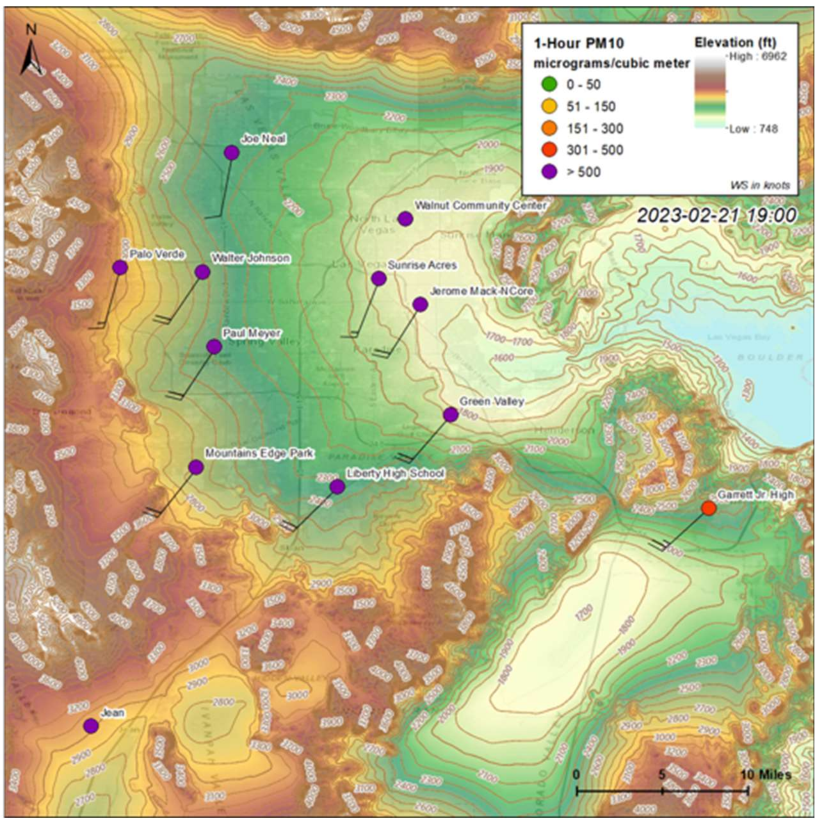
Exceptional Event Demonstration for PM_{10} Exceedances in Clark County, Nevada – February 21, 2023



Final Report Prepared for

U.S. EPA Region 9
San Francisco, CA

June 2024

Sonoma Technology

Exceptional Event Demonstration for PM_{10} Exceedances in Clark County, Nevada – February 21, 2023

Prepared by

Crystal McClure, PhD
Annie Anderson, PhD
Jeff Beamish
Kayla Besong, PhD
Melissa Chaveste
Cari Gostic
Samantha Kramer, PhD
Charles Scarborough
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

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June 2024

Cover graphic shows the PM_{10} concentrations, AQI level, wind speed and wind direction in the Las Vegas Valley at 19:00 PST on February 21, 2023.

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

Contents

Figures

Tables

1. Narrative Conceptual Model

In late February 2023, a strong frontal passage traversed California, driving a windblown dust event that lofted and entrained dust from the Mojave Desert and increased particulate matter (PM) concentrations in Clark County, Nevada, on February 21, 2023. During this episode, the 2012 24-hour National Ambient Air Quality Standards (NAAQS) threshold was exceeded for particles with a diameter of less than 10 microns (PM_{10}) at 10 monitoring sites in Clark County: Paul Meyer, Mountains Edge, Walter Johnson, Palo Verde, Joe Neal, Green Valley, Liberty High School, Jerome Mack, Sunrise Acres, and Walnut Community Center. Two additional sites experienced NAAQS exceedances but were not regulatorily significant. All sites throughout the Las Vegas Valley experienced significantly enhanced hourly PM_{10} concentrations. The widespread impact on PM_{10} concentrations in Clark County indicates that this was 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 into Clark County, arriving in the afternoon on February 21, 2023. The U.S. Environmental Protection Agency (EPA) Exceptional Event Rule (EER) (U.S. Environmental Protection Agency, 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 greater than 25 mph in the Mojave Desert source region coincide 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 (U.S. Environmental Protection Agency, 2019).

Overall, the February 21, 2023, PM_{10} concentrations at the 10 affected sites ranks above the 99th percentile for all 2019-2023 PM_{10} events in Clark County and is 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 establishes 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, Nevada – designating the February 21, 2023, 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

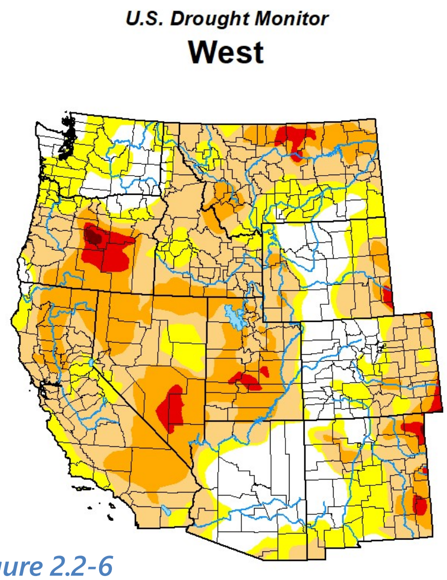


Figure 2.2-6

The Mojave Desert in southeastern California and Clark County, Nevada, were under increasing severe drought conditions on and before February 21, 2023. 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

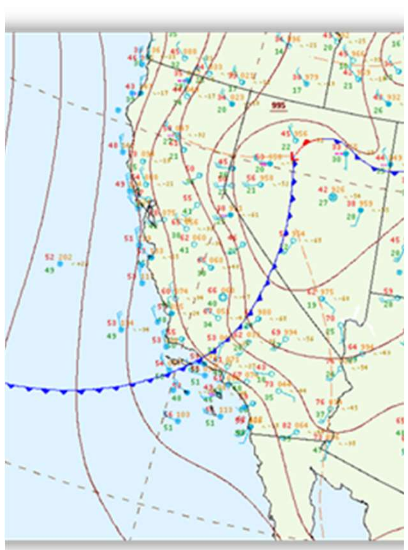


Figure 3.1-5

A frontal passage through California precipitated a large pressure gradient across Clark County, Nevada, and the Mojave Desert, culminating in high-wind speeds and gusts across the area starting around 13:00 PST and lasting through the rest of the day on February 21, 2023. Meteorological analysis and radar images of this event show the frontal passage (and associated dust) entering Clark County at 16:00 PST on February 21. 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

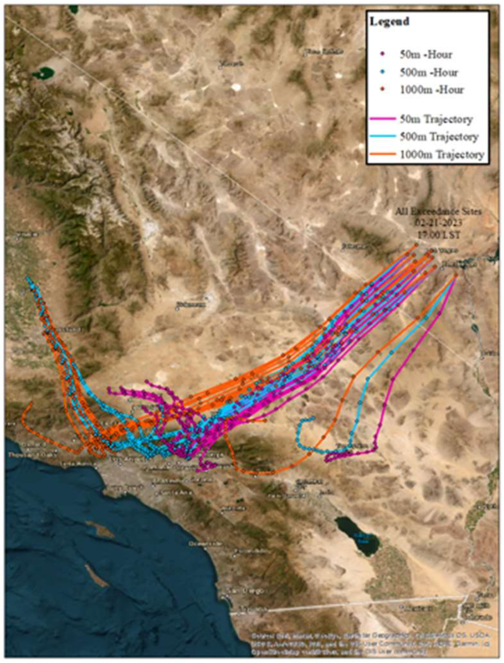


Figure 3.2-1

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, Nevada, within two to six hours of the exceedance.

See Section 3.2.

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

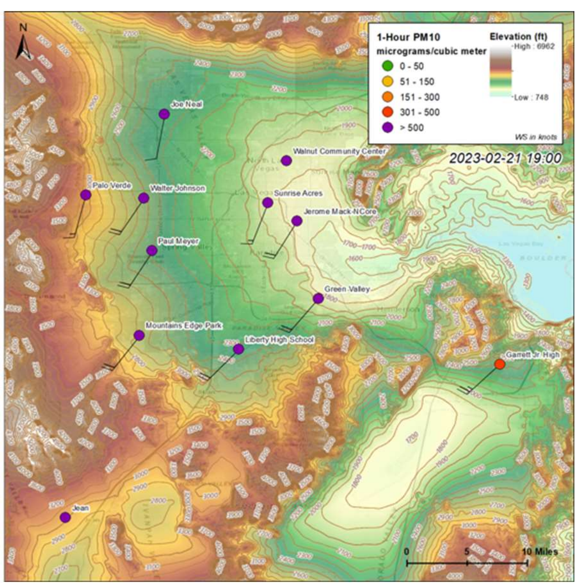


Figure 3.2-11

Enhanced PM_{10} concentrations arrived in Clark County beginning at 16:00 PST on February 21, 2023, with peak concentrations occurring between 19:00 and 22:00 PST. Concentrations remained enhanced through the remainder of the day. High PM_{10} concentrations at 12 sites across Clark County coincided with the frontal passage and occurred at the same time as the 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

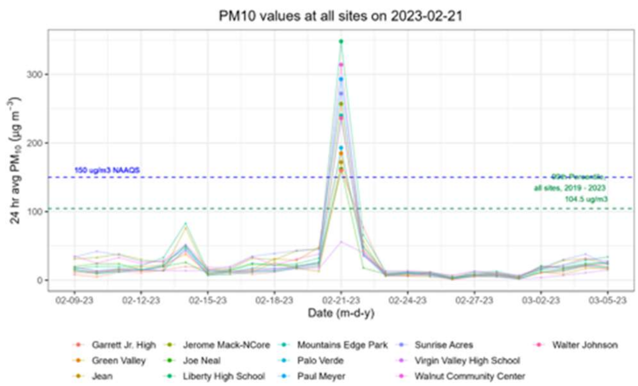


Figure 3.3-5

Twelve PM_{10} monitoring sites exceeded the NAAQS on February 21, 2023; ten sites experienced exceedances that were regulatorily significant, while two experienced exceedances that were not. Almost all sites throughout Clark County showed peak hourly concentrations of PM_{10} well above 1,000 $\mu g/m^3$. The widespread high PM_{10} concentrations concur with a regional high-wind exceptional event. PM_{10} concentrations at all 12 sites exceeded the five-year 99th percentile on February 21, 2023.

See Section 3.3.

High-Wind PM_{10} Alerts Issued


CLARK COUNTY NEVADA

News Release

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 **Tuesday, Feb. 21, 2023**

Air Quality Dust Advisory Issued for Tuesday Afternoon and Early Wednesday

The Clark County Department of Environment and Sustainability has issued a dust advisory for **Tuesday afternoon, Feb. 21 and early Wednesday, Feb. 22**, 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. Division of Air Quality forecasters said the advisory will be in effect from about 3 p.m. Tuesday, through the overnight hours into early Wednesday morning.

AIR QUALITY ADVISORY DUST ADVISORY

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

Clark County Nevada issued an Air Quality Dust Advisory in advance of the February 21, 2023, event due to forecasted high PM_{10} concentrations. This was also posted to social media for public access via Twitter. The National Weather Service (NWS) also issued several alerts and social media statements. Multiple news outlets reported on the high wind and dusty conditions on February 21, 2023.

See Section 3.3.

Comparison with Historical Data

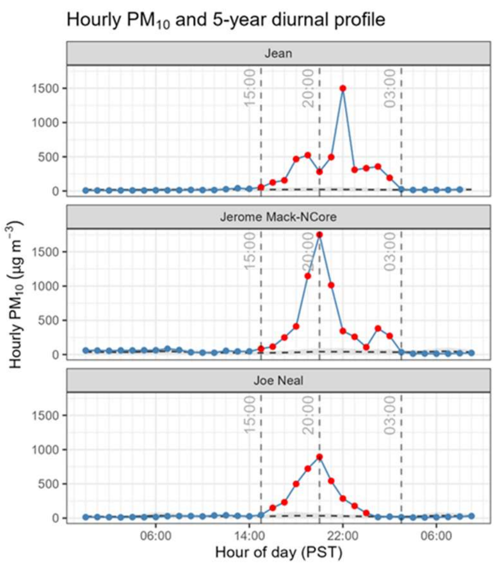


Figure 3.3-4

PM_{10} concentrations at the 10 sites that experienced regulatorily significant exceedances were above the five-year 99th percentile and the NAAQS on February 21, 2023. These PM_{10} concentrations are also significantly outside typical seasonal and monthly ranges. 30-year climatology analyses show temperatures and soil moisture in the Mojave Desert source region and Clark County were significantly outside of the historical normal on the event date.

See Section 3.4.

Not Reasonably Controllable or Preventable

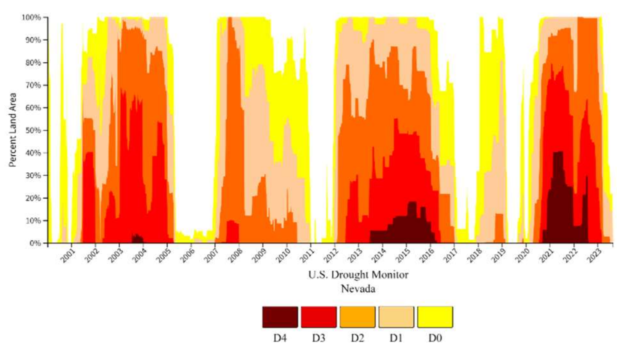


Figure 4.3-3

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

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 (U.S. Environmental Protection Agency, 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 the EER, exceptional events, such as high-wind dust events that affect PM_{10} concentrations can be excluded from calculations of the NAAQS attainment (i.e., design values) if a clear causal relationship can be established between a specific event and the monitoring exceedance (U.S. Environmental Protection Agency, 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 is a “natural event,” where windblown dust is from natural sources or all significant anthropogenic sources of windblown dust have 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 PM 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 February 21, 2023, met the 25-mph sustained wind speed threshold in 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" (U.S. Environmental Protection Agency, 2016) describes a three-tier analysis approach to determine a "clear causal relationship" for exceptional events demonstrations from an air agency. A summary of analysis requirements for each tier is listed in **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 Tier 1 analysis. Tier 2 analysis is warranted when sustained winds during the exceptional event are ≥ 25 mph but does not meet the other thresholds required in Tier 1 analysis.
- Tier 3 analysis is necessary when the impacts of the dust event on PM_{10} levels are more complicated than conditions described in the first two Tiers. Tier 3 analysis is needed when sustained winds during the exceptional event do not meet the 25-mph threshold; events categorized as Tier 3 may require additional analysis such as Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) trajectories from the source area or source-specific emissions inventories.

Table 2.1-1. High-wind PM_{10} exception 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 nRCP criterion. • To satisfy the nRCP criterion, the exceedance(s) must be associated with: - A dust storm that is the focus of a Dust Storm Warning. - Sustained winds that are ≥ 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 criterion of 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 source area. - Source-specific emissions inventories. - Meteorological and chemical transport modeling. - PM filter chemical speciation analysis where filter-based monitors are used.

2.1.3 Demonstration Outline

The PM_{10} exceedance on February 21, 2023, qualifies for Tier 2 analysis and may be referred to as a high-wind dust event with sustained winds at or above the high-wind threshold of 25 mph. On February 21, resultant hourly average wind speeds greater than the 25-mph threshold were observed at several air quality system (AQS) measurement sites in the Mojave Desert source region of southeastern California.

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 (Sections 3.3.2) and ground images during the event (Section 3.3.5). Guidance for a Tier 2 analysis recommends a controls analysis when the dust source is not anthropogenic. Section 2.2 identifies anthropogenic and natural sources of dust. Section 2.2.1 and 2.2.2 discuss the dust source for the event on February 21, natural, undisturbed lands southwest of Las Vegas, including an analysis of climatological factors that fostered prime conditions for lofted dust. Sections 2.2.3 and 4.1 identify regional emissions and other sources of PM_{10}, and Section 4 identifies control measures against 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 filter 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 February 21, 2023. Focusing on the characterization of the meteorology, source region terrain and climatology, transport, and air quality on the days leading up to the event, we conducted the following specific analyses, the results of which are presented in Section 3:

- Performed a top-down meteorological analysis to trace the conditions between the surface and 250 millibars (mb) that led to the high-wind event in southern Nevada,
- Compiled maps and imagery of aerosol optical depth (AOD) 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 PM 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 wind conditions.

2.1.4 Regulatory Significance

The high-wind dust event that occurred on February 21, 2023, caused 24-hour PM_{10} NAAQS exceedances with regulatory significance at the 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) sites. 24-hour PM_{10} exceedance values are listed in Table 2.1-3.

Table 2.1-3. 24-hour PM_{10} concentrations recorded at the sites that experienced an exceedance of the NAAQS on February 21, 2023.

Monitor AQS ID - POC	Site Name	24-hour PM_{10} Exceedance Concentration (µg/m^3)
32-003-0043-1	Paul Meyer	293
32-003-0044-1	Mountains Edge	240
32-003-0071-1	Walter Johnson	236
32-003-0073-1	Palo Verde	193
32-003-0075-1	Joe Neal	162
32-003-0298-1	Green Valley	185
32-003-0299-1	Liberty High School	348
32-003-0540-1	Jerome Mack	257
32-003-0561-1	Sunrise Acres	272
32-003-2003-1	Walnut Community Center	314

A NAAQS exceedance that is approved by the EPA as an exceptional event may be excluded from regulatory examination under the EER. 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 the 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 February 21, 2023, 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 the Clark County Department of Environment and Sustainability (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 February 21, 2023, 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 Mojave Desert in southeastern California (Figure 2.2-1). The primary land classifications in this region, shown by the Sentinel-2 Land Use/Land Cover map, 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 no to little 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 with natural sources of dust that are predisposed to high-wind events.

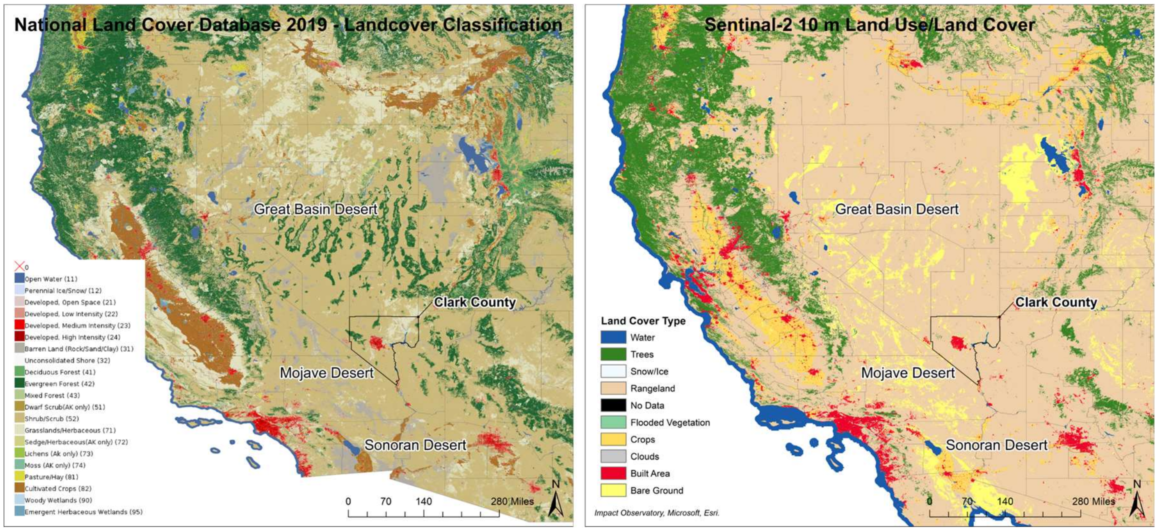


Figure 2.2-1. Land cover type for the western U.S. from (left) the National Land Cover Database-2019 and (right) Sentinel-2 satellite.

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.

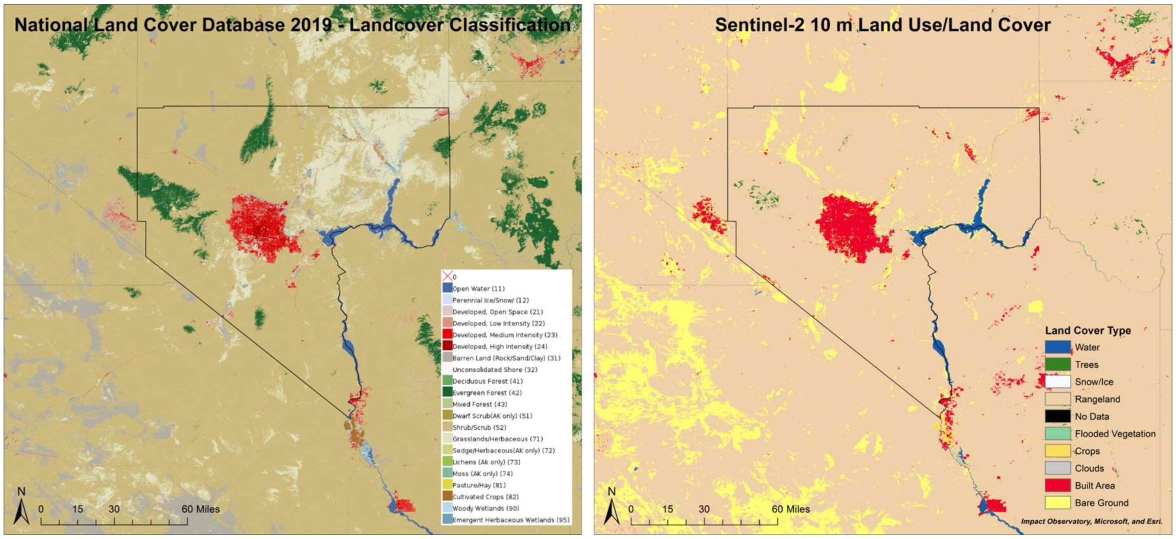


Figure 2.2-2. Land cover type for Clark County, Nevada, and surrounding area from the (left) the National Land Cover Database-2019 and (right) Sentinel-2 satellite.

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).

Clark County is located in the southern portion of Nevada and borders California and Arizona. The 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, 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 hot summertime temperatures (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 (~107 mm annual precipitation, 22% of which occurs during the summer monsoon season from 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 out of 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, the days leading up to the February 21, 2023, exceedance experienced normal to above-normal maximum daily temperatures. Concurrently, precipitation accumulation for the Las Vegas Area was below normal by late February (**Figure 2.2-3** and **Figure 2.2-4**).

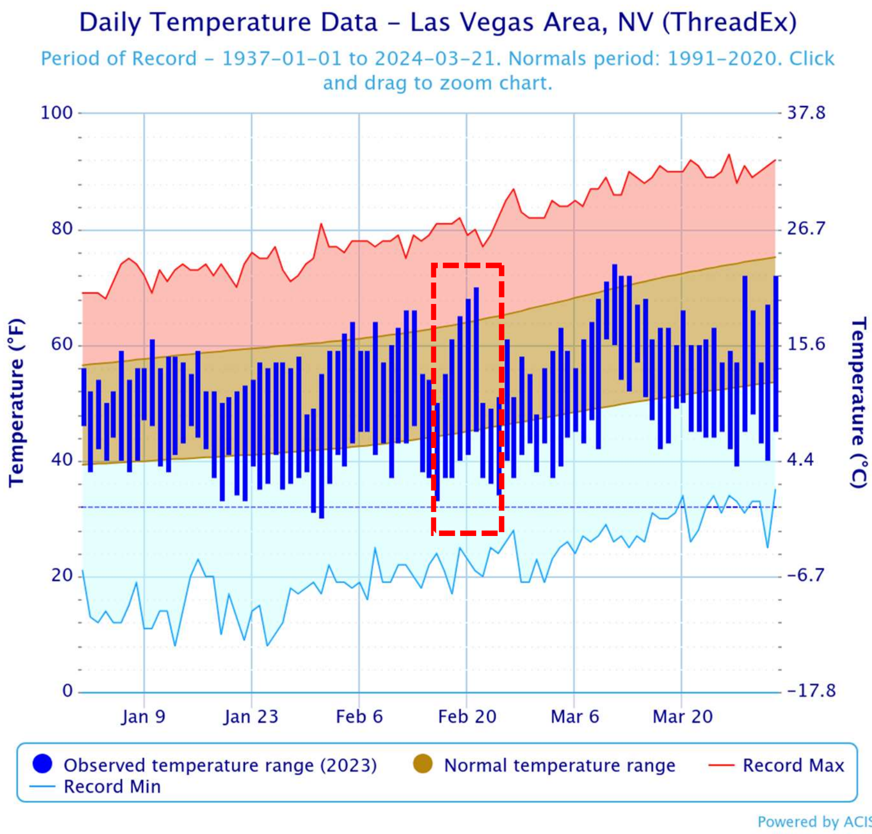


Figure 2.2-3. The temperature records for the Las Vegas area in Nevada from January 1, 1937, through March 3, 2023, by day, including (dark blue) observed temperature range in 2023, (brown) normal temperature range, (red) record maximum, and (light blue) record minimum. The red box indicates the dates of above normal temperatures before the February 21, 2023, event. Data from the National Weather Service: https://www.weather.gov/wrh/Climate?wfo=vef.

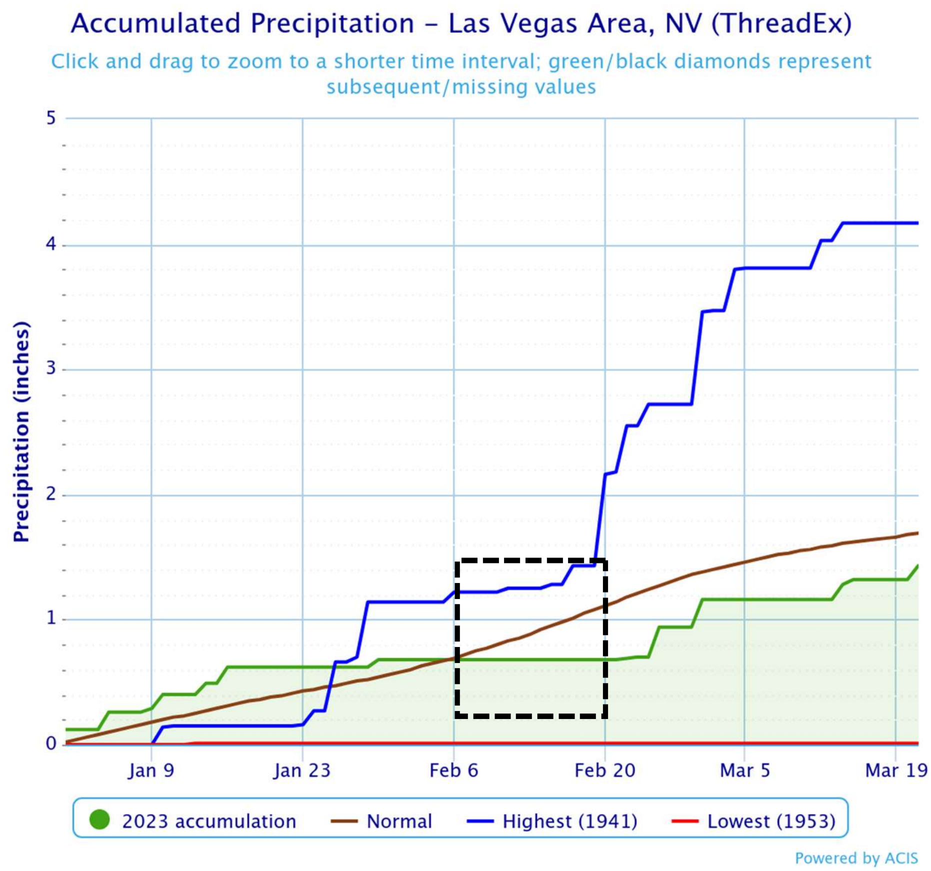


Figure 2.2-4. The precipitation records the Las Vegas area in Nevada by day, including (green) accumulation in 2023, (brown) normal, (blue) record maximum, and (red) record minimum. The black box indicates the period of low accumulated precipitation before the February 21, 2023, event. Data from NWS: **https://www.weather.gov/wrh/Climate?wfo=vef**.

The areas of the western U.S. that experienced "extreme drought" conditions progressively decreased in size and severity in the months before the PM_{10} exceedance, as highlighted by the Palmer Drought Severity Index (PDSI) produced by the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Protection (NCEP). (Figure 2.2-5). Despite improving drought conditions in parts of the western U.S., by February 21, 2023, all of Nevada and the Mojave Desert source region were under an abnormal-to-extreme drought (Figure 2.2-6 and Figure 2.2-7).

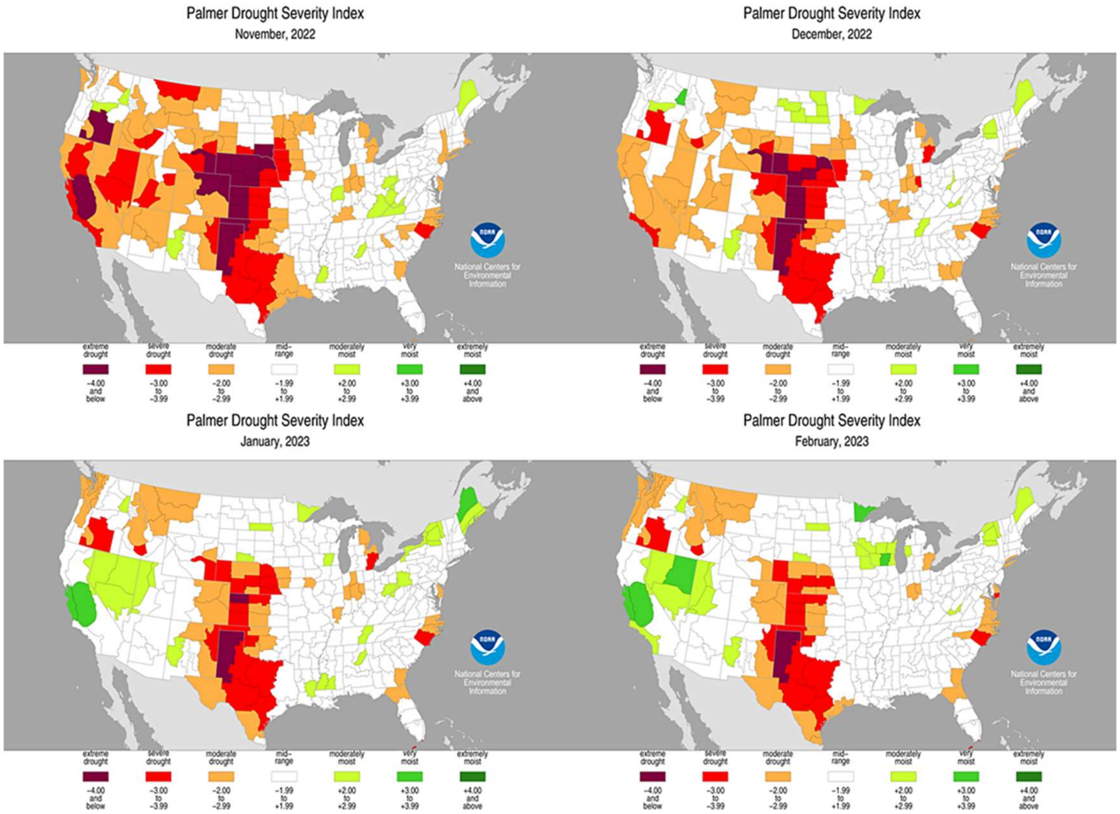


Figure 2.2-5. Palmer Drought Severity Index for November 2022 to February 2023.

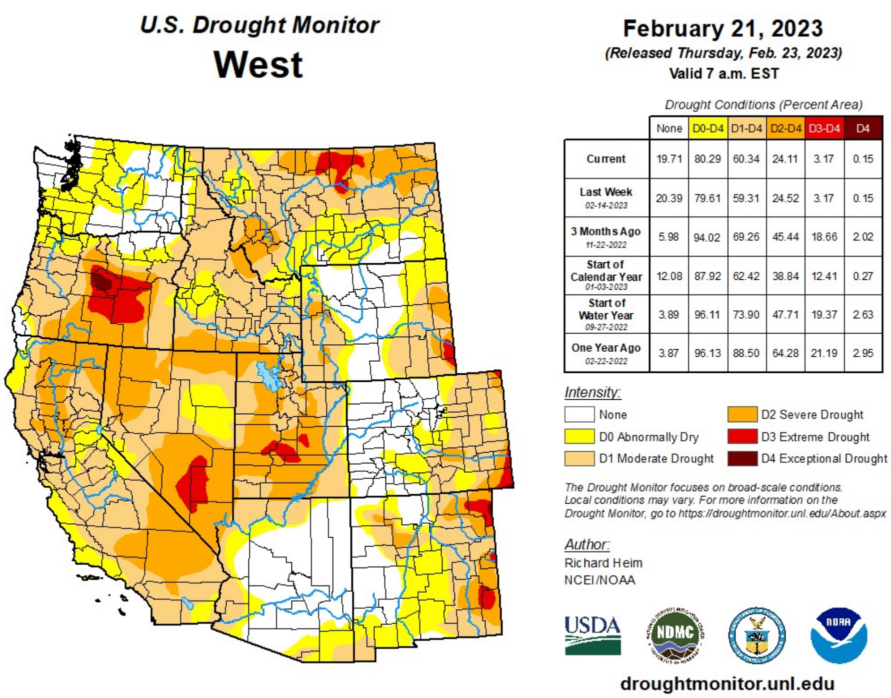
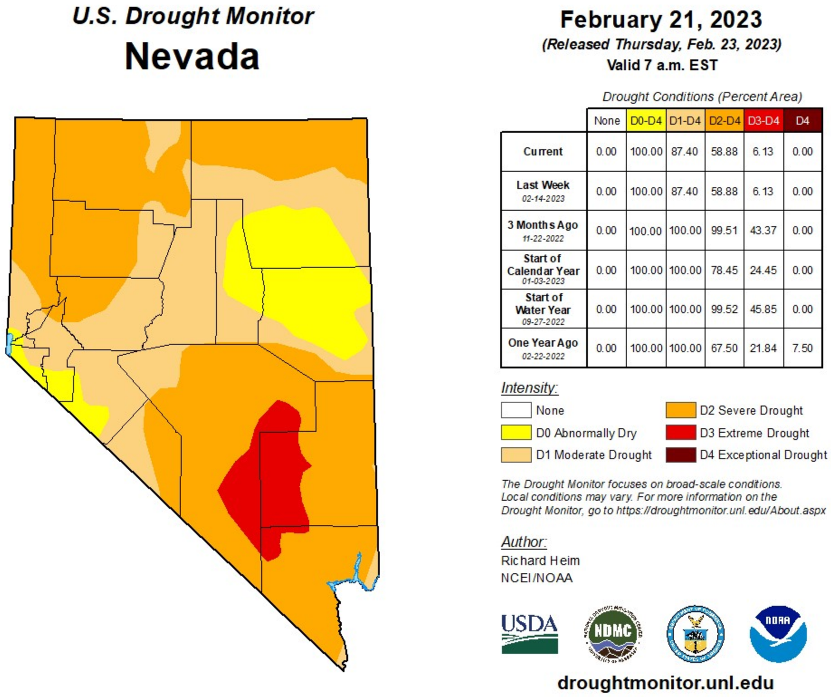


Figure 2.2-6. U.S. Drought Monitor values for the western U.S. on February 21, 2023.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	87.40	58.88	6.13	0.00
Last Week 02-14-2023	0.00	100.00	87.40	58.88	6.13	0.00
3 Months Ago 11-22-2022	0.00	100.00	100.00	99.51	43.37	0.00
Start of Calendar Year 01-03-2023	0.00	100.00	100.00	78.45	24.45	0.00
Start of Water Year 09-27-2022	0.00	100.00	100.00	99.52	45.85	0.00
One Year Ago 02-22-2022	0.00	100.00	100.00	67.50	21.84	7.50

Figure 2.2-7. U.S. Drought Monitor values for Nevada on February 21, 2023.

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 February 20 and 21 (from 1993 – through 2022). The median maximum daily temperature varies in the source region, but range from approximately 40 °F to 66 °F.

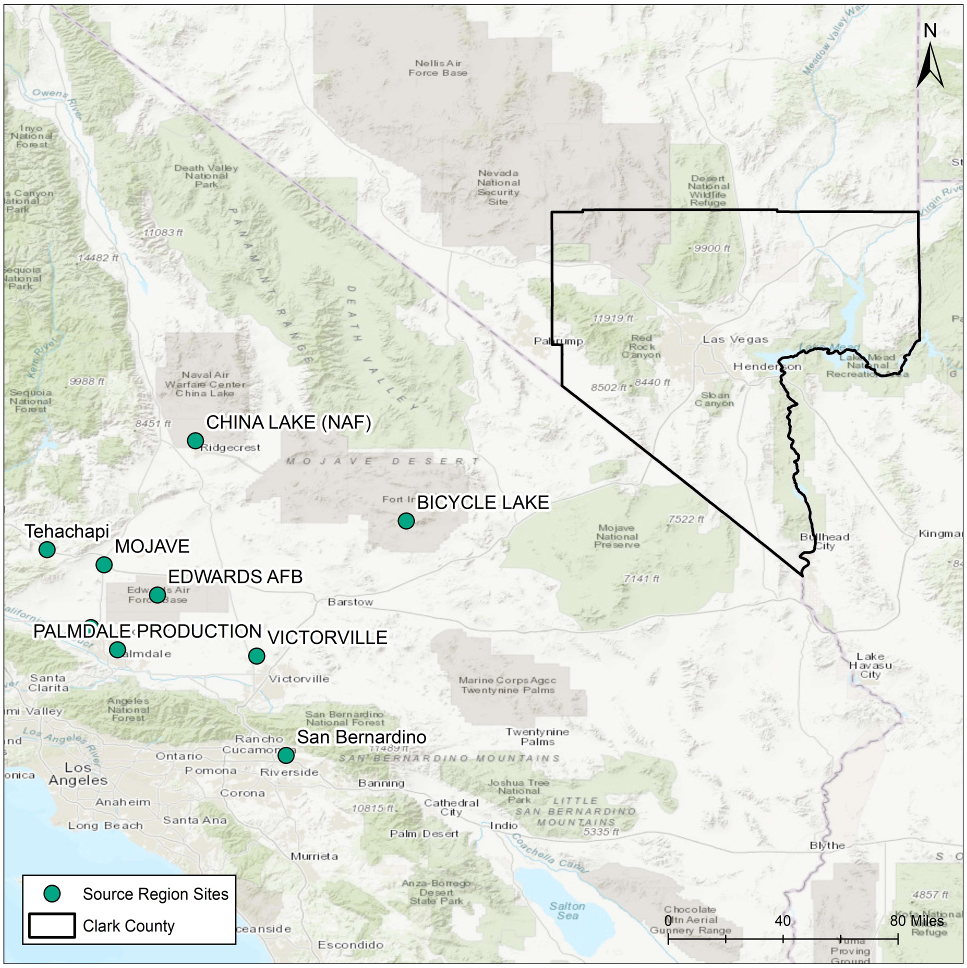


Figure 2.2-8. Location of ASOS measurement sites in the wind-blown dust source region.

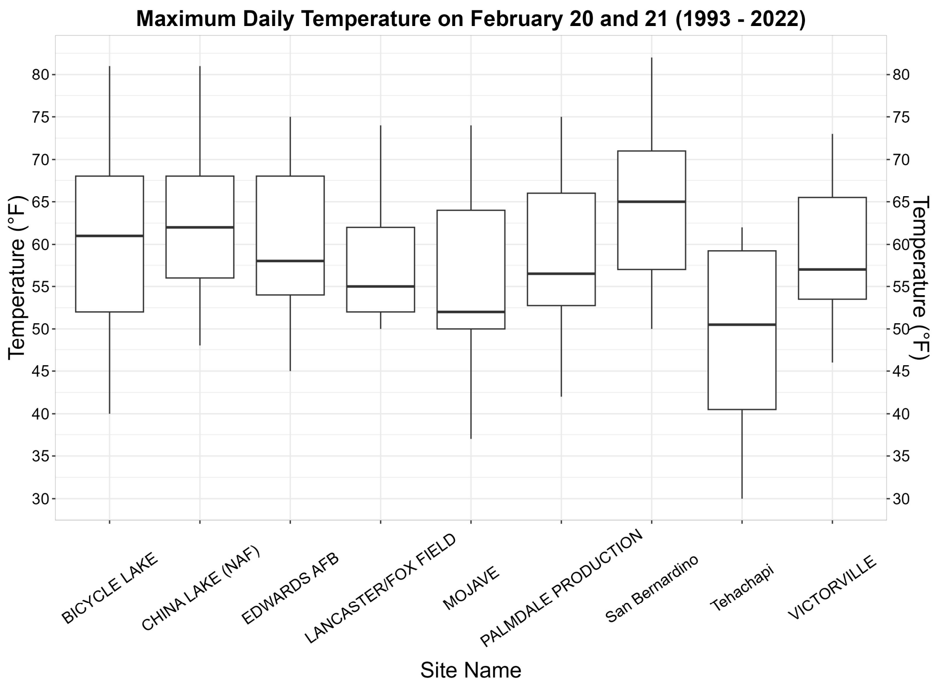


Figure 2.2-9. The average maximum daily temperature on February 20 and February 21 from 1993 through 2022 at each measurement site.

