Exceptional Event Demonstration for PM_{10} Exceedances in Clark County, Nevada – April 11, 2022

Final Report Prepared for

U.S. EPA Region 9
San Francisco, CA

June 2024

Sonoma Technology

This document contains blank pages to accommodate two-sided printing.

Exceptional Event Demonstration for PM_{10} Exceedances in Clark County, Nevada – April 11, 2022

Prepared by

Crystal McClure, PhD
Annie Anderson, PhD
Jeff Beamish
Kayla Besong, PhD
Melissa Chaveste
Cari Gostic
Samantha Kramer, PhD
Charles Scarborough
Ningxin Wang, PhD
Patrick Zahn
Steve Brown, PhD

Sonoma Technology
1450 N. McDowell Blvd., Suite 200
Petaluma, CA 94954
Ph 707.665.9900 | F 707.665.9800
sonomatech.com

Prepared for

Clark County Department of Environment and Sustainability
Division of Air Quality
4701 W. Russell Road, Suite 200
Las Vegas, NV 89118
Ph 702.455.3206
www.clarkcountynv.gov

Final Report
STI-1922072-8062

June 2024

Cover graphic shows camera images from the M Resort Hotel in Las Vegas on April 11, 2022, at 16:00 PST.

Contents

Figures

Tables

1. Narrative Conceptual Model

In mid-April 2022, a strong frontal passage travelled through southeastern California and southern Nevada, driving a windblown dust event which lofted and entrained dust from the Mojave Desert and increased particulate matter concentrations in Clark County, NV, on April 11, 2022. During this episode, the 2012 24-hour National Ambient Air Quality Standards (NAAQS) threshold of 150 µg/m^3 was exceeded for particles with a diameter of less than 10 microns (PM_{10}) at 10 monitoring sites in Clark County: Paul Meyer, Walter Johnson, Palo Verde, Joe Neal, Sunrise Acres, Jerome Mack, Liberty High School, Mountains Edge, Walnut Community Center, and Green Valley. Three additional sites also experienced NAAQS exceedances and all other sites throughout Clark County experienced enhanced hourly PM_{10} concentrations but were not regulatorily significant. The widespread impact on PM_{10} concentrations in Clark County indicates a regional dust event. The exceedances at the 10 regulatorily significant sites affect the PM_{10} attainment designation for Clark County during the 2021-2023 design value period.

Due to severe drought conditions in the Mojave Desert in southeastern California, strong winds created by the pressure gradient from the frontal passage lofted, entrained, and transported dust to Clark County in the late morning on April 11, 2022. The U.S. Environmental Protection Agency (EPA) Exceptional Event Rule (EER) (EPA, 2016) allows air agencies to omit air quality data from the design value calculation if it can be demonstrated that the measurement in question was caused by an exceptional event. In this case, enhanced wind speeds > 25 mph in the Mojave Desert source region and Clark County coincided with the frontal passage and increased PM_{10} concentrations along the transport path, which is consistent with a high-wind dust event as described in the EPA Guidance on High Wind Dust Events (EPA, 2019).

Overall, the PM_{10} events on April 11, 2022, at the 10 affected sites rank above the 99th percentile for all 2018-2022 PM_{10} events in Clark County and are clearly exceptional compared to typical PM_{10} conditions. Windblown dust from the Mojave Desert is shown to be entirely from natural, undisturbed lands and can be considered a natural event that could not be mitigated by anthropogenic actions beyond public warnings. Overall, this report includes detailed analyses that establish a clear causal relationship between the high-wind event in the Mojave Desert region of southeastern California with the enhanced PM_{10} concentrations measured at the 10 affected sites in Clark County, NV – designating the April 11, 2022, event as a High Wind Dust Exceptional Event.

Key narrative evidence and timeline elements are shown below and expanded on in this document:

Pre-Event Climatological Context

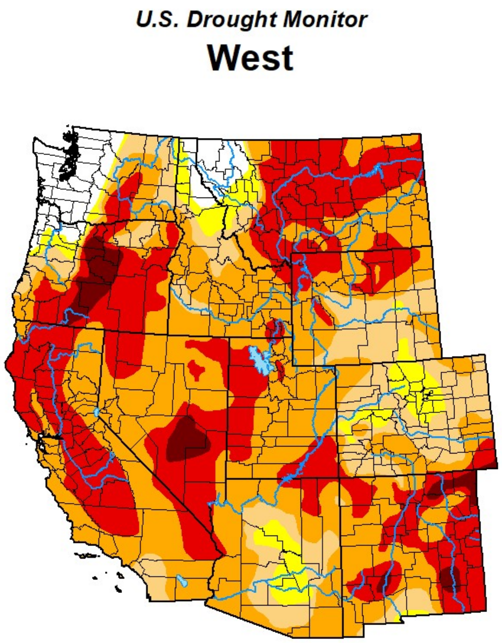

Figure 2.2-6

The Mojave Desert in southeastern California and Clark County, NV, were under extreme-to-exceptional drought conditions on and before the April 11, 2022, event. Temperatures were above normal and precipitation below normal compared to climatology. The barren land cover, including the Mojave Desert source region, was primed for significant dust production during the high-wind event.

See Section 2.2.

Inciting High-Wind Event

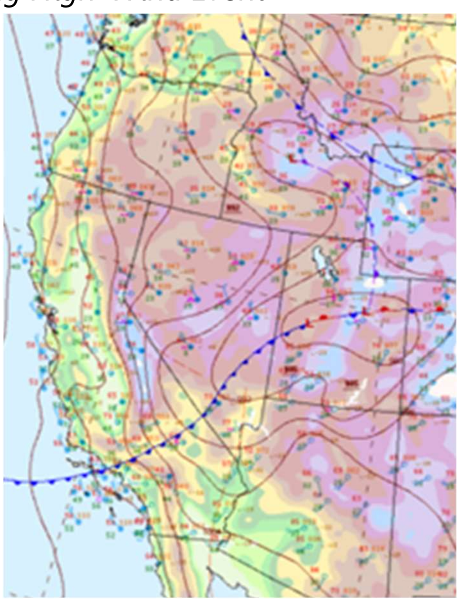

Figure 3.1-4

A frontal passage through southern Nevada precipitated a large pressure gradient across Clark County and the Mojave Desert culminating in high wind speeds and gusts across the area between 08:00 and 21:00 PST on April 11, 2022. The meteorological analysis and radar images show the frontal passage (and associated dust) entering Clark County, NV, from 10:00-12:00 PST on April 11. Wind speeds in the Mojave Desert well exceeded the 25-mph sustained wind threshold over natural undisturbed lands. This caused lofting, entrainment, and transport of PM_{10} from the source region into Clark County.

See Section 3.1.

Transport of PM_{10} from the Source Region to Clark County

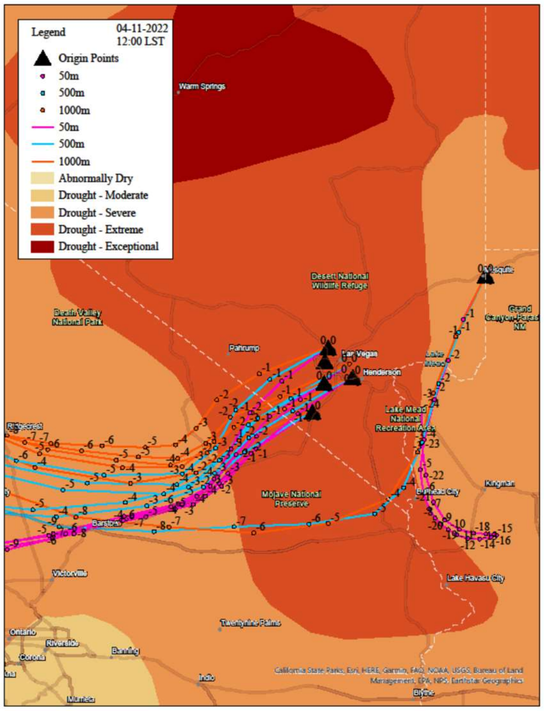

Figure 3.2-2

Back trajectories and meteorological data along the frontal passage confirm the Mojave Desert in southeastern California (located to the southwest of Clark County) as the source region for the high-wind dust event. The frontal passage pushed northeastward through the source region enroute to Clark County, NV, within two to six hours of the exceedance.

See Section 3.2

Enhanced PM_{10} from High Wind Dust Event Arrives in Clark County

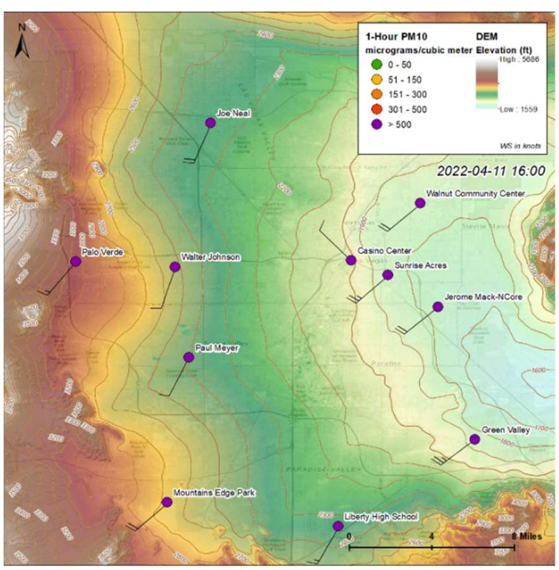

Figure 3.2-10

Enhanced PM_{10} concentrations arrived in Clark County from 10:00-12:00 PST on April 11, with an initial peak at 13:00 and secondary peak at 16:00. Concentrations remained enhanced for the remainder of the day. High PM_{10} concentrations at 13 sites across Clark County coincided with the frontal passage and occurred at the same time as high wind speed and gust measurements. Widespread high PM_{10} concentrations at all Clark County sites occurred simultaneously, indicating a regional high-wind event.

See Section 3.2

Effect of PM_{10} Concentrations in Clark County

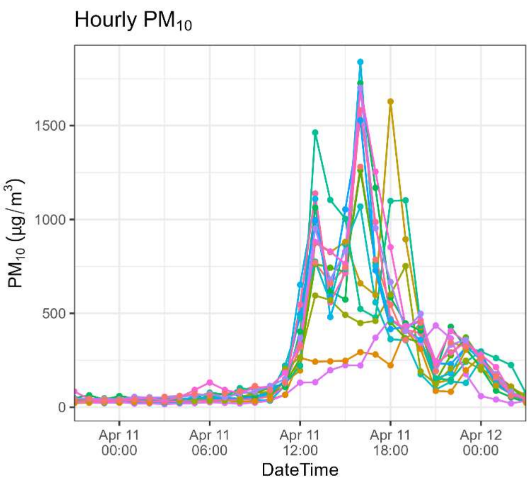

Figure 3.3-6

Thirteen PM_{10} monitoring sites exceeded the 24-hour PM_{10} NAAQS of 150 µg/m^3 on April 11, 2022 (10 were regulatorily significant; three were not regulatorily significant). Almost all sites throughout Clark County showed peak hourly concentrations of PM_{10} well above 500 µg/m^3. The widespread high PM_{10} concentrations concur with a regional high-wind exceptional event. PM_{10} concentrations at all 13 sites exceeded the 5-year 99th percentile and the NAAQS on April 11, 2022.

See Section 3.3

High Wind PM_{10} Alerts Issued

News Release

County Commission:
James B. Gibson, Chairman
Justin Jones, Vice Chairman
Marilyn Kirkpatrick
William McCurdy II
Ross Miller
Michael Naft
Tick Segerblom

Yolanda King, County Manager

Office of Public Communications • (702) 455-3546 • FAX (702) 455-3558 •

Contact: Kevin J. MacDonald, Public Information Officer — Mobile: (702) 232-0931 — E-mail: KevMac@ClarkCountyNV.gov

For Immediate Release — **Monday, April 11, 2022**

Air Quality Dust Advisory Issued for Monday

The Clark County Department of Environment and Sustainability has issued a dust advisory for **Monday, April 11**, to advise residents and local construction sites of the possibility of elevated levels of blowing dust due to the forecast of high winds in our area.

Airborne dust is a form of inhalable air pollution called particulate matter or PM, which aggravates respiratory diseases. Under windy conditions people with heart or lung disease, older adults, and children may feel better staying indoors as much as possible because they could be at greater risk from particulates, especially when they are physically active, according to the U.S. Environmental Protection Agency. Consult your physician if you have a medical condition that makes you sensitive to air pollution.

Figure 3.3-1

The National Weather Service (NWS) issued a Dust Storm Warning for Clark County on April 11. Clark County Nevada issued a Dust Advisory and Construction Notice in advance of the April 11 event due to forecasted high PM_{10} concentrations. They advised residents and local construction sites that enhanced levels of blowing dust would be possible due to high winds. On April 11, 2022, multiple news outlets also reported on the high wind, low visibility, and extremely dusty conditions.

See Section 3.3

Comparison with Historical Data

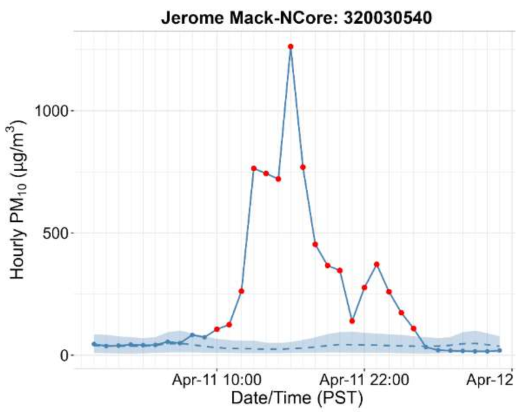

Figure 3.4-32

PM_{10} concentrations at all 10 regulatorily significant monitoring sites exceeded the 5-year 99th percentile and NAAQS on April 11, 2022. PM_{10} concentrations were also significantly outside typical seasonal and monthly ranges. The 30-year climatology analyses show temperatures, wind speeds, and soil moisture in the Mojave Desert source region and Clark County were significantly outside of historically normal conditions on the event date.

See **Section 3.4.**

Not Reasonably Controllable or Preventable

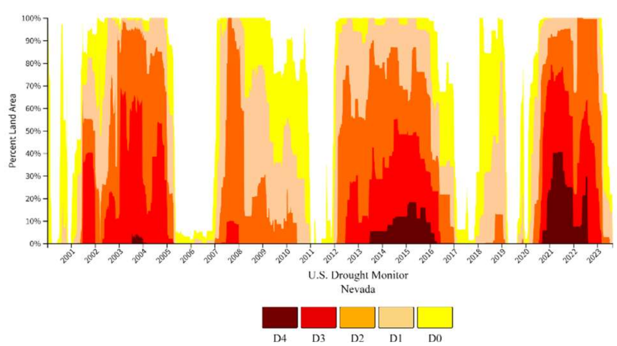

Figure 4.3-3

Based on the severe drought in the source region and the high-wind frontal passage, control measures for PM_{10} within Clark County were quickly overwhelmed and were unable to prevent the exceedance event. Significant evidence shows that high winds lofted, entrained, and transported PM_{10} from natural undisturbed lands and this event was natural and not reasonably controllable or preventable.

See **Sections 4 and 5**.

2. Background

2.1 Demonstration Description

2.1.1 PM_{10} Exceptional Event Rule Summary

The U.S. EPA EER (EPA, 2016) allows air agencies to omit air quality data from the design value calculation if it can be demonstrated that the measurement in question was caused by an exceptional event. According to EER, exceptional events, such as high-wind dust events that increase PM_{10} concentrations, can be subject to exclusion from design value calculations of the NAAQS attainment if a clear causal relationship can be established between a specific event and the PM_{10} exceedance (EPA, 2016). The EER states that an exceptional event demonstration must meet the following six statutory elements:

1. A narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s),
2. A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation,
3. Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times,
4. A demonstration that the event was both not reasonably controllable and not reasonably preventable,
5. A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event, and
6. Documentation that the air agency followed the public comment process.

Specifically, a high-wind dust demonstration must show that the dust event was a "natural event," where windblown dust came from natural sources or all significant anthropogenic sources of windblown dust had been reasonably controlled using best available control measures (BACM) (EPA, 2016). Further, air agencies must show that the event met the high-wind threshold of a sustained wind speed of 25-mph or more, or an alternative area-specific high-wind threshold. The high-wind threshold is the minimum wind speed capable of causing particulate matter emissions from natural, undisturbed lands. If the 25-mph wind speed threshold was not met, a more detailed analysis is necessary to support the "not reasonably controlled or preventable" criterion. The winds causing the PM_{10} exceedance on April 11, 2022, met the 25-mph sustained wind speed threshold in Clark County and the Mojave Desert dust source region.

2.1.2 Requirements for Demonstration Based on Tier

The EPA "Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Influenced by High Wind Dust Events Under the 2016 Exceptional Events Rule" (EPA, 2019) describes a three-tier analysis approach to determine a "clear causal relationship" for exceptional events demonstrations. A summary of analysis requirements for each tier is listed in **Tier 3** analysis is necessary when the impacts of a dust event on PM10 levels are more complicated than the conditions described in the first two Tiers. Tier 3 analysis is needed when sustained winds do not meet the 25-mph threshold and may require additional analysis methods, such as the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model trajectories from the source area or source-specific emissions inventories.

Table 2.1-1.

- Tier 1 analysis is applicable when the exceptional event is associated with a large-scale dust storm where recorded visibility is ≤ 0.5 miles, sustained winds are ≥ 40 mph, and is a focus of a Dust Storm Warning.
- Tier 2 analysis is applicable when the impacts of the dust event on PM_{10} levels are less clear and require more supportive documentation than a Tier 1 analysis. Tier 2 analysis is warranted when sustained winds are ≥ 25 mph, but the event does not meet the other thresholds required in a Tier 1 analysis.
- Tier 3 analysis is necessary when the impacts of a dust event on PM_{10} levels are more complicated than the conditions described in the first two Tiers. Tier 3 analysis is needed when sustained winds do not meet the 25-mph threshold and may require additional analysis methods, such as the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model trajectories from the source area or source-specific emissions inventories.

Table 2.1-1. High-wind PM_{10} exceptional event guidance requirements by tier.

Tier	Requirements
1	• Referred to as "Large-Scale, High-Energy, High Wind Dust Events." • Does not need justification to support the "not reasonably controllable or preventable" (nRCP) criterion. • To satisfy the nRCP criterion, exceedance(s) must be associated with: - A dust storm that is the focus of a Dust Storm Warning. - Sustained winds ≥ 40 mph. - Reduced visibility ≤ 0.5 miles. • Must occur over a "large geographic area."
2	• Referred to as "High Wind Dust Events with Sustained Winds at or above the High Wind Threshold." • Does not meet criteria for Tier 1 high-wind dust events. • High-wind threshold: - Default of ≥ 25 mph for certain states. - Measured as "at least one full hour in which the hourly average wind speed was at or above the area specific high wind threshold;" EPA will consider shorter averaging times as part of the weight-of-evidence demonstration, even if the hourly average was not above the threshold. • Must conduct a controls analysis for events where the dust source was anthropogenic: - Identify anthropogenic and natural sources. - Document whether a SIP, FIP, or other control measures addresses the event-related pollutant and all sources. - Confirm effective implementation of control measures.
3	• Referred to as "High Wind Dust Events with Sustained Winds less than the High Wind Threshold." • Sustained winds did not meet the threshold (i.e., sustained winds ≤ 25 mph). • Requirements same as Tier 2, except with the addition of the following possible analyses: - HYSPLIT trajectories of the source area. - Source-specific emissions inventories. - Meteorological and chemical transport modeling. - PM chemical speciation analysis where filter-based monitors are used.

2.1.3 Demonstration Outline

The PM_{10} exceedance on April 11, 2022 qualifies for Tier 2 analysis since it is a high-wind dust event with sustained winds at or above the high-wind threshold. To be designated a Tier 2 event, wind speeds must meet the sustained-wind threshold of 25 mph. On April 11, 2022, sustained wind speeds in the Mojave Desert source region were significantly higher than the 25-mph threshold.

Table 2.1-2 provides a breakdown by section of all required analyses for the High Wind Exceptional Event. Sections 3.1-3.3 discuss the high wind event in detail, including a meteorological analysis (Section 3.1), the timeline of the high wind dust event (Section 3.2), and evidence of the high wind dust event observed at the surface (Section 3.3). This includes media coverage of and ground images during the event (Sections 3.3.2 and 3.3.5 respectively). Guidance for a Tier 2 analysis recommends a controls analysis when the dust source is not anthropogenic. **Section Error! Reference source not found.** identifies anthropogenic and natural sources of dust. Section 2.2.1 and 2.2.2 discuss the source of dust for the event on April 11, which was natural, undisturbed lands southwest of Las Vegas, including an analysis of climatological factors that contributed to conditions that resulted in lofted dust. Sections 2.2.3 and 4.1 identify regional emissions and other sources of PM_{10}, and Section 4 identifies control measures for PM_{10} emissions that exist in Clark County.

Table 2.1-2. Analysis elements required for a Tier 2 and 3 High Wind Exceptional Event by section in this report.

Tier	Elements	Section of This Report (Analysis Type)
2	High Wind Dust Event	Section 3 (Clear Causal Relationship)
	Sustained Wind Threshold	Section 3.1.1 (Meteorological Analysis) and 3.2.2 (High Wind Event Timeline)
	Controls Analysis for Dust Source	Section 2.2.3 (Regional Emissions of PM_{10}), Section 4.1 (Other Possible Source of PM_{10} in Clark County), Section 4.2 (PM_{10} Control Measures in Clark County), Section 4.3 (Reasonableness of Control Measures), and Section 4.4 (Effective Implementation of Control Measures)
3	HYSPLIT trajectories of source area	Section 3.2 (Transport to Clark County)
	Source-specific emissions inventories	Section 2.2.3 (Regional Emissions of PM_{10})
	Meteorological and chemical transport modeling	Section 3.1.1 (Meteorological Analysis)
	PM chemical speciation analysis where filter-based monitors are used	Section 3.3.4 (Particulate Matter Analysis)

Following the EPA's exceptional event guidance, we performed Tier 2 and Tier 3 analyses to show the "clear causal relationship" between the high wind dust event and the PM_{10} exceedance event in Clark County, Nevada, on April 11, 2022. Focusing on characterizing the meteorology; source region terrain and climatology; dust transport; and air quality on the days leading up to the event, we conducted the following analyses. The results are presented in Section 3:

- Performed a top-down meteorological analysis to trace the conditions between the surface and 250 mb that led to the high wind event in southern Nevada,
- Compiled maps and imagery of suspended dust and regional wind speed from satellite data,
- Showed the transport patterns via HYSPLIT modeling, and identified where the back trajectory air mass intersected with dust sources,
- Compared the timeline of meteorological events, high wind speeds, and enhanced PM_{10} concentrations,
- Tracked surface meteorological conditions along the transport path between the source region and Clark County,
- Compiled media coverage of the high wind dust event and ground-based visibility imagery during the event,
- Examined speciated particulate matter concentrations during the event,
- Compared diurnal patterns of PM_{10} during the event to historical measurements,
- Performed meteorologically similar day analysis to assess PM_{10} concentrations on days with comparable meteorology and wind conditions.

2.1.4 Regulatory Significance

The high wind dust event that occurred on April 11, 2022 caused 24-hour PM_{10} NAAQS exceedances with regulatory significance at Paul Meyer (Monitor AQS ID 32-003-0043, POC 1), Mountains Edge (Monitor AQS ID 32-003-0044, POC 1), Walter Johnson (Monitor AQS ID 32-003-0071, POC 1), Palo Verde (Monitor AQS ID 32-003-0073, POC 1), Joe Neal (Monitor AQS ID 32-003-0075, POC 1), Green Valley (Monitor AQS ID 32-003-0298, POC 1), Liberty High School (Monitor AQS ID 32-003-0299, POC 1), Jerome Mack (Monitor AQS ID 32-003-0540, POC 1), Sunrise Acres (Monitor AQS ID 32-003-0561 POC 1), and Walnut Community Center (Monitor AQS ID 32-003-2003, POC 1). The 24-hour PM_{10} exceedance values are listed in Table 2.1-3.

Table 2.1-3. The 24-hour PM_{10} concentrations for sites that exceeded the NAAQS on April 11, 2022.

Monitor AQS ID	Site Name	24-hour PM_{10} Exceedance Concentration (µg/m^3)
32-003-0043	Paul Meyer	335
32-003-0044	Mountains Edge	259
32-003-0071	Walter Johnson	341
32-003-0073	Palo Verde	333
32-003-0075	Joe Neal	359
32-003-0298	Green Valley	340
32-003-0299	Liberty High School	365
32-003-0540	Jerome Mack	300
32-003-0561	Sunrise Acres	367
32-003-2003	Walnut Community Center	396

A NAAQS exceedance that is approved by the EPA as an exceptional event may be excluded from regulatory examination under the Exceptional Events Rule. Seven additional suspected wind-blown dust events occurred in Clark County between 2021 and 2023. Table 2.1-4 shows the 2021-2023 design values at each of these 10 monitoring sites with and without EPA concurrence on proposed exceptional PM_{10} events between 2021 and 2023.

Table 2.1-4. 2021-2023 design values at monitoring sites in the Las Vegas Valley without and with EPA concurrence that the April 11, 2022, and other suspected events qualify as exceptional events.

Monitor Site Name	Design Value Without EPA Concurrence	Design Value With EPA Concurrence
Paul Meyer	2.0	0.0
Mountains Edge	1.7	0.3
Walter Johnson	2.3	0.3
Palo Verde	1.7	0.0
Joe Neal	2.3	0.3
Green Valley	2.7	0.0
Liberty High School	3.0	0.3
Jerome Mack	3.7	0.3
Sunrise Acres	3.0	0.3
Walnut Community Center	4.0	1.0

Further details on the design values with and without concurrence, as well as data completeness, may be found in the Initial Notification Summary Information (INI) submitted by Clark County, DES to EPA Region 9 on February 12, 2024.

We request that the EPA evaluate the following assessment of the wind-blown dust event that occurred in Clark County on April 11, 2022, and agree to exclude the event from regulatory decisions regarding PM_{10} attainment.

2.2 Historical Non-Event Model

2.2.1 Land Type for Source Region and Clark County

Land use and cover type data from both the 2019 National Land Cover Database (NLCD) (Dewitz, 2021) and Sentinel-2 satellite are shown for the approximate source region of the Mojave Desert in southeastern California (Figure 2.2-1). The primary land classifications, shown by the Sentinel-2 Land Use/Land Cover map, in this region are bare ground and rangeland, with small pockets of forest and built area. Bare ground is defined as "areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with little to no vegetation." Rangeland is defined as "open areas covered in homogenous grasses with little to no taller vegetation; wild cereals and grasses with no obvious human plotting." The primary classifications shown by the 2019 NLCD map are mostly shrub/scrub, grasslands/herbaceous, and barren land (rock/sand/clay). Classifications from both maps indicate that the source region is primarily land with little to no vegetation cover and with natural sources of dust which are predisposed to high wind events.

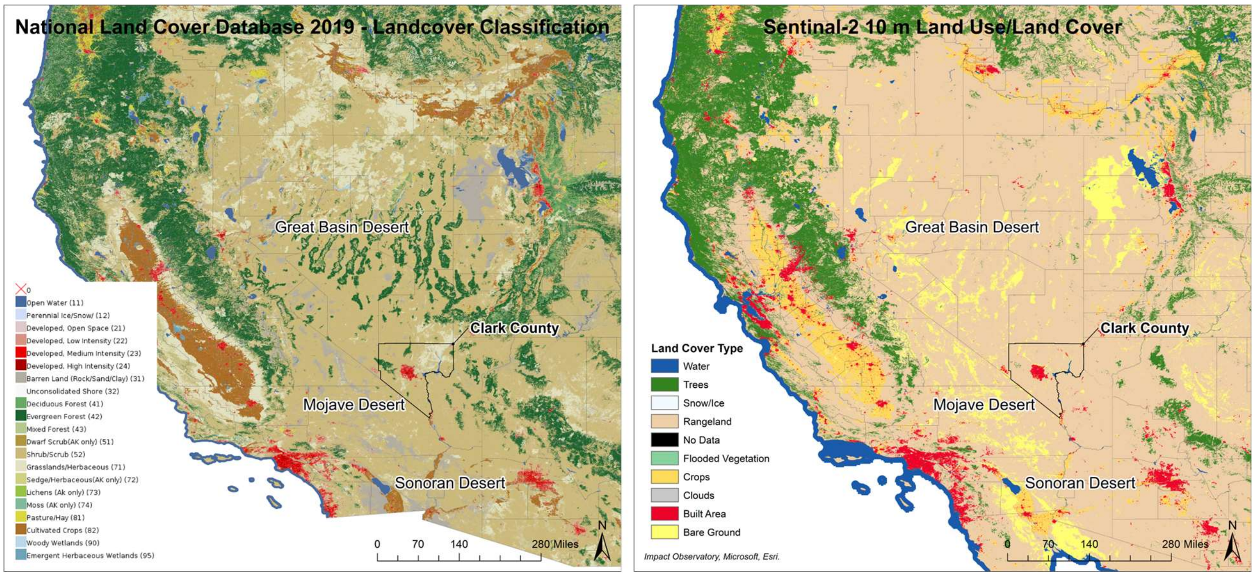

Figure 2.2-1. Land cover type for the western U.S. from (left) the National Land Cover Database-2019 and (right) Sentinel-2 satellite.

Figure 2.2-2 shows the land use and cover of Clark County and the surrounding area. The dominant land cover type in Clark County and the surrounding area is rangeland with pockets of bare ground and built area. Built area is defined as "human made structures; major road and rail networks; large homogenous impervious surfaces including parking structures, office buildings, and residential housing." Central Clark County (i.e., Las Vegas and surrounding communities) is mostly classified as built area with some small areas of bare ground, surrounded by rangeland.

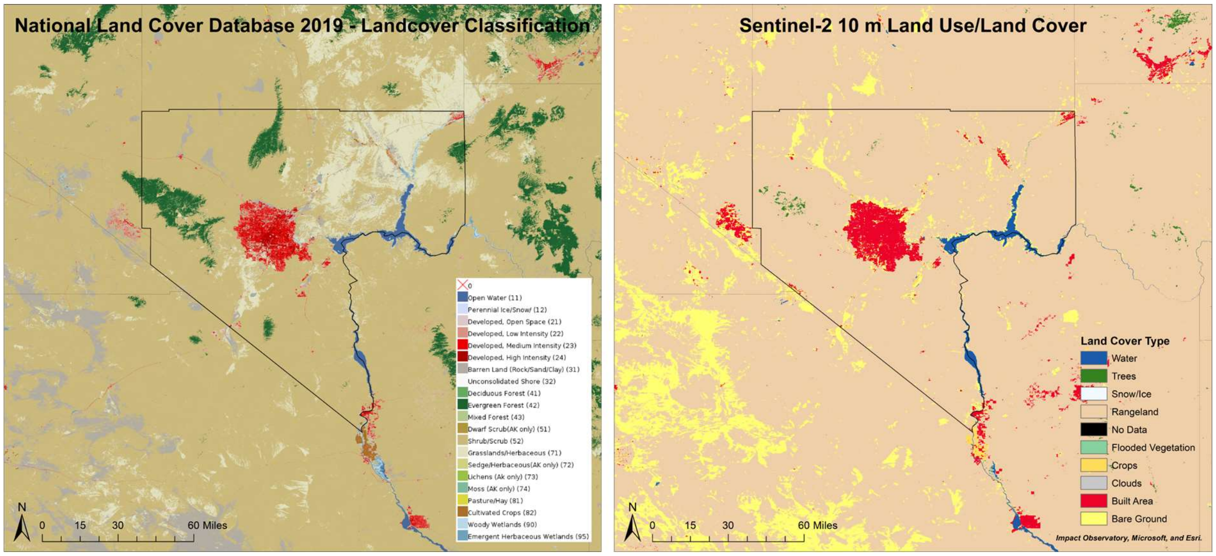

Figure 2.2-2. Land cover type for Clark County, Nevada and surrounding area from the (left) the National Land Cover Database-2019 and (right) Sentinel-2 satellite.

2.2.2 Climatology for Source Region and Clark County

The source region is the Mojave Desert in southeastern California. The Mojave Desert is part of the Mojave Basin and Range Ecoregion, which is located primarily in southern California and southern Nevada (including Clark County), with smaller portions in Arizona and Utah (Sleeter and Raumann, 2012). In general, the roughly 130,000 km^2 ecoregion is composed of broad basins and scattered mountains that are generally lower, warmer, and drier than those of the Central Basin and Range (which border the ecoregion to the north and covers the majority of Nevada). The ecoregion climate is characterized by high temperatures during summer months and very little annual precipitation (50–250 mm) in the valleys. In addition to the Mojave Desert, the ecoregion includes other desert areas in southeastern California and southern Nevada. The Mojave Desert is the driest of the deserts that comprise the greater North American Desert. This is due in part to the presence of the Sierra Nevada Mountain ranges to the west, which produce a rain shadow effect that inhibits significant moisture from reaching the Desert. Additionally, heavy use of off-road vehicles and motorcycles in some areas has made the soils susceptible to wind and water erosion (Griffith et al. 2016)[1].

Clark County is located in the southern portion of Nevada and borders California and Arizona. Clark County includes the City of Las Vegas, one of the fastest growing metropolitan areas in the United States with a population of approximately 2.2 million (U.S. Census Bureau, 2020). Las Vegas is located in a 1,600 km^2 desert valley basin at 500 to 900 m above sea level (Langford et al., 2015). It is surrounded by the Spring Mountains to the west (3,000 m elevation) and the Sheep Mountain Range to the north (2,500 m elevation). Three mountain ranges comprise the southern end of the valley. The valley floor slopes downward from west to east, which influences surface wind, temperature,

[1] https://pubs.usgs.gov/of/2016/1021/ofr20161021_sheet1.pdf

precipitation, and runoff patterns. The Cajon Pass and I-15 corridor to the east is an important atmospheric transport pathway from the Los Angeles Basin into the Las Vegas Valley (Langford et al., 2015).

The Las Vegas Valley climatology features abundant sunshine and average summer month high temperatures of 34 °C to 40 °C. Because of the mountain barriers to moisture inflow, the region experiences dry conditions year-round with approximately 107 mm of annual precipitation, 22% of which occurs during the summer monsoon season in July through September. The urban heat island effect in Las Vegas during summer leads to large temperature gradients within the valley, with generally cooler temperatures on the eastern side. During the summer season, monsoon moisture brings high humidity and thunderstorms to the region, typically in July and August (National Weather Service Forecast Office, 2020). Winds in the Las Vegas basin tend to be from the southwest during spring and summer (Los Angeles is upwind), while winds in the fall and winter tend to be out of the northwest, with air transported between the neighboring mountain ranges and along the valley.

Compared to the long-term climate record in the Las Vegas Area, in the days leading up to April 11, 2022, there was record or close to record maximum daily temperatures, and the temperature range was above the long-term normal.. Concurrently, precipitation accumulation for the Las Vegas Area was below normal by April (**Figure 2.2-3** and **Figure 2.2-4**).

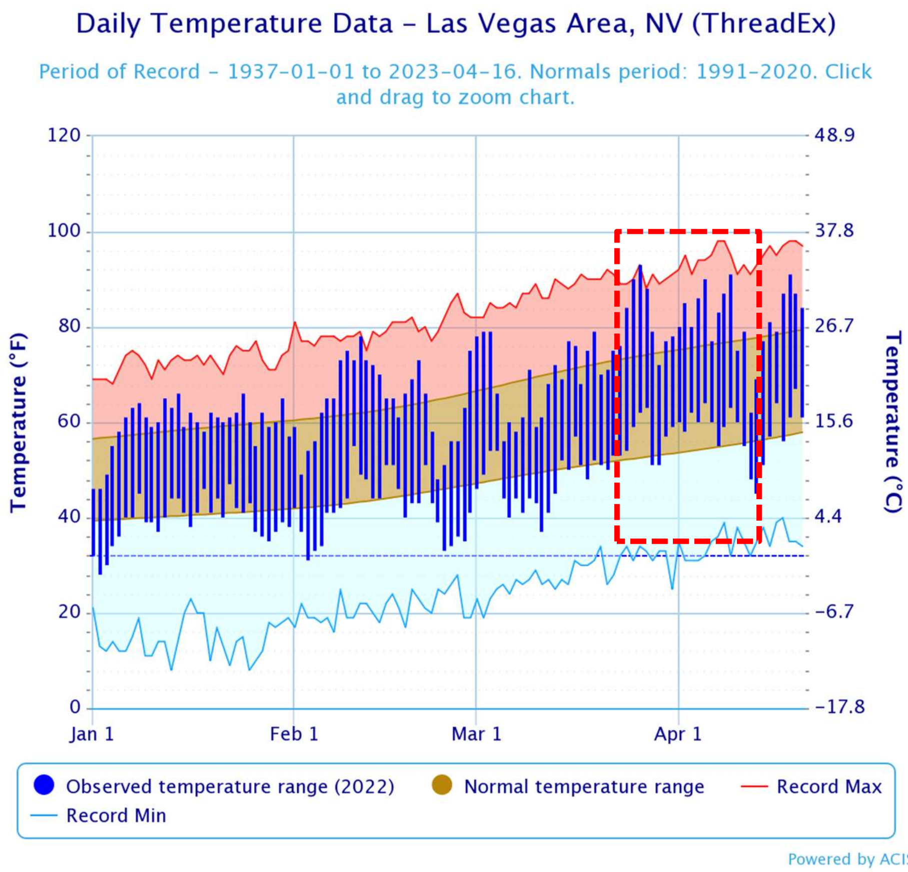

Figure 2.2-3. Las Vegas Area, Nevada temperature records from January 1, 1937 through December 26, 2022 by day including (dark blue) observed temperature range 2022, (brown) normal temperature range, (red) record maximum, (light blue) record minimum. The red box indicates the dates of high and record heat before the April 11, 2022 event. Data from NWS: https://www.weather.gov/wrh/Climate?wfo=vef.

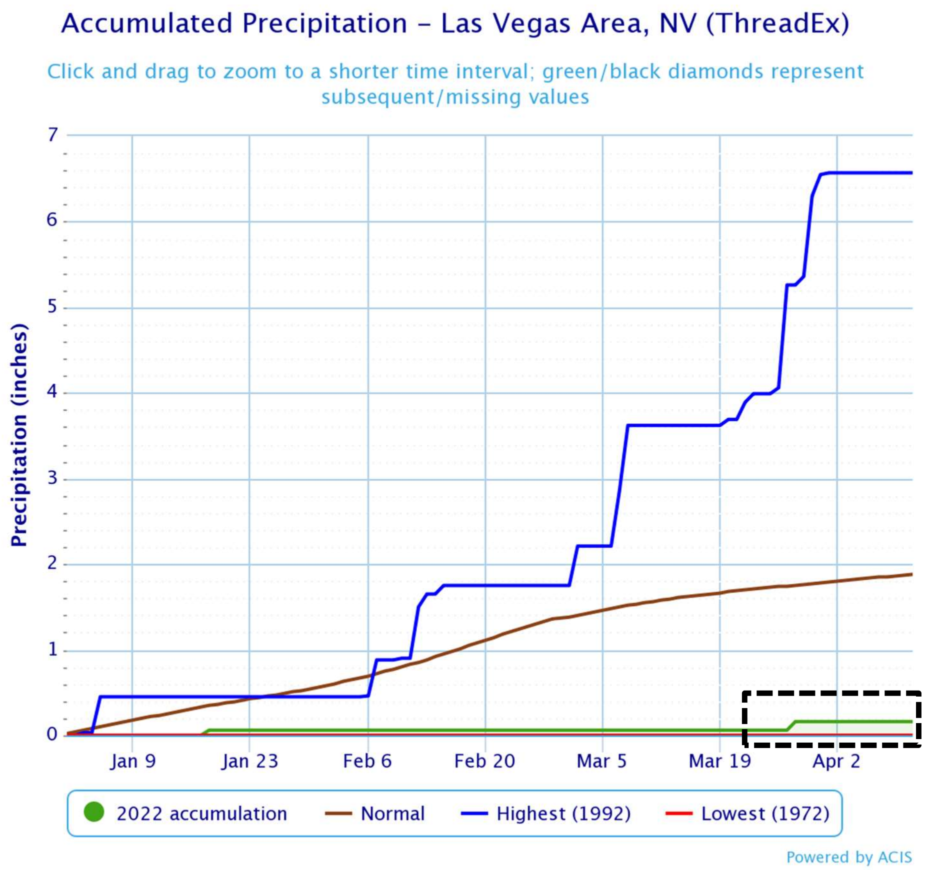

Figure 2.2-4. Las Vegas Area, Nevada precipitation records by day including (green) accumulation in 2022, (brown) normal, (blue) record maximum, (red) record minimum. The black box indicates the period of low accumulated precipitation before the April 11, 2022 event. Data from NWS: https://www.weather.gov/wrh/Climate?wfo=vef.

The extreme hot and dry conditions in 2022 are also highlighted by the Palmer Drought Severity Index (PDSI) produced by the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Protection (NCEP). The western U.S. drought conditions progressively increased in area and severity in the months before the PM_{10} exceedance (**Figure 2.2-5**). By April 2022, all counties in Nevada were classified as moderate to extreme drought.

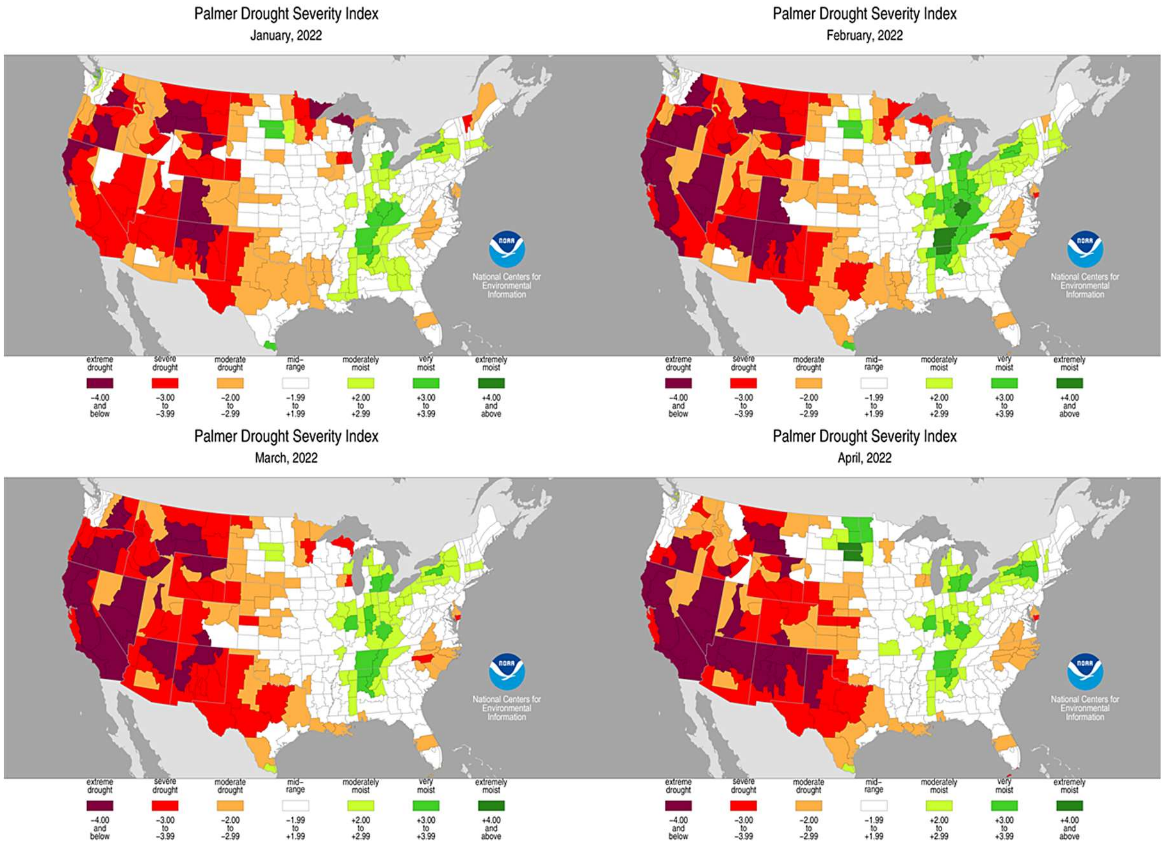

Figure 2.2-5. Palmer Drought Severity Index for January through April 2022.

On April 12, 2022, the western U.S. was under widespread drought conditions (**Figure 2.2-6**). The source region for this event was under moderate to extreme drought (D1 - D4). The western U.S., including Nevada, was under drought conditions which increased in area and severity in the year, months, and week before the PM_{10} exceedance. By April 12th all of Nevada was included in the drought (**Figure 2.2-7**).

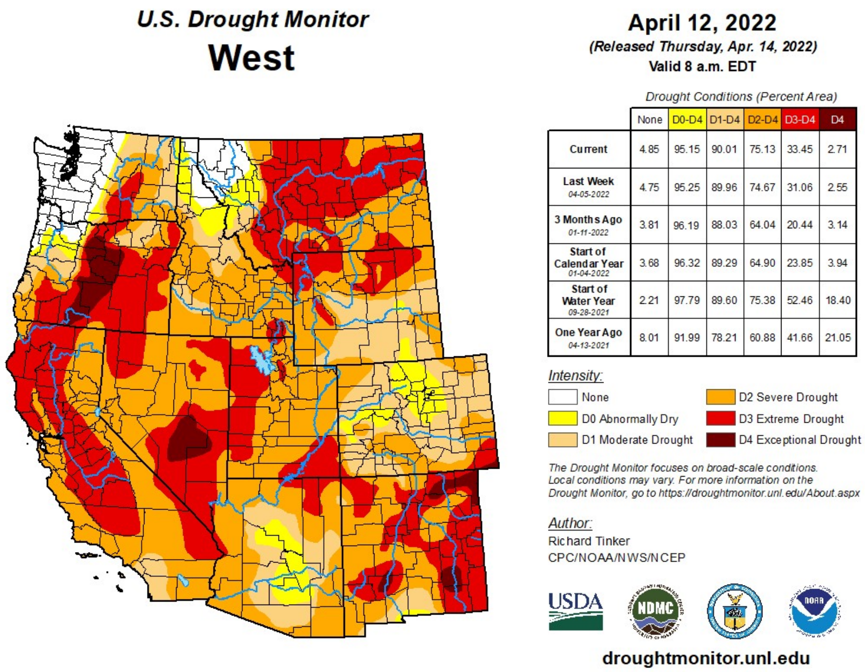

Figure 2.2-6. U.S. Drought Monitor values for the western U.S. on April 12, 2022.

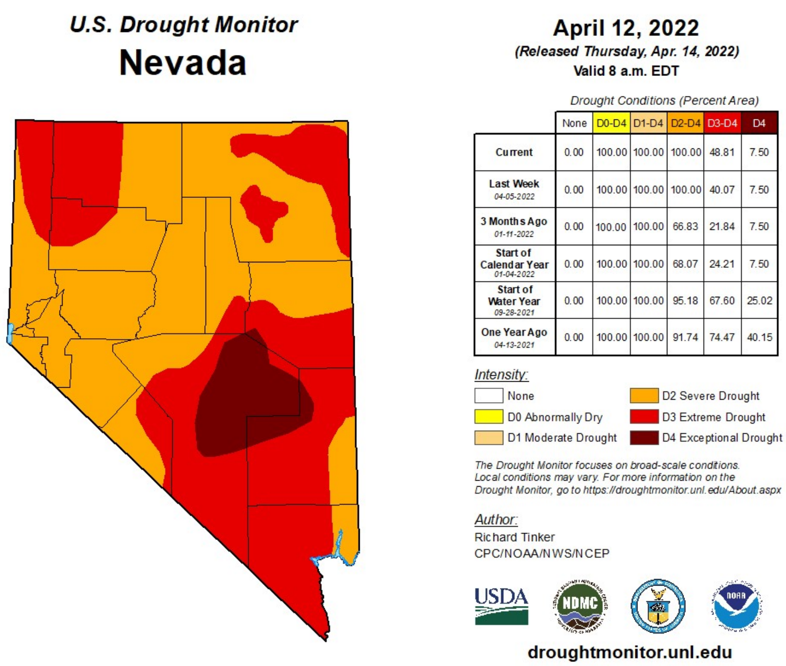

Figure 2.2-7. U.S. Drought Monitor values for the Nevada on April 12, 2022.

There are several Automated Surface Observing Systems (ASOS) weather measurement sites in the wind-blown dust source region with data spanning multiple decades (Figure 2.2-8). Figure 2.2-9 shows the distribution of the maximum daily temperatures at several sites in the wind-blown dust source region on April 10 and 11 (1991 – 2021). The median maximum daily temperature varies in the source region, but ranges from approximately 60 °F to 76 °F.

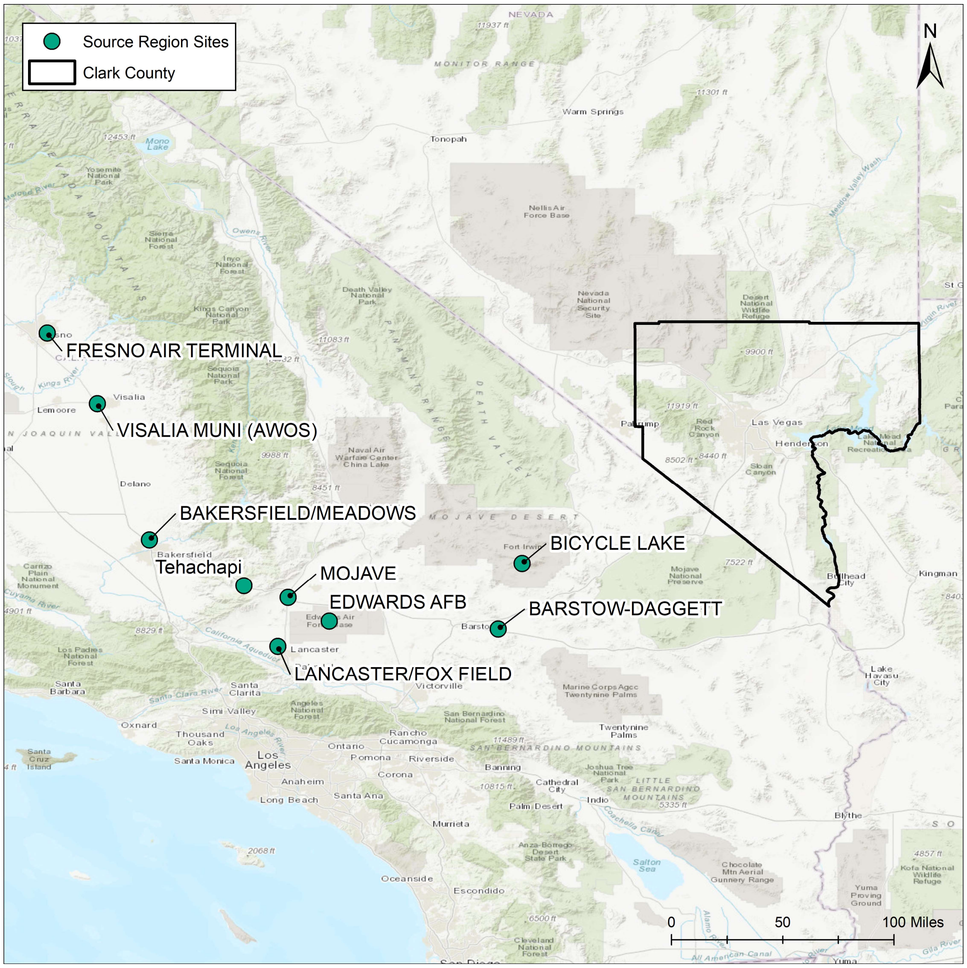

Figure 2.2-8. Location of ASOS measurement sites in the wind-blown dust source region.

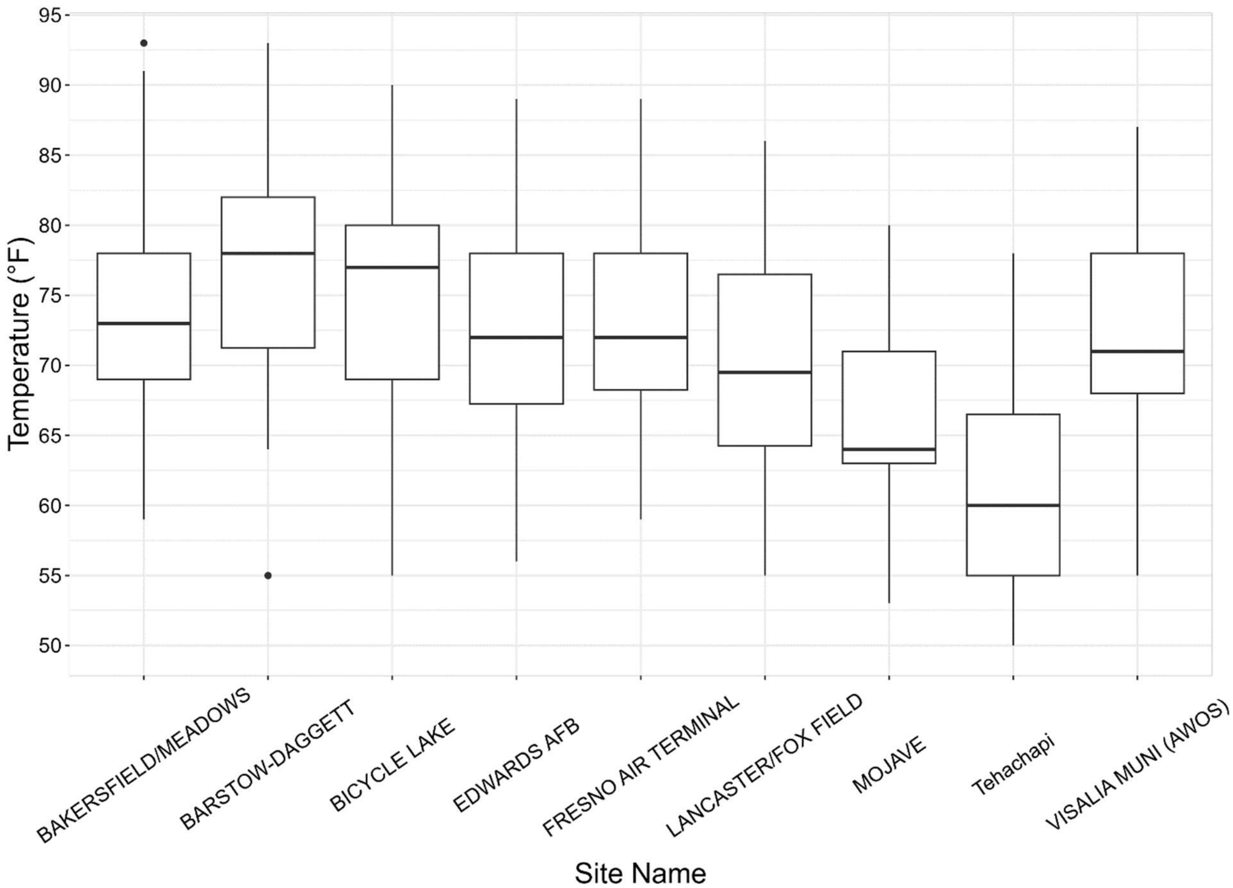

Figure 2.2-9. Maximum daily temperature on April 10 and 11, 2022, compared to 1991-2021 distribution at each measurement site.

