀ concentrations over time also provides empirical evidence for Dust Control Program progress.
- **Portable In-Situ Wind Erosion Laboratory (PI-SWERL) monitoring** to measure the potential amount of PM₁₀ emissions that can be generated throughout the ODSVRA under different wind shear conditions. This is often referred to as sand surface "emissivity" and is a critical parameter in modeling stipulated by the SOA.
- **Uncrewed aerial system (UAS or drone) surveys** to monitor and quantify changes in dune morphology, sediment erosion and deposition, and vegetation cover within the 48-acre foredune restoration area (FRA) and PE, as well as backdune areas of the ODSVRA.¹⁵ Dune

¹³ The term meteorological is, in general, shortened to "met" in ARWP figures and tables showing meteorological stations and/or data.

¹⁴ State Parks' PM₁₀ monitoring is not used to assess attainment of ambient air quality standards, but its consistent methodology allows for trends in PM₁₀ to be defined across space and through time.

¹⁵ The 48-acre FRA consists of dust control projects 2020-VG-01, 2020-VG-02, and 2020-VG-03 (see Figure 2-12).

morphology and vegetation change monitoring are used to assess the performance of different vegetation projects at the ODSVRA.

- **Other vegetation change monitoring** conducted by State Parks personnel that complements UAS surveys and assists in assessing the performance of different vegetation projects at the ODSVRA. These include human line-intercept transect sampling and photo point monitoring to document vegetation cover and species composition within dust control project areas.

State Parks' report on field monitoring activities conducted during the reporting period is provided below.

2.2.1 METEOROLOGICAL AND PM₁₀ MONITORING

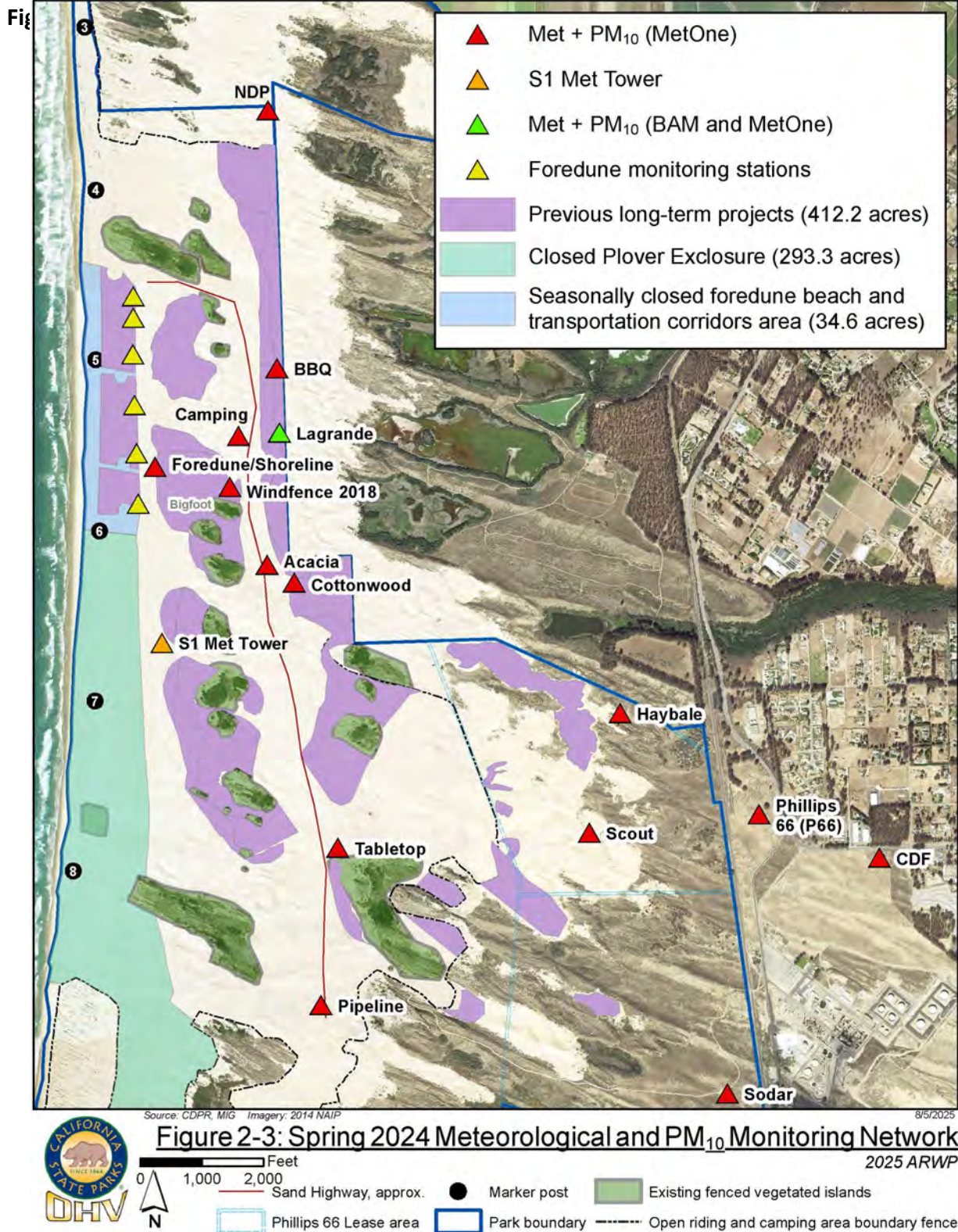
State Parks' meteorological and PM₁₀ monitoring network varies slightly from year to year depending on specific goals, objectives, and dust control measures identified in the annual ARWP cycle. The Desert Research Institute (DRI) has historically prepared a report of key findings related to State Parks' meteorological and PM₁₀ monitoring network. The following information has been summarized from the DRI-prepared and SAG-reviewed "Report of Findings: ODSVRA Meteorological and PM₁₀ Monitoring Network, 2024." This report, and the SAG's review comments, are provided as Attachment 03 to this 2025 ARWP.

From April 1, 2024, to September 30, 2024, State Parks maintained the meteorological and PM monitoring network shown in Figure 2-3, consisting of 15 stations located throughout and downwind of the ODSVRA. The network has been in operation since 2020 but prior to 2021 there were fewer stations. Moreover, the ODSVRA was closed to off-highway vehicle (OHV) activity in 2020 due to COVID-related closure restrictions. Thus, the period of record considered herein, with a full complement of stations and active OHV activity, is restricted to 2021 through 2024. Each station has a MetSens500 instrument that measures wind speed and wind direction (ultrasonically), ambient temperature, atmospheric pressure, and relative humidity (RH), and a MetOne 212 particle profiler to measure PM₁₀.¹⁶ The MetOne instrument is calibrated against a Beta Attenuation Monitor (BAM) in a dust chamber prior to deployment and after removal from the field in October.¹⁷

"Backdune areas" generally refers to the dunes east of the 48-acre FRA. As shown in Figure 2-2, all dust control projects except the three projects associated with the FRA are located in backdune areas.

¹⁶ In addition, stations on open sand areas also had Sensit saltation sensors; however, as recommended by the SAG, no analysis of Sensit data occurred in 2024.

¹⁷ MetOne particle profiler PM₁₀ concentrations are derived from environmentally controlled and field-calibrated relations between particle count data collected by the MetOne instrument and mass-based PM₁₀ concentration data collected by a United States Environmental Protection Agency (USEPA) Federal Equivalent Method (FEM) BAM PM₁₀ monitor. Refer to State Parks' 2021 ARWP, Attachment 06, for detailed MetOne particle profiler PM₁₀ calibration procedures.



The environmental data collected by these stations provide a means to examine spatial trends in PM₁₀ concentrations (in micrograms per cubic meter, or $\mu\text{g m}^{-3}$) across the ODSVRA in relation to wind speed (in meters per second, or m s^{-1}) and wind power density (WPD, in Watts per square meter, or W m^{-2}), and to evaluate if these relations have changed through time.

WPD (in W m^{-2}) is defined as:¹⁸

$$WPD = 0.5 \rho_a u_z^3$$

Where:

ρ_a = Air density at sea level (1.212 kilograms per cubic meter [kg m^{-3}], and assumed constant)

u_z = Wind speed (m s^{-1}) at measurement height z (in meters [m]) above ground level (AGL)

To compare WPD among different locations and between different years, the height of measurement of wind speed must be the same for each location. Total Wind Power Density (TWPD, W m^{-2}), which is the summation of valid hourly values of wind power density (W m^{-2}) for the monitoring period (April-September), characterizes the total wind energy at a location (see Attachment 03). As the emission of PM₁₀ from the sand is of critical importance for air quality concerns, the mean hourly wind speed that corresponds with the onset of a rapid increase in PM₁₀ at the monitoring stations is used to set the lower limit for the summation for calculating TWPD. For the stations on open sand-sheet areas of the ODSVRA, this wind speed is 5.5 m s^{-1} measured at 3.5 m AGL. The data are also filtered for the wind direction range of 248 to 326 degrees ($^\circ$), as winds in this range will transport the PM₁₀ originating in the ODSVRA toward the CDF and Mesa2 air quality monitoring stations.

Along the north-south dimension of the network, higher mean hourly PM₁₀ concentrations were observed in the north (Shoreline station) compared to the south (Pipeline station) for equivalent wind speeds. In 2024, the mean hourly PM₁₀ concentration range at the Shoreline station was $9 \mu\text{g m}^{-3}$ to $619 \mu\text{g m}^{-3}$, within the wind speed range of 5.5 m s^{-1} to 12.6 m s^{-1} .¹⁹ At the southernmost station, Pipeline, the PM₁₀ concentration range was $18 \mu\text{g m}^{-3}$ to $430 \mu\text{g m}^{-3}$, within the wind speed range of 5.5 m s^{-1} to 13.5 m s^{-1} .

Similar to TWPD, Total Hourly PM₁₀ (TPM₁₀, in $\mu\text{g m}^{-3}$) is calculated for each station for the monitoring period (April-September). TPM₁₀ is the summation of valid hourly values of PM₁₀ paired with the valid hourly values of TWPD (for hourly wind speed $\geq 5.5 \text{ m s}^{-1}$ and wind direction 248° to 326°) for that station.

¹⁸ Kalmikov, A., 2017. Wind power fundamentals. In Wind Power Engineering, ed. T.M. Letcher. Elsevier Science Publishing Co., Incorporated.

¹⁹ In the 2024 ARWP, BBQ station was used as the northern station, but it had instrument issues from April to September 2024 that limited the quality and length of the data record for this 2025 ARWP.

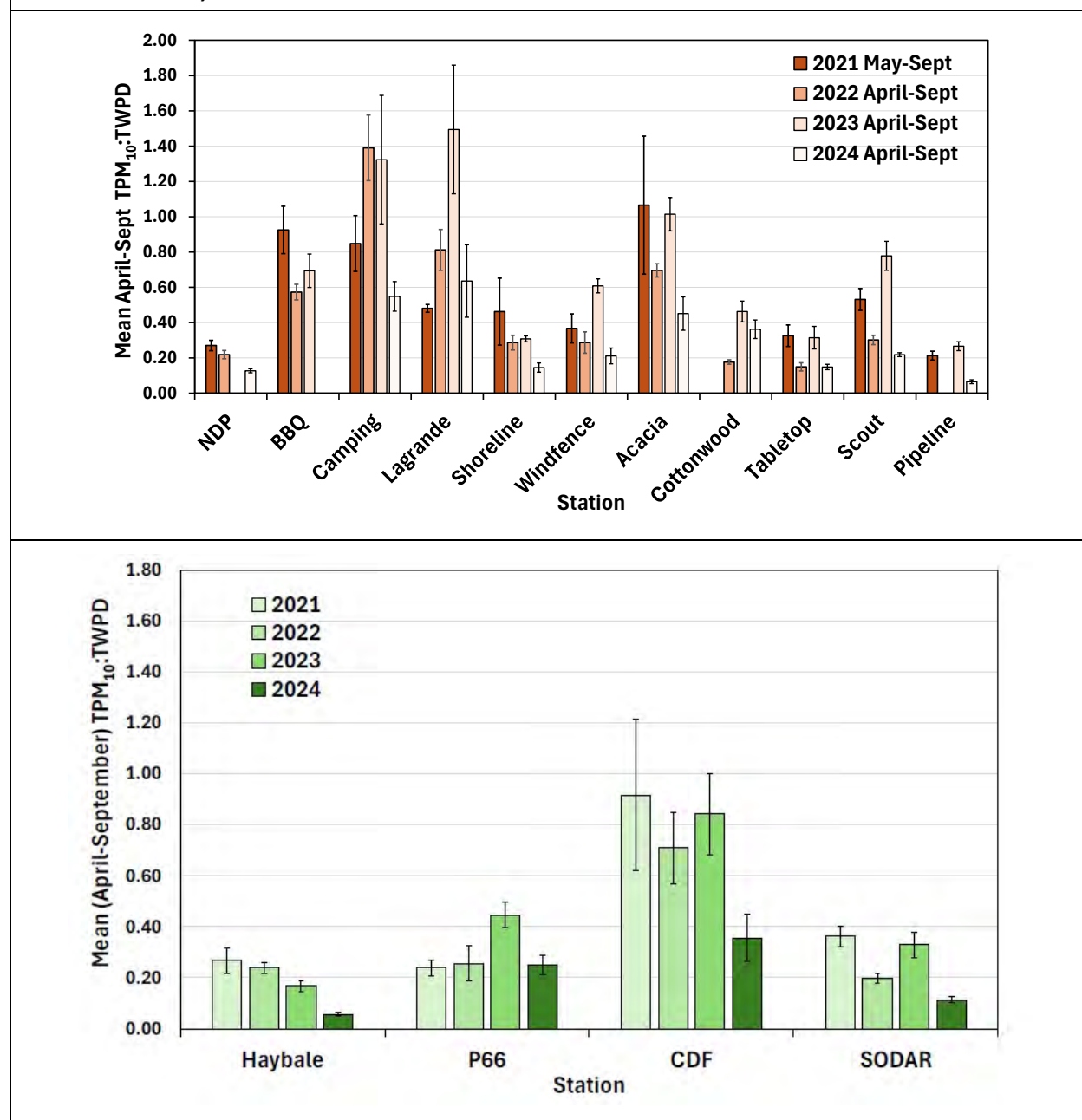
The change in the ratio of Total Hourly PM_{10} (TPM_{10}) to TWPDP ($TPM_{10}:TWPDP$) for the stations on sand-sheet and not on sand-sheet areas of the ODSVRA for available data from April to September, 2021 to 2024, is shown in Figure 2-4. The mean seasonal $TPM_{10}:TWPDP$ ratio for stations on sand-sheet areas (including the Northern Dune Preserve station [NDP station]) is variable as a function of position. The stations with the greatest $TPM_{10}:TWPDP$ ratio have consistently been the northern stations BBQ through to Acacia and Cottonwood. The NDP station, which is located on a sand-sheet area in a non-riding area, has lower mean ratio values than the stations in the northern zone of the ODSVRA where OHV activity is allowed. The data shown in Figure 2-4 suggest that, in most cases, the 2024 $TPM_{10}:TWPDP$ ratios for the stations located on sand-sheet areas of the ODSVRA are the lowest values observed over this four-year period, except for the Lagrande and Cottonwood stations. This suggests that the ODSVRA emissivity, in general, has decreased through time, which has been observed in PI-SWERL emissivity data (see Section 2.2.2).

The stations downwind of ODSVRA sand-sheet areas (Haybale, Phillips 66 [P66], sonic detection and ranging [SODAR],²⁰ and CDF) also show variability in the $TPM_{10}:TWPDP$ ratio across the four-year record (Figure 2-4). The CDF station registered the highest $TPM_{10}:TWPDP$ ratio as it has the lowest TWPDP values on a monthly basis but still has PM_{10} concentration levels similar to the monitoring stations farther to the west that experience higher wind speeds.

The station data provide a means to examine longitudinal and latitudinal trends in PM_{10} as well as upwind and in the lee of vegetation islands. The Shoreline, Windfence, Acacia, Cottonwood, Haybale, P66, and CDF stations define a west-east transect approximately 4.2 kilometers (km) long at an azimuth of approximately 300° . For each of these stations in 2021, 2022, 2023, and 2024, Figure 2-5 shows the change in normalized mean hourly PM_{10} concentration along this transect for wind in the directional range of 248° to 326° and when wind speed measured at the Shoreline station was $\geq 5.5 \text{ m s}^{-1}$ (same as lower limit of wind speed for defining $TPM_{10}:TWPDP$ ratio). Note that the PM_{10} has been normalized by dividing by mean hourly PM_{10} concentration at a station by the mean hourly PM_{10} concentration at the Acacia station, which consistently had the greatest PM_{10} concentrations along this west-to-east transect.

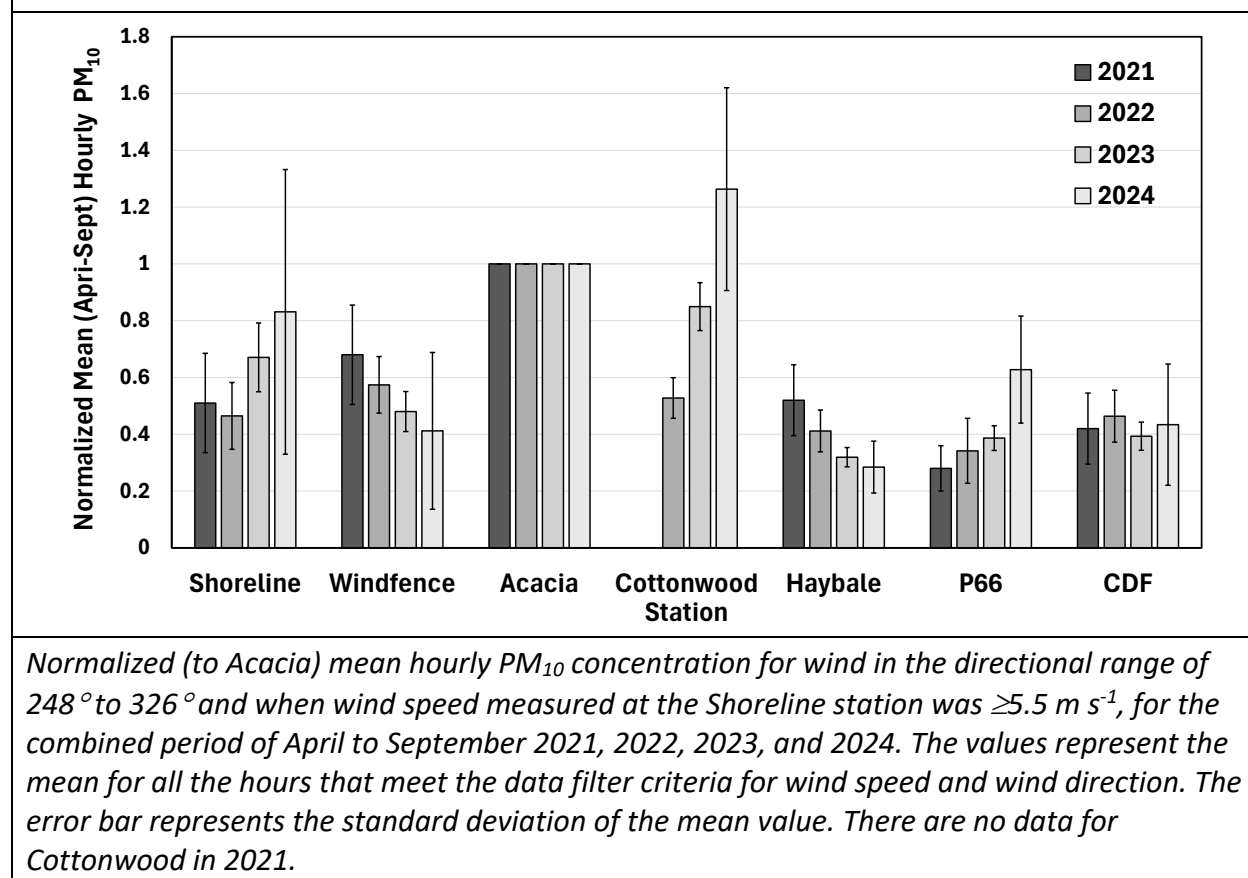
²⁰ This monitoring network site formerly included a SODAR instrument. The instrument was installed in May 2019 and removed from operation in February 2023, although other instruments continued to be operated at the SODAR monitoring site in 2024. In 2025, no instruments were installed at the SODAR monitoring network site.

Figure 2-4. Comparison of Mean Ratio of TPM_{10} :TSP for April to September, 2021 to 2024, for Stations on Sand Sheet Areas and Not on Sand Sheet Areas



The mean monthly TPM_{10} :TSP ratio, 2021-2024, (based on the summation of mean hourly data) for the stations that are located on sand-sheet areas of the ODSVRA (top panel) and the stations that are located downwind of (i.e., not on) ODSVRA sand-sheet areas (bottom panel). The values represent the mean ratio based on the six (individual) monthly ratio values. The error bar represents the standard deviation of the mean value. Note (top panel): BBQ had a high degree of instrument issues in 2024 and was not included in the plot.

Figure 2-5. Comparison of Normalized Mean Hourly PM₁₀ Concentrations Along 4.2-Kilometer West-to-East Transect



As shown in Figure 2-5, the normalized mean hourly PM₁₀ for the six months (i.e., April through September) over these four years show the Acacia station has consistently had the highest mean hourly PM₁₀ concentration along this transect, except in 2024 when the Cottonwood station had the highest mean hourly PM₁₀ concentration. The highest concentrations of PM₁₀ are observed at the Acacia and Cottonwood stations, with a decrease in mean concentration toward the shoreline. For these four years of normalized mean hourly PM₁₀ concentration, the normalized concentration decreases appreciably beginning at the Haybale station, which marks the eastern edge of areas with open sand upwind of this station in a non-riding area.

The Shoreline and Windfence stations (see Figure 2-3) are positioned to examine the effect of a large area of vegetation on the concentration of PM₁₀ in an upwind-downwind configuration (Shoreline-Windfence). The dust control/revegetation area identified as Bigfoot (see Figure 2-3), with the Shoreline station on the west and the Windfence station on the east, was initiated in 2019. Gillies et al. (2024) reported that in 2023 the mean hourly concentration of PM₁₀ for the wind direction and wind speed constraints of 284° to 300° and wind speed $\geq 5.5 \text{ m s}^{-1}$ at the Shoreline station, the mean hourly PM₁₀ concentrations at the Windfence station were lower for

the same comparable hours.²¹ Prior to 2023, the mean hourly PM₁₀ concentrations at the Windfence station were higher than those at the Shoreline station for the same comparable hours.²² In 2024, the pattern between the mean hourly PM₁₀ concentrations for these two stations is the same as observed in 2023 (i.e., Windfence less than [$<$] Shoreline). The mean hourly PM₁₀ concentration at the Windfence station (for the same wind direction and wind speed constraints) is 0.60 (± 0.24) when normalized against the concentration at the Shoreline station (i.e., PM₁₀ Windfence/PM₁₀ Shoreline). This decrease in normalized mean hourly PM₁₀ at the Windfence station compared with the Shoreline station in 2023 and 2024 suggests that the Bigfoot revegetation dust control area is modulating the PM₁₀ concentrations (i.e., lowering the PM₁₀) as the dust-laden air passes over it. This result suggests that the re-vegetation management method is a critically important tool for both modulating the air flow by slowing the wind as it passes over the vegetation and demonstrably lowering the PM₁₀ concentration in the dust-laden air.

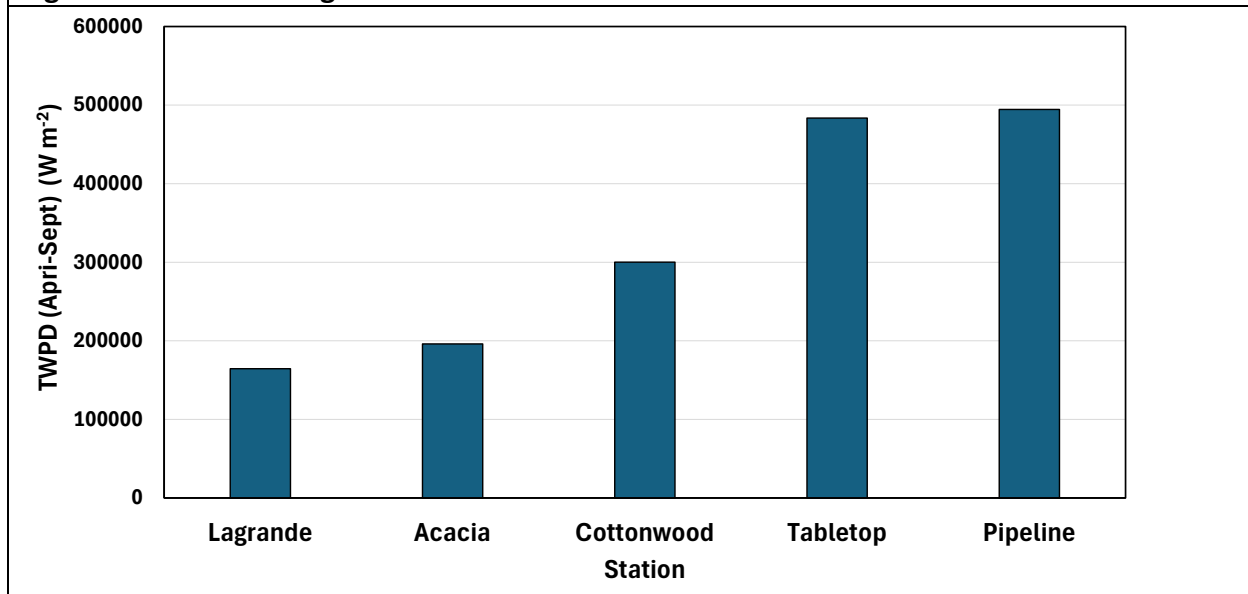
The 2024 TWPD data (see Figure 2-6) show that for the north-south distance covered by the network the TWPD was higher in the south than in the north, which corroborates what has previously been reported and indicates that this pattern has persisted since monitoring was initiated. The station TPM₁₀:TWPD data (see Figure 2-7) indicate that the PM₁₀ concentrations for the same WPD are higher in the northern stations, indicating that the emissivity of the sand surfaces upwind of these stations remains high in relation to the other stations and that this area is still a rich source for PM₁₀ emissions. The high PM₁₀ concentrations and emissivity in this area may be due to the presence of the “sand highway,” which remains a high use area for OHVs. The gradient of decreasing emissivity from north to south has also been observed in the PI-SWERL data. The 2024 TPM₁₀:TWPD data shown in Figure 2-7 compared with data from previous years^{23,24} indicate that this pattern has persisted since the monitoring was initiated.

²¹ Gillies, J.A., G. Nikolich, and E. Furtak-Cole, 2024. Increments of Progress Towards Air Quality Objectives - ODSVRA Dust Controls, 2023 Update - Revised. Report prepared for State Parks and the SAG. February 15, 2024. This report was included as Attachment 07 to State Parks' 2024 ARWP.

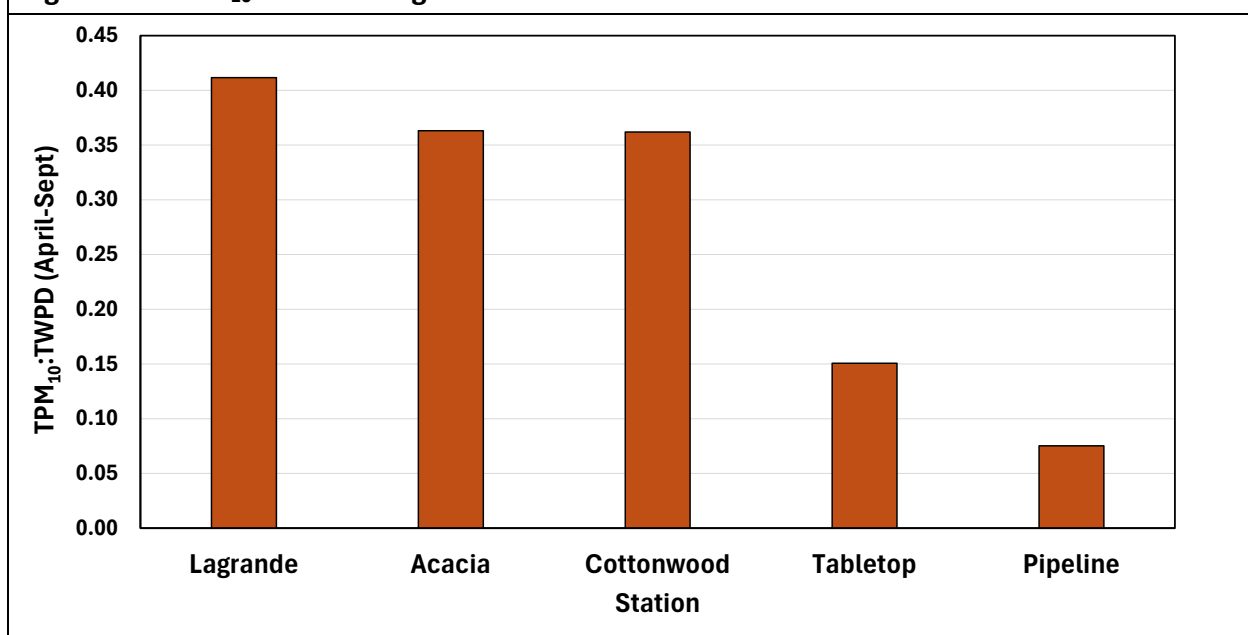
²² See Figure 10 in Gillies, J.A., E. Furtak-Cole, and V. Etyemezian, 2022 (footnote 23).

²³ Gillies, J.A., E. Furtak-Cole, and V. Etyemezian, 2022. Increments of Progress Towards Air Quality Objectives - ODSVRA Dust Controls. Report prepared for California State Parks by DRI, December 2022.

²⁴ See footnote 21.

Figure 2-6. TWPD Along North-to-South Transect

TWPD (W m⁻²) summed for April to September 2024 along a north-to-south transect from the Lagrande station in the north to the Pipeline station in the south.

