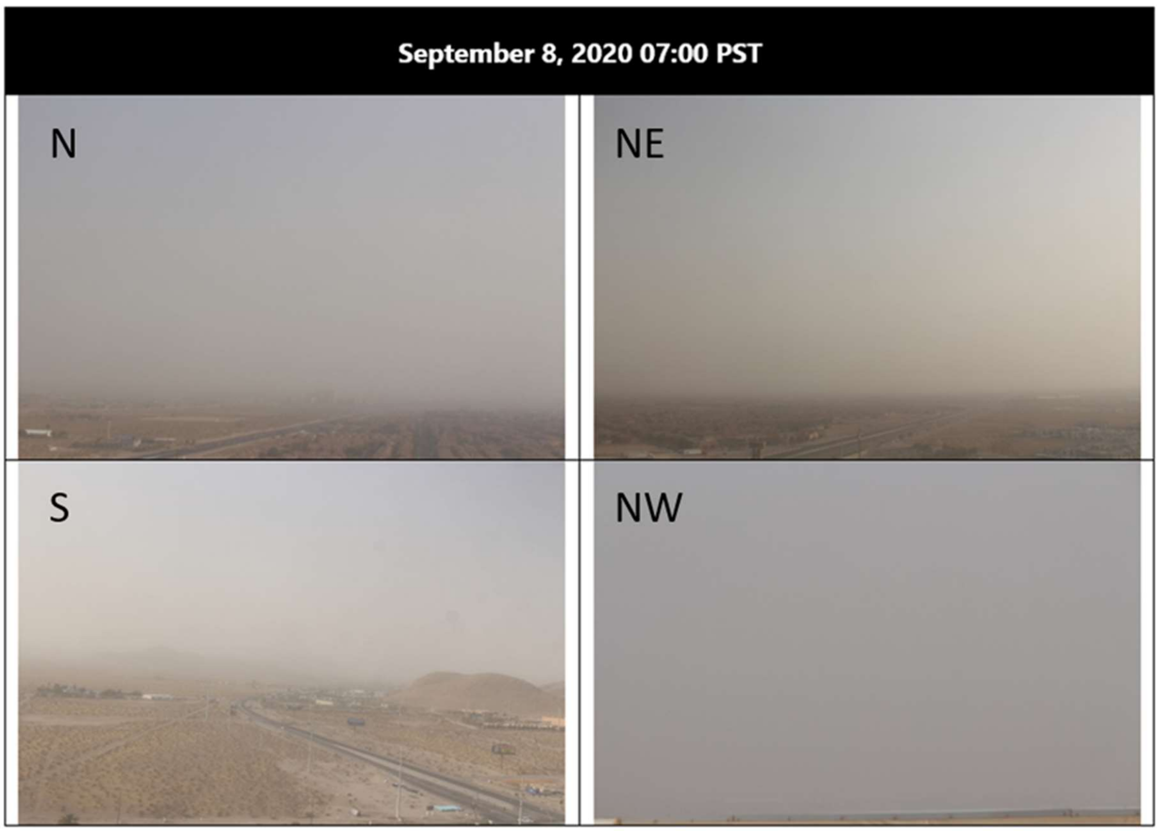
Exceptional Event Demonstration for PM_{10} Exceedances in Clark County, Nevada – September 8, 2020



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, 2020

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Final Report
STI-1922072-7985

June 2024

Cover graphic shows visibility images from the M Resort Hotel in the Las Vegas valley on September 8, 2020, at 08:00 PST. Visibility images are available in real-time from Clark County DES here: https://bit.ly/408P7yD.

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Contents

Figures

Tables

1. Narrative Conceptual Model

Extremely smoky conditions were widespread throughout the southwestern U.S. during early September. In addition to these smoky conditions, a strong frontal passage through northern Nevada drove a wind-blown dust event that increased particulate matter (PM) concentrations in Clark County, NV, on September 8, 2020. 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 Jerome Mack, Paul Meyer, Walter Johnson, Joe Neal, Green Valley, Sunrise Acres, Boulder City, and Jean monitoring sites in Clark County. While all of these sites exceeded the 24-hour PM_{10} standard, only the exceedance at the Jerome Mack monitoring site was of regulatory significance. The exceedance at the Jerome Mack monitoring site affects the PM_{10} attainment designation for Clark County during the 2019-2021 design value period.

Due to severe drought conditions in the Great Basin Desert in Nevada, strong winds from the frontal passage lofted, entrained, and transported dust to Clark County, arriving early in the morning on September 8, 2020. The U.S. Environmental Protection Agency (EPA) Exceptional Event Rule (EER) (U.S. Environmental Protection Agency, 2016) allows air agencies to omit air quality data from the design value calculation if it can be demonstrated that the measurement in question was caused by an exceptional event. In this case, enhanced wind speeds greater than 25 mph in Great Basin Desert source region and the Las Vegas valley coincide with increased PM_{10} concentrations and are 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, 2020, PM_{10} event at Jerome Mack ranks above the 99th percentile (99.94%) for all 2016-2020 PM_{10} events in Clark County and is clearly exceptional compared to typical PM_{10} conditions. Windblown dust from the Great Basin Desert is shown to be entirely from natural, undisturbed lands and can be considered a natural event that could not be mitigated by anthropogenic actions beyond public warnings. Overall, this report includes detailed analyses that establishes a clear causal relationship between the high-wind event in the Great Basin Desert and Clark County with the enhanced PM_{10} concentrations measured at Jerome Mack, and justify designating the September 8, 2020, 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

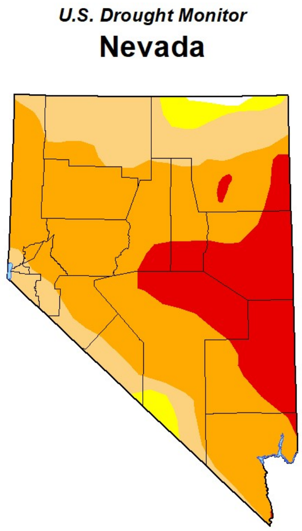


Figure 2.2-7

Clark County, NV, and the surrounding source regions were under increasingly severe drought conditions on September 8, 2020. Temperatures were above normal and precipitation below normal compared to climatology. The barren land cover, including the Great Basin Desert source region, was primed for significant dust production during the high-wind event.

See Section 2.2.

Inciting High-Wind Event

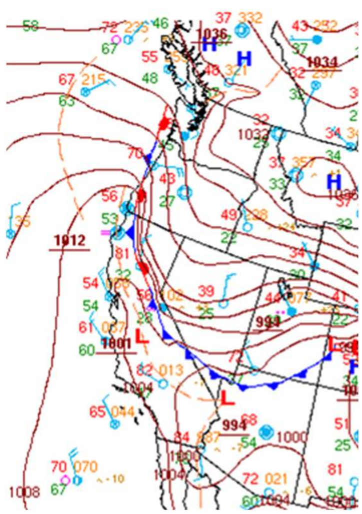


Figure 3.1-14

A frontal passage containing high wind speeds and gusts descended from the north across the Great Basin Desert and into Clark County, NV, between 16:00 PST on September 7 and 07:00 PST on September 8, 2020. Wind speeds in the Great Basin Desert and Clark County 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

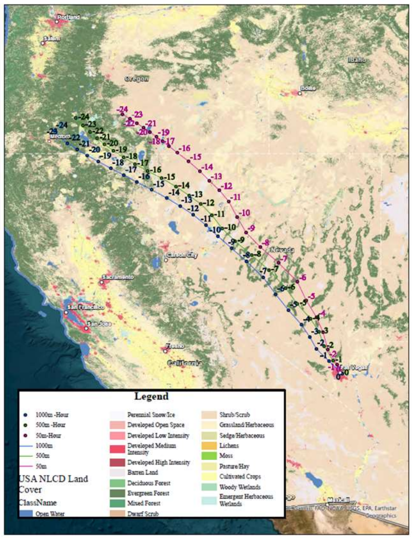


Figure 3.2-2

Back trajectories and meteorological data along the frontal passage confirm the Great Basin Desert (located to the north of Clark County) as the source region for the high-wind dust event. The frontal passage descended from the north through the source region enroute to Clark County, NV, within 24 hours of the exceedance.

See Section 3.2.

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

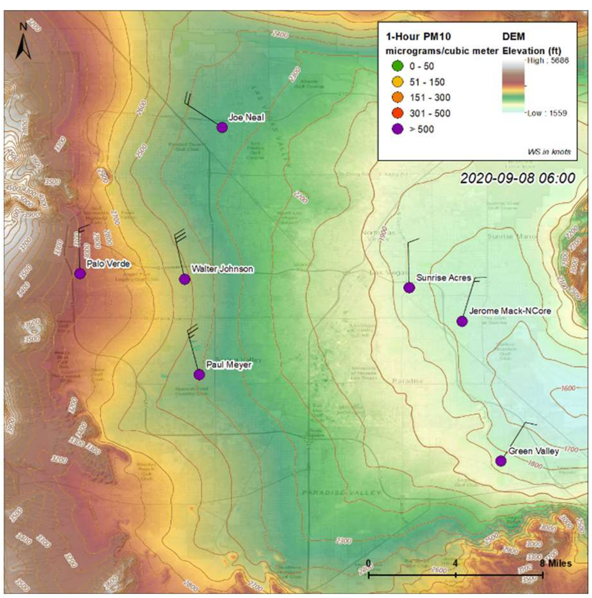


Figure 3.2-11

Enhanced PM_{10} arrived in Clark County beginning at 03:00 PST on September 8, 2020, and remained enhanced through 10:00 PST. High PM_{10} concentrations at Jerome Mack coincided with high wind speeds and wind gust measurements. Seven other monitoring sites in addition to Jerome Mack also exceeded the NAAQS on September 8, 2020. The widespread high PM_{10} concentrations occurred simultaneously with a regional high-wind event.

See Section 3.2.

Effect of PM_{10} Concentrations in Clark County

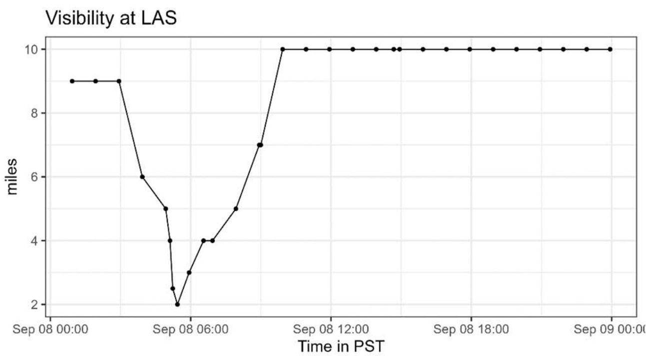
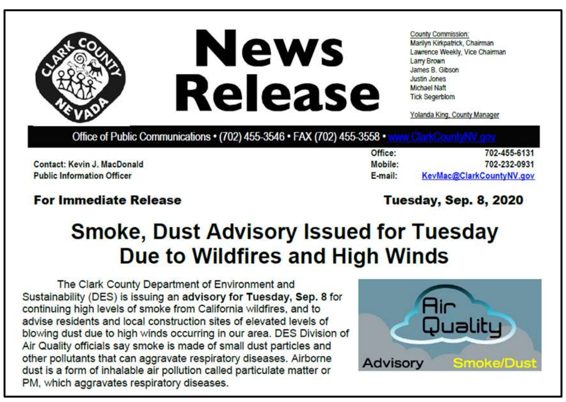


Figure 3.3-9

Poor visibility and obscured camera images show the effects of PM_{10} concentrations in Clark County. $PM_{2.5}/PM_{10}$ ratios plummeted, confirming windblown dust as the source of emissions.

See Section 3.3.

High Wind PM_{10} Alerts Issued



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For Immediate Release **Tuesday, Sep. 8, 2020**

Smoke, Dust Advisory Issued for Tuesday Due to Wildfires and High Winds

The Clark County Department of Environment and Sustainability (DES) is issuing an **advisory for Tuesday, Sep. 8** for continuing high levels of smoke from California wildfires, and to advise residents and local construction sites of elevated levels of blowing dust due to high winds occurring in our area. DES Division of Air Quality officials say smoke is made of small dust particles and other pollutants that can aggravate respiratory diseases. Airborne dust is a form of inhalable air pollution called particulate matter or PM, which aggravates respiratory diseases.

Air Quality
Advisory Smoke/Dust

Figure 3.3-2

Clark County, NV, issued a Smoke and Dust Advisory due to wildfires and high winds on September 8, 2020. This was also posted to social media for public access via Twitter. The National Weather Service also issued several alerts and social media statements. Multiple news outlets reported on high winds and dusty conditions on September 8, 2020.

See Section 3.3.

Comparison with Historical Data

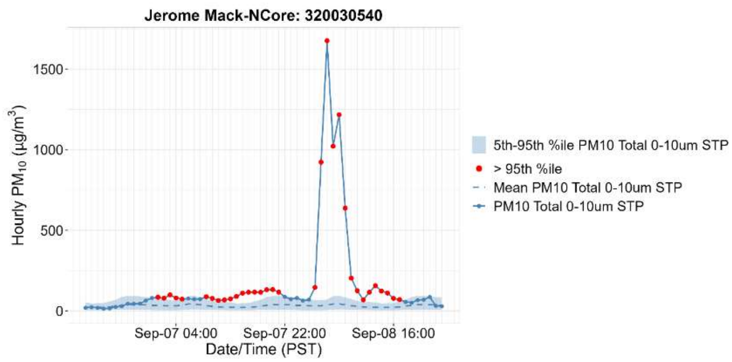


Figure 3.4-3

PM_{10} at Jerome Mack exceeded the 5-year 99th percentile and the NAAQS on September 8, 2020. PM_{10} concentrations are also significantly outside typical seasonal and monthly ranges. 30-year climatology analyses show temperatures, wind speeds, and soil moisture are significantly outside of historical normal on the event date.

See Section 3.4.

Not Reasonably Controllable or Preventable

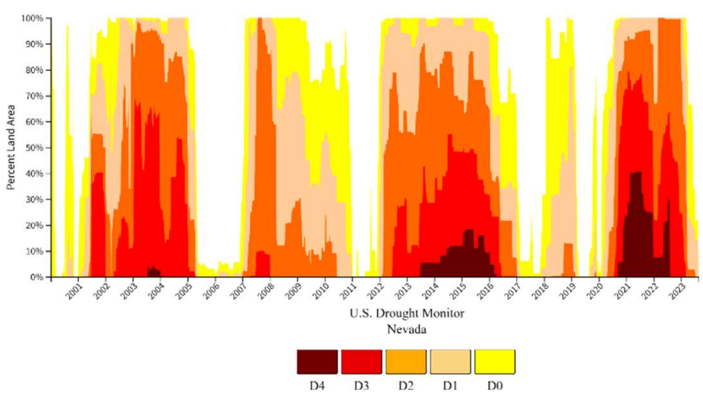


Figure 4.3-3

Based on the severe drought in the source region and the high-wind frontal passage, control measures for PM_{10} within Clark County were quickly overwhelmed and unable to prevent an exceedance event. Significant evidence that shows 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 Section 4 and 5.

2. Background

2.1 Demonstration Description

2.1.1 PM_{10} Exceptional Event Rule Summary

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

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

Specifically, a high-wind dust demonstration must show that the dust event is a “natural event” where windblown dust from natural sources or all significant anthropogenic sources of windblown dust have been reasonably controlled using Best Available Control Measures (BACM) (U.S. Environmental Protection Agency, 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” (nRCP) criterion. The winds contributing to the PM_{10} exceedance on September 8, 2020, 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" (U.S. Environmental Protection Agency, 2016) describes a three-tier analysis approach to determine a "clear causal relationship" for exceptional events demonstrations from an air agency. A summary of analysis requirements for each tier is listed in **Table 2.1-1**.

- Tier 1 analysis is applicable when the exceptional event is associated with a large-scale dust storm where recorded visibility is ≤0.5 miles, sustained winds are ≥40 mph, and is a focus of a Dust Storm Warning.
- Tier 2 analysis is applicable when the impacts of the dust event on PM_{10} levels are less clear and require more supportive documentation than Tier 1 analysis. Tier 2 analysis is warranted when the exceptional event sustained winds are ≥25 mph, but does not meet the other thresholds required in Tier 1 analysis.
- Tier 3 analysis is necessary when the impacts of the dust event on PM_{10} levels are more complicated than conditions described in the first two Tiers. Tier 3 analysis is needed when exceptional event sustained winds do not meet the 25-mph threshold. Events that fall under Tier 3 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 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, 2020, qualifies for Tier 2 analysis since it is a high-wind dust event with sustained winds at or above the high-wind threshold. On this date, resultant hourly average wind speeds greater than the 25-mph threshold necessary for Tier 2 were observed within the Las Vegas metropolitan region and in the Great Basin Desert source region. Additionally, 5-minute ASOS data from Harry Reid Int'l Airport showed multiple measurements of wind speeds greater than 25 mph throughout the day.

Table 2.1-2 provides a breakdown by section of all required analyses for the high-wind exceptional event. Sections 3.1-3.3 discuss the high-wind event in detail, including a meteorological analysis (Section 3.1), the timeline of the high-wind dust event (Section 3.2), and evidence of the high-wind dust event observed at the surface (Section 3.3). This includes media coverage of (Sections 3.3.2) and ground images taken during the event (Sections 3.3.5). Guidance for a Tier 2 analysis recommends a controls analysis when the dust source is not anthropogenic. Section 2.2 identifies anthropogenic and natural sources of dust. Section 2.2.1 and 2.2.2 discuss the dust source for the event on September 8, 2020, which were the natural, undisturbed lands in the Great Basin Desert region of central Nevada, and 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 Tier 2 and 3 high-wind exceptional events by section in this report.

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

Following the EPA's exceptional event guidance, we performed Tier 2 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, 2020. Focusing on the characterization of the meteorology, source region terrain and climatology, transport, and air quality on the days leading up to the event, we conducted the following specific analyses, the results of which are presented in Section 3.

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

2.1.4 Regulatory Significance

The high-wind dust event that occurred on September 8, 2020, caused a 24-hour PM_{10} NAAQS exceedance of 302 µg/m^3 that has regulatory significance at Jerome Mack (Monitor AQS ID 32-003-0540, POC 1). A NAAQS exceedance that is approved by the EPA as an exceptional event may be excluded from regulatory examination under the EER. Without EPA concurrence that the wind-blown dust event on September 8, 2020, qualifies as an exceptional event, the 2019-2021 design value at Jerome Mack is 1.3. This is outside of the attainment standard of 1.0. With EPA concurrence on the September 8, 2020, event, the 2019-2021 design value at Jerome Mack is 1.0, within the attainment standard. Further details may be found in the Initial Notification Summary Information (INI) submitted by Clark County, Department of Environment and Sustainability (DES) to EPA Region 9 on July 6, 2022.

We request that the EPA evaluate the following assessment of the wind-blown dust event that occurred in Clark County on September 8, 2020, 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 show the Great Basin Desert in Nevada as the approximate source region (Figure 2.2-1). The primary land classifications in this region, shown by the Sentinel-2 Land Use/Land Cover map, are bare ground and rangeland, with small pockets of forest and built area. Bare ground is defined as "areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with no to little vegetation." Rangeland is defined as "open areas covered in homogenous grasses with little to no taller vegetation; wild cereals and grasses with no obvious human plotting". The primary classifications shown by the 2019 NLCD map are mostly shrub/scrub, grasslands/herbaceous, and barren land (rock/sand/clay). Classifications from both maps indicate that the source region is primarily land with little to no vegetation cover with natural sources of dust that are predisposed to high-wind events.

Figure 2.2-2 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.

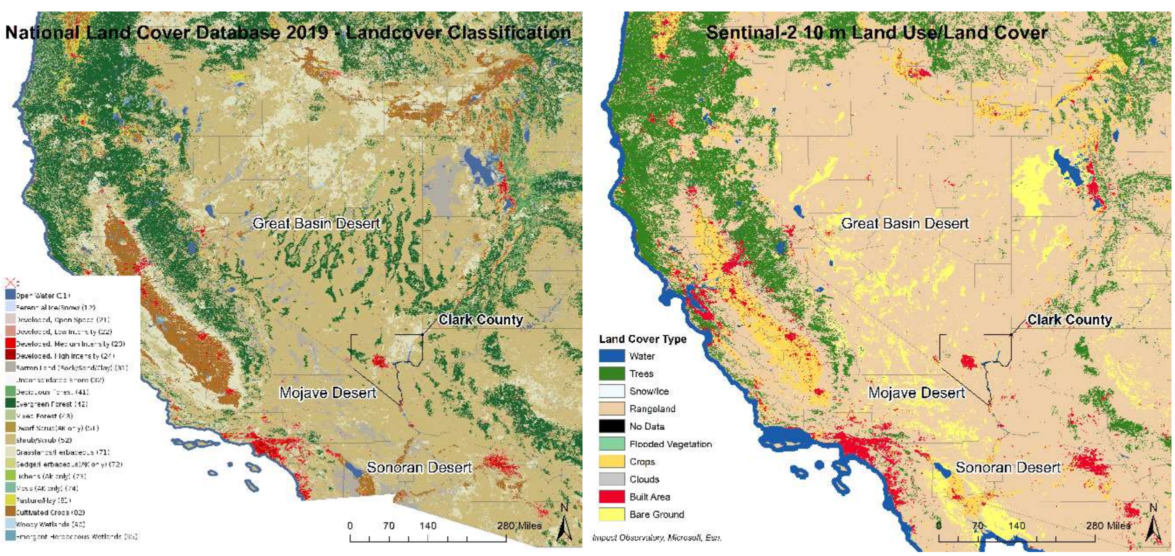


Figure 2.2-1. Land cover type for the Western U.S. from (left) the National Land Cover Database-2019 and (right) Sentinel-2 satellite.

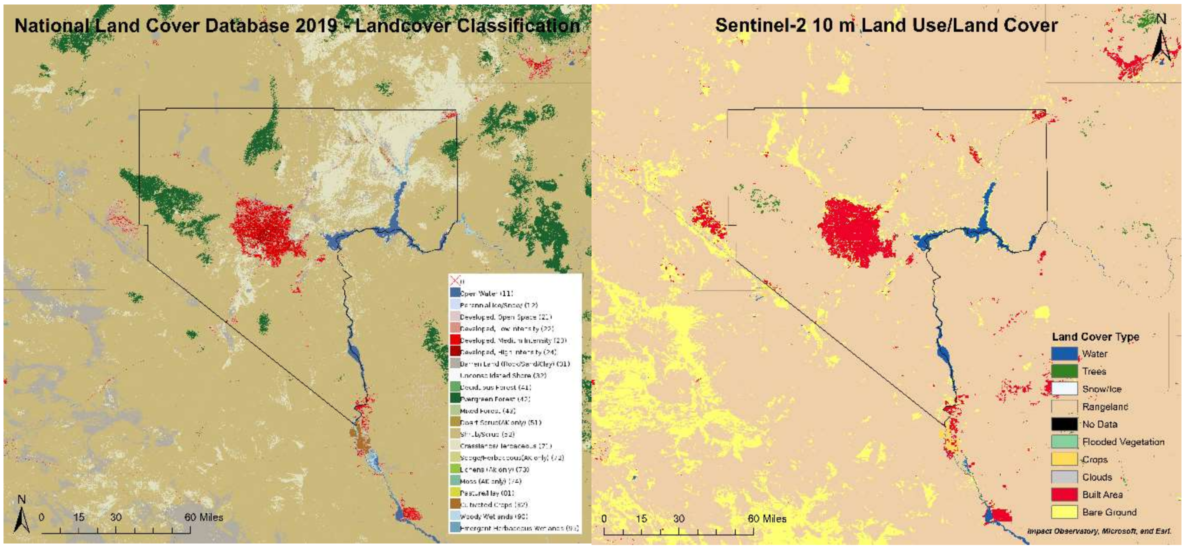


Figure 2.2-2. Land cover type for Clark County, NV, and surrounding area from (left) the National Land Cover Database-2019 and (right) Sentinel-2 satellite.

2.2.2 Climatology for Source Region and Clark County

The Great Basin Desert is an approximately 492,000-km^2 cold desert region within the greater Great Basin that is located between the Sierra Nevada Mountain range to the west and Wasatch Mountain range to the east. The desert spans a large portion of Nevada and Utah and extends into the southeastern portion of California. The desert also borders the Mojave Desert to the southwest, the Colorado Plateau to the southeast, and the Columbian Plateau to the north. Due to the presence of the Sierra Nevada Mountain ranges to the west, a rain shadow effect inhibits significant moisture from reaching the desert. The climate of the desert is arid to semiarid with cold, wet winters and hot, dry summers. The border of the desert extends into western and northern Clark County.

Clark County is located in the southern portion of Nevada and borders California and Arizona. The county includes the City of Las Vegas, one of the fastest growing metropolitan areas in the United States with a population of approximately 2.2 million (U.S. Census Bureau, 2020). Las Vegas is located in a 1,600 km^2 desert valley basin at 500 to 900 m above sea level (Langford et al., 2015). It is surrounded by the Spring Mountains to the west (3,000 m elevation) and the Sheep Mountain Range to the north (2,500 m elevation). Three mountain ranges comprise the southern end of the valley. The valley floor slopes downward from west to east, which influences surface wind, temperature, precipitation, and runoff patterns. The Cajon Pass and I-15 corridor to the east is an important atmospheric transport pathway from the Los Angeles Basin into the Las Vegas valley (Langford et al., 2015).

The Las Vegas valley climatology features abundant sunshine and hot summertime temperatures (average summer month high temperatures of 34 °C to 40 °C). Because of the mountain barriers to moisture inflow, the region experiences dry conditions year-round (~107 mm annual precipitation, 22% of which occurs during the summer monsoon season from July through September). The urban heat island effect in Las Vegas during summer leads to large temperature gradients within the valley, with generally cooler temperatures on the eastern side. During summer, 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, 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.

On the days leading up to the September 8, 2020, exceedance, there were record or close-to-record maximum daily temperatures compared to the long-term climate record in the Las Vegas area. Concurrently, precipitation accumulation for the Las Vegas area was below normal by early September (**Figure 2.2-3 and Figure 2.2-4**).

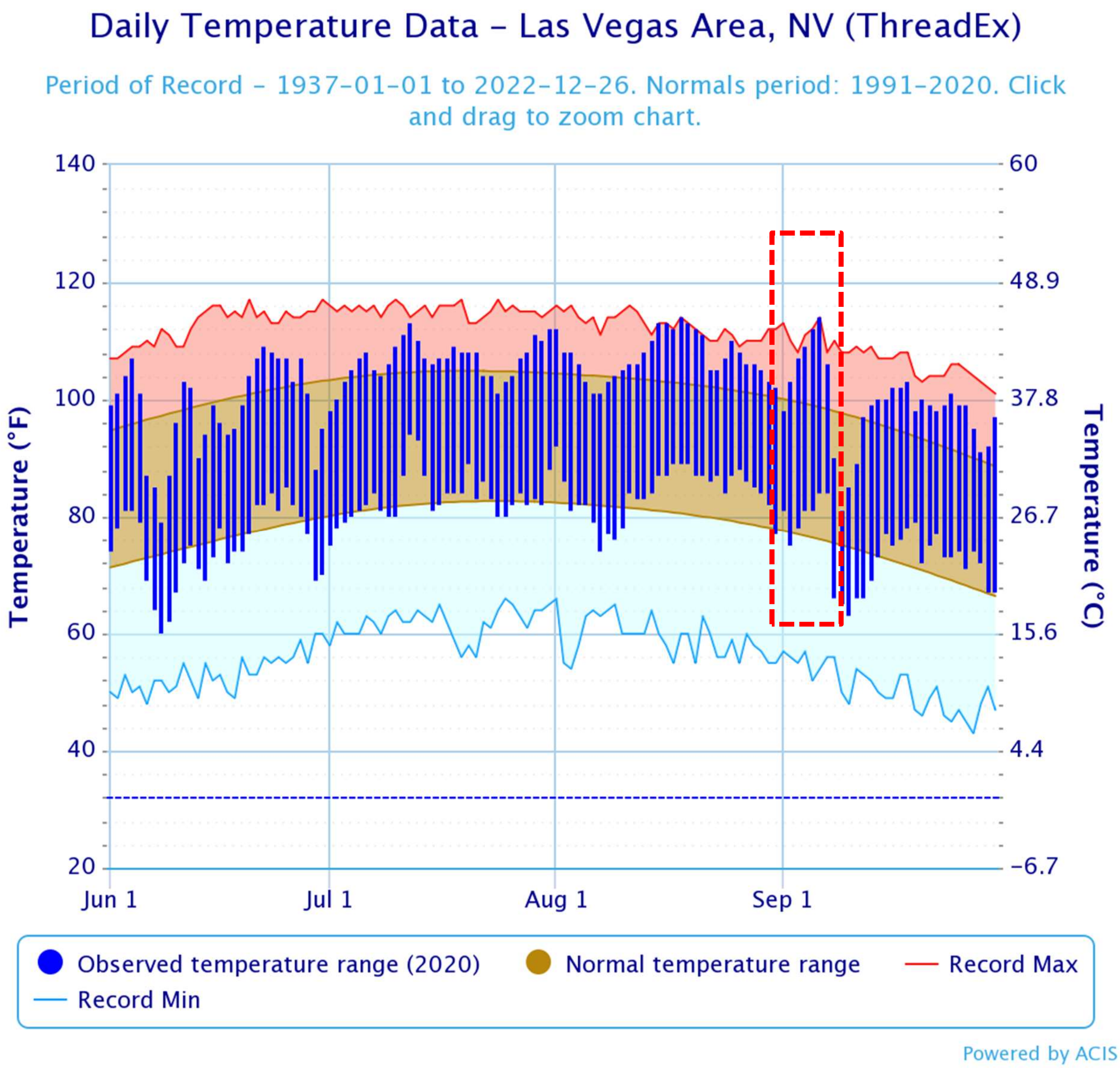


Figure 2.2-3. Temperature records for the Las Vegas area in Nevada from January 1, 1937 through December 26, 2022 by day, including (dark blue) observed temperature range 2020, (brown) normal temperature range, (red) record maximum, (light blue) record minimum. The red box indicates the dates of high and record heat before the September 8, 2020, event. Data from NWS: **https://www.weather.gov/wrh/Climate?wfo=vef**.