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.

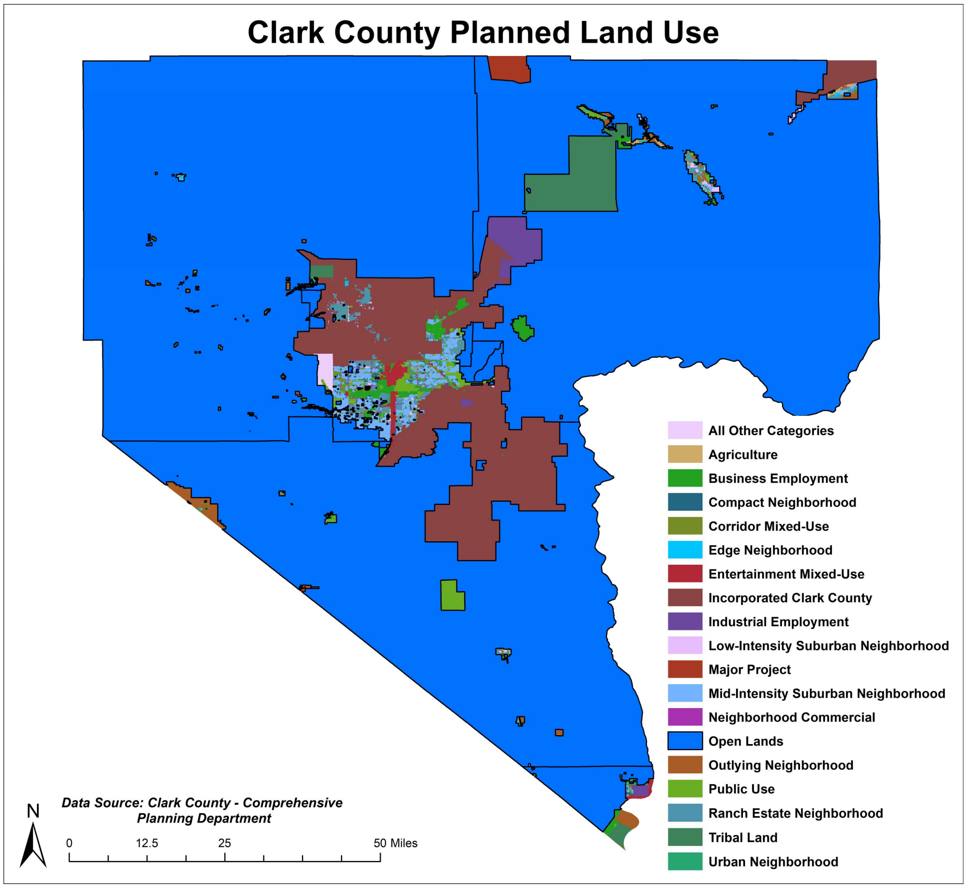


Figure 2.2-10. Planned land-use boundaries of Clark County.

Planned land use around the Garret Jr. High site is comprised entirely of incorporated land (Figure 2.2-11). The site is in the center of a block that contains a large sports complex with grassy sports fields, open grassy fields, tracks, tennis courts, and the Garret Junior High School. The immediate area surrounding the block consists of suburban neighborhoods with little exposed dirt or gravel.

Figure 2.2-11. Planned land-use boundaries in the area around the Garrett Jr High station.

Planned land use around the Green Valley site is comprised entirely of incorporated land (**Figure 2.2-12**). 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 occupied by buildings (baseball fields and single-family homes) and paved surfaces (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.

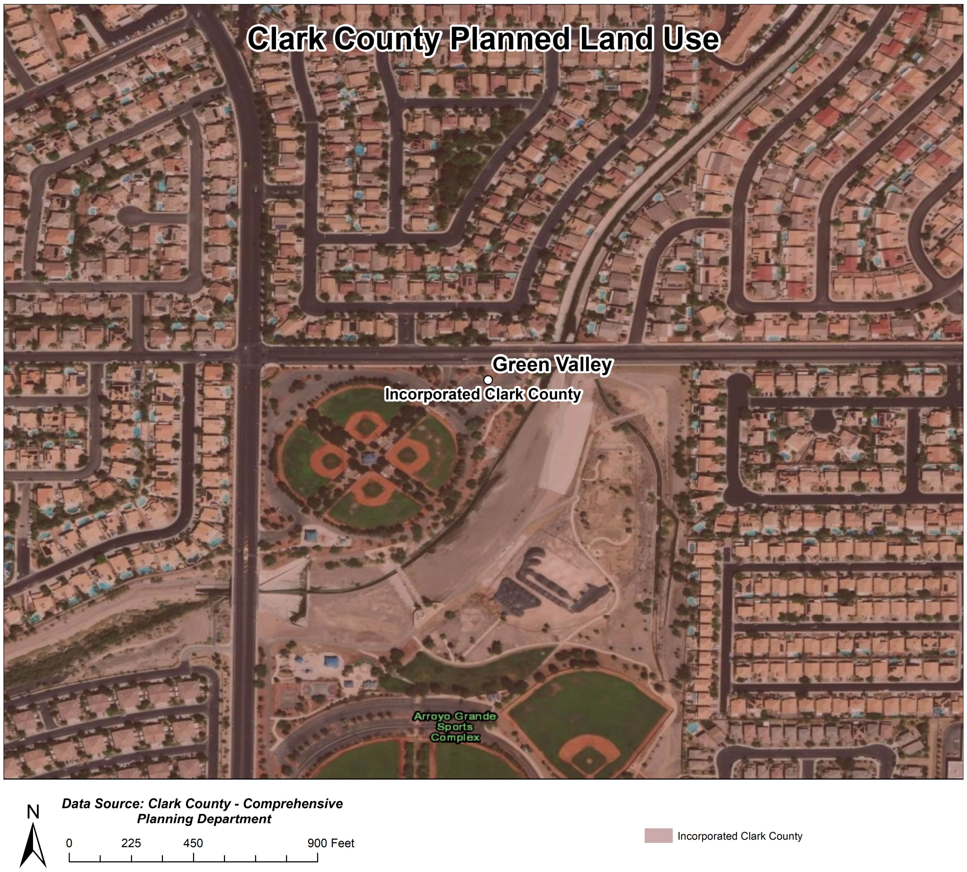


Figure 2.2-12. Planned land-use boundaries in the area around the Green Valley station.

Planned land use around the Jerome Mack site is comprised of public use to the west (Jerome Mack Middle School campus), a mid-intensity suburban neighborhood to the south, an urban neighborhood to the southeast, a compact neighborhood to the northeast, and business employment to the north and northwest. An aqueduct borders the Jerome Mack site immediately to the north (Figure 2.2-13). Much of the surrounding area includes buildings and paved surfaces consisting of parking lots and roads, with little exposed dirt or gravel.

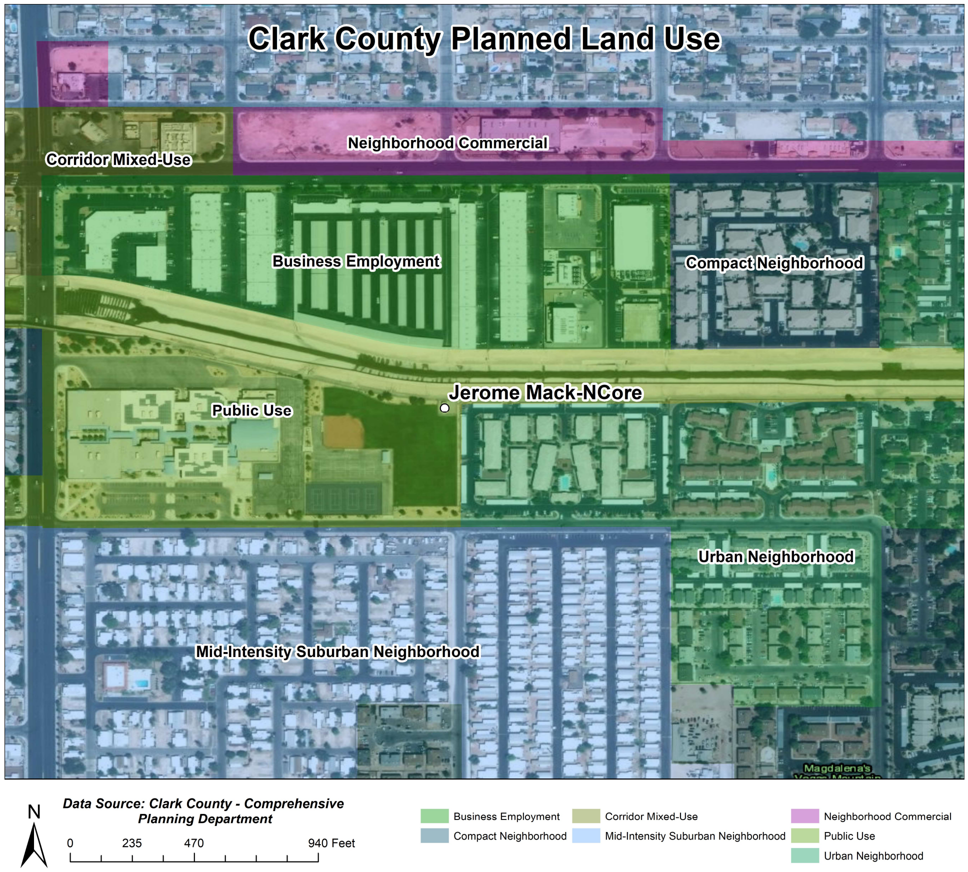


Figure 2.2-13. Planned land-use boundaries in the area around the Jerome Mack station.

Planned land use around the Joe Neal site is largely incorporated Clark County, as well as Ranch Estate Neighborhood to the west (Figure 2.2-14). Both uses are largely residential, with little exposed dirt or gravel; however, vacant lots are visible to the east and southeast of the monitor.

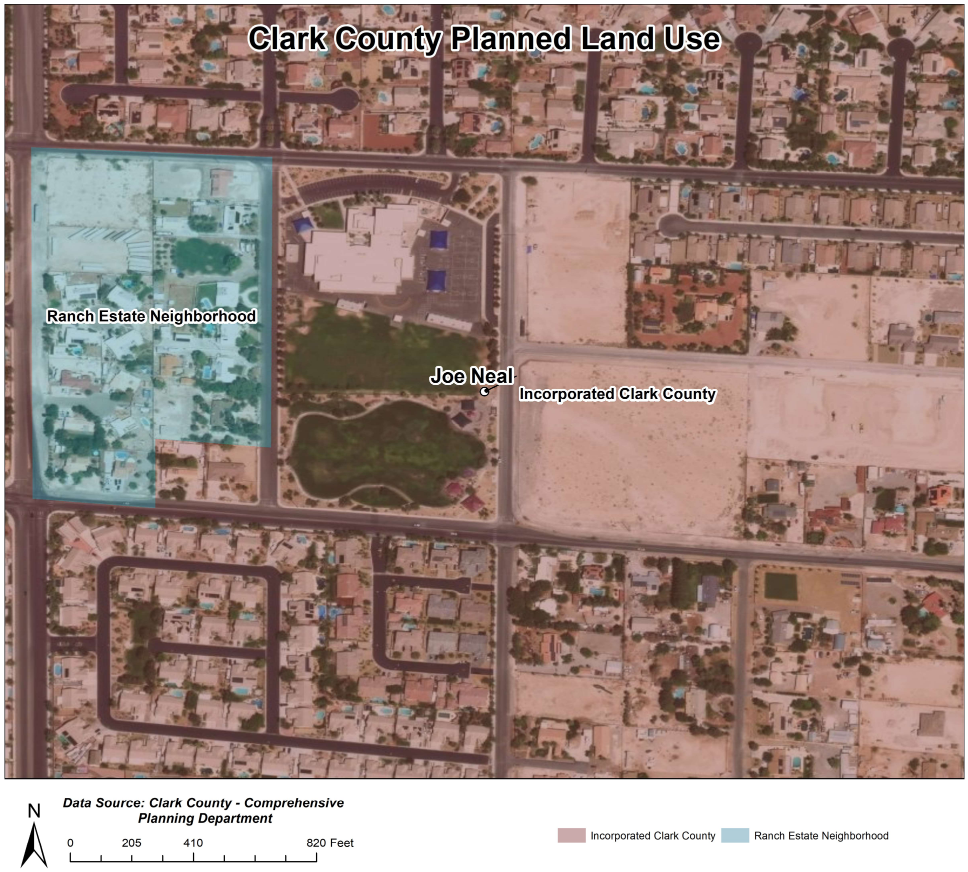


Figure 2.2-14. Planned land-use boundaries in the area around the Joe Neal station.

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 2.2-15**). 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 area surrounding the Liberty High School site are mostly paved surfaces with little exposed dirt and gravel.

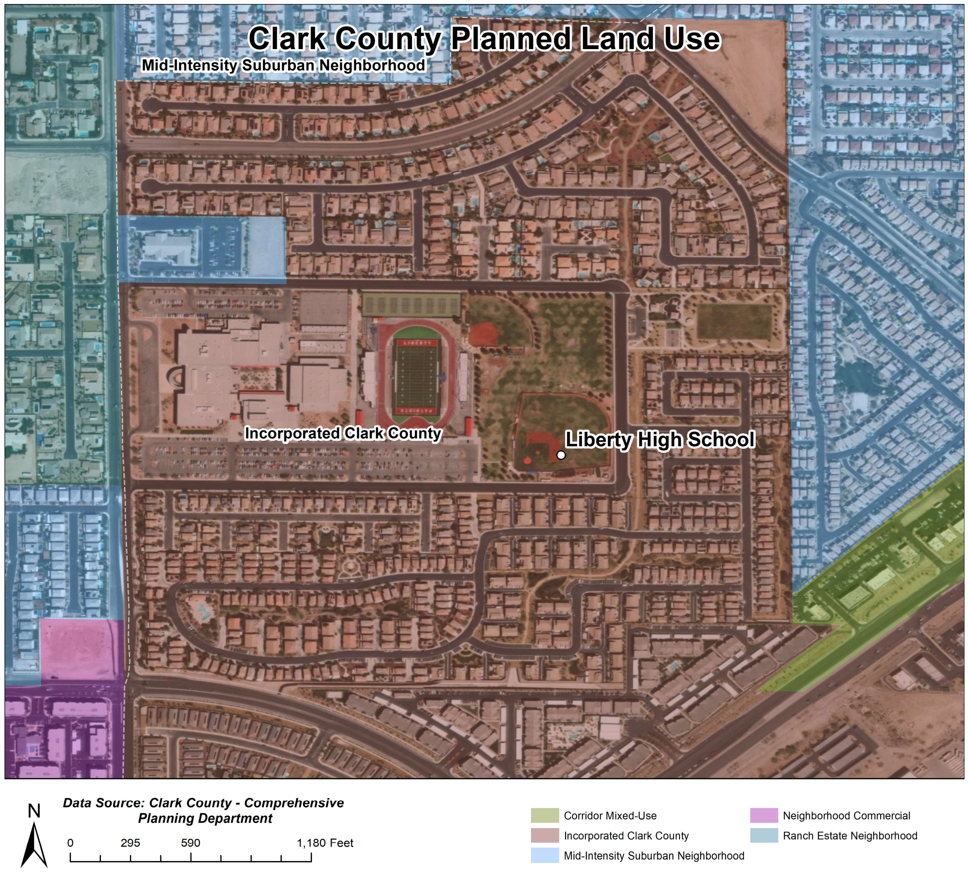


Figure 2.2-15. Planned land-use boundaries in the area around the Liberty High School station.

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 2.2-16). 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 2.2-16. Planned land-use boundaries in the area around the Mountains Edge station.

Planned land use around the Palo Verde site is comprised entirely of incorporated land (**Figure 2.2-17**). Much of the surrounding area is comprised of buildings and paved surfaces, including 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 2.2-17. 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 neighborhoods (Figure 2.2-18). 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 2.2-18. 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 2.2-19**). Residential areas are also present to the south, including compact neighborhoods, mid-intensity suburban neighborhoods, and commercial neighborhoods. Much of the surrounding area is comprised of buildings and paved surfaces, including 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.

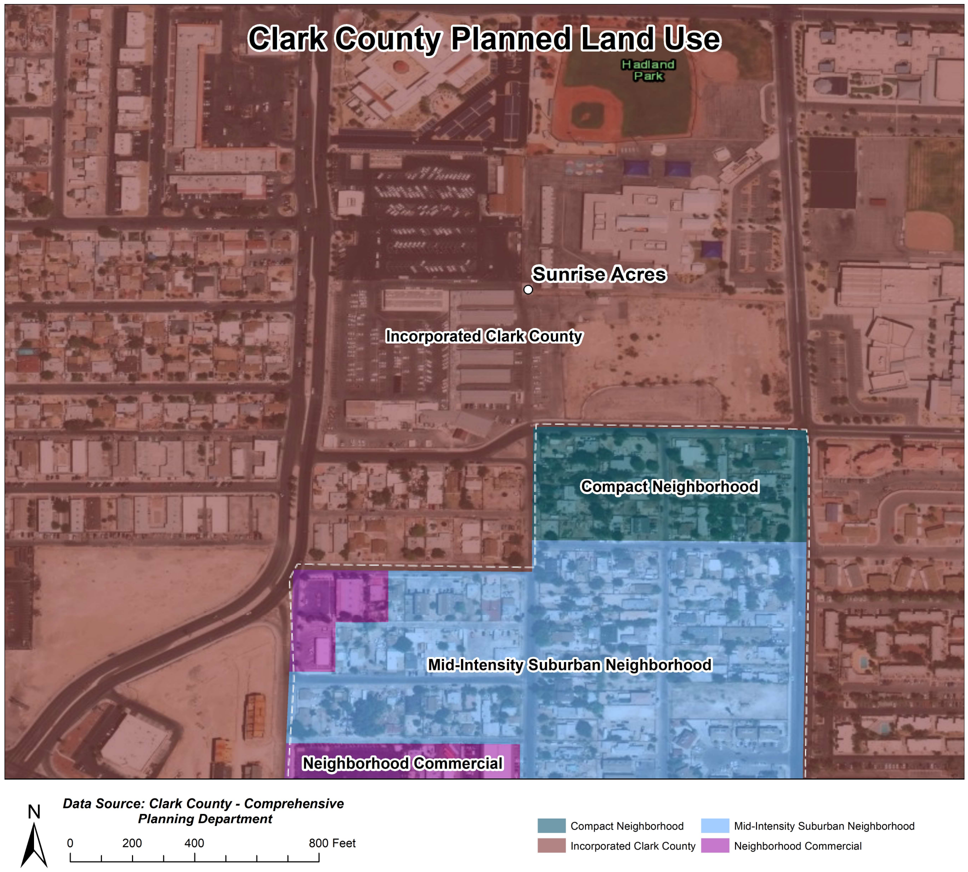


Figure 2.2-19. Planned land-use boundaries in the area around the Sunrise Acres station.

Planned land use around the Walnut Community Center site is comprised of public use (Walnut Park) and business employment to the south (Figure 2.2-20). With the exception of grass fields to the west and east, there is virtually no area with grass or exposed dirt or gravel.

Figure 2.2-20. Planned land-use boundaries in the area around the Walnut Community Center station.

Planned land use around the Walter Johnson site is comprised entirely of incorporated Clark County (Figure 2.2-21). The site is highly residential with little exposed dirt or gravel. The site also neighbors a city park that contains some bare ground.

Figure 2.2-21. Planned land-use boundaries in the area around the Walter Johnson station.

Figure 2.2-22 shows the 2023 National Emissions Inventory (NEI) PM_{10} point sources around the affected sites. The size of the point source marker is proportional to the total annual PM_{10} emissions, and the map shows that most sites are not near any 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 of PM_{10} annually, and 1 site to the north that emits 4-7 tons of PM_{10} annually.

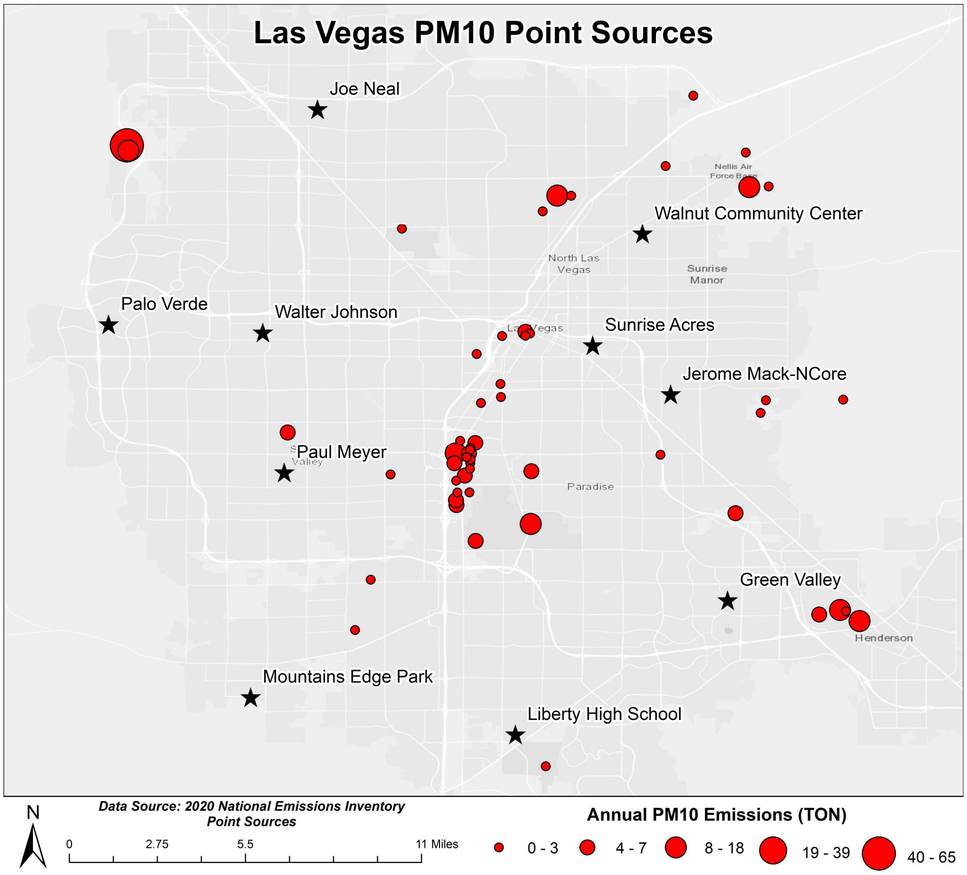


Figure 2.2-22. 2023 National Emissions Inventory (NEI) point sources of PM_{10}.

Clark County 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 February 21, 2023, exceedance.

Nonpoint sources in Clark County 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 2.2-2-Figure 2.2-23). Increasing contributions from construction-related emissions are due to increasing conversion of vacant lands to built areas. Therefore, wind erosion from construction, paved roads, and other sources has made an increasingly significant contribution to total emissions. As shown in Figure 2.2-11 through Figure 2.2-21, many 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 February 21, 2023, 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 was issued for Tuesday, February 21, 2023, and Wednesday, February 22, due to blowing dust via southwesterly winds from the Mojave Desert. A Dust Advisory 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.

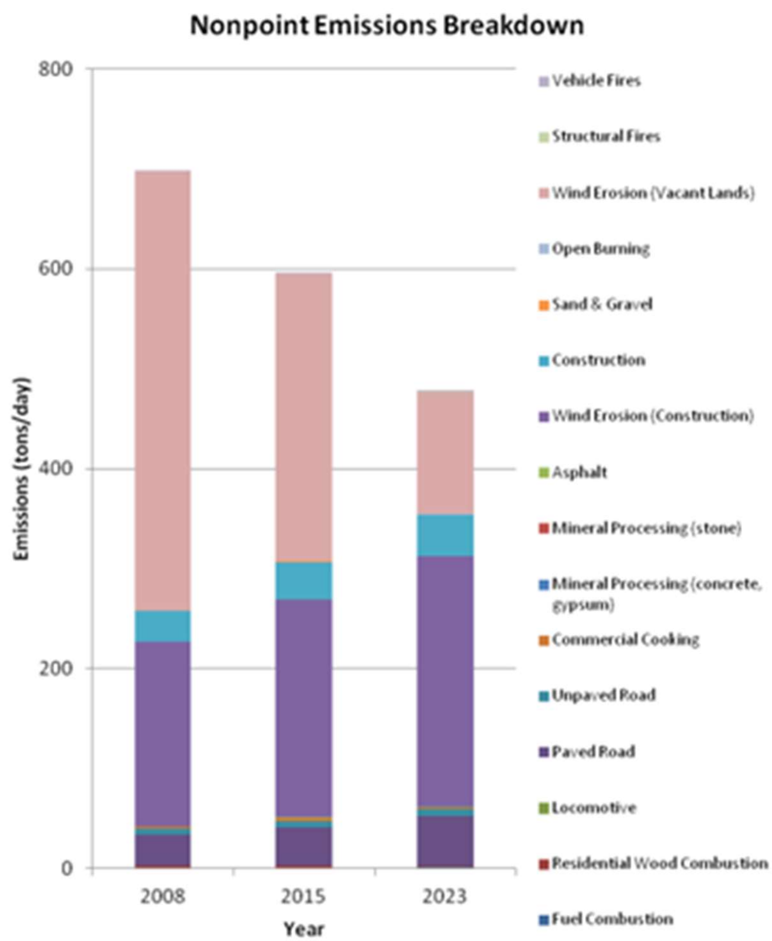


Figure 2.2-23. Nonpoint emissions inventory breakdown from the 2012 "Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10})" document.

2.2.4 Historical Analysis of PM_{10} in Clark County

The 24-hour average PM_{10} values recorded on the event day ranged from 160 µg/m^3 at the Garrett Jr. High site to 348 µg/m^3 at the Liberty High School site. Table 2.2-1 displays the statistical summary of 24-hour average PM_{10} concentrations from the five years preceding the event (2019-2023) at all affected sites. The Garrett Jr. High, Liberty High School, and Walnut Community Center sites do not have a full five years of data collection, and summary statistics are therefore shown for the data available. The median concentration ranges from 16 µg/m^3 at the Garrett Jr. High site to 35 µg/m^3 at the Walnut Community Center site. The 99th percentile concentrations are at or below 119 µg/m^3 at the sites with a complete five years of data, and at or below 177 µg/m^3 at the newer sites with less than five years of data. Therefore, the 24-hour average PM_{10} values recorded on the event day were well above seasonal averages and about 2-3 times the 99th percentile for most of the individual sites.

Table 2.2-1. Five-year (2019-2023) statistical summaries of 24-hour average PM_{10} concentration at affected sites. Sites that began data collection less than five years ago are indicated with an asterisk (*) and summary statistics are shown for available data.

Statistic (µg/m³)	Green Valley	Jean	Jerome Mack	Joe Neal	Mountains Edge Park	Palo Verde	Paul Meyer	Sunrise Acres	Walter Johnson	*Garrett Jr. High	*Liberty High School	*Walnut Community Center
Count	1,759	1,740	1,735	1,747	1,123	1,734	1,753	1,747	1,761	937	914	883
Mean	25	20	34	28	22	19	24	36	23	22	28	39
Median	21	17	30	26	18	17	21	32	20	16	23	35
Mode	18	13	31	26	16	15	18	29	17	16	13	36
St. Dev	24	19	26	24	21	17	20	26	20	24	29	32
Minimum	2	1	4	2	1	1	3	4	3	1	2	6
95th percentile	48	47	63	53	45	39	46	71	44	49	53	68
99th percentile	109	91	119	88	92	67	88	110	83	140	139	177
Maximum	586	236	445	513	325	333	335	468	341	350	365	470
Range	584	235	441	511	324	332	332	464	338	349	363	464
Exceedances (> 150 µg/m³)	11	8	14	8	6	5	7	13	8	7	9	12
24-hour average on 2/21/2023	**185**	**172**	**257**	**162**	**240**	**193**	**293**	**272**	**236**	**160**	**348**	**314**

Seasonal and monthly trends in the 24-hour average PM_{10} data at all affected sites for the five years preceding the event (2019-2023) are shown in boxplots in Figure 2.2-24 and Figure 2.2-25 (note that data are limited for several newer sites, as described in Table 2.2-1). The interquartile range is represented by the lower (25th percentile) and upper (75th percentile) edges of the box, 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 and have been removed for monthly and seasonal trend clarity (Section 3.4.2 will present the same box plots but include the outliers). Interquartile ranges across the seasons show significant overlap, with median 24-hour average PM_{10} values lowest in winter (16 µg/m^3) and highest in summer (25 µg/m^3). For February, the interquartile range is 11-27 µg/m^3, with a median value of 17 µg/m^3.

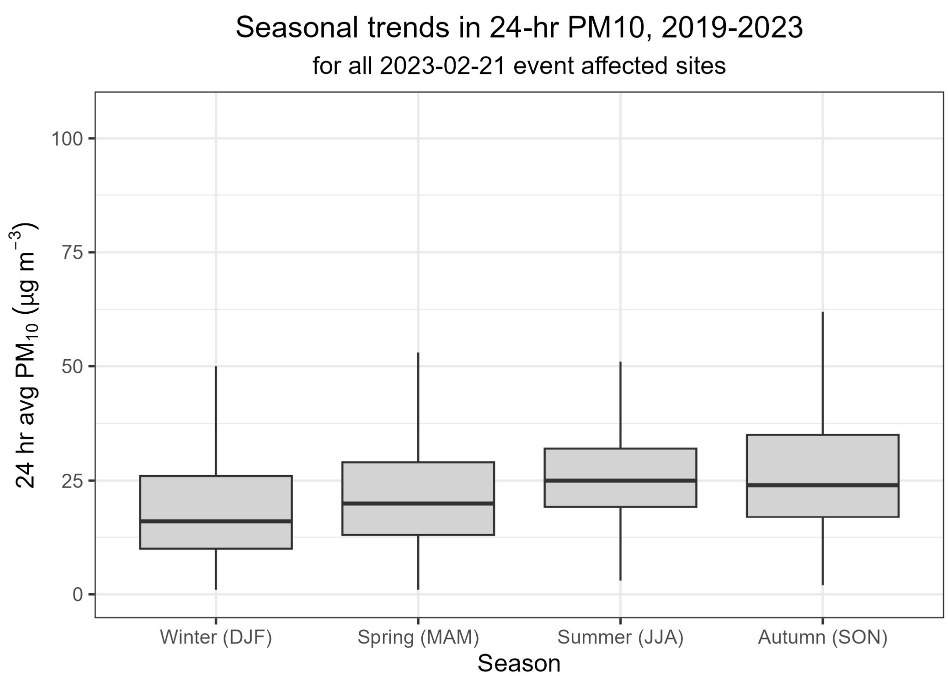


Figure 2.2-24. Seasonal trends in values of PM_{10} concentrations from 2019-2023 (outliers have been removed for trend clarity).

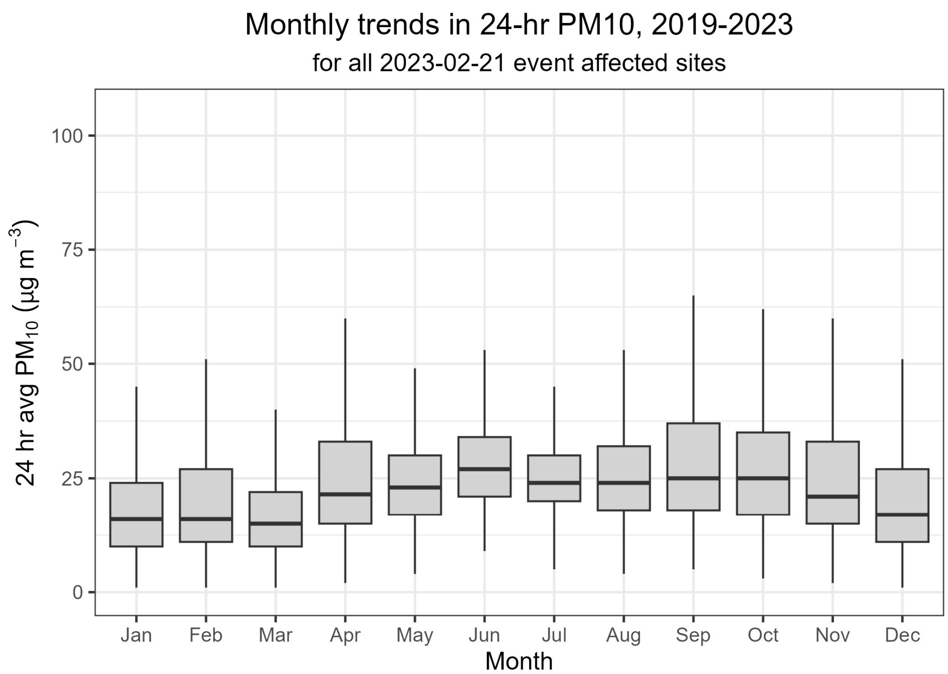


Figure 2.2-25. Monthly trends in values of PM_{10} concentrations from 2019-2023 (outliers have been removed for trend clarity).

3. Clear Causal Relationship

During late February 2023, a frontal passage through California drove a windblown dust event that increased PM_{10} concentrations in Clark County, Nevada, on February 21, 2023. Strong, sustained winds in the Mojave Desert source region were greater than 50 mph. The frontal passage lofted, entrained, and transported dust from the source region to Clark County starting at 16:00 PST on February 21, 2023, and lasted 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 wind speeds from the southwest of up to 20 mph on an hourly average within Clark County coincided with increased PM_{10} concentrations on February 21. The Mojave Desert source region experienced sustained winds speeds above 50 mph, and evidence shows that (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 in Clark County 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 evidence of 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 February 21, 2023, dense blowing dust from the Mojave Desert region of southeastern California impacted the Las Vegas region and led to 24-hour average PM_{10} concentrations above the NAAQS threshold at 12 sites throughout the area; 10 sites experienced regulatorily significant concentrations, while 2 did not. Strong winds in the Mojave Desert region of southeastern California produced dense blowing dust that was transported to the Las Vegas metropolitan area on February 21, increasing PM_{10} concentrations starting at 16:00 PST, peaking at 19:00-22:00 PST, and lasting through the end of the day. All sites within the Las Vegas Valley experienced enhanced PM_{10} concentrations concurrently with the sites that experienced the exceedance event. 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 that led to poor air quality during this period, observational data were analyzed from the following sources:

- Upper-air winds and geopotential heights
- Surface pressure and front analysis
- Dual-polarization Doppler radar imagery
- Hourly surface wind speed and direction

This meteorological analysis will take a “top-down” approach, first investigating the upper-level weather conditions, then linking the upper-level observations to the corresponding mid- and lower-level and surface weather patterns. For completeness, this analysis examines the period between February 20 and 22, 2023.

250-mb Analysis

During the early morning hours of February 20, 2023, a ridge of high pressure resided off the Pacific Northwest coast. On the northern periphery of this ridge, a region of strong winds, known as a jet streak, was present south of Alaska. Jet streaks are important weather features that can influence the strength and position of weather patterns from the upper levels of the atmosphere down to the Earth's surface. In this instance, winds at 250-mb south of Alaska were blowing in a zonal direction (west-to-east) at speeds analyzed at 150-200 knots (kt)s south of the Aleutian Islands (**Figure 3.1-1**). The associated divergence aloft on the northern edge of the jet streak would be the catalyst for the formation of a 250-mb trough in the Gulf of Alaska.

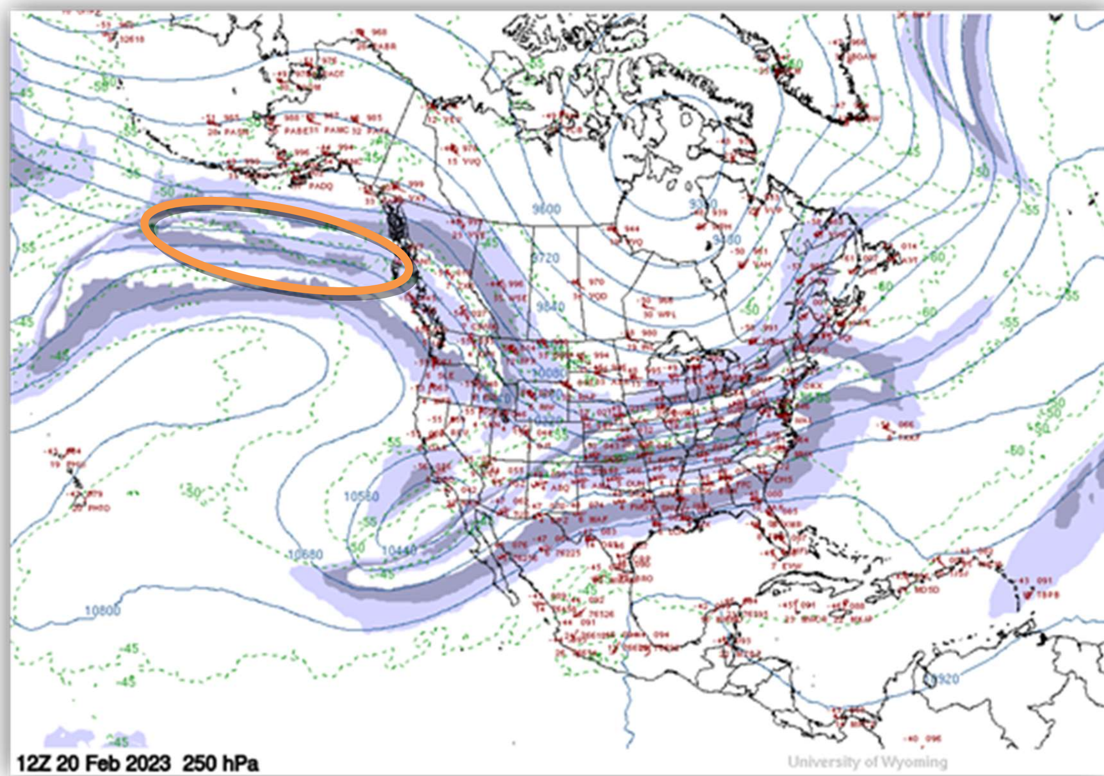


Figure 3.1-1. 250-mb map valid at 04:00 PST on February 20, 2023. A jet streak (circled in orange) aided in the development of the trough aloft.

Twelve hours later (16:00 PST on February 20), a 250-mb trough began to form off the British Columbia coast, with the jet streak positioned west of the trough axis. This positioning allowed the trough to deepen and move southeastward. By 04:00 PST on February 21, the 250-mb trough became better defined as it approached the Pacific Northwest coast (**Figure 3.1-2**). 175 kt winds within the jet streak persisted west of the trough axis, allowing the 250-mb trough to continue its southeast trajectory toward Clark County, Nevada.

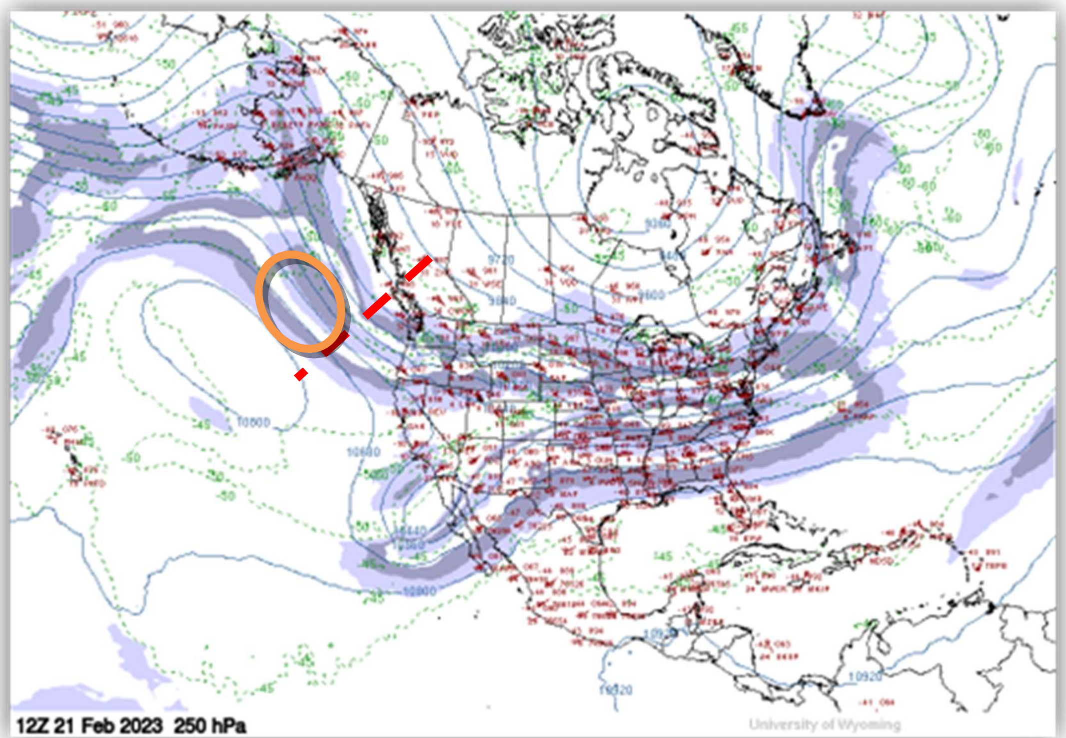


Figure 3.1-2. 250-mb map valid at 04:00 PST on February 21, 2023. The jet streak (circled in orange) is positioned northwest of the trough axis (red dashed line), allowing the trough to move southeastward.