Figure 2-7. TPM₁₀:TWPD Along North-to-South Transect

TPM₁₀:TWPD summed for April to September 2024 along a north-to-south transect from the Lagrande station in the north to the Pipeline station in the south.

The difference in the PM₁₀ concentration data between the Shoreline and Windfence stations, which lie on either side of a large revegetation area, shows that in 2023 and 2024 the downwind Windfence station has lower mean hourly PM₁₀ concentrations than the Shoreline station. This supports the suggestion made by Gillies and Nikolich (2024) that this revegetated area is of sufficient size, plant cover density, and low (or zero) emissivity to influence the dispersion and deposition processes such that the downwind concentrations are lower than the upwind concentrations.²⁵ This further suggests that the revegetation method for reducing dust emissions from the ODSVRA is highly effective.

Beginning on April 1, 2025, State Parks re-installed the ODSVRA meteorological and PM₁₀ monitoring network; however, the 2025 network shown in Figure 2-8 is different from the 2024 network (see Figure 2-3) with respect to the number of stations and the position of some stations. These changes were made in coordination with the SAG and focus the monitoring network on characterizing the west-to-east and north-to-south PM₁₀ gradients and wind patterns to ensure that the data can be used to compare with past observations and spatial trends. As has been done previously by DRI, the MetOne 212 particle profiler instruments were calibrated against a BAM PM₁₀ monitor in DRI's dust chamber prior to deployment in 2025.²⁶

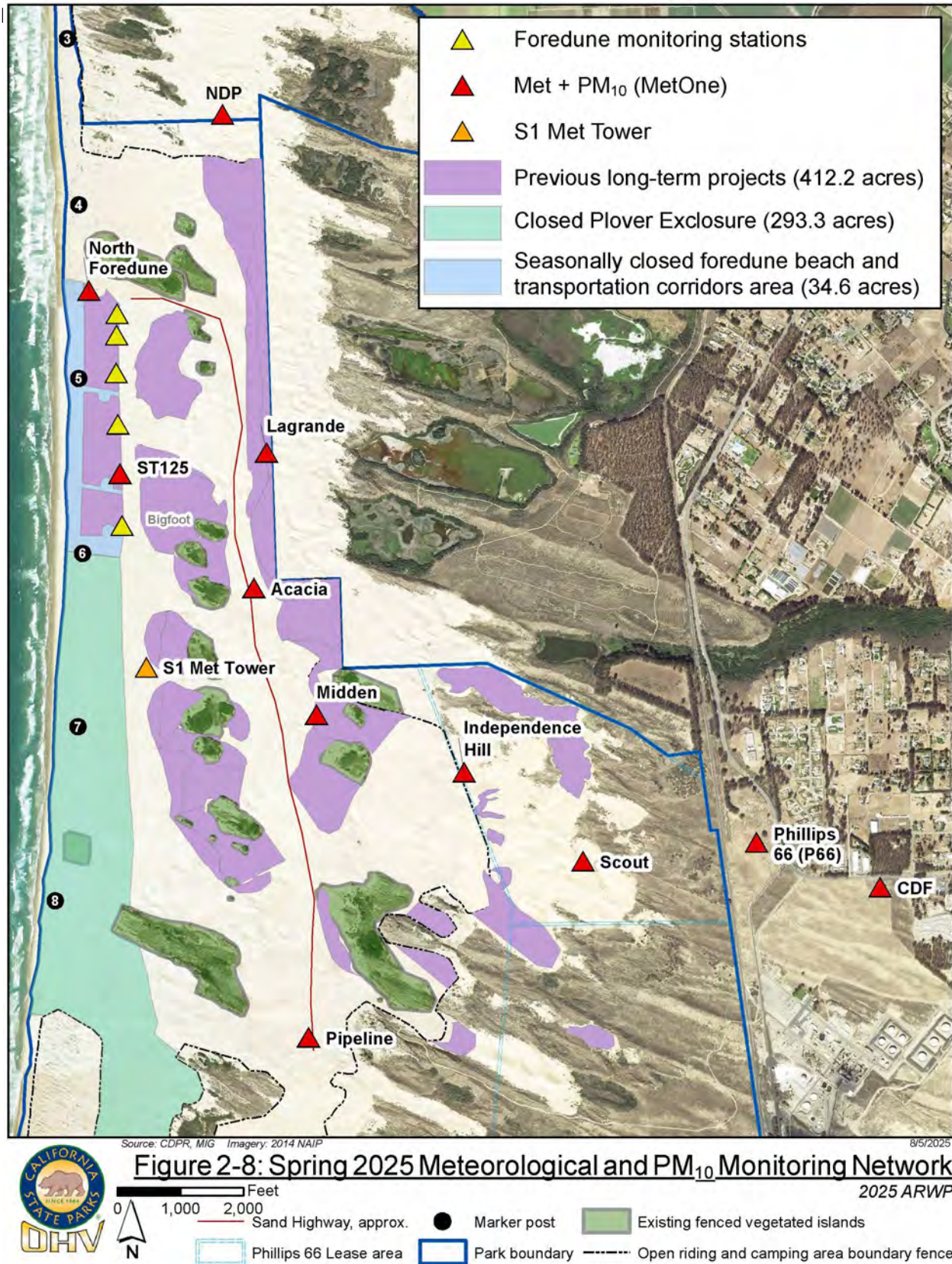
2.2.2 PI-SWERL/EMISSION MONITORING

DRI has measured PM₁₀ surface emissivity at the ODSVRA using the PI-SWERL device since 2011. The earliest data collection efforts were mainly for information gathering purposes and to help develop sampling methods for later campaigns. Since August 2013, data collection efforts in different parts of the ODSVRA (e.g., riding versus non-riding areas) and at different times of year (e.g., spring versus fall) have helped State Parks, the SAG, and the SLOAPCD to understand how surface emissivity varies spatially throughout the park as well as how emissivity varies through time due to natural and human processes. Importantly, State Parks and the SAG have used the PI-SWERL data collected by DRI to establish emissivity grids and parameterize PM₁₀ emissions from the ODSVRA for the purposes of modeling pursuant to the SOA's excess emissions framework.²⁷ As described in more detail in Section 2.3.2, State Parks and the SLOAPCD have, at the recommendation of the SAG, used the PI-SWERL emissivity data to spatially subdivide the ODSVRA into specific geographic units that have different emissivity characteristics for modeling purposes.

²⁵ See footnote 21.

²⁶ Although initially installed in 2025, Sensit saltation sensors were removed in May 2025 per SAG recommendation.

²⁷ Refer to State Parks' 2024 ARWP, Attachment 08, for the SAG memo "Updated SAG Recommendations for Establishing Emissivity Grids to be used in Modeling Pre-Disturbance Conditions and Future Excess Emissions Reductions."



In total, between August 2013 and September 2022, DRI conducted nearly 1,800 total PI-SWERL emissivity tests at the ODSVRA, including nearly 1,000 tests in areas open to OHV recreation year-round, more than 500 tests in areas closed to OHV recreation year-round, and more than 250 tests in areas that are or were seasonally open to OHV recreation (e.g., the Plover Enclosure). In May and September 2024, DRI, in consultation with the SAG, measured emissivity at an additional 673 locations, as summarized in Table 2-2.

The following information has been summarized from SAG report “ODSVRA PI-SWERL Emissivity Update Report (2013-2024).” This report is provided as Attachment 05 to this 2025 ARWP.

In 2024, DRI measured emissivity at 673 locations in the riding and non-riding areas of the ODSVRA (see Table 2-2). These tests were conducted in May 2024 (365 tests completed) and September 2024 (308 tests completed). The May 2024 sampling design reproduced, as closely as possible, the locations that were tested in 2019, which consisted of the most comprehensive spatial coverage of emissivity measurements across the ODSVRA. In contrast, the September 2024 measurements were made to reproduce, as best as possible, the PI-SWERL measurements made in 2022 at the FRA, the PE, and the seasonal foredune beach and transportation corridors area. Additional measurements were made in September 2024 in the northern dune preserve (Non-Riding Area North zone), Non-Riding Area Central zone, South Oso Flaco dunes (Non-Riding Area South zone), and along two west-to-east transects through the riding area of the ODSVRA, for the purpose of examining how the emissivity of the sand in these areas may have changed in the approximately five-month period since May 2024. The motivation for the repeat measurements is to understand whether different environmental conditions (e.g., rainfall, dew, surface moisture) and OHV riding have an impact on dust emission potential.

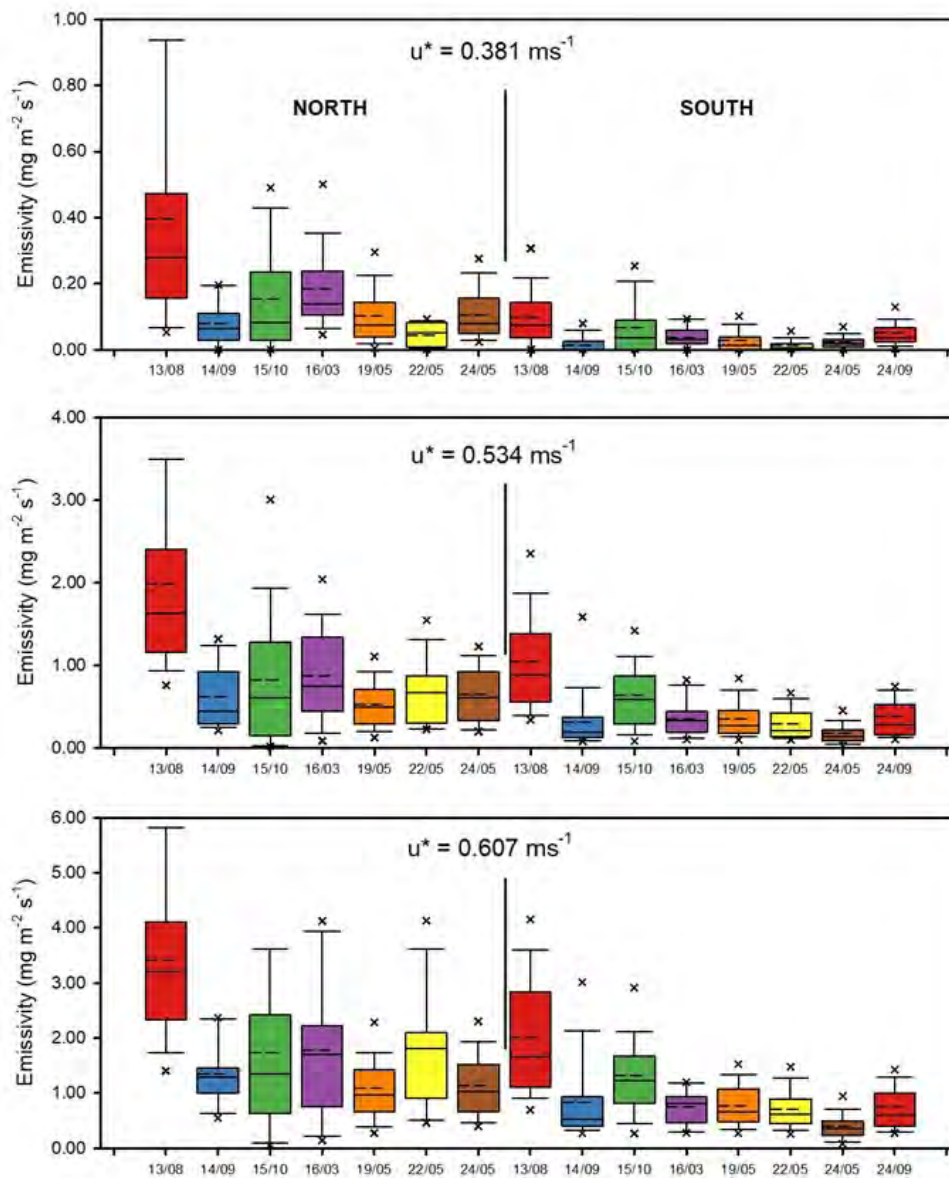
DRI applied quality assurance/quality control (QA/QC) protocols to ensure data integrity and to validate operational parameters according to prescribed ranges (e.g., flow and revolutions per minute [RPM] values vary <2% during a test cycle with constant RPM). All tests indicated that the 2024 data were valid for subsequent analysis. Data were reduced to calculate the mean emissivity (milligrams per square meter per second [$\text{mg m}^{-2} \text{s}^{-1}$]) for the periods when the PI-SWERL RPM was constant for each of the rotational speeds (2,000, 3,000, and 3,500 RPM), which correspond to shear velocities (u^*) of 0.381, 0.534, and 0.607 m s^{-1} assuming the roughness of the surface is equivalent to flat sand. The median emissivity values for each test u^* , grouped by the defined excess emissions management zones (see Section 2.3.2), were used to update the zonal emissivity relations for the current year (2025) and for the 1939 landscapes to determine the excess emissions condition as per the SOA.

Table 2-2. PI-SWERL Emissivity Tests at ODSVRA (as of July 31, 2025)			
Excess Emissions Model Zone	PI-SWERL Testing Summary^(A)		
	2025 ARWP Report	Previously Reported	Total Tests as of July 31, 2025
Riding Areas			
Central-North Subregion	80	415 ^(B)	495
Central-South Subregion	259	569	828
<i>Subtotal</i>	<i>339</i>	<i>984</i>	<i>1,323</i>
Non-Riding Areas			
North Zone	59	111	170
Central Zone	92	221	313
South Zone	42	67	109
<i>Subtotal</i>	<i>193</i>	<i>399</i>	<i>592</i>
Other Areas			
Foredune Restoration Area	67	110	177
Plover Exclosure (seasonal management)	0	198	198
Plover Exclosure (year-round closure management)	30	23	53
Seasonal Exclosure (open to riding) ^(C)	15	57 ^(D)	72
Seasonal Exclosure (closed to riding) ^(C)	29	45	74
<i>Subtotal</i>	<i>141</i>	<i>433</i>	<i>574</i>
Total PI-SWERL Tests	673	1,816	2,489
Source: DRI (see Attachment 05)			
(A) This table presents the number of PI-SWERL tests used to develop the emissivity grids used in the excess emissions modeling presented in this 2025 ARWP. PI-SWERL tests that were not used to inform the excess emissions modeling are not included in this table.			
(B) This value includes 72 tests that were conducted in the FRA prior to the installation of the FRA in December 2019.			
(C) As described in footnote 7, the Seasonal Exclosure is the same geographic area as the foredune beach and transportation corridors area.			
(D) This value includes 33 tests conducted in the foredune beach and transportation corridors area prior to the installation of the FRA in December 2019.			

The results of the updated analysis of the PI-SWERL measurements for the 2013 to 2024 period are, in general, as follows:

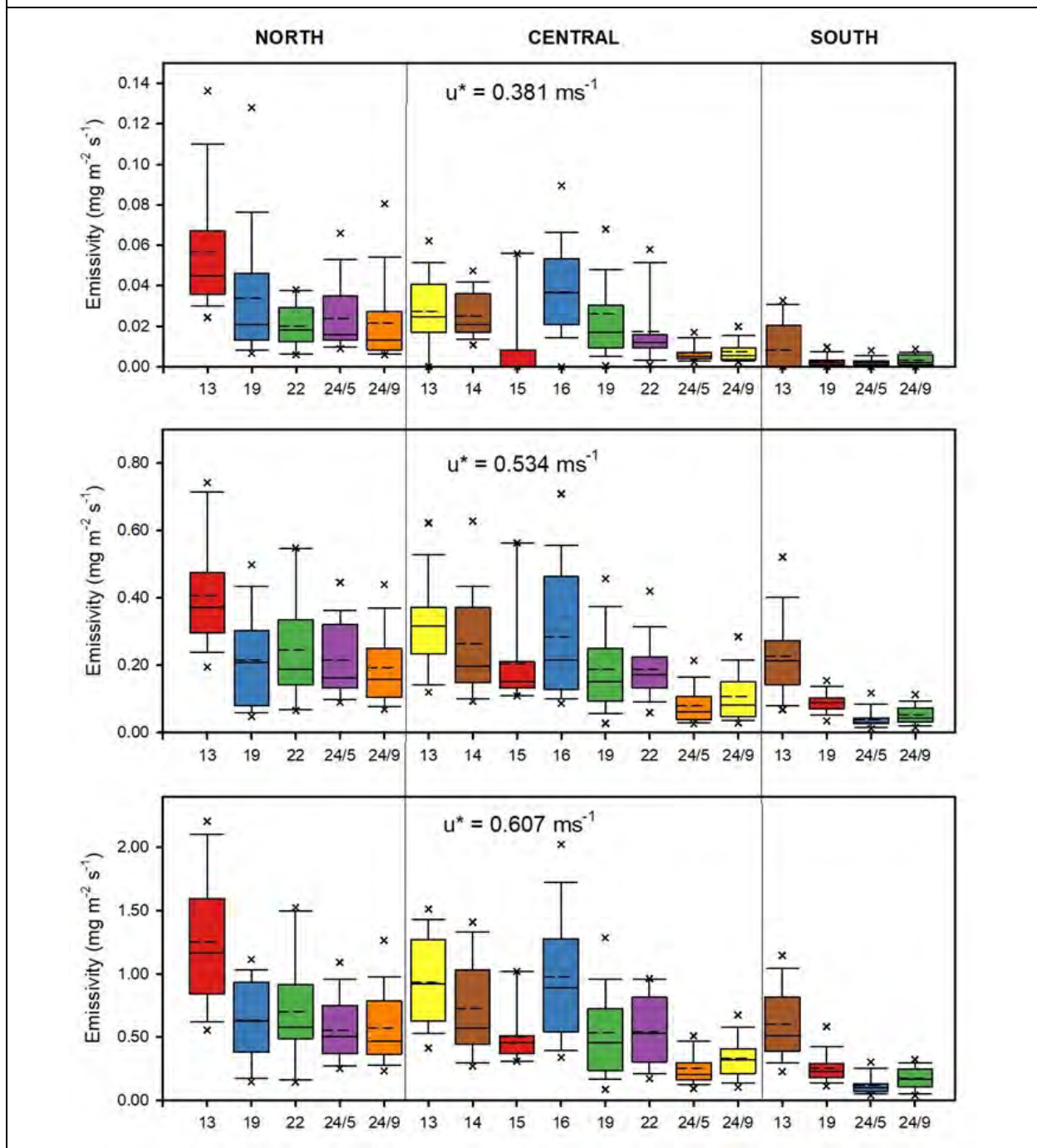
- The emissivity values in the riding area zones were, on average, approximately two to three times greater than those in the non-riding area zones (see Figure 2-9 and Figure 2-10).
- For the riding area, the 2024 results are similar to those measured in 2019. In addition:
 - The Riding Area Central-South sub-region had the smallest emissivity values in May 2024, but these increased slightly in September 2024 (to 2019 levels).
 - The Riding Area Central-North sub-region had emissivity values in May 2024 similar to those in May 2019. (No September measurements were conducted in 2019 or 2024.)
- For the non-riding areas, there was a gradual decline in emissivity values from north to south (evident in the 2024 data, as well for 2019 and 2013 when comprehensive spatial sampling was done). In addition:
 - The Non-Riding Area Central and South zones had the smallest emissivity values in May 2024, but these increased slightly in September 2024 (to 2019 levels).
 - The Non-Riding Area North zone had emissivity values in 2024 that were lower than those in 2019, but the September 2024 values were lower than those in May 2024, unlike in other zones. These differences, however, are unlikely to be statistically significant.
- For the FRA, the 2024 emissivity values were almost identical to those measured in 2022. Both the 2022 and 2024 values were substantially lower than those between 2013 and 2019 when the area was OHV-accessible.
- For the PE, the 2024 emissivity values were only slightly greater than those in 2022, but both campaign years had values well below those measured in previous years when seasonal OHV traffic was allowed.
- For the Seasonal Exclosure (SE) zone, the 2024 emissivity values were generally less than those in 2022, and the difference is greater for the measurements taken at the end of the closure period (i.e., the measurements taken at the end of the riding period were similar in 2022 and 2024).

Refer to Section 2.3.2 for additional information on the revised emissivity relations incorporated into the excess emissions modeling required by the SOA.

Figure 2-9: Box and Whisker Plots of PI-SWERL Emissivity Measurements in the Riding Area

Box-and-whisker plots of PI-SWERL measurements in the riding area for all sampling campaigns between 2013 and 2024, inclusive. The colored boxes define the range of the 25th and 75th percentiles; the whiskers correspond to the 10th and 90th percentiles; and the outer symbols (x) indicate the 5th and 95th percentiles. The median value is given by the horizontal solid line within the box, whereas the arithmetic mean (average value) is shown by the horizontal dashed line. The three panels correspond to the three RPM speeds used in the PI-SWERL device to characterize dust emissions at any single measurement location. Note that the measurements from two campaigns in 2015 and 2019 were combined in this graph, whereas the 2024 campaigns are represented separately.

Figure 2-10: Box and Whisker Plots of PI-SWERL Emissivity Measurements in the Non-Riding Area



Box-and-whisker plots of PI-SWERL measurements in the non-riding area for all sampling campaigns between 2013 and 2024, inclusive. See Figure 2-9 for explanation of symbols and interpretation of box plots. Note that the Non-Riding Area North and South zones were sampled during every campaign year.

2.2.2.1 MECHANICAL RAKING OPERATIONS SAMPLING

In May 2024, DRI conducted a SAG-designed PI-SWERL study of mechanical raking operations at the ODSVRA. This PI-SWERL sampling was conducted in addition to, and not for the purposes of, the development of emissivity grids for excess emissions modeling, and the data from the mechanical raking campaign are not included in emissivity grids developed for excess emissions modeling purposes (see Section 2.3.2.1). The following information has been summarized from the DRI-prepared and SAG-reviewed “Evaluation of Potential Changes in Dust Emissions due to Mechanical Raking of ODSVRA Beach Areas.” This report, and the SAG’s review comments, are provided as Attachment 06 to this 2025 ARWP.

DRI’s mechanical raking PI-SWERL sampling included 135 PI-SWERL tests designed to determine if mechanical raking of beach areas for the purpose of removing nails, broken glass, and other debris that may pose a hazard to visitors or wildlife from open sand areas could result in a measurable change in the emissivity of a selected beach area. The raking action actively disturbs the surface of the sand and removes debris and organic material from the top approximately 2 to 6 inches of the sand surface. The methodology followed by State Parks and DRI was as follows:

- 1) Identify and mark an area of the beach with two approximately equivalent-sized areas, one that would be mechanically raked (beach area 1) and the other not mechanically raked (beach area 2), both of which would be exposed to OHV activity
- 2) Identify an area of equivalent size in the northern dune preserve that would not be mechanically raked or experience any OHV activity (a control area)
- 3) Rake beach area 1 (done on May 21, 2024)
- 4) Do not rake beach area 2

The first set of PI-SWERL measurements were made on May 20, 2024, the day prior to the mechanical raking on beach area 1. Fifteen locations, following an equal-spaced grid pattern, were identified in each of the sampling areas, and emissivity at each site (beach area 1, beach area 2, and northern dune preserve control area) was measured using the Hybrid 3500 PI-SWERL test.²⁸ The raking of the test area was carried out by State Parks’ personnel on May 21, 2024, between the hours of 08:00 a.m. and 10:00 a.m. The raking implement, two Barber Surf Rake Model 600HD units linked together, was towed by a John Deere 9430T tractor at a speed of approximately 5 to 10 miles per hour (see Figure 2-11). The 10-inch-long tines of the raking implement spaced 2 inches apart were set to a penetration depth of 6 inches. The tracked vehicle

²⁸ Gillies, J.A., E. Furtak-Cole, G. Nikolich, and V. Etyemezian, 2022. The role of off highway vehicle activity in augmenting dust emissions at the Oceano Dunes State Vehicular Recreation Area, Oceano CA. Atmospheric Environment: X, 13, 100146, doi: 10.1016/j.aeaoa.2021.100146

pulled the raking implement in a north-south or south-north direction covering the test area. Sampling locations were measured for emissivity (in $\text{mg m}^{-2} \text{s}^{-1}$) again on May 22, 2024, approximately 24 hours after the raking, and finally on May 31, 2024, approximately 10 days after raking.

Figure 2-11. Raking Implement and Tow Vehicle



The results of DRI's PI-SWERL emissivity testing of mechanically raked and unraked areas indicates that:

- The median emissivity values of the mechanically raked beach area 1 and the unraked beach area 2 were not significantly different for all PI-SWERL test u^* values for all three testing days; and
- The median emissivity values of the mechanically raked beach area 1 and the unraked beach area 2 were significantly different compared with the median emissivity of the northern dune preserve control area for all three PI-SWERL test u^* values for each testing day; however, the lower emissivity of the non-riding area compared with the riding area has been documented previously.^{29,30}

DRI found that the similarity of the median emissivity values for mechanically raked beach area 1 and unraked beach area 2 to each other and to the overall median emissivity relation of the excess emissions modeling management zone in which the testing occurred (i.e., Riding Area Central-North sub-region, prior to inclusion of the 2024 PI-SWERL data) suggests that the beach raking did not alter, to the limit of measurement resolution, the emissivity between the two conditions.

²⁹ *Ibid.*

³⁰ Refer to State Parks' 2024 ARWP, Attachment 08, for the SAG memo "Updated SAG Recommendations for Establishing Emissivity Grids to be used in Modeling of Pre-Disturbance Conditions and Future Excess Emissions Reductions."

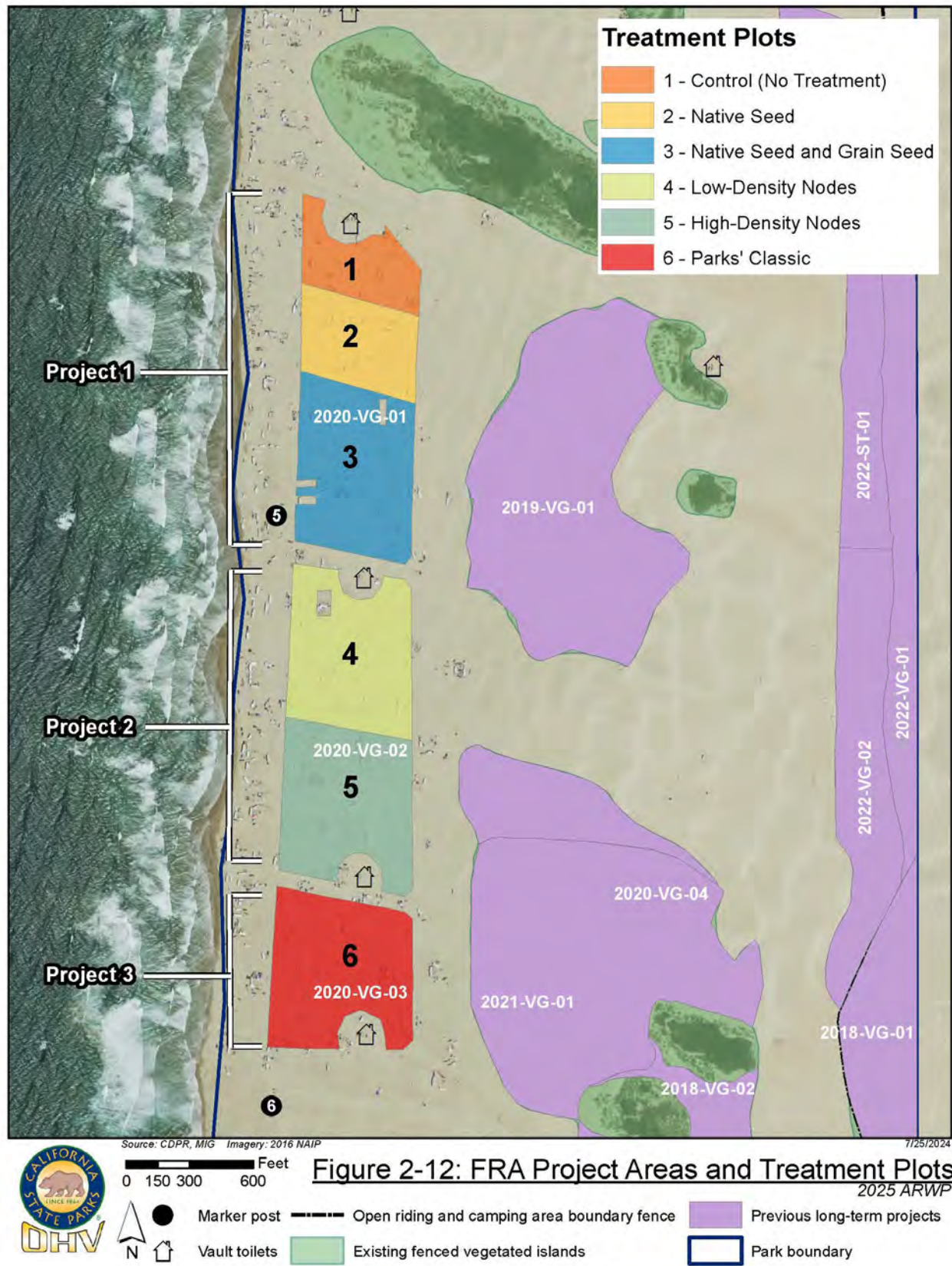
DRI noted that the mechanical raking was limited in scope because it was relatively short-term and based on a single raking event; however, as the beach raking on a selected area is expected to occur no more than several times per year, it is unlikely that there would be a cumulative effect of beach raking on emissivity. As no demonstrable effect on emissivity could be quantified one and ten days after raking, DRI concluded it would be reasonable to assume that month-long periods between raking would not have any cumulative effect on emissivity of the beach areas, especially as OHV activity on the beach areas is a near-constant source of surface disturbance and its effect on emissivity has been previously demonstrated.³¹

2.2.3 FOREDUNE RESTORATION AREA (FRA) UNCREWED AERIAL SYSTEM (UAS) SURVEYS

State Parks initiated the 48-acre FRA project in late 2019. The rationale for the treatment was to re-establish a vegetated foredune ecosystem, similar to what might have been present prior to extensive vehicular disturbance, such as observed in early historical aerial photography (e.g., 1939). Such a re-established foredune could naturally disrupt incoming boundary layer flow from the ocean, reduce surface shear stress, and decrease sand flux across the foredune's width and for some distance downwind. As a mitigation strategy, the FRA will reduce saltation-driven dust emissions and contribute to improved air quality downwind. The restoration treatment is based on a SAG design in which the 48-acre FRA is subdivided into three different projects and six different TPs, as follows (see Figure 2-12):

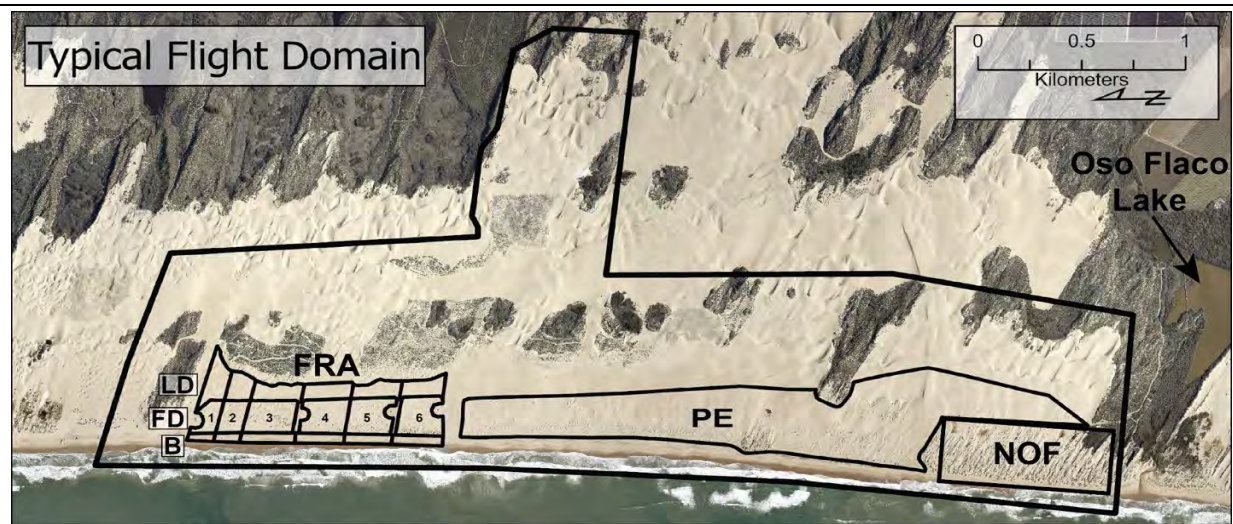
- Project 1 – Foredune North (18.8 acres, 2020-VG-01):
 - TP 1 – Control (4.0 acres): No treatment other than sheep's foot surface texturing to create divots for seeds and low-level aerodynamic roughness
 - TP 2 – Native Seed (5.2 acres): Native seed mix with sheep's foot surface texturing
 - TP 3 – Native Seed and Grain Seed (9.6 acres): Native seed mix and sterile ryegrass seeds with sheep's foot surface texturing
- Project 2 – Foredune Central (18.8 acres, 2020-VG-02):
 - TP 4 – Low-Density Nodes (9.1 acres): Low-density random planting nodes (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
 - TP 5 – High-Density Nodes (9.7 acres): High-density random planting nodes with the same planting and straw protection strategy
- Project 3 – Foredune South (9.9 acres, 2020-VG-03):
 - TP 6 – Parks' Classic (9.9 acres): Sheep's foot surface texturing, spreading straw over the entire area, planting foredune-specific species, and seeding the area with native seed.