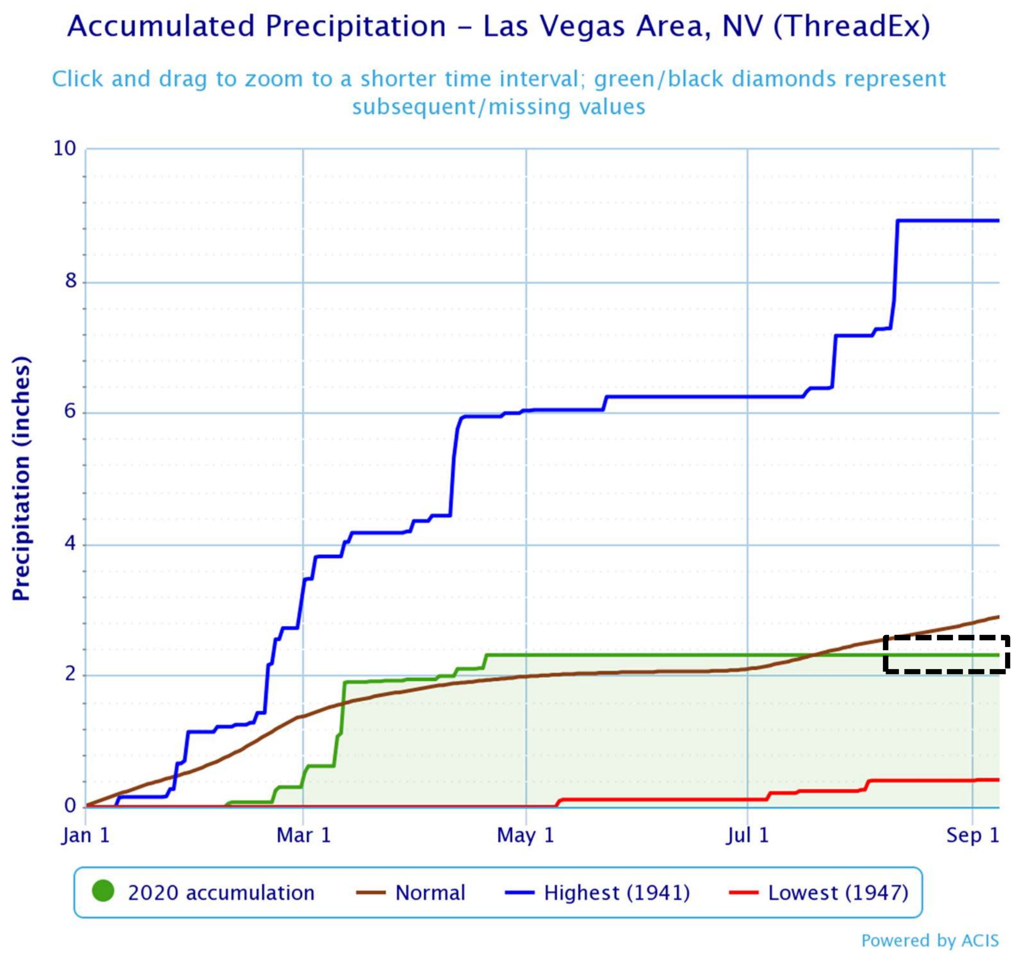


Figure 2.2-4. Precipitation records for the Las Vegas area in Nevada by day, including (green) accumulation in 2020, (brown) normal, (blue) record maximum, (red) record minimum. The black box indicates the period of low accumulated precipitation before the September 8, 2020, event. Data from NWS: **https://www.weather.gov/wrh/Climate?wfo=vef**.

The extreme hot and dry conditions in 2020 are also highlighted by the Palmer Drought Severity Index (PDSI) produced by the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Protection (NCEP). The western U.S. drought conditions progressively increased in area and severity in the months before the PM_{10} exceedance (**Figure 2.2-5**). By September 2020, all counties in Nevada were classified as moderate to extreme drought.

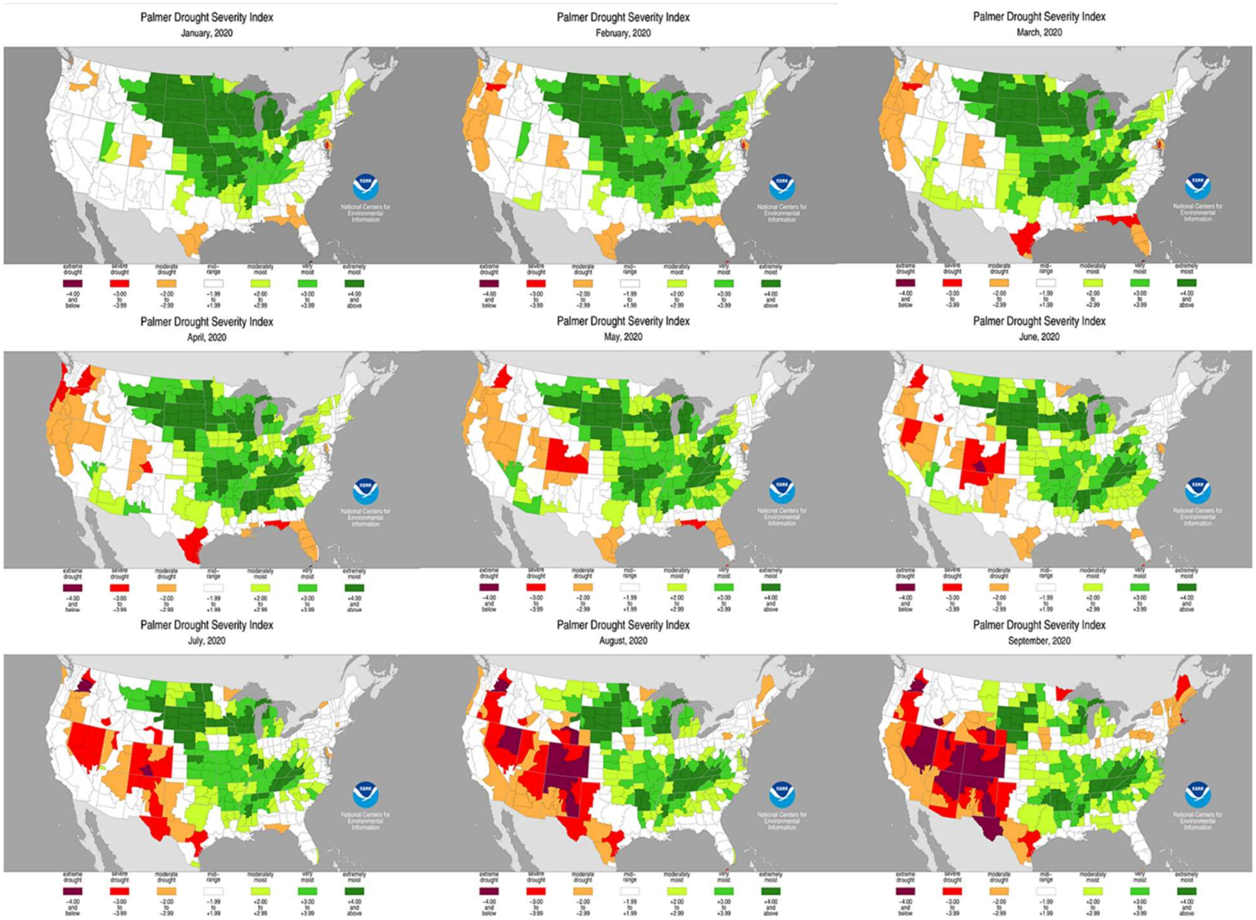


Figure 2.2-5. Palmer Drought Severity Index for January through September 2020.

On September 8, 2020, the western U.S. was under widespread drought conditions (**Figure 2.2-6**). The source region for this event was under moderate to extreme drought (D1-D3). The western U.S., including Nevada, was under drought conditions which increased in area and severity in the year, months, and week before the PM_{10} exceedance. By September 8, 2020 nearly all (99.53%) of Nevada was included in the drought (**Figure 2.2-7**).

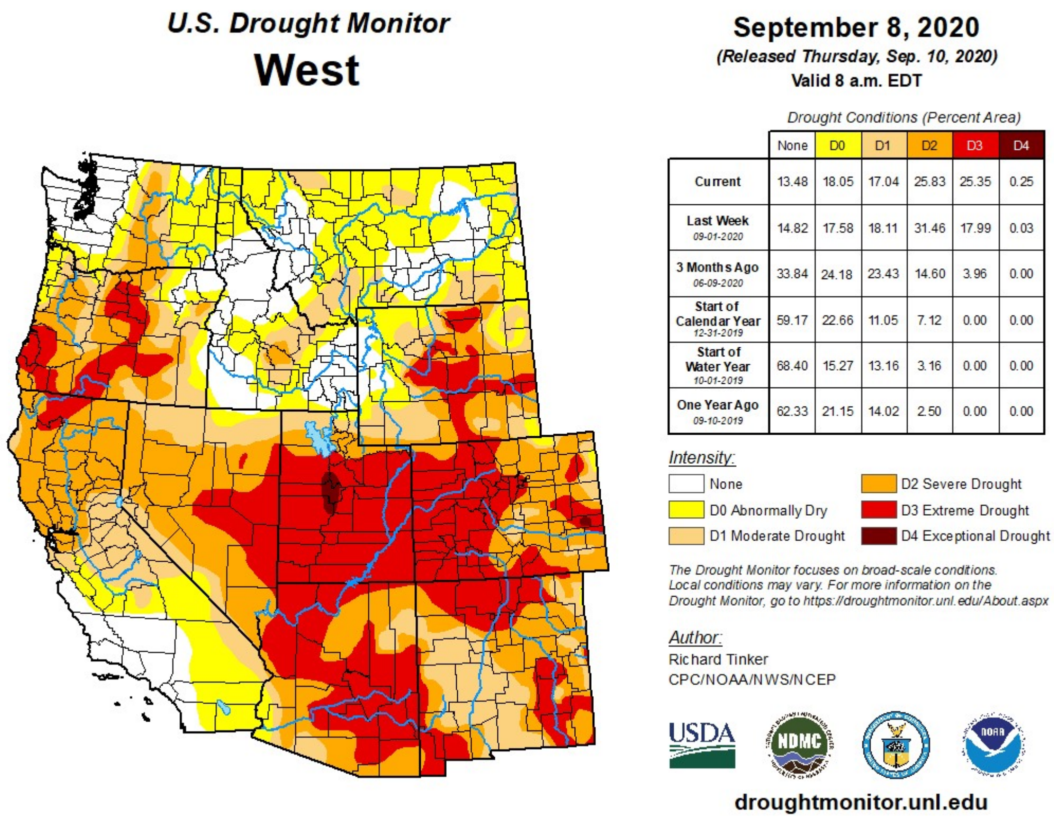
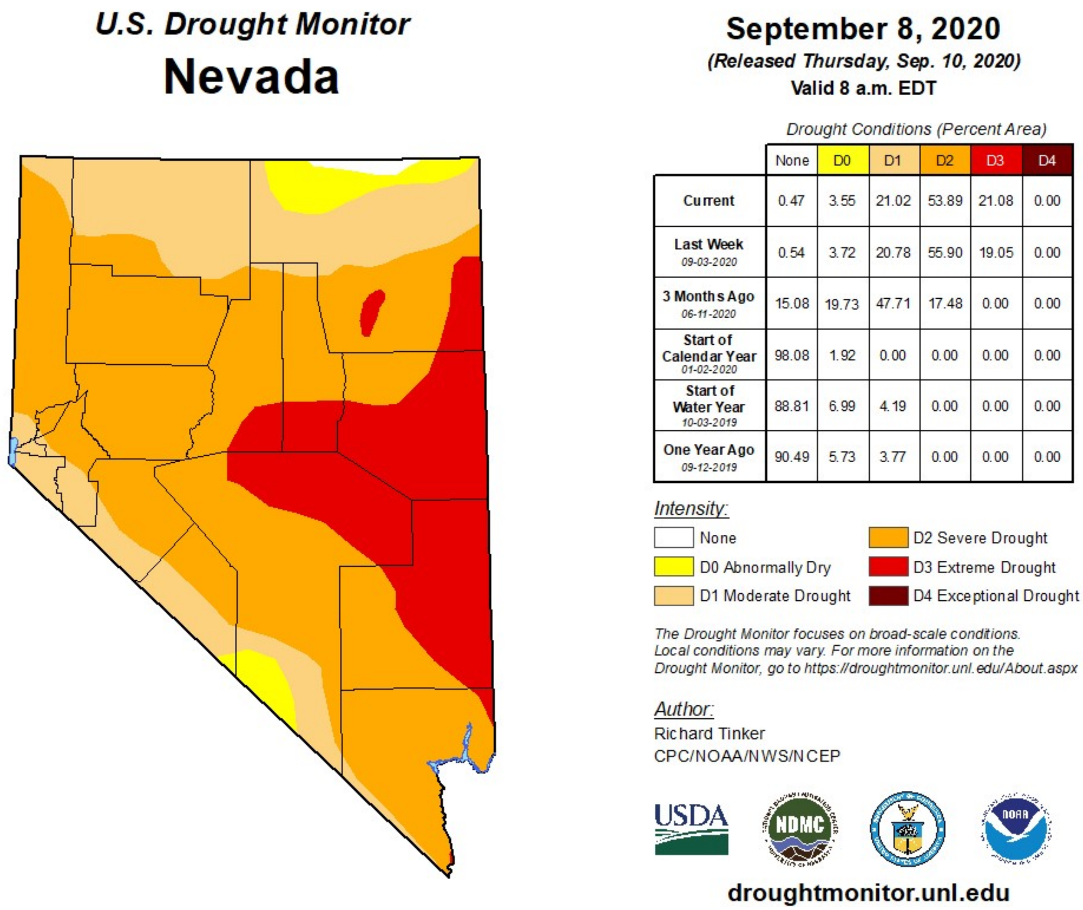


Figure 2.2-6. U.S. Drought Monitor values for the western U.S. on September 8, 2020.



	None	D0	D1	D2	D3	D4
Current	0.47	3.55	21.02	53.89	21.08	0.00
Last Week 09-03-2020	0.54	3.72	20.78	55.90	19.05	0.00
3 Months Ago 06-11-2020	15.08	19.73	47.71	17.48	0.00	0.00
Start of Calendar Year 01-02-2020	98.08	1.92	0.00	0.00	0.00	0.00
Start of Water Year 10-03-2019	88.81	6.99	4.19	0.00	0.00	0.00
One Year Ago 09-12-2019	90.49	5.73	3.77	0.00	0.00	0.00

Figure 2.2-7. U.S. Drought Monitor values for the Nevada on September 8, 2020.

There are several Automated Surface Observing Systems (ASOS) weather measurement sites in the wind-blown dust source region with data spanning multiple decades (Figure 2.2-8). Figure 2.2-9 shows the distribution of the maximum daily temperatures at several sites in the wind-blown dust source region on September 7 and 8 (1990 – 2019). The median maximum daily temperatures recorded at all sites on September 7 and 8 (1990 – 2019) are between approximately 85 °F and 93 °F.

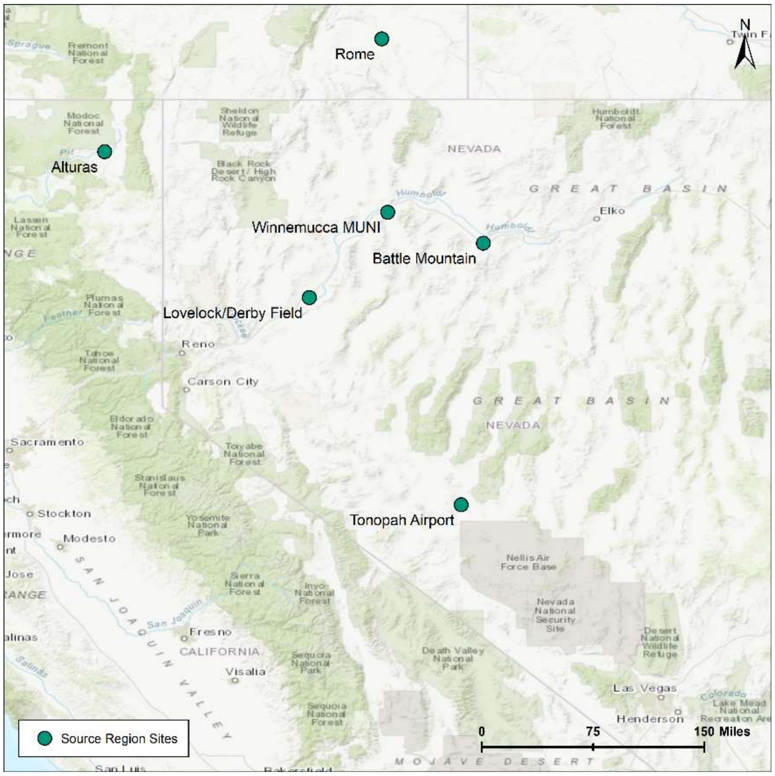


Figure 2.2-8. Location of ASOS measurement sites in the wind-blown dust source region.

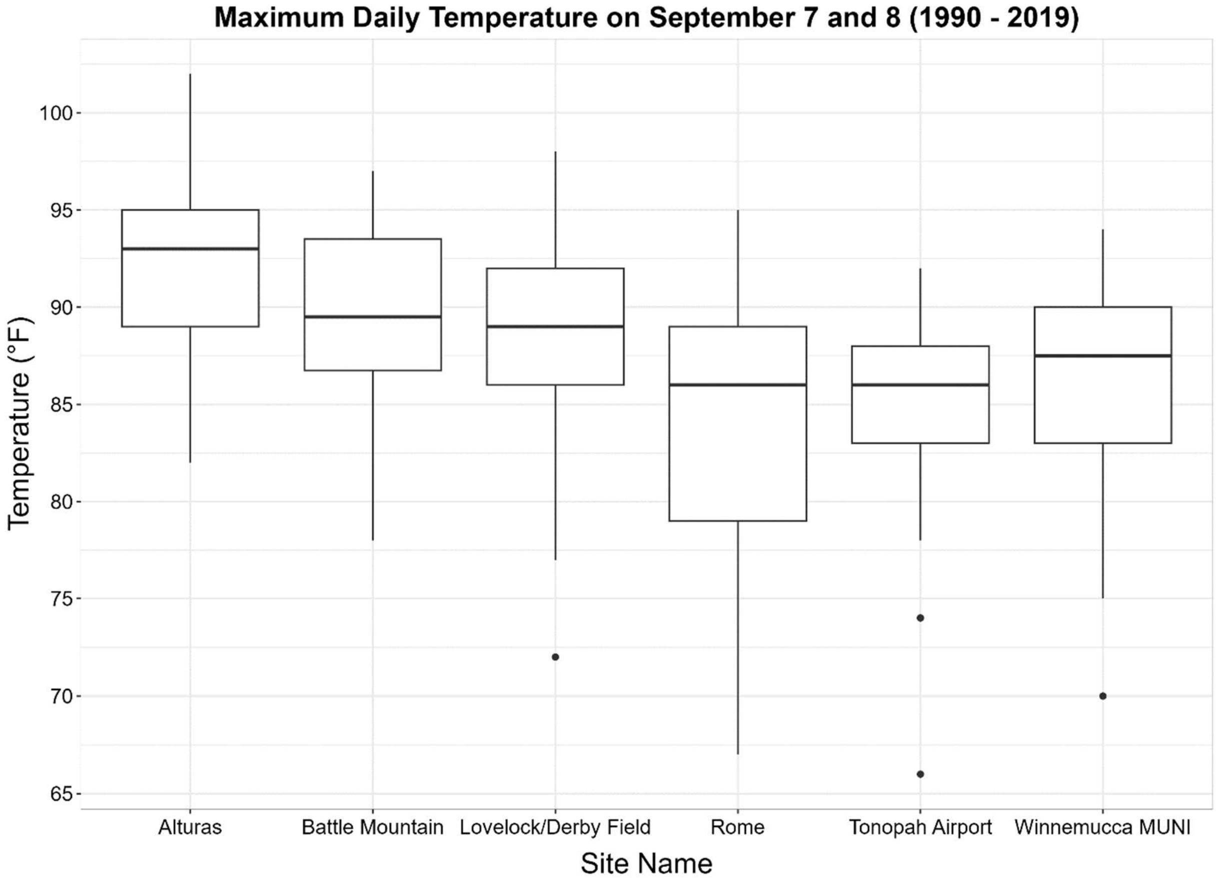


Figure 2.2-9. Maximum daily temperature on September 7 and 8, 1990 – 2019.

2.2.3 Regional Emissions of PM_{10}

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

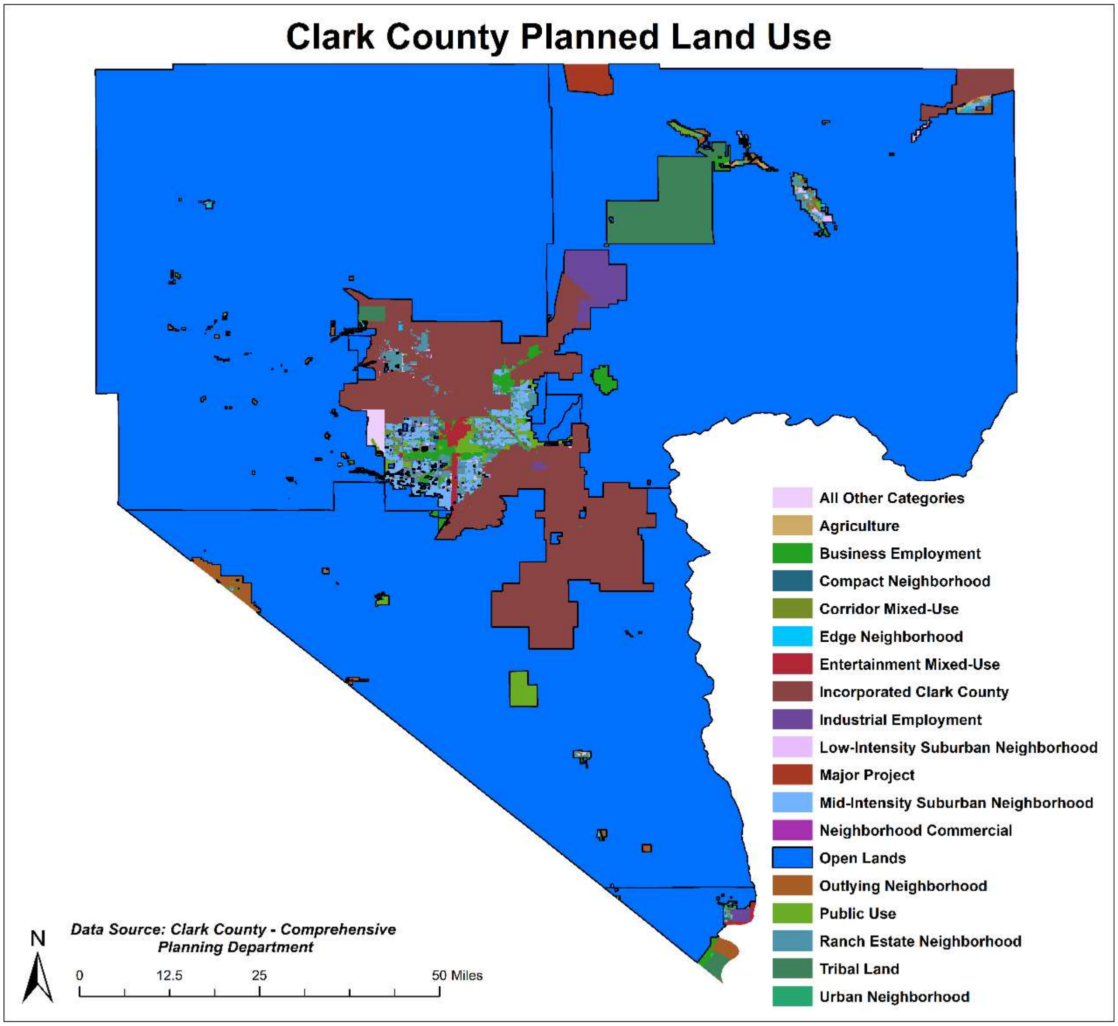


Figure 2.2-10. Planned land use boundaries of Clark County.

Planned land use around the Jerome Mack monitoring 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 2.2-11**). Much of the surrounding area is comprised of buildings and paved surfaces such as parking lots and roads, with little exposed dirt or gravel.

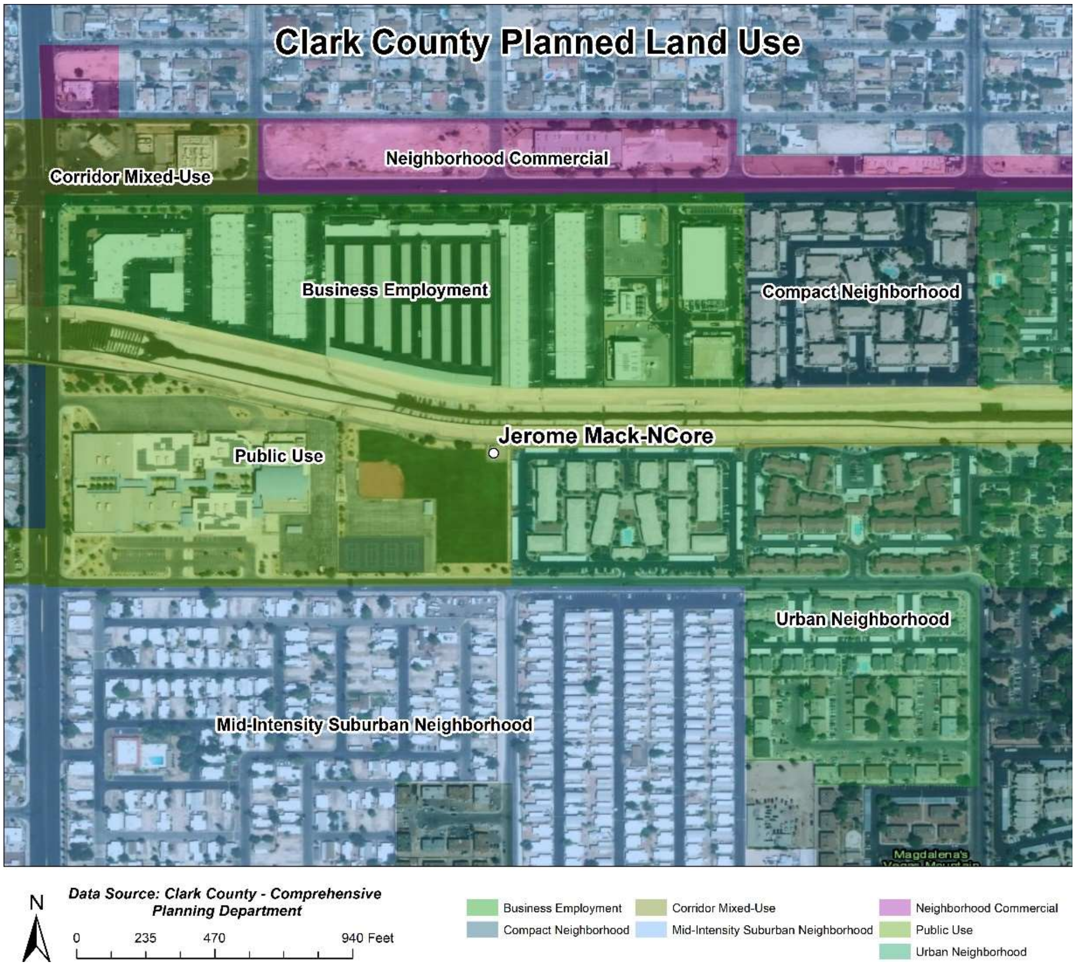


Figure 2.2-11. Planned land use boundaries in the area around the Jerome Mack monitoring station.