2.2.3 Regional Emissions of PM_{10}

Open lands account for approximately 86% of the total area of Clark County (~4.3 million acres), followed by incorporated lands at 8% (~400,000 acres), tribal lands at 1.5% (~80,000 acres), and the remaining planned land use categories at a combined 4.5% (~242,000 acres) (Figure 2.2-10). Open lands and incorporated Clark County largely align with bare ground and rangeland (see Figure 2.2-2), suggesting that dust may have been picked up in Clark County during the high wind event.

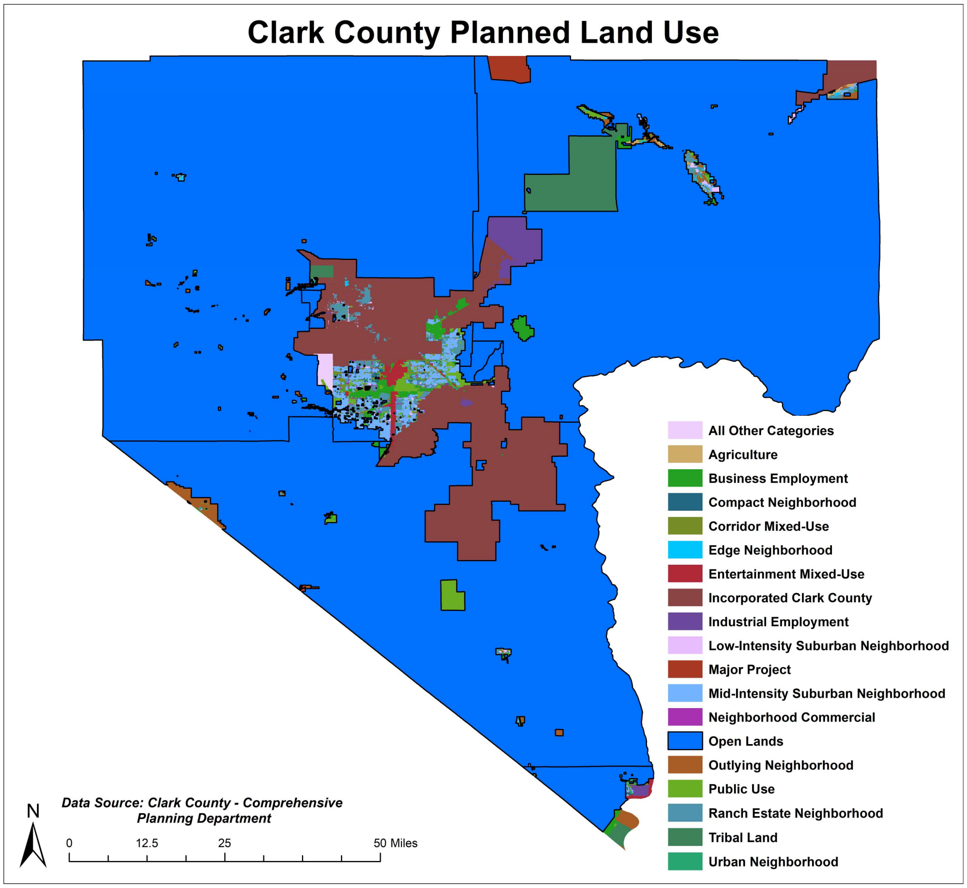

Figure 2.2-10. Planned land use boundaries of Clark County.

Planned land use around the Green Valley site is comprised entirely of incorporated land (Figure 2.2-11). The site is situated at the north, central end of a recreational sports complex. Much of the surrounding area to the north and west of the site is buildings, including baseball fields and single-family homes, and paved surfaces consisting of parking lots and roads, with little exposed dirt or gravel. The sports complex consists of a mixture of dirt and grassy fields, paved surfaces, and patches of trees.

Figure 2.2-11. Planned land use boundaries in the area around the Green Valley station.

Planned land use around the Jerome Mack site is comprised of public use to the west (Jerome Mack Middle School campus), mid-intensity suburban neighborhood to the south, urban neighborhood to the southeast, compact neighborhood to the northeast, and business employment to the north and northwest. An aqueduct borders Jerome Mack immediately to the north (Figure 2.2-12). Much of the surrounding area is buildings and paved surfaces consisting of parking lots and roads, with little exposed dirt or gravel.

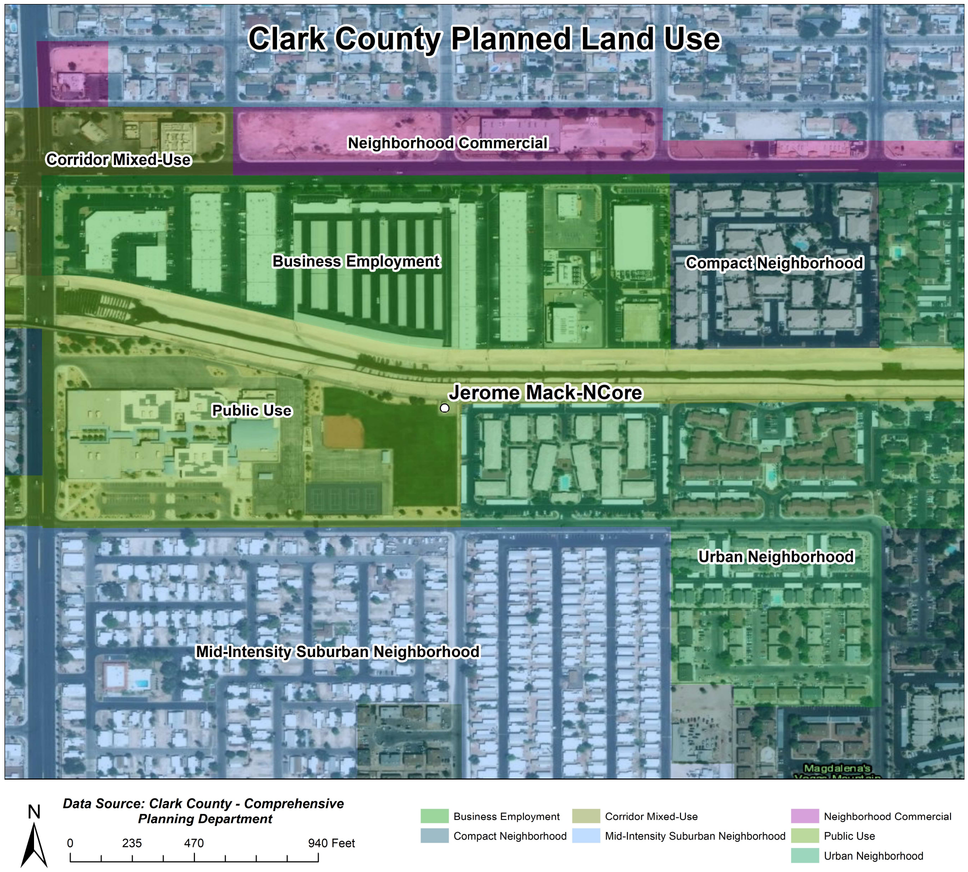

Figure 2.2-12. Planned land use boundaries in the area around the Jerome Mack station.

Planned land use around the Joe Neal site is largely incorporated Clark County, as well as Ranch Estate Neighborhood to the west (Figure 2.2-13). Both uses are largely residential with little exposed dirt or gravel, however vacant lots are visible to the east and southeast of the monitor.

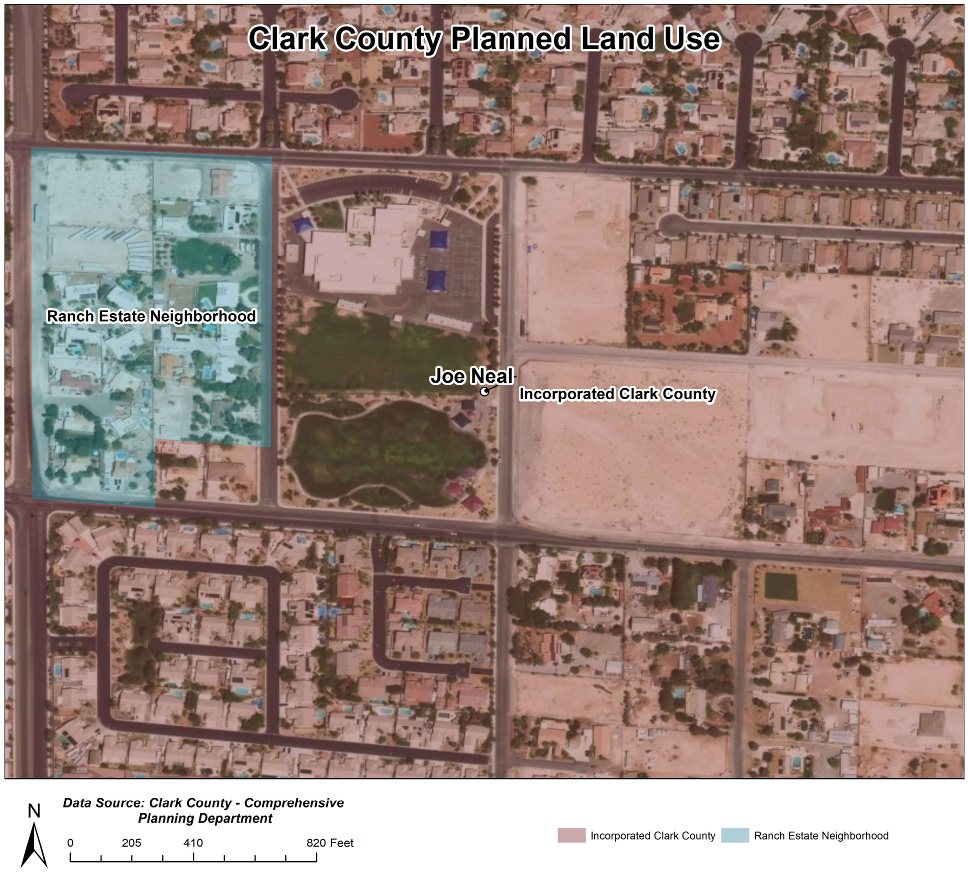

Figure 2.2-13. Planned land use boundaries in the area around the Joe Neal station.

Planned land use around the Liberty High School site is comprised of incorporated Clark County, Ranch Estate neighborhood, neighborhood commercial, and mid-intensity suburban neighborhood to the west, and mid-intensity suburban neighborhood and corridor mixed-use to the east (**Figure 2.2-14**). The Liberty High School site is at the southeastern edge of the Liberty High School campus near a baseball field and bordering a road. With the exception of the baseball field and a small strip of shrubs, grass, dirt, and gravel to the east, the immediate surroundings of the Liberty High School site are mostly paved surfaces with little exposed dirt and gravel.

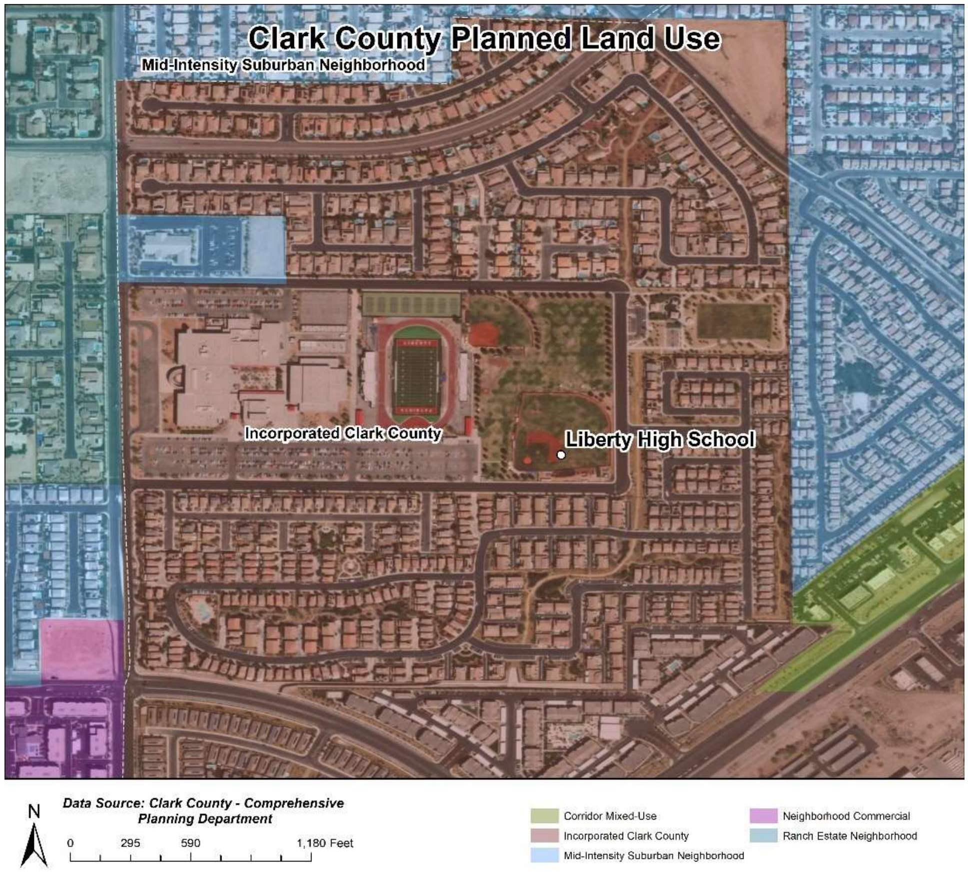

Figure 2.2-14. Planned land use boundaries around the Liberty High School monitoring station.

Planned land use around the Mountains Edge Park site is comprised of open lands to the south and mid-intensity suburban neighborhood to the north (Figure 2.2-15). Corridor mixed-use land exists to the east of the site, but it is largely residential. The Mountains Edge Park site is at the north end of Mountains Edge Regional Park, which consists of open grassy fields, baseball fields, parking lots, and short trees. Open lands outside of the park boundary are undeveloped and mostly dirt and gravel, which may contribute to local dust during high-wind events.

Figure 2.2-15. Planned land use boundaries around the Mountains Edge monitoring station.

Planned land use around the Palo Verde site is comprised entirely of incorporated land (**Figure 2.2-16**). Much of the surrounding area is buildings and paved surfaces consisting of parking lots and roads. The site is approximately one mile east of the 215 highway and has an aqueduct on its southern border. With the exception of baseball fields to the west, there is virtually no area with exposed dirt or gravel.

Figure 2.2-16. Planned land use boundaries in the area around the Palo Verde station.

Planned land use around the Paul Meyer site is comprised entirely of public use and mid-intensity suburban neighborhood (Figure 2.2-17). The site is highly residential, and, with the exception of a neighboring baseball field, there is virtually no area with exposed dirt or gravel.

Figure 2.2-17. Planned land use boundaries in the area around the Paul Meyer station.

Planned land use around the Sunrise Acres site is comprised mostly of incorporated land (**Figure 2.2-18**). Residential areas including compact neighborhood, mid-intensity suburban neighborhood, and commercial neighborhood are also present to the south. Much of the surrounding area is buildings and paved surfaces consisting of parking lots and roads, with little exposed dirt or gravel. A vacant undeveloped lot and a baseball field are present nearby which may contribute to local dust during high wind events.

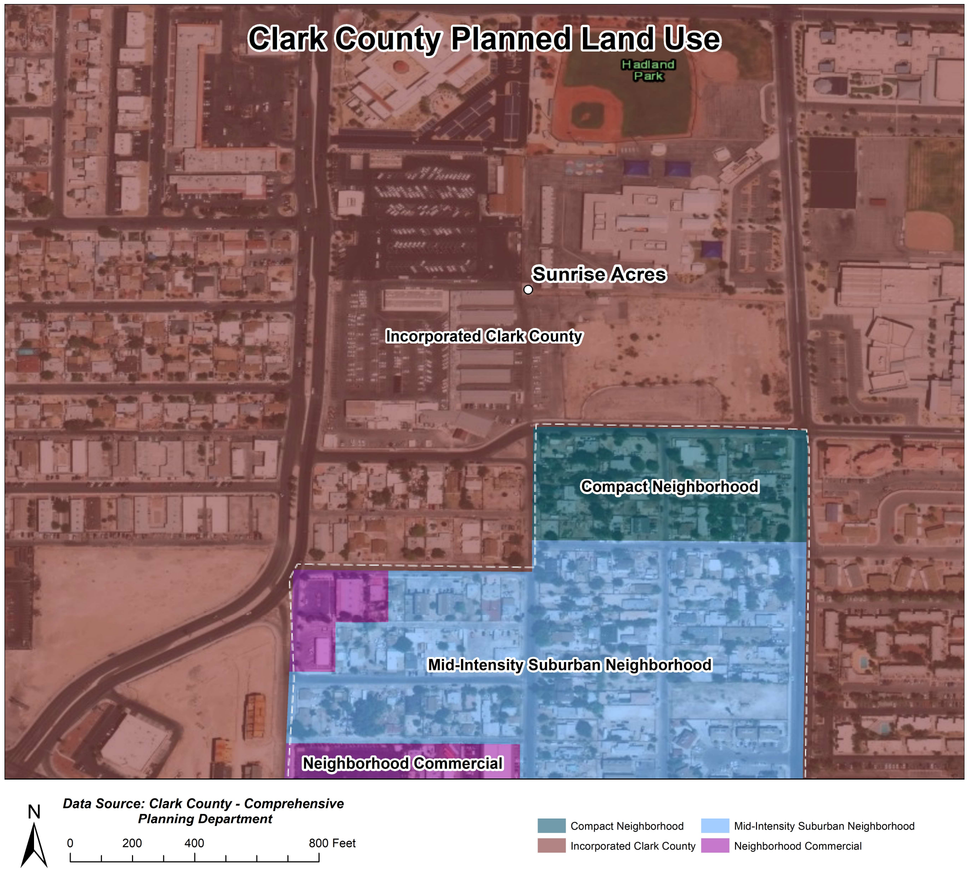

Figure 2.2-18. Planned land use boundaries in the area around the Sunrise Acres station.

Planned land use around the Walnut Community Center site is comprised of public use (Walnut Park) and business employment to the south (Figure 2.2-19). With the exception of grass fields to the west and east, there is virtually no area with grass or exposed dirt or gravel.

Figure 2.2-19. Planned land use boundaries around the Walnut Community Center monitoring station.

Planned land use around the Walter Johnson site is comprised entirely of incorporated Clark County (Figure 2.2-20). The site is highly residential with little exposed dirt or gravel. The site is also neighboring a city park which contains some bare ground.

Figure 2.2-20. Planned land use boundaries in the area around the Walter Johnson station.

Figure 2.2-21 shows the 2020 National Emissions Inventory (NEI) PM_{10} point sources around the affected sites, where the size of the point source marker is proportional to the total annual PM_{10} emissions. The map shows that most sites are not near major point sources. For example, there are no PM_{10} point sources within approximately 2 miles of the Jerome Mack site, and the closest point sources emit less than 3 tons of PM_{10} annually. The Green Valley site is approximately 3 miles from the nearest point sources, which includes 3 sites to the east emitting up to 8-18 tons PM_{10} annually, and 1 site to the north that emits 4-7 tons PM_{10} annually.

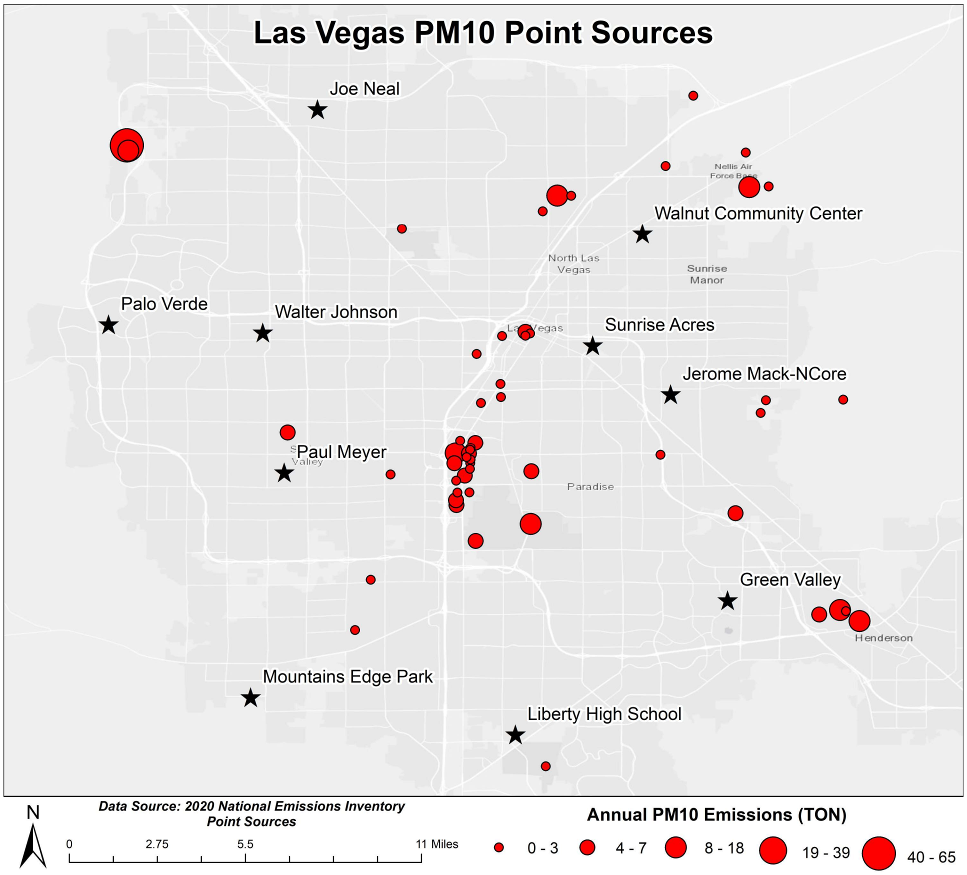

Figure 2.2-21. 2020 Emissions Inventory (NEI) point sources of PM_{10}.

Clark County, Nevada provided information on all PM_{10} emissions as part of the 2012 "Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10})" document. Point sources contributed 0.31% of PM_{10} emissions in 2008 and are projected to contribute 0.59% of PM_{10} emissions in 2023. Given the small contribution of point sources to total PM_{10} emissions and the lack of significant point sources near the sites, it is unlikely that point sources contributed to the April 11, 2022, exceedance.

Nonpoint sources, however, contribute greater than 98% of PM_{10} emissions. The assessment shows a reduction of 31% in total PM_{10} emissions between 2008 and 2023, with notable decreases in the contribution of wind erosion (vacant lands) to total PM_{10} emissions between 2008 and 2023 (Figure 2.2-22). Increasing contributions from construction-related emissions are due to increasing conversion of vacant lands to built area. Therefore, there has been an increasing contribution to total emissions from wind erosion from construction, paved roads, construction, and other sources. As shown in Figure 2.2-11 through Figure 2.2-20, most sites are not near major paved roads. For example, the Jerome Mack site is approximately a quarter of a mile away from a major paved road source (S Lamb Blvd), as is the Green Valley site (N Stephanie St). Thus, paved roads and on-road emissions likely did not contribute to the April 11, exceedance. The Sunrise Acres site is approximately 530 feet from the nearest major paved road source (N Eastern Ave), so these emissions may be more likely to impact this site.

A Dust Advisory and Construction Notice (and Dust Storm Warning) was issued for Monday, April 11, 2022, due to forecasted blowing dust via southwesterly winds from the Mojave Desert. A Dust Advisory and Construction Notice requires construction sites to immediately inspect their construction sites, implement BACM, and avoid blasting activity at threshold wind speeds to mitigate windblown dust. Additionally, during a Dust Advisory, compliance officers will inspect construction and stationary source sites during the dust event to ensure BACM are being implemented, with any violations receiving a Notice of Violation.

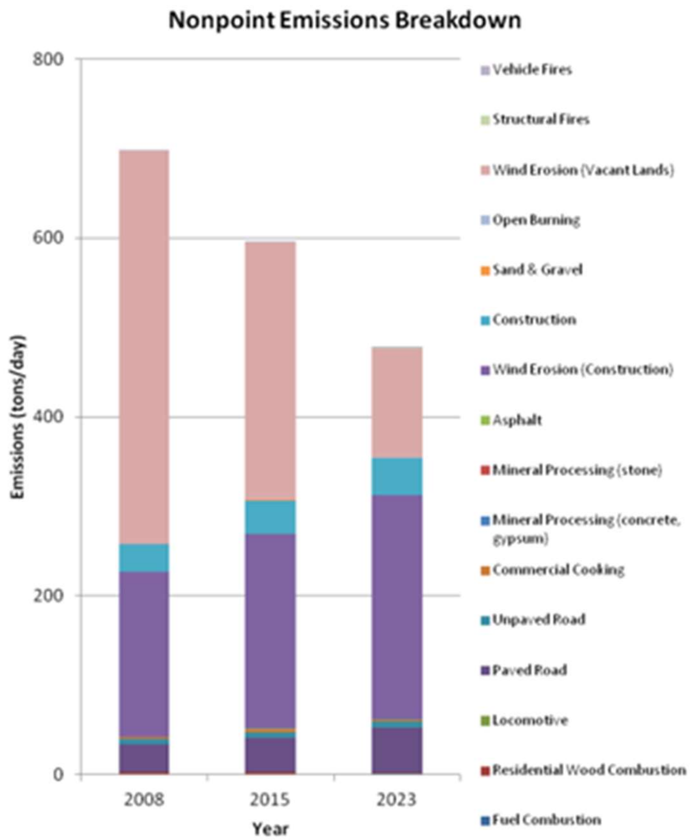

Figure 2.2-22. Nonpoint emissions inventory breakdown from the 2012 'Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10})" document.

2.2.4 Historical Analysis of PM_{10} in Clark County

Table 2.2-1 displays a statistical summary of 24-hour average PM_{10} concentrations from the five years preceding the event (2018-2022) at all sites which exceeded the 24-hour PM_{10} NAAQS in Clark County including Casino Center, Green Valley, Jean, Jerome Mack, Joe Neal, Liberty High School, Mountains Edge Park, Palo Verde, Paul Meyer, Sunrise Acres, Virgin Valley High School, Walnut Community Center, and Walter Johnson. (Although not regulatorily significant, the table includes statistics for Casino Center, Jean, and Virgin Valley High School monitoring sites to examine the regional effect of the high wind dust event.) Note that data collection at four sites did not begin until 2021, thus summary statistics are shown for the data available through December 2022 for these sites. Mean concentrations range from 20 to 42 µg/m^3 and medians range from 16 to 37 µg/m^3.

Table 2.2-1. Five-year* statistical summary of 24-hour average PM_{10} concentration at affected sites, 2018 – 2022. *Sites that began data collection less than 5 years ago are indicated, and statistics were taken for the time data collection began until December 2022, as indicated by the value in the 'count' row.

Statistic ($\mu g/m^3$)	Casino Center*	Green Valley	Jean	Jerome Mack	Joe Neal	Liberty High School*	Mountains Edge Park*	Palo Verde	Paul Meyer	Sunrise Acres	Virgin Valley High School*
Mean	36	25	20	35	28	31	23	20	24	36	23
Median	31	21	16	31	25	26	18	17	21	32	19
Mode	27	20	17	31	26	18	16	15	18	25	14
St. Dev	27	24	18	25	23	32	22	16	19	25	18
Minimum	7	2	1	4	2	2	1	2	3	4	3
95th percentile	70	49	47	66	52	62	47	40	47	72	49
99th percentile	129	108	89	116	85	201	104	67	88	105	104
Maximum	318	586	236	445	513	365	325	333	335	468	200
Range	311	584	235	441	511	363	324	331	332	464	197
Count	303	1820	1795	1790	1813	610	819	1796	1814	1796	714
Exceedances (> 150 $\mu g/m^3$)	3	9	7	13	7	8	5	4	6	11	3

Seasonal and monthly trends in the 24-hour average PM_{10} data for the 5 years preceding the event (2018-2022) are shown in boxplots in Figure 2.2-23 and Figure 2.2-24. The lower and upper edges of the box correspond to the interquartile range (the 25th and 75th percentiles respectively), and the middle bar is the median value. The whiskers extend to the smallest and largest value within 1.5 times the interquartile range. Points beyond this range are considered outlying and have been removed for monthly and seasonal trend clarity (see Section 3.4 for trends including outliers). Interquartile ranges for 24-hour average PM_{10} values have high overlap across seasons, ranging from 11 to 35 µg/m^3 with median values ranging from 17 µg/m^3 in winter to 26 µg/m^3 in summer. In spring, the median value is 20 µg/m^3 and the interquartile range is 14-30 µg/m^3. In April, the interquartile range is 16 – 33 µg/m^3, with a median value of 22 µg/m^3.

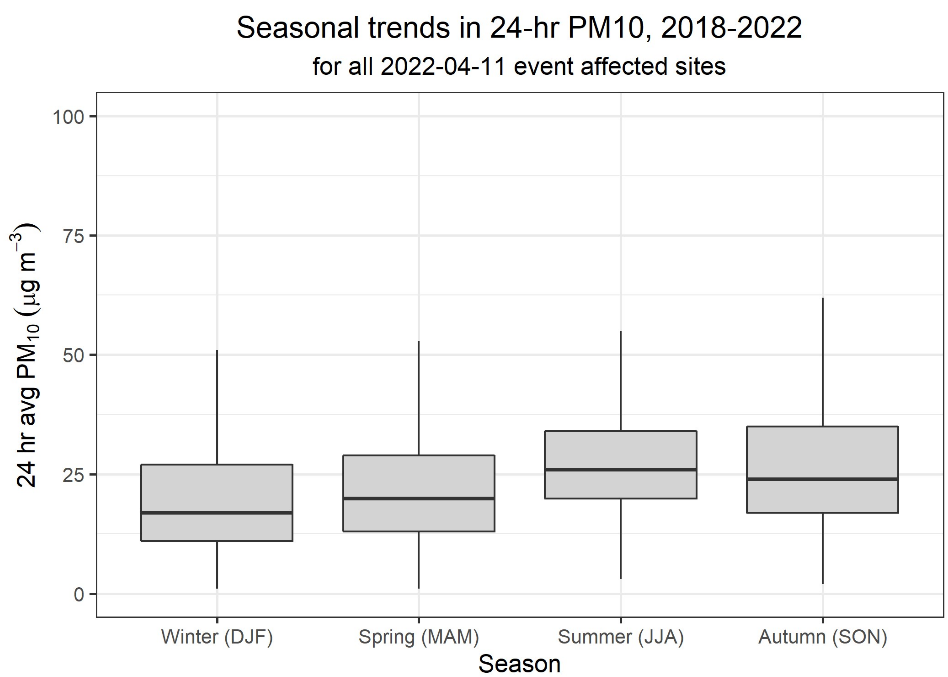

Figure 2.2-23. Seasonal trends in values of PM_{10} from 2018-2022 (outliers have been removed for trend clarity).

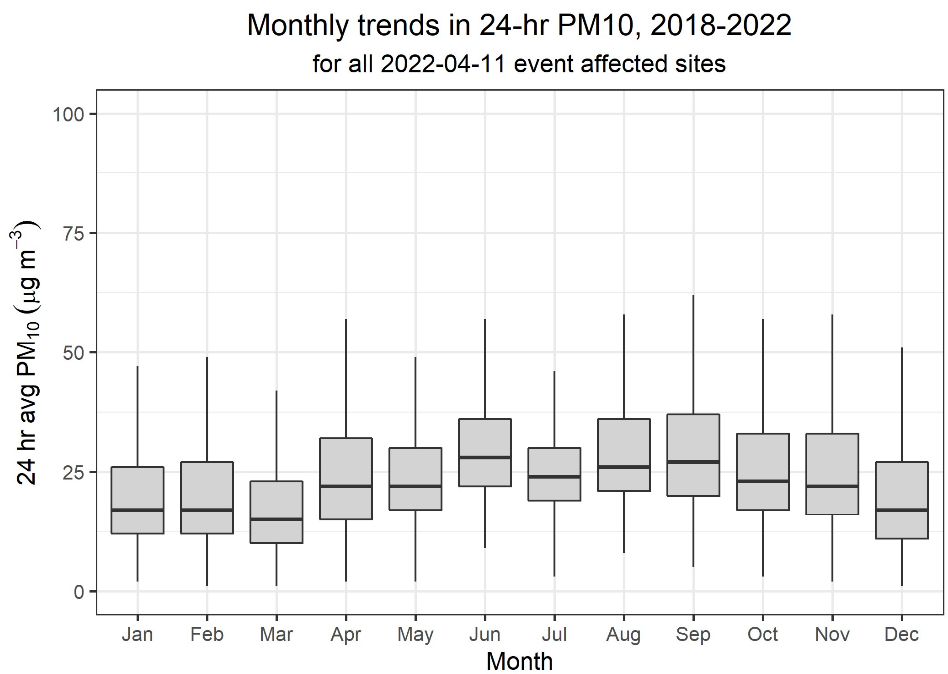

Figure 2.2-24. Monthly trends in values of PM_{10} from 2018-2022 (outliers have been removed for trend clarity).

3. Clear Causal Relationship

During mid-April, a frontal passage through southeastern California and southern Nevada drove a windblown dust event that increased PM_{10} concentrations in Clark County, Nevada on April 11, 2022. Strong sustained winds in the Mojave Desert source region were well above 25 mph (greater than 40 mph). The frontal passage lofted, entrained, and transported dust from the source region to Clark County starting at 10:00-12:00 PST on April 11 and lasting through the end of the day. The severe drought conditions affecting the Mojave Desert in southeastern California, as shown in **Section 2.2**, created an ample source of dust from friable soils. Enhanced hourly average wind speeds up to 25 mph within Clark County coincided with increased PM_{10} concentrations on April 11. The Mojave Desert source region experienced sustained winds speeds above 40 mph, hourly average winds exceeding 25 mph, and (1) transport from the Mojave Desert to Clark County is clearly evident via HYSPLIT, meteorological analyses, and radar images, (2) visibility was greatly reduced in Clark County during the high PM_{10} concentrations, and (3) PM_{10} concentrations were exceptionally outside of typical ranges. Within this section, we provide meteorological evidence of lofting, entrainment, and transport of dust from the dust source region (the Mojave Desert) with the frontal passage, evidence of transport from the source region to Clark County via HYSPLIT trajectory modeling and meteorological analysis, and impacts of the high wind dust event at the surface in Clark County. We also provide additional evidence using statistical and meteorological similar event analysis to compare this dust event with other high PM_{10} days in Clark County.

3.1 High Wind Event Origin

3.1.1 Meteorological Analysis

On April 11, 2022, dust impacted the Las Vegas region from the Mojave Desert, which led to 24-hour average PM_{10} concentrations above the NAAQS threshold at 13 sites through the area (10 regulatorily significant, three non-regulatorily significant). Strong winds in the Mojave Desert region of southeastern California produced dense blowing dust that was transported to the Las Vegas metropolitan area, increasing PM_{10} concentrations starting at 10:00-12:00 PST on April 11, peaking at 13:00-16:00 PST and lasting through the end of the day. All other sites within the Las Vegas Valley experienced enhanced PM_{10} concentrations concurrently with the exceeding sites. Several large-scale meteorological factors led to favorable conditions for blowing dust on this day. To account for these meteorological factors, observation data were analyzed leading up to and during the dust event. The following narrative will discuss the meteorological factors that led to this blowing dust event.

To assess the meteorological conditions leading to poor air quality during this period, observational data were analyzed from the following sources:

- 250-mb heights and winds (approximately 30,000 feet above sea level (ASL)
- 500-mb heights and winds (approximately 18,000 ASL)
- Surface pressure readings, wind measurements, and fronts
- Drought conditions

This meteorological analysis will take a top-down approach, relating the upper-level weather conditions to the corresponding mid-level and surface weather patterns. This analysis will focus on the period between 04:00 PST April 10 and 16:00 PST April 12, 2022.

250-mb Weather Patterns

Upper-level jets are narrow bands of strong winds in the upper levels of the troposphere. In the left-exit region (LER) of a jet, divergence aloft induces upward vertical motion at mid-levels with corresponding decreases in pressure at the surface (Bluestein, 1993). These jet dynamics were a key factor in the blowing dust event that occurred on April 11, 2022, in the Las Vegas region.

Upper-level weather maps at 250 mb on the morning (04:00 PST) of April 10 showed a broad upper-level trough of low pressure extending from the northern Gulf of Alaska across southwestern Canada, Montana, and the Dakotas. A jet streak positioned on the western half of this trough served to deepen the trough and advance it southeastward. At this time, the left-exit region (LER) of the jet streak was positioned just off the Pacific Northwest Coast. By the afternoon of April 10 (16:00 PST), the 250-mb trough had deepened over southwestern Canada, with the LER of the jet streak positioned over northern Oregon.

At 04:00 PST on April 11, the upper-level trough further deepened, and the jet streak intensified with its LER over southeastern Oregon and northern Nevada (**Figure 3.1-1**). By 16:00 PST on April 11, the upper-level trough was at its deepest point, and the trough axis ran north-south through western Nevada. However, with the upper-level jet streak now extending through the bottom of the trough, through Nevada and across northern Utah, the trough would begin to lose strength. The upper-level trough and jet streak gradually weakened on April 12 as the trough slowly advanced east of Nevada.

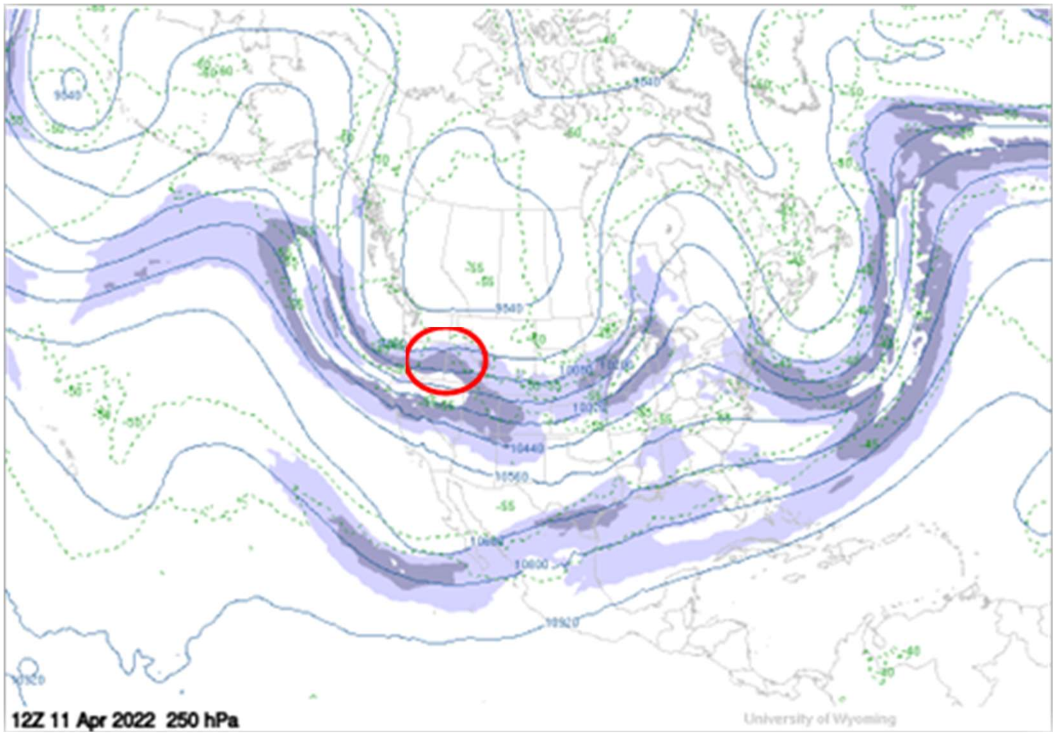

Figure 3.1-1. 250-mb map 04:00 PST April 11, 2022. Jet streak LER circled in red. Source: Univ. of Wyoming.

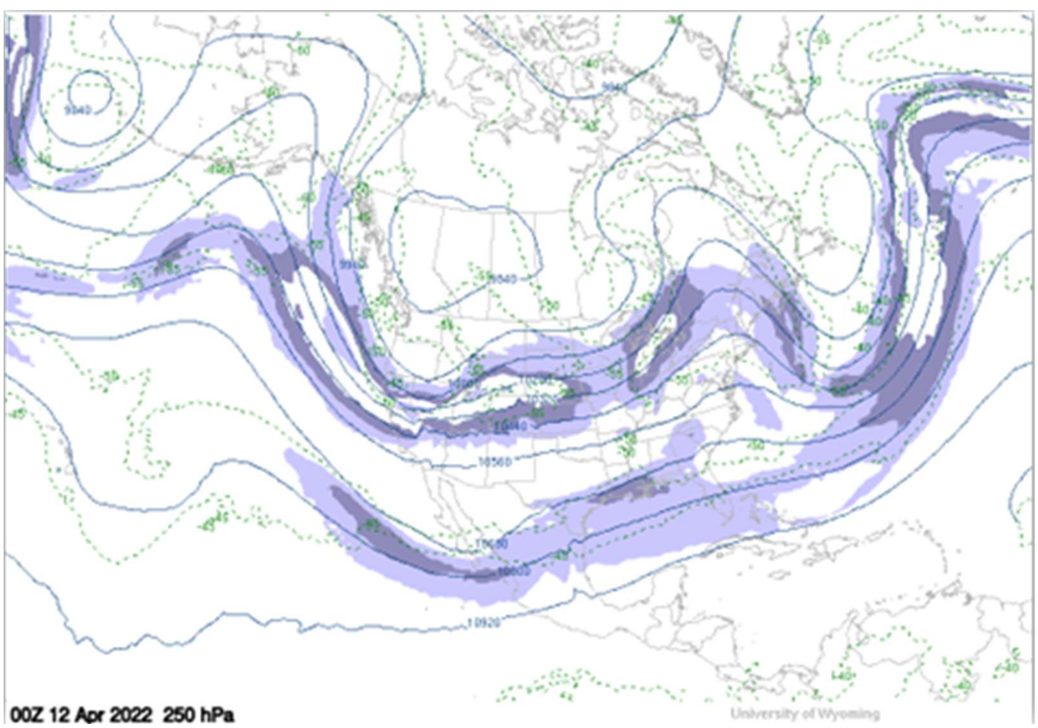

Figure 3.1-2. 250-mb map 16:00 PST April 11, 2022. Trough axis runs north-south through western Nevada, with jet streak extending through the bottom of the trough. Source: Univ. of Wyoming.

As shown in Figure 3.1-1 above, the position of the LER at 04:00 PST on April 11 would have increased upward vertical motion at mid- and lower-levels in the atmosphere, leading to a decrease in surface pressure. Furthermore, the position of the jet streak on the western flank of the trough would intensify the upper-level trough. This deepening of the trough is evident in **Figure 3.1-2**.

500-mb Weather Patterns

The development of a 500-mb trough during this period matches well with the upper-level dynamics described above. At 16:00 PST on April 10, a broad mid-level trough stretched from the British Columbia Coast to the Dakotas. Within this area of low pressure, a short-wave trough was observed over Vancouver Island. At this time, 500-mb heights within this cut-off low were 534 dm.

By 04:00 PST on April 11, with the upper-level jet streak LER positioned over southern Oregon, the 500-mb trough rapidly deepened to 528 dm and advanced southeastward over coastal Oregon and Washington. On the afternoon of April 11 (16:00 PST), the 500-mb trough reached its maximum depth and was positioned directly beneath the 250-mb trough, with its axis also extending north-south through western Nevada (**Figure 3.1-3**).

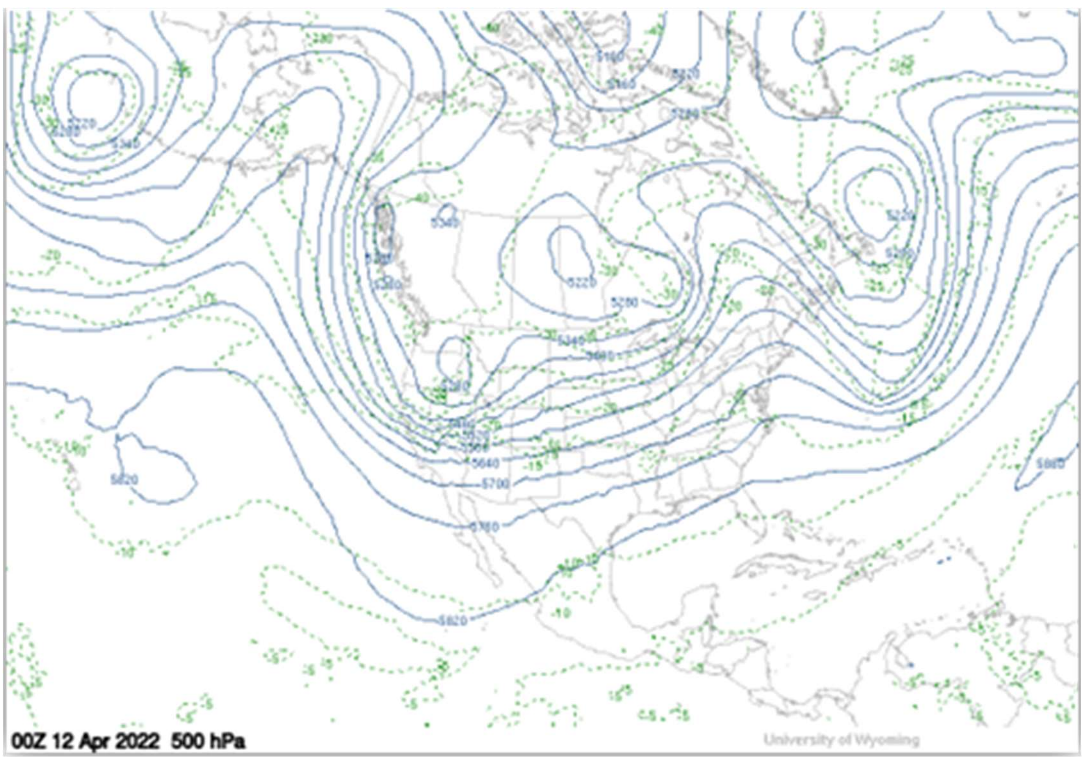

Figure 3.1-3. 500-mb map 16:00 PST April 11, 2022. Trough axis runs north-south through western Nevada. Source: University of Wyoming.

The position of the upper-level and mid-level troughs of low pressure would increase vertical motion in the atmosphere, resulting in deepening surface low pressure.

Surface Weather Patterns

At 16:00 PST on April 10, an area of weak surface low pressure was observed off the Pacific Northwest Coast, with sea level pressure levels of approximately 1012 mb. By 04:00 PST on April 11, as the LER of the upper-level jet streak was positioned over southern Oregon and the 500-mb trough rapidly deepened over the Pacific Northwest Coast, the surface low pressure system also rapidly deepened to 992 mb and moved inland over central Oregon. A trailing surface front was observed extending from this low center southwestward off the northern California coast.

By the afternoon of April 11 (16:00 PST), the surface low had deepened further to 988 mb and had progressed into central Utah. At this time, a surface front extended from the low center across southern Nevada and southern California (Figure 3.1-4). By the following morning (04:00 PST on April 12), the cold front had departed southern Nevada, advancing into northern Arizona.

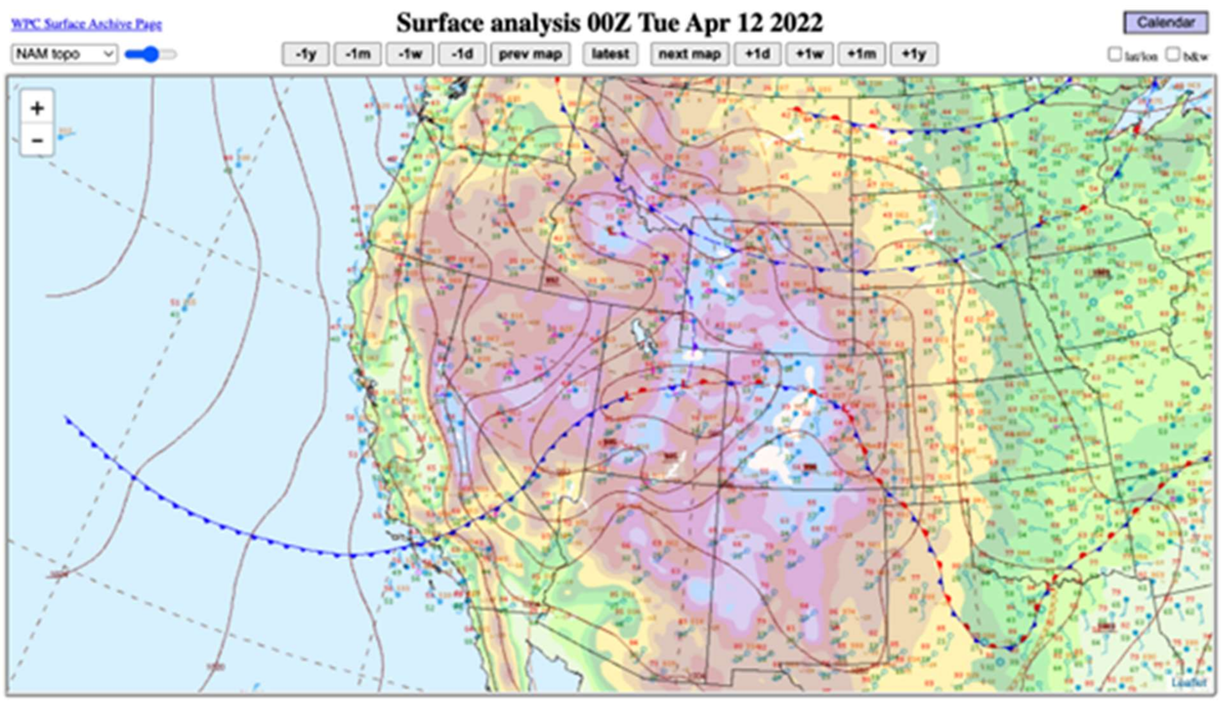

Figure 3.1-4. Surface low pressure system and associated front at 4:00 p.m. PST on April 11, 2022. Source: NOAA's Weather Prediction Center.

As the surface front approached the Las Vegas region, sea level pressure at Harry Reid International Airport (KLAS) dropped from 1003 mb at 04:00 PST on April 11 to 992 mb at 16:00 PST on April 11. With a surface high pressure system off the California Coast, a west-to-east pressure gradient developed across the deserts of eastern California and southern Nevada (Figure 3.1-4). Strong southwesterly winds developed in Las Vegas as a result of the increasing pressure gradient.

Periods of sustained winds of at least 25 mph were observed at KLAS from 15:00 PST on April 11 to 21:00 PST, with peak wind gusts over 50 mph. The KLAS Meteorological Aerodrome Reports

(METARs) also reported reductions in visibility and blowing dust from 12:00 PST until 20:00 PST on April 11. Coinciding with the period of strong winds and observations of blowing dust, hourly PM_{10} concentrations exceeded 1,000 µg/m^3 at six sites in the Las Vegas area between 13:00 PST and 19:00 PST.

During the peak winds of this event, sustained wind speeds over 35 mph were observed not only across the Las Vegas area but also extending westward into the Mojave Desert, where sustained winds over 45 mph were observed (Figure 3.1-5). This broader area of high winds likely produced regional dust in areas upwind of Las Vegas in addition to the dust produced locally in the Las Vegas area.

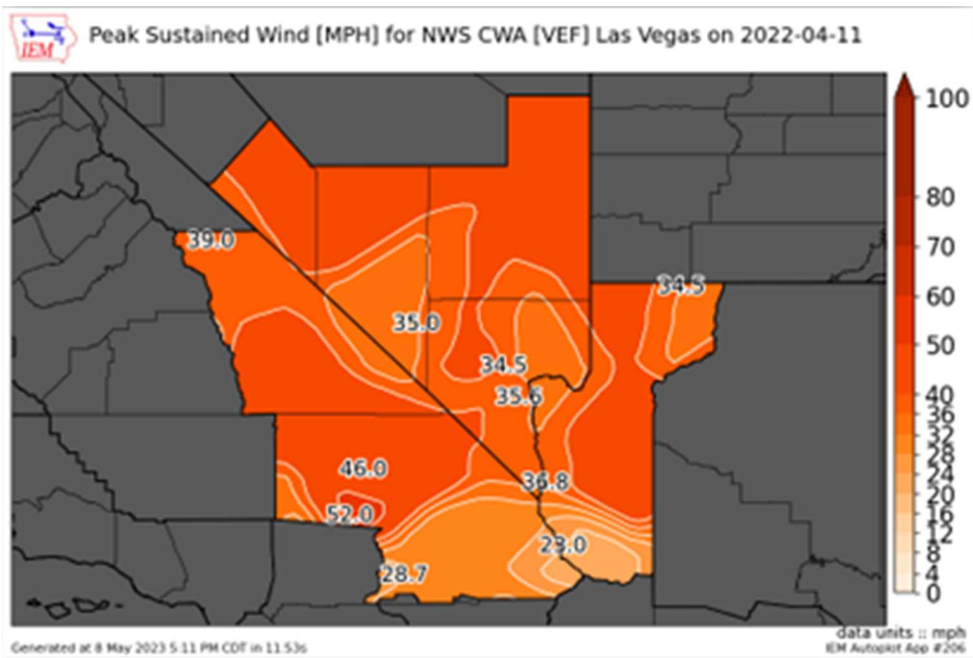

Figure 3.1-5. Peak sustained wind speeds over 35 mph observed across Las Vegas westward into the Mojave Desert. Source: Iowa State University.