The 250-mb map at 04:00 PST on February 21 showed a well-defined trough across the Pacific Northwest and northern Sierra Nevada Mountain Range. The trough axis was near the Reno upper air station (KREV), with a 150-175 kt jet streak located west of the trough axis (Figure 3.1-3). By February 22, the 250-mb trough axis entered southern Nevada and became stationary. This was due to the jet streak becoming elongated through the base of the trough and the jet stream winds eventually shifting east of the trough axis. This positioning led to the 250-mb trough gradually weakening and slowing its progression eastward.

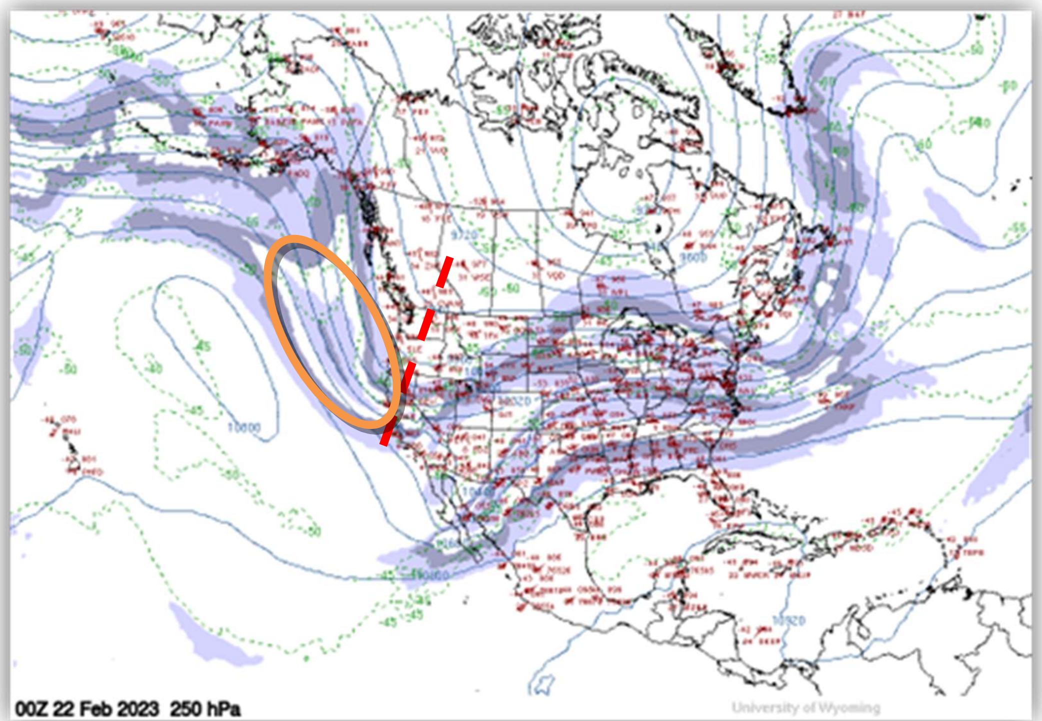


Figure 3.1-3. 250-mb map valid at 04:00 PST on February 21, 2023. A jet streak (circled in orange) was positioned west of a 250-mb trough (red dashed line), pushing the trough into southern Nevada.

500-mb Analysis

A 250-mb jet streak can strongly influence weather patterns at 500-mb. Vertical ascent associated with jet streaks can amplify troughs at the mid-levels (500-mb), with 500-mb height falls and cyclogenesis occurring in the lower atmosphere.

During the early morning hours of February 20, 2023, a 500-mb trough was located in the northeastern Gulf of Alaska, which was to the north of a 588-dm high (Figure 3.1-4). The position of the 500-mb trough was east of the 250-mb jet streak, a configuration that persisted during the day. By the late afternoon of February 20, the 500-mb trough was off the British Columbia coast and within the left exit region (LER) of the 250-mb jet streak, where divergence aloft was present. The 500-mb trough continued to strengthen due to its position under a region favoring divergence at 250 mb.

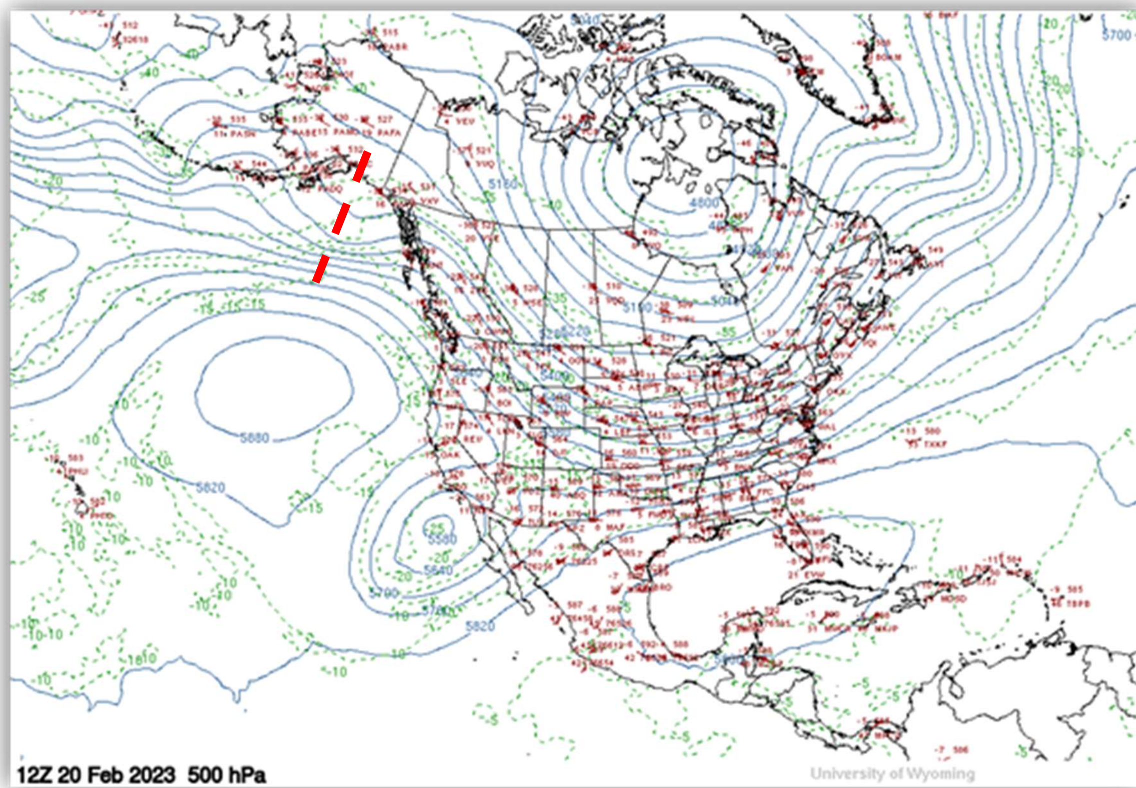


Figure 3.1-4. 500-mb map valid at 04:00 PST on February 20, 2023. A trough axis (red dashed line) was analyzed in the northeastern Gulf of Alaska.

The Las Vegas upper air weather station (KVEF) recorded a 500-mb height reading of 569-dm on the late afternoon of February 20. As the trough progressed southeastward on February 21, height falls continued in southern Nevada. At 04:00 PST, the 500-mb height measurement recorded at KVEF was 565-dm. Twelve hours later, the 500-mb height measurement dropped to 554-dm, with the trough axis over northern California and northwestern Nevada.

500-mb height measurements reached their minimum the morning of February 22, when the 500-mb trough was directly over southern Nevada. At this time, the 500-mb height measurement recorded at KVEF measured 527 dm. Height increases were noted later in the day at KVEF, as the 500-mb trough weakened over southern Nevada. This weakening was due to the jet streak becoming elongated across the 250-mb trough and shifting east of the trough axis.

Surface Analysis

The origins of the surface cold front that impacted Clark County on February 21 can be traced back to a 1,012-mb surface low-pressure system that originated in the Gulf of Alaska during the late afternoon of February 19. This system, and the associated developing cold front, moved toward the

British Columbia coast by the morning of February 20, and the center of the surface low-pressure system dropped to 1,004-mb. This deepening occurred as the surface low was below the LER of the 250-mb jet streak shown in Figure 3.1-1, and below the 500-mb trough shown in Figure 3.1-4. It is in this region where aloft divergence led to surface convergence, resulting in continued cyclogenesis. By the early afternoon of February 20, central pressure within the surface low dropped to 991-mb as the low moved over the British Columbia coast.

The surface weather map the morning of February 21 depicted a 991-mb low analyzed in southeastern British Columbia, with the associated cold front stretching from the Idaho/Montana border to northern California. At 250-mb, the surface low remained near the LER of the jet streak. The cold front in northern California resided in an area of diffluence at 500-mb and 250-mb. The diffluent wind pattern aloft led to additional cyclogenesis, where the cold front strengthened, and a second area of low pressure developed across California and western Nevada in the early afternoon (**Figure 3.1-5**).

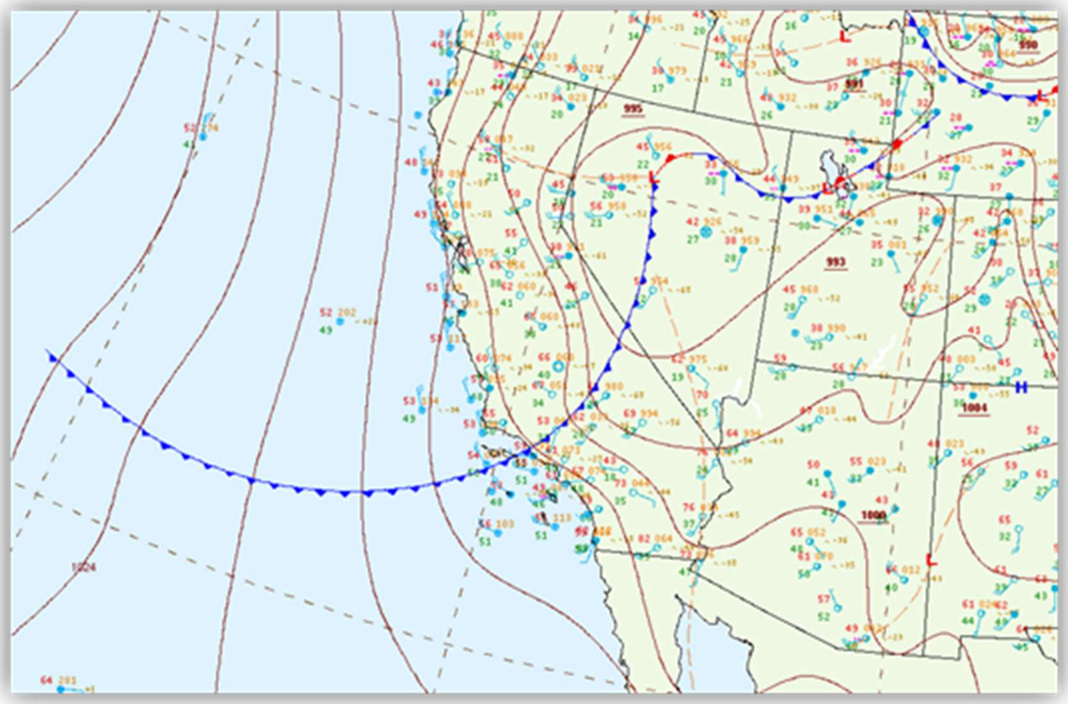


Figure 3.1-5. Surface weather map valid at 13:00 PST on February 21, 2023. A 995-mb low was analyzed in northwestern Nevada, with an associated cold front stretching from western Nevada to southern California.

In response to cyclogenesis the afternoon of February 21, the surface pressure gradient in southern California and southern Nevada increased. Due to the strengthening pressure gradient, surface wind speeds increased in Clark County and the Mojave Desert, which produced blowing dust in the early afternoon hours southwest of Las Vegas. Southwesterly winds persisted throughout the afternoon, which transported dust from the Mojave Desert into Clark County. By 17:00 PST, hourly PM_{10} concentrations exceeded 154 µg/m^3 at all 12 PM_{10} monitoring sites in Clark County. These readings coincided with Doppler radar reflectivity scans, with high reflectivity related to dust recorded in Clark County at 17:00 PST (Figure 3.1-6).

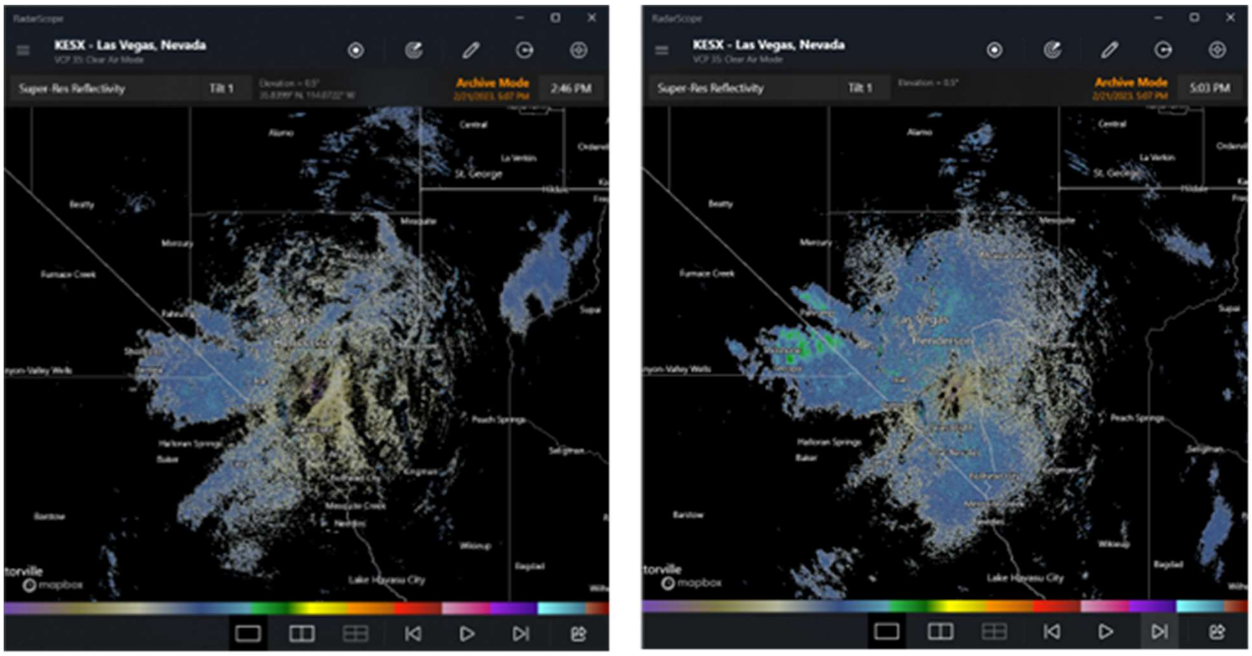


Figure 3.1-6. Doppler radar reflectivity scans, valid at 14:46 PST (left) and 17:03 PST (right). Dense blowing dust generated reflectivity returns southwest of Las Vegas, Nevada, in the afternoon, with the reflectivity returns from dust appearing in Clark County by 17:00 PST. Courtesy: RadarScope

By the early evening of February 21, a 984-mb low was present north of Las Vegas, with a cold front extending from southeastern Nye County to Los Angeles County, California. Surface winds continued to strengthen as the pressure gradient remained strong in southern Nevada and southern California. The strongest winds associated with this dust event occurred during the 18:00-23:00 PST timeframe, with all NWS ASOS sites recording their peak wind gusts during this period (Table 3.1-1). The maximum wind gust for this event occurred at the Harry Reid Airport ASOS (KLAS) site, where a wind gust of 63 mph and blowing dust were observed at 20:56 PST.

Table 3.1-1. Peak wind gusts and time of occurrence at Las Vegas-area ASOS for February 21, 2023. Data courtesy: National Weather Service.

ASOS Site	Peak Wind Gust (mph)	Time of Occurrence (PST)
Harry Reid Airport (KLAS)	63	20:56
Nellis Air Force Base (KLSV)	61	23:54
Henderson Exec. Airport (KHND)	56	20:35
North Las Vegas Airport (KVGT)	54	22:30

The cold front entered Clark County around 22:00-23:00 PST, which generated isolated rain showers across the region. However, dust was still present across much of Clark County during this time, as indicated by PM_{10} monitors and the correlation coefficient product from the dual-polarization Doppler radar. The correlation coefficient product on radar determines if targets scanned by the radar beam have a similar shape and size. Highly correlated values are synonymous with falling precipitation, while low-correlation values indicate scattered dust particles of varying sizes. The radar returns at 22:10 PST (Figure 3.1-7) show much of Clark County with low-correlation coefficient returns, while high-correlation values are located by a rain shower northwest of Spring Valley.

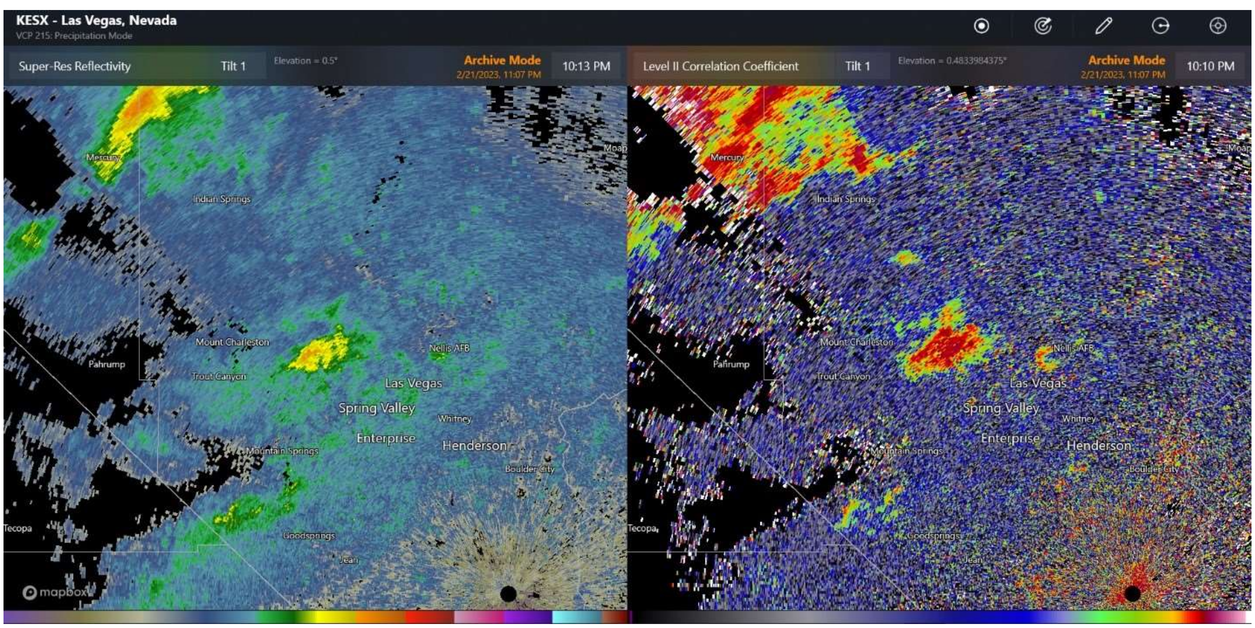


Figure 3.1-7. Doppler radar reflectivity (left) valid at 22:13 PST and correlation coefficient (right) valid at 22:10 PST on February 21, 2023. Most reflectivity returns around Clark County were due to dust, corroborated by low-correlation values between targets scanned by radar (scattered blue colors on the right panel). Northwest of Spring Valley, isolated showers were present, with high correlation shown in targets scanned by radar (solid red color on the right panel).

By 23:00 PST on February 21, 11 of the 12 Clark County PM_{10} monitoring sites continued to record hourly PM_{10} concentrations greater than 154 µg/m^3. The lone exception was the Walter Johnson monitoring site (133 µg/m^3 at 23:00 PST), where light rain prior to 23:00 PST aided dispersion of dust.

The cold front departed Clark County between 01:00-04:00 PST on February 22, with the surface-pressure gradient gradually decreasing through the morning and afternoon hours. With the front exiting Clark County, wind speeds decreasing, and scattered light precipitation moving in behind the front, PM_{10} concentrations dropped during the early morning hours of February 22. All 12 PM_{10} monitoring sites recorded hourly concentrations lower than 155 µg/m^3 by 03:00 PST.

3.1.2 Satellite Images and Analysis

Satellite imagery and reanalysis products also provide evidence of dust transport from the Mojave Desert to Clark County due to a strong frontal passage. The Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) reanalysis product uses satellite data to calculate surface wind speeds and shows high hourly average and hourly peak wind speeds in the source region and in Clark County for February 21, 2023 (**Figure 3.1-8** and **Figure 3.1-9**). The pressure gradient over the deserts in eastern California and southern Nevada generated strong and gusty southwesterly winds leading to widespread blowing dust. The MERRA-2 reanalysis figures show average winds speeds at 11-13 m/s (25-29 mph) in the Mojave Desert source region and Clark County on February 21, 2023, with maximum wind speeds greater than 11 m/s (25 mph). Unfortunately, visible imagery does not capture the dust event due to cloud cover.

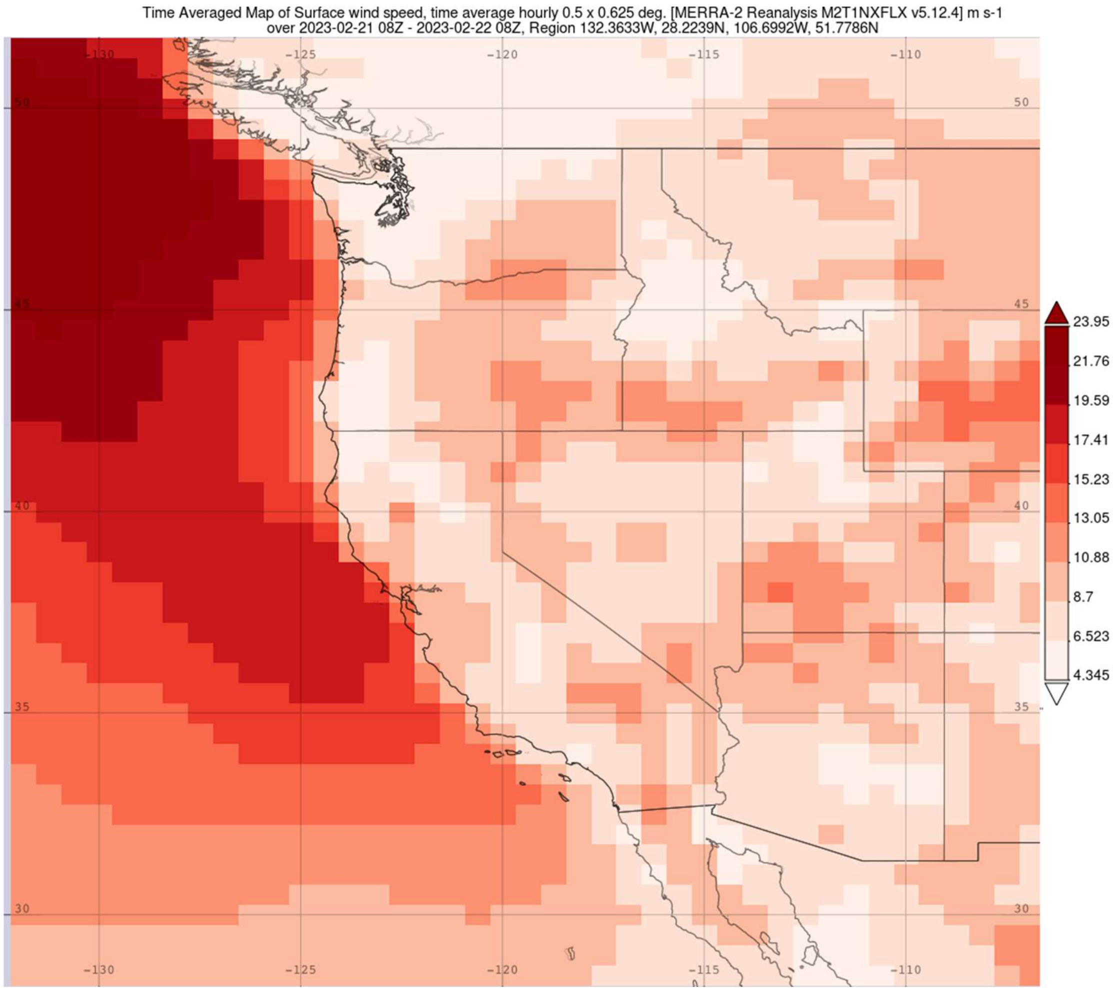


Figure 3.1-8. MERRA-2 reanalysis data showing hourly averaged surface wind speeds (m/s) from February 21, 2023, at 08:00 UTC (February 21, 2023, at 00:00 PST) to February 22, 2023, at 08:00 UTC (February 22, 2023, at 00:00 PST).

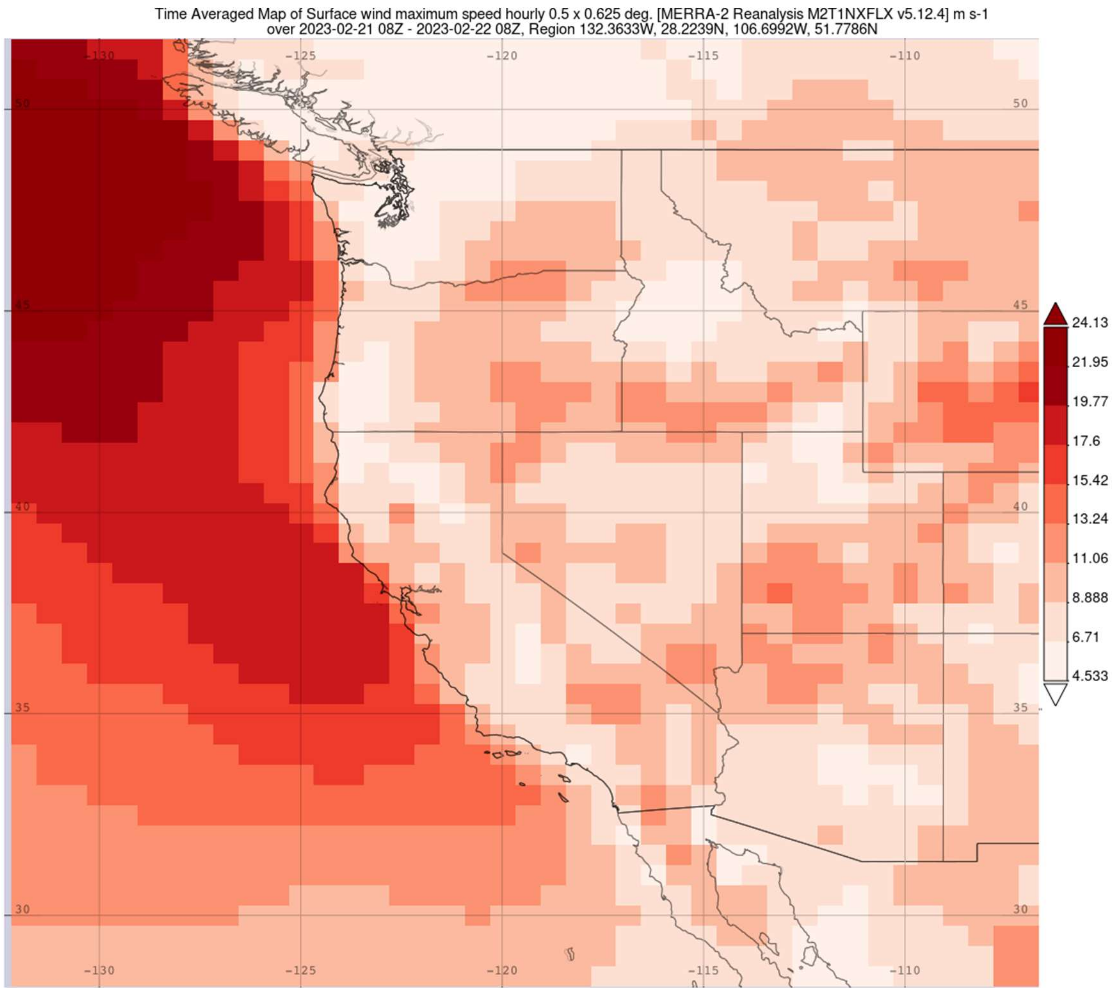


Figure 3.1-9. MERRA-2 reanalysis data showing maximum surface wind speeds (m/s) from February 21, 2023, at 08:00 UTC (February 21, 2023, at 00:00 PST) to February 22, 2023, at 08:00 UTC (February 22, 2023, at 00:00 PST).

3.1.3 Supporting Ground-Based Data

We were unable to find ground-based images in the source region due to its 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 3.1-10 shows the peak sustained wind speeds in southeastern California and the Mojave Desert of 53 mph on February 21, 2023. 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.

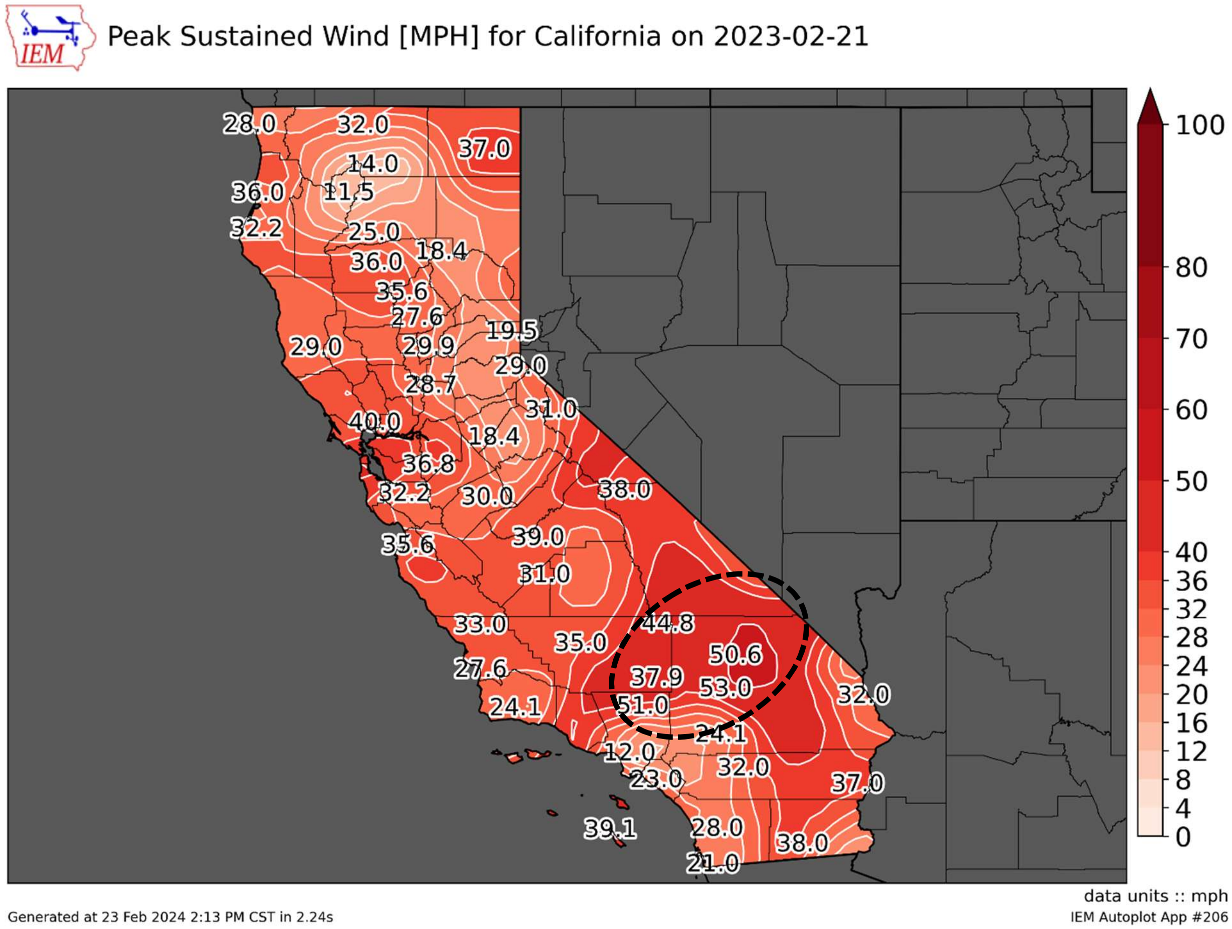


Figure 3.1-10. Peak sustained winds in California on February 21, 2023. The Mojave Desert source region, shown approximately by the black dashed line, is located in southeastern California. Data source: **https://mesonet.agron.iastate.edu/plotting/auto/**.

Figure 3.1-11 shows the distribution of maximum daily temperatures recorded at several sites in the wind-blown source region on February 20 and 21 (1993-2022), and the maximum daily temperatures recorded on February 20 and 21, 2023. The site locations are shown in Figure 2.2-8. Maximum daily temperatures recorded at all sites near or above the third quartile in the dust region and along the transport path compared to maximum daily temperatures from 1993-2022. Maximum daily temperatures recorded at all sites on February 21, 2023, the day of the PM_{10} exceedance, were well above the median. The maximum daily temperatures recorded on February 20 and 21, 2023, provide evidence that the wind-blown dust source regions in the Mojave source region were atypically hot on the day before the PM_{10} exceedance.

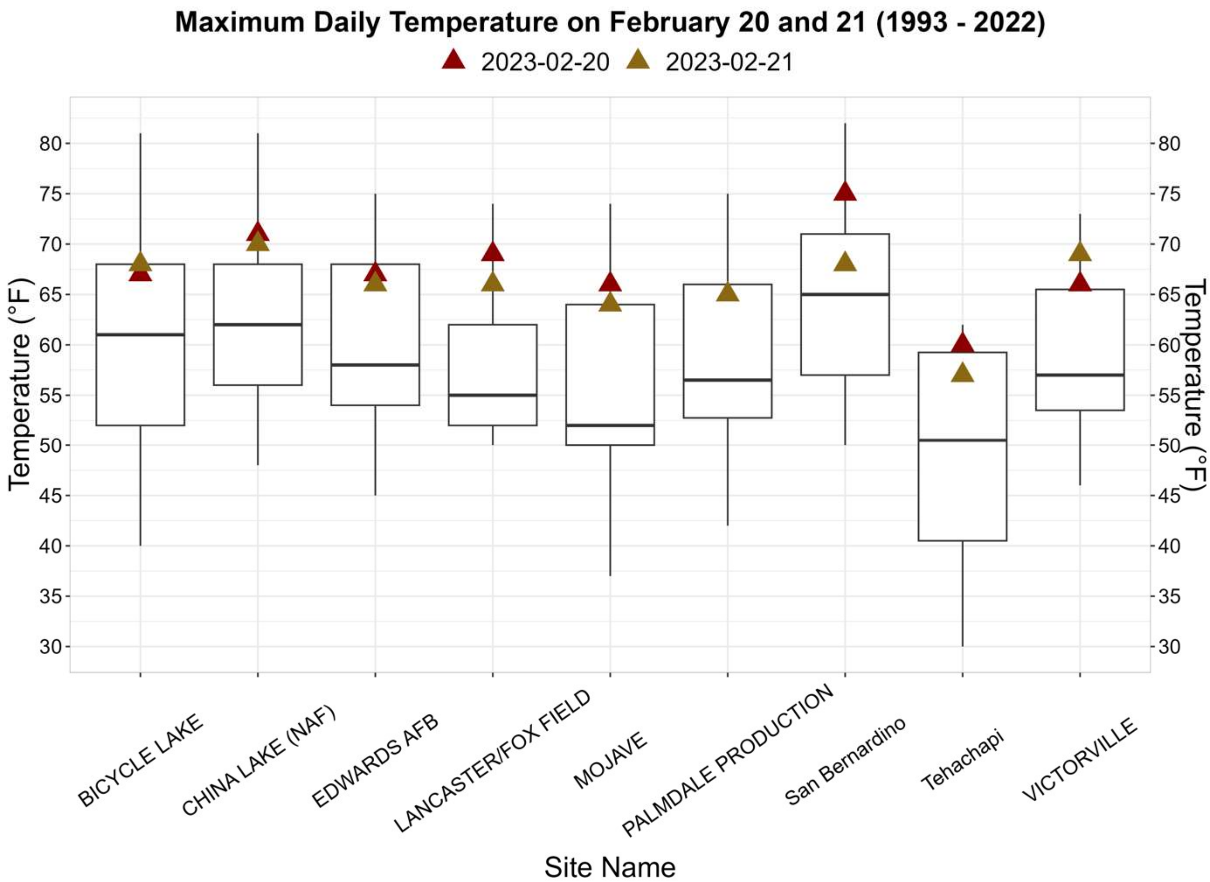


Figure 3.1-11. Maximum daily temperature on February 20 and 21, 2023, compared to the 1993-2022 distribution at each site.

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 afternoon through the evening of February 21, 2023, via 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 into the Clark County area, (3) satellite reanalysis showing high winds in the Mojave Desert and Clark County, (4) ground-based measurements of high temperatures in the Mojave Desert region before the event on February 21, and (5) aggregated measurements of high winds in the Mojave Desert source region on February 21.

3.2 Transport to Clark County

3.2.1 HYSPLIT Analysis

Backwards trajectories were modeled from all 12 exceedance sites starting on February 21, 2023, at 17:00 PST, the start of the high PM_{10} concentrations (hourly concentration greater than 150 µg/m^3). These trajectories were modeled 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 were used as meteorological input. Temporal resolution of the NAM-12 km meteorological data is three hours and is run by the NCEP.

