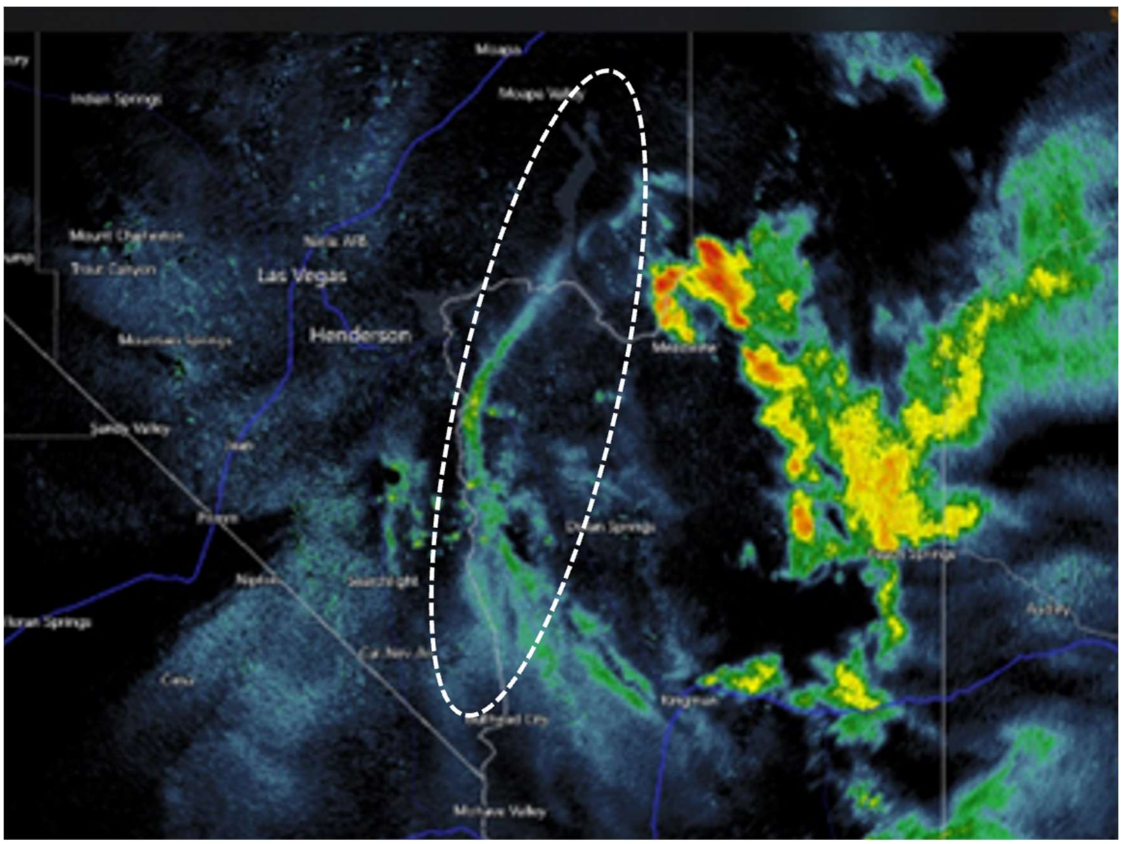
Exceptional Event Demonstration for PM_{10} Exceedances in Clark County, Nevada – September 8-9, 2022



Final Report Prepared for

U.S. EPA Region 9
San Francisco, CA

June 2024

STi Sonoma Technology

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Exceptional Event Demonstration for PM_{10} Exceedances in Clark County, Nevada – September 8-9, 2022

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The cover graphic shows the outflow boundary from the Hurricane Kay-initiated thunderstorm the impacted PM_{10} concentrations in Clark County on September 8-9, 2022.

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Contents

Figures

Tables

1. Narrative Conceptual Model

In the afternoon on September 8, 2022, a thunderstorm was produced by Hurricane Kay in northwestern Arizona. From this thunderstorm, a strong outflow boundary was produced with associated high winds that pushed through the Mojave Desert region in northwestern Arizona and southern Nevada, driving a windblown dust event that increased particulate matter (PM) concentrations in Clark County, NV, on September 8-9, 2022. During this episode, the 2012 24-hour National Ambient Air Quality Standards (NAAQS) threshold was exceeded for particles with diameter less than 10 microns (PM_{10}) at the Paul Meyer, Walter Johnson, Palo Verde, Joe Neal, Green Valley, Liberty High School, Jerome Mack, Sunrise Acres, and Walnut Community Center monitoring sites in Clark County. These exceedances 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 Arizona and Nevada, strong winds from the outflow boundary lofted, entrained, and transported dust into Clark County, arriving the evening of September 8, 2022. The U.S. Environmental Protection Agency (EPA) Exceptional Event Rule (EER) (EPA, 2016) allows air agencies to omit air quality data from the design value calculation if it can be demonstrated that the measurement in question was caused by an exceptional event. In this case, wind speeds greater than 25 mph in Mojave Desert source region occur immediately prior to extremely enhanced PM_{10} concentrations in Clark County, 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 September 8-9, 2022, PM_{10} event at all regulatorily significant sites ranks at or above the 99th percentile compared to all 2018-2022 PM_{10} data in Clark County and is clearly exceptional compared to typical PM_{10} conditions. Windblown dust from the Mojave Desert in Arizona and Nevada 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 and Clark County with the enhanced PM_{10} concentrations measured at all sites in the Las Vegas Valley – designating the September 8-9, 2022, event as a High Wind Dust Exceptional Event.

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

Pre-Event Climatological Context

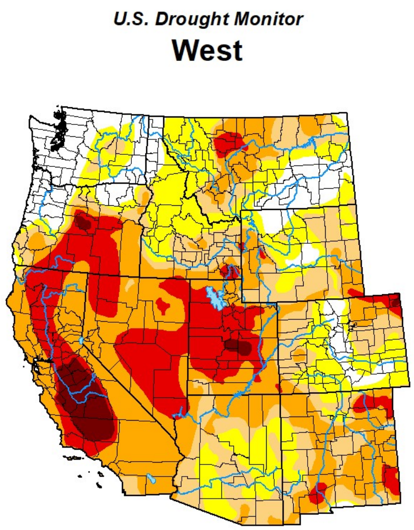

Figure 2.2-6

The Mojave Desert in northwestern Arizona and southern Nevada were under extreme to exceptional drought conditions on and before the September 8-9, 2022, event. Temperatures were above normal and precipitation below normal compared to climatology. The barren land cover, including the Mojave Desert source region, was primed for significant dust production during the high-wind event.

See Section 2.2.

Inciting High-Wind Event

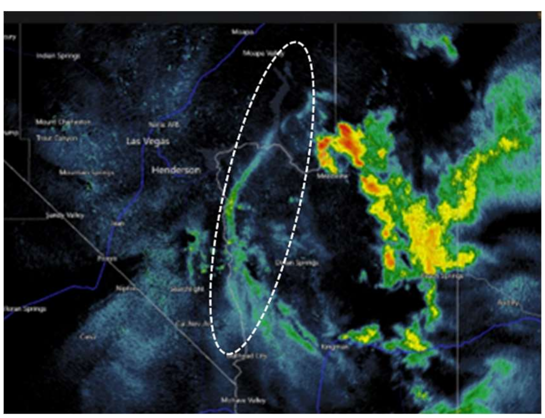

Figure 3.1-3

An outflow boundary from a hurricane-initiated thunderstorm created high wind speeds and gusts, which pushed through the Mojave Desert in northwestern Arizona and southern Nevada between 18:00 and 20:00 PST on September 8, 2022. The meteorological analysis and radar images show the outflow boundary (and associated dust) entered Clark County, NV, between 19:00 and 21:00 PST on September 8. 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 Source Region to Clark County

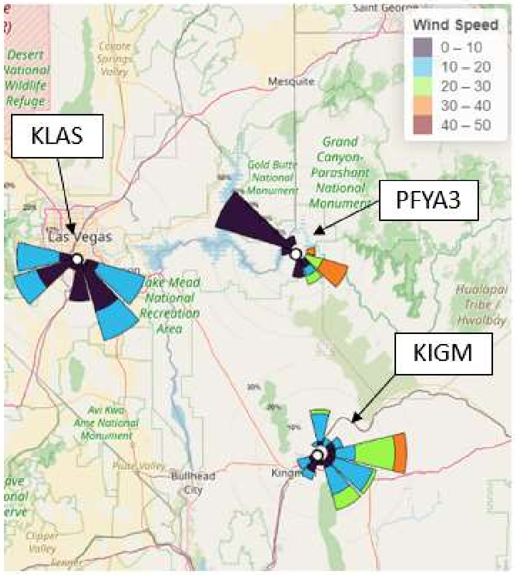

Figure 3.2-1

Meteorological data and radar images show the outflow boundary high winds and transport across the Mojave Desert in northwestern Arizona and southern Nevada, confirming this area as the source region for the high-wind dust event. The outflow boundary passage pushed northwestward through the source region enroute to Clark County, NV, within two to three hours of the exceedance in Clark County.

See Section 3.2.

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

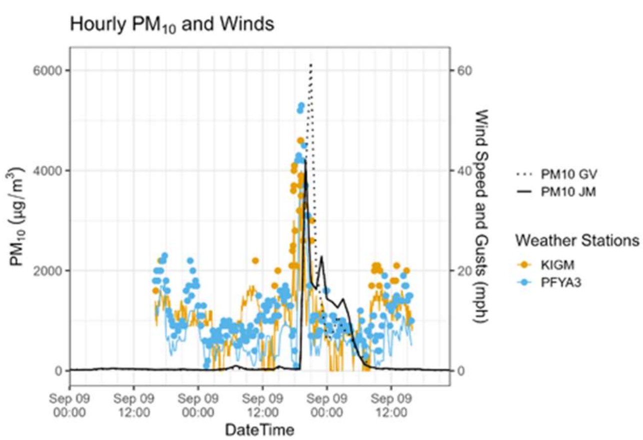

Figure 3.2-2

Enhanced PM_{10} arrived in Clark County beginning at 19:00-20:00 PST on September 8 and remained enhanced through 10:00 PST on September 9, 2022. High PM_{10} concentrations at all monitoring sites in Clark County coincided with the outflow boundary passage and occurred immediately after the high wind speed and gust measurements at upwind sites. 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

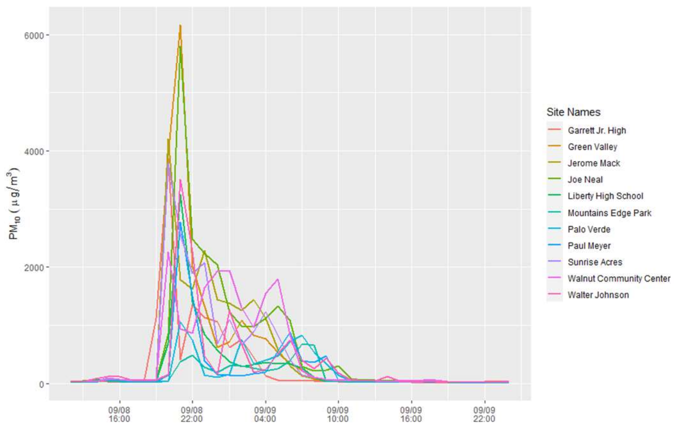

Figure 3.3-2

All monitoring sites in Clark County except Mountains Edge exceeded the NAAQS on September 8-9, 2022, though not all of these sites are regulatorily significant. PM_{10} concentrations peaked at 6,000 µg/m^3 and visibility decreased to 2.5 miles at the height of the event. The widespread high PM_{10} concentrations concur with a regional high-wind exceptional event.

See Section 3.3.

High Wind or PM_{10} Alerts Issued

News Release

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

Yolanda King, County Manager

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

Contact: Kevin J. MacDonald, Public Information Officer
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For Immediate Release — **Friday, Sept. 9, 2022**

Air Quality Dust Alert Issued for Friday

The Clark County Department of Environment and Sustainability has issued a dust alert for **Friday, Sept. 9** due to elevated levels of dust from high winds. Officials say unhealthy levels of dust for sensitive groups of people are imminent or occurring in the local area.

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

Figure 3.3-1

Clark County Nevada issued a Dust Alert due to high winds and extremely dusty conditions on September 9, 2022. Multiple news outlets reported on the high wind and dusty conditions on September 8 and 9, 2022.

See Section 3.3.

Comparison with Historical Data

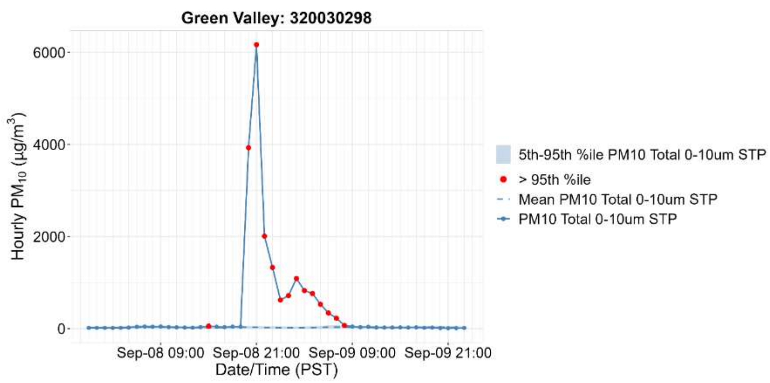


Figure 3.4-25

PM_{10} at all sites in the Las Vegas Valley exceeded the five-year 99th percentile on September 8 and 9, 2022. PM_{10} concentrations are also significantly outside typical seasonal and monthly ranges. 30-year climatology analyses show high temperatures and low soil moisture in the Mojave Desert source region and Clark County were significantly outside historical norms on the event date.

See Section 3.4.

Not Reasonably Controllable or Preventable

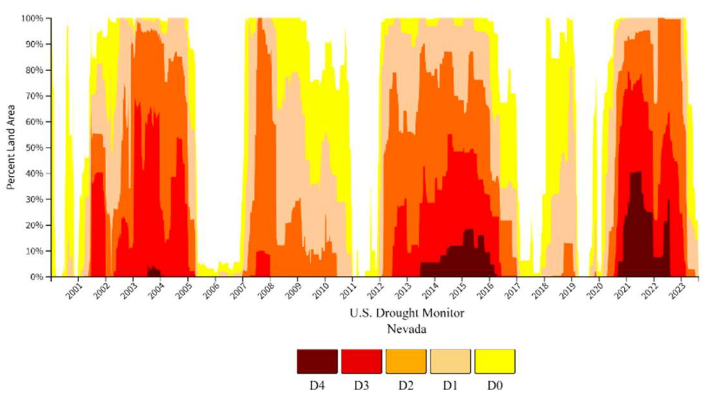


Figure 4.3-3

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

See Sections 4 and 5.

2. Background

2.1 Demonstration Description

2.1.1 PM_{10} Exceptional Event Rule Summary

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

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

Specifically, a high-wind dust demonstration must show that the dust event is a “natural event,” where windblown dust comes from natural sources or where 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. Winds in the source region contributing to the PM_{10} exceedance on September 8, 2022, met the 25-mph sustained wind speed threshold.

2.1.2 Requirements for Demonstration Based on Tier

The EPA "Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Influenced by High Wind Dust Events Under the 2016 Exceptional Events Rule" (EPA, 2019) describes a three-tier analysis approach to determine a "clear causal relationship" for exceptional events demonstrations 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 the 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 an exceptional event has sustained winds ≥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 do not meet the 25-mph threshold and may require additional analysis, such as Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model trajectories from the source area or source-specific emissions inventories.

Table 2.1-1. High-wind PM_{10} 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 "not reasonably controllable or preventable" (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 September 8-9, 2022, qualifies for Tier 2 analysis since it is a high-wind dust event with sustained winds at or above the high-wind threshold in the source region. On September 8-9, 2022, five-minute ASOS data from the Kingman Airport [KIGM] and Pierce Ferry [PFYA3] (part of the Hydrometeorological Automated Data System, owned by NPSLMR) weather stations in northwestern Arizona capture the passage of a strong gust front and measured 20-mph increases in sustained wind speed within one hour. Sustained wind speeds up to 40 mph were recorded in the source region as a result of the gust front, far exceeding the 25-mph threshold. This short period of intense gusty winds lifted dust from the surface in northwestern Arizona and transported it northwest towards Las Vegas in the next one to two hours, causing enhanced PM_{10} concentrations that peaked between 20:00-21:00 PST in Clark County. The intense wind conditions upwind of Clark County coupled with the severe drought conditions that persisted throughout the region during September 2022 demonstrate that September 8-9, 2022, should be designated a Tier 2 high-wind dust event.

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 visibility data during (Section 3.3.5) the event. 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. Sections 2.2.1 and 2.2.2 discuss the dust source for the event on September 8-9, 2022, which were the natural, undisturbed lands in the Mojave Desert region of northwestern Arizona and southern Nevada. These sections include 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)
	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, NV, on September 8-9, 2022. 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 upper-level and surface that led to the high-wind event in southern Nevada.
- 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.

2.1.4 Regulatory Significance

The high-wind dust event that occurred on September 8-9, 2022, caused 24-hour PM_{10} NAAQS exceedances with regulatory significance at Paul Meyer (Monitor AQS ID 32-003-0043, POC 1), Walter Johnson (Monitor AQS ID 32-003-0071, POC 1), Palo Verde (Monitor AQS ID 32-003-0073, POC 1), Joe Neal (Monitor AQS ID 32-003-0075, POC 1), Green Valley (Monitor AQS ID 32-003-0298, POC 1), Liberty High School (Monitor AQS ID 32-003-0299, POC 1), Jerome Mack (Monitor AQS ID 32-003-0540, POC 1), Sunrise Acres (Monitor AQS ID 32-003-0561, POC 1), and Walnut Community Center (Monitor AQS ID 32-003-2003, POC 1). The 24-hour PM_{10} exceedance values are listed in Table 2.1-3.

Table 2.1-3. 24-hour PM_{10} concentrations for sites that exceeded the NAAQS on September 8 or 9, 2022.

Date	Monitor AQS ID - POC	Site Name	24-Hour PM_{10} Exceedance Concentration ($\mu g/m^3$)
September 8, 2022	32-003-0043-1	Paul Meyer	234
	32-003-0071-1	Walter Johnson	307
	32-003-0075-1	Joe Neal	513
	32-003-0298-1	Green Valley	586
	32-003-0299-1	Liberty High School	285
	32-003-0540-1	Jerome Mack	445
	32-003-0561-1	Sunrise Acres	468
	32-003-2003-1	Walnut Community Center	278
September 9, 2022	32-003-0043-1	Paul Meyer	160
	32-003-0071-1	Walter Johnson	229
	32-003-0073-1	Palo Verde	212
	32-003-0075-1	Joe Neal	429
	32-003-0298-1	Green Valley	231
	32-003-0540-1	Jerome Mack	341
	32-003-0561-1	Sunrise Acres	273
	32-003-2003-1	Walnut Community Center	471

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 windblown dust events occurred between 2021 and 2023. Table 2.1-4 shows the 2021-2023 design values at each of the monitoring sites affected on September 8-9, 2022 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 Clark County without and with EPA concurrence that the September 8-9, 2022, and other suspected events qualify as exceptional events.

Monitor Site Name	Design Value Without EPA Concurrence	Design Value With EPA Concurrence
Paul Meyer	2.0	0.0
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 EPA evaluate the following assessment of the windblown dust event that occurred in Clark County on September 8-9, 2022, and agree to exclude the event from regulatory decisions regarding PM_{10} attainment.

2.2 Historical Non-Event Model

2.2.1 Land Type for Source Region and Clark County

Land-use and cover-type data from both the 2019 National Land Cover Database (NLCD) (Dewitz, 2021) and Sentinel-2 satellite are shown for the approximate source region of northwestern Arizona and southern Nevada (Figure 2.2-1). The primary land classifications, shown by the Sentinel-2 Land Use/Land Cover map in this region are bare ground and rangeland, with small pockets of 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 which are predisposed to high-wind events.

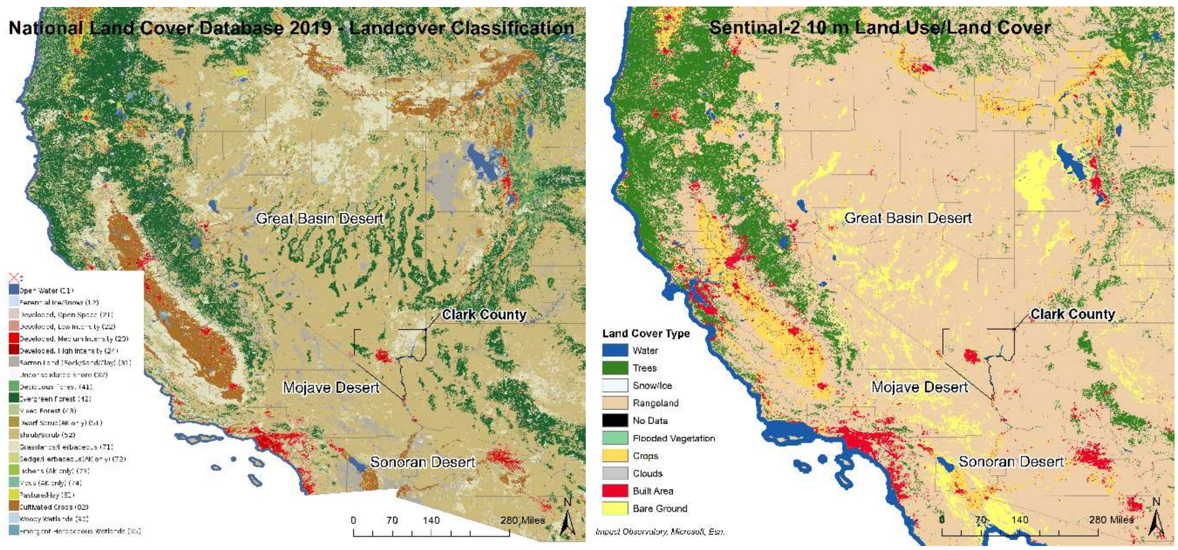


Figure 2.2-1. Land cover type for the western U.S. from (left) the 2019 NLCD and (right) Sentinel-2 satellite.

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.

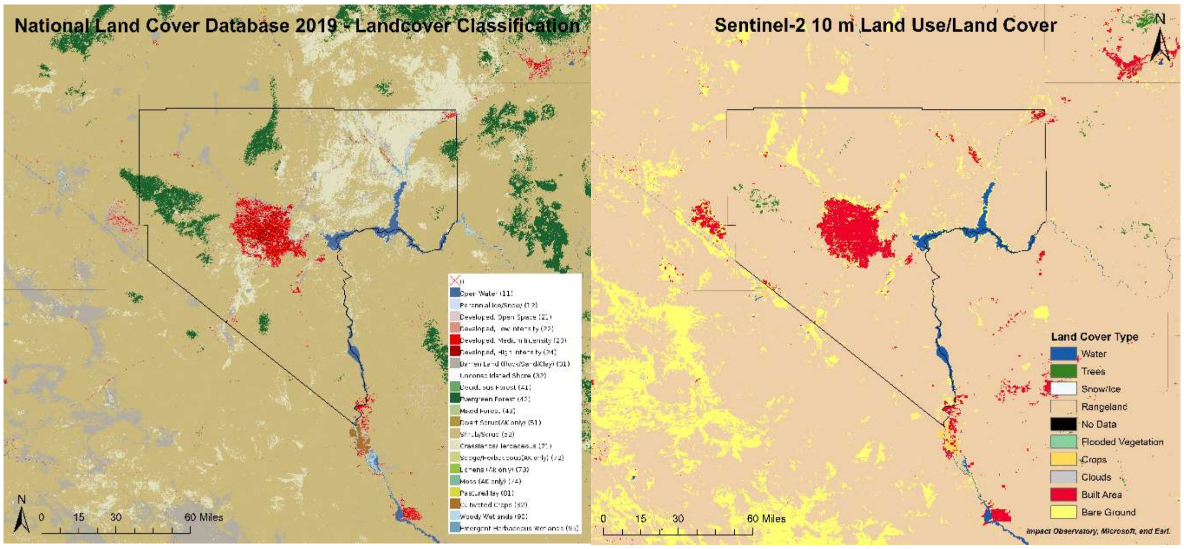


Figure 2.2-2. Land cover type for Clark County, NV, and the surrounding area from the (left) National Land Cover Database-2019 and (right) Sentinel-2 satellite.

2.2.2 Climatology for Source Region and Clark County

The source region of northwest Arizona intersects portions of several Omernik Level III ecoregions, primarily including the Mojave Basin and Range and the Arizona/New Mexico Plateau (Omernik 1987; EPA, 2013; Griffith et al. 2014). The Mojave Basin and Range ecoregion 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 borders 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). The ecoregion includes the Mojave Desert as well as 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, 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. The northwest Arizona portion of this ecoregion also includes the Lower Grand Canyon ecoregion, which is lower and warmer than the upstream Grand Canyon, with larger areas having Mojave Desert-scrub vegetation and Mojave Desert influences. Annual precipitation in the Lower Grand Canyon is 8 to 12 inches (203 to 305 mm), and the soil moisture regime is aridic (Griffith et al. 2014).

The Arizona/New Mexico Plateau ecoregion includes canyons, mountains, mesas, and buttes (Bryce et al. 2003). The Plateau is a large transitional region between lower, more arid shrublands and surrounding higher, forested, mountainous ecoregions to the northeast and south (Griffith et al. 2014). The northwestern Arizona portion includes the Arizona Strip Plateaus, which averages 11 to 14 inches (279 to 356 mm) of precipitation annually, which is less than other portions of the ecoregion.

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

In September 2022, the temperature was generally within or above the long-term normal temperature range compared to the long-term climate record in the Las Vegas area (**Figure 2.2-3**). A large temperature drop was observed the day after the dust event due to the influence from Hurricane Kay. Concurrently, precipitation accumulation for the Las Vegas area was significantly below normal for September (**Figure 2.2-4**).

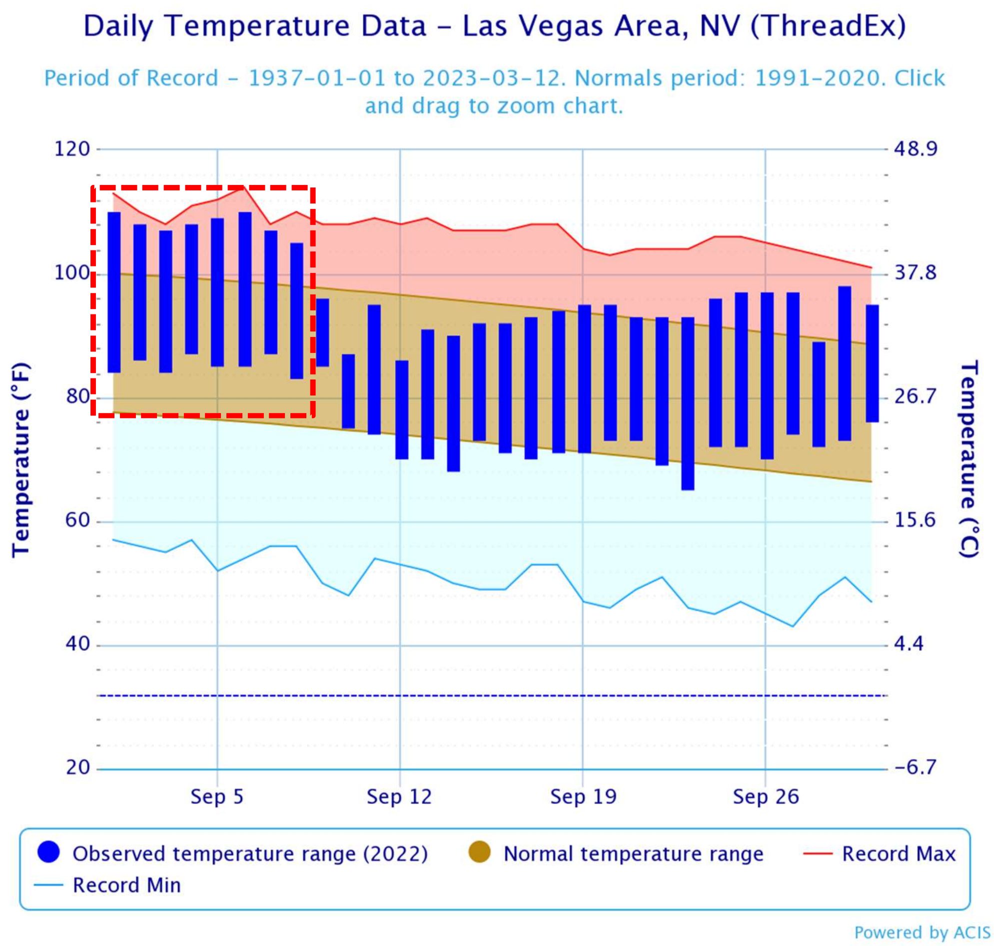


Figure 2.2-3. Las Vegas area, NV, temperature records from January 1, 1937, through December 26, 2022, by day including (dark blue) observed temperature range 2022, (brown) normal temperature range, (red) record maximum, and (light blue) record minimum. The red box indicates the dates of high and record heat before the September 8-9, 2022, event. Data from NWS: https://www.weather.gov/wrh/Climate?wfo=vef.

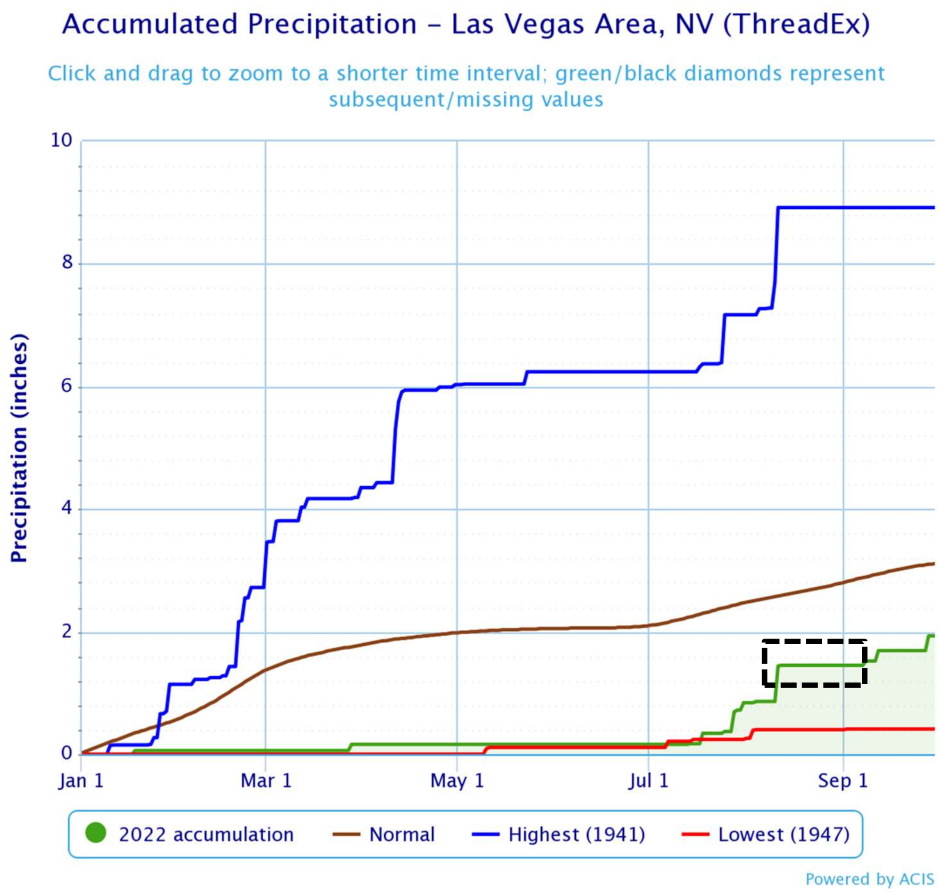


Figure 2.2-4. Las Vegas area, NV, precipitation records by day, including (green) accumulation in 2022, (brown) normal, (blue) record maximum, and (red) record minimum. The black box indicates the period of low accumulated precipitation before the September 8-9, 2022, event. Data from NWS: https://www.weather.gov/wrh/Climate?wfo=vef.

The dry conditions in 2022 are also highlighted by the Palmer Drought Severity Index (PDSI) produced by the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Protection (NCEP). The PDSI showed moderate to severe drought in southern Nevada and northwestern Arizona in August and September 2022 (Figure 2.2-5). The drought index decreased slightly for southern Nevada during September 2022, in part due to rainfall from Hurricane Kay that occurred after this dust event.

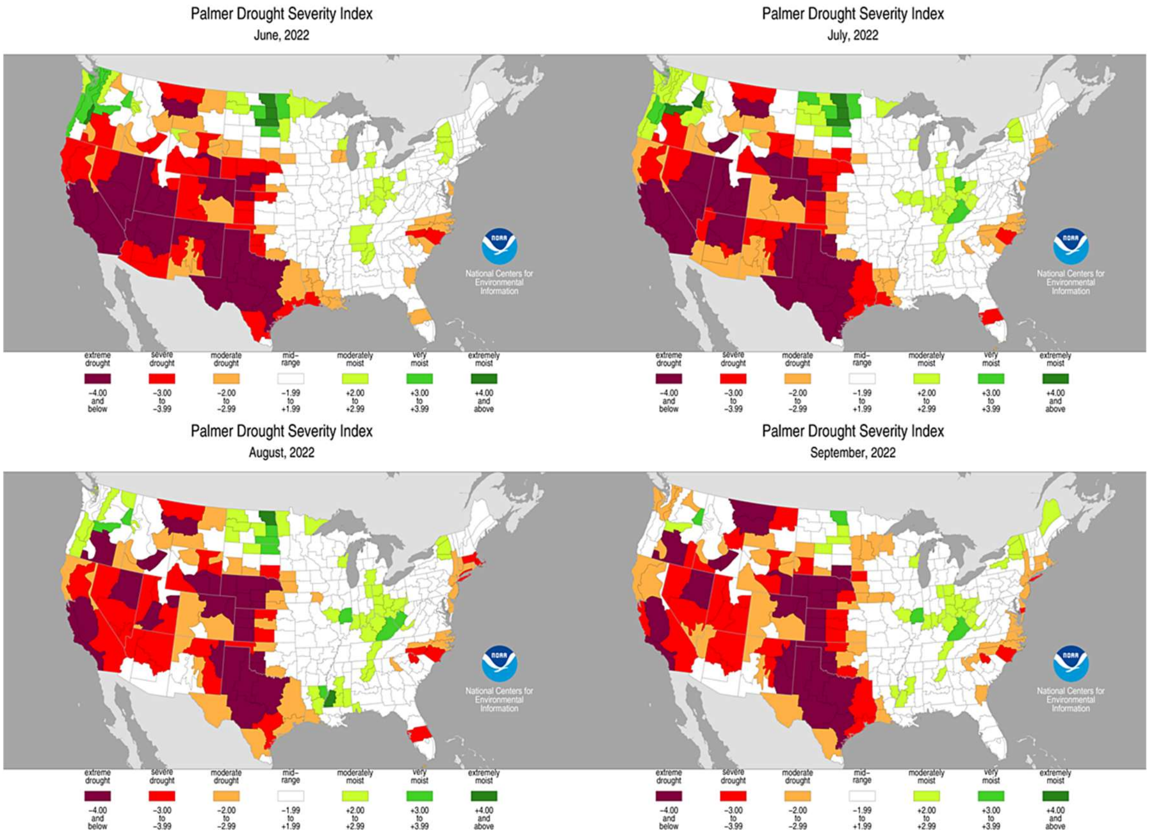
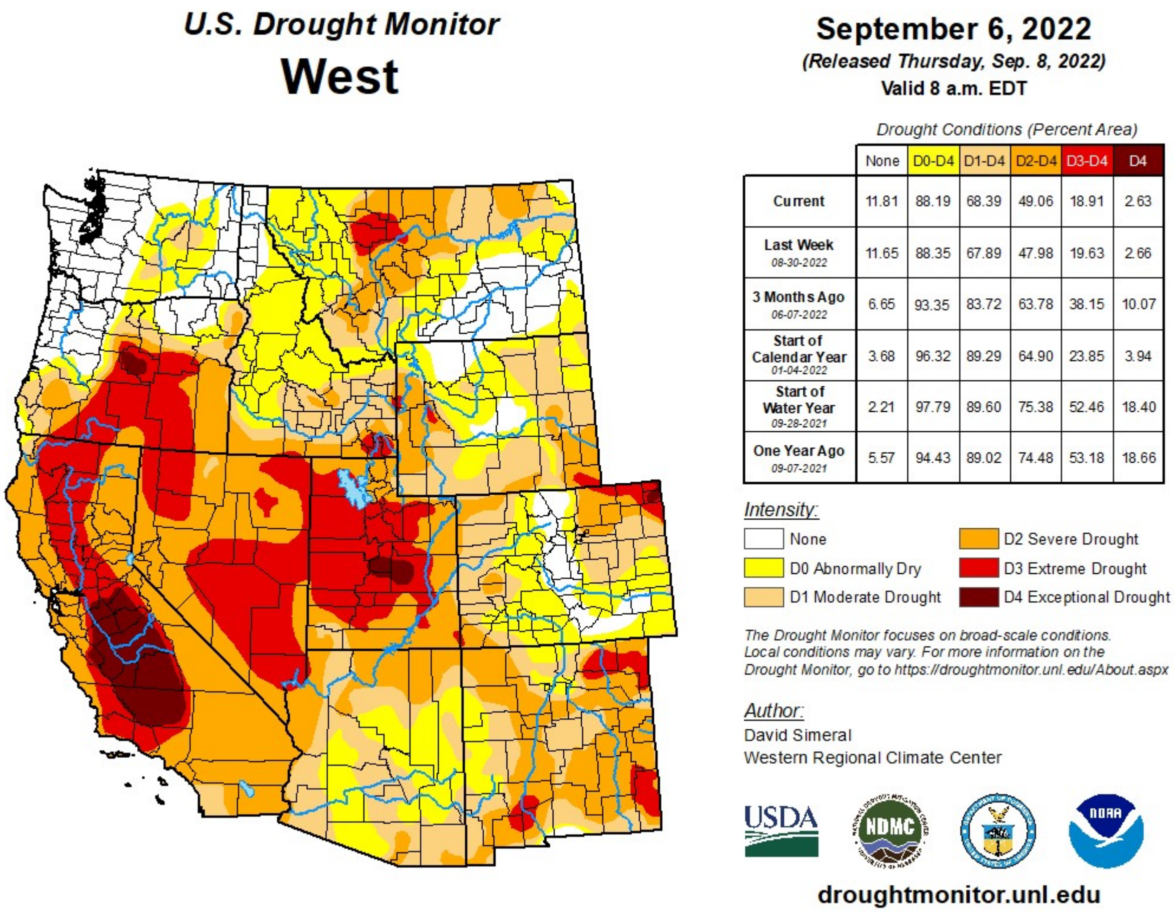


Figure 2.2-5. Palmer Drought Severity Index for June-September 2022.

Immediately before the September 8, 2022, event and the influence of Hurricane Kay, the western U.S. was under widespread drought conditions (**Figure 2.2-6**). The western U.S., including Nevada, remained in widespread drought conditions in area and severity in the year, months, and weeks before the PM_{10} exceedance. The northwestern Arizona and southern Nevada source region for this event were under moderate to extreme drought (D1 - D3). As of September 6, 2022, all (100%) of Nevada was included in the drought (**Figure 2.2-7**), including 99.52% in severe to exceptional drought (D2 - D4).