Exceedances of the 24-hour NAAQS PM_{10} standard were observed across the same region where the widespread strong winds were observed, with Unhealthy to Very Unhealthy AQI levels observed from Las Vegas to the Mojave Desert (Figure 3.1-6).

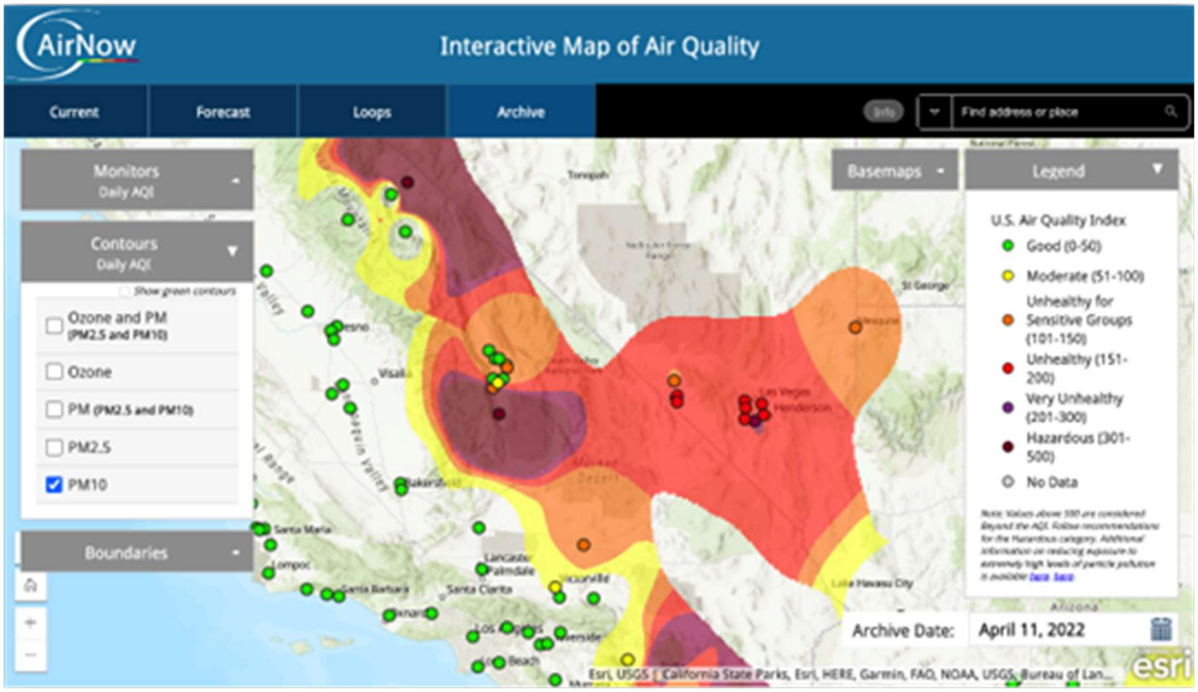

Figure 3.1-6. 24-hour average PM_{10} AQI levels for April 11, 2022. Source: AirNow.

A final factor that set the stage for this windblown dust event was the existence of severe drought conditions across eastern California and southern Nevada (as shown in Section 2.2.2). While soil moisture in this desert region is low on average, soil moisture was below normal due to the drought, making additional loose soil available to be lofted into the atmosphere by the strong winds.

Radar imagery taken during the event period at 0.5◦ tilt is shown in Figure 3.1-7 through Figure 3.1-9. The location of a radar shadow to the west-southwest of the station, a result of mountainous terrain, is noted in the top-left image in each panel. A buildup of airborne dust to the west of Clark County intensifies the radar signature starting at 13:00 PST and reaching a peak between 15:00-17:00 PST. The dust signature is pushed eastward across Clark County by westerly surface winds, and still visible through 21:00 PST.

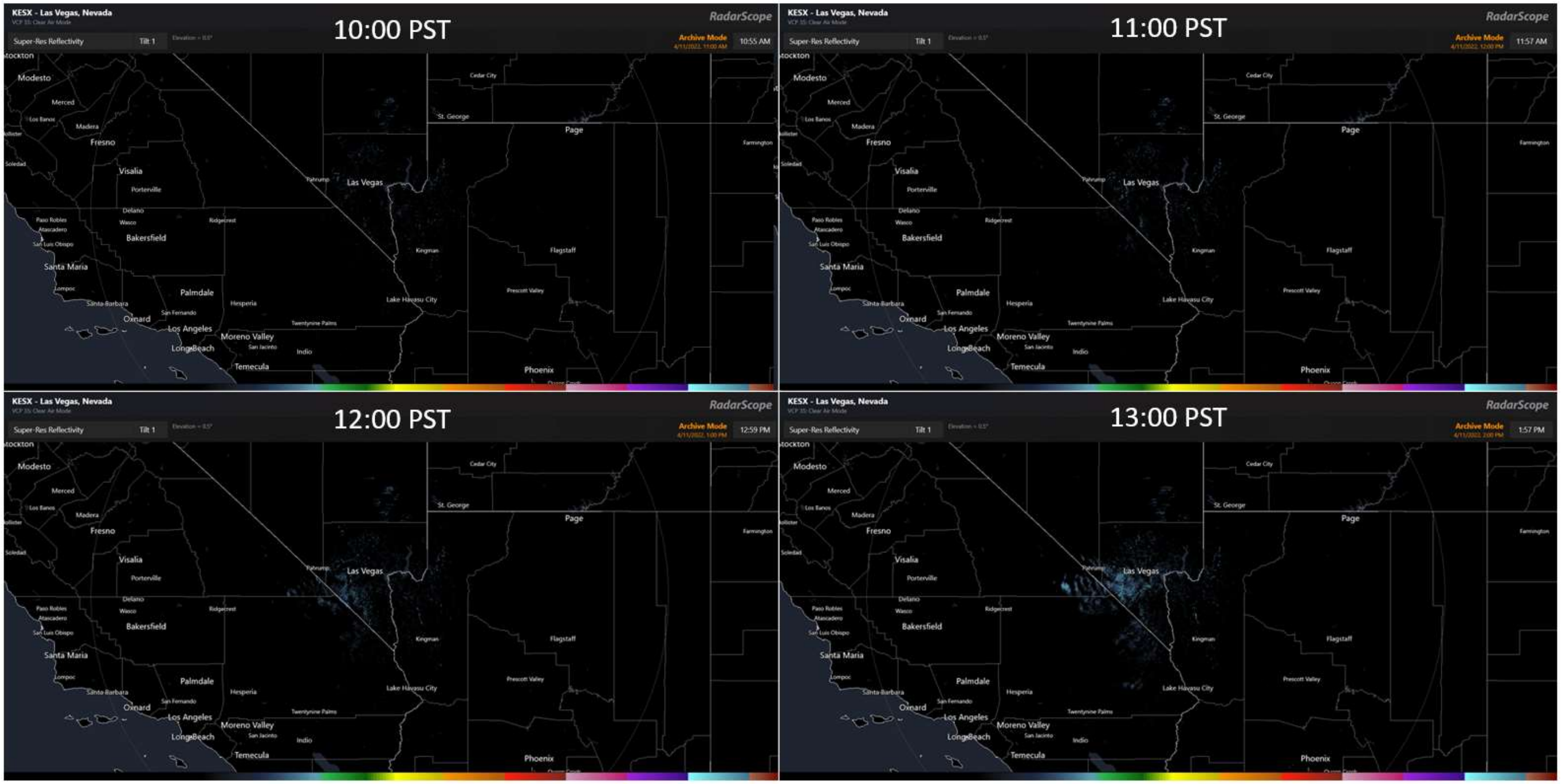

Figure 3.1-7. Doppler radar image, valid 10:00 to 13:00 PST on April 11, 2022 (converted from PDT in top right corner of images). Source: RadarScope

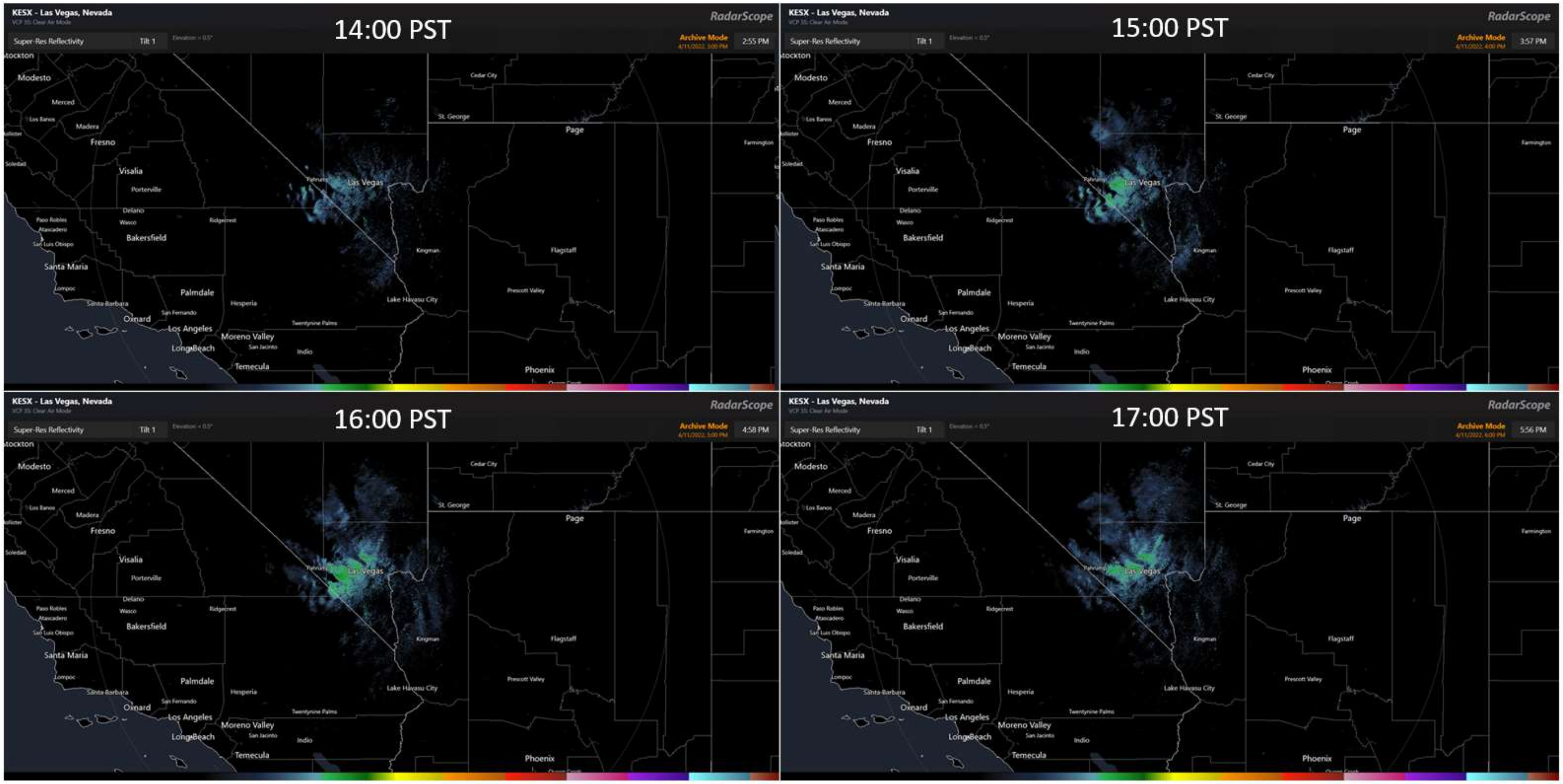

Figure 3.1-8. Doppler radar image, valid 14:00 to 17:00 PST on April 11, 2022 (converted from PDT in top right corner of images). Source: RadarScope

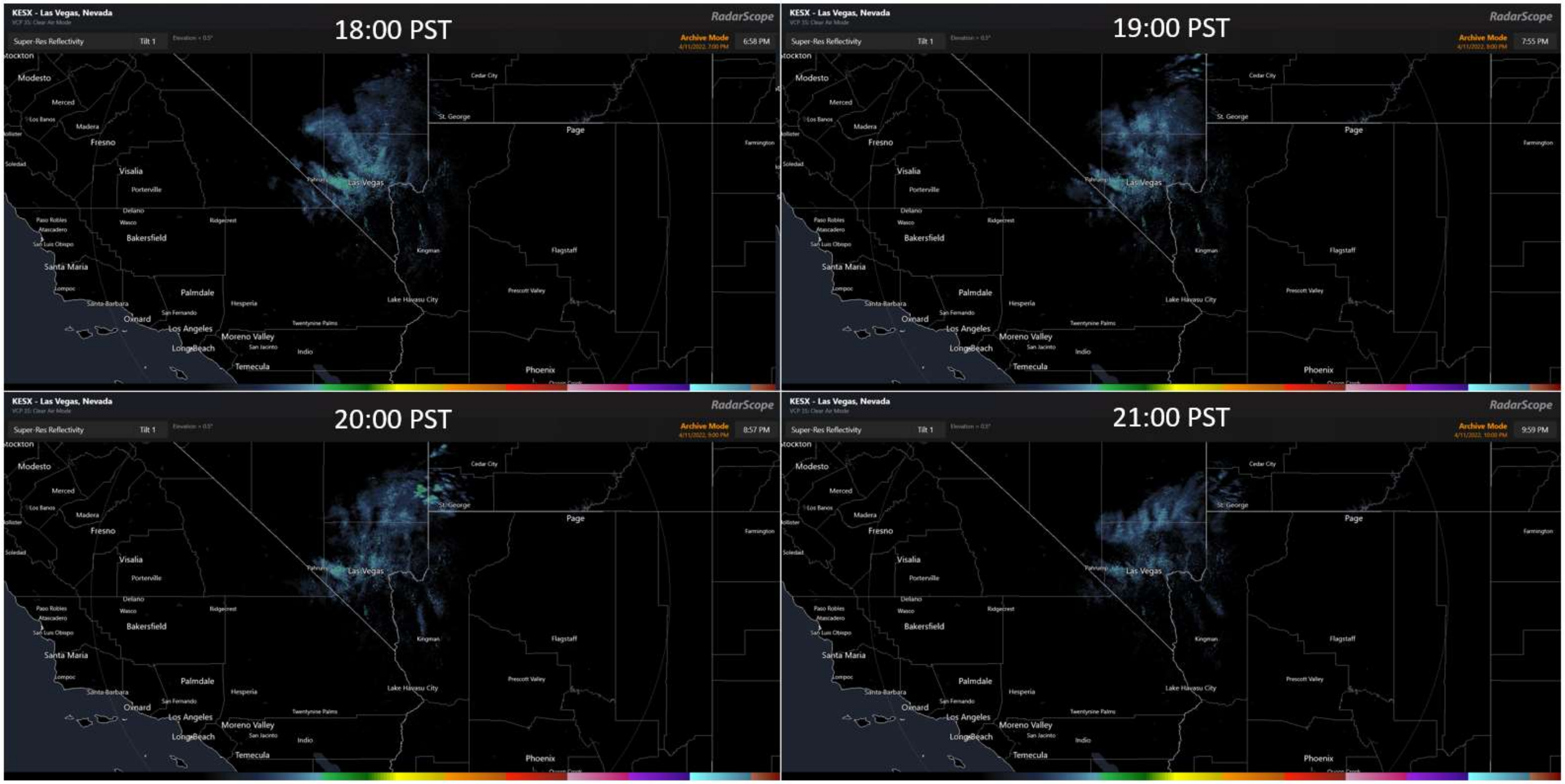

Figure 3.1-9. Doppler radar image, valid 18:00 to 21:00 PST on April 11, 2022 (converted from PDT in top right corner of images). Source: RadarScope

3.1.2 Satellite Images and Analysis

Satellite imagery and reanalysis products also provide evidence of dust from the Mojave region of California to Clark County. NOAA-20 Visible Infrared Imaging Radiometer Suite (VIIRS) true color satellite imagery is available for 14:30 PST on April 11, 2022. Figure 3.1-10 shows mixed clouds (white) and dust (gray) imagery shown in southern California and Nevada are indicative of the high winds and lofted dust associate with the frontal passage and high winds discussed in Section 3.1.1. The Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) reanalysis data show peak hourly average and hourly peak wind speeds in the source region and in the Las Vegas Valley for April 11, 2022 (Figure 3.1-11 and Figure 3.1-12). Strong southwesterly winds due to the increasing pressure gradient from the frontal passage developed in the deserts of southern Nevada and southeastern California. Due to the increasing pressure gradient, strong southwesterly winds developed in Las Vegas. These high winds of around 17 m/s (corresponding to approximately 40 mph) are shown in MERRA-2 reanalysis figures for April 11, 2022 and the sustained winds of at least 25 mph continued through 22:00 PST on April 11, 2022.

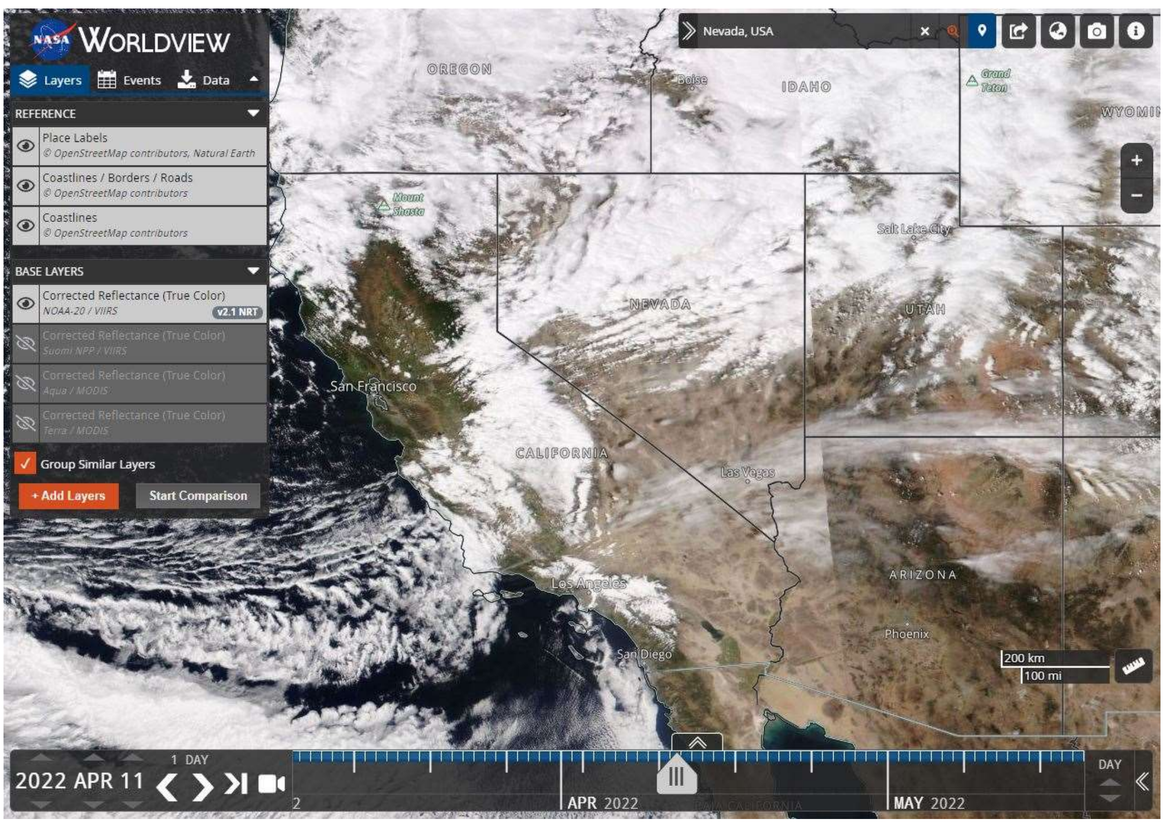

Figure 3.1-10. Satellite imagery of true color from NOAA-20 VIIRS at 14:30 local time on April 11, 2022.

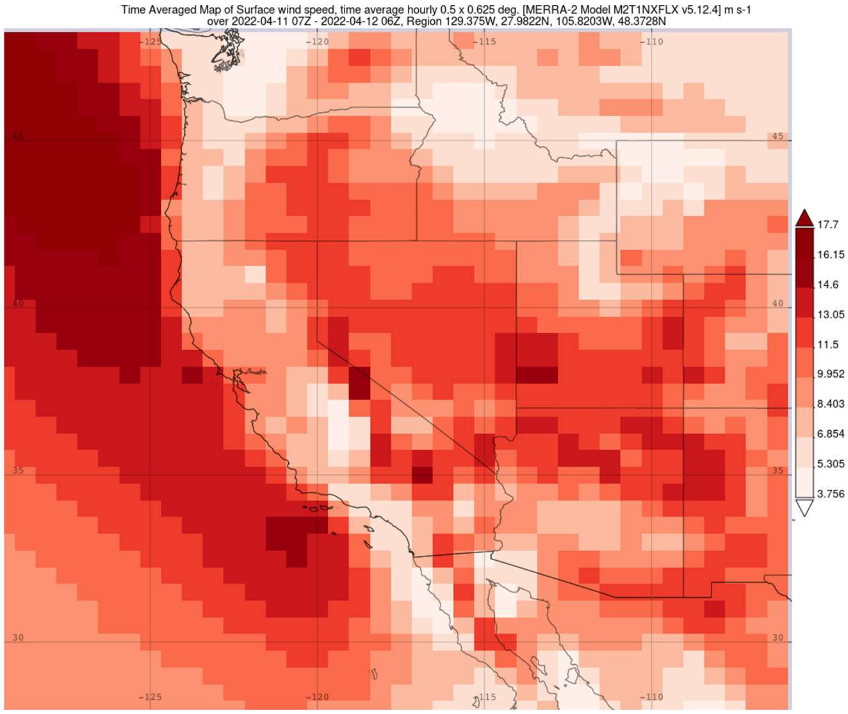

Figure 3.1-11. MERRA-2 reanalysis data hourly averaged surface wind speed (m/s) over April 11, 2022 07:00 UTC (April 10, 2022 at 23:00 PST) – April 12, 2022 06:00 UTC (April 11, 2022 at 22:00 PST).

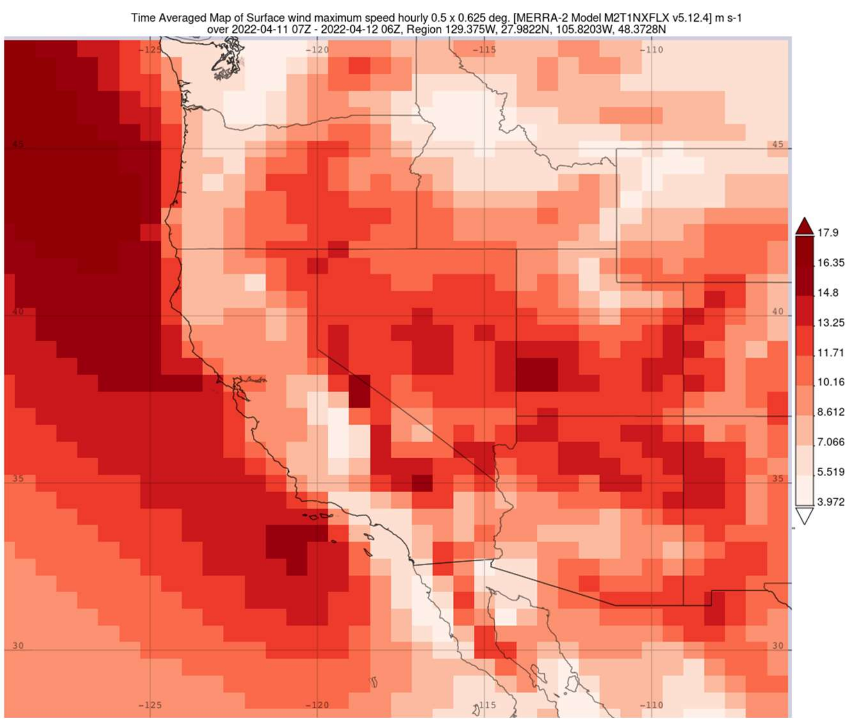

Figure 3.1-12. MERRA-2 reanalysis data hourly maximum surface wind speed (m/s) over April 11, 2022 07:00 UTC (April 10, 2022 at 23:00 PST) – April 12, 2022 06:00 UTC (April 11, 2022 at 22:00 PST).

3.1.3 Supporting Ground-Based Images

We were unable to find ground-based images in the source region due to the remote location. Satellite imagery was highlighted in the previous section as a substitute.

Peak sustained winds in the Mojave Desert (southeastern California) were developed via the Iowa State University Mesonet Automated Data Plotter. This tool aggregates automated weather data records from the selected region. Figure 3.1-13 shows the peak sustained wind speeds in southeastern California and Mojave Desert peaked at 46 mph on Aril 11, 2022. These peak sustained wind speeds were well above the 25-mph threshold in the source region and could easily loft, entrain, and transport PM_{10} downwind quickly to Clark County.

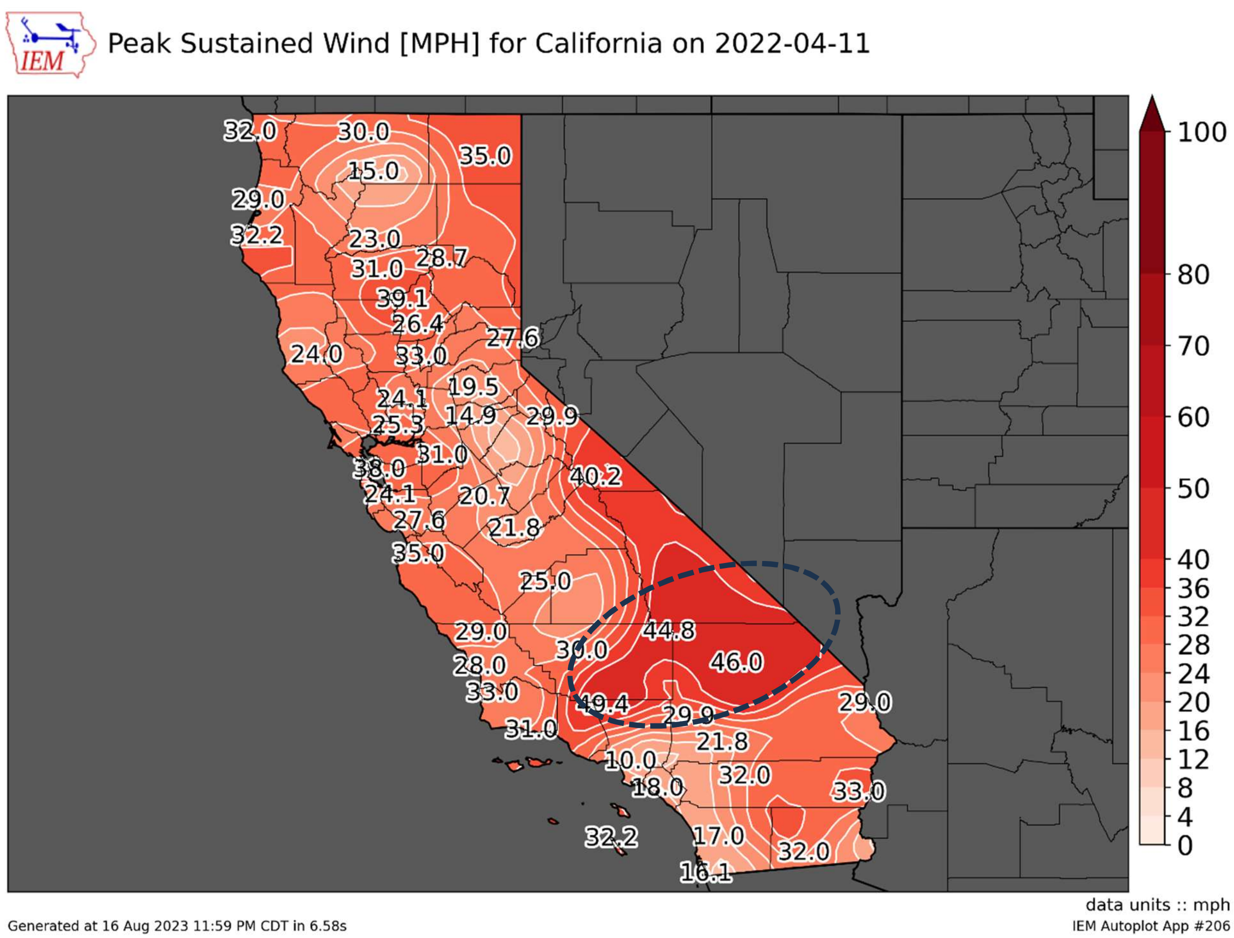

Figure 3.1-13. Peak sustained winds for California on April 11, 2022. The source region is located in southeastern California (the Mojave Desert region). The black dashed line shows the approximate source region. Data source https://mesonet.agron.iastate.edu/plotting/auto/

Figure 3.1-14 shows the distribution of maximum daily temperatures recorded at several sites in the wind-blown source region on April 10 and 11 (1991 – 2021), and the maximum daily temperatures recorded on April 10 and 11, 2022. The site locations are shown in Figure 2.2-8. Maximum daily temperatures recorded at all sites except Tehachapi were at or above the 75th percentile in the dust region and along the transport path compared to maximum daily temperatures from 1991 – 2021. Maximum daily temperatures recorded at all sites on April 11, 2022, the day of the PM_{10} exceedance, were below the median due to blowing dust reducing incoming solar radiation. The maximum daily temperatures recorded on April 10 provide evidence that the wind-blown dust source regions in the Mojave source region were unusually hot on the day before the PM_{10} exceedance.

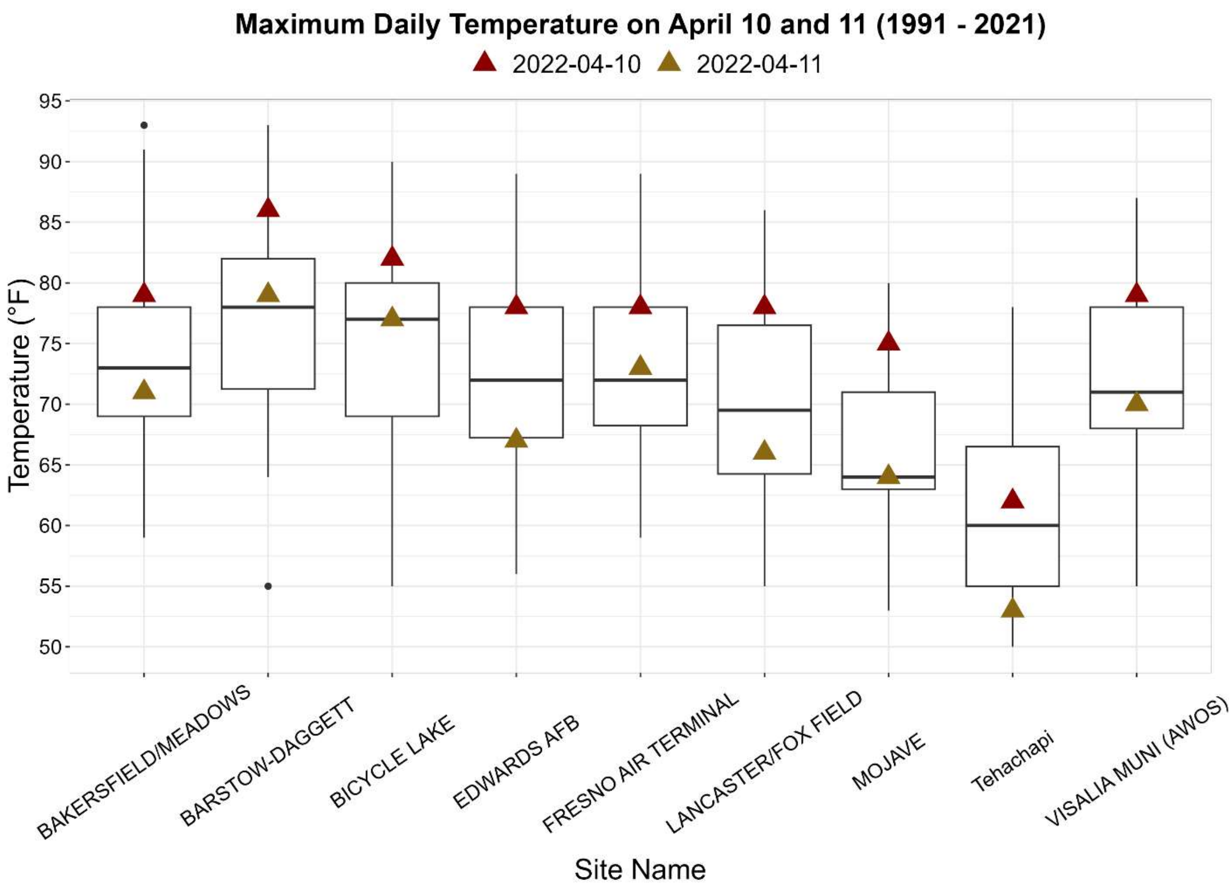

Figure 3.1-14. Maximum daily temperature on April 10 and 11, 2022, compared to the 1991 – 2021 distribution at each site.

Overall, we find overwhelming evidence that PM_{10} was very likely lofted, entrained, and transported from the Mojave Desert region in southeastern California in the late morning through evening on April 11, 2022 via a strong winds associated with a frontal passage. The evidence corroborating this assertion includes (1) the meteorological analysis that shows conditions were consistent with a high wind event in the Mojave Desert, (2) radar images from Las Vegas showing the progression of dust moving from the Mojave Desert in southeastern California into the Clark County area, (3) satellite visible imagery and winds in the Mojave Desert and Clark County during the event, (4) ground-based measurements of high temperatures in the Mojave Desert region before the event on April 10, 2022, and (5) aggregated measurements of high winds in the Mojave Desert source region on April 11, 2022.

3.2 Transport to Clark County

3.2.1 HYSPLIT Analysis

Backwards trajectories were modeled from Jerome Mack, Jean, Green Valley Station, Joe Neal, Mountains Edge, and Virgin Valley at the start of the high PM_{10} concentrations (hourly concentration greater than 150 µg/m^3), 12:00 PST at 50, 500, and 1,000-m heights (**Figure 3.2-1**). Archived North American Mesoscale Forecast System (NAM) data with resolution of 12 km was used as meteorologic input. Temporal resolution of the NAM 12 km is three hours and is run by NCEP.

At all heights, trajectories approach the Las Vegas region from the west-southwest, over the Mojave National Preserve, revealing it as the source region. The Mojave National Preserve is just east-southeast of the Sierra Nevada range, located within its rain shadow, yielding a majorly barren and scrub/shrub landcover (**Figure 3.2-2** and **Figure 3.2-3**, left). Throughout the region each trajectory passes through areas in severe and extreme drought conditions (Figure 3.2-2 and Figure 3.2-3, right).

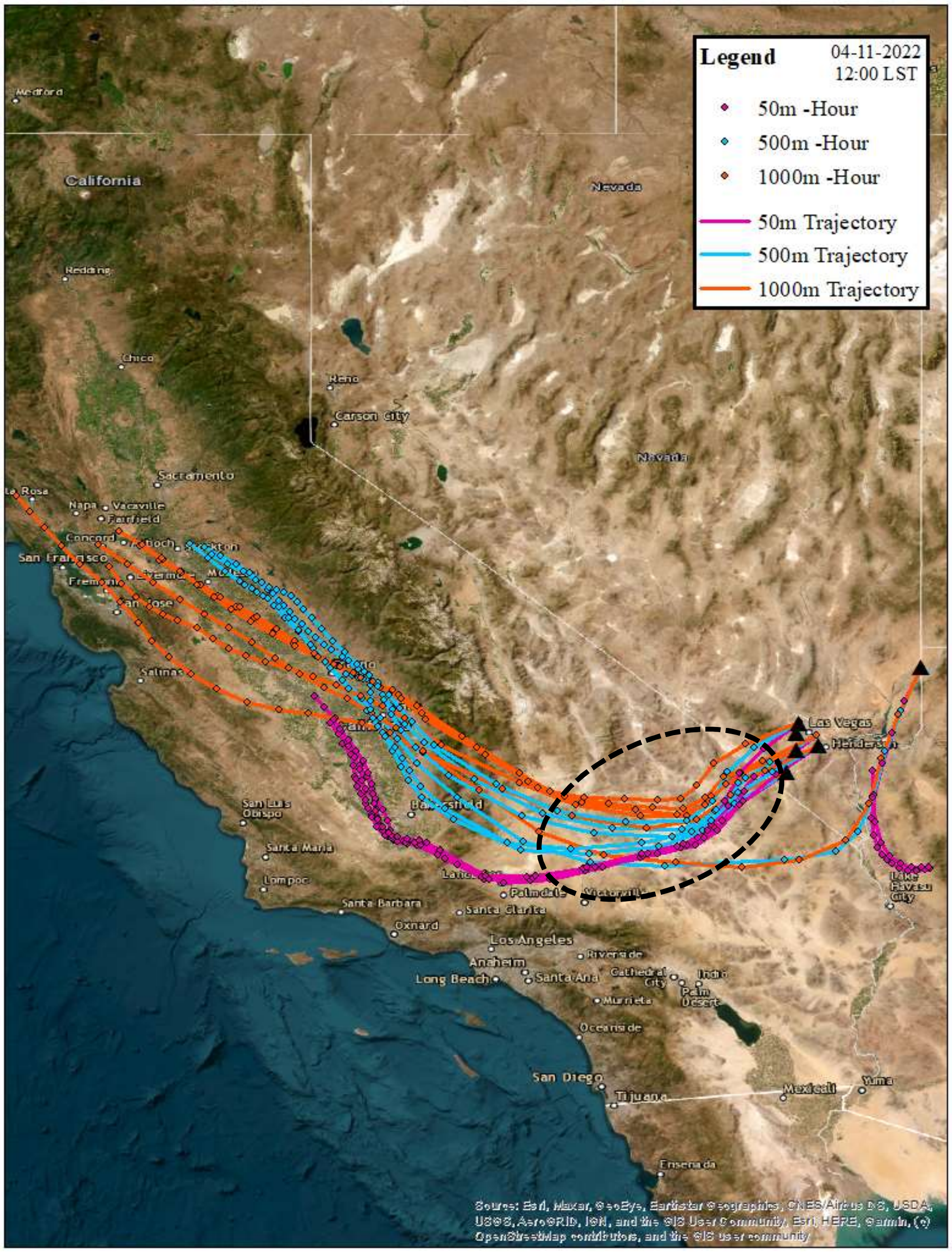

Figure 3.2-1. HYSPLIT 24-hour back trajectories from Jerome Mack, Jean, Green Valley Station, Joe Neal, Mountains Edge, and Virgin Valley on April 11, 2022 12:00 PST, originating at (maroon) 50-m, (green) 500-m, and (blue) 1,000-m with hourly points. The approximate location of the Mojave Desert source region is shown by a black, dashed box.

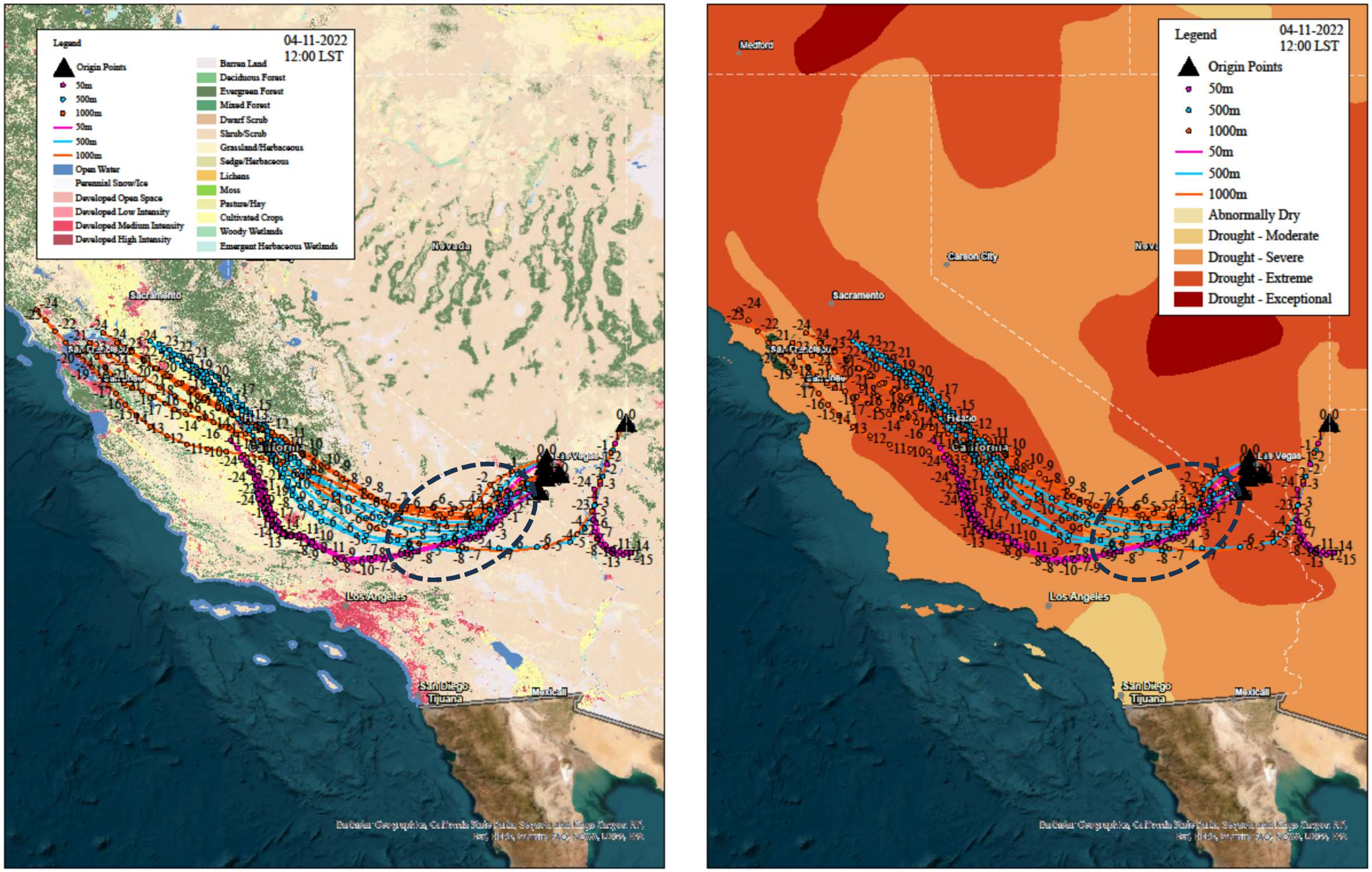

Figure 3.2-2. HYSPLIT 24-hour back trajectories from Jerome Mack, Jean, Green Valley Station, Joe Neal, Mountains Edge, and Virgin Valley on April 11, 2022 12:00 PST overlayed on (left) national land type database and (right) drought monitor class. The approximate location of the Mojave Desert source region is shown by a black, dashed circle.

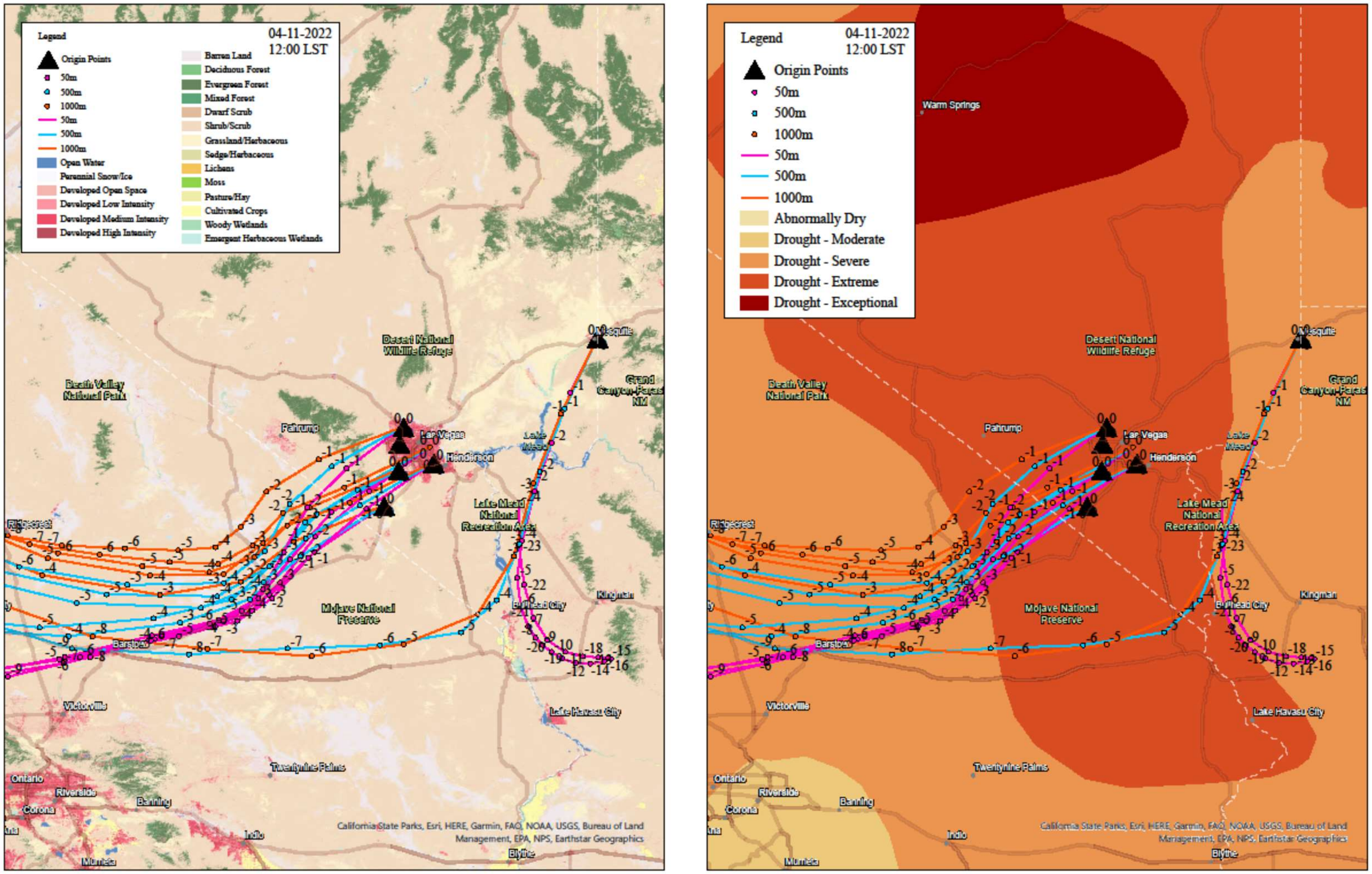

Figure 3.2-3. Zoomed in HYSPLIT 24-hour back trajectories from Jerome Mack, Jean, Green Valley Station, Joe Neal, Mountains Edge, and Virgin Valley on April 11, 2022 12:00 PST overlayed on (left) national land type database and (right) drought monitor class.

3.2.2 High Wind Event Timeline

The wind-blown dust event that occurred on April 11, 2022 affected 10 measurement sites with regulatory significance (with six additional non-regulatorily significant NAAQS exceedances) in Clark County and caused a maximum 24-hour PM_{10} concentration of 367 µg/m^3 at Sunrise Acres. Concentrations of PM_{10} begin to rise at 10:00 PST, reaching an initial peak at 13:00 PST and a daily maximum at 16:00 PST at most Clark County measurement sites. PM_{10} concentrations remain enhanced through the early morning of April 12.

In addition to the meteorological evidence of the frontal passage, wind speed and PM_{10} concentrations along the trajectory are provided in **Figure 3.2-4 and Figure 3.2-5.** As stated in the meteorological analysis in Section 3.1.1, a south-moving frontal system created a strong pressure gradient across eastern California and Southern Nevada on April 11, 2022. Regions on a similar latitude show subsequent increases in PM_{10} concentration between 09:00 and 15:00 PST with the approach of this frontal system and associated high winds. Measurements from Kern and San Bernardino counties in California, labeled one and two in Figure 3.2-4, see an initial increase in PM_{10} concentrations starting at 08:00 PST. This increase in PM_{10} is accompanied by an increase in hourly average wind speeds in the Mojave Desert region at Ridgecrest-Ward, Barstow and Trona AQS measurement sites (Figure 3.2-5). Hourly average wind speed at all of these source-region sites exceed 25 mph during the event on April 11, fulfilling a key factor for a Tier 2 high-wind dust event as defined by EPA guidance (i.e., sustained winds above 25 mph in a natural undisturbed desert source region). At 9:00 to 10:00 PST, PM_{10} concentrations in Pahrump, Nevada (labeled as region three) begin to increase. Region three is omitted from Figure 3.2-5 because no AQS sites in Pahrump report meteorological data. Finally, monitors in Las Vegas (region four) show enhanced concentrations starting after 10:00. This confirms the source direction and timeline of dust movement from the Mojave source region to Clark County. Wind speeds measured in Clark County were not as intense as peak hourly wind speeds measured in the source region. No sites in Clark County measured an hourly average wind speed above 25 mph. This regional progression of enhanced PM_{10} provides significant evidence of windblown dust due to high winds along the steep pressure gradient created by an approaching frontal system.

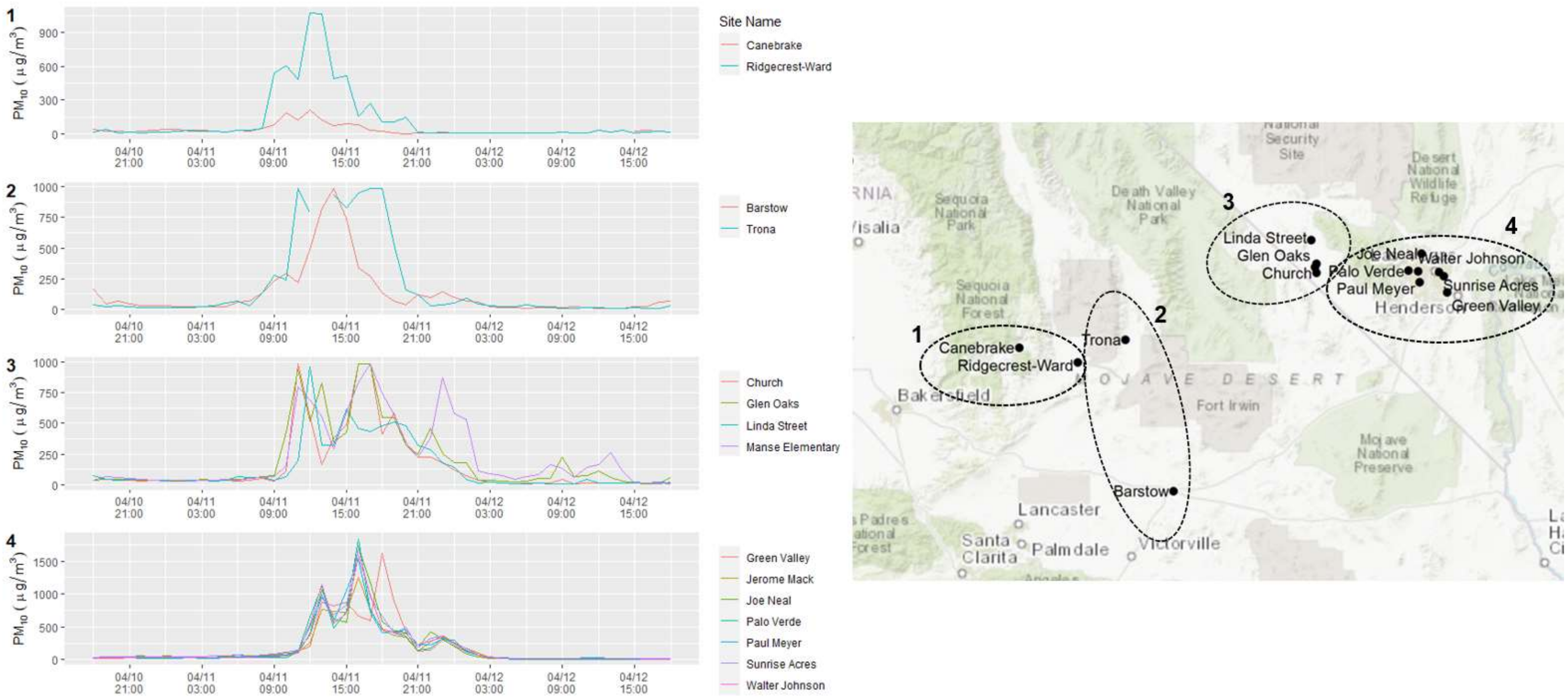

Figure 3.2-4. Timeseries of PM_{10} (left) along the pressure gradient resulting from an approaching cold front. Panel 1 includes data from Kern County, panel 2 includes data from San Bernadino County, panel 3 includes data from the Pahrump, Nevada area, and panel 4 includes data from the Las Vegas area. The map (right) and site locations are mapped and circled by region. Numbering in the map corresponds to numbering in the time series figures.