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

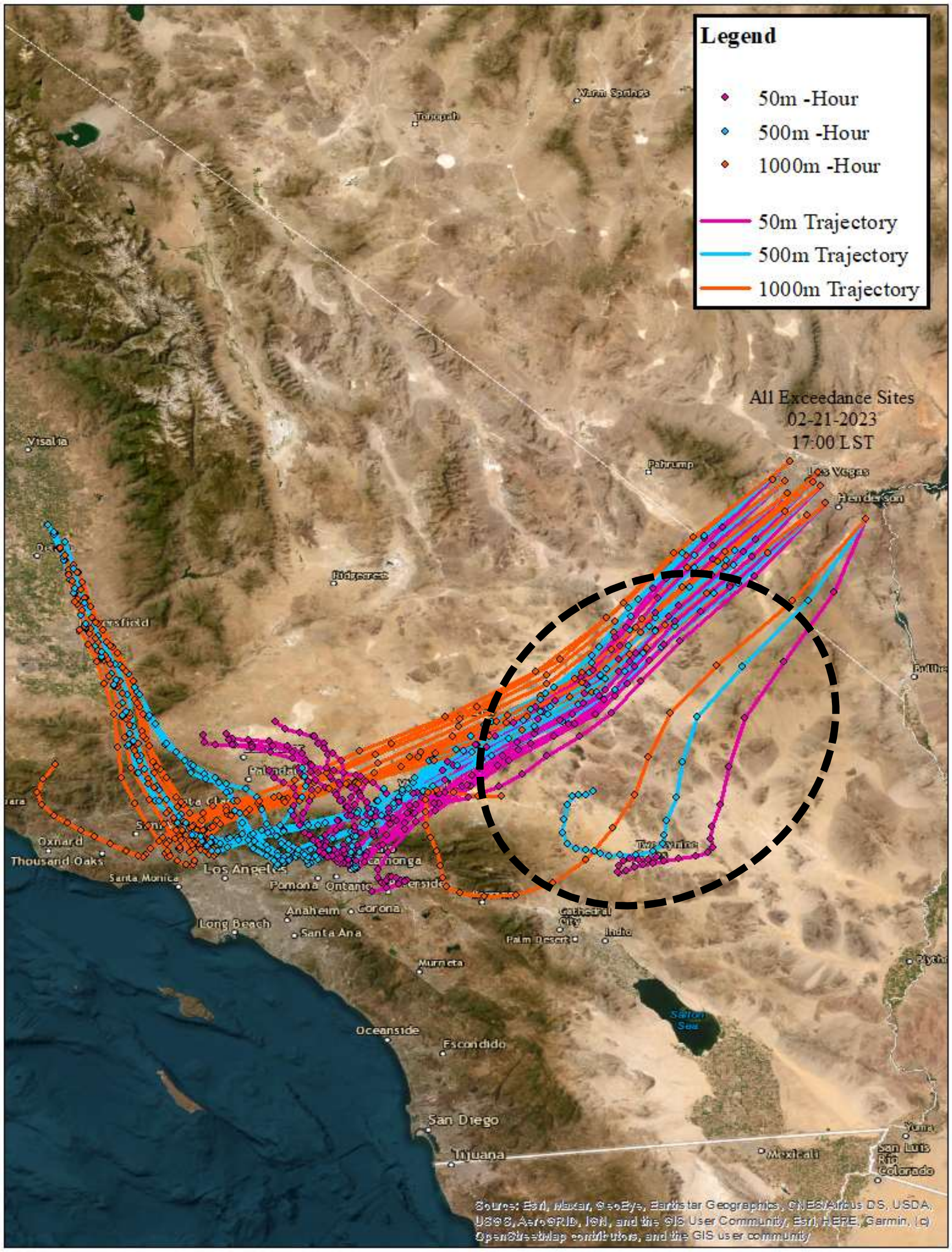


Figure 3.2-1 HYSPLIT 24-hour back trajectories from all 12 exceedance sites on February 21, 2023, at 17:00 PST, originating at (maroon) 50-m, (green) 500-m, and (blue) 1,000-m with hourly points. The approximate location of the Mojave Desert source region is shown by a black, dashed oval.

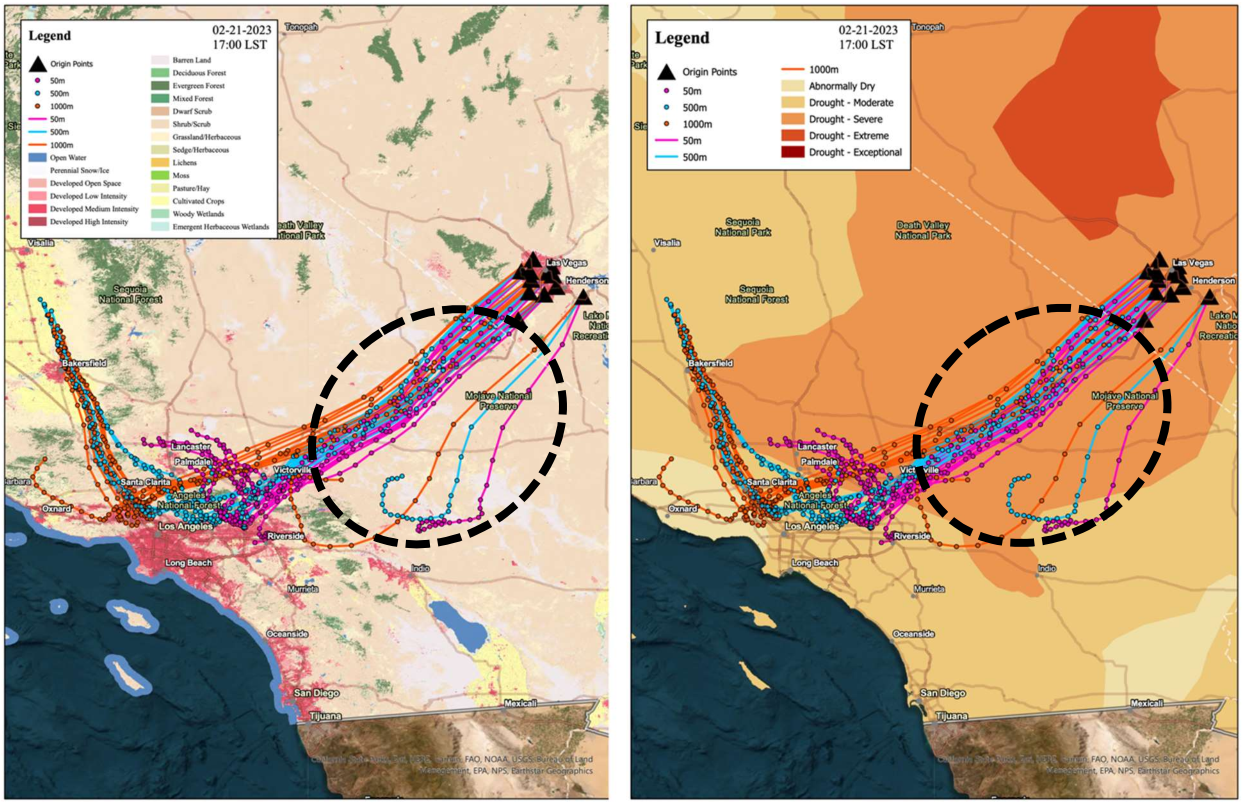


Figure 3.2-2. HYSPLIT 24-hour back trajectories from all 12 exceedance sites on February 21, 2023, at 17:00 PST, overlayed on (left) national land type database and (right) drought monitor class. The approximate location of the Mojave Desert source region is shown by a black, dashed oval.

3.2.2 High-Wind Event Timeline

The wind-blown dust event that occurred on February 21, 2023, caused 24-hour PM_{10} NAAQS exceedances with regulatory significance at 10 measurement sites in Clark County (with 2 additional sites experiencing NAAQS exceedances that were not regulatorily significant) and caused a maximum 24-hour PM_{10} concentration of 348 µg/m^3 at the Liberty High School site. Concentrations of PM_{10} began to rise at 16:00 PST in Clark County, reached a peak concentration between 19:00-22:00 PST, and remained enhanced through midnight at measurement sites throughout the county.

In addition to the meteorological evidence of the approach of the frontal system, timeseries graphs and a map showing PM_{10} concentrations and hourly average wind speeds in the source region are also provided in Figure 3.2-3 and Figure 3.2-4. As stated in the meteorological analysis in Section 3.1.1, the cold front moving westward across California on the morning of February 21 strengthened the pressure gradient across eastern California and southern Nevada by that afternoon. This is reflected by the enhanced PM_{10} concentrations and wind speeds recorded throughout the region between 12:00-23:00 PST. PM_{10} and wind measurements are available from AQS stations situated along the HYSPLIT-modeled transport path (**Figure 3.2-3**). Note that there are no PM_{10} measurement sites between region 1 and 2 to supplement these plots.

PM_{10} concentrations rose to 250 µg/m^3 in the source region (labelled region 1 in **Figure 3.2-3**) starting at 12:00 PST, when a rise in wind speeds initially lofted dust into the air. **Figure 3.2-4** shows that hourly average winds speeds exceeded 20 mph in region 1 at this time and continued to rise into the afternoon. Hourly average wind speeds exceeded the 25-mph threshold at four source-region AQS measurement sites—Barstow, Hesperia-Olive Street, Lucerne Valley-Middle School and Victorville- Park Ave—during peak PM_{10} concentrations, 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). PM_{10} concentrations began to rise in region 2 three hours later at 15:00 PST (**Figure 3.2-3**), as lofted dust from the source region, supplemented by continued lofting throughout transport across the Mojave Desert, was pushed by enhanced winds along the pressure gradient and traveled westward,. Lofted PM_{10} reached Clark County at 16:00 PST, as shown by the initial rise in PM_{10} concentrations that continued to a peak at greater than 1,500 µg/m^3 at multiple AQS sites between 19:00-22:00 (**Figure 3.2-3**). Sites in regions 1 and 2 also recorded extremely enhanced concentrations during this period due to the strengthening pressure gradient and frontal passage. Hourly wind speeds in Clark County were enhanced during peak PM_{10} concentrations, but did not reach the intensity experienced in the Mojave Desert source region. Hourly winds in Clark County remained mostly below 20 mph, with one site recording a maximum of 23 mph (**Figure 3.2-4**).

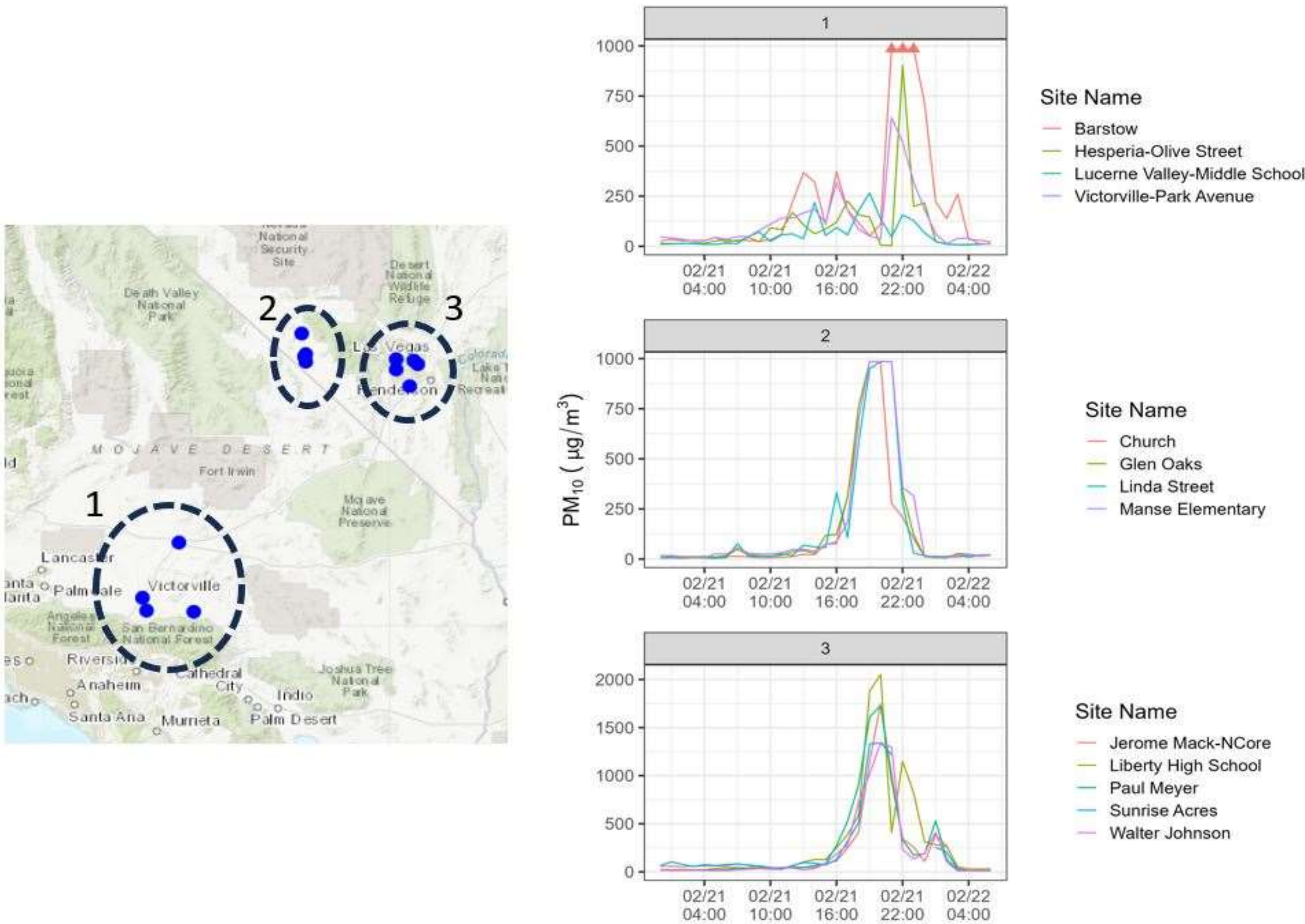


Figure 3.2-3. Timeseries of PM_{10} concentrations (right) along the strong pressure gradient associated with an approaching cold front. Data from AQS measurement sites is included from the (1) western Mojave Desert region of California, (2) Pahrump, Nevada, and (3) Clark County, Nevada. Site locations are mapped and circled by region (left). Numbering in the map corresponds to the numbering in the time series figures on the right. The observations recorded between 21:00 and 23:00 PST at the Barstow AQS site, represented by triangles in plot panel 1, reached the maximum possible value (985 μg/m^3) from the instrument.

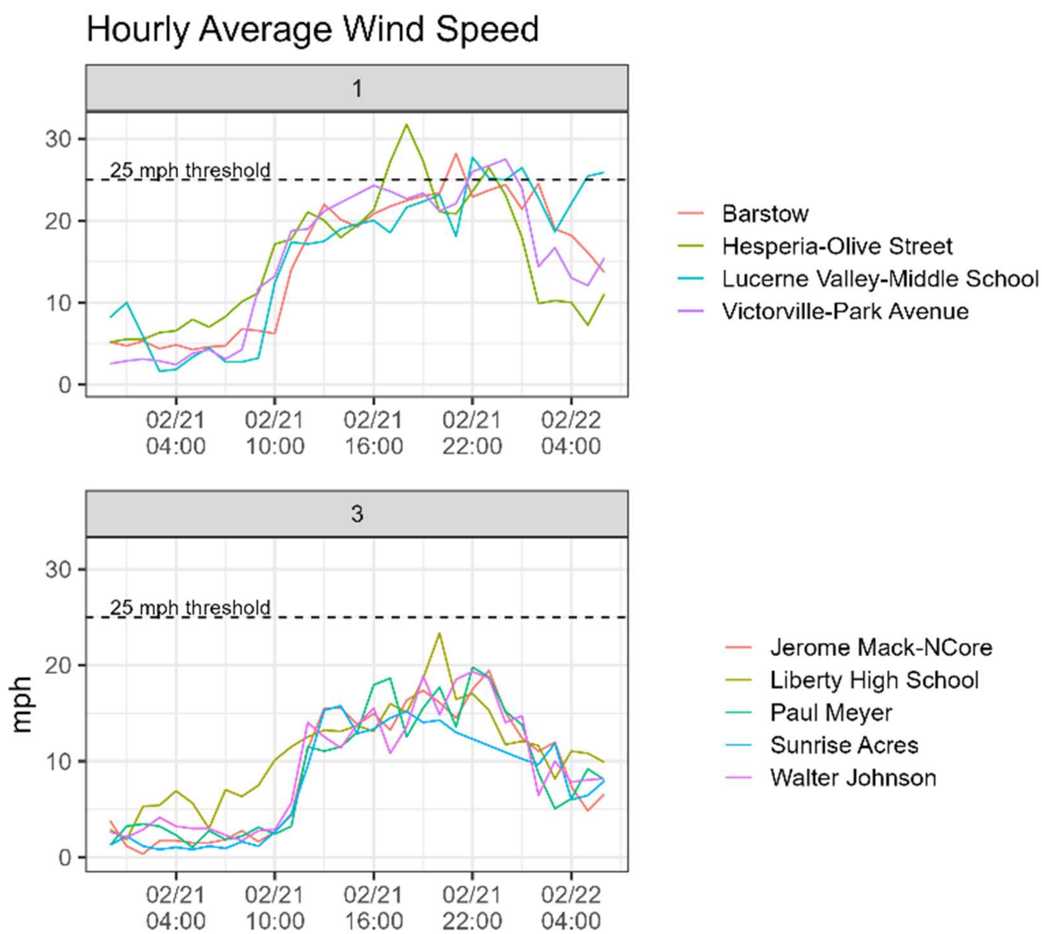


Figure 3.2-4. Timeseries of hourly average wind speed measured at AQS sites displayed in Figure 3.2-3. Numbers that label each panel correspond to labels on the timeseries and in the map of Figure 3.2-3. Meteorology data are not reported from any sites in region 2.

The rise in PM_{10} concentrations in Clark County on February 21, 2023, coincides with enhanced wind speeds in Clark County, showcased in **Figure 3.2-4** by shorter-averaged wind data. **Figure 3.2-5** shows the distribution of wind speed and direction across wind observations taken at five-minute increments at the Harry Reid International Airport (LAS) on February 21. Shorter-averaged wind speeds showcase the fleeting, gusty conditions in Las Vegas caused by the approaching frontal system. Five-minute-reported winds reached 40.2 mph with gusts reaching 63 mph. Winds in Las Vegas came mostly from the southwest, consistent with an approaching cold front and the direction of the source region.

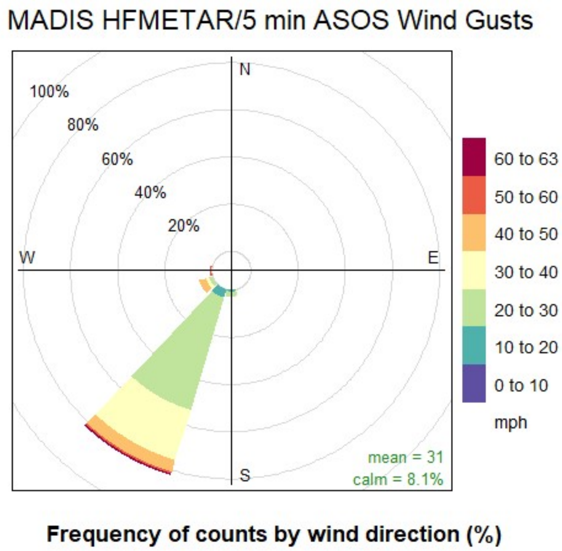


Figure 3.2-5. Wind rose of both wind speed and direction data captured on February 21, 2023, at Harry Reid International Airport (LAS). Wind data are sourced from the Iowa Environmental Mesonet (https://mesonet.agron.iastate.edu/).

The rise in PM_{10} concentrations began around 16:00 PST, when regional sustained wind speeds approached and exceeded 20 mph, coinciding with the approach of the frontal system (**Figure 3.2-6**). PM_{10} concentrations increased to a maximum between 19:00 and 22:00 PST, with many affected sites exceeding a PM_{10} concentration of 1,000 µg/m^3 as wind gusts in the Las Vegas Valley breached 40-60 mph.

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 3.2-13**). By 10:00 PST, winds shifted southwesterly in the southern part of 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 13:00 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 and west 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 also accumulated in the lower elevation areas of the Valley (in the northeast and east) between 16:00 and 19:00 PST. By 19:00, all sites in the valley recorded "hazardous" levels of PM_{10} concentrations with winds from the southwest, indicating a regional influence of PM_{10} concentrations from the southwest that were impacting the whole Las Vegas Valley. By 22:00 PST, concentrations of PM_{10} started to decrease due to light rain and 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 dirt-covered part of the sports complex near the Green Valley site, may have contributed to local dust during the high-wind event, evidence of high winds over the natural, undisturbed Mojave 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 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 February 21, 2023.

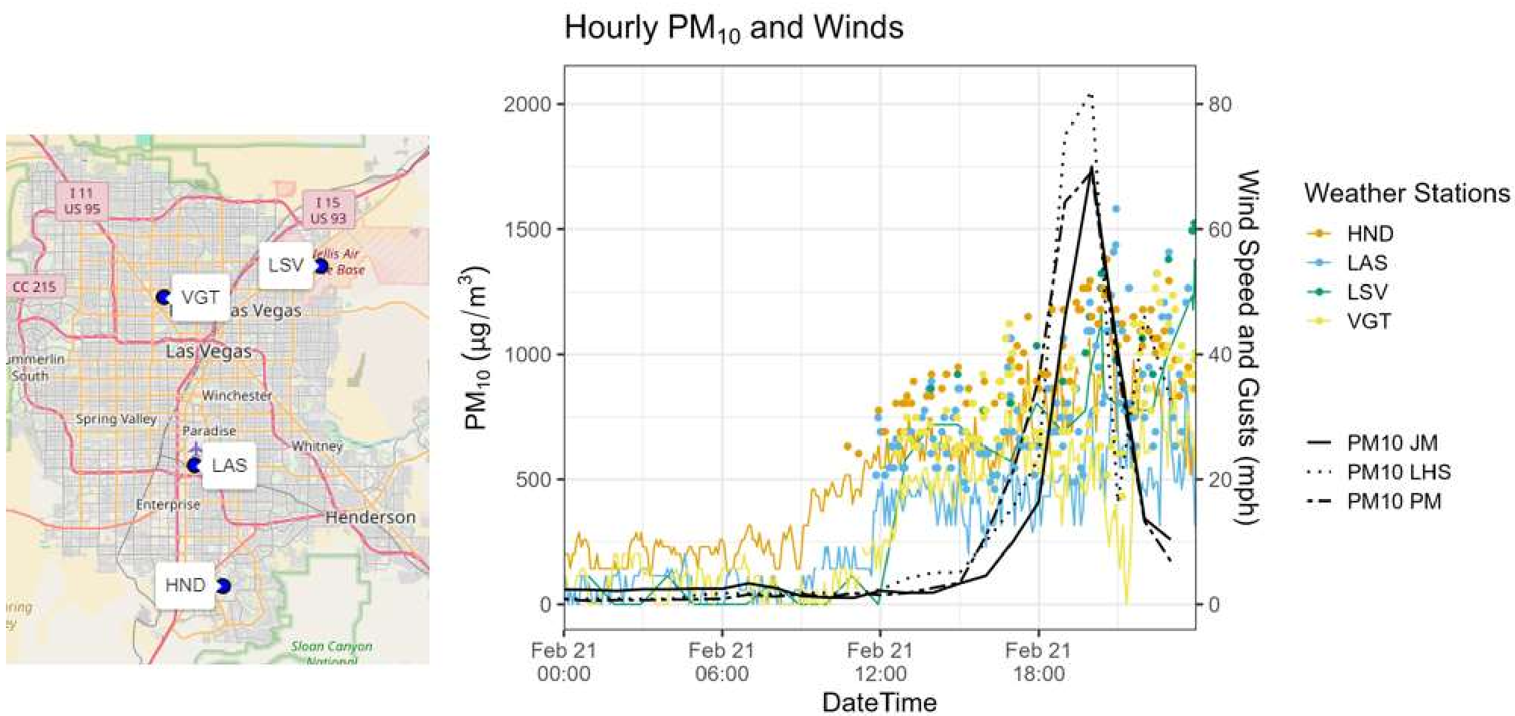


Figure 3.2-6. Hourly PM_{10} concentrations (µg/m^3) at the Jerome Mack (JM), Liberty High School (LHS), and Paul Meyer (PM) monitoring sites, and wind speed (lines) and wind gusts (dots) from the HND (Henderson Executive Airport), LAS (Harry Reid International Airport), LSV (Nellis Airforce Base), and VGT (North Las Vegas Airport) ASOS weather stations on February 21, 2023, between 00:00 and 23:59 PST.

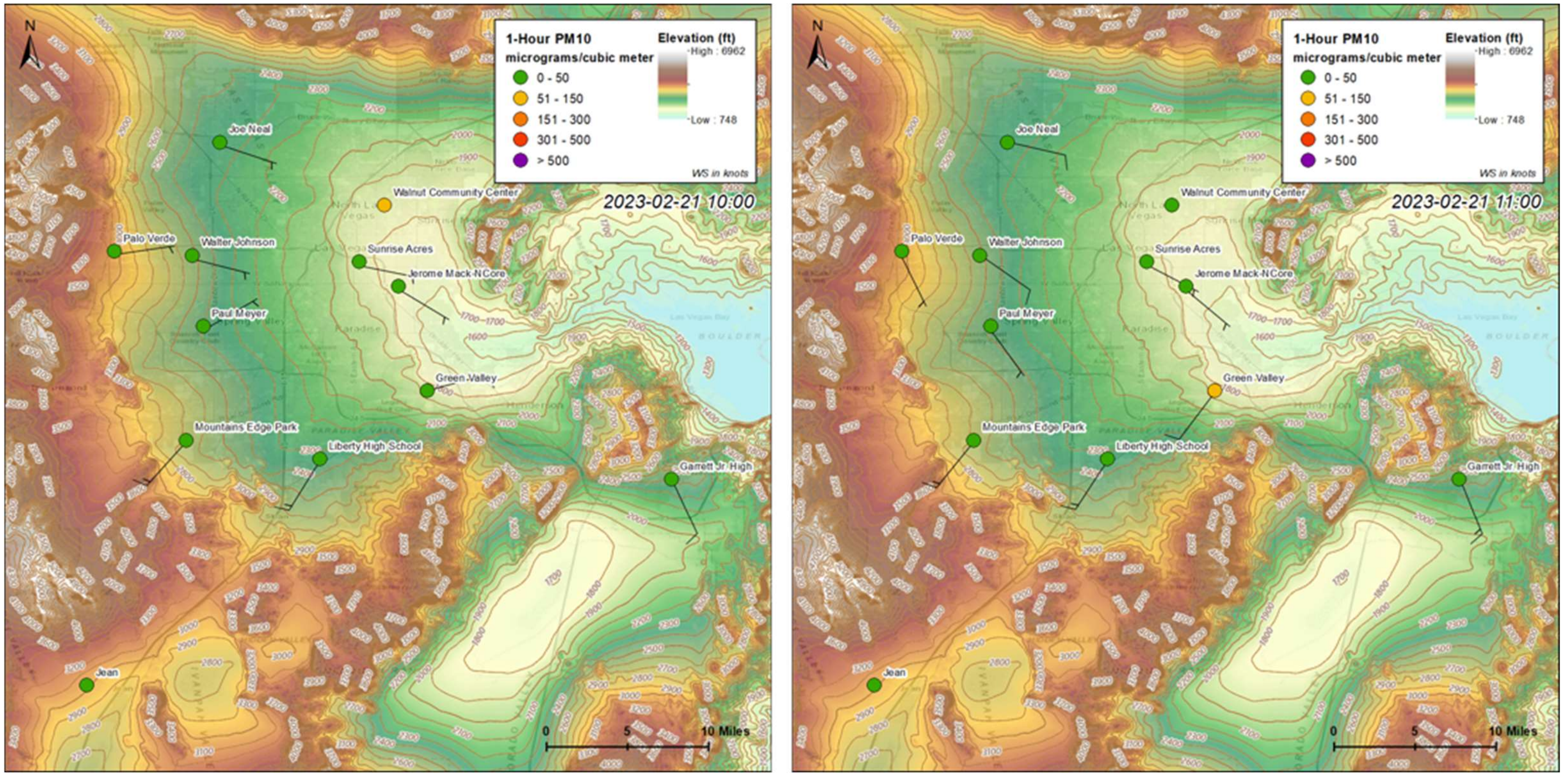


Figure 3.2-7. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for February 21, 2023, from 10:00 PST to 11:00 PST.

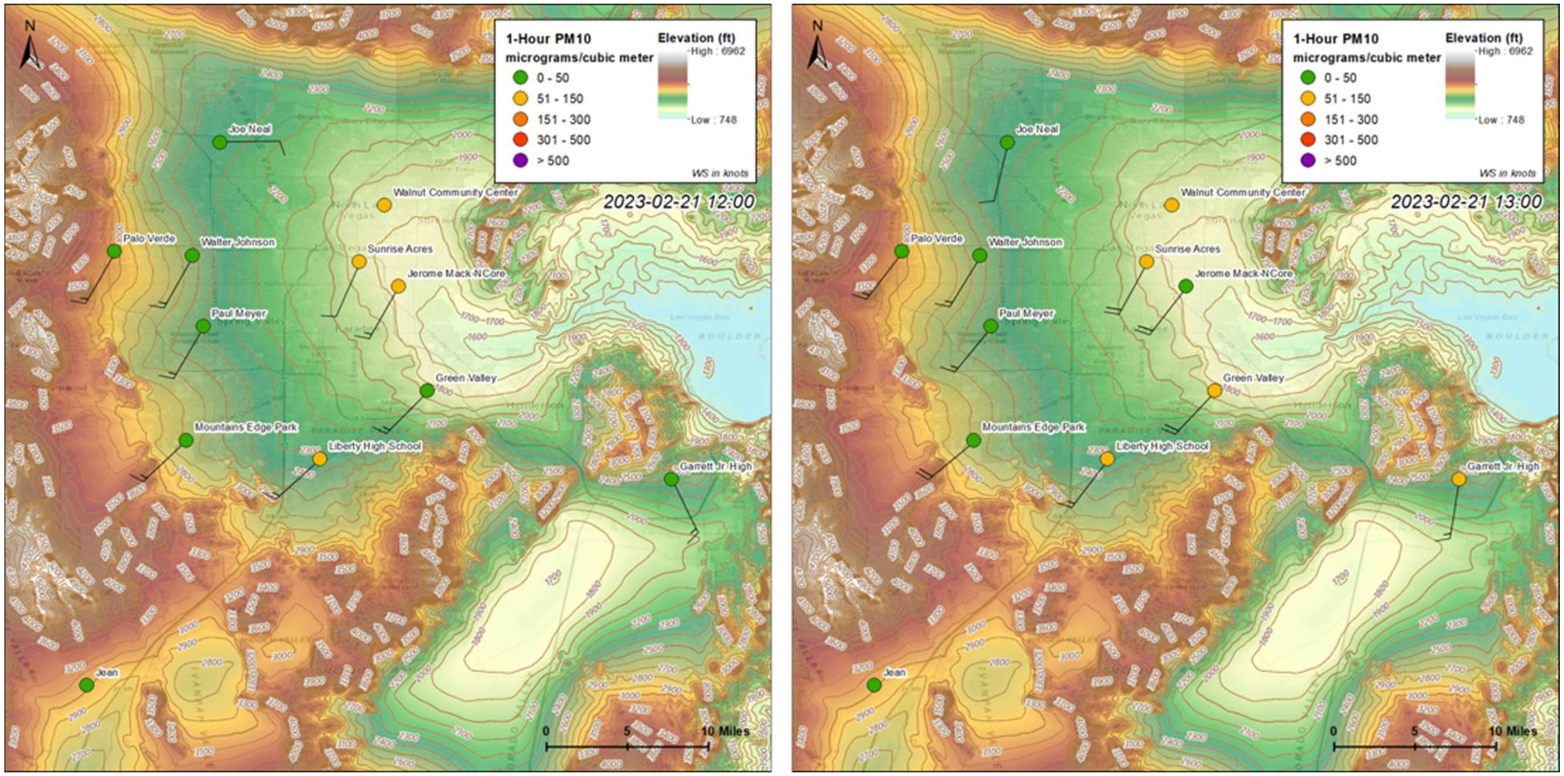


Figure 3.2-8. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for February 21, 2023, from 12:00 PST to 13:00 PST.

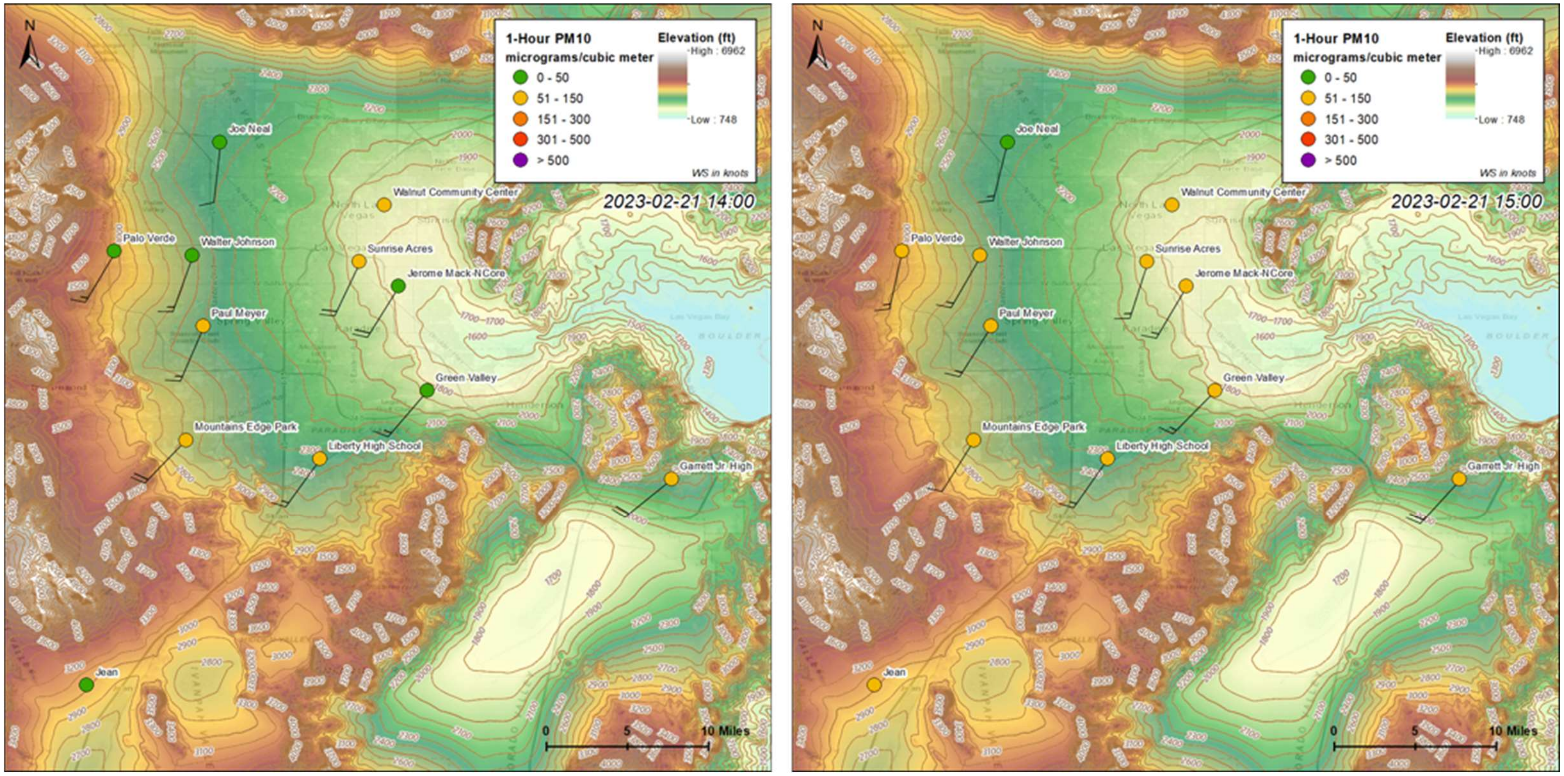


Figure 3.2-9. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for February 21, 2023, from 14:00 PST to 15:00 PST.

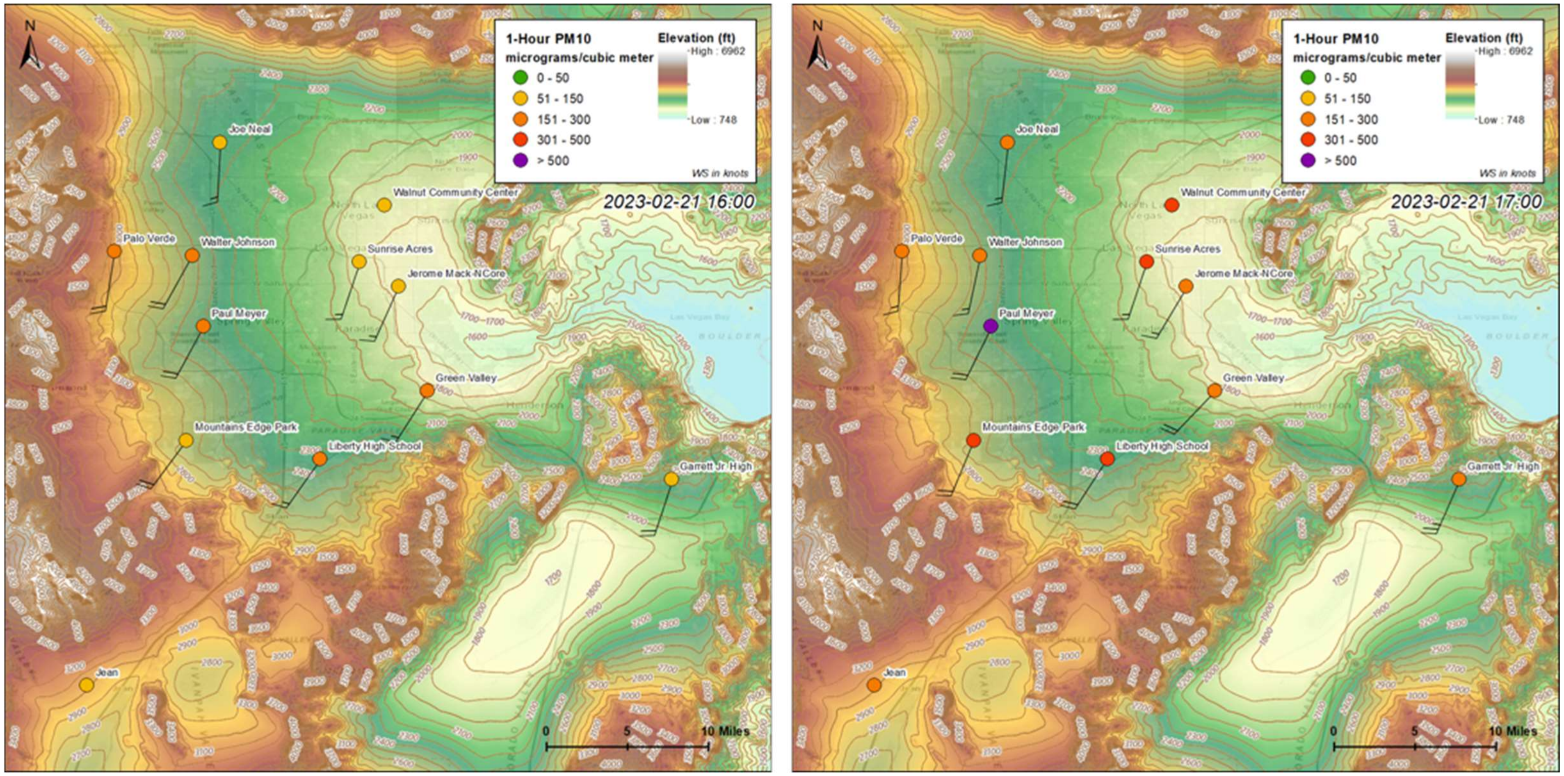


Figure 3.2-10. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for February 21, 2023, from 16:00 PST to 17:00 PST.

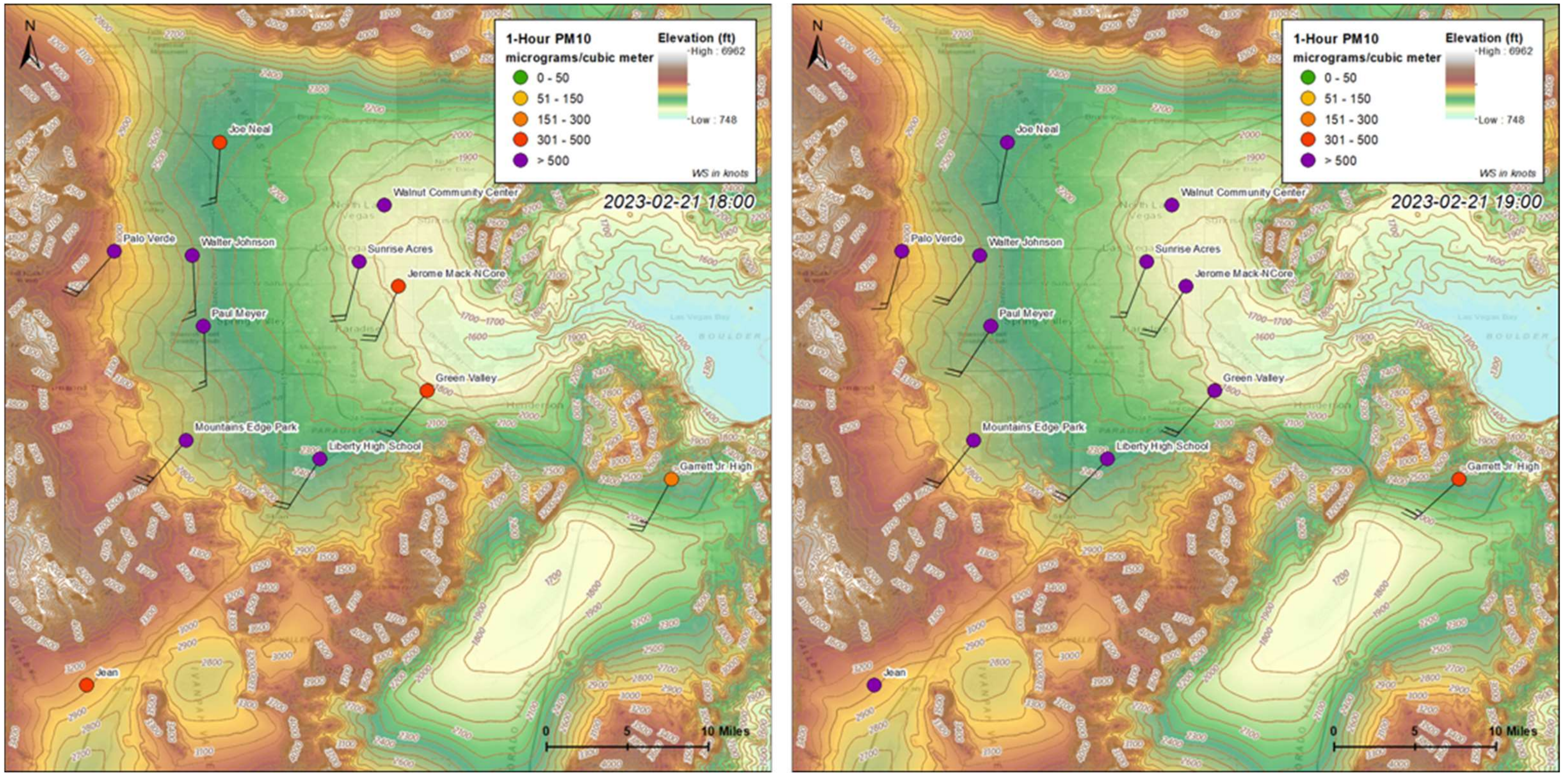


Figure 3.2-11. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for February 21, 2023, from 18:00 PST to 19:00 PST.