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	11.81	88.19	68.39	49.06	18.91	2.63
Last Week 08-30-2022	11.65	88.35	67.89	47.98	19.63	2.66
3 Months Ago 06-07-2022	6.65	93.35	83.72	63.78	38.15	10.07
Start of Calendar Year 01-04-2022	3.68	96.32	89.29	64.90	23.85	3.94
Start of Water Year 09-28-2021	2.21	97.79	89.60	75.38	52.46	18.40
One Year Ago 09-07-2021	5.57	94.43	89.02	74.48	53.18	18.66

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

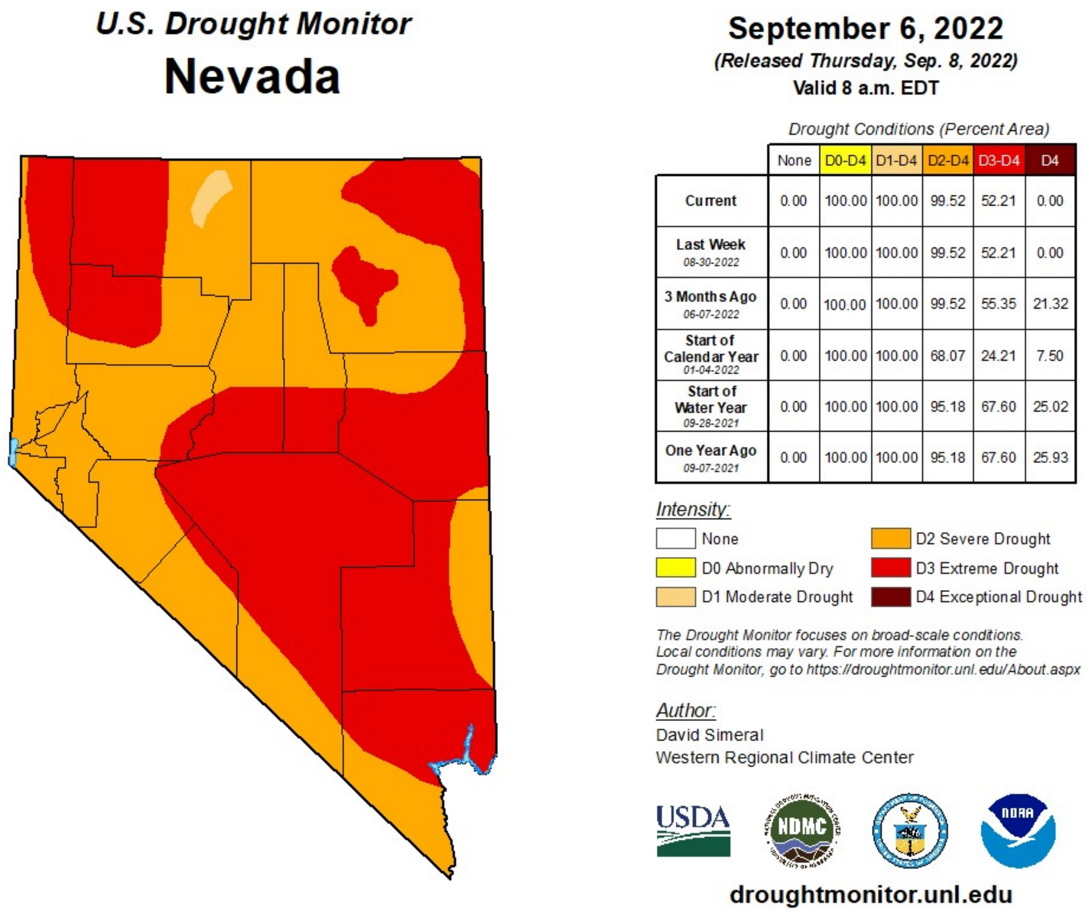


Figure 2.2-7. U.S. Drought Monitor values for the Nevada on September 6, 2022.

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 2.2-8). Open lands and incorporated Clark County largely align with bare ground and rangeland (Figure 2.2-2), suggesting that dust may have been picked up in Clark County during the high-wind event.

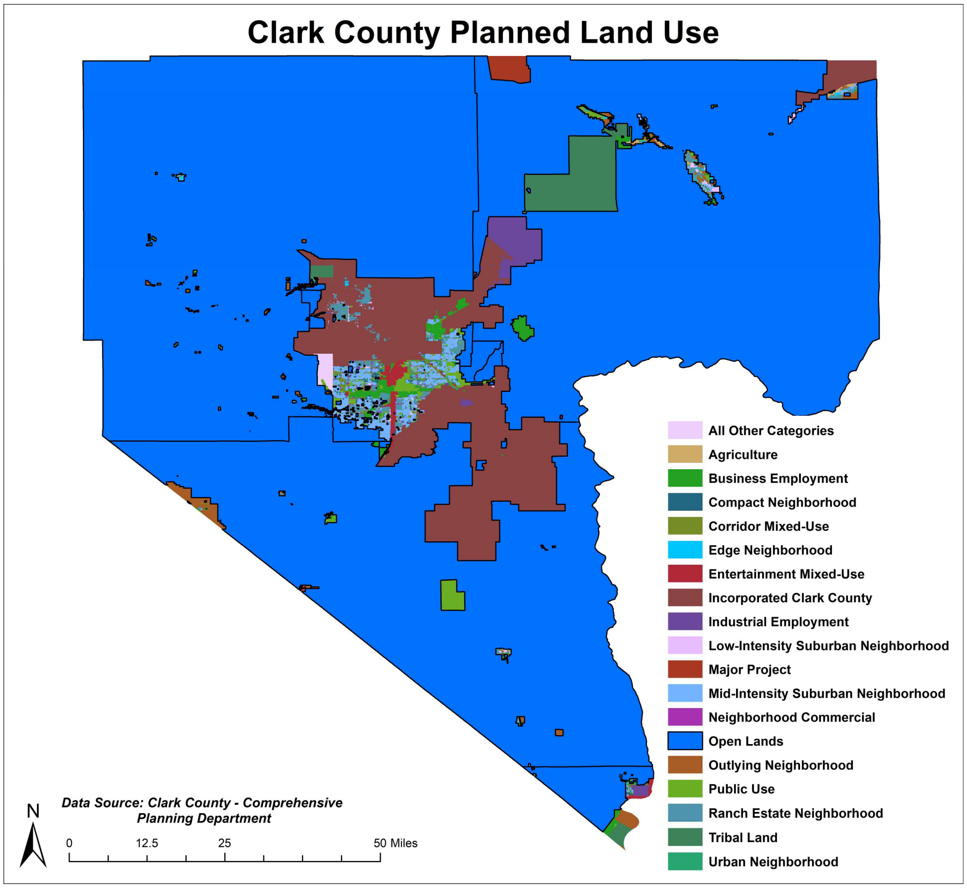


Figure 2.2-8. Planned land use boundaries of Clark County.

Planned land use around the Green Valley site is comprised of incorporated Clark County (Figure 2.2-9). The sports complex to the south includes exposed land, such as a dog park and dirt bike tracks. The remainder of the surrounding area is residential buildings and paved surfaces, with little exposed dirt or gravel.

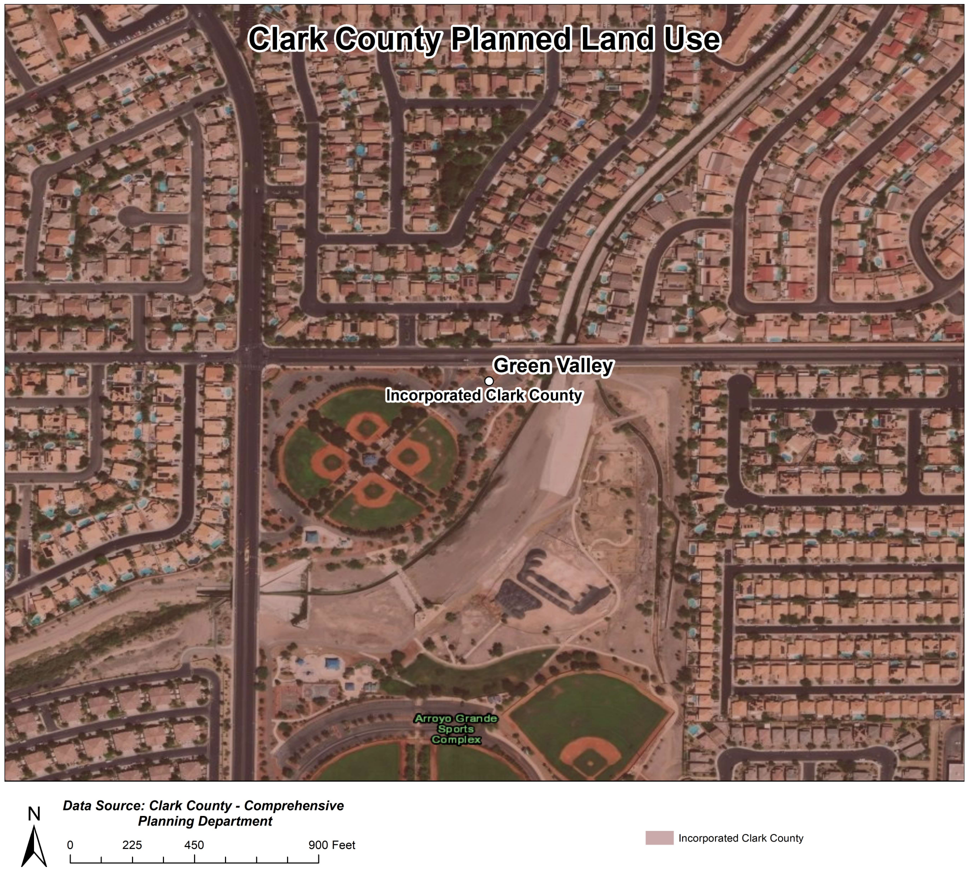


Figure 2.2-9. Planned land use boundaries in the area around the Green Valley station.

Planned land use around the Jerome Mack site is comprised of public use to the west (Jerome Mack Middle School campus), mid-intensity suburban neighborhood to the south, urban neighborhood to the southeast, compact neighborhood to the northeast, and business employment to the north and northwest. An aqueduct borders Jerome Mack immediately to the north (**Figure 2.2-10**). Much of the surrounding area is buildings and paved surfaces consisting of parking lots and roads, with little exposed dirt or gravel.

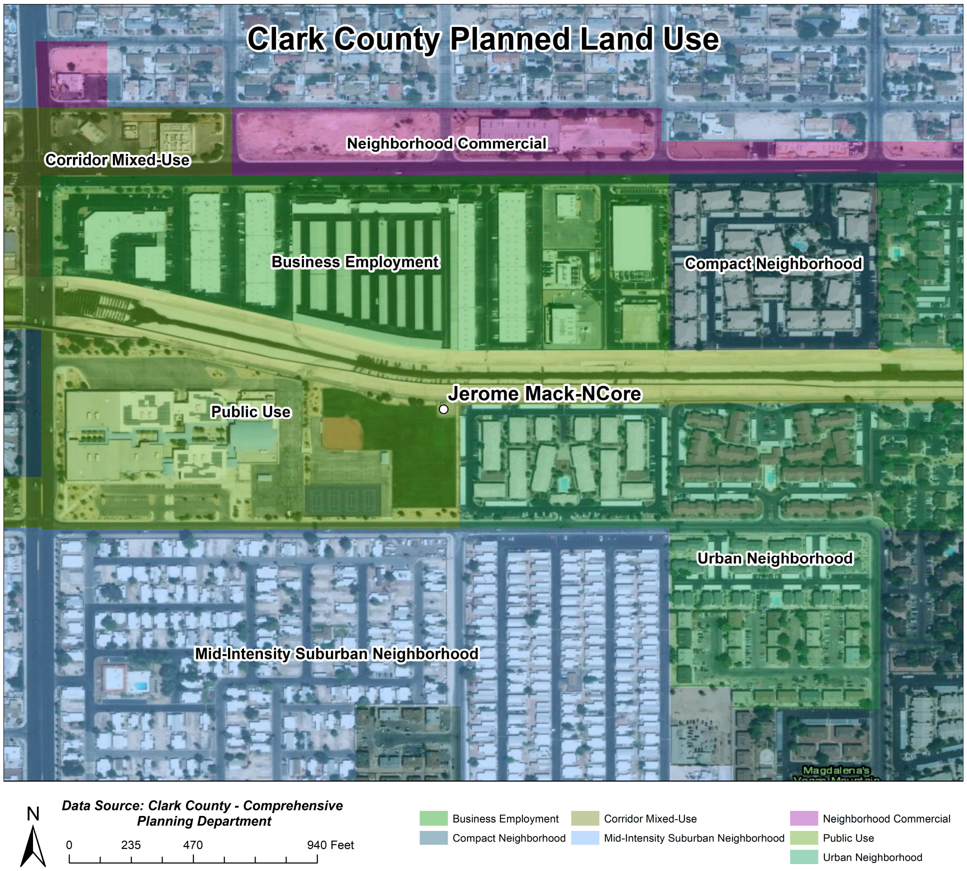


Figure 2.2-10. Planned land use boundaries in the area around the Jerome Mack station.

Planned land use around the Joe Neal site is largely incorporated Clark County, as well as the Ranch Estate neighborhood to the west (Figure 2.2-11). Both of these uses are largely residential with little exposed dirt or gravel. However, vacant lots are visible to the east and southeast of the monitor.

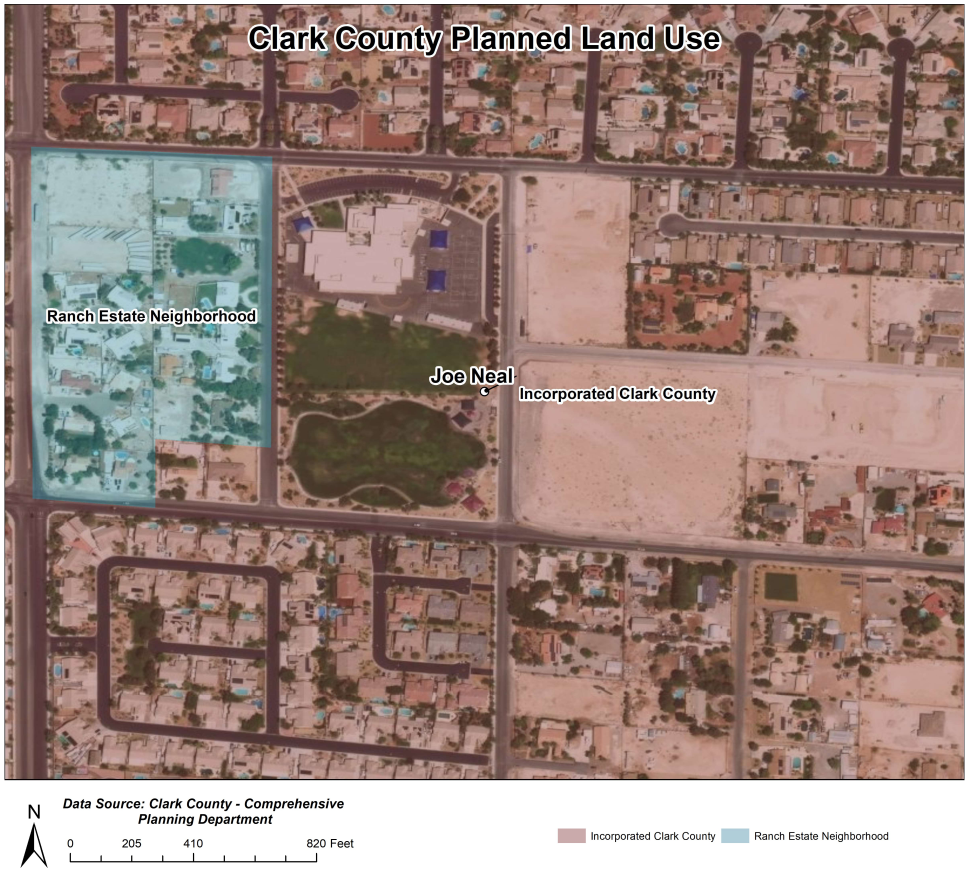


Figure 2.2-11. Planned land use boundaries in the area around the Joe Neal station.

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 2.2-12**). The Liberty High School site is at the southeastern edge of the Liberty High School campus near a baseball field and bordering a road. With the exception of the baseball field and a small strip of shrubs, grass, dirt, and gravel to the east, the immediate surroundings of the Liberty High School site are mostly paved surfaces with little exposed dirt and gravel.

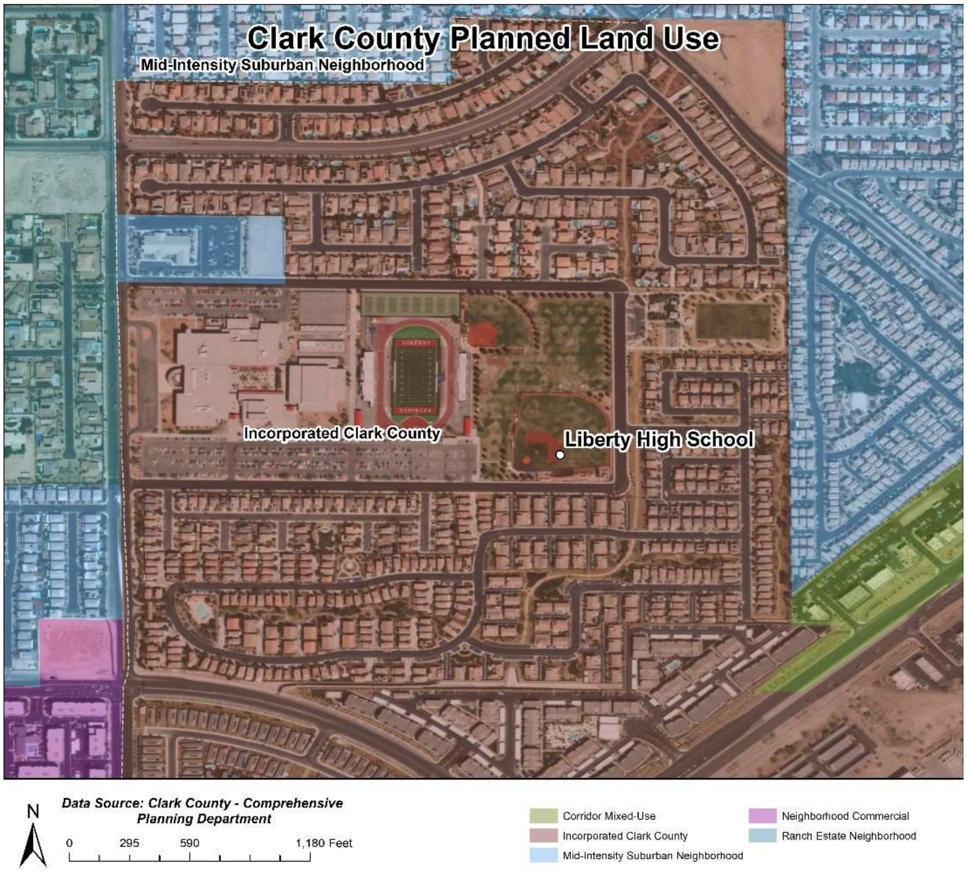


Figure 2.2-12. Planned land use boundaries around the Liberty High School monitoring station.

Planned land use around the Palo Verde site is comprised entirely of incorporated land (Figure 2.2-13). Much of the surrounding area is buildings and paved surfaces consisting of parking lots and roads. The site is approximately one mile east of the 215 highway and has an aqueduct on its southern border. With the exception of baseball fields to the west, there is virtually no area with exposed dirt or gravel.

Figure 2.2-13. Planned land use boundaries in the area around the Palo Verde station.

Planned land use around the Paul Meyer site is comprised entirely of public use and mid-intensity suburban neighborhood (Figure 2.2-14). 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 2.2-14. 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 2.2-15**). Residential areas, including compact neighborhood, mid-intensity suburban neighborhood, and commercial neighborhood, are also present to the south. Much of the surrounding area is buildings and paved surfaces consisting of parking lots and roads, with little exposed dirt or gravel. A vacant undeveloped lot and a baseball field are present nearby, which may contribute to local dust during high-wind events.

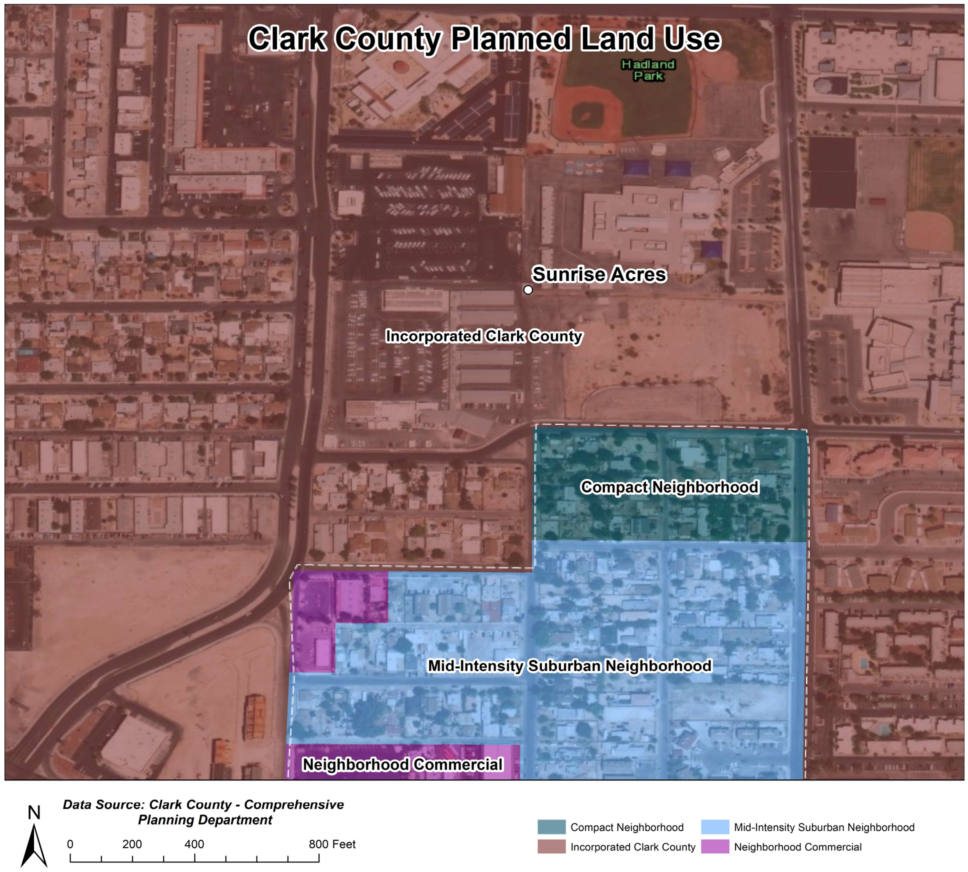


Figure 2.2-15. Planned land use boundaries in the area around the Sunrise Acres station.

Planned land use around the Walnut Community Center site is comprised of public use (Walnut Park) and business employment to the south (Figure 2.2-16). With the exception of grass fields to the west and east, there is virtually no area with grass or exposed dirt or gravel.

Figure 2.2-16. Planned land use boundaries around the Walnut Community Center monitoring station.

Planned land use around the Walter Johnson site is comprised entirely of incorporated Clark County (Figure 2.2-17). The site is highly residential with little exposed dirt or gravel. The site also neighbors a city park, which contains some bare ground.

Figure 2.2-17. Planned land use boundaries in the area around the Walter Johnson station.

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

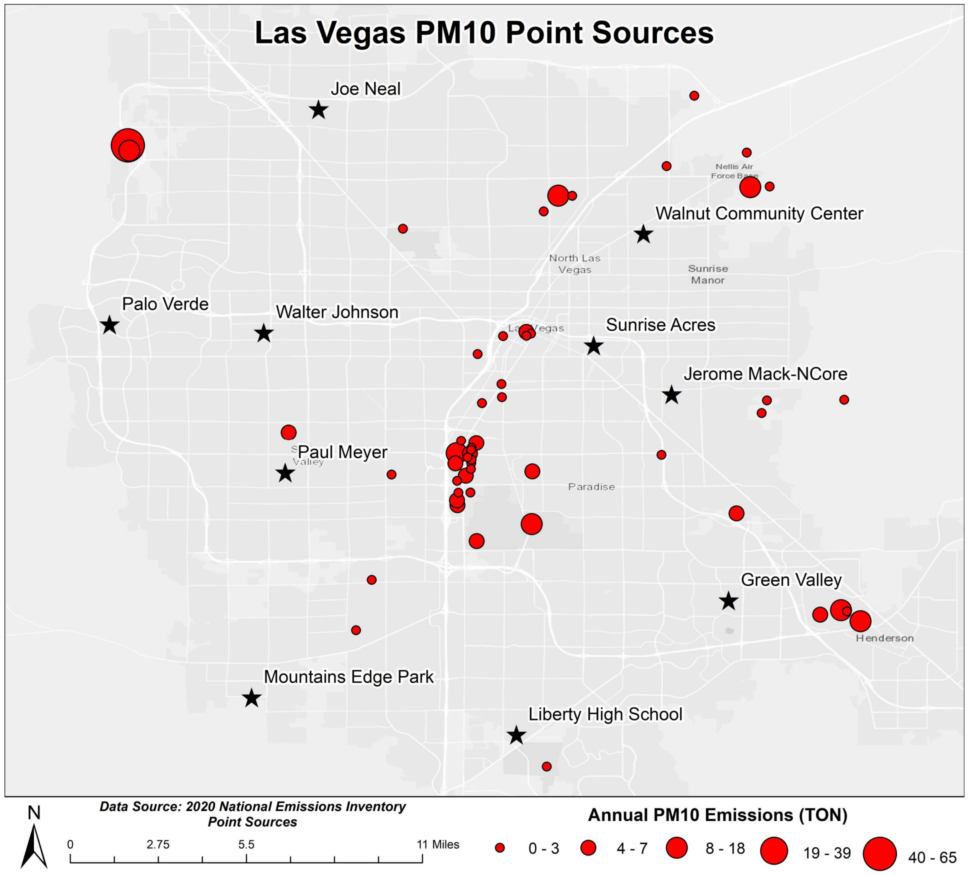


Figure 2.2-18. 2020 NEI point sources of PM_{10} in Clark County.

Clark County, NV, 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 September 8-9, 2022, exceedance. Nonpoint sources, however, contribute greater than 98% of PM_{10} emissions. The assessment shows a reduction of 31% in total PM_{10} emissions between 2008 and 2023, with notable decreases in the contribution of wind erosion (vacant lands) to total PM_{10} emissions between 2008 and 2023 (Figure 2.2-19). Increasing contributions from construction-related emissions are due to increasing conversion of vacant lands to built area. Therefore, wind erosion from construction, paved roads, construction, and other sources have increasingly contributed to total emissions. As shown in Figure 2.2-9 through Figure 2.2-17, most sites are not near major paved roads. For example, the Jerome Mack site is approximately a quarter of a mile away from a major paved road source (S Lamb Blvd), as is the Green Valley site (N Stephanie St). Thus, paved roads and on-road emissions likely did not contribute to the September 8-9, 2022, exceedance. The Sunrise Acres site is approximately 530 feet from the nearest major paved road source (N Eastern Ave), so these emissions may have more likely impacted this site.

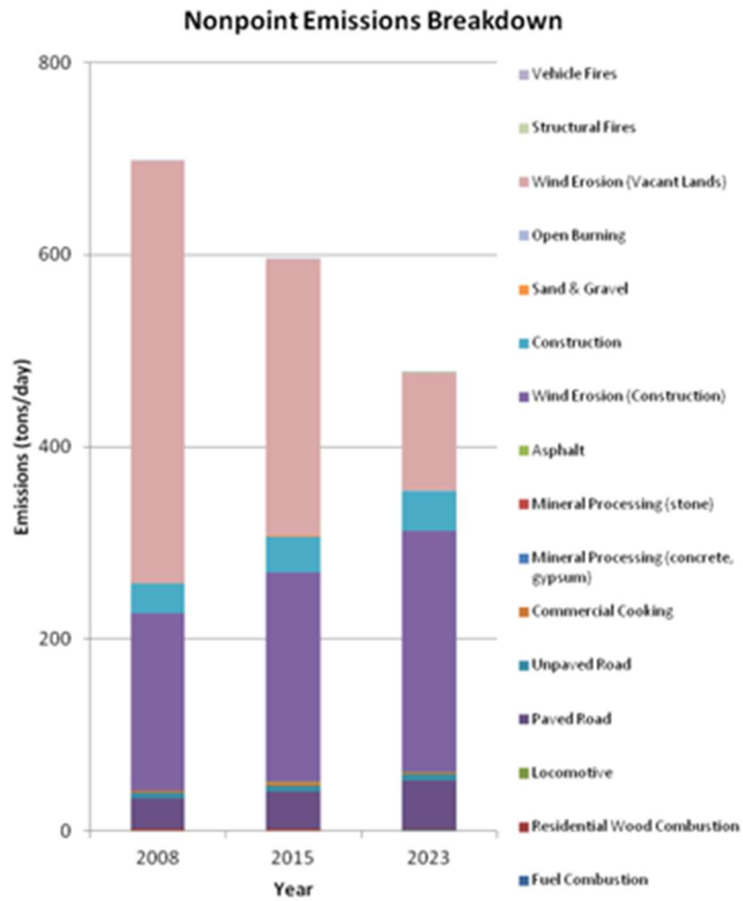


Figure 2.2-19. Nonpoint emissions inventory breakdown from the 2012 "Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10})" document.

2.2.4 Historical Analysis of PM_{10} in Clark County

Table 2.2-1 displays a statistical summary of 24-hour average PM_{10} concentrations from the five years preceding the event (2018-2022) at the affected sites, which include Green Valley, Jerome Mack, Joe Neal, Palo Verde, Paul Meyer, Sunrise Acres, Liberty High School, Walnut Community Center, and Walter Johnson. Garrett Junior High, Liberty High School, and Walnut Community Center data collection did not begin until spring 2021, and summary statistics are shown for the data available through December 2022. Although not regulatorily significant, the table includes statistics for the Garrett Jr. High monitoring site to examine the regional effect of the high-wind dust event. The median concentration ranges from 17 µg/m^3 at Garrett Jr. High and Palo Verde to 37 µg/m^3 at the Walnut Community Center site. The 99th percentile values were below 116 µg/m^3 at the three sites with a complete five years of data, and between 145 and 201 µg/m^3 at the newer sites with less than two years of data.

Table 2.2-1. Five-year statistical summaries of 24-hour average PM_{10} concentration at affected sites from 2018 – 2022, with the exception of Garrett Jr. High, Liberty High School, and Walnut Community Center, where data collection began spring 2021. Summary statistics for all data are available through December 2022.

Statistic (µg/m³)	Green Valley	Jerome Mack	Joe Neal	Palo Verde	Paul Meyer	Sunrise Acres	Walter Johnson	Garrett Jr. High*	Liberty High School*	Walnut Community Center*
Mean	25	35	28	20	24	36	23	23	31	42
Median	21	31	25	17	21	32	20	17	26	37
Mode	20	31	26	15	18	25	17	11	18	36
St. Dev	24	25	23	16	19	25	19	27	32	35
Minimum	2	4	2	2	3	4	3	3	2	7
95th percentile	49	66	52	40	47	72	44	52	62	76
99th percentile	108	116	85	67	88	105	78	145	201	181
Maximum	586	445	513	333	335	468	341	350	365	470
Range	584	441	511	331	332	464	338	347	363	463
Count	1,820	1,790	1,813	1,796	1,814	1,796	1,822	635	610	579
Exceedances (>150 µg/m³)	9	13	7	4	6	11	7	5	8	10

Seasonal and monthly trend analysis in the 24-hour average PM_{10} data at all affected sites combined for the five years preceding the event (2018-2022) are shown in boxplots in Figure 2.2-20 and Figure 2.2-21 (note that data is limited for several sites as described in Table 2.2-1). The lower edge (25th percentile) and upper edge (75th percentile) of the box correspond to the interquartile range, and the middle bar is the median value. The whiskers extend to the smallest and largest value within 1.5 times the interquartile range. Points beyond this range are considered outlying and have been removed for monthly and seasonal trend clarity (see Section 3.4.2) for trends including outliers. Median 24-hour average PM_{10} values are lowest in winter (median value of 18 µg/m^3) and highest in summer (median values of 27 µg/m^3), with significant overlap in the interquartile ranges. For September, the interquartile range is 20 to 38 µg/m^3, with a median value of 28 µg/m^3.

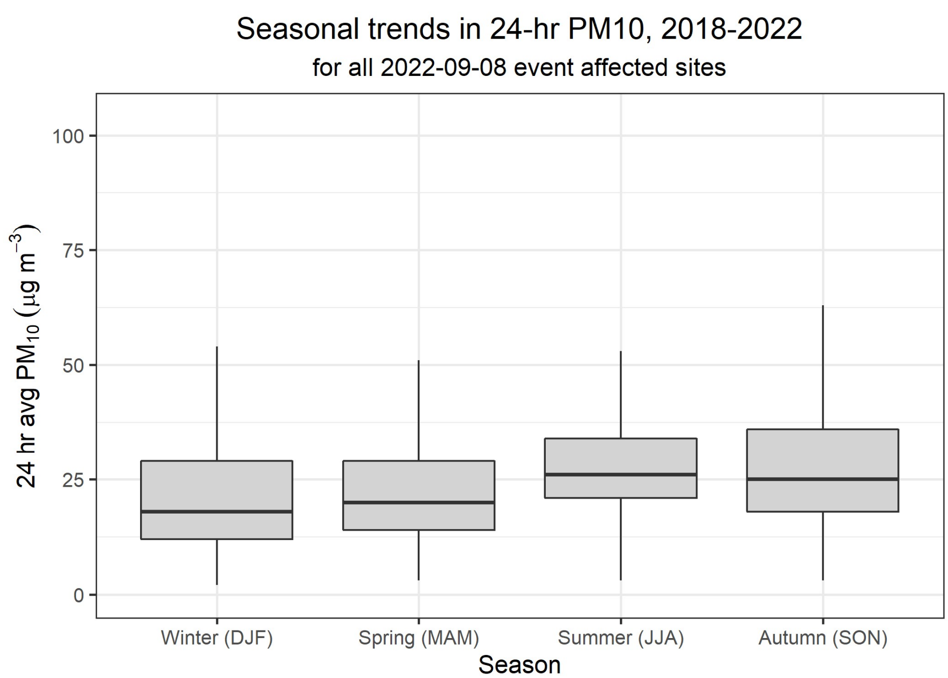


Figure 2.2-20. Seasonal trends in values of PM_{10} from 2018-2022 (outliers have been removed for trend clarity).

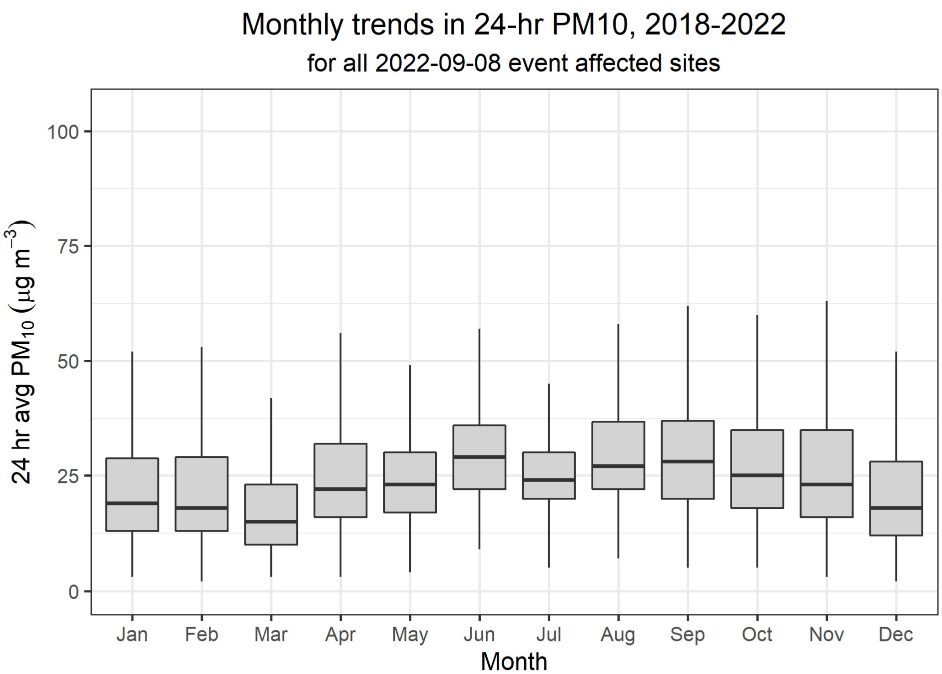


Figure 2.2-21. Monthly trends in values of PM_{10} from 2018-2022 (outliers have been removed for trend clarity).

3. Clear Causal Relationship

3.1 High-Wind Event Origin

On September 8, 2022, a hurricane-initiated thunderstorm created an outflow boundary with associated high winds speeds. The outflow boundary passage through the Mojave Desert region of northwestern Arizona and southern Nevada drove a windblown dust event that increased PM_{10} concentrations in Clark County, NV, on September 8-9, 2022. 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 starting between 19:00 and 20:00 PST on September 8 and lasting through 10:00 PST on September 9, 2022. The severe drought conditions affecting the Mojave Desert, as shown in Section 2.2, created an ample source of dust from friable soils. Although wind speeds in Clark County were less than the 25-mph threshold, enhanced wind speeds at upwind meteorological sites in the Mojave Desert rapidly increased to 30-40 mph immediately prior to the enhanced PM_{10} concentrations experienced in Clark County. Transport from the Mojave Desert to Clark County is clearly evident via meteorological analyses and radar images. Visibility was greatly reduced in Clark County during high PM_{10} concentrations, which 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 outflow boundary passage, evidence of transport from the source region to Clark County via radar images and meteorological analysis, and the impact of the high-wind dust event at the surface in Clark County. We also provide additional evidence using statistical analyses to compare this dust event with typical PM_{10} days in Clark County.

3.1.1 Meteorological Analysis

Several weather factors contributed to the blowing dust event in the Las Vegas region on September 8-9, 2022. To assess which meteorological variables led to poor air quality, observational data was analyzed from the following sources:

- Upper-air winds and geopotential heights
- Satellite and Doppler radar imagery
- Hourly surface wind speed and direction

The analysis of these data sets uncovered three primary contributors to the blowing dust event. The following sections detail each of these meteorological contributors, and their subsequent roles in the dust event. For completeness, this analysis examines the period between September 4 and the afternoon of September 9, 2022.

Hurricane Kay

One key contributor to the September 8-9, 2022, dust event was the evolution of Hurricane Kay in the eastern Pacific Ocean. Kay developed into a tropical depression the morning of September 4, strengthening into a category 1 hurricane the following afternoon. The storm approached the western Baja California coast by the evening of September 7, steered by a broad upper-level high pressure system over southern Utah. Kay continued to travel parallel to the western Baja coastline on September 8, as the upper-level high weakened and a shortwave trough of low pressure aloft entered the northern Rockies. The upper-level weather pattern allowed Kay to enter cooler waters north of the Baja California Spur. As a result of the cool, Pacific waters, Kay weakened to a tropical storm by the evening of September 8 and transitioned to a post-tropical cyclone the evening of September 9.

While Kay did not make landfall in southern Nevada, its subsequent path parallel to the Baja California coast resulted in a large moisture influx across the southwestern U.S. Satellite precipitable water imagery depicted a surge in moisture moving up the Gulf of California throughout the day on September 7, with precipitable water values in the Las Vegas upper air sounding increased from 0.76 inches in the morning to 1.05 inches by the early evening. By the morning of September 8, atmospheric moisture continued to increase in the Las Vegas region, with upper air sounding data measuring a precipitable water value of 1.37 inches (see **Figure 3.1-1**). The abundance of moisture from Kay led to an increased likelihood of thunderstorm activity across southern Nevada and western Arizona.

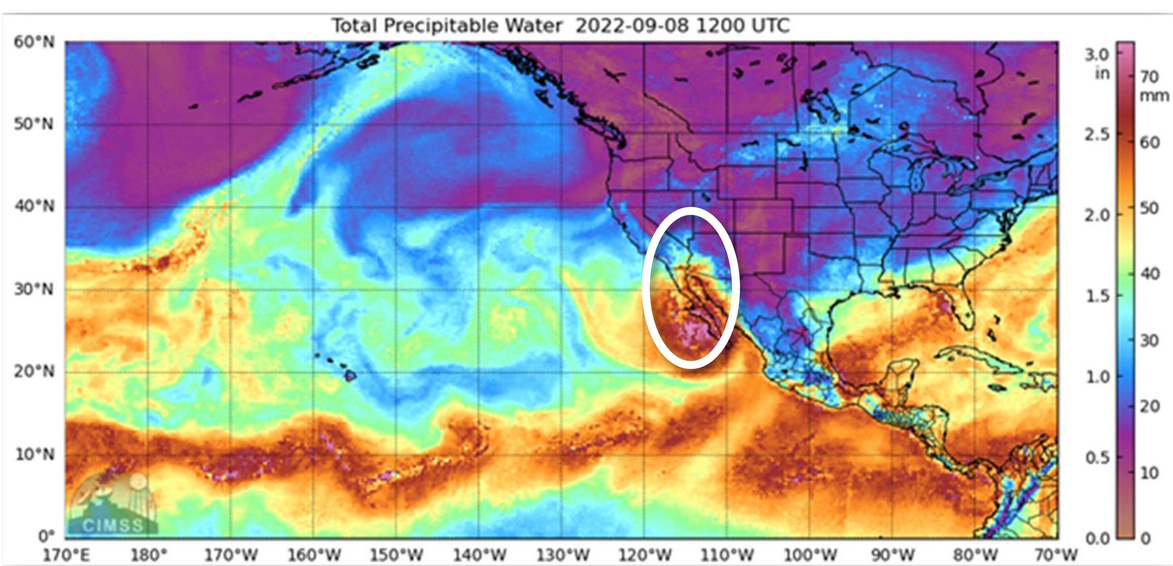


Figure 3.1-1. Satellite total precipitable water (PWAT) the morning of September 8, 2022. Deep moisture (circled) associated with Hurricane Kay off Baja California was transported into southern Nevada, leading to an increased threat of thunderstorms. Source: CIMSS.

Upper-Level Divergence

Another key factor in the September 8-9, 2022, dust event was the upper-level weather pattern over southern Nevada. The 250-mb weather map on the evening of September 7 shows the upper-level cyclonic circulation of Hurricane Kay off the southern Baja California coast, a ridge of high pressure over southwestern New Mexico, and a low-pressure trough off the Pacific Northwest coast.