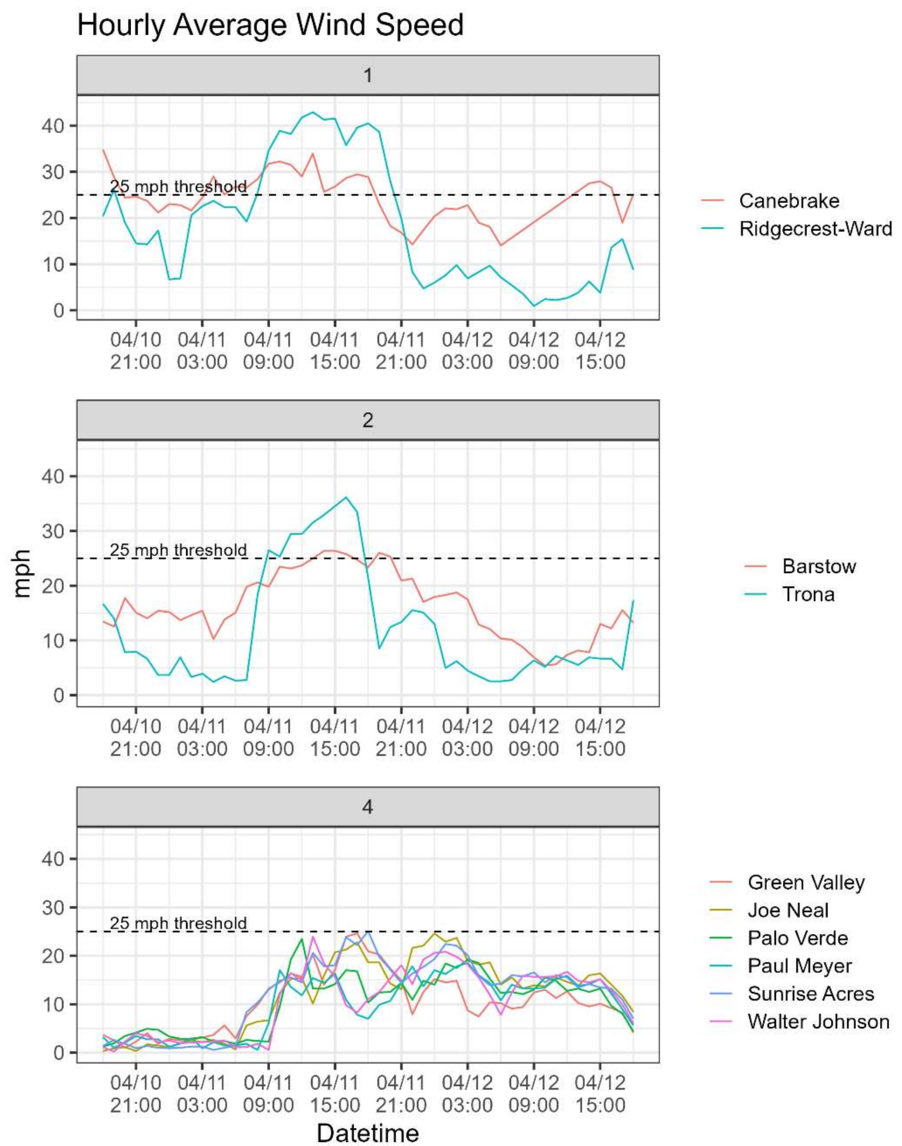

Figure 3.2-5. Hourly average wind speed at sites shown in Figure 3.2-4 sourced from the AQS database. Sites that do not report meteorological data are omitted. The number above each plot panel matches the numbered panels and circled regions in Figure 3.2-4.

Wind speed, direction, and concentrations across Clark County, Nevada are consistent with the approach of a frontal system. The wind rose shown in Figure 3.2-6 shows the distribution of five-minute wind speed and direction observations measured at Harry Reid Int'l Airport (LAS) in Las Vegas on April 11. The highest wind speeds, between 24 – 32.2 mph, come from a southwesterly direction as expected with the approach of a frontal system.

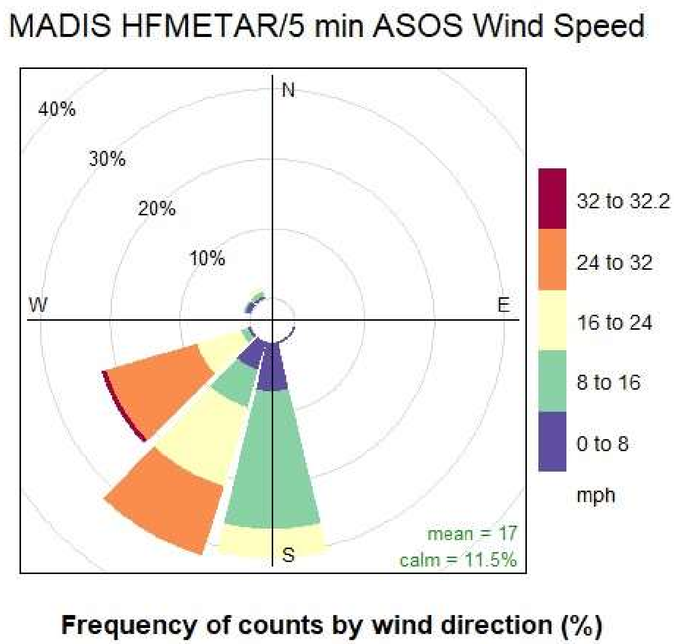

Figure 3.2-6. Wind rose including both wind speed and direction for April 11, 2022, at Harry Reid Int'l Airport (LAS). Wind data was sourced from the Iowa Environmental Mesonet (https://mesonet.agron.iastate.edu/).

Wind speed, direction, and PM_{10} concentrations across Clark County are also consistent with a frontal passage (shown in Figure 3.2-7 through Figure 3.2-12). By 10:00 PST, winds started to shift southwesterly throughout the Las Vegas Valley due to the influx of winds through the mountain pass between the Spring Mountains and the McCullough Range, a major wind and transport corridor into the Valley. The shift in winds, starting with the southwestern sites and moving up to the northeastern sites, occurred between 10:00 and 14:00 PST as the pressure gradient from the low-pressure system and frontal movement started to affect the Las Vegas Valley. High concentrations of PM_{10} started in the southwest of the Valley, directly in line with the mountain pass and the winds passing over the Spring Mountains associated with the frontal passage. PM_{10} concentrations at sites nearest the Spring Mountains and directly downwind of mountain pass were the first to rise starting at 11:00 to 12:00 PST. By 13:00 PST, all sites in the valley recorded PM_{10} concentrations > 500 $\mu g/m^3$ with winds from the southwest, indicating a regional influence of PM_{10} concentrations from the southwest that was impacting the entire Las Vegas Valley. These exceptionally high concentrations of PM_{10} continued through 17:00 PST. By 18:00-21:00 PST, concentrations of PM_{10} started to decrease due to declining winds speeds across Clark County. Although PM_{10} concentrations remained high through the end of the day, the drop in wind speeds is mirrored by a decrease in PM_{10} concentrations.

Enhanced PM_{10} concentrations at the affected sites were likely caused by a high-wind event in the source region rather than local emissions, in part because planned land use around these sites, which can be generally described as developed with little exposed dirt or gravel, is not conducive to enhanced concentrations. Further, the fact that enhanced PM_{10} concentrations were recorded at all sites in the Las Vegas Valley indicates a regional high-wind dust event. While it is possible that some portions of planned land use, such as the undeveloped lot to the east of the Joe Neal site, may have contributed to local dust during the high wind event, evidence of high winds over a natural, undisturbed desert region upwind of Clark County is clearly the main driver of this dust event. As shown by the timeline of events, high winds from a front lofted PM_{10} in the Mojave Desert source region and caused a regional dust event across southern California that extended into Clark County. Even if there were some contributions from local dust sources due to high winds, the regional dust event is the main source of the extreme PM_{10} concentrations experienced on April 11, 2022.

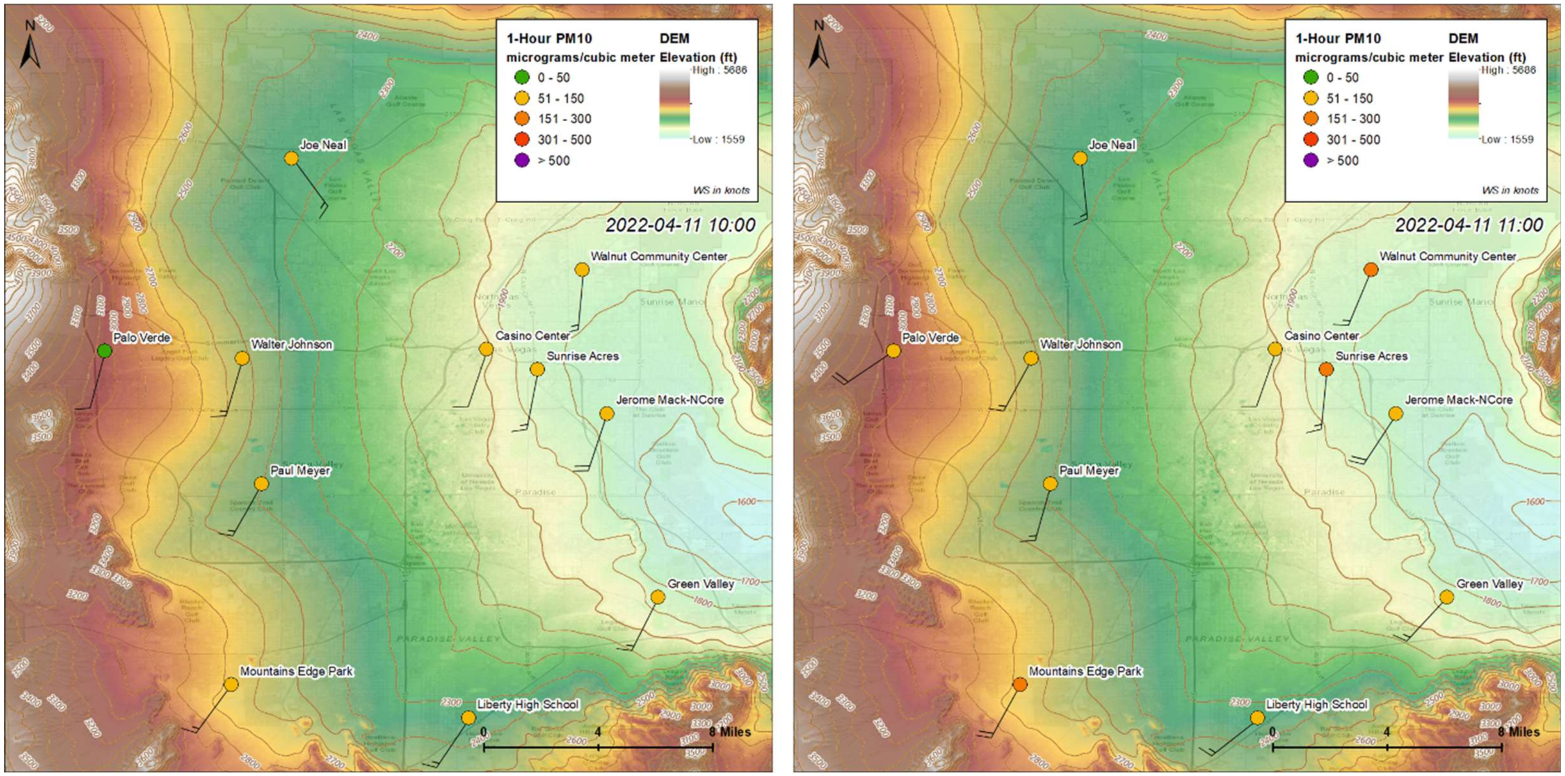

Figure 3.2-7. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for April 11, 2022 from 10:00 PST to 11:00 PST.

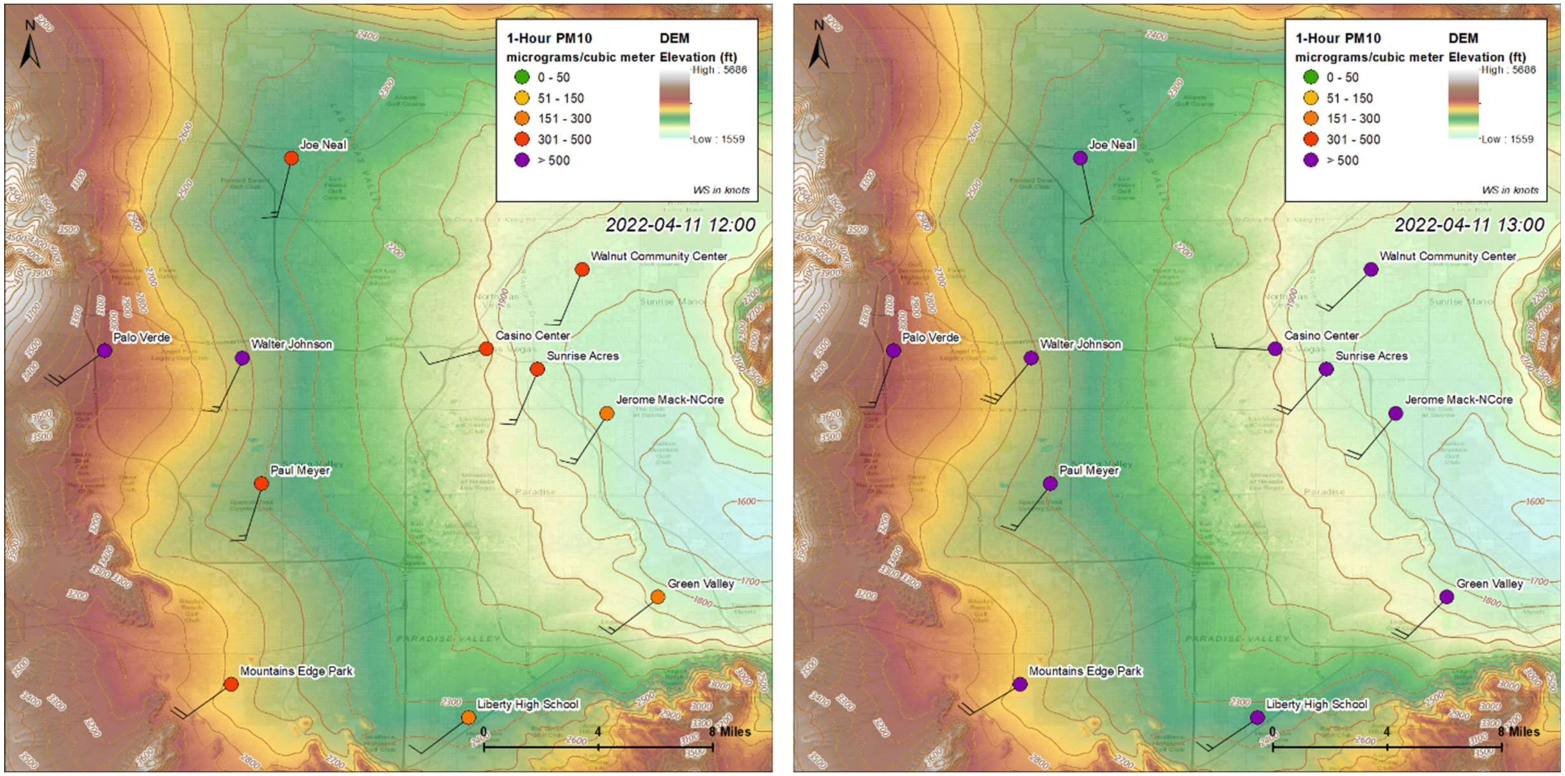

Figure 3.2-8. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for April 11, 2022 from 12:00 PST to 13:00 PST.

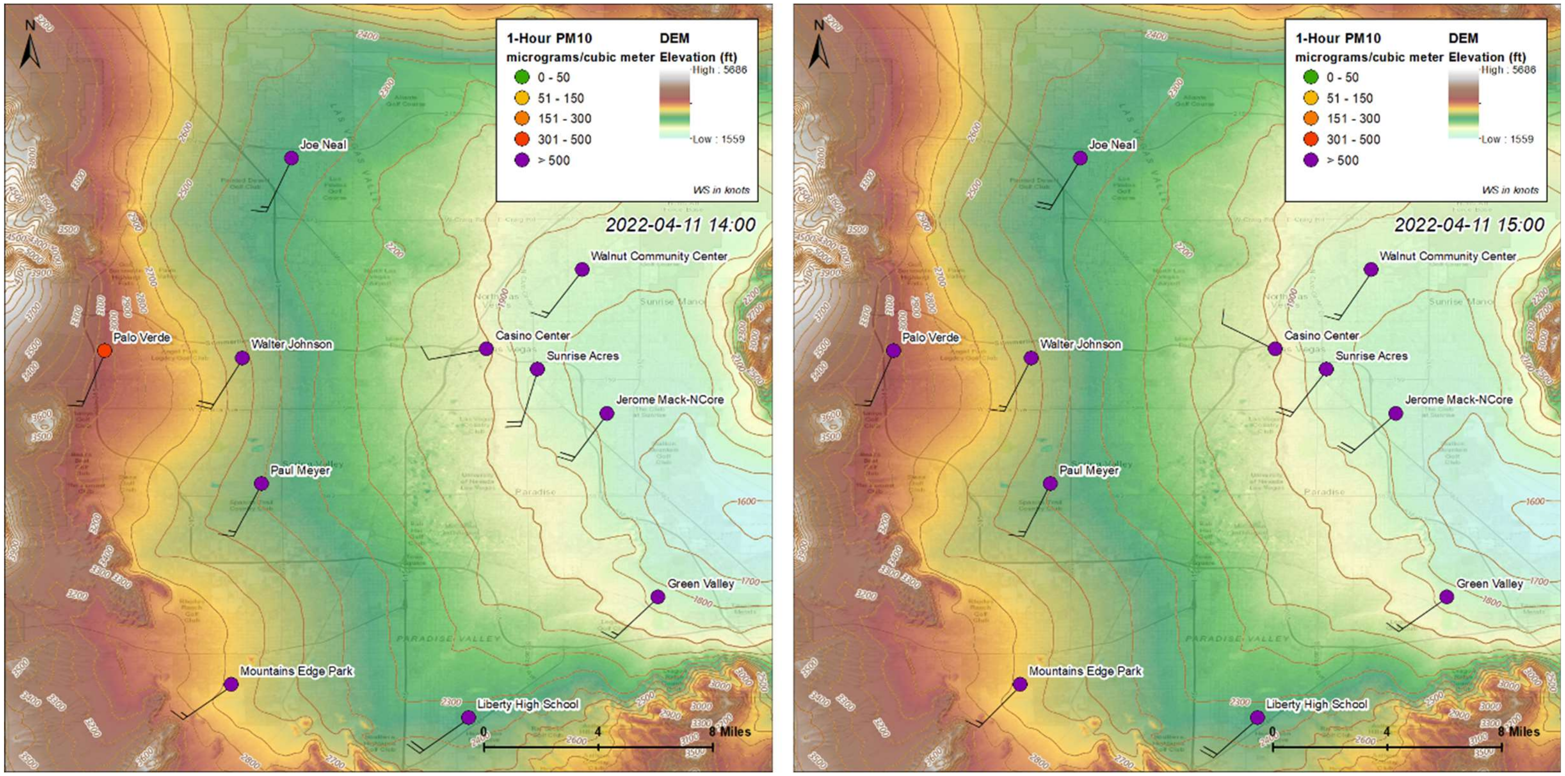

Figure 3.2-9. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for April 11, 2022 from 14:00 PST to 15:00 PST.

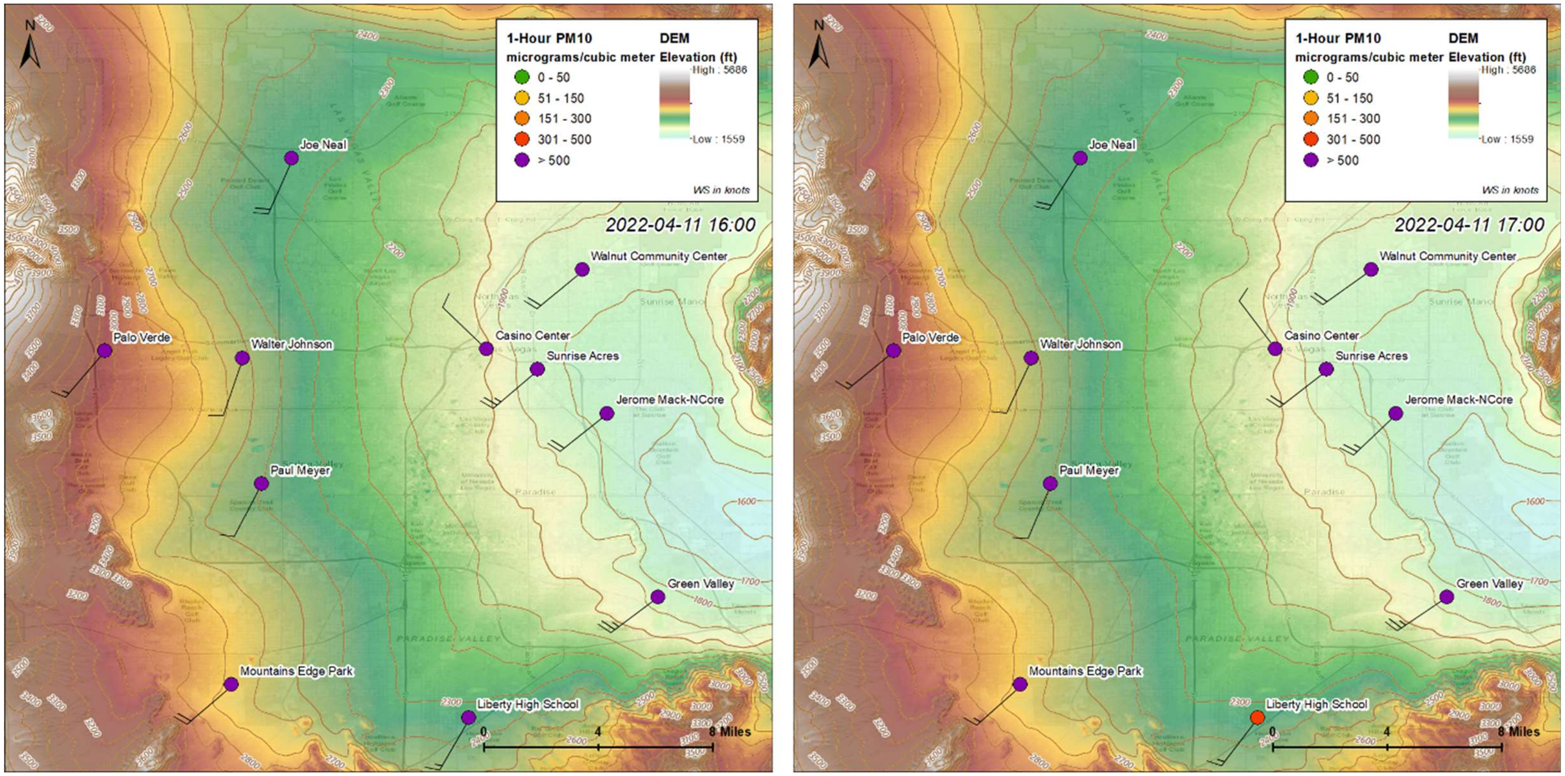

Figure 3.2-10. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for April 11, 2022 from 16:00 PST to 17:00 PST.

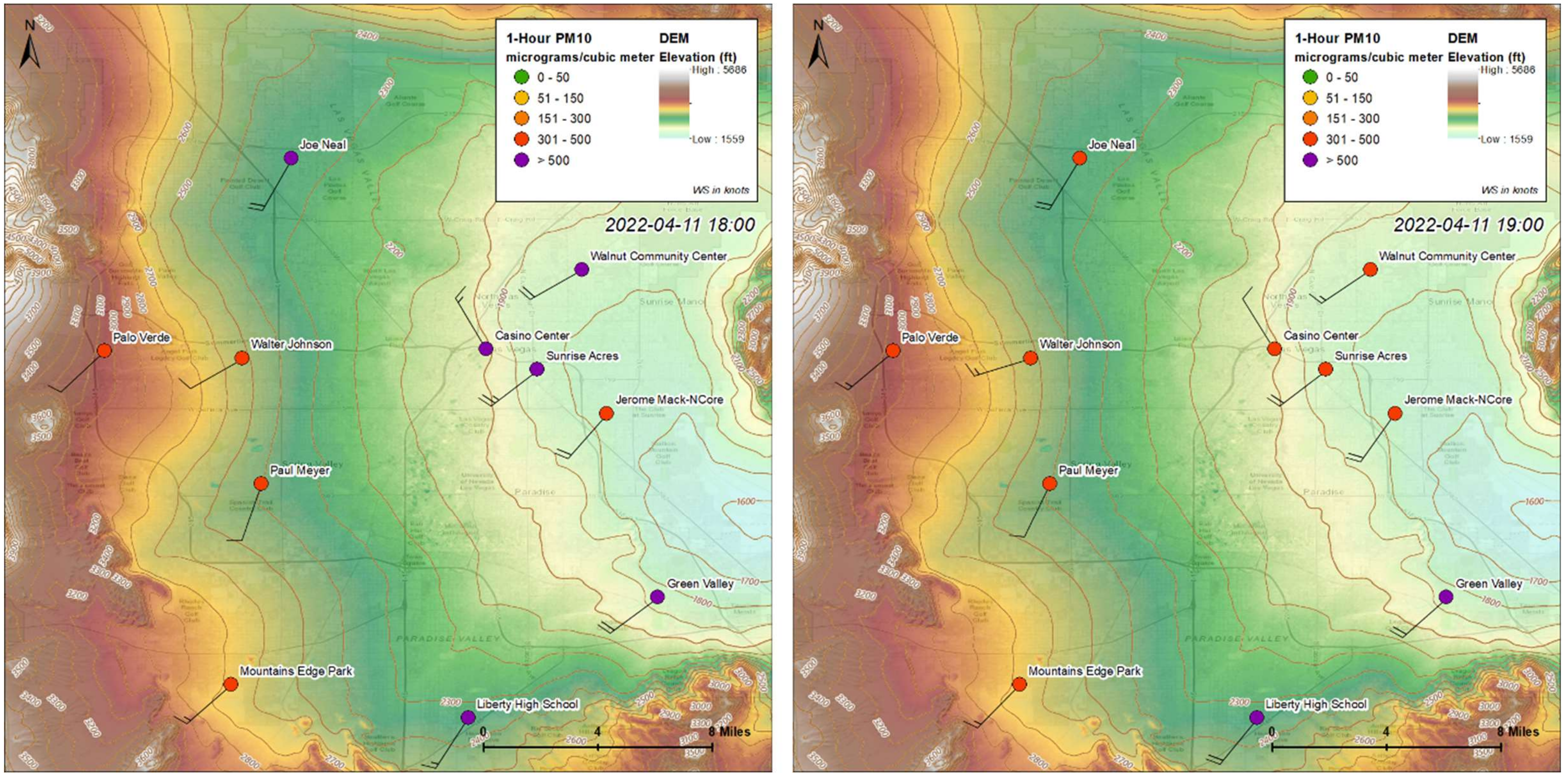

Figure 3.2-11. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for April 11, 2022 from 18:00 PST to 19:00 PST.

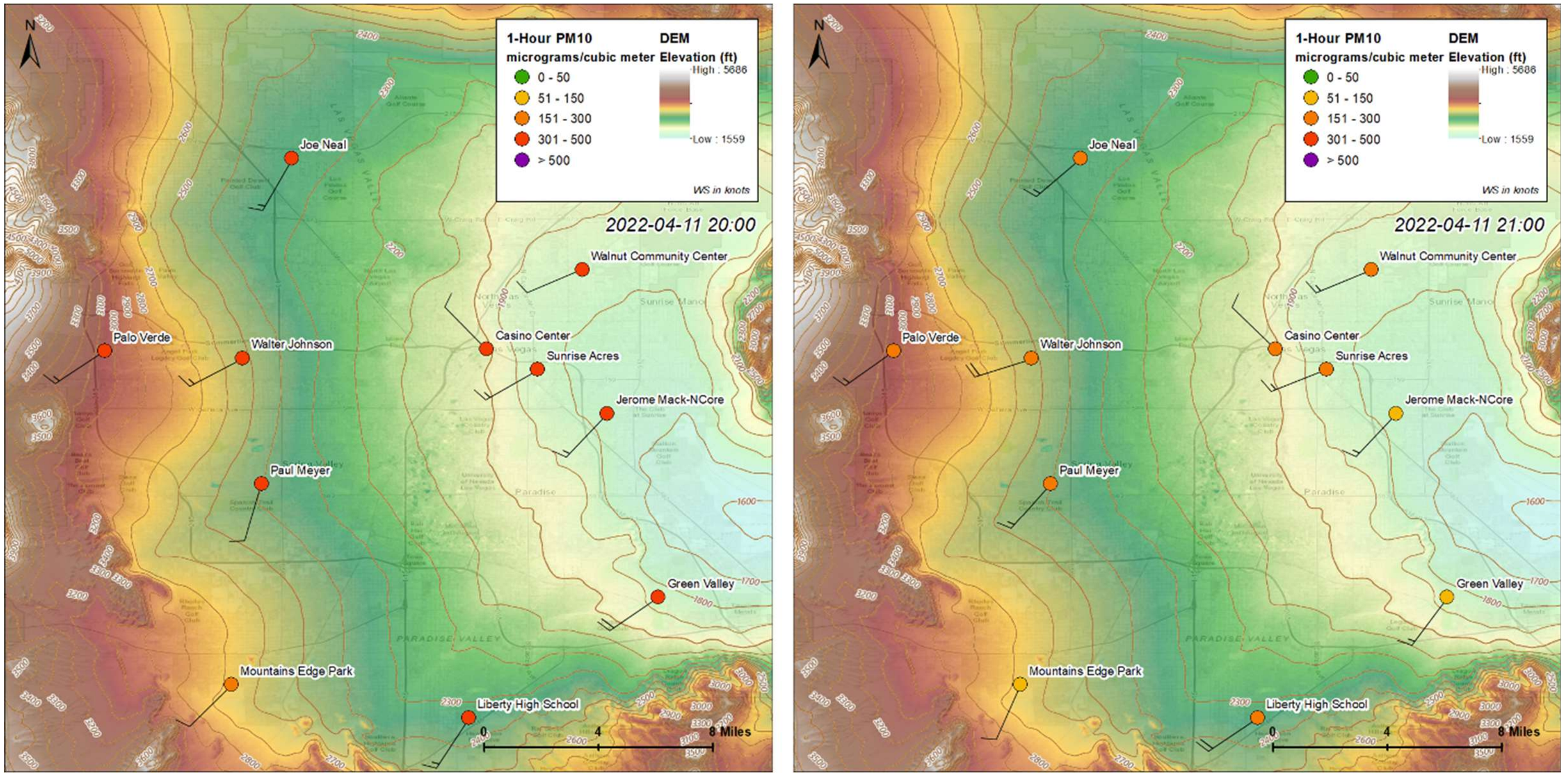

Figure 3.2-12. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for April 11, 2022 from 20:00 PST to 21:00 PST.

Peak sustained winds for Clark County and the surrounding regions are also confirmed by the peak sustained winds shown previously in Section 3.1.1 (Figure 3.1-5) using the Iowa State University Mesonet Automated Data aggregation tool. This plot shows sustained winds greater than the 25-mph high wind threshold on April 11, 2022, providing further proof that this was a high wind event affecting Clark County.

Overall, we find overwhelming evidence that PM_{10} was transported from the Mojave Desert in the late morning through evening on April 11, 2022 with a strong frontal passage. Hourly average sustained wind speeds in the source region and along the transport path show sustained speeds greater than 25 mph, the high wind threshold. PM_{10} concentrations from monitors along the frontal passage also show the lofted dust from the Mojave Desert in southeastern California. The evidence corroborating this assertion includes (1) HYSPLIT analyses showing transport from the Mojave Desert in southeastern California to Clark County in two to six hours, (2) changes in wind speed along the transport path, (3) enhanced PM_{10} evidence from monitoring sites along the transport path, and (4) ground-based observation of PM_{10} and wind speed/direction in Clark County that corroborate the PM_{10} event time of arrival.

3.3 Impacts of Wind-Blown PM_{10} Dust at the Surface

3.3.1 Clark County Alerts

Clark County Nevada created a news release and a Twitter post for April 11, 2022 with an air quality Dust Advisory to warn people to limit their time outdoors (**Figure 3.3-1**). They advised residents and local construction sites of the possible enhanced blowing dust levels due to the high winds forecast. During windy conditions people with respiratory diseases, older adults, and children may feel better when staying indoors since they are at a greater risk. Airborne dust is described as a form of particulate matter pollution that aggravates respiratory diseases. The article includes recommendations such as limiting outdoor exertion when dust is in the air and keeping doors and windows closed to reduce your exposure to the dust.

Additionally, Clark County issued a Dust Advisory for April 11, 2022 shown in **Figure 3.3-2**. This advisory requires construction sites to immediately inspect their construction sites, implement BACM, and avoid blasting activity at threshold wind speeds to mitigate wind-blown dust. Additionally, compliance officers will inspect construction and stationary source sites during the dust event to ensure BACM are being implemented, with any violations receiving a Notice of Violation.

News Release

Clark County Nevada

County Commission:
James B. Gibson, Chairman
Justin Jones, Vice Chairman
Marilyn Kirkpatrick
William McCurdy II
Ross Miller
Michael Naft
Tick Segerblom

Yolanda King, County Manager

Office of Public Communications • (702) 455-3546 • FAX (702) 455-3558 • www.ClarkCountyNV.gov

Contact: Kevin J. MacDonald
Public Information Officer

Mobile: (702) 232-0931
E-mail: KevMac@ClarkCountyNV.gov

For Immediate Release **Monday, April 11, 2022**

Air Quality Dust Advisory Issued for Monday

The Clark County Department of Environment and Sustainability has issued a dust advisory for **Monday, April 11**, to advise residents and local construction sites of the possibility of elevated levels of blowing dust due to the forecast of high winds in our area.

Airborne dust is a form of inhalable air pollution called particulate matter or PM, which aggravates respiratory diseases. Under windy conditions people with heart or lung disease, older adults, and children may feel better staying indoors as much as possible because they could be at greater risk from particulates, especially when they are physically active, according to the U.S. Environmental Protection Agency. Consult your physician if you have a medical condition that makes you sensitive to air pollution.

Figure 3.3-1. News release by Clark County Nevada on April 11, 2022 indicating dust present and air quality advisory.

DES
DEPARTMENT OF ENVIRONMENT AND SUSTAINABILITY

Clark County Department of Environment and Sustainability

Division of Air Quality

DUST ADVISORY

for Monday, April 11, 2022

Attention Dust Control Permit Holders, Contractors, and Stationary Sources

National Weather Service reports and the weather models used by the Division of Air Quality (DAQ) predict **sustained winds of 25-35 mph**, with **gusts of 40-50 mph**, from Monday afternoon into the night.

DAQ directs all permittees to immediately inspect their site(s) and employ Best Available Control Measures to stabilize all disturbed soils and reduce blowing dust. Permittees with multiple sites should contact each site superintendent to ensure compliance with the Clark County Air Quality Regulations.

BLASTING: This forecast is for wind gusts 40-50 mph or more. Project operators should not load blasting materials or perform any blasting operations. You are required to monitor National Weather Service reports for wind speeds; if wind gusts above 25 mph are forecast, discontinue charging additional blast holes. Limit the blast to holes charged at the time the wind report is made.

Compliance officers will inspect construction and stationary source sites during this episode to ensure Best Available Control Measures are being implemented. Any observed violation may receive a Notice of Violation.

Figure 3.3-2. Email from AQDCP@ClarkCountyNV.gov to all Dust Control Permit holders in advance of the April 11, 2022 dust event.

3.3.2 Media Coverage

Clark County provided urgent information to the community about the Dust Storm Warning on April 11, 2022 by issuing a statement on Twitter as shown in Figure 3.3-4Figure 3.3-3. Additionally, many news sources including the Las Vegas Review-Journal, 3 News, Weatherboy, KTNV Las Vegas, Fox 10 Phoenix, Associated Press, Fox 5 Las Vegas, US News, Kion 46, and 8 News Now reported on the windy conditions and dust present on April 11, 2022. National Weather Service Las Vegas posted on

Twitter about the dust storm warnings on April 11, 2022 (**Figure 3.3-3** and **Figure 3.3-5**). Screenshots of the news articles referenced throughout this section are available for viewing in **Appendix A**.

The Las Vegas Review-Journal reported that early on April 12, 2022 the National Weather Service said that a low-pressure system that went through Southern Nevada had a peak wind gust of 76 mph at Angel Peak within the Spring Mountains. On April 11, 2022, a wind gust of 64 mph was recorded in the Red Rock Canyon area. The National Weather Service also issued an advisory for a dust channel in Sandy Valley that was moving northeast to the Las Vegas Valley on April 11, 2022. (https://www.reviewjournal.com/local/weather/spring-storm-brings-windy-cooler-weather-to-las-vegas-2559453/)

3 News reported that the air quality in the Las Vegas Valley area was registered as hazardous and off the charts at some times throughout the day on April 11, 2022. High winds were expected from a storm arriving from the northwest with a high wind warning going into effect from 11:00 PDT on April 11, 2022 to 03:00 PDT on April 12, 2022. The Clark County DES issued an Air Quality Advisory and provided recommendations to reduce your exposure to dust. (https://news3lv.com/news/local/high-wind-warning-issued-for-southern-nevada-as-strong-gusts-expected)

Weatherboy reported that the National Weather Service issued a Dust Storm Warning for Las Vegas and nearby areas due to dangerous conditions. The conditions include very low visibility, blowing dust, and strong winds. The National Weather Service cautions drivers to pull over, turn off all lights, and remove your foot from the brake if you are caught driving in a dust storm. Driving in a dust storm can threaten your life and should be avoided. (https://weatherboy.com/dust-storm-warning-for-las-vegas-surrounding-areas/)

KTNV Las Vegas reported that Clark County has a dust storm warning until April 11, 2022 at 16:15 PDT. The National Weather Service also warned people to be ready for a sudden drop in visibility in an emergency alert. The potential hazards include blowing dust, low visibility, and gusty winds. The forecast included wind speeds of 25-35 mph with gusts of 50-60 mph. (https://www.ktnv.com/news/dust-storm-warning-issued-for-central-clark-county)

Fox 10 Phoenix reported that parts of Las Vegas were experiencing a dust storm on April 11, 2022. There was a Dust Storm Warning for the Las Vegas Valley and I-15, south to the Nevada-California State Line and for areas in Arizona's Mohave County. A strong weather system with strong winds and gusts up to 55-77+ mph was forecasted according to the National Weather Service Las Vegas office. Wind speeds went up to 61 mph at Kingman Airport in Arizona. (https://www.fox10phoenix.com/news/las-vegas-haboob-national-weather-service-issues-dust-storm-warming)

KTNV Las Vegas reported that a high wind warning is in effect until April 12, 2022 at 03:00 PDT. Southwest gusts were expected to hit 50-75 mph during the afternoon. Northwest winds after midnight will have gusts of 45 mph, with lows in the upper 40s. (https://www.ktnv.com/weather/13-

first-alert-weather-forecast-monday-morning-apr-11-2022#:~:text=High%20Wind%20Warning%20until%203%20a.m.&text=LAS%20VEGAS%20%E2%80%94%20Southwest%20gusts%20will,strong%20crosswinds%2C%20and%20blowing%20debris)

The Associated Press, Fox 5 Las Vegas, US News, and Kion 46 reported that there were unusually gusty winds that have contributed to a dust storm warning in the Las Vegas area. The National Weather Service issued an advisory for a dust channel in Sandy Valley that was moving northeast toward the Las Vegas Valley. Some of the cities that will be impacted include Las Vegas, Henderson, and North Las Vegas. There are cameras on I-15 on the California-Nevada border that show powerful winds and the National Weather Service warned that winds are greater than 60 mph with less than a quarter-mile visibility. (https://apnews.com/article/storms-reno-nevada-las-vegas-weather-75dd357f66149609d0101dd813e2c332, https://www.fox5vegas.com/2022/04/11/potentially-damaging-winds-dust-hit-parts-nevada/, https://www.usnews.com/news/best-states/nevada/articles/2022-04-11/potentially-damaging-winds-dust-hit-parts-of-nevada, https://kion546.com/news/2022/04/11/potentially-damaging-winds-dust-hit-parts-of-nevada/)

8 News Now reported on a 54-mph wind gust that was recorded at the Harry Reid International Airport. The dust storm warnings that started on Monday morning in east San Bernardino County and Primm moved eastward. The dust channel was 14 miles northwest of Dolan Springs, Arizona moving eastward at 17:57 PDT. There were windy conditions in Las Vegas throughout the afternoon with reduced visibility. (https://www.8newsnow.com/news/local-news/wind-gusts-picking-up-across-the-las-vegas-valley/)

KTNV Las Vegas reported on a high wind warning for the Las Vegas Valley with a High Wind Warning and Wind Advisory on April 11, 2022. Safety recommendations for dust storms and downed power lines were included. (https://www.yahoo.com/lifestyle/high-wind-warning-las-vegas-133945753.html?guccounter=1)

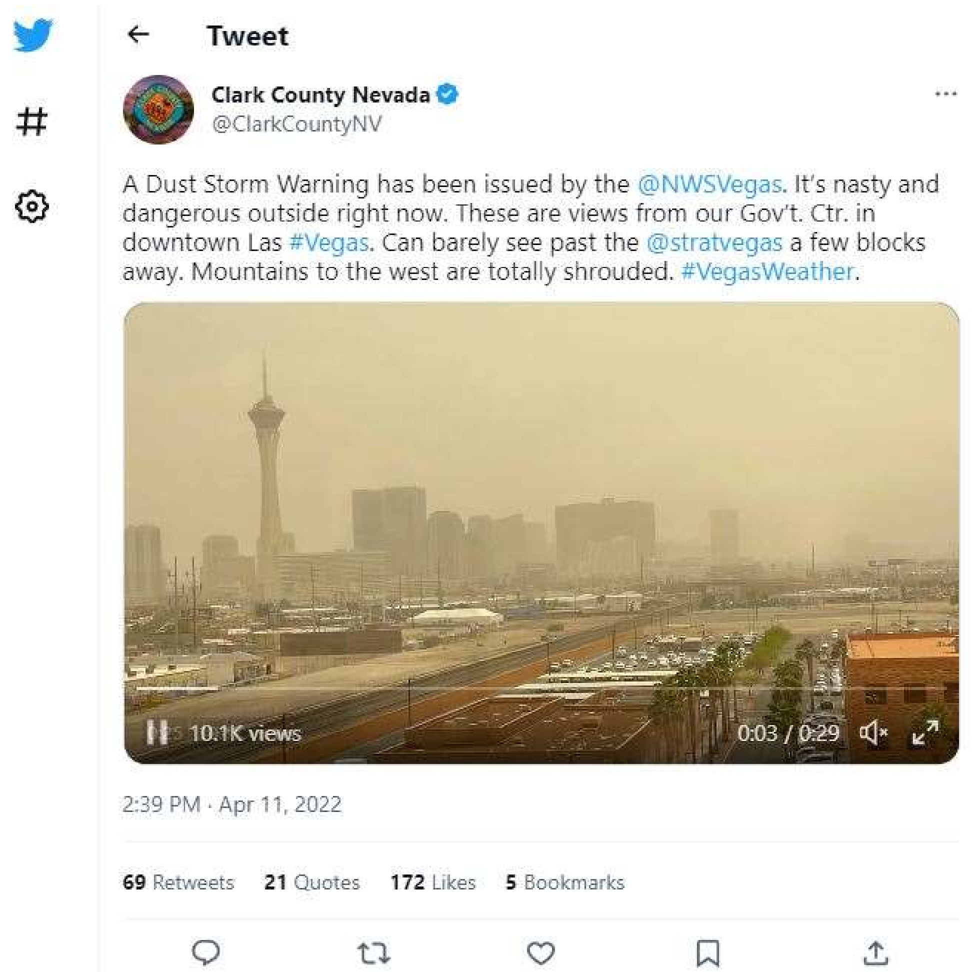

Figure 3.3-3. Twitter post from Clark County Nevada on April 11, 2022 indicating dust present and dust storm warning.

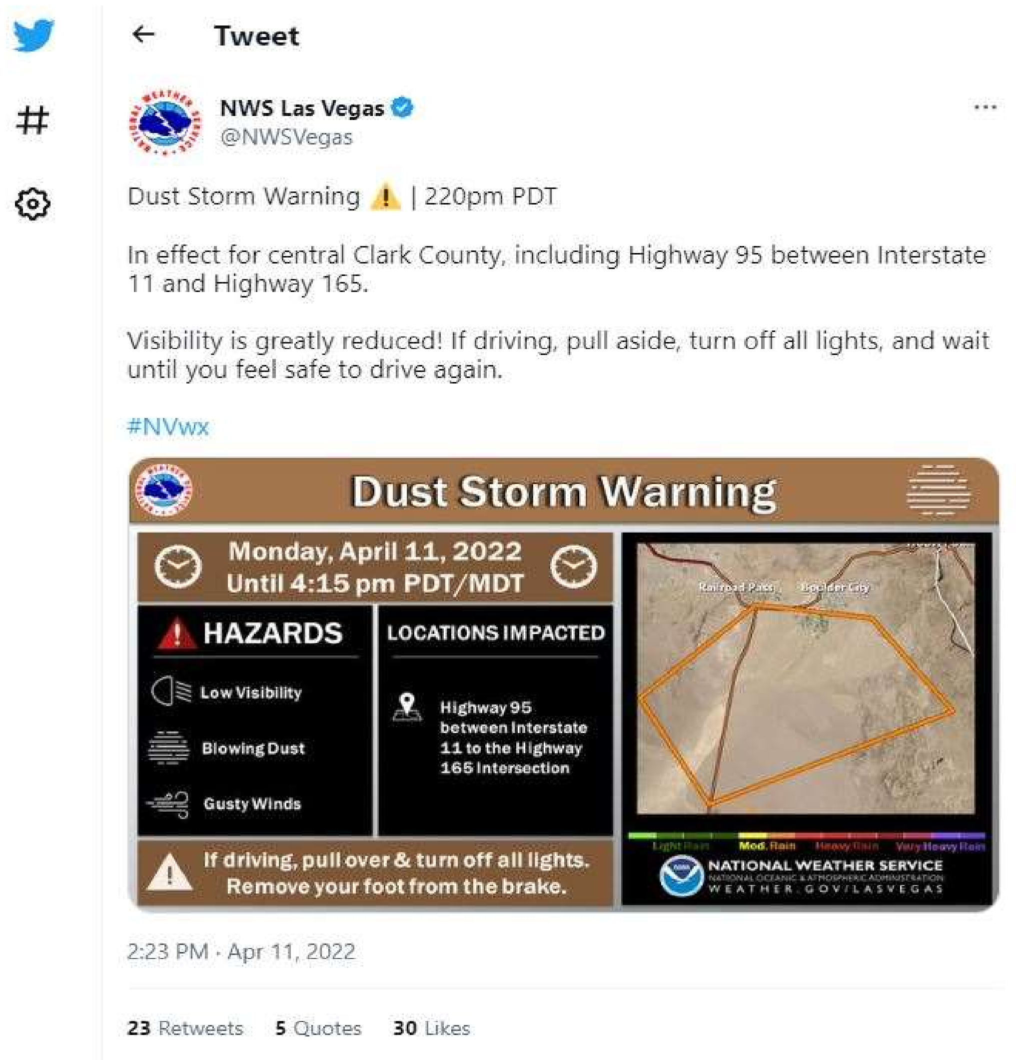

Figure 3.3-4. Twitter post from National Weather Service Las Vegas on April 11, 2022 indicating a dust storm warning for central Clark County.

Figure 3.3-5. Twitter post from National Weather Service Las Vegas on April 11, 2022 indicating a dust storm warning for central Clark County, including Las Vegas metro.

Table 3.3-1 includes all urgent weather messages (include wind advisories) and dust storm warnings for Clark County, the Mojave source region, and surrounding counties also affected by the dust event. These notices are also available in Appendix A.

Table 3.3-1. National Weather Service Las Vegas, Nevada Urgent Weather Message and Dust Storm Warnings issued on April 11, 2022.

Warning	Time (PDT)	Location
Urgent Weather Message	03:00	Northwest Plateau-Northwest Deserts- Lake Mead National Recreation Area- Esmeralda and Central Nye County-Northeast Clark County- Sheep Range, Eastern Sierra Slopes-Owens Valley-White Mountains of Inyo County, Death Valley National Park-Western Mojave Desert-Eastern Mojave Desert, Western Clark and Southern Nye County-Spring Mountains- Red Rock Canyon-Las Vegas Valley-Southern Clark County, Morongo Basin, Lincoln County
Urgent Weather Message	04:28	Western Mojave Desert, Eastern Sierra Slopes-Owens Valley-White Mountains of Inyo County, Death Valley National Park-Eastern Mojave Desert, Northwest Plateau-Northwest Deserts- Lake Mead National Recreation Area- Esmeralda and Central Nye County-Northeast Clark County- Western Clark and Southern Nye County-Sheep Range- Spring Mountains-Red Rock Canyon-Las Vegas Valley-Southern Clark County, Lincoln County, Morongo Basin

Urgent Weather Message	09:47	Eastern Sierra Slopes-Owens Valley-White Mountains of Inyo County, Western Mojave Desert, Death Valley National Park-Eastern Mojave Desert, Northwest Plateau-Northwest Deserts- Lake Mead National Recreation Area- Esmeralda and Central Nye County-Northeast Clark County- Western Clark and Southern Nye County-Sheep Range- Spring Mountains-Red Rock Canyon-Las Vegas Valley-Southern Clark County, Lake Havasu and Fort Mohave-Cadiz Basin-San Bernardino County-Upper Colorado River Valley, Lincoln County, Morongo Basin
Dust Storm Warning	11:36	North central San Bernardino County in southern California
Dust Storm Warning	12:35	North central San Bernardino County in southern California
Dust Storm Warning	13:08	Northeastern San Bernardino County in southern California, Central Clark County in southern Nevada
Dust Storm Warning	13:18	Central Mohave County in northwestern Arizona
Dust Storm Warning	13:30	North central San Bernardino County
Dust Storm Warning	13:38	Northwestern Nye County in south central Nevada, Northeastern Esmeralda County in south central Nevada
Dust Storm Warning	13:57	Northeastern San Bernardino and Central Clark Counties
Dust Storm Warning	14:14	Central Clark County in southern Nevada

Dust Storm Warning	14:24	Northeastern San Bernardino County in southern California, Southeastern Inyo County in south central California, West central Clark County in southern Nevada
Dust Storm Warning	14:35	Central Mohave County
Dust Storm Warning	14:47	Northwestern Nye and northeastern Esmeralda counties
Dust Storm Warning	15:10	Central Mohave County in northwestern Arizona
Dust Storm Warning	15:24	Central San Bernardino County in southern California
Dust Storm Warning	15:26	Northwestern Nye and northeastern Esmeralda counties
Dust Storm Warning	15:32	Central Clark County
Dust Storm Warning	15:35	Northeastern San Bernardino, southeastern Inyo and west central Clark counties
Dust Storm Warning	15:42	Southwestern Inyo County in south central California
Dust Storm Warning	16:08	Central Clark County
Dust Storm Warning	16:10	Northeastern San Bernardino, southeastern Inyo and west central Clark counties
Dust Storm Warning	16:15	Central San Bernardino County
Dust Storm Warning	16:34	Southwestern Inyo County
Dust Storm Warning	16:50	West central Mohave County in northwestern Arizona
Dust Storm Warning	16:57	Central Mohave County
Dust Storm Warning	17:15	Central San Bernardino County
Dust Storm Warning	17:40	Southwestern Inyo County
Dust Storm Warning	17:42	Central Mohave County
Dust Storm Warning	19:07	Central Mohave County in northwestern Arizona
Dust Storm Warning	20:22	Central Mohave County
Dust Storm Warning	21:00	Central Mohave County

3.3.3 Pollutant and Diurnal Analysis

As discussed in Section 3.2, PM_{10} concentrations in the Las Vegas Valley start to increase in the late morning on April 11, 2022, which coincides with the increasing winds caused by a frontal passage. Figure 3.3-6 shows a nearly simultaneous sharp increase in PM_{10} concentrations at almost all sites in the Las Vegas Valley. PM_{10} concentrations rise slightly earlier at more western sites, such as the Palo Verde and Walter Johnson sites, due to the westerly wind directions on April 11. PM_{10} concentrations at most sites reach a local maximum at approximately 12:00-13:00 PST on April 11, followed by a small decrease in the proceeding few hours, then an absolute maximum at approximately 16:00 PST. PM_{10} concentrations at the Green Valley, Joe Neal, Palo Verde, Paul Meyer, Sunrise Acres, Walnut Community Center, and Walter Johnson sites reach above 1,000 µg/m^3 at 16:00 PST, then decrease throughout the day as winds move dust out of the area. The concurrent rise in PM_{10} at all sites around Clark County indicates a regional dust event.

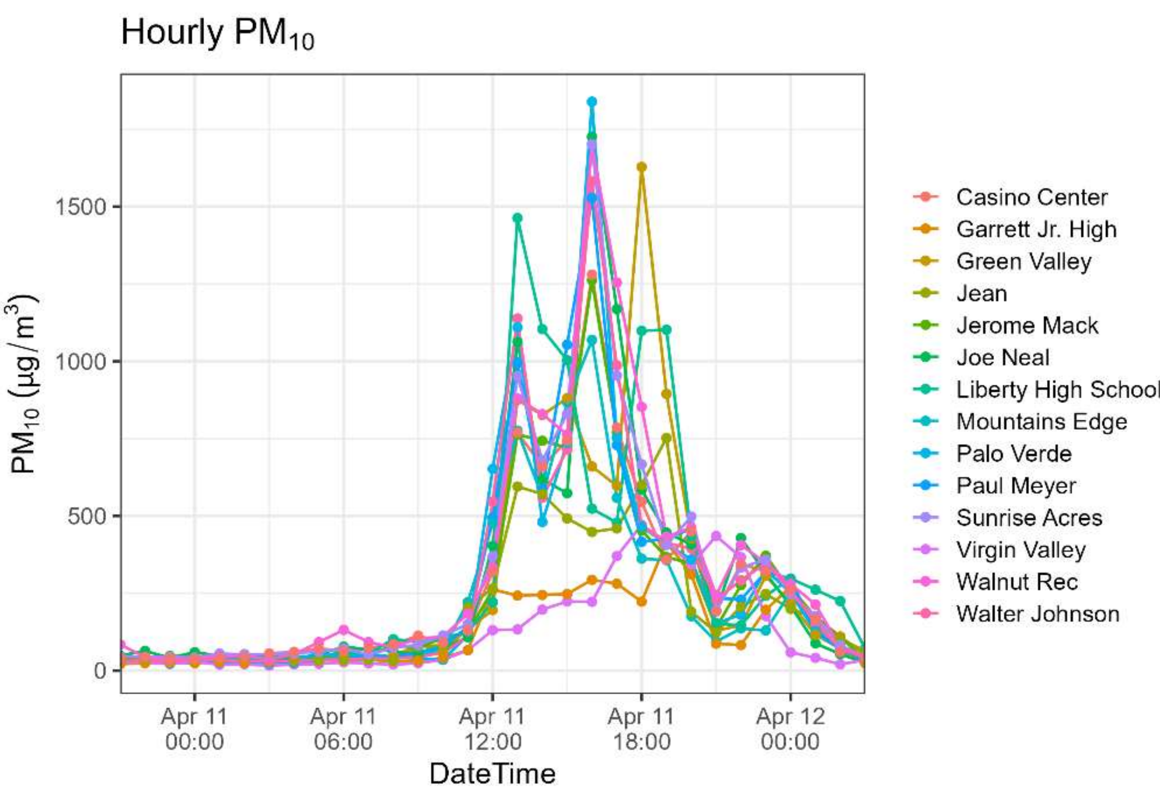

Figure 3.3-6. Hourly PM_{10} observations from all Clark County measurement sites on the event date, including the regulatorily significant sites: Paul Meyer, Mountains Edge, Walter Johnson, Palo Verde, Joe Neal, Green Valley, Liberty High School, Jerome Mack, Sunrise Acres, and Walnut Rec.