Figure 2.2-12 shows the 2020 National Emissions Inventory (NEI) PM_{10} point sources around the Jerome Mack site (zoomed version in the right panel), where the size of the point source marker is proportional to the total annual PM_{10} emissions. The map shows that 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.

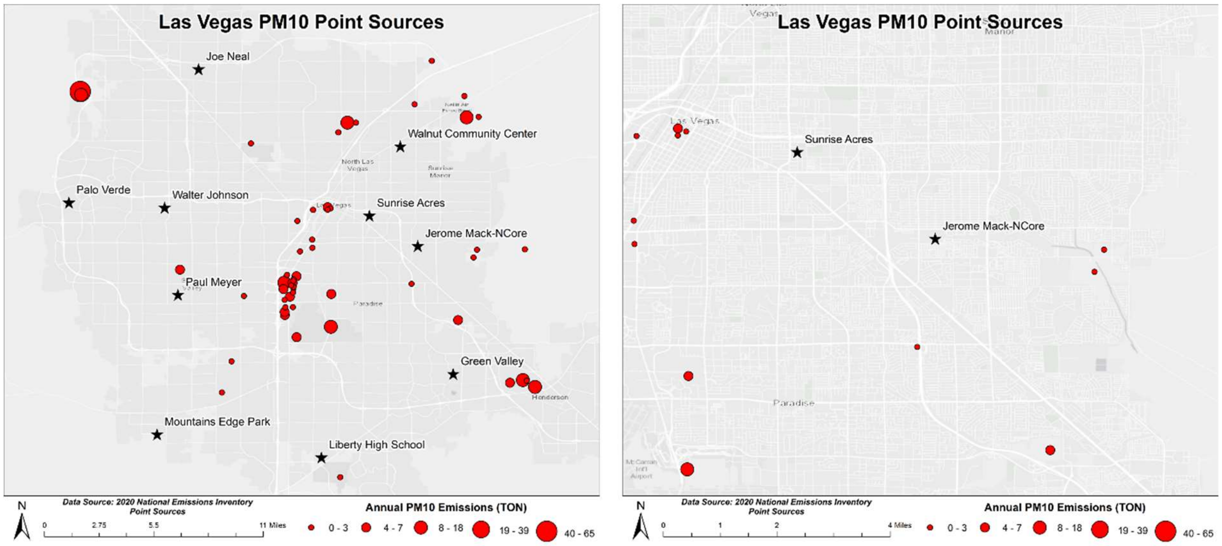


Figure 2.2-12. 2020 NEI point sources of PM_{10}. The left panel includes the entirety of Clark County, NV, PM_{10} point sources, while the right panel includes a zoomed in view of PM_{10} point sources around Jerome Mack.

Clark County provided information on all PM_{10} emissions as part of the 2012 "Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10})" State Implementation (SIP) document for PM_{10}. 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 Jerome Mack site, it is unlikely that point sources contributed to the September 8, 2020, exceedance.

Non-point 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 2.2-13**). Increasing contributions from construction-related emissions are due to increasing conversion of vacant lands to built area. Therefore, there has been an increasing contribution to total emissions from wind erosion from construction, paved roads, construction, and other sources. The Jerome Mack site is approximately a quarter of a mile away from a major paved road source (S Lamb Blvd), so paved roads and on-road emissions likely did not contribute to the September 8, 2020, exceedance. Further, a dust advisory was issued for September 8, 2020, which requires construction sites to implement BACM, inspect their construction sites, and cease all blasting activity to mitigate windblown dust.

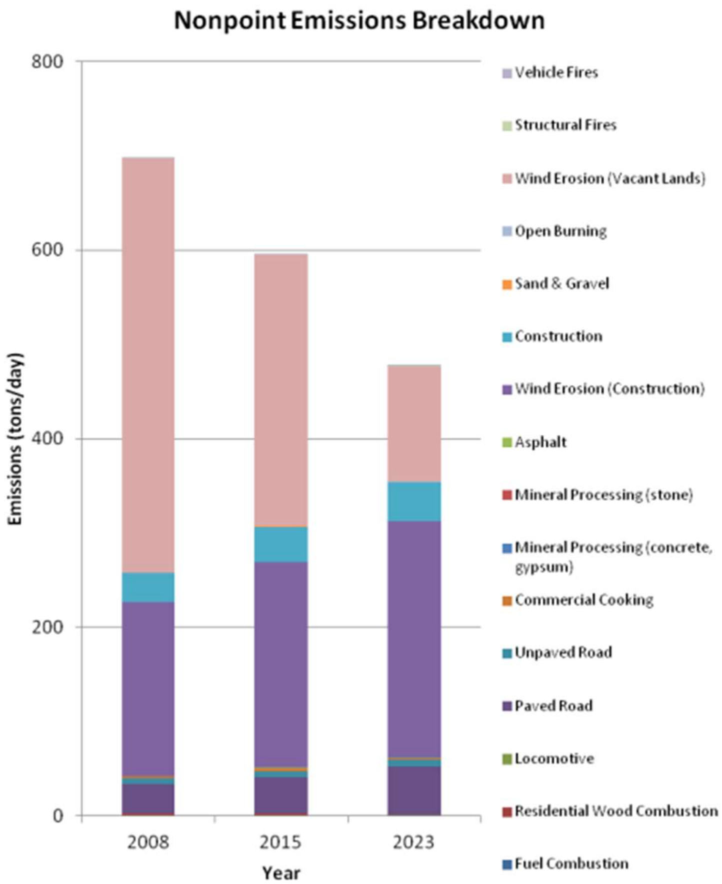


Figure 2.2-13. Nonpoint emissions inventory breakdown from the 2012 "Redesignation Request and Maintenance Plan for Particulate Matter (PM_{10})" document.

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 at the Jerome Mack site from the five years preceding the event (2016-2020). The mean concentration is 32 μg/m^3 and the median concentration is 28 μg/m^3.

Table 2.2-1. Five-year statistical summary of 24-hour average PM_{10} concentration at affected sites, 2016 – 2020.

Statistic ($\mu g/m^3$)	Jerome Mack
Mean	32
Median	28
Mode	23
St. Dev	20
Minimum	2
95th percentile	62
99th percentile	93
Maximum	309
Range	307
Count	1,760
Exceedances (>150 $\mu g/m^3$)	6

Seasonal and monthly trends in the 24-hour average PM_{10} data for the five years preceding the event (2016-2020) are shown in boxplots in Figure 2.2-14 and Figure 2.2-15. The lower and upper edges of the box correspond to the interquartile range (the 25th and 75th percentiles respectively), and the middle bar is the median value. The whiskers extend to the smallest and largest value within 1.5 times the interquartile range. Points beyond this range are considered outliers 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 were found to be lowest in spring (median value of 21 $\mu g/m^3$) and highest in autumn (median value of 36 $\mu g/m^3$). For September, the interquartile range was 24 – 41 $\mu g/m^3$, with a median value of 32 $\mu g/m^3$.

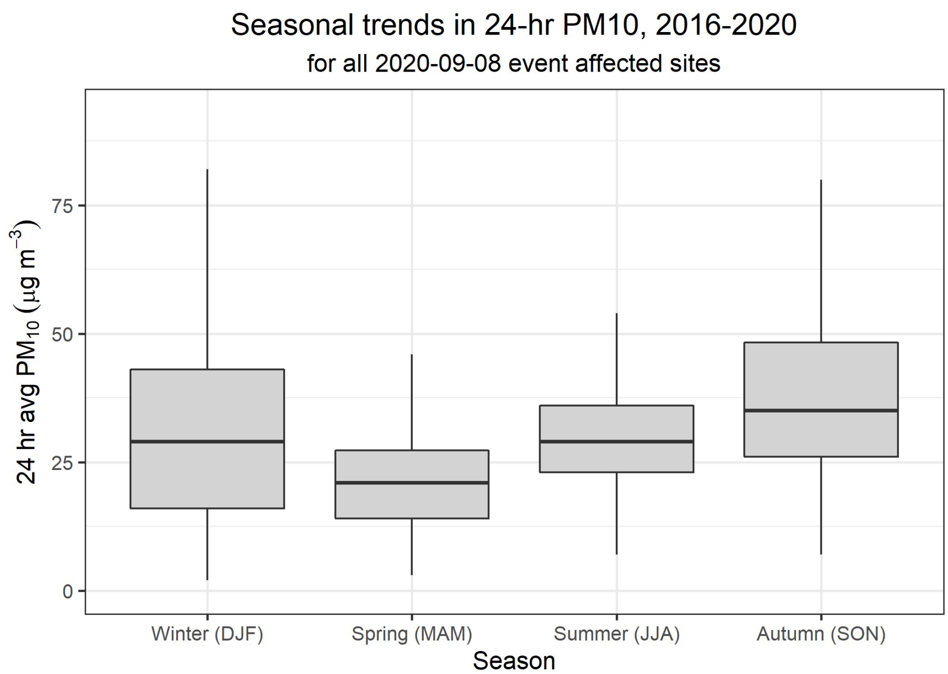


Figure 2.2-14. Seasonal trends in values of PM_{10} at Jerome Mack from 2016-2020 (outliers have been removed for trend clarity).

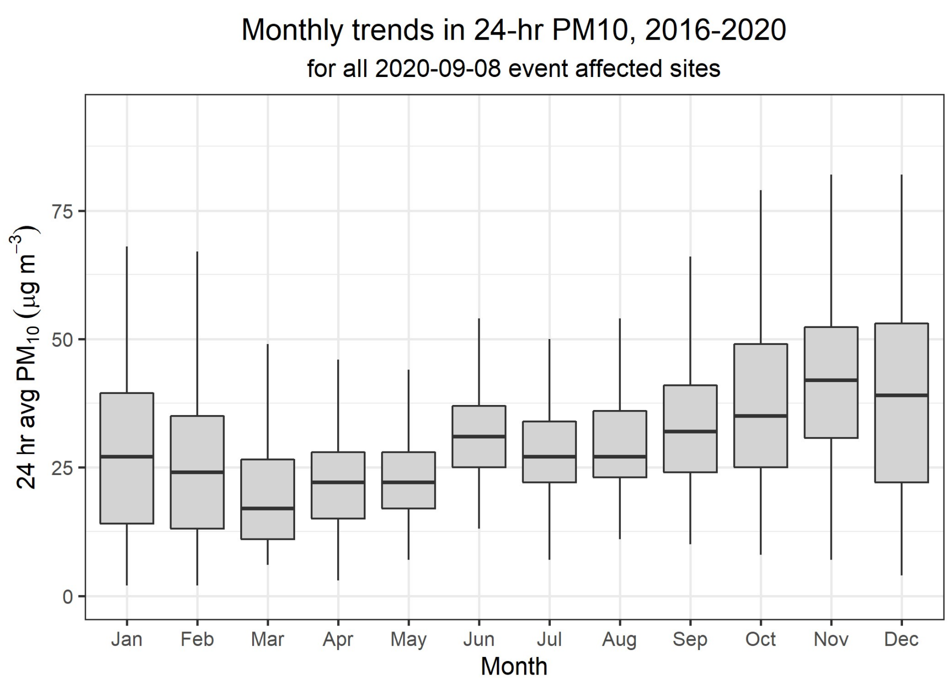


Figure 2.2-15. Monthly trends in values of PM_{10} at Jerome Mack from 2016-2020 (outliers have been removed for trend clarity).

3. Clear Causal Relationship

During early September, a strong frontal passage through northern Nevada drove a wind-blown dust event that increased PM_{10} concentrations in Clark County, NV, on September 8, 2020. Strong winds well above 25 mph from the frontal passage lofted, entrained, and transported dust into Clark County starting in the early morning on September 8, 2020, at 03:00 and lasting through 10:00 PST. The severe drought conditions affecting the Great Basin Desert in Nevada, as shown in **Section 2.2**, created an ample source of dust from friable soils. Enhanced wind speeds greater than 25 mph in the Las Vegas valley coincided with increased PM_{10} concentrations during the 03:00-10:00 PST period. Within this section, we provide meteorological evidence of lofting, entrainment, and transport of dust from the dust source region, (the Great Basin Desert Region) with the frontal passage, evidence of transport from the source region to Clark County via HYSPLIT trajectory modeling and meteorological analysis, and impacts of the high-wind dust event at the surface in Clark County. We also provide additional evidence using statistical and meteorological similar event analysis to compare this dust event with other high PM_{10} days in Clark County.

3.1 High Wind Event Origin

3.1.1 Meteorological Analysis

The PM_{10} exceedance concentration on September 8, 2020, occurred at the Jerome Mack monitoring site with a 24-hour average PM_{10} value of 302 µg/m^3, well exceeding the 150 µg/m^3 standard. Concentrations of PM_{10} started to increase at 03:00 PST on September 8, 2020, and peaked at 05:00 PST, remaining high until 10:00 PST. Though not regulatorily significant, seven other sites (Paul Meyer, Walter Johnson, Joe Neal, Green Valley, Sunrise Acres, Boulder City, and Jean) also experienced daily PM_{10} concentrations greater than 150 µg/m^3 on September 8, 2020. Sustained wind speeds both in the source region and Clark County were found to be above the 25-mph high-wind threshold.

A variety of large-scale meteorological factors led to favorable conditions for blowing dust on September 8, 2020. To account for these meteorological factors, observation data were analyzed leading up to and during the dust event. The observation data reviewed for this analysis includes:

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

This meteorological analysis is a "top-down" approach, first investigating the upper-level weather conditions, then linking the upper-level observations to the corresponding lower-level and surface weather patterns. This analysis will focus on the time period between 00:00 UTC on September 7, 2020 (16:00 PST on September 6, 2020) and 00:00 UTC on September 9, 2020 (16:00 PST on September 8, 2020).

250-mb Height Analysis

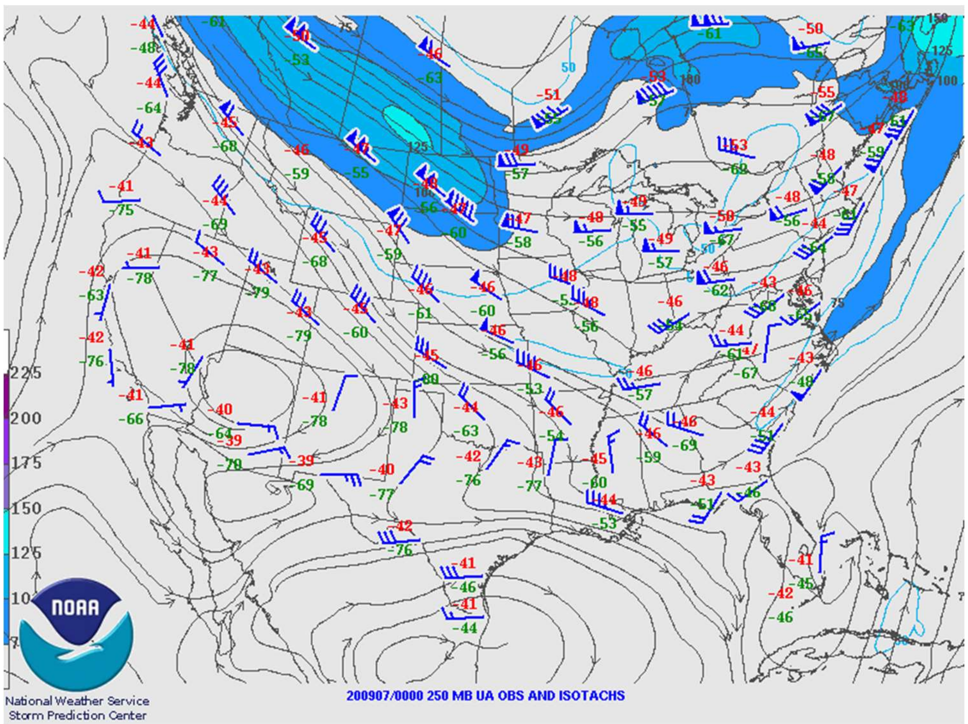


Figure 3.1-1. National Weather Service Storm Prediction Center 250 mb observations and isotach map for 00:00 UTC on September 7, 2020 (16:00 PST on September 6, 2020).

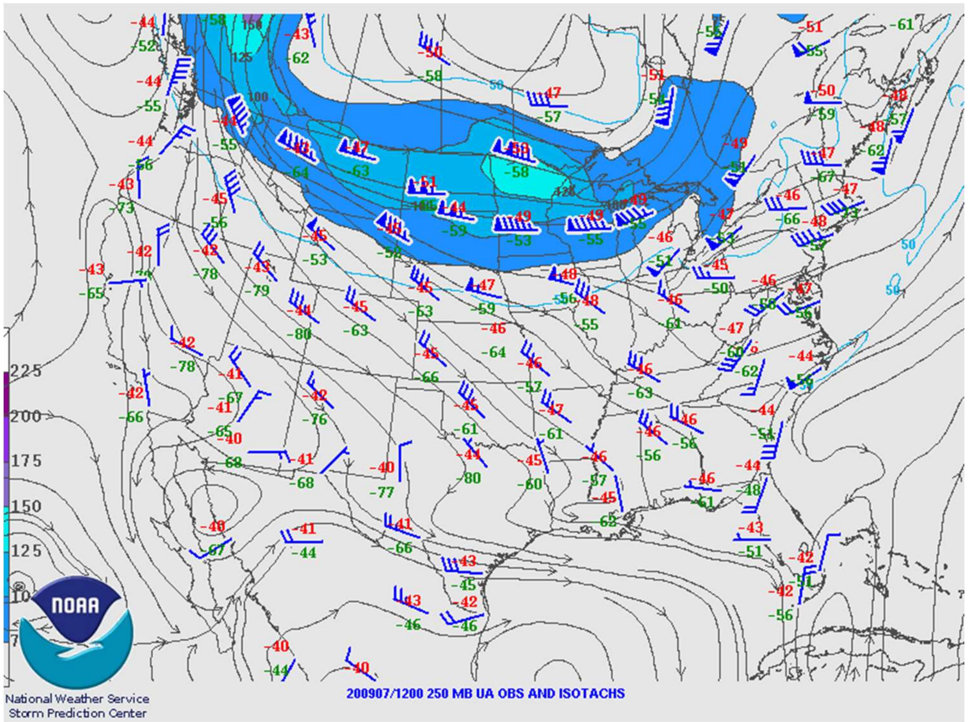


Figure 3.1-2. National Weather Service Storm Prediction Center 250 mb observations and isotach map for 12:00 UTC on September 7, 2020 (04:00 PST on September 7, 2020).

At 00:00 UTC on September 7, 2020 (16:00 PST on September 6, 2020), two large-scale patterns were evident at 250 mb (see Figure 3.1-1). The first pattern was a long-wave ridge of high pressure over the eastern Pacific Ocean and Gulf of Alaska. Downstream of this pattern, a long-wave trough of low pressure resided over much of central and southern Canada. On the western flank of this long-wave trough, an embedded 250-mb short-wave trough was noted over the far northern portions of British Columbia and Alberta. Furthermore, within this 250-mb short-wave trough, a 125-145 kt jet streak occurred in northern British Columbia.

This jet streak, along with upper-level high pressure off the British Columbia coast, would be the impetus behind the strengthening of the 250-mb short-wave trough. By 12:00 UTC on September 7, 2020 (04:00 PST on September 7, 2020), the 250 mb short-wave trough axis was better defined, and resided over southern British Columbia and central Alberta (see Figure 3.1-2). On the left side of the 250-mb trough axis, a 140-170 knots (kt) jet streak existed, driving the upper-level trough southward. Twelve hours later at 00:00 UTC on September 8, 2020 (16:00 PST on September 7, 2020), the 125-150 kt jet streak remained on the left side of the 250-mb trough axis, with the axis now extending from central Idaho northeastward into central Manitoba (see Figure 3.1-3). In addition, a divergent wind pattern was noted over northern Montana. The divergence aloft was within the left-exit region (LER) of the jet streak, driving further development of the 250-mb trough.

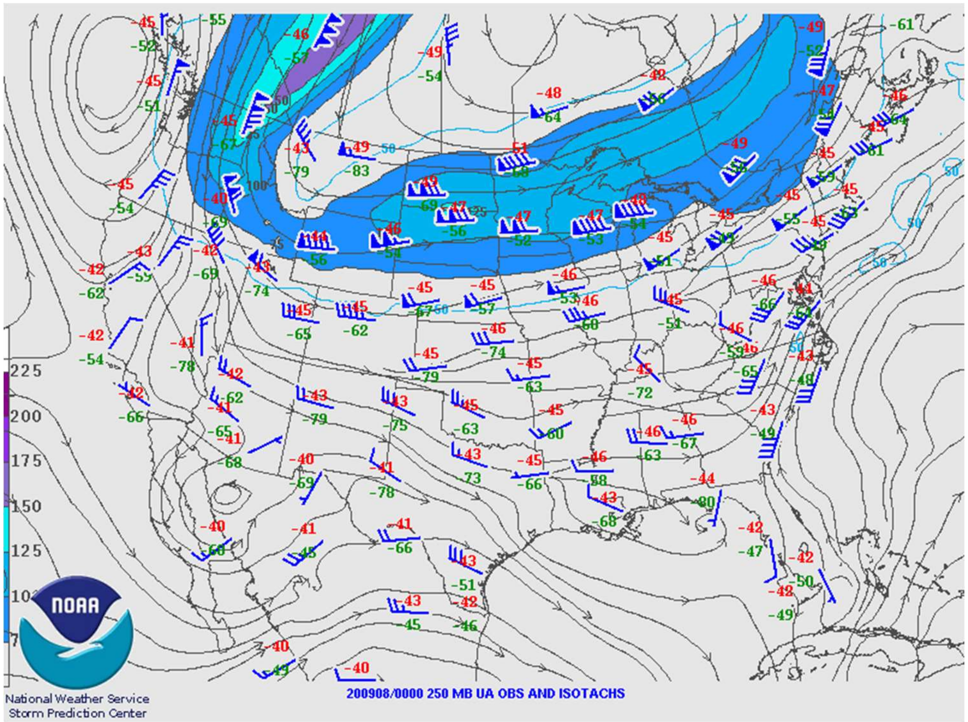


Figure 3.1-3. National Weather Service Storm Prediction Center 250 mb observations and isotach map for 00:00 UTC on September 8, 2020 (16:00 PST on September 7, 2020).

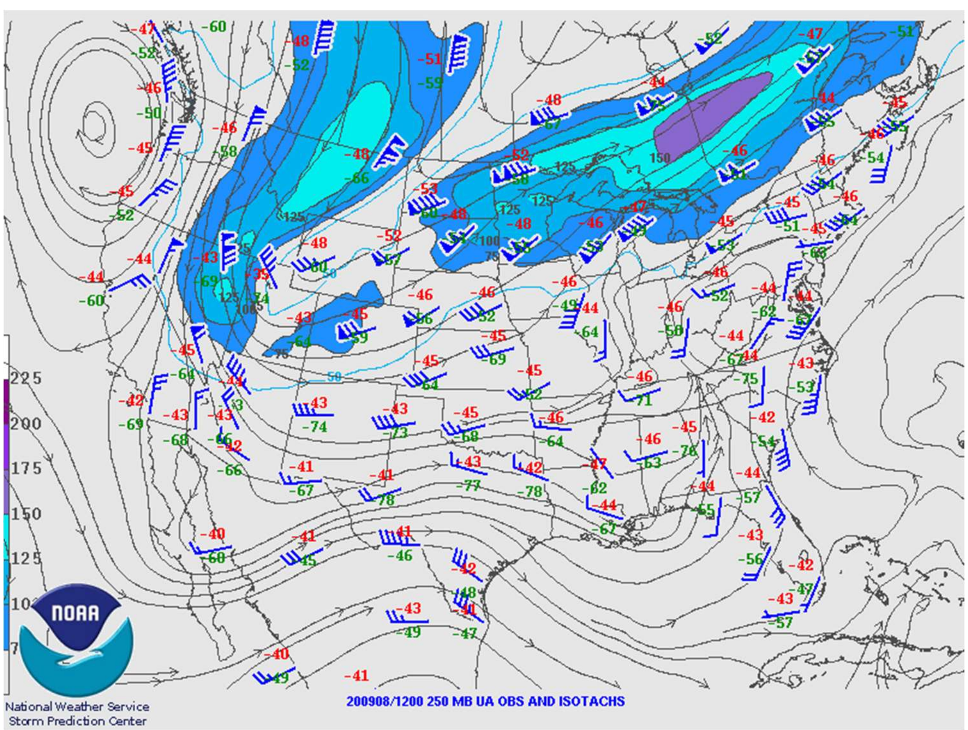


Figure 3.1-4. National Weather Service Storm Prediction Center 250 mb observations and isotach map for 12:00 UTC on September 8, 2020 (04:00 PST on September 8, 2020).

At 12:00 UTC on September 8, 2020 (04:00 PST on September 8, 2020), the 250 mb trough had advanced farther south, with the axis now stretching from far eastern Nevada to the Manitoba/Ontario border (see **Figure 3.1-4**). The jet streak had weakened to around 125 kt by this point but remained on the left side of the 250 mb trough axis. The LER of the jet streak by this time was over southeastern Idaho, northern Utah, and western Wyoming, with the associated divergence allowing the upper-level trough to continue its southward progression. By 00:00 UTC on September 9, 2020 (16:00 PST on September 8, 2020), the short-wave trough axis was now east of Clark County, NV (see **Figure 3.1-5**). However, the strong 125-kt jet streak that existed over the previous 36 hours had weakened to 50-70 kt on both the left and right side of the trough axis, allowing an area of upper-level low pressure to form east of Salt Lake City, UT.

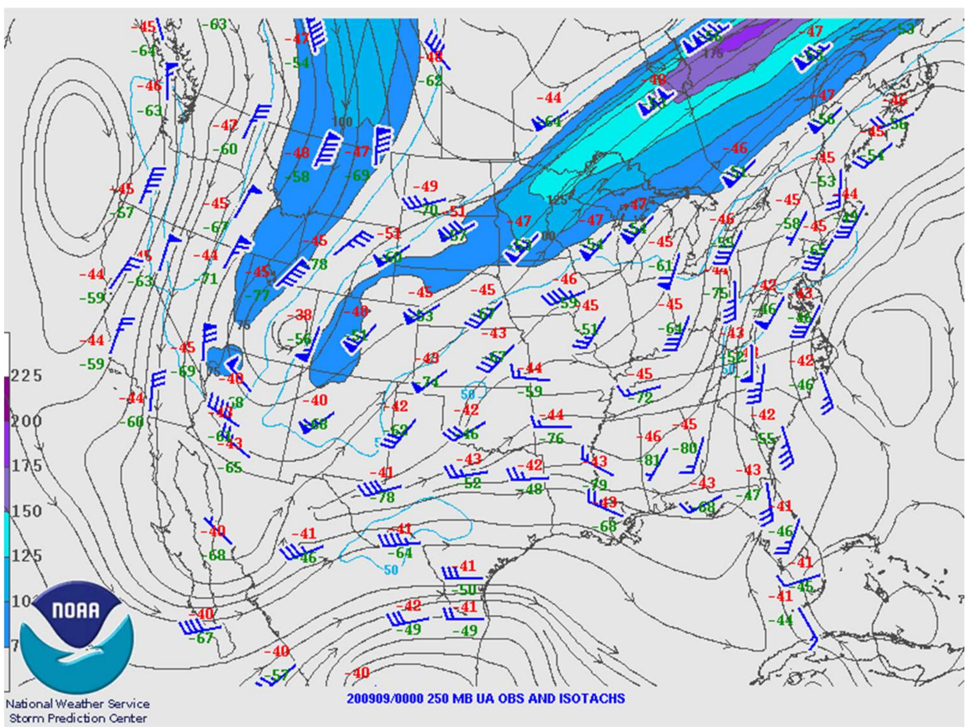


Figure 3.1-5. National Weather Service Storm Prediction Center 250 mb observations and isotach map for 00:00 UTC on September 9, 2020 (16:00 PST on September 8, 2020).