By the morning of September 8, the aloft trough came onshore in the Pacific Northwest, while Kay's upper-level circulation remained off Baja California and the high-pressure ridge resided over Arizona and New Mexico. Southern Nevada was positioned between Kay's upper-level circulation to the south and the aloft trough north. Due to this pattern, 250-mb winds in Las Vegas were easterly at 5 knots, compared to 30-40-knot southerly to southwesterly winds in Arizona and 70-95-knot west-southwesterly winds in Idaho and western Montana (see Figure 3.1-2). This led to a divergent wind pattern across southern Nevada, northwestern Arizona, and southwestern Utah. Divergence aloft promotes rising air, which favored thunderstorm development around the Las Vegas region.

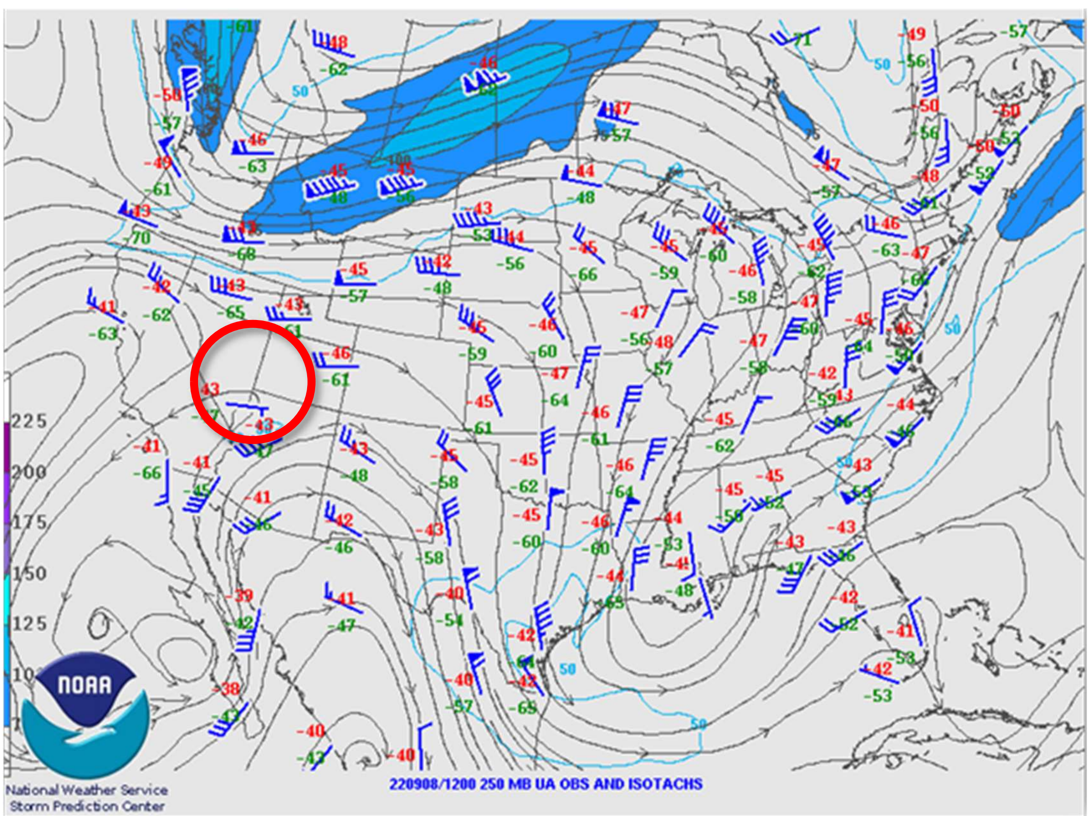


Figure 3.1-2. 250-mb map the morning of September 8, 2022. Divergence aloft (red circle) led to a favorable region for thunderstorm formation over northwestern Arizona and southwestern Utah. Source: NOAA Storm Prediction Center.

Convection and Outflow Winds

The final factor resulting in the blowing dust event was thunderstorm initiation, and the subsequent outflow winds generated by convection. Due to abundant precipitable water, upper-level divergence in the region, and a daytime maximum temperature of 105 °F increasing atmospheric instability, thunderstorm initiation occurred across southwestern Utah and northwestern Arizona around 11:00 to 14:00 PST. By 16:00-17:00 PST, a cluster of thunderstorms was present in northwestern Arizona, moving toward southern Nevada. Doppler radar detected the presence of an outflow boundary from the thunderstorm complex approaching Boulder City by 19:00 PST (see Figure 3.1-3), with the outflow reaching the Las Vegas metropolitan area between 20:00 and 21:00 PST.

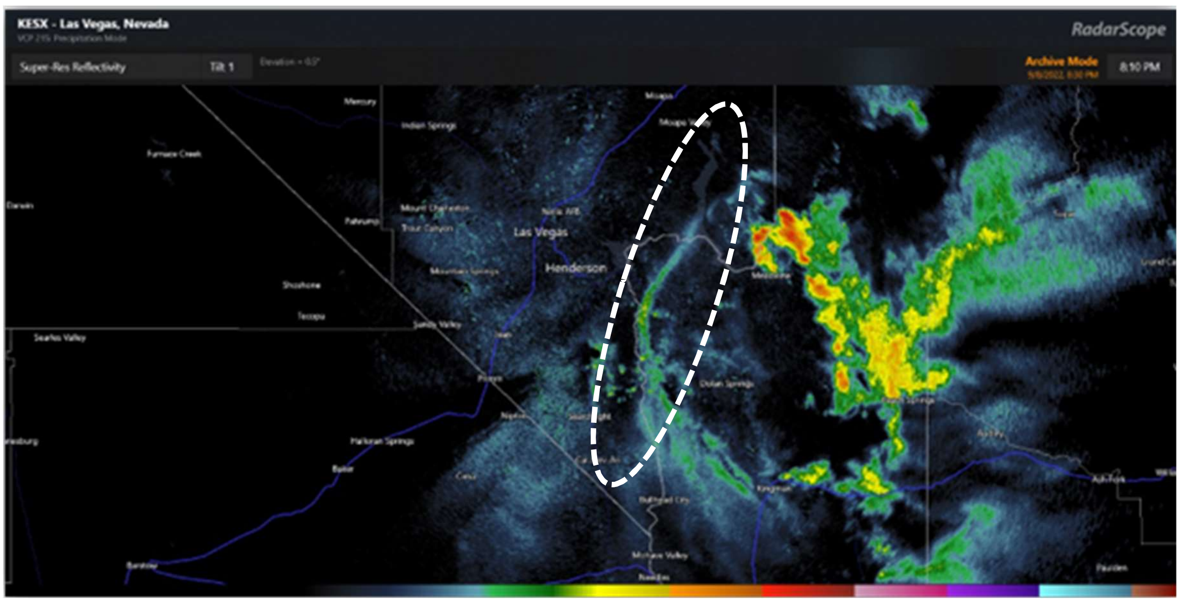


Figure 3.1-3. Doppler radar image, valid 19:10 PST on September 8, 2022. An outflow boundary (white-dashed circle) associated with thunderstorms in northwestern Arizona approaches southern Nevada, containing gusty winds and dense blowing dust. Source: RadarScope.

The progression of this series of events is shown through hourly radar images in Figure 3.1-4 through Figure 3.1-7. Figure 3.1-4 shows the initial thunderstorms building and moving to the northwest. Figure 3.1-5 shows the initial thunderstorms continuing to build and creating the initial outflow boundary starting at 18:00 PST on September 8. Once the outflow boundary was created, the thunderstorms started to decay through the rest of the radar period. As stated previously, the outflow boundary entered Boulder City by 19:00 PST, and the outflow boundary continued to push west through the Las Vegas area by 20:00 PST (Figure 3.1-6). Finally, the outflow boundary pushed all the way through Clark County by 22:00 PST on September 8 (Figure 3.1-7). The radar reflectivity shows the outflow boundary plus dust lofted and transported along with the gusty winds.

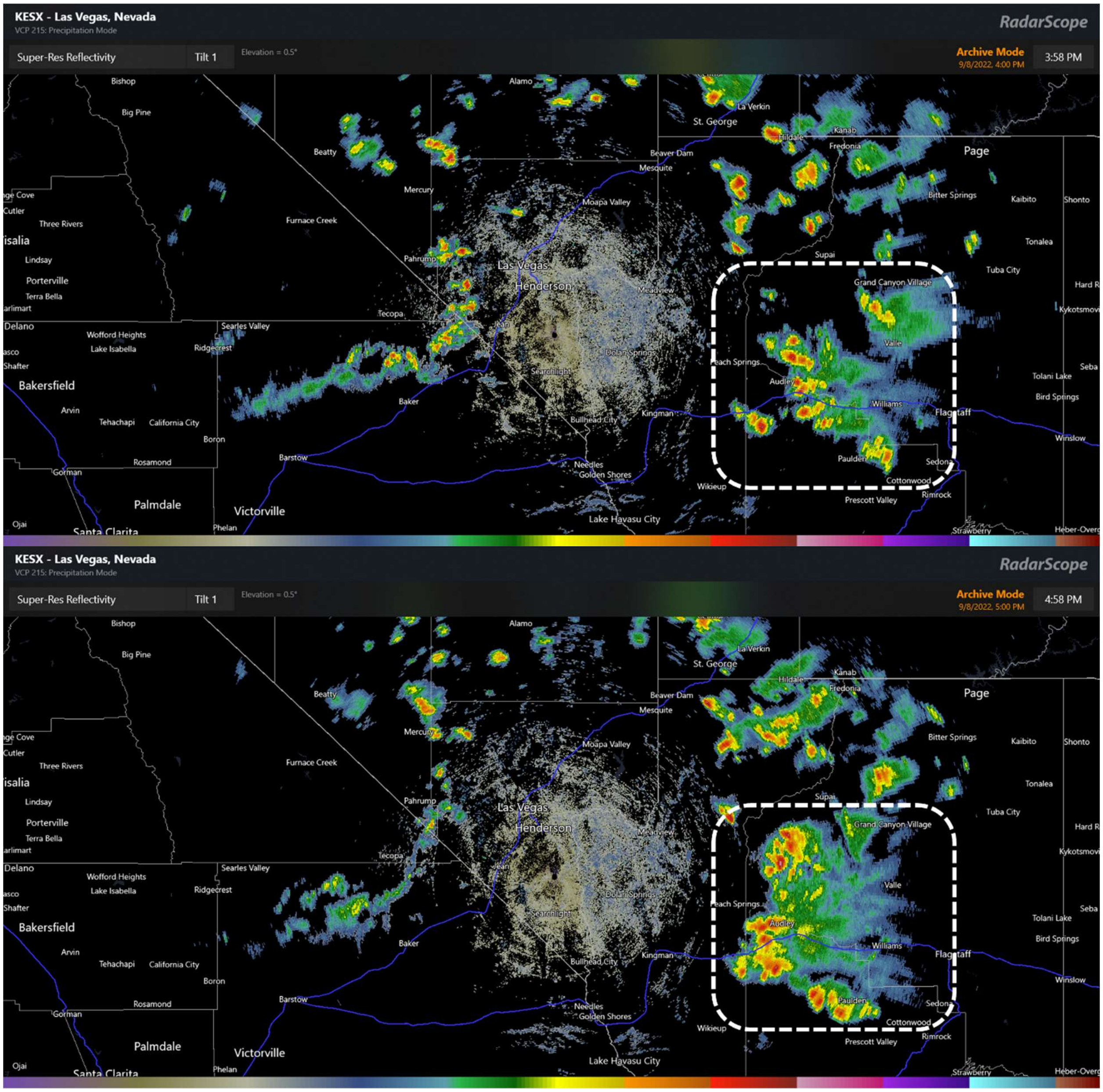


Figure 3.1-4. Radar imagery from KESX, Las Vegas at 0.5° tilt on September 8, 2022, between 15:00 PST and 16:00 PST (converted from PDT in top right corner of images). The thunderstorms causing the outflow boundary and dust lofting are shown in white boxes. Source: RadarScope.

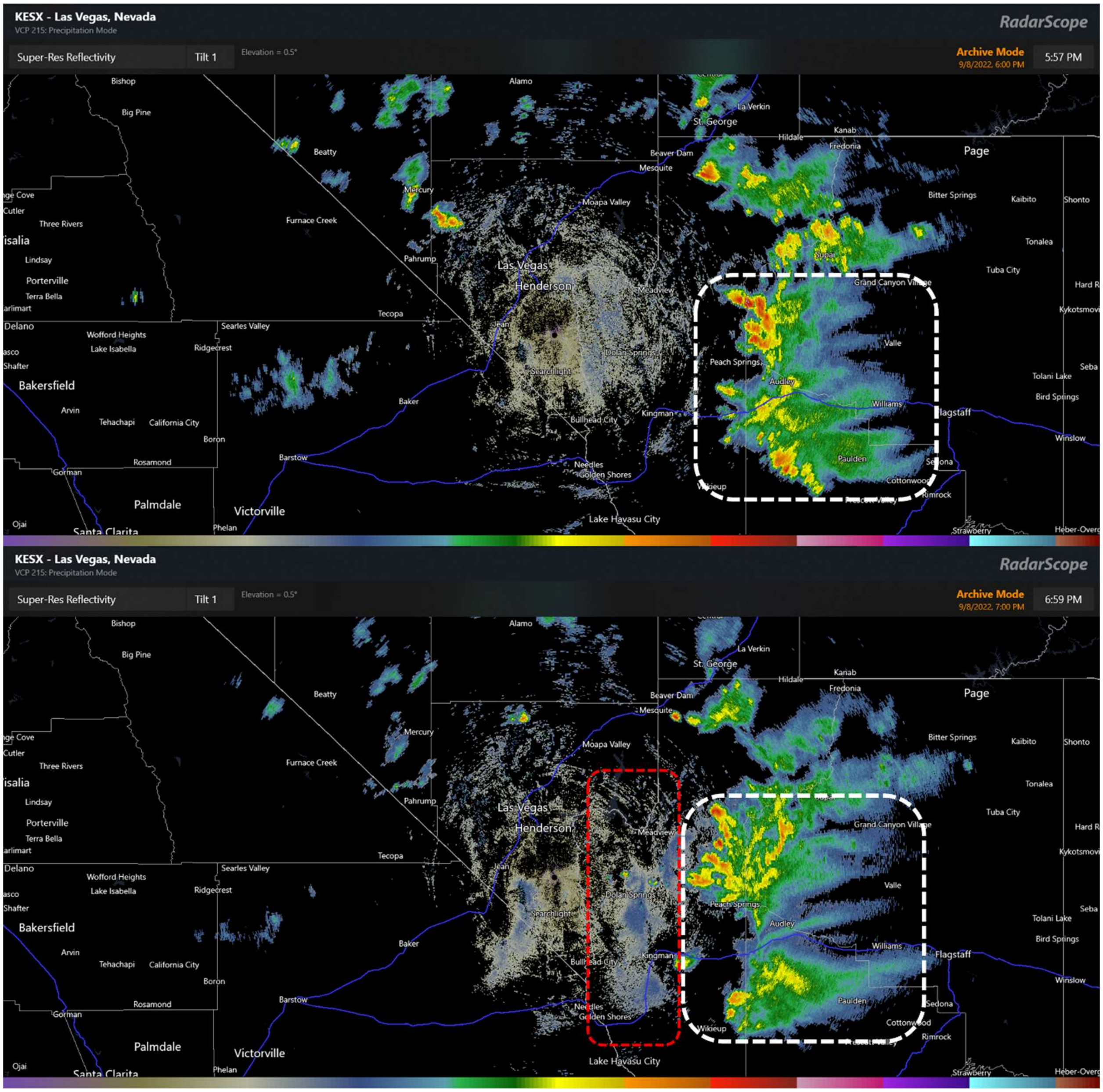


Figure 3.1-5. Radar imagery from KESX, Las Vegas at 0.5° tilt on September 8, 2022, between 17:00 PST and 18:00 PST (converted from PDT in top right corner of images). The thunderstorms causing the outflow boundary and dust lofting are shown in white boxes. The outflow boundary is shown in the red boxes. Source: RadarScope

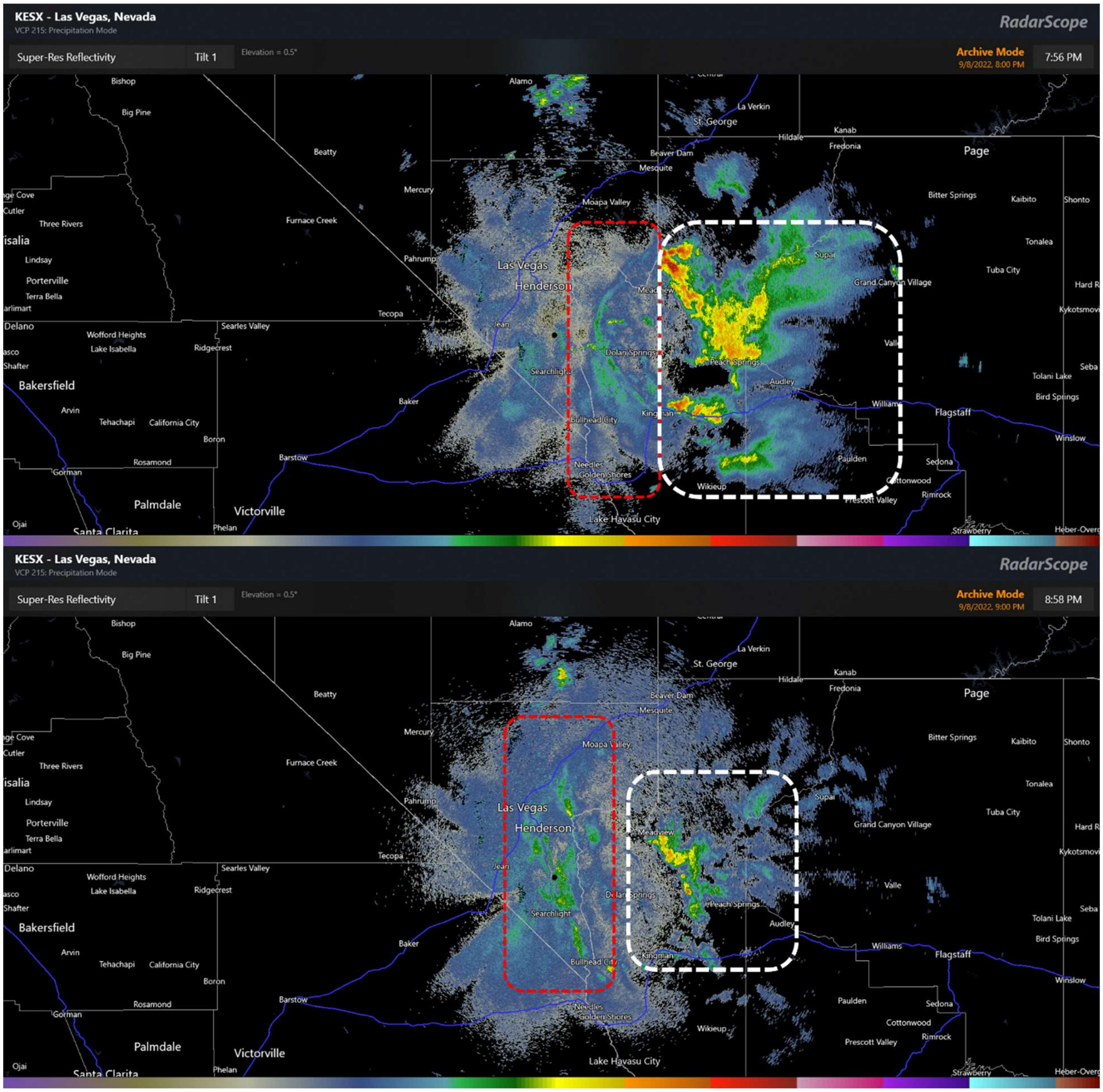


Figure 3.1-6. Radar imagery from KESX, Las Vegas at 0.5° tilt on September 8, 2022, between 19:00 PST and 20:00 PST (converted from PDT in top right corner of images). The thunderstorms causing the outflow boundary and dust lofting are shown in white boxes. The outflow boundary is shown in the red boxes.

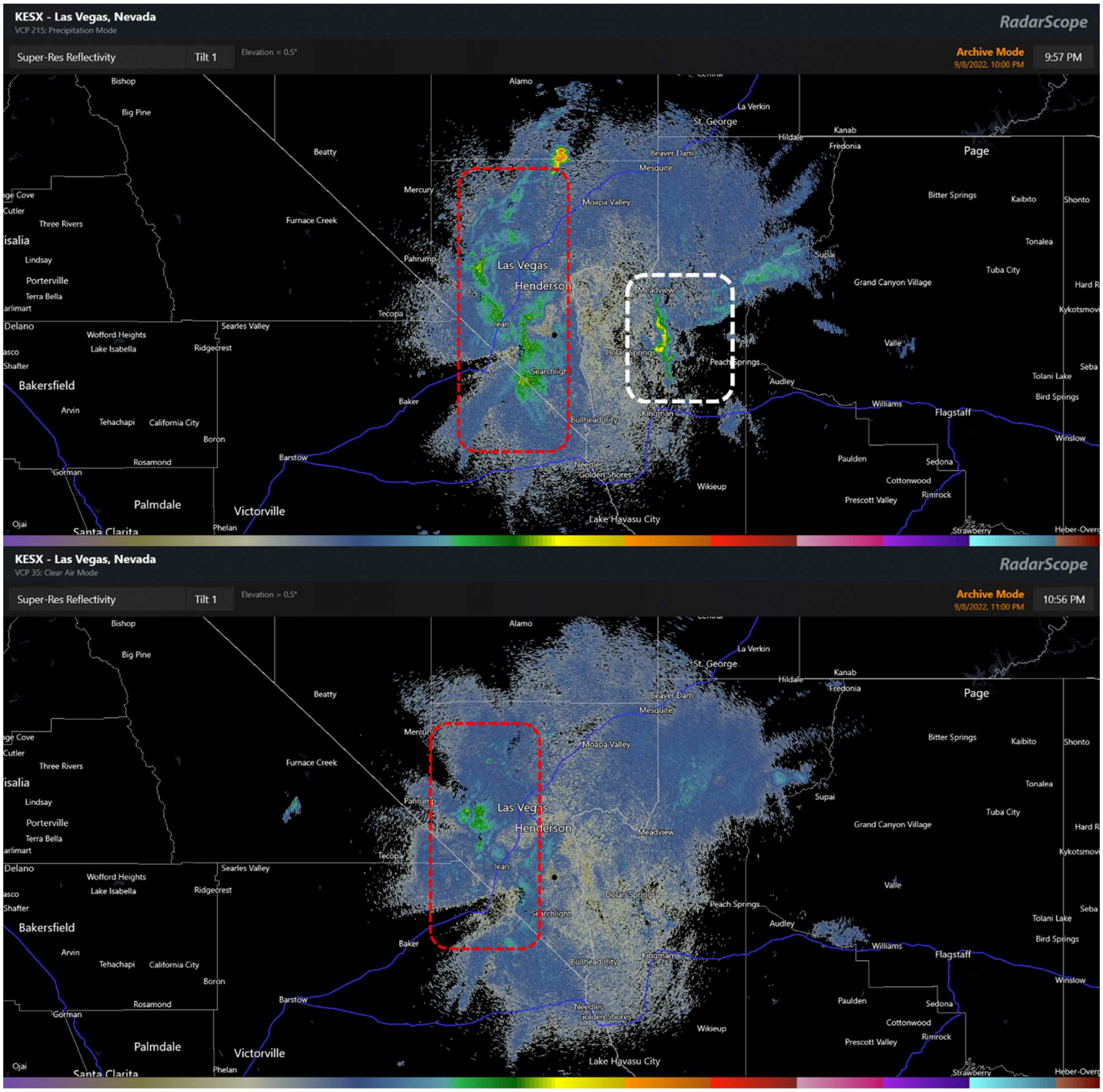


Figure 3.1-7. Radar imagery from KESX, Las Vegas at 0.5° tilt on September 8, 2022, between 21:00 PST and 22:00 PST (converted from PDT in top right corner of images). The thunderstorms causing the outflow boundary and dust lofting are shown in white boxes. The outflow boundary is shown in the red boxes. Source: RadarScope.

The outflow boundary shifted winds from light southerly at 19:00 PST to moderate and gusty east-southeasterly in the 20:00-21:00 PST timeframe. Numerous weather stations across the Las Vegas metropolitan area reported 20-35 mph wind gusts (Figure 3.1-8) as the boundary passed by. At the North Las Vegas Airport (KVGT), the 21:00 PST winds were sustained at 25 mph, with a recorded peak gust of 31 mph.

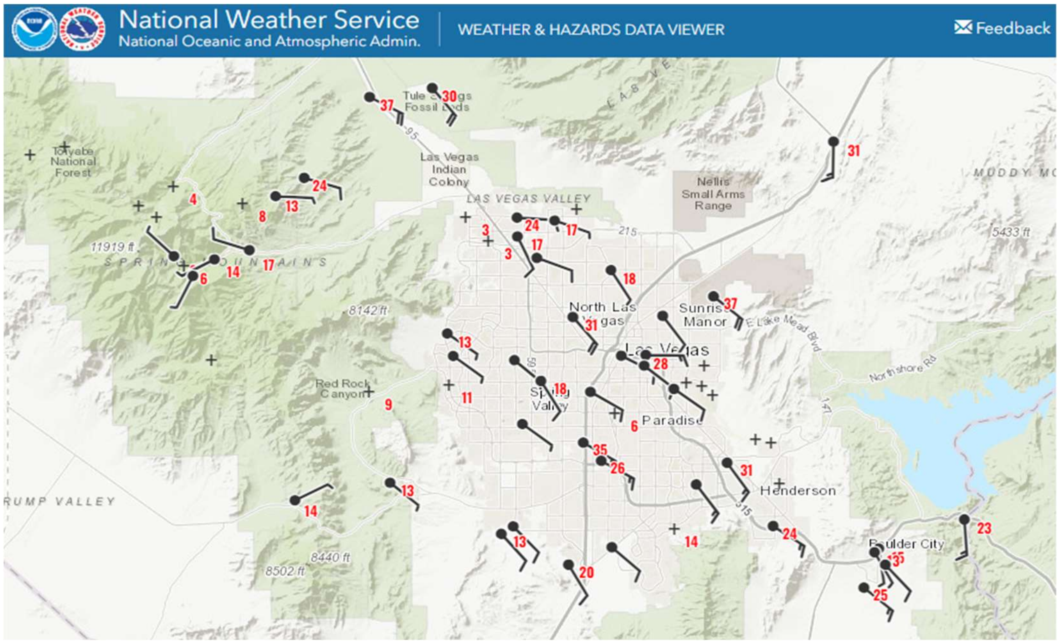


Figure 3.1-8. Reported wind direction, speed, and gust (red numbers) at 21:00 PST on September 8, 2022. Courtesy: National Weather Service

As the outflow boundary departed the Las Vegas metropolitan area, wind speeds rapidly diminished, becoming calm to light and variable throughout much of the morning on September 9. While these winds were not producing additional blowing dust, the lack of dispersion allowed lingering dust to remain in the Las Vegas metropolitan area. Dispersion of dust increased between 10:00 and 12:00 PST on September 9 as south-southeasterly winds strengthened to 10-20 mph.

3.1.2 Satellite Images and Analysis

The thunderstorm and associated outflow boundary causing the dust event on September 8-9, 2022, was a local event that was not well captured by satellite imagery. Visible imagery does show the effects of Hurricane Kay impacting northwestern Arizona and southern Nevada on September 8 and 9, 2022, in Figure 3.1-9 and Figure 3.1-10.

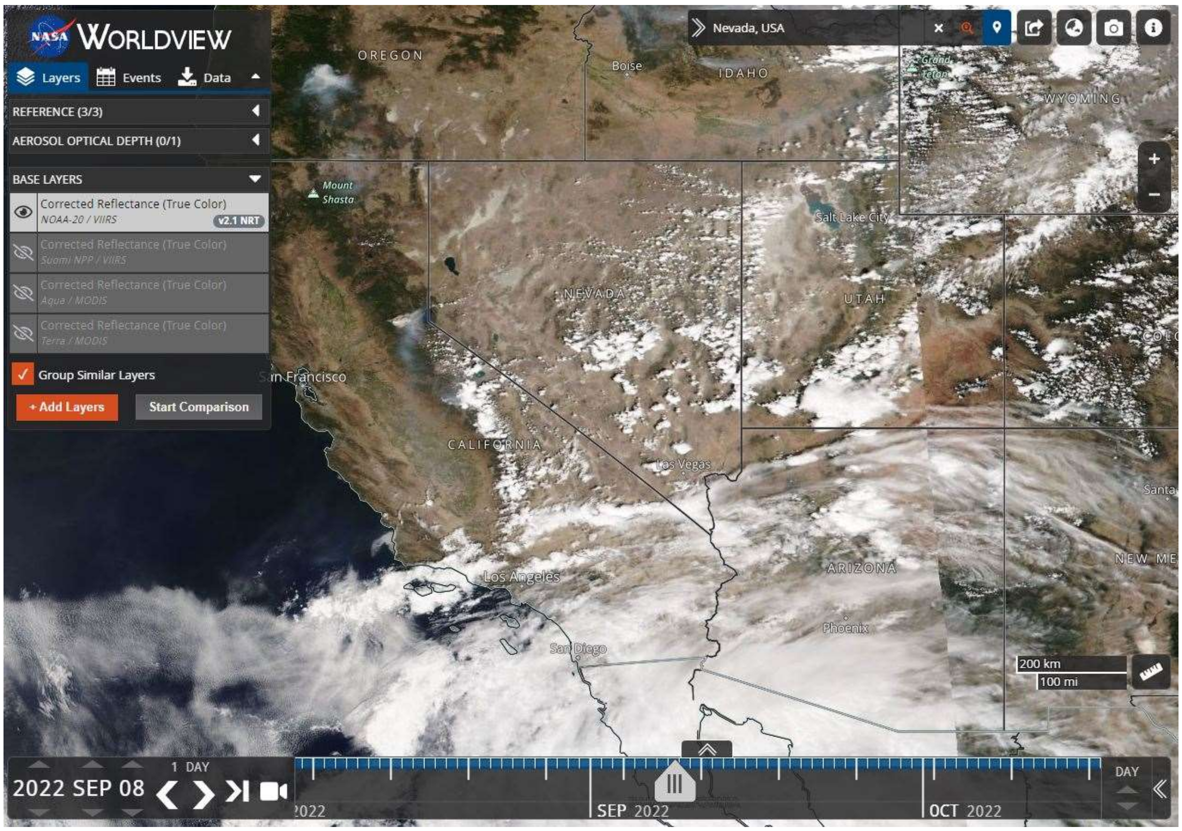


Figure 3.1-9. Satellite imagery of true color from NOAA-20 VIIRS at 14:30 local time on September 8, 2022.

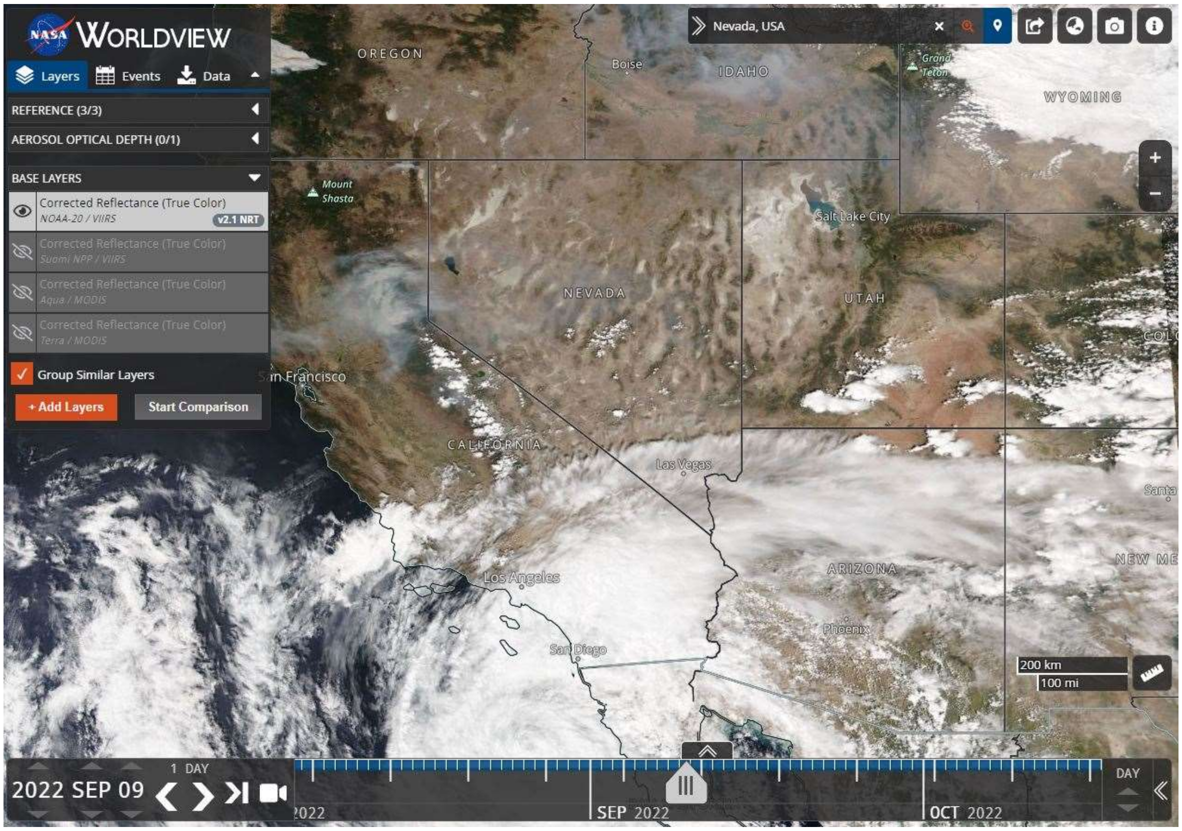


Figure 3.1-10. Satellite imagery of true color from NOAA-20 VIIRS at 14:30 local time on September 9, 2022.

3.1.3 Supporting Ground-Based Data

We were unable to find ground-based images in the source region due to the remote location.

Peak sustained winds in the Mojave Desert area of northwestern Arizona and southern Nevada (dust source regions) were developed via the Iowa State University Mesonet Automated Data Plotter. This tool aggregates automated weather data records from the selected region. Figure 3.1-11 shows the peak sustained wind speeds in northwestern Arizona and Mojave Desert peaked at 36 mph on September 8, 2022 (the 86-mph region is associated with the thunderstorms, not the outflow boundary created and shown in the radar images in Section 3.1.1). Figure 3.1-12 shows the peak sustained wind speeds in southern Nevada and Mojave Desert peaked around 37 mph on September 8, 2022. These peak sustained wind speeds were well above the 25-mph threshold in the Mojave Desert source region in both Arizona and Nevada and could easily loft, entrain, and transport PM_{10} downwind quickly to Clark County.

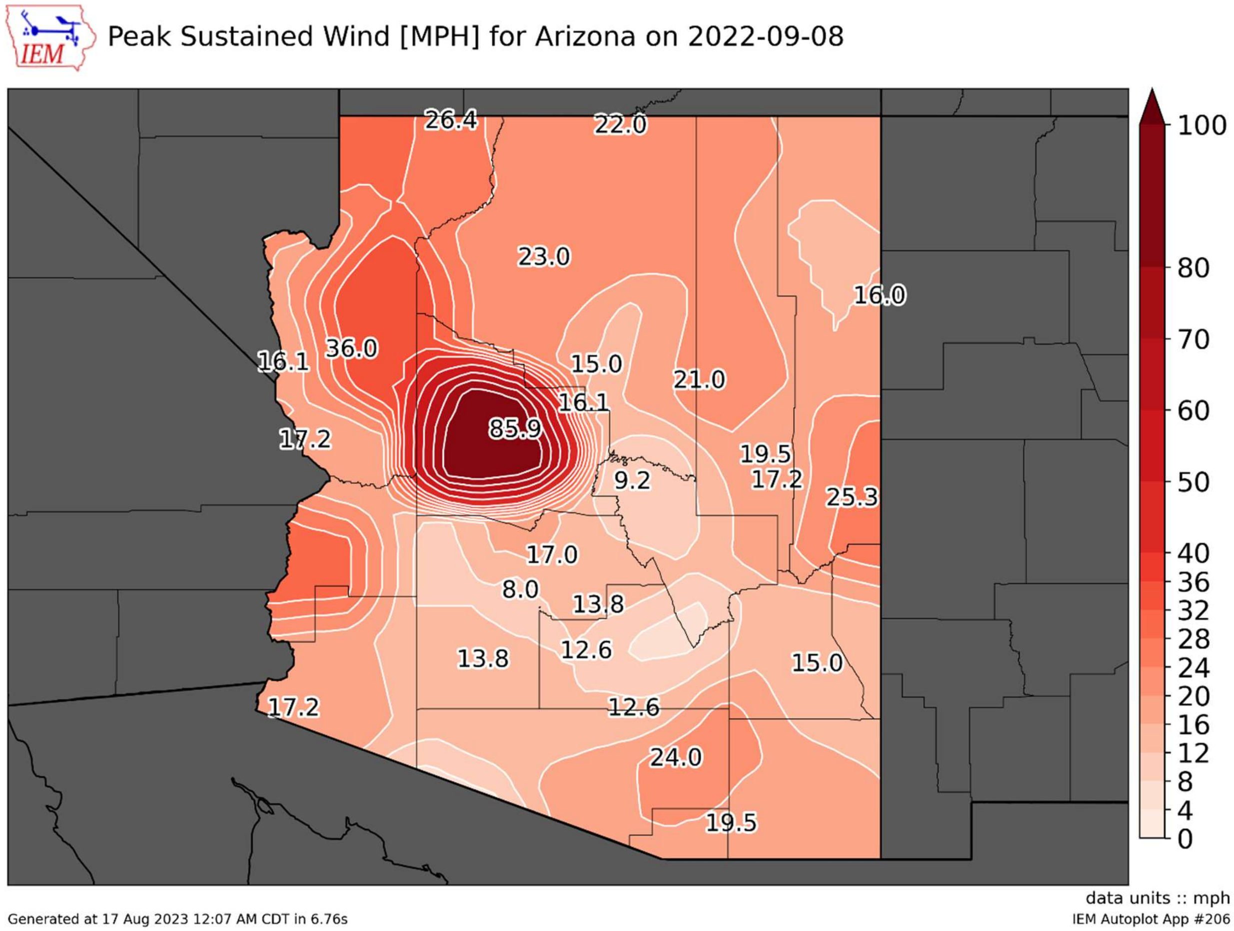


Figure 3.1-11. Peak sustained winds for Arizona on September 8, 2022. The source region is located in the northwestern part of Arizona (the Mojave Desert region). Data source https://mesonet.agron.iastate.edu/plotting/auto/.

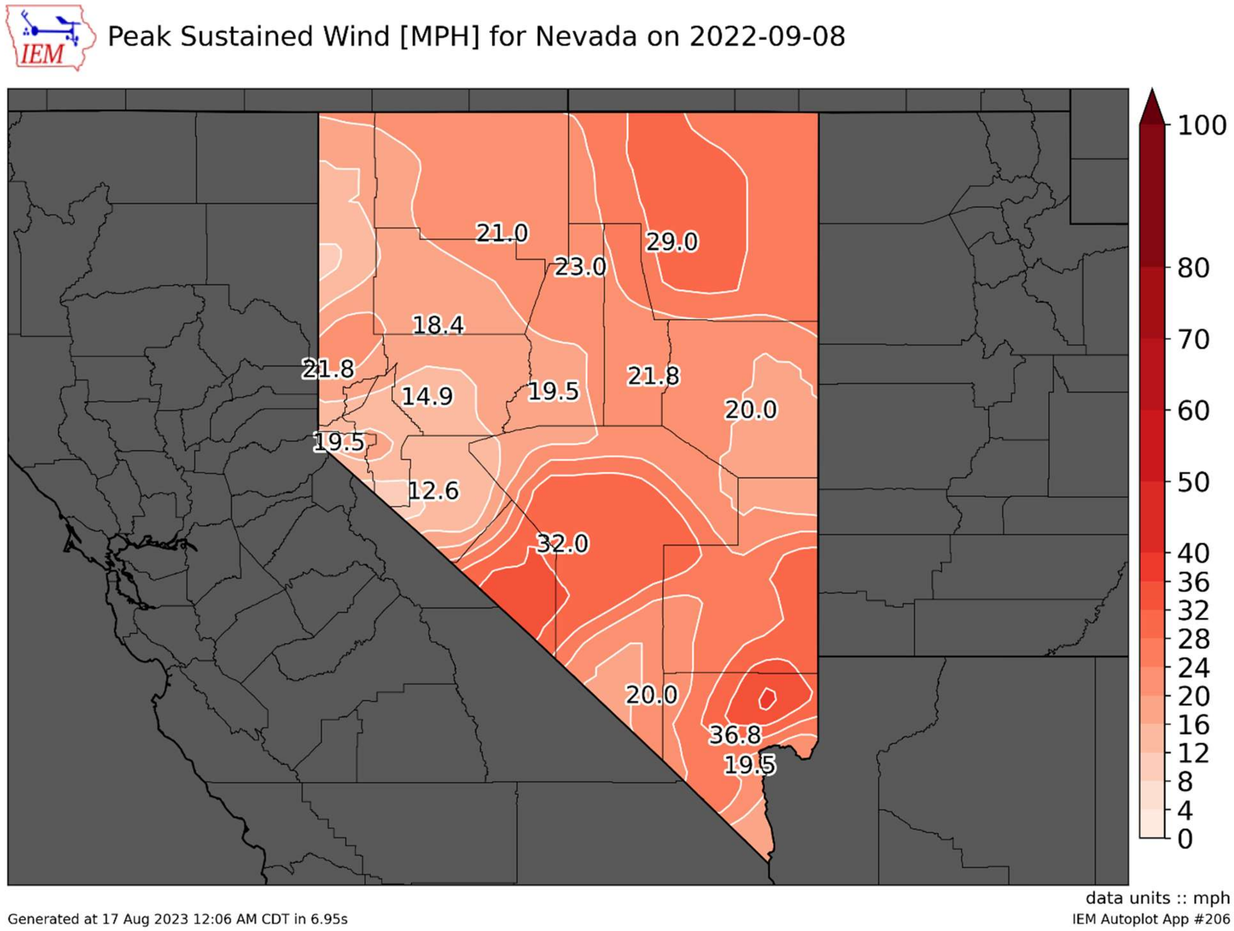


Figure 3.1-12. Peak sustained winds for Nevada on September 8, 2022. The source region is located in the southern part of Nevada (the Mojave Desert region). Data source https://mesonet.agron.iastate.edu/plotting/auto/.