³¹ See footnote 28.



Since 2019, a crew from the University of California, Santa Barbara (UCSB) (and formerly Arizona State University [ASU]), in collaboration with State Parks, has conducted biannual UAS surveys using a fixed-wing, fully autonomous WingtraOne UAS (or drone) with high resolution visual (red, green, and blue [RGB]) and multispectral cameras to map geomorphic and vegetation changes across the ODSVRA. The focus for the analyses of the UAS monitoring has been primarily on the FRA plots and adjoining beach and backdune areas, but also includes most of the ODSVRA's open riding area as well as the Plover Exclosure (PE) and the North Oso Flaco foredune reference site. The typical extent of the UAS mapping domain is shown in Figure 2-13.

Figure 2-13. UAS Mapping Domain



Map showing the typical extent of the UAS surveys (north oriented to the left). The FRA and foredune (FD) treatment plots (TP) 1-6 are shown with adjoining beach (B), foredune (FD), and landward dune (LD) polygons for examining volumetric exchanges with the FRA. The Plover Exclosure (PE, as of February 2024) and North Oso Flaco reference site are also shown. The underlying orthomosaic is from January 27, 2023.³²

For analysis of the development and performance of the FRA treatment plots (TP), UAS imagery datasets are used to create the following data products (see also Table 2-3):

- Twelve (12) visual (RGB) georeferenced aerial orthomosaic images of the FRA at approximately 1.5 centimeter (cm) resolution
- Ten (10) multispectral (RGB-red edge [RE]-near-infrared [NIR]-panchromatic [Pan]) georeferenced orthomosaic images of the FRA at approximately 3.0 to 7.5 cm resolution collected concurrently with the RGB datasets since October 2020

³² National Geodetic Survey, 2024. 2023 NOAA NGS Aerial Imagery for Situational Awareness: Central California. <https://www.fisheries.noaa.gov/inport/item/69185>.

- Ten (10) Normalized Difference Vegetation Index (NDVI) orthomosaics used to assess vegetation cover in the FRA at approximately 3.0 to 7.5 cm resolution derived from the multispectral orthomosaic datasets
- Ten (10) georeferenced, orthorectified maps of vegetation cover derived from RGB and NDVI imagery used to track changes in plant cover within the FRA
- Twelve (12) three-dimensional point clouds of surface topography within the FRA at a decimated resolution of 10 cm
- Twelve (12) three-dimensional digital terrain models (DTMs) of topography within the FRA at 10 cm pixel resolution
- Eleven (11) topographic change maps derived from statistically significant pixels of erosion and deposition between DTM intervals used to assess geomorphic and sediment volume changes

To date, 12 UAS mapping campaigns have been conducted dating back to October 2019, just prior to implementation of the restoration treatments in February 2020 (see Table 2-3). Initially, only RGB imagery was captured until October 2020 (following the first plant growth season) when both RGB and multispectral imagery (RGB, NIR, and RE bands) were flown concurrently to map vegetation. The NDVI is used to identify vegetation on the surface (differentiated from sand or straw) to quantify plant cover within the dunes. The NDVI is calculated using a ratio of the difference in reflectance values of NIR light (reflected strongly by plants) and red (R) light (absorbed by plants).

To date, 10 multispectral datasets have been collected. UAS flights occur biannually in October and February, as constrained by the nesting season for Western Snowy Plover (March through September), during which State Parks does not permit UAS flights. This timing also roughly brackets the plant growth and sand-transporting wind seasons.

The UAS is typically flown at altitudes over 100 m AGL, as controlled by flight planning software, and is equipped with an on-board, survey-grade global positioning system (GPS) with post-processing kinematic (PPK) correction capabilities. During data collection, a GPS base station is operated in static collection mode and these occupation datasets are used to refine UAS photo point locations to within millimeters of their real-world location.

Table 2-3. UAS Survey Campaign Specifications					
UAS Survey Campaign	Survey Date	Sensor Payload	Average Altitude (m)	Ground Sampling Distance (GSD) (cm per pixel)	Total Uncertainty (m)
1. Baseline pre-restoration survey	October 1-2, 2019	Sony RX1RII	114	1.45	0.038
2. Initial treatment installations	February 10-11, 2020	Sony RX1RII	123	1.56	0.033
3. First post-treatment survey and growing season	October 13-15, 2020	Sony RX1RII	121	1.54	0.037
	October 16, 2020	Micasense RedEdge-MX	113	7.53	—
4. End of first year of geomorphic response and vegetation growth	February 17-18, 2021	Sony RX1RII	120	1.52	0.030
	February 18-21, 2021	Micasense RedEdge-MX	118	7.89	—
5. Second growing season	October 4-5, 2021	Sony RX1RII	121	1.54	0.025
	October 5-7, 2021	Micasense RedEdge-MX	119	7.82	—
6. End of second year of geomorphic response and vegetation growth	February 23-25, 2022	Sony RX1RII	112	1.42	0.043
	February 25-26, 2022	Micasense RedEdge-MX	116	7.71	—
7. Third growing season	October 17-18, 2022	Sony RX1RII	125	1.66	0.026
	October 19-21, 2022	Micasense RedEdge-P	111	3.67	—
8. End of third year of geomorphic response and vegetation growth	February 23, 2023	Sony RX1RII	121	1.59	0.034
	February 20-21, 2023	Micasense RedEdge-P	120	3.97	—
9. Fourth growing season	October 9, 2023	Sony RGB61	108	1.65	0.049
	October 10-13 2023	Micasense RedEdge-P	135	4.42	—

Table 2-3. UAS Survey Campaign Specifications					
UAS Survey Campaign	Survey Date	Sensor Payload	Average Altitude (m)	Ground Sampling Distance (GSD) (cm per pixel)	Total Uncertainty (m)
10. End of fourth year of geomorphic response and vegetation growth	February 23, 2024	Sony RGB61	116	1.78	0.071
	February 21-23, 2024	Micasense RedEdge-P	133	4.38	—
11. Fifth growing season	October 29-30, 2024	Sony RGB61	107	1.65	0.047
	October 14-18, 2024	Micasense RedEdge-P	121	3.96	—
12. End of fifth year of geomorphic response and vegetation growth	February 20-21, 2025	Sony RGB61	125	1.89	0.030
	February 18-19, 2025	Micasense RedEdge-P	123	4.05	—
<i>Note: Specifications for the RGB and multispectral UAS campaigns. Multispectral sensors were only used after installation of the vegetation treatments in February 2020. GSD is the distance between the center of adjacent pixels and describes the cell size of each pixel in centimeters (cm) (i.e., pixel resolution). Total Uncertainty values are the calculated vertical uncertainty for datasets used in DTM development and volumetric change detection mapping. As the multispectral datasets were not used for this purpose, no uncertainty value is shown.</i>					

State Parks and UCSB use the UAS survey datasets described above to quantify and interpret changes in plant cover, geomorphology, and sediment budgets within the FRA. An in-depth report on the data collection, analytical methods, and detailed results from the UAS monitoring flight of the FRA are provided in the UCSB report “2024-2025 ODSVRA Foredune Restoration UAS Monitoring Report.” This UCSB report, and the SAG’s review comments, are included as Attachment 04 to this 2025 ARWP.

Figure 2-14 shows a comparison between the initial (October 2019) RGB UAS orthophoto mosaic of the FRA and the most recent image (February 2025). These images and related datasets are used to interpret geomorphic responses within the FRA TPs, such as aeolian sand transport corridors (ripples), deflation surfaces (coarse lag deposits), and dune development. Cumulative results of observed geomorphic and vegetation coverage changes, respectively, from the UAS surveys of the FRA through to February 2025 are summarized in Section 2.2.3.1 and in Section 2.2.4.2.

Figure 2-14. Comparison of FRA between October 2019 and February 2025

Visible (RGB) orthophoto mosaics of the FRA from the initial baseline survey (October 2019) prior to restoration treatment implementation in February 2020, and from the latest (February 2025) UAS survey. Numbers represent the TPs: TP 1 – Control (sheep's foot texturing), TP 2 – Native Seed, TP 3 – Native Seed and Grain Seed, TP 4 – Low-Density Nodes (straw plantings), TP 5 – High-Density Nodes (straw plantings), and TP 6 – Parks' Classic (broadcast straw, randomly planted seedlings, and broadcast seed). Notable aeolian activity, nebkha development, and streamlined shadow dune accretion are widespread in all treatments except within the control plot (TP 1).

2.2.3.1 FRA MORPHOLOGICAL CHANGES

Figure 2-15 to Figure 2-17 provide topographic change maps and time series of normalized volumetric changes within the FRA TPs and their adjoining geomorphic units between October 2019 and February 2025. Geomorphic units include each of the foredune treatment areas (FD), an adjoining beach area (B), and landward backdune areas (LD) (see Figure 2-13 and Figure 2-14). The first interval (October 2019 to February 2020) provides baseline reference conditions prior to implementation of the restoration treatments. Corresponding change values are shown in Table 2-4.

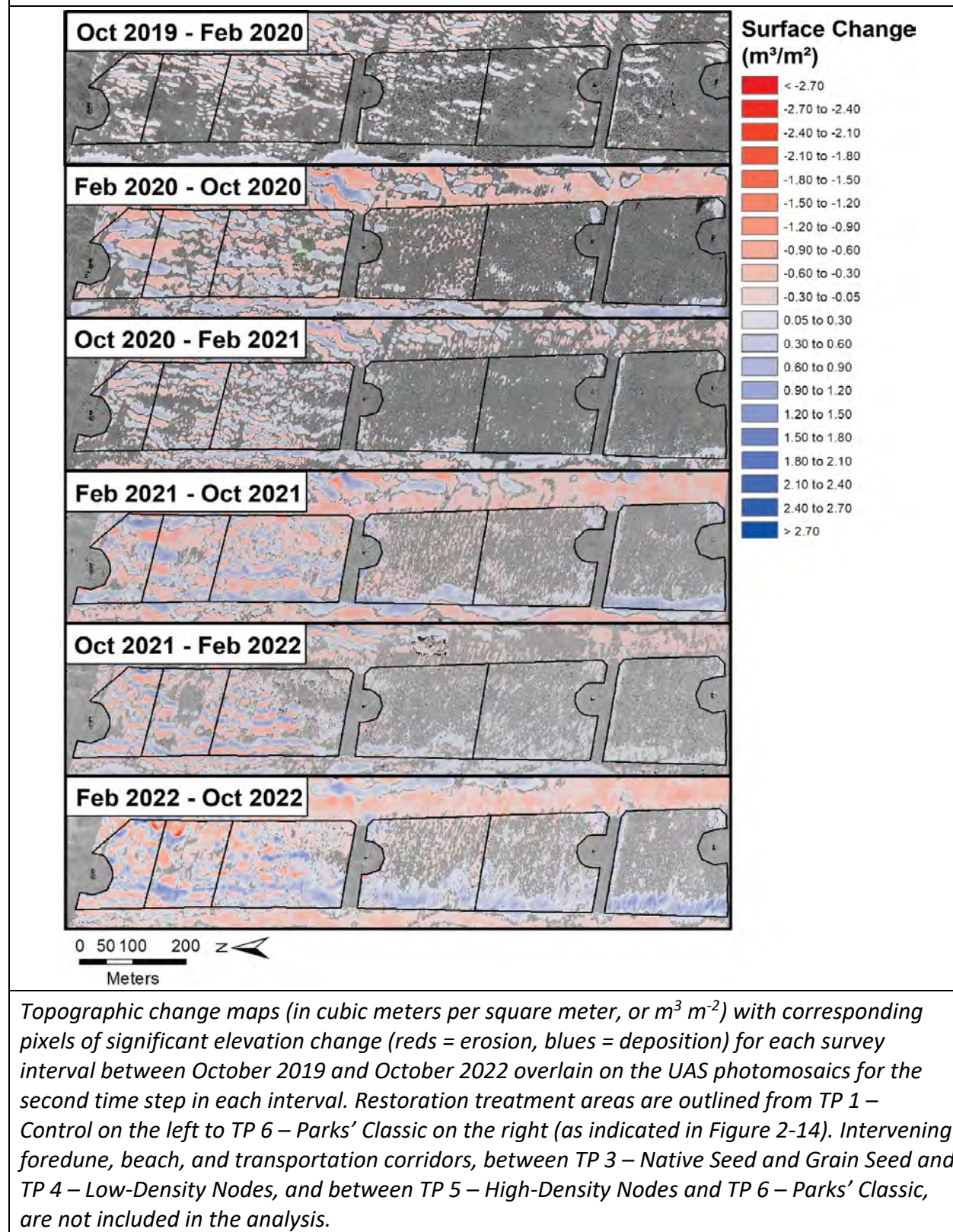
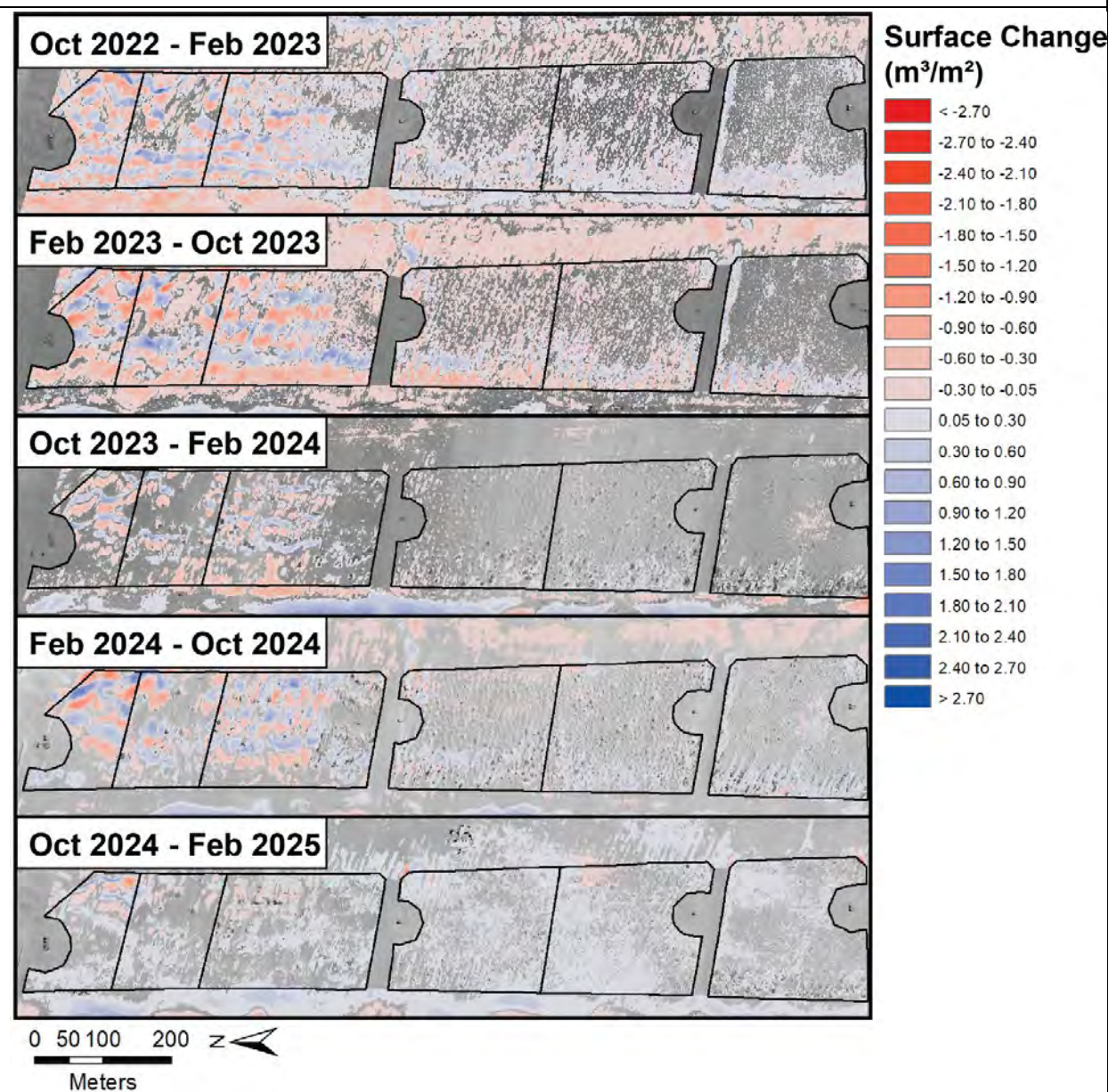
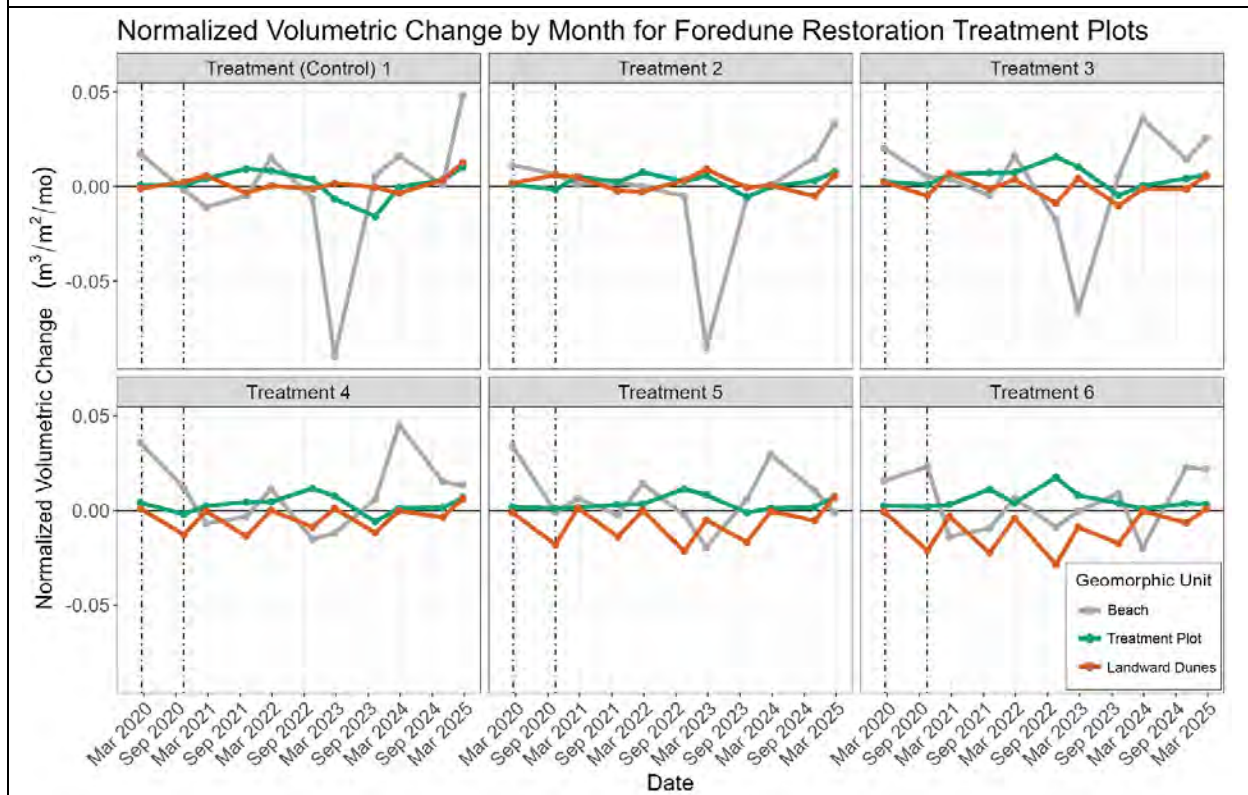
Figure 2-15. Topographic Change Maps (October 2019 to October 2022)

Figure 2-16. Topographic Change Maps (October 2022 to February 2025)

Topographic change map (in $\text{m}^3 \text{m}^{-2}$) with corresponding pixels of significant elevation change (reds = erosion, blues = deposition) for each survey interval between October 2022 and February 2025 overlain on the UAS photomosaics for the second time step in each interval. Restoration treatment areas are outlined from TP 1 – Control on the left to TP 6 – Parks’ Classic on the right. Intervening foredune, beach, and transportation corridors, between TP 3 – Native Seed and Grain Seed and TP 4 – Low-Density Nodes, and between TP 5 – High-Density Nodes and TP 6 – Parks’ Classic, are not included in the analysis.

Figure 2-17. Normalized Volumetric Change by Month for Foredune Restoration Treatment Plots



Time series of normalized volumetric changes (in cubic meters per square meter per month, or $m^3 m^{-2} mo^{-1}$) derived from successive surveys for each FRA TP (FD), adjacent beach (B), and landward dune (LD) unit. Each point represents net results of volumetric change for the preceding interval (e.g., 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).

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Treatment Plot	Geomorphic Unit	Oct. 2019 to Feb. 2020	Feb. 2020 to Oct. 2020	Oct. 2020 to Feb. 2021	Feb. 2021 to Oct. 2021	Oct. 2021 to Feb. 2022	Feb. 2022 to Oct. 2022	Oct. 2022 to Feb. 2023	Feb. 2023 to Oct. 2023	Oct. 2023 to Feb. 2024	Feb. 2024 to Oct. 2024	Oct. 2024 to Feb. 2025	Net Change, Oct. 2019 to Feb. 2024
TP 1 – Control	B	1.7	-0.2	-1.1	-0.5	1.5	-0.7	-9.0	0.6	1.6	0.1	4.8	-0.1
	FD	0.1	0.1	0.4	0.9	0.8	0.4	-0.7	-1.6	0.0	0.4	1.0	0.1
	LD	-0.1	0.2	0.6	-0.3	0.0	-0.1	0.2	0.0	-0.4	0.4	1.3	0.1
TP 2 – Native Seed	B	1.1	0.6	0.1	0.2	0.0	-0.5	-8.5	-0.6	0.1	1.5	3.3	-0.1
	FD	0.1	-0.2	0.5	0.3	0.8	0.3	0.6	-0.6	0.0	0.3	0.8	0.2
	LD	0.2	0.6	0.5	-0.2	-0.3	0.3	0.9	-0.1	0.1	-0.5	0.6	0.1
TP 3 – Native Seed and Grain Seed	B	2.0	0.5	0.4	-0.5	1.6	-1.8	-6.6	0.6	3.6	1.4	2.5	0.3
	FD	0.3	0.1	0.6	0.7	0.7	1.6	1.0	-0.5	0.0	0.4	0.3	0.5
	LD	0.2	-0.5	0.7	-0.1	0.4	-0.9	0.4	-1.0	-0.1	-0.1	0.3	-0.3
TP 4 – Low-Density Nodes	B	3.6	1.2	-0.7	-0.3	1.1	-1.5	-1.2	0.6	4.5	1.5	1.3	0.8
	FD	0.4	-0.2	0.2	0.4	0.4	1.2	0.8	-0.6	0.1	0.1	0.7	0.3
	LD	0.1	-1.3	0.0	-1.4	0.0	-0.9	0.1	-1.2	0.0	-0.4	0.6	-0.7
TP 5 – High-Density Nodes	B	3.4	-0.1	0.6	-0.2	1.4	-0.3	-2.0	0.6	3.0	1.1	-0.1	0.7
	FD	0.2	0.1	0.1	0.3	0.3	1.1	0.8	-0.1	0.1	0.2	0.7	0.4
	LD	-0.1	-1.8	0.1	-1.4	0.0	-2.2	-0.5	-1.7	-0.1	-0.5	0.7	-1.1
TP 6 – Parks' Classic	B	1.6	2.3	-1.4	-1.0	0.6	-0.9	-0.1	0.9	-2.0	2.3	2.2	0.5
	FD	0.2	0.2	0.3	1.1	0.4	1.7	0.8	0.4	0.1	0.4	0.3	0.7
	LD	-0.1	-2.1	-0.3	-2.2	-0.4	-2.9	-0.9	-1.8	0.0	-0.7	0.1	-1.5

Note: Normalized surface volumetric changes for the FRA TPs (FD, bold values) and adjoining beach (B) and landward dune (LD) zones. Blue cells indicate sand accumulation; red cells show erosion. Uncertainty values associated with individual measurement campaigns are provided in Table 2-3 in Section 2.2.3.

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Pixels of statistically significant elevation change in the FRA are determined by a two-tailed t-test at a 95% confidence interval in the geomorphic change detection (GCD) package. Co-located significant change pixels are then used to calculate volumes of sediment erosion (reds) or deposition (blues) between surveys in cubic meters per square meter ($\text{m}^3 \text{m}^{-2}$), which is effectively an average depth of change (in m) over the entire TP (or adjoining unit) areas. Data are also normalized by month to allow comparison of change through time (Table 2-4) across different observation intervals (i.e., approximately eight months between the February to October interval and only approximately four months between the October to February interval). Pixels of statistically insignificant change are not shown in the change detection maps and are not used to calculate sediment volumes.

Generally, the beach units fronting the FRA show a declining, albeit highly variable, trend in sand volumes from positive values in the initial October 2019 to February 2020 baseline interval to negative values by February 2023. More recently, the beach units fronting all TPs, except TP 6, have shown distinct positive trends and values of sedimentation between October 2023 and February 2024. Net change values since the baseline survey (Table 2-4) suggest a general trend of minor erosion in the northern beach units, transitioning toward a more depositional state in the southern units.

All TPs in the FRA have accumulated and stored sediment since the FRA was established. With some exceptions, most intervals showed positive sediment budgets (see Figure 2-17 and Table 2-4). However, there were occasional erosional periods with net sediment loss from some, but not all, of the TPs. For example, between February and October, 2023, all TPs had net losses of sediment (erosion) with the exception of TP-6 (Parks Classic). TP 1 and TP 2 continue to show some of the lowest rates of sediment accumulation, reflecting significant beach erosion and sediment bypassing due to limited vegetation establishment and nebkha dune development. TP 3 shows the second highest net accumulation of sand and only recorded one erosional interval (February 2023 to October 2023). TP 4 and TP 5 experienced comparatively moderate change, as the fourth and third (respectively) highest accumulating plots. TP 6 is the only plot that has not exhibited a negative change interval and recorded the greatest net deposition, although this is associated largely with accumulations from sand fences on the northern side and dune development on the seaward edge of the plot. Since October 2022, all TPs have shown neutral to slightly positive trends in normalized sediment volumes.