Figure 3.3-7 shows the measured hourly PM_{10} concentrations on April 11, 2022 together with the diurnal profile of the historical hourly data from 2018-2022. On April 11, 2022 starting from 09:00 PST, the hourly PM_{10} began surpassing the five-year 95th percentile. Peak values near 1,500 µg/m^3 were observed between 16:00 and 18:00 PST.

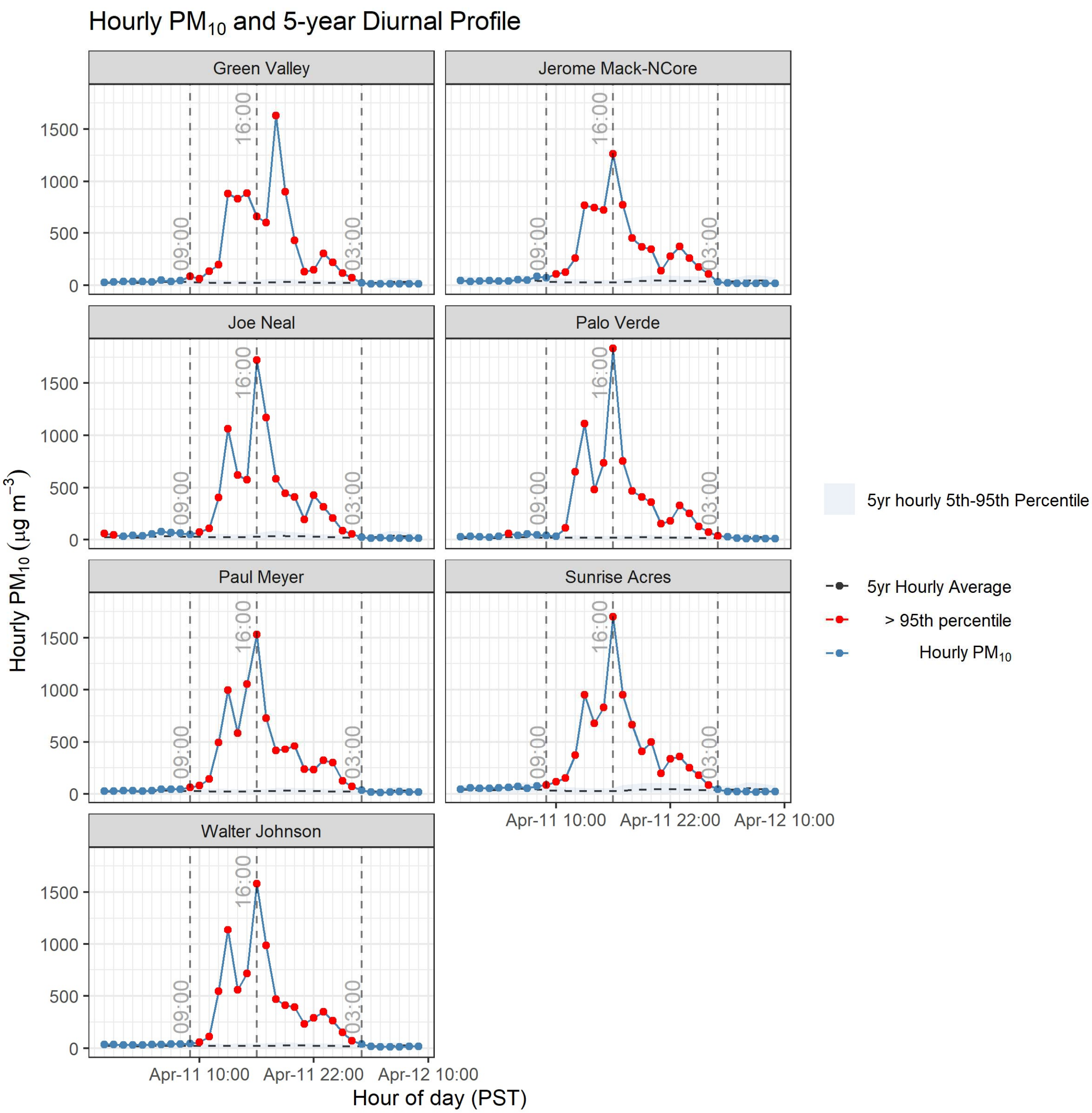

Figure 3.3-7. Measured hourly PM_{10} values compared to five-year diurnal pattern. The dotted solid line represents the hourly PM_{10} values measured on the event day. The dashed line represents the mean hourly PM_{10} for each hour of the day from 2018-2022 at each site and the blue shaded area indicates the 5th - 95th percentile.

The 24-hour average PM_{10} values at all sites in Clark County before the exceedance event on April 11, 2022, were below or at 50 µg/m³ and below the 99th percentile of the five-year (2018-2022) historical values (Figure 3.3-8). On April 11, 2022, the day of the exceedance, the 24-hour average PM_{10} values at all but one site exceeded the 24-hour PM_{10} NAAQS value of 150 µg/m³, and all sites exceeded the 99th percentile. The simultaneous increase in PM_{10} concentrations at all sites, with many exceeding the NAAQS threshold, suggests a regional source of PM_{10} such as a wind-blown dust event.

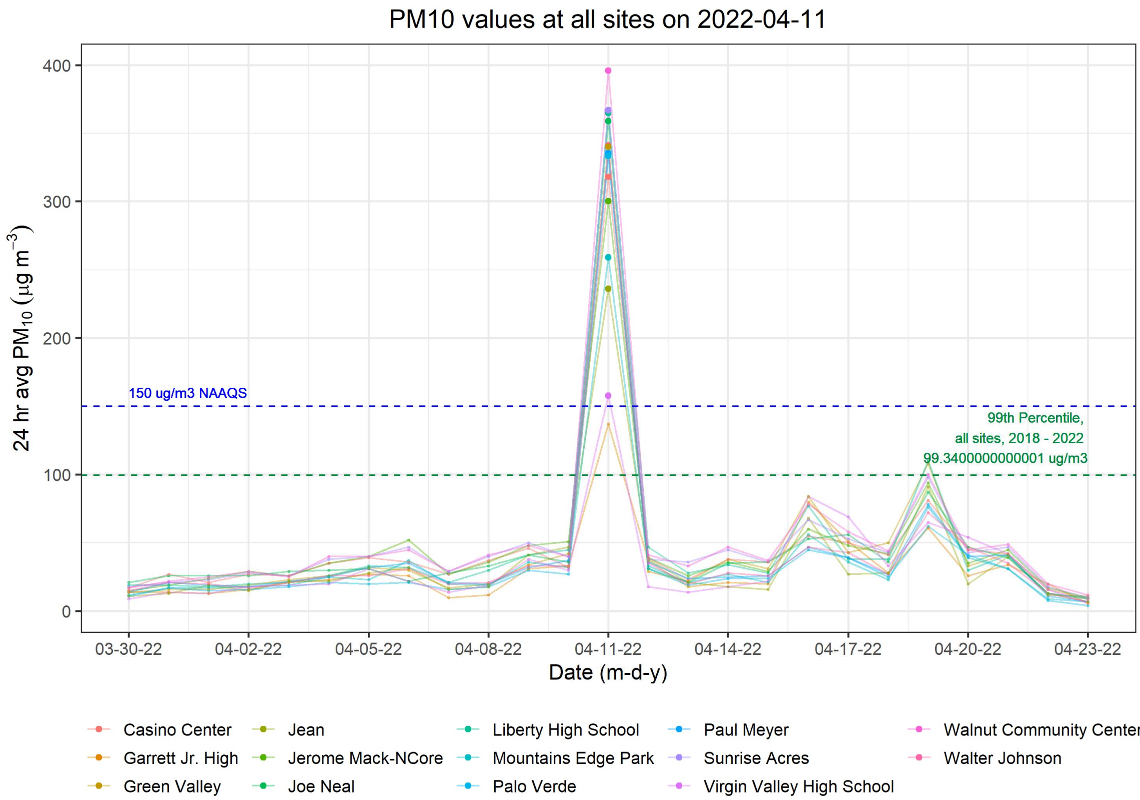

Figure 3.3-8. PM_{10} values at all Clark County, Nevada measurement Sites from March 30, 2022 to April 23, 2022 with NAAQS (blue dash) indicated. The green dashed line indicates the 99th percentile of 99.34 µg/m³ of the five-year historical values at these sites.

3.3.4 Particulate Matter Analysis

Before the high wind dust event on April 11, 2022, the hourly $PM_{2.5}$ to PM_{10} ratio is approximately average at all sites except Jean based on the 2018 – 2022 ratio data (Figure 3.3-9). Late morning on April 11, the hourly $PM_{2.5}/PM_{10}$ ratio at all sites dropped below the 5th percentile for the remainder of the day. The low value of less than 0.1 is consistent with values from dust events reported in studies (Jiang et al., 2018). The decrease in the $PM_{2.5}/PM_{10}$ ratio observed during the late morning is also consistent with the increase in hourly PM_{10} concentrations as described in Section 3.3.2.

$PM_{2.5}/PM_{10}$ ratios rise mid-morning on April 12, then continue to rise to less than normal levels throughout the day following the high wind dust event.

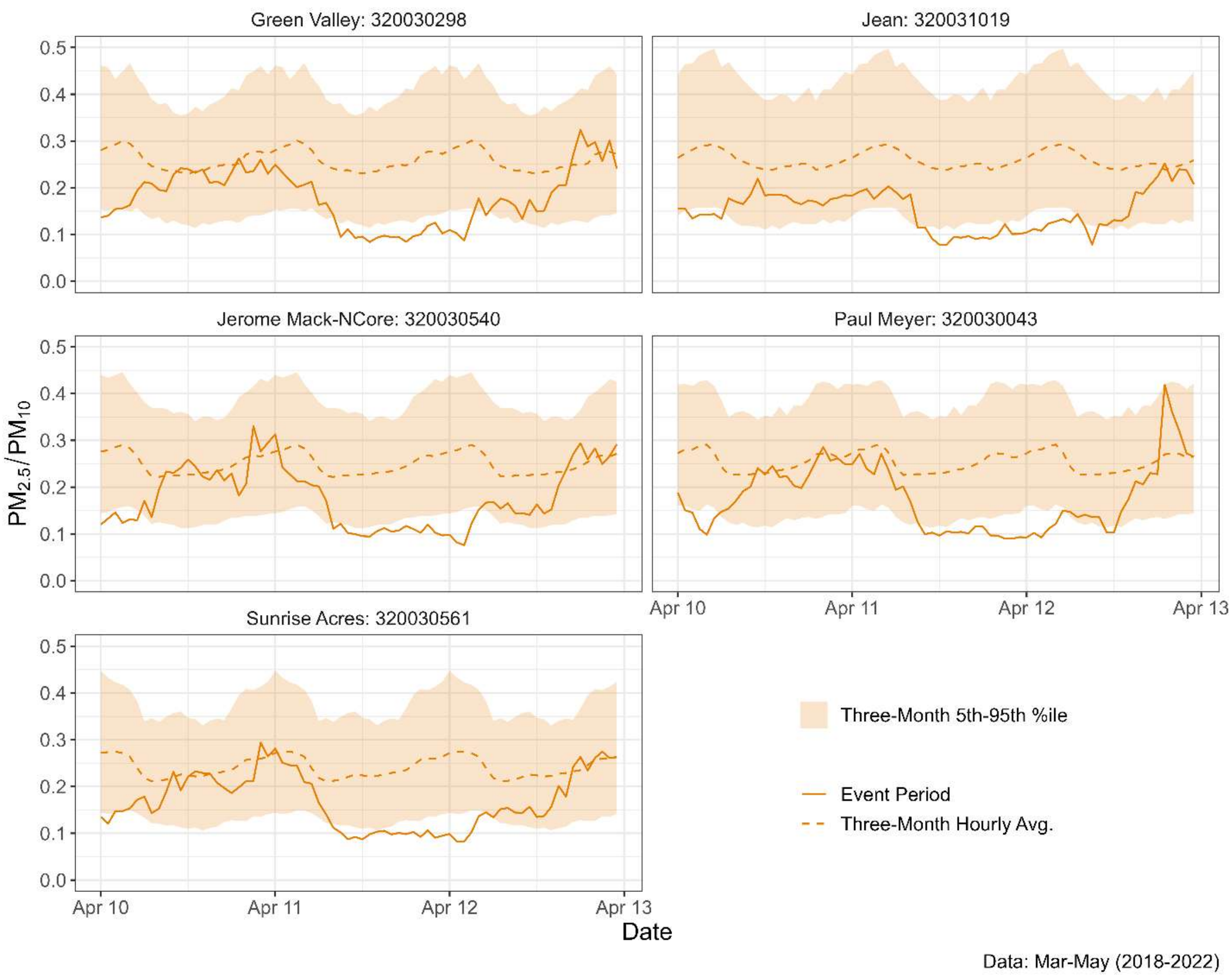

Figure 3.3-9. Ratio of $PM_{2.5}/PM_{10}$ concentrations at the Green Valley, Jean, Jerome Mack, Paul Meyer, and Sunrise Acres sites before, during, and after the April 11, 2022, PM_{10} exceedance. The five-year average $PM_{2.5}/PM_{10}$ diurnal ratio is displayed as a dotted line, and the 5th to 95th percentile range is shown as a shaded ribbon. The average and 5th to 95th percentile ratio is calculated across March – May of 2018 – 2022.

Speciated $PM_{2.5}$ measurements were recorded at Jerome Mack on April 11, 2022. $PM_{2.5}$ measurements are collected on a three-day cadence in Clark County. Figure 3.3-10 shows the measurement of crustal elements calcium, iron, and potassium as well as soil during the wind-blown dust event in comparison to the 90th percentile measurement calculated across seven years of data. On April 11, the concentration of each examined parameter was well above the 90th percentile concentration. This evidence strongly supports the abundance of airborne, soil-based dust during the event period.

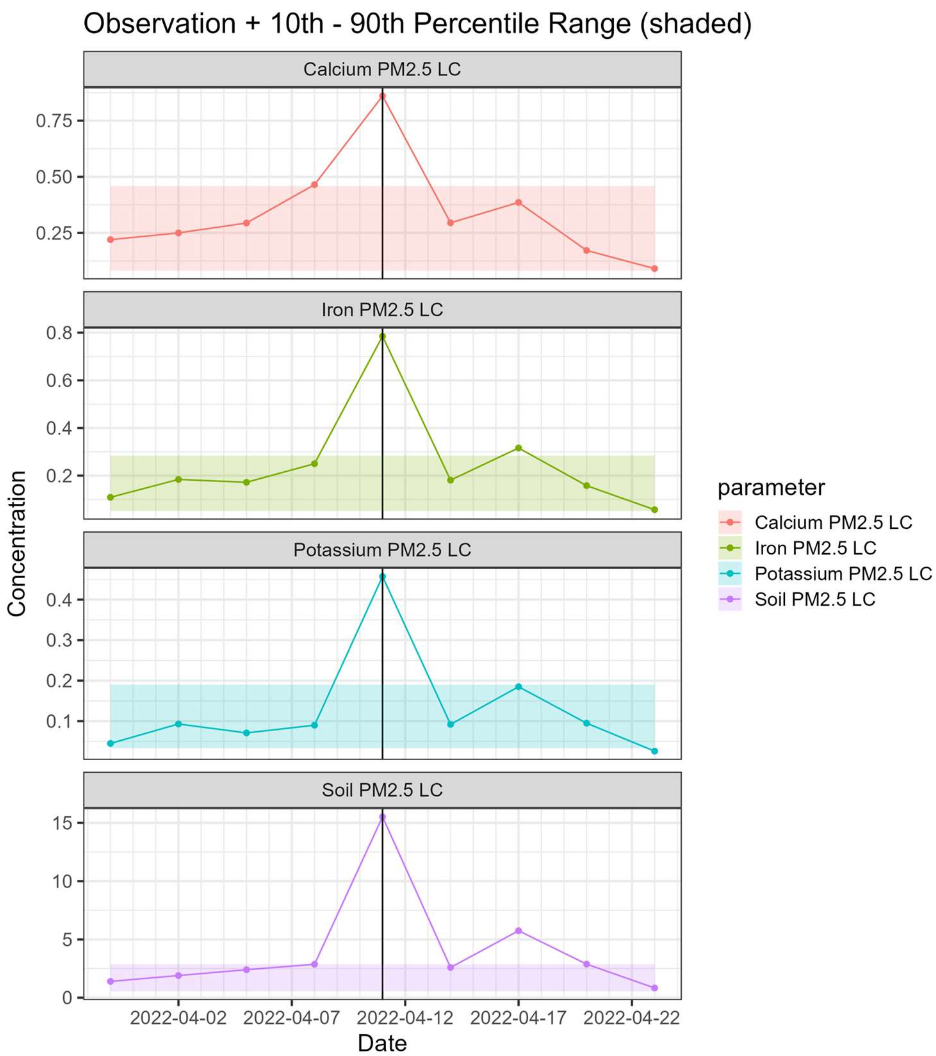

Figure 3.3-10. Speciated $PM_{2.5}$ measurements recorded at Jerome Mack. The shaded region shows the 10th - 90th percentile of measurements calculated over seven years (2016-2022).

3.3.5 Visibility/Ground-Based Images

Visibility data is available from airport monitoring sites through the NWS Weather and Hazards Data Viewer. Figure 3.3-11 shows visibility observations on April 11, 2022 at Harry Reid Int'l Airport (LAS) in Las Vegas. Concurrent with the increasing wind speeds and the estimated time of frontal passage, visibility decreases between 10:00-15:00 PST, and remains below the 10-mile maximum measurement through midnight. This is confirmed by camera images in the Las Vegas Valley (Figure 3.3-12 through Figure 3.3-18), which show intensification of dusty conditions and low visibility between 10:00 and 15:00 PST. Images end at 16:00 PST due to limitations of photography in low-light conditions.

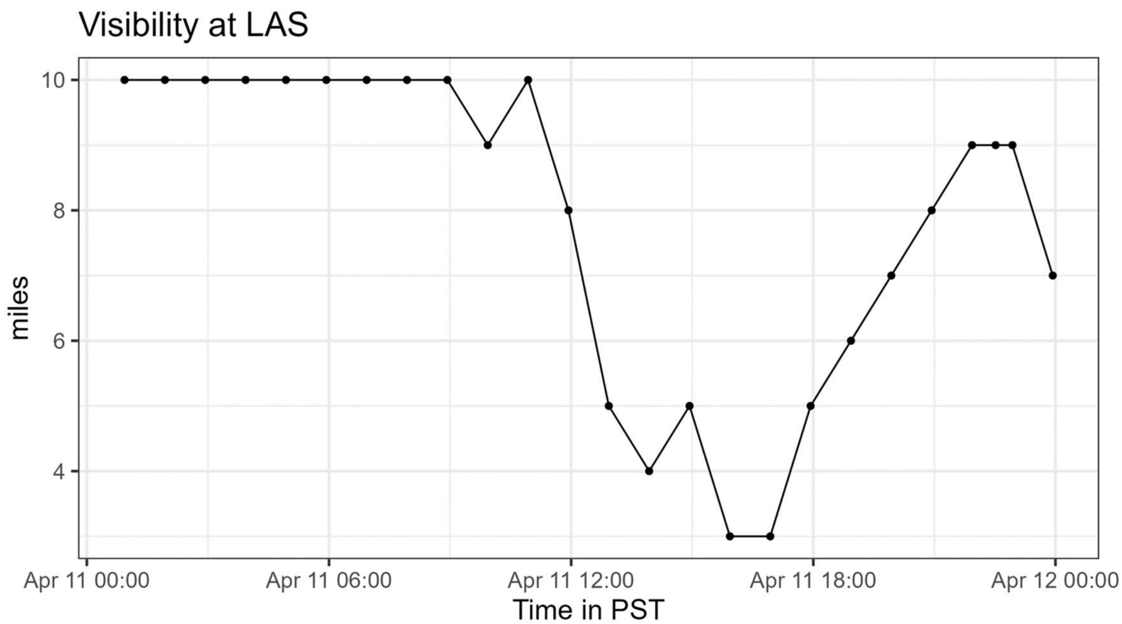

Figure 3.3-11. Visibility in miles on April 11, 2022 recorded as Harry Reid Int'l Airport. Visibility data is sourced from the Iowa Environmental Mesonet (https://mesonet.agron.iastate.edu/).

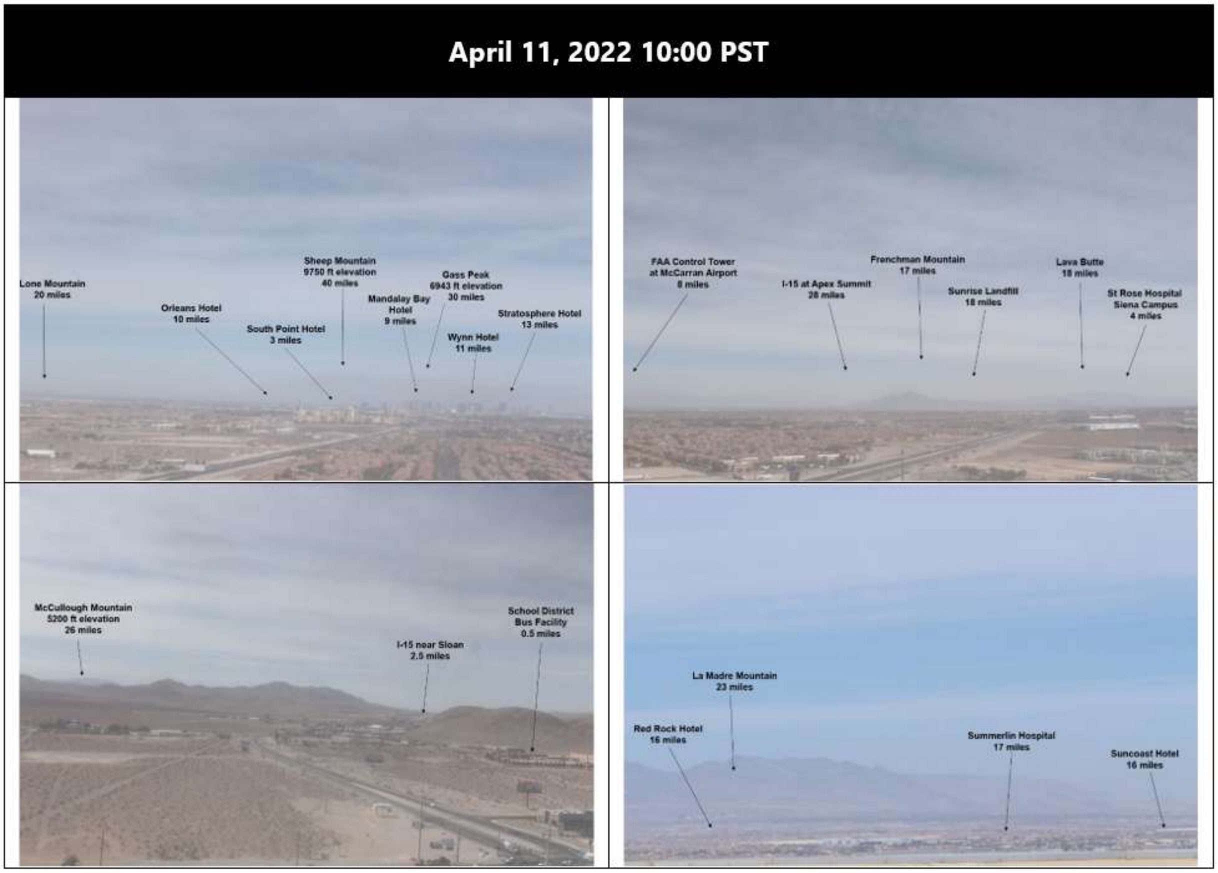

Figure 3.3-12. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on April 11, 2022 10:00 PST.

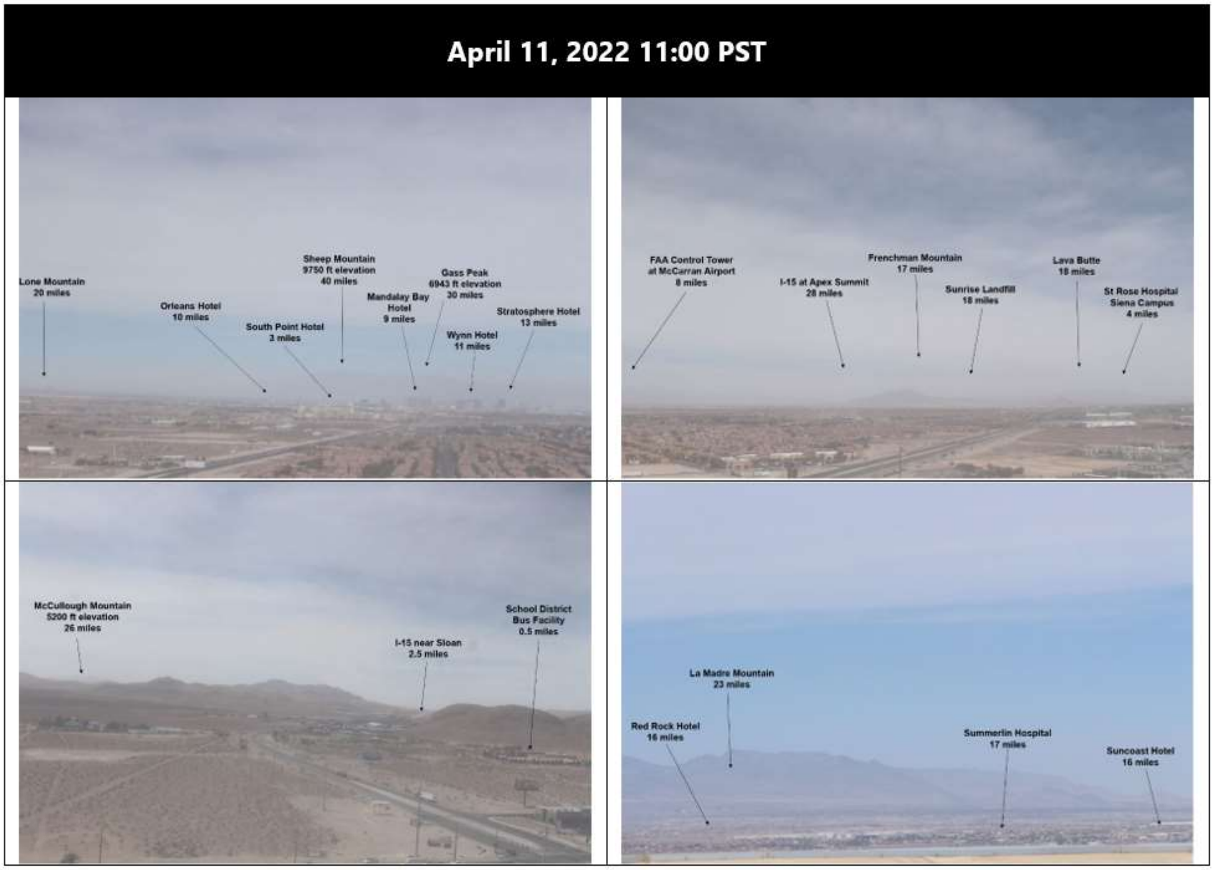

Figure 3.3-13. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on April 11, 2022 11:00 PST.

Figure 3.3-14. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on April 11, 2022 12:00 PST.

Figure 3.3-15. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on April 11, 2022 13:00 PST.

Figure 3.3-16. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on April 11, 2022 14:00 PST.

Figure 3.3-17. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on April 11, 2022 15:00 PST.

Figure 3.3-18. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on April 11, 2022 16:00 PST.

Overall, we find overwhelming evidence that PM_{10} was transported from the Mojave Desert in southeastern California to Clark County by approximately 10:00-12:00 PST on April 11, 2022. PM_{10} concentrations increase along with the frontal passage that entered the Clark County area at approximately 10:00 PST and peaked at around 13:00-16:00 PST on April 11. This suggests that Clark County was impacted by a regional high wind dust event originating in the Mojave Desert. The evidence corroborating this assertion includes (1) forecasted alerts and media coverage in Clark County and surrounding areas, (2) an abrupt, concurrent increase at all PM_{10} monitoring sites in Clark County, (3) a drop in $PM_{2.5}/PM_{10}$ values indicating windblown dust sources, (4) decreased visibility at the Las Vegas airport corresponding with the PM_{10} event time of arrival, and (5) extremely dusty ground-based images from the M Resort Hotel in Las Vegas on April 11, 2022. All pieces of evidence suggest a significant impact of windblown dust at the surface in Clark County on the event date.

3.4 Comparison of Exceptional Event with Historical Data

3.4.1 Percentile Ranking

The 24-hour average PM_{10} concentration observed on April 11, 2022 ranked above the 99th percentile of all the concentrations observed in the five-year period from 2018-2022 at all sites, and was the highest measurement recorded in the period at six out of ten sites (Table 3.4-1).

Table 3.4-1. Five-year* (2018-2022) rank and percentile of PM_{10} values on April 11, 2022 at affected sites. *Sites where data collection began less than five-years ago are indicated.

Date	Site	Rank	Percentile	24-hour PM_{10} (µg/m^3)
4/11/2022	Casino Center*	1	100	318
4/11/2022	Green Valley	2	99.95	340
4/11/2022	Jean	1	100	236
4/11/2022	Jerome Mack	4	99.83	300
4/11/2022	Joe Neal	3	99.89	359
4/11/2022	Liberty High School*	1	100	365
4/11/2022	Mountains Edge Park*	2	99.88	259
4/11/2022	Palo Verde	1	100	333
4/11/2022	Paul Meyer	1	100	335
4/11/2022	Sunrise Acres	2	99.94	367
4/11/2022	Virgin Valley High School*	3	99.72	158
4/11/2022	Walnut Community Center*	2	99.83	396
4/11/2022	Walter Johnson	1	100	341

An annual time series of 24-hour average PM_{10} concentrations for each affected site is provided in Figure 3.4-1 through Figure 3.4-13. April 11, 2022 is marked by a red point for comparison to the 150 µg/m^3 NAAQS threshold (blue line) and the five-year (2018-2022) 99th percentile (green line) described in Table 2.2-1 (note that for Garrett Jr. High and Liberty High School sites data only dates back to spring 2021). At all sites, observations on April 11 were above the five-year 99th percentile.

A five-year time series of 24-hour average PM_{10} concentrations for each affected site is provided in Figure 3.4-14 through Figure 3.4-26 to compare the event day to the range of normal values. Other exceedances of the 150 µg/m^3 NAAQS threshold (blue dashed line) were further investigated for potential dust event evidence based on meteorological data and visibility camera images to compare to April 11, 2022. Days which showed preliminary evidence of being a high-wind dust event or for which other exceptional event narratives have been prepared are also marked in the annual and five-year time series figures at all sites.

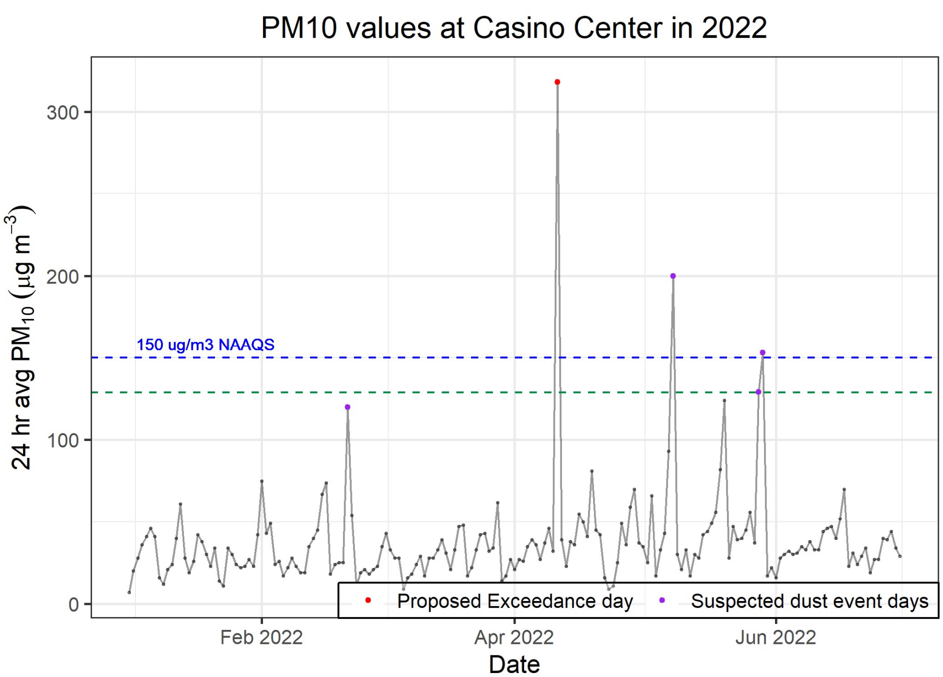

Figure 3.4-1. Casino Center 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

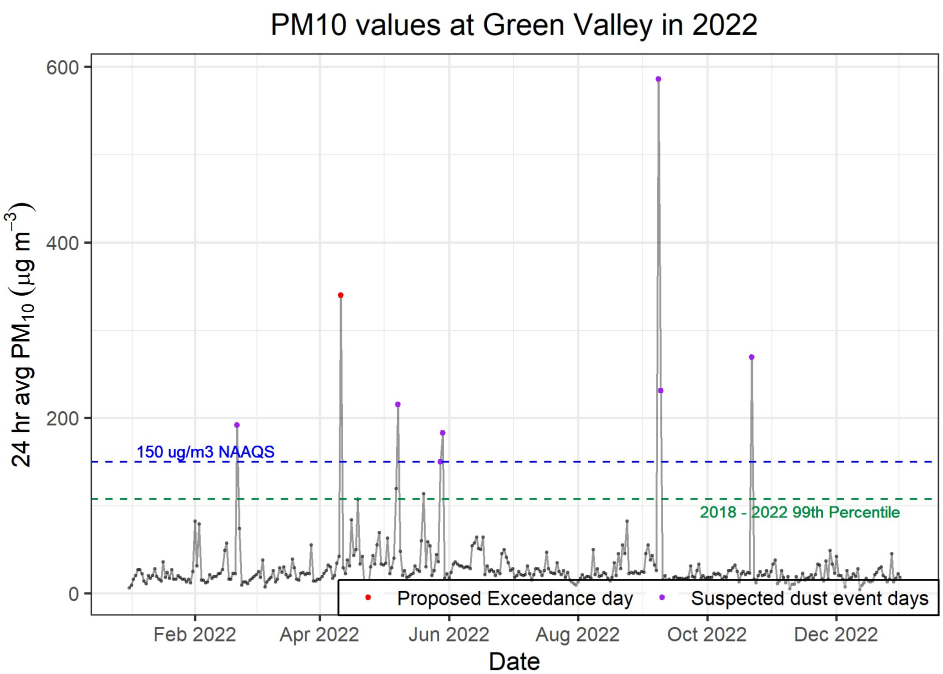

Figure 3.4-2. Green Valley 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

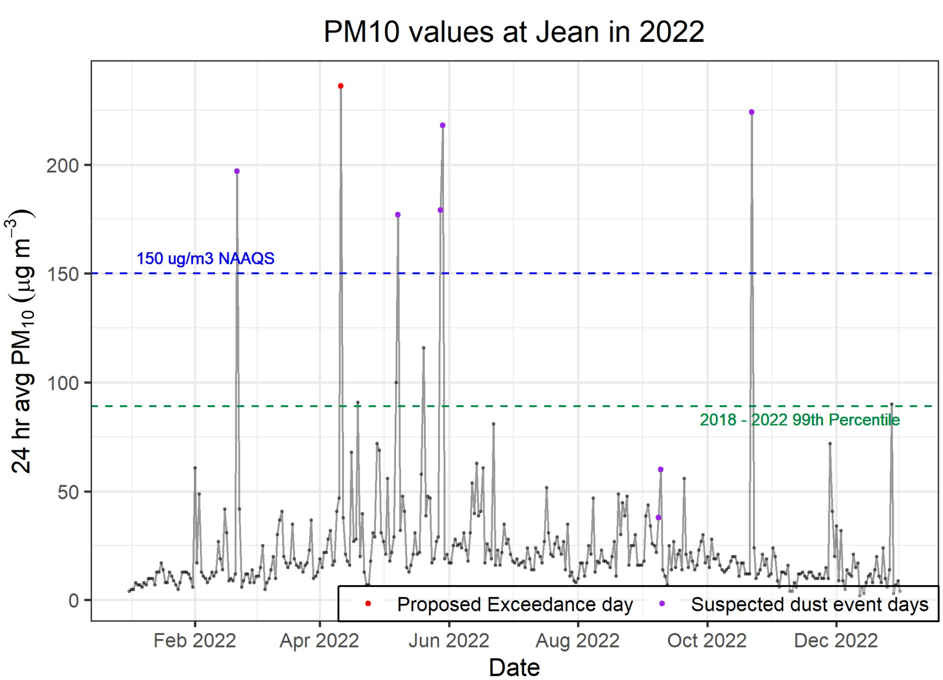

Figure 3.4-3. Jean 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

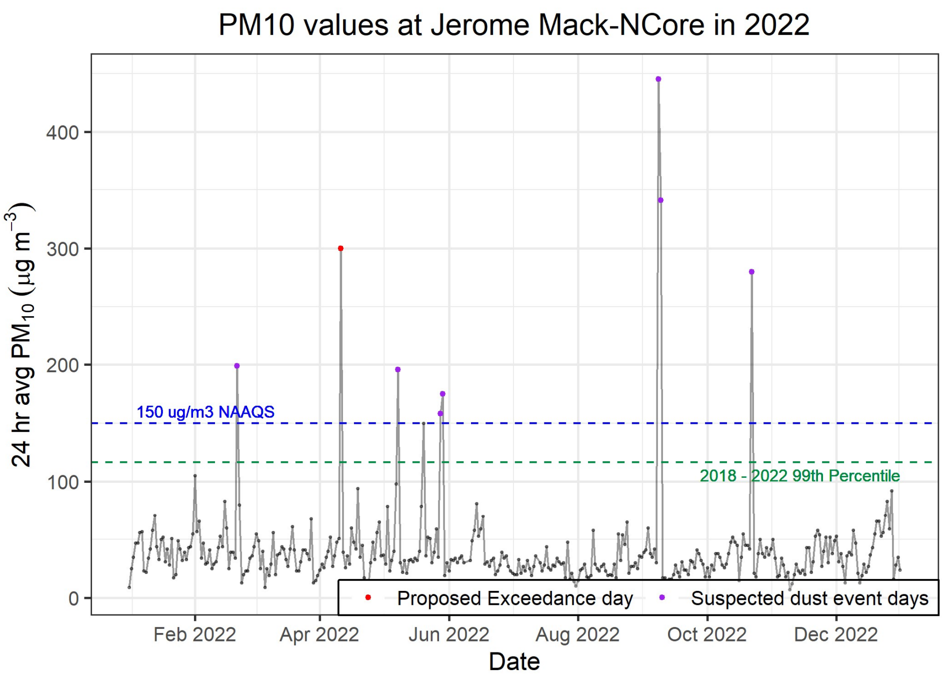

Figure 3.4-4. Jerome Mack 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

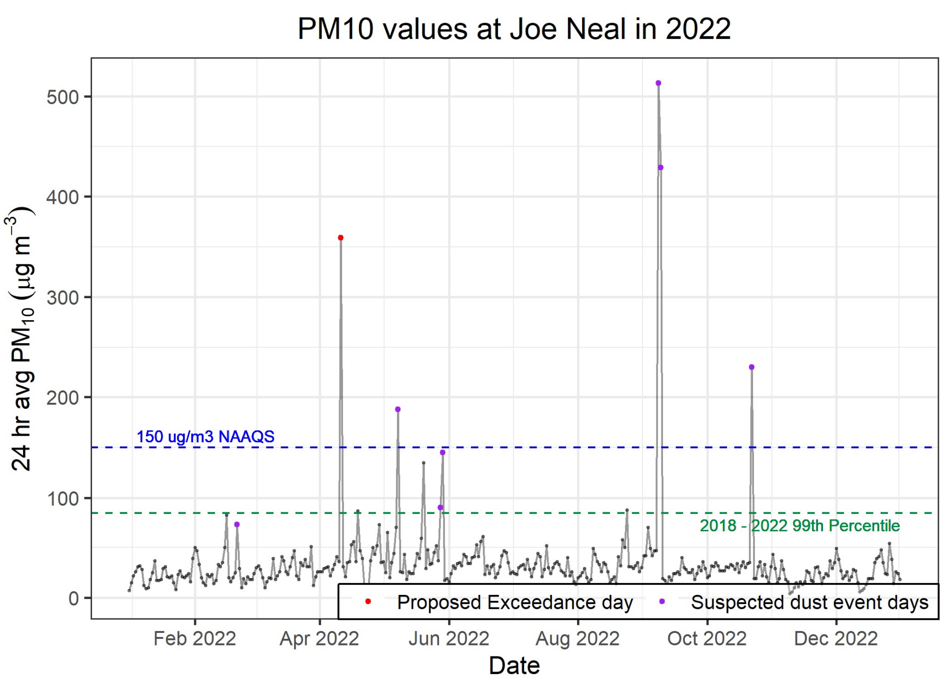

Figure 3.4-5. Joe Neal 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

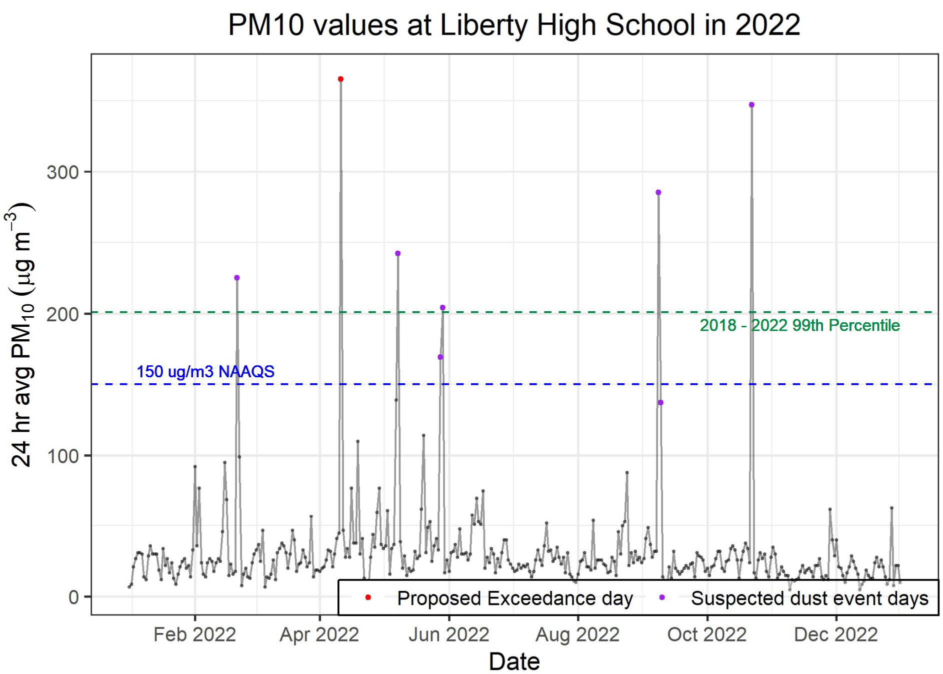

Figure 3.4-6. Liberty High School 24-hour PM_{10} measurement in μg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

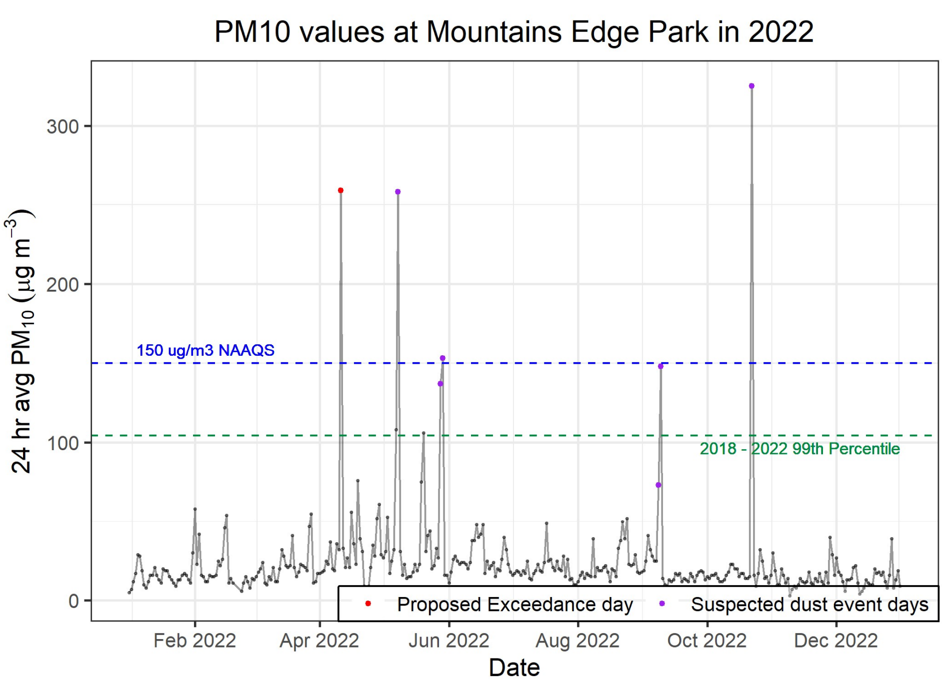

Figure 3.4-7. Mountains Edge Park 24-hour PM_{10} measurement in μg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

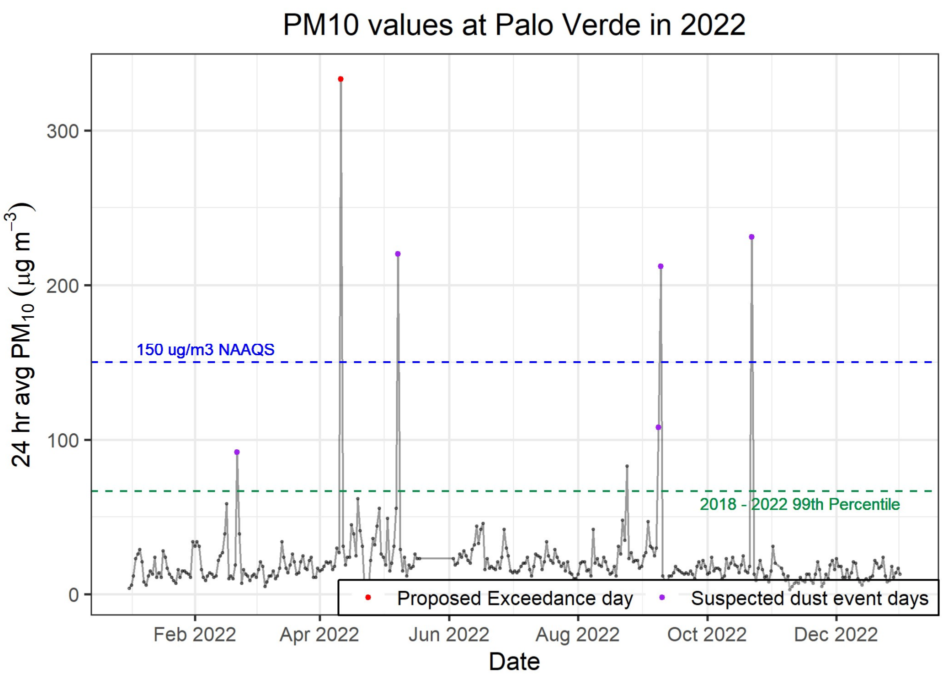

Figure 3.4-8. Palo Verde 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

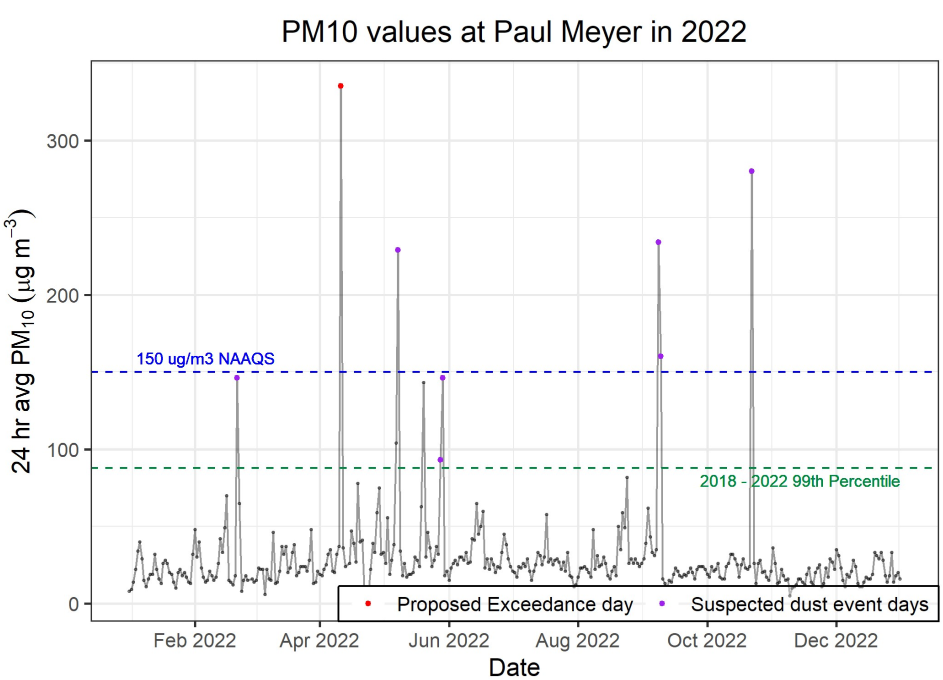

Figure 3.4-9. Paul Meyer 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

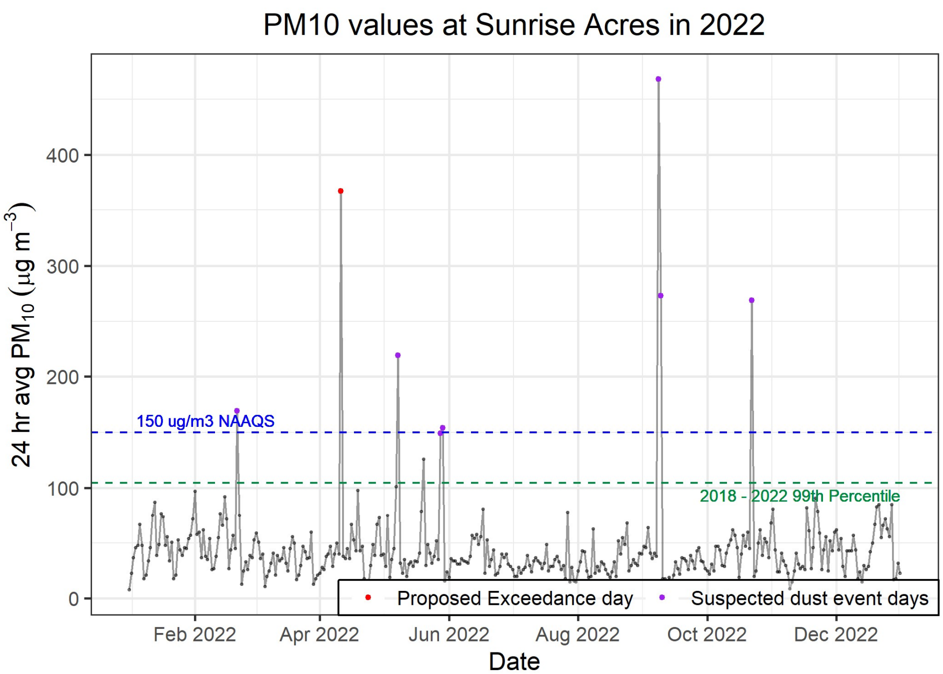

Figure 3.4-10. Sunrise Acres 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

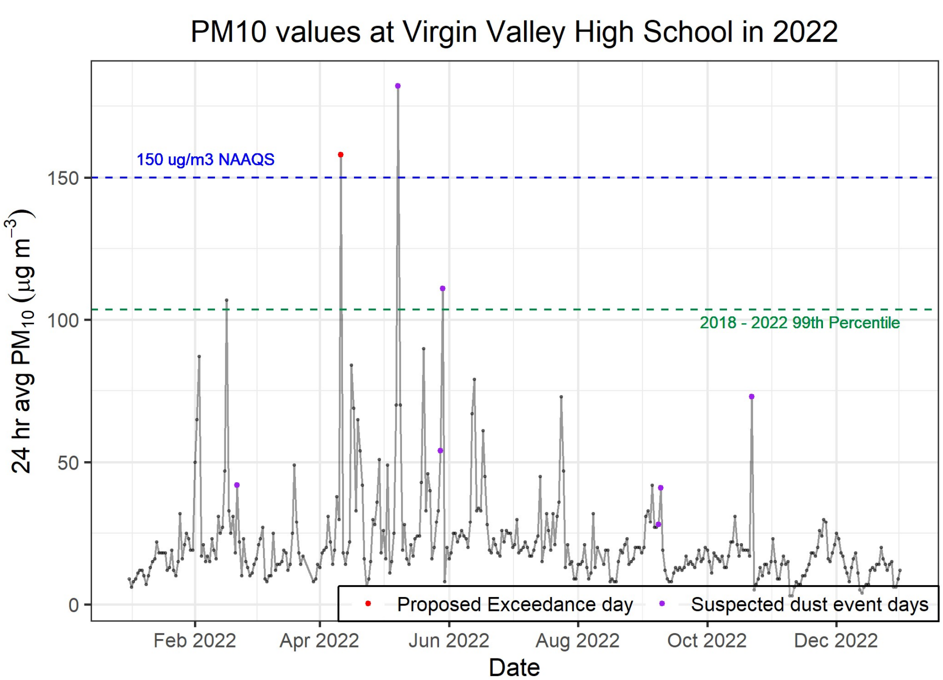

Figure 3.4-11. Virgin Valley High School 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