Overall, we found overwhelming evidence that PM_{10} was very likely lofted, entrained, and transported from the Mojave Desert region in northwestern Arizona and southern Nevada in the late afternoon and evening on September 8, 2022. The lofting and entrainment of PM_{10} was due to the gusty winds from the outflow boundary of a Hurricane Kay-initiated thunderstorm. The evidence corroborating this assertion includes (1) the meteorological analysis that shows conditions from Hurricane Kay, upper-level divergence, and convection and outflow winds were conducive for strong winds; (2) radar images from Las Vegas showing the progression of dust moving from the Mojave Desert in northwestern Arizona and southern Nevada into the Clark County area along the outflow boundary progression; and (3) aggregated measurements of high winds in the Mojave Desert source region in Arizona and Nevada on September 8, 2022.

3.2 Transport to Clark County

3.2.1 HYSPLIT Analysis

Unfortunately, due to the very local-scale, quick-moving outflow boundary from the hurricane-initiated thunderstorms in northwestern Arizona, HYSPLIT modeling does not provide useful information for this event. We rely on the radar observations and meteorological analysis in Section 3.1 and the event timeline in Section 3.2.2 to provide evidence for this dust event.

3.2.2 High-Wind Event Timeline

Timelines of two-minute rolling average wind speeds reported every five minutes at stations in the source region (northwestern Arizona) and Las Vegas are provided in **Figure 3.2-1**. The movement of the gust front detailed in Section 3.1.1 can be tracked by subsequent, sudden intensification of wind conditions first at KIGM, and then at PFYA3, as the outflow boundary traveled northwest. Sustained wind observations increased from under 10 mph to 30 mph between 17:20 and 17:50 PST at KIGM. Then, winds at PFYA intensified suddenly from near-zero to 40 mph sustained speeds between 18:15 and 19:15 PST. As shown by the mapped wind roses in Figure 3.2-1, the highest wind speeds recorded between 16:00 PST on September 8 and 00:00 PST on September 9, 2022, came from an east-southeasterly direction toward Las Vegas. Two-minute rolling average wind speeds exceeded the 25-mph threshold at both source-region weather stations, reaching a maximum of 36 mph at KIGM and 40 mph at PFYA3. The EPA should consider shorter-averaged wind speed observations in lieu of hourly average wind speeds in comparison to the 25-mph threshold due to the fleeting nature of the outflow boundary from a thunderstorm. The intensity of winds caused by a gust front are not well captured by hourly average metrics. The outflow boundary that caused the windblown dust event on September 8-9 moved quickly through the region, causing sudden and drastic increases in wind speeds that calmed just as quickly and returned to prior conditions. Furthermore, a lack of available continuous wind-speed data in the source region prevents an accurate calculation of hourly average wind speed.

Concentrations of PM_{10} increased rapidly in Clark County between 19:00 and 21:00 on September 8, 2022. This aligns well with the timing between the passage of the outflow boundary in northwestern Arizona (17:00-18:30 PST) and enhanced PM_{10} concentrations measured in Clark County (19:00-21:00 PST), providing evidence that supports the transport of dust entrained by the gust front between the source region and Las Vegas.

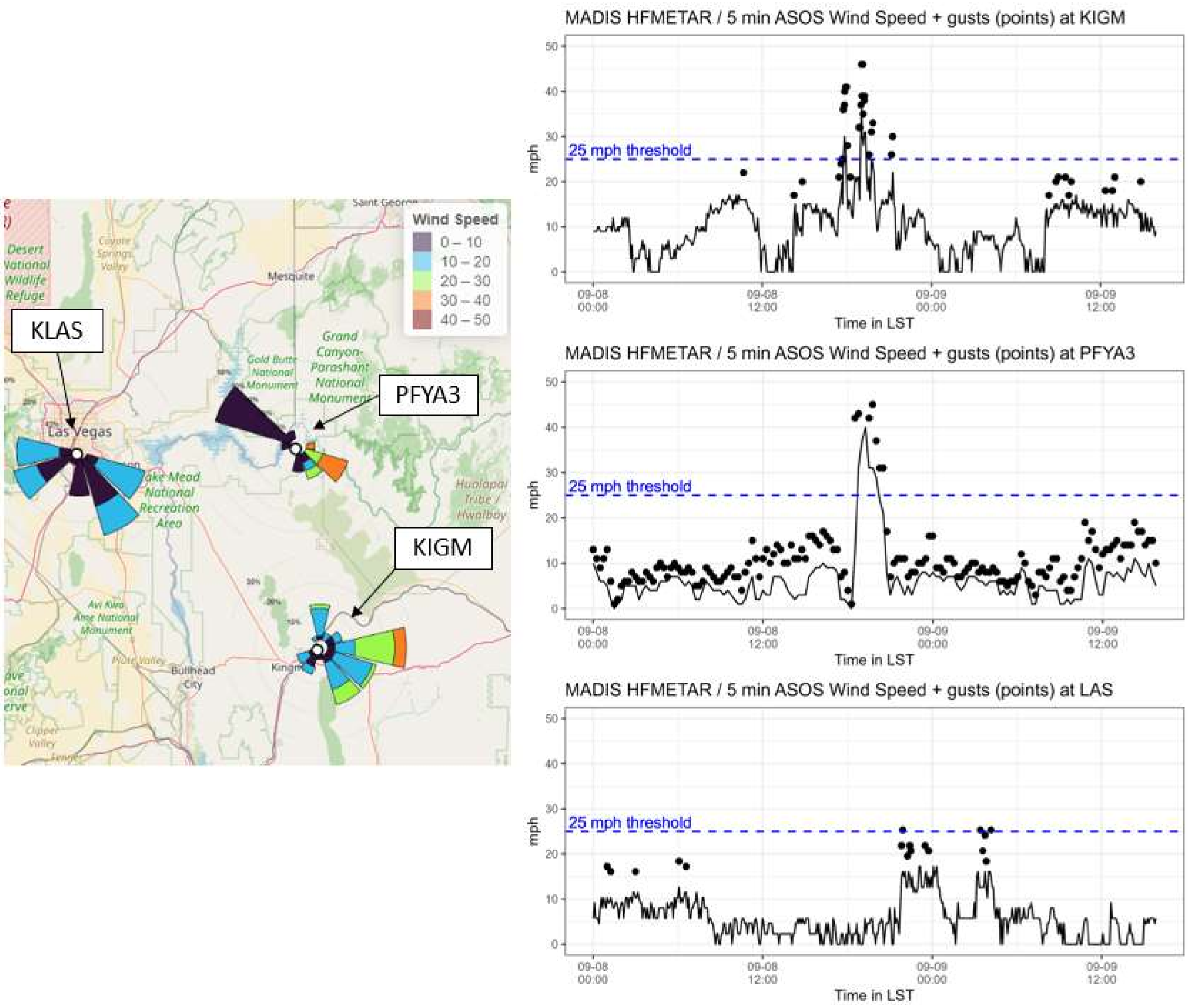


Figure 3.2-1. (Left) Weather stations (PFYA3, KIGM, and KLAS) between the source region and Las Vegas overlaid with wind roses displaying wind speed and wind direction from 16:00 PST on September 8, 2022, to 00:00 PST on September 9, 2022. (Right) Timeseries of wind speed and wind direction data at PFYA3, KIGM, and KLAS on September 8-9, 2022. Data comprises two-minute rolling average wind speed (line) and gusts (points) reported at five-min intervals. Data is sourced from the NWS Weather and Hazards Data Viewer (**https://www.wrh.noaa.gov/map**).

The period of high PM_{10} concentrations immediately followed a burst of high wind speed in the source region (**Figure 3.2-2**). Wind speeds first rose as the outflow boundary pushed across northwestern Arizona between 17:00 and 18:30 at both KIGM and PFYA3. PM_{10} concentrations in the Las Vegas Valley, shown at Green Valley and Jerome Mack, were enhanced between 19:00 and 21:00 PST as dust entrained by the gust front was transported into Clark County.

The progression of wind speed and PM_{10} concentrations across the Las Vegas Valley associated with this event is shown in **Figure 3.2-3 through Figure 3.2-102.** Before the event occurred (15:00 – 18:00 PST), winds were light out of the west-southwest with PM_{10} concentrations in the good to moderate

AQI range (< 150 µg/m^3). By 19:00 PST, the Garrett Jr. High monitoring site in the far southeast corner of the Las Vegas Valley showed an extreme enhancement of PM_{10} from < 50 µg/m^3 at 18:00 PST to > 500 µg/m^3 in one hour. Winds at Garrett also shifted to the southeast after being variable for the last few hours. Garrett Jr. High in Boulder City, Nevada, being the first affected monitoring site is consistent with the meteorological analysis, the direction of the outflow boundary movement, and direction of the source region. By 20:00 PST, all sites in the eastern half of the Valley show extremely enhanced concentrations of PM_{10} (> 500 µg/m^3) and winds out of the southwest. Only the eastern half of the Valley is affected at this point due to the outflow boundary movement from southeast to northwest. Additionally, one of the major transport corridors into the Valley is the mountain pass at the southeastern end of the Las Vegas Valley. This mountain pass near Boulder City separates the northern McCullough Range to the south and the Sunrise and River Mountains to the north. This is shown via the topographic background in Figure 3.2-3 through Figure 3.2-102. Monitoring sites that were directly downwind of the mountain pass, such as Green Valley, Sunrise Acres, and Joe Neal are affected by the outflow boundary and associated PM_{10} first. Sites in the southwestern portion of the Valley are initially protected by the McCullough Range until 21:00 PST when the outflow boundary and PM_{10} pushes fully into the Valley. By 21:00 PST, the entire Valley is affected with all sites except Mountains Edge showing concentrations of > 500 µg/m^3. The additional hour of PM_{10} affecting the eastern Valley sites is the cause for higher 24-hour PM_{10} concentrations at those sites compared to the western sites on September 8.

Due to the rapid nature of this event, the outflow boundary had fully pushed through the Las Vegas Valley by 22:00 PST. As the outflow boundary exited the Valley, winds became light and variable as shown by the variability in wind direction between 23:00 PST on September 8 and 06:00 PST on September 9. During this light and variable wind period, PM_{10} was allowed to linger from the dust storm and settle in at the low elevation sites such as Jerome Mack, Sunrise Acres, and Walnut Community Center. This is the cause for higher 24-hour PM_{10} concentrations at the lower elevation sites on September 9. By 07:00-10:00 PST, winds from the southwest pick up, pushing the lingering PM_{10} towards the northern and western sites and finally pushing the dust out of the valley. Most sites fell below approximately 150 µg/m^3 by around 10:00 PST.

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 elevated concentrations. Further, enhanced PM_{10} concentrations at all sites in the Las Vegas Valley is indicative of 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 a natural, undisturbed desert region upwind of Clark County is clearly the main driver of this dust event. As shown by the timeline of events, high winds from a gust front lofted PM_{10} in the northwestern Arizona source region and caused a regional dust event extending 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 September 8 and 9, 2022.

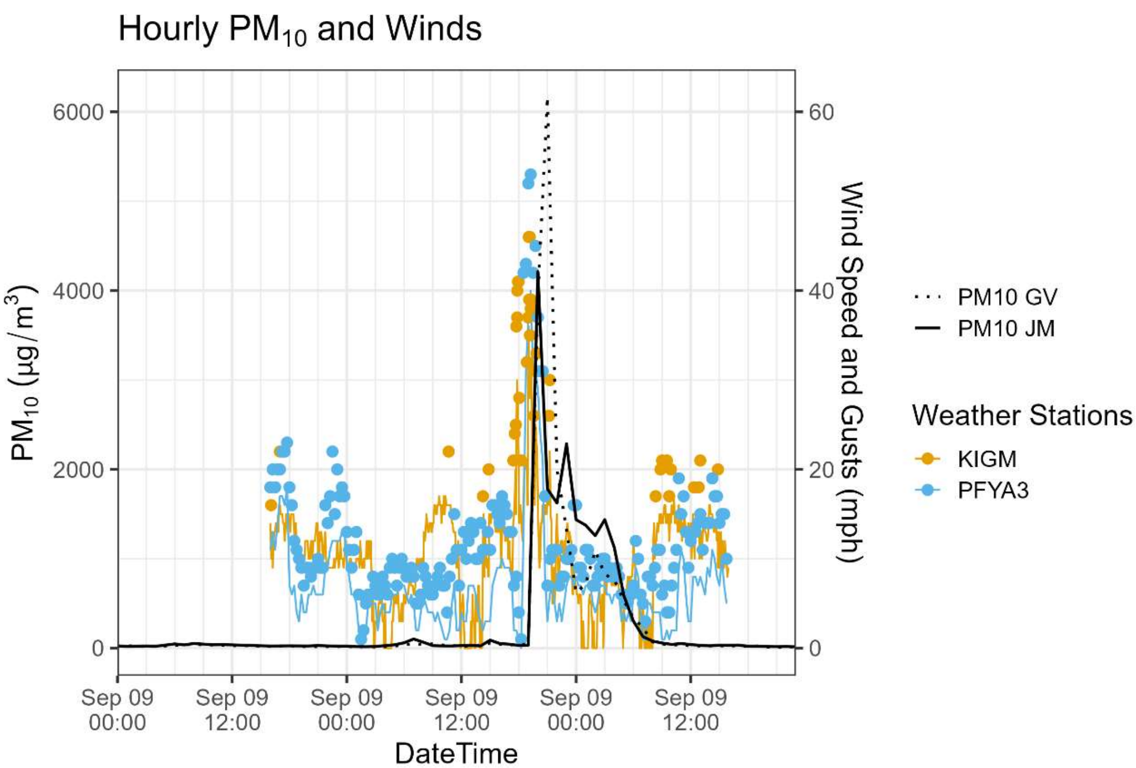


Figure 3.2-2. Hourly PM_{10} in µg/m^3 with wind speeds (lines) and wind gusts (dots) from KIGM and PFYA3 weather stations. See map in Figure 3.2-1.

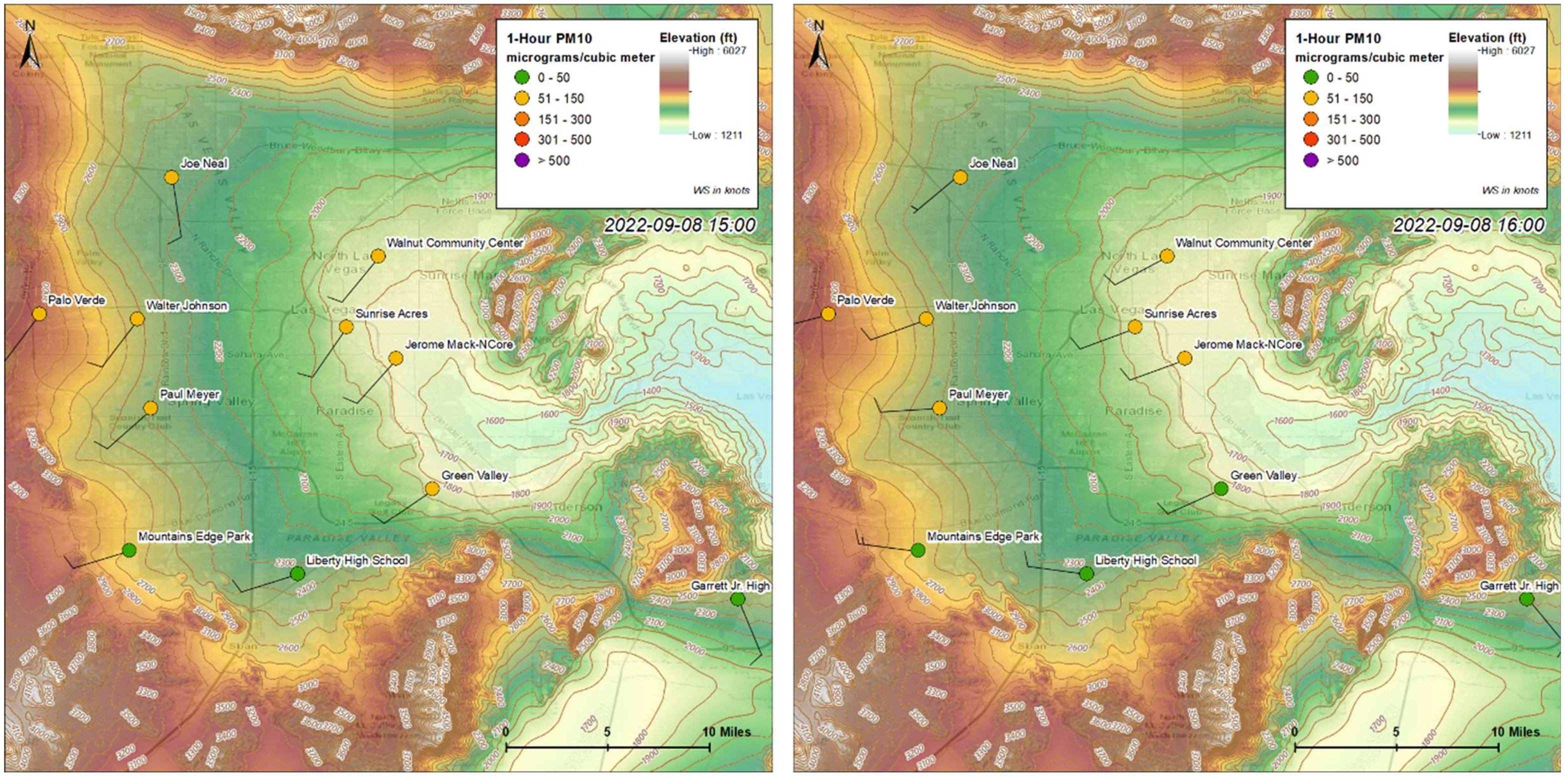


Figure 3.2-3. Surface observations of wind speed, wind direction, and hourly PM_{10} from each measurement site in Clark County, NV, and ground elevation for September 8, 2022, from 15:00 to 16:00 PST.

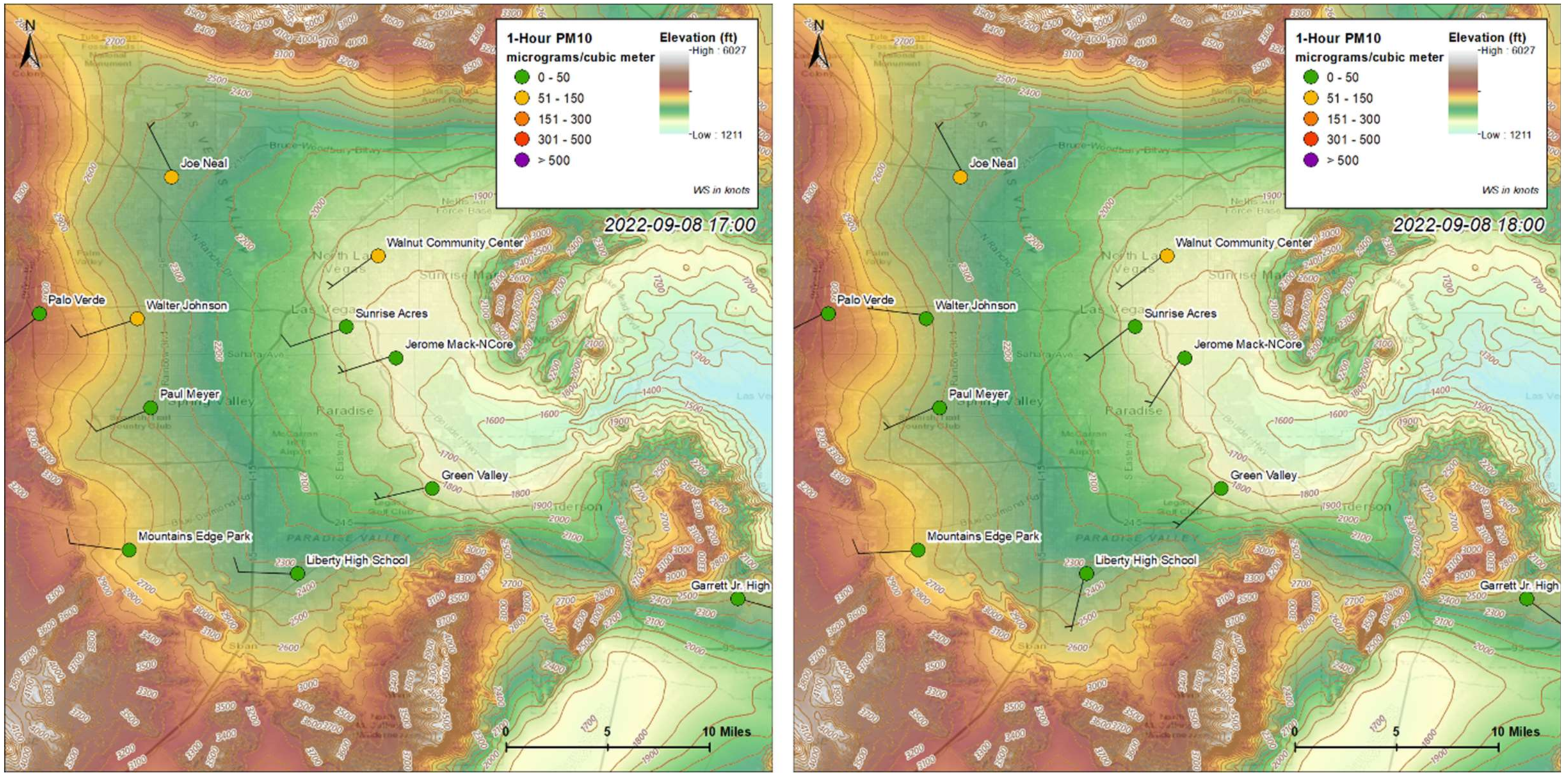


Figure 3.2-4. Surface observations of wind speed, wind direction, and hourly PM_{10} from each measurement site in Clark County, NV, and ground elevation for September 8, 2022, from 17:00 to 18:00 PST.

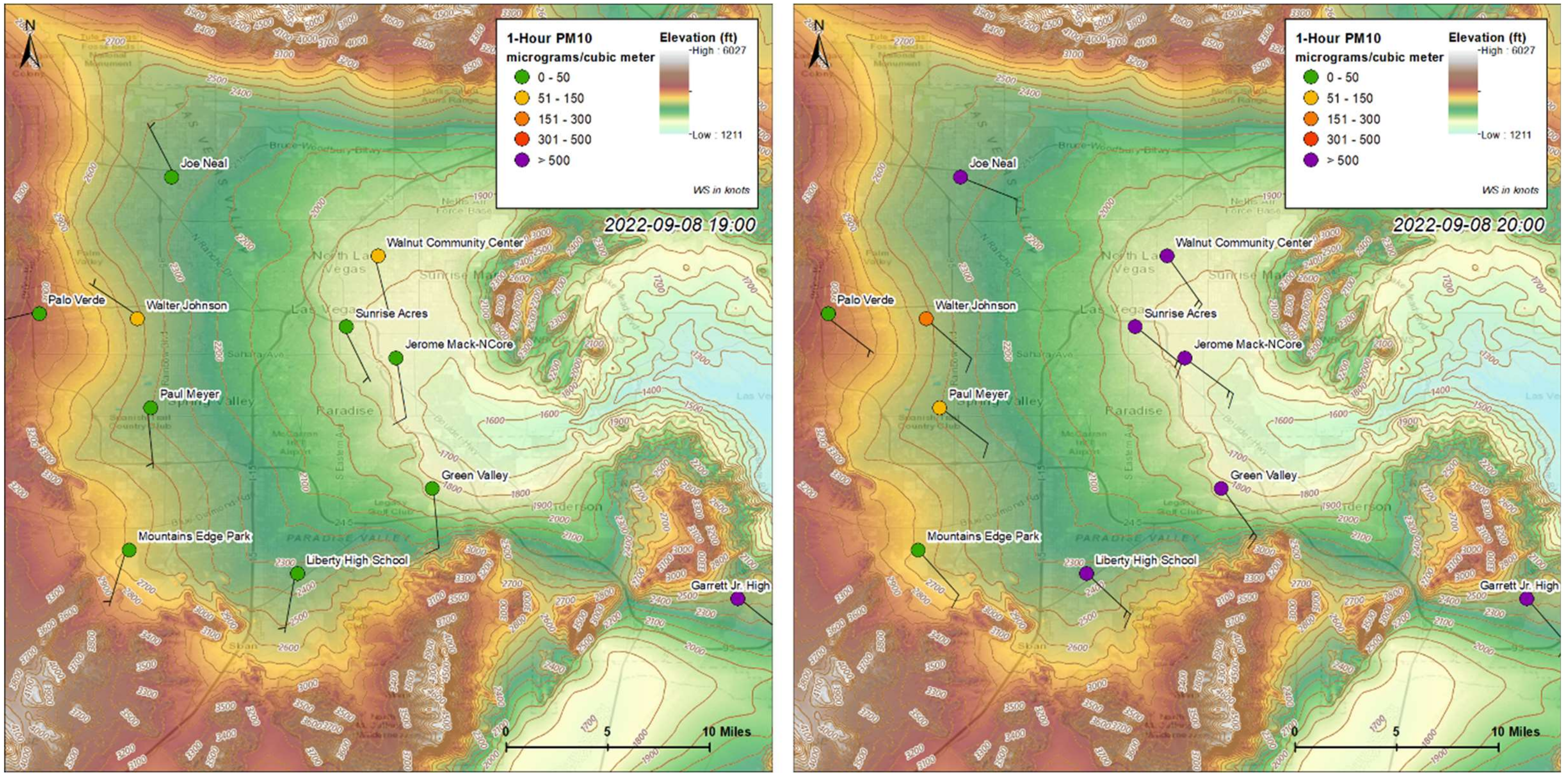


Figure 3.2-5. Surface observations of wind speed, wind direction, and hourly PM_{10} from each measurement site in Clark County, NV, and ground elevation for September 8, 2022, from 19:00 to 20:00 PST.

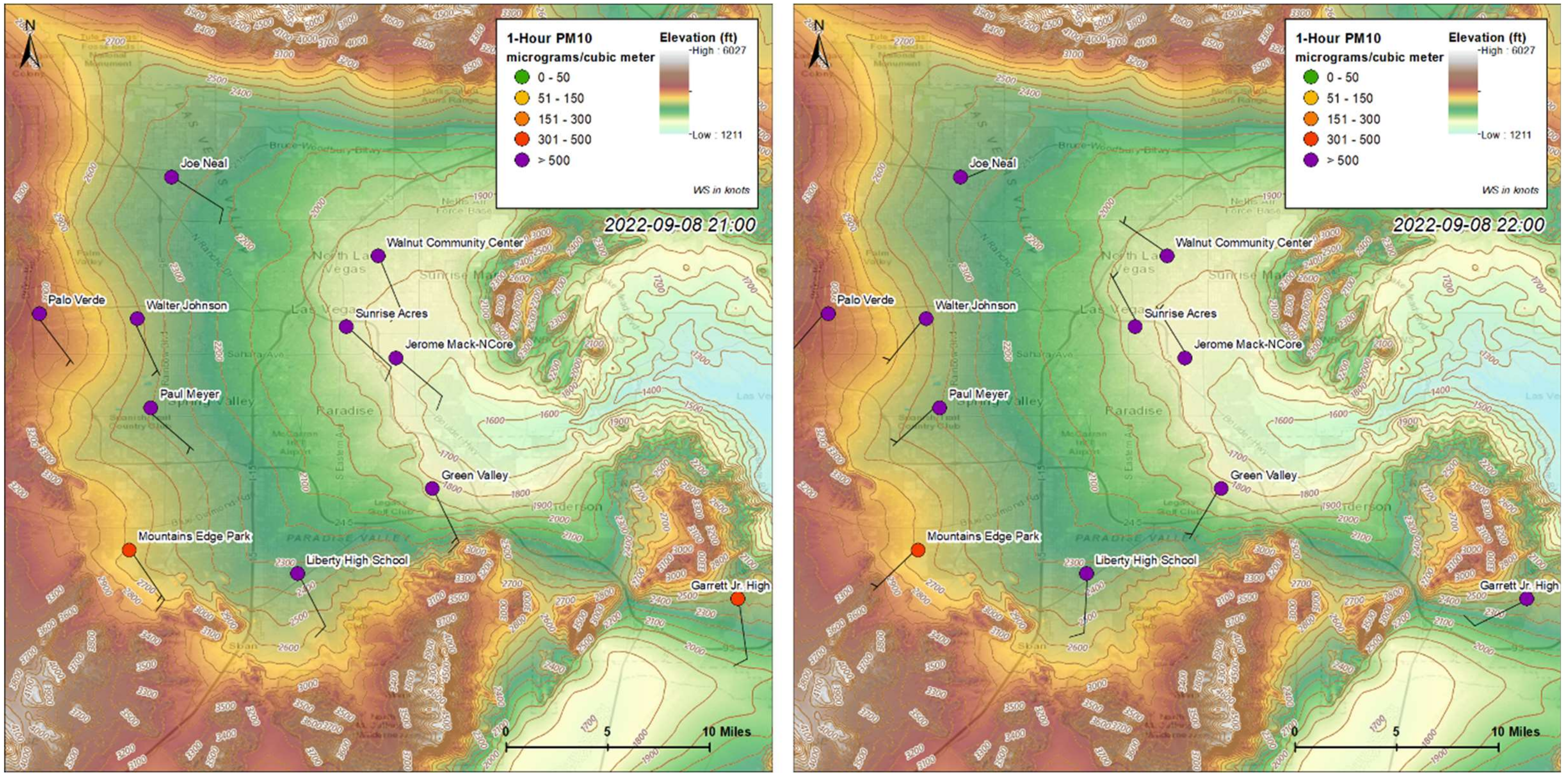


Figure 3.2-6. Surface observations of wind speed, wind direction, and hourly PM_{10} from each measurement site in Clark County, NV, and ground elevation for September 8, 2022, from 21:00 to 22:00 PST.

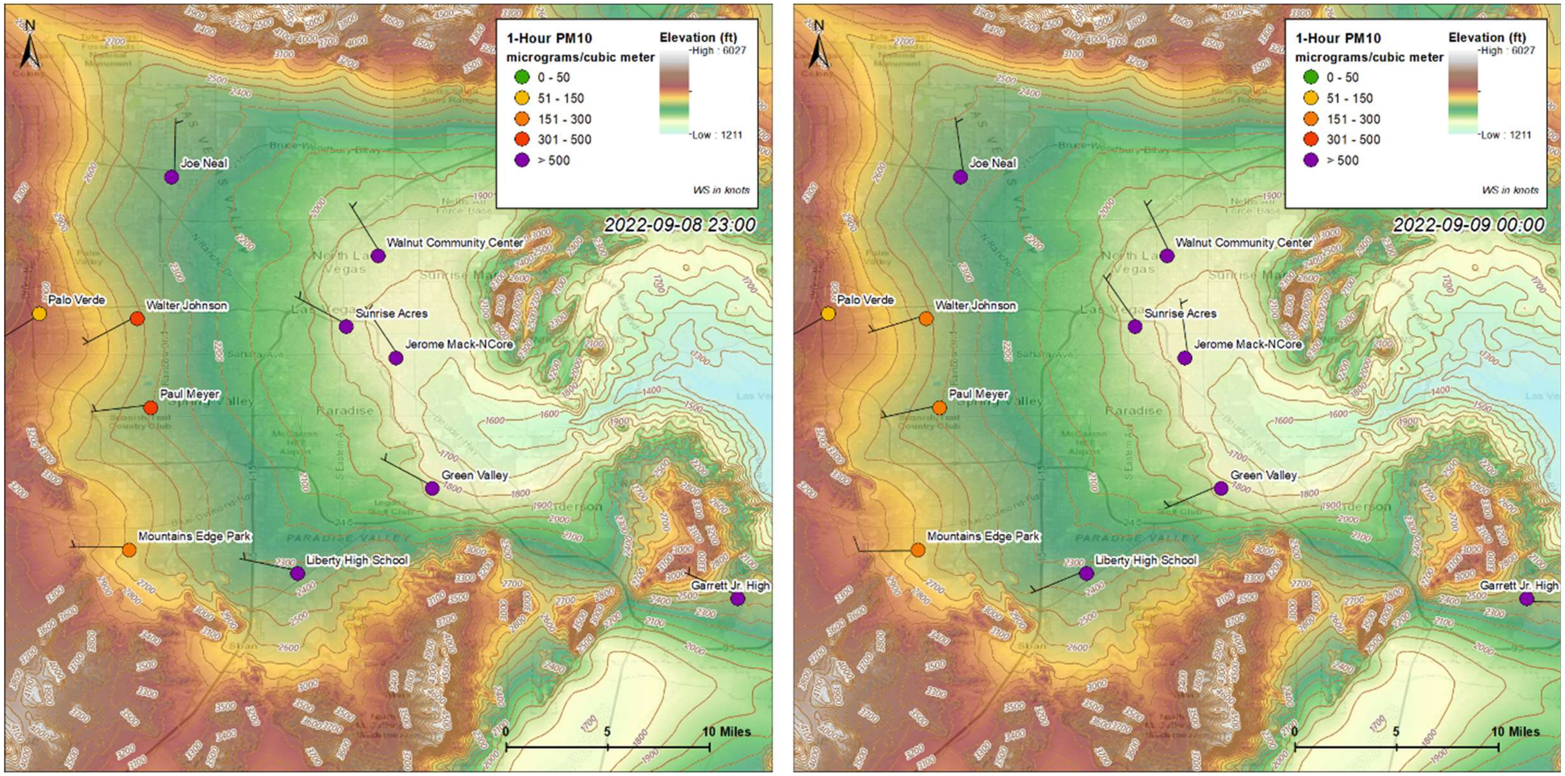


Figure 3.2-7. Surface observations of wind speed, wind direction, and hourly PM_{10} from each measurement site in Clark County, NV, and ground elevation for September 8, 2022, at 23:00 PST to September 9, 2022, at 00:00 PST.

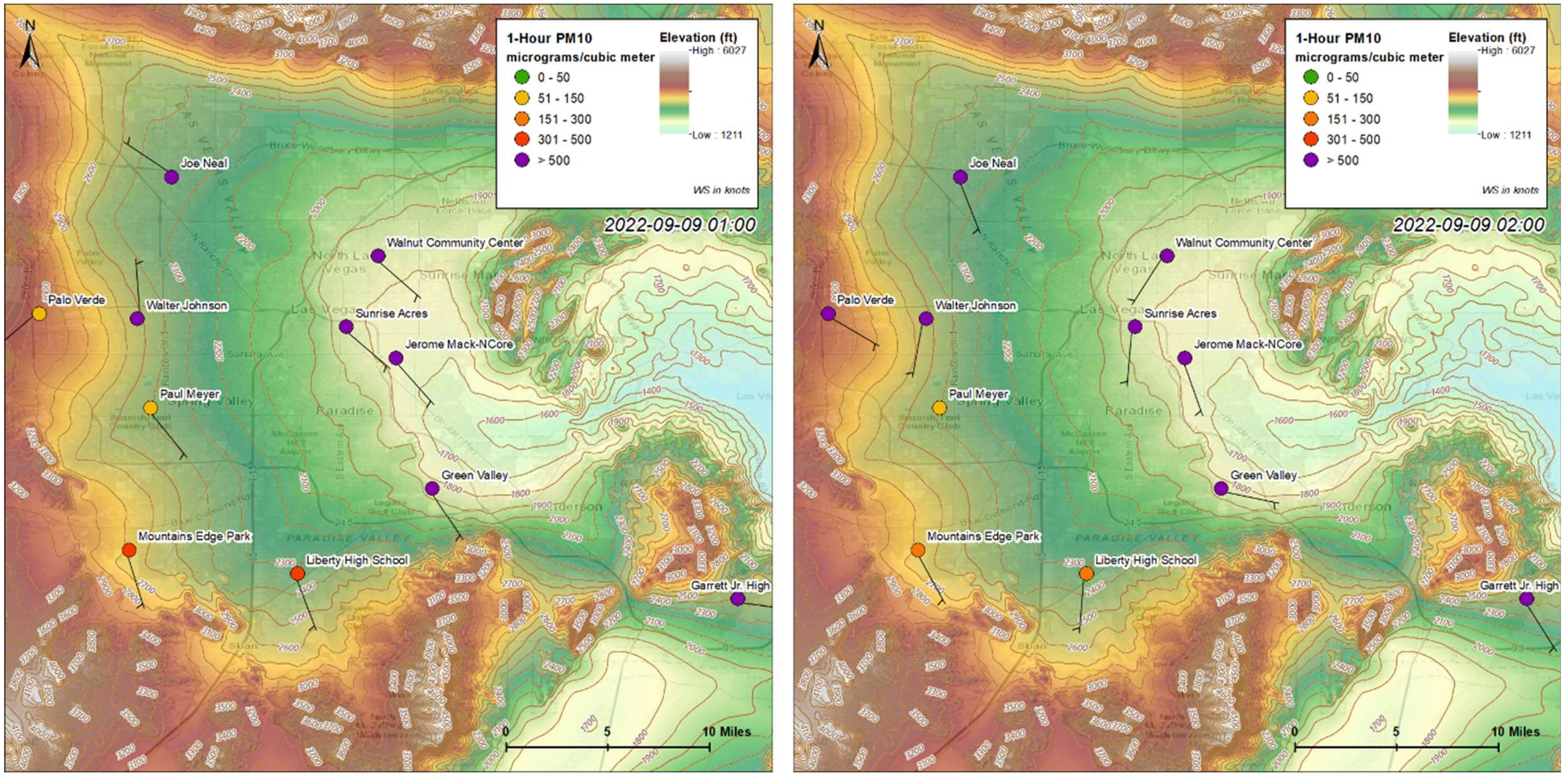


Figure 3.2-8. Surface observations of wind speed, wind direction, and hourly PM_{10} from each measurement site in Clark County, NV, and ground elevation for September 9, 2022, from 01:00 to 02:00 PST.