The foredune plots vary notably in sedimentation and geomorphic responses to vegetation establishment and/or treatment types. TP 1 and TP 2 were the least altered by treatment interventions and maintained similar change patterns across all intervals. Sand transport in these plots generated low-lying (0.4 m to 0.6 m), slowly migrating semi-continuous transverse and barchanoid dune ridges and protodunes. Limited plant cover established in TP 1 except for a very few plants near the seaward edge of the plot, first observed in October 2022 (see Section

2.2.3.2). Some shadow dunes were present in the landward half of these plots, but these were not associated with vegetation (i.e., nebkha), but rather with nodes of cemented sand and anthropogenic debris.³³ Following the winter storm season of 2023-2024, vegetation wrack and propagules that washed into the plots gave rise to an increase in vegetation cover by October 2024. TP 2 developed nebkha cluster in the center of the plot, but this had not expanded notably by February 2025. Both TP 1 and TP 2 recorded the smallest net changes in sand volume over the monitoring period (see Table 2-4).

TP 3 developed significant nebkha, predominantly with *Abronia latifolia*, which have begun to coalesce and form discontinuous ridges over 2 m tall - the tallest dunes across all of the TPs. Nebkha coalescence and elongation are important stages for eventual established foredune development. The latest two intervals (since February 2024) showed positive volumetric changes within TP 3, among the greatest and most consistent sediment budget responses across the sites, despite a roughly 40% decline in plant cover from the peak value in October 2022 (see Section 2.2.3.2, Table 2-5 and Figure 2-18). This reflects a feedback mechanism between nebkha dune growth, plant cover, and aerodynamics. Initially, before significant dune development, small scale vegetation roughness promotes sediment deposition around and behind plants. Eventually, this leads to development of small vegetated dune mounds, or nebkha. As nebkha grow larger, their form and related aerodynamic roughness begins to exert more control than plant cover on deposition patterns. The dunes then begin to extend downwind via enhanced deposition in a shadow dune in the wake zone that is typically unvegetated. Thus, once larger dunes are developed, plant-scale roughness becomes secondary to form-roughness. So, at this stage of dune development in the TPs, declines in vegetation cover do not appear to influence observed sediment budget responses. It is unknown, however, if this response will persist if plant cover stays at this level or continues to decline.

In the planting node treatments TP 4 and TP 5, erosional streets” between planting nodes persisted while nebkha continued to grow and slowly coalesce in both plots. These streets formed initially by wind erosion between the randomly arranged nodes, but their presence is not a concern as wind-aligned sand transport corridors and blowouts are common in established discontinuous foredunes in the region and at the North Oso Flaco reference site. TP4 and TP5 experienced the fourth and third highest net positive deposition amounts, respectively, to date (see Table 2-4). Nebkha dunes in TP 5 are larger than in TP 4 and closer in height to the larger dunes in TP 3, with some dunes over 1.5 m tall. In the most recent February 2025 surveys, however, dunes in TP 4 had grown notably, particularly along the seaward half of the plot. Nebkha coalescence was observed in both treatments along the seaward half of the

³³ For more discussion, see Hilgendorf, Z., I.J. Walker, N. Swet, and M. Heffentrager, 2023. UCSB 2022-2023 ODSVRA Foredune Restoration Survey Report. Research report to the SAG and State Parks. 44 p.

plot by October 2023.

TP 6 had the most intensive treatment with the highest planting density and complete surface straw cover on installation. Although this plot maintains the highest plant coverage (see Section 2.2.3.2, Table 2-5 and Figure 2-18), greatest depositional volumes, and highest net positive sediment budget (see Table 2-4), the development of large nebkha has followed a different pathway than most other plots (TP 3 to TP 5). An appreciable amount of the accretion in TP 6 is associated with significant drift development along the sand fence on the northern border with the transportation corridor (see Figure 2-15 and Figure 2-16). This drift does not reflect the effectiveness of the treatment itself and was not removed from the volumetric calculations due to its varying shape and difficulty defining its boundaries. A similar fence-drift pattern is also observed on the north fence line of TP 4. Nebkah within TP 6, downwind of the sand fencing or inland from the seaward edge, have yet to exhibit significant development, while plant cover has also declined markedly by approximately 43% from the peak in October 2023 (see Table 2-5 and Figure 2-18).

In terms of performance of the treatments to date, the restoration plots continue to evolve on different trajectories as a function of the initial treatments and variability in other controlling factors such as sand supply to the beach, plant cover, and roughness effects. Performance is assessed by relative cumulative rankings of the following six criteria developed in collaboration with State Parks and the SAG:³⁴ 1) maintenance of a positive sediment budget, 2) maintenance of aeolian activity, 3) development of native plant communities, 4) development of dynamic dunes, 5) relative cost, and 6) dust control potential. As explained in more detail in Attachment 04, relative rankings have not changed significantly since October 2022. Overall, TP 3 has maintained the highest performance since installation, followed by TP 5, due largely to continued positive sediment budgets, greatest amounts of dune development and extension, consistent maintenance of aeolian activity, and continued increases in plant cover, all with collective impacts for providing the greatest potential reductions in dust emissions. Next to TP 1 – Control, which received no vegetation treatment, TP 2 maintains the lowest performance due to modest amounts of accretion and dune development, low rates of plant cover increase, and correspondingly lower relative dust emissions reduction potential. The most intensive treatment (TP 6) dropped to third lowest rank due to continued declines in sediment budget, limited dune development, and marked declines in vegetation cover. Performance of this site is also biased by significant accretion in the plot downwind of a drift fence on the northern boundary with the transportation corridor. Monitoring will continue as the treatments evolve to detect further responses indicative of success or concern for adaptive management and for

³⁴ Walker, I. J., Z. Hilgendorf, J.A. Gillies, C.M. Turner, E. Furtak-Cole, and G. Nikolich, 2023. Assessing performance of a “nature-based” foredune restoration project, Oceano Dunes, California, USA. *Earth Surface Processes and Landforms*, 48(1), 143-162.

longer-term sustainability of the FRA as a dust control mitigation site. To address the influence of the sand fences in some of the treatment plots, a sub-region within each TP will be analyzed separately to remove signals from fence effects for the next ARWP, as recommended by the SAG.

2.2.3.2 UAS VEGETATION COVERAGE

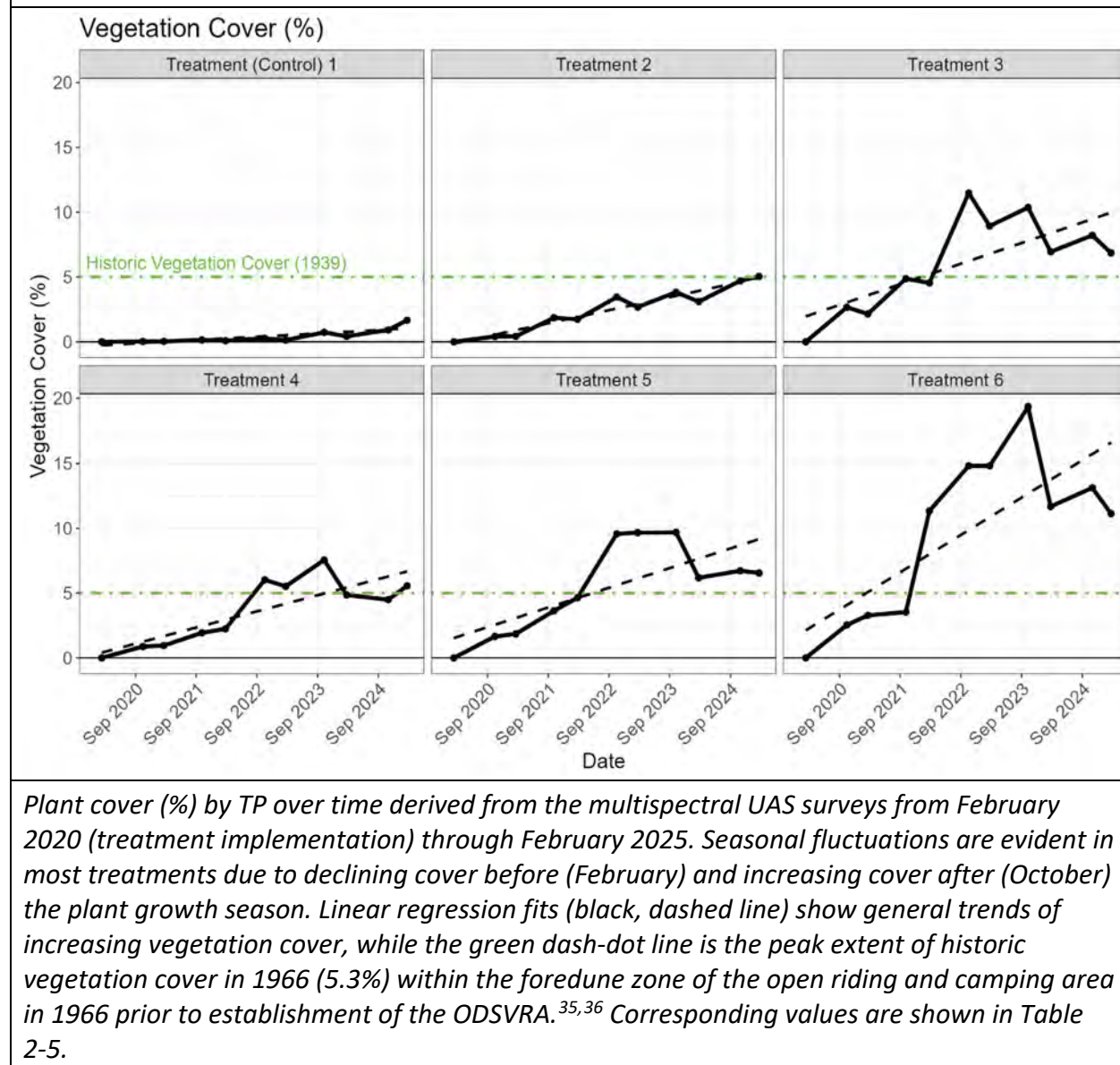
UCSB calculated NDVI values for all multispectral surveys to detect and map vegetation cover in the FRA TPs and changes over time. Percent vegetation cover has generally increased over time in all TPs (see Figure 2-18 and Table 2-5). TP 6 shows the greatest plant cover change (from 2.5% in October 2020 to 11.1% by February 2025), followed by TP 3 (from 2.7% in October 2020 to 6.9% by February 2025), TP 5 (from 1.7% in October 2020 to 6.6% by February 2025), TP 4 (from 0.9% in October 2020 to 5.0% by February 2025), TP 2 (from 0.4% in October 2020 to 5.0% by February 2025), and TP 1 (from 0.0% in October 2020 to 1.3% by February 2025).

Historically, within the broader foredune zone of the OHV riding area, plant cover was 2.6 % in 1939, rose to a peak of 5.3 % in 1966, but steadily declined to approximately 1% from 1985 to 1998. Although 1939 is defined as the “pre-disturbance” state for the purposes of dust emissions modelling and refining the related SOA target, the dunes had experienced earlier vehicular, equestrian, and other recreational activities by then. Thus, these initial lower values still reflect the influence of decades of recreation in the dunes prior to the earliest aerial photography. Within the FRA site specifically, the maximum observed plant cover was 3.3% in 1939, and plant cover then declined to negligible cover by 1985. Since then, plant cover in the FRA remained negligible until implementation of the restoration treatments in 2020. In contrast, at the nearby South Oso Flaco foredune reference site, plant cover was 26% in 1939, decreased to a low of 24% in 1949, increased to a peak of 66% in 2012, and remained greater than (>) 60% by 2020. At North Oso Flaco, foredune plant cover was extremely low (<1%) in the 1930s but increased notably after 1985 to over 24% by 2012. Plant cover estimates in these reference sites partly reflect the influence of invasive species and more recent restoration efforts in these areas.

Following restoration in the FRA, plant cover has increased to an average of 6.13% across all TPs by February 2025 (see Table 2-5), which remains below historic coverage ranges of the nearby reference sites at North and South Oso Flaco but now exceeds the historic maximum cover of 1939 (5.3%) in the broader foredune zone of ODSVRA, generally, albeit in patchwork form distributed across five different restoration treatments. Superimposed on the general increasing trends in plant cover, Figure 2-18 also shows seasonal declines (February), then increases (October) in vegetation bracketing the plant growth season. Most treatments also showed a notable decline in plant cover in recent monitoring intervals (October 2023 to February 2025); however, TP 1 and TP 2 continue to show consistent increases over this time. These increases are partly in response to 1) wave overwash events in the preceding year that

deposited debris and some vegetation propagules within the seaward portions of these plots and facilitated establishment and expansion of vegetation and some small nebkha within TP 1 (see Figure 2-19), and 2) notable increases in smaller vegetation along the seaward edge of TP 2 and TP 3. Figure 2-20 provides a change comparison of vegetation cover (black pixels) and a net cover change map of vegetation growth/expansion (green pixels) and loss (red pixels).

Figure 2-18. Percent Vegetation Cover by Foredune Treatment

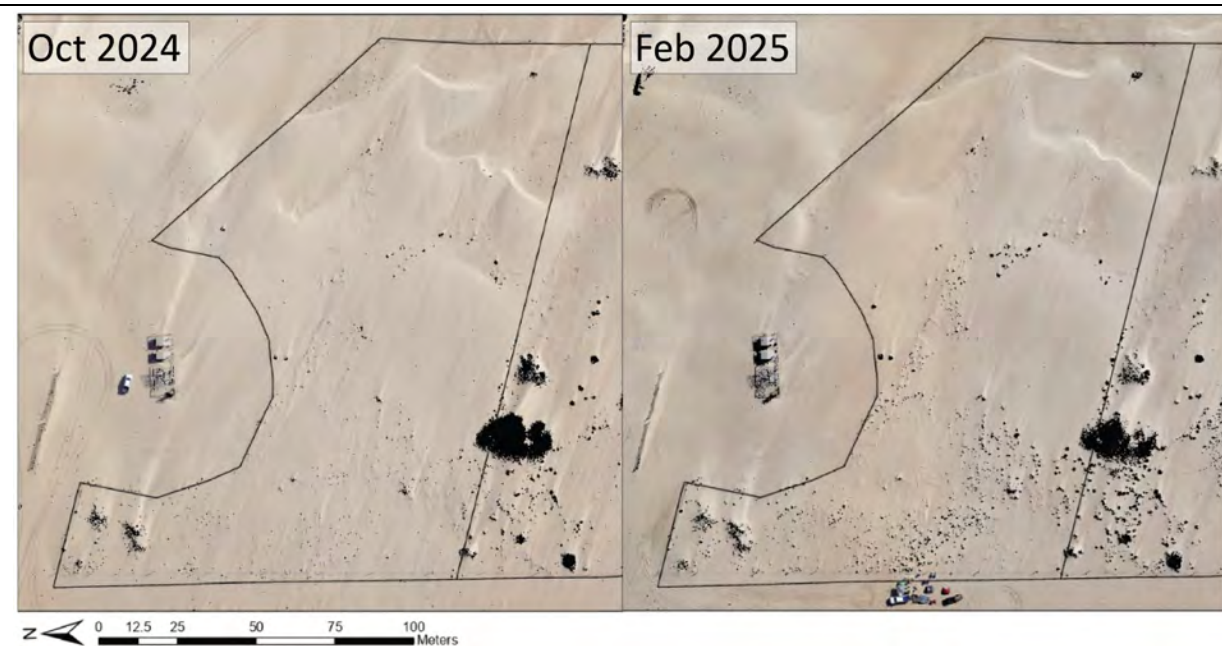


³⁵ Swet, N., Z. Hilgendorf, and I.J. Walker, 2022. UCSB Historical Vegetation Cover Change Analysis (1930-2020) within the Oceano Dunes SVRA. Technical report to the SAG and State Parks. 86 p. This technical report submitted to the SAG and State Parks is available in State Parks' 2022 ARWP (Attachment 07-04).

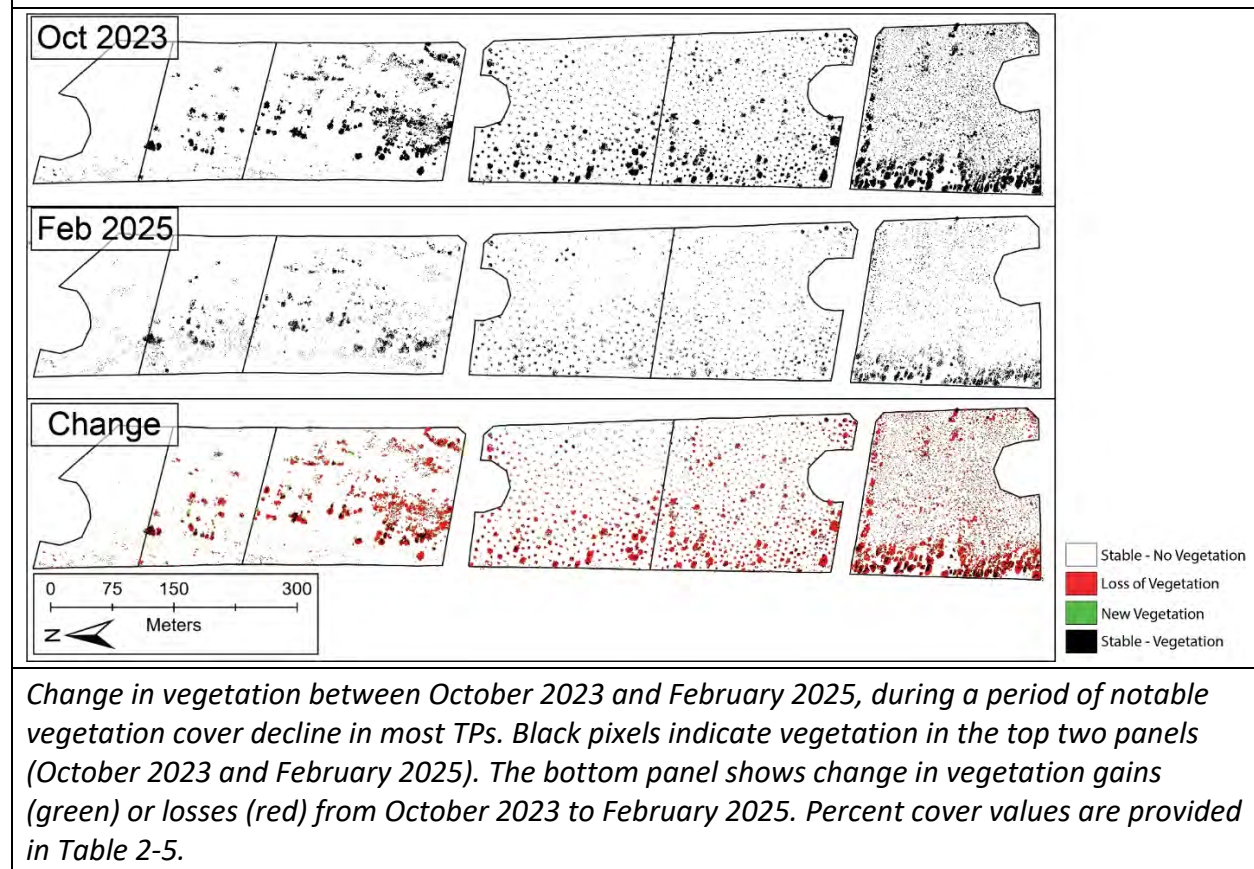
³⁶ Hilgendorf, Z., C. Turner, and I.J. Walker, 2021. UCSB-ASU 2020-2021 ODSVRA Foredune Restoration UAS Survey Report. This technical report submitted to State Parks is available as Attachment 08 to State Parks' 2021 ARWP.

Table 2-5. Percent Vegetation Cover by Foredune Treatment

UAS Survey	TP 1 – Control	TP 2 – Native Seed	TP 3 – Native Seed and Grain Seed	TP 4 – Low-Density Nodes	TP 5 – High-Density Nodes	TP 6 – Parks' Classic
February 10-11, 2020	0.0	0.0	0.0	0.0	0.0	0.0
October 16, 2020	0.0	0.4	2.7	0.9	1.7	2.5
February 18-21, 2021	0.0	0.4	2.2	1.0	1.9	3.3
October 5-7, 2021	0.1	1.9	4.9	1.9	3.6	3.5
February 25-26, 2022	0.1	1.7	4.6	2.2	4.6	11.4
October 19-21, 2022	0.3	3.5	11.5	6.0	9.6	14.8
February 20-21, 2023	0.1	2.7	8.9	5.5	9.7	14.8
October 10-13, 2023	0.7	3.8	10.4	7.6	9.7	19.4
February 21-23, 2024	0.4	3.1	7.0	4.9	6.2	11.7
October 14-18, 2024	0.9	4.7	8.2	4.5	6.7	13.1
February 18-19, 2025	1.7	5.0	6.9	5.6	6.6	11.1

Figure 2-19. Expansion of Vegetation between October 2024 and February 2025

Expansion of vegetation in TP 1 – Control (left) and TP 2 – Native Seed (right) between October 2024 and February 2025 in response to overwash deposits of debris and plant propagules during the winter of the preceding year. Vegetation pixels are shown in black, overlying the RGB orthomosaic image for each year.

Figure 2-20. Patterns of Vegetation Change (October 2023 to February 2025)

2.2.4 OTHER VEGETATION MONITORING

In addition to UAS surveys, State Parks monitors changes in vegetation in dust control projects using line-intercept transect sampling and photo point monitoring.

2.2.4.1 FOREDUNE LINE-INTERCEPT TRANSECT SAMPLING

The line-intercept method is used to estimate the percent cover of species within the 48-acre foredune project and one reference site that had been closed to vehicular activity for at least 20 years and not subject to restoration plantings in the past. In fall 2024, State Parks sampled the following foredune areas:

- The 48-acre foredune project (2020-VG-01, 2020-VG-02, and 2020-VG-03, planted in February 2020). This area was also surveyed in 2020 to 2023, and the same transect lines were surveyed in 2024.
- The North Oso Flaco foredune reference site, which was surveyed in 2021, 2023, and 2024 to account for potential changes caused by storm surges or other environmental changes.

The results of State Parks' 2024 line-intercept transect sampling are summarized in Table 2-6

and discussed below. Refer to Attachment 07 for detailed information on State Parks' line-intercept sampling methodology and results.

With regard to vegetation cover, in 2024:

- The treatment type with the highest vegetation cover (for any single transect) was TP 6 – Parks' Classic (15.0%), followed by TP 3 – Native Seed and Grain Seed (14.0%), and then TP 4 – Low-Density Nodes (6.0%). From 2020 to 2024, the TP with the highest vegetation cover has varied but has been either TP 6 (in 2023, 44.3%) or TP 3 (in 2020, 4.0%; 2021, 28.7%; and 2022, 24.8%).
- Three of the six treatment types showed an increase in mean vegetation cover compared to 2023 results (TP 1 – Control, 0.6%; TP 2 – Native Seed, 0.5%; and TP 3, 7.3%).
- Three of the six treatment types showed a decrease in mean vegetation cover compared to 2023 results (TP 4 – Low-Density Nodes, -1.9%; TP 5 – High-Density Nodes, -6.0%; and TP 6, -2.8%).
- None of the six treatment types met or exceeded the mean vegetation cover of the North Oso Flaco reference site in 2024 (18.4%). From 2020 to 2024, the only TP that has exceeded the mean vegetation cover of the North Oso Flaco reference site (based on that year's sampling result) was TP 6 in 2023.

Table 2-6. Summary of Foredune Line-Intercept Sampling Results			
Survey Site^(A)	Species Richness^(B)	Mean Percent Cover	Range in Percent Cover
2022^(C)			
Foredune TP 1 – Control	2 (1)	0.0%	0.0%
Foredune TP 2 – Native Seed	3 (2)	2.7%	0.0% - 21.0%
Foredune TP 3 – Native Seed and Grain Seed	4 (3)	10.1%	0.0% - 24.8%
Foredune TP 4 – Low-Density Nodes	7 (6)	5.1%	0.0% - 8.6%
Foredune TP 5 – High-Density Nodes	9 (8)	6.4%	0.7% - 16.9%
Foredune TP 6 – Parks' Classic	10 (9)	13.8%	8.2% - 21.4%
Reference Site – North Oso Flaco Foredune	10 (8)	23.0%	6.2% - 60.1%
2023^(C)			
Foredune TP 1 – Control	8 (6)	0.0%	0.0%
Foredune TP 2 – Native Seed	5 (4)	3.1%	0.0% - 12.5%
Foredune TP 3 – Native Seed and Grain Seed	7 (6)	6.7%	0.0% - 12.6%
Foredune TP 4 – Low-Density Nodes	10 (9)	7.9%	0.0% - 21.6%
Foredune TP 5 – High-Density Nodes	9 (8)	11.3%	0.0% - 30.5%
Foredune TP 6 – Parks' Classic	10 (9)	17.8%	5.7% - 44.3%
Reference Site – North Oso Flaco Foredune	11 (9)	16.9%	0.7% - 42.7%
2024			
Foredune TP 1 – Control	4 (3)	0.6%	0.0% - 1.3%
Foredune TP 2 – Native Seed	3 (2)	3.6%	0.0% - 13.8%
Foredune TP 3 – Native Seed and Grain Seed	5 (4)	14.0%	1.7% - 26.5%
Foredune TP 4 – Low-Density Nodes	9 (8)	6.0%	0.0% - 14.2%
Foredune TP 5 – High-Density Nodes	10 (9)	5.3%	0.0% - 10.9%
Foredune TP 6 – Parks' Classic	10 (9)	15.0%	6.1% - 31.3%
Reference Site – North Oso Flaco Foredune	12 (10)	18.4%	1.7% - 45.0%
(A) The foredune was planted in 2020. All foredune treatment areas were approximately 4.5 years old at the time of the 2024 line-intercept sampling. State Parks typically conducts this survey once in September or October, when the survey will not disturb nesting Western Snowy Plover and California Least Tern.			
(B) The main value reflects total species richness. The value in parentheses reflects native species richness.			
(C) Refer to State Parks' 2024 ARWP, Section 2.2.5.3, Table 2-5.			

With regard to species diversity, in 2024:³⁷

- The treatment types with the highest native and total species richness were TP 5 and TP, both of which had 9 native and 10 total species present, followed by TP 4 Nodes, which had 8 native and 9 total species present. In comparison, the North Oso Flaco reference site had 10 native and 12 total species present.
- Two of the six treatment types showed an increase in total species richness compared to 2023 results: TP 4 (from 8 to 9 species), and TP 5 (from 7 to 10 species).³⁸
- One of the six treatment types (TP 2) showed a decrease in total species richness compared to 2023 results.
- Three of the six treatment types showed no change in total species richness compared to 2023 results: TP 1, TP 3, and TP 6.

Comparison of UAS and Line-Intercept Vegetation Monitoring Results

State Parks' line-intercept transect sampling methods were designed to monitor the establishment of vegetation cover and species richness within specific project areas. Two other independent reporting efforts also evaluated vegetation cover within the ODSVRA using aerial imagery to analyze total vegetation cover, each using different imagery sources.^{39,40} These studies provide an opportunity to cross-reference State Parks' line-intercept sampling results.

The first study (Swet et al., 2022)⁴¹ included a historical aerial imagery analysis of the North Oso Flaco foredune that showed vegetation cover of 24.4% in 2012 and 19.1% in 2020, corroborating State Parks' transect results for the North Oso Flaco foredune reference site showing 23.0% in 2021, 16.9% in 2023, and 18.4% in 2024 (see Table 2-6). The reference transect lines showed a high degree of variability in cover ranging from 1.7% to 45.0% cover in 2024, which shows that vegetation within foredune habitats is highly clustered, making it difficult to analyze change over time and determine target cover classes. Furthermore, the results from Swet et al., 2022 and the State Parks' transects corroborate that foredunes

³⁷ In 2023, there were four native wetland species that were only present in the storm surge wrack on the western side of the 48-acre foredune. These species, which included marsh jaumea (*Jaumea carnosa*), saltgrass (*Distichlis spicata*), dune rush (*Juncus lescurii*), and California bulrush (*Schoenoplectus californicus*), were not expected to persist and were not observed in 2024. Thus, these four species were excluded from the comparison of species richness values between 2023 and 2024 (but not discounted in Table 2-6).

³⁸ The total species richness values shown in Table 2-6 include wetland species that were observed in storm surge wrack in 2023; the summary comparison of total species results excludes wetland species. Refer to Attachment 07 for additional details and information on species observed during line-intercept monitoring.

³⁹ Swet et al., 2022. See footnote 35.

⁴⁰ Hilgendorf, Z., C. Turner, and I.J. Walker, 2021. UCSB-ASU 2020-2021 ODSVRA Foredune Restoration UAS Survey Report. This technical report submitted to State Parks is available as Attachment 08 to State Parks' 2021 ARWP.

⁴¹ Swet et al., 2022. See footnote 35.

systems show a natural fluctuation in vegetation over relatively short periods of time.

The second study is the UAS surveys discussed in Section 2.2.3.2. When comparing results from the State Parks' transects and UAS surveys conducted in fall 2024, both methods generally showed similar vegetation cover within the same TPs and followed a similar trend in areas where cover increased, decreased, or showed little change. For TP 1 and TP 2, vegetation cover has increased gradually but consistently from 2020 through 2024. (One exception is that the 2023 State Parks survey showed a decrease in cover in TP 2) Within TP 4, TP 5, and TP 6, vegetation cover generally increased for the first three years (2020, 2021, and 2022) and then either leveled off or decreased during the subsequent two years (2023 and 2024). TP 3 is the exception, showing a continued decline in the UAS surveys from 2022 to 2025, while State Parks' transects showed an initial decline from 2021 to 2023 and a rebound in 2024 to the highest cover measurement to date. All four State Parks transects within this TP showed an increase in cover from 2023 to 2024, which indicates consistent expansion of vegetation along the transect lines within this TP. Given that the UAS survey did not show this increase, it may not be representative of the entire TP. The discrepancy could be a result of the differences in sampling methodology or due to sampling error. One possible explanation related to differences in sampling methodology could be the presence of non-photosynthetic material (i.e., leafless stems or woody material) that would have been measured in the State Parks transect sampling but may not have been accounted for in the UAS survey. Another possible explanation is that the State Parks transect end points shifted as dune topography changed. Given the small sample size, these shifts could result in significant variation in cover between years, even if it is not representative of the TP as a whole.