500-mb Height Analysis

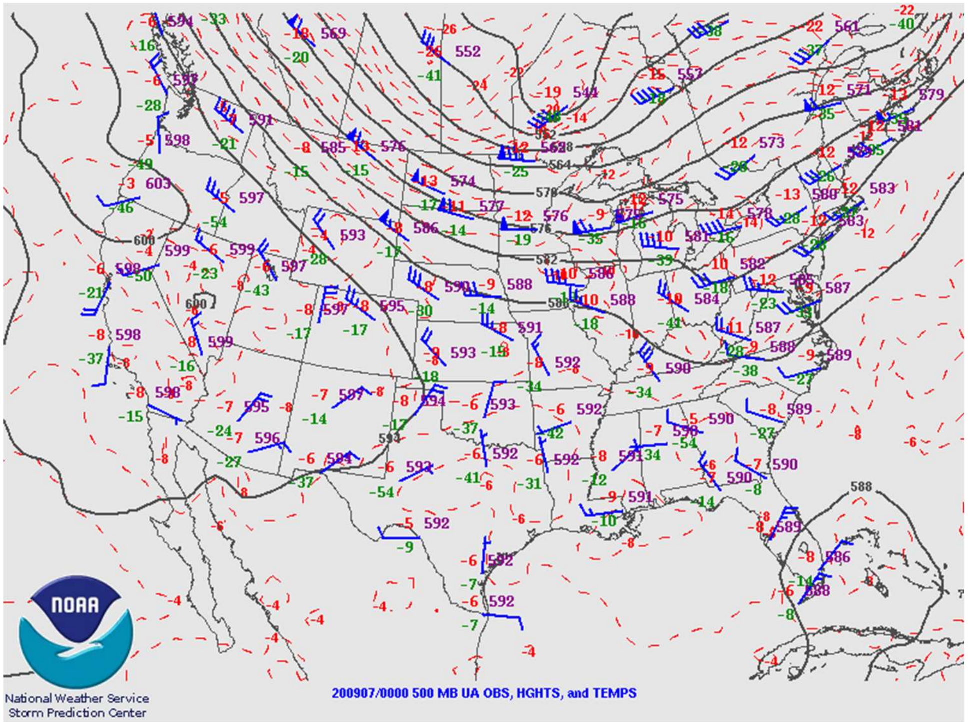


Figure 3.1-6. National Weather Service Storm Prediction Center 500 mb observation, geopotential height, and temperature map for 00:00 UTC on September 7, 2020 (16:00 PST on September 6, 2020).

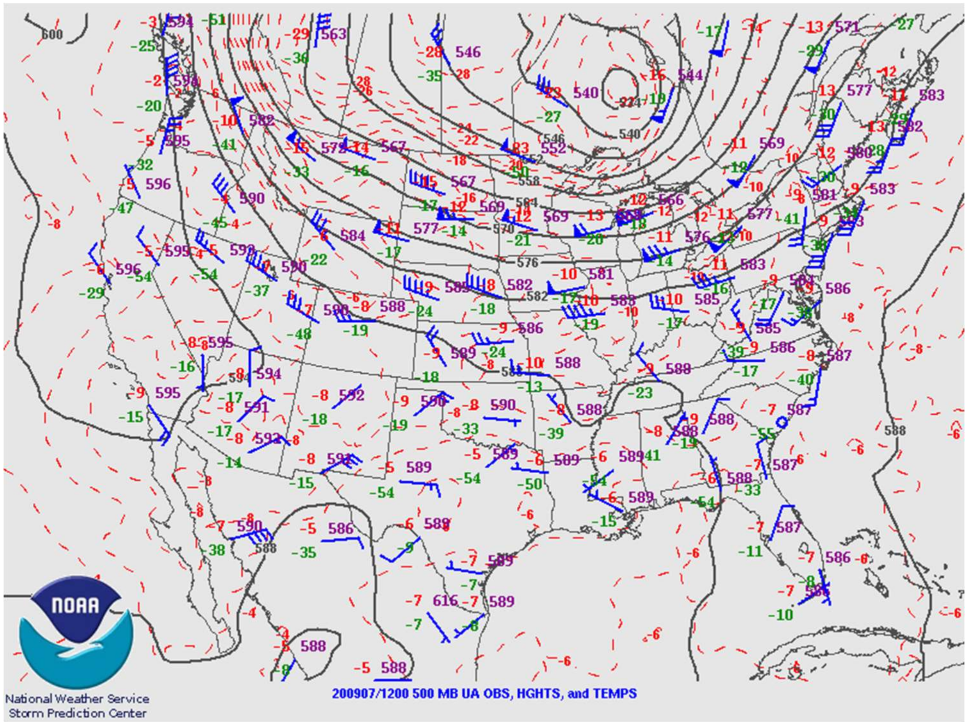


Figure 3.1-7. National Weather Service Storm Prediction Center 500 observation, geopotential height, and temperature map for 12:00 UTC on September 7, 2020 (04:00 PST on September 7, 2020).

While the jet streak at 250 mb deepened the upper-level trough, the associated aloft divergence within the LER of the jet streak also impacted the trough development at 500 mb. As the 250-mb jet streak entered western British Columbia from 00:00-12:00 UTC on September 7, 2020 (16:00 PST on September 6, 2020 – 04:00 PST on September 7, 2020), a 500-mb short-wave trough formed over southern British Columbia (Figure 3.1-6 and Figure 3.1-7). This trough continued to deepen and traverse south by 00:00 UTC on September 8, 2020 (16:00 PST on September 7, 2020) (Figure 3.1-8). While the short-wave trough axis at 500 mb was over southern Idaho and south-central Montana, the LER of the 250-mb jet streak remained north, over central Idaho and far western Montana.

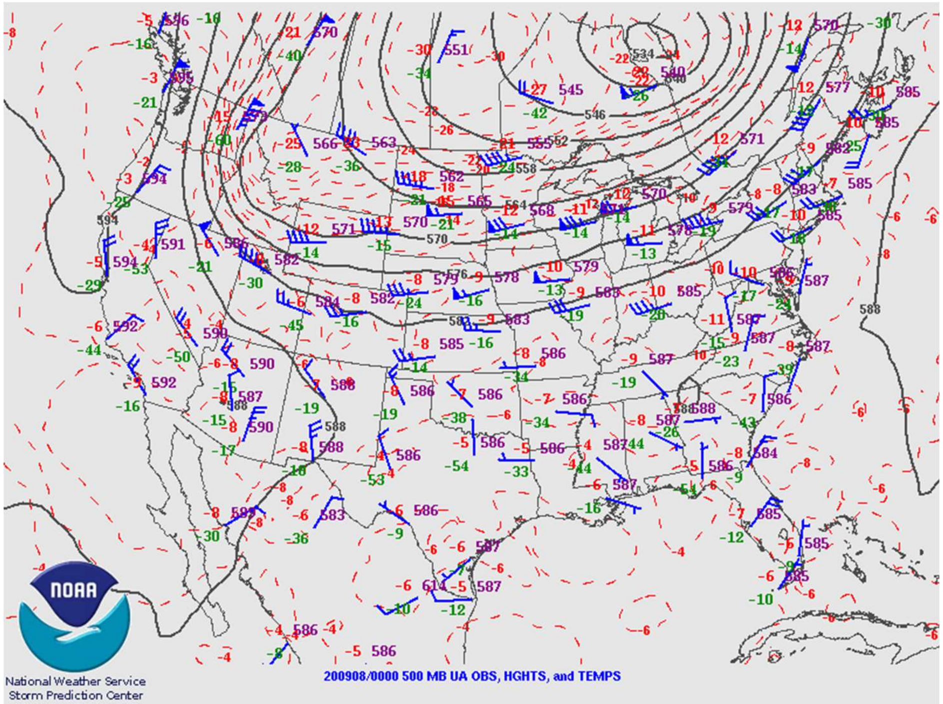


Figure 3.1-8. National Weather Service Storm Prediction Center 500 mb observation, geopotential height, and temperature map for 00:00 UTC on September 8, 2020 (16:00 PST on September 7, 2020).

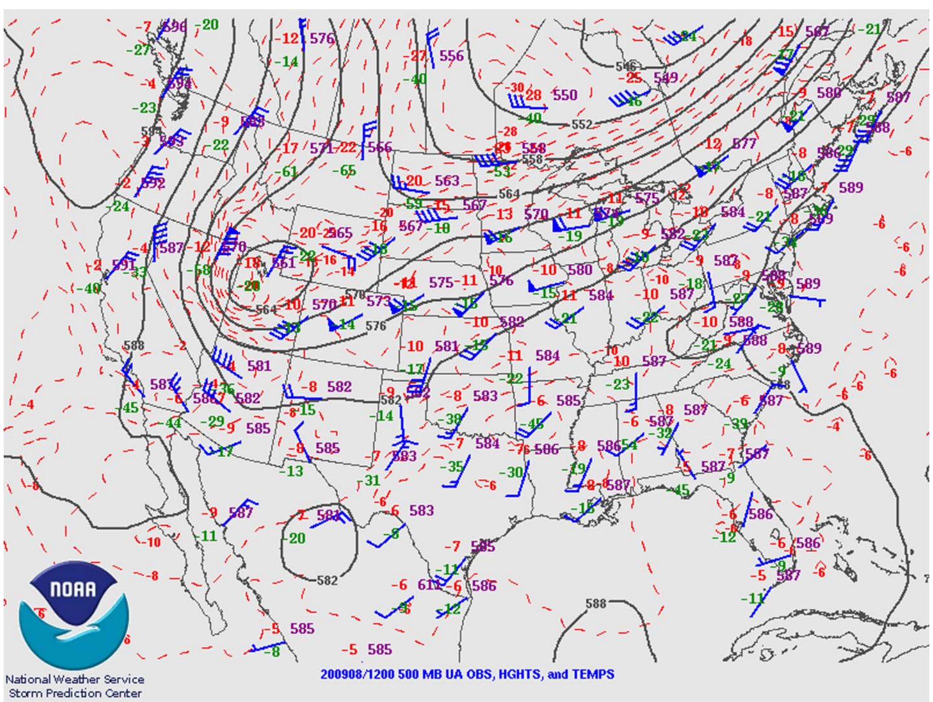


Figure 3.1-9. National Weather Service Storm Prediction Center 500 mb observation, geopotential height, and temperature map for 12:00 UTC on September 8, 2020 (04:00 PST on September 8, 2020).

Due to the jet streak's proximity to the 500-mb trough, deepening continued at 12:00 UTC on September 8, 2020 (04:00 PST on September 8, 2020) (**Figure 3.1-9**). At this point, the 500-mb trough axis was just north of Clark County, NV. At the same time, the jet streak at 250 mb had weakened to 125 kt, but was positioned near Elko, NV. Despite the weakened state of the jet streak, a 561-decameter (dm) low-pressure center formed near Salt Lake City, UT. This was the same region where the LER was present at 250 mb, along with a divergent 250 mb wind field in far northern Utah and southwestern Wyoming. Additional weakening of the 250-mb jet streak was noted at 00:00 UTC on September 9, 2020 (16:00 PST on September 8, 2020), which resulted in a subtle shift in the 562-dm low from Salt Lake City to southeastern Utah (**Figure 3.1-10**). Despite this shift, the associated trough axis with the 562-dm low was south of Clark County, NV.

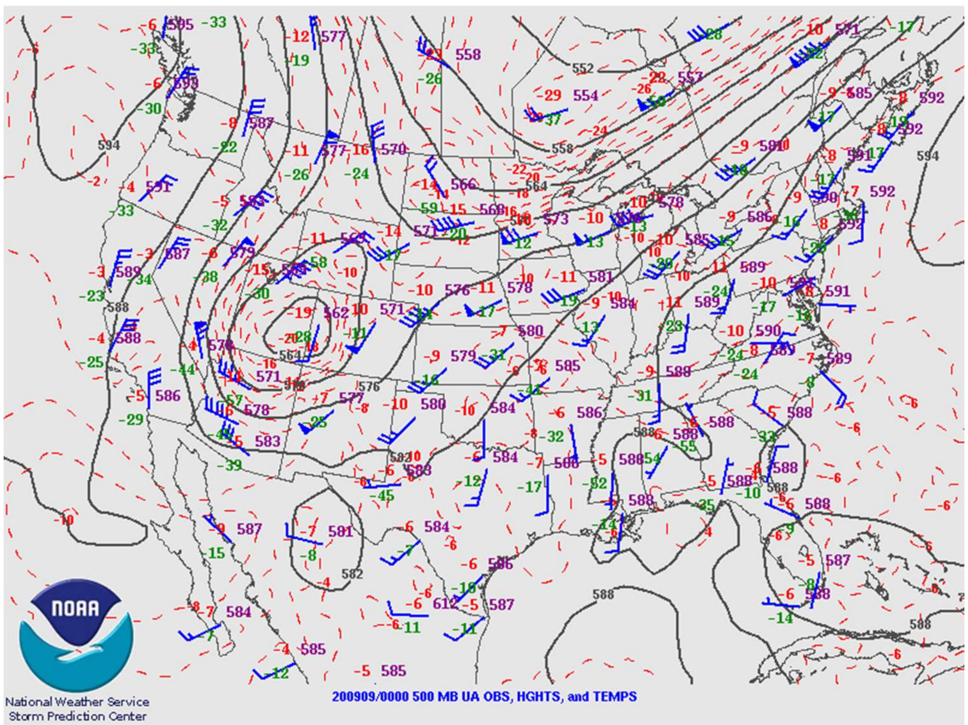


Figure 3.1-10. National Weather Service Storm Prediction Center 500 mb observation, geopotential height, and temperature map for 00:00 UTC on September 9, 2020 (16:00 PST on September 8, 2020).

Surface Analysis

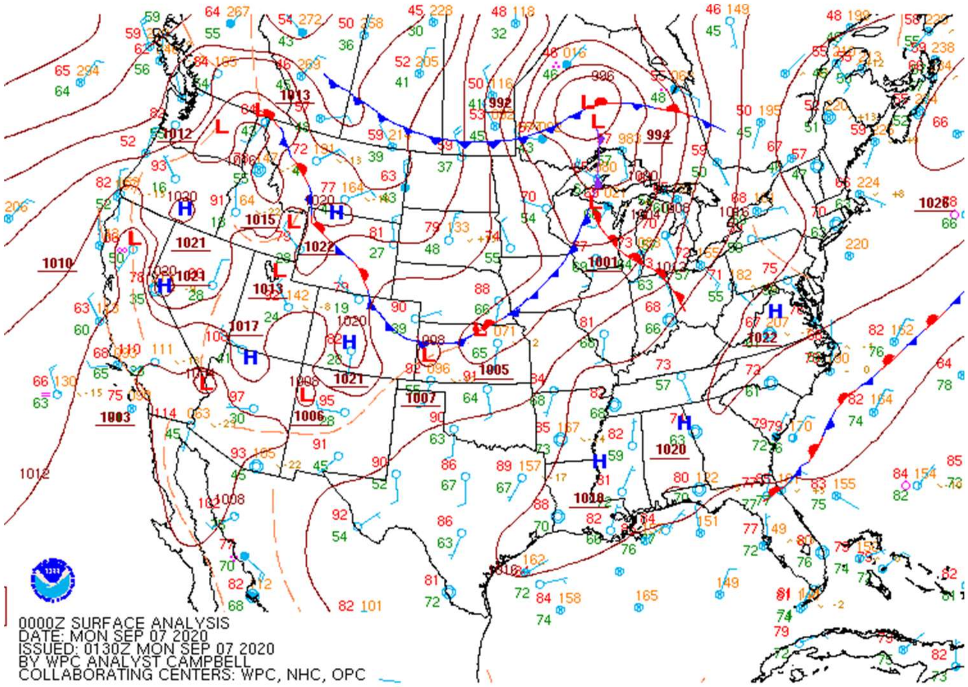


Figure 3.1-11. National Weather Service Weather Prediction Center surface analysis map for 00:00 UTC on September 7, 2020 (16:00 PST on September 6, 2020).

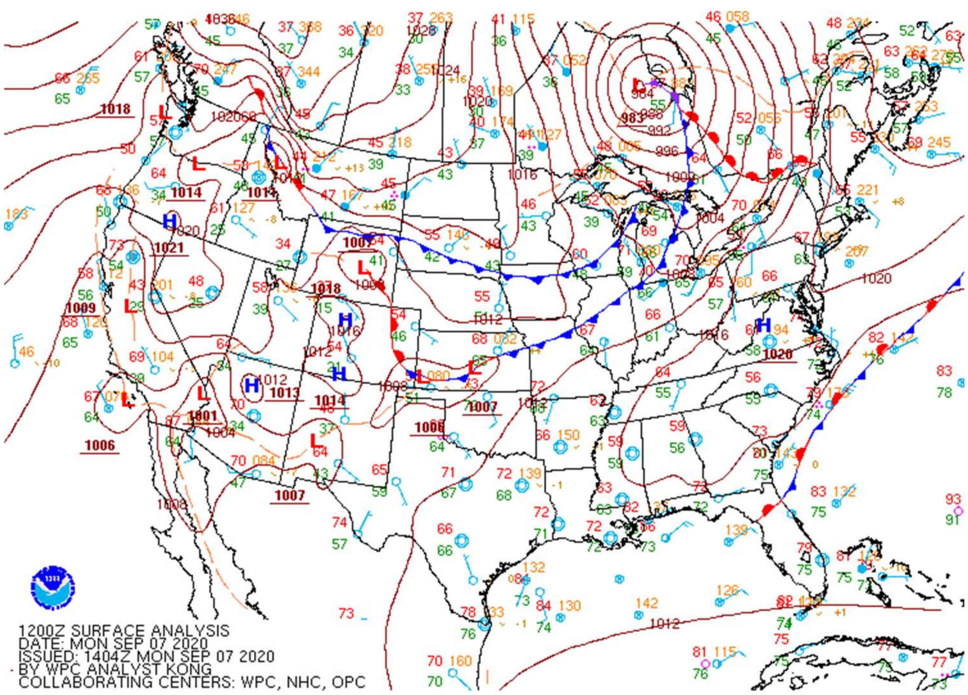


Figure 3.1-12. National Weather Service Weather Prediction Center surface analysis map for 12:00 UTC on September 7, 2020 (04:00 PST on September 7, 2020).

As a strong upper-level jet streak resulted in the development of a low-pressure center at both 250 and 500 mb, mid-latitude cyclogenesis was underway in the lowest levels of the atmosphere. Between 00:00 and 12:00 UTC on September 7, 2020 (16:00 PST on September 6, 2020 and 04:00 PST on September 7, 2020), a stalled stationary front extended from northwestern Montana to southwestern Wyoming, while strong surface high pressure moved from Yukon into northern British Columbia (**Figure 3.1-11 and Figure 3.1-12**). By 00:00 UTC on September 8, 2020 (16:00 PST on September 7, 2020), the nose of the 250-mb jet streak entered northern Idaho, allowing the stationary front to transition into a cold front with a 1000-mb low over southwestern Wyoming (**Figure 3.1-13**). Farther north, a 1038-mb high-pressure system had moved into southern Alberta. Between this surface high and the surface low in southwestern Wyoming, a strong +38-mb pressure gradient developed, leading to strong and gusty northerly winds behind the cold front.

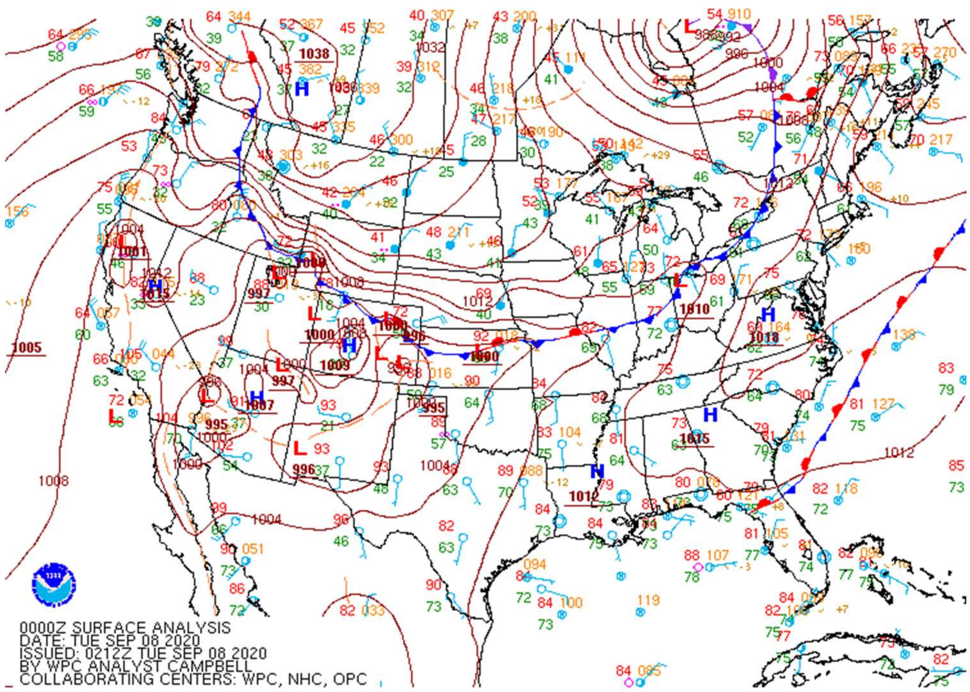


Figure 3.1-13. National Weather Service Weather Prediction Center surface analysis map for 00:00 UTC on September 8, 2020 (16:00 PST on September 7, 2020).

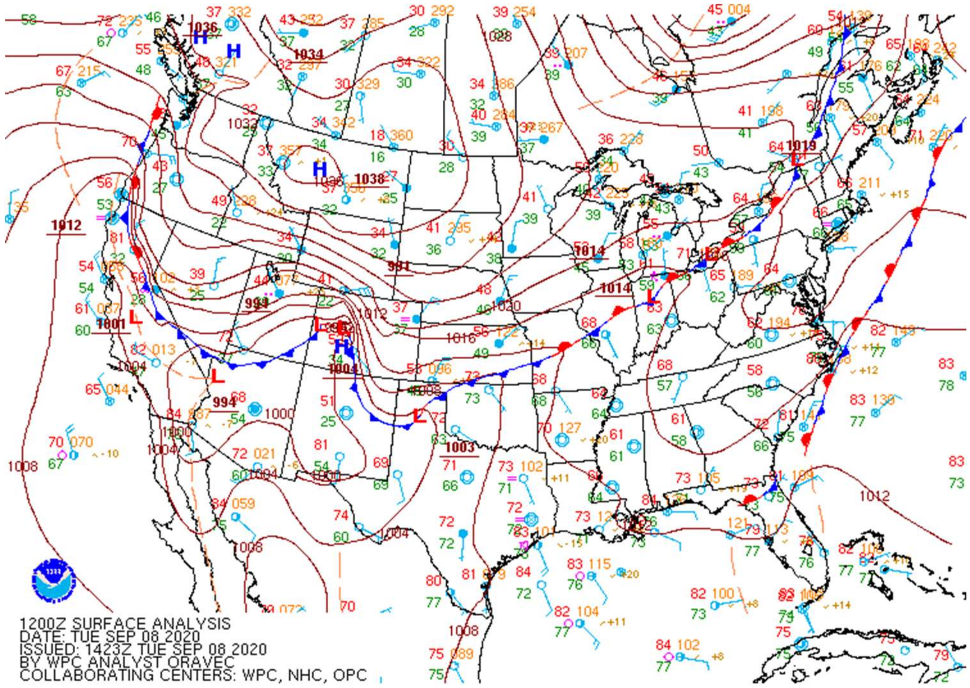


Figure 3.1-14. National Weather Service Weather Prediction Center surface analysis map for 12:00 UTC on September 8, 2020 (04:00 PST on September 8, 2020).

Cyclogenesis continued at 12:00 UTC on September 8, 2020 (04:00 PST on September 8, 2020) (**Figure 3.1-14**). At this time, the 250-mb jet streak was now into far northeastern Nevada. Meanwhile, at the surface, a 994-mb low was present near the Four Corners region, while the associated cold front was entering Clark County, NV, from the north. The 1,038-mb surface high at this point had moved into western Montana, with a strong pressure gradient of +44 mb from the surface high to the surface low. As the front exited Clark County, NV, by 15:00 UTC on September 8, 2020 (07:00 PST on September 8, 2020), strong northerly to northeasterly surface winds developed due to the strong pressure gradient between the front and surface high to the north. These strong winds (sustained around 20 mph with gusts over 30 mph) continued through 06:00 UTC on September 9, 2020 (22:00 PST on September 8, 2020), with the surface pressure gradient weakening through the early morning hours (**Figure 3.1-15**).

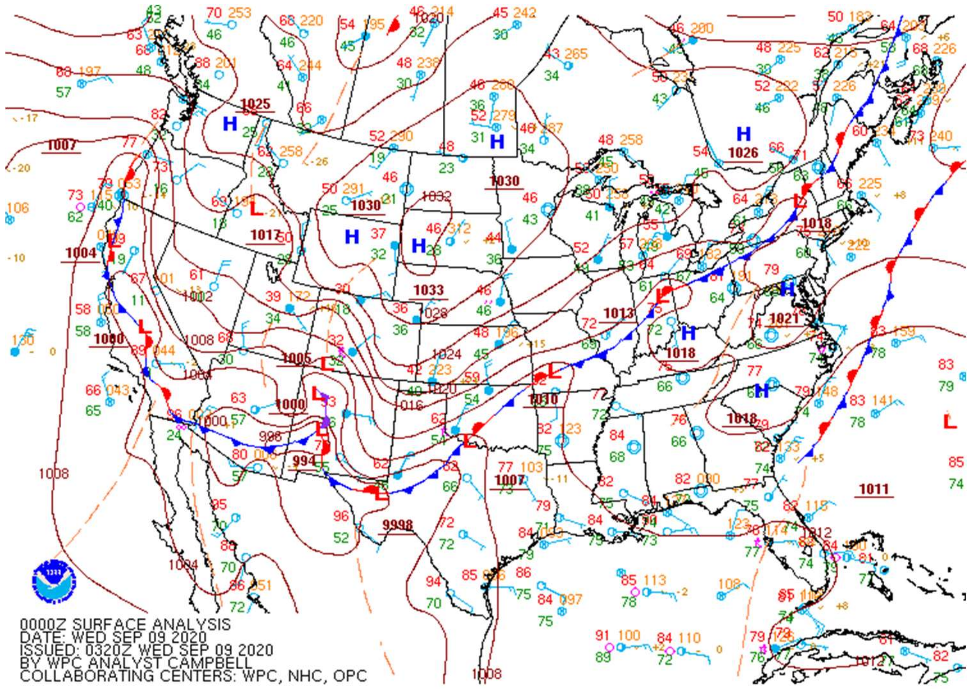


Figure 3.1-15. National Weather Service Weather Prediction Center surface analysis map for 00:00 UTC on September 9, 2020 (16:00 PST on September 8, 2020).

3.1.2 Satellite Images and Analysis

Satellite imagery and reanalysis products also provide evidence of dust corresponding with a strong frontal passage. Before the frontal passage, we see high Multi-Angle Implementation of Atmospheric Correction (MAIAC) Aerosol Optical Depth (AOD) values due to dust and smoke from the northern California wildfires across Nevada (**Figure 3.1-16**). MAIAC AOD imagery from MODIS on September 8 shows a continuous area of high AOD behind the frontal passage that has pushed through the Clark County area between satellite images (**Figure 3.1-17**). The highest AOD values are shown in California and to the south of Clark County with lower values visible throughout the state of Nevada. The high AOD values shown are a result of a combination of wildfire smoke and dust shown by the gray and brown mixture shown in the true color image (**Figure 3.1-18**).

The Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) reanalysis data show peak hourly average and hourly peak wind speeds in the source region and in the Las Vegas valley for September 8, 2020 (**Figure 3.1-19 and Figure 3.1-20**). Strong northerly to northeasterly surface winds developed by 15:00 UTC (07:00 PST) because of the strong pressure gradient between the front exiting Clark County and the surface high in the north. These high winds of around 20 m/s (corresponding to approximately 45 mph) are shown in MERRA-2 reanalysis figures for September 8, 2020, and the strong winds continued through 06:00 UTC on September 9, 2020.