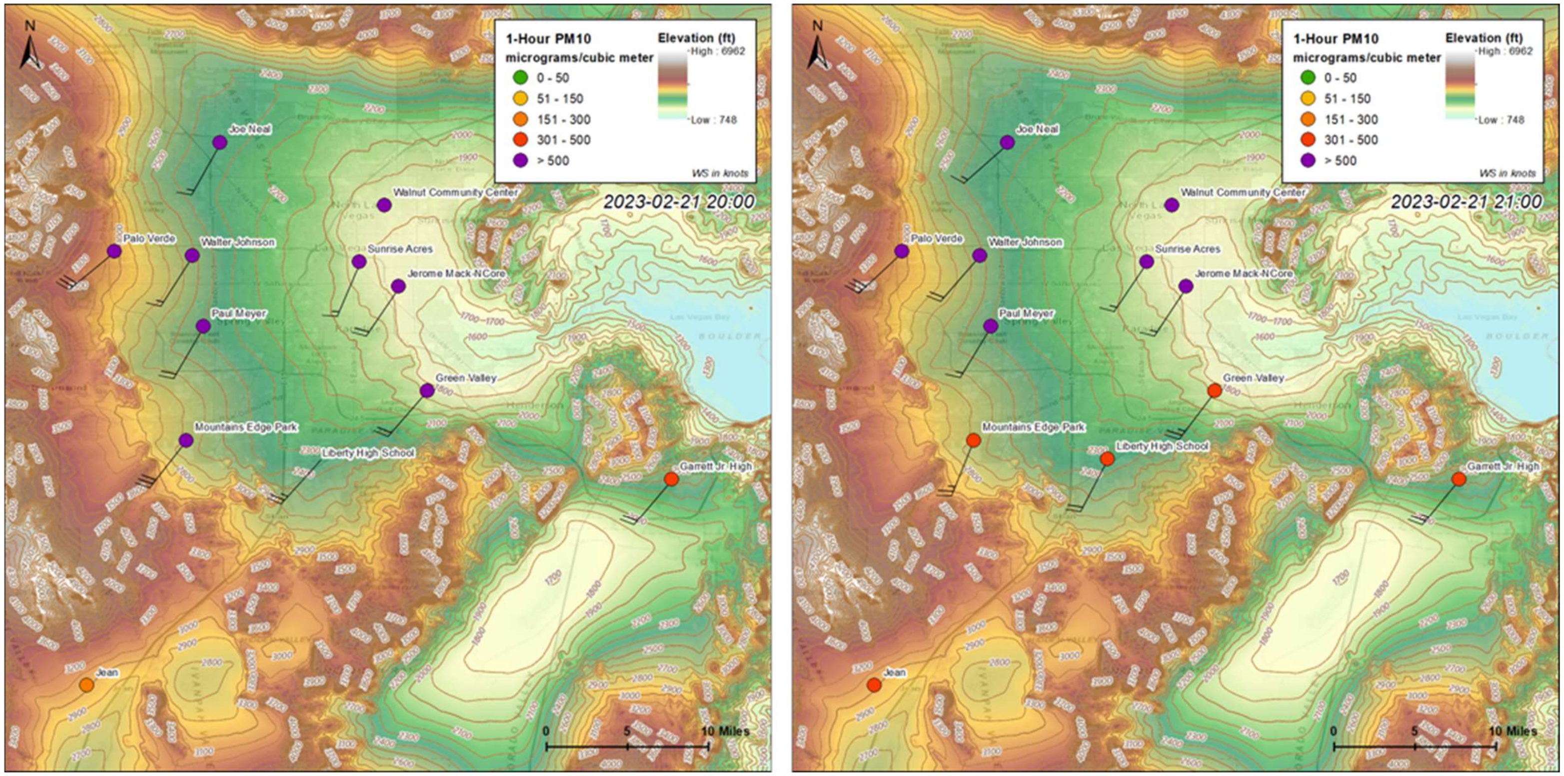


Figure 3.2-12. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for February 21, 2023, from 20:00 PST to 21:00 PST.

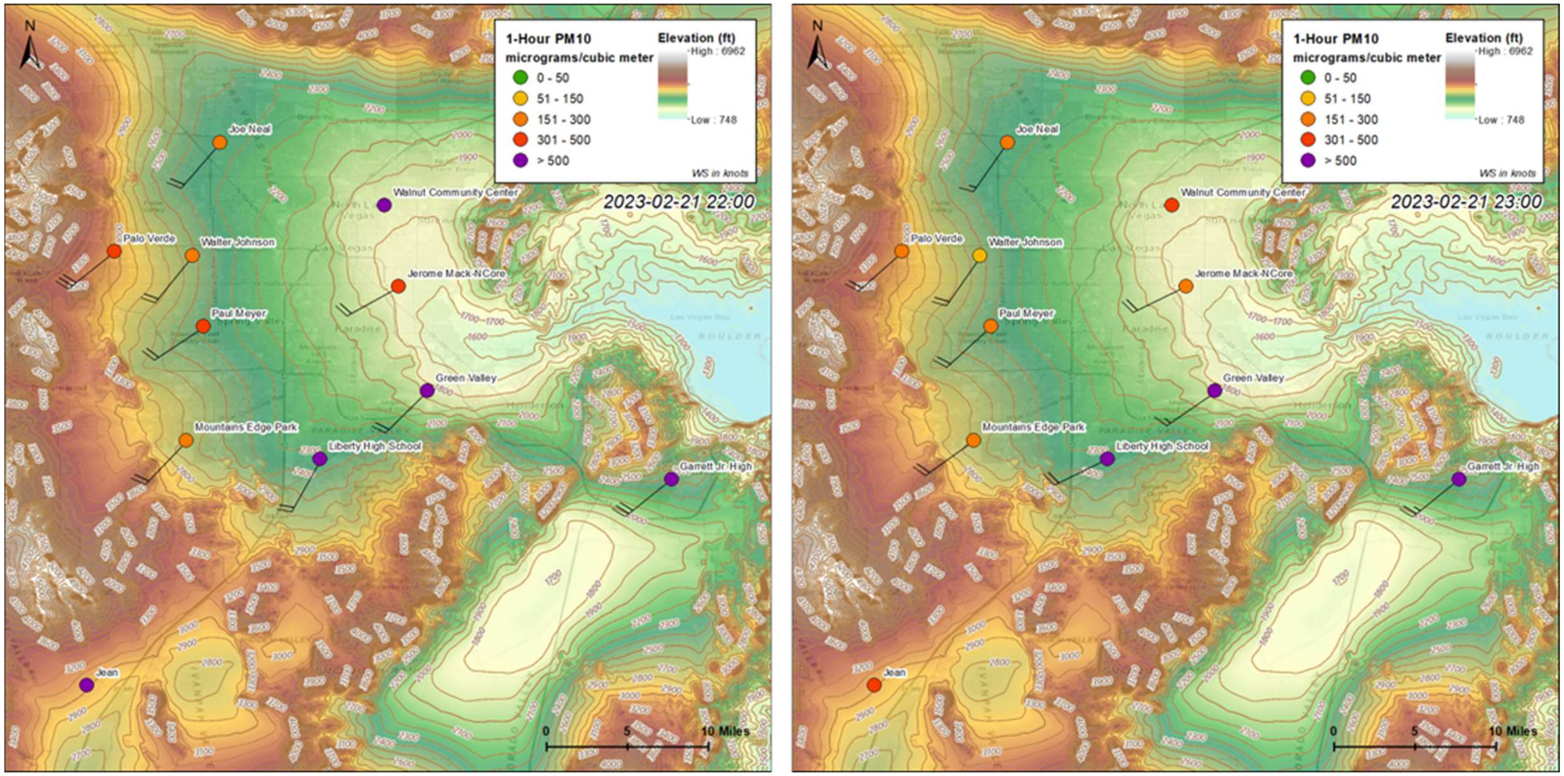


Figure 3.2-13. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for February 21, 2023, from 22:00 PST to 23:00 PST.

Peak sustained winds for Clark County, Nevada, and the surrounding regions were also confirmed using the Iowa State University Mesonet Automated Data aggregation tool, and the results are shown in Figure 3.2-14. This plot shows sustained winds greater than the 25-mph high-wind threshold on February 21, 2023, providing further proof that this was a high-wind event affecting both the source region and Clark County.

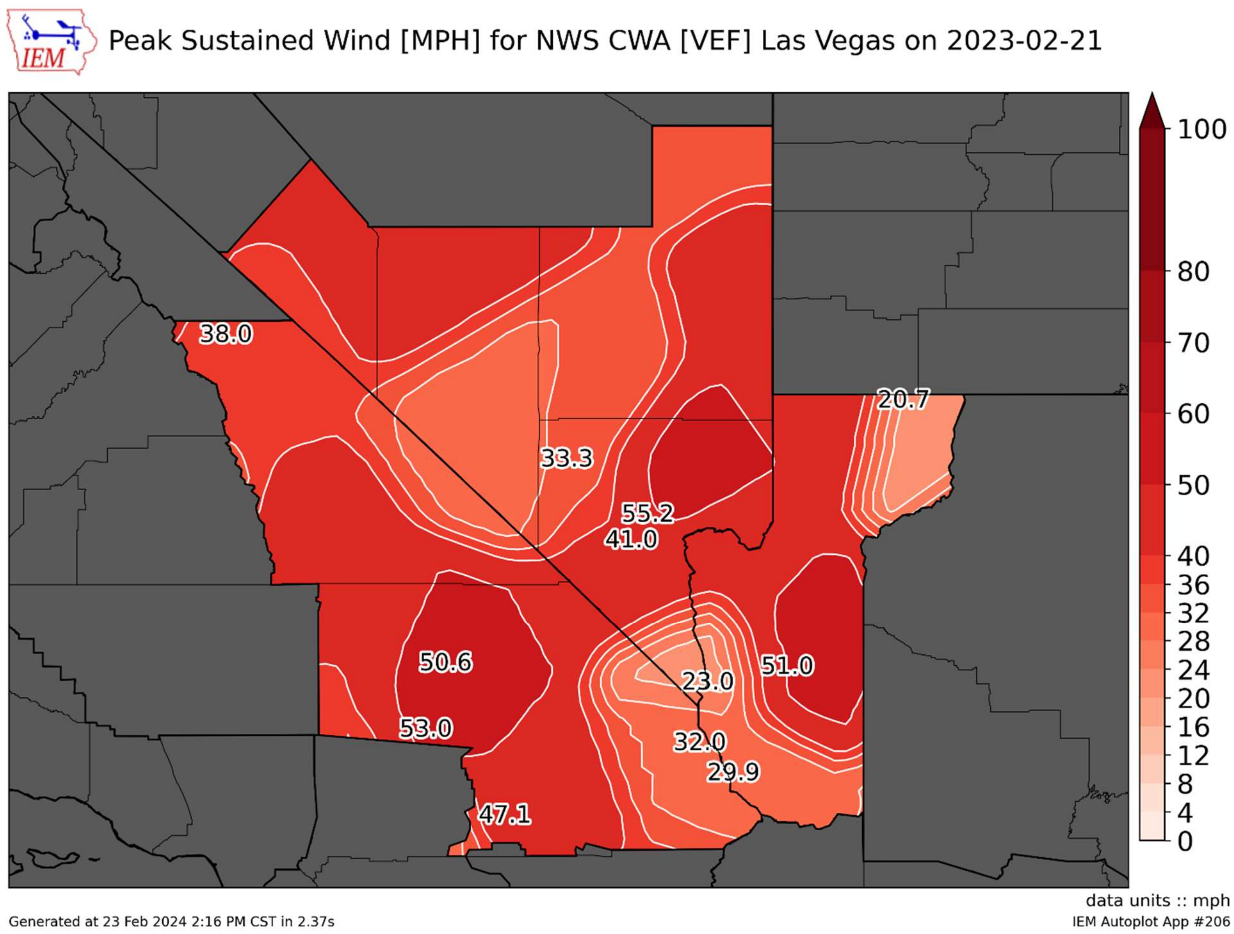


Figure 3.2-14. Peak sustained winds in Clark County, Nevada, and surrounding counties on February 21, 2023. Data source: https://mesonet.agron.iastate.edu/plotting/auto/.

Overall, we find overwhelming evidence that PM_{10} was transported by a strong frontal passage from the Mojave Desert in the afternoon through evening on February 21, 2023. Hourly average 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} concentrations 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

On Tuesday, February 21, 2023, Clark County issued a news release for an Air Quality Dust Advisory for the afternoon of February 21 and early Wednesday, February 22 (**Figure 3.3-1**). The Advisory warned people to limit their time outdoors. They advised residents and local construction sites that enhanced levels of blowing dust would be possible due to the forecast of high winds. Airborne dust is described as a form of inhalable particulate matter air pollution that aggravates respiratory diseases. The news release suggested that the public should stay indoors as much as possible under windy conditions, especially members of the public who would be at greater risk from particulate matter pollution. They included a list of eight tips for people to use to limit their exposure to dust, such as driving slowly on unpaved roads and keeping windows and doors closed.

News Release

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

Kevin Schiller, 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 **Tuesday, Feb. 21, 2023**

Air Quality Dust Advisory Issued for Tuesday Afternoon and Early Wednesday

The Clark County Department of Environment and Sustainability has issued a dust advisory for **Tuesday afternoon, Feb. 21 and early Wednesday, Feb. 22**, 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. Division of Air Quality forecasters said the advisory will be in effect from about 3 p.m. Tuesday, through the overnight hours into early Wednesday morning.

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 February 21, 2023, issuing the air quality dust advisory.

3.3.2 Media Coverage

Clark County provided urgent information to the community about the Dust Advisory on February 21, 2023, by issuing a statement on Twitter (Figure 3.3-2**Error! Reference source not found.**). The NWS Las Vegas also issued a statement on Twitter about the threat for wind damage and high wind gusts of 50-70+ mph (Figure 3.3-3). Additionally, many news sources, including Fox 5 Las Vegas, Las Vegas Sun, 8 News Now, KTNV Las Vegas, Las Vegas Review-Journal, and 13 Action News, reported on the high winds and dust present on February 21, 2023. Screenshots of the news articles referenced throughout this section are in Appendix A.

Figure 3.3-2. Twitter post from the official Clark County, Nevada, account on February 21, 2023, announcing a Dust Advisory for February 21 and 22.

Figure 3.3-3. Twitter post from the official NWS Las Vegas account on February 21, 2023, about the high wind gusts of 50-70+ mph expected during the evening.

Fox 5 Las Vegas reported on the Dust Advisory issued by the Clark County Department of Sustainability for that afternoon of February 21, 2023, and February 22, due to blowing dust and high winds. The report discussed how airborne dust made of particulate matter could aggravate people with respiratory diseases and the recommendation that people with lung or heart disease stay indoors as much as possible (https://www.fox5vegas.com/2023/02/21/air-quality-advisory-issued-tuesday-wednesday-clark-county/).

The Las Vegas Sun reported that a winter storm was expected to bring winds capable of downing power lines and trees in Arizona, New Mexico, and Nevada. The article discussed NWS forecasts of wind gusts that could hit 55 mph in metropolitan Phoenix and up to 70 mph in Prescott and Flagstaff. Weather forecasters and local and state officials encouraged people to stay off the roads (https://lasvegassun.com/news/2023/feb/21/storm-to-bring-high-winds-to-arizona-new-mexico-ne/).

8 News Now reported on strong winds, dust impacts, and downed power lines around the Las Vegas area. The Las Vegas Valley was impacted by strong winds that affected traffic during rush hour on the evening of February 21, 2023. A few traffic lights were out, leading to a four-way stop and some damage reported near U.S. 95 and Decatur Boulevard. High wind gusts in the Las Vegas area were up to 63 mph at LAS, and more than 19,000 people lost power across the valley (**https://www.8newsnow.com/news/local-news/wild-wind-dust-impact-rush-hour-traffic-downed-power-lines-and-outages-across-las-vegas/**).

KTNV reported on the high wind warning that affected the valley in the early afternoon of February 21, 2023. The Las Vegas branch of the NWS issued a high wind warning for southern Nevada from February 21 at 13:00 PST to February 22 at 10:00 PST. The forecast was that snow and rain may come to the Las Vegas Valley, along with wind speeds of up to 70 mph. NV Energy prepared for the conditions by increasing the number of people working overnight to respond quickly to issues (**https://www.ktnv.com/news/high-winds-forecast-to-move-into-the-valley-today**).

Fox 5 Las Vegas reported that high winds were expected to hit the Las Vegas Valley from the afternoon on February 21, 2023, to the morning on February 22. Southern Nevada and Las Vegas were preparing for a High Wind Warning. They advised people in the southwest Valley to prepare for winds gusts of 70-80 mph during the evening of February 21. The report noted the importance of securing any loose outdoor furniture or other objects that could be picked up by the high winds. The Federal Aviation Administration issued a ground delay at LAS for the evening on February 21 that was in effect until 00:59 PST on the morning of February 22 (**https://www.fox5vegas.com/2023/02/21/high-wind-hit-las-vegas-valley-tuesday-afternoon/**).

KTNV Las Vegas reported on wind gusts of up to 70 mph blowing into the Las Vegas Valley on February 21, 2023. The high winds were expected to impact areas of south-central and southern Nevada, northwest Arizona, and southeast California. Meteorologists expected widespread power outages along with damaging winds that could blow down trees and power lines. The report also mentioned that travel could also be difficult due to dust and reduced visibility conditions (**https://www.ktnv.com/weather/wind-gusts-up-to-70-mph-getting-ready-to-blow-into-the-las-vegas-valley**).

The Las Vegas Review-Journal reported that the high winds on February 21, 2023, caused power outages, closed roads, and delayed air travel. The NWS reported that wind gusts reached up to 82 mph at Allegiant Stadium. There were power outages that led the Clark County School District to transition to distant learning for some schools on February 22 and 23. According to the Regional Transportation Commission, the southbound lanes of Interstate 15 were closed in the community of Primm, Nevada, because of high winds and low visibility conditions on the way into California. There were also high winds that grounded some inbound flights into Las Vegas on February 21 (**https://www.reviewjournal.com/local/weather/powerful-las-vegas-windstorm-causes-outages-closures-flight-delays-2732370/**).

13 Action News reported on the dangerous winds that would impact the Las Vegas Valley on February 21, 2023. They reported the possibility of gusts of up to 70 mph and that winds were expected to peak from 19:00 PST on February 21 to 01:00 PST on February 22 (**https://news.yahoo.com/dangerous-windstorm-blowing-las-vegas-011152279.html**).

Table 3.3-1 includes all urgent weather messages issued by NWS Las Vegas on February 21, 2023, for Clark County and the surrounding counties that were also affected by the high wind warnings. These notices are also available in Appendix A.

Table 3.3-1. Urgent weather messages issued by the National Weather Service, Las Vegas, Nevada, on February 21, 2023.

Warning	Time (PST)	Location
Urgent Weather Message (High Wind Warning)	01:54	Western Mojave Desert, Eastern Sierra Slopes-Owens Valley-White Mountains of Inyo County, Northwest Plateau-Northwest Deserts-Death Valley National Park, Eastern Mojave Desert-Morongo Basin-Cadiz Basin, 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-Lake Mead National Recreation Area, San Bernardino County-Upper Colorado River Valley,
Urgent Weather Message (High Wind Warning)	12:34	Western Mojave Desert, Eastern Sierra Slopes-Owens Valley-White Mountains of Inyo County, Northwest Plateau-Northwest Deserts-Death Valley National Park, Eastern Mojave Desert-Morongo Basin-Cadiz Basin, 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-Lake Mead National Recreation Area, San Bernardino County-Upper Colorado River Valley

3.3.3 Pollutant and Diurnal Analysis

Figure 3.3-4 illustrates the timeline of PM_{10} concentrations recorded from February 21 and 22, 2023, showing the 1-hour average PM_{10} concentrations for three select sites on the event day. The figure includes a shaded region showing the five-year, site-specific, hourly 5th - 95th percentile of PM_{10} concentrations. In this case, it is difficult to see the shaded region due to the magnitude of this event in comparison to typical values, and thus the data points have also been colored red if they exceeded the 95th percentile. Beginning near 15:00 PST on February 21, the hourly PM_{10} concentrations surpassed the five-year 95th percentiles at all sites. The event reached a peak near 20:00 PST, recording maximum hourly values above 1,500 µg/m^3. The concentrations remained above the 95th percentile until approximately 03:00 PST on February 22. The hourly time series for all sites compared to their hourly 95th percentiles are presented with additional details in Section 3.4.2.

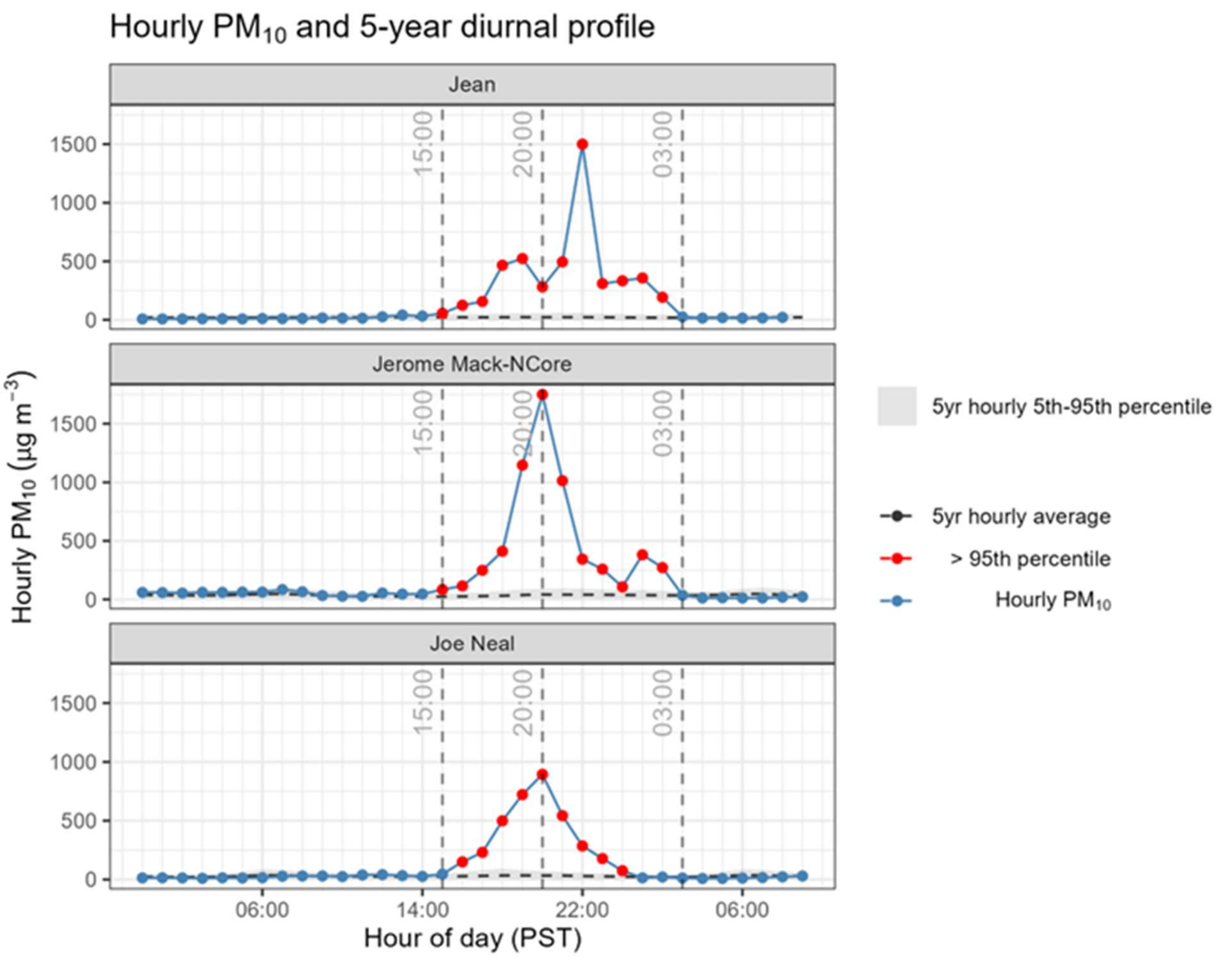


Figure 3.3-4. Hourly PM_{10} concentrations recorded on February 21-22, 2023; measurements are colored red if they exceeded the five-year (2019-2023), site-specific, hourly 95th percentile.

During the event, 24-hour average PM_{10} concentrations reached over 300 μg/m^3, exceeding both the five-year, combined-site 99th percentile as well as the NAAQS 150 μg/m^3 threshold (Figure 3.3-5). The 24-hour average PM_{10} values at all sites in Clark County before and after February 21 were far below the 99th percentile. The episodic and simultaneous increase in PM_{10} concentrations across the monitoring sites, far surpassing the 99th percentile threshold, suggests a regional source of PM_{10} in line with a wind-blown dust event.

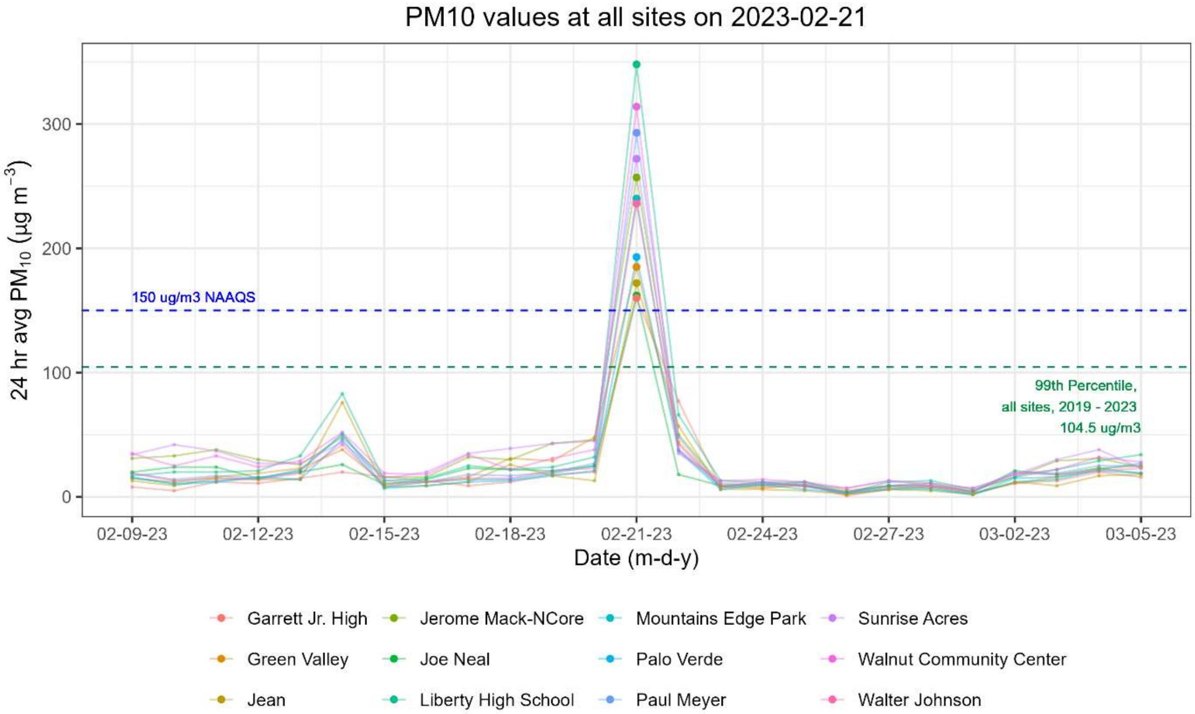


Figure 3.3-5. 24-hour PM_{10} values in Clark County, Nevada, in February 2023, with the NAAQS threshold (blue dash) and five-year 99th percentile (green dash) indicated. The 99th percentile is calculated from 2019-2023 values for all sites combined.

3.3.4 Particulate Matter Analysis

No chemical speciation data are available on February 21, 2023, as speciated $PM_{2.5}$ measurements are collected on a three-day cadence in Clark County. Measurements were not taken on the event date, and the observations from surrounding days—February 20 and 23—do not reflect conditions on February 21.

Before the high-wind dust event on February 21, 2023, the hourly $PM_{2.5}/PM_{10}$ ratio is approximately average at all sites based on the 2019-2023 ratio data (**Figure 3.3-6**). In the afternoon on February 21, 2023, the hourly $PM_{2.5}/PM_{10}$ ratio at all sites dropped to a low value of approximately 0.1 and stayed below the 5th percentile for the rest 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 midday of February 21 is also consistent with the increase in hourly PM_{10} concentrations, as described in **Section 3.2.2**; $PM_{2.5}/PM_{10}$ ratios rose early in the morning on February 22.

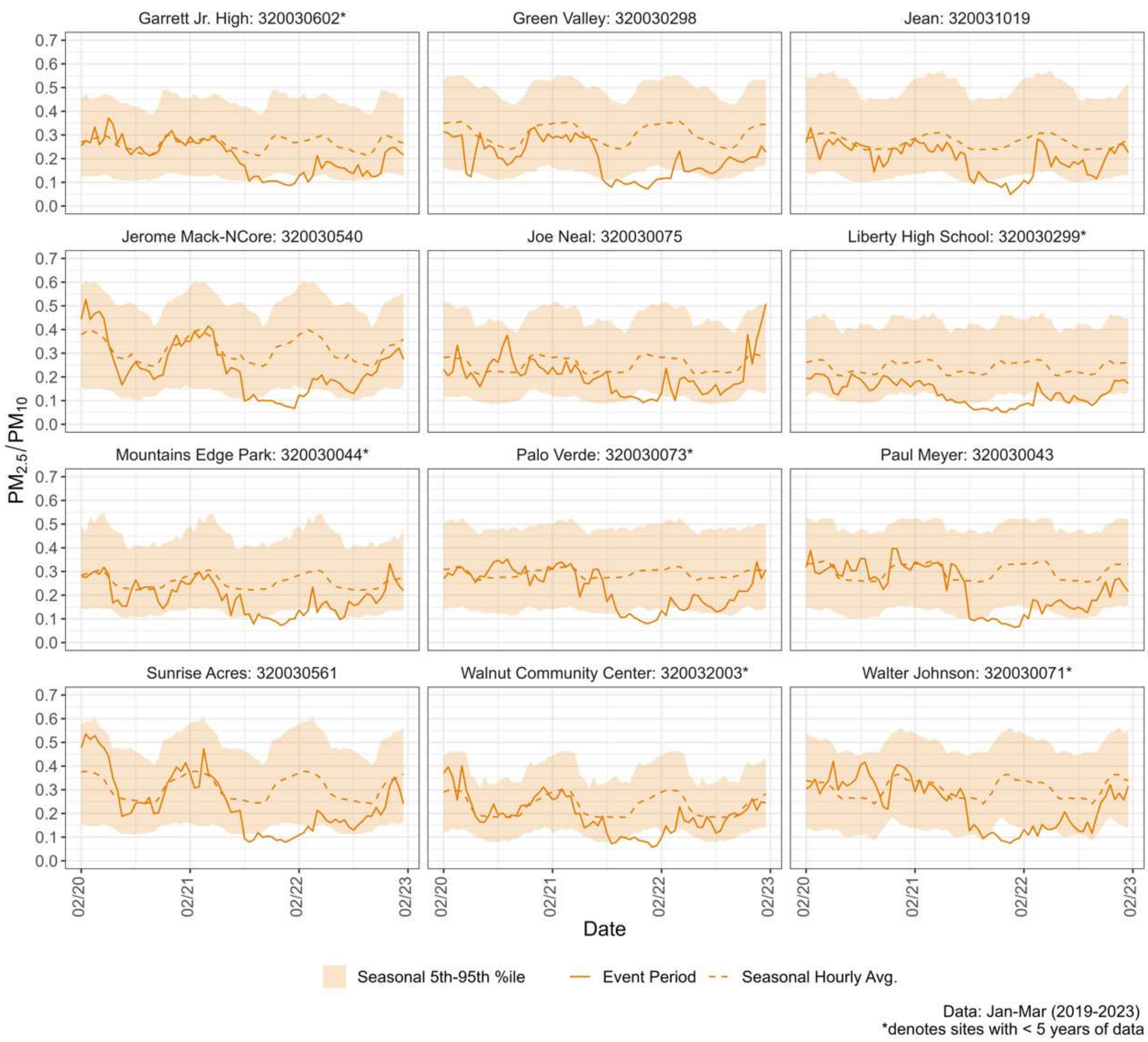


Figure 3.3-6. Ratio of $PM_{2.5}/PM_{10}$ concentrations at the Garret Jr. High, Green Valley, Jean, Jerome Mack, Joe Neal, Liberty High School, Mountains Edge Park, Palo Verde, Paul Meyer, Sunrise Acres, Walnut Community Center, and Walter Johnson sites before, during, and after the February 21, 2023, PM_{10} event. 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 January-March of 2019-2023.

3.3.5 Visibility/Ground-Based Images

Visibility data are available from airport monitoring sites at LAS through the NWS Weather and Hazards Data Viewer. Figure 3.3-7 shows visibility observations on February 21, 2023, at LAS. Concurrent with the increasing wind speeds and the estimated time of the frontal passage, visibility decreased between 16:00-20:00 PST and remained below the 10-mile maximum measurement through midnight. This is confirmed by camera images taken in the Las Vegas Valley (Figure 3.3-8 through Figure 3.3-12), which show the increased intensity of the dusty and low visibility conditions between 15:30-17:30 PST, before sunset darkened the camera images beyond use.

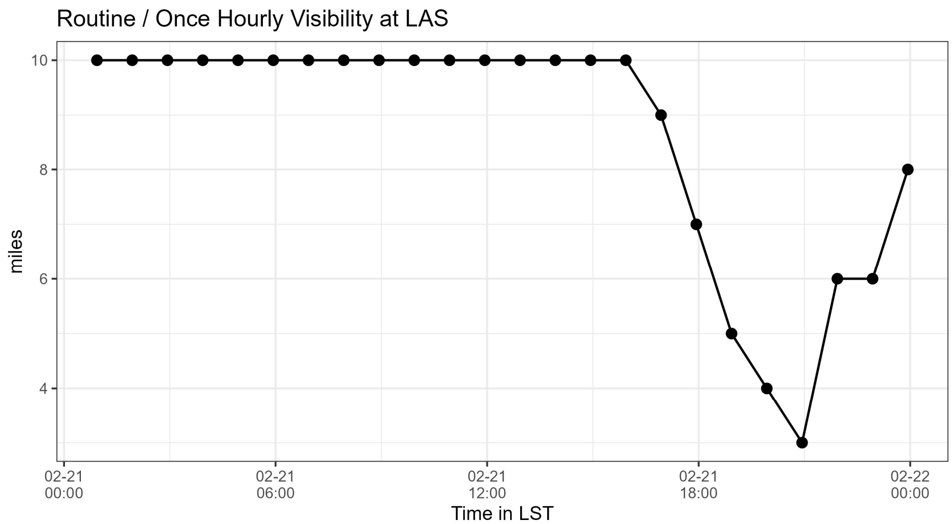


Figure 3.3-7. Visibility in miles on February 21, 2023, recorded at the Harry Reid International Airport (LAS). Visibility data are sourced from the Iowa Environmental Mesonet (https://mesonet.agron.iastate.edu/).

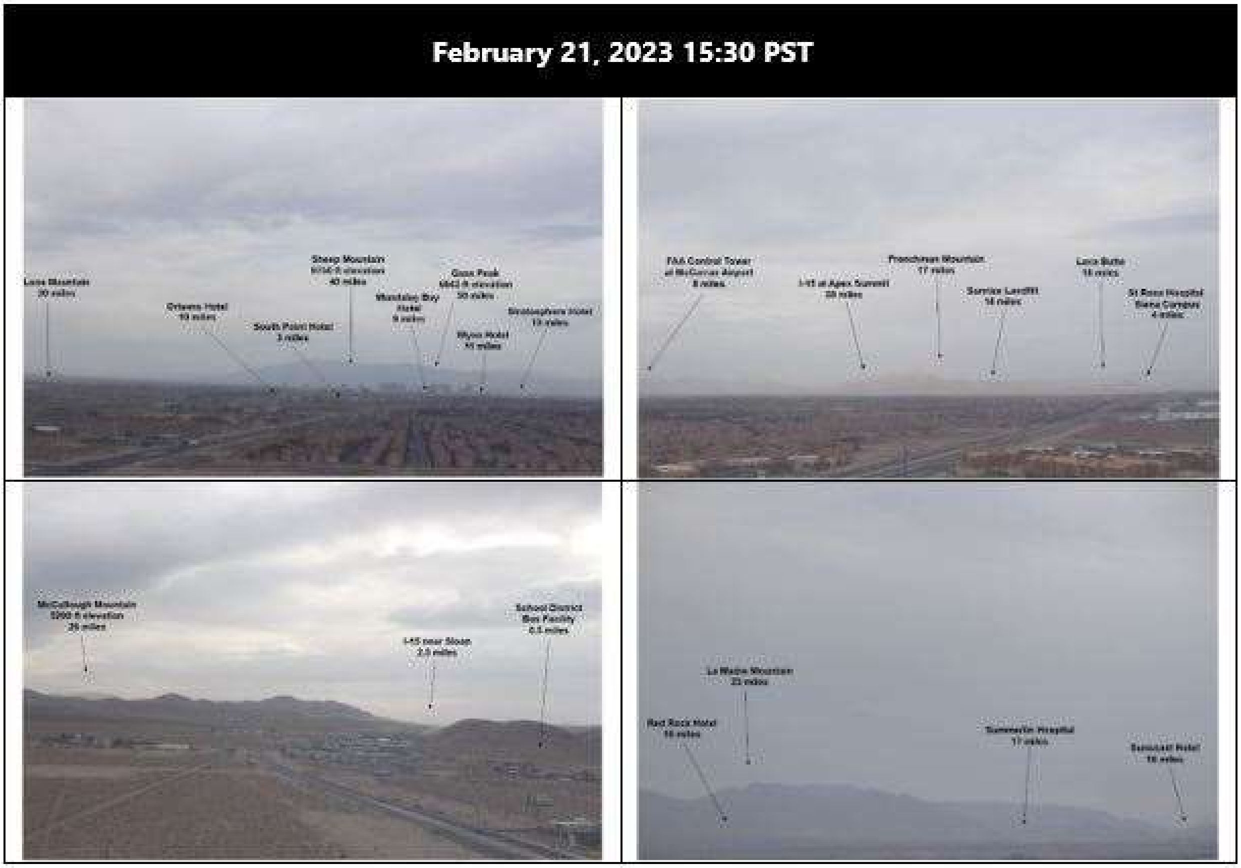


Figure 3.3-8. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on February 21, 2023, at 15:30 PST.