2.2.4.2 BACKDUNE LINE INTERCEPT TRANSECT SAMPLING

In general, State Parks uses the same line-intercept transect methods to monitor changes in foredune and backdune areas; however, within backdune habitats, early successional communities (early seral) and climax communities (late seral) can vary considerably in species composition and percent cover. For this reason, both early seral and late seral reference sites were sampled for comparison. The late seral reference transects were first sampled in 2021 and the early seral reference transects were first sampled in 2022. Follow-up surveys of these original transect lines occurred during fall 2024. In addition, in fall 2024, State Parks sampled three backdune vegetation projects located east of marker posts 6 and 8 that were originally planted in the fall and winter of 2021/2022 (see Figure 2-2):

- The La Grille Hill vegetation project, planted in January 2022 (2022-VG-03, 19.9 acres)
- The North Orion vegetation project, planted in November 2021 (2022-VG-12, 4.9 acres)
- The South Orion vegetation project, planted in November 2021 (2022-VG-13, 5.7 acres)

The results of State Parks' 2024 backdune line-intercept transect sampling are summarized in

Table 2-7 and discussed below. With regard to backdune vegetation cover, in 2024:

- Each backdune project area showed healthy levels of vegetation cover, with mean vegetation cover ranging from 20.0% to 48.5%. The project with the highest mean vegetation cover (48.5%) was the La Grille Hill vegetation project (2022-VG-03), while the project with the lowest mean vegetation cover (20.0%) was the South Orion vegetation project (2022-VG-13).
- None of the three backdune projects sampled met or exceeded the mean vegetation cover of the early seral (67.2%) or late seral (78.5%) reference sites.

With regard to backdune species richness, in 2024:

- The early seral and late seral reference sites combined had 22 native and 23 total species. In comparison, the three backdune projects combined had 16 native and 25 total species.
- The dominant species within the early seral reference site, dune bush lupine (*Lupinus chamissonis*), was also the dominant species observed within all backdune projects.

State Parks anticipates that the backdune areas surveyed in 2024 will continue to grow and approach the vegetation cover of the reference sites in upcoming growing seasons.

Table 2-7. Summary of Backdune Line-Intercept Sampling Results				
Survey Site	Age of Planting (Years)	Total Species Richness	Mean Percent Cover	Range in Percent Cover
La Grille Hill (2022-VG-03)	3	23	48.5%	40.1% - 58.1%
North Orion (2022-VG-12)	3	17	24.5%	0.6% - 52.7%
South Orion (2022-VG-13)	3	15	20.0%	13.7% - 23.5%
Reference site – early seral	-	17	67.2%	54.0% - 87.8%
Reference site – late seral	-	16	78.5%	77.2% - 82.4%

2.2.4.3 FOREDUNE AND BACKDUNE PHOTO POINT MONITORING

State Parks has conducted on-the-ground photo point monitoring of the 48-acre foredune project since 2020. Initial photo point monitoring occurred before the installation of the foredune in February 2020. Subsequent monitoring has occurred in May 2020, October 2020, and each subsequent October since 2020. 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 area. Select ground photo point monitoring examples are shown in Figure 2-21. In addition to on-the-ground monitoring, State Parks has also conducted drone, or UAS, aerial photo point monitoring of the foredune project. The initial UAS imagery was captured in May 2020, with subsequent UAS imagery captured in December 2020 and every winter since. Two photo points were taken of each treatment area (one from the east and one from the west for each area). Select aerial photo point monitoring examples are shown in Figure 2-22.

On-the-ground and aerial photo point monitoring of backdune projects was conducted using the same methodology described for the 48-acre foredune project. Backdune ground photo monitoring was initiated in 2018 and is usually conducted in the summer and/or fall of each year. In 2024, ground photo monitoring was conducted in the fall only. Backdune photo points are positioned to capture changes within the general areas where backdune projects are located. The number of photos for each photo point and the number of photo points vary at each location to sufficiently capture each area. In total, 27 photo points were monitored in 2024. Select backdune ground photo point monitoring examples are shown in Figure 2-23.

Backdune UAS photo points were initiated in December 2020, with subsequent imagery captures in December 2021 and every winter since, including February/March 2025. The number of photos for each photo point and the number of photo points vary at each location to sufficiently capture each area. Select backdune aerial photo point monitoring examples are shown in Figure 2-24.

Refer to Attachment 07 for detailed information on State Parks' photo point sampling methodology and results.

Figure 2-21. Example Ground Photo Point Monitoring – Foredune Project

Ground photo point of foredune project TP 6 – Parks' Classic facing west prior to planting (top photo taken February 4, 2020) and 4.5 years after treatment (bottom photo taken November 4, 2024).

Figure 2-22. Example Aerial Photo Point Monitoring – Foredune Project

Aerial photo point of foredune project TP 5 – High-Density Nodes facing east approximately three months after planting (top photo taken May 8, 2020) and five years after treatment (bottom photo taken February 18, 2025).

Figure 2-23. Example Ground Photo Point Monitoring – Backdune Project

Ground photo point of the BBQ Flats backdune project (2019-VG-01), facing south prior to planting (top photo taken October 17, 2018) and 5.5 years after planting (bottom photo taken November 4, 2024).

Figure 2-24. Example Aerial Photo Point Monitoring – Backdune Project

Aerial photo point of the La Grille Hill South backdune project near 2022-VG-03 immediately after vegetation planting (top photo taken March 6, 2022) and three years after vegetation planting (bottom photo taken March 19, 2025).

2.3 REPORT ON PROGRESS TOWARD AIR QUALITY OBJECTIVES

This 2025 ARWP reports on the improvement in air quality conditions downwind of the ODSVRA and the reduction in mass emissions that has occurred within the ODSVRA pursuant to the SOA's excess emissions methodology. This section provides the following:

- An updated DRI "Increments of Progress" report (Section 2.3.1) that provides the latest information on the relation between wind power, dust control projects, and downwind PM_{10} concentrations
- A description of changes incorporated into the SOA's excess emissions methodology between August 1, 2024, and July 31, 2025, and the results of the latest excess emissions modeling for the current reporting year (Section 2.3.2)
- Updated evaluation metrics for the 2024/2025 period (Section 2.3.3)
- A brief report on track-out control at the ODSVRA (Section 2.3.4)

2.3.1 INCREMENTS OF PROGRESS TOWARD AIR QUALITY OBJECTIVES

As described in Section 2.1, dust control projects such as temporary wind fencing, straw treatments, and vegetation have been used within the ODSVRA to reduce PM_{10} emissions originating from the ODSVRA and to lower the regional PM_{10} burden on the Nipomo Mesa. Since 2013, when there were effectively no dust control projects in place at the ODSVRA, the amount of acreage managed for dust control purposes has increased to 412.2 acres of specific dust control projects and 740.1 acres of total Dust Control Program area (including other operational activities such as the closed Plover Enclosure and the seasonally closed foredune beach and transportation corridors area) as of July 31, 2025 (see Section 2 and Figure 2-2). Since 2020, DRI has evaluated, in part, the efficacy of the ODSVRA Dust Control Program by comparing the ratio of TPM_{10} concentrations ($\mu g\ m^{-3}$) and TWPDP ($W\ m^{-2}$) to see if the ODSVRA dust emission system is producing less, more, or the same amount of PM_{10} for the same wind energy conditions. The rationale for this approach, and the methodology for determining the ratio of TPM_{10} :TWPDP, is described in State Parks' 2024 ARWP (Section 2.3.1). In general, DRI's evaluation of 2011 to 2023 TPM_{10} :TWPDP has shown a downward trend in the TPM_{10} :TWPDP ratio at the CDF and Mesa2 monitoring stations with increasing amounts of dust control acreage. DRI has updated the evaluation of TPM_{10} :TWPDP with data from April to September 2024. The following information has been summarized from the DRI-prepared and SAG-reviewed "Increments of Progress Toward Air Quality Objectives, ODSVRA Dust Control 2024 Update." This report, and the SAG's review comments, are provided as Attachment 08 to this 2025 ARWP.

The calculated TWPDP at the S1 meteorological tower for the period April to September each year from 2011 to 2024 is shown in Figure 2-25. For 2024, the 179,572 $W\ m^{-2}$ is 10.7% lower

than for the same period in 2023 (TWPD=201,148 W m^{-2}). In the 14-year record from 2011 to 2024, 2019 had the lowest observed and 2022 the highest observed value of TWPD, with the median TWPD for the period 2011-2024 being 205,441 W m^{-2} . Over the 14-year record, 2015, 2017, 2021, and 2024 had the highest TWPD values.

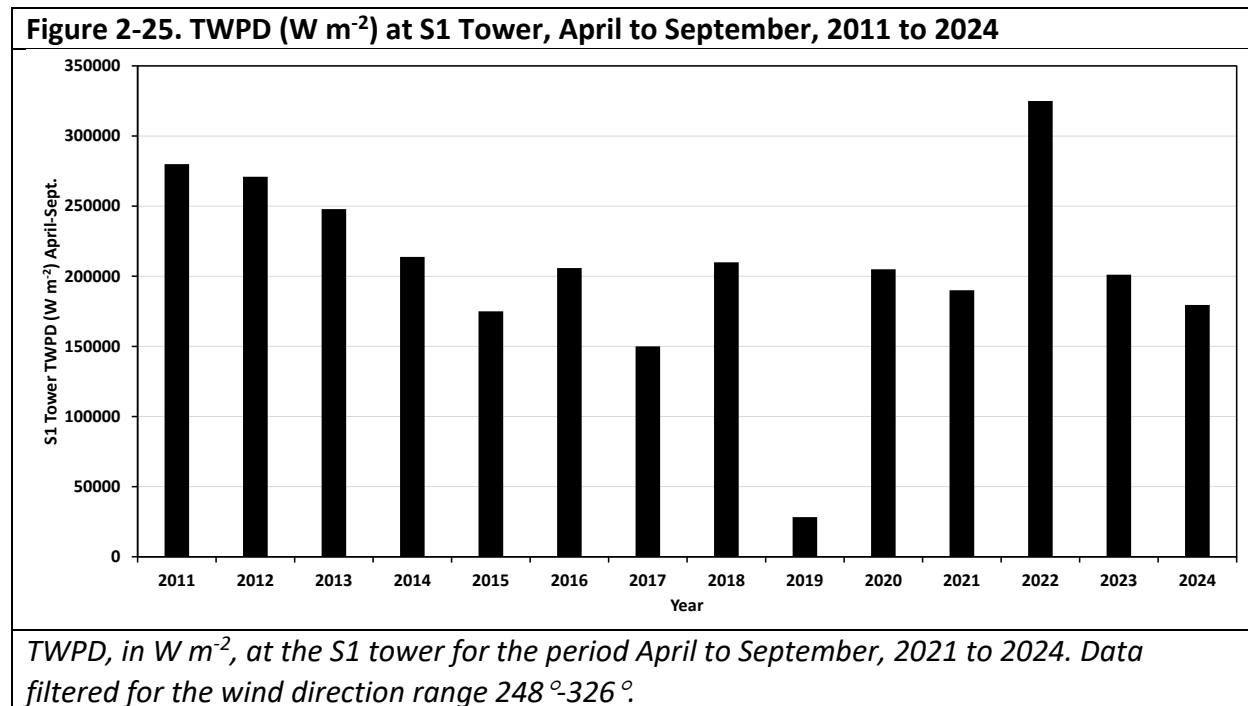


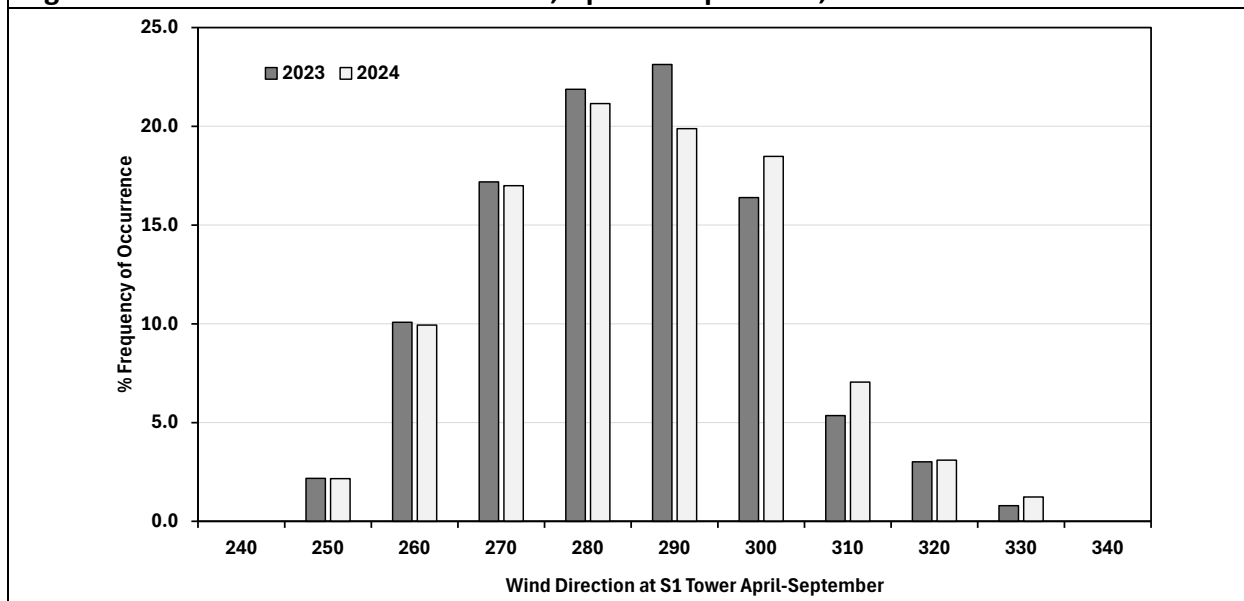
Figure 2-26 shows the distribution of wind direction at the S1 tower for 2023 and 2024 when applying a directional filter of 248° to 326° , which represents the conditions when it is most likely that the PM_{10} reaching the CDF and Mesa2 monitoring stations originated from saltation within the ODSVRA. The distributions have the same median value of 280° for both years. As observed previously, TWPD measured at the S1 tower correlates with TPM_{10} at the CDF and Mesa2 monitoring stations.^{42,43,44,45} This relation was also observed for the 2024 data (see Figure 2-27).

⁴² Gillies, J.A., E. Furtak-Cole, and V. Etyemezian, 2020. Increments of Progress Towards Air Quality Objectives - ODSVRA Dust Controls. Report prepared for California State Parks by DRI, December 2020.

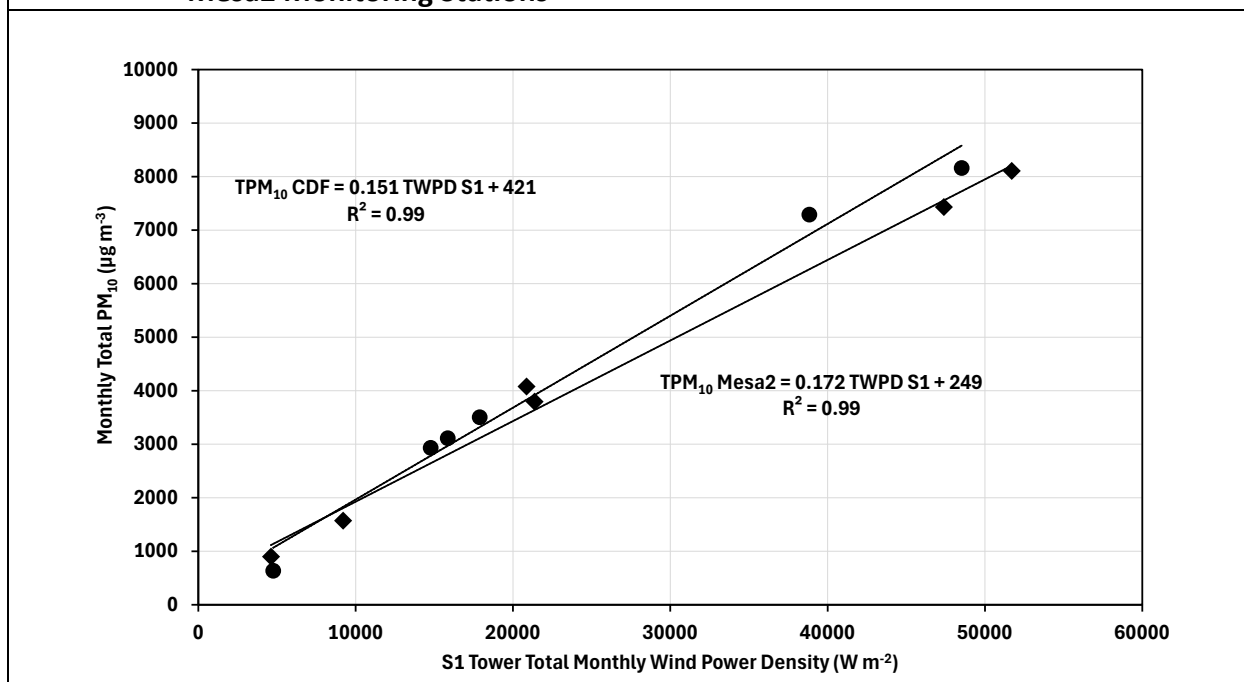
⁴³ Gillies, J.A., E. Furtak-Cole, and V. Etyemezian, 2021. Increments of Progress Towards Air Quality Objectives - ODSVRA Dust Controls. Report prepared for California State Parks by DRI, December 2021.

⁴⁴ See footnote 23.

⁴⁵ Gillies, J.A., E. Furtak-Cole, and G. Nikolich, 2023. Increments of Progress Towards Air Quality Objectives - ODSVRA Dust Controls. Report prepared for California State Parks by DRI, December 2023.

Figure 2-26. Wind Direction at S1 Tower, April to September, 2023 and 2024

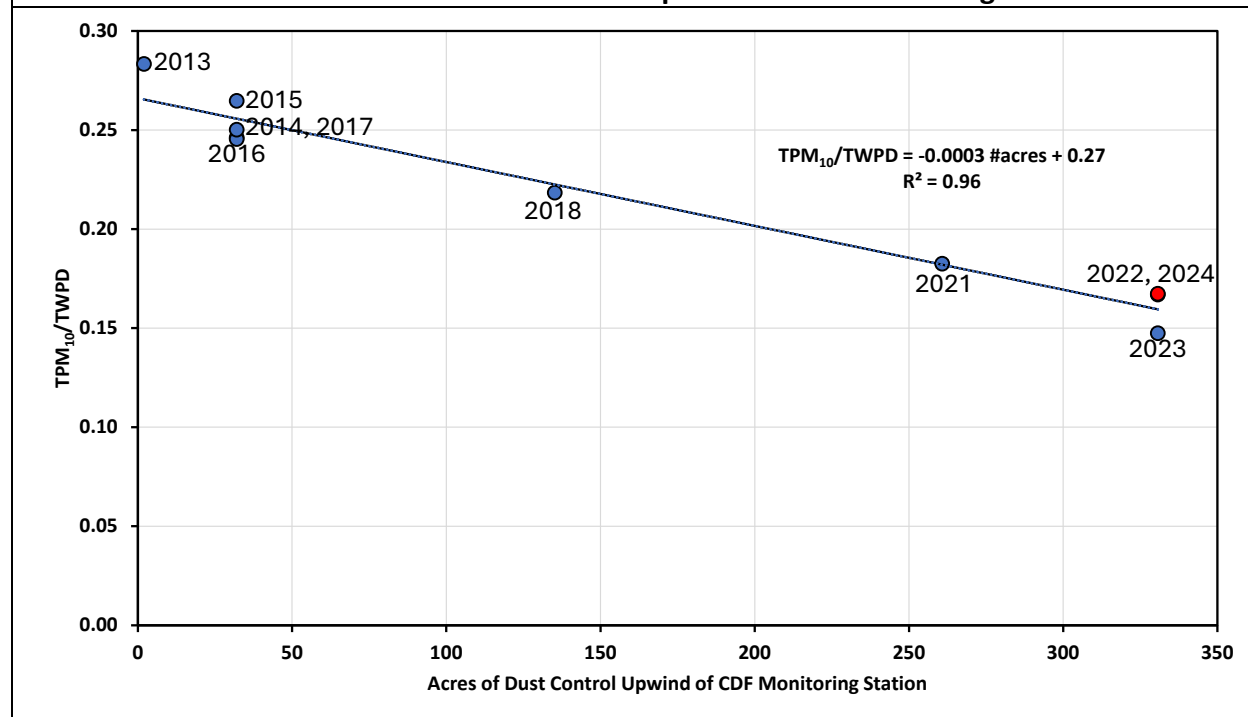
The distribution of wind direction at the S1 tower for the period April to September, 2023 and 2024, after applying the filtering criteria (wind between 248° and 326°).

Figure 2-27. Relation Between TPM_{10} ($\mu g m^{-3}$) and TWPDP ($W m^{-2}$) at SLOAPCD CDF and Mesa2 Monitoring Stations

The relation between monthly TPM_{10} and monthly TWPDP for all hours when the wind direction was from 248° to 326° observed at the CDF station (diamonds) and the Mesa2 station (circles), the wind speeds were greater than or equal to ($\geq$) $3.5 m s^{-1}$ (at the CDF and Mesa2 stations), and hours wherein there were fewer than three days since the last record of precipitation were removed.

Based on the number of acres of dust control that have been established from 2013 (2 acres) through 2024 (330 acres) upwind of the CDF station, Figure 2-28 shows that at the CDF station for the period April through September, a downward trend in the TPM_{10} :TWPD ratio with increasing amounts of dust control acreage has been observed.^{46,47}

Figure 2-28. Relation Between TPM_{10} :TWPD Ratio Measured at SLOAPCD CDF Monitoring Station and Acres of Dust Control Upwind of CDF Monitoring Station



The relation between TPM_{10} :TWPD ratio value measured at the CDF station and the acres of dust control placed upwind of the CDF station from 2013 through 2024. The acres of dust control are accounted for in the directional range 270° to 325° centered on the CDF station. Data from 2019 and 2020 were excluded as discussed in Attachment 08. Note that 2014 and 2017 data and 2022 and 2024 (red circle) data align on top of each other.

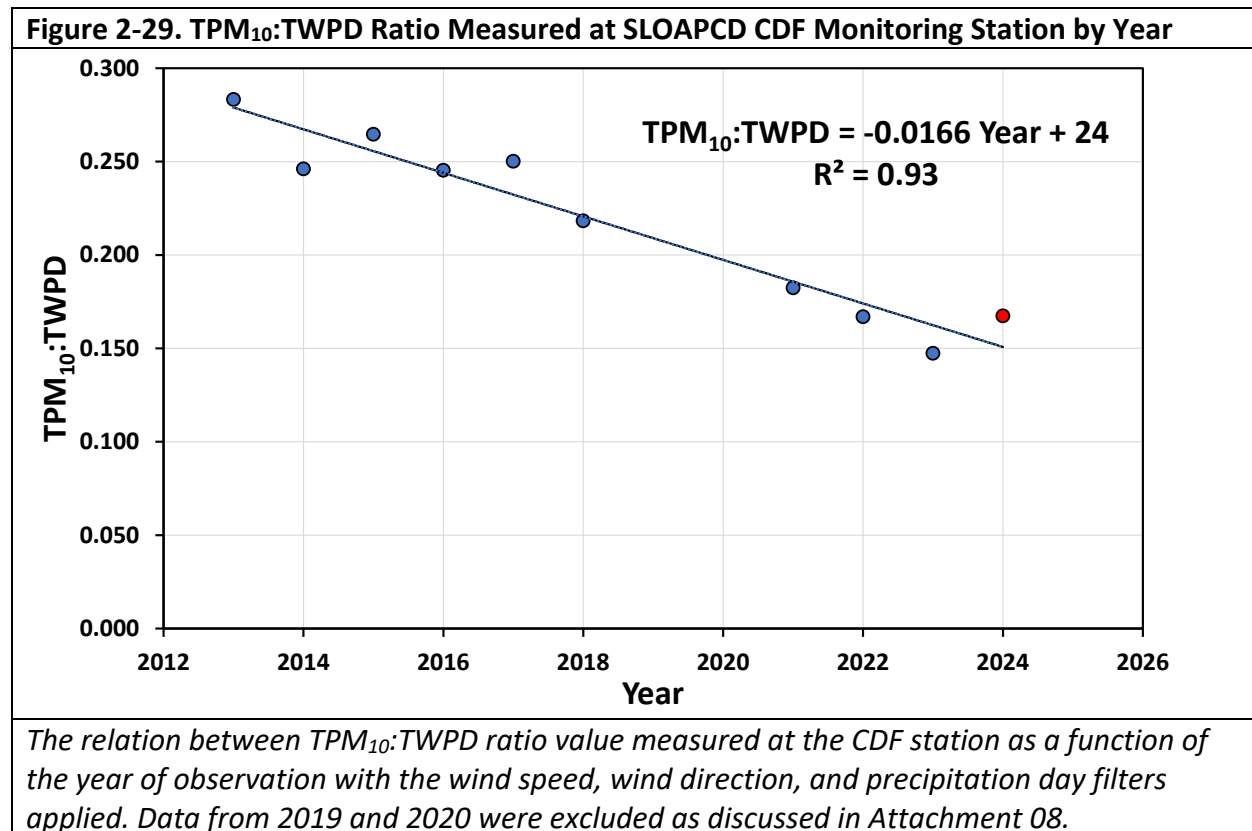
As shown in Figure 2-28, the ratio of TPM_{10} : TWPD for 2024 (0.17) shows a slight increase over 2023 (0.15). This may indicate that the ratio, representing the area upwind of the CDF station, has stabilized in the last three years and that the control measures in place have reached a static condition. The change in the TPM_{10} :TWPD ratio from 2023 (0.15) to 2024 (0.17) may also be reflective of natural variation in the dust emission system due to changing surface emissivity conditions as well as influences that are associated with the transport and dispersion of PM_{10} originating from different source areas within the ODSVRA. The ODSVRA dust emission system

⁴⁶ For the purposes of the TPM_{10} :TPWD evaluation, dust control measures are considered upwind of the CDF station if the measure lies within the directional range 270° to 325°, as centered on the CDF station.

⁴⁷ As described in Attachment 08, the relation between TPM_{10} :TPWD at the CDF station and the acres of dust control upwind of the CDF station excludes data from 2019 (insufficient wind data) and 2020 (OHV activity at the ODSVRA was restricted due to COVID-19).

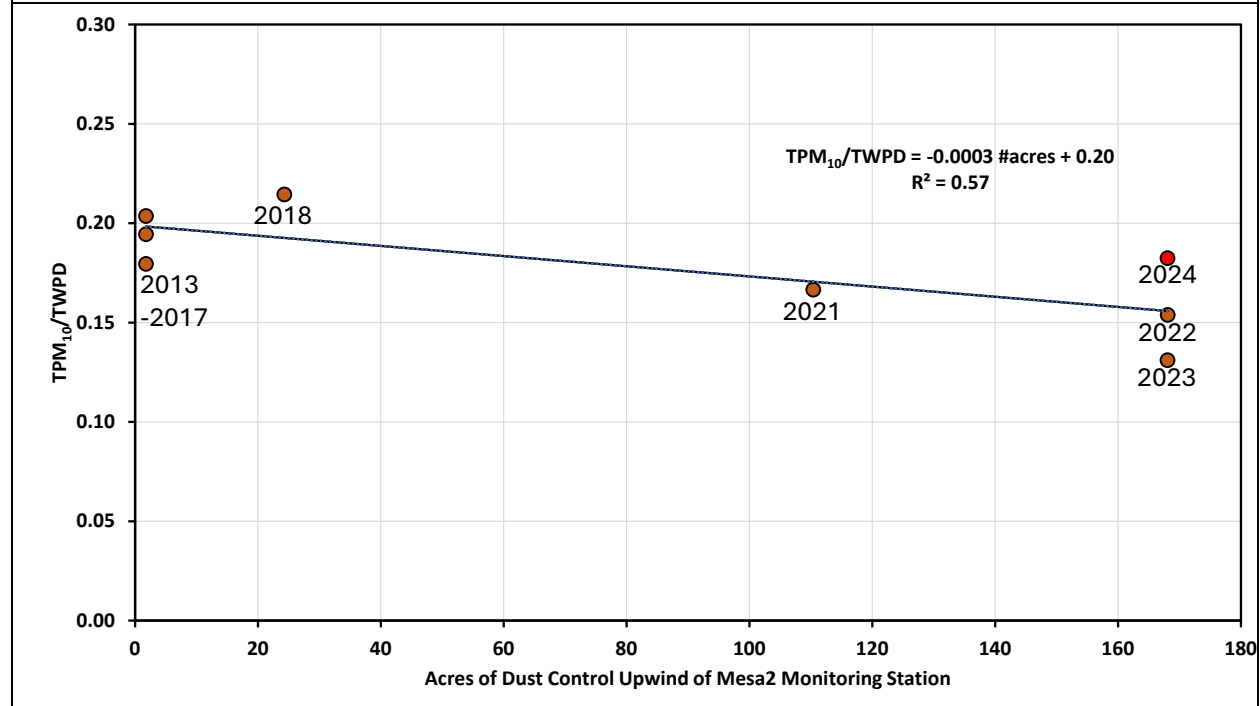
is complex, with many non-linearities in the emission, transport, and dispersion of PM₁₀ that contribute to dust emission variability across space and through time and make it difficult to assess the relative influence of these processes that result in year-to-year variability of the TPM₁₀:TWPD ratio. For example, with respect to differences in wind direction between April and September, 2023 and 2024 (after applying the directional filter of 248° to 326°), the median wind direction was 297° in 2023 and 282° in 2024. This shift to more westerly winds in 2024 decreases the travel distance from the source areas to the CDF and Mesa2 monitoring stations, which will reduce the amount of dispersion and deposition between the source areas and the monitoring stations. This could lead to higher concentrations of PM₁₀ for similar wind conditions (i.e., speed and turbulence characteristics).