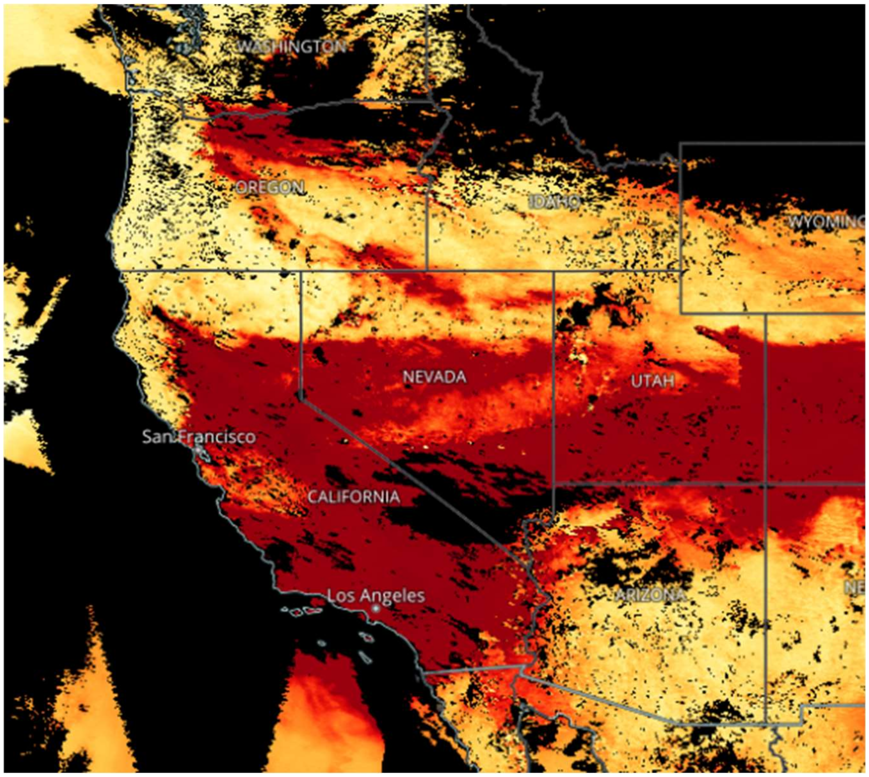


Figure 3.1-16. Satellite aerosol optical depth from MAIAC Aqua and Terra combined. Terra imagery at 10:30 local time and Aqua imagery at 13:30 local time on September 7, 2020 (pre-frontal passage).

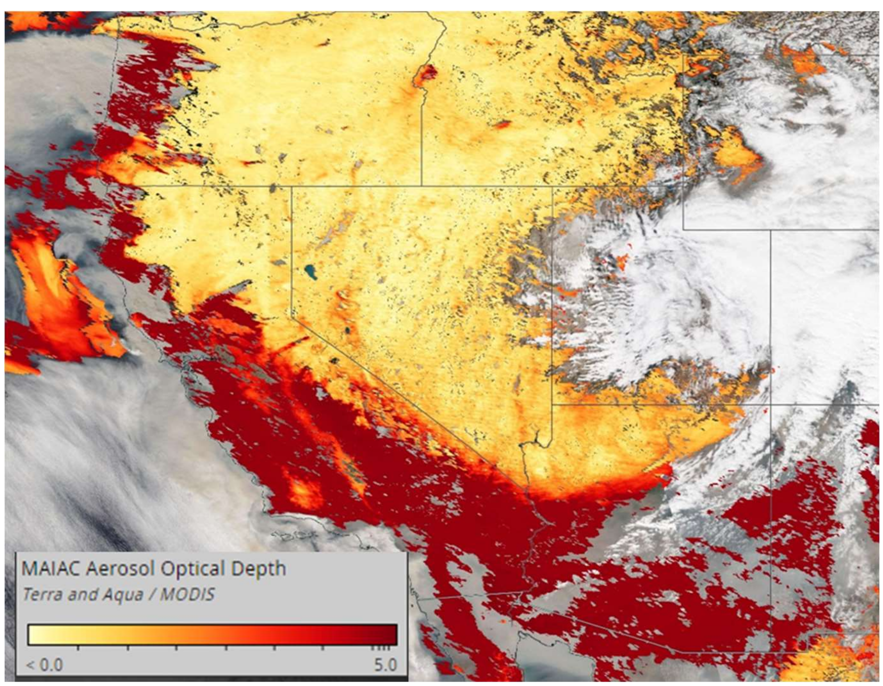


Figure 3.1-17. Satellite aerosol optical depth from MAIAC Aqua and Terra combined. Terra imagery at 10:30 local time and Aqua imagery at 13:30 local time on September 8, 2020.

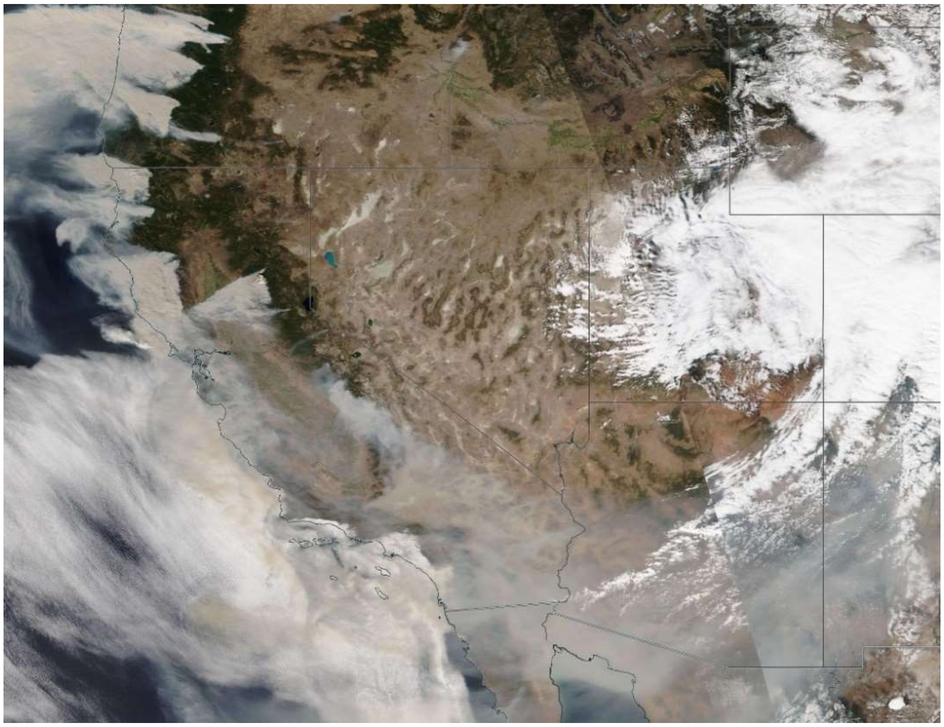


Figure 3.1-18. Satellite imagery of true color from NOAA-20 VIIRS at 14:30 local time on September 8, 2020.

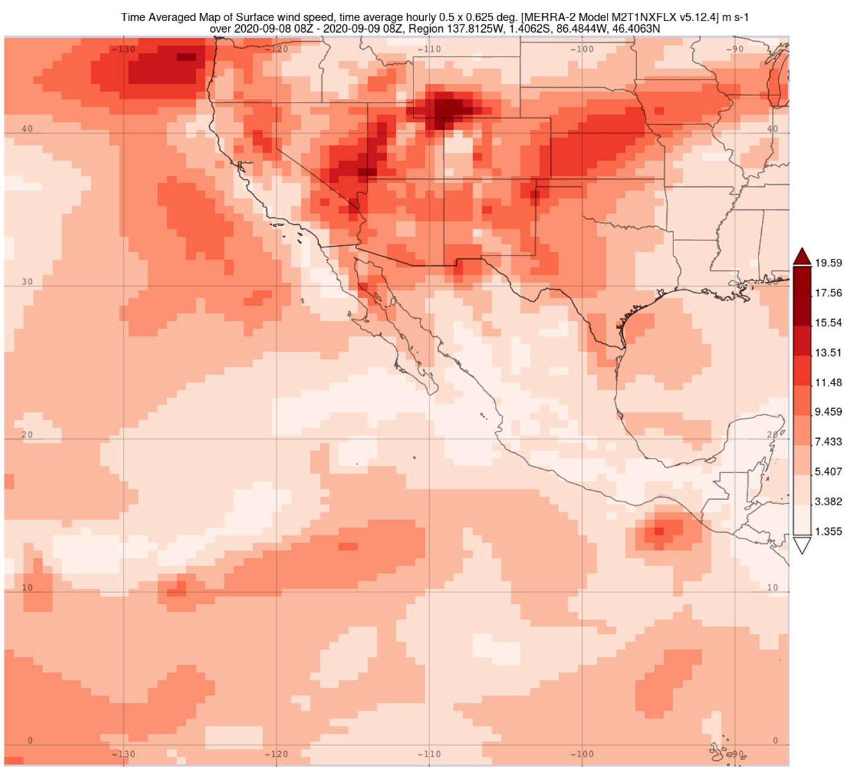


Figure 3.1-19. MERRA-2 reanalysis data hourly averaged surface wind speed (m/s) over September 8, 2020 08:00 UTC (00:00 PST) – September 9, 2020 08:00 UTC (00:00 PST).

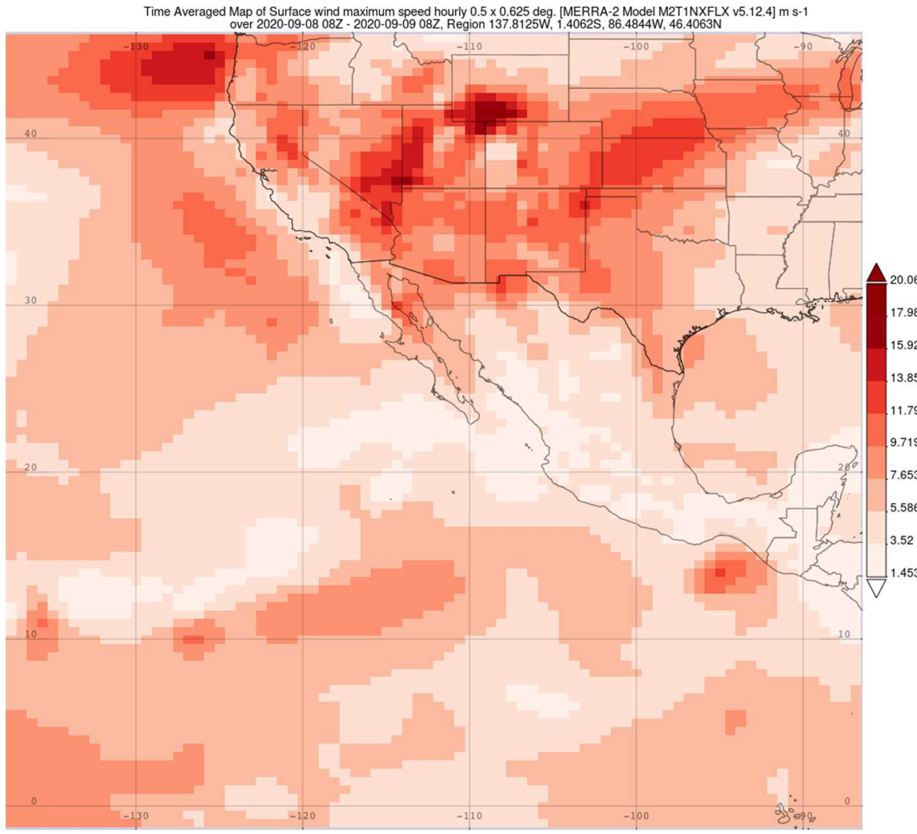


Figure 3.1-20. MERRA-2 reanalysis data hourly maximum surface wind speed (m/s) over September 8, 2020 08:00 UTC (00:00 PST) – September 9, 2020 08:00 UTC (00:00 PST).

3.1.3 Supporting Ground-Based Data

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

Peak sustained winds for Nevada, including the Great Basin source region, were mapped via the Iowa State University Mesonet Automated Data Plotter. This tool aggregates automated weather data records from the selected region. Figure 3.1-21 shows the peak sustained wind speeds throughout Nevada on September 8, 2020. Peak sustained wind speeds were well above the 25-mph threshold in the source region and could easily loft, entrain, and transport PM_{10} downwind to Clark County.

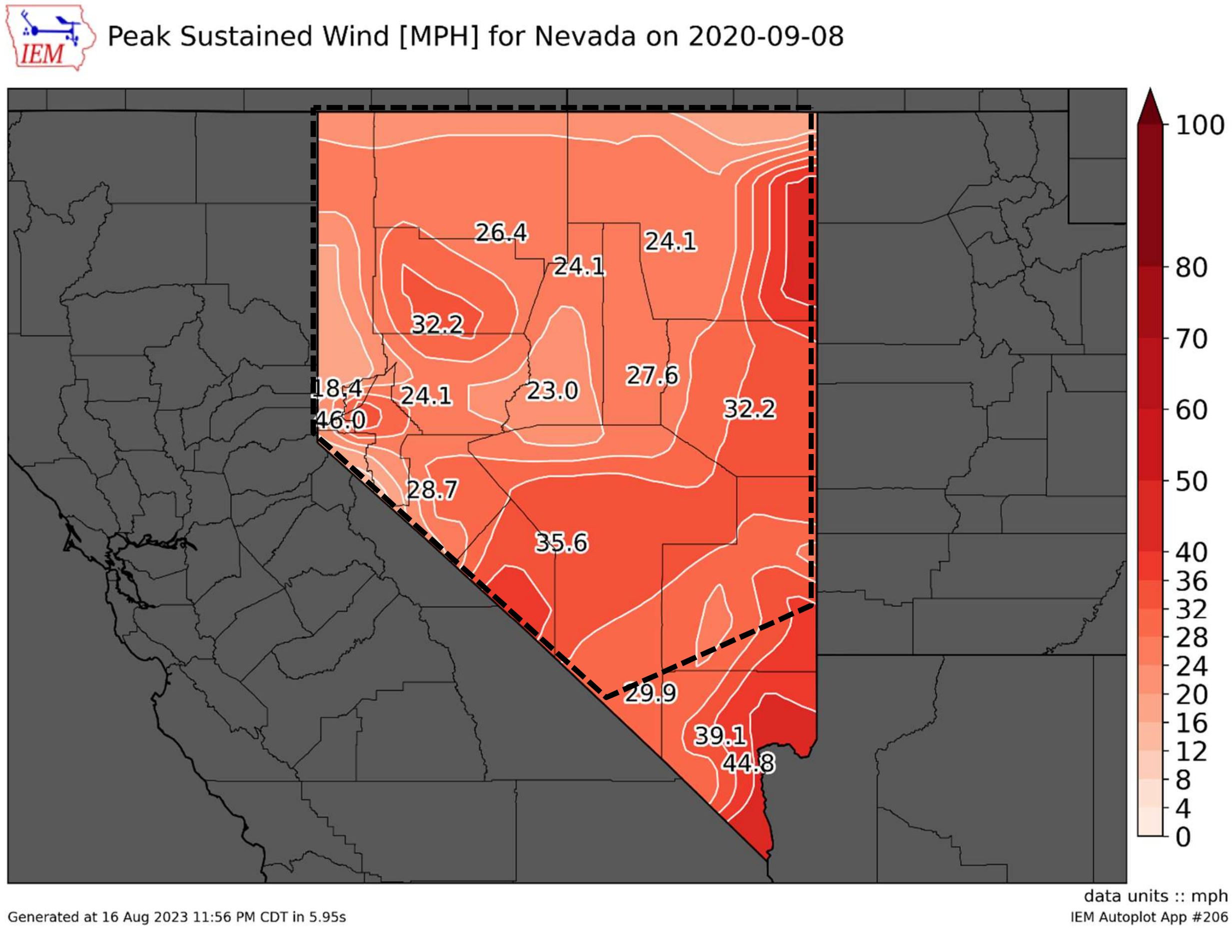


Figure 3.1-21. Peak sustained winds for Nevada on September 8, 2020. Data source https://mesonet.agron.iastate.edu/plotting/auto/. The approximate location of the Great Basin Desert in Nevada is shown by a black dashed polygon.

Figure 3.1-22 shows the distribution of maximum daily temperature recorded at several sites in the wind-blown dust source region on September 7 and 8 (1990 – 2019), and the maximum daily temperature recorded on September 7 and 8, 2020. The site locations are shown in Figure 2.2-8. Maximum daily temperatures recorded at all sites on September 7, 2020, were above the 75th percentile in the dust origin region and along the transport path compared to maximum daily temperatures from 1990 to 2019. Maximum daily temperatures recorded at four out of the seven sites on September 8, 2020, the day of the PM_{10} exceedance, were above the 75th percentile compared to 1990-2019. The maximum temperatures recorded on September 7 and 8 provide evidence that the wind-blown dust source region was unusually hot on the day before and the day of the PM_{10} exceedance.

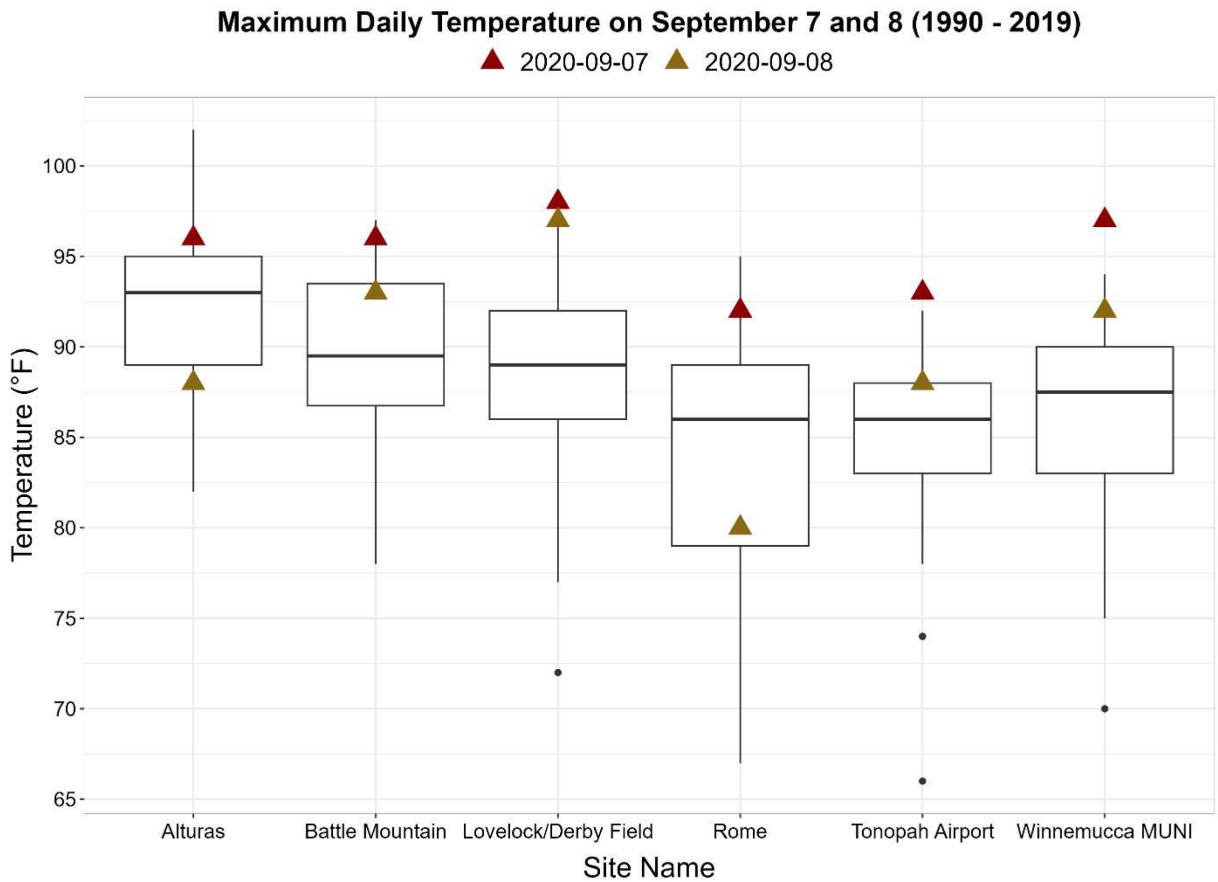


Figure 3.1-22. Maximum daily temperature on September 7 and 8, 2020, compared to 1990 – 2019 distribution at each site.

Overall, we find overwhelming evidence that PM_{10} was very likely lofted, entrained, and transported from the Great Basin Desert region late on September 7 and early on September 8, 2020, via a strong frontal passage. The evidence corroborating this assertion includes (1) the meteorological analysis that shows conditions were consistent with a high-wind event in the Great Basin Desert, (2) satellite retrievals showing high AOD and winds in the Great Basin Desert, and (3) ground-based measurements of high winds and temperatures in the Great Basin Desert on September 7 and 8, 2020.

3.2 Transport to Clark County

3.2.1 HYSPLIT Analysis

Backwards trajectories were modeled from the Jerome Mack monitoring station at the start of the high PM_{10} concentrations (hourly concentrations greater than 150 µg/m^3), 04:00 PST at 50, 500, and

1,000 m heights (**Figure 3.2-1**). Archived North American Mesoscale (NAM) Forecast System data with resolution of 12 km was used as meteorologic input. Temporal resolution of the NAM 12 km meteorological data is 3 hours and is run by the NCEP.

At all heights, trajectories approach the Las Vegas region from the northwest over the Great Basin Desert, revealing it as the source region. The Great Basin Desert is located just east of the Sierra Nevada Mountain range within its rain shadow, yielding barren land and scrub/shrub landcover (Figure 2.2-1). Throughout the Great Desert Basin each trajectory passes through areas with both severe and extreme drought conditions (**Figure 3.2-2**).

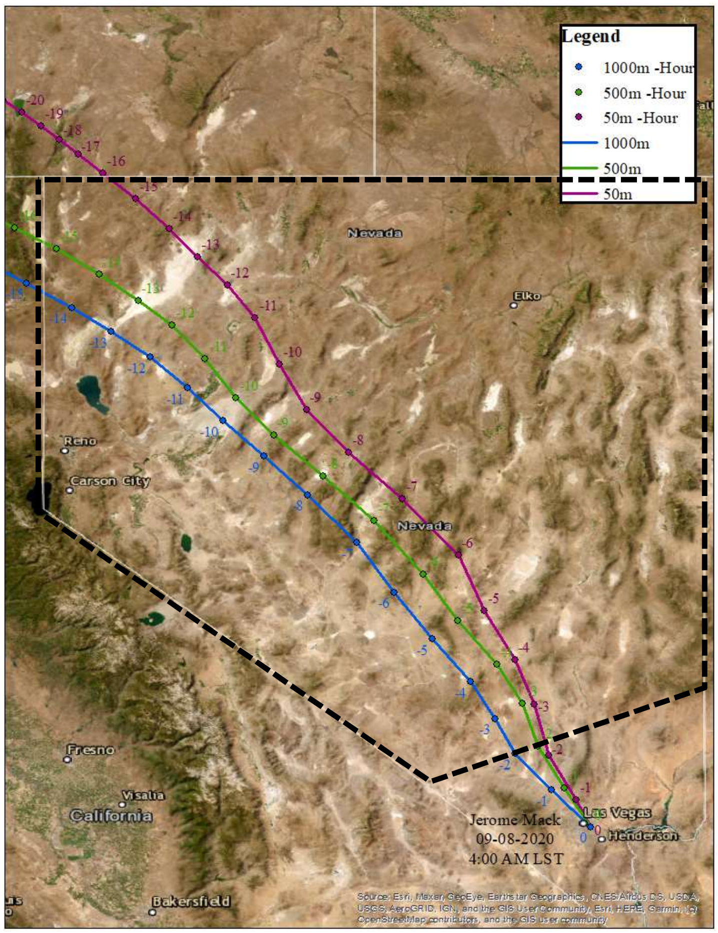


Figure 3.2-1. HYSPLIT 24-hour back trajectories from Jerome Mack on September 8, 2020, 04:00 PST, originating at (maroon) 50 m, (green) 500 m, and (blue) 1,000 m with hourly points. The approximate location of the Great Basin Desert in Nevada is shown by a black dashed polygon.

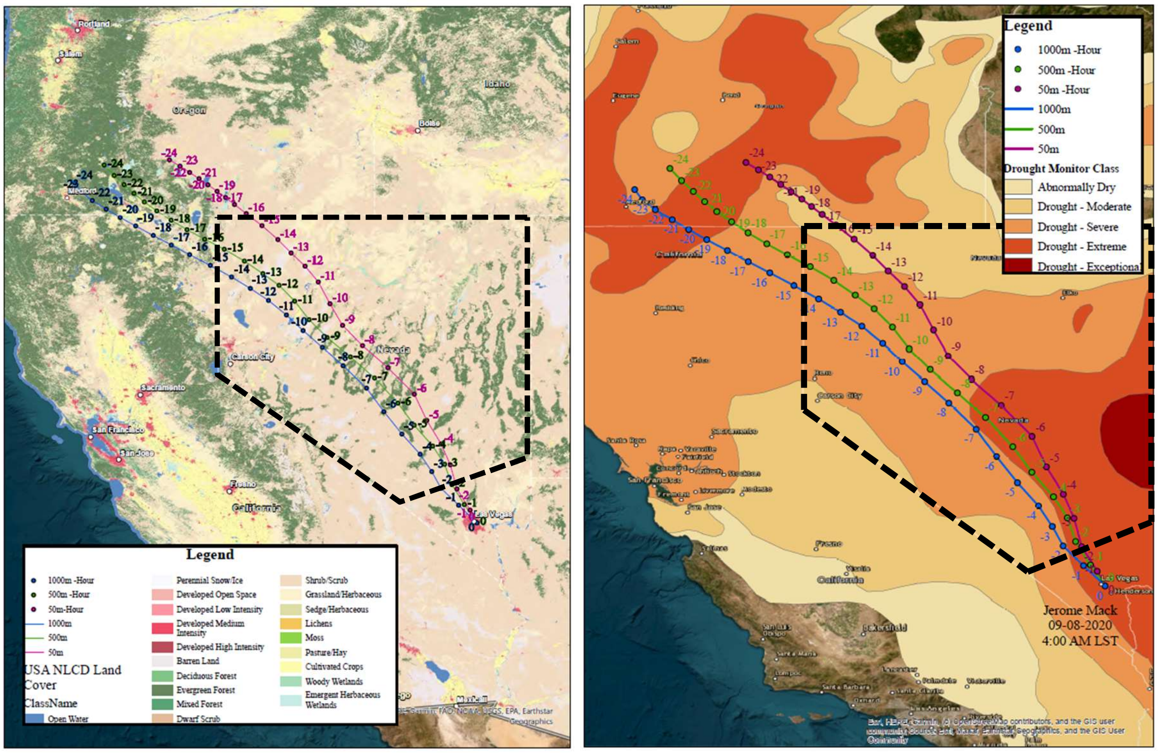


Figure 3.2-2. HYSPLIT 24-hour back trajectories from Jerome Mack on September 8, 2020 04:00 PST overlayed on (left) national land type database and (right) drought monitor class. The approximate location of the Great Basin Desert in Nevada is shown by a black dashed polygon.

3.2.2 High-Wind Event Timeline

The 24-hour average PM_{10} exceedance concentration on September 8, 2020, at Jerome Mack was 302 µg/m^3. Concentrations of PM_{10} start to increase at 03:00 PST on September 8, 2020, at Jerome Mack, peaking at 05:00 and remaining high until 10:00 PST (Figure 3.2-3). Though not regulatorily significant, seven other sites (Paul Meyer, Walter Johnson, Joe Neal, Green Valley, Sunrise Acres, Boulder City, and Jean) also experienced 24-hour PM_{10} concentrations greater than 150 µg/m^3 on September 8, 2020. Figure 3.2-4 shows resultant hourly average winds measured at Air Quality System (AQS) sites in Clark County. Only one hourly average wind measurement greater than 25 mph was recorded on September 8 at Walter Johnson. However, as shown in Figure 3.1-21, winds speeds north of Las Vegas in the source region were well above the 25-mph threshold on September 8. High wind speeds in the source region as well as the ongoing drought conditions across Nevada suggest that the enhanced dust concentrations during this event were from the natural, undisturbed desert sources north of Clark County.

Northerly wind direction aligns with the frontal passage (Figure 3.2-5) outlined in Section 3.1.1. Figure 3.2-6 tracks the movement of the cold front southward across Nevada. Meteorological data from three weather stations along the HYSPLIT trajectory modeled in Section 3.2.1 were sourced from the Iowa Environmental Mesonet (https://mesonet.agron.iastate.edu/). These stations are, from north to south, Lovelock (LOL), Tonopah Airport (TPH), and Desert Rock (DRA). A minimum sea level pressure (SLP), rise in wind speed and a shift in wind direction from westerly to northerly indicate the passage of a cold front. The time when minimum SLP occurred at a station is marked by the black dotted line in each plot panel of Figure 3.2-6 and noted next to each station on the map. This minimum is nearly concurrent with an increase in wind speed and shift in wind direction at each station, and therefore approximates the time of frontal passage. The cold front passes LOL around 18:00 PST on September 7, then continues southward and reaches TPH at 23:00 PST on September 7. Figure 3.2-6 shows that the cold front moves through DRA and the Las Vegas region (LAS) close to 03:00 PST on September 8, bringing with it a sharp pressure gradient and subsequent gusty wind conditions that enhanced PM_{10} concentrations to their maximum by 05:00 PST.