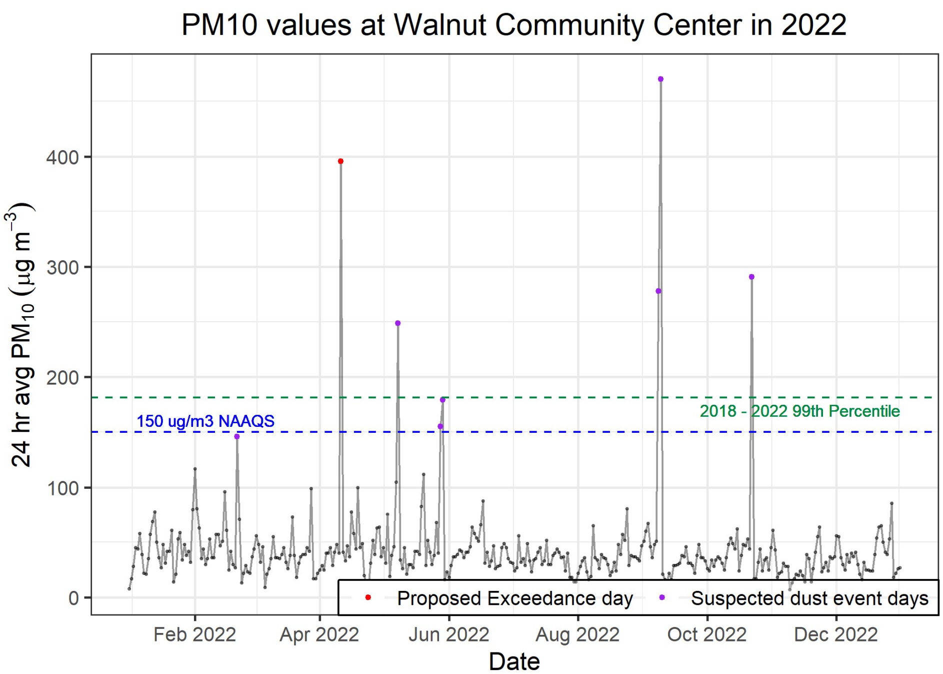

Figure 3.4-12. Walnut Community Center 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

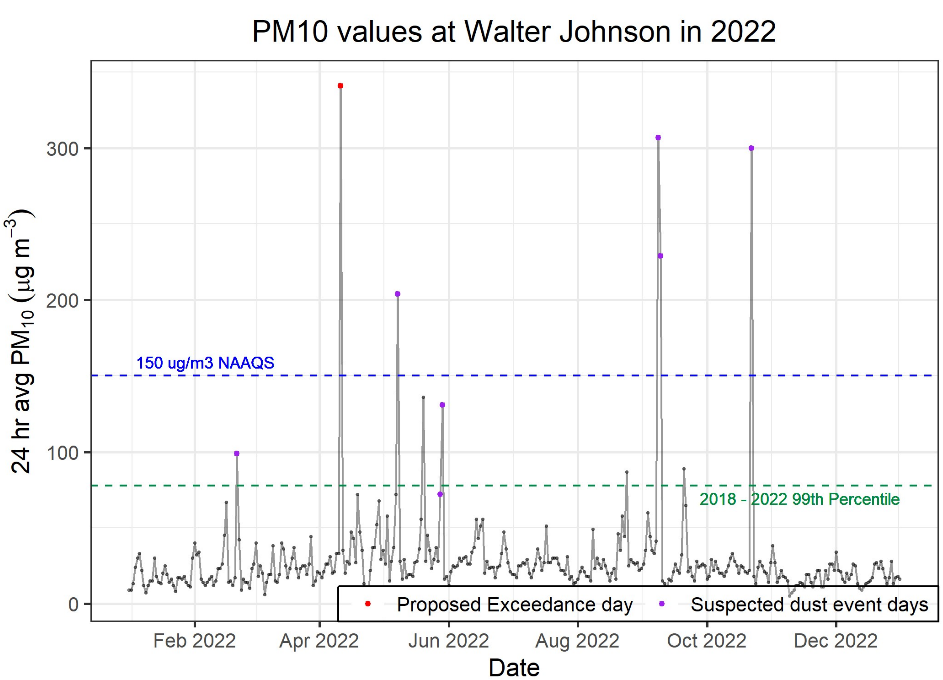

Figure 3.4-13. Walter Johnson 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) 2018-2022 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

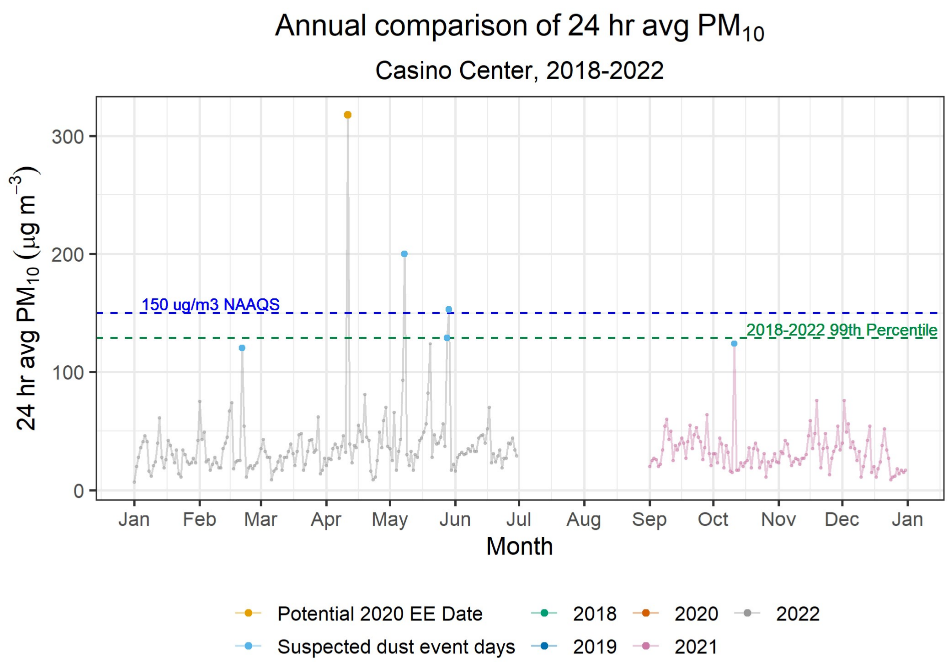

Figure 3.4-14. Casino Center 24-hour PM_{10} measurements in µg/m³ from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

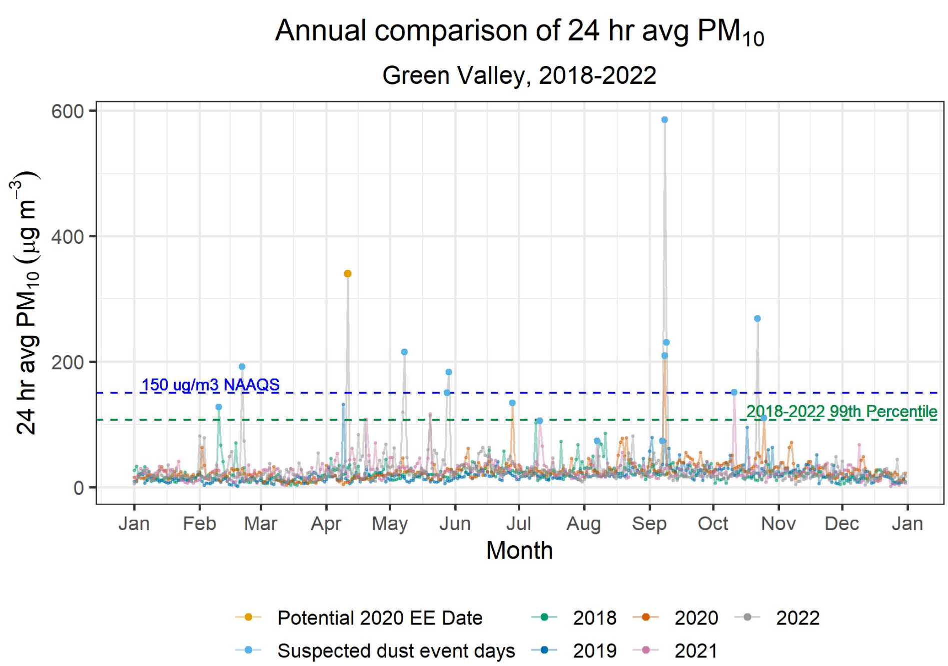

Figure 3.4-15. Green Valley 24-hour PM_{10} measurements in µg/m³ from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

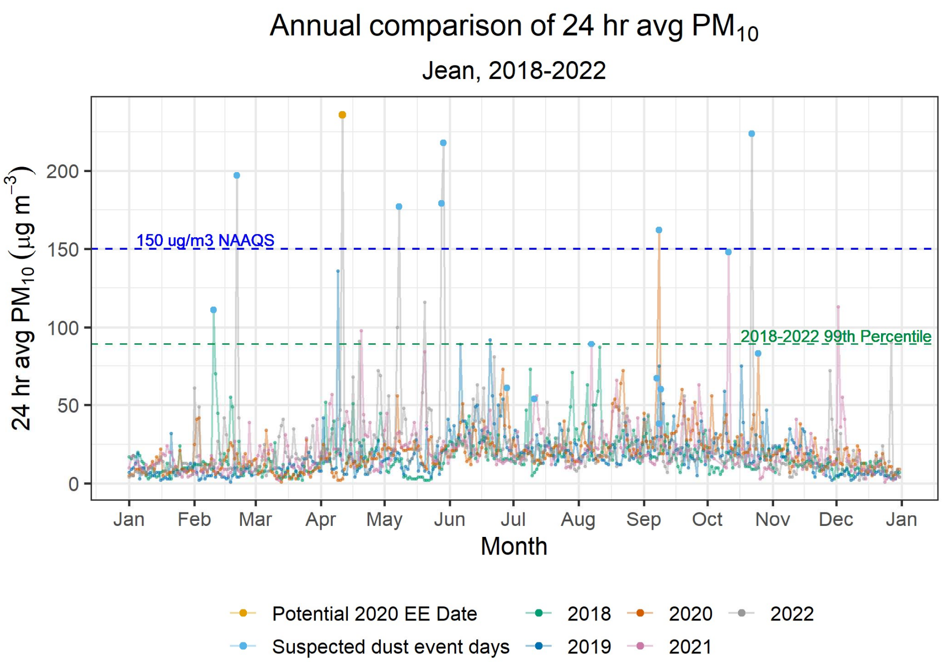

Figure 3.4-16. Jean 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

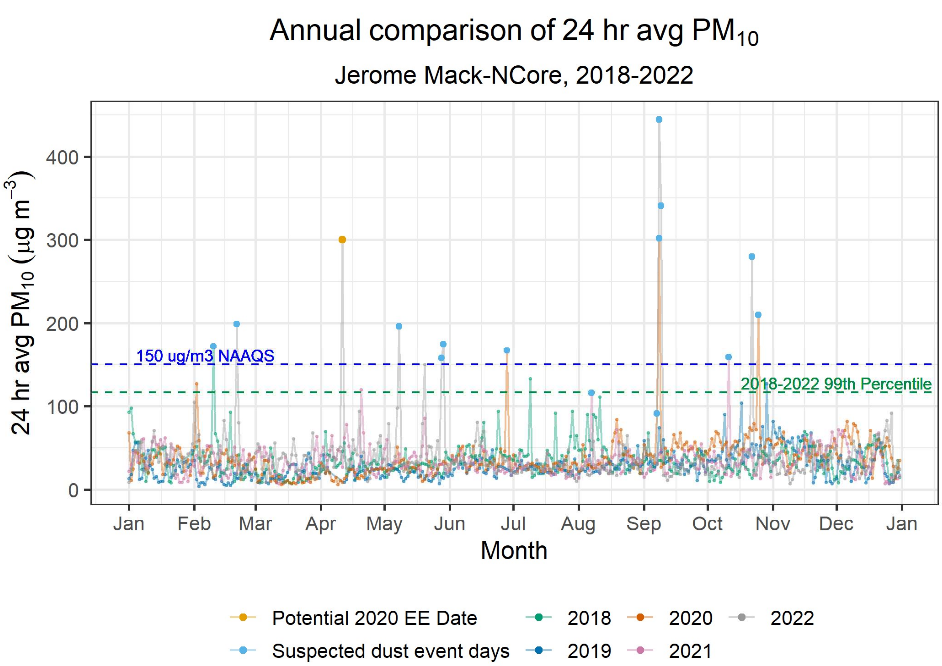

Figure 3.4-17. Jerome Mack 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

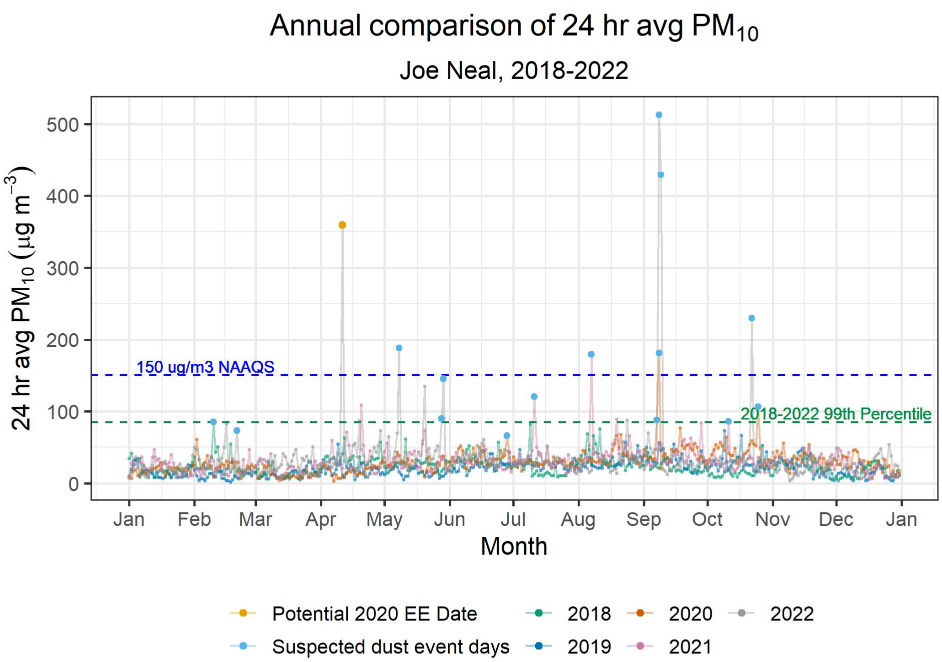

Figure 3.4-18. Joe Neal 24-hour PM_{10} measurements in µg/m³ from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

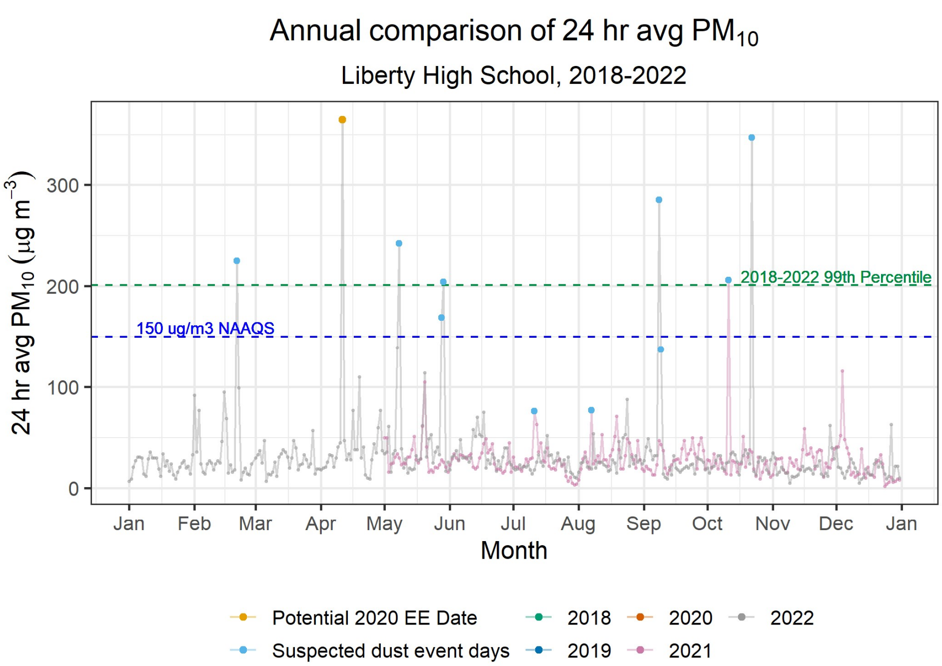

Figure 3.4-19. Liberty High School 24-hour PM_{10} measurements in µg/m³ from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

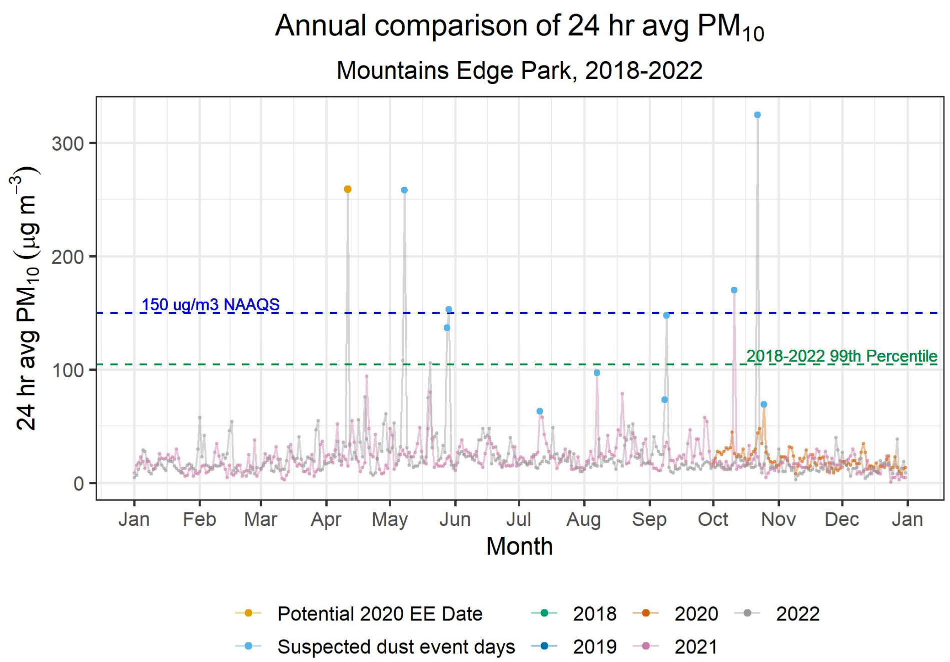

Figure 3.4-20. Mountains Edge Park 24-hour PM_{10} measurements in μg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

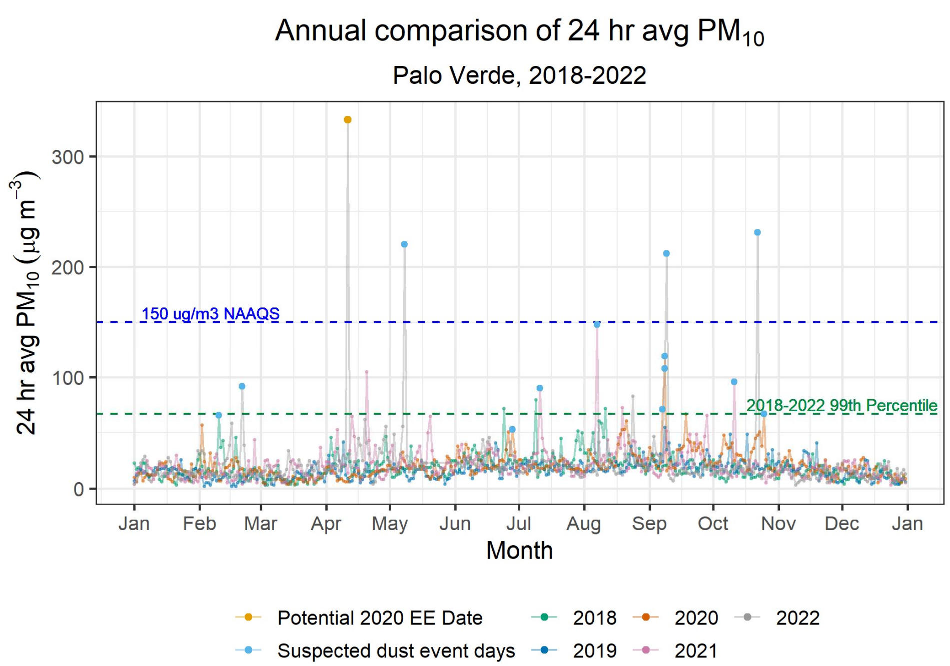

Figure 3.4-21. Palo Verde 24-hour PM_{10} measurements in μg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

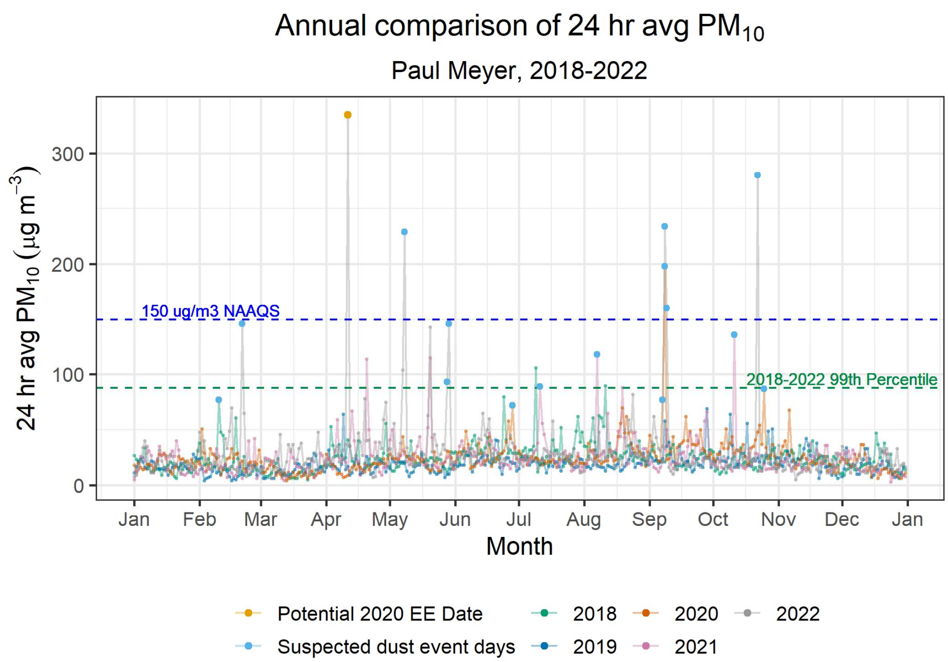

Figure 3.4-22. Paul Meyer 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

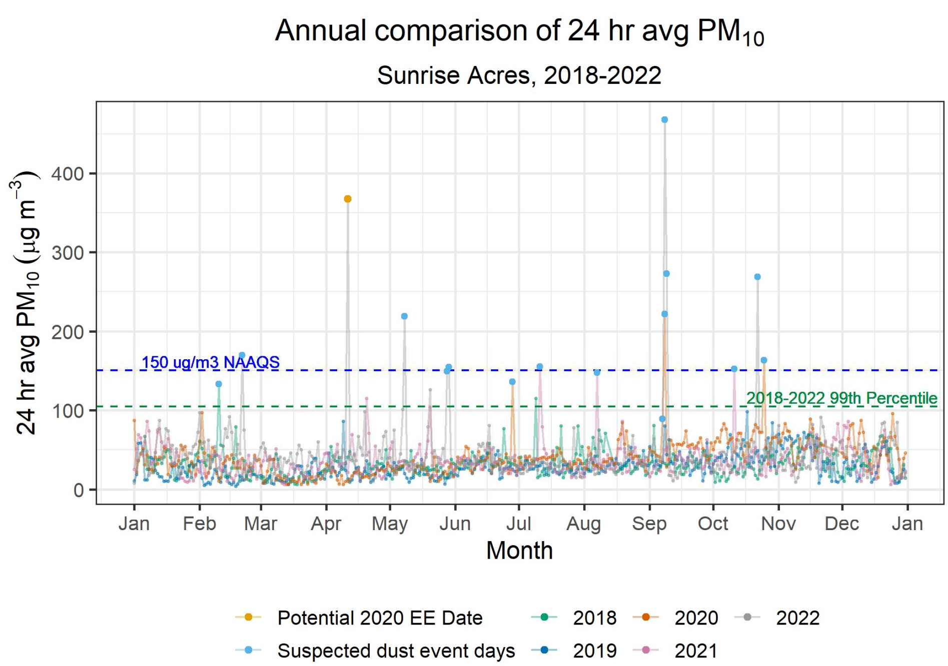

Figure 3.4-23. Sunrise Acres 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

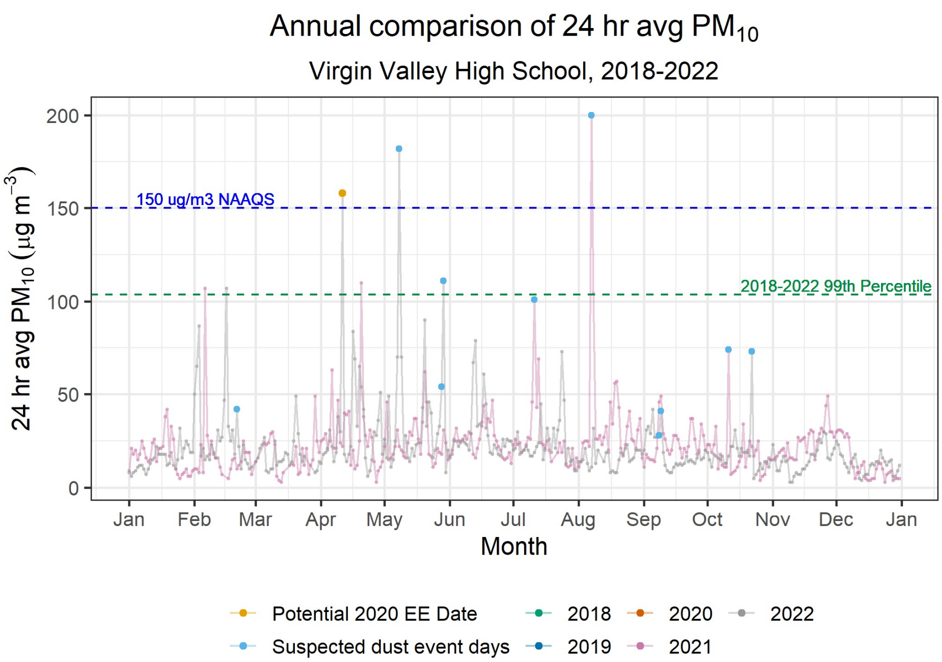

Figure 3.4-24. Virgin Valley High School 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

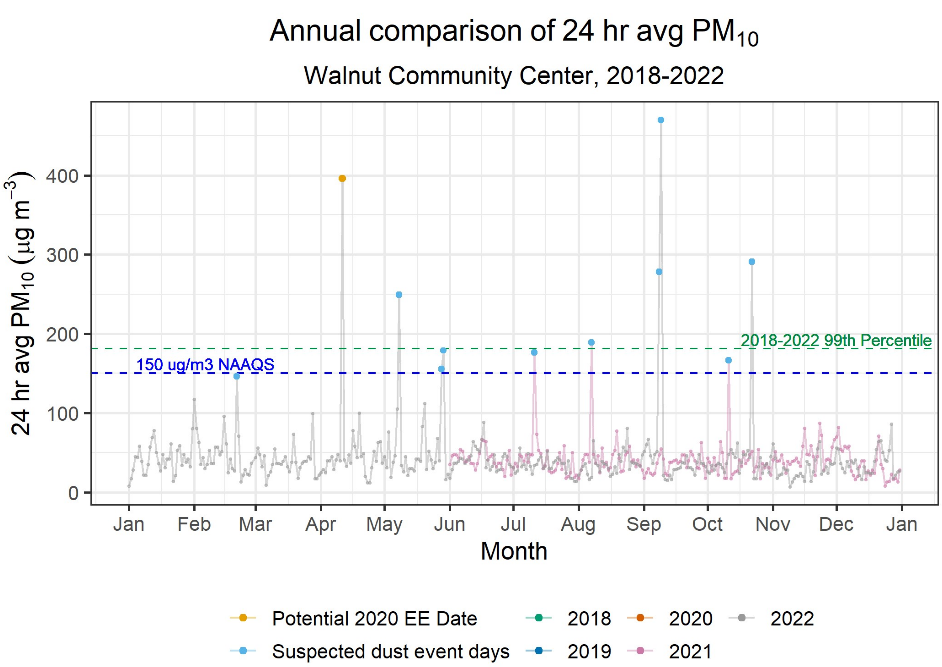

Figure 3.4-25. Walnut Community Center 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

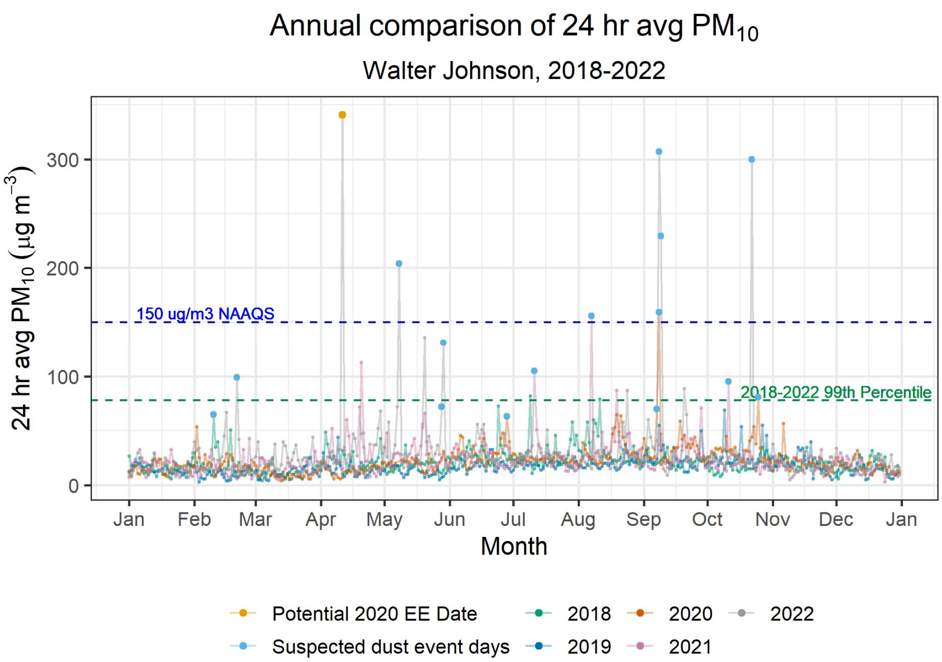

Figure 3.4-26. Walter Johnson 24-hour PM_{10} measurements in µg/m^3 from 2018-2022 by month with 99th percentile (green dash) and NAAQS (grey dash) indicated.

3.4.2 Event Comparison with Diurnal/Seasonal Patterns

The 24-hour average PM_{10} concentrations were compared to five-year (2018-2022) monthly and seasonal averages are shown in boxplots in **Figure 3.4-27** and **Figure 3.4-28.** The lower and upper edges of the boxes correspond to the interquartile range (the 25th and 75th percentiles, respectively), and the middle bar is the median value. The whiskers extend to the smallest and largest value within 1.5 times the interquartile range. Points beyond this range are considered outliers. The concentrations recorded on April 11, 2022 are shown to be the highest recorded outliers for April and spring during the entire five-year period.

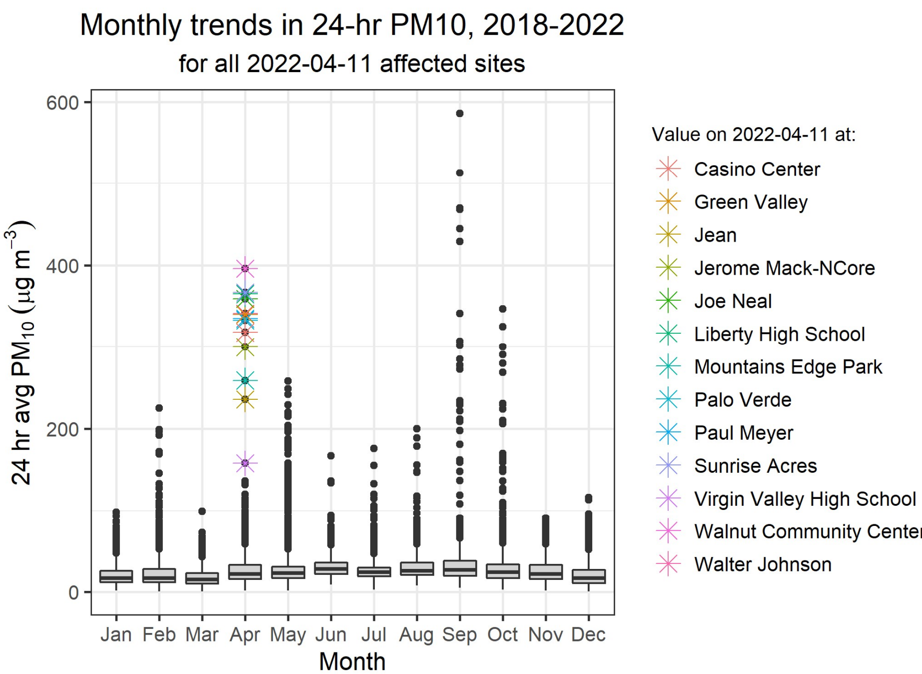

Figure 3.4-27. Monthly trend in 24-hour PM_{10} for 2018-2022, including outliers and highlighting the potential exceedance event day.

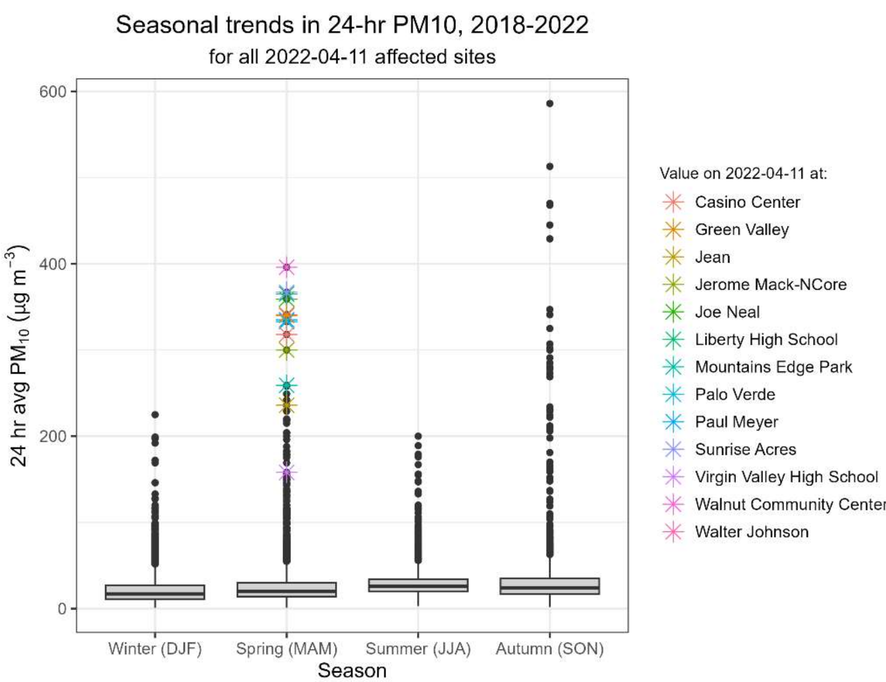

Figure 3.4-28. Seasonal trend in 24-hour PM_{10} for 2018-2022, including outliers and highlighting the potential exceedance event day.

The hourly PM_{10} concentrations were also compared to five-year (2018-2022) hourly averages. A summary of the maximum value observed compared to the five-year (2018-2022) 95th percentile is shown in Table 3.4-2 and time series are shown in Figure 3.4-29 through Figure 3.4-41. At the Palo Verde site, for example, the hourly PM_{10} concentration reached a maximum of 1,839 µg/m^3 at 16:00, 46 times the five-year 95th percentile of 40 µg/m^3. Similar trends were seen across the other sites.

Table 3.4-2. Summary of max hourly PM_{10} measurements compared to five-year hourly PM_{10} 95th percentile. *Sites where data collection began less than five-years ago are indicated.

Site Name	Time of hourly PM_{10} max (PST)	Hourly PM_{10} (µg/m^3)	Five-year hourly PM_{10} 95th percentile (µg/m^3)	Hourly/five-year 95th percentile
Casino Center*	4/11/2022 16:00	1,280	66	19
Green Valley	4/11/2022 18:00	1,628	59	27
Jean	4/11/2022 19:00	752	61	12
Jerome Mack	4/11/2022 16:00	1,263	54	24
Joe Neal	4/11/2022 16:00	1,726	63	27
Liberty High School*	4/11/2022 13:00	1,463	62	24
Mountains Edge Park*	4/11/2022 16:00	1,069	52	20
Palo Verde	4/11/2022 16:00	1,839	40	46
Paul Meyer	4/11/2022 16:00	1,528	45	34
Sunrise Acres	4/11/2022 16:00	1,701	57	30
Virgin Valley High School*	4/11/2022 18:00	471	84	6
Walnut Community Center*	4/11/2022 16:00	1,702	87	20
Walter Johnson	4/11/2022 16:00	1,582	43	37

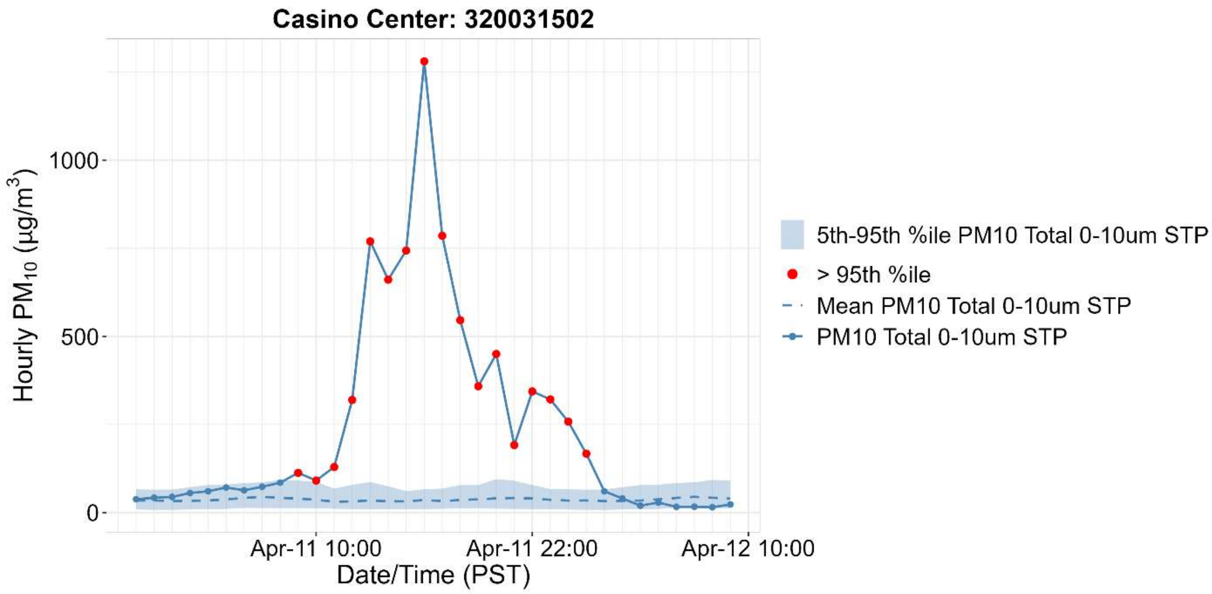

Figure 3.4-29. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Casino Center from 2018-2022. *Data collection began less than five-years ago at this site.

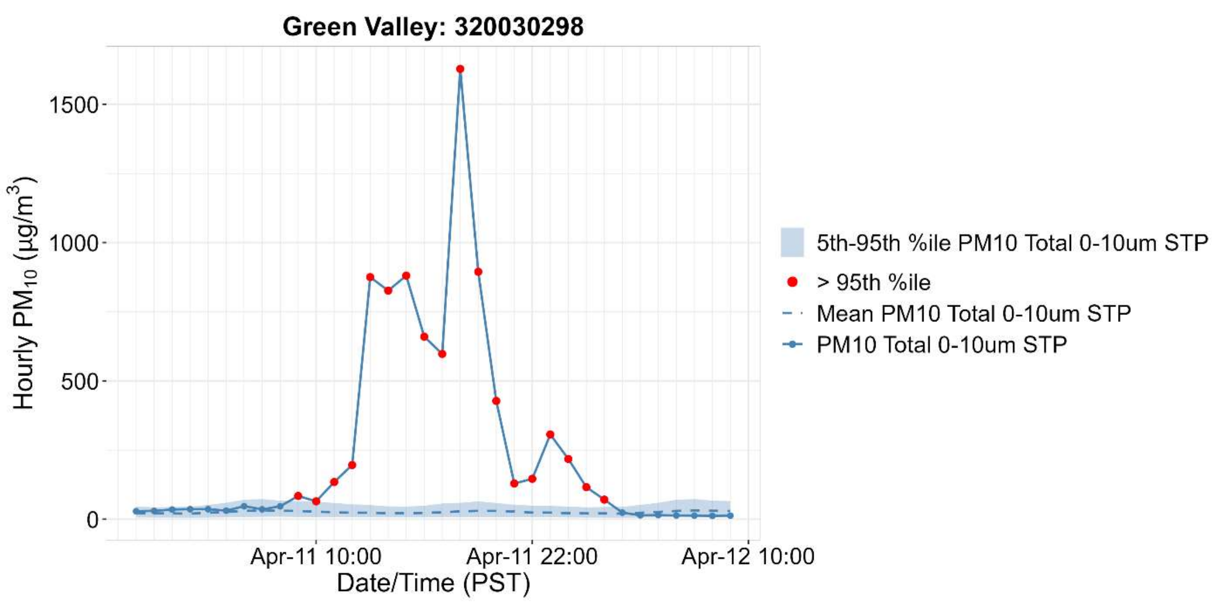

Figure 3.4-30. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Green Valley from 2018-2022.

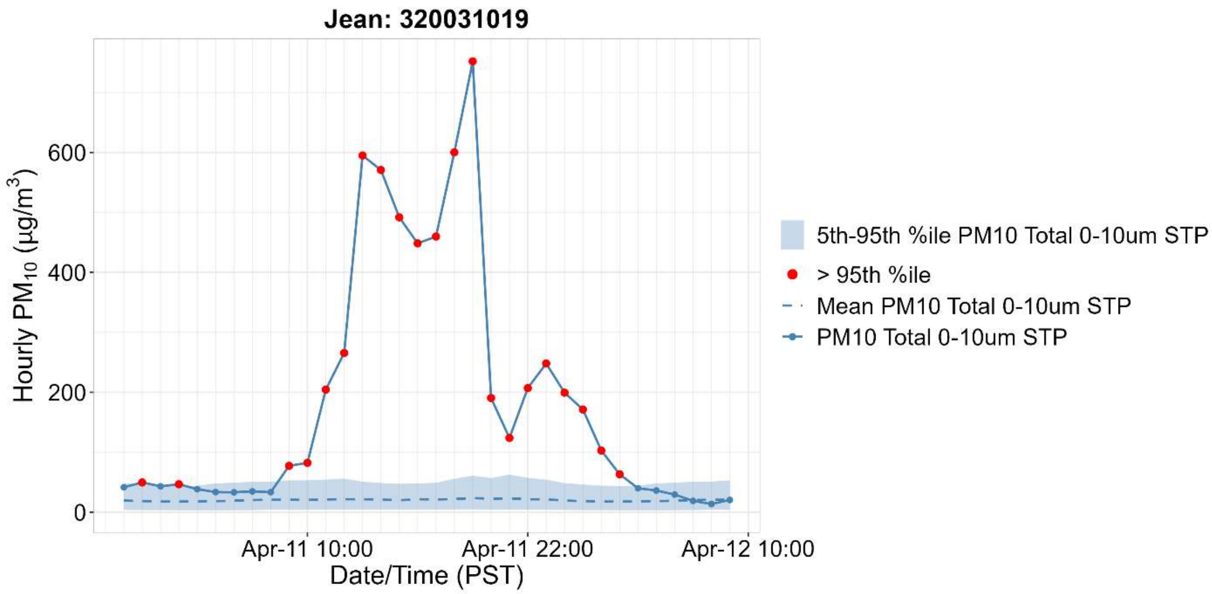

Figure 3.4-31. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Jean from 2018-2022.

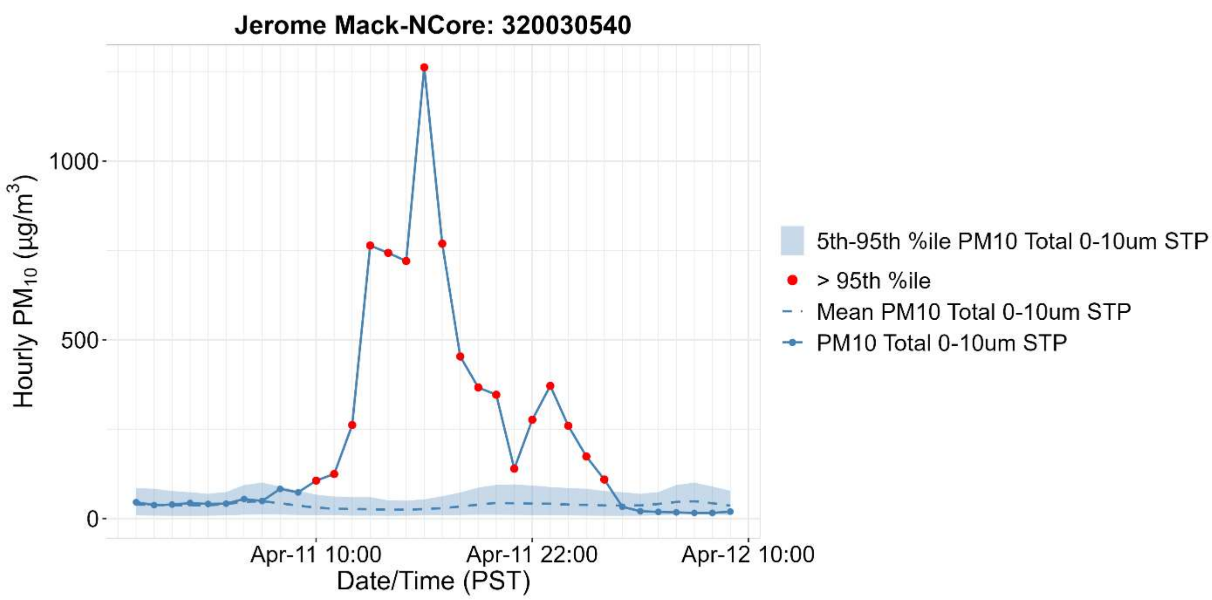

Figure 3.4-32. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Jerome Mack from 2018-2022.

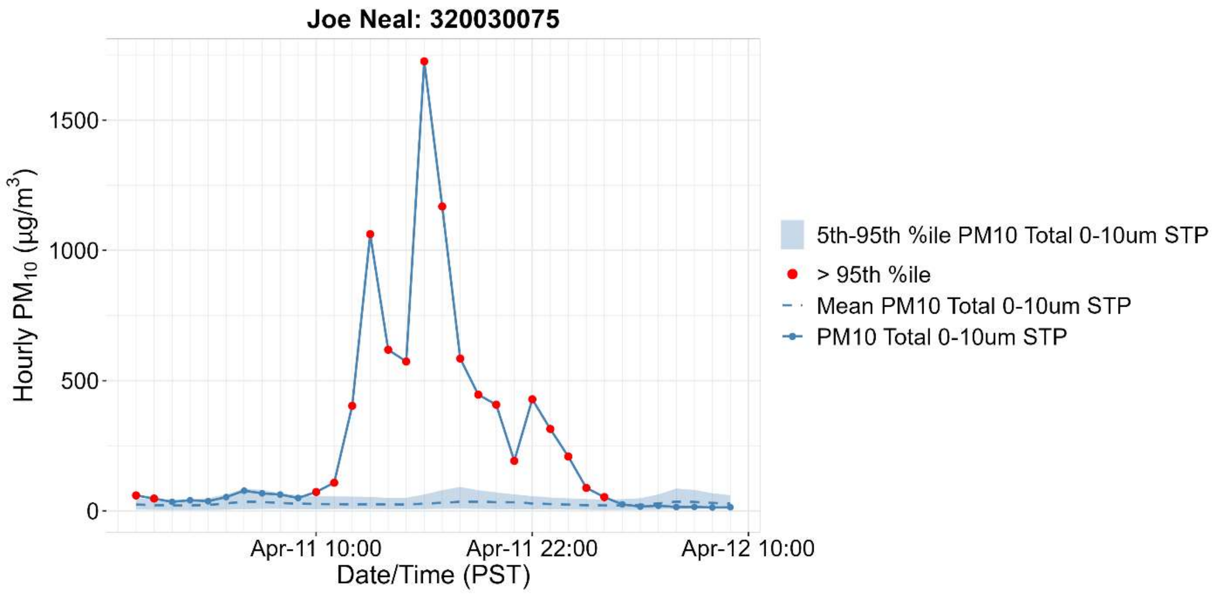

Figure 3.4-33. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Joe Neal from 2018-2022.

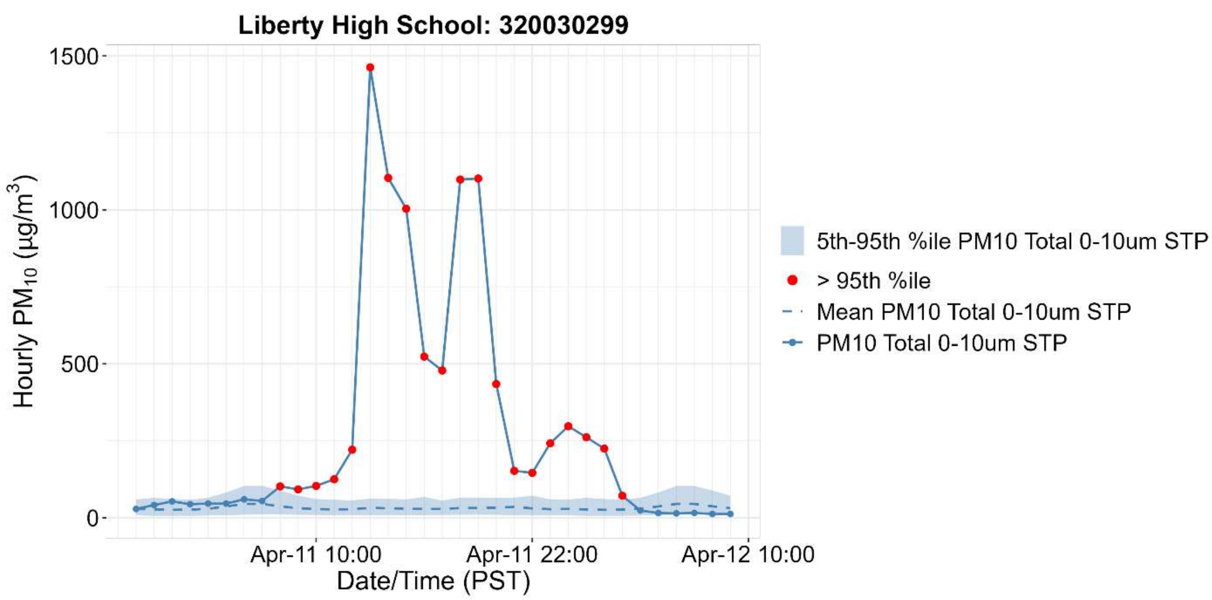

Figure 3.4-34. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Liberty High School from 2018-2022. *Data collection began less than five-years ago at this site.

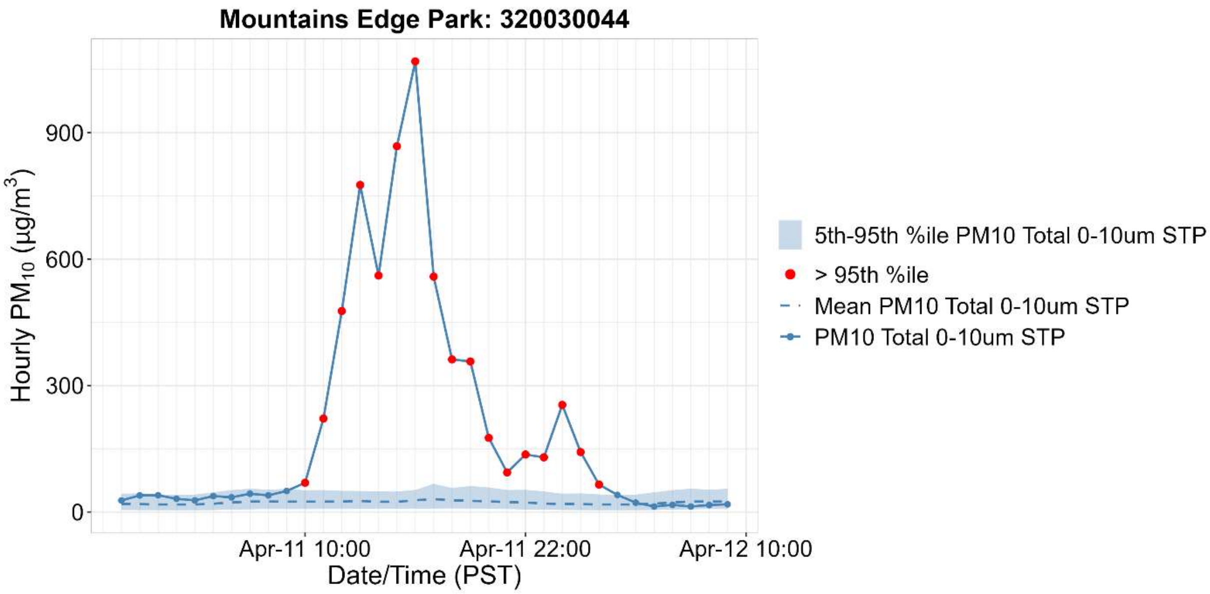

Figure 3.4-35. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Mountains Edge Park from 2018-2022. *Data collection began less than five-years ago at this site.