Figure 2-29 shows the change in the TPM₁₀:TWPD ratio for the CDF station as a function of year, which provides a more generalized representation of the ratio as a function of the state of the surface conditions upwind of the CDF monitoring station for the April-September period across the 11 years of filtered PM₁₀ and wind speed and direction data. The TPM₁₀:TWPD ratio steadily decreased from 2013 through to 2023 then increased slightly in 2024, but it will take more years of data to determine whether there is an upward trend, indicating that sand surfaces at the ODSVRA are becoming more emissive, or whether the ratio will become stable, indicating that the dust emission system has stabilized with respect to the driving force of TWPD producing similar levels of PM₁₀ concentrations.



The ratio of TPM_{10} :TWPD for the Mesa2 station and S1 tower data for the period April through September for the years 2013 through 2024 as a function of acres of dust control upwind of the Mesa2 station is shown in Figure 2-30. This figure shows that a downward trend in the TPM_{10} :TWPD ratio is observed with increasing acres of dust control for the period 2018 (24.3 acres) to 2024 (168 acres).⁴⁸ Prior to 2018, there was no clear trend in the TPM_{10} :TWPD ratio data as there were few acres of dust control upwind of the Mesa2 monitoring station.

Figure 2-30. Relation Between TPM_{10} :TWPD Ratio Measured at SLOAPCD Mesa2 Monitoring Station and Acres of Dust Control Upwind of Mesa2 Monitoring Station



The relation between TPM_{10} :TWPD ratio value measured at the Mesa2 station and the acres of dust control placed upwind of the Mesa2 station from 2013 through 2024. The acres of control are accounted for in the directional range 270° to 305°. Data from 2019 and 2020 were excluded as discussed in Attachment 08. Note that for the 2013-2017 data points some years are aligned on top of one another.

Figure 2-30 indicates that a downward trend in the TPM_{10} :TWPD ratio through time for the Mesa2 station is supported with the inclusion of the 2024 datum. The value of 0.18 in 2024 does, however, indicate an increase from the previous two years. This may represent natural variation in the dust emission system as described above. As at the CDF monitoring station, there was also a shift in wind direction in 2024 compared to 2023, with a median wind direction of 297° in 2023 and 284° in 2024. This shift to more westerly winds could be sufficient to influence the TPM_{10} :TWPD ratio as the wind will be transporting PM_{10} from different zones

⁴⁸ For the purposes of the TPM_{10} :TPWD evaluation, dust control measures are considered upwind of Mesa2 if the measure lies within the directional range 270° to 305°, as centered on Mesa2.

from which the PM₁₀ has been emitted and potentially the size, in terms of acres, of the area under dust management upwind of the Mesa2 station. The wind direction data for 2023 and 2024, when further partitioned to represent a narrower direction defined by the frequency of occurrence representing $\geq 85\%$ of the data in 2023 (280° to 320°) and $\geq 78\%$ of the data in 2024 (270° to 305°), show that in 2024, the number of acres that are defined as being under dust management (i.e., active revegetation) within the defined directional range (i.e., 270° to 305°) decreased by 55% compared with the acres defined as under dust management in 2023. The smaller amount of upwind acres of managed areas could, in part, explain the increase in the TPM₁₀:TWPD ratio in 2024 (i.e., there was a greater potential for dust generated from unmanaged areas in 2024 reaching the Mesa2 station than in 2023).

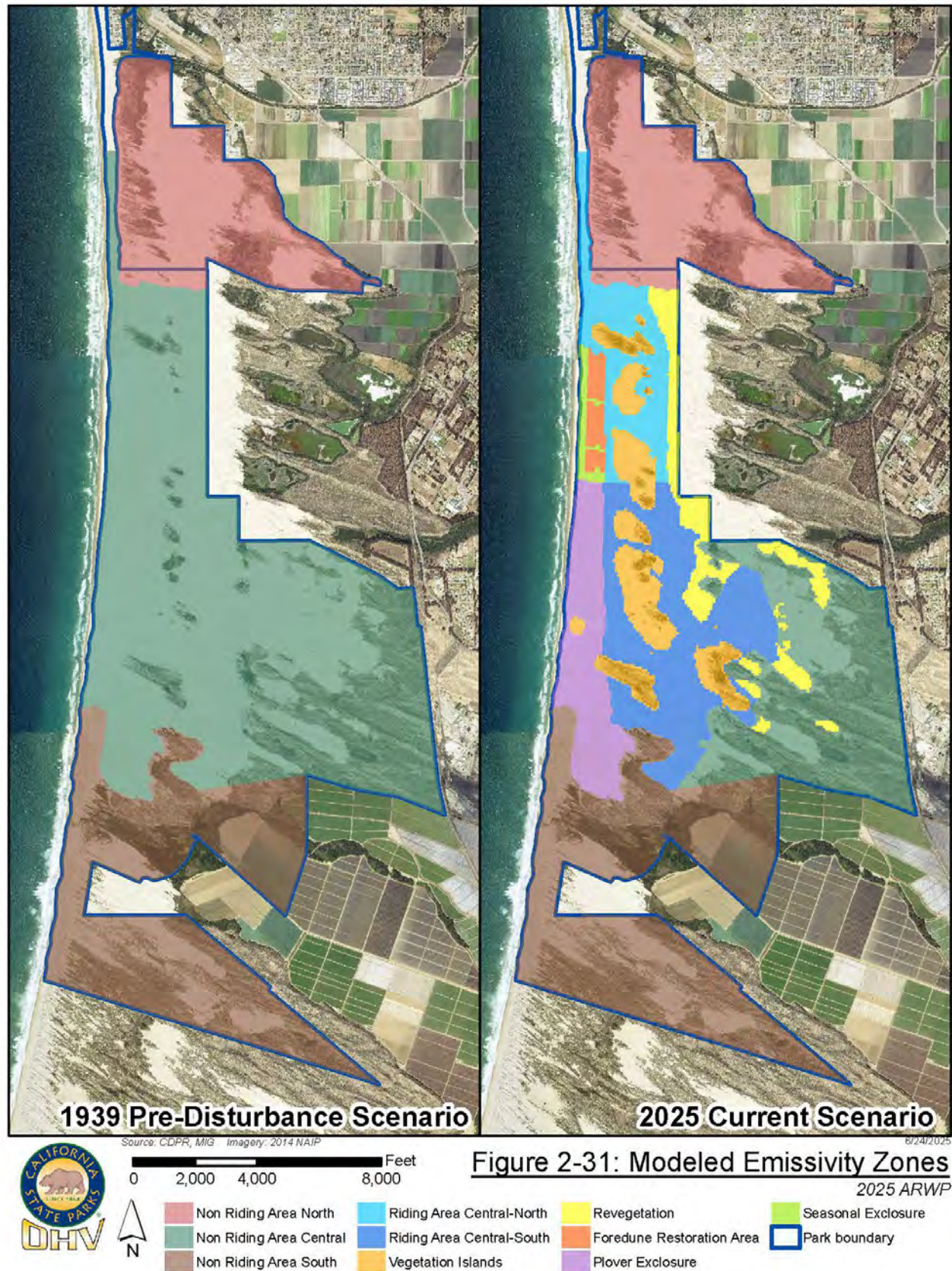
Without further modification or enhancement of the acres under dust control at the ODSVRA, DRI expects that the value of the TPM₁₀:TWPD metric will oscillate around a mean value that is currently 0.16 (± 0.01) for the CDF station and 0.15 (± 0.03) for the Mesa2 station based on the last three years of data. Even if the acres of dust control remain essentially unchanged, variability in the TPM₁₀:TWPD metric can be expected due to the vagaries of wind climatology and shifts in emissivity strength across space driven, in part, by changing patterns of OHV activity as a function of location and frequency of disturbance within the ODSVRA.

2.3.2 EXCESS EMISSIONS MODELING

State Parks' 2024 ARWP provides background information on the SOA's excess emissions requirement (2024 ARWP Section 2.3.2.1) and the methodology developed by State Parks, in consultation with the SAG, for modeling whether the ODSVRA is in a condition of excess emissions (2024 ARWP Section 2.3.2.2). In general, the current methodology for assessing excess emissions involves comparing the "naturally occurring" emissions from the ODSVRA when it was minimally impacted by OHV recreation, referred to as the "pre-disturbance" scenario, against the current management landscape of the ODSVRA. For each scenario, the ODSVRA is sub-divided into management zones or sub-regions, each of which is assigned a different emissivity power relation based on comprehensive PI-SWERL testing completed to date. For the pre-disturbance scenario, which is based on 1939 landscape conditions, the ODSVRA is divided into three zones: Non-Riding Area North, Non-Riding Area Central, and Non-Riding Area South. For the current landscape (i.e., as of July 31, 2025), the ODSVRA is divided into nine different zones:

- | | |
|---|------------------------------------|
| 1. Riding Area Central-North Sub-Region | 6. Foredune Restoration Area (FRA) |
| 2. Riding Area Central-South Sub-Region | 7. Plover Exclosure (PE) |
| 3. Non-Riding Area North Zone | 8. Seasonal Exclosure (SE) |
| 4. Non-Riding Area Central Zone | 9. Vegetation Islands |
| 5. Non-Riding Area South Zone | 10. Revegetated Project Areas |

The 1939 pre-disturbance and current landscape management zones are shown in Figure 2-31.



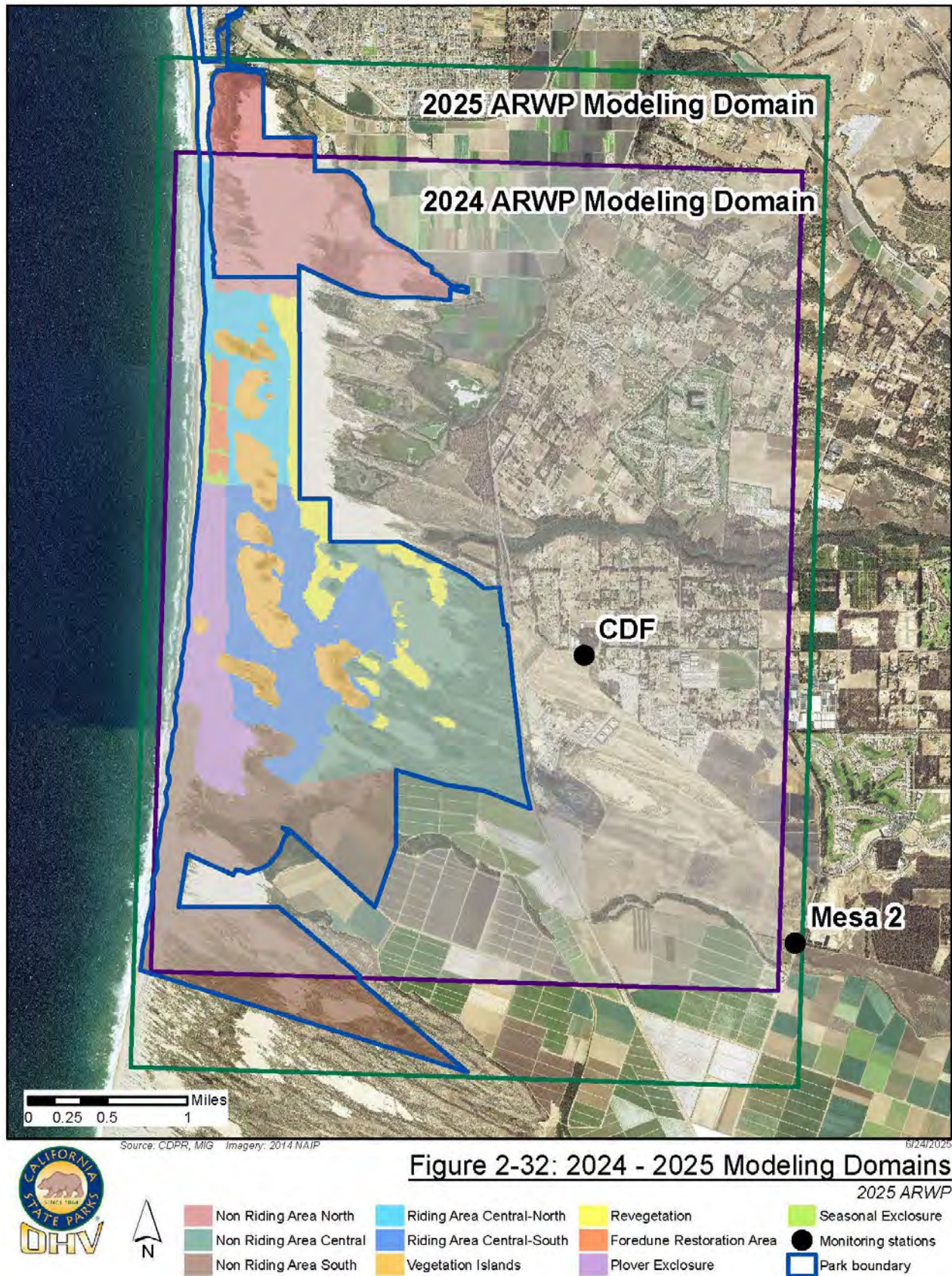
The remainder of this section describes updates to the excess emissions modeling methodology implemented since August 1, 2024; and presents the results of the modeling conducted by DRI, in coordination with the SAG, that shows the ODSVRA, as of July 31, 2025, does not emit dust to a level that is in excess of naturally occurring conditions.

2.3.2.1 EXCESS EMISSIONS MODEL UPDATES

State Parks' 2024 ARWP Work Plan identified and recommended certain refinements to the excess emission model, including changes to the extent of the model domain and model grid cell size; continued use of updated, comprehensive emissivity relations; and use of an updated vegetation layer to model non-emissive areas of the ODSVRA (2024 ARWP Section 3.2.2). Since August 1, 2024, State Parks and DRI, in consultation with the SAG, have incorporated these refinements, as follows:

- **Increased Model Domain and Grid Size:** Due to meteorological model constraints, the modeling domain used in the 2024 ARWP did not cover the entirety of the ODSVRA. As shown in Figure 2-32, small areas in the northern and southern parts of the ODSVRA were not captured in the model, and the domain did not extend east to the SLOAPCD's Mesa2 air quality monitoring station. This has been corrected in 2025. To have the emission model cover the entire area of the ODSVRA required, most notably, the size (area) of an individual grid cell needed to be increased from 21 m by 21 m to 25 m by 25 m. Adjusting the model to the new grid size required a series of steps to resize the grid cells as well as correctly position the centroid of each grid cell using a geographic information system (GIS) (see 2024 ARWP Section 3.2.2). Once the grid of cells was re-sized, GIS was used to define the emissivity zones for the current and 1939 landscapes. Following this, grid cells that are divided at the borders of emissivity zones and the border of the ODSVRA were assigned as either interior or exterior using the following rule: If a grid square, by area, was $\geq 50\%$ within the defined boundary that cut across the square, the square was defined to be in its specified zone or, in the case of the ODSVRA border and surrounding properties, to be interior or exterior to the ODSVRA. GIS was also used to identify grid cells that contain vegetation using vegetation cover masks for 1939 and 2024 based on UCSB analysis (see below). If a grid square, by area, is $\geq 50\%$ covered by vegetation, it is defined as being non-emitting. If a grid square is $< 50\%$ covered, it is assigned the emissivity of the zone within which it resides. This 50% grid square area threshold has been used in previous reports and tested for uncertainty.⁴⁹

⁴⁹ See State Parks' 2024 ARWP, Section 2.3.2.2.



- **Refined Meteorological Data Inputs:** Two refinements were made with respect to the input data to the CALMET model used to simulate wind conditions across the ODSVRA: 1) the spatial resolution of the underlying digital elevation model (DEM) that defines the topography within the modeling domain was increased from 20 m resolution to 5 m resolution, and 2) additional meteorology data from stations operating external to the ODSVRA were incorporated into the CALMET model to refine the calculation of surface wind speed across the modeling domain. The surface wind speed at 10 m AGL from these stations is used to calculate the surface wind shear velocity (u^* m s⁻¹) that is needed to estimate the emission of PM₁₀ dust from each grid cell for each hour of simulation. The change in grid cell size and the CALMET model revisions resulted in increases or decreases in the total emissions attributed to the identified emissivity zones; however, the changes are relatively minor, ranging from a 1.6% (increase in the FRA) to a 5.8% (decrease in the Non-Riding Area Central) among the defined zones and an overall increase to the total mass emissions of 1.8 metric tons per day, a 1.5% increase.
- **Updated Emissivity Relations:** As described in Section 2.2.2, DRI conducted new PI-SWERL monitoring in 2024 that adds to the comprehensive dataset used to develop emissivity relations throughout the ODSVRA. The latest excess emissions model incorporates the 2024 PI-SWERL data into updated emissivity relations. For the three non-riding area zones, including the 2024 PI-SWERL data resulted in emissivity being generally lower for equivalent values of u^* compared to the relations based on the 2013-2022 data, with the divergence to lower emissions most evident when u^* exceeds 0.50 m s⁻¹. For the two Riding Area zones, Central-North and Central-South, the emissivity in the Central-North sub-region is essentially unchanged for the two datasets; however, for the Central-South sub-region, the addition of the 2024 PI-SWERL data noticeably decreased the emissivity for equivalent u^* values for the entire range of u^* . For the FRA zone, emissivity was essentially unchanged between the two datasets. For the Seasonal Exclusion (SE) zone, emissivity decreased with the addition of the 2024 PI-SWERL data, while emissivity increased with the addition of the 2024 PI-SWERL data for the PE. Refer to Attachment 05 for the SAG's 2024 PI-SWERL report.
- **Updated Vegetation Mask:** The latest excess emissions modeling incorporates an updated vegetation mask layer based on newly acquired and more recent remote sensing data analyzed by UCSB and State Parks (up to 2024). The results of the UCSB analysis are presented in the UCSB report "Recent (2020-2024) Changes in Vegetation Cover within the Oceano Dunes SVRA." This report is included as Attachment 09 to this 2025 ARWP. The updated vegetation layer was constructed through image analysis efforts of UCSB and converted to the required 25 m by 25 m grid cell layer by State

Parks. State Parks also carried out the necessary GIS analysis to determine the percent cover of vegetation in each grid cell to evaluate whether the cell emitted PM₁₀ (i.e., vegetation coverage ≤50%) or was set to zero emissions (i.e., vegetation coverage >50%). The updated 2024 vegetation layer showed an increase in vegetation throughout the ODSVRA, reducing modeled emissions of PM₁₀ from the ODSVRA by approximately 2.3 metric tons per day.

2.3.2.2 EXCESS EMISSIONS MODELING RESULTS

The DRI model was programmed with the model refinements summarized in Section 2.3.2.1, and emissions scenarios were run for the pre-disturbance and current landscape conditions (see Table 2-8 and Attachment 10). Figure 2-33 shows maps of the spatial distribution of emissions for each of the two scenarios. The pre-disturbance emissions map (left panel) indicates relatively uniform emissions with largest values in the Non-Riding Area Central zone and smallest values in the Non-Riding Area North zone (Dune Preserve). White areas correspond to zero emissions in association with the vegetation cover mask from 1939. For the current emissions map (right panel), the white zones include the vegetation cover mask from 2024 as well as the vegetation islands and vegetation dust control projects as of July 31, 2025. The current emissions map shows considerable variation in emissions, with large values in the sub-regions where OHV riding is allowed. When summed across the entire model domain covering the ODSVRA (see Figure 2-33), the total emissions for the 10 highest emissivity days in May 2013 amount to 135.2 metric tons per day for the pre-disturbance scenario, whereas the current landscape scenario emits only 122.5 metric tons per day. The small emissions from the FRA and PE are sufficient to compensate for the large emissions from the riding area, and therefore, **the modeling indicates that the ODSVRA, as currently configured according to management zones and accounting for all treatment projects implemented since 2013, does not emit dust to a level that is in excess of the “naturally occurring” conditions inherent to the pre-disturbance scenario.** In this respect, there is compliance with the SOA.

Figure 2-33. Spatial Distribution of Emissions for Pre-Disturbance and Current Landscape (as of July 31, 2025) Conditions

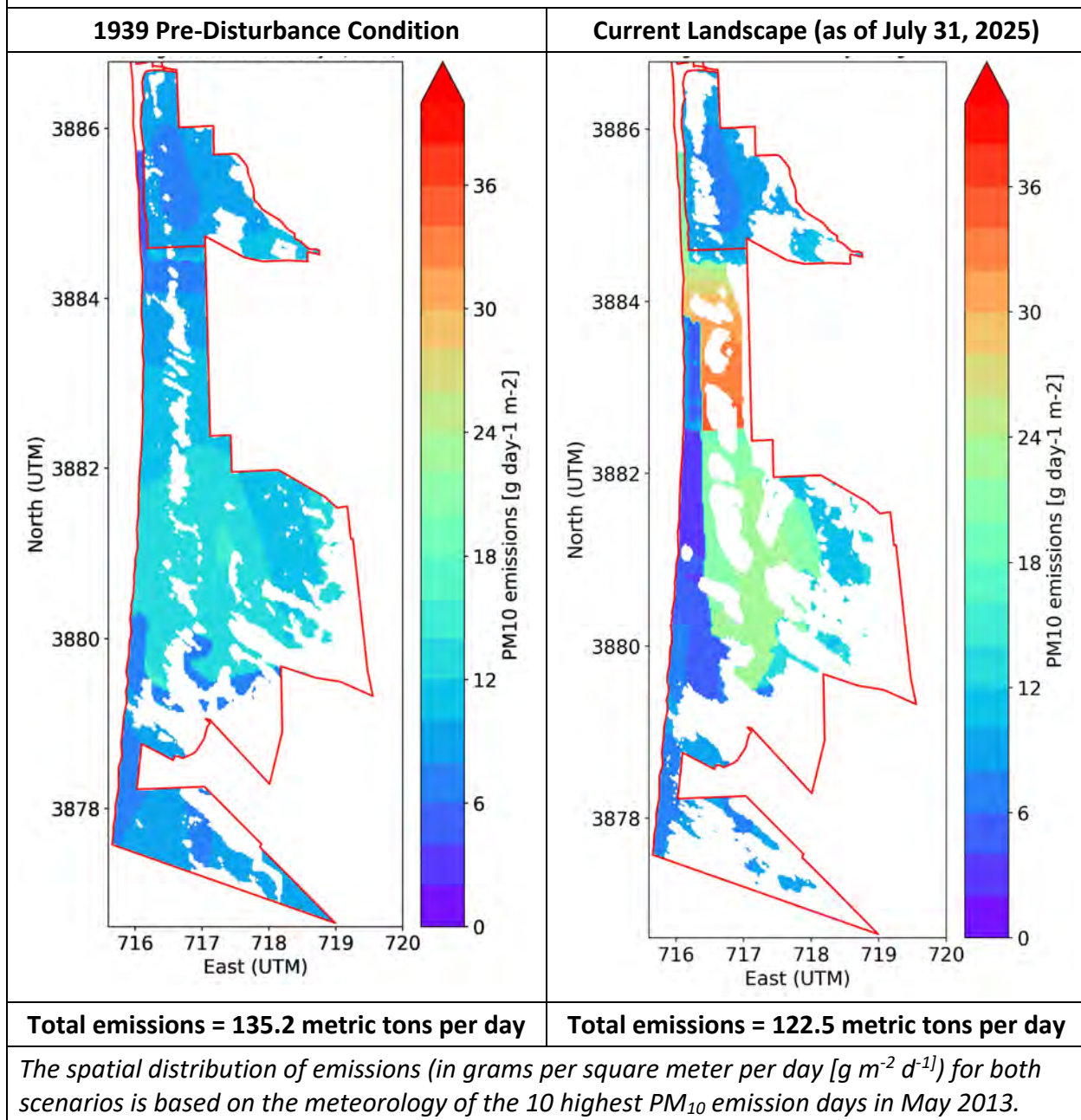


Table 2-8. Modeled Pre-Disturbance (1939) and Current (2025) Landscape Total Mass Emissions Estimates					
Modeled Scenario and Emissivity Zone	Modeled Area (Acres)	Modeled Emissions in Metric Tons per Day		Change in Modeled Emissions with 2024 PI-SWERL Data	
		2013 to 2022 PI-SWERL Data	2013 to 2024 PI-SWERL Data	Metric Tons Per Day	% Change
1939 Pre-Disturbance Scenario					
Non-Riding Area North	617.9	24.7	21.9	-2.8	-11.3%
Non-Riding Area Central	1,922.2	120.4	91.4	-29.0	-24.1%
Non-Riding Area South	660.1	34.0	22.0	-12.0	-35.3%
Total ^(A)	3,200.2	179.0	135.2	-43.8	-24.5%
Current Landscape (as of July 31, 2025)					
Non-Riding Area North	442.3	18.1	15.5	-2.6	-14.4%
Non-Riding Area Central	243.7	17.1	11.	-5.4	-31.6%
Non-Riding Area South	330.5	18.1	10.6	--7.5	-41.4%
Riding Area Central-North	250.2	29.7	29.3	-0.4	-1.3%
Riding Area Central-South	547.2	62.4	48.1	-14.3	-22.9%
Foredune Restoration Area	49.1	0.9	0.9	0.0	0.0%
Plover Exclosure	304.7	3.7	5.0	1.3	35.1%
Seasonal Exclosure	33.7	1.4	1.2	-0.2	-14.3%
Vegetation Islands	120.3	0.0	0.0	0.0	-
Revegetation	159.9	0.0	0.0	0.0	-
Total ^(A)	2,481.6	151.3	122.5	-28.9	-19.1%
Net Change in Emissions, 1939 to Current Landscape ^(A)		-27.7	-12.7	14.7	53.3%
SOA Excess Emissions Condition?		No	No	--	--
Source: DRI, 2025 (see Attachment 10)					
(A) Totals may not equal due to rounding. Value reflects the difference between the pre-disturbance and current landscape totals for the modeled scenario.					

2.3.3 EVALUATION METRICS

State Parks' 2021 ARWP incorporated a new set of evaluation metrics intended to provide a streamlined dashboard for reporting Particulate Matter Reduction Plan (PMRP) evaluation metrics, tracking Dust Control Program progress, and informing adaptive management strategies at the ODSVRA. The updated evaluation metrics include "Dust Mitigation Targets" that compile specific, measurable endpoints and "Dust Mitigation Indicators" that document progress in key areas that lack a specific, measurable target or endpoint for various reasons. To provide continuity with past ARWP documents, State Parks' summary report on PMRP evaluation metrics is provided below. Refer to Attachment 11 for a detailed summary of evaluation metrics.

2.3.3.1 DUST MITIGATION TARGETS

Key dust mitigation targets include the cumulative dust control project acreage at the ODSVRA and the PM₁₀ mass emissions reductions achieved from the ODSVRA (as of July 31 of the ARWP reporting year).

Dust Mitigation Treatments

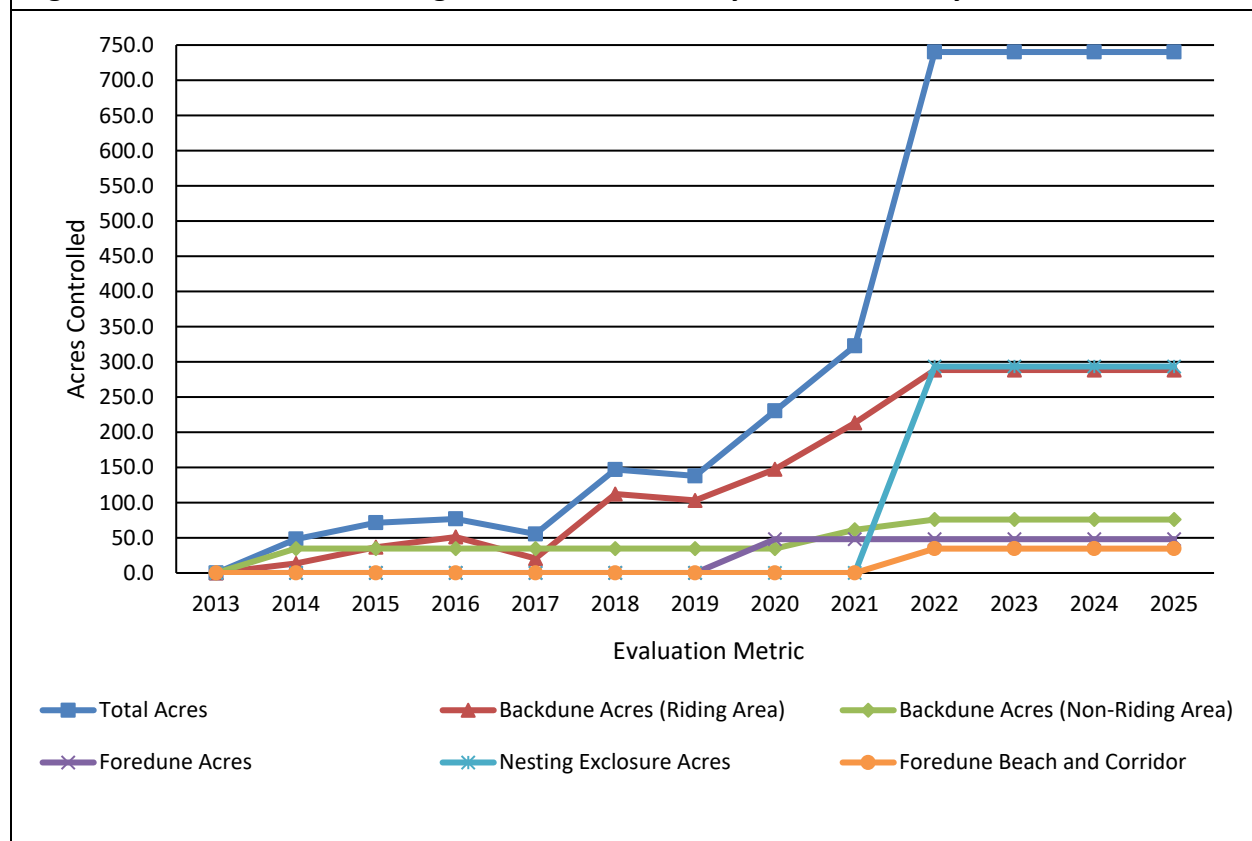
Compared to 2013 baseline conditions, when there were no long-term dust control projects at the ODSVRA, State Parks now manages 740.1 acres of land for dust control benefits (see Figure 2-34). Nearly 90% of this managed land is located inside the ODSVRA open riding and camping area, as defined by the 2013 open riding and camping area boundary. Refer to Section 2.1 for State Parks' detailed report on dust control projects installed at the ODSVRA as of July 31, 2025.