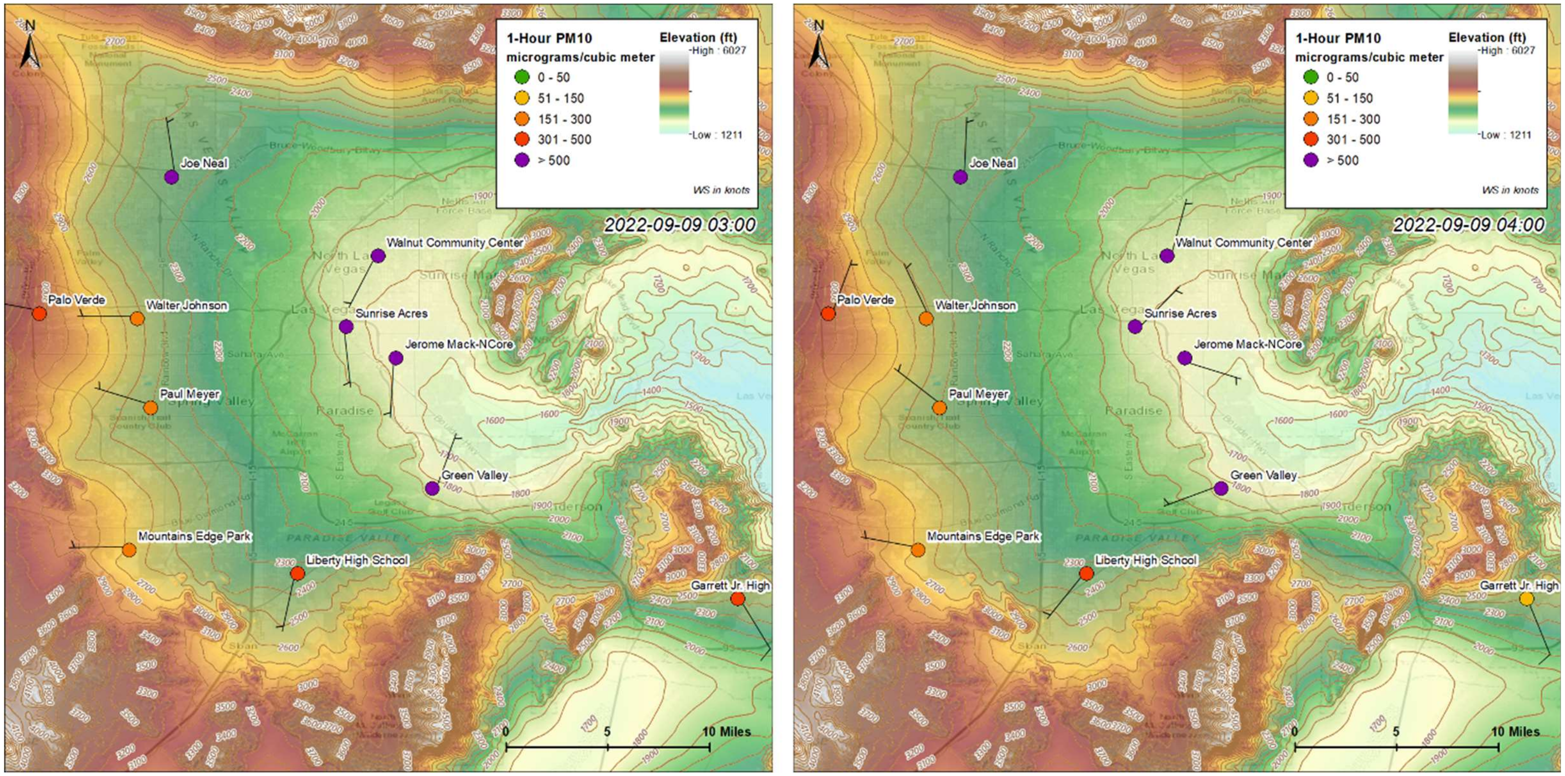


Figure 3.2-9. Surface observations of wind speed, wind direction, and hourly PM_{10} from each measurement site in Clark County, NV, and ground elevation for September 9, 2022, from 03:00 to 04:00 PST.

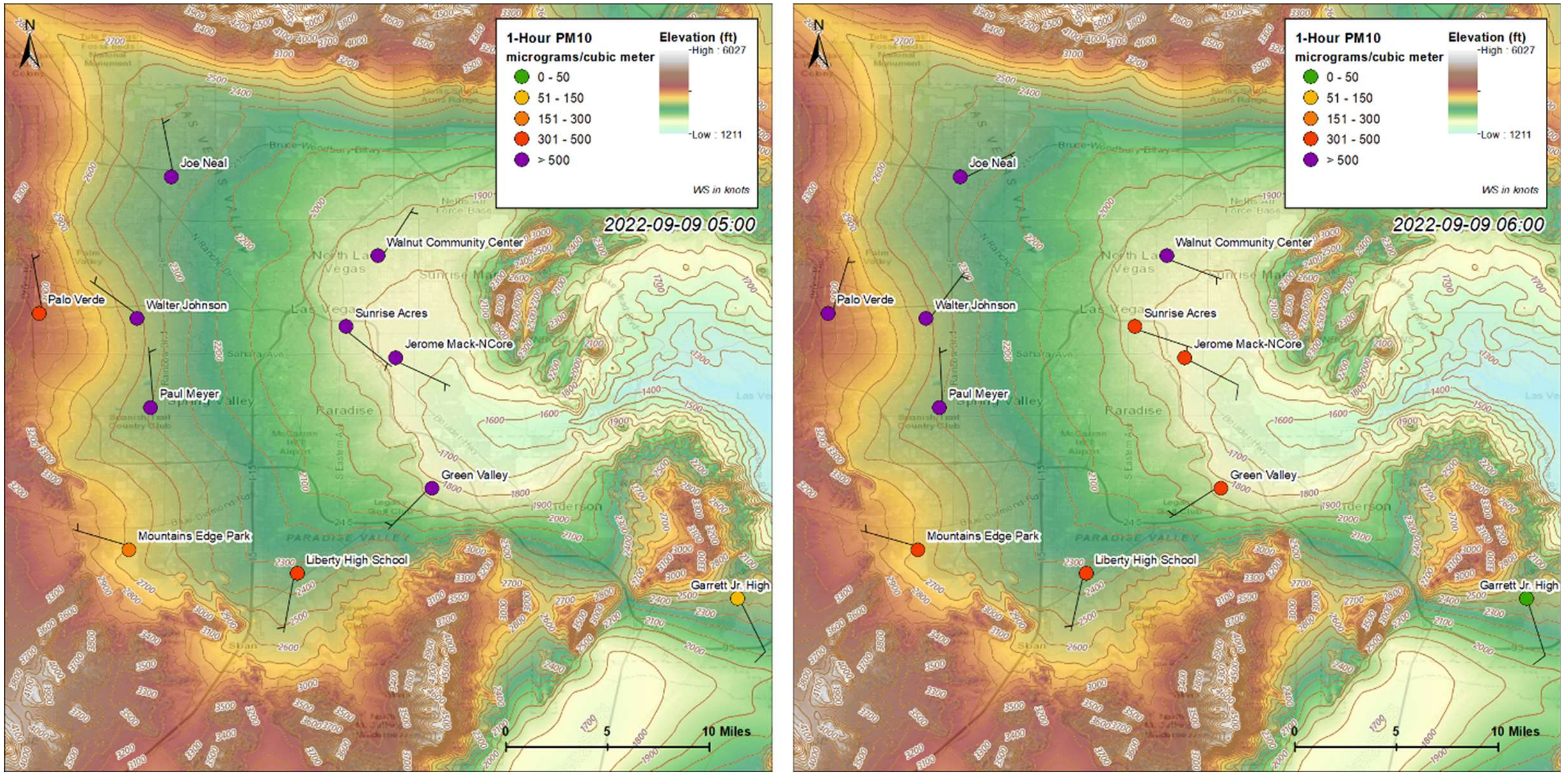


Figure 3.2-10. Surface observations of wind speed, wind direction, and hourly PM_{10} from each measurement site in Clark County, NV, and ground elevation for September 9, 2022, from 05:00 to 06:00 PST.

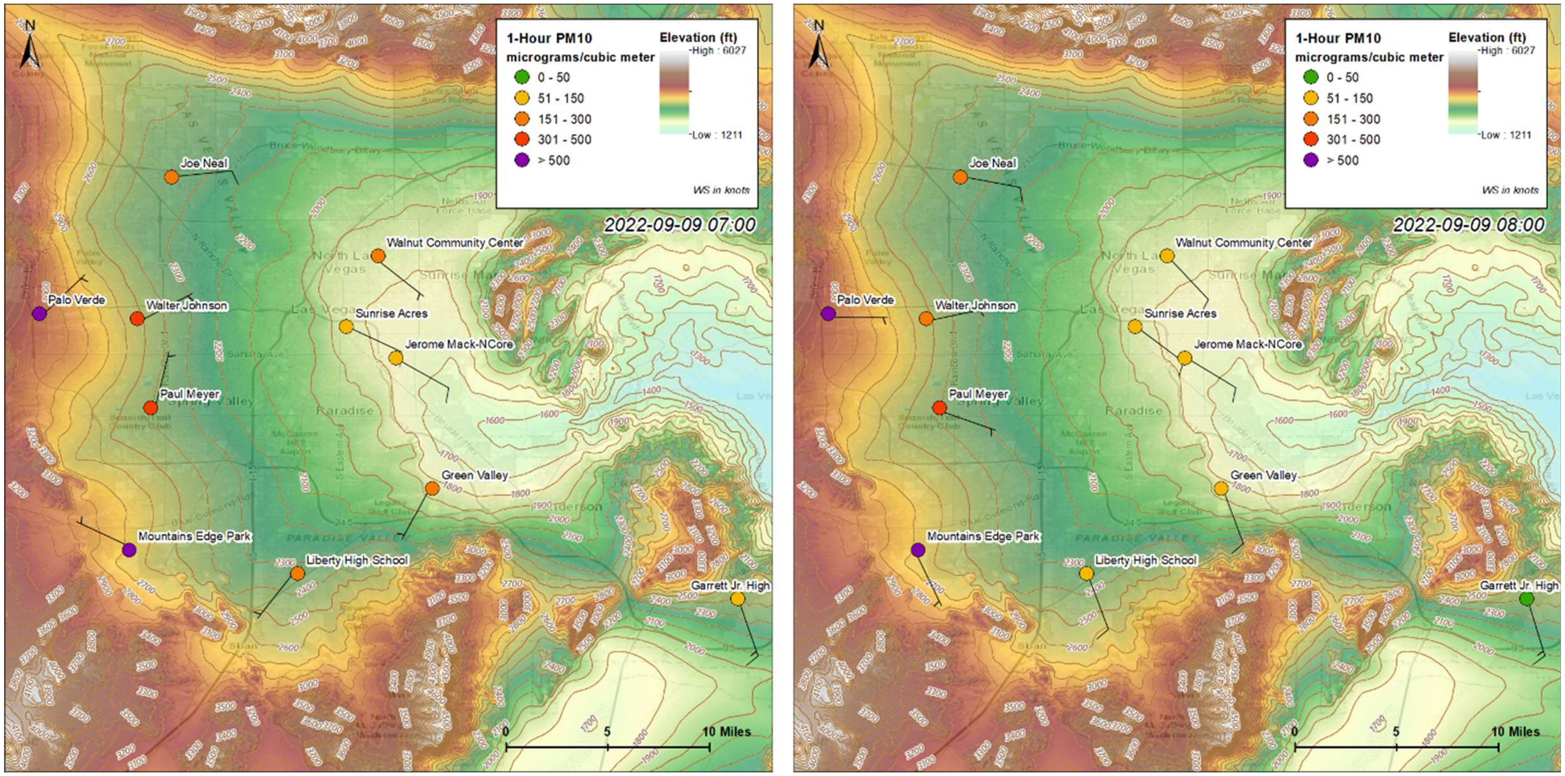


Figure 3.2-11. Surface observations of wind speed, wind direction, and hourly PM_{10} from each measurement site in Clark County, NV, and ground elevation for September 9, 2022, from 07:00 to 08:00 PST.

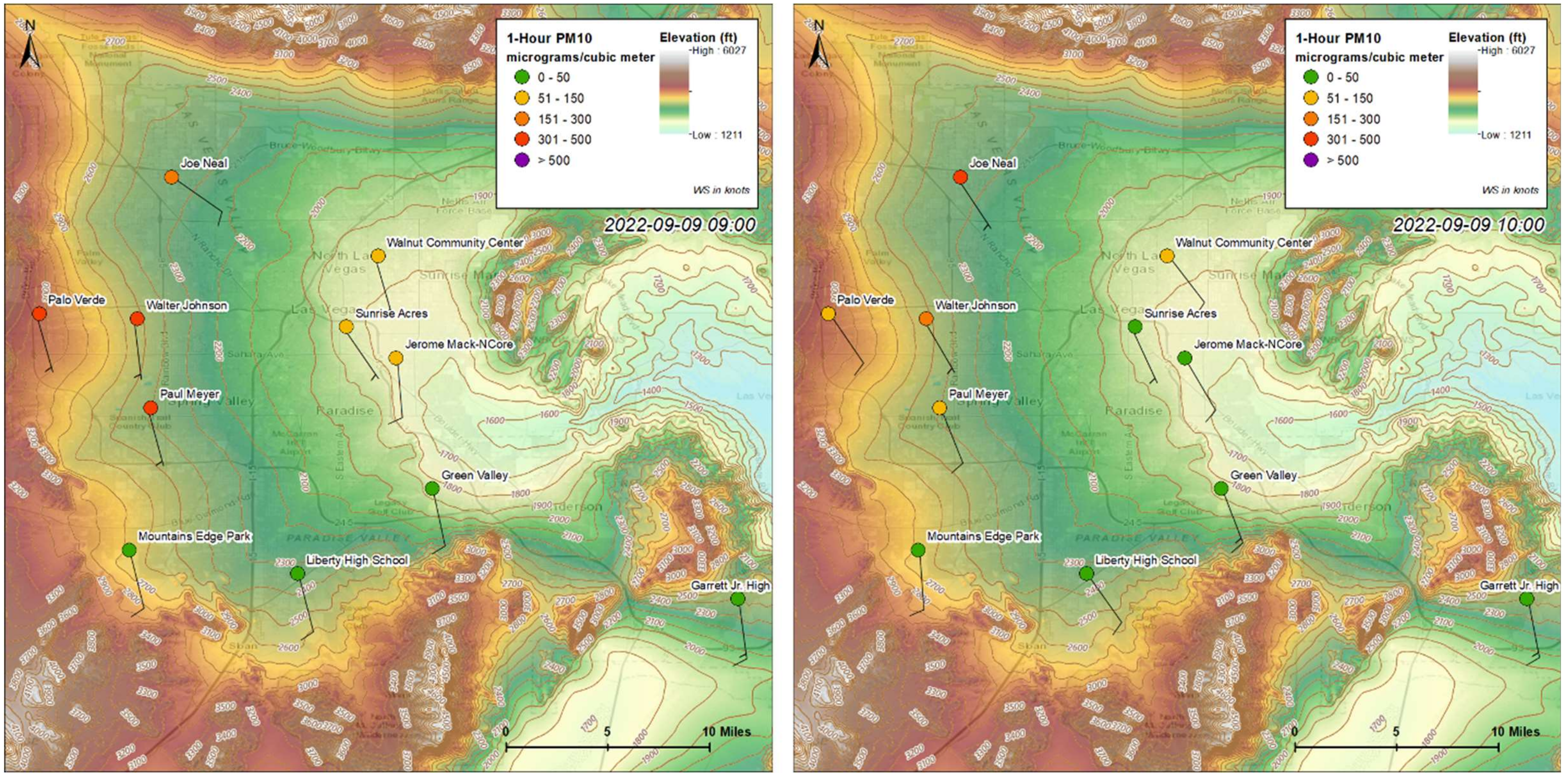


Figure 3.2-12. Surface observations of wind speed, wind direction, and hourly PM_{10} from each measurement site in Clark County, NV, and ground elevation for September 9, 2022, from 09:00 to 10:00 PST.

Overall, we found overwhelming evidence that PM_{10} was transported from the Mojave Desert in northwestern Arizona and southern Nevada in the late afternoon and evening on September 8, 2022, with a strong outflow boundary. Wind speeds in the source region and along the transport path show sustained speeds greater than the high-wind threshold of 25 mph. While wind speeds at the Las Vegas airport do not show sustained hourly speeds greater than 25 mph, the source region included wind speed well above the 25-mph threshold and the interpolated wind speed value for Clark County was greater than 25 mph on September 8, 2022. PM_{10} concentrations increased starting at the easternmost monitors, consistent with a westerly moving outflow boundary from northwestern Arizona. (Unfortunately, there are no PM_{10} monitors between the source region and the easternmost monitor in Clark County.) The evidence corroborating this assertion includes (1) abrupt changes in wind speed along the transport path; (2) high sustained wind speeds (greater than the 25-mph threshold) recorded in the northwestern Arizona Mojave Desert source region; and (3) ground-based observations of PM_{10} and wind speed/direction in Clark County that corroborate the PM_{10} event time of arrival.

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

3.3.1 Clark County Alerts

Clark County Nevada created a news release for September 9, 2022, with a dust alert due to high winds to warn people about airborne dust, which can aggravate respiratory diseases. They advised people with respiratory diseases, children, and older adults to limit their time outdoors when it was windy. The news release stated that unhealthy levels of dust for sensitive groups of people were imminent or occurring within the area. Detailed suggestions to limit exposure to dust are described in the news release. **Figure 3.3-1** shows the air quality dust alert news release from Clark County DES.

No Construction Notices or Dust Advisories were forecast or issued for this event due to the extremely atypical meteorological situation. Since this dust event was generated by the outflow boundary from a hurricane-initiated thunderstorm, forecasting the dust impacts in advance was not possible.

News Release

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

Yolanda King, County Manager

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

Contact: Kevin J. MacDonald
Public Information Officer

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

For Immediate Release — **Friday, Sept. 9, 2022**

Air Quality Dust Alert Issued for Friday

The Clark County Department of Environment and Sustainability has issued a dust alert for **Friday, Sept. 9** due to elevated levels of dust from high winds. Officials say unhealthy levels of dust for sensitive groups of people are imminent or occurring in the local area.

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

Figure 3.3-1. News release by Clark County Nevada on September 9, 2022, indicating high winds and dust were present.

3.3.2 Media Coverage

Many news sources, including KSNV, Fox 5, KLAS, the Las Vegas Review Journal, KTNV, Kion 46, the Las Vegas Sun, and KKLZ reported on the windy conditions and dust present from September 8-9, 2022. Screenshots of the news articles referenced in this section are included in **Appendix A.**

KSNV reported on poor air quality and low visibility in the Las Vegas region on Friday morning. Dust blew into the valley on Thursday night due to thunderstorms. The area around Las Vegas had several readings of very unhealthy or unhealthy air quality (**https://news3lv.com/news/local/dust-continues-to-linger-over-las-vegas-valley-friday-unhealthy-air-quality-clark-county-nv-thunderstorms-arizona-southern-nevada-weather-wx-9-9-2022**).

Fox 5 reported that the Clark County Department of Environment and Sustainability issued a dust alert for Friday due to winds. The news alert advised that unhealthy levels of dust for sensitive populations were happening within the valley (**https://www.fox5vegas.com/2022/09/09/clark-county-issues-air-quality-dust-advisory-las-vegas-valley-friday/**).

KLAS reported that there were visibility issues along the Las Vegas strip due to blowing dust and wind Thursday evening into Friday afternoon. There reported gusts up to 45 mph and cautioned people who have respiratory diseases to limit their time outdoors to reduce inhaled dust particles (**https://www.8newsnow.com/weather/blowing-dust-wind-reduce-visibility-across-las-vegas-valley/**).

The Las Vegas Review Journal reported that the Clark County DES issued a dust alert early on Friday due to high winds and dust that started on Thursday evening. The visibility at the North Las Vegas Airport was three-quarters of a mile and the Harry Reid International Airport visibility was 1.25 miles around 10 p.m. (https://www.reviewjournal.com/local/weather/air-quality-recovers-to-good-across-most-of-las-vegas-valley-2636771/).

KTNV Las Vegas reported that a wall of thick dust was pushed into the Las Vegas Valley Thursday night into Friday morning. They warned of sudden wind gusts and reduced visibility. The dust contributed to poor air quality throughout the Las Vegas Valley (https://www.ktnv.com/weather/nws-las-vegas-strong-winds-blowing-dust-throughout-the-valley-low-visibility).

KTNV Las Vegas also reported that the dust from storms on Thursday evening was finally thinning out Friday afternoon (https://www.ktnv.com/weather/13-first-alert-weather-forecast-friday-morning-september-9-2022).

Kion 46 reported on dust looming over Las Vegas due to high winds. Clark County DES issued a dust alert on Friday for the Las Vegas area. There was low visibility with higher-than-usual dust levels, which are unhealthy for people, especially if they have respiratory issues (https://kion546.com/news/2022/09/09/las-vegas-area-under-dust-alert-the-day-after-gusty-winds/).

The Las Vegas Sun reported that there were dust and flash flood alerts for the Las Vegas area. On Friday, there were unhealthy levels of dust for sensitive groups with wind gusts up to 20 mph. They included tips to reduce dust exposure, which included keeping windows and doors closed, running air conditioners, and changing out dirty filters (https://kion546.com/news/2022/09/09/las-vegas-area-under-dust-alert-the-day-after-gusty-winds/).

KKLZ reported haze was present in the sky on Friday. They also shared information from the Clark County DES dust warning issued Friday, September 9, that included tips to limit dust exposure (https://kion546.com/news/2022/09/09/las-vegas-area-under-dust-alert-the-day-after-gusty-winds/).

3.3.3 Pollutant and Diurnal Analysis

As discussed in Section 3.2, PM_{10} concentrations in the Las Vegas Valley started to increase at 19:00 PST on September 8, 2022, which coincided with the outflow boundary passage. Figure 3.3-2 and the associated map in Figure 3.3-3 show that PM_{10} first increased at the Garrett Jr. High monitoring site, which is the eastern most monitoring site. Next, sites in eastern Las Vegas Valley including Green Valley, Jerome Mack, and Sunrise Acres experienced a dramatic increase in PM_{10} concentrations. Finally, sites in the western side of the Las Vegas Valley including Walter Johnson, Paul Meyer, and Palo Verde showed a dramatic increase in PM_{10} between 20:00 and 21:00 PST on September 8, 2022. PM_{10} concentrations peaked at >6,000 µg/m^3, and enhanced concentrations persisted through 10:00 PST on September 9, 2022. The persistence of PM_{10} after the outflow boundary passed was due to stagnant winds that allowed dust to remain in the Las Vegas Valley early on September 9. By 10:00 PST, southerly winds picked up and started to move dust out of the area. The concurrent rise in PM_{10} at all sites around Clark County indicates a regional dust event.

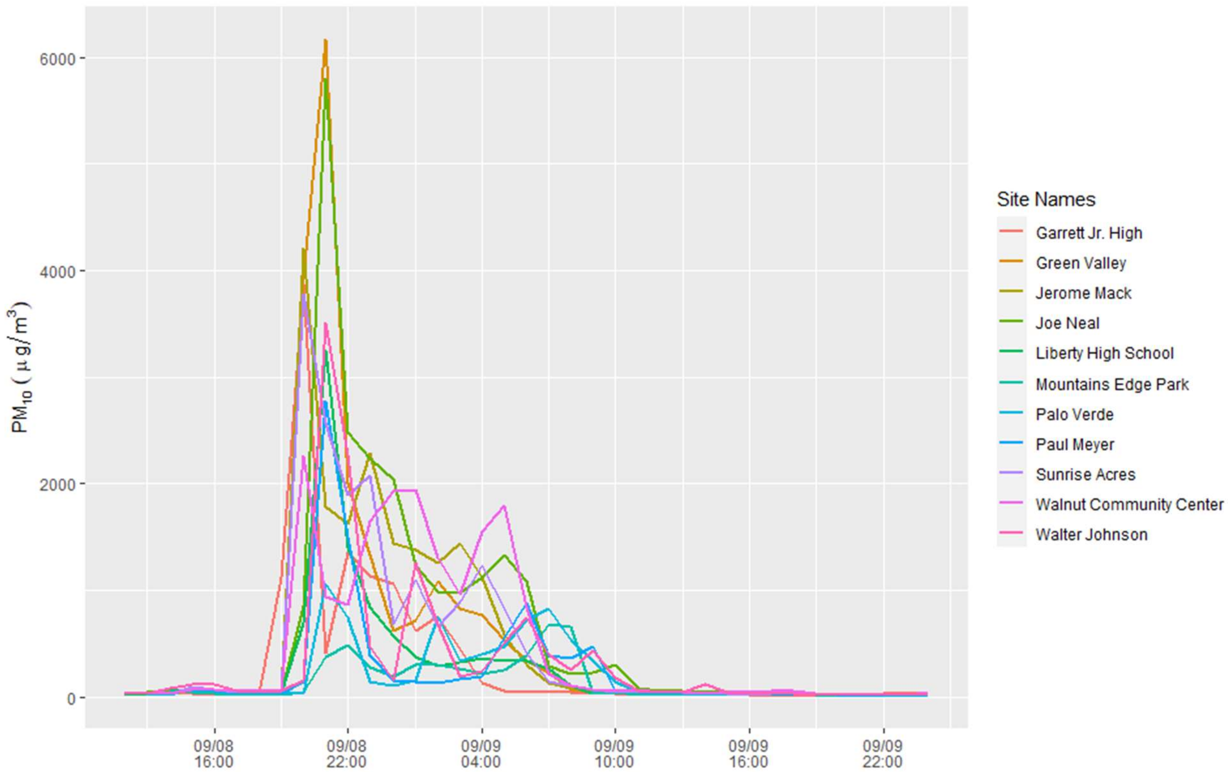


Figure 3.3-2. Hourly PM_{10} in µg/m^3 measured at all sites around Clark County, including the regulatorily significant sites: Paul Meyer, Walter Johnson, Palo Verde, Joe Neal, Green Valley, Liberty High School, Jerome Mack, Sunrise Acres, and Walnut Community Center.

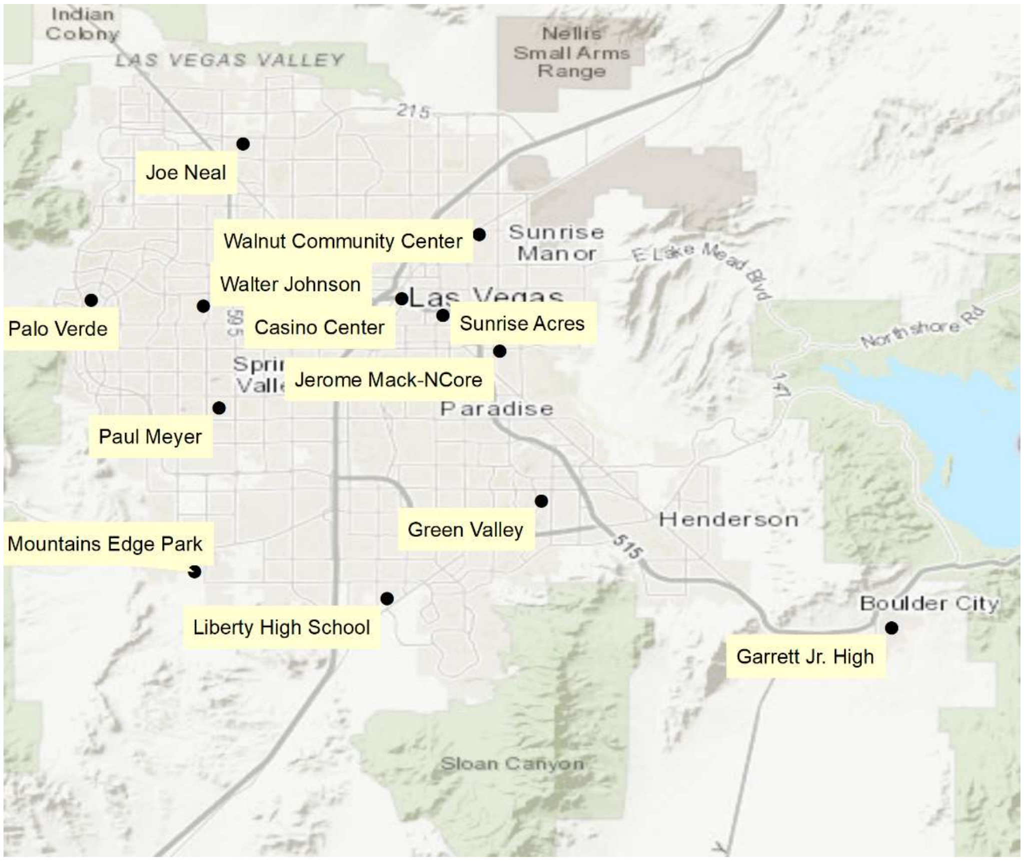


Figure 3.3-3. PM_{10} sites in Clark County associated with Figure 3.3-2 and Figure 3.3-4.

Figure 3.3-4 shows the measured hourly PM_{10} concentrations on September 8-9, 2022, together with the 5th-95th percentiles of the five-year historical hourly data from 2018-2022 for affected sites. On September 8, 2022, at 19:00 PST, an extremely abrupt increase in hourly PM_{10} concentrations occurred, far surpassing the five-year 95th percentile. The drastic increase appears to follow a trajectory in time and intensity across sites from areas southwest of the city (Green Valley site), through Jerome Mack and Sunrise Acres sites, to sites northwest of the city (Joe Neal site). Sites to the west of the city center (Paul Meyer, Walter Johnson, and Palo Verde) appear to be offset by approximately one hour and reach slightly lower maximum values, suggesting the Green Valley-Joe Neal trajectory was more directly in the dust plume. The event peaked at 20:00-21:00 PST, recording maximum hourly values near 6,000 $\mu g/m^3$. Concentrations remained above the 95th percentile until ~10:00 PST the following day.

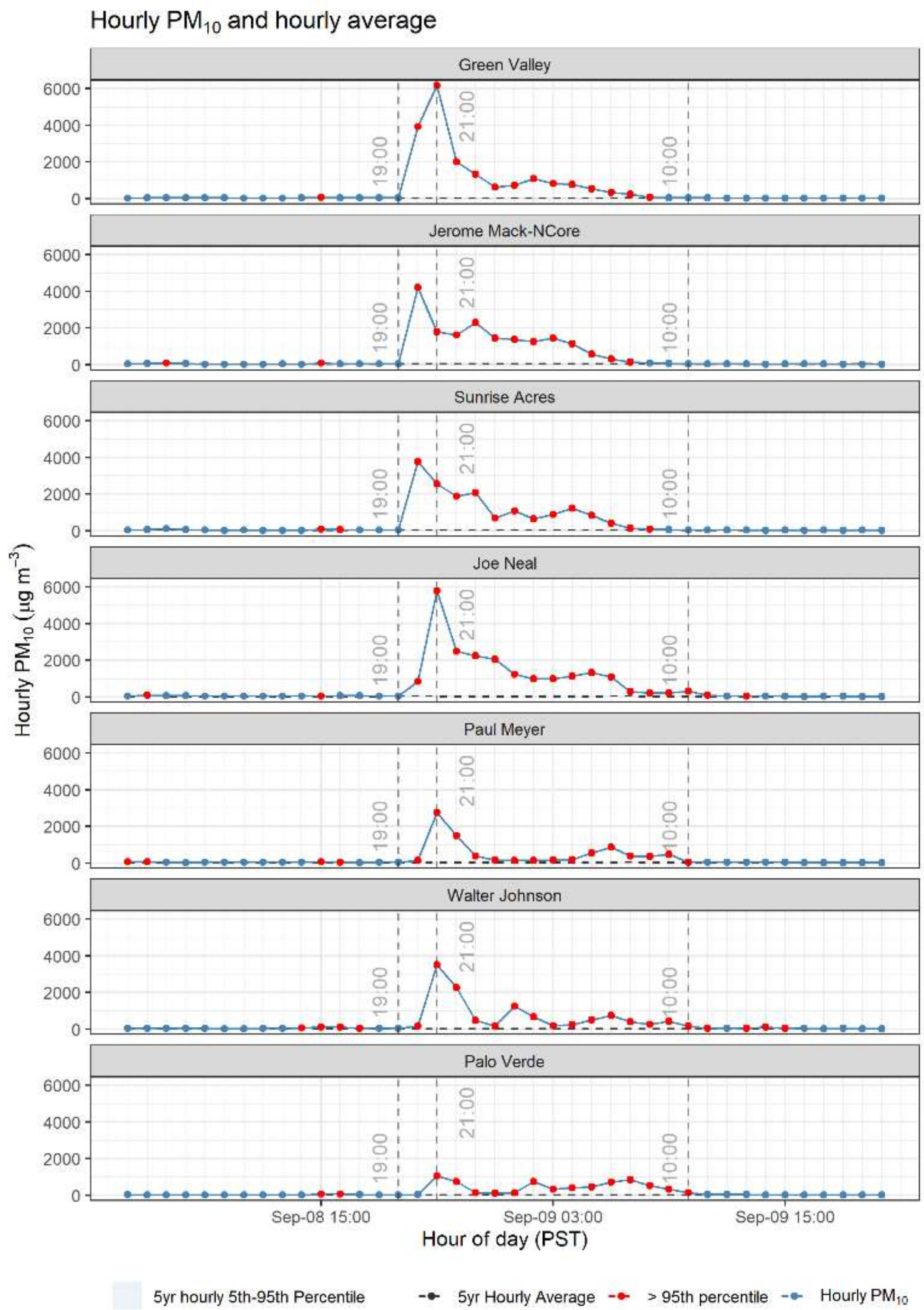


Figure 3.3-4. Hourly PM_{10} concentrations compared to the five-year hourly average (dashed line) and five-year 5th-95th percentile (shaded area) in 1-hour PM_{10} concentrations from 2018-2022 at affected sites. Hourly concentrations exceeding the 95th percentile are shown in red. The order of the sites illustrates the timing and intensity of the dust plume appears to originate from the southeast (Green Valley site), through the Jerome Mack and Sunrise Acres sites, before moving northwest toward the Joe Neal site. (See the map in Figure 3.3-3 for monitor locations.)

The 24-hour average PM_{10} values at all sites in Clark County before and after the exceedance event on September 8 and 9, 2022, remained well below the 99th percentile of the five-year hourly average (2018-2022) (**Figure 3.3-5**). On September 8 and 9, 2022, all sites in Clark County (except Jean and Virgin Valley, which are not in the Las Vegas Valley and were not as acutely affected by the outflow boundary) showed PM_{10} values well exceeding the 99th percentile. Most of these also exceeded the NAAQS value. The simultaneous increase in PM_{10} concentrations at all sites, with all sites in the Las Vegas Valley exceeding the 99th percentile threshold, suggests a regional source of PM_{10} such as a wind-blown dust event.

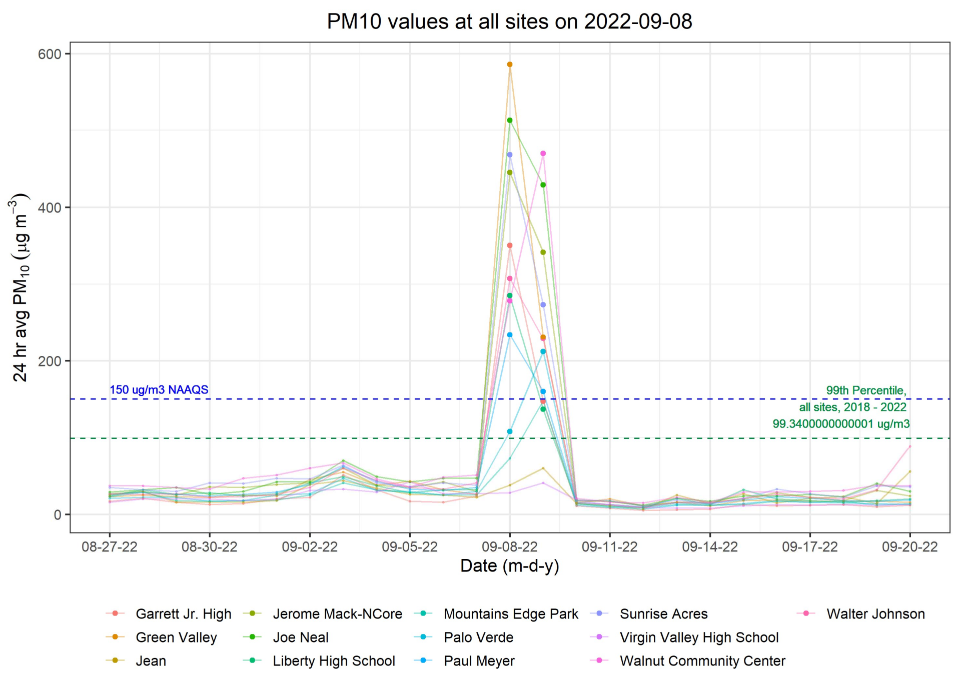


Figure 3.3-5. PM_{10} values at all Clark County, NV, measurement sites from August 27, 2022, to September 20, 2022, with NAAQS (blue dash) indicated. The green dashed line indicates the 99th percentile of 99.34 µg/m^3, which is the five-year historical values at these sites.

3.3.4 Particulate Matter Analysis

Before the suspected high-wind dust event on September 8 and 9, 2022, the hourly $PM_{2.5}/PM_{10}$ ratio at all sites remained slightly below the three-month hourly average based on 2018 – 2022 ratio data (**Figure 3.3-6**). Late in the day on September 8, coincident with the outflow boundary passage, the hourly $PM_{2.5}/PM_{10}$ ratio at the Green Valley, Jerome Mack, Paul Meyer, and Sunrise Acres sites all dropped to approximately 0.1 and remained low into the next day (September 9). $PM_{2.5}/PM_{10}$ ratios at the Jean site fell to approximately 0.1 early on September 9 because it is the westernmost site in Clark County and thus was the last to experience the dust event (also at much lower concentrations as shown in **Section 3.3.3**). The low $PM_{2.5}/PM_{10}$ value at all sites, which is below the 5th percentile of the 2018 – 2022 values, is consistent with values from dust events reported in studies (Jiang et al., 2018). The decrease in the $PM_{2.5}/PM_{10}$ ratios observed late in the day on September 8 and early in the morning on September 9 is consistent with the increase in hourly PM_{10} concentrations as described in Section 3.2.2. $PM_{2.5}/PM_{10}$ ratios rose midday on September 9 and continued to increase into September 10. This precipitous drop in $PM_{2.5}/PM_{10}$ ratios is highly indicative of a windblown dust event because manually entrained and transported dust particles are most likely to be in the PM_{10} (coarse + fine) mode rather than the $PM_{2.5}$ (fine) mode, causing the ratio of the two to drop.

Speciated $PM_{2.5}$ measurements are collected on a three-day cadence in Clark County and were recorded at Jerome Mack on September 8, 2022. **Figure 3.3-7** shows the measurement of crustal elements calcium, iron, and potassium, as well as calculated soil during the wind-blown dust event in comparison to the 90th percentile measurement calculated across seven years of data. On September 8, the concentration of each examined parameter was well above the 90th percentile concentration. This evidence strongly supports the abundance of airborne, soil-based dust during the event period.

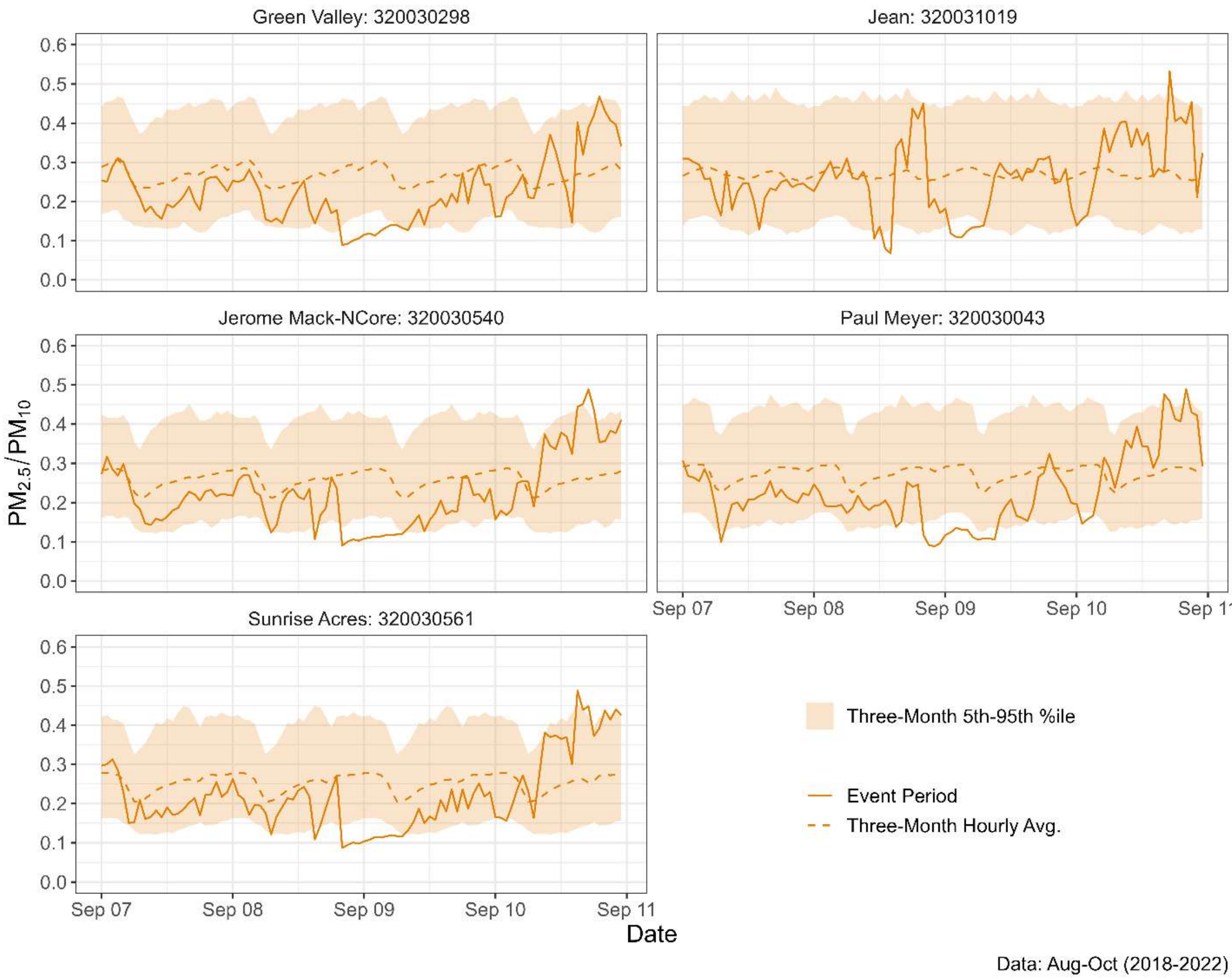


Figure 3.3-6. $PM_{2.5}/PM_{10}$ concentration ratios before, during, and after the September 8 and 9, 2022, PM_{10} exceedance. The five-year average $PM_{2.5}/PM_{10}$ diurnal ratio is displayed as a dotted line, and the 5th-to-95th percentile range is shown as a shaded ribbon. The hourly average and the 5th-to-95th percentile ratio is calculated from August to October between 2018 and 2022.