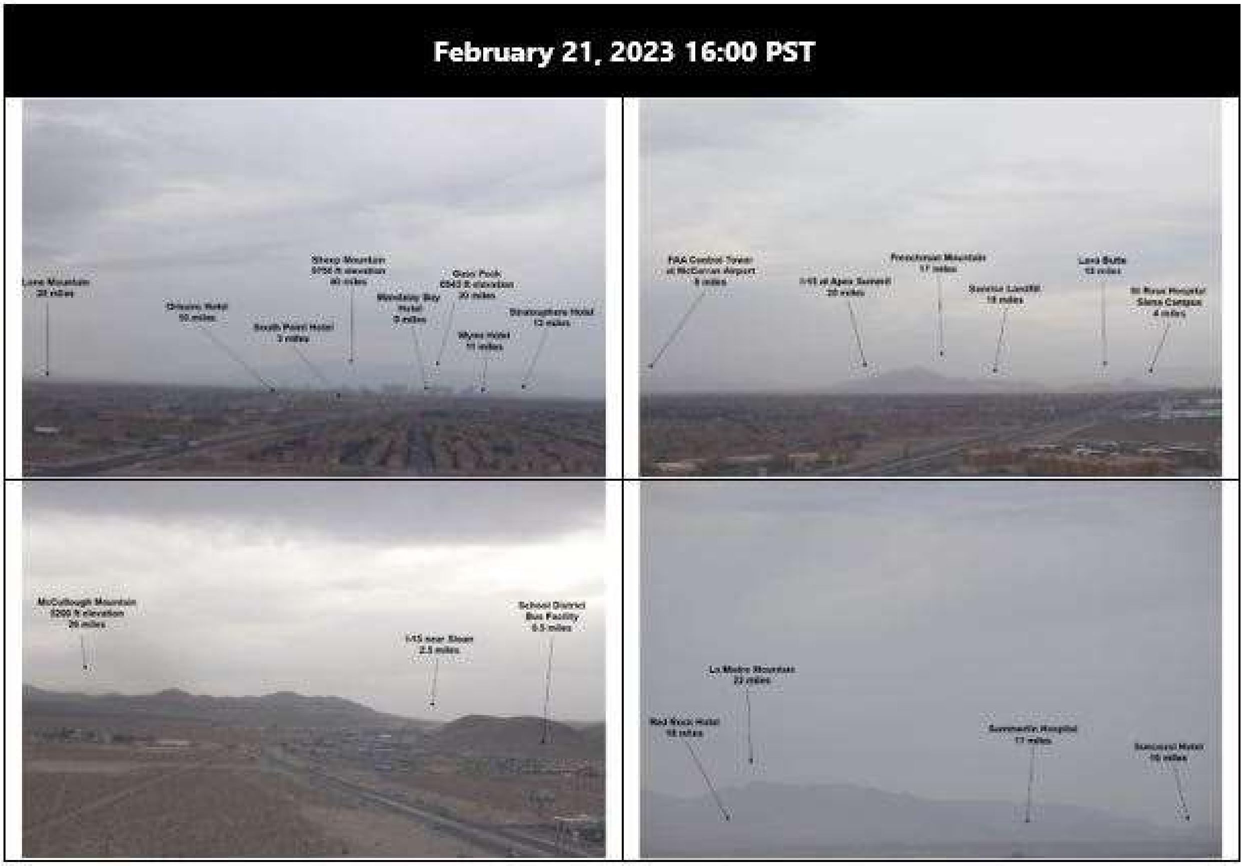


Figure 3.3-9. Camera images for the north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on February 21, 2023, at 16:00 PST.

Figure 3.3-10. Camera images for the north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on February 21, 2023, at 16:30 PST.

Figure 3.3-11. Camera images for the north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on February 21, 2023, at 17:00 PST.

Figure 3.3-12. Camera images for the north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on February 21, 2023, at 17:30 PST.

Overall, we find overwhelming evidence that PM_{10} was transported from the Mojave Desert in southeastern California to Clark County by approximately 16:00-23:00 PST on February 21, 2023. Winds started to shift southwesterly in the Las Vegas Valley starting at 10:00-13:00 PST. PM_{10} concentrations increase in the Las Vegas Valley with the increasing pressure gradient stretching across the Mojave Desert and Clark County and the associated frontal passage which peaked between 16:00-19:00 PST. 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 in PM_{10} concentrations at all monitoring sites in Clark County; (3) a drop in $PM_{2.5}/PM_{10}$ ratio values, indicating windblown dust sources; (4) decreased visibility at the LAS airport corresponding with the PM_{10} event time of arrival; and, (5) PM_{10} concentrations well outside typical hourly and daily averages on February 21. 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 the event day ranked in the top 10 and above the 99th percentile of all concentrations observed in the five-year period from 2019-2023 at all 12 sites (Table 3.4-1). A total of 12 unique days from the five-year period ranked at a higher percentile than the event day across the sites. These 12 days were given a preliminary evaluation for evidence of also being dust events. All 12 days were associated with dust events, wildfire events, or a combination of the two, and the results are summarized in Table 3.4-2. Full demonstrations supporting exceptional events on these days have been prepared for 10 of the 12 days and can be referenced for further evidence. The other two days showed preliminary evidence of atypical events that should be taken into consideration in their rankings, and this preliminary evidence is summarized on the Clark County DEQ website (https://desaqmonitoring.clarkcountynv.gov/Events).

Table 3.4-1. Five-year (2019-2023) rank and percentile of PM_{10} values at affected sites on the February 21, 2023, event day. *Sites with less than five years of available data are indicated, and summary statistics are shown for available data.

Date	Site	Rank	Percentile	24-hour PM_{10} ($\mu g/m^3$)
2/21/2023	*Garrett Jr. High	6	99.5	160
2/21/2023	Green Valley	8	99.6	185
2/21/2023	Jean	7	99.7	172
2/21/2023	Jerome Mack	6	99.7	257
2/21/2023	Joe Neal	8	99.6	162
2/21/2023	*Liberty High School	2	99.9	348
2/21/2023	Mountains Edge Park	4	99.7	240
2/21/2023	Palo Verde	5	99.8	193
2/21/2023	Paul Meyer	2	99.9	293
2/21/2023	Sunrise Acres	4	99.8	272
2/21/2023	*Walnut Community Center	3	99.8	314
2/21/2023	Walter Johnson	4	99.8	236

Table 3.4-2. Summary of unique days with higher PM_{10} percentile rankings than the February 21, 2023, event day.

Date	Preliminary Evidence of Atypical Event?	Full Exceptional Event Demonstration Prepared?	Summary of Event
9/8/2020	Yes	Yes	Combination of smoke and frontal passage, high winds
7/11/2021	Yes	No	Dust from passing thunderstorms and regional smoke
8/7/2021	Yes	No	Regional wildfire smoke resulting in PM_{10}, $PM_{2.5}$, and ozone exceedances
2/21/2022	Yes	Yes	High-wind dust event
4/11/2022	Yes	Yes	High-wind dust event
5/8/2022	Yes	Yes	Dust event
5/28/2022	Yes	Yes	Dust event
5/29/2022	Yes	Yes	Dust event
9/8/2022	Yes	Yes	Passing thunderstorm dust event
9/9/2022	Yes	Yes	Passing thunderstorm dust event
10/22/2022	Yes	Yes	Dust event
7/31/2023	Yes	Yes	Combination of nearby wildfire and thunderstorm generated dust event

The following figures provide additional comparisons of the February 21, 2023, event day to the normal range of values:

- Annual time series graphs of 24-hour average PM_{10} concentrations for each affected site are provided in Figure 3.4-1 through Figure 3.4-12. Observations on the event day were above the five-year 99th percentile at all sites, and the highest value observed in 2023 for all sites except Garrett Jr. High.
- Five-year time series graphs of 24-hour average PM_{10} concentrations for each affected site are provided in Figure 3.4-13 through Figure 3.4-24.

In these figures, other exceedances of the 150 $\mu g/m^3$ NAAQS threshold (shown by the blue dashed line) that were further investigated for potential dust event-evidence, as described in Table 3.4-2, are indicated as 'suspect dust event days.'

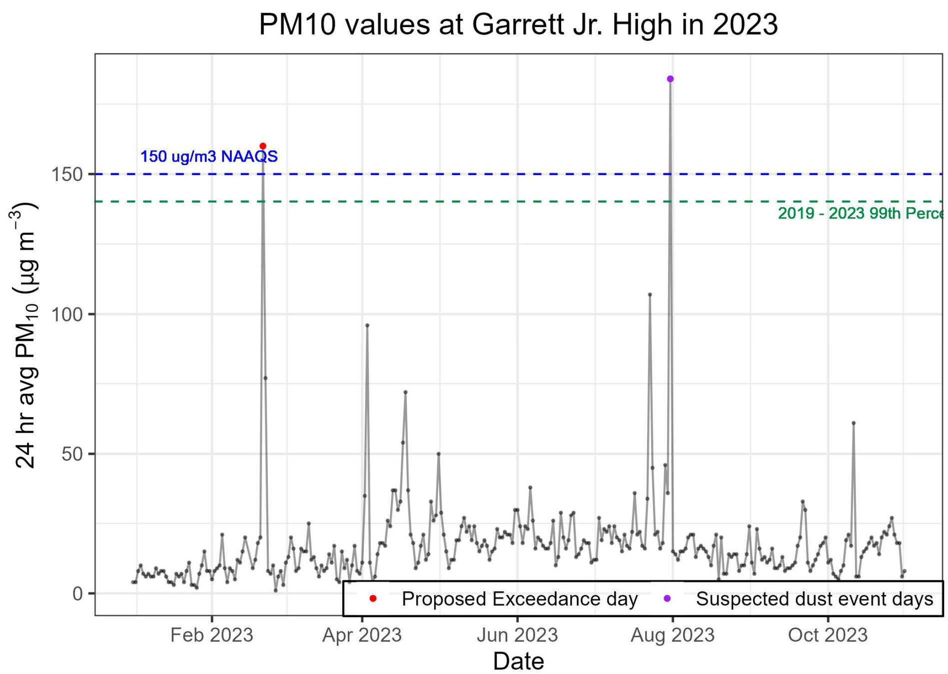


Figure 3.4-1. Garrett Jr. High monitoring site 24-hour PM_{10} measurement in µg/m^3 for 2023, with the (green dash) 2019-2023 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

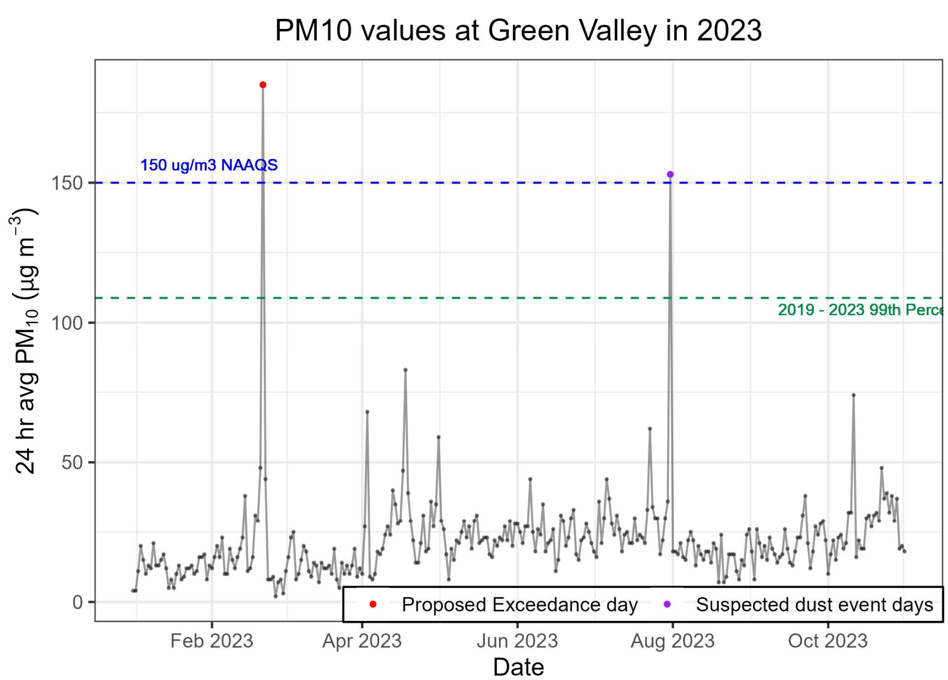


Figure 3.4-2. Green Valley monitoring site 24-hour PM_{10} measurement in µg/m^3 for 2023, with the (green dash) 2019-2023 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

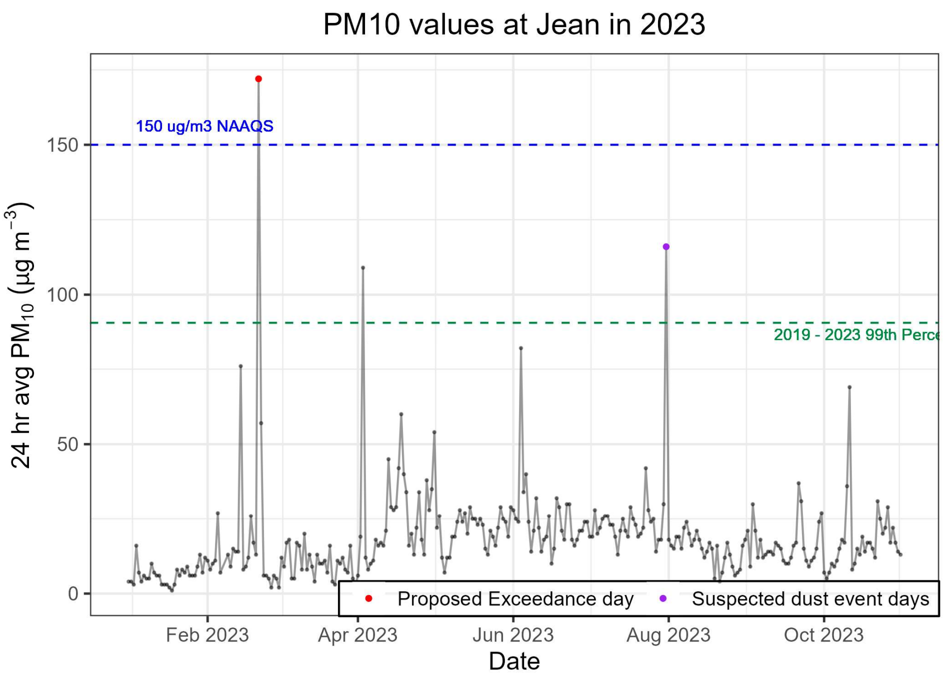


Figure 3.4-3. Jean monitoring site 24-hour PM_{10} measurement in µg/m^3 for 2023, with the (green dash) 2019-2023 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

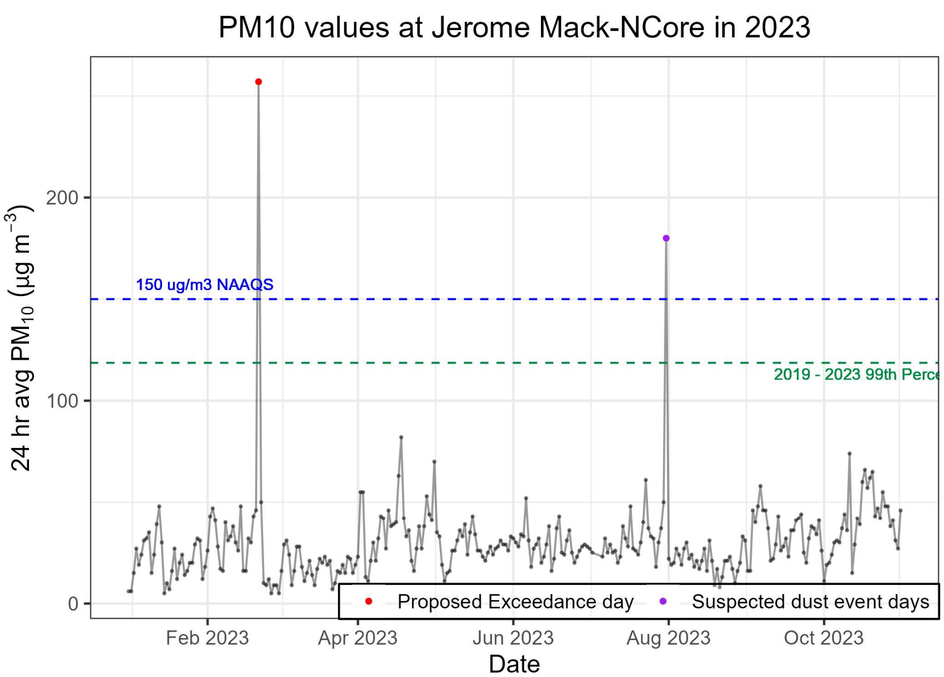


Figure 3.4-4. Jerome Mack monitoring site 24-hour PM_{10} measurement in µg/m^3 for 2023, with the (green dash) 2019-2023 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

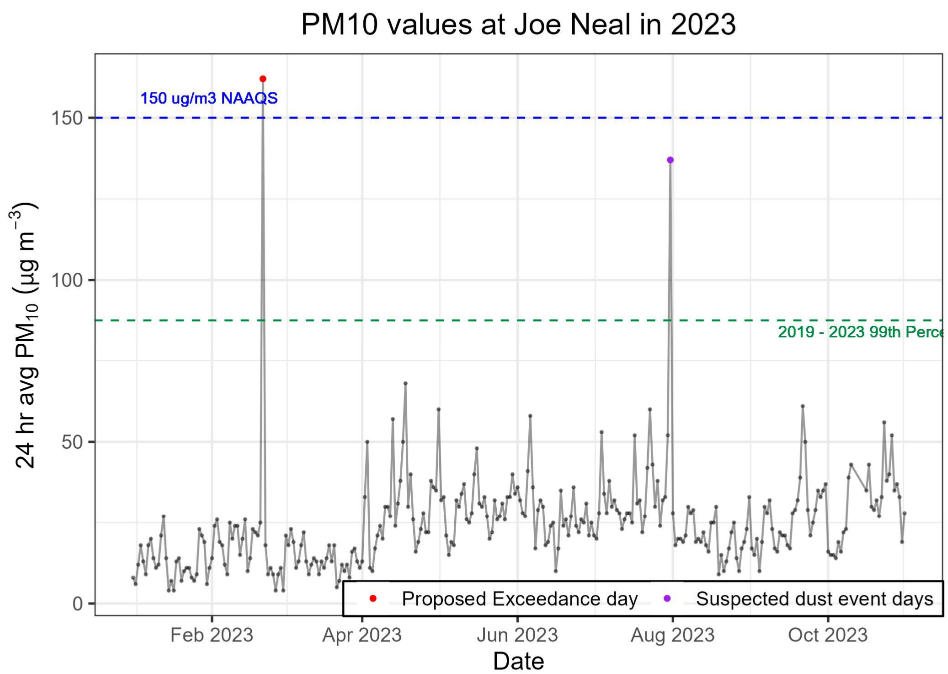


Figure 3.4-5. Joe Neal monitoring site 24-hour PM_{10} measurement in µg/m^3 for 2023, with (green dash) 2019-2023 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

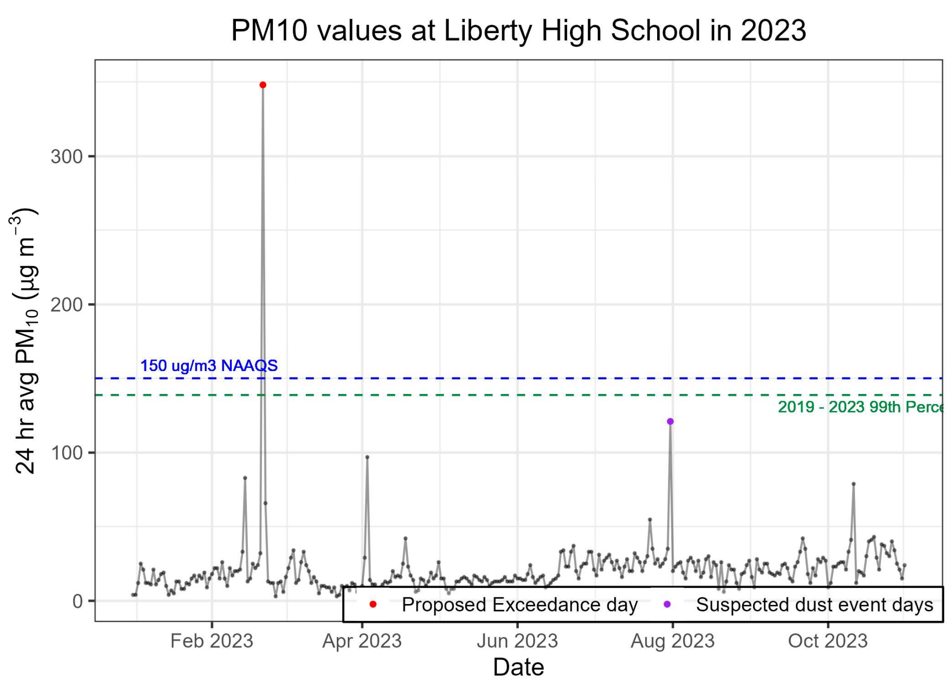


Figure 3.4-6. Liberty High School monitoring site 24-hour PM_{10} measurement in µg/m^3 for 2023, with the (green dash) 2019-2023 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

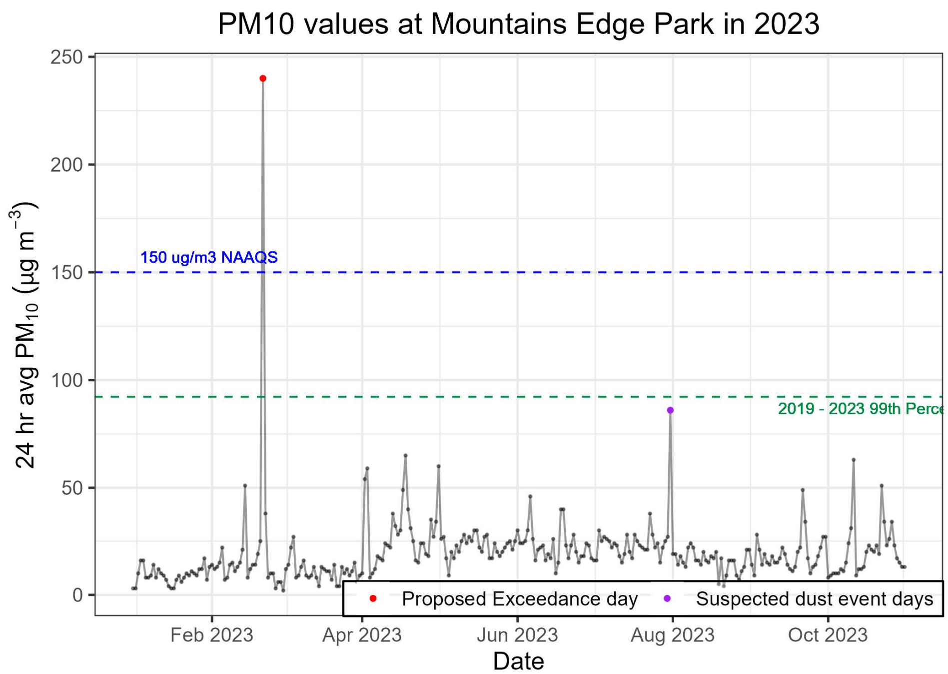


Figure 3.4-7. Mountains Edge Park monitoring site 24-hour PM_{10} measurement in µg/m^3 for 2023, with the (green dash) 2019-2023 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

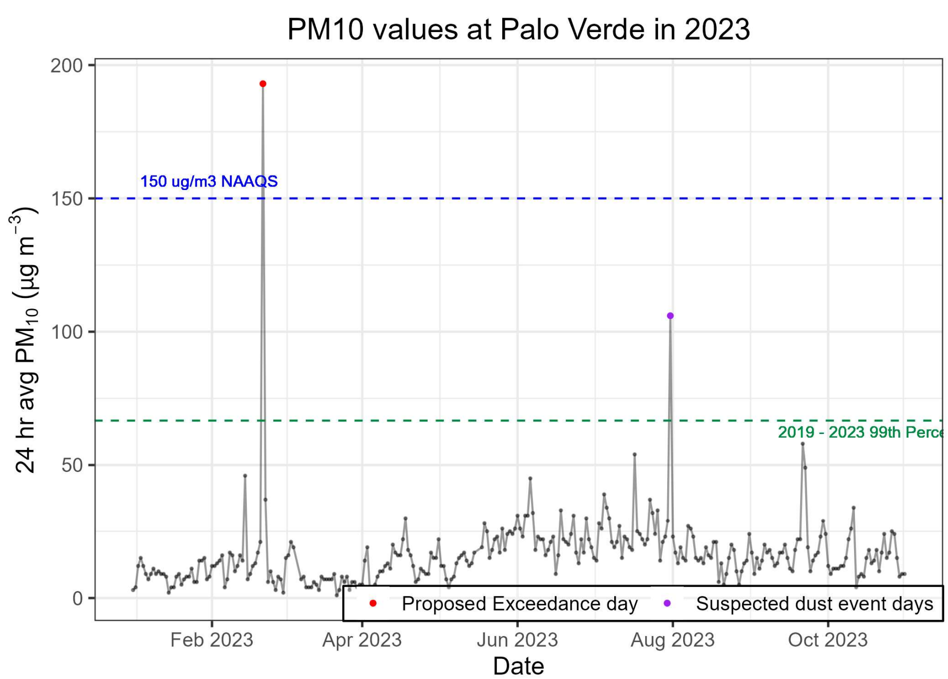


Figure 3.4-8. Palo Verde monitoring site 24-hour PM_{10} measurement in µg/m^3 for 2023, with the (green dash) 2019-2023 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

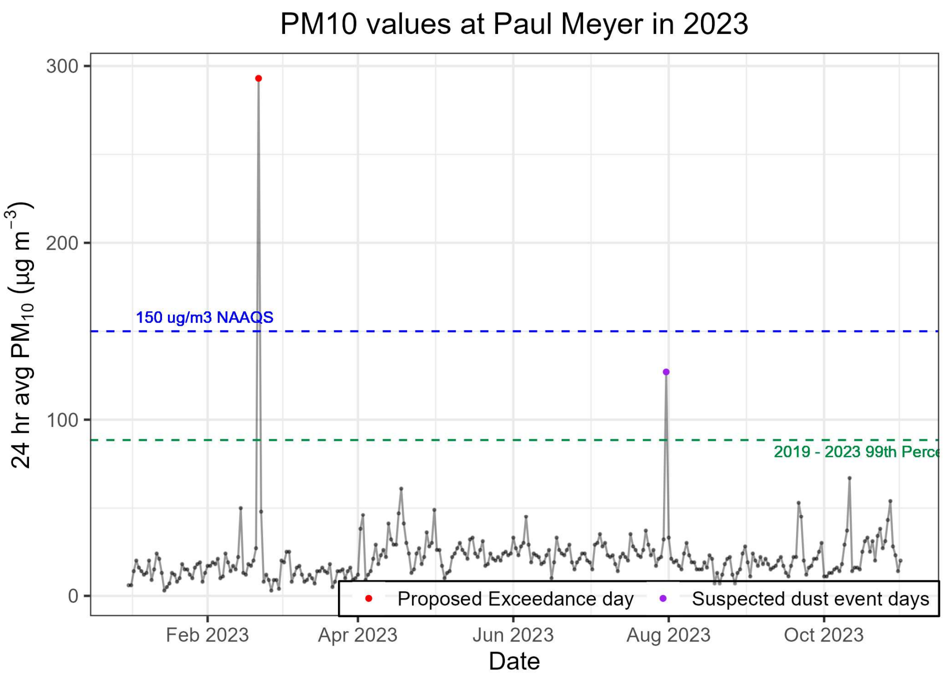


Figure 3.4-9. Paul Meyer monitoring site 24-hour PM_{10} measurement in µg/m^3 for 2023, with the (green dash) 2019-2023 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

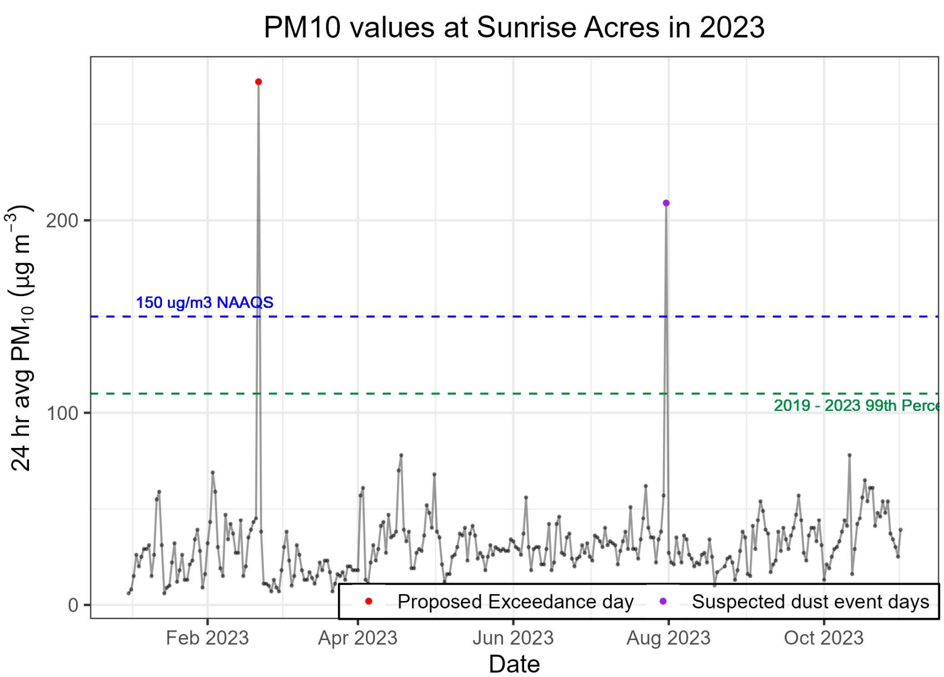


Figure 3.4-10. Sunrise Acres monitoring site 24-hour PM_{10} measurement in µg/m^3 for 2023, with the (green dash) 2019-2023 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

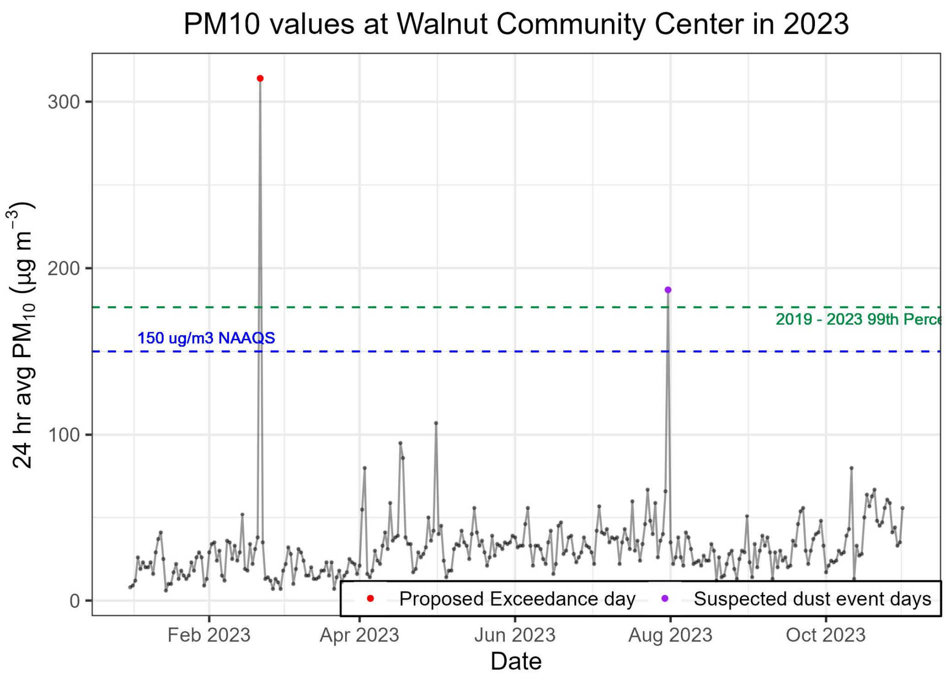


Figure 3.4-11. Walnut Community Center monitoring site 24-hour PM_{10} measurement in µg/m^3 for 2023, with the (green dash) 2019-2023 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

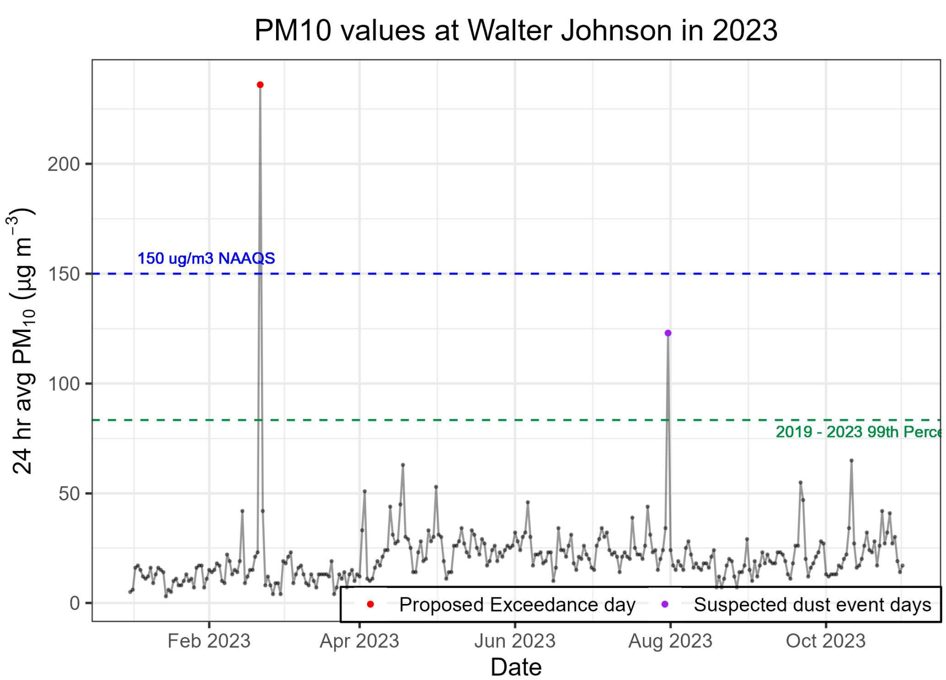


Figure 3.4-12. Walter Johnson monitoring site 24-hour PM_{10} measurement in µg/m^3 for 2023, with the (green dash) 2019-2023 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

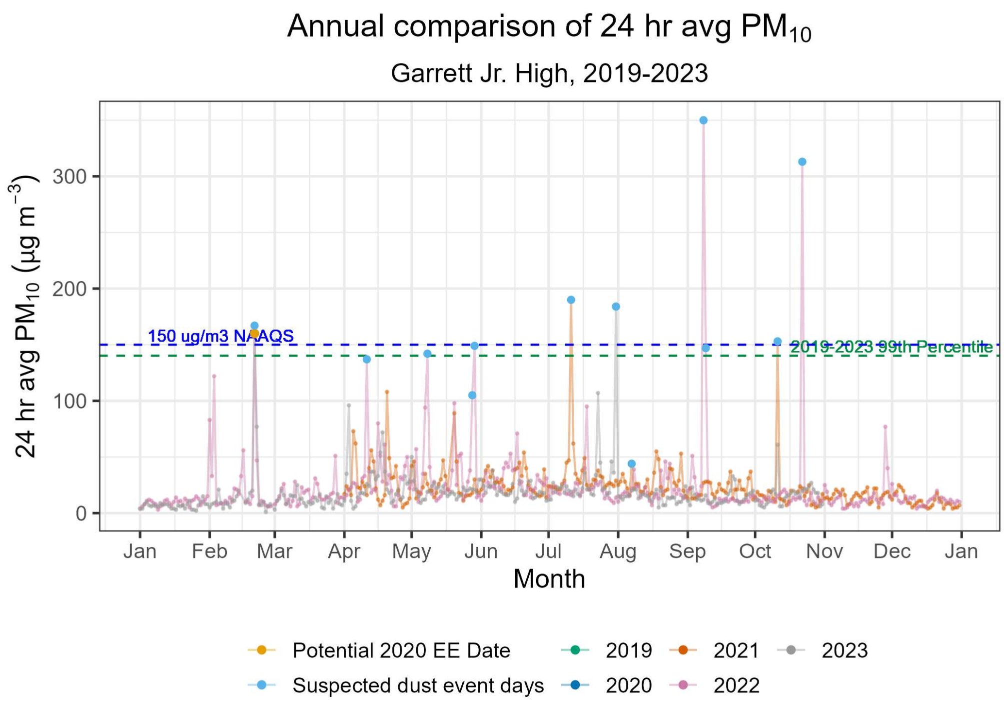


Figure 3.4-13. Garrett Jr. High monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2019-2023 by year with the 99th percentile (green dash) and (grey dash) NAAQS indicated.

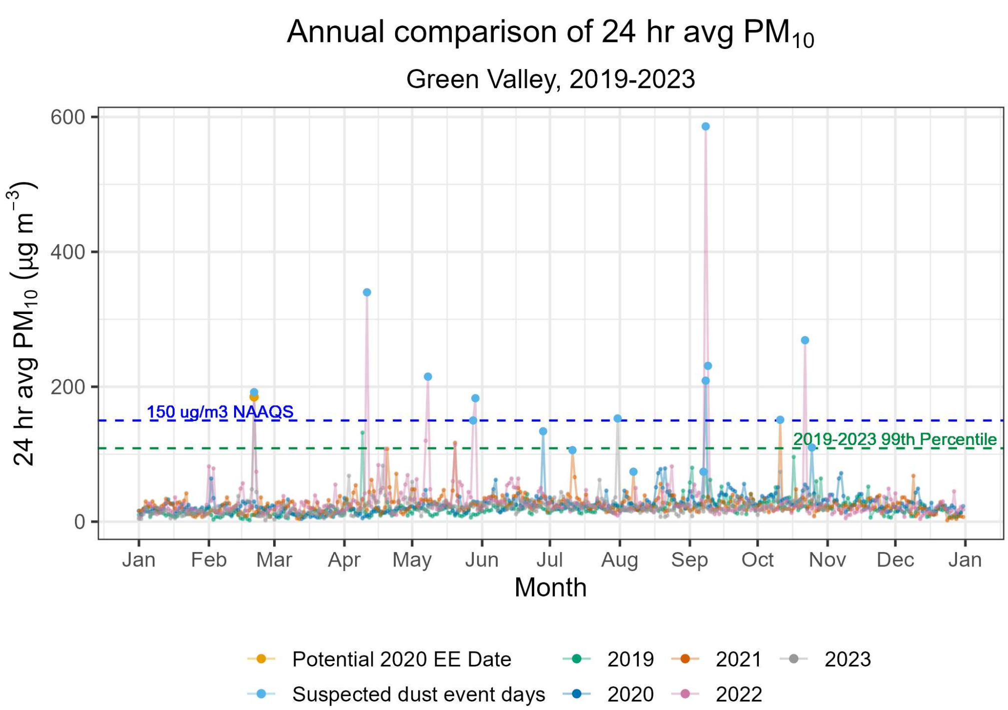


Figure 3.4-14. Green Valley monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2019-2023 by year with the (green dash) 99th percentile and (grey dash) NAAQS indicated.

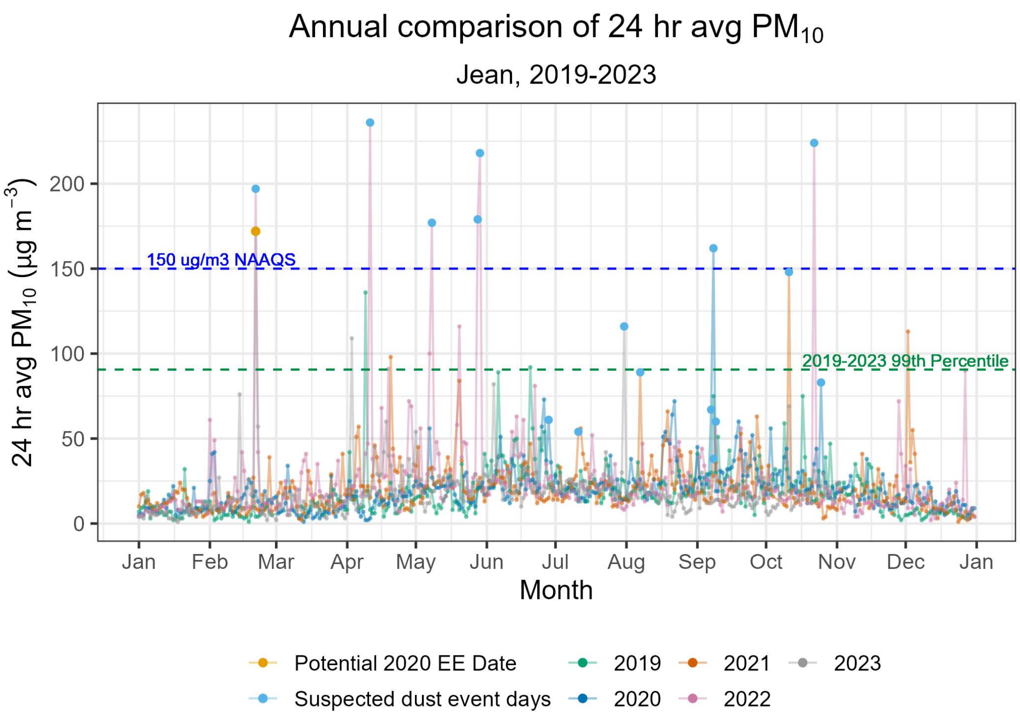


Figure 3.4-15. Jean monitoring site 24-hour PM_{10} measurements in μg/m^3 from 2019-2023 by year with the (green dash) 99th percentile and (grey dash) NAAQS indicated.