PM₁₀ Mass Excess Emissions

Under the excess emissions framework, as of July 31, 2025, current modeled PM₁₀ mass emissions from the ODSVRA (122.5 metric tons per day) are approximately 12.7 metric tons per day less than the modeled pre-disturbance condition mass emissions (135.2 metric tons per day; see Table 2-8). The ODSVRA, therefore, is not in a condition of excess emissions. Refer to Section 2.3.2 for additional information on excess emissions modeling.

2.3.3.2 DUST MITIGATION INDICATORS

Key dust mitigation indicators include the number of high wind days and the number of exceedances of the state and federal ambient air quality standards, the status of the 48-acre foredune restoration project, and the amount of backdune stabilization occurring under the Dust Control Program. Dust mitigation indicators are compared against 2013 baseline conditions where appropriate but do not have a specific measurable target or goal to achieve.

Figure 2-34. ODSVRA Dust Mitigation Treatments, July 31, 2013, to July 31, 2025

Air Quality Indicators

As shown in Figure 2-35, between January 1, 2025, and July 31, 2025, the number of high wind event days at the SLOAPCD's CDF air quality monitoring station (71 days) was higher than the number of days for approximately the same period in 2019 (30 days), 2020 (55 days), 2021 (51 days), 2022 (64 days), but lower than those in 2023 (72 days), and higher than those in 2024 (51 days).⁵⁰ However, the number of days in which the 24-hour average PM₁₀ California Ambient Air Quality Standard (CAAQS) of 50 µg m⁻³ was exceeded at the SLOAPCD's CDF air quality monitoring station in 2025 (22 days) was higher than the same comparable period in 2019 (16 days); lower than same period in 2020 (30 days), 2021 (28 days), and 2022 (54 days); and higher than the same period in 2023 (16 days) and 2024 (14 days). Likewise, the number of days in which the 24-hour average PM₁₀ CAAQS of 50 µg m⁻³ was exceeded at the SLOAPCD's Mesa2 air

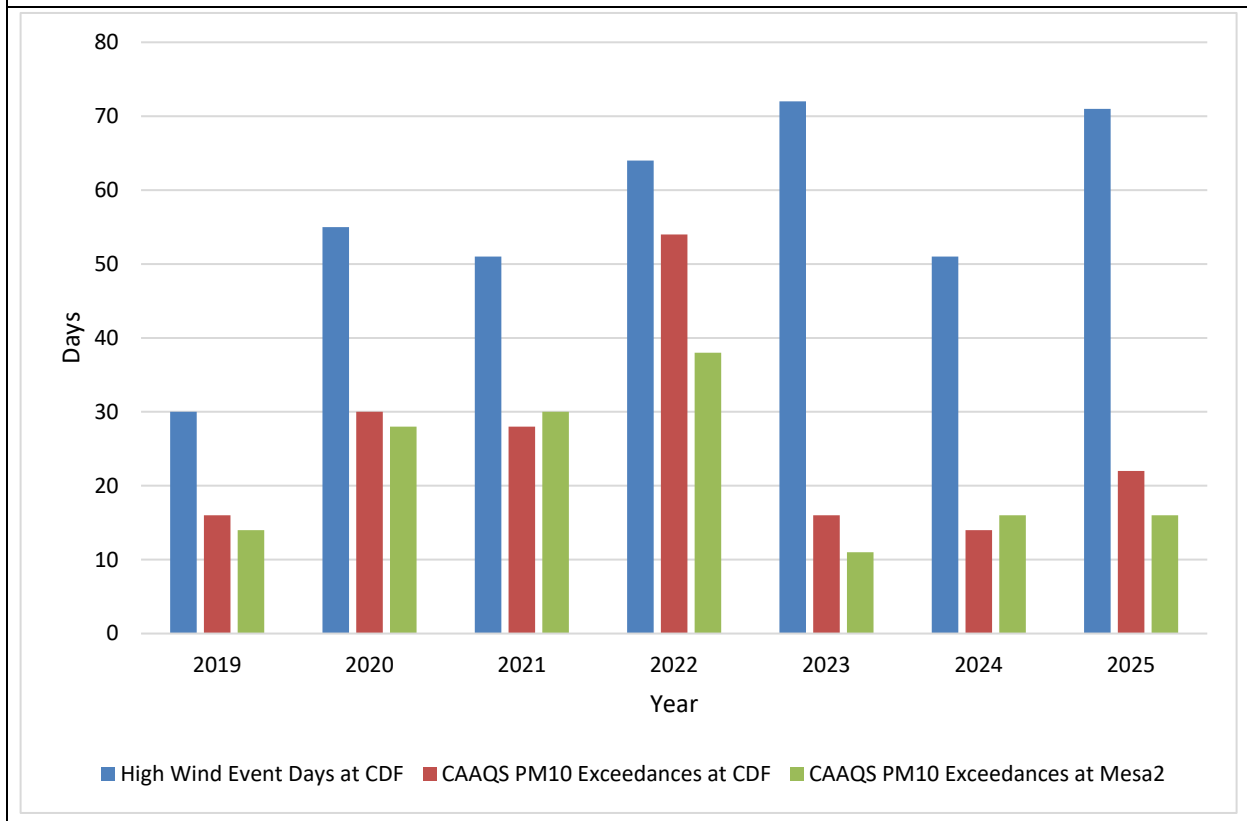
⁵⁰ Since 2021, State Parks' ARWPs have, in coordination with the SAG, defined "high wind event day" as any day when the 3:00 PM Pacific Standard Time (PST) hourly wind speed at the CDF air quality monitoring station exceeds 8 miles per hour and the 1:00 PM PST hourly wind direction is between 290° and 360°. Resultant wind speed data for the CDF station (USEPA Air Quality System ID #060792007) are from the California Air Resources Board (CARB) Air Quality and Meteorological Information System website:

https://www.arb.ca.gov/aqmis2/aqmis2.php?_ga=2.46929383.1773760890.1688103838-837133623.1674194586.

Data may be preliminary and will be verified by the SLOAPCD. The ARWP high wind event definition may differ from the definition used by the SLOAPCD in SLOAPCD reports and studies.

quality monitoring station in 2025 (16 days) was higher than the same comparable period in 2019 (14 days); lower than the same period in 2020 (28 days), 2021 (30 days), and 2022 (38 days); higher than the same period in 2023 (11 days); and the same as in 2024 (16 days).⁵¹ There were no exceedances of the National Ambient Air Quality Standard (NAAQS) of $150 \mu\text{g m}^{-3}$ at either the CDF or Mesa2 air quality monitoring stations during the listed period. The last exceedance of the NAAQS occurred at the CDF air quality monitoring station in 2013.

Figure 2-35. High Wind Event Days at CDF Air Quality Monitoring Station and 24-Hour Average PM₁₀ CAAQS Exceedances at CDF and Mesa2 Air Quality Monitoring Stations, Approximately January through July, 2019 to 2025



Foredune Restoration

Based on UCSB UAS survey results (see Section 2.2.3.1), net surface volume changes since the October 2019 to February 2020 baseline survey (see Table 2-4) suggest minor erosion in the northern beach plots (TP 1 – Control to TP 2 – Native Seed), transitioning toward a more

⁵¹ The 2025 estimate of the number of days above the CAAQS at the CDF air quality monitoring station is based on standard conditions for daily average PM₁₀ BAM data for the CDF (USEPA Air Quality System ID #060792007) and Mesa2 (USEPA Air Quality System ID #060792004) air quality monitoring stations are from CARB's Air Quality and Meteorological Information System website:

https://www.arb.ca.gov/aqmis2/aqmis2.php?_ga=2.46929383.1773760890.1688103838-837133623.1674194586. Data may be preliminary and will be verified by the SLOAPCD.

depositional state in the southern plots (TP 3 – Native Seed and Grain Seed to TP 6 – Parks’ Classic). In general, net deposition has occurred across all FRA TPs, with some deviations. Most plots saw distinct negative (erosional) responses from February to October 2023 (except for TP 6) (see Figure 2-17 and Table 2-4), but trends shifted to positive in all but one treatment (TP 6) in the most recent interval.

After its fifth growing season (2024), UCSB UAS surveys showed that percent plant cover (normalized by total area of each TP; see Table 2-4) increased between spring 2024 and spring 2025 in TP 1, TP 2, TP 4 – Low-Density Nodes, and TP 5 – High-Density Node and decreased between spring 2024 and spring 2025 in TP 3 and TP 6. State Parks’ line-intercept transect sampling identified an increase in mean vegetation cover (compared to 2023 results) in foredune TP 1, TP 2, and TP 3, and a decrease in mean vegetation cover in TP 4, TP 5, and TP 6. State Parks’ line-intercept transect sampling also showed that total species richness (i.e., native and non-native species) increased (compared to 2023 results) for TP 4, TP 5 and decreased for TP 2, and total species richness remained the same for TP 1, TP 3, and TP 6 (see Table 2-6). The spring 2024 to spring 2025 trends are not consistent with longer term UAS survey results, which have shown continual averaged increases in plant cover for all TPs, albeit with high variability and notable declines in TP 3, TP 4, TP 5, and TP 6 since 2023. Refer to Section 2.2.3 and Section 2.2.4 for detailed information on State Parks’ foredune vegetation monitoring activities.

Backdune Stabilization

Compared to 2013 baseline conditions, when there were no long-term dust control projects at the ODSVRA, State Parks continues to manage 740.1 acres of land for dust control benefits, including the 293.3-acre PE and 34.6-acre seasonal foredune beach and transportation corridors area. Excluding these areas, State Parks has installed 412.2 acres of total dust control projects at the ODSVRA. The total dust control acreage remains unchanged since 2022, though all temporary wind fencing and straw treatments have been converted to vegetation projects. As of July 31, 2024, there are 364.2 total acres of backdune stabilization measures in the ODSVRA, all of which are under vegetation treatment. Refer to Section 2.1 for State Parks’ detailed report on dust control projects installed at the ODSVRA as of July 31, 2025.

2.3.4 TRACK-OUT CONTROL

Condition 1.c of the original 2018 SOA required State Parks to install SLOAPCD-approved sand track-out control devices at the Grand Avenue and Pier Avenue entrances to the ODSVRA. This requirement was not modified by the November 2019 or October 2022 SOA amendments. State Parks completed the construction of the Grand Avenue track-out control project in November 2022.⁵² State Parks has not proceeded with the construction of Pier Avenue track-out control

⁵² Refer to State Parks’ 2021 ARWP, Attachment 05 (Sediment Track-out Prevention Measures), for detailed plans for track-out control at Grand Avenue.

project due to the uncertain future of this entrance; however, State Parks continues to use temporary rubber track-out mats at this entrance. The temporary mats were originally installed in 2019 and are regularly cleaned when the beach is open to public vehicle activity. State Parks also continues to conduct ongoing street sweeping activities on Pier and Grand Avenues at a minimum of three times per week.

2.4 OTHER DUST CONTROL PROGRAM ACTIVITIES

State Parks, the SAG, and the SLOAPCD may undertake activities to further support and inform the overall adaptive management approach to dust control at the ODSVRA. State Parks' report on other Dust Control Program-related activities is provided below.

2.4.1 SAG REVIEWS OF STUDY REPORTS

Report: Evaluation of Potential Changes in Dust Emissions due to Mechanical Raking of ODSVRA Beach Areas

Author: Desert Research Institute (J. Gillies and G. Nikolich)

Draft Date: June 27, 2024

Date State Parks Requested SAG Review: July 18, 2024

SAG Response Date: July 29, 2024

Final Publication Date: August 22, 2024

Report: Increments of Progress Towards Air Quality Objectives – ODSVRA Dust Controls 2024 Update

Author: Desert Research Institute (J. Gillies, G. Nikolich, and E. Furtak-Cole)

Draft Date: December 4, 2024

Date State Parks Requested SAG Review: April 24, 2025

SAG Response Date: May 8, 2025

Final Publication Date: May 14, 2025

Report: Report of Findings: ODSVRA Meteorological and PM₁₀ Monitoring Network, 2024

Author: Desert Research Institute (J. Gillies and G. Nikolich)

Draft Date: February 2025

Date State Parks Requested SAG Review: April 17, 2025

SAG Response Date: May 15, 2025

Final Publication Date: June 5, 2025

Report: Foredune Restoration UAS Survey Report (UCSB 2023-2024 ODSVRA)

Author: University of California—Santa Barbara (Z. Hilgendorf, I. Walker, and M. Heffentrager)

Draft Date: June 9, 2025

Date State Parks Requested SAG Review: June 10, 2025

SAG Response Date: June 26, 2025

Final Publication Date: July 11, 2025

Report: Recent (2020 – 2024) Vegetation Cover Changes within the Oceano Dunes SVRA

Author: University of Wisconsin (M. Heffentrager) and University of California—Santa Barbara (Z. Hilgendorf, I. Walker, and M. Heffentrager)

Draft Date: June 9, 2025

Date State Parks Requested SAG Review: June 10, 2025

SAG Response Date: June 26, 2025

Final Publication Date: July 9, 2025

2.4.2 SAG-GENERATED REPORTS AND MEMOS

During the 2025 ARWP reporting period (August 1, 2024, through July 31, 2025), the SAG generated the following reports and memoranda:

- **November 18, 2024: SAG Recommendations for Reductions in ODSVRA Meteorological and PM₁₀ Monitoring Network, 2025-2028.** Suggestions from the SAG about how to streamline the data monitoring network, with several options presented and evaluated according to pros and cons.
- **December 1, 2024: Management of Vegetated Areas in Respect of Zero Emissions.** SAG memo to State Parks summarizing discussions at the October 14, 2014, in-person meeting regarding management imperatives for dust emissions from vegetated areas in the ODSVRA.
- **January 10, 2025: SAG Membership Process.** Joint State Parks/SLOAPCD/CARB/SAG document describing protocols for changing membership in the SAG.
- **February 14, 2025: Toward a Data-Informed Metric for Assessing Progress Leading to PM₁₀ Reductions Downwind of the ODSVRA.** SAG memo responding to the request from the SLOAPCD Hearing Board about using dust concentration measurements to assess progress toward achieving the goals of the SOA.
- **May 11, 2025: ODSVRA PI-SWERL Update (2013-2024).** Extensive summary report from the SAG on PI-SWERL campaigns including the most recent 2024 measurements with new emissivity power relations for use in modeling of dust emissions by DRI.

2.4.3 SAG PARTICIPATION IN MEETINGS

During the 2025 ARWP reporting period (August 1, 2024, through July 31, 2025), the SAG participated in a number of important meetings and made several presentations to stakeholder groups. In addition to those highlighted below, there were numerous regularly scheduled and ad hoc meetings between SAG members and other individuals on topics related to dust emission measurement/modeling and SOA compliance assessment. Meetings and presentations include the following:

- SAG Monthly Online Meeting, July 18, 2024, via Zoom (all SAG members present)
- OHMVR Commission Meeting, August 1, 2024 (B. Bauer in attendance via remote link)

- State Parks/SLOAPCD/SAG Discussion on proposed revisions to the SOA, September 5, 2024
- SAG Monthly Online Meeting, September 23, 2024, via Zoom (all SAG members present)
- SLOAPCD/SAG Discussion on SAG membership changes, October 2, 2024
- SAG Semi-Annual In-Person Meeting, October 14, 2024, Oceano, California (all SAG members present)
- SLOAPCD Hearing Board Meeting, October 15, 2024, San Luis Obispo, California (presentation by SAG Chair B. Bauer)
- SLOAPCD/State Parks/SAG Discussion on Hearing Board request for a data metric, November 15, 2024
- SAG Monthly Online Meeting, November 18, 2024, via Zoom (all SAG members present)
- SAG Monthly Online Meeting, December 16, 2024, via Zoom (all SAG members present)
- SLOAPCD/State Parks/SAG Discussion on SAG membership protocols, December 18, 2024
- SAG Monthly Online Meeting, January 13, 2025, via Zoom (all SAG members present)
- SLOAPCD/State Parks/CARB/SAG Meeting on final SAG membership protocols, January 28, 2025
- SAG Quarterly Online Meeting, February 10, 2025, via Zoom (all SAG members present)
- SAG Monthly Online Meeting, March 10, 2025, via Zoom (all SAG members present)
- SAG Semi-Annual Meeting, April 14, 2025, via Zoom (all SAG members present)
- SAG Monthly Online Meeting, May 14, 2025, via Zoom (all SAG members present)
- SAG Monthly Online Meeting, June 16, 2025, via Zoom (all SAG members present)
- SLOAPCD Board Meeting, June 25, 2025, San Luis Obispo, California (presentation by SAG Chair B. Bauer)
- Bi-weekly meetings with State Parks, August 2024 through July 2025, via Teams (SAG Chair B. Bauer and Program Manager J. O'Brien present)
- Bi-weekly meetings with SLOAPCD Management, August 2024 through July 2025, via Zoom (SAG Chair B. Bauer and Assistant Air Pollution Control Officer K. Tupper present)
- Bi-weekly ARWP Meetings with State Parks project personnel, August-October 2024/May-July 2025, via Teams (SAG Chair B. Bauer, Program Manager J. O'Brien, Senior Scientist R. Glick, and consultants present)

2.4.4 PUBLIC RELATIONS CAMPAIGN

State Parks' public relations campaign is intended to educate the public on regional air quality issues in southern San Luis Obispo County surrounding the ODSVRA, how they are being

addressed, and how the public can be part of the solution.⁵³ During the reporting period, the campaign:

- Continued to host a digital two-page flyer that explains the basics about sand movement in a dune system. This flyer is located on the ODSVRA's Particulate Matter Information website: <https://ohv.parks.ca.gov/pages/1170/files/FAQ%20FINAL.pdf>
- Continued to host a video that provides a broad overview of the Oceano Dunes Air Quality Management Program. This video is located on the ODSVRA's Particulate Matter Information website: <https://youtu.be/qkbf7kia3-Q>
- Continued to host the Frequently Asked Questions (FAQ) document with specific information about air quality and the dust mitigation activities. This FAQ document is located on the ODSVRA's Particulate Matter Information website: https://ohv.parks.ca.gov/?page_id=26918
- Continued to conduct website maintenance for the ODSVRA's Particulate Matter Information website.
- Created social media posts on the Oceano Dunes Facebook page, focusing on the Dust Control Program and educating the public on the things they can do to help: <https://www.facebook.com/OceanoDunesDistrictPismoBeach/>

2.4.5 COASTAL COMMISSION COORDINATION

The 2024 ARWP Work Plan included the conversion of 12.3 acres of straw treatments to native dune vegetation and other activities that occurred in project areas that had already been permitted previously by the California Coastal Commission. Accordingly, 2024 Work Plan activities were not subject to a new or amended Coastal Development Permit (CDP), and no coordination with the Coastal Commission was necessary.

⁵³ Refer to State Parks 2023 ARWP, Attachment 12, for State Parks' public relations campaign details.

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3 WORK PLAN (AUGUST 1, 2025, TO JULY 31, 2026)

This chapter of the ARWP proposes activities that State Parks will undertake to sustain the progress the Dust Control Program has made in reducing current PM₁₀ emissions to a level that is not in excess of the naturally occurring conditions inherent to the modeled 1939 pre-disturbance condition. As described in detail in this chapter, State Parks intends to reopen a part of the Plover Exclosure (PE) to seasonal recreation. This management change is an operational decision that is independent of the Dust Control Program; however, as described in Section 2.1, the management status of the PE has the potential to influence dust emissions and compliance with the SOA. State Parks' Work Plan, therefore, emphasizes and focuses on providing supplemental planting to maintain dust control project effectiveness, and refining the excess emissions modeling methodology to adequately model changes in emissions that may occur with operational changes to the PE. For the period of approximately August 1, 2025, to July 31, 2026, State Parks is proposing the following Dust Control Program activities:

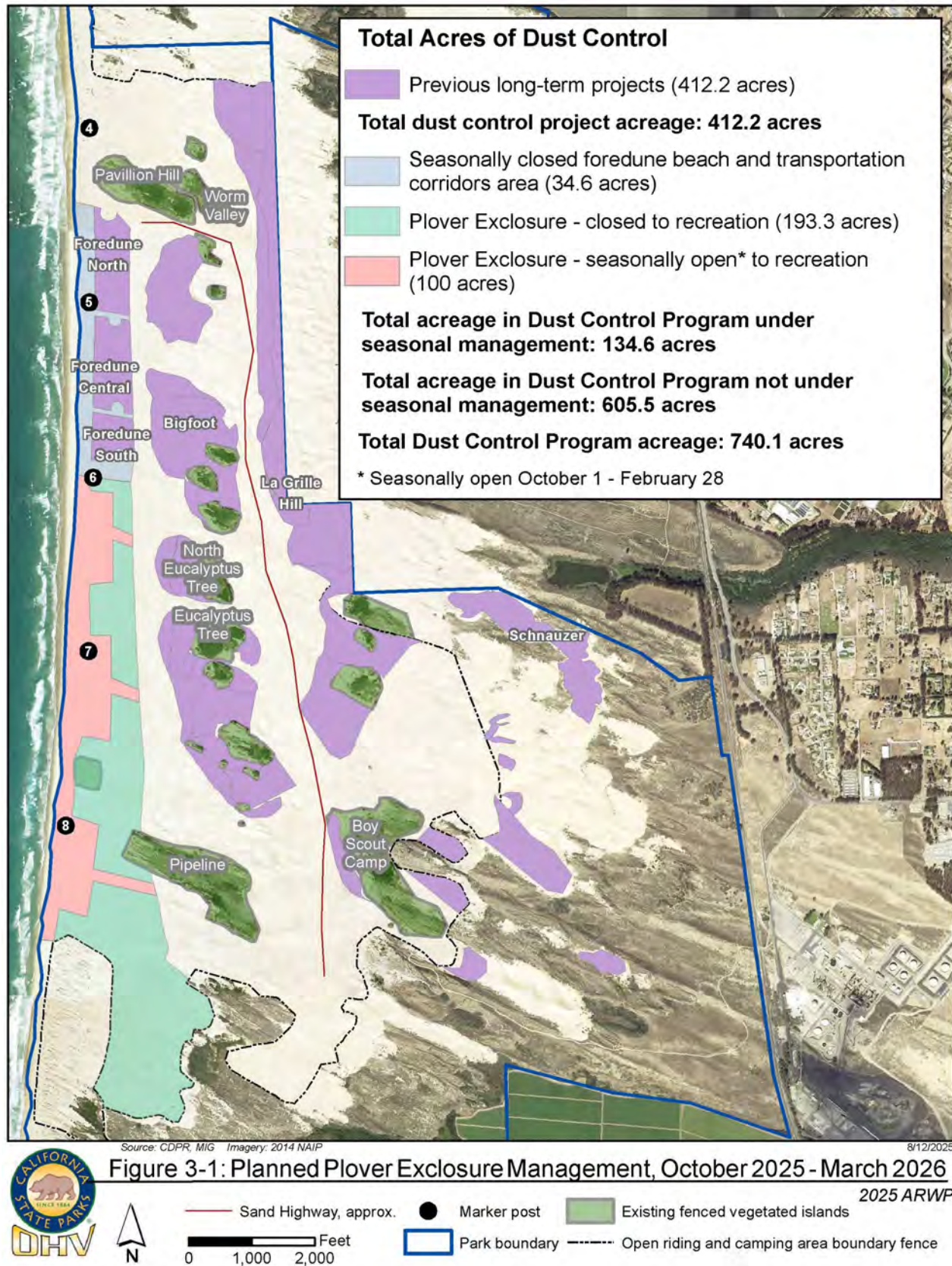
- Provide supplemental vegetation planting in 28.9 acres of previous vegetation treatment areas
- Continue Dust Control Program field monitoring and air quality modeling activities
- Continue SAG consultation, including updating the approach to evaluating Dust Control Program progress
- Continue to implement the Dust Control Program public relations campaign
- Coordinate with the California Coastal Commission on 2024 ARWP permitting requirements, if needed

State Parks' description of the planned management change to the PE and proposed Dust Control Program projects and activities is provided below.

3.1 RETURN OF PLOVER EXCLOSURE TO SEASONAL CLOSURE STATUS

As described in Section 2.1, the approximately 300-acre PE has been closed to vehicular and non-vehicular recreation since October 2021. State Parks intends to reopen up to approximately 100 acres of land within the PE to vehicular and non-vehicular recreation on a seasonal basis (from October 1 to February 28, or approximately five months a year).⁵⁴ The planned reopening of the PE would occur on October 1, 2025. Figure 3-1 shows the planned management status for the PE from October 1, 2025, to February 28, 2026.

⁵⁴ Typically, under a seasonal management regime, the Plover Exclosure would be opened on October 1 of one calendar year and closed on the last day of February in the following calendar year.



As shown in Figure 3-1, State Parks' planned management of the PE from October 1, 2025, to February 28, 2026, would permit vehicular and non-vehicular recreation along approximately 50 acres of shoreline and approximately 50 acres of the interior of the PE, distributed across three distinct areas. The total acreage reopened to vehicular and non-vehicular recreation between October 2025 and February 2026 would, therefore, be up to approximately 100 acres. Each of the three interior areas would abut the shoreline zone and link to the larger open riding and camping areas via access corridors. This proposed configuration was made in consultation with the SAG and represents a sound, methodical, and incremental approach to returning the PE to a seasonal recreation management status. The proposed configuration maximizes public access while preserving changes in the PE that have occurred since October 2021, and which have provided a dust control benefit. The proposed configuration also considers historical camping patterns, staff and labor availability, visitor safety, and emergency access factors.

3.1.1 ASSUMED EMISSIVITY RELATION FOR SEASONAL PLOVER EXCLOSURE

State Parks' planned return of part of the PE to a seasonal recreation status could modify the emissivity characteristics of the PE assumed in the excess emissions modeling required by the SOA. State Parks has coordinated with the SAG to address potential changes in emissivity that may result from changes in the management status of the PE, and the following discussion was provided by the SAG for this ARWP.

In order to assess the consequences of transitioning to a new management regime that allows seasonal access by campers and OHV riders to sections of the Plover Exclosure (as was the case prior to October 1, 2021, before the area was closed off to OHV traffic year-round), it is necessary to model the anticipated future increase in dust emissions resulting from seasonal disturbance of the sand surface by OHV traffic. A crucial step involves selecting an emissivity power relation that adequately represents the potential dust emissions for those portions of the PE that will be managed under the new regime. Given that it is complicated to model dust emissions on a seasonal basis,⁵⁵ it becomes essential to develop an emissivity power relation that realistically portrays the potential dust emissions averaged over an entire year, reflecting the fact that during the non-riding (exclosure) period dust emissions are likely to be less than during the riding (open) period.

A previous SAG report (see Section 2.2.2) summarized the entirety of PI-SWERL measurements taken in the footprint of the PE area between August 2013 and September 2022 (subsequently supplemented by measurements in 2024). The majority of measurement campaigns prior to 2021, when seasonal OHV access was allowed, were conducted late in the closure period (i.e.,

⁵⁵ According to the SOA, the stipulated modeling approach involves simulation of dust emissions using the meteorology of the 10 highest emissions days for the period May 1 through August 31, 2013, and a representative emissivity grid derived from PI-SWERL measurements. Simulations are not performed seasonally with current wind conditions, although the emissivity grid is updated regularly.

August, September) or shortly after the closure period ended (i.e., October). This was the case in 2013, 2014, 2015, and 2019. Additional measurements in 2022 and 2024 characterize emissivity potential during permanent closure with no seasonal disturbance from OHV traffic. In 2016, one set of 23 measurements was conducted late in the open riding period (i.e., March), and these are the only data available that characterize the influence of OHV riding specifically in the PE. This collection of data is a primary source of input for calculating emissivity power relations for the PE under the new management regime. However, an additional set of PI-SWERL measurements is available from an adjacent area immediately to the north of the PE - the Seasonal Exclusion (SE) zone,⁵⁶ and these data help to inform the potential influence of OHV riding during a management regime when seasonal access is allowed. Similar to measurements in the PE, the majority of measurements in the SE zone were conducted in the late summer or early fall, but this is irrelevant because prior to 2019 this area was open to OHV access year-round so there was no closure period with reduced emissions. Seasonal exclusion only occurred after the creation of the FRA in late 2019, and therefore only the measurements from 2022 and 2024 are characteristic of the end of the closure period (having been conducted in September of each year). In total, there are 251 measurements from the PE and 146 from the SE zone (each measurement comprising three speeds of the PI-SWERL device) available to be used in calculating emissivity power relations.

The guiding principles and procedures for the analysis included the following: (1) use all data available, if appropriate; (2) separate the data into groups that reasonably characterize the potential emissions during the riding and non-riding periods; (3) use the median values to characterize the data distributions in each of the groups (consistent with previous practice as applied to other management zones in the ODSVRA); (4) use a weighted mean to characterize the riding and non-riding periods according to length of each period, five months (October to February) and seven months (March to September), respectively, applied separately to each of the two zones; (5) calculate a simple arithmetic average for the results from the PE and the SE zone; and (6) generate a single emissivity power relation based on these averages to be used in the DRI model to characterize the potential dust emissions from the sections of the PE that will fall under the new management regime.

Table 3-1 shows the results of the analysis. There was an imbalance in the number of measurements directly in the PE characterizing the riding-influenced period ($n = 23$) relative to those during the non-riding period ($n = 228$). This reflects the practical realities associated with acquiring PI-SWERL measurements immediately after the riding period (i.e., in early March) because of the confounding influence on emission measurements by frequent rainfall events. Typically, the PI-SWERL campaigns are not scheduled until May (and again in September) when the likelihood of rain is much reduced. Thus, the only measurements that pertain to the

⁵⁶ See Attachment 05 and State Parks' 2024 ARWP, Attachment 08.