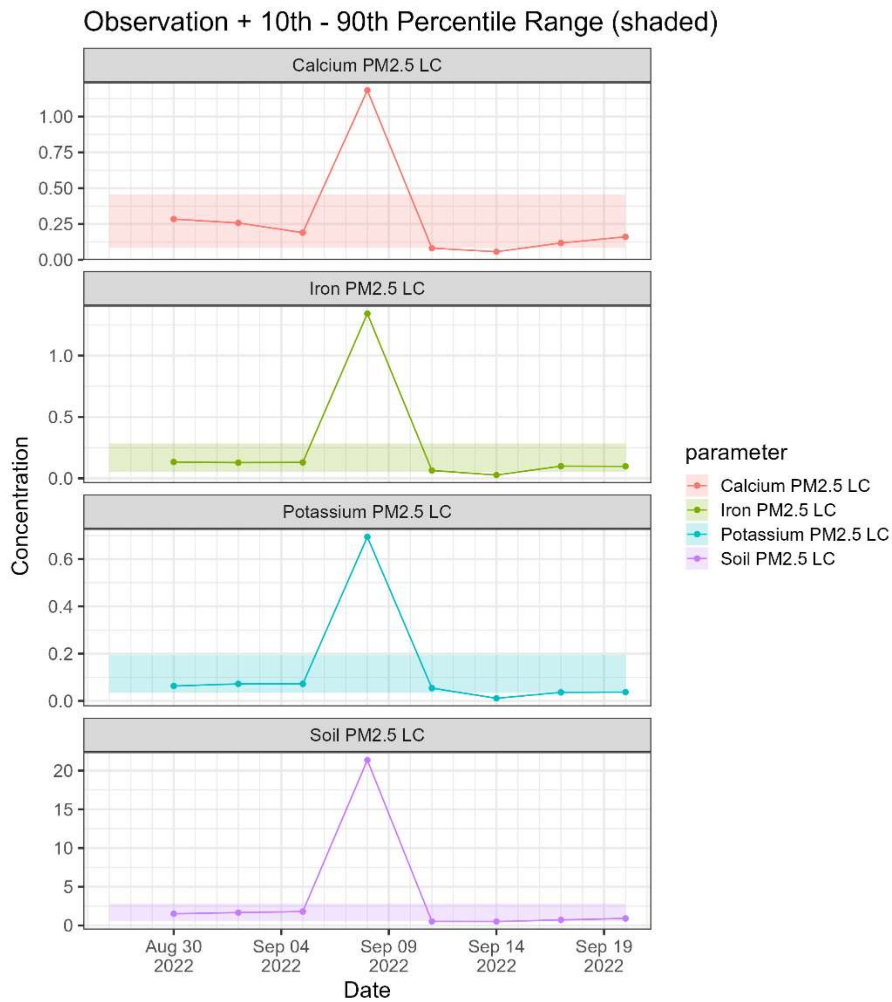


Figure 3.3-7. Speciated $PM_{2.5}$ measurements recorded at Jerome Mack. The shaded region shows the 10th-90th percentile of measurements calculated over seven years (2016-2022).

3.3.5 Visibility/Ground-Based Images

Visibility data is available from airport monitoring sites through the NWS Weather and Hazards Data Viewer. Figure 3.3-8 shows visibility observations on September 8-9, 2022, at Harry Reid International Airport (LAS) in Las Vegas. Visibility dropped drastically at 20:00 from 10 miles to below 2.5 miles, concurrent with an increase in PM_{10} concentrations at AQS sites in Clark County. This event occurred after sundown, so camera images in the Las Vegas Valley were unavailable to capture conditions due to limitations of photography in low light.

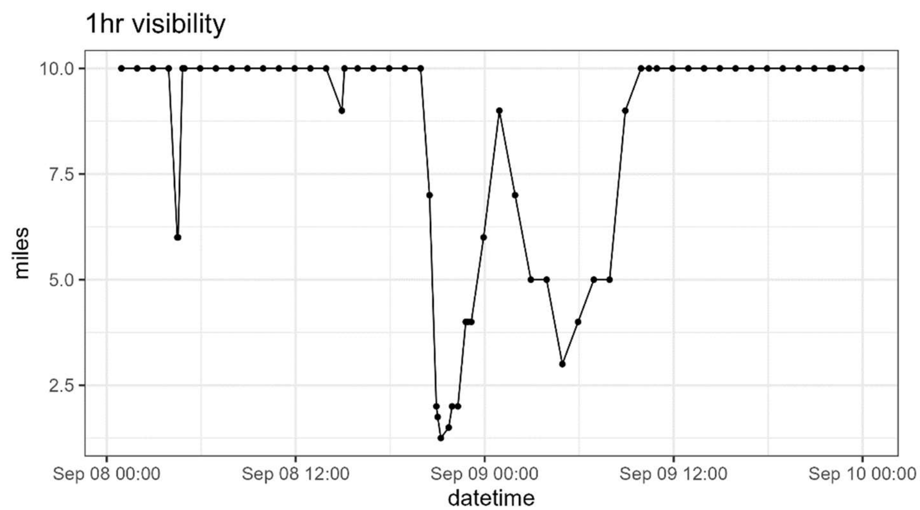


Figure 3.3-8. Visibility in miles on September 8-9, 2022, recorded as Harry Reid International Airport. Visibility data is sourced from the Iowa Environmental Mesonet (**https://mesonet.agron.iastate.edu/**).

Overall, we found overwhelming evidence that PM_{10} was transported from the Mojave Desert in northwestern Arizona and southern Nevada to Clark County by approximately 19:00-20:00 PST on September 8, 2022. PM_{10} concentrations increased with the outflow boundary progression through the Clark County area. Concentrations of PM_{10} peaked and visibility dropped to a minimum at 20:00-21:00 PST on September 8, 2022. Monitoring sites were affected by dramatically increased PM_{10} in an east-to-west pattern. This suggests that Clark County was impacted by a regional high-wind dust event that lofted dust along the outflow boundary and pushed westerly from in the Mojave Desert region of northwestern Arizona and southern Nevada. The evidence corroborating this assertion includes (1) dust alerts and media coverage in Clark County; (2) an abrupt, concurrent increase at all PM_{10} monitoring sites in Clark County; (3) a drop in $PM_{2.5}/PM_{10}$ ratio values indicating windblown dust sources; (4) an increase in crustal elements from speciated $PM_{2.5}$ measurement indicating windblown dust as a major contributor; and (5) decreased visibility at the Las Vegas airport corresponding with the PM_{10} event time-of-arrival on September 8, 2022, and lasting through the high-PM_{10} concentrations on September 9, 2022.

3.4 Comparison of Exceptional Event with Historical Data

3.4.1 Percentile Ranking

An annual time series of 24-hour average PM_{10} concentrations for each affected site is provided in **Figure 3.4-1 through Figure 3.4-10**. September 8-9, 2022, are marked by a red point for comparison to the 150-µg/m^3 NAAQS threshold (blue line) and the five-year (2018-2022) 99th percentile value (green line) described in Table 2.2-1 (note that data at the Garrett Jr. High, Liberty High School, and

Walnut Community Center sites only dates back to spring 2021). Observations on September 8-9 were the highest annual observation at six of the 10 sites, and either September 8 or 9 were significantly above the five-year 99th percentile at all sites, suggesting a wide-spread regional event.

A five-year time series of 24-hour average PM_{10} concentrations for each affected site is provided in Figure 3.4-11 through Figure 3.4-20 to compare the event day to the range of normal values. Other exceedances of the 150-µg/m^3 NAAQS threshold (blue dashed line) were further investigated for potential evidence of a dust event based on meteorological data and visibility camera images to compare to September 8-9, 2022. Days that showed preliminary evidence of being a high-wind dust event are also marked in the annual and five-year time series figures at all sites.

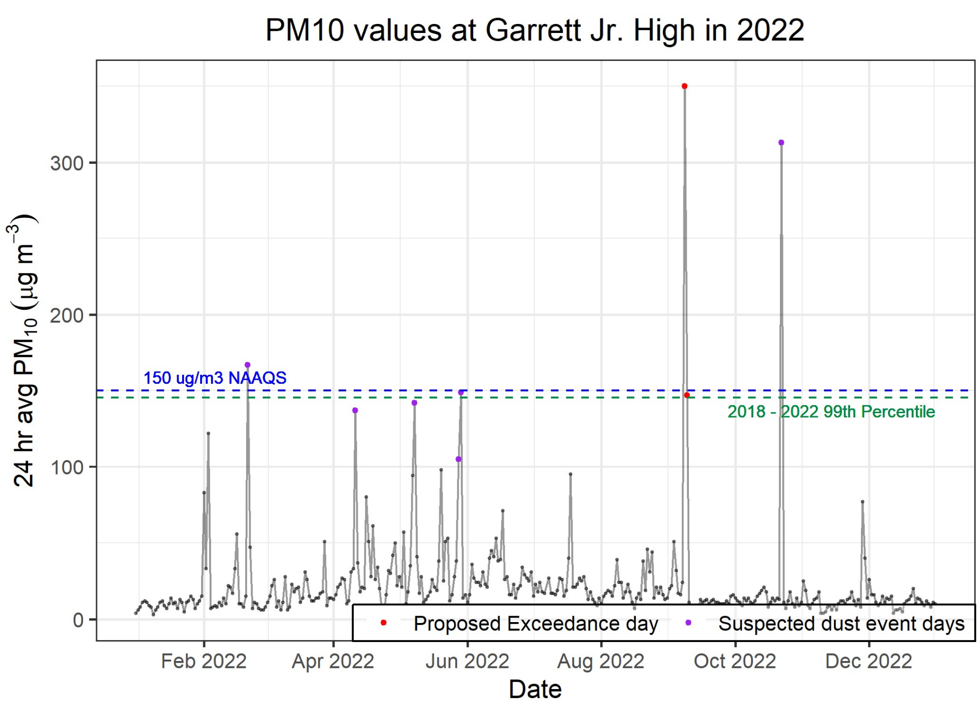


Figure 3.4-1. Garrett Jr. High 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) five-year* 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated. *Earliest data available for Garrett Jr. High is April 2021.

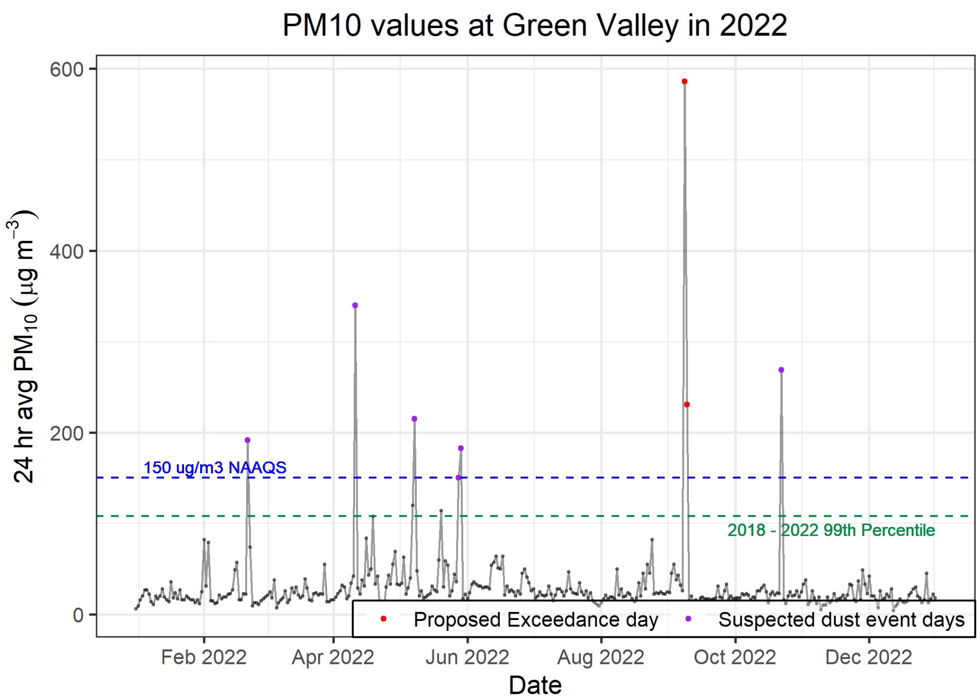


Figure 3.4-2. Green Valley 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

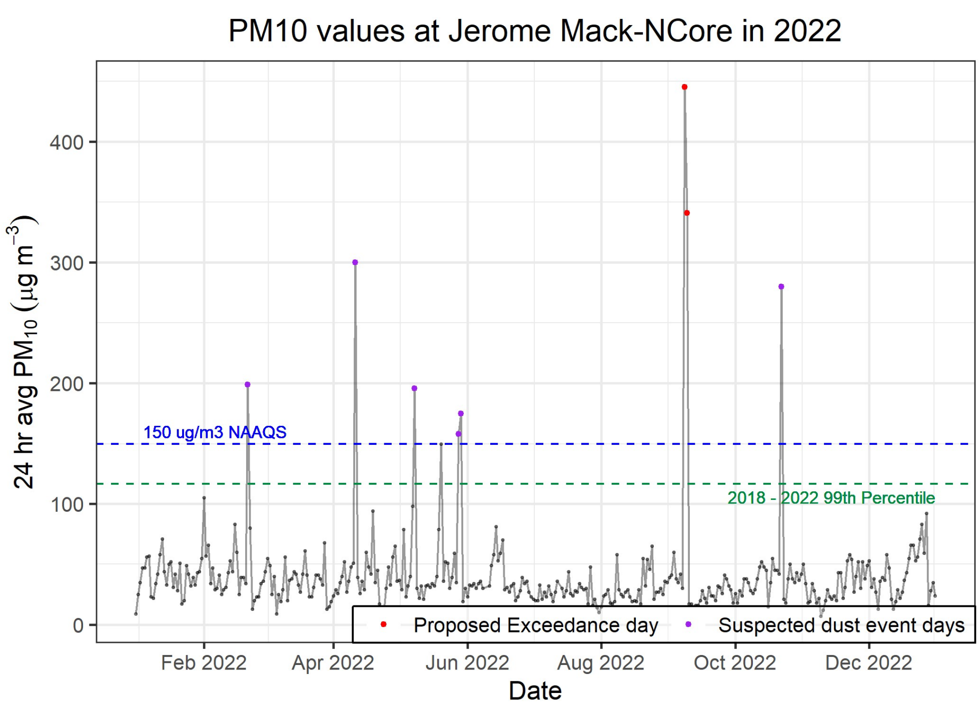


Figure 3.4-3. Jerome Mack 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

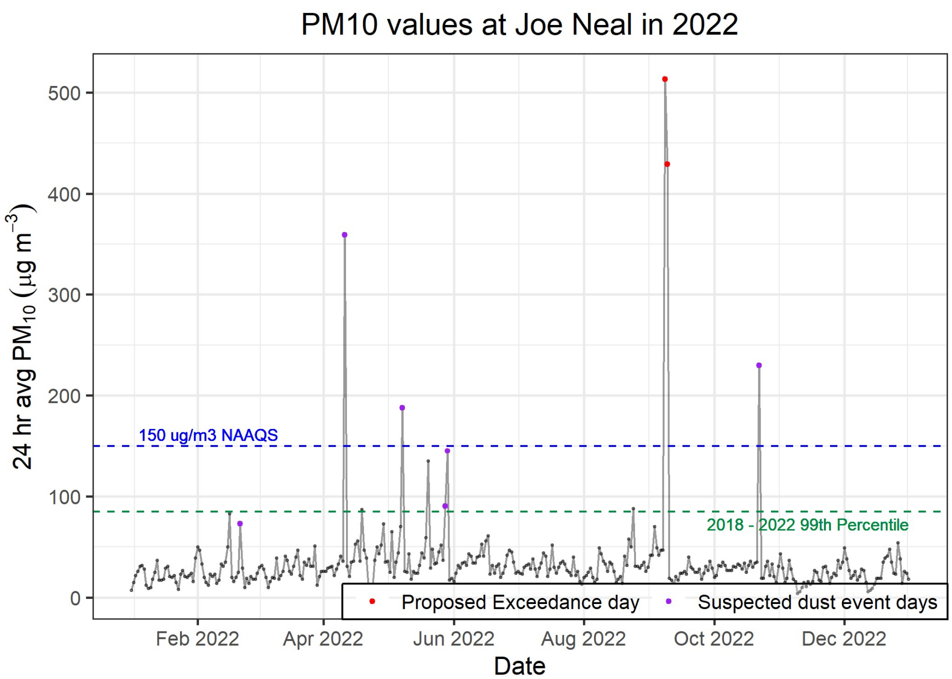


Figure 3.4-4. Joe Neal 24-hour PM_{10} measurement in μg/m^3 for 2022 with (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

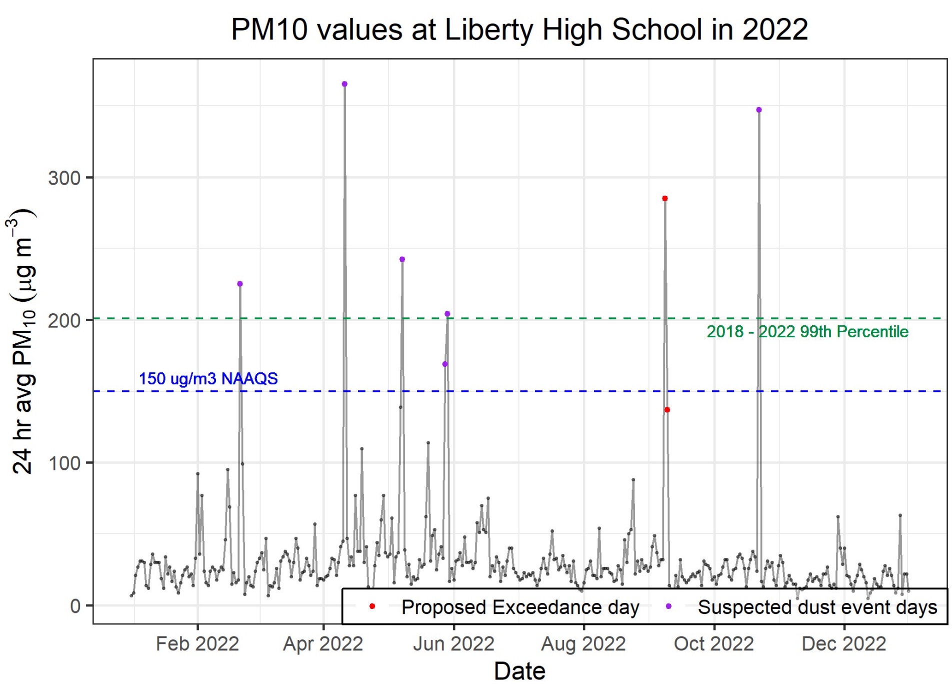


Figure 3.4-5. Liberty High School 24-hour PM_{10} measurement in μg/m^3 for 2022 with (green dash) five-year* 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated. *Earliest data available for Liberty High School is May 2021.

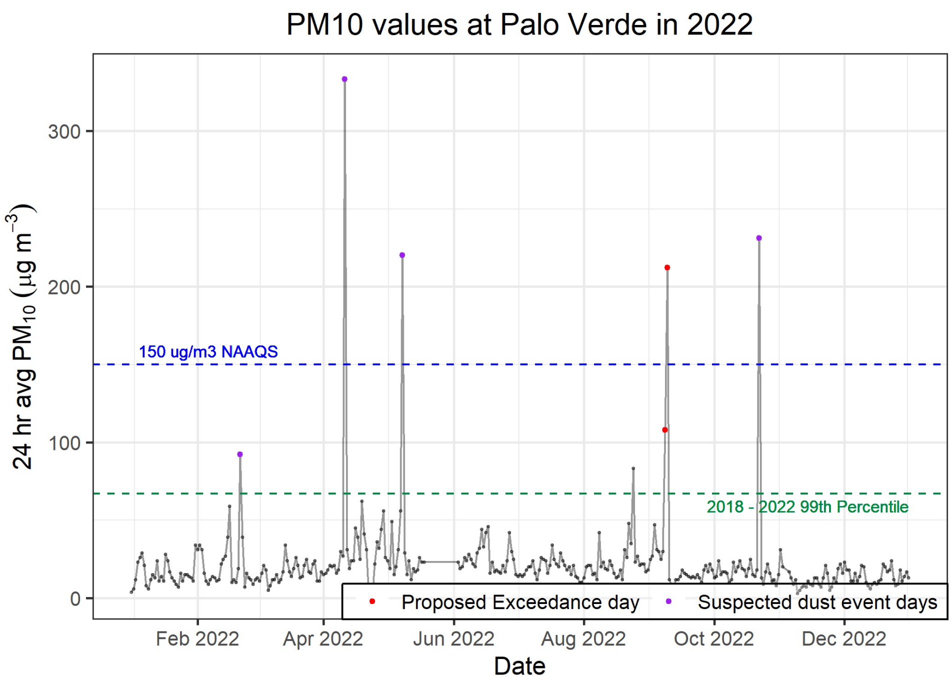


Figure 3.4-6. Palo Verde 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

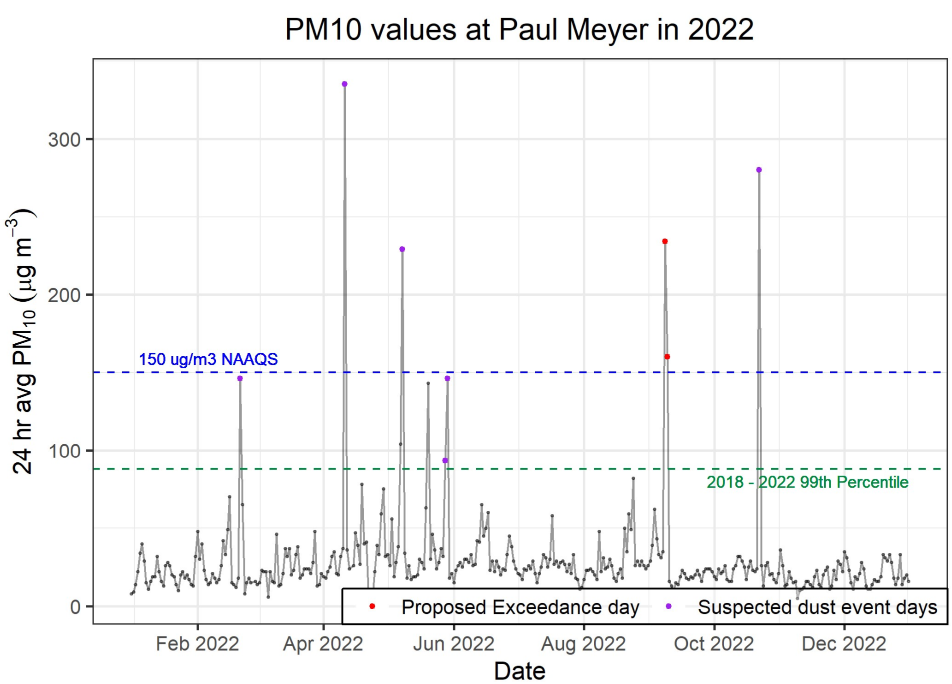


Figure 3.4-7. Paul Meyer 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

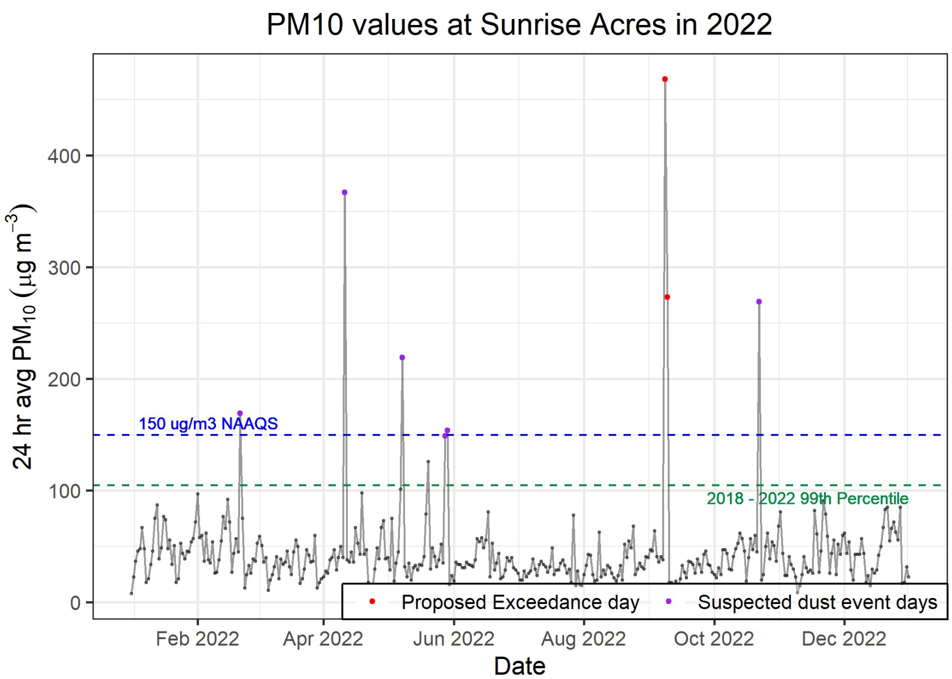


Figure 3.4-8. Sunrise Acres 24-hour PM_{10} measurement in μg/m^3 for 2022 with (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

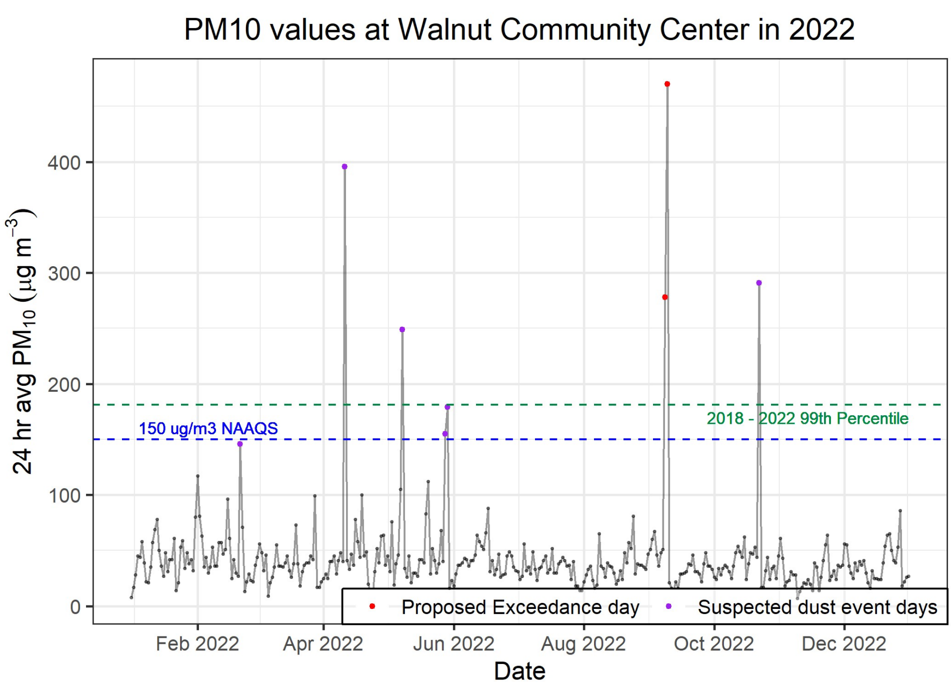


Figure 3.4-9. Walnut Community Center 24-hour PM_{10} measurement in μg/m^3 for 2022 with (green dash) five-year* 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated. *Earliest data available for Walnut Community Center is June 2021.

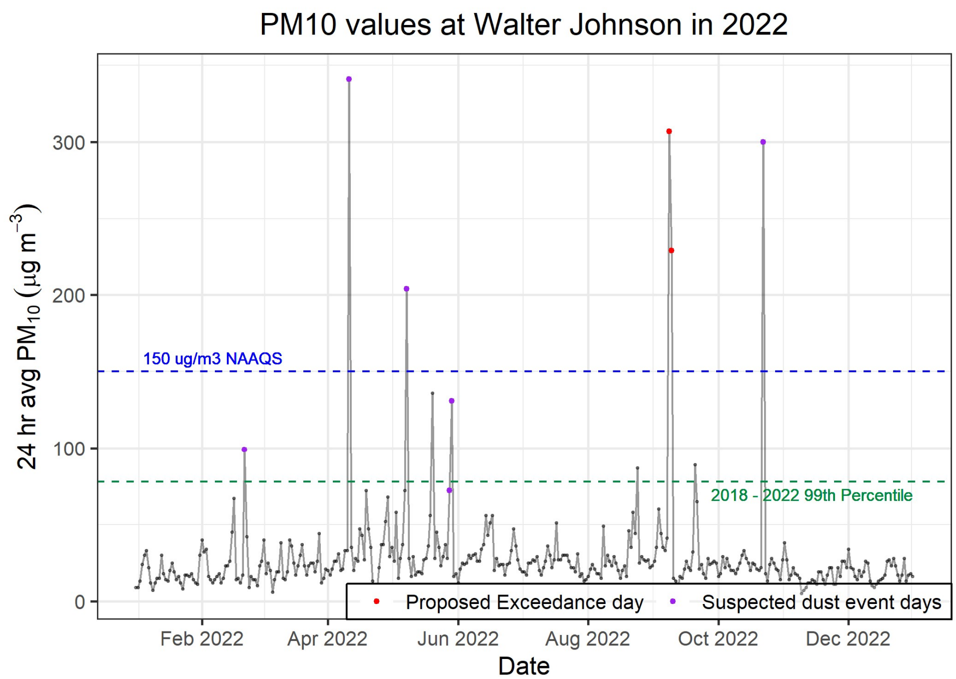


Figure 3.4-10. Walter Johnson 24-hour PM_{10} measurement in µg/m^3 for 2022 with (green dash) five-year 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

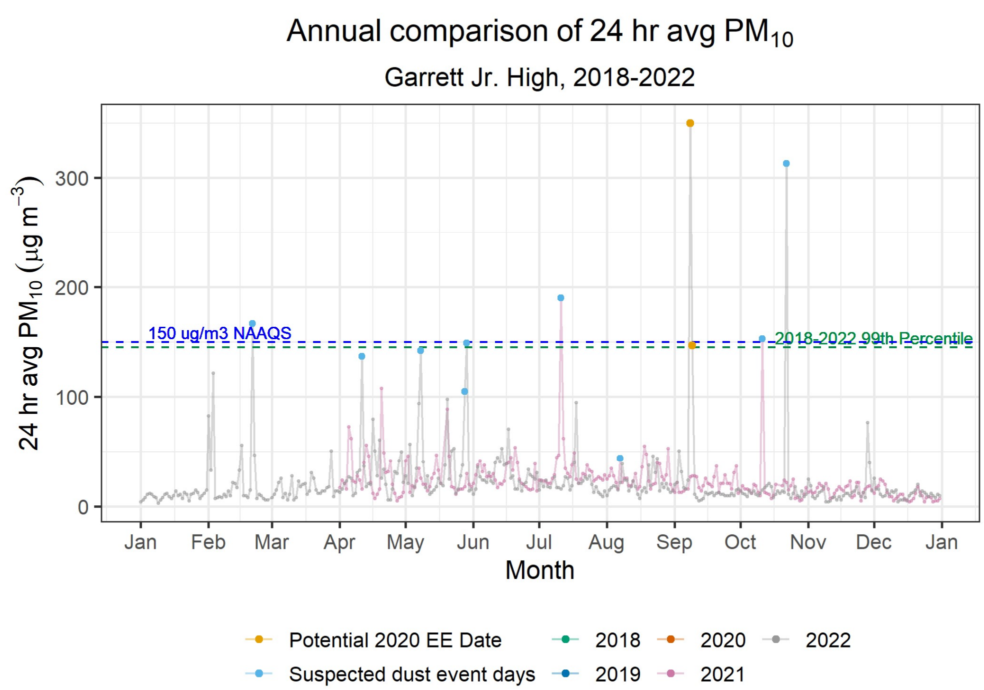


Figure 3.4-11. Garrett Jr. High 24-hour PM_{10} measurements in µg/m^3 from previous five years by year with 99th percentile (green dash) and NAAQS (blue dash) indicated.

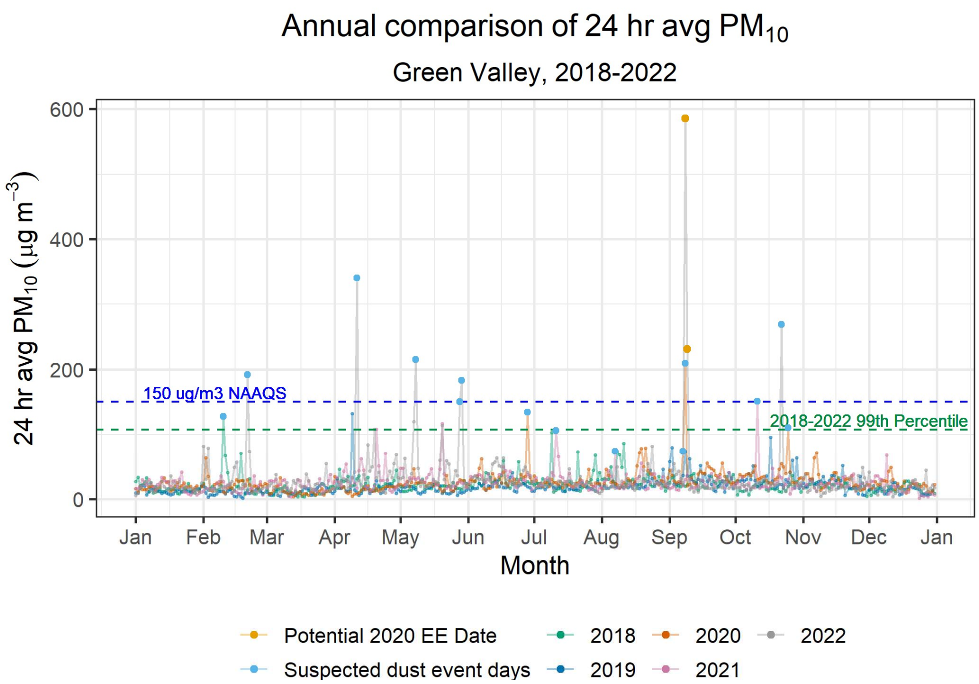


Figure 3.4-12. Green Valley 24-hour PM_{10} measurements in µg/m^3 from previous five years by year with 99th percentile (green dash) and NAAQS (blue dash) indicated.

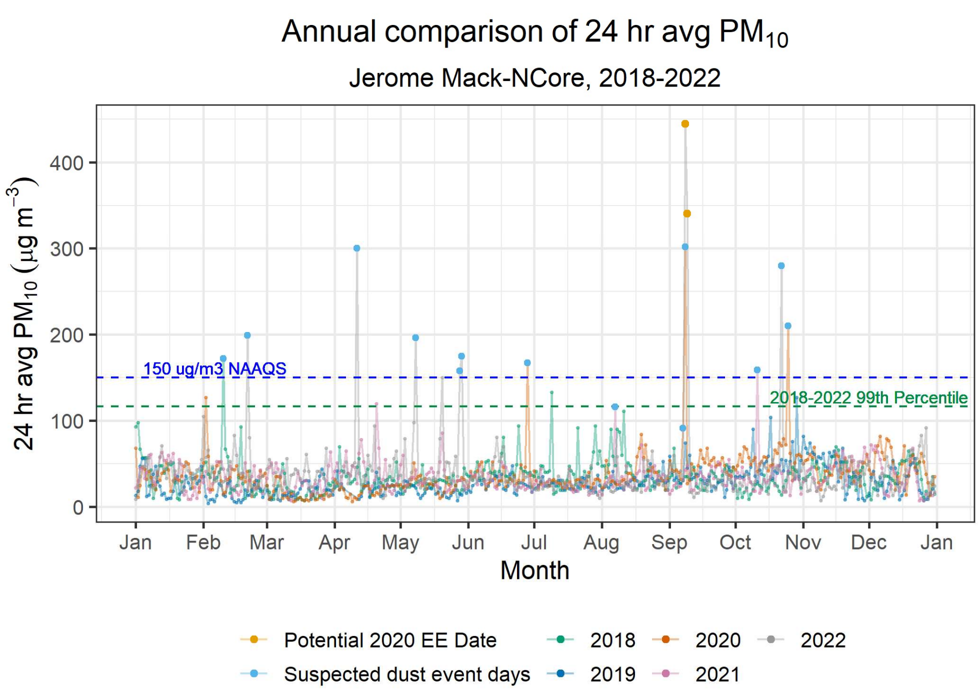


Figure 3.4-13. Jerome Mack 24-hour PM_{10} measurements in µg/m^3 from previous five years by year with 99th percentile (green dash) and NAAQS (blue dash) indicated.

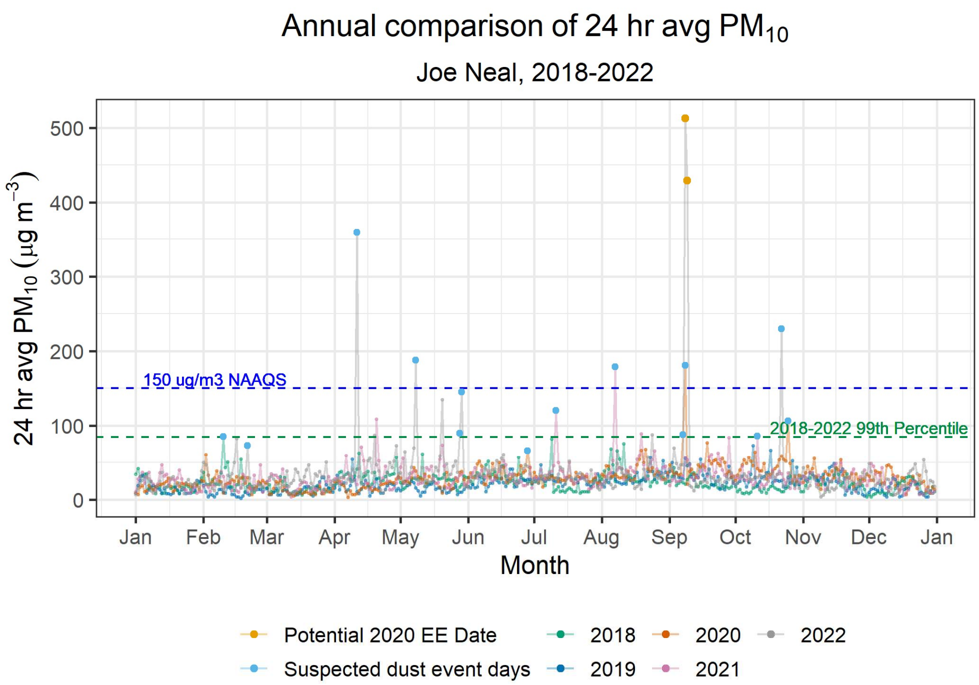


Figure 3.4-14. Joe Neal 24-hour PM_{10} measurements in µg/m^3 from previous five years by year with 99th percentile (green dash) and NAAQS (blue dash) indicated.