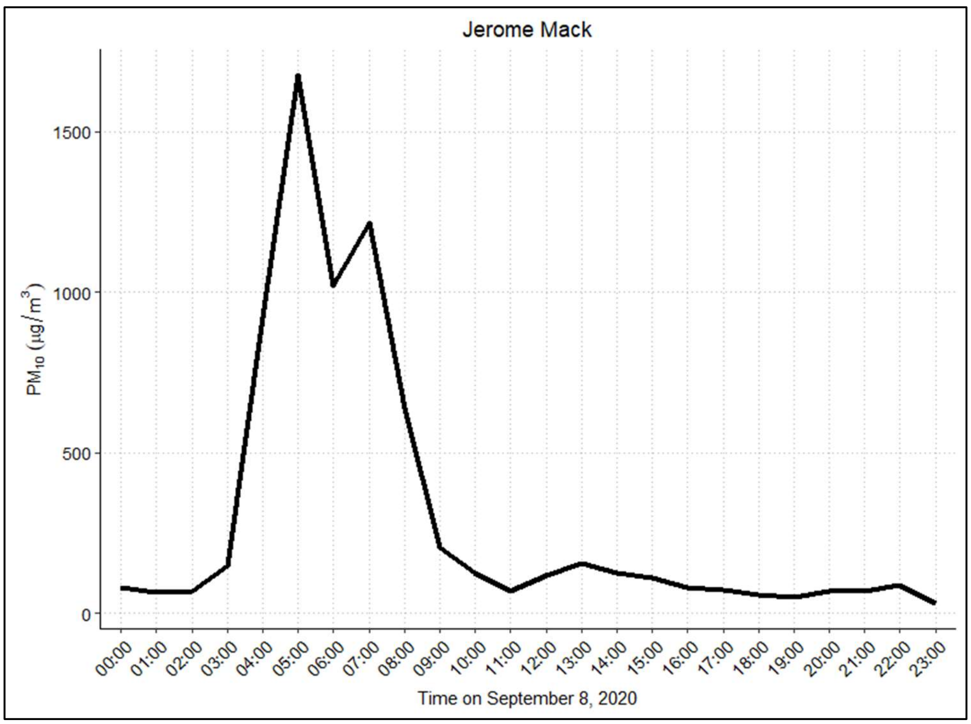


Figure 3.2-3. Hourly PM_{10} measurements in µg/m^3 at Jerome Mack on September 8, 2020.

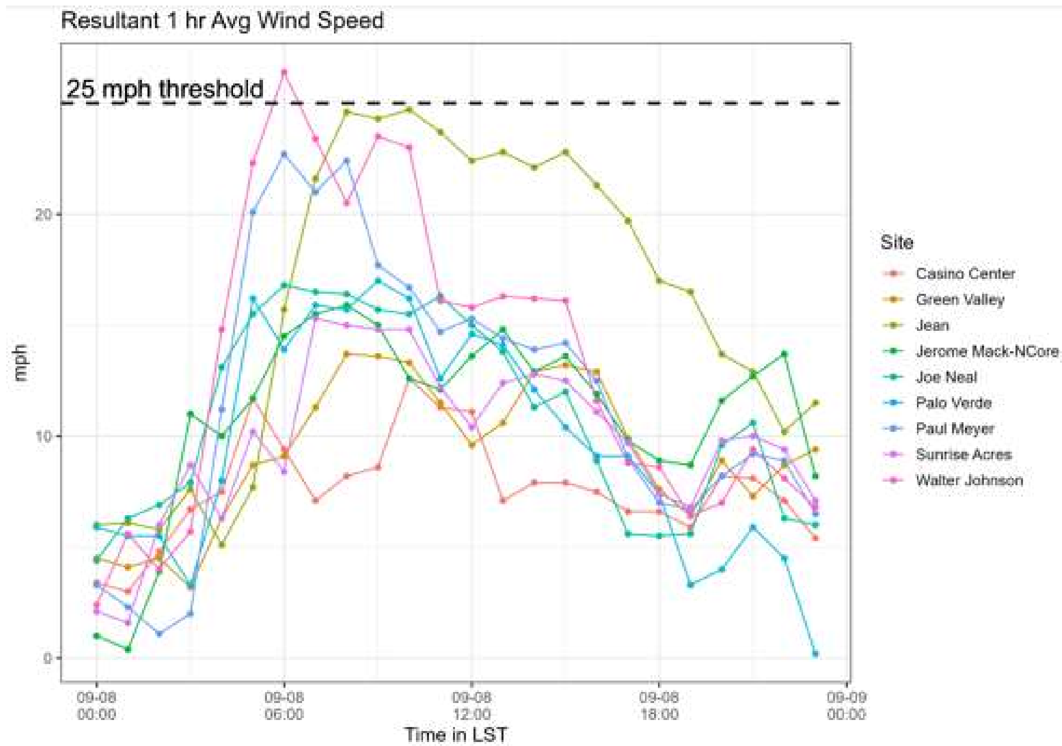


Figure 3.2-4. Resultant hourly average wind speed at AQS sites in Clark County sourced from the AQS database.

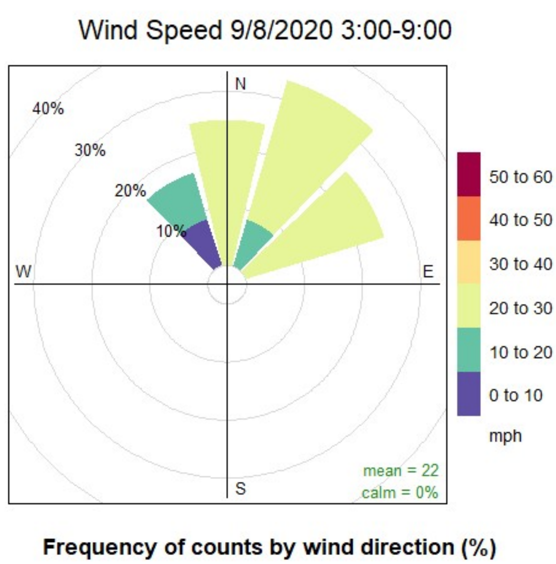


Figure 3.2-5. Wind rose including both wind speed and direction for September 8, 2020, 03:00-09:00 at Harry Reid Int'l Airport (LAS). Wind data is sourced from the Iowa Environmental Mesonet (https://mesonet.agron.iastate.edu/).

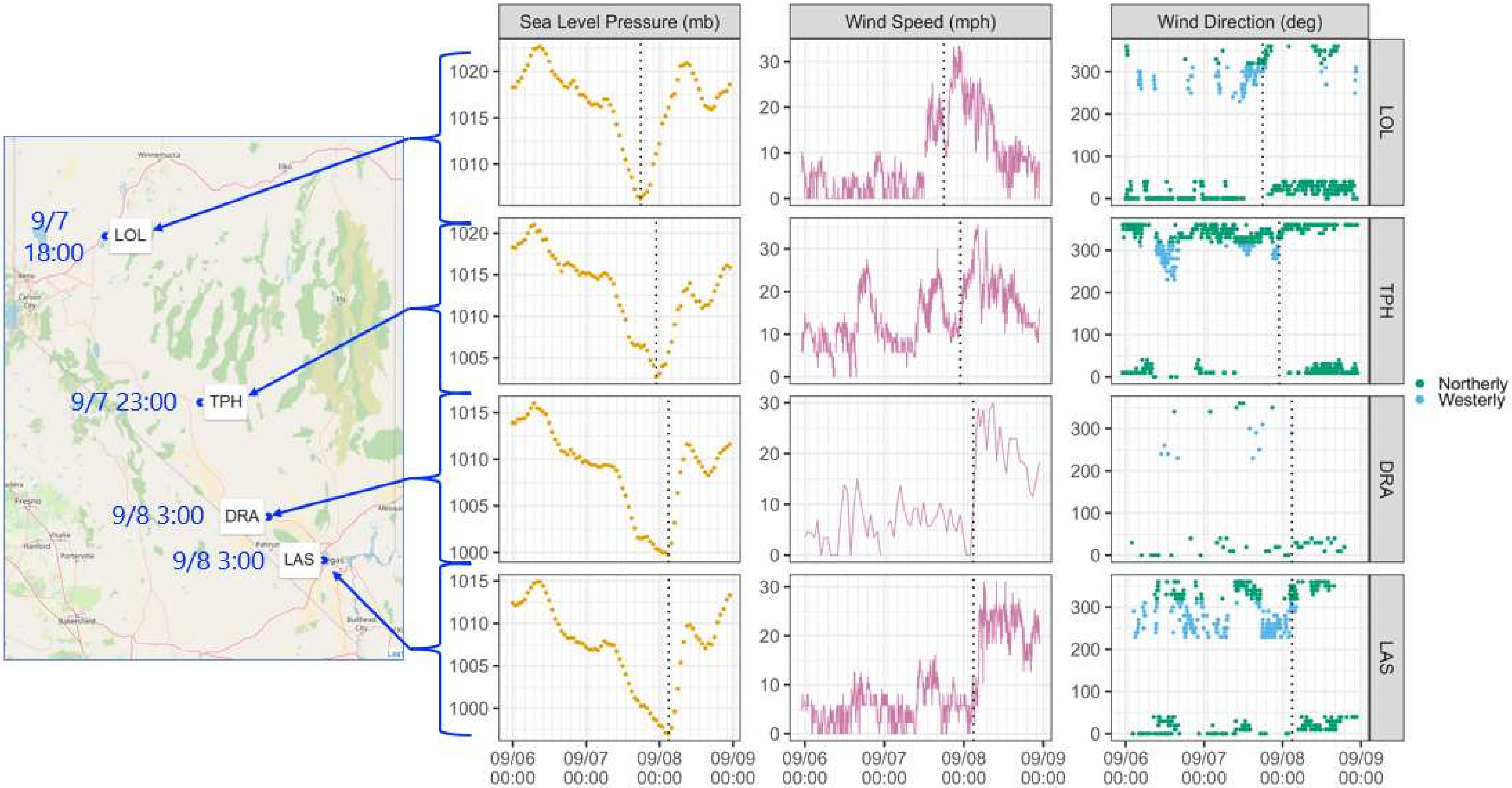


Figure 3.2-6. Timeseries of sea level pressure (SLP), wind speed, and wind direction between 00:00 PST on September 7 and 00:00 PST on September 9 at four weather stations in Nevada: LOL, TPH, DRA and LAS. The approximate time of frontal passage at each station is noted in blue on the map. The black dotted line in each plot panel marks the time when minimum SLP occurred at that station. In the wind direction plot panels, "westerly" (blue) refers to the 45-degree arc between 225 and 315 degrees, and "northerly" (green) refers to the 45-degree arc between 315 and 45 degrees (across the discontinuity at 360/0 degrees). Wind and pressure data is sourced from the Iowa Environmental Mesonet (https://mesonet.agron.iastate.edu/).

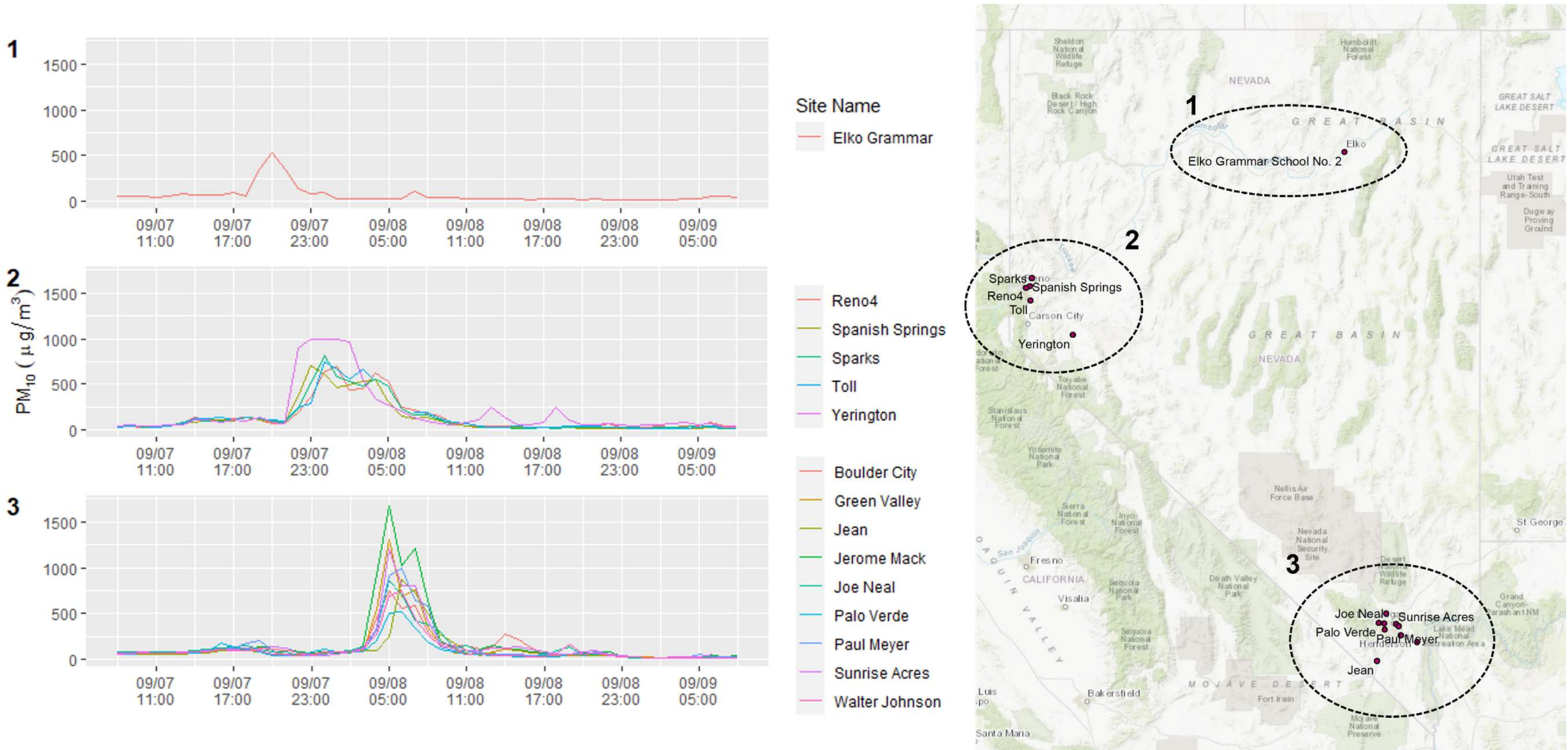


Figure 3.2-7. Timeseries of PM_{10} (left) along the frontal passage. The top left figure (1) includes data from Elko, the middle-left figure (2) includes data from the Reno area, and the bottom left figure (3) includes data from the Las Vegas area. The map (right) and site locations are mapped and circled by region. Numbering on the map corresponds to numbering on the time series figures.

In addition to the meteorological evidence of the frontal passage, PM_{10} concentrations in Elko and Reno are provided in **Figure 3.2-7**. As stated in the meteorological analysis in Section 3.1.1, the frontal passage entered northern Nevada around 16:00 PST on September 7, 2020. The Elko area was the first impacted by lofted dust from the Great Basin Desert and showed a significant enhancement in PM_{10} starting around 18:00 PST on September 7, 2020. As the front moved through northern Nevada, Reno was subsequently affected and saw an increase in PM_{10} by approximately 21:00 PST on September 7, 2020. Finally, we saw Clark County monitoring stations affected by the dust event by 03:00 PST on September 8, 2020. As the frontal passage pushed south across the Great Basin Desert, the PM_{10} concentrations increased as they reached Clark County. This provides significant evidence of windblown dust along a frontal passage due to high winds.

The period of high PM_{10} concentrations coincides with high wind speed (**Figure 3.2-8**). The subsequent rise in wind speed along the HYSPLIT trajectory is shown in Figure 3.2-8. Wind speeds first rose with the frontal passage at the northernmost station, LOL, around 19:00 PST on September 7. Wind speeds then rose at TPH, DRA, and LAS in succession as the frontal system moved southward. PM_{10} concentrations at all sites in the Las Vegas valley started to increase around 03:00 PST on September 8, coinciding with the time of frontal passage at DRA and LAS, and peak wind speeds just north of Las Vegas at DRA. PM_{10} concentrations at all sites in the Las Vegas valley reach at least 151 $\mu g/m^3$ by 04:00 PST, with most sites reaching above 301 $\mu g/m^3$ and up to >500 $\mu g/m^3$. PM_{10} concentrations increase to a maximum at 05:00 PST at Jerome Mack, as wind gusts in the Las Vegas valley (measured at LAS) breach 40 mph. PM_{10} concentrations at all sites in the Las Vegas valley begin falling by 09:00 to 10:00 PST, but do not drop below 50 $\mu g/m^3$ until 23:00 PST. Wind speeds at all sites (excluding Palo Verde) in the Las Vegas valley fall to around 10 knots (11.5 mph) by 23:00 PST, coinciding with the fall in PM_{10} concentrations.

Wind speed, direction, and concentrations across Clark County, NV, are also consistent with a frontal passage (**Figure 3.2-9 to Figure 3.2-14**). Before the event, winds are light and variable throughout the Las Vegas Valley (01:00 – 02:00 PST). By 03:00 – 04:00 PST, winds shift to the northwest with the approaching frontal passage. PM_{10} starts to increase with the heaviest accumulation at the lower elevation sites like Jerome Mack and Sunrise Acres. By 05:00 – 08:00 PST, all sites within the Valley experience multiple hours of extremely high PM_{10} concentrations (> 300 $\mu g/m^3$) with consistent winds out of the northwest. By 09:00 – 12:00 PST, winds start to decline and PM_{10} concentrations decline as well. The consistent wind direction and regional extreme enhancement of PM_{10} is a clear indication of a high-wind dust event with an upwind PM_{10} source.

Enhanced PM_{10} concentrations at the affected sites were likely caused by a high-wind event in the source region rather than local emissions, in part because planned land use around these sites, which can be generally described as developed with little exposed dirt or gravel, is not conducive to enhanced concentrations. Further, the fact that enhanced PM_{10} concentrations were recorded at all sites in the Las Vegas Valley indicates a regional high-wind dust event. While it is possible that some portions of planned land use, there are no significant PM_{10} point sources near the Jerome Mack monitoring site which could have contributed to local dust during the high-wind event. Evidence of high winds over the natural, undisturbed Mojave Desert region upwind of Clark County is clearly the main driver of this dust event. As shown by the timeline of events, high winds from a front lofted PM_{10} in the Great Basin Desert source region and caused a regional dust event that extended into Clark County. Even if there were some contributions from local dust sources due to high winds, the regional dust event is the main source of the extreme PM_{10} concentrations experienced on September 8, 2020.

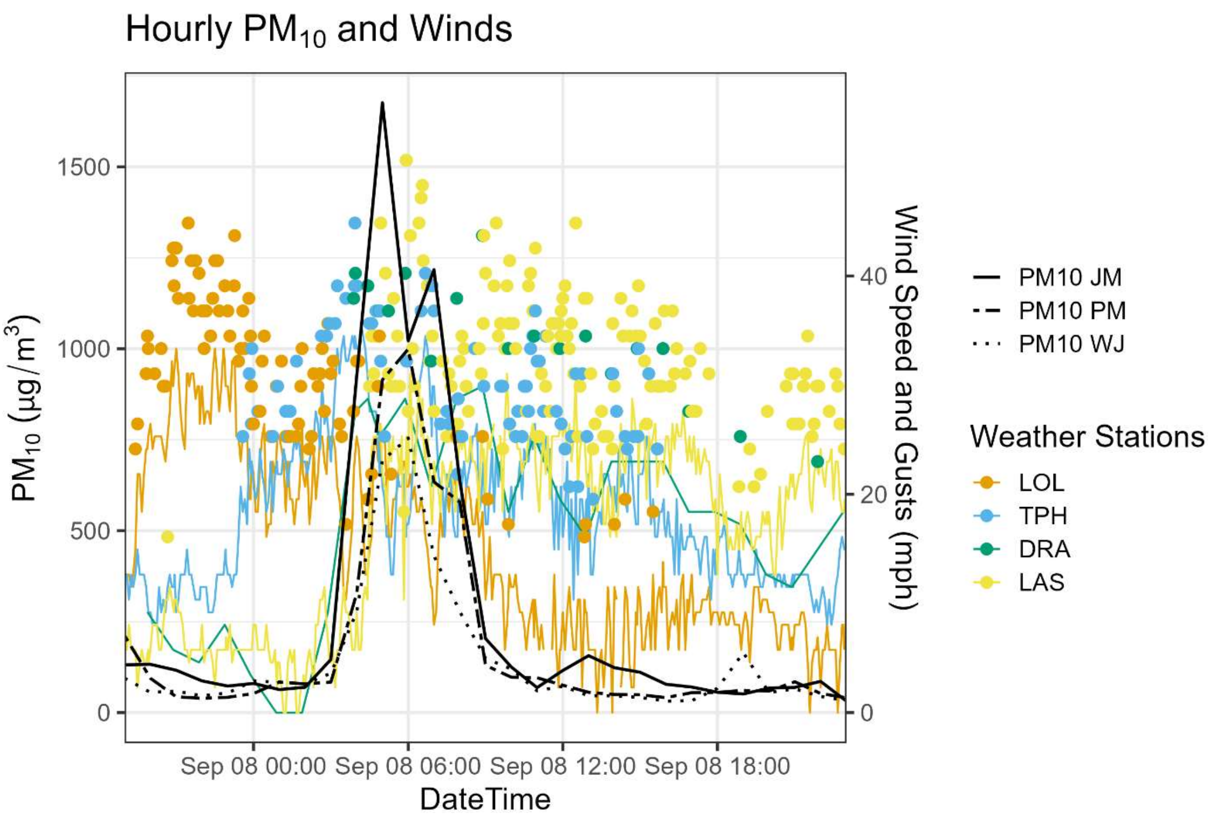


Figure 3.2-8. Hourly PM_{10} ($\mu g/m^3$) at Jerome Mack (JM), Paul Meyer (PM), and Walter Johnson (WJ), and wind speed (lines) and wind gusts (dots) from LOL, TPH, DRA, and LAS weather stations between September 7 at 18:00 PST and September 9, 2020, at 00:00 PST.

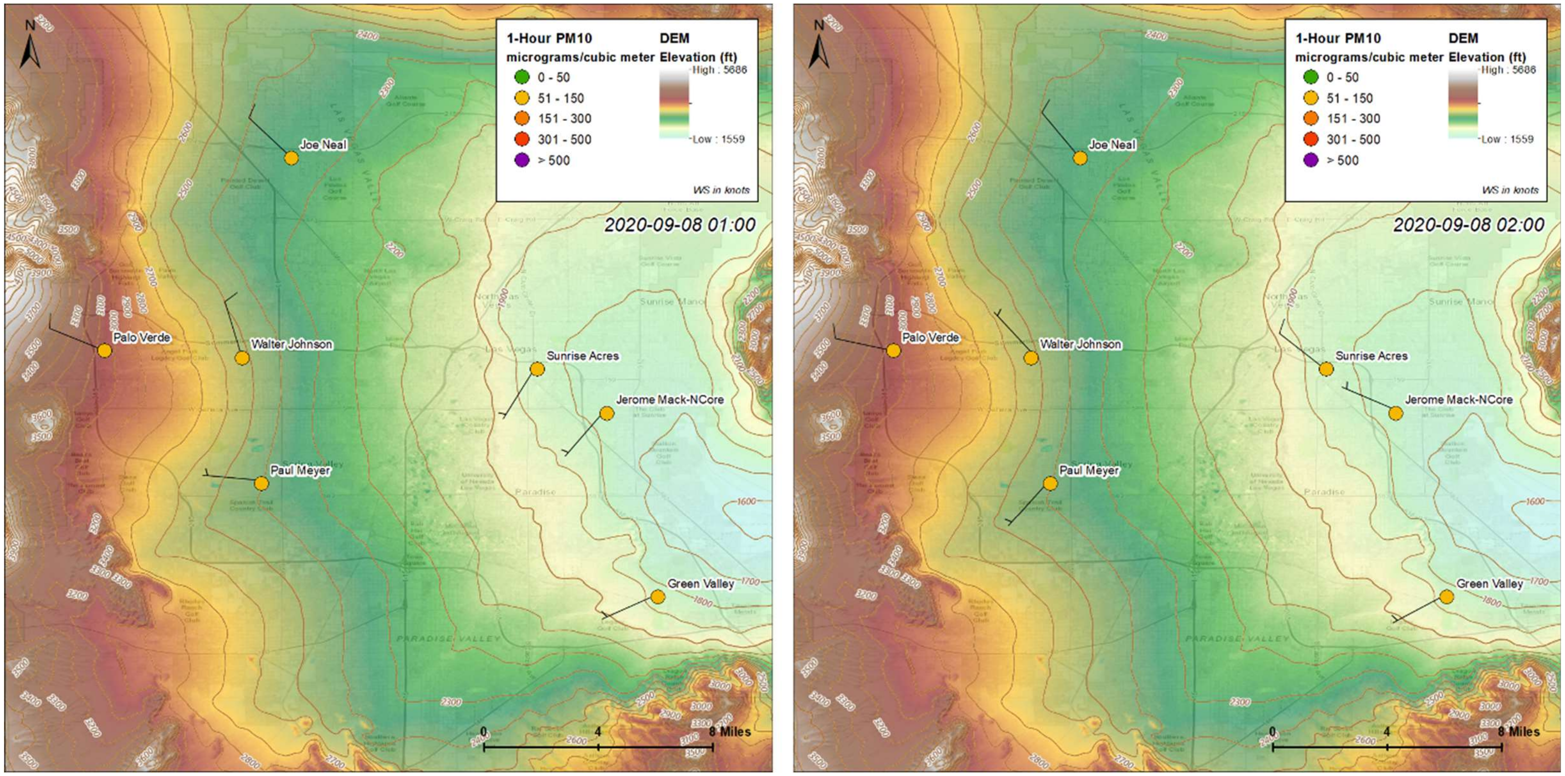


Figure 3.2-9. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, (left) 01:00 PST and (right) 02:00 PST on September 8, 2020.

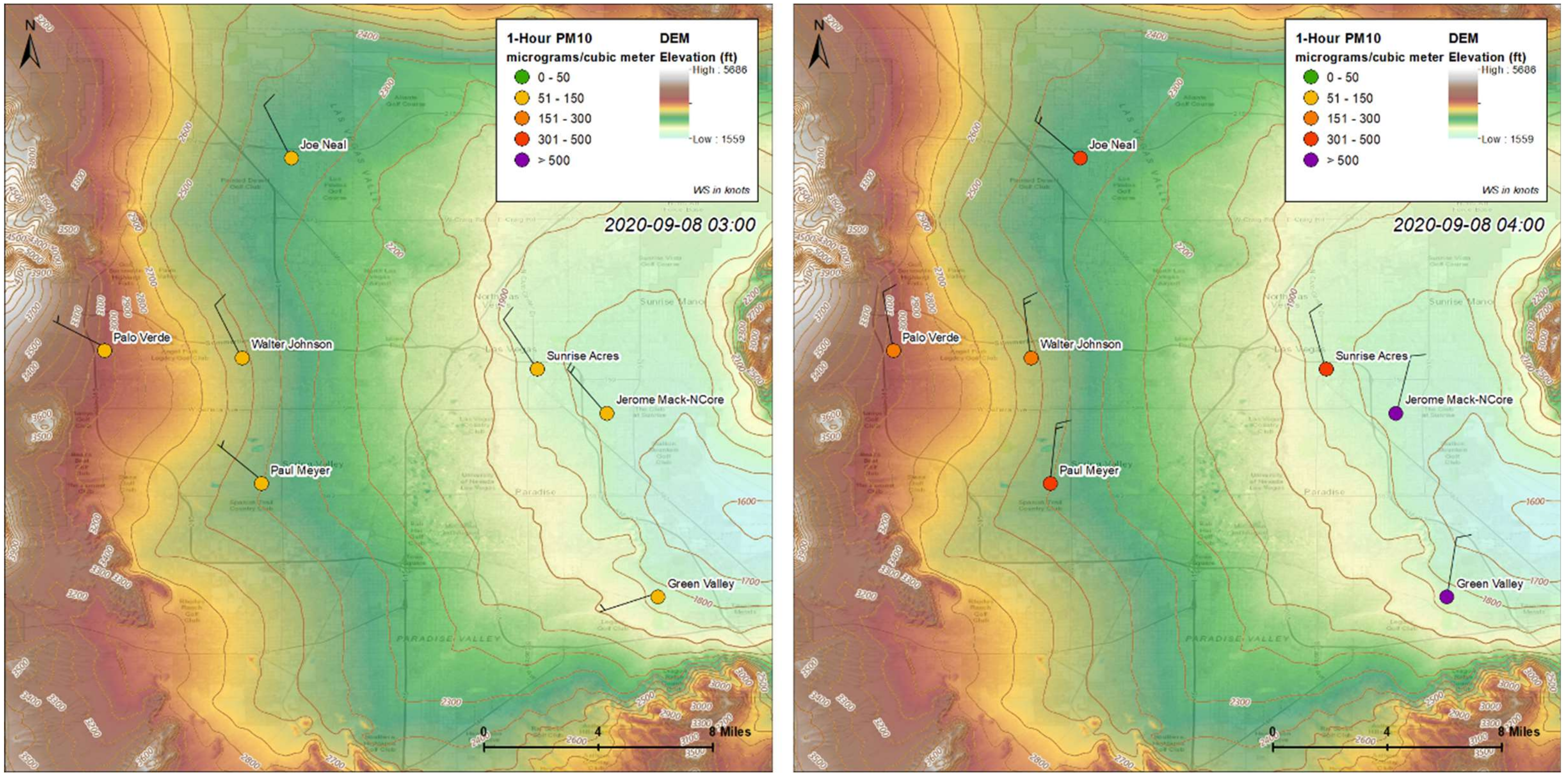


Figure 3.2-10. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for (left) 03:00 PST and (right) 04:00 PST on September 8, 2020.