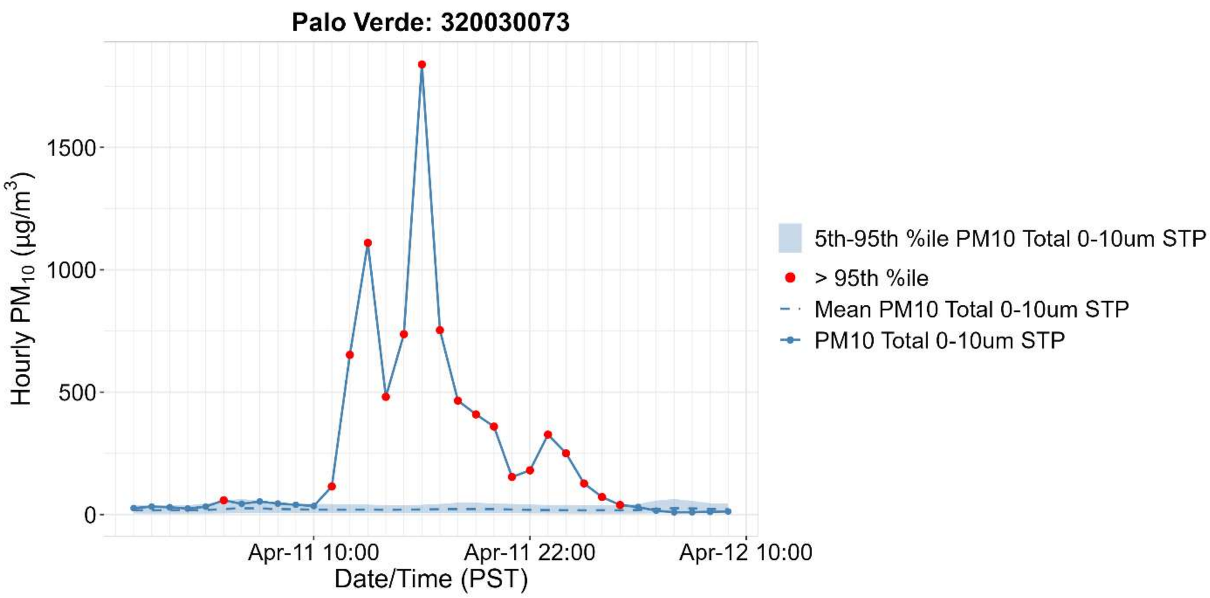

Figure 3.4-36. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Palo Verde from 2018-2022.

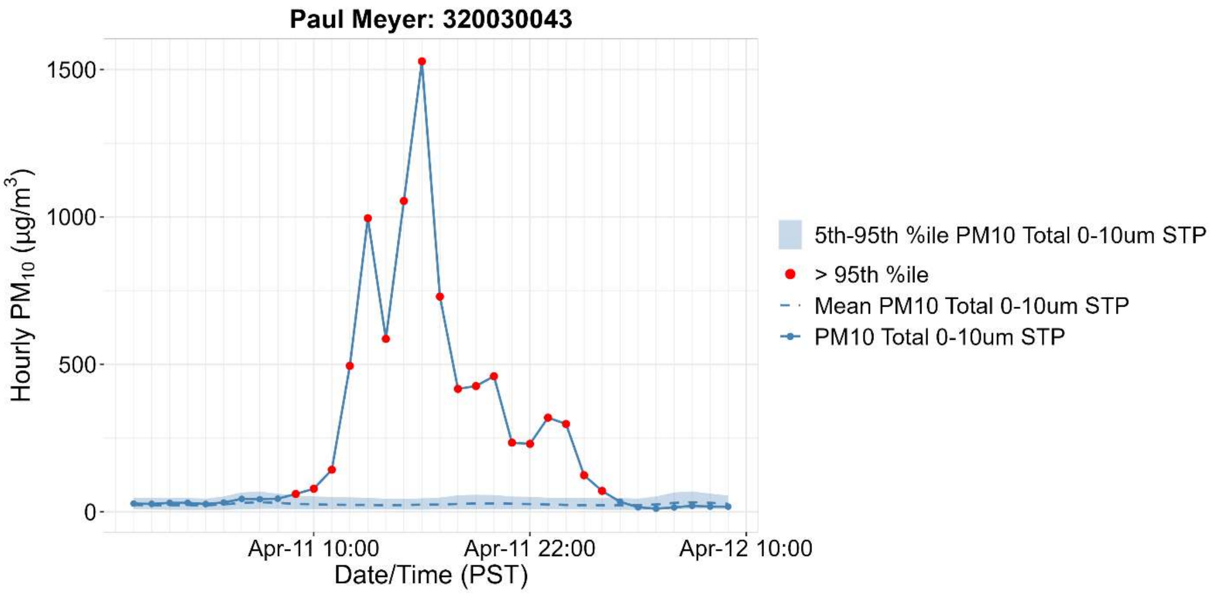

Figure 3.4-37. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Paul Meyer from 2018-2022.

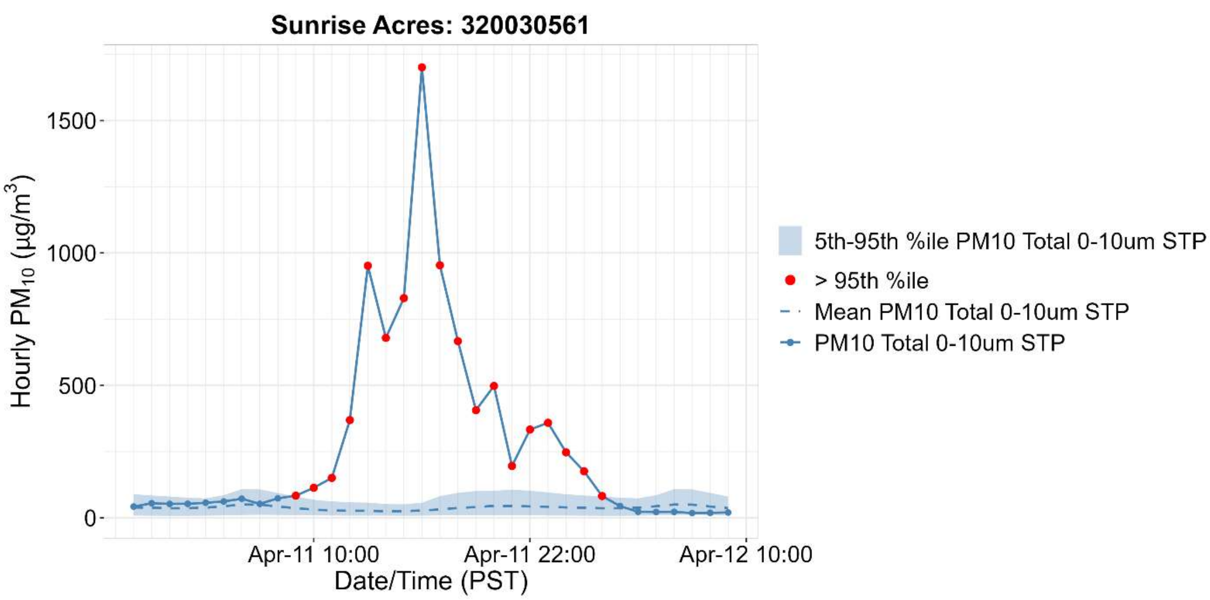

Figure 3.4-38. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Sunrise Acres from 2018-2022.

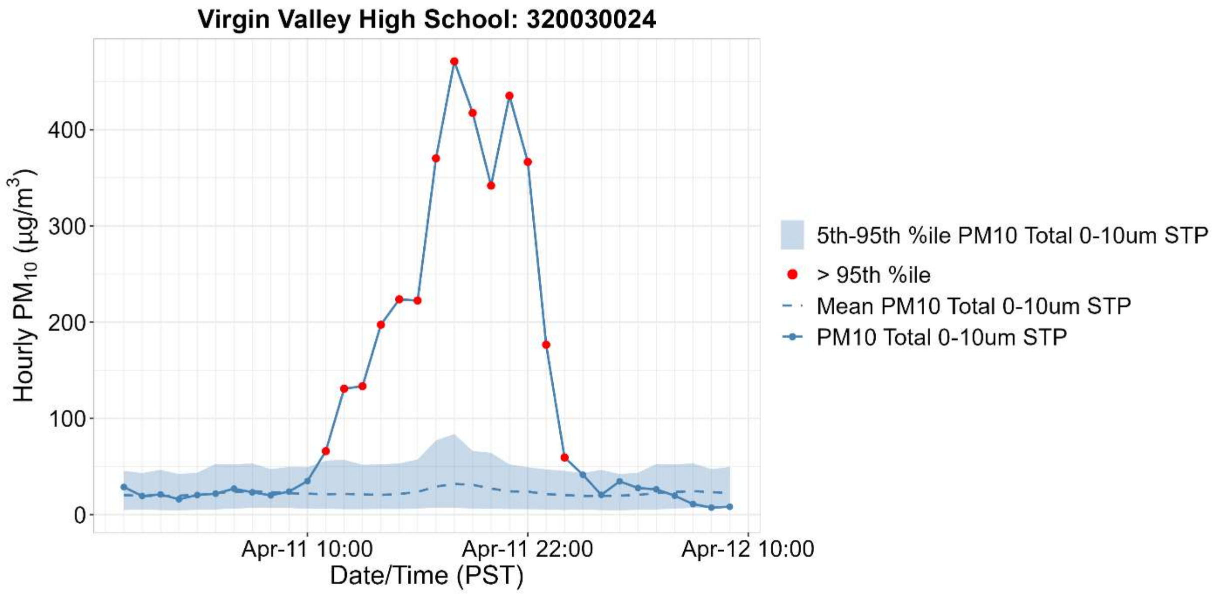

Figure 3.4-39. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Virgin Valley High School from 2018-2022. *Data collection began less than five-years ago at this site.

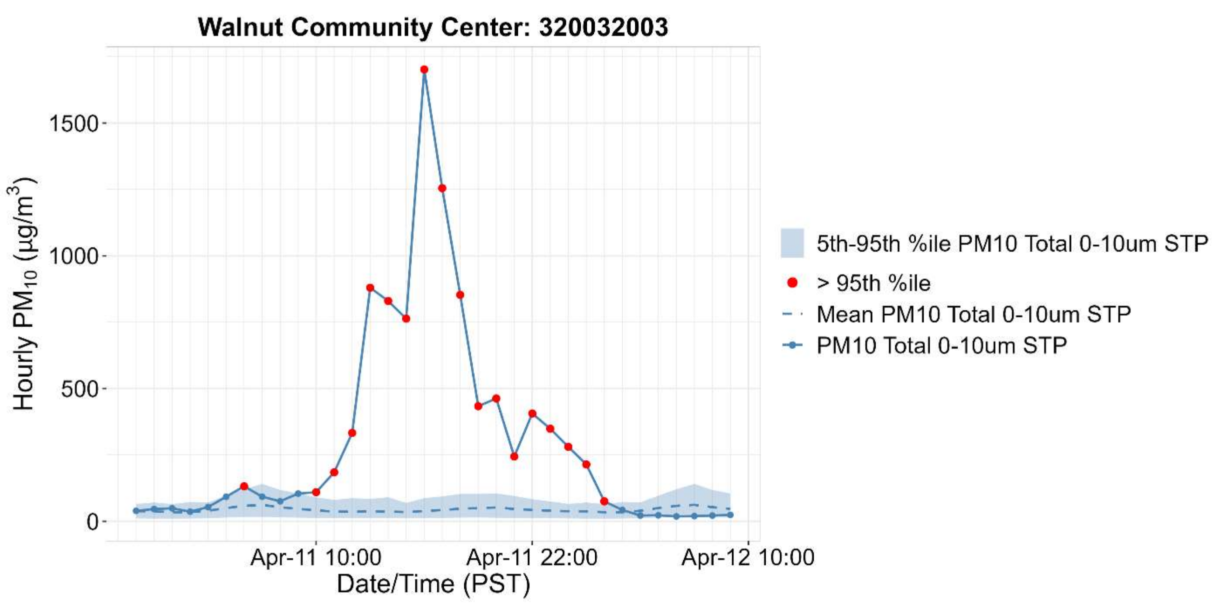

Figure 3.4-40. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Walnut Community Center from 2018-2022. *Data collection began less than five-years ago at this site.

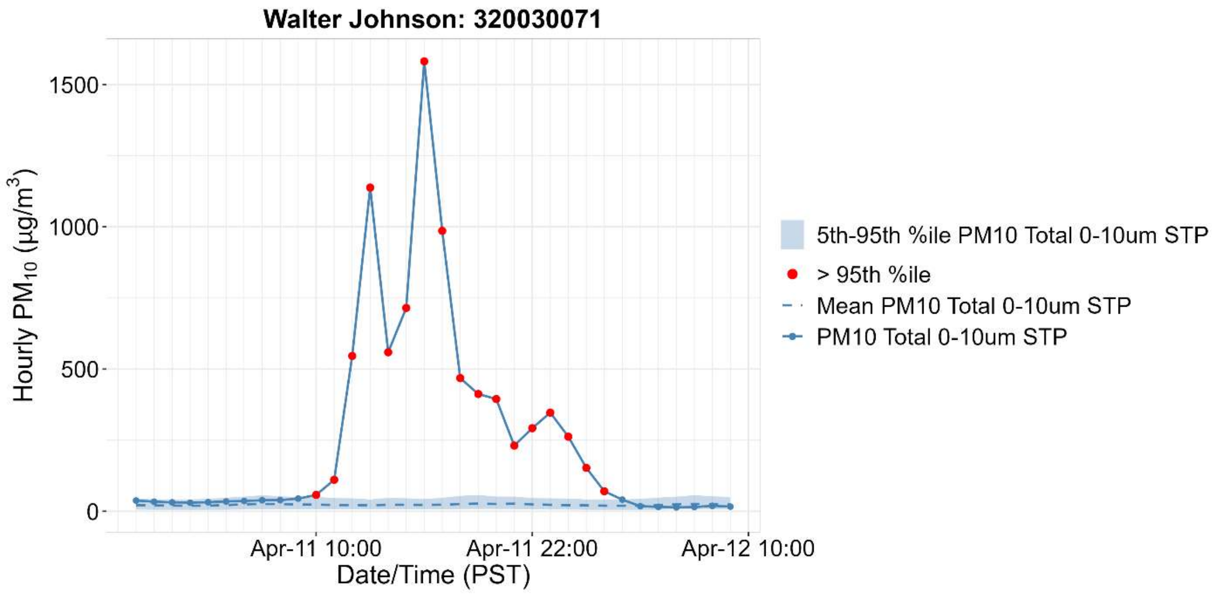

Figure 3.4-41. Hourly PM_{10} concentrations compared to the hourly average (dashed line) and 5th - 95th percentile (shaded area) in 1-hour PM_{10} at Walter Johnson from 2018-2022.

3.4.3 Event Comparison with Climatology

Thirty-year seasonal climatology was created using European Environment Agency (ERA5) reanalysis at 0.25° x 0.25° horizontal resolution from 1993 through 2022 for both the source region and Clark County. Temperature, volumetric soil moisture, and maximum winds speed were chosen and modeled as the most likely variables to influence a windblown dust event in both the source region and Clark County. This analysis shows the seasonal March-April-May thirty-year average for each variable in the top panel and the event date departure from the seasonal climatology in the bottom panel. Figure 3.4-42 shows the climatology compared with the event date for the source region. On the event date the source region is experiencing lower than normal soil moisture and max ground level wind speeds were well above average. Temperatures were not above normal, likely due to dust blocking incoming solar radiation in the source region starting early in the morning. Figure 3.4-43 shows the climatology compared with the event date for Clark County. On the event date Clark County is experiencing ground level temperatures just below the long-term average, lower to normal soil moisture, and max ground level wind speeds at or exceeding 4 m/s (9 mph) above the typical climatological average. Again, temperatures were not above normal likely due to dust blocking incoming solar radiation starting around 10:00 PST. This climatological evidence provides proof that the conditions on the event date were abnormally dry and windy in both the source region and Clark County, leading to a windblown dust event.

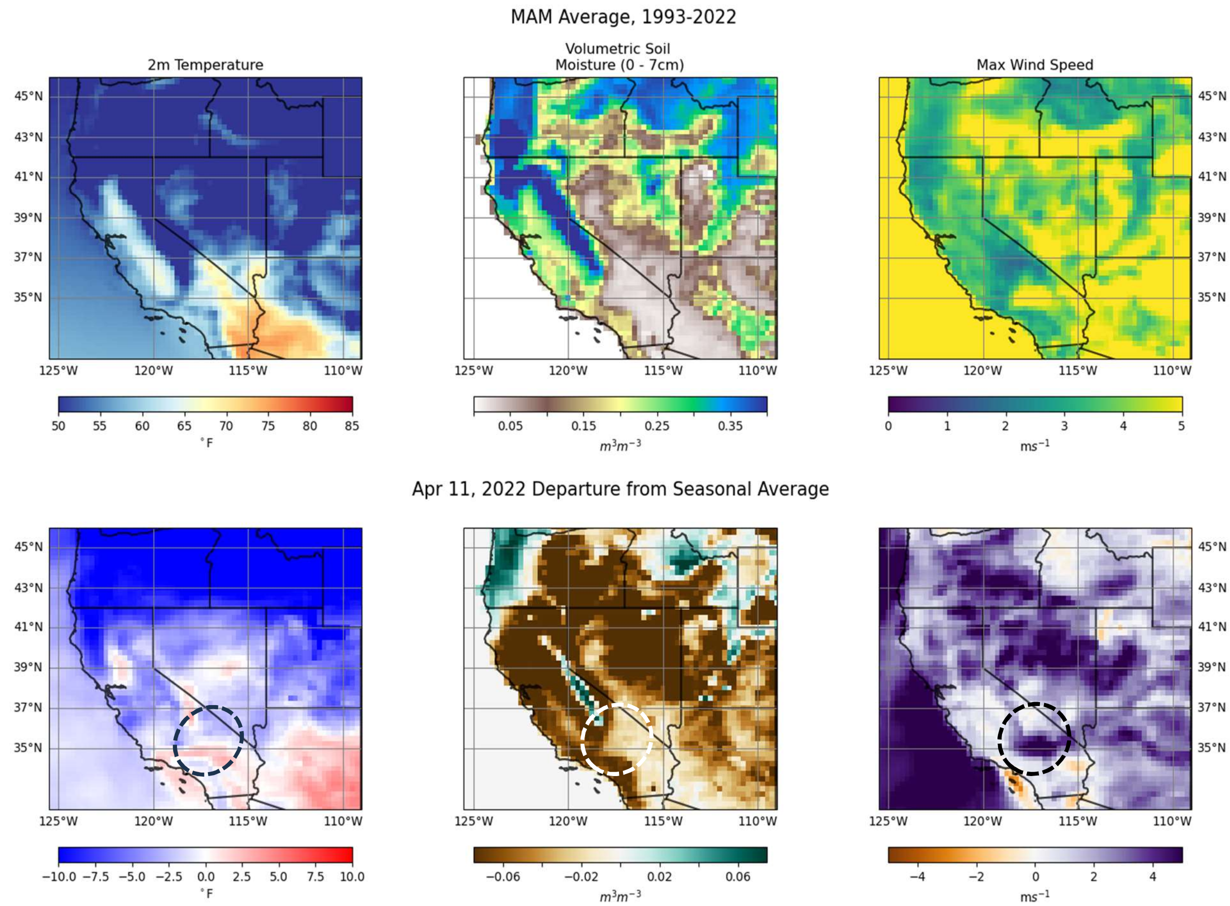

Figure 3.4-42. The thirty-year March-May seasonal climatological average based on ERA5 reanalysis for 2-meter temperature, volumetric soil moisture of the first 7 centimeters, and maximum 10-meter wind speed (top row) and the daily departure for April 11, 2022 from the 30-year average (bottom row). The source region is circled.

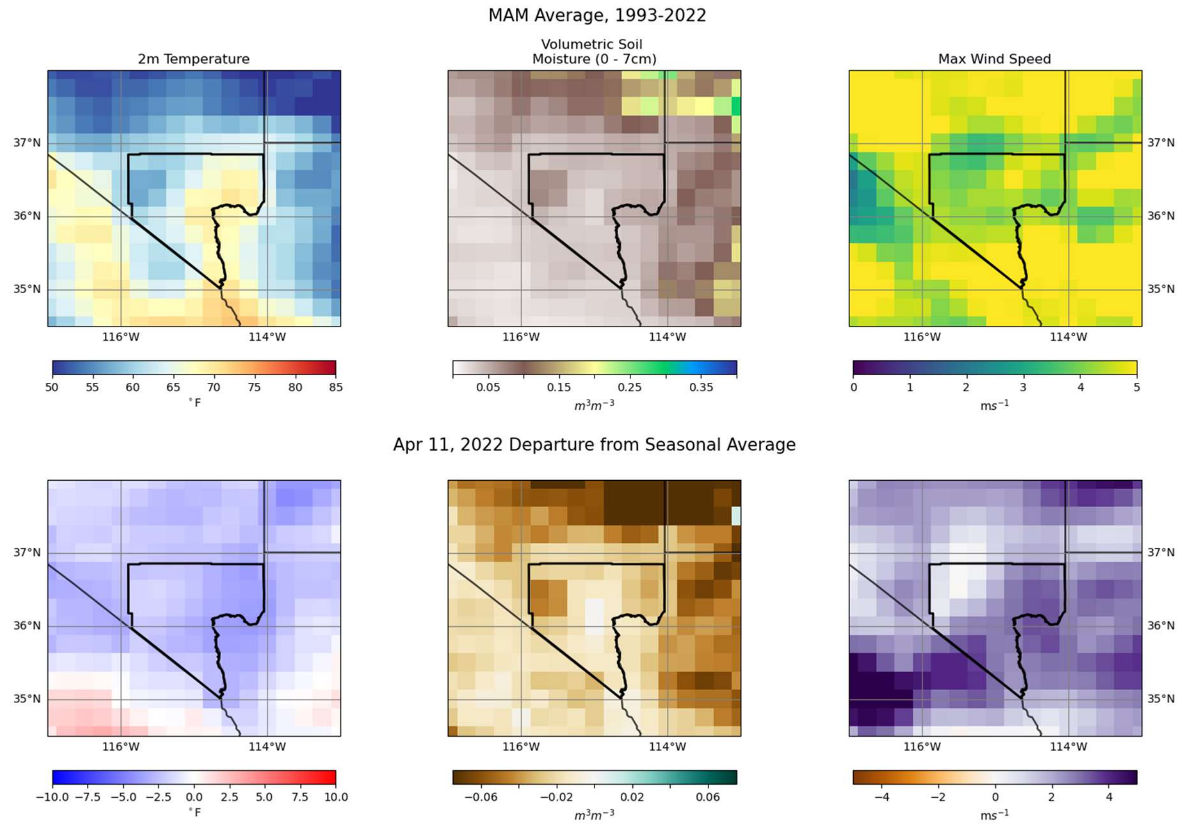

Figure 3.4-43. The thirty-year March-May seasonal climatological average for Clark County based on ERA5 reanalysis for 2-meter temperature, volumetric soil moisture of the first 7 centimeters, and maximum 10-meter wind speed (top row) and the daily departure for April 11, 2022 from the 30-year average (bottom row). Clark County is outlined in black.

3.5 Meteorological Similar Analysis

Enhanced surface-level wind speeds and frequent wind gusts on April 11, 2022 created prime conditions to maintain the suspension of fine dust particles in the air in the midst of regional drought. The sustained wind speed exceeded 20 mph for the nine-hour period between 14:00 PST to 22:00 PST, and multiple wind gusts greater than 45 mph were recorded. The maximum gust for the day reached 54 mph. The strongest winds came from the southwest direction. The timing of highest wind speeds and wind gusts aligns with the timing of enhanced PM_{10} concentrations. Visibility at LAS dropped to three miles at LAS on the afternoon of April 11, 2022 during peak wind gusts.

The following sections compare surface-level wind and visibility on April 11, 2022 to dates that show (1) comparable wind profiles that did not show PM_{10} concentrations above the NAAQS and (2) a PM_{10} concentration above the NAAQS but a lack of notable wind speeds. All wind speed, wind direction, and visibility values in the subsequent two sections were measured at LAS and downloaded from the Iowa Environmental Mesonet (IEM) data portal. (http://mesonet.agron.iastate.edu/)

3.5.1 Wind Event Days without High Concentration

The comparison of the event date to specific non-event high wind days without enhanced PM concentrations shows key differences between comparable wind events and the event date, April 11, 2022. All dates in the years 2016-2020 were considered when identifying days with a wind event comparable to the event date. Three criteria descriptive of the magnitude and length of the wind event on April 11, 2022 were applied to identify comparable dates: (1) nine or more hourly-reported wind speed observations greater than 20 mph, (2) seven or more wind gusts greater than 45 mph, and (3) peak daily wind gust greater than or equal to 50 mph. Additionally, dates were filtered to those without enhanced PM_{10} (<100 μg/m^3) at monitors in Clark County. A single date was identified as a comparable wind event without high PM_{10} concentrations, listed in Table 3.5-1.

Table 3.5-1. Similar meteorological event days without enhanced PM_{10} concentrations identified by days with nine wind speed observations > 20 mph, seven wind gusts > 45 mph, and a peak wind gust >= 50 mph. PM_{10} concentrations are reported at Jerome Mack (JM), Paul Meyer (PM), Walter Johnson (WJ), Palo Verde (PV), Joe Neal (JN), Green Valley (GV), Jean (J), Sunrise Acres (SA), Mountains Edge (ME), Walnut Rec. (WR), Virgin Valley (VV), and Casino Center (CC).

			Daily PM_{10} (μg/m^3)											
Date	Daily Wind Speed (mph)	Peak Wind Gust (mph)	JM	PM	WJ	PV	JN	GV	J	SA	ME	WR	VV	CC
2022-02-21 (event date)	13	54	300	335	341	333	359	340	236	367	259	396	158	318
2022-03-20	17	62	41	38	37	21	47	29	19	50	21	38	49	48

A comparison between April 11, 2022 comparable date March 20, 2022 is outlined below. Figure 3.5-1, Figure 3.5-2, and Figure 3.5-3 below compare surface-level wind and visibility conditions on the event date and March 20, 2022. The wind profile on March 20, 2022 matches the intensity of winds experienced on the event date; multiple wind gusts exceeded 45 mph and sustained winds exceeded 20 mph for the eight-hour period between 14:00 – 22:00 PST (Figure 3.5-1). Figure 3.5-2 shows that the highest wind speeds, between 20-40 mph, came from the southwest on the event date, and from the northwest on March 20. On March 20, visibility remained at the maximum value of 10 miles throughout the day (Figure 3.5-3). The maintenance of high visibility on March 20 confirms that the high winds event did not dramatically affect levels of suspended dust particles, a claim supported by the fact that daily PM_{10} concentration was relatively low, 50 μg/m^3 or less at all examined sites. In contrast, visibility on the event date reached a minimum of 3 miles during peak winds. Figure 3.5-4 compares 24-hour HYSPLIT back-trajectories from Las Vegas ending at 12:00 PST (20:00 UTC) on April 11, 2022, at the beginning of the event period, and 14:00 PST (22:00 UTC) on March 20, 2022, when PM_{10} concentrations were at a daily maximum. On the event date, near-surface transport towards Las Vegas occurred with trajectories paths below 200 m in altitude. This facilitated entrainment and transport of dust from the source region into Las Vegas. On March 20, 2022, the transport paths towards Las Vegas occurred at high altitudes greater than 500 m, inhibiting surface-level transport from dust sources surrounding Las Vegas. Furthermore, wind speeds in the source region on April 11, 2022 were much higher than on March 22. Figure 3.5-5 shows the spatial distribution of peak sustained wind speeds centered on the Las Vegas NWS forecast office (VEF). In the direction of back trajectories on April 11, to the southwest of Las Vegas, sustained wind speeds reached 52 mph. In the direction of back trajectories on March 20, to the northwest of Las Vegas, peak sustained wind speeds did not exceed 40 mph. This combination of lack of surface transport and lower source-region wind speeds on March 20 may account for the discrepancy in daily PM_{10} concentrations between April 11, 2022 and March 20, 2022 under comparable wind conditions.

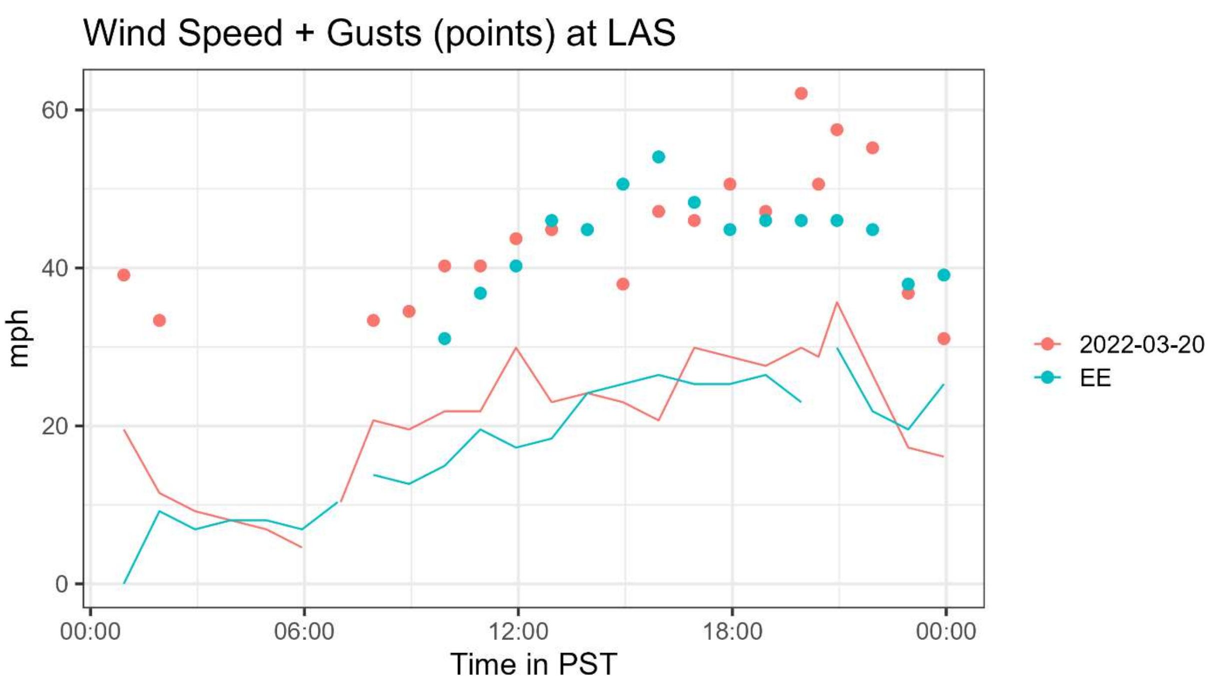

Figure 3.5-1. Wind speed and maximum hourly wind gust in mph at LAS for March 20, 2022 (pink) and the April 11, 2022 suspected exceptional event (EE) day (teal).

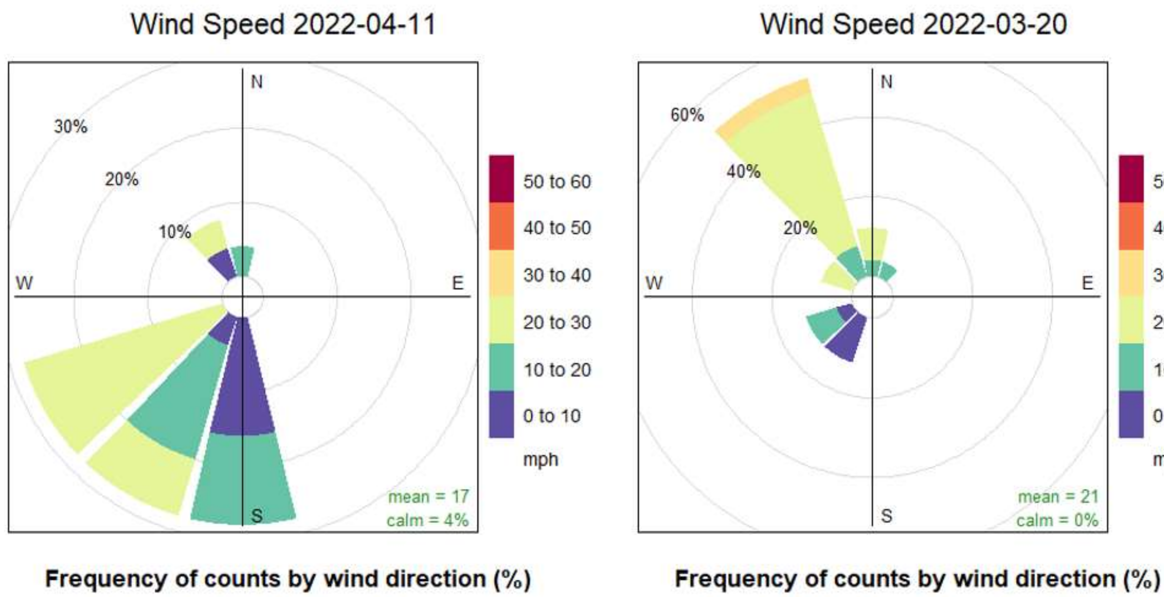

Figure 3.5-2. Wind speed (mph) and direction frequency for (left) April 11, 2022, the suspected exceptional event day, and (right) March 20, 2022.

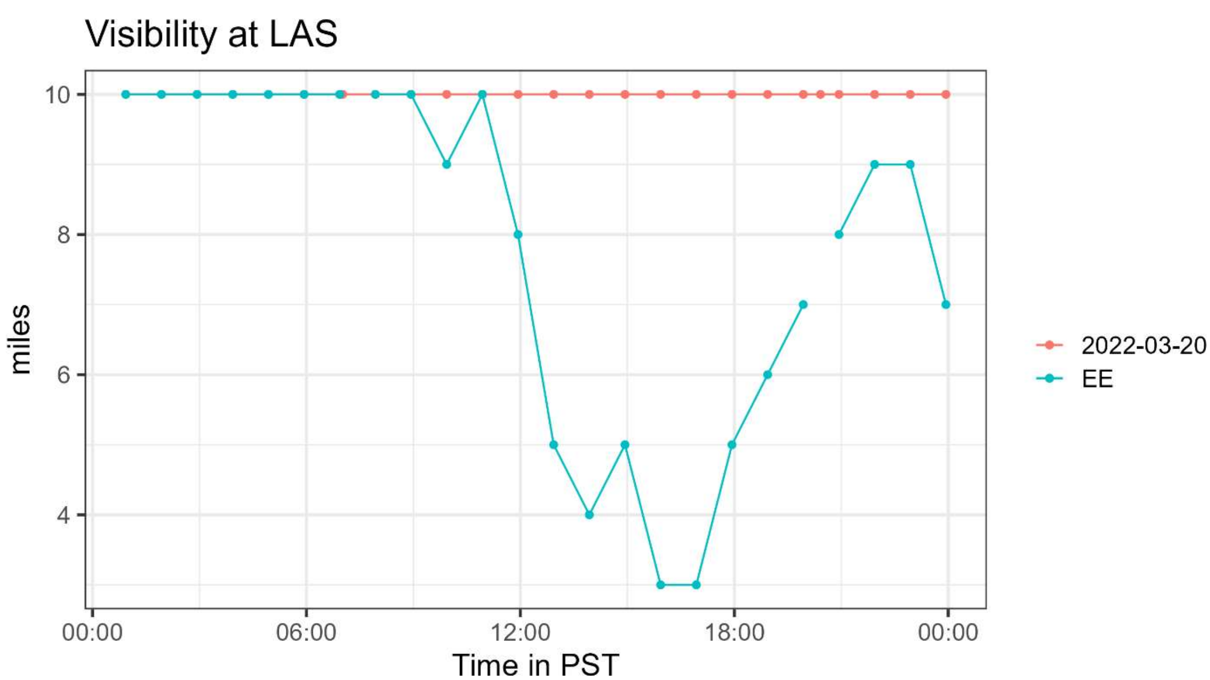

Figure 3.5-3. Hourly-reported visibility in miles at LAS for March 20, 2022 (pink) and the April 11, 2022 suspected exceptional event day (EE) (teal).

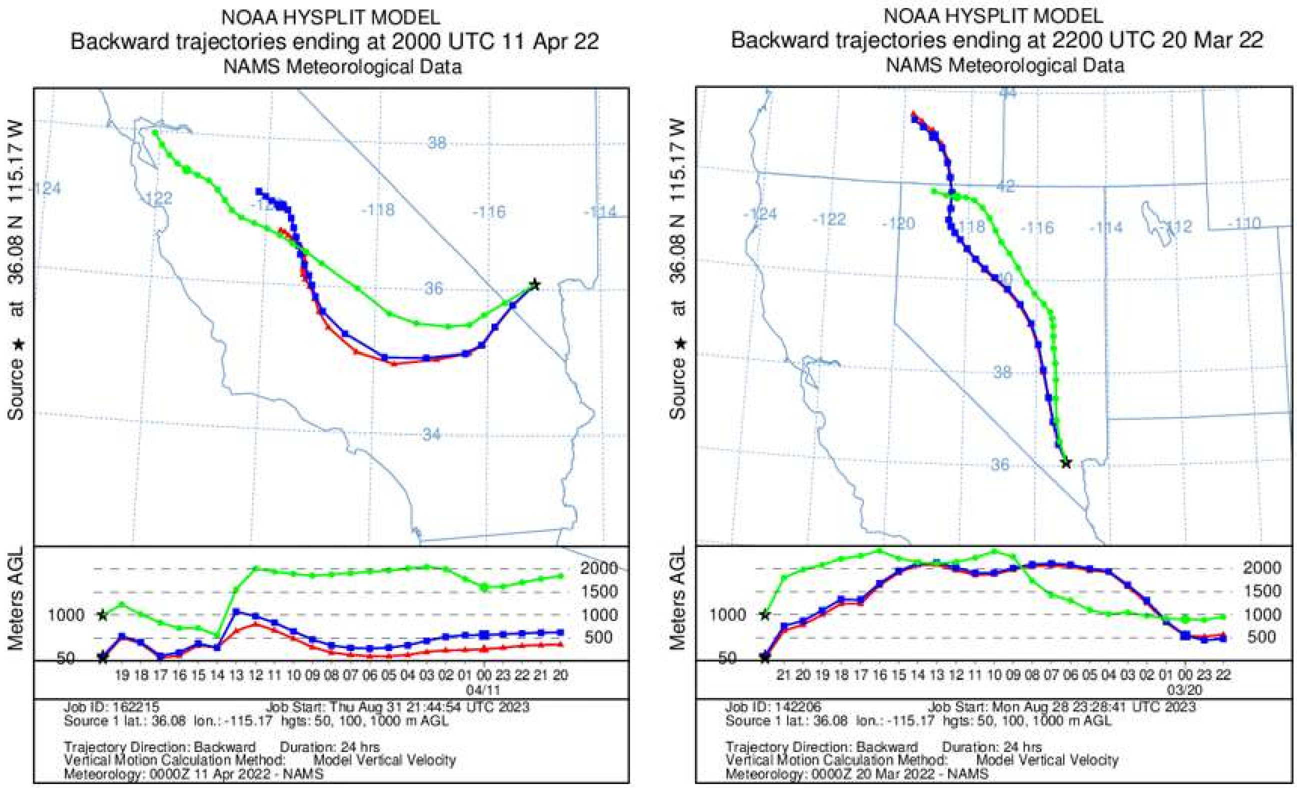

Figure 3.5-4. 24-hour HYSPLIT back-trajectories initiated from Las Vegas at (left) 20:00 UTC (12:00 PST) on April 11, 2022 (event date) and (right) 22:00 UTC (14:00 PST) on March 20, 2022 at 50-m (red), 100-m (blue) and 1,000-m (green).

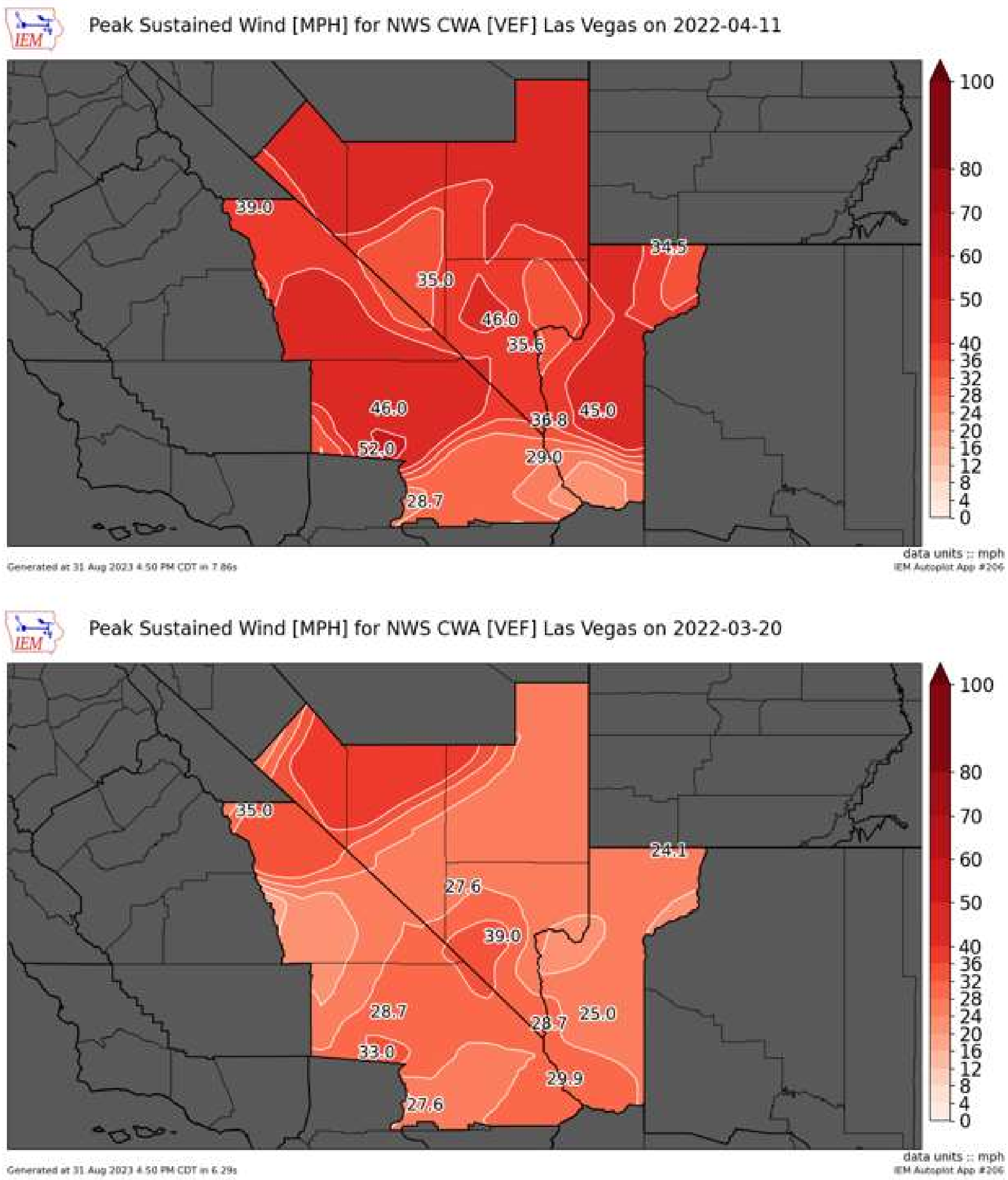

Figure 3.5-5. Spatial distribution of peak sustained wind speeds on April 11, 2022 (top) and March 20, 2022 (bottom) in Clark County and surrounding regions. Generated from automated ASOS data using the Iowa Environmental Mesonet's plotter tool (https://mesonet.agron.iastate.edu/plotting/auto).

3.5.2 High Concentration Days in the same Season

Dates in the same season as the suspected exceptional event were screened by daily PM_{10} concentration to compare surface meteorological conditions against conditions on the event date.

All dates in the mid-winter to early spring, between February and June 2022, were screened. The only other days when PM_{10} exceeded the NAAQS during this period were February 21, May 8, 2022, and May 28-29, 2022 which are also suspected high-wind dust events.

4. Not Reasonably Controllable or Preventable

4.1 Other Possible Sources of PM_{10} in Clark County

According to the EPA 2019 High Wind Dust Event Guidance document (and quoted Code of Federal Regulations [CFR] therein), agencies are required to (1) identify natural and anthropogenic sources of emissions contributing to the monitored exceedance, including contributions from local sources; (2) identify a relevant State Implementation Plan (SIP) for sources identified as natural and anthropogenic sources of emissions contributing to the monitored exceedance, including contributions from local sources and the implementation of these controls; and (3) provide evidence of effective implementation to satisfy the nRCP criterion.

Section 2.2.3 provides evidence for natural and anthropogenic sources near the Paul Meyer, Mountain's Edge, Walter Johnson, Palo Verde, Joe Neal, Green Valley, Liberty High School, Jerome Mack, Sunrise Acres, and Walnut Community Center monitoring sites of PM_{10} that could have contributed to the April 11, 2022, exceedance. As shown in Section 3.2, however, the main source of PM_{10} is the large bare ground/land area to the southwest of Clark County (identified in the rest of the document as the Mojave Desert source region), which is outside of the jurisdiction of Clark County and, therefore, not subject to control measures. Additional conclusions from this analysis indicate that anthropogenic point sources were unlikely to contribute to a PM_{10} exceedance event and BACM are in place to control fugitive sources such as construction emissions. According to the 2012 "Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10})," the main sources of enhanced PM_{10} emissions in Clark County, Nevada, are (1) wind-blown dust, (2) re-entrained road dust, and (3) construction emissions. These nonpoint emission sources contribute approximately 98% of total annual PM_{10} emissions and are often amplified by dry arid conditions. Control measures have been implemented and enforced to mitigate emissions from the sources listed above within the jurisdiction of Clark County. Therefore, since natural bare ground was identified as the most likely source that contributed to the April 11, 2022, event (fulfilling nRCP part 1), in this section we focus on providing information on control measures used in Clark County to mitigate emissions from construction sites and possible dust sources in both the SIP (fulfilling nRCP part 2), and providing evidence of effective implementation (fulfilling nRCP part 3).

4.2 PM_{10} Control Measures in Clark County

For an air quality episode to qualify as a high-wind exceptional event, Clark County DES must show that all anthropogenic sources of PM_{10} are reasonably controlled (40 CFR 50.14(b)(5)(ii)). The

Exceptional Event rule provides that enforceable control measures that EPA approved into the SIP within five years of the date of the event (40 CFR 50.14(b)(8)(v)) are presumptively reasonable. Controls adopted into the SIP more than five years before the event date may also be reasonable (81 FR 68238), and EPA will also consider other control measures not approved into the SIP if the air pollution control agency is implementing and enforcing the control measures (81 FR 68238-9).

Clark County DES operates one of the most robust fugitive emissions control programs in the country to reduce ambient air concentrations of PM_{10}. The 2001 PM_{10} SIP details emission sources and BACM that have been coded into the Clark County Air Quality Regulation (AQR). These include (1) stabilization of open areas and vacant lands (Section 90); (2) stabilization of unpaved roads and paving of unpaved roads when traffic volume is equal to or greater than 150 vehicles per day (Section 91); (3) stabilization of unpaved parking areas, including material handling and storage yards, and generally prohibiting the construction of new unpaved parking lots in the nonattainment area (Section 92); (4) requirements for paved roads, street sweeping equipment, and other dust-mitigating devices (Section 93); and (5) permitting and dust control requirements for construction activities (Section 94). These BACM are updated and continued in the most recent 2012 Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10}) (2012 Maintenance Plan) document for Clark County, Nevada, which was approved by EPA and extends through 2023. The 2012 updated SIP and AQR document are provided as evidence in **Appendix B**.

The 2012 Maintenance Plan also identified the Natural Events Action Plan for High-Wind Events: Clark County, Nevada (DES 2005) as a control measure. Since submission of the 2012 Maintenance Plan, DES replaced this action plan with the Clark County Mitigation Plan for Exceptional Events (DES 2018). DES developed this revised plan in response to EPA's 2016 EER (81 FR 68216) that required areas with historically documented or known seasonal exceptional events to develop mitigation plans (40 CFR 51.930(b)). EPA does not require this plan to be included in the SIP or be federally enforceable, but did review each plan to assure that the required elements were included. The revised plan includes practices from the first action plan:

- A high-wind event notification system that includes an early warning procedure.
- Education and outreach programs.
- Enhanced enforcement and compliance programs to reduce emissions.
- Submittal of required documentation to EPA in the event of an exceedance.

The new plan includes more sophisticated air quality advisories and alerts, and commits to maintaining an open line of communication with neighboring areas involved in high PM_{10} ambient air concentration events. The new plan also references the Clark County flood control system (Clark County 2018) and street sweeping schedule for Las Vegas Valley, Hydrological Area 212 (HA 212) referenced in Appendix J of the 2001 PM_{10} SIP (DES 2001). This system maintains a robust flood control system that minimizes silt deposition from flood waters onto roads, parking areas, and undeveloped land. The system undergoes continuous expansion to accommodate new development in the Las Vegas Valley, with the following recent plan changes:

- Duck Creek – Gilispie System: March 2023;
- Harry Reid Airport Peaking Basin Outfall and Van Buskirk System: Feb. 2022;
- Monson Channel-Jimmy Durant to Boulder Highway: Apr. 2022;
- Blue Diamond 02 Channel, Decatur-Le Baron to Richmar: July 2020;
- Gowan Outfall Facilities-Simmons to Clayton: May 2021;
- Pittman Wash-Interstate Channel: June 2020.[2]

The Nevada Department of Transportation, Clark County, the City of Las Vegas, the City of North Las Vegas, and the City of Henderson maintain policies requiring rapid removal of silt deposits from paved roads after storm events.

In addition to regulating direct releases of PM_{10} to the atmosphere, DES' control measures includes requirements to reduce precursors, including VOC, NO_x, and SO_x, which can react in the atmosphere to form PM_{10} emissions under certain meteorological conditions. The control measures also regulate mercury emissions. Mercury emissions are a source of PM pollution when emitted in a non-gaseous form or when adsorbed by PM to form particulate mercury. Thus, standards designed to control mercury emissions also reduce PM_{10} ambient air concentrations.

The following section explains the reasonable control measures that collectively assure that all local sources of anthropogenic sources impacting HA 212 were reasonably controlled before and after the event. The measures include controls that are presumptively reasonable because EPA approved the control measure into the SIP within five years of the event, along with other reasonable measures.

4.2.1 Presumptively Reasonable Controls

The following measures are reasonable because EPA approved the control measures into the SIP within five years of the event date:

Section 12.0-12.6 Permitting Programs – Sections 12.0 and 12.1 originally adopted November 3, 2009; last amended February 20, 2024, and awaiting SIP approval. Section 12.2 originally adopted May 18, 2010; last amended March 14, 2014, and SIP-approved October 17, 2014. Sections 12.3 and 12.4 originally adopted May 18, 2010; last amended July 20, 2021, and awaiting SIP-approval. Section 12.5 originally adopted May 18, 2010 and awaiting SIP-approval. Section 12.1 requires all minor stationary sources to obtain a permit to construct and operate if they have the potential to emit 5 tons per year (tpy) or more of a regulated pollutant, or if they are subject to another AQR, such as a control technique guideline (CTG) Reasonable Available Control Technologies (RACT) rule, that requires a minor source to obtain a permit. Some emissions units at these minor stationary sources must comply with RACT requirements when proposing an emissions increase that meet or

[2] The flood plan and updates are available at https://www.regionalflood.org/programs-services/document-library/master-plan-documents.

exceed the significance thresholds. Sections 12.2-12.5 requires all major stationary sources to obtain a permit to construct and operate. Some emissions units must comply with RACT requirements when they are the subject of an emissions increase in PM_{10} or its precursors that meets or exceeds the minor New Source Review (NSR) significance thresholds. In addition, these rules implement the federally mandated NSR Program for attainment, unclassifiable, and nonattainment areas. New major sources and existing major sources undertaking a modification that results in a significant increase in PM_{10} emissions or its precursors must install and operate Best Available Control Technology (BACT) or Lowest Achievable Control Technology (LAER).

Section 26 Emissions of Visible Air Contaminants – Amended April 26, 1983; last amended May 5, 2015; and SIP-approved June 16, 2017. This rule requires all sources to generally maintain an average opacity below 20%, with certain sources subject to a lower 10% average opacity standard.

Section 41 Fugitive Dust – Originally adopted June 25, 1992; last amended January 21, 2020; and SIP-approved May 19, 2022. This rule requires fugitive emissions abatement to prevent airborne PM emissions during construction and deconstruction activities, and during use of unpaved parking lots, agricultural operations, and raceways. The rule includes notice, registration, and permitting requirements.

Section 90 Fugitive Dust from Open Areas and Vacant Lots – Originally adopted June 22, 2000; last amended January 21, 2020; and SIP-approved May 19, 2022. This rule requires certain owners of land to take measures to prevent access of trespassers operating motor vehicles on the land. Owners must also create a stable surface area, including gravel installation that provides a 20% non-erodible cover. Landowners of large parcels must develop and submit a dust mitigation plan.

Section 93: Fugitive Dust from Paved Roads and Street Sweeping Equipment – Originally adopted June 22, 2000; last amended January 21, 2020; and SIP-approved May 19, 2022. This rule requires construction and reconstruction of roads in accordance with road shoulder widths and drivable median stabilization requirements. It also establishes an opacity standard for unpaved shoulders and medians, and for the use of road cleaning equipment. The rule requires road wetting when using rotary brushes and blowers to clean roads and allows only vacuum type crack cleaning seal equipment.