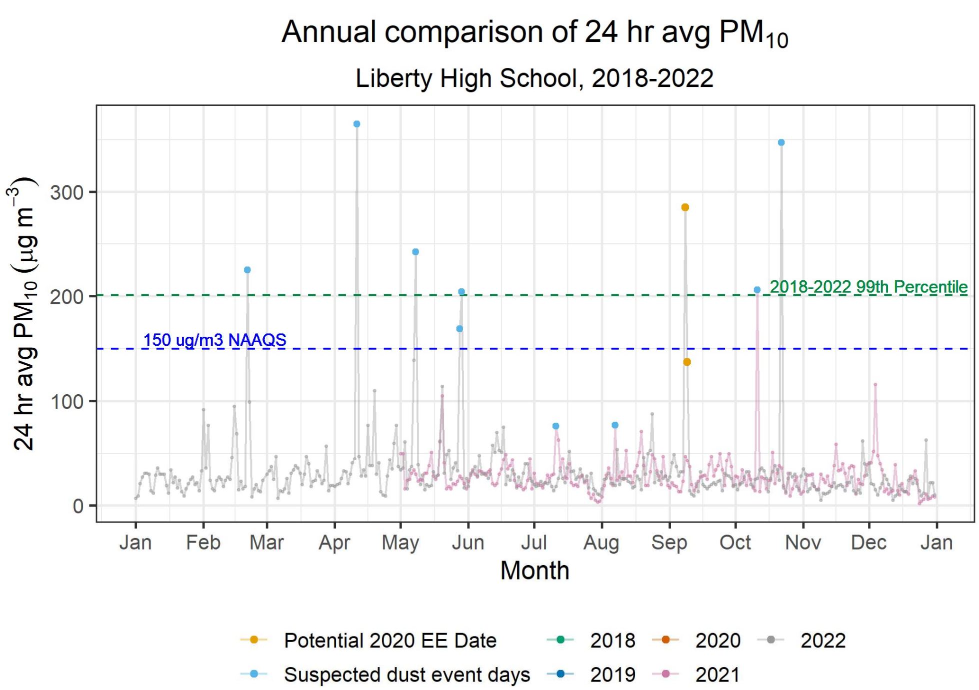


Figure 3.4-15. Liberty High School 24-hour PM_{10} measurements in µg/m^3 from previous five years by year with 99th percentile (green dash) and NAAQS (blue dash) indicated.

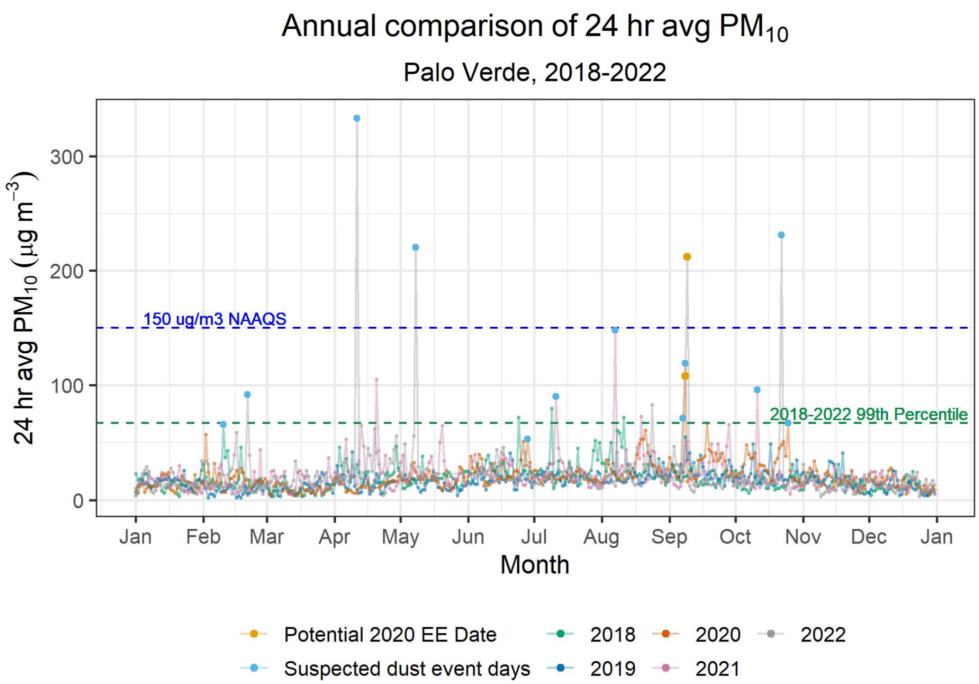


Figure 3.4-16. Palo Verde 24-hour PM_{10} measurements in µg/m³ from previous five years by year with 99th percentile (green dash) and NAAQS (blue dash) indicated.

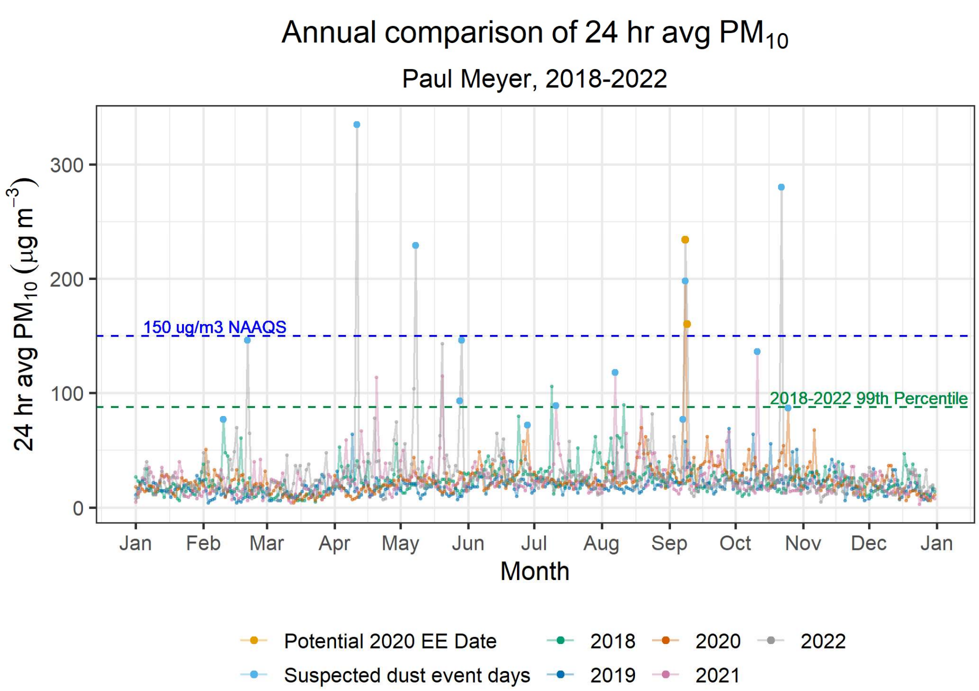


Figure 3.4-17. Paul Meyer 24-hour PM_{10} measurements in µg/m³ from previous five years by year with 99th percentile (green dash) and NAAQS (blue dash) indicated.

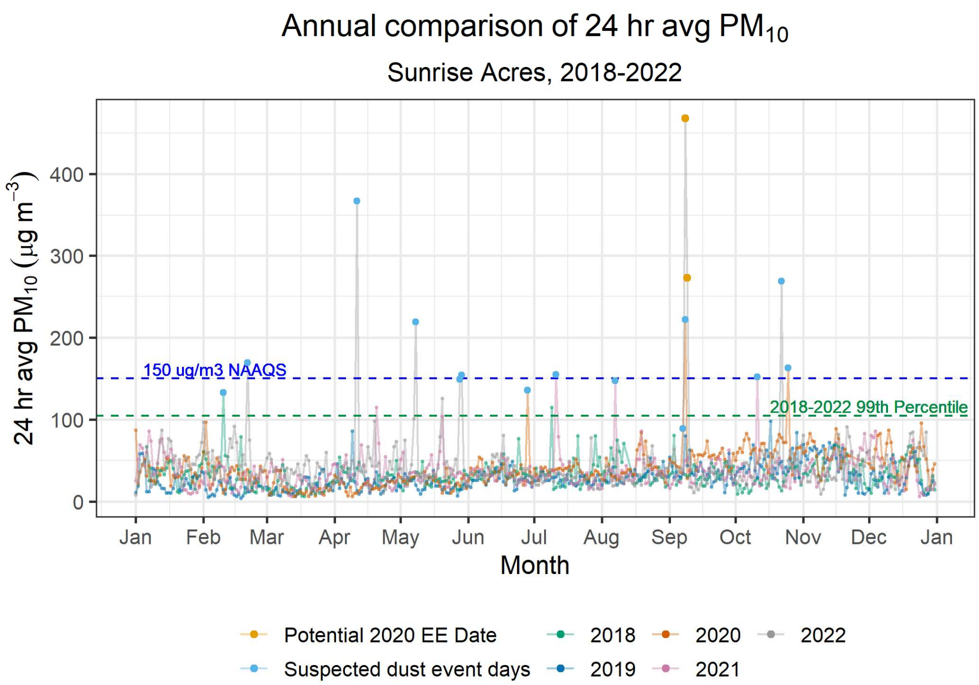


Figure 3.4-18. Sunrise Acres 24-hour PM_{10} measurements in µg/m^3 from previous five years by year with 99th percentile (green dash) and NAAQS (blue dash) indicated.

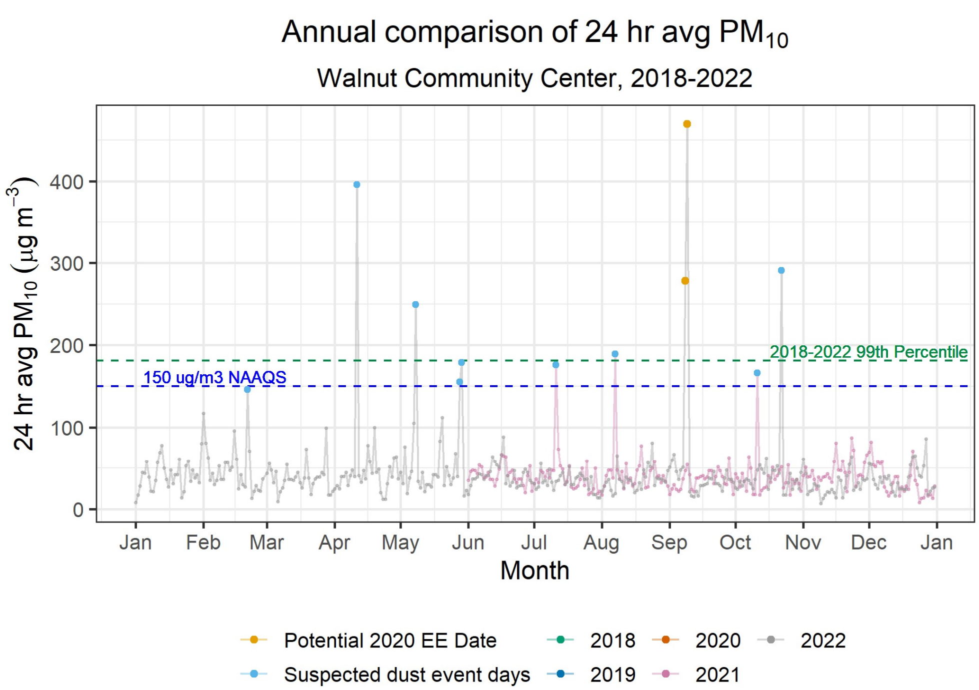


Figure 3.4-19. Walnut Community Center 24-hour PM_{10} measurements in µg/m^3 from previous five years by year with 99th percentile (green dash) and NAAQS (blue dash) indicated.

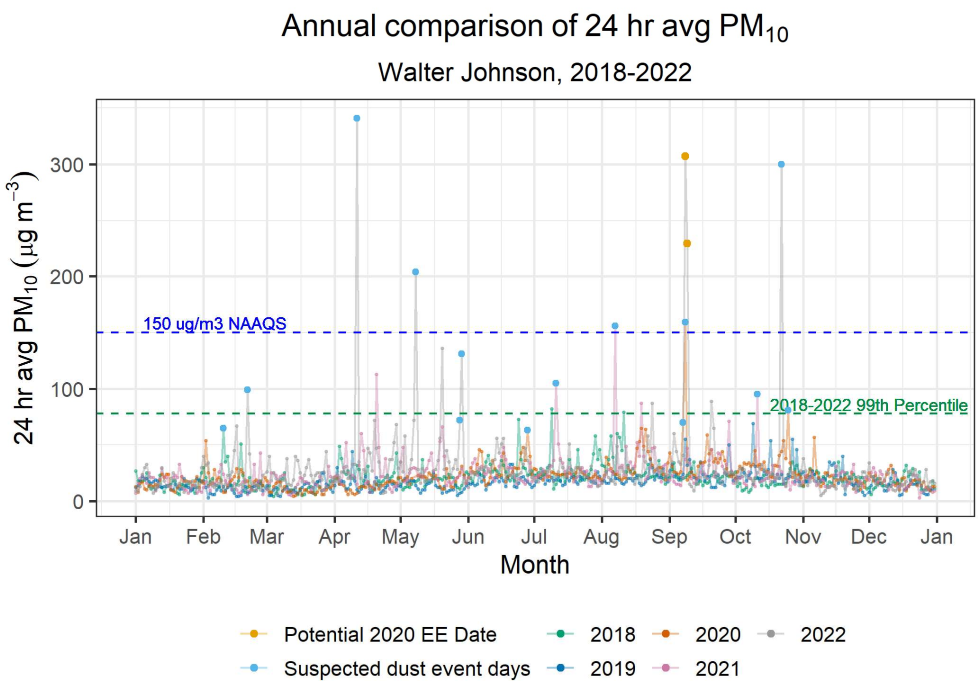


Figure 3.4-20. Walter Johnson 24-hour PM_{10} measurements in μg/m^3 from previous five years by year with 99th percentile (green dash) and NAAQS (blue dash) indicated.

The 24-hour average PM_{10} concentration observed on September 8 and 9, 2022, ranked as the highest of all the concentrations observed in the five-year period from 2018-2022 at six of the 10 sites (Table 3.4-1), and within the top four for the remaining four sites (greater than the 99th percentile). Of the four sites where the September 8-9, 2022, concentrations were not the highest observed (Liberty High School, Palo Verde, Paul Meyer, and Walter Johnson), higher observations were made on April 11, May 8, and October 22, 2022. All of these days also have extensive evidence of high-wind dust events, and full demonstrations supporting exceptional events on these days have been prepared.

Table 3.4-1. Five-year rank and percentile of PM_{10} values on September 8 and 9, 2022, at affected sites.

Site	Rank	Percentile	24-hour PM_{10} ($\mu g/m^3$)
September 8, 2022			
Garrett Jr. High*	1	100	350
Green Valley	1	100	586
Jerome Mack	1	100	445
Joe Neal	1	100	513
Liberty High School*	3	99.67	285
Palo Verde	7	99.67	108
Paul Meyer	3	99.89	234
Sunrise Acres	1	100	468
Walnut Community Center*	4	99.48	278
Walter Johnson	2	99.95	307
September 9, 2022			
Garrett Jr. High*	7	99.06	147
Green Valley	4	99.84	231
Jerome Mack	2	99.94	341
Joe Neal	2	99.94	429
Liberty High School*	10	98.52	137
Palo Verde	4	99.83	212
Paul Meyer	6	99.72	160
Sunrise Acres	3	99.89	273
Walnut Community Center*	1	100	470
Walter Johnson	4	99.84	229

* Data collection began in spring 2021 at Garrett Jr. High, Liberty High School, and Walnut Community Center.

3.4.2 Event Comparison with Diurnal/Seasonal Patterns

The 24-hour average PM_{10} concentrations were compared to five-year (2018-2022) monthly and seasonal averages, and are shown in boxplots for September 8, 2022, in Figure 3.4-21 and Figure 3.4-23 and September 9, 2022, in Figure 3.4-22 and Figure 3.4-24. The interquartile range corresponds to the lower (25th percentile) and upper (75th percentile) edges of the boxes, and the middle bar is the median value. The whiskers extend to the smallest and largest value within 1.5 times the interquartile range. Points beyond this range are considered outliers. The concentrations recorded on September 8 and 9, 2022, are shown to be the highest recorded outliers for September and the autumn season during the entire five-year period.

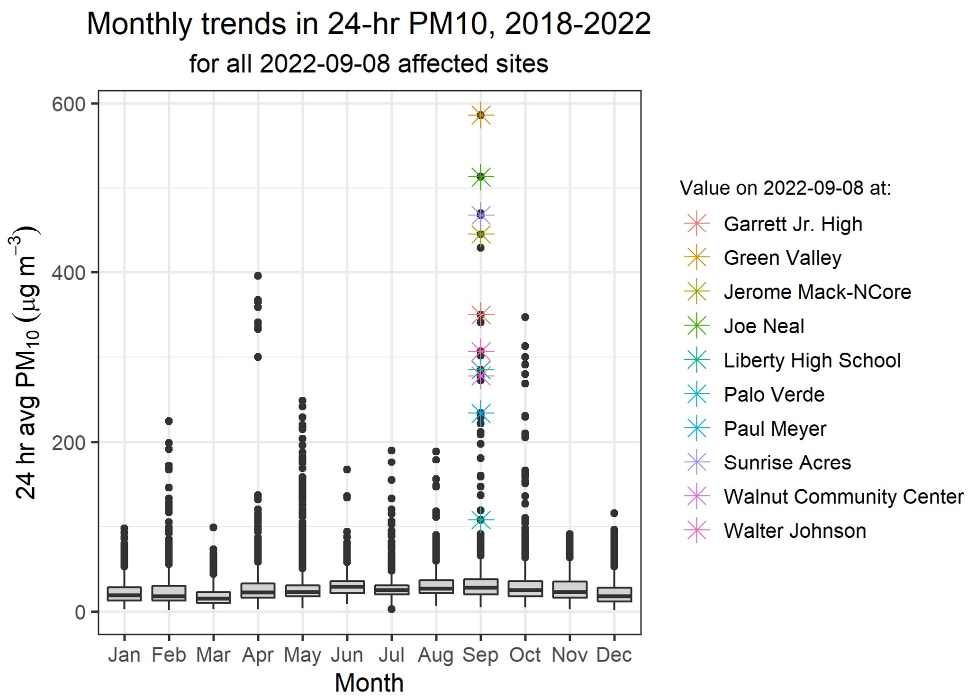


Figure 3.4-21. Monthly trend in 24-hour PM_{10} concentrations for 2018-2022, including outliers and highlighting the values on September 8, 2022.

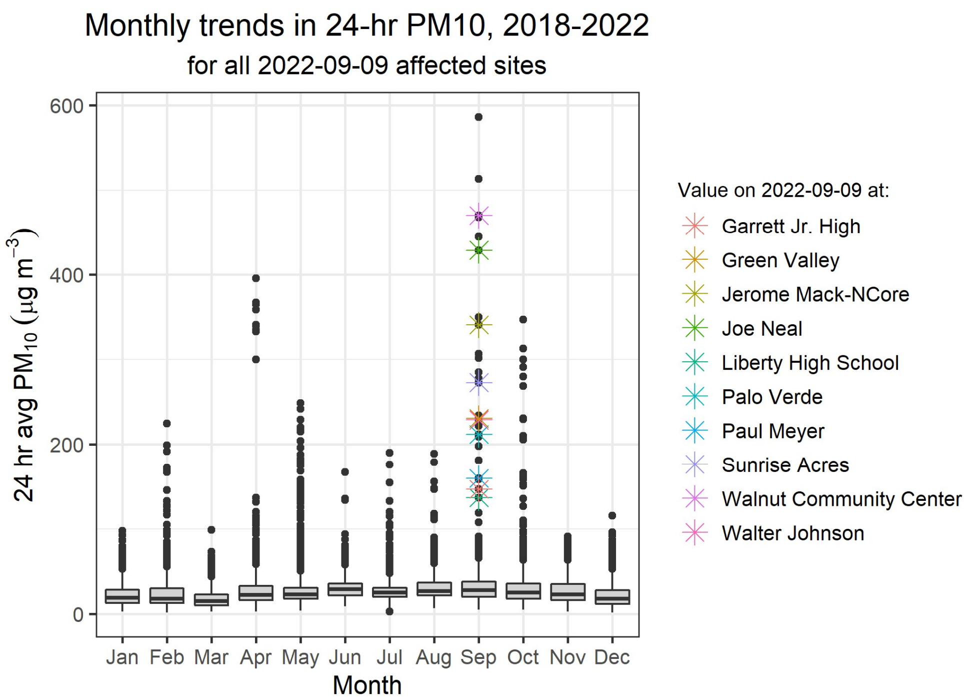


Figure 3.4-22. Monthly trend in 24-hour PM_{10} concentrations for 2018-2022, including outliers and highlighting the values on September 9, 2022.

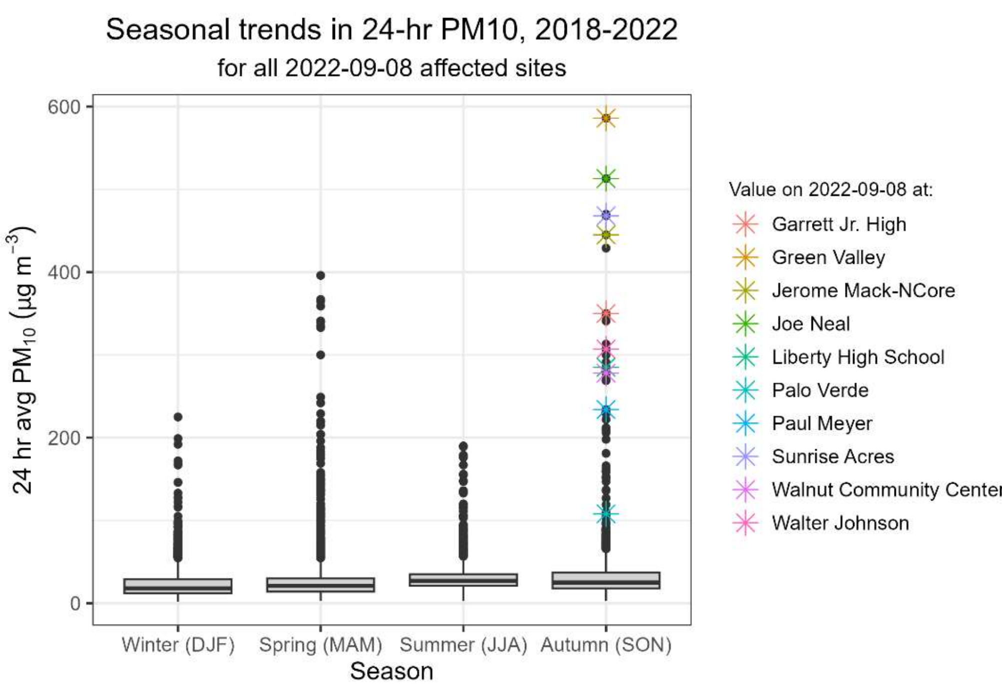


Figure 3.4-23. Seasonal trend in 24-hour PM_{10} concentrations for 2018-2022, including outliers and highlighting the values on September 8, 2022.

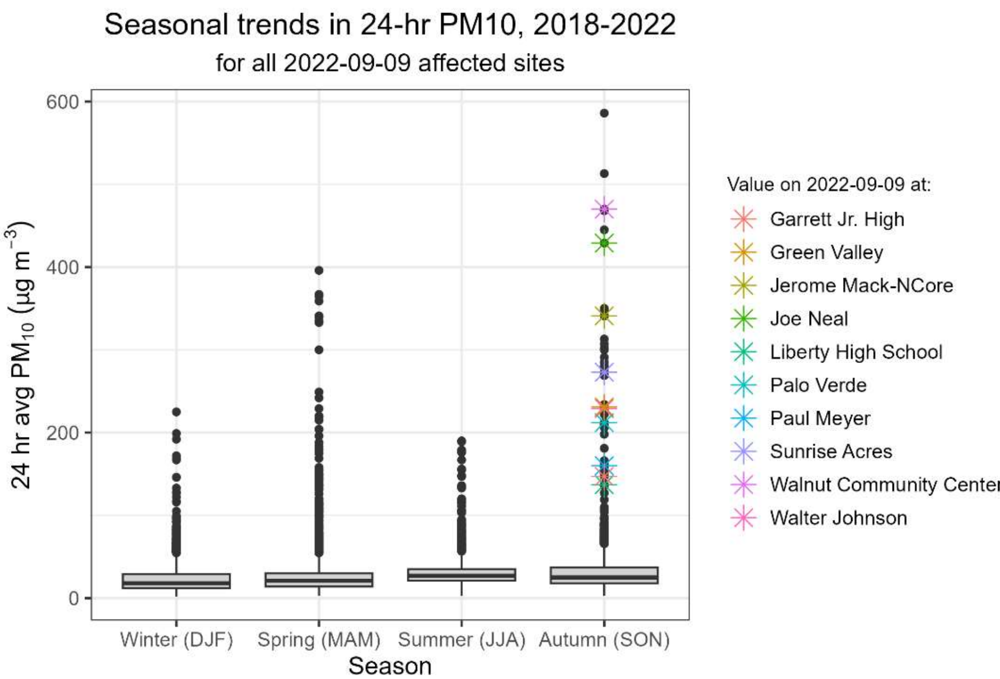


Figure 3.4-24. Seasonal trend in 24-hour PM_{10} concentrations for 2018-2022, including outliers and highlighting the values on September 9, 2022.

The hourly PM_{10} concentrations were compared to five-year (2018-2022) hourly averages. A summary of the maximum value observed compared to the five-year (2018-2022) 95th percentile is shown in Table 3.4-2, and time series are shown in Figure 3.4-25 through Figure 3.4-33. At the Green Valley site, for example, the hourly PM_{10} concentration on September 8, 2022, at 19:00 PST was measured to be 42 µg/m^3, compared to a five-year 95th percentile of 65 µg/m^3. Within the following hour, measurements surpassed the five-year 95th percentile with a value of 3,929 µg/m^3. The event reached a maximum of 6,168 µg/m^3 at 21:00, 118 times the 95th percentile value of 52 µg/m^3. Similar trends were seen across the other sites.

Table 3.4-2. Summary of max hourly PM_{10} measurements compared to five-year hourly PM_{10} 95th percentile.

Site Name	Date and Time of Hourly PM_{10} Max (PST)	Hourly PM_{10} (µg/m^3)	Five-Year Hourly PM_{10} 95th Percentile (µg/m^3)	Hourly/Five-Year 95th Percentile
Paul Meyer	9/8/2022 21:00	2,770	52	54
Walter Johnson	9/8/2022 21:00	3,508	51	69
Palo Verde	9/8/2022 21:00	1,062	43	25
Joe Neal	9/8/2022 21:00	5,797	64	91
Green Valley	9/8/2022 21:00	6,168	52	118
Liberty High School	9/8/2022 21:00	3,257	66	50
Jerome Mack	9/8/2022 20:00	4,213	94	45
Sunrise Acres	9/8/2022 20:00	3,784	102	37
Walnut Community Center	9/8/2022 20:00	2,256	105	22

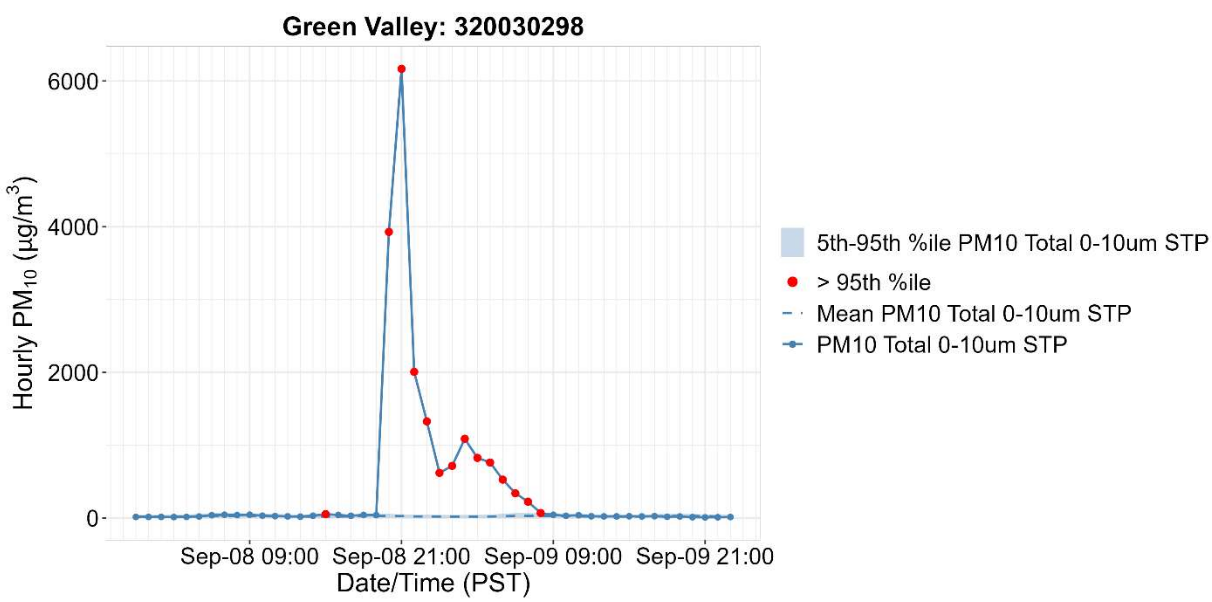


Figure 3.4-25. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 1-hour PM_{10} concentration 5th-95th percentile (shaded area) at Green Valley from 2018-2022.

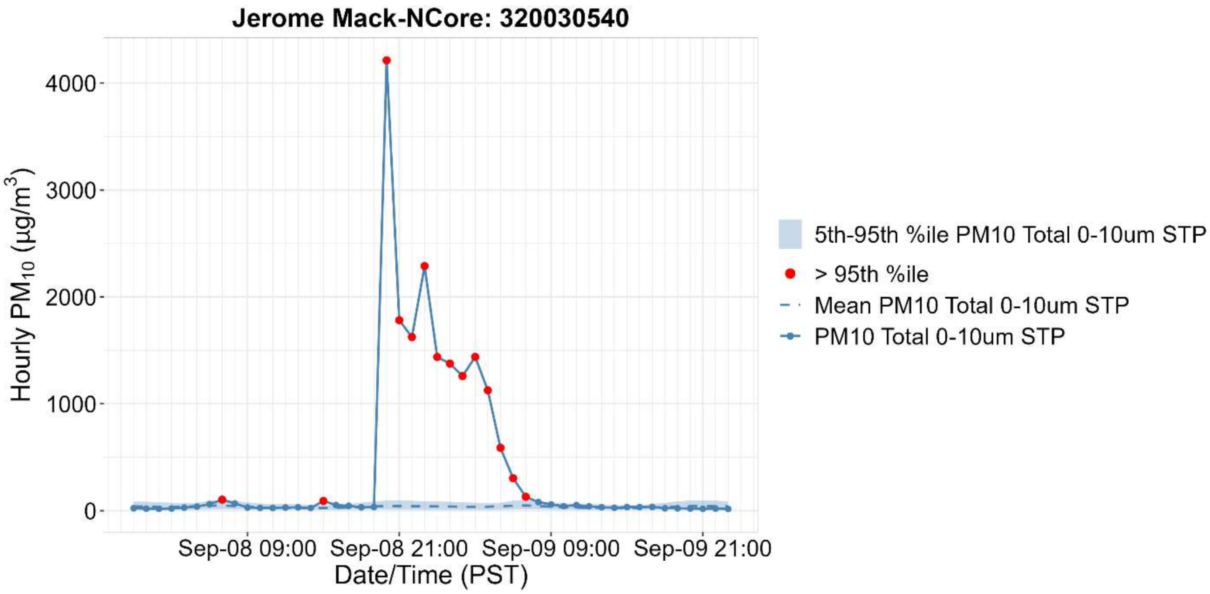


Figure 3.4-26. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 1-hour PM_{10} concentration 5th-95th percentile (shaded area) at Jerome Mack from 2018-2022.

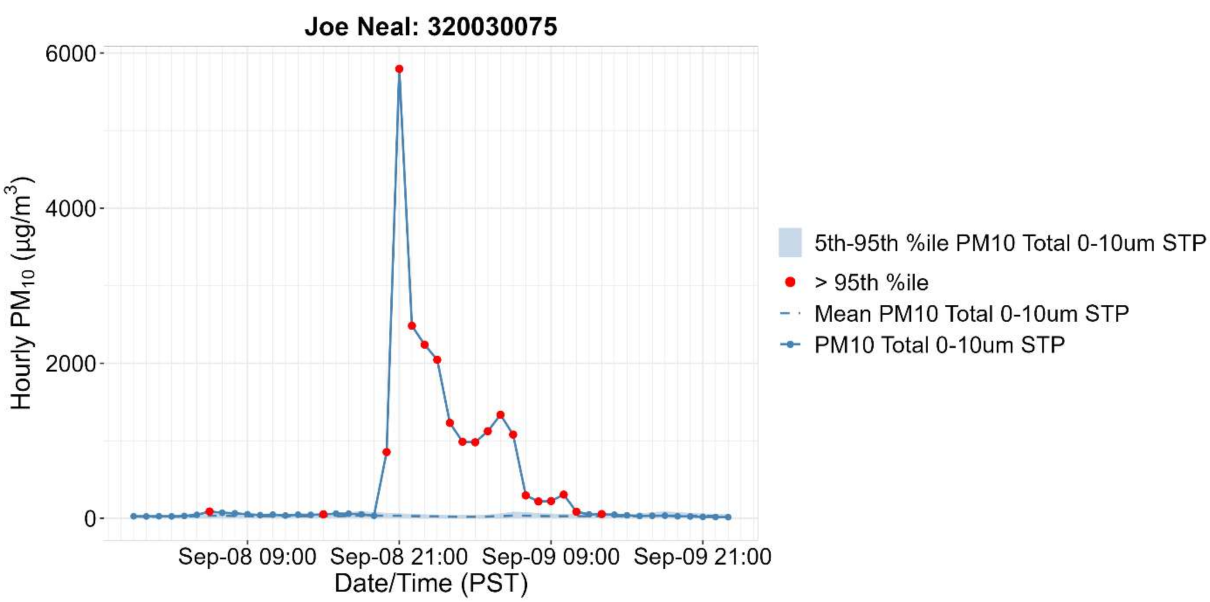


Figure 3.4-27. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 1-hour PM_{10} concentration 5th-95th percentile (shaded area) at Joe Neal from 2018-2022.

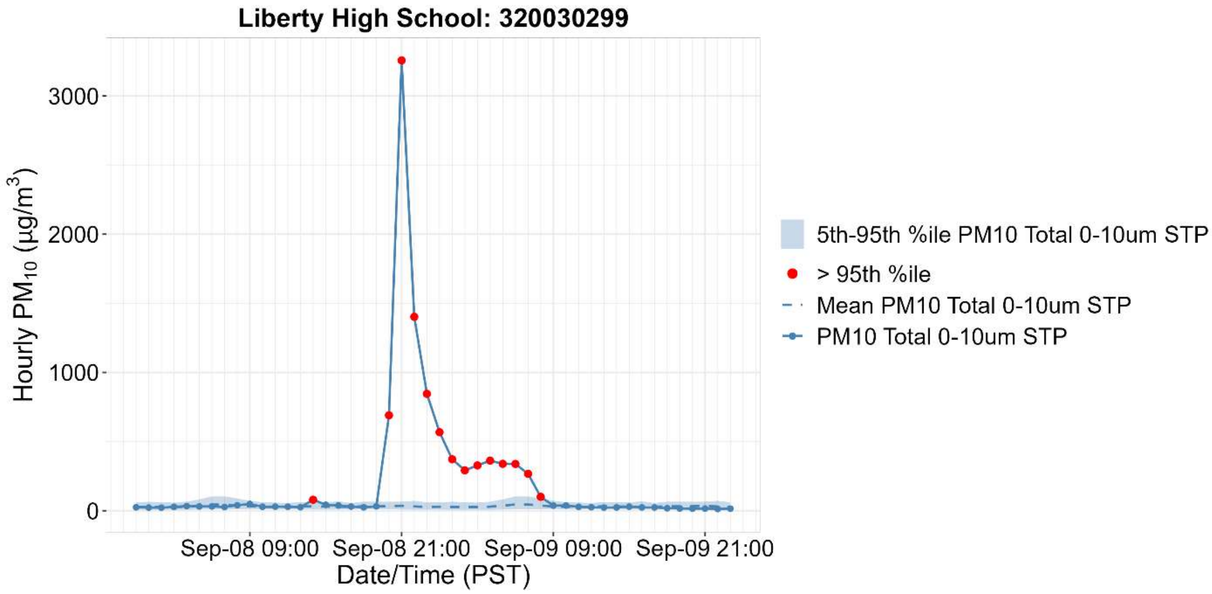


Figure 3.4-28. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 1-hour PM_{10} concentration 5th-95th percentile (shaded area) at Liberty High School from 2018-2022.

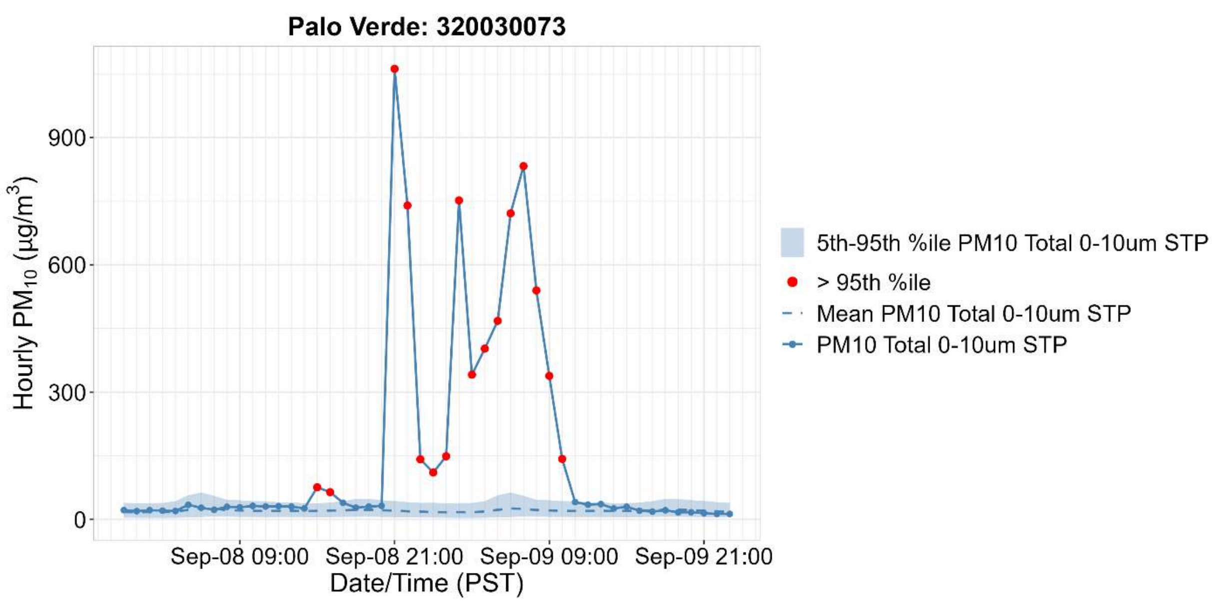


Figure 3.4-29. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 1-hour PM_{10} concentration 5th-95th percentile (shaded area) at Palo Verde from 2018-2022.

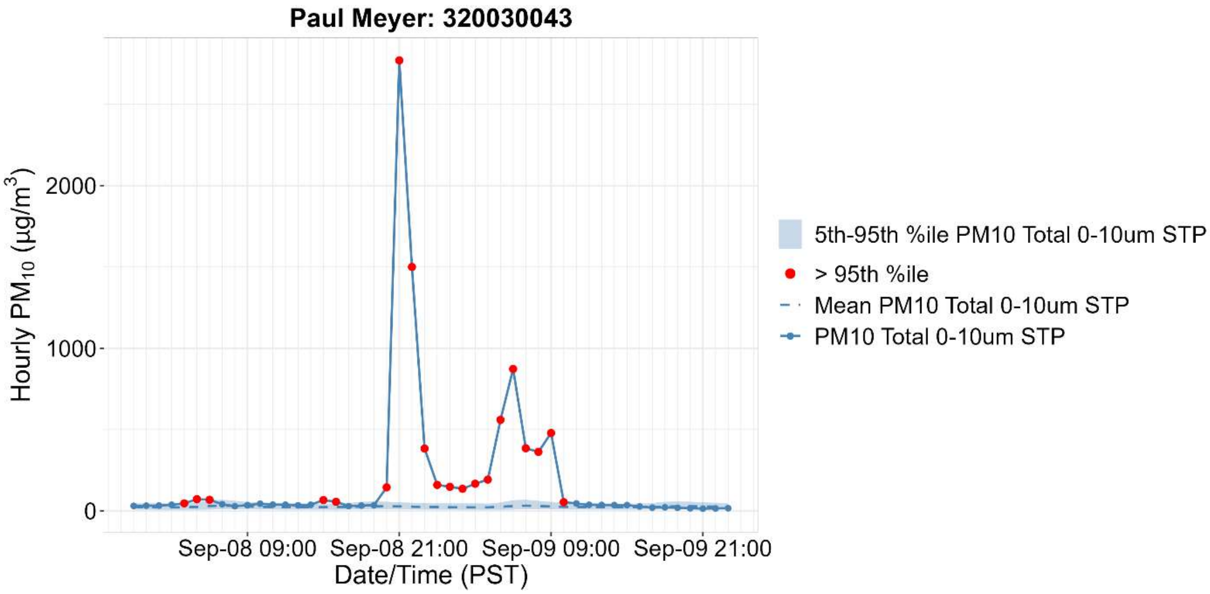


Figure 3.4-30. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 1-hour PM_{10} concentration 5th-95th percentile (shaded area) at Paul Meyer from 2018-2022.