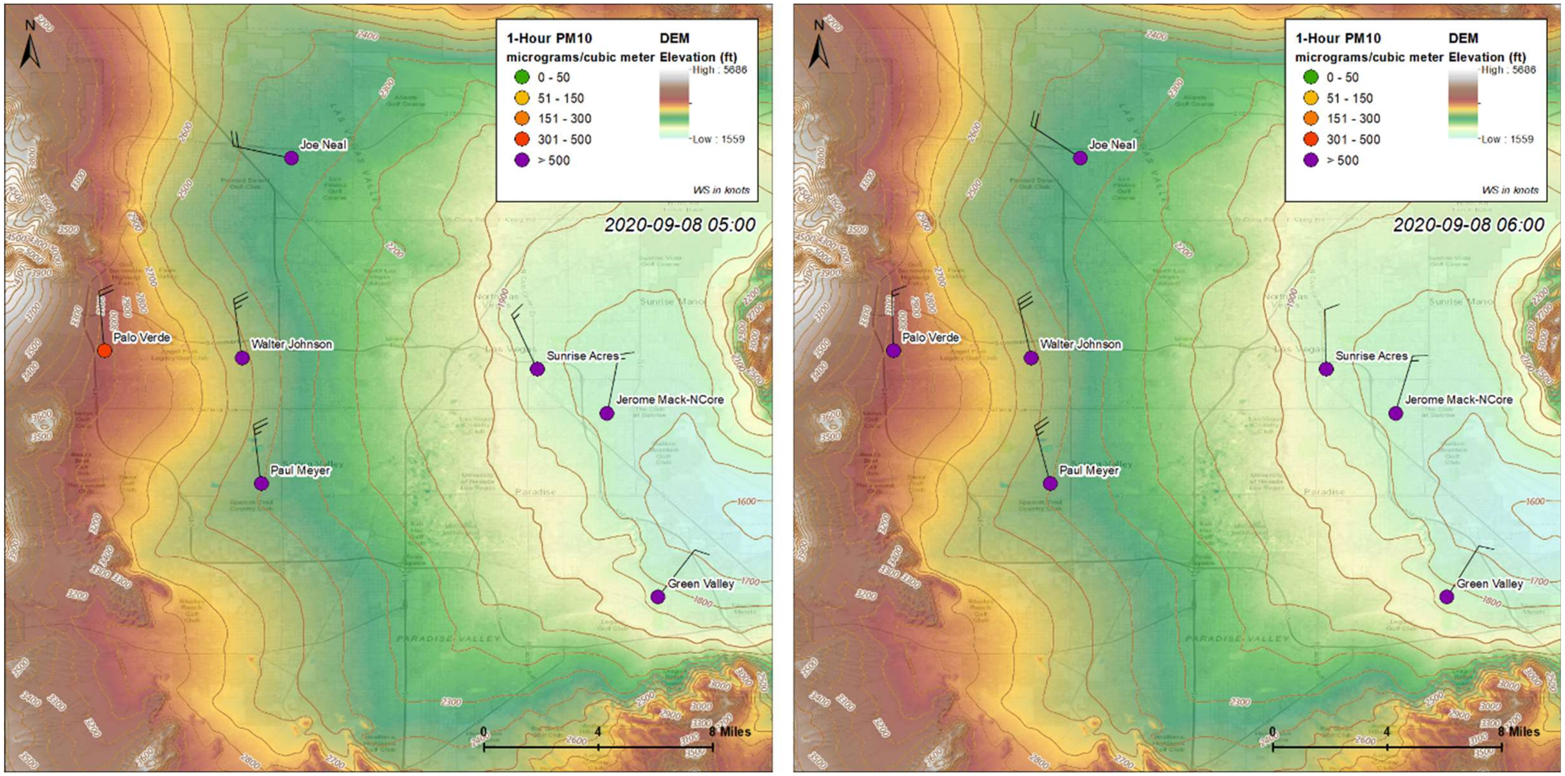


Figure 3.2-11. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for (left) 05:00 PST and (right) 06:00 PST on September 8, 2020.

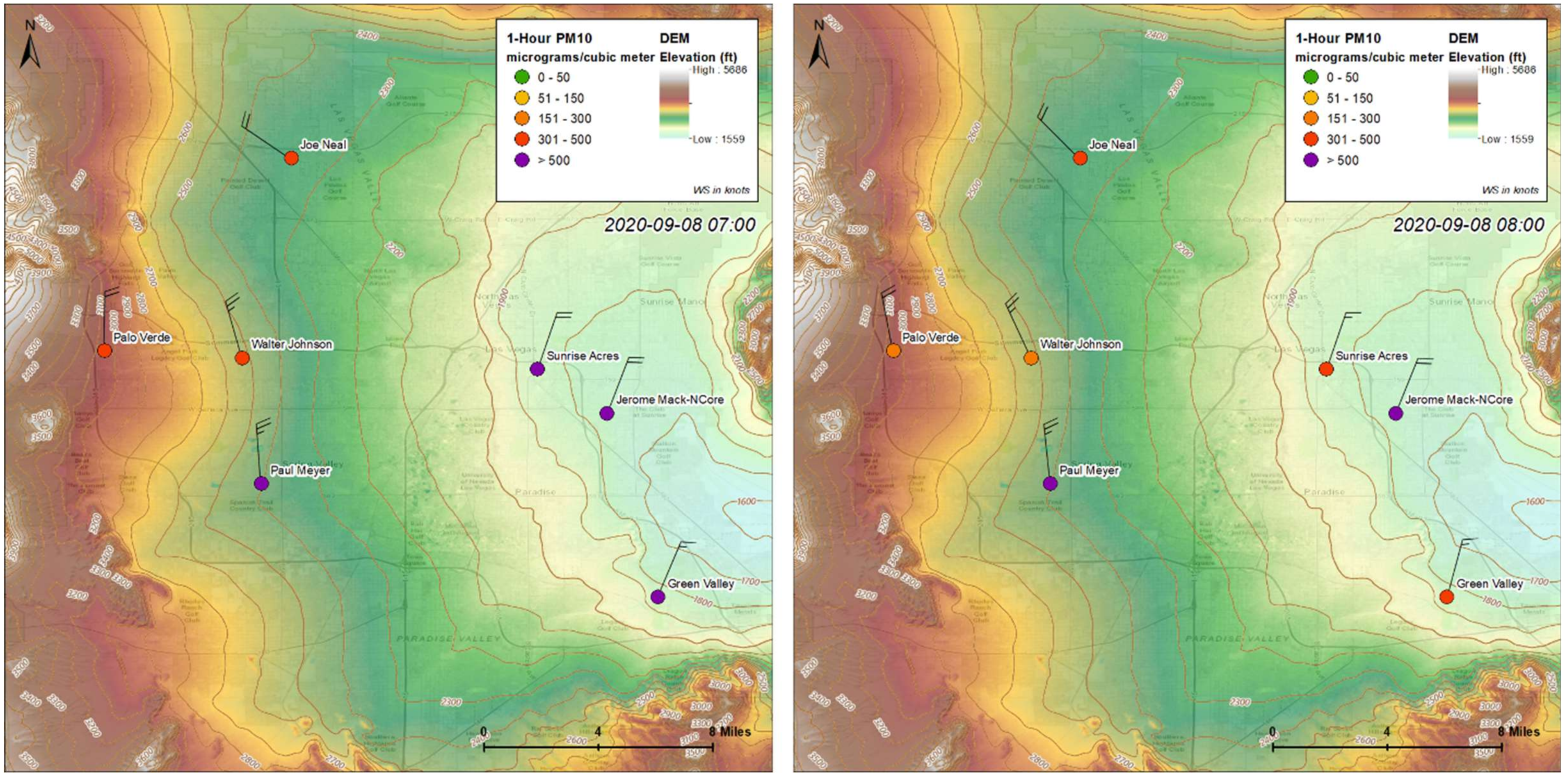


Figure 3.2-12. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for (left) 07:00 PST and (right) 08:00 PST on September 8, 2020.

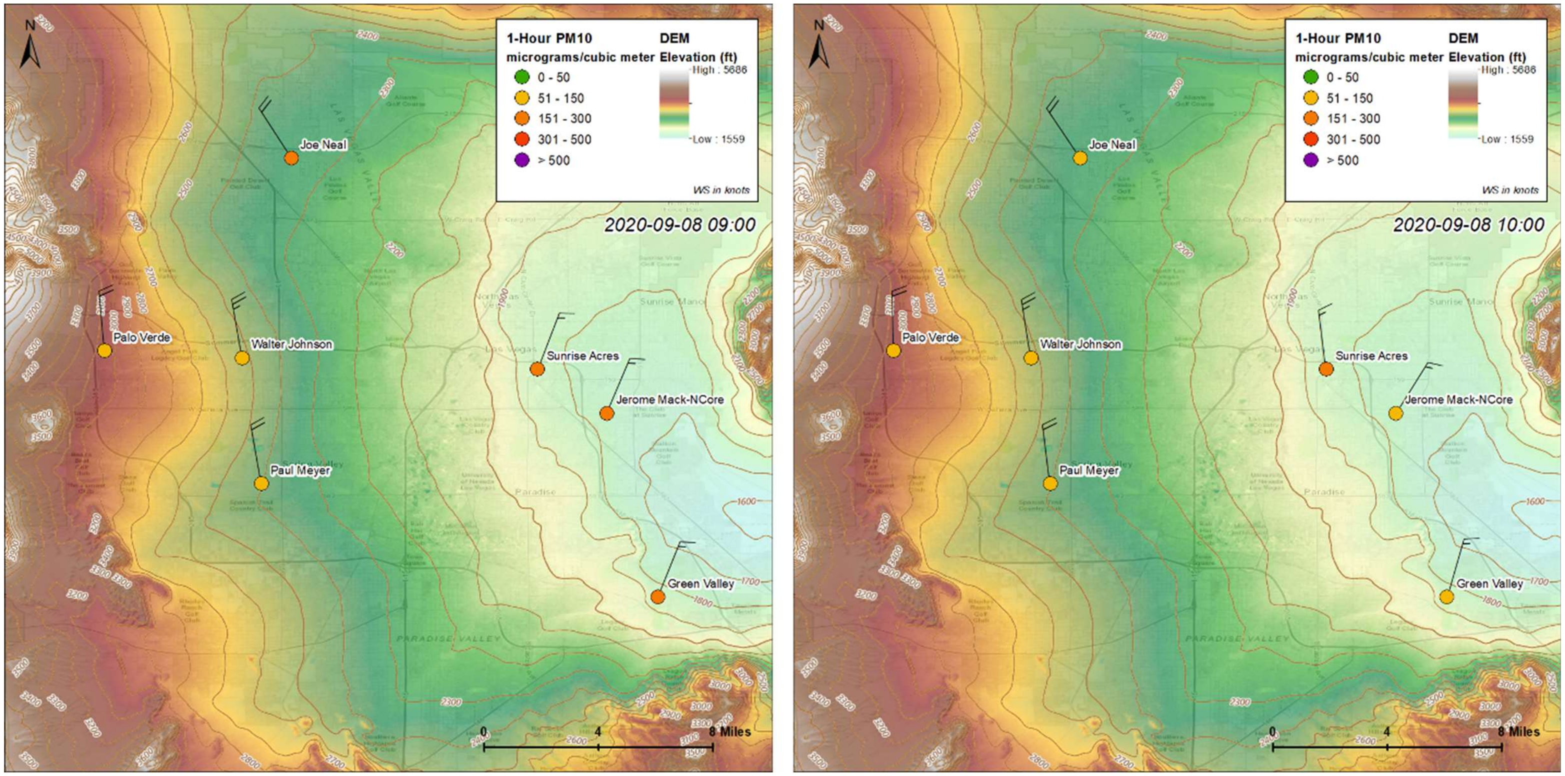


Figure 3.2-13. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for (left) 09:00 PST and (right) 10:00 PST on September 8, 2020.

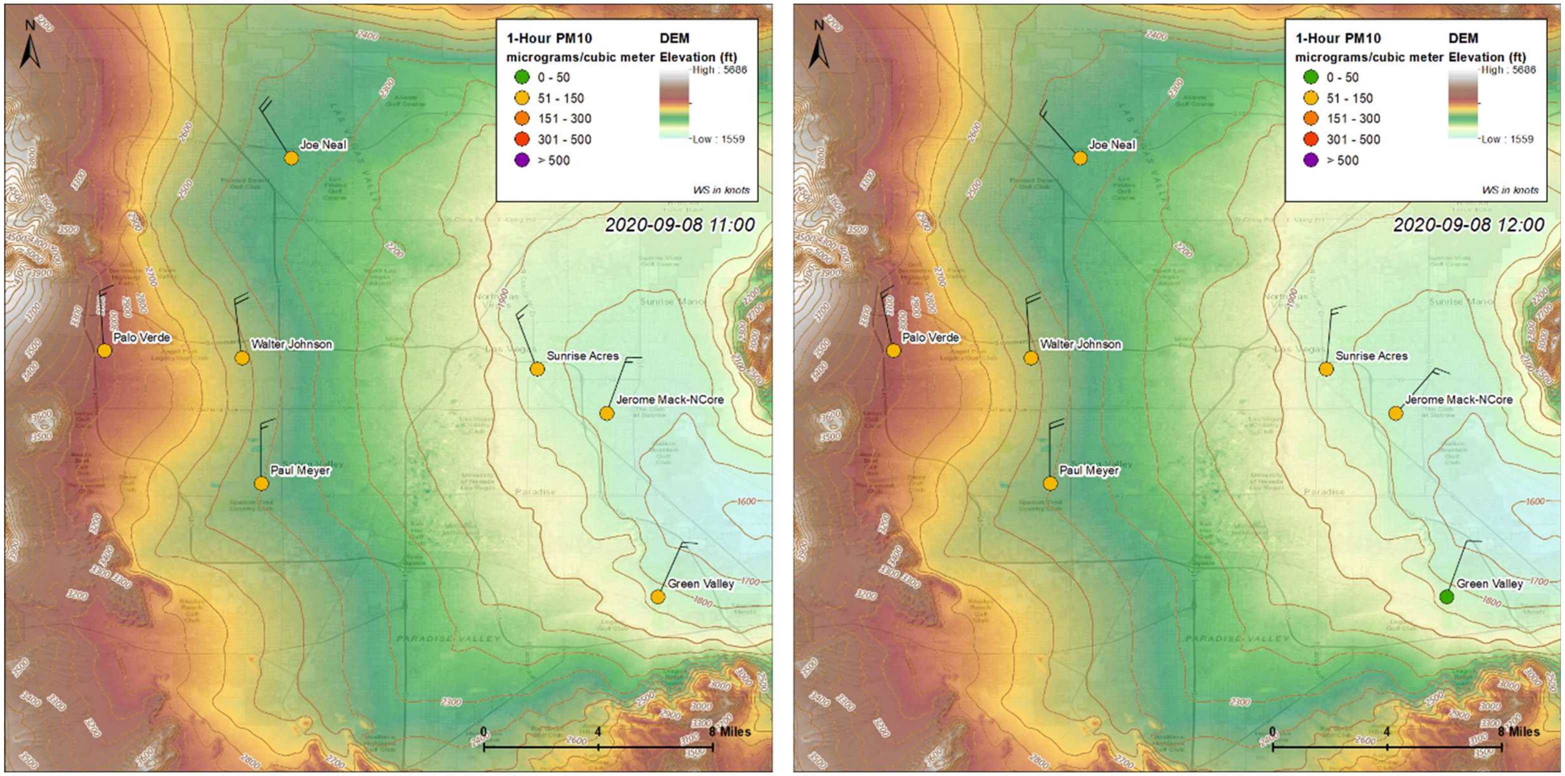


Figure 3.2-14. Topographical map showing surface observations of wind speed, wind direction, and hourly PM_{10} concentrations from each measurement site in Clark County, Nevada, for (left) 11:00 PST and (right) 12:00 PST on September 8, 2020.

Peak sustained winds for Clark County and the surrounding regions are shown in **Figure 3.2-15** using the Iowa State University Mesonet Automated Data aggregation tool. This plot shows sustained winds greater than the 25-mph high-wind threshold on September 8, 2020, providing further proof that this was a high-wind event affecting Clark County.

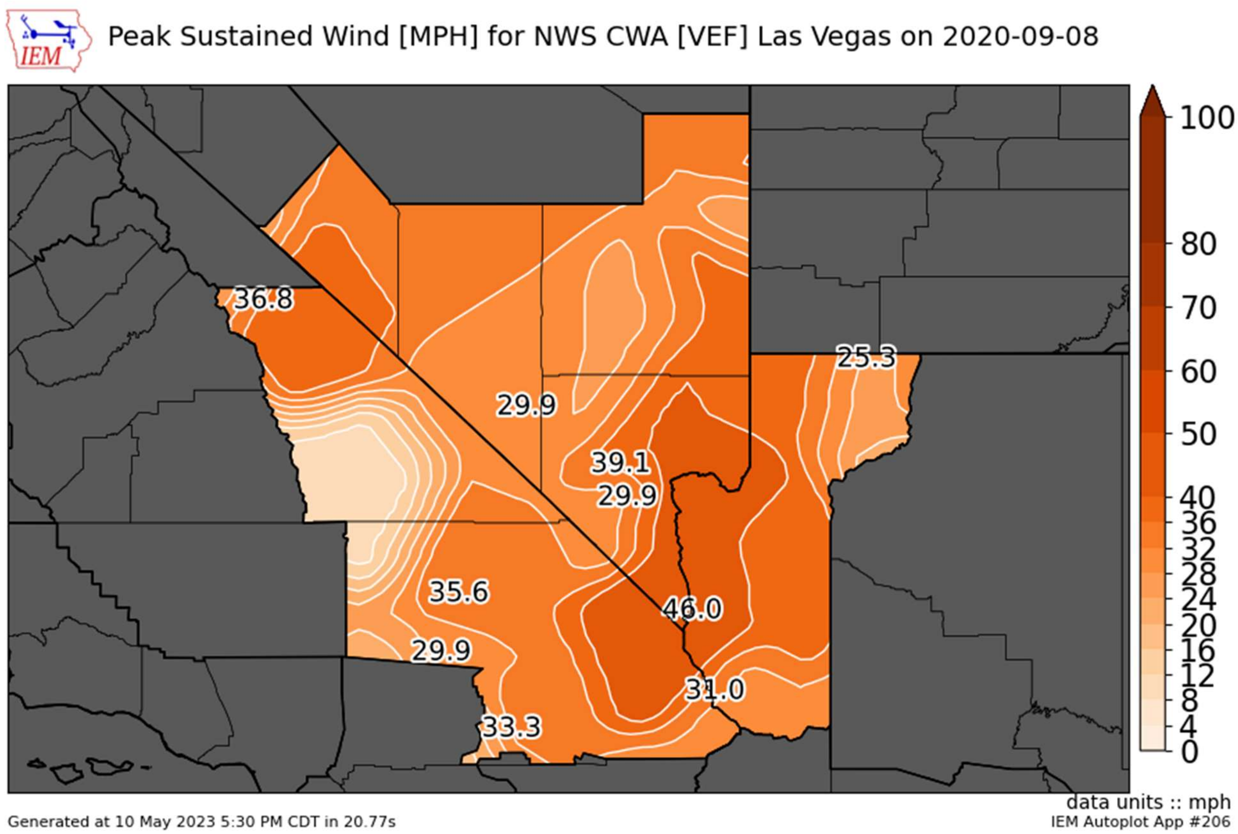


Figure 3.2-15. Peak sustained winds in Clark County and surrounding counties on September 8, 2020. Data source **https://mesonet.agron.iastate.edu/plotting/auto/**.

Overall, we find overwhelming evidence that PM_{10} was transported from the Great Basin Desert region late on September 7 and early September 8 via a strong frontal passage. Wind speeds in the source region, along the transport path, and in Clark County show sustained speeds of greater than 25 mph, the high-wind threshold. PM_{10} concentrations from monitors along the frontal passage also show the lofted dust from the Great Basin Desert. The evidence corroborating this assertion includes (1) HYSPLIT analyses showing transport from the Great Basin Desert in less than 24 hours, (2) abrupt changes in SLP, wind speed, and wind direction along the transport path, (3) PM_{10} evidence from monitoring sites along the transport path, and (4) ground-based observation of PM_{10} and wind speed/direction in Clark County that corroborate the PM_{10} event time of arrival.

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

3.3.1 Clark County Alerts

On Tuesday, September 8, 2020, Clark County issued a Dust Advisory for the day and required all dust control permit holders, contractors, and stationary sources to immediately inspect their site(s) and employ BACM to stabilize all disturbed soils and reduce blowing dust (**Figure 3.3-1**). Clark County Nevada also created a news release and a Twitter post for September 8, 2020, with an air quality advisory for smoke and dust to warn people to limit their time outdoors. They advised local construction workers and residents to stay indoors as much as possible during windy conditions. The news release alerted the public that there are continued high levels of smoke from California wildfires and enhanced levels of blowing dust from the high winds. The health effects of smoke and dust are described to include worsening respiratory diseases and shortness of breath. Detailed suggestions to limit your exposure to the pollutants are described in the news release and briefly mentioned on Twitter. **Figure 3.3-2 and Figure 3.3-3** provide both posts from Clark County DES.

Clark County Department of Environment and Sustainability,

Division of Air Quality

DUST ADVISORY

For Tuesday September 08, 2020

Attention Dust Control Permit Holders, Contractors, and Stationary Sources

The National Weather Service and the weather models used by the Division of Air Quality (Air Quality) predict **sustained winds of over 25 mph**, with **gusts of 40 mph**, beginning Tuesday morning and lasting through late afternoon.

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

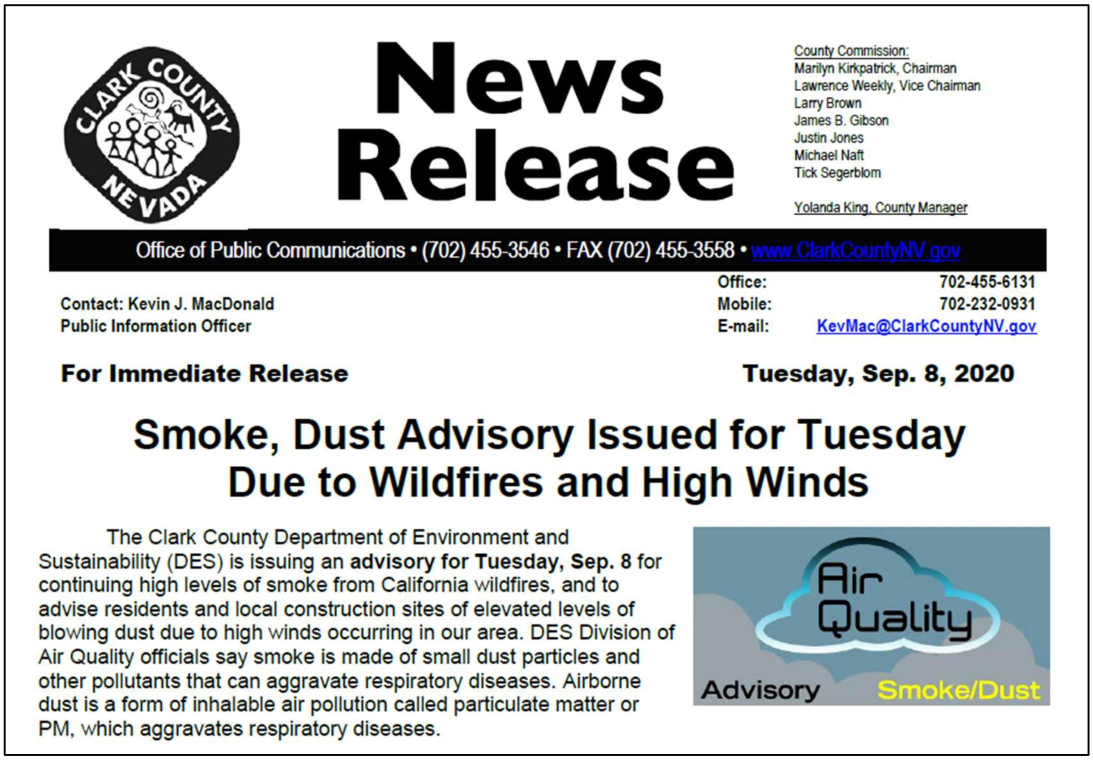
BLASTING: This forecast is for wind gusts of 40 mph or more. Project operators should not load blasting materials or perform any blasting operations. You are required to monitor National Weather Service for wind speeds, if wind gusts above 25 mph are stated, discontinue charging additional blast holes.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

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

It is important this Dust Advisory be sent to all supervisors, foremen, and subcontractors working on your construction projects and at PM_{10} stationary sources.

Please direct questions about this Dust Advisory to a DAQ compliance supervisor at (702) 455-5942.

Figure 3.3-1. Dust Advisory notice sent by Clark County DES to all dust control permit holders, contractors, and stationary sources in Clark County for September 8, 2020.



News Release

County Commission:
Marilyn Kirkpatrick, Chairman
Lawrence Weekly, Vice Chairman
Larry Brown
James B. Gibson
Justin Jones
Michael Naft
Tick Segerblom

Yolanda King, County Manager

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Contact: Kevin J. MacDonald
Public Information Officer

Office: 702-455-6131
Mobile: 702-232-0931
E-mail: KevMac@ClarkCountyNV.gov

For Immediate Release **Tuesday, Sep. 8, 2020**

Smoke, Dust Advisory Issued for Tuesday Due to Wildfires and High Winds

The Clark County Department of Environment and Sustainability (DES) is issuing an **advisory for Tuesday, Sep. 8** for continuing high levels of smoke from California wildfires, and to advise residents and local construction sites of elevated levels of blowing dust due to high winds occurring in our area. DES Division of Air Quality officials say smoke is made of small dust particles and other pollutants that can aggravate respiratory diseases. Airborne dust is a form of inhalable air pollution called particulate matter or PM, which aggravates respiratory diseases.

Figure 3.3-2. News release by Clark County Nevada on September 8, 2020, indicating smoke and dust are present and issuing an air quality advisory.

Figure 3.3-3. Twitter post from Clark County Nevada on September 8, 2020, indicating smoke and dust are present and informing residents of an air quality advisory and mitigative actions.

3.3.2 Media Coverage

Many news sources including 8 News Now, KTNV Las Vegas, Clark County Today, AP News, Las Vegas Review-Journal, and Laughlin Nevada Chamber of Commerce reported on the windy conditions, dust, and smoke present on September 8, 2020. Screenshots of the news articles referenced in this section are included in Appendix A. The NWS office in Las Vegas tweeted about smoky and dusty conditions on September 8, 2020 (see Figure 3.3-4), and Dust Storm Warnings were issued for Lincoln County just north of Clark County (Table 3.3-1). The NWS alerts are also provided in Appendix A.

8 News Now reported that wind gusts over 50 mph were recorded in the Las Vegas valley along with many downed trees and power outages. A high-wind advisory was in effect for the valley, with 50-55 mph gusts possible, and a high-wind warning was in effect for Lake Mead and the Colorado River,

with gusts between 50-60 mph possible. (https://www.8newsnow.com/news/local-news/high-winds-lower-temperatures-move-into-las-vegas-valley/).