Section 94 Permitting and Dust Control for Construction and Temporary Commercial Activities – Adopted June 22, 2000; amended January 21, 2020; SIP-approved May 19, 2022; last amended August 3, 2021; and awaiting further revision before SIP approval. This rule applies to all construction and temporary commercial activities that disturb or have the potential to disturb soil. It requires a dust control permit and maintenance of a dust mitigation plan.

4.2.2 Other Reasonable Control Measures

The following identifies additional reasonable control measures that assure that all anthropogenic sources of PM_{10} emissions were controlled before and after the event. The controls fall into one of three categories: (1) EPA approved the control measures into the SIP more than five years before the event date; (2) the state submitted revisions that EPA has not yet approved into the SIP; or, (3) the Clean Air Act (CAA) and EPA do not require states to submit the type of control measure for SIP approval. As explained below, these control measures are reasonable because they meet or exceed CAA requirements, enhance enforcement efforts, and are equal or more stringent than control programs found in other state SIPs.

State Control Measures

Nevada Regional Haze State Implementation Plan – Originally adopted October 2009 and partially SIP approved March 26, 2012, and August 28, 2013, awaiting SIP approval. Prepared by the Nevada Division of Environmental Protection (NDEP) and codified by DES in AQR Section 12.14 on June 7, 2022. This plan requires reductions in visibility impairing pollutants, and thereby reduces the potential for PM_{10} formation. The plan specifically required Reid Gardner (a point source in Clark County) to meet PM control requirements by June 30, 2016, or to shutdown Units 1, 2, 3 by this date. The 2022 revised plan, which should become effective during the second maintenance period, requires the installation of low NO_x burners and selective non-catalytic reduction control equipment to reduce visibility impairing pollution on lime kilns operating in Clark County. This rule is reasonable because the controls imposed met the CAA's Best Available Retrofit Technology (BART) standard.

NAC 445B.737-774, Heavy-Duty Vehicle Program – adopted October 22, 1992; last amended October 18, 2002. The NDEP and Nevada Department of Motor Vehicles (DMV) jointly developed this rule to reduce motor vehicle related pollution by limiting excessive tailpipe or smokestack emissions from any gasoline or diesel-powered vehicle with a manufacturer's gross vehicle weight rating (GVWR) of 14,001 lbs. or more. Enforcement inspectors pull over heavy-duty vehicles for random roadside testing to determine if the exhaust from their vehicle exceeds state opacity standards. Violators must repair and retest the vehicle within 30 days. Fleets may also request opacity testing in their fleet yard. Fleet managers voluntarily repair and re-test vehicles failing the inspection. This regulation is reasonable because it exceeds EPA's inspection and maintenance program requirements, and actively prevents smoking vehicles from operating on roads.

NAC 445B.400-735, Inspection and Maintenance Program – adopted September 28, 1988; subsequently amended and SIP-approved July 3, 2008; last amended October 18, 2022. The NDEP and the Nevada DMV jointly developed this rule, administered by the DMV, to control vehicle emissions. The rule reduces motor vehicle-related NO_x and VOC emissions through the vehicle inspection and emissions-related repairs. Clark County requires annual emissions testing before renewing a vehicle's registration. All gasoline-powered vehicles must be tested, with limited exceptions, as well as diesel-powered vehicles weighing up to 14,000 lbs. gross vehicle weight rating (GVWR). EPA approved the inspection and maintenance program as part of the Carbon Monoxide State Implementation Plan: Las Vegas Valley Nonattainment Area, Clark County, Nevada (CO SIP[3]), in September 2004 (69 FR 56351). This inspection and maintenance program is reasonable because it (1) exceeds EPA's requirements for a basic inspection and maintenance program, and (2) follows a standard that qualifies as a low-enhanced performance standard.

NAC 445B.3611-3689 Nevada Mercury Control Program – Originally adopted May 4, 2006; last revised November 2, 2016. Mercury emissions can also be a source of PM pollution when emitted as in non-gaseous form a particulate or when adsorbed by PM to form particulate mercury. Thus, standards designed to control mercury emissions also reduce PM_{10} ambient air concentrations. The rule requires particulate emissions control technologies to reduce mercury emissions from thermal units located in precious metal mines. The CAA does not require states to submit hazardous air pollutant control measures for SIP approval. These measures are reasonable because they reduce the ambient air concentration of PM_{10} by requiring use of the Maximum Achievable Control Technology (MACT) and apply in addition to the federal standards at 40 CFR Part 63, Subpart E.

County Air Quality Regulations

Section 14 New Source Performance Standards (NSPS) - Originally adopted September 3, 1981; last amended March 15, 2022. Regulations in this section are reasonable because they implement EPA's federal PM and total suspended particulate (TSP) emissions limitations in 40 CFR Part 60 "New Source Performance Standards" (NSPS) that apply to a variety of stationary sources. EPA has delegated implementation and enforcement of the federal standards to DES. The CAA does not require states to submit NSPS control measures for SIP approval.

Section 13 National Emissions Standards for Hazardous Air Pollutants (HAP) – Originally adopted September 3, 1981; last amended March 15, 2022. Regulations in this section are reasonable because they implement federal HAP emissions limitations in 40 CFR Part 63 that apply to a variety of stationary sources that emit particulate emissions in the form of metal HAP. These standards are based on Maximum Achievable Control Technology. EPA has delegated implementation and enforcement of the standards to DES. The CAA does not require states to submit HAP control measures for SIP approval.

Section 27 Particulate Matter from Process Weight Rate – Originally adopted September 3, 1981 (SIP approved June 18, 1982); last amended July 1, 2004. Establishes process weight restrictions for PM emissions for all operations. This regulation is reasonable because it establishes maximum rates for PM emissions from stationary sources that are more stringent than any specific CAA or SIP

[3] https://webfiles.clarkcountynv.gov//Environmental%20Sustainability/SIP%20Related%20Documents/Carbon_Monoxide_State_Implementation_Plan_Revision-without_Appendices.pdf

requirement, and comparable to limits found in other state SIPs. Compare the rule, for example, to Chapter 1200-3-7 "Process Emission Standards" in the Tennessee SIP.[4]

Section 28 Fuel Burning Equipment – Originally adopted December 28, 1978; SIP-approved August 27, 1981; last amended July 1, 2004. This rule applies to fuel burned for the primary purpose of producing heat or power by indirect heat transfer. It regulates the burning of coke, coal, lignite, coke breeze, fuel oil, and wood, but not refuse. The regulation targets reductions in PM_{10} emissions, but by promoting good combustion practices, the rule also produces NO_x and VOC emissions reduction co-benefits that further reduce the potential for PM_{10} formation. The rule establishes PM emissions rates based on heat input. This regulation is reasonable because it establishes maximum rates for PM emissions from stationary sources that are more stringent than any specific CAA or SIP requirement and emissions limitations found in other states. Compare the rule, for example, to Chapter 13 "Emission Standards for Particulate Matter" in the Louisianna SIP.[5]

Section 42 Open Burning – Originally adopted December 28, 1978; SIP-approved August 27, 1981; last amended July 1, 2004. This rule requires preauthorization to burn any combustible material and prohibits open burning during air pollution episodes, which is consistent with the Nevada Emergency Episode Plan. This regulation is reasonable because it allows the Control Officer to assess and prevent any burning that could lead to a PM_{10} NAAQS exceedance. The rule also is comparable to similar control measures found in other SIPs. See, for example, South Coast Air Quality Management District's Rule 444[6].

Section 91 Fugitive Dust from Unpaved Roads, Unpaved Alleys, and Unpaved Easement Roads – Originally adopted June 22, 2000; last amended April 15, 2014; and SIP-approved October 6, 2014. This rule applies to unpaved roads, including unpaved alleys, unpaved road easements, and unpaved access roads for utilities and railroads. It requires PM emissions control measures including paving or application of dust palliatives. This regulation is reasonable because it targets and reduces emissions of event-related fugitive dust emissions using state-of-the-art emissions controls, which are more stringent than the best practices recommended by EPA. See "Fugitive Dust Control Measures and Best Practices," EPA, January 2022[7].

Section 92 Fugitive Dust from Unpaved Parking Lots and Storage Areas – Originally adopted June 22, 2000; amended April 15, 2014; SIP-approved October 6, 2014; last amended August 3, 2021. This rule applies to lot and storage areas greater than 5,000 ft^2. The rule generally requires owners of a lot or storage area to pave the area or cover it in two inches of gravel. It also prohibits visible dust plumes from crossing the property boundary. This regulation is reasonable because it targets and reduces emissions of event-related fugitive dust emissions using state-of-the-art emissions controls, which are more stringent than the best practices recommended by EPA. See "Fugitive Dust Control

[4] https://www.epa.gov/system/files/documents/2021-12/chapter-1200-3-7.pdf
[5] https://www.epa.gov/air-quality-implementation-plans/louisiana-lac-33iii-ch-13-section-1301-emission-standards
[6] https://ww2.arb.ca.gov/sites/default/files/2021-06/SouthCoastSMP.pdf
[7] https://www.epa.gov/system/files/documents/2022-02/fugitive-dust-control-best-practices.pdf

Measures and Best Practices," EPA, January 2022. The rule also regulates sources not typically regulated in other state SIPs.

Section 94 Permitting and Dust Control for Construction and Temporary Commercial Activities – Adopted June 22, 2000; amended January 21, 2020; SIP-approved May 19, 2022; last amended August 3, 2021. This rule applies to all construction and temporary commercial activities that disturb or have the potential to disturb soil. It requires a dust control permit and maintenance of a dust mitigation plan. This regulation is reasonable because it targets and reduces emissions of event-related fugitive dust emissions using state-of-the-art emissions controls, which are more stringent than the best practices recommended by EPA. See "Fugitive Dust Control Measures and Best Practices," EPA, Jan. 2022. The rule also regulates sources not typically regulated in other state SIPs.

Transportation Conformity – Clark County works closely with the Regional Transportation Commission of Southern Nevada (RTC) to assure that regional transportation plans and transportation improvement programs in HA 212 are consistent with and conform to Clark County's air quality program requirements, including the PM_{10} SIP and corresponding motor vehicle emissions budget (MVEB).

In this section (and in Appendix B), we have provided information on adopted presumptively and other reasonable control measures used in Clark County to mitigate emissions from construction sites and other possible dust sources, fulfilling part 2 of the nRCP criterion.

4.3 Reasonableness of Control Measures

Table 2 in the 2019 High-wind Dust Exceptional Event Guidance document provides example factors that an air agency and EPA may consider when assessing the reasonableness of controls as part of the nRCP criterion. This table details example factors, such as (1) control requirements based on area's attainment status, (2) the frequency and severity of past exceedances, (3) the use of widespread measures, and (4) jurisdiction. In this section, we address all the possible factors that evaluate the reasonableness of controls.

4.3.1 Historical Attainment Status

The 2012 Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10}) document for Clark County, Nevada, provides a comprehensive historical analysis of the Clark County nonattainment area. Briefly, after the passage of the 1990 Clean Air Act Amendments, EPA designated all areas previously classified as Group I areas as "moderate" nonattainment areas, including HA 212 (CAA §107(d)(4)(B)). EPA required these moderate nonattainment areas to submit a SIP by November 1991 that would demonstrate attainment of the PM_{10} NAAQS by December 1994. Because of unprecedented regional growth, high-wind events, and other factors, Clark County could not demonstrate attainment by the required date, and EPA reclassified HA 212 as a "serious" nonattainment area on January 8, 1993 (58 FR 3334). In 1997, a PM_{10} SIP revision was submitted. In December 2000, the Clark County Board of County Commissioners (BCC) requested that the state formally withdraw all previously submitted SIPs and addenda because none demonstrated attainment of the NAAQS.

After completing comprehensive research and work programs to address the problems identified in the 1997 PM_{10} SIP revision, Clark County submitted a new SIP to EPA in June 2001 that met federal requirements for remediating serious PM_{10} nonattainment areas. This new SIP demonstrated that the adoption and implementation of BACM for fugitive sources and continuation of controls for stationary sources would result in attainment of the annual average PM_{10} NAAQS by 2001, and attainment of the 24-hour NAAQS by December 31, 2006. Although the CAA required the SIP demonstrate attainment of the PM_{10} NAAQS no later than December 31, 2001, EPA granted Clark County a five-year extension for the 24-hour NAAQS attainment date. Clark County supported its extension request with a "Most Stringent Measure" control analysis that showed the emission control programs proposed for the valley were at least as stringent, if not more so, than control programs implemented in other nonattainment areas.

In June 2004, EPA published final approval of the Clark County PM_{10} SIP (69 FR 32273). In June 2007, Clark County submitted a milestone achievement report that described the county's progress in implementing the SIP. In August 2010, EPA determined HA 212 had attained the PM_{10} NAAQS (75 FR 45485).

In August 2012, the Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10}) (i.e., 2012 Maintenance Plan) was formally approved, and EPA redesignated the Clark County PM_{10} nonattainment area to attainment for the 1987 24-hour NAAQS. To achieve attainment of the 1987 24-hour PM_{10} NAAQS, Clark County DES implemented emissions control measures that lead to a permanent and enforceable improvement in air quality, as required by CAA Section 107(d)(3)(E)(iii) (42 U.S.C. 7407). The 2012 Maintenance Plan explained that Clark County adopted comprehensive fugitive dust controls in the Section 90 series of the AQR, and implemented and enforced SIP and non-SIP regulations to control PM_{10} emissions from stationary and nonpoint sources. The maintenance plan summarized the progress in attaining the PM_{10} standard, demonstrated that all Clean Air Act and Clean Air Act Amendment requirements for attainment had been met, and presented a plan to assure continued maintenance over the next 10 years. The plan became federally enforceable and determined how Clark County maintained the 1987 PM_{10} NAAQS through 2023.

In 2022, Clark County began work on a Second PM_{10} Maintenance Plan. For this plan, Clark County DES must show attainment in the background and assessment design value periods, specified as the 2017-2019 background period and the 2021-2023 assessment period. This exceptional event demonstration and the associated demonstrations for the 2021-2023 design value period will show that Clark County's HA 212 area is in attainment of the PM_{10} NAAQS but for the proven exceptional event dates. Approval and implementation of the Second PM_{10} Maintenance Plan is expected in 2024.

4.3.2 Historical Analysis of Past PM_{10} Exceedances

The 2012 Maintenance Plan document for Clark County, Nevada, provides historical context of regulatory efforts by Clark County to achieve attainment of PM_{10} NAAQS over the past 30 years, and a robust weight-of-evidence trend analysis for PM_{10} concentrations from 2001-2010. With the implementation of the PM_{10} SIP control measures, evidence shows a decreasing trend in PM_{10} design values, especially after BACM implementation (Figure 4.3-1). The decrease in wind erosion from vacant lands has driven the decreasing trend of PM_{10} emissions as construction within the Las Vegas Valley overtakes vacant lands. Given that the Las Vegas Valley was designated as being in "moderate" and later "serious" nonattainment for the PM_{10} NAAQS in the early 1990s, PM_{10} emissions before 1999 were likely high relative to the 2008-2010 period shown in Figure 4.3-1. This confirms that PM_{10} emissions have decreased over the past 30 years since the implementation of BACM from anthropogenic sources.

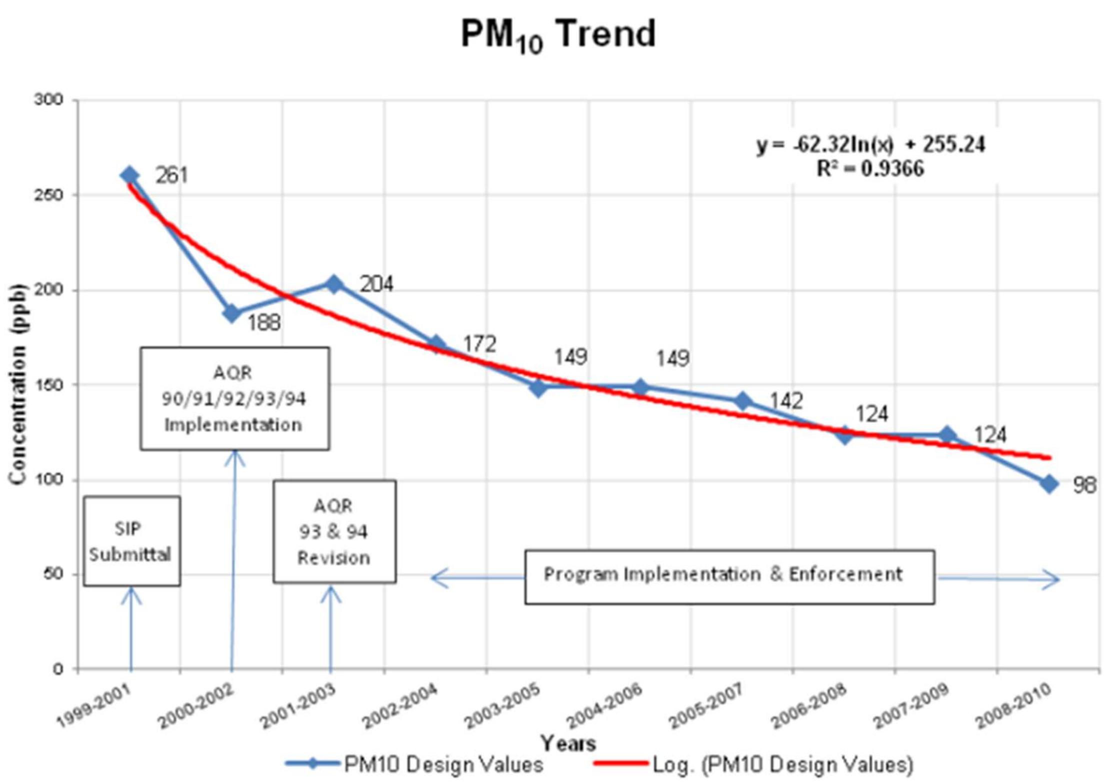

Figure 4.3-1. PM_{10} trends from the 2012 Maintenance Plan.

Continuing this evaluation through 2022, Figure 4.3-2 shows the three-year running average concentration at a long-running PM_{10} monitoring site in Clark County (Paul Meyer: AQS ID 32-003-0043) (orange line), along with the three-year running average of drought conditions in Nevada (blue bars). Drought conditions are categorized on a scale of D0 (abnormally dry) to D4 (exceptional), and Figure 4.3-2 shows the three-year running average of D2 (severe) conditions. We see that the typical five-year cyclical drought pattern in Nevada has increased in magnitude in the most recent years and this has corresponded to an uptick in average PM_{10} concentrations. This suggests that the control measures put in place via the 2012 SIP have been at least partially counterbalanced by increasing drought throughout the state of Nevada, affecting PM_{10} concentrations. Figure 4.3-3 shows the D0 - D4 drought conditions for 2000-2023, highlighting the increase in D3 (extreme) and D4 drought conditions through the most recent years. According to NLCD 2019 data, 87% of Nevada's land cover is bare ground or land that has little vegetation cover. The expansion in magnitude of severe-to-exceptional drought conditions will disproportionately affect natural areas prone to dust lofting, entrainment, and transport, ultimately enhancing PM_{10} concentrations.

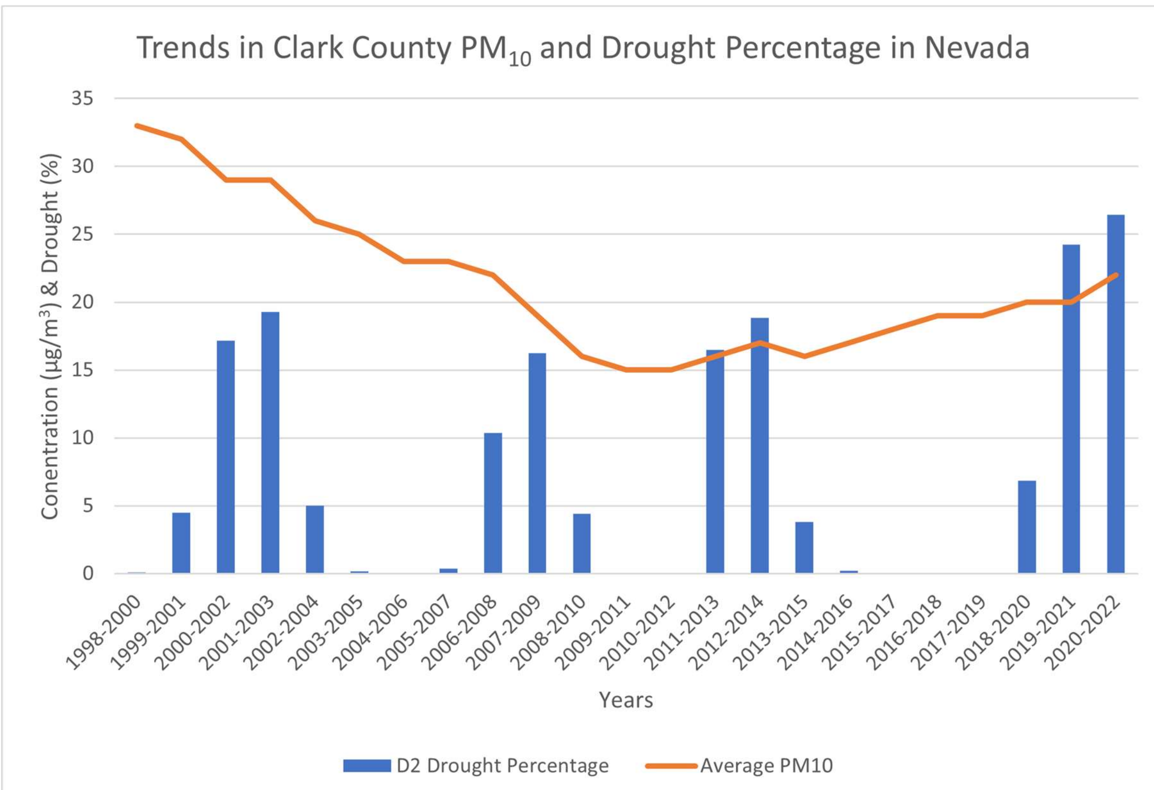

Figure 4.3-2. Three-year running average of PM_{10} concentrations (µg/m^3) at the long-running Paul Meyer monitoring site (AQS: 32-003-0043) (orange line) and the D2 (severe) drought percentage of Nevada (blue bars). Source: https://www.drought.gov/states/nevada.

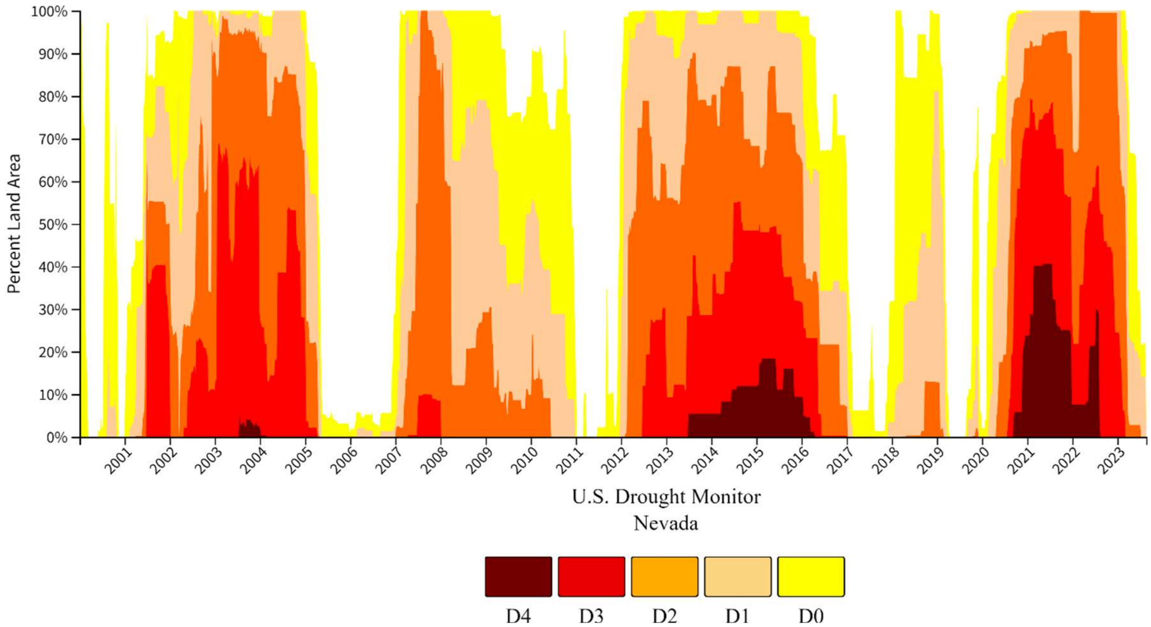

Figure 4.3-3. Drought statistics for Nevada from 2000-2023, colored by drought severity for D0 to D4. Source: https://www.drought.gov/states/nevada.

Historical PM_{10} exceedance frequency in Clark County has varied among air quality monitoring sites since the late 1990s and early 2000s. Figure 4.3-4 and Figure 4.3-5 show historical 24-hour PM_{10} exceedance count and concentration and design values at site in HA212 with at least 20 years of data. PM_{10} exceedances at the Joe Neal and Green Valley sites occurred at a greater frequency (≥1 exceedance per year) in the late 1990s and early 2000s followed by a drop to no exceedances per year in the mid-2000s coinciding with BACM implementation and less severe drought conditions. Other sites show one exceedance every few years before 2022. The number of exceedances per year increased in the 2010s for most long-term sites, coinciding with more widespread and severe drought conditions in Nevada. The number of exceedances rose significantly for all long-term sites in 2022 and 2023 due to the wind-blown dust exceptional events. Without these 2022 and 2023 events, the number of exceedances would more closely align with the mid-2000s period. These observations are consistent with the historical PM_{10} and drought analysis presented in the 2012 Maintenance Plan.

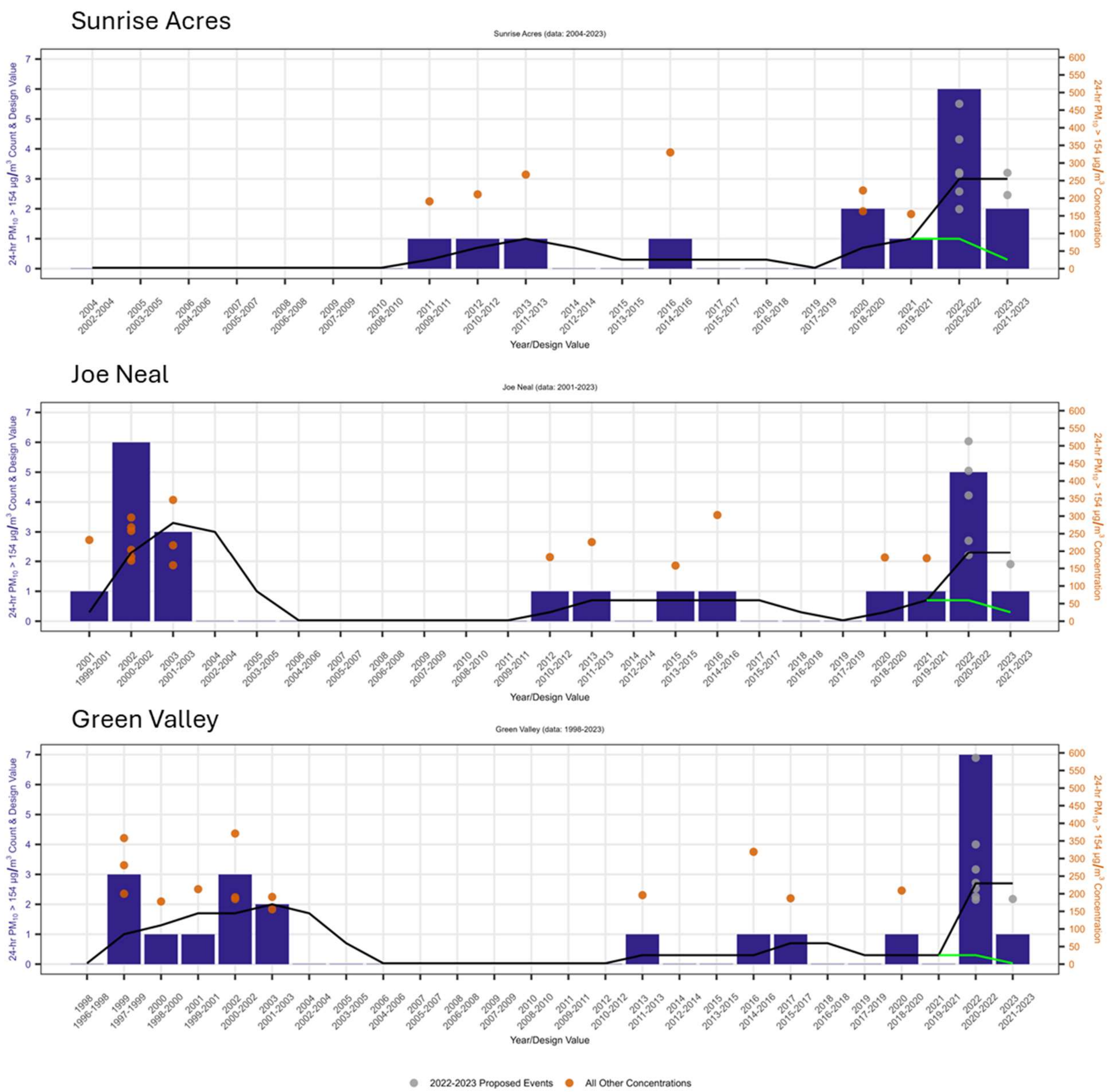

Figure 4.3-4. Historical 24-hour PM_{10} exceedance count (purple bars) and concentration (orange dots) per year/design value period at the Sunrise Acres, Joe Neal, and Green Valley monitoring sites (AQS: 32-003-0561; 32-003-0075; 32-003-0298). The gray dots represent the proposed 2022-2023 PM_{10} exceptional events, the black line represents the design value for all periods with all PM_{10} exceptional events included, and the green line represents the design value for the period with the 2022-2023 PM_{10} exceptional events excluded.

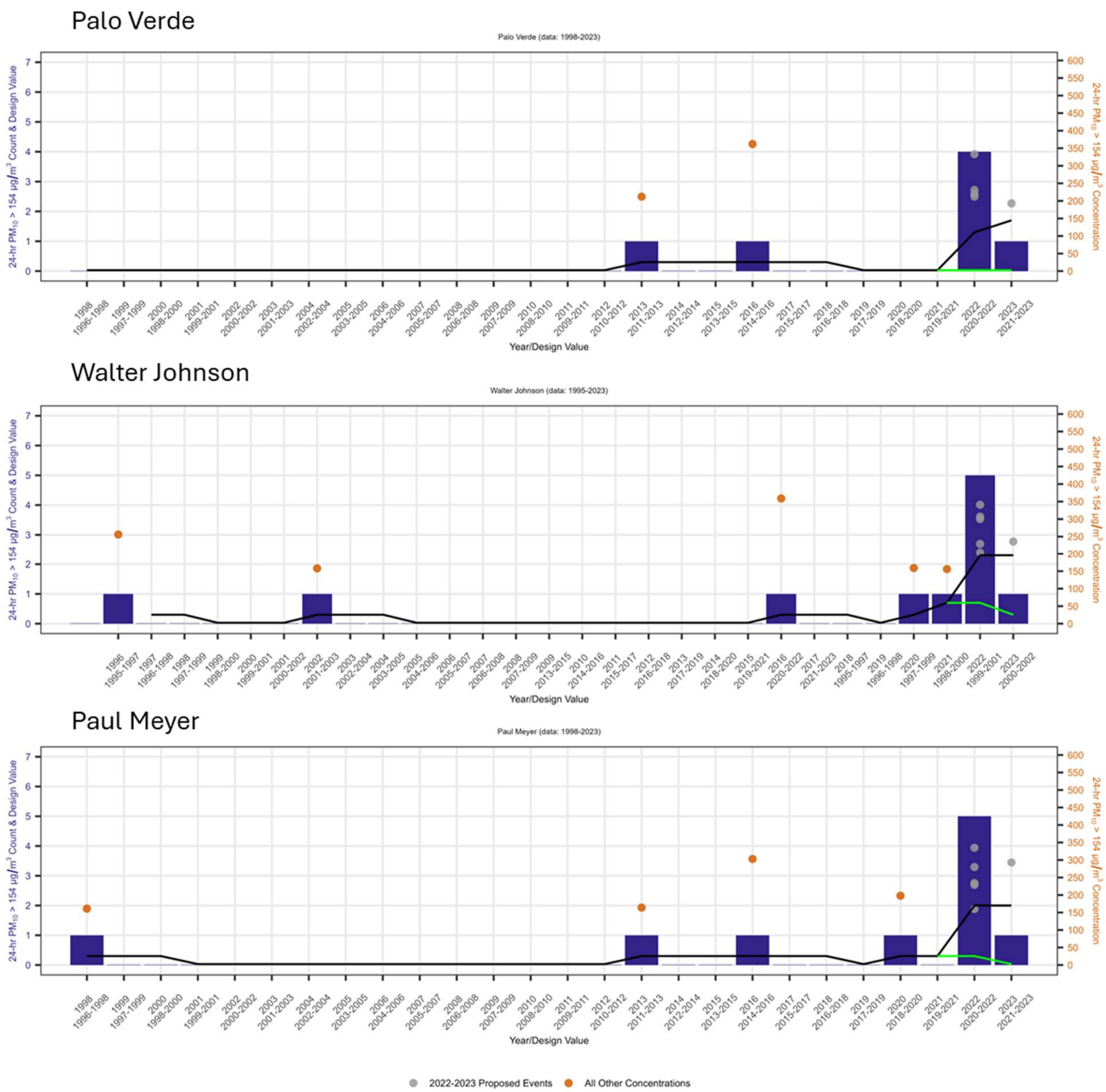

Figure 4.3-5. Historical 24-hour PM_{10} exceedance count (purple bars) and concentration (orange dots) per year/design value period at the Palo Verde, Walter Johnson, and Paul Meyer monitoring sites (AQS: 32-003-0073; 32-003-0071; 32-003-0043). The gray dots represent the proposed 2022-2023 PM_{10} exceptional events, the black line represents the design value for all periods with all PM_{10} exceptional events included, and the green line represents the design value for the period with the 2022-2023 PM_{10} exceptional events excluded.

4.3.3 Widespread Use of Controls

In addition to the similar controls listed per rule in Section 4.2, Clark County's dust control measure regulatory framework is similar to that of nearby jurisdictions. Rule 403 in the Rules and Regulations of the Mojave Desert Air Quality Management District (MDAQMD)[8] and Rule 310 of Maricopa County's (Arizona) Air Pollution Control Regulations[9] describe the regulations and enforcement of fugitive dust control measures. Like the fugitive dust controls outlined in Clark County's AQR, MDAQMD and Maricopa County provide definitions of control measures that dust-producing operations in the air agency's jurisdiction must apply to prevent, reduce, or mitigate fugitive dust. The control measures implemented by Clark County, MDAQMD, and Maricopa County emphasize the stabilization of site surfaces, and have requirements for equipment usage, permitting, and enforcement. The rules of the respective jurisdictions provide differing levels of detail and requirements regarding fugitive dust control measures. Further, the rules of the respective jurisdictions are tailored to fit the specific dust control challenges each jurisdictions faces.

The stabilization of site surfaces is defined similarly across Clark County, MDAQMD, and Maricopa County as the reduction of dust-producing capability of a disturbed surface through the treatment of the surface using methods such as watering, paving, manual compacting, or chemical treatment. Stabilization of site surfaces—where a portion of the earth's surface or material placed on the earth's surface is disturbed and has the potential to produce fugitive dust emissions—is required across all three jurisdictions. Stabilization is a critical component of dust control measures across the three jurisdictions. During high-wind events, all three jurisdictions must ensure that site surfaces are stabilized to prevent wind-blown dust. Maricopa County and Clark County specify in their respective rules that, during high-wind events, certain operations that destabilize surfaces such as blasting must cease, whereas MDAQMD requires that "non-essential" destabilizing operations must be reduced.

Specific rules regarding equipment use vary slightly across the three jurisdictions in requirements and level of detail, but generally include requirements such as speed limits for equipment while on site and limits on hauling vehicles (e.g., covers over dust-producing material). For example, MDAQMD requires that hauling vehicles working at a mining, stone, asphalt, or clay facility maintain at least six inches of freeboard (i.e., the distance between the hauled material and the top of the hauling container) on haul vehicles when transporting material on public roads, whereas Maricopa County requires that hauling vehicles working off-site in areas accessible to the public maintain at least three inches of freeboard on haul vehicles when transporting material. Maricopa County also provides details on hauling truck operations working under other circumstances, such as on-site and not accessible to the public.

Dust control plans required across the three jurisdictions vary slightly, but are integral parts of the permitting process that detail control measures that will be implemented. All dust control plans require basic information such as site details, control measures, contingency control measures, and a summary of general day-to-day operations. The circumstance under which a dust-generating operation must submit a dust control plan differs between the jurisdictions. For example, there are seven circumstances that would require the submittal of a dust control plan to MDAQMD, such as a

[8] https://www.mdaqmd.ca.gov/home/showpublisheddocument/8482/637393282546170000
[9] https://www.maricopa.gov/DocumentCenter/View/5354/Rule-310---Fugitive-Dust-from-Dust-Generating-Operations-PDF?bidId=

"Residential Construction/Demolition Activity with a Disturbed Surface Area of at least ten (10) acres." Maricopa County, however, requires the submittal of a dust control plan for any potential dust-generating operation that would meet or exceed 0.10 acres. Clark County, under Section 94 of the AQR, requires the submittal of a dust control plan for "Construction and Temporary Commercial Activities" under four circumstances (e.g., Construction Activities that disturb soils 0.25 acres or greater in overall area).

Enforcement of dust control regulations and dust control plan compliance are also similar, but differ in level of detail and stringency between the three jurisdictions. Clark County's enforcement activities are extensive and detailed. For example, per Section 94 of the AQR, Clark County requires that, under certain circumstances, a Dust Control Monitor (i.e., a construction superintendent or other on-site representative) is given power to ensure the dust-generating operation is compliant with dust control regulations and follows the dust control plan. Maricopa County has similar rules regarding an official monitor of dust control regulation and dust control plan compliance. Officials in charge of monitoring dust-producing activities are trained in dust control practices and are generally responsible for managing and enforcing dust control practices at the dust-producing site. Dust-producing operations in violation of regulations and their dust control plan are subject to penalties.

The prevalence of similar standard fugitive dust control practices employed by Clark County, MDAQMD, and Maricopa County provide a benchmark for reasonable dust controls for similar environments in the southwest U.S.

4.3.4 Jurisdiction

As detailed in **Section 3.1.1**, on April 11, 2022, dense blowing dust from the Mojave Desert source region impacted the Las Vegas metropolitan area. Due to the strengthening pressure gradient caused by an associated cold front, surface wind speeds increased in Clark County and the Mojave Desert, which produced blowing dust in the late morning/early afternoon hours southwest of Las Vegas on April 11, 2022. Strong winds in the Mojave Desert source region were well above 25 mph from the frontal passage, which lofted, entrained, and transported dust from the source region to Clark County. The hourly PM_{10} concentrations detailed in **Section 3.2.2** show an eastward progression of high PM_{10} concentrations and wind speeds consistent with the direction of travel of the cold front. By 13:00 PST, all sites in the Las Vegas Valley exceeded 500 $\mu g/m^3$. Ground-based evidence, including particulate matter analysis (**Section 3.3.4**) and visibility monitors (**Section 3.3.5**), provide additional strong evidence that PM_{10} control measures within Clark County were overwhelmed and unable to prevent an exceedance event on April 11, 2022. The timeline shown in this exceptional event demonstration highlights the progression of extremely high concentrations of PM_{10} from the source region into Clark County (and HA 212) within a very short period of time. This progression clearly indicates an upwind source of windblown dust. As the strong winds lofted, entrained, and transported dust from the Mojave Desert in southeastern California and southern Nevada, this source region was outside the jurisdiction of Clark County and the implemented control measures.

4.4 Effective Implementation of Control Measures

In addition to the SIP and AQR documentation previously provided, the Clark County DES is responsible for monitoring and forecasting air quality and enforcing dust mitigation measures before, during, and after an exceptional event. Clark County issues "advisories" and "Construction Notices" when weather conditions are forecast to be favorable for a wind-blown dust event. Advisories consist of health-based notifications disseminated to the public that provide educational materials on how to limit exposure and mitigate emissions for dust, $PM_{2.5}$, seasonal ozone, ozone, and/or smoke. Construction Notices are notifications to stationary sources, dust control permit holders, and contractors that detail mitigation measures. The issuance of Construction Notices may not meet the wind threshold for a potential high-wind dust event, but if weather conditions change to prompt a public advisory or alert, stationary sources are sent a detailed form of the public advisory or an alert with language specific to their operations and dust abatement requirements.

Dust Advisories are issued for forecasts of sustained wind speeds of 25 mph or more, or wind gusts of 40 mph or more. Construction Notices are issued for forecasts of sustained wind speeds of 20 mph or more, or wind gusts of 30-35 mph or more. Upon issuance of either a Construction Notice or an Advisory, the DES directs stationary sources to inspect their site(s), cease blasting operations, and employ BACM to stabilize all disturbed soils and reduce blowing dust. Recipients of a Construction Notice are informed that the DES officials will inspect sites to ensure BACM is being implemented.

Specific construction-related control measures include required dust control classes for construction superintendents or other on-site representatives.[10] Clark County also collects air quality complaints (including dust complaints) submitted online, over the phone, or via email, and responds to all complaints within 24 hours or the next business day.[11] Expansive rules and BACM for dust control at construction and temporary commercial activities are included in AQR Section 94. These include requirements for dust control monitors, soil stabilization standards, testing methods, and rules for non-compliance or violations if a permit or Dust Mitigation Plan has been violated. During high-wind dust periods, Clark County compliance officers inspect construction and stationary source sites to ensure BACM are being implemented, and any observed violation may receive a Notice of Non-Compliance or a Notice of Violation.

On April 11, 2022, a Dust Advisory and Construction Notice was issued by Clark County to all dust control permit holders, contractors, and stationary sources instructing them to immediately inspect their site(s) and employ BACM to stabilize disturbed soils and reduce blowing dust (see **Appendix D**). In the case of a Dust Advisory and Construction Notice, compliance officers inspect construction and stationary source sites during the episode to ensure BACM are being implemented, where any observed violation may receive a Notice of Violation. This and other Clark County public-facing alerts shown in **Section 3.3.1** indicated the implementation of BACM and enforcement procedures.

[10] https://www.clarkcountynv.gov/government/departments/environment_and_sustainability/compliance/dust_classes.php
[11] https://www.clarkcountynv.gov/government/departments/environment_and_sustainability/division_of_air_quality/air_quality_complaints.php

Appendix C also provides all inspection information and notices of violation from the April 11, 2022, event.

The Clark County DES is comprised of Monitoring, Compliance and Enforcement, and Planning divisions. The Monitoring Division is primarily responsible for weather and air quality monitoring, forecasting Air Quality Index (AQI) levels and coordinating with other divisions and Clark County more broadly on the issuance of Construction Notices or Advisories. The Compliance and Enforcement Division is responsible for disseminating Construction Notices to appropriate stationary sources, dust control permit holders, and contractors. This department also disseminates Advisories to the public, conducts field inspections of sources before and during a dust event, alerts alleged violators of compliance statuses, and documents observations made in the field of enforcement actions. The Planning Division is responsible for coordinating with the other divisions to prepare exceptional event packages. Full details on these procedures can be found in Appendix D. Based on the implementation of increased control measures, as well as compliance and the enforcement of advisories for windblown dust, part 3 of the nRCP requirement is fulfilled.

The documentation and analysis presented in this demonstration and appendices demonstrate that all identified sources that caused or contributed to the exceedance were reasonably controlled, effectively implemented, and enforced at the time of the event; therefore, emissions associated with the April 11, 2022, PM_{10} event were not reasonably controllable or preventable.

5. Natural Event

The April 11, 2022 event is the result of a frontal passage and associated pressure gradient that caused high winds over the Mojave Desert source regions which lofted, entrained, and transport dust into Clark County, Nevada. In the case when high wind events pass over natural undisturbed lands, the EPA considers high-wind dust events natural. In addition, there were controls in place for anthropogenic sources, **Section 4.2**, during the high-wind dust event. Therefore, we conclude this event meets the EPA criteria for a natural event.

6. Conclusions

The evidence provided within this report demonstrates that the PM_{10} exceedance on April 11, 2022 was caused by a High Wind Dust Event where dust was lofted, entrained, and transported from the extremely dry Mojave Desert in southeastern California to Clark County, Nevada. Key elements and evidence associated with the event timeline include:

1. A low-pressure system and associated frontal passage from the north of Clark County caused a sharp rise in southwesterly wind speeds across an extremely dry desert source region in the Mojave Desert to the southwest of Clark County. The pressure gradient across southern California and Nevada associated with the frontal passage deepened from approximately 04:00-16:00 PST on April 11, 2022. With this pressure gradient, dust from the Mojave Desert was lofted, entrained, and transported to Clark County by 10:00-12:00 PST on April 11. Meteorological measurements in the source region and along the transport path show winds greater than the 25-mph threshold.

2. Back trajectories and meteorological data along the frontal passage confirm the Mojave Desert as the source region for the high wind dust event. The frontal passage pushed south, causing a strengthening of the pressure gradient between Clark County and the source region, which led to high winds bringing dust from the Mojave within two to six hours of the exceedance. Satellite data, meteorological data, and visibility measurements all align to confirm event transport from the Mojave Desert. PM_{10} measurements along the frontal passage increase as winds push through Kern and San Bernardino counties in California then Nye and Clark counties in Nevada, confirming high PM_{10} along the timeline and trajectories established.

3. The frontal passage entered Clark County at approximately 10:00-12:00 PST on April 11, 2022. Along with the frontal passage, PM_{10} was extremely enhanced, construction and weather alerts were issued, visibility measurements indicate dusty conditions, and $PM_{2.5}/PM_{10}$ ratios dropped (indicating windblown dust).

4. PM_{10} concentrations increased at the same time as the frontal passage pushed into Clark County starting at approximately 10:00 PST and peaked in intensity by 13:00-16:00 PST on April 11, 2022. 24-hour PM_{10} concentrations were above the NAAQS threshold of 150 $\mu g/m^3$ at 13 sites (regulatory significance at 10 sites: Green Valley at 340 $\mu g/m^3$, Jerome Mack at 300 $\mu g/m^3$, Joe Neal at 359 $\mu g/m^3$, Liberty High School at 365 $\mu g/m^3$, Mountains Edge at 259 $\mu g/m^3$, Palo Verde at 333 $\mu g/m^3$, Paul Meyer at 335 $\mu g/m^3$, Sunrise Acres at 367 $\mu g/m^3$, Walnut Community Center at 396 $\mu g/m^3$, and Walter Johnson at 341 $\mu g/m^3$). The other three sites exceeding the 24-hour PM_{10} NAAQS recorded concentrations above the 99th percentile but were not regulatorily significant in this case. Hourly PM_{10} concentrations at all affected sites in Clark County peaked above 500 $\mu g/m^3$ through the event on April 11. The concurrent rise in PM_{10} at all sites around Clark County indicates a regional dust event.

5. All sites of regulatory (and nonregulatory) significance exceeded the five-year 99th percentile and the NAAQS on April 11, 2022. Hourly PM_{10} concentrations are also significantly outside typical diurnal, monthly, and seasonal ranges.
6. Clark County, Nevada, and the surrounding source region was under increasingly severe drought conditions on and before the April 11, 2022 event. The 30-year climatology shows that wind speeds were above normal, while soil moisture was below normal. The barren land cover in the Mojave Desert source region was primed for significant dust production during the high wind event. PM_{10} control measures within Clark County were quickly overwhelmed and unable to prevent an exceedance event on April 11, 2022. Dust lofted and transported from this natural, undisturbed area experiencing severe drought is considered to be a natural and not reasonable or controllable event.
7. Analysis comparing another date similar to April 11, 2022 include dates with comparable wind profiles that did not show PM_{10} concentrations above the NAAQS. This analysis indicates that in the absence of an extremely dry source region and high surface winds, PM_{10} concentrations would not have been exceptionally high.

Within this document the following requirements for the EER have been met:

1. A narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s),
2. A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation,
3. Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times,
4. A demonstration that the event was both not reasonably controllable and not reasonably preventable,
5. A demonstration that the event was a human activity that is unlikely to recur at a particular location or was a natural event, and
6. Documentation that the air agency followed the public comment process (included in **Appendix E**).

The high wind dust event that occurred on April 11, 2022 caused 24-hour PM_{10} NAAQS exceedances with regulatory significance at Green Valley (Monitor AQS ID 32-003-0298, POC 1), Jerome Mack (Monitor AQS ID 32-003-0540, POC 1), Joe Neal (Monitor AQS ID 32-003-0075, POC 1), Liberty High School (Monitor AQS ID 32-003-0299, POC 1), Mountains Edge (Monitor AQS ID 32-003-0044, POC 1), Palo Verde (Monitor AQS ID 32-003-0073, POC 1), Paul Meyer (Monitor AQS ID 32-003-0043, POC 1), Sunrise Acres (Monitor AQS ID 32-003-0561 POC 1), Walnut Community Center (Monitor AQS ID 32-003-2003, POC 1) and Walter Johnson (Monitor AQS ID 32-003-0071, POC 1). On April 11, 2022, the 24-hour PM_{10} reached 340 µg/m^3 at Green Valley, 300 µg/m^3 at Jerome Mack, 359 µg/m^3 at Joe

Neal, 365 µg/m^3 at Liberty High School, 259 µg/m^3 at Mountains Edge, 333 µg/m^3 at Palo Verde, 335 µg/m^3 at Paul Meyer, 367 µg/m^3 at Sunrise Acres, 396 µg/m^3 at Walnut Community Center, and 341 µg/m^3 at Walter Johnson. Seven additional suspected windblown dust events occurred between 2021 and 2023. Without EPA concurrence that the wind-blown dust event on April 11, 2022 and the other suspected events qualify as an exceptional event, the 2020-2022 design value is 2.0 at Paul Meyer, 1.7 at Mountains Edge, 2.3 at Walter Johnson, 1.7 at Palo Verde, 2.3 at Joe Neal, 2.7 at Green Valley, 3.0 at Liberty High School, 3.7 at Jerome Mack, 3.0 at Sunrise Acres, and 4.0 at Walnut Community Center. This is outside of the attainment standard of 1.0. With EPA concurrence on April 11, 2022 and the other suspected events, the 2021-2023 design value is 0.0 at Paul Meyer, 0.3 at Mountains Edge, 0.3 at Walter Johnson, 0.0 at Palo Verde, 0.3 at Joe Neal, 0.0 at Green Valley, 0.3 at Liberty High School, 0.3 Jerome Mack, 0.3 at Sunrise Acres, and 1.0 at Walnut Community Center, within the attainment standard. Within this demonstration, all elements of the EER have been addressed. Therefore, we request that the EPA consider the overwhelming evidence of windblown dust that occurred in Clark County on April 11, 2022, and agree to exclude the event from regulatory decisions regarding PM_{10} attainment.

7. References

Bluestein, H. B. (1993). Observations and Theory of Weather Systems. Vol. II. Synoptic–Dynamic Meteorology in Midlatitudes.

Clark County Department of Air Quality Planning Division (2012) Redesignation request and maintenance plan for particulate matter (PM_{10}). Final Report, April. Available at https://files.clarkcountynv.gov/clarknv/Environmental%20Sustainability/SIP%20Related%20Documents/PM10_Plan_2012.pdf.

Dewitz, J., and U.S. Geological Survey, 2021, National Land Cover Database (NLCD) 2019 Products (ver. 2.0, June 2021): U.S. Geological Survey data release, doi:10.5066/P9KZCM54.

Griffith, G.E., Omernik, J.M., Smith, D.W., Cook, T.D., Tallyn, E., Moseley, K., and Johnson, C.B., 2016, Ecoregions of California (poster): U.S. Geological Survey Open-File Report 2016–1021, with map, scale 1:1,100,000, http://dx.doi.org/10.3133/ofr20161021.

Jiang, N., Dong, Z., Xu, Y., Yu, F., Yin, S., Zhang, R. and Tang, X. (2018). Characterization of PM10 and PM2.5 Source Profiles of Fugitive Dust in Zhengzhou, China. Aerosol Air Qual. Res. 18: 314-329. https://doi.org/10.4209/aaqr.2017.04.0132

Langford A.O., Senff C.J., Alvarez R.J., Brioude J., Cooper O.R., Holloway J.S., Lin M.Y., Marchbanks R.D., Pierce R.B., Sandberg S.P., Weickmann A.M., and Williams E.J. (2015) An overview of the 2013 Las Vegas Ozone Study (LVOS): impact of stratospheric intrusions and long-range transport on surface air quality. *Atmospheric Environment*, 109, 305-322, doi: 10.1016/j.atmosenv.2014.08.040, 2015/05/01/. Available at http://www.sciencedirect.com/science/article/pii/S1352231014006426.

National Weather Service Forecast Office (2020) Las Vegas, NV: general climatic summary. Available at https://www.wrh.noaa.gov/vef/lassum.php.

Sleeter, B. M., & Raumann, C. G. (2012). *Mojave Basin and Range Ecoregion: Chapter 29 in Status and trends of land change in the Western United States--1973 to 2000* (No. 1794-A-29, pp. 293-302). US Geological Survey. Available at https://pubs.usgs.gov/pp/1794/a/chapters/pp1794a_chapter29.pdf.

U.S. Census Bureau (2010) State & County QuickFacts. Available at https://www.census.gov/quickfacts/.

U.S. Environmental Protection Agency (2016) Guidance on the preparation of exceptional events demonstrations for wildfire events that may influence ozone concentrations. Final report, September. Available at www.epa.gov/sites/production/files/2016-09/documents/exceptional_events_guidance_9-16-16_final.pdf.

U.S. Environmental Protection Agency (2019) Guidance on the preparation of demonstrations in support of requests to exclude ambient air quality data influenced by high wind dust events under the 2016 exceptional events rule. Final report, April. Available at https://www.epa.gov/sites/default/files/2019-04/documents/high_wind_dust_event_guidance.pdf.