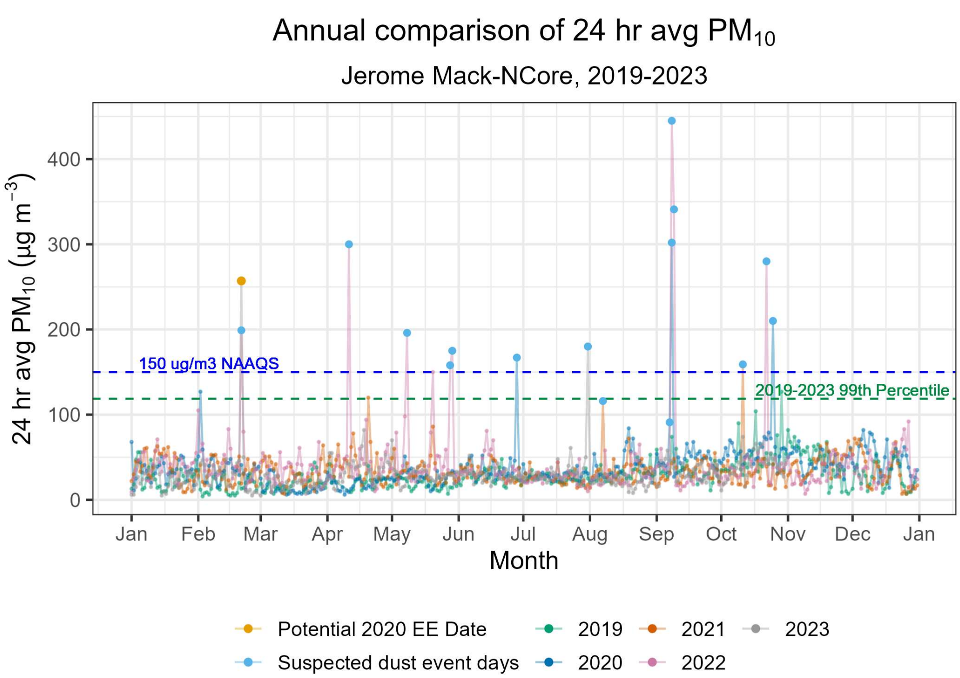


Figure 3.4-16. Jerome Mack monitoring site 24-hour PM_{10} measurements in μg/m^3 from 2019-2023 by year with the (green dash) 99th percentile and (grey dash) NAAQS indicated.

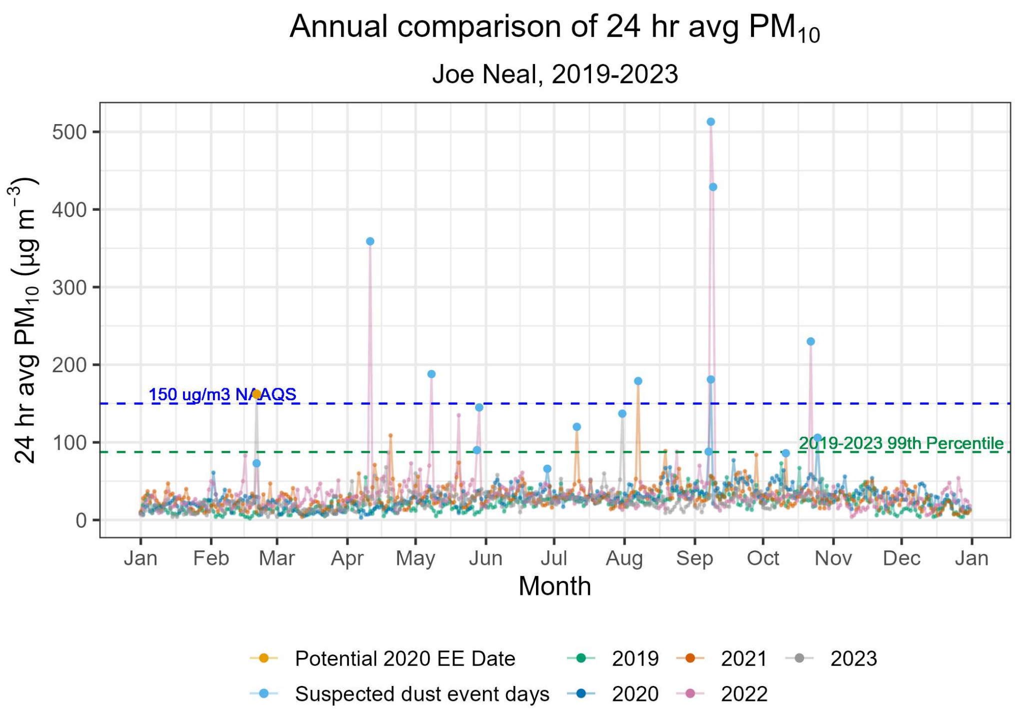


Figure 3.4-17. Joe Neal monitoring site 24-hour PM_{10} measurements in µg/m³ from 2019-2023 by year with the (green dash) 99th percentile and (grey dash) NAAQS indicated.

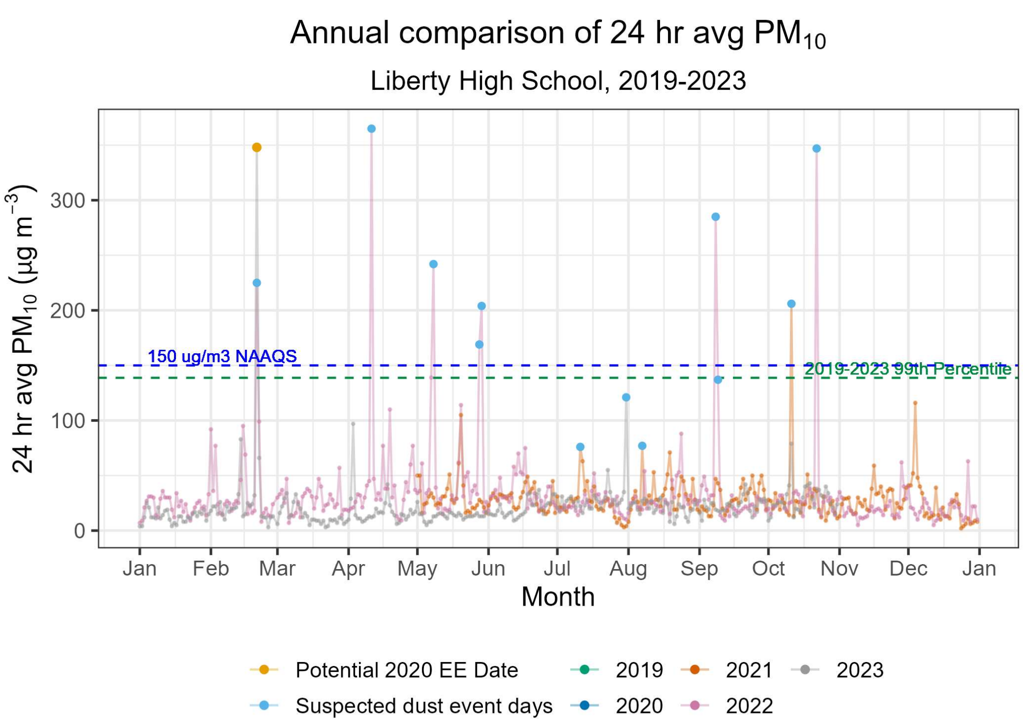


Figure 3.4-18. Liberty High School monitoring site 24-hour PM_{10} measurements in µg/m³ from 2019-2023 by year with the (green dash) 99th percentile and (grey dash) NAAQS indicated.

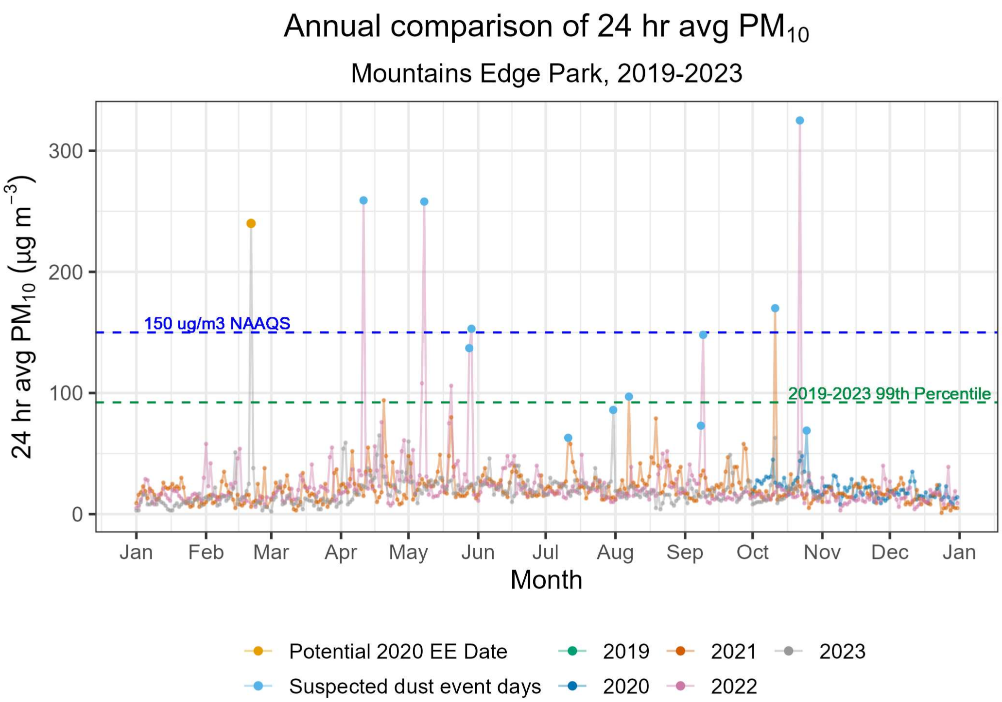


Figure 3.4-19. Mountains Edge Park monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2019-2023 by year with the (green dash) 99th percentile and (grey dash) NAAQS indicated.

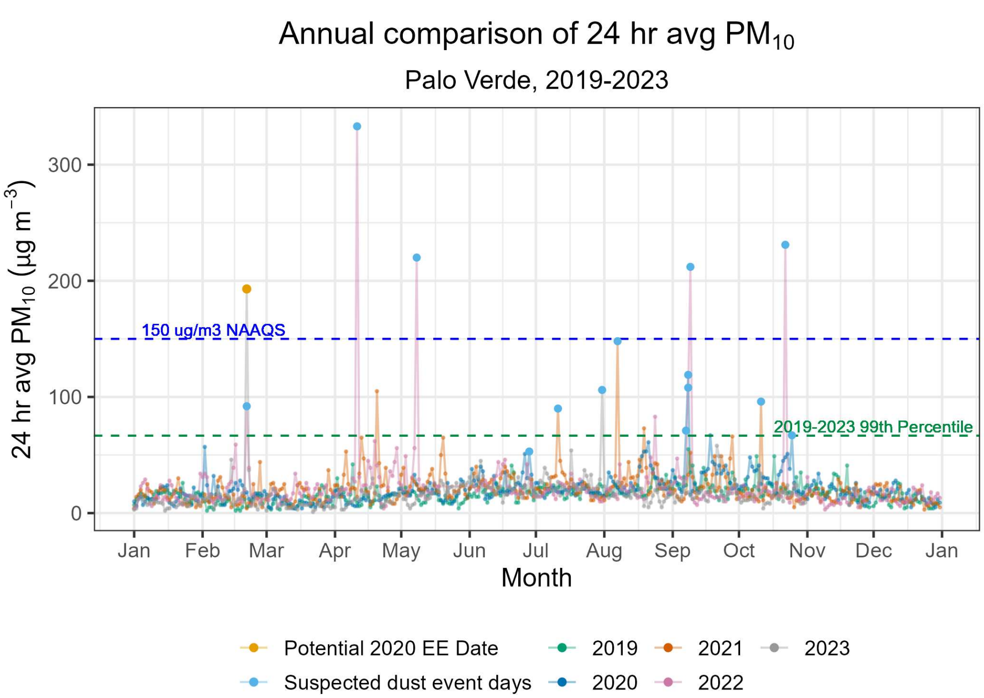


Figure 3.4-20. Palo Verde monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2019-2023 by year with the (green dash) 99th percentile and (grey dash) NAAQS indicated.

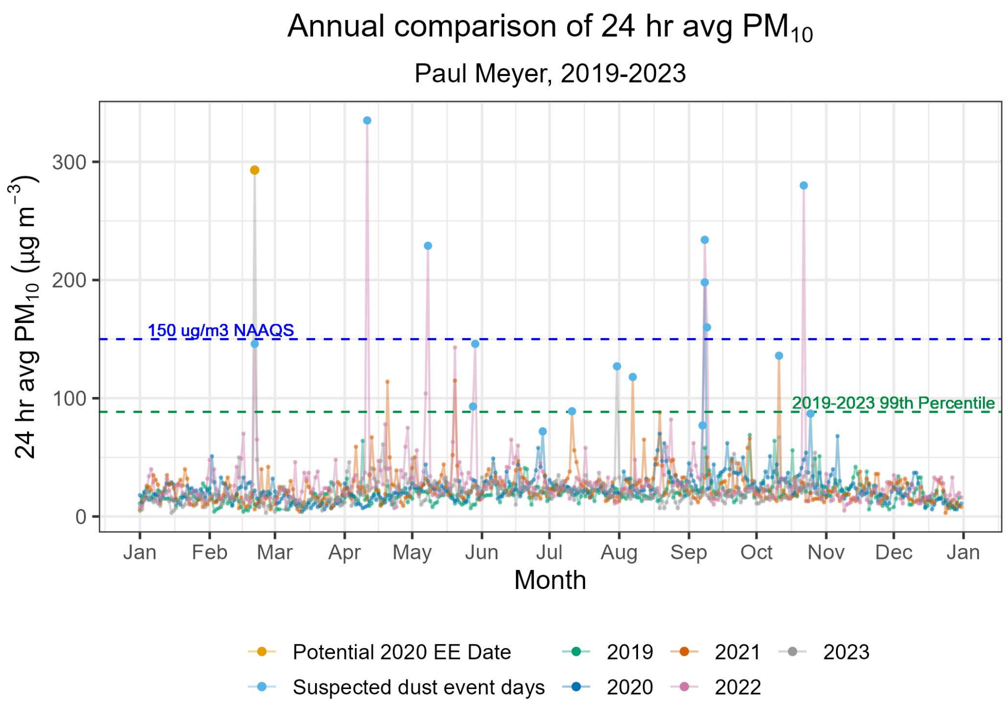


Figure 3.4-21. Paul Meyer monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2019-2023 by year with the (green dash) 99th percentile and (grey dash) NAAQS indicated.

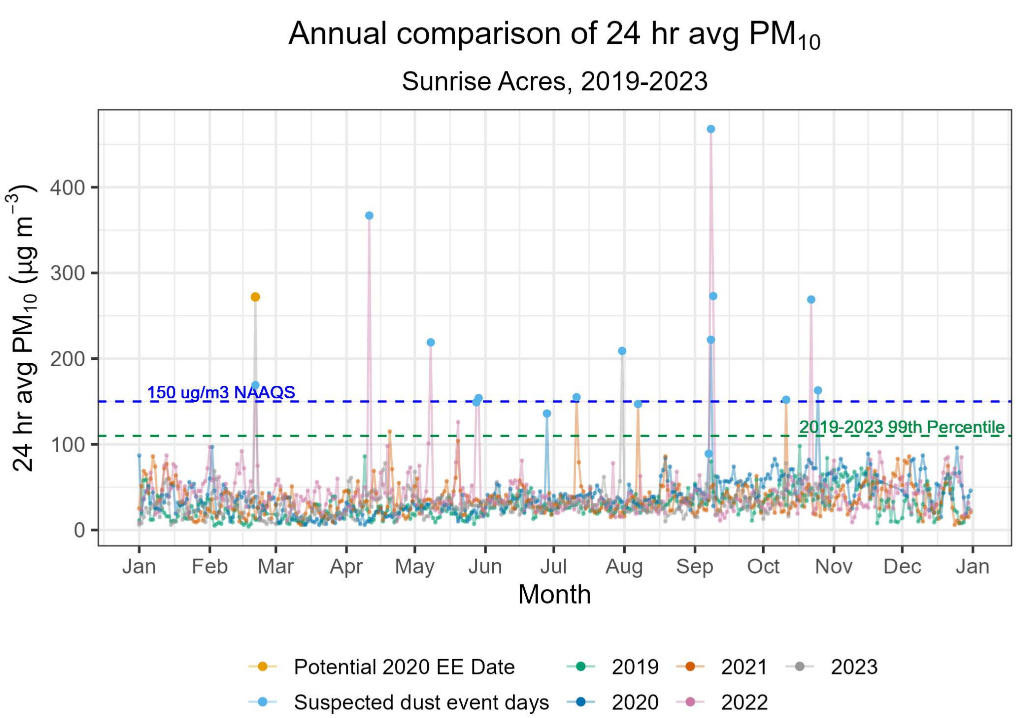


Figure 3.4-22. Sunrise Acres monitoring site 24-hour PM_{10} measurements in µg/m^3 from 2019-2023 by year with the (green dash) 99th percentile and (grey dash) NAAQS indicated.

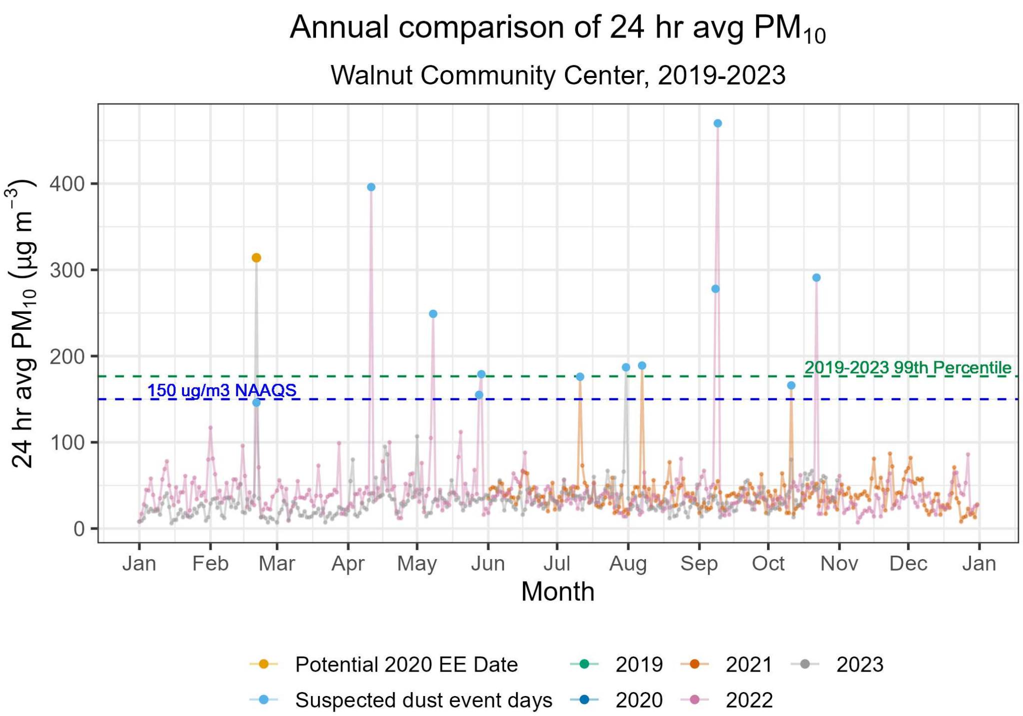


Figure 3.4-23. Walnut Community Center monitoring site 24-hour PM_{10} measurements in µg/m³ from 2019-2023 by year with the 99th percentile and (grey dash) NAAQS indicated.

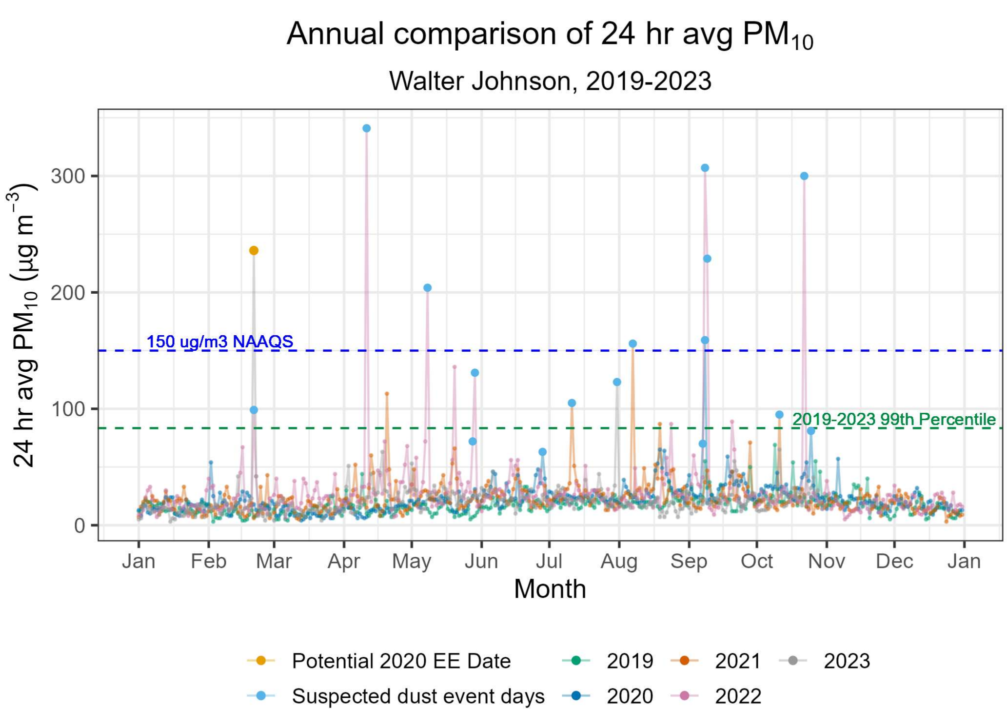


Figure 3.4-24. Walter Johnson monitoring site 24-hour PM_{10} measurements in µg/m³ from 2019-2023 by year with the (green dash) 99th percentile and (grey dash) NAAQS indicated.

3.4.2 Event Comparison with Diurnal/Seasonal Patterns

The hourly PM_{10} concentrations were compared to five-year (2019-2023) hourly averages. A summary of the maximum value observed compared to the five-year 95th percentile is shown in Table 3.4-3, and time series graphs are shown in Figure 3.4-25. At the Mountains Edge Park site, for example, the event reached a maximum of 1,964 µg/m^3 at 20:00, 36 times the 95th percentile value of 55.1 µg/m^3. Similar trends were seen across the other sites.

Table 3.4-3. Summary of max hourly PM_{10} measurements on the event date at each site compared to the five-year hourly PM_{10} 95th percentile.

Site Name	Time of Hourly PM_{10} Max (PST)	Max Hourly PM_{10} (µg/m^3)	Five-Year Hourly PM_{10} 95th percentile (µg/m^3)	Ratio of Max to Five-Year 95th Percentile
Mountains Edge Park	2/21/2023 20:00	1,964	55.1	36
Liberty High School	2/21/2023 20:00	2,053	59.3	35
Paul Meyer	2/21/2023 20:00	1,729	55.4	31
Palo Verde	2/21/2023 20:00	1,302	43.2	30
Jean	2/21/2023 22:00	1,500	57.3	26
Walter Johnson	2/21/2023 20:00	1,345	51.9	26
Garrett Jr. High	2/21/2023 23:00	1,035	45.7	23
Jerome Mack	2/21/2023 20:00	1,750	95.0	18
Walnut Community Center	2/21/2023 21:00	1,615	90.3	18
Green Valley	2/21/2023 20:00	934.4	57.9	16
Sunrise Acres	2/21/2023 20:00	1,340	103.3	13
Joe Neal	2/21/2023 20:00	894.3	72.5	12

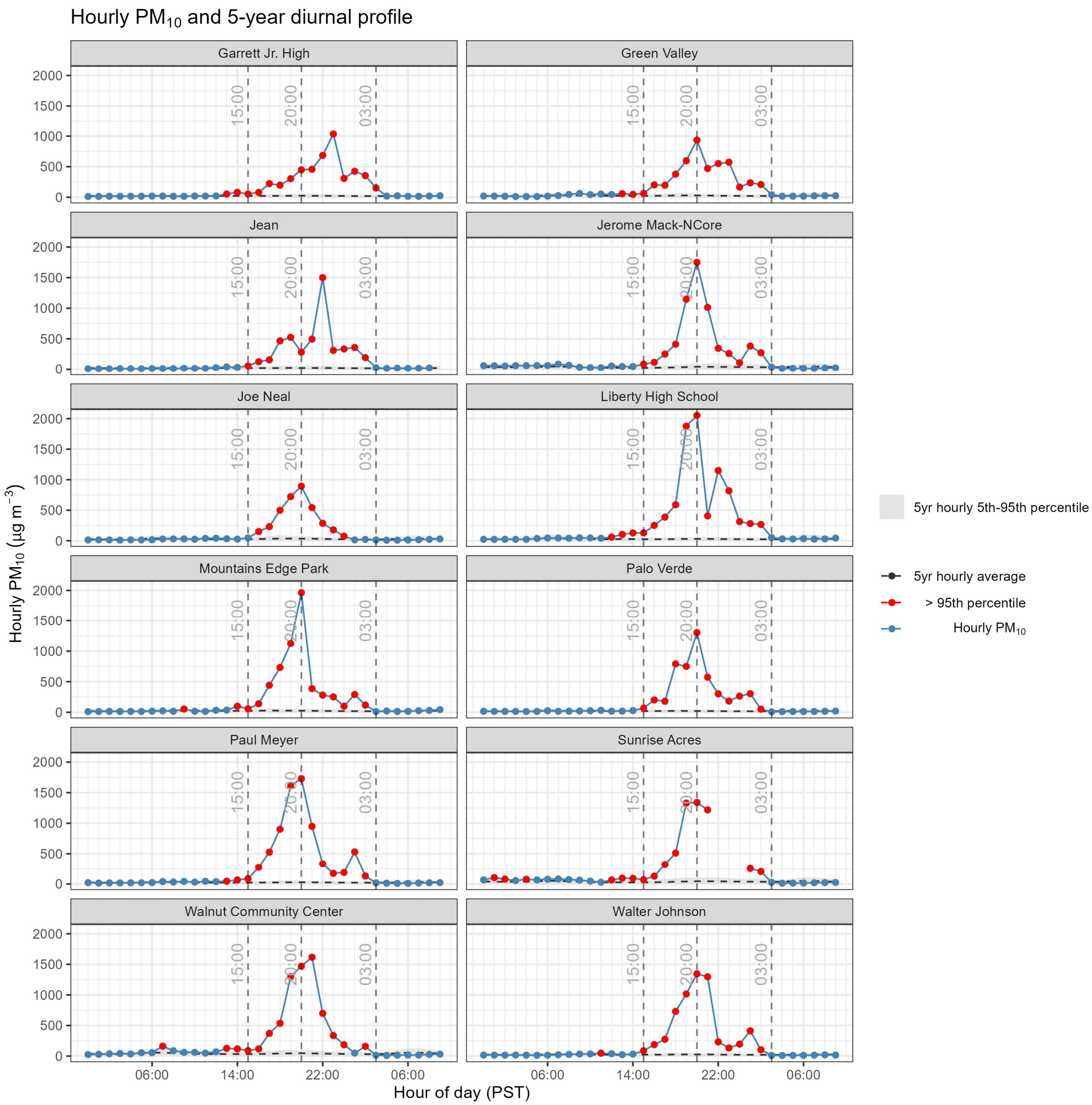


Figure 3.4-25. Hourly PM_{10} concentrations on the event date at each site; concentrations are marked red if they exceed the five-year hourly 95th percentile.

The 24-hour average PM_{10} concentrations were also compared to five-year (2019-2023) monthly and seasonal averages, shown in the boxplots in Figure 3.4-26 and Figure 3.4-27. The concentrations recorded on the event day are shown to be the highest recorded outliers for the month of February and the winter seasons during the entire five-year period.

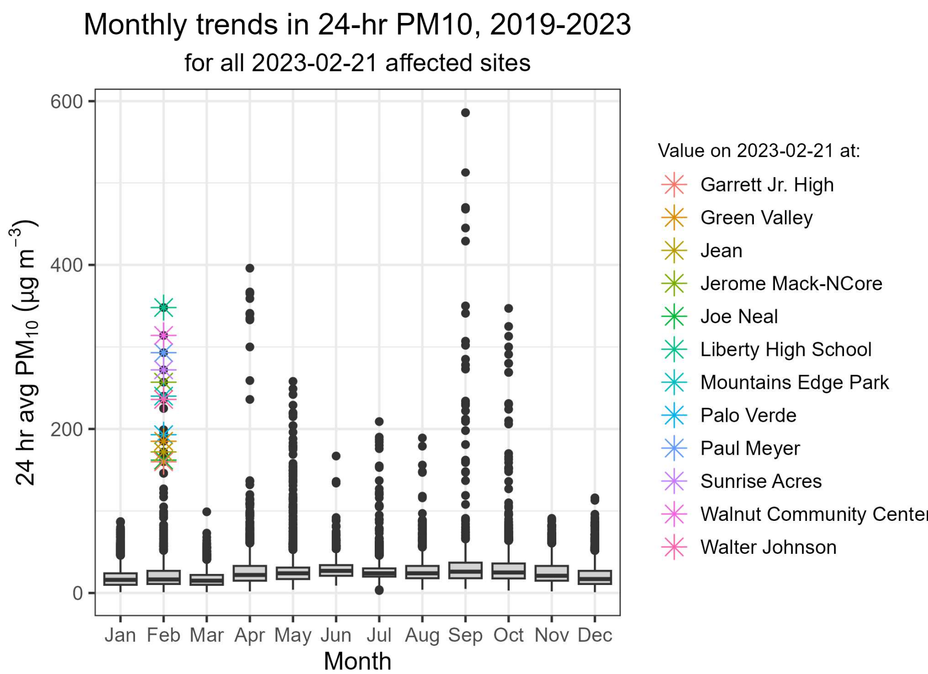


Figure 3.4-26. Monthly trend in 24-hour PM_{10} concentrations for 2019-2023, including outliers, and highlighting the potential exceedance event day.

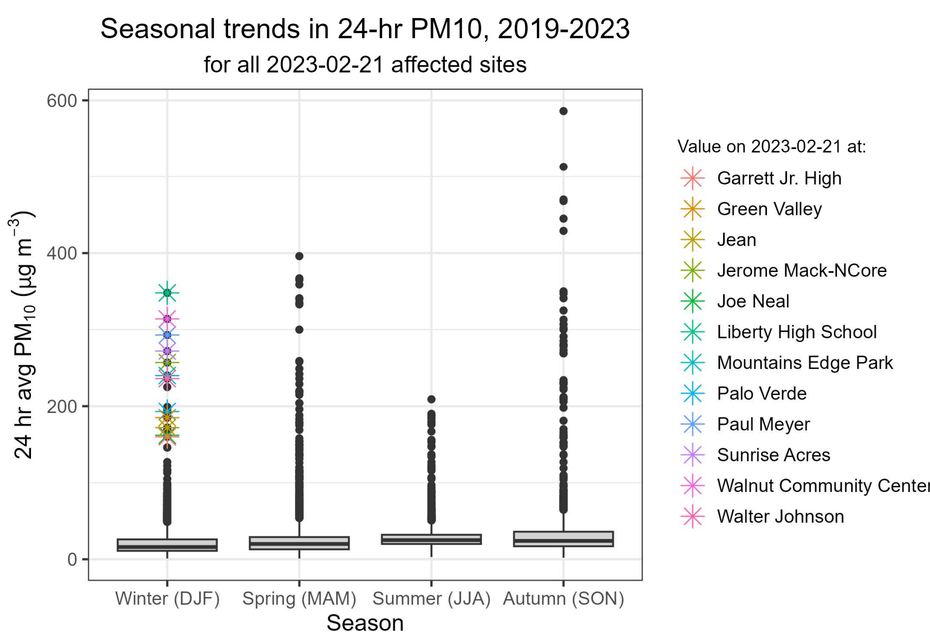


Figure 3.4-27. Seasonal trend in 24-hour PM_{10} concentrations for 2019-2023, including outliers, and highlighting the potential exceedance event day.

Thirty-year seasonal climatology was created using European Environment Agency (ERA5) reanalysis at 0.25° x 0.25° horizontal resolution from 1994 through 2023 for both the Mojave Desert 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 (December, January, and February) thirty-year average for each variable in the top panel and the event date departure from the seasonal climatology in the bottom panel. Figure 3.4-28 shows the climatology compared with the event date for the source region. On the event date, the source region of central-southern California experienced ground level temperatures up to 10 °F above the long-term average, considerably lower-than-normal soil moisture, and slightly enhanced maximum ground level wind. Figure 3.4-29 shows the climatology compared with the event date for Clark County. On the event date, Clark County experienced ground level temperatures largely above the long-term average, lower-than-normal soil moisture, and maximum ground level wind speeds slightly below the climatological average. This climatological data provides evidence that the temperature and soil moisture conditions on the event date were mostly abnormal from average in both the source region and Clark County, leading to a favorable environment for a dust event.

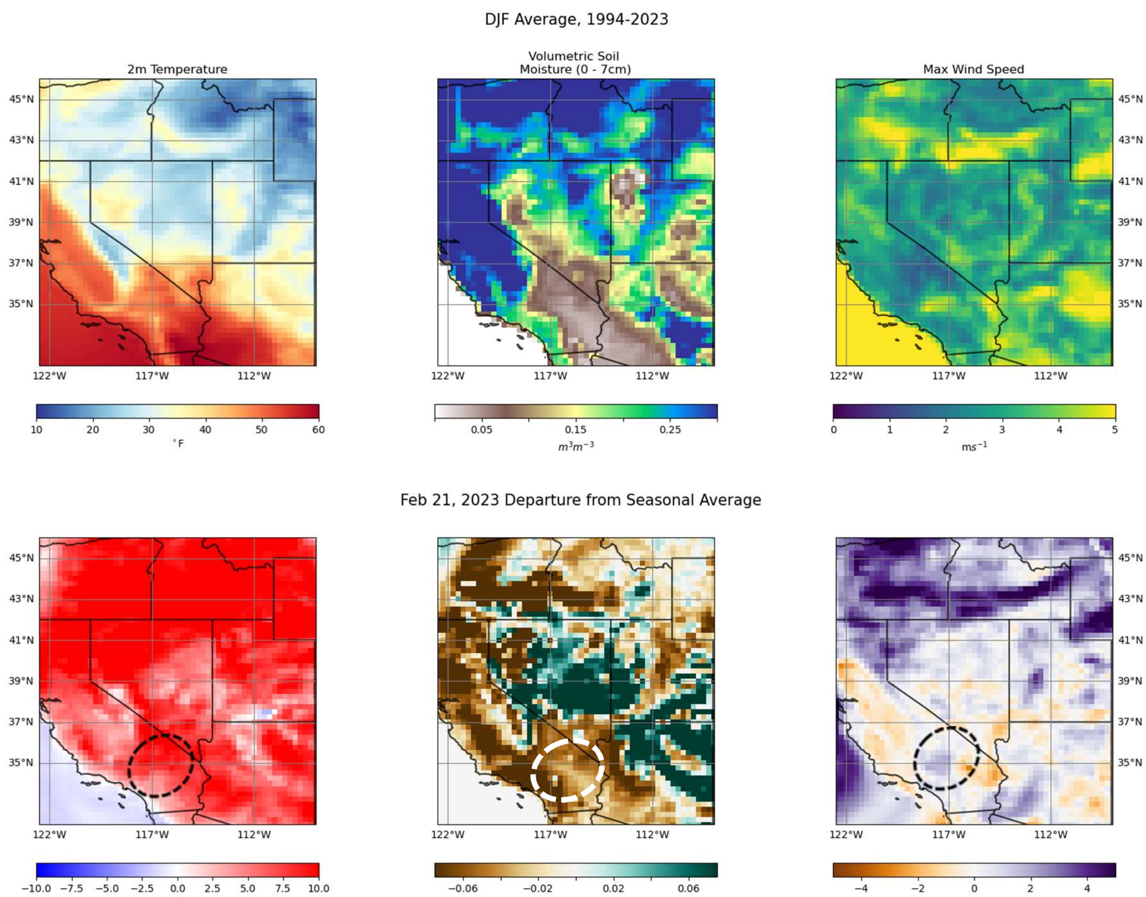


Figure 3.4-28. The thirty-year December-February seasonal climatological average for the Mojave Desert source region based on ERA5 reanalysis for (top row) 2-meter temperature, volumetric soil moisture of the first 7 centimeters, and maximum 10-meter wind speed, and (bottom row) the daily departure for February 21, 2023, from the 30-year average. The source region is circled.

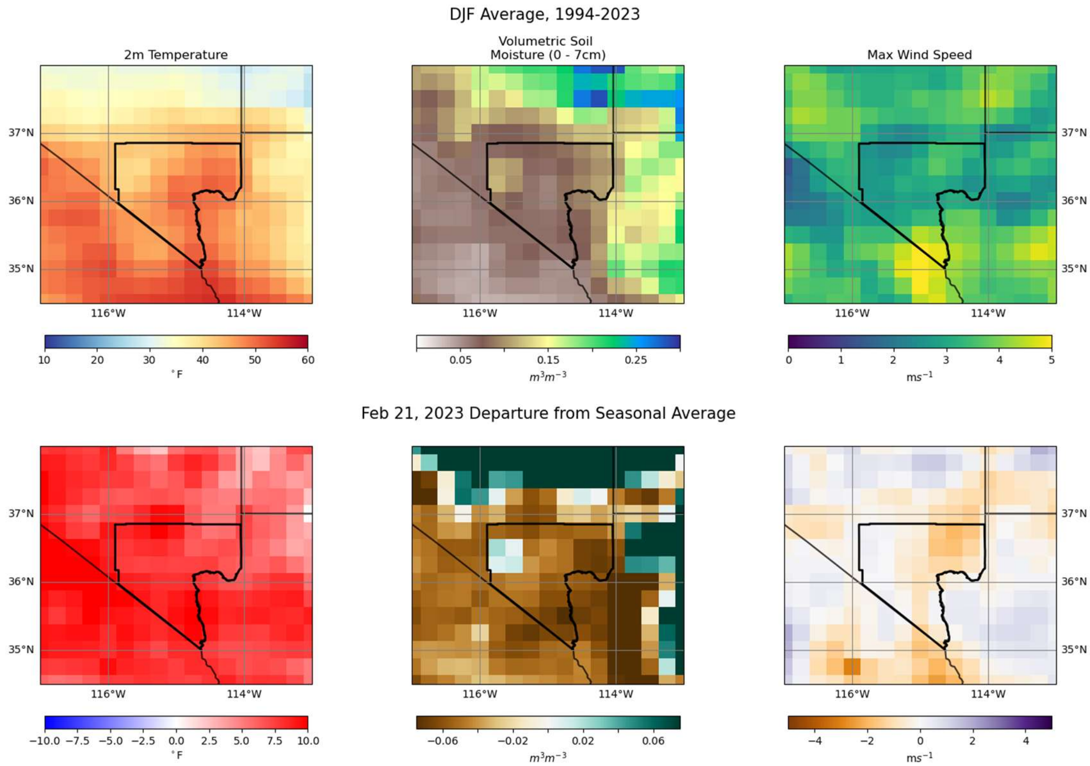


Figure 3.4-29. The thirty-year December-February seasonal climatological average for Clark County based on ERA5 reanalysis for (top row) 2-meter temperature, volumetric soil moisture of the first 7 centimeters, and maximum 10-meter wind speed, and (bottom row) the daily departure for February 21, 2023, from the 30-year average. Clark County is outlined in black.

3.5 Meteorological Similar Analysis

Enhanced surface-level wind speeds on February 21, 2023, created prime conditions to maintain the suspension of fine dust particles in the air in the midst of regional drought. Wind gusts greater than 30 mph were observed starting at 12:00 PST and increased in intensity into the evening, reaching a maximum of 63 mph at 21:00 PST. Sustained wind speeds reached a maximum of 40 mph at 21:00 PST. The strongest winds came from the southwest direction. The highest wind speeds and gusts occurred concurrently with peak PM_{10} concentrations, which peaked between 16:00-22:00 PST. Visibility at LAS dropped to a minimum of 3 miles during the evening of February 21.