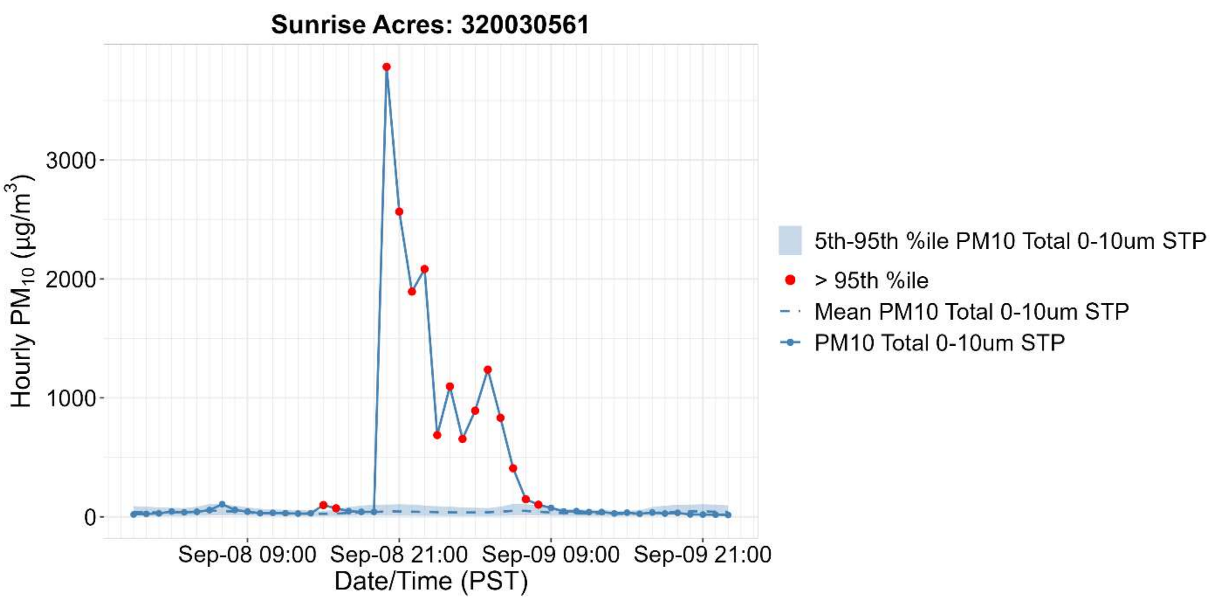


Figure 3.4-31. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 1-hour PM_{10} concentration 5th-95th percentile (shaded area) at Sunrise Acres from 2018-2022.

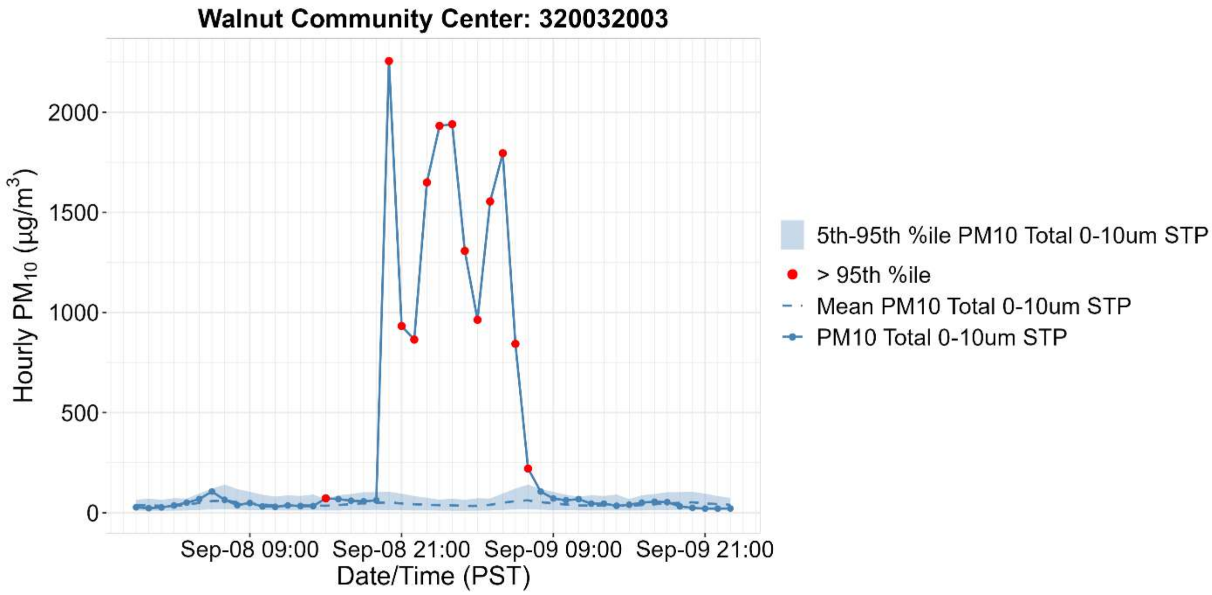


Figure 3.4-32. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 1-hour PM_{10} concentration 5th-95th percentile (shaded area) at Walnut Community Center from 2018-2022.

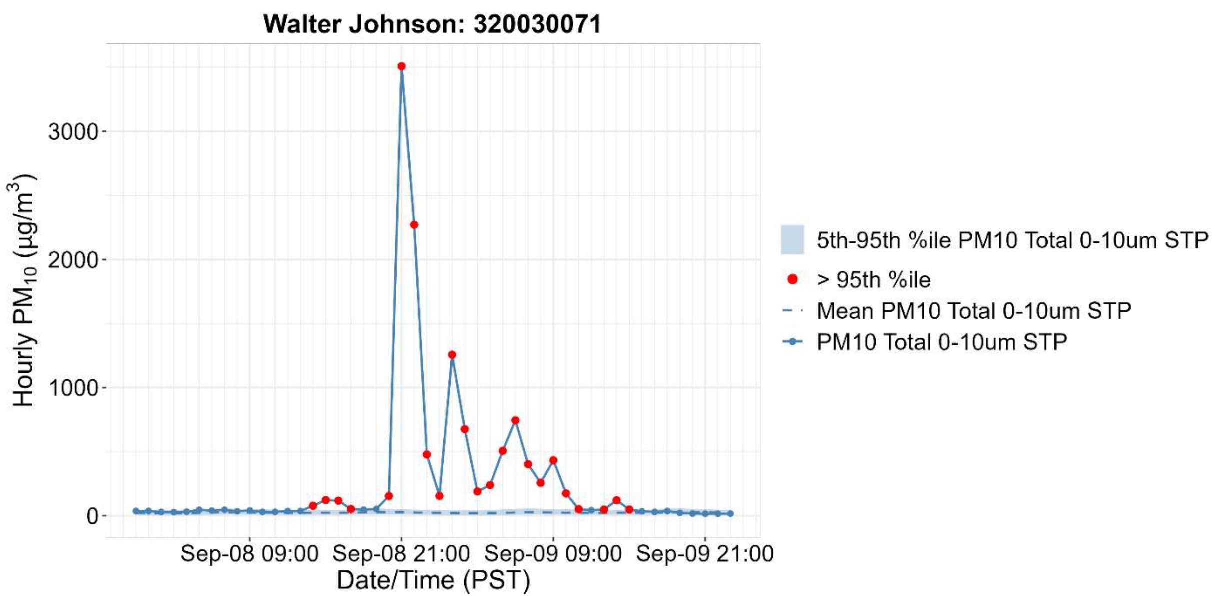


Figure 3.4-33. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 1-hour PM_{10} concentration 5th-95th percentile (shaded area) at Walter Johnson from 2018-2022.

3.4.3 Event Comparison with Climatology

Thirty-year seasonal climatology was created using European Environment Agency (ERA5) reanalysis at 0.25° x 0.25° horizontal resolution from 1993 through 2022 for both the source region and Clark

County. Temperature, volumetric soil moisture, and maximum winds speed were chosen and modeled as the most likely variables to influence a windblown dust event in both the source region and Clark County. This analysis shows the seasonal September-October-November thirty-year average for each variable in the top panel and the event date departure from the seasonal climatology in the bottom panel. **Figure 3.4-34** shows the climatology compared with the event date for the source region. On the event date, the source region was experiencing ground-level temperatures at or more than 20 °F above the long-term average, lower-than-average to normal soil moisture, and slightly higher-than-average to normal wind speeds. **Figure 3.4-35** shows the climatology compared with the event date for Clark County. On the event date Clark County is experiencing ground-level temperatures more than 20 °F above the long-term average. The climatological data unfortunately does not capture the local-scale, very-short duration outflow boundary event well. However, the climatological evidence provides proof that the conditions on the event date were abnormally hot in both the source region and Clark County, leading to a windblown dust event.

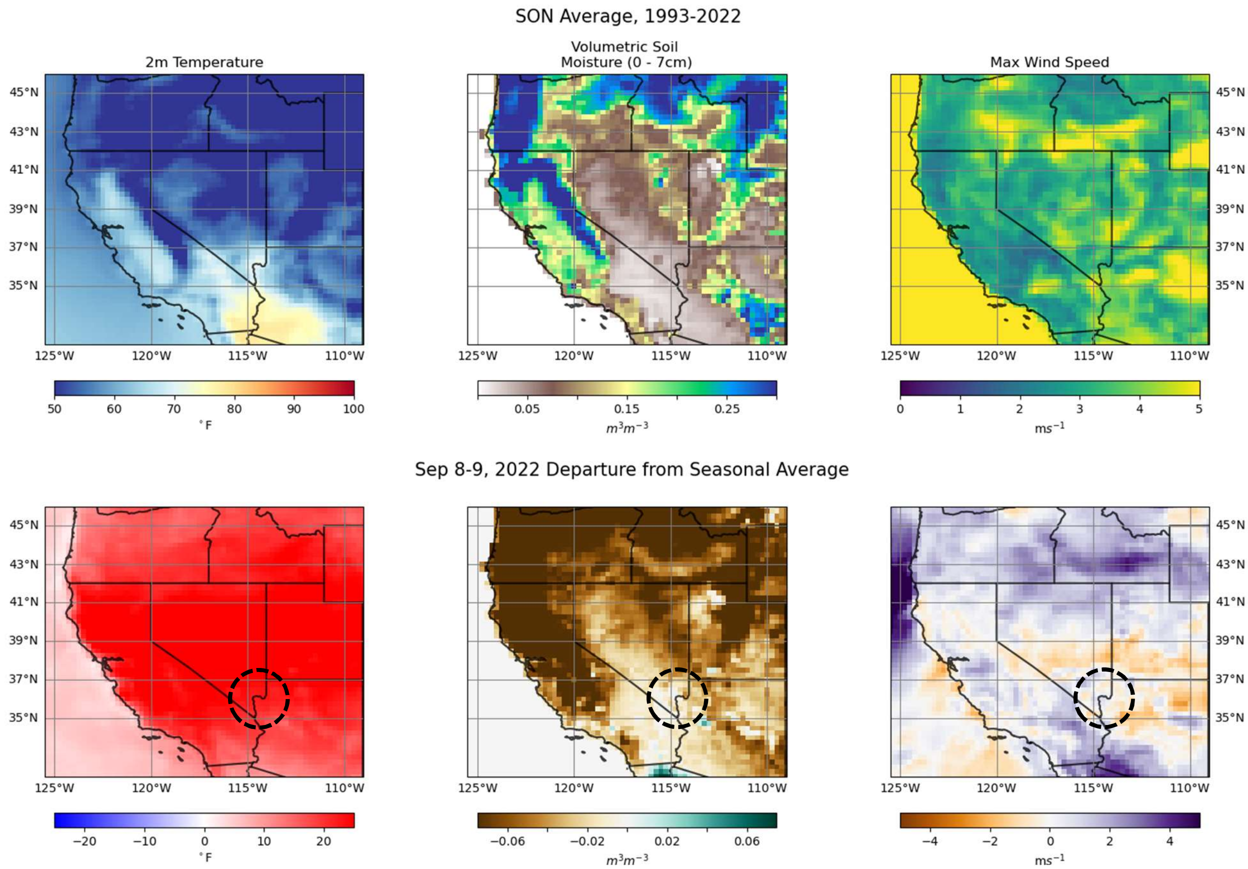


Figure 3.4-34. The thirty-year September-November seasonal climatological average based on ERA5 reanalysis for 2-m temperature, volumetric soil moisture of the first 7 cm, maximum 10-m wind speed (top row), as well as the daily departure for September 8-9, 2022, from the 30-year average (bottom row). The source region is circled.

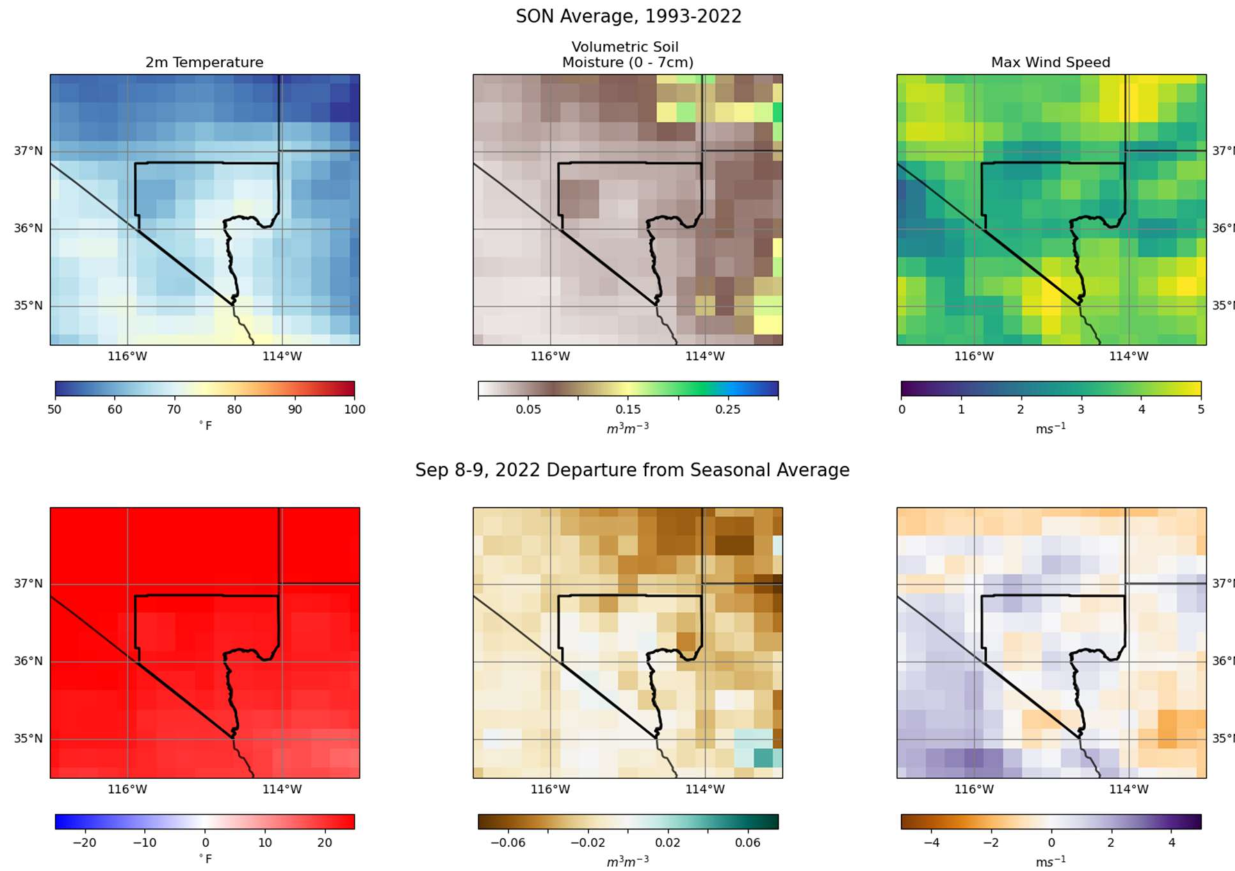


Figure 3.4-35. The thirty-year September-November seasonal climatological average for Clark County based on ERA5 reanalysis for 2-m temperature, volumetric soil moisture of the first 7 cm, and maximum 10-m wind speed (top row), as well as the daily departure for September 8-9, 2022, from the 30-year average (bottom row). Clark County is outlined in black.

3.5 Meteorological Similar Analysis

We do not provide a meteorological similar analysis for this date because it is not accurate to compare this event, which was produced by a local-scale, short-term outflow boundary, to other large-scale high-wind events or high PM_{10} dates without high-wind events.

4. Not Reasonably Controllable or Preventable

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

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

Section 2.2.3 provides evidence for natural and anthropogenic sources near the Paul Meyer, 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 September 8-9, 2022, exceedance. As shown in Section 3.2, however, the main source of PM_{10} is the large bare ground/land area to the southeast 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 September 8-9, 2022, event (fulfilling nRCP part 1), in this section we focus on providing information on control measures used in Clark County to mitigate emissions from construction sites and possible dust sources in both the SIP (fulfilling nRCP part 2) and providing evidence of effective implementation (fulfilling nRCP part 3).

4.2 PM_{10} Control Measures in Clark County

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

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

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

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

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

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

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

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[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.

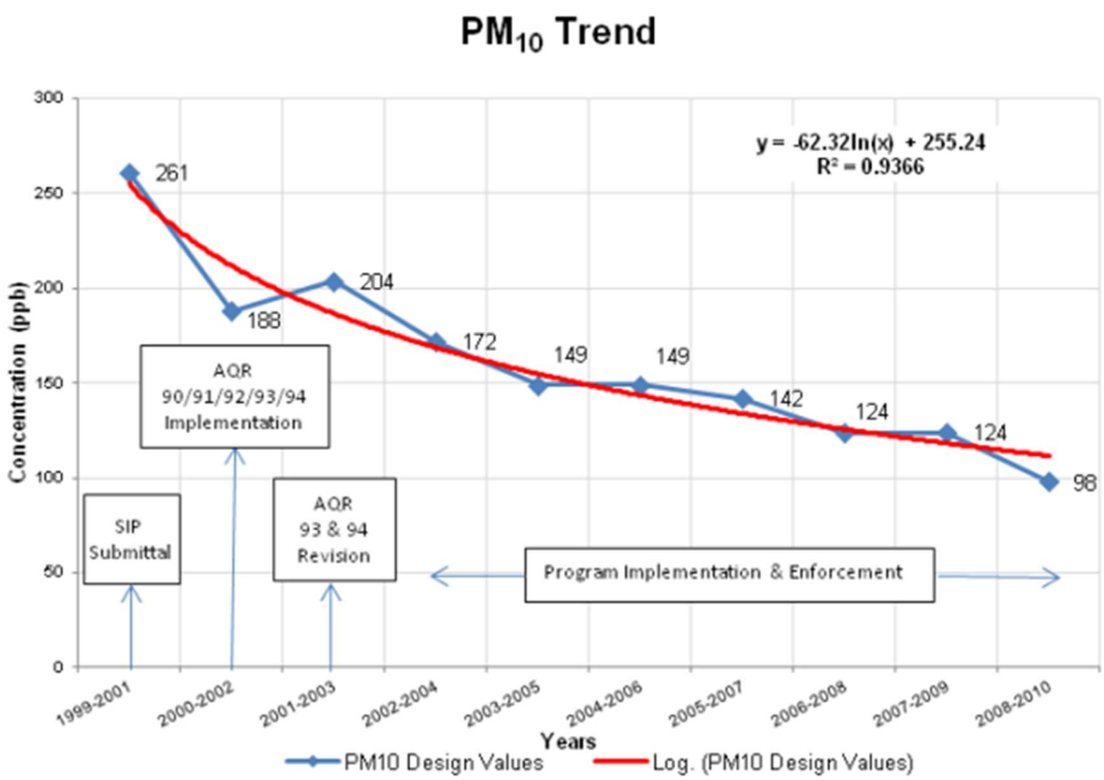

Figure 4.3-1. PM_{10} trends from the 2012 Maintenance Plan.

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.

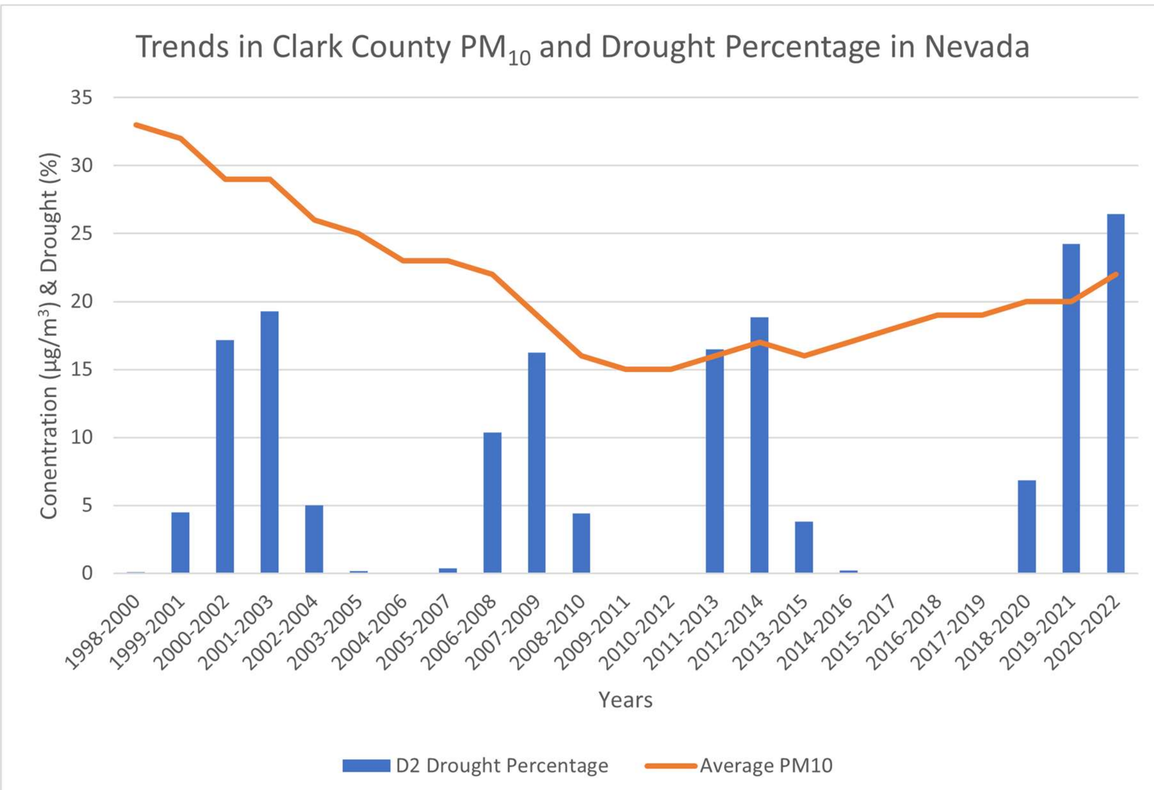

Figure 4.3-2. Three-year running average of PM_{10} concentrations (µg/m^3) at the long-running Paul Meyer monitoring site (AQS: 32-003-0043) (orange line) and the D2 (severe) drought percentage of Nevada (blue bars). Source: **https://www.drought.gov/states/nevada**.

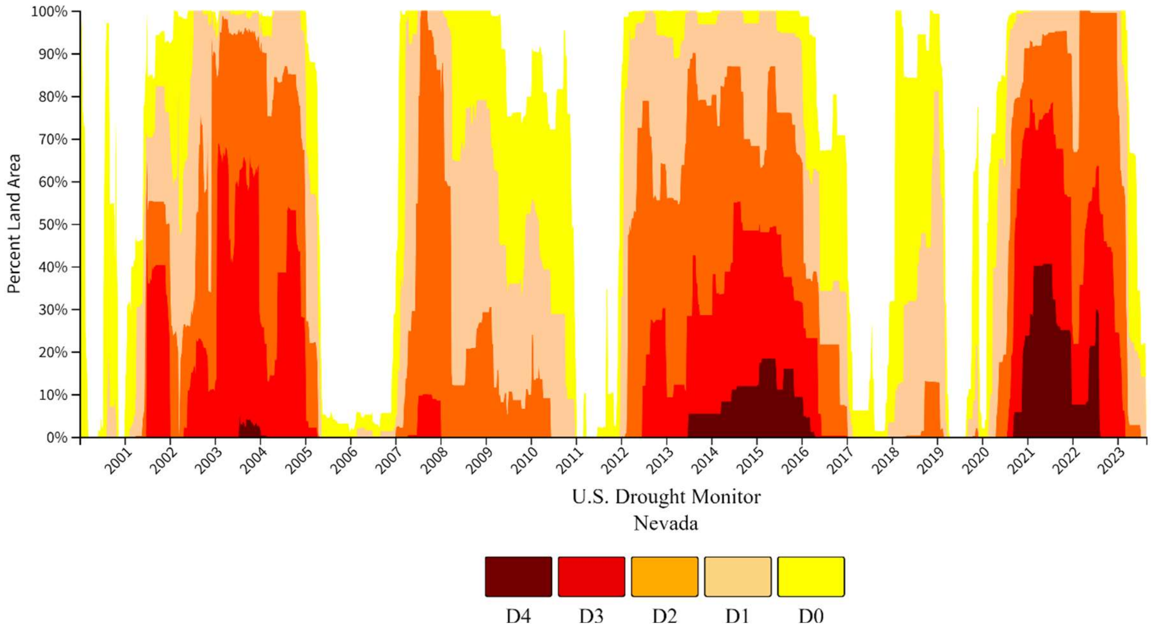

Figure 4.3-3. Drought statistics for Nevada from 2000-2023, colored by drought severity for D0 to D4. Source: https://www.drought.gov/states/nevada.

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.

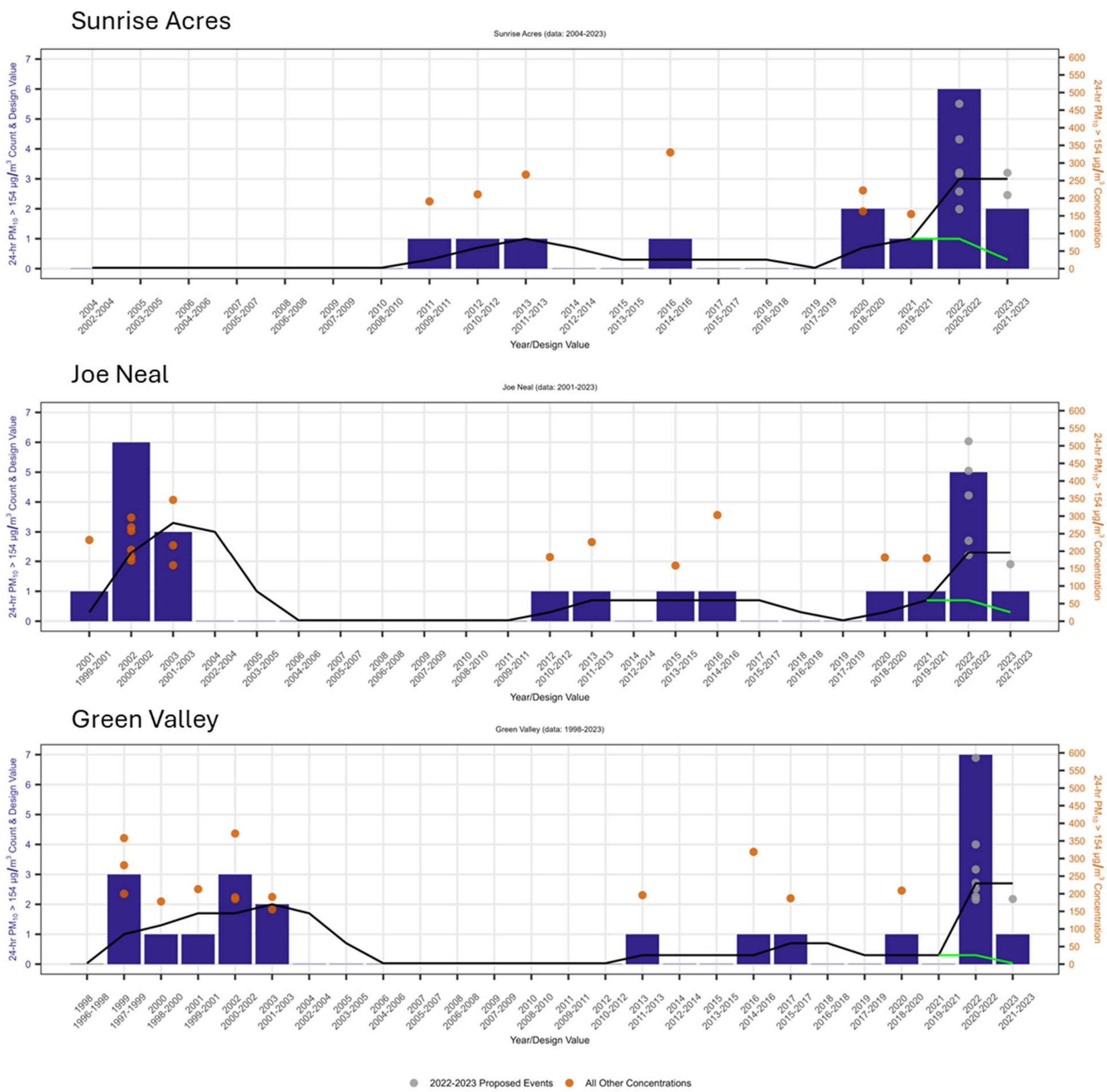

Figure 4.3-4. Historical 24-hour PM_{10} exceedance count (purple bars) and concentration (orange dots) per year/design value period at the Sunrise Acres, Joe Neal, and Green Valley monitoring sites (AQS: 32-003-0561; 32-003-0075; 32-003-0298). The gray dots represent the proposed 2022-2023 PM_{10} exceptional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

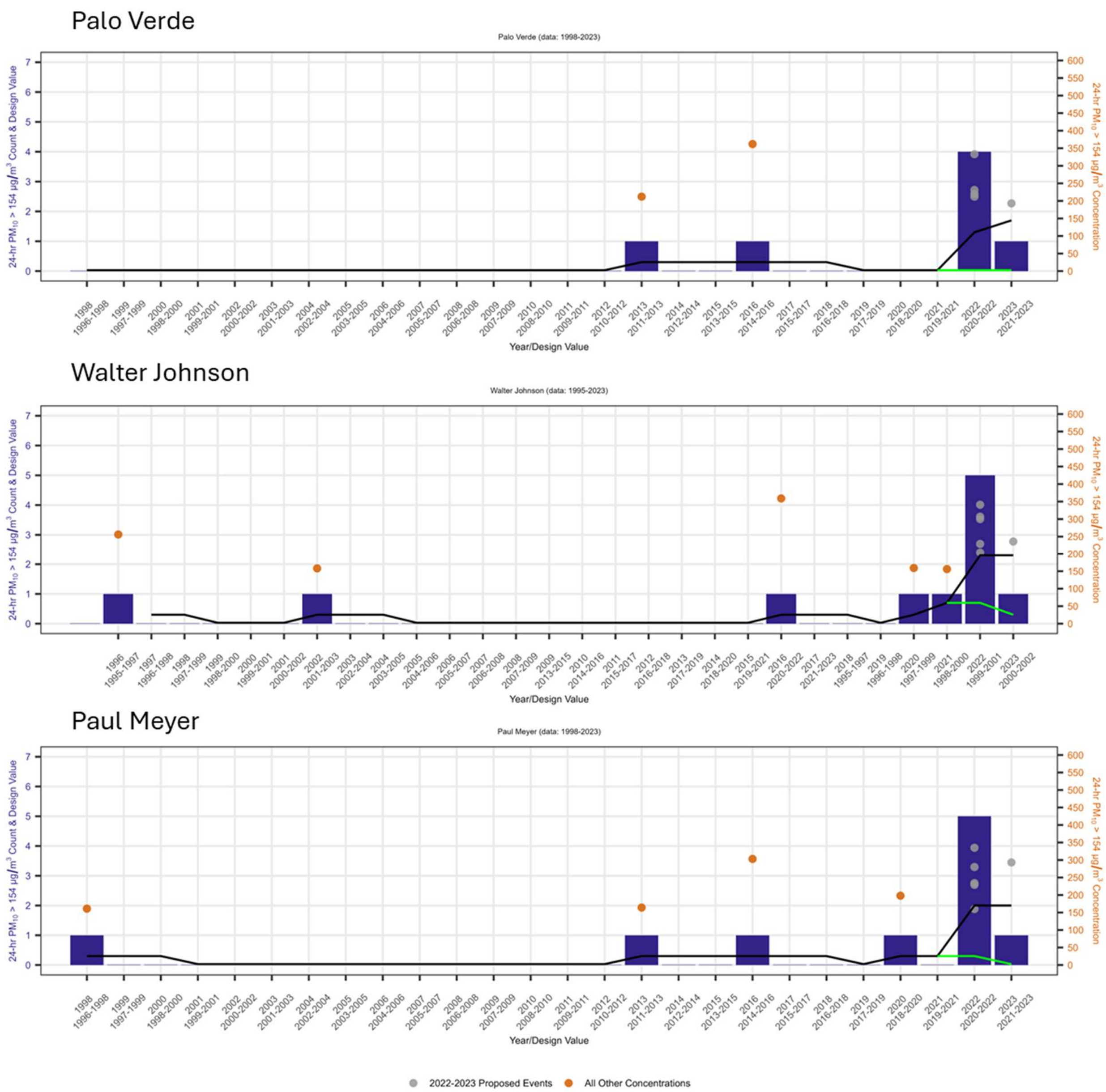

Figure 4.3-5. Historical 24-hour PM_{10} exceedance count (purple bars) and concentration (orange dots) per year/design value period at the Palo Verde, Walter Johnson, and Paul Meyer monitoring sites (AQS: 32-003-0073; 32-003-0071; 32-003-0043). The gray dots represent the proposed 2022-2023 PM_{10} 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 September 8, 2022, a hurricane-initiated thunderstorm created an outflow boundary with associated high-speed winds. The outflow boundary passage through the Mojave Desert region of northwestern Arizona and southern Nevada drove a windblown dust event that increased PM_{10} concentrations in Clark County, Nevada, on September 8-9, 2022. 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 a westward progression of high PM_{10} concentrations and wind speeds consistent with the direction of travel of the outflow boundary; this observation is particularly noticeable on September 8 at 19:00 PST, where the Garrett Jr. High monitoring site in the southeast of the Las Vegas Valley recorded PM_{10} concentrations above 500 µg/m^3, while most sites to the west were below 50 µg/m^3. In the following hour, all eastern sites recorded concentrations above 500 µg/m^3 with southeasterly winds. 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 September 8-9, 2022. The timeline shown in this exceptional event demonstration highlights the progression of extremely high concentrations of PM_{10} from the source region into Clark County (and HA 212) within a very short period of time. This progression clearly indicates an upwind source of windblown dust. As the outflow boundary lofted, entrained, and transported dust from the Mojave Desert in northwestern Arizona 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.

Although neither a Construction Notice nor a Dust Advisory was issued by Clark County before the exceedance on September 8-9, 2022 event due to the unpredictable nature of this event, a Dust Alert

[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

was issued to the public on September 9 (shown in **Section 3.3.1**, with additional details in **Appendix C**). Since this dust event was generated by the outflow boundary from a hurricane-initiated thunderstorm, forecasting the dust impacts in advance was not possible. This and other Clark County public-facing alerts indicate the implementation of BACM and other enforcement procedures. Since it was not possible to forecast the September 8-9 event, Appendix C provides the regularly scheduled construction site inspections performed on these dates by the Compliance and Enforcement Department. Appendix C also provides an example of information that is representative of what inspectors might produce to document their efforts when responding to a Construction Notice or Dust Advisory.

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 September 8-9, 2022, PM_{10} event were not reasonably controllable or preventable.

5. Natural Event

The September 8-9, 2022 event is the result of a gust front passage with high winds proceeding directly over the area the Mojave Desert in northwestern Arizona and southern Nevada and into Clark County, NV. In the case that 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 September 8 and 9, 2022 were caused by a High Wind Dust Event where dust was lofted, entrained, and transported from the extremely dry Mojave Desert in northwestern Arizona and southern Nevada. Key elements and evidence associated with the event timeline include:

1. Convection was initiated due to Hurricane Kay and upper-level divergence over northwest Arizona in the afternoon (11:00-14:00 PST) on September 8, 2022. By 16:00-17:00 PST, the thunderstorms were building and moving northwest. An outflow boundary from the thunderstorms first appeared around 18:00 PST and quickly pushed through northwestern Arizona, including the Mojave Desert, to reach Boulder City, NV, by 19:00 PST. By 20:00-21:00 PST, the outflow boundary had pushed through Clark County and transported dust in its wake. High winds from the outflow boundary lofted, entrained, and transported dust from the Mojave Desert into Clark County by 19:00-21:00 PST on September 9. Radar sequences confirm the meteorological analysis and outflow boundary progression. Meteorological measurements in the source region and along the transport path show 30-40 mph winds, which exceed the 25-mph threshold.

2. With the passage of the outflow boundary, PM_{10} concentrations were extremely enhanced, visibility measurements dramatically decreased, $PM_{2.5}/PM_{10}$ ratio concentrations dropped (indicating windblow dust), and $PM_{2.5}$ speciated crustal elements were enhanced. PM_{10} concentrations peaked in Clark County by 20:00-21:00 PST on September 8, 2022, consistent with the outflow boundary passage. Winds calmed once the outflow boundary passed through Clark County, but stagnant conditions allowed PM_{10} concentrations to linger through the early morning on September 9. By 10:00 PST on September 9, southerly winds picked up and pushed dust out of the area, allowing PM_{10} concentrations to decrease back to normal levels.

3. PM_{10} concentrations increased at the same time as the frontal passage pushed into Clark County starting at 19:00-20:00 PST and peaked in intensity in Clark County by 20:00-21:00 PST on September 8, 2022. The 24-hour PM_{10} concentrations on September 8 and/or 9 were above the NAAQS threshold of 150 $\mu g/m^3$ at all sites within the Las Vegas Valley, except for Mountains Edge. Of regulatory significance, 24-hour PM_{10} concentrations on September 8 at Paul Meyer, Walter Johnson, Joe Neal, Green Valley, Liberty High School, Jerome Mack, Sunrise Acres, and Walnut Community Center ranged from 234 to 586 $\mu g/m^3$. On September 9, 24-hour PM_{10} concentrations at Paul Meyer, Walter Johnson, Palo Verde, Joe Neal, Green Valley, Jerome Mack, Sunrise Acres, and Walnut Community Center ranged from 160 to 471 $\mu g/m^3$. All sites in the Las Vegas Valley exceeded the 99th percentile for 24-hour PM_{10}, but not all were regulatorily significant in this case. Hourly PM_{10} concentrations at all sites in Clark County peaked above 6,000 $\mu g/m^3$ through the event on September 8 and 9, 2022. The concurrent rise in PM_{10} at all sites around Clark County indicates a regional dust event.

4. Of regulatory significance, PM_{10} at Paul Meyer, Walter Johnson, Palo Verde, Joe Neal, Green Valley, Liberty High School, Jerome Mack, Sunrise Acres, and Walnut Community Center was at or exceeded the five-year 99th percentile and the NAAQS on September 8-9, 2022. PM_{10} concentrations are also significantly outside typical diurnal, monthly, and seasonal ranges.
5. Clark County, NV, and the surrounding source region was under increasingly severe drought conditions on and before the event on September 8-9, 2022. The 30-year climatology shows that temperatures were significantly above normal, while soil moisture was below normal. The barren land cover in the Mojave Desert source region of northwestern Arizona and southern Nevada was primed for significant dust production during the high-wind event. PM_{10} control measures within Clark County were quickly overwhelmed and were unable to prevent an exceedance event on September 8-9, 2022. Dust lofted and transported from this natural, undisturbed area experiencing severe drought is considered to be a natural event that was not reasonable or controllable.

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 September 8-9, 2022, caused 24-hour PM_{10} NAAQS exceedances with regulatory significance at Paul Meyer (Monitor AQS ID 32-003-0043, 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). Seven additional suspected windblown dust events occurred between 2021 and 2023. Without EPA concurrence that the windblown dust event on September 8-9, 2022, and the other suspected events qualify as exceptional events, the 2021-2023 design value is 2.0 at Paul Meyer, 2.3 at Walter Johnson, 1.7 at Palo Verde, 2.3 at Joe Neal, 2.7 at

Green Valley, 3.0 at Liberty High School, 3.7 at Jerome Mack, 3.0 at Sunrise Acres, and 4.0 at Walnut Community Center. This is outside of the attainment standard of 1.0. With EPA concurrence on September 8-9, 2022, and the other suspected events, the 2021-2023 design value is 0.0 at Paul Meyer, 0.3 at Walter Johnson, 0.0 at Palo Verde, 0.3 at Joe Neal, 0.0 at Green Valley, 0.3 at Liberty High School, 0.3 at Jerome Mack, 0.3 at Sunrise Acres, and 1.0 at Walnut Community Center, within the attainment standard. 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 September 8-9, 2022, and agree to exclude the event from regulatory decisions regarding PM_{10} attainment.

7. References

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