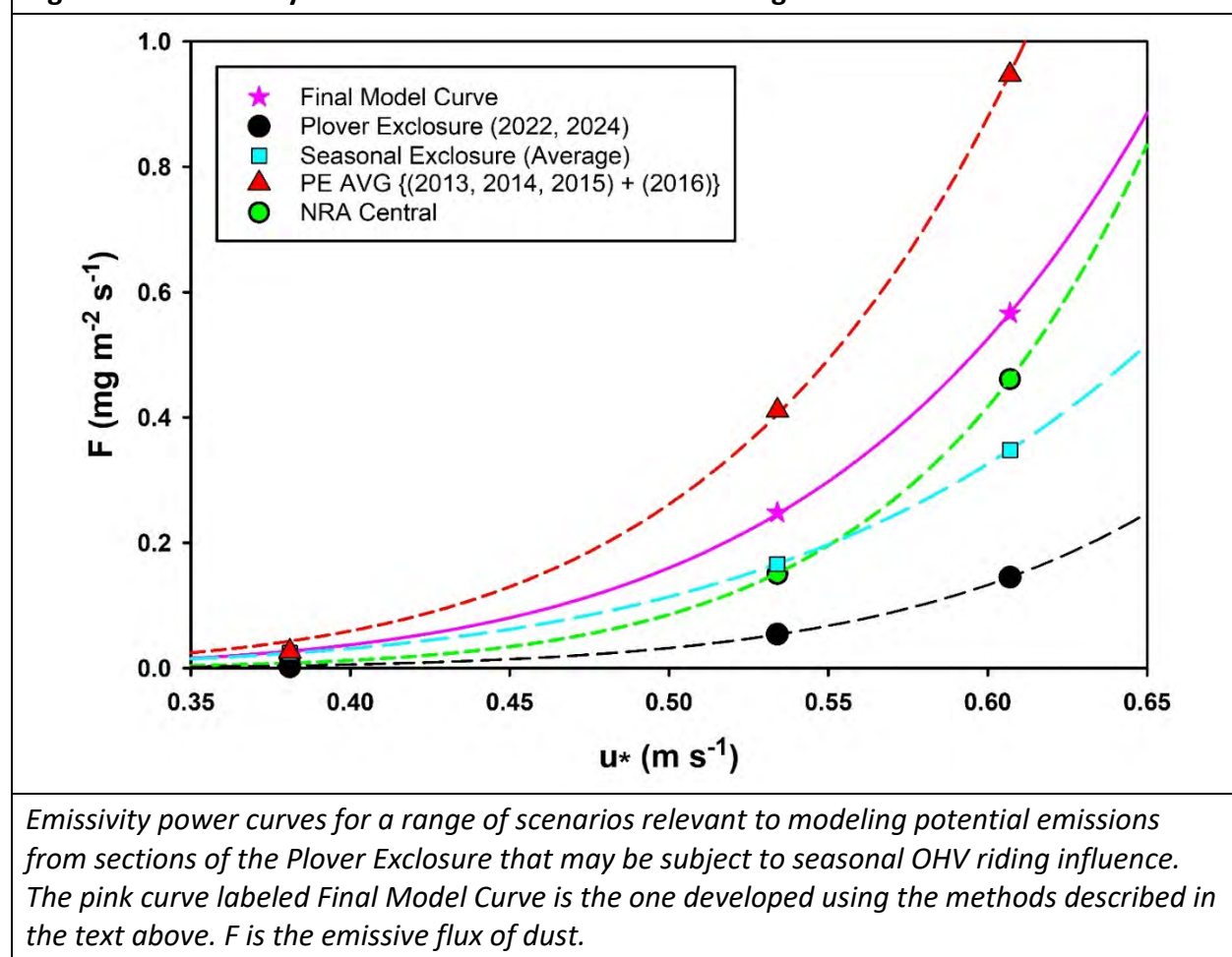
influence of OHV riding within the PE are those from March, 2016, which had much larger median emissivity values than any other period. It is not known to what extent these measurements are representative of the influence of OHV riding during a seasonal management regime, but they cannot be dismissed or ignored without good reason. Regardless, the imbalance in available measurements from the PE characterizing the riding and non-riding periods compels the use of the data from the SE zone, which includes the influence of OHV riding in an area that is immediately adjacent to the PE. In particular, both regions have extensive beach zones that likely have similar dust emission potential. Table 3-1 shows that the March, 2016 median values were greater than any other, and these contributed to a relatively large weighted average for the PE. In contrast, the median values for the SE zone are somewhat smaller than for the PE, for both the riding-influenced and non-riding periods, yielding weighed averages that are approximately one-half of those in the PE. This is likely due to the predominance of measurements in the beach area west of the FRA and along the access corridors close to the beach, whereas the majority of measurements made in the PE were from locations farther inland. The final median values used to develop the emissivity power relation for the DRI model therefore reflect a compromise mandated by the uncertainties associated with the available data.

Table 3-1. Power Relation Data for Seasonal Transition of Plover Exclosure									
Variable	Riding Influences			Closed to OHV Traffic			Weighted Average of Medians		
Plover Exclosure									
Samples (n)	23			228			-		
Shear (u*)	0.381	0.534	0.607	0.381	0.534	0.607	0.381	0.534	0.607
Median	0.053	0.612	1.326	0.000	0.158	0.448	0.022	0.347	0.814
Seasonal Exclosure Area									
Samples (n)	71			75			-		
Shear (u*)	0.381	0.534	0.607	0.381	0.534	0.607	0.381	0.534	0.607
Median	0.045	0.274	0.558	0.045	0.274	0.558	0.045	0.274	0.558
	Average (Arithmetic) of Medians								
Shear (u*)	-						0.381	0.534	0.607
Median	-						0.021	0.248	0.566
Note: This table summarizes data results used in calculating the emissivity power relation to be used in the DRI model, as applied to the areas of the Plover Exclosure that will be transitioned to a seasonal management regime. Shear velocity (u*) given in m s ⁻¹ , and median emissivity given in mg m ⁻² s ⁻¹ .									

The three median values used to develop the emissivity power relation (0.021, 0.248, 0.566 $mg\ m^{-2}\ s^{-1}$) yielded power relation coefficients of $a = 14.748$ (gain) and $b = 6.528$ (exponent) using the established protocols for curve fitting. A graph of the curve is presented in Figure 3-2, which also shows several other curves for comparison. The Final Model Curve indicates that the predicted dust emissions from the areas subject to seasonal riding influence will be much

greater than the current emissive flux based on the 2022 and 2024 PI-SWERL measurements (black circles), which characterize the PE in its current state (i.e., closed access). The red triangles show one of many curves that were considered for implementation based on averaging the medians of the measurements from March 2016 (at the end of the riding period) with the medians from the cluster of measurements from 2013, 2014, and 2015 (at the end of the non-riding period). This option was considered as a balance between the riding and non-riding periods, but ultimately rejected because the measurements were conducted many years ago prior to implementation of many rehabilitation projects and well before closure of the PE. It is not known how representative these data are to the situation today (as reflected by the curve with the black circles). Also shown for comparison is the curve that characterizes the Non-Riding Area Central zone, which comprises all PI-SWERL data from 2013 to 2024 for areas permanently exclosed to OHV access. It is noteworthy that the Final Model Curve is approximately the same as the Non-Riding Area Central zone, with slightly elevated emissions predicted.

Figure 3-2. Emissivity Power Curves for Relevant Modeling Scenarios



The results of the excess emissions modeling using the assumed emissivity relation for seasonally managed areas of the PE are presented in Section 3.3.1. As described in more detail in Section 3.3.1, the planned return of up to approximately 100 acres of the PE to seasonal recreation would not cause the ODSVRA to be in a condition of excess emissions.

3.3 DUST CONTROL PROJECTS PROPOSED FOR AUGUST 1, 2025, TO JULY 31, 2026

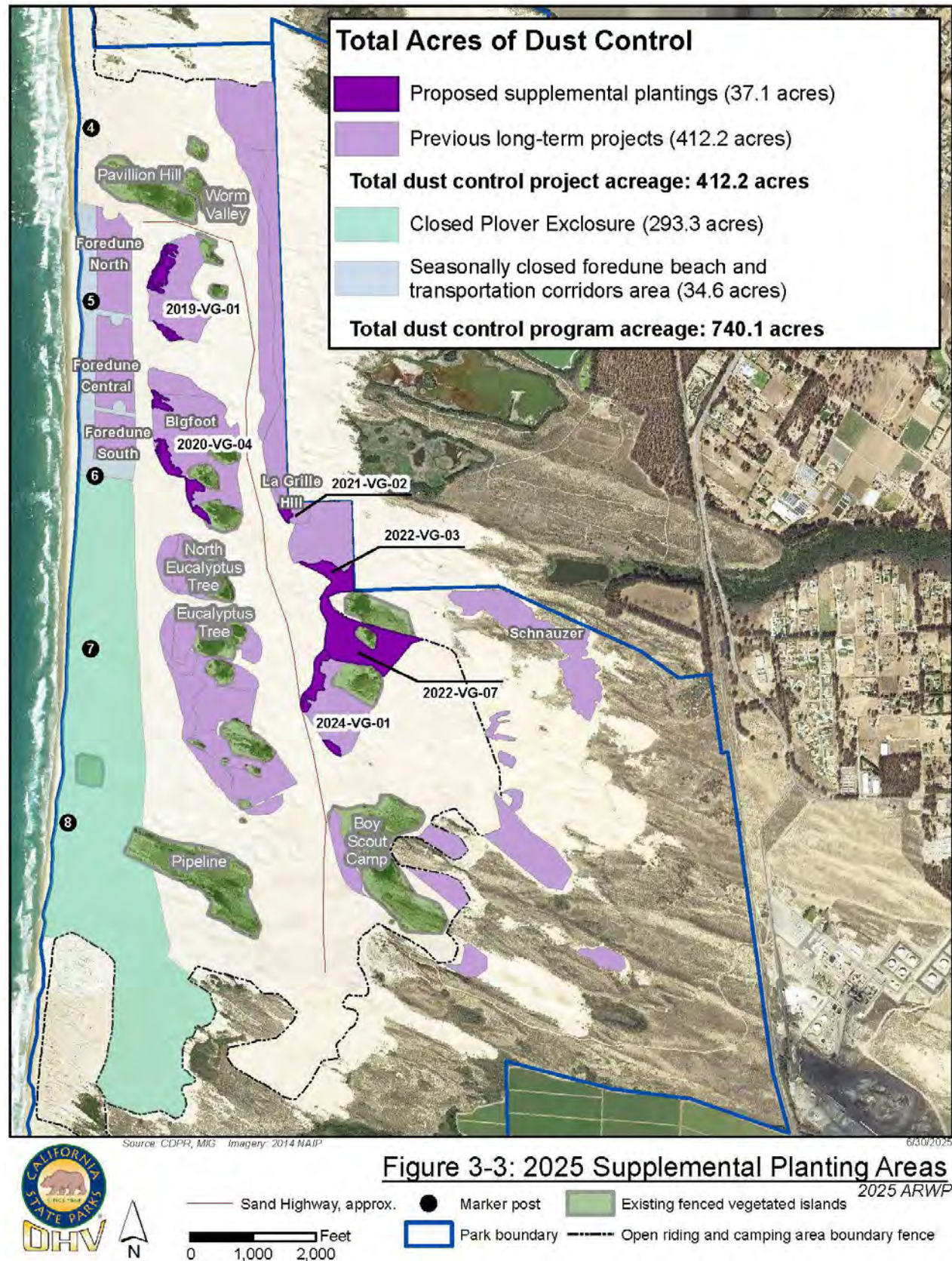
3.3.1 SUPPLEMENTAL PLANTING

State Parks proposes to perform supplemental planting and seeding activities on six previously installed vegetation projects totaling approximately 37.1 acres (2022-VG-07, 22.7 acres; 2020-VG-04, 5.0 acres; 2019-VG-01, 4.2 acres; 2024-VG-01, 3.8 acres; 2022-VG-03, 0.8 acres; 2021-VG-02, 0.7 acres, see Figure 3-3). Lagrille Hill (south) 2022-VG-07, a project area that is within the ODSVRA open riding area and directly upwind of the CDF air quality monitoring station, had previously been treated with seed only and not container stock, resulting in slow vegetation recruitment and low vegetation cover. To improve vegetation cover, this entire project area will receive installation of straw, native container plants, native seed, and sterile grain seed. The remaining five proposed project areas have each had significant sand inundation on the western edge within specific sections of the projects resulting in burial and loss of vegetation cover. These areas had originally been treated with straw, container plants and native seed, and sterile grain seed. To improve vegetation cover and species diversity, supplemental planting is proposed in these areas including installation of straw, native container plants, native seed, and sterile grain seed.

State Parks will, in coordination and consultation with the SAG, continue to evaluate and monitor backdune vegetation projects and conduct supplemental planting activities in areas where vegetation has not yet become established.

3.3.2 PLANTING PALETTE/ESTIMATE OF PLANTS AND SEED NEEDED FOR DUST CONTROL PROJECTS

State Parks will 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, 2025, State Parks estimates up to approximately 111,436 plants and 461 pounds of native seed would be required to complete State Parks' proposed supplemental planting activities (see Section 3.2.1). Refer to Attachment 12 for estimates of planting and seeding activity associated with State Parks' proposed 2025 Work Plan.



3.4 AIR QUALITY MODELING ACTIVITIES

State Parks, in coordination with DRI and the SAG, proposes to conduct the air quality modeling activities described below from August 1, 2025, to July 31, 2026.

3.4.1 PREDICTION OF FUTURE EXCESS EMISSIONS REDUCTIONS

As summarized in Section 2.3.2.2, the results of the excess emissions modeling conducted by DRI indicate the ODSVRA, as currently configured according to management zones and accounting for all treatment projects implemented since 2013, does not emit dust to a level that is in excess of the naturally occurring conditions inherent to the pre-disturbance scenario and therefore is in compliance with the SOA. As discussed in Section 3.1, State Parks intends to reopen up to 100 acres of the PE for seasonal recreation and has coordinated with the SAG to model the potential effects of this management change. The results of the excess emissions modeling with the PE's planned management status between October 2025 and February 2026 (up to approximately 100 acres of seasonal recreation) is summarized in Table 3-2. As shown in Table 3-2, the modeled 2026 landscape scenario is predicted to emit 127.2 metric tons per day of PM₁₀ emissions, which is approximately 8.0 metric tons per day less than the modeled pre-disturbance landscape scenario (135.2 metric tons per day). Accordingly, an estimate of the amount of additional dust control projects needed to comply with the SOA, and predictions of future excess emissions reductions that would occur with new dust control projects, are not necessary at this time.

3.4.2 MODEL REFINEMENTS

As described in Section 2.2.2, State Parks and the SAG have used the PI-SWERL data collected by DRI to establish emissivity grids and parameterize PM₁₀ emissions from the ODSVRA for the purposes of modeling pursuant to the SOA's excess emissions framework. State Parks will coordinate with DRI and the SAG to conduct updated PI-SWERL tests between August 1, 2025, and July 31, 2026, and incorporate this new information into the emissivity power relations used in the excess emissions model. As described in more detail in Section 3.4.3, State Parks anticipates that, at a minimum, PI-SWERL testing will occur in the PE in September 2025 and March 2026 and that emissivity power relations will be updated after each of these sampling campaigns is complete.

Table 3-2. Modeled Total Mass Emissions Estimates for the Pre-Disturbance (1939) Scenario, Current (2025) Landscape Scenario without Seasonal Recreation in the Plover Exclosure, and Predicted (2026) Landscape Scenario with Seasonal Recreation in the Plover Exclosure			
Emissivity Zone	Modeled Emissions in Metric Tons per Day		
	Pre-Disturbance (1939) Landscape^(A)	Current (2025) Landscape without Seasonal Recreation in the Plover Exclosure^(A)	Predicted (2026) Landscape with Seasonal Recreation in the Plover Exclosure
Non-Riding Area North	21.9	15.5	15.5
Non-Riding Area Central	91.4	11.8	11.8
Non-Riding Area South	22.0	10.6	10.6
Riding Area Central-North	-	29.3	29.3
Riding Area Central-South	-	48.1	48.1
Foredune Restoration Area	-	0.9	0.9
Plover Exclosure (seasonal management)	-	-	6.3
Plover Exclosure (year-round closure management)	-	5.0	3.5
Seasonal Exclosure	-	1.2	1.2
Vegetation Islands	-	0.0	0.0
Revegetation	-	0.0	0.0
Total^(B)	135.2	122.5	127.2
Net Change from 1939 Pre-Disturbance Landscape	-	-12.7	-8.0
Excess Emissions Exist?	-	No	No
Source: DRI, 2025 (see Attachment 10)			
(A) See Table 2-8.			
(B) Totals may not equal due to rounding.			

3.5 FIELD MONITORING ACTIVITIES

State Parks, in coordination with DRI and the SAG, proposes to conduct the field monitoring activities described below from August 1, 2025, to July 31, 2026. Field monitoring activities would generally continue in a manner similar to previous years' efforts.

3.5.1 METEOROLOGICAL AND PM₁₀ MONITORING

As described in Section 2.2.1, State Parks conducts meteorological and PM₁₀ monitoring, with an emphasis on data collection from April 1st to September 30th. This network was reinstalled in April 2025 and will be maintained through September 2025. DRI will analyze and use the data collected by the network to update Increments of Progress reporting (see Section 2.3.1) in the 2026 ARWP. State Parks anticipates re-installing the network shown in Figure 2-8 in April 2026. As has been done previously by DRI, the MetOne 212 particle profilers will be calibrated against a BAM PM₁₀ monitor in the DRI dust chamber prior to and following deployment.

3.5.2 UAS SURVEYS

Consistent with previous years (see Section 2.2.3), UAS surveys for the 2025 ARWP Work Plan (August 1, 2025, to July 31, 2026) will occur in October 2025 and February 2026, as well as October 2026 (as part of the 2026 ARWP). UAS surveys will involve both RGB and multispectral bands. The same data products mentioned in Section 2.2.3 will be produced (georeferenced orthophoto mosaics, DTMs, geomorphic change maps, vegetation maps) and interpreted to describe changes in the FRA.

In consultation with UCSB, State Parks will also work with the SAG to determine whether other additional useful UAS surveys should be carried out in 2025/2026.

3.5.3 PI-SWERL SURVEYS

State Parks will coordinate with DRI to undertake additional PI-SWERL sampling in 2025 and 2026. Preliminarily, State Parks anticipates DRI will measure emissivity within the PE prior to some, or all, of this defined emissivity zone being re-opened for OHV activity and camping (September 2025), at the end of the seasonal recreation period (March 2026). State Parks will coordinate with DRI to conduct PI-SWERL testing as close as possible to the date that access to the PE for OHV recreation and camping becomes restricted due to the Western Snowy Plover and California Least Tern breeding season. As described in Section 3.3.2, the updated emissivity data will be used to refine emissivity relations for the PE as it transitions from nearly five years of closure to seasonal recreational activities.

In consultation with DRI, State Parks will also work with the SAG to determine whether other additional useful PI-SWERL measurement campaigns should be carried out in 2025/2026 (beyond the planned PE campaigns) to further the current understanding of the dust emissions system and inform air quality modeling and management of dust emissions at the ODSVRA. Any new

measurements would be incorporated into the global dataset of PI-SWERL measurements used in the excess emissions modeling.

3.5.4 FOREDUNE MONITORING

State Parks and UCSB propose to conduct the foredune monitoring activities described below from August 1, 2025, to July 31, 2026.

3.5.4.1 FRA MORPHOLOGICAL CHANGES

As described in Sections 2.2.3, 2.2.3.1, and 3.4.2, interpretation of geomorphic changes within the FRA TPs will continue.

3.5.4.2 UAS VEGETATION COVERAGE

As described in Sections 2.2.3.2 and 3.4.2, interpretation of plant cover changes within the FRA TPs will continue.

3.5.4.3 LINE-INTERCEPT TRANSECT SAMPLING

State Parks will coordinate with the SAG to review the current foredune line-intercept transect sampling methodology and determine whether this sampling should continue using the current methodology (see Section 2.2.4.1), proceed using a revised methodology, or be discontinued. If monitoring continues, it is anticipated sampling would occur in winter 2025.

3.5.4.4 PHOTO POINT MONITORING

State Parks will conduct foredune ground and aerial photo point monitoring using the same methodology described in Section 2.2.4.3.

3.5.5 BACKDUNE MONITORING

State Parks will coordinate with the SAG to review the current backdune line-intercept transect sampling methodology and determine whether this sampling should continue using the current methodology (see Section 2.2.4.2), proceed using a revised methodology, or be discontinued. If monitoring continues, it is anticipated sampling would occur in winter 2025; however, due to the amount of backdune vegetation projects installed at the ODSVRA (37 projects, see Table 2-1), State Parks anticipates different backdune projects will be sampled and monitored.

3.6 OTHER DUST CONTROL PROGRAM ACTIVITIES

3.6.1 SAG ACTIVITIES

Pursuant to the 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 2025/2026 include, but are not limited to, updated emissivity relations that capture changes in recreational management within the PE emissivity zone (see Section 3.1).

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. The SAG may consult with State Parks and the SLOAPCD to ensure access to relevant context and information in preparing such reports and reviews. To ensure independence, however, 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.

The SAG anticipates the following meeting and workshop activities in 2025/2026:

- One annual full-day meeting at the ODSVRA, with the participation of State Parks and SLOAPCD staff
- Quarterly half-day SAG meetings, with the participation of State Parks and SLOAPCD staff as needed
- Regular monthly calls among the full SAG, with State Parks and SLOAPCD staff as 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 the SLOAPCD

3.6.2 PUBLIC RELATIONS CAMPAIGN

As described in Section 2.4.4, State Parks has finalized a public relations campaign to educate the public on regional air quality issues in southern San Luis Obispo County surrounding the ODSVRA, how they are being addressed, and how the public can be part of the solution. State Parks will continue to implement aspects of this campaign, including social media posts, in 2025/2026.

3.6.3 COASTAL COMMISSION COORDINATION

Regarding State Parks' proposed Dust Control Program activities for the August 1, 2025, to July 31, 2026, period (e.g., installing monitoring equipment, etc.), State Parks will coordinate with the California Coastal Commission as needed.

3.7 ADAPTIVE MANAGEMENT

State Parks' Draft PMRP⁵⁷ prepared under the original SOA defined "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 that are based on scientific findings and the needs of society. Results are used to modify management policy, strategies, and practices.

The history of dust mitigation efforts in the ODSVRA has been detailed in prior ARWPs and is summarized in the sections above. The progress made since 2013 is testimony to the successful and effective implementation of adaptive management by State Parks, not only in terms of the many projects that were completed that reduced dust emissions but also with respect to the sophistication of the modeling effort that informs the air quality program and the shift in management approach regarding compliance assessment.

A key element of the overall strategy was to use measurements of meteorological conditions and dust concentrations within the ODSVRA and from nearby stations (e.g., CDF, Mesa2, Oso Flaco) collected since 2013 to monitor changing conditions and to drive the DRI emission-dispersion model that was created specifically for the ODSVRA. The model results, in turn, were used to identify hot spots of dust emissions, which were targeted for immediate treatment. Those treatments led to reductions in dust emissions and PM₁₀ concentrations at the CDF and Mesa2 monitoring stations (as documented in prior ARWPs). Subsequent modeling scenarios and treatment projects have led to additional dust mitigation benefits, documenting a continually decreasing trend in normalized, cumulative PM₁₀ concentrations (TPM₁₀:TWPD) at CDF (see Figure 2-28) as a function of increasing acreage in dust control treatments immediately upwind of the monitoring station between 2013 and 2023 (see also Section 2.3.1).

Between 2013 and 2017, the dust control projects amounted to fewer than 45 acres, but there was a perceptible decline in the TPM₁₀:TWPD ratio. Large areas were treated between 2017 and 2022, leading to significant and steady declines in the TPM₁₀:TWPD ratio (see Figure 2-28 and Figure 2-30). Although no additional acreage was closed to public access in the open riding and camping area between 2022 and 2023, the ratio still declined to its lowest value of about 0.15. In 2025, the ratio generally held steady at 0.17. Additional measurements in 2025 will yield more insight. Despite highly varying wind conditions from year to year (see Figure 2-25), the downward trend in the TPM₁₀:TWPD ratio is consistent with other metrics of dust emission reductions in the ODSVRA. For example, the SLOAPCD reports a decreasing trend in violations

⁵⁷ State Parks' Draft PMRP is available on the following SLOAPCD website (under "June 11, 2019 Update," "Important Documents," "Particulate Matter Reduction Plan – June 2019"): <https://www.slocleanair.org/air-quality/oceano-dunes-efforts.php>.

of Rule 1001, with a maximum of 63 in 2017 to a minimum of 10 in 2024.⁵⁸ Thus, significant progress has been made in mitigating dust emissions from the ODSVRA due to the adaptive management strategy adopted by State Parks.

The mobile sand-dominated landscape of the ODSVRA is a dynamic one that is complex in its geologic history, contemporary geomorphology, evolving biogeography, varying meteorology and climatology, and sensitivity and responsiveness to human influences. Consequently, **long-term monitoring is essential to improve understanding of the key processes at work and, more importantly, to provide critical indicators of the relative success of dust-mitigation efforts.**

For 2026 and beyond, there will be continuing field monitoring of relevant meteorological and dust-related parameters and foredune evolution to gauge progress toward the SOA objectives. This will include updating the PI-SWERL emissivity grid and implementing model refinements as appropriate and consistent with the evolving understanding of the dynamics of sand transport and dust emissions within the ODSVRA.

⁵⁸ SLOAPCD, 2024. *Report on 2024 Air Quality in San Luis Obispo County*. June 18, 2025.

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4 BUDGETARY CONSIDERATIONS

State Parks' estimated budget to develop and implement the 2025/2026 Work Plan described in Chapter 3 is \$2,774,700. A detailed breakdown of this estimated budget is provided in Table 4-1. This budget covers all activities from July 1, 2025, through June 30, 2026, including existing contracts with SAG members. The approximately \$2.78 million budget shown in Table 4-1 is lower than the costs that State Parks identified for proposed activities in the 2024 ARWP (\$3.78 million) due to changes in contracts.

Table 4-1. Estimated 2025/2026 Work Plan Budget			
Dust Control Activity	Third-Party Contract Costs	Other Costs	Total Costs^(A)
Vegetation Plantings (Foredune, and Supplemental Plantings)			
Labor	\$714,000	\$238,000	\$952,000
Materials	\$0	\$165,000	\$165,000
Equipment	\$186,500	\$0	\$186,500
Greenhouse facilities	\$300,000	\$0	\$300,000
<i>Subtotals</i>	<i>\$1,200,500</i>	<i>\$403,000</i>	<i>\$1,603,500</i>
Maintenance and Installation of Wind and Other Fencing			
Labor	\$0	\$50,000	\$50,000
Materials	\$0	\$40,000	\$40,000
Equipment	\$0	\$0	\$0
<i>Subtotals</i>	<i>\$0</i>	<i>\$90,000</i>	<i>\$90,000</i>
Monitoring (Air Quality, Meteorological, UAS, and Other Monitoring) and Modeling			
Instrument operations	\$96,800	\$55,000	\$151,800
Data analysis	\$301,000	\$0	\$301,000
<i>Subtotals</i>	<i>\$397,800</i>	<i>\$55,000</i>	<i>\$452,800</i>
Dust Control Project Design and Technical Assistance			
Scientific expertise (DRI)	\$200,000	\$0	\$200,000
SAG Costs			
Scientific expertise	\$107,000	\$0	\$107,000
Other Items of Expense			
Miscellaneous ^(B)	\$71,600	\$249,800	\$321,400
TOTAL COSTS	\$1,976,900	\$797,800	\$2,774,700
(A) The cost estimate does not include permanent State Parks staff positions assigned to these duties but includes seasonal staff time and overtime for permanent staff.			
(B) Miscellaneous costs include contracts for greenhouse assistance, fuel, equipment repairs, purchases, and other Dust Control Program support costs.			

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5 IMPLEMENTATION SCHEDULE

Table 5-1 through Table 5-5 below present schedules for implementing the dust control activities identified in Chapter 3. The tables cover an approximately 14-month period from June 2025 to July 2026.

Table 5-1. Dust Control Measures														
State Parks Task/Activity^(A)	2025							2026						
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Consult with SAG on project selection		O	→	→	X									
Manage seasonal recreation in Plover Exclosure					O	→	→	→	X					
Collect native seed and plants, cultivate growth, procure additional plants from nurseries	→	→	→	→	→	X								
Distribute straw mulch					O	→	X							
Initiate seeding and planting							O	→	→	X				
Table Key:	O	Task Start			→	Task In Progress				X	Task Complete			

Table 5-2. Continued Foredune Monitoring and Assessment by State Parks Staff														
State Parks Task/Activity	2025							2026						
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Consultation with SAG on monitoring		O	→	X									O	→
Transect sampling				O	→	→	→	→	X					
Photo point monitoring					O X									
Data analysis										O	→	X		
Table Key:	O	Task Start			→	Task In Progress				X	Task Complete			

Table 5-3. Supplemental Planting in Previous Treatment Areas														
State Parks Task/Activity	2025							2026						
	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 5-4. Field Monitoring and Air Quality Modeling Activities														
State Parks Task/Activity	2025							2026						
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Meteorological and PM ₁₀ data acquisition	→	→	→	→	→	→	→	→	→	→	→	→	→	→
PI-SWERL surveys and data analysis				O	→	→	X			O	→	→	X	
UAS surveys					O X				O X					
Improvement of DRI air quality model performance	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Table Key:	O	Task Start			→	Task In Progress			X	Task Complete				

Table 5-5. Continued SAG Consultation and Evaluation														
State Parks Task/Activity	2025							2026						
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Consultation with SAG on 2025 ARWP	O	→	→	→	X									
Refinement of excess emissions modeling	→	→	→	→	→	→	→	→	→	→	→	→	→	→
SAG quarterly meetings			X		X				X			X		
Consultation with SAG on 2026 ARWP											O	→	→	→
Table Key:	O	Task Start			→	Task In Progress				X	Task Complete			

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