The following sections compare surface-level wind and visibility conditions on February 21, 2023, 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 with a lack of notable wind speeds. All wind speed, wind direction, and visibility values in the next two sections were measured at LAS and downloaded from the Iowa Environmental Mesonet 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_{10} concentrations shows key differences between the comparable wind events and the event date. All dates in the years 2016-2023 were considered when identifying days with a wind event comparable to the event date. Two criteria that describe the intensity of the wind event on February 21, 2023, were applied to identify comparable dates: (1) a peak wind gust greater than 60 mph, and (2) at least four measured wind gusts greater than 50 mph. Additionally, dates were filtered to those without enhanced PM_{10} concentrations (<100 µg/m^3) recorded at monitors in Clark County. A single date was identified as a comparable wind event without high PM_{10} concentrations, and is listed in Table 3.5-1.

Table 3.5-1. A day with similar meteorological conditions without enhanced PM_{10} concentrations for comparison with the February 21, 2023, event date. PM_{10} concentrations are reported across both dates 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), Garrett Jr. High (GJH), and Liberty High School (LHS).

			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	GJH	LHS
2023-02-21 (event date)	**11**	**63**	**257**	**293**	**236**	**193**	**162**	**185**	**172**	**272**	**240**	**314**	**160**	**348**
2022-03-20	17	62	41	38	37	21	47	29	19	50	21	38	26	40

A comparison between the meteorological conditions on the event date of February 21, 2023, and the comparable date March 20, 2022, is outlined below. Figure 3.5-1 through 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, exceeds the intensity of the wind event that occurred on the event date with higher-speed wind gusts and a longer period of sustained winds above 20 mph (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 high visibility conditions on March 20, 2022, confirms that the high-wind event did not dramatically affect levels of suspended dust particles, a claim supported by the fact that daily PM_{10} concentrations were relatively low (50 µg/m^3 or less) at all examined sites. In contrast, visibility conditions on the event date reached a minimum of 3 miles during peak winds. A key difference between the event date and March 20, 2022, is displayed in Figure 3.5-4, which shows the spatial distribution of peak sustained wind speeds centered on the Las Vegas NWS forecast office. On February 21, peak sustained winds exceeded 30 mph in most of the area surrounding Las Vegas, and were especially enhanced (>40 mph) towards the southwest along the path of air transport. In contrast, on March 20, 2022, some of the highest peak winds occurred within the Las Vegas metropolitan area. Wind speeds in the scrubland/bare-ground regions surrounding Las Vegas were notably lower on March 20, 2022, compared to the event date, particularly to the northwest in the direction of air. Another key difference is the altitude of air transport towards Clark County.

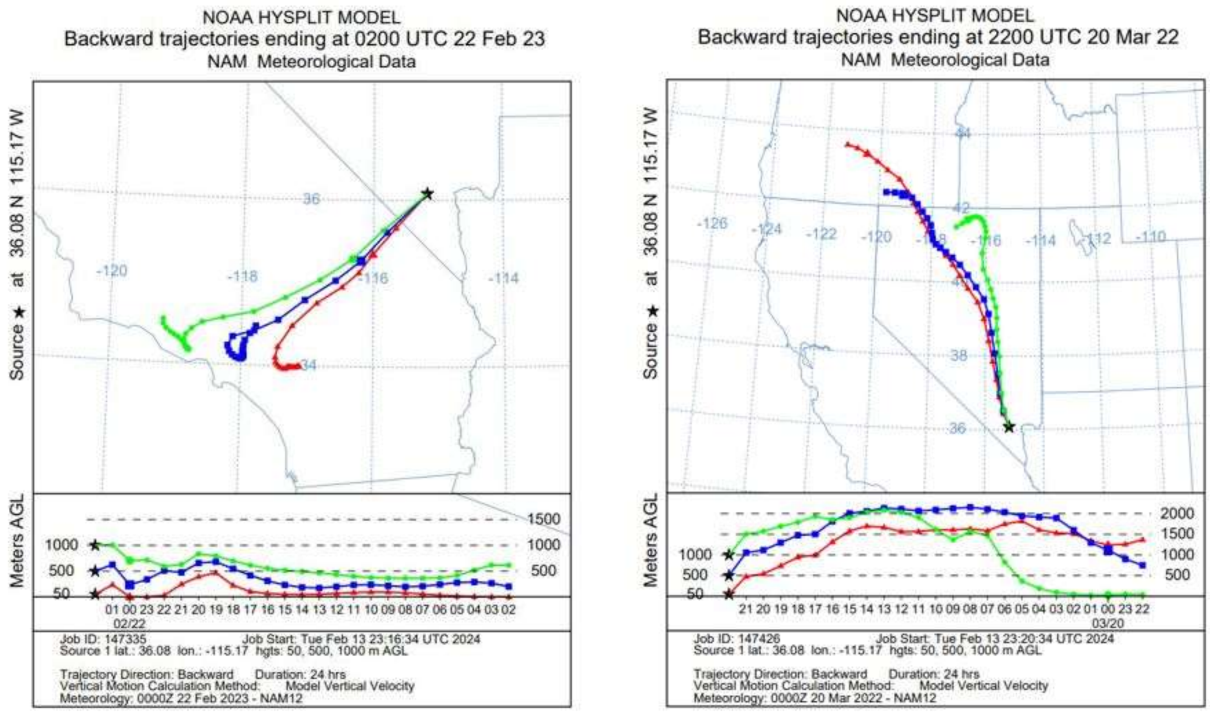


Figure 3.5-5 compares HYSPLIT back-trajectories on the event date of February 21, 2023, ending at 18:00 PST (during the rapid increase in PM_{10} concentrations), and March 20 2022, ending at 14:00 PST (approximate time of maximum PM_{10}). On the event date, near-surface transport (<250 m) occurred in the hours before arrival in Las Vegas. This low-altitude transport facilitated entrainment and transport of dust from the surface of the Mojave Desert source region near Las Vegas. March 20, 2022, lacked surface-level transport, as air transport towards Las Vegas occurred above 500 m, which would not loft and transport dust from surrounding regions. These differences in regional wind speed profiles and the altitude of transport to the Las Vegas region may account for the discrepancy in daily PM_{10} concentrations between February 21, 2023, and March 20, 2022, under comparable local wind conditions.

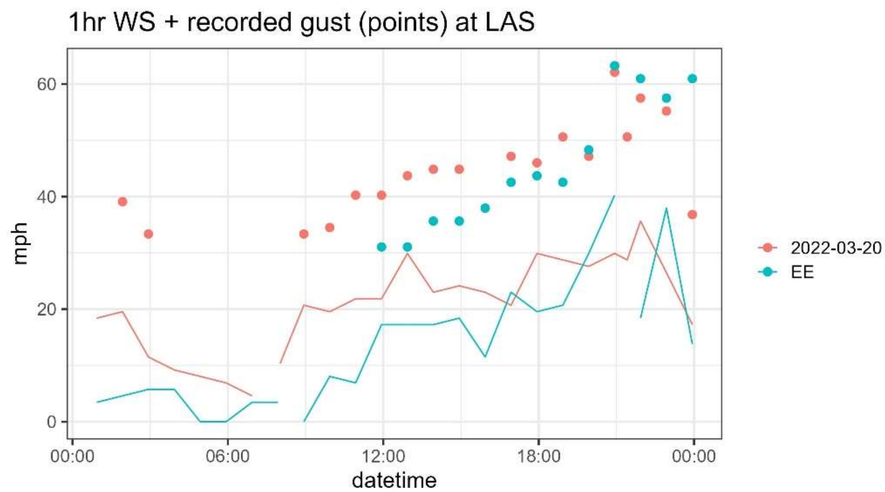


Figure 3.5-1. Wind speeds and maximum hourly wind gusts in mph at LAS for March 20, 2022 (pink), and the February 21, 2023, suspected exceptional event (EE) day (teal).

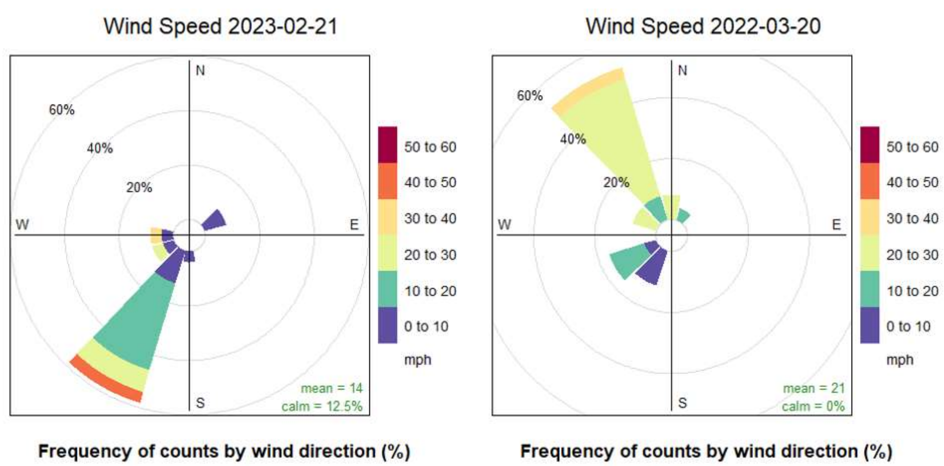


Figure 3.5-2. Wind speed (mph) and direction frequency for (left) February 21, 2023, the suspected exceptional event day (EE), and (right) March 20, 2022.

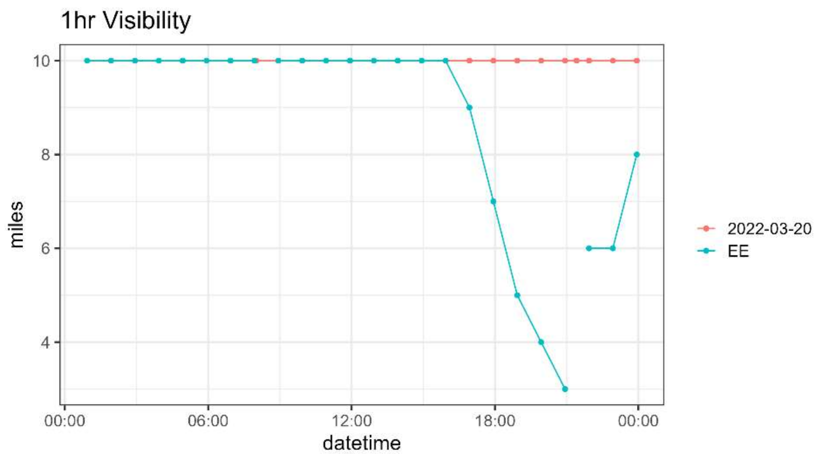
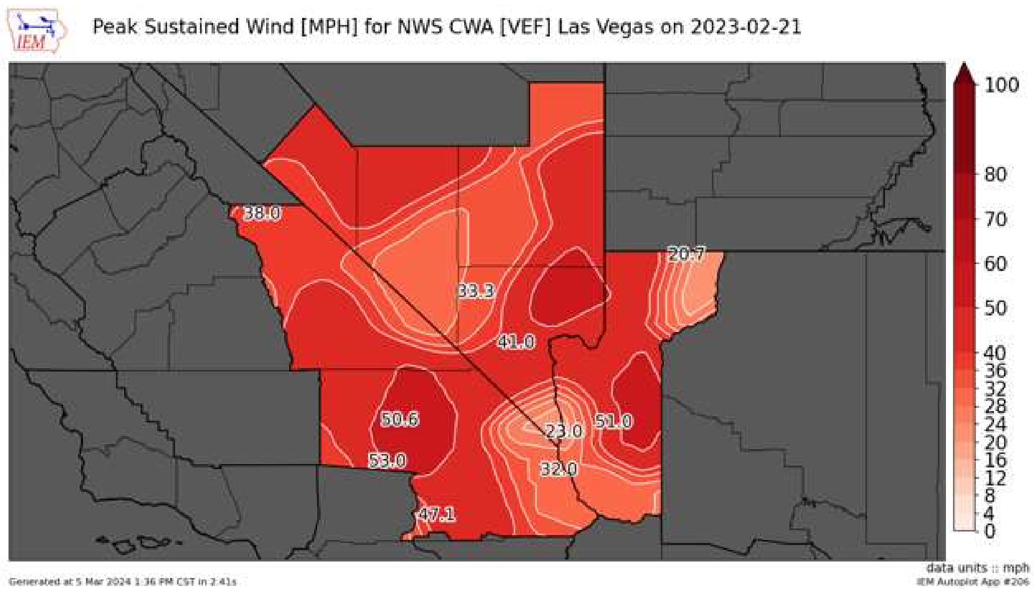


Figure 3.5-3. Hourly reported visibility in miles at LAS for March 20, 2022 (pink), and the October 22, 2022, suspected exceptional event (EE) day (teal).



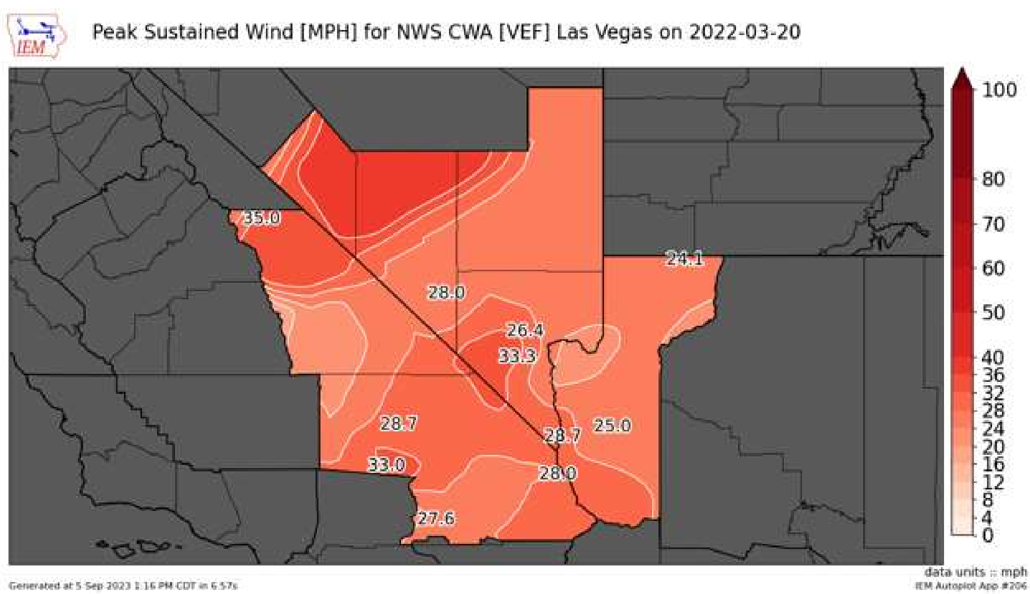


Figure 3.5-4. Spatial distribution of peak sustained wind speeds on February 21, 2023 (top), and March 20, 2022 (bottom), in Clark County and the surrounding regions. Generated from automated ASOS data using the Iowa Environmental Mesonet's plotter tool (**https://mesonet.agron.iastate.edu/plotting/auto**).

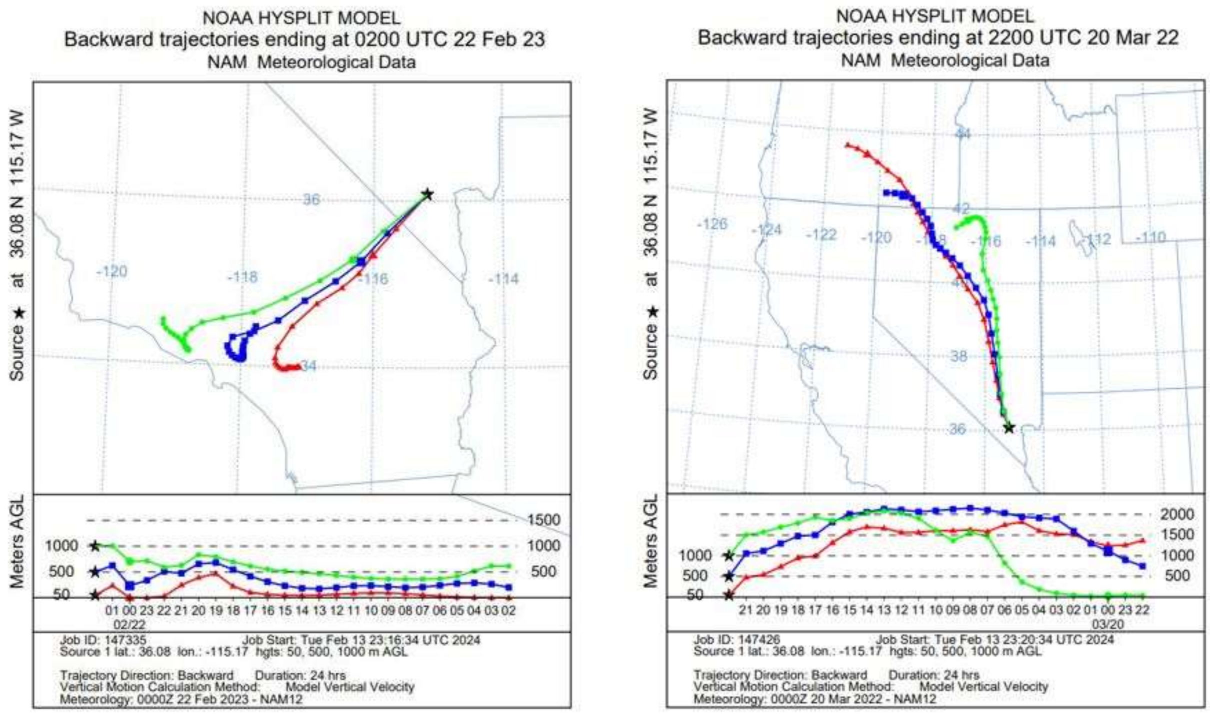


Figure 3.5-5. 24-hour HYSPLIT back-trajectories initiated from Las Vegas at (left) 02:00 UTC (18:00 PST) on February 22, 2023 (event date), and (right) 22:00 UTC (10:00 PST) on March 20, 2022, at 50 m (red), 100 m (blue), and 1,000 m (green).

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 with the event date. All dates from winter to mid-spring, between December 2022 and April 2023, were screened. PM_{10} concentrations did not exceed the NAAQS on any other days during this period.

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, Joe Neal, Green Valley, Jerome Mack, Liberty High School, Walnut Community Center, Sunrise Acres, and Palo Verde monitoring sites of PM_{10} that could have contributed to the February 21, 2023, 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 February 21, 2023, 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.[1]

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

[1] 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[2]), 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

[2] 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.[3]

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.[4]

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[5].

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[6].

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

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

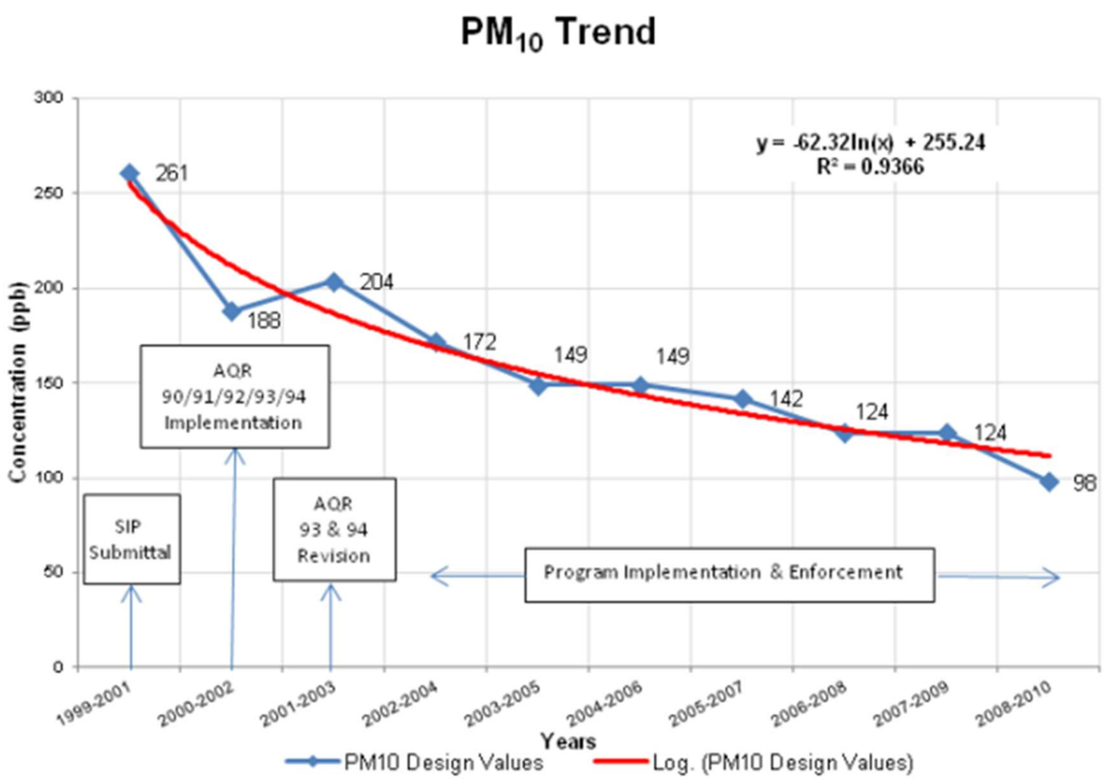


Figure 4.3-1. PM_{10} trends from the 2012 Maintenance Plan.

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.

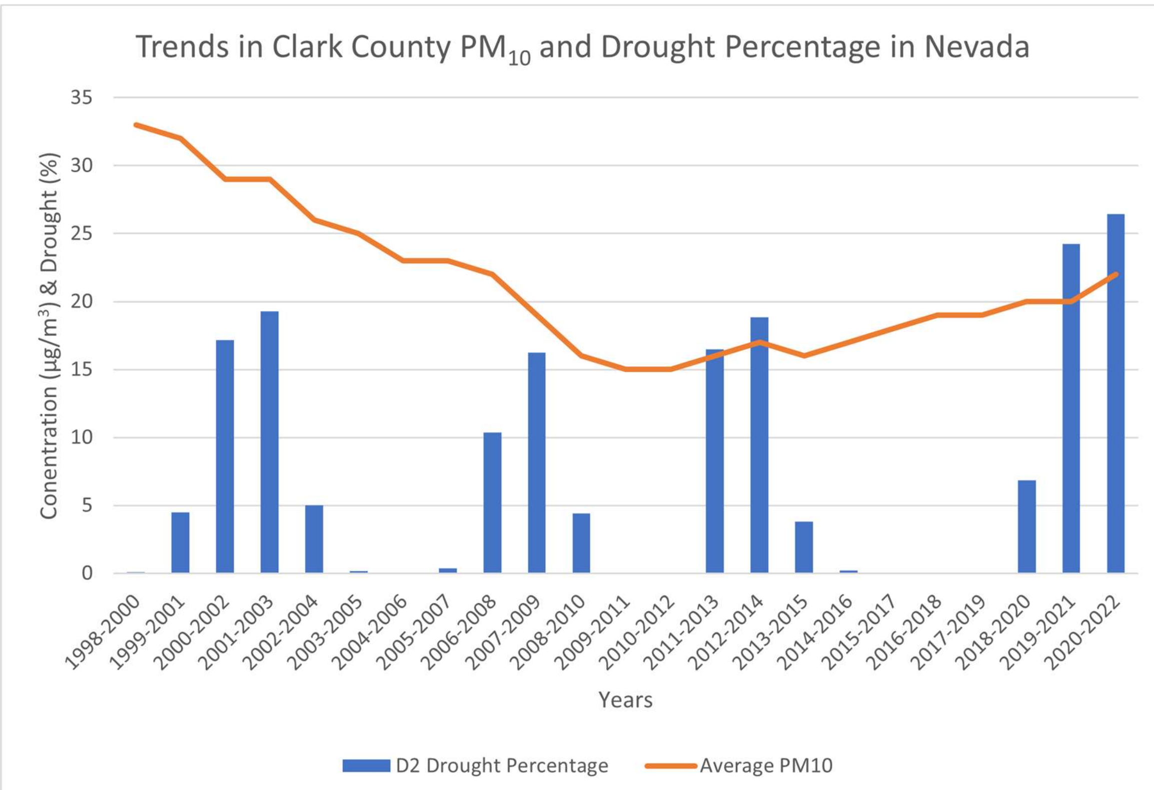


Figure 4.3-2. Three-year running average of PM_{10} concentrations (µg/m^3) at the long-running Paul Meyer monitoring site (AQS: 32-003-0043) (orange line) and the D2 (severe) drought percentage of Nevada (blue bars). Source: https://www.drought.gov/states/nevada.

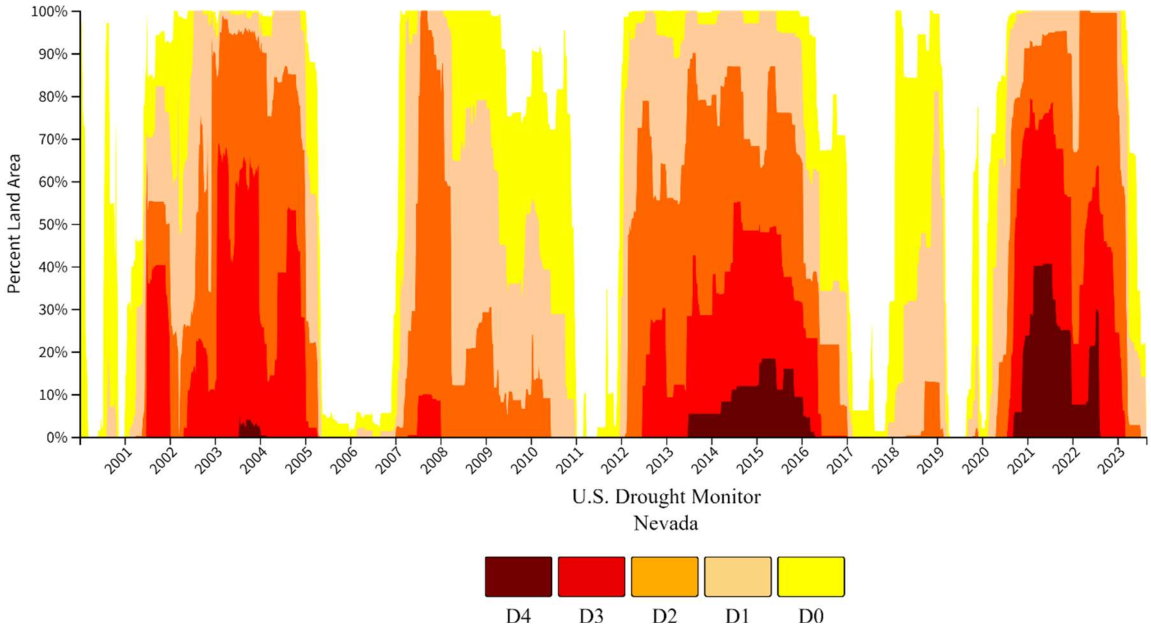


Figure 4.3-3. Drought statistics for Nevada from 2000-2023, colored by drought severity for D0 to D4. Source: https://www.drought.gov/states/nevada.

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.

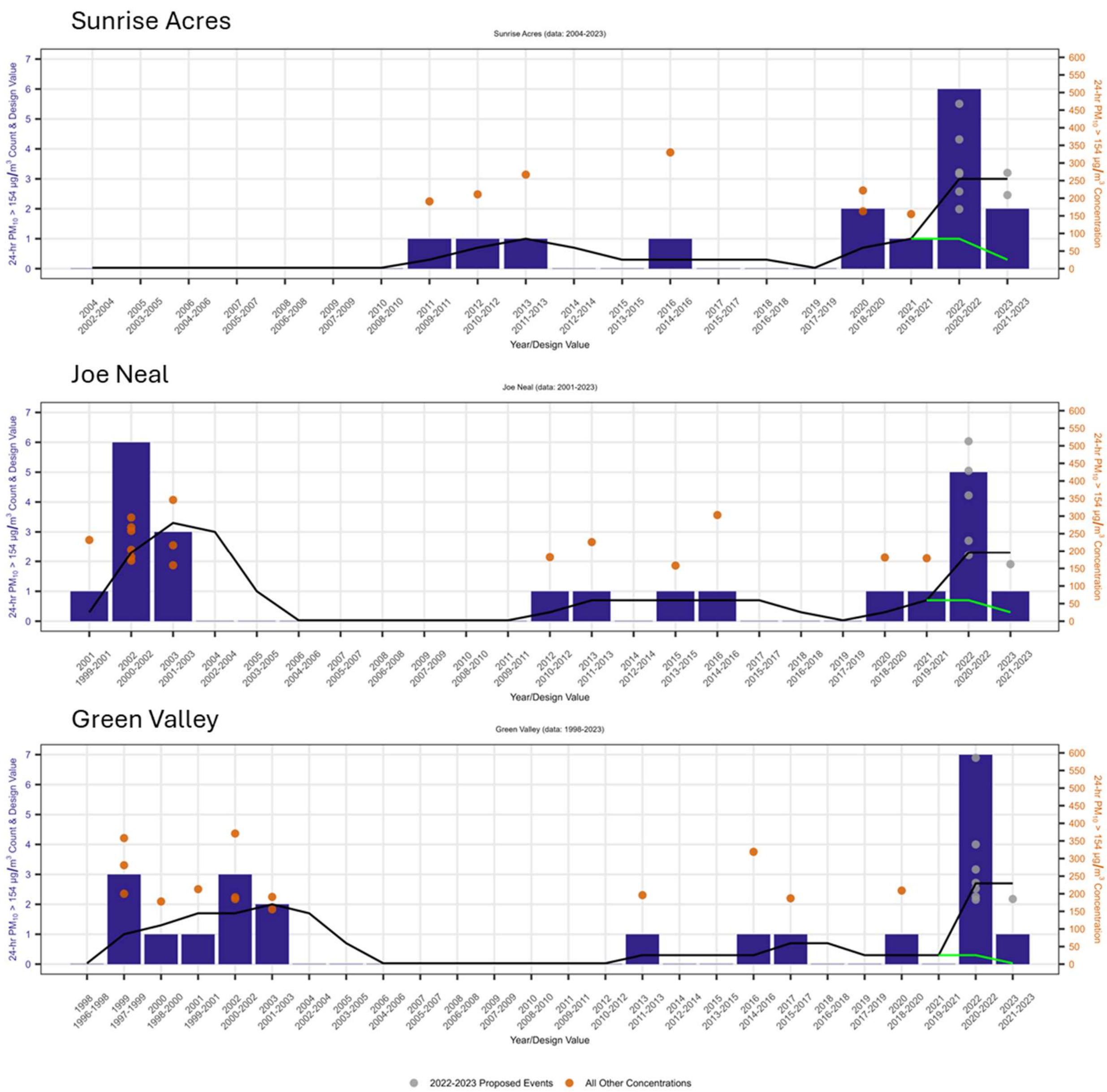


Figure 4.3-4. Historical 24-hour PM_{10} exceedance count (purple bars) and concentration (orange dots) per year/design value period at the Sunrise Acres, Joe Neal, and Green Valley monitoring sites (AQS: 32-003-0561; 32-003-0075; 32-003-0298). The gray dots represent the proposed 2022-2023 PM_{10} exceptional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

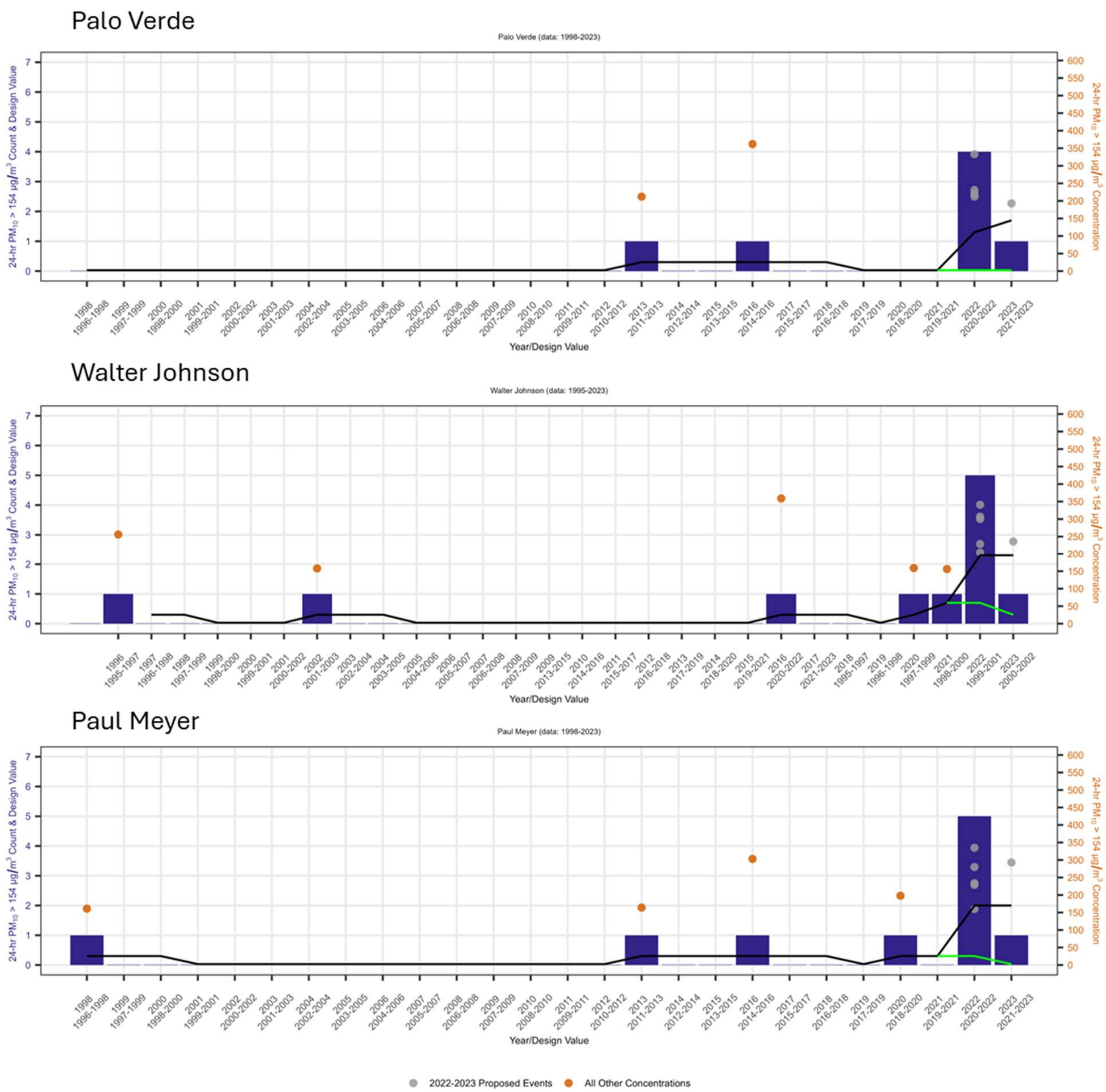


Figure 4.3-5. Historical 24-hour PM_{10} exceedance count (purple bars) and concentration (orange dots) per year/design value period at the Palo Verde, Walter Johnson, and Paul Meyer monitoring sites (AQS: 32-003-0073; 32-003-0071; 32-003-0043). The gray dots represent the proposed 2022-2023 PM_{10} 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)[7] and Rule 310 of Maricopa County's (Arizona) Air Pollution Control Regulations[8] 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 detail 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

[7] https://www.mdaqmd.ca.gov/home/showpublisheddocument/8482/637393282546170000

[8] 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 February 21, 2023, 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 early afternoon hours southwest of Las Vegas on February 21, 2023. Strong winds in the Mojave Desert source region were well above 25 mph from the outflow boundary 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 18:00 to 19:00 PST, all sites in the Las Vegas Valley well exceeded the NAAQS. 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 February 21, 2023. 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.[9] 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.[10] 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 February 21, 2023, a Dust Advisory 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, 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** indicate the

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

implementation of BACM and enforcement procedures. **Appendix C** also provides all inspection information and notices of violation from the February 21, 2023, 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 February 21, 2023, PM_{10} event were not reasonably controllable or preventable.

5. Natural Event

The February 21, 2023, event is the result of a frontal passage with high winds caused by a pressure gradient over the Mojave Desert source region, which produced winds that lofted, entrained, and transported 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} exceedances on February 21, 2023 were caused by a high-wind dust event where dust was lofted, entrained, and transported from the Mojave Desert in southeastern California. 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 a dry desert source region in the Mojave Desert to the southwest of Clark County at approximately 16:00-23:00 PST on February 21, 2023. With this frontal passage, dust from the Mojave Desert was lofted, entrained, and transported to Clark County by 16:00 PST on February 21. 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. As the frontal passage pushed south, this caused a strengthening of the pressure gradient between Clark County and the source region, which led to high winds bringing dust from the Mojave Desert into Clark County within a few hours of the exceedance. Satellite reanalysis data, meteorological data, and visibility measurements all align to confirm event transport from the Mojave Desert. PM_{10} measurements along the frontal passage increased as winds push through San Bernardino County in California then Nye and Clark counties in Nevada, confirming high PM_{10} concentrations along the timeline and trajectories established.

3. Associated with the frontal passage, PM_{10} concentrations were extremely enhanced, 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 around the same time as the frontal passage pushed into Clark County starting at approximately 16:00 PST and peaked in intensity by 19:00-22:00 PST on February 21, 2023. 24-hour PM_{10} concentrations were above the NAAQS threshold of 150 µg/m^3 at 12 sites, and 10 sites recorded regulatory significant concentrations: Jerome Mack at 257 µg/m^3, Paul Meyer at 293 µg/m^3, Walter Johnson at 236 µg/m^3, Palo Verde at 193 µg/m^3, Joe Neal at 162 µg/m^3, Green Valley at 185 µg/m^3, Sunrise Acres at 272 µg/m^3, Mountains Edge at 240 µg/m^3, Walnut Community Center at 314 µg/m^3, and Liberty High School at 348 µg/m^3. The other two 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 some sites in Clark County peaked above 1,000 µg/m^3 through the event on February 21. The concurrent rise in PM_{10} concentrations at all sites around Clark County indicates a regional dust event.

5. All sites of regulatory significance exceeded the five-year 99th percentile and the NAAQS on February 21, 2023. Hourly PM_{10} concentrations are also significantly outside typical diurnal, monthly, and seasonal ranges.

6. Both Clark County, Nevada, and the surrounding source region were under severe drought conditions on and before the February 21, 2023, event. The 30-year climatology shows that temperatures and 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 February 21, 2023. 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 with a comparable wind profile and meteorological conditions to February 21, 2023, 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 February 21, 2023, caused 24-hour PM_{10} NAAQS exceedances with regulatory significance at the 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) monitoring sites. On February 21, 2023, the 24-hour PM_{10} reached 293 µg/m^3 at the Paul Meyer site, 240 µg/m^3 at the Mountains Edge site, 236 µg/m^3 at the Walter Johnson site, 193 µg/m^3 at the Palo Verde site, 162 µg/m^3 at the Joe Neal site, 185 µg/m^3 at the Green Valley site, 348 µg/m^3 at the Liberty High School site, 257 µg/m^3 at the Jerome Mack site, 272 µg/m^3 at the Sunrise Acres site, and 314 µg/m^3 at the Walnut Community Center site. Seven additional suspected wind-blown dust events occurred in Clark County between 2021 and 2023. Without EPA concurrence that the wind-blown dust event on February 21, 2023, and the other suspected events qualify as an exceptional event, the 2021-2023 design value is 2.0 at the Paul Meyer site, 1.7 at the Mountains Edge site, 2.3 at the Walter Johnson site, 1.7 at the Palo Verde site, 2.3 at the Joe Neal site, 2.7 at the Green Valley site, 3.0 at the Liberty High School site, 3.7 at the Jerome Mack site, 3.0 at the Sunrise Acres site, and 4.0 at the Walnut Community Center site. This is outside of the attainment standard of 1.0. With EPA concurrence on February 21, 2023, and the other suspected events, the 2021-2023 design value is 0.0 at the Paul Meyer site, 0.3 at the Mountains Edge site, 0.3 at the Walter Johnson site, 0.0 at the Palo Verde site, 0.3 at the Joe Neal site, 0.0 at the Green Valley site, 0.3 at the Liberty High School site, 0.3 at the Jerome Mack site, 0.3 at the Sunrise Acres site, and 1.0 at the Walnut Community Center site, which are all 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 February 21, 2023, and agree to exclude the event from regulatory decisions regarding PM_{10} attainment.

7. References

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 PM_{10} and $PM_{2.5}$ 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, May 1. 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.