KTNV Las Vegas reported that winds in Las Vegas exceed 40 mph. The high winds and dry air heightened fire danger, and a red flag warning was in place for September 8, 2020. Although the thick smoke started to clear as winds brought in less smoky air, the strong winds kicked up dust and smoke particles that resulted in unhealthy air quality levels. (link no longer available, text saved in Appendix A)

Clark County Today reported that more than 31,000 people lost power the night of September 7, 2020 into September 8, 2020 during a windstorm. Dispatch logs from the Clark Regional Emergency Response Agency (CRESA) show over three dozen calls for brush or bark dust fires, downed power lines, and residential fires. A red flag warning remained in effect through September 9, 2020, at 20:00 PDT because of breezy and hot conditions with low humidity (https://www.clarkcountytoday.com/news/air-quality-improves-but-wind-and-fire-threat-remains-for-clark-county/).

Associated Press (AP) News reported that extremely strong winds created weather hazards in Las Vegas and other areas of Nevada on September 8, 2020. Almost 4,500 NV Energy customers lost power before 08:00 PDT. The National Weather Service issued an advisory for wind gusts as high as 55 mph in Las Vegas and possibly stronger near the Colorado River. The high winds may help to push out smoke from the California wildfires, but could also give Nevada its own fire danger. (https://apnews.com/article/las-vegas-weather-colorado-river-archive-nevada-9718047099185e109d04105328552155).

The Las Vegas Review-Journal reports on gusty winds hitting Las Vegas and cooler temperatures due to a cold front. The winds from the north pushed a lot of the smoke from the California wildfires out of the hazy Las Vegas sky and caused a streetlight on Peccole Strada to fall over. (https://www.reviewjournal.com/local/weather/gusty-winds-whip-las-vegas-cooler-temperatures-prevail-2113579/).

The Laughlin Nevada Chamber of Commerce reported on the Clark County Department of Environment and Sustainability's (DES) smoke and dust advisory. This included tips to mitigate exposure during the advisory. (http://business.laughlinchamber.com/news/details/smoke-dust-advisory-issued-for-tuesday-due-to-wildfires-and-high-winds).

Figure 3.3-4. Twitter post from National Weather Service in Las Vegas on September 8, 2020, indicating smoke and dust were present.

Table 3.3-1. National Weather Service in Las Vegas, NV, warnings issued on September 8, 2020.

Warning	Time (PDT)	Location
Urgent Weather Message	06:27	Lake Havasu and Fort Mohave-Lake Mead National Recreation Area-San Bernardino County-Upper Colorado River Valley Including Lake Havasu City, Desert Hills, Topock, Bullhead City, Oatman, Mohave Valley, Needles, Hoover Dam, and Laughlin
Dust Storm Warning	08:37	Southeastern Lincoln County in south-central Nevada
Dust Storm Warning	10:00	Southeastern Lincoln County
Dust Storm Warning	10:24	Southeastern Lincoln County in south-central Nevada
Dust Storm Warning	11:27	Southeastern Lincoln County in south-central Nevada

3.3.3 Pollutant and Diurnal Analysis

As discussed in Section 3.2, the period of high PM_{10} concentrations in the Las Vegas valley on September 8, 2020, coincides with high wind speeds. Wind speeds measured at the weather stations in and around the Las Vegas valley rose as the frontal passage moved southward into Clark County early on September 8. Figure 3.3-5 shows the wind speeds and gusts measured at five weather stations in and around Las Vegas, together with the hourly PM_{10} concentrations at Jerome Mack from September 6-10, 2020. The ASOS meteorological station locations are shown in the lower panel of Figure 3.3-5. Hourly PM_{10} levels at Jerome Mack exceeded 1,000 µg/m^3 in the early morning hours of September 8, coinciding with enhanced wind speeds up to 40 mph and gusts up to 60 mph measured at the weather stations during this five-day period.

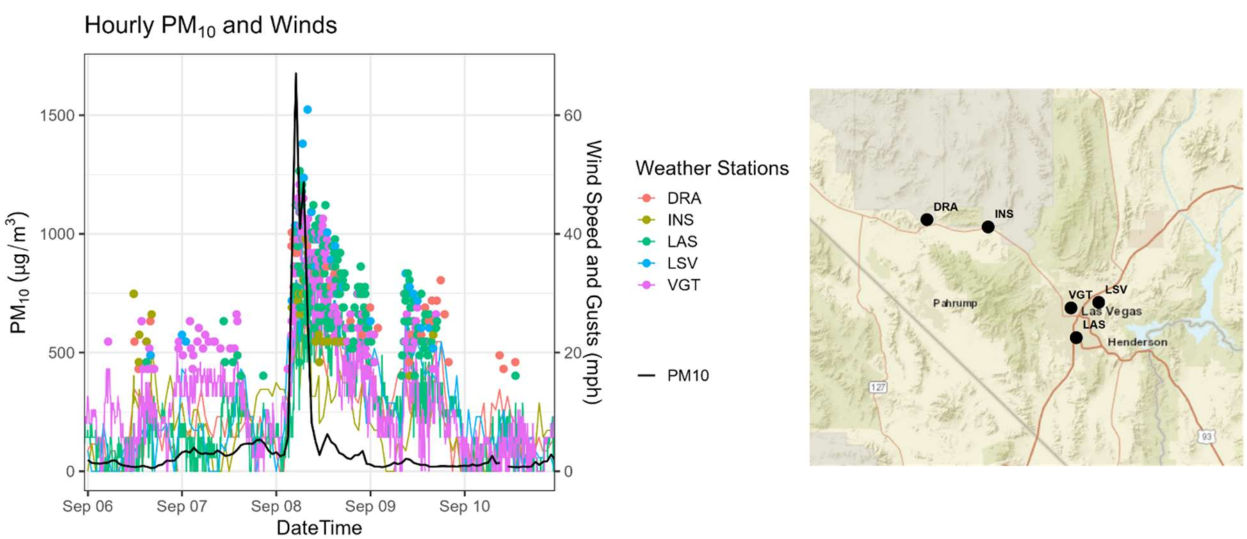

Figure 3.3-5. (Left) Hourly PM_{10} concentrations in µg/m^3 with wind speed (lines) and wind gusts (dots) from DRA, INS, LAS, LSV, and VGT weather stations. (Right) The locations of each ASOS meteorological station are shown relative to Las Vegas.

The 24-hour average PM_{10} values at all sites in Clark County before and after the exceedance event on September 8, 2020, remained mostly below the 99th percentile of the five-year (2016-2020) historical values (Figure 3.3-6). On September 7, 2020, the 24-hour average PM_{10} values at the majority of these sites exceeded the 99th percentile of five-year historical data (2016-2020) of 74 µg/m^3. The PM_{10} concentrations continued to increase on September 8, 2020. On the day of the exceedance event, the 24-hour average PM_{10} values at 8 out of the 9 sites (except Palo Verde) exceeded the NAAQS value of 150 µg/m^3, with Jerome Mack having the highest concentration of 302 µg/m^3.

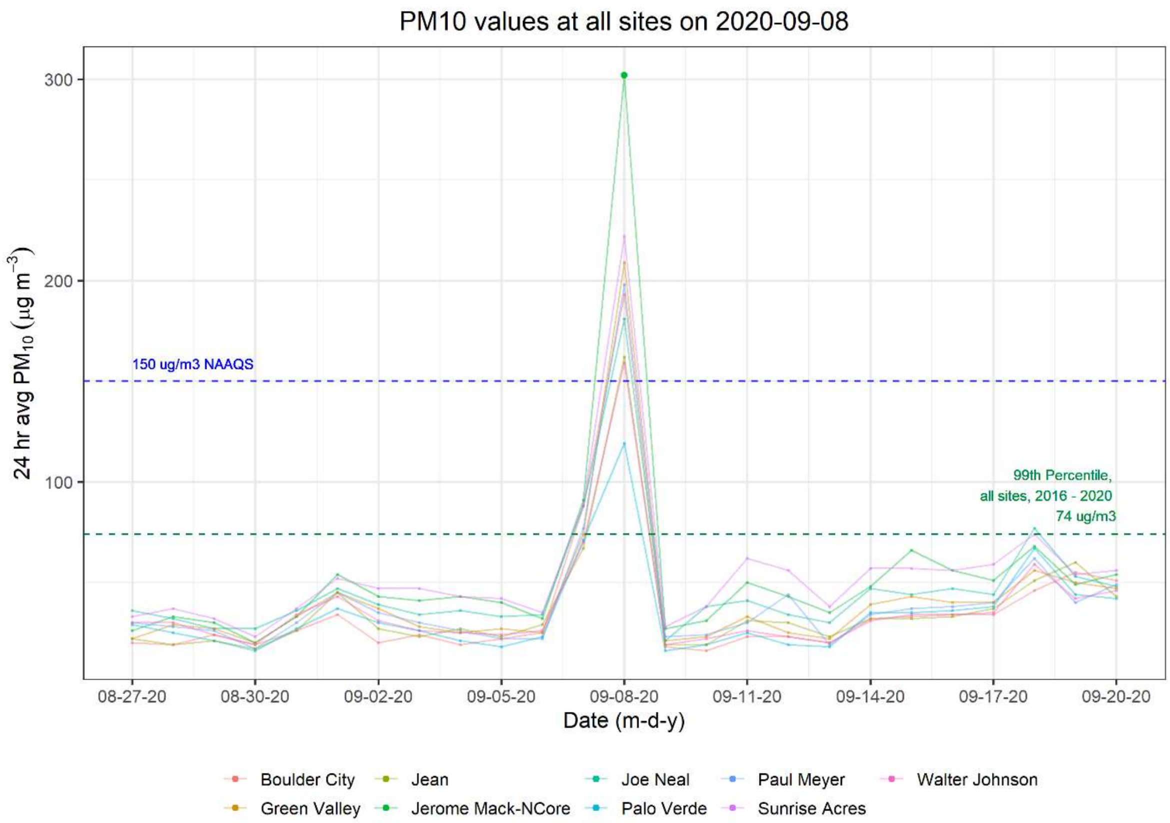

Figure 3.3-6. PM_{10} values at all Clark County, NV, measurement sites from August 27 – September 20, 2020, with NAAQS (blue dash) indicated. The green dashed line indicates the 99th percentile of 74 µg m^{-3} of the five-year historical values at these sites.

Figure 3.3-7 shows the measured hourly PM_{10} concentrations at Jerome Mack on September 8, 2020, together with the diurnal profile of the 5th - 95th percentiles of the historical data from 2016-2020. On September 8, 2020, starting from 03:00 PST, the hourly PM_{10} surpassed the five-year 95th percentile at Jerome Mack. PM_{10} continued increasing after 03:00 PST, reaching the peak value of 1,676 µg/m^3 at 05:00 PST, and remained well above the 95th percentile until 17:00 PST on that day. It is clear from the comparison of the hourly PM_{10} concentrations on September 8, 2020, to their counterparts in the past five years that exceptional factors were contributing to the exceedance event on that day.

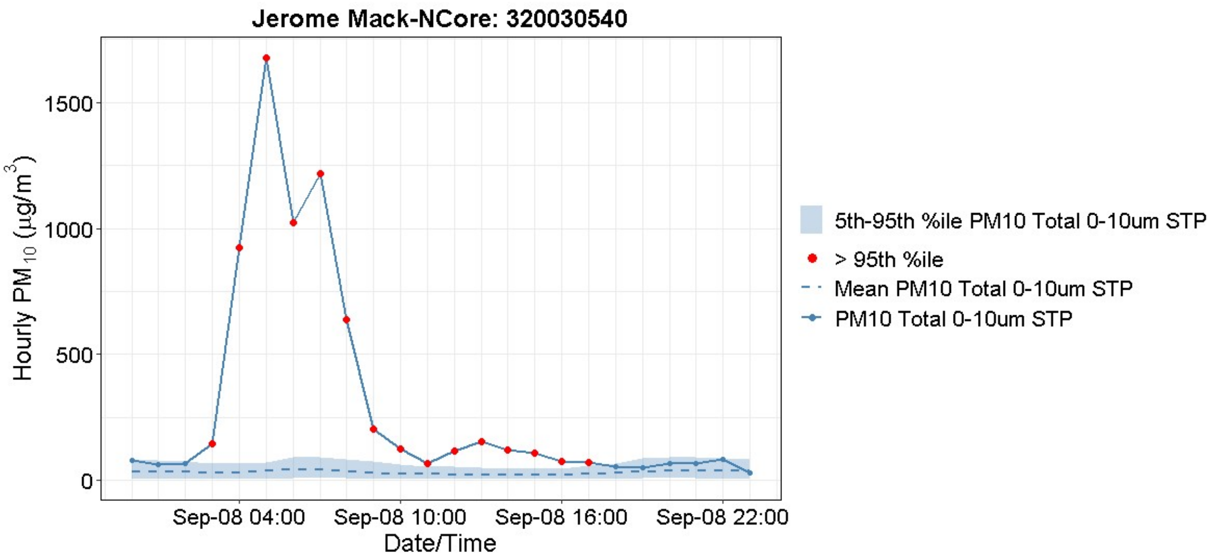

Figure 3.3-7. Measured hourly PM_{10} values at Jerome Mack for each hour of the day. The dotted solid line represents the hourly PM_{10} values measured on September 8, 2020. The upper boundary of the blue area indicates the 95th percentile hourly PM_{10} from 2016-2020 at Jerome Mack while the lower boundary is the 5th percentile. The dashed line represents the mean hourly PM_{10} for each hour of the day from 2016-2020.

3.3.4 Particulate Matter Analysis

Before the suspected high-wind dust event on September 8, 2020, the hourly $PM_{2.5}/PM_{10}$ ratio remained relatively high (i.e., 0.4-0.6) on September 7, 2020, above the hourly 95th percentile based on 2016-2020 ratio data (**Figure 3.3-8**). On September 8, 2020, the hourly $PM_{2.5}/PM_{10}$ ratio at Jerome Mack dropped significantly, from approximately 0.6 to 0.1 between 02:00 and 04:00 PST, and stayed low for the rest of the day. The low value of 0.1, which is below the 5th percentile of the 2016-2020 $PM_{2.5}/PM_{10}$ ratios at Jerome Mack, is consistent with values from dust events reported in studies (Jiang et al., 2018). The dramatic decrease in the $PM_{2.5}/PM_{10}$ ratio observed at 03:00 PST is also consistent with the increase in hourly PM_{10} concentrations as described in **Section 3.2.2**. $PM_{2.5}/PM_{10}$ ratios rise late in the evening on September 8, then continue to rise to normal levels the following day. 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.

No chemical speciation data are available on September 8, 2020, since speciated $PM_{2.5}$ measurements are collected on a three-day cadence in Clark County. Measurements were not taken on the event date, and the observations from surrounding days, September 6 and 9, do not reflect conditions on September 8.

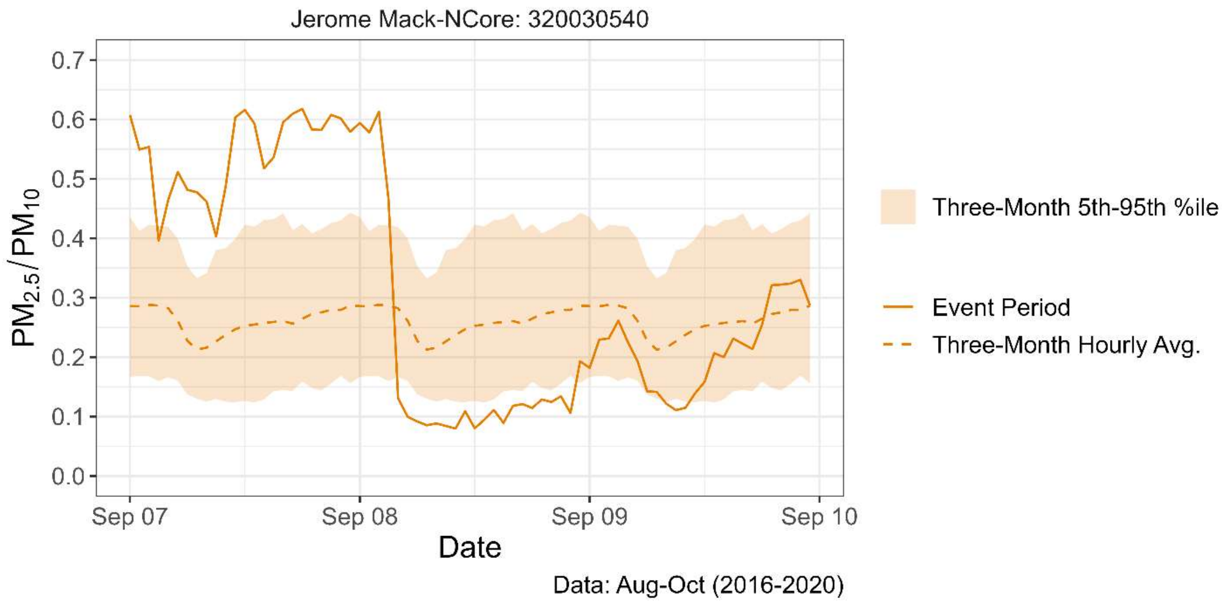

Figure 3.3-8. Ratio of $PM_{2.5}/PM_{10}$ concentrations at the Jerome Mack site before, during, and after the September 8, 2020, PM_{10} exceedance. The five-year average $PM_{2.5}/PM_{10}$ hourly ratio is displayed as a dotted line, and the 5th to 95th percentile range is shown as a shaded ribbon. The 5th to 95th percentile ratio is calculated across August-October from 2016-2020.

3.3.5 Visibility/Ground-Based Images

Concurrent with the increasing wind speeds and the estimated time of frontal passage, visibility at LAS decreased (**Figure 3.3-9**) starting at 03:00 and remained low until 10:00 PST. This is confirmed by camera images in the Las Vegas valley from the M Resort Hotel (**Figure 3.3-10 through Figure 3.3-16**), which showed dusty conditions and low visibility on the morning of September 8, 2020. Images begin at 05:00 PST due to limitations of photography before sunrise. Figures 3.3-16 and 3.3-17 show clearer conditions following the dust event to compare against Figures 3.3-11 through 3.3-15, which were taken during the dust event.

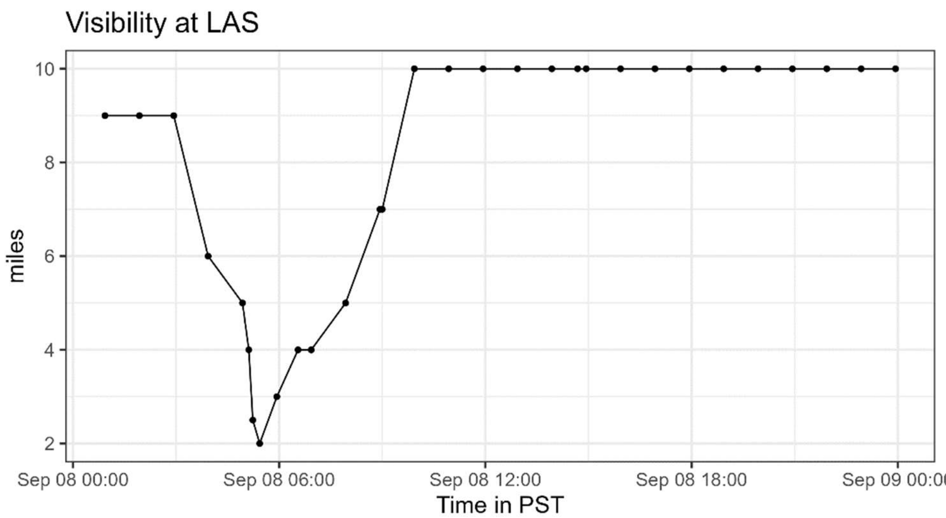

Figure 3.3-9. Visibility in miles on September 8, 2020, recorded as Harry Reid Int'l Airport. Visibility data is sourced from the Iowa Environmental Mesonet (https://mesonet.agron.iastate.edu/).

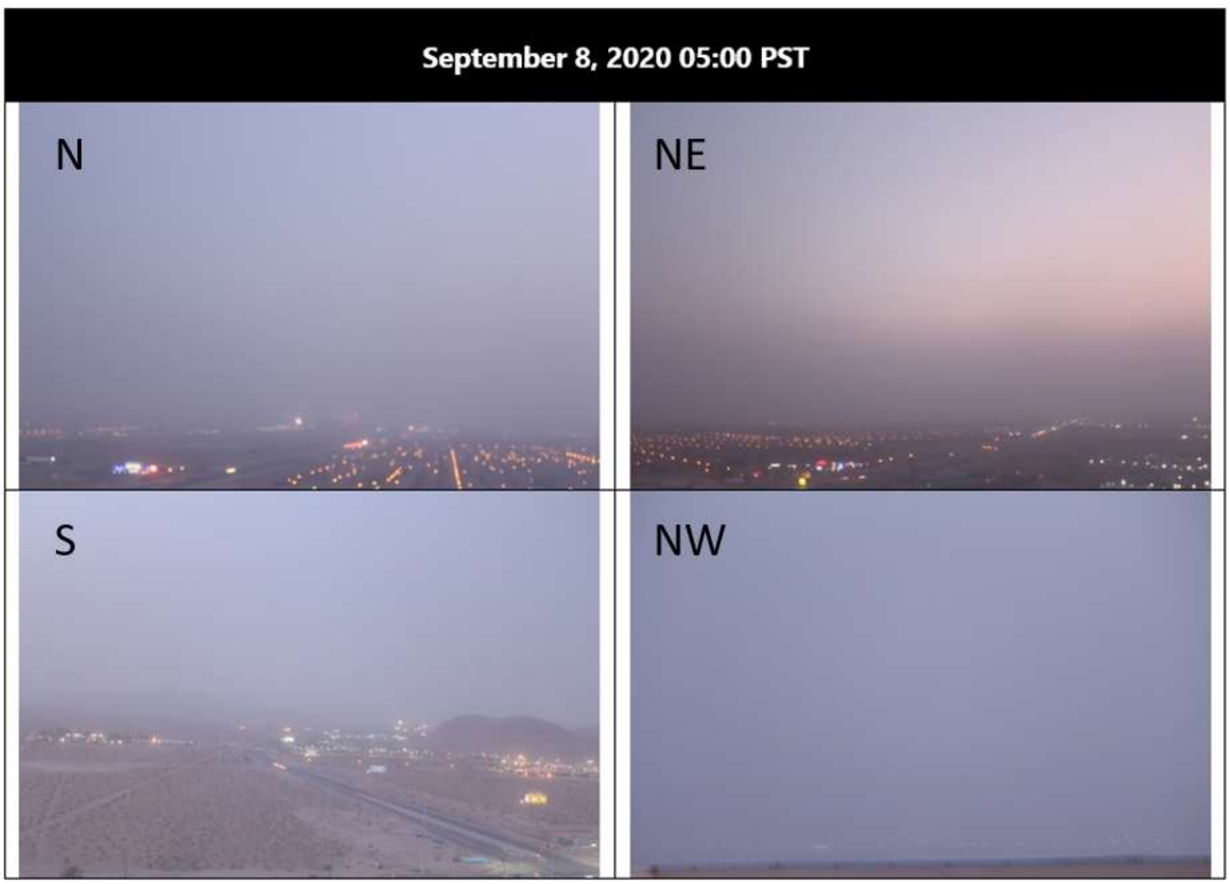

Figure 3.3-10. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on September 8, 2020, at 05:00 PST.

Figure 3.3-11. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on September 8, 2020, at 06:00 PST.

Figure 3.3-12. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on September 8, 2020, at 07:00 PST.

Figure 3.3-13. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on September 8, 2020, at 08:00 PST.

Figure 3.3-14. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on September 8, 2020, at 09:00 PST.

Figure 3.3-15. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on September 8, 2020, at 10:00 PST.

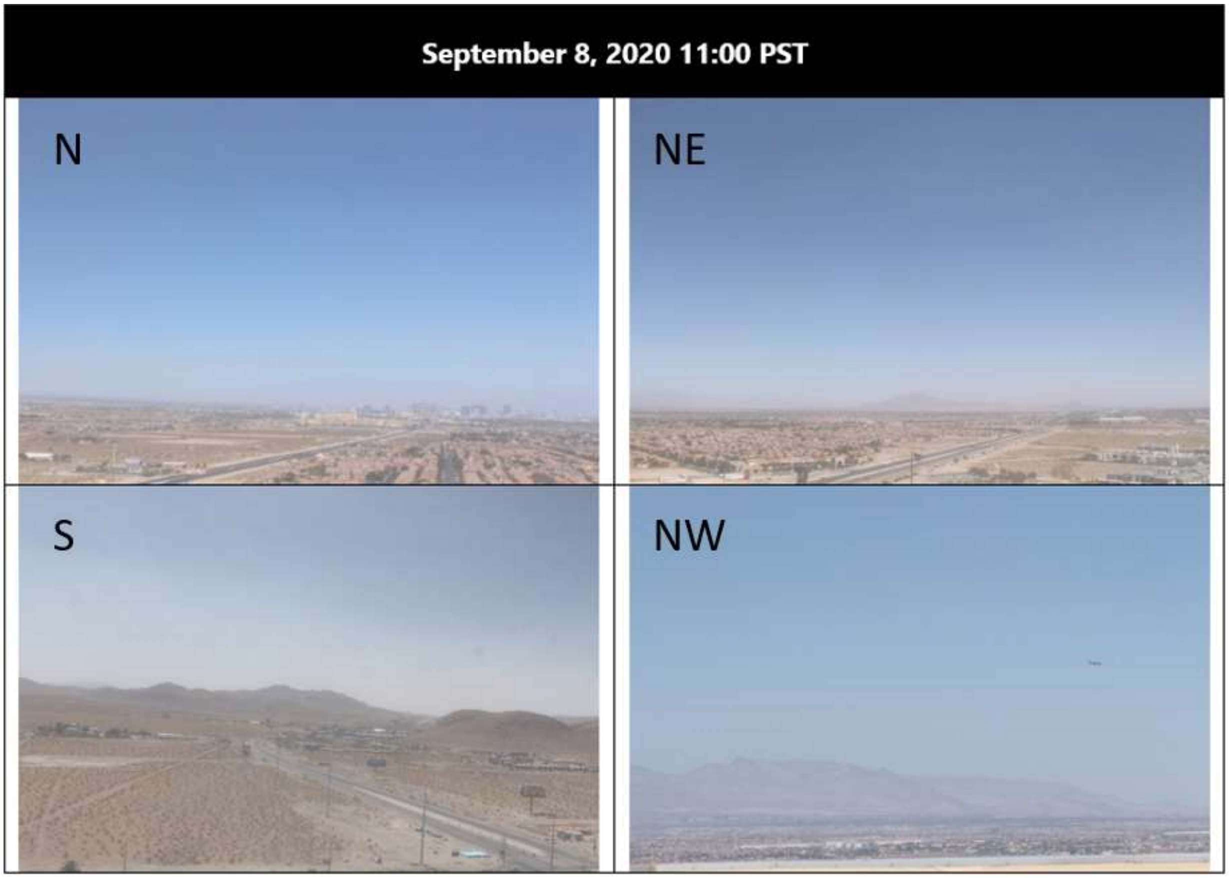

Figure 3.3-16. Camera images for north (top left), south (bottom left), northeast (top right), and northwest (bottom right) coordinal directions from Clark County, Nevada, on September 8, 2020, at 11:00 PST.

Overall, we find overwhelming evidence that after PM_{10} was transported from the Great Basin Desert region late on September 7 and early on September 8, PM_{10} concentrations increased at the same time as wind speeds in Clark County, starting at 03:00 PST on September 8, 2020. This suggests that Clark County was impacted by a high-wind dust event originating in the Great Basin Desert region. The evidence corroborating this assertion includes (1) forecast alerts and media coverage in Clark County and surrounding areas, (2) abrupt increases in wind speed corresponding with abrupt increases in PM_{10} in Clark County, (3) a precipitous drop in $PM_{2.5}/PM_{10}$ values indicating windblown dust sources, and (4) decreased visibility and camera images of Clark County showing dust corresponding with the PM_{10} event time of arrival on September 8, 2020.

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 is provided in Figure 3.4-1, showing the highest annual concentration occurred on September 8. A five-year annual time series is provided in Figure 3.4-2 to indicate the range of normal values. September 8, 2020, is marked on this time series with an orange point for comparison. September 8, 2020, was well above the 99th percentile for the preceding five years (dashed green line) and had the second highest overall PM_{10} concentration from 2016-2022.

Exceedances of the 150 µg/m^3 NAAQS threshold (blue dashed line) occurred six times at the Jerome-Mack site in the five-year period (including September 8, 2020). This occurred once in each year from 2016 through 2018, and three times in 2020. These exceedances were further investigated for potential dust event evidence based on meteorological data, satellite images, and visibility camera images (additional details provided below). All six of the exceedances showed preliminary evidence to be a potential dust event, and were flagged as a suspected dust event day, marked by a blue point in the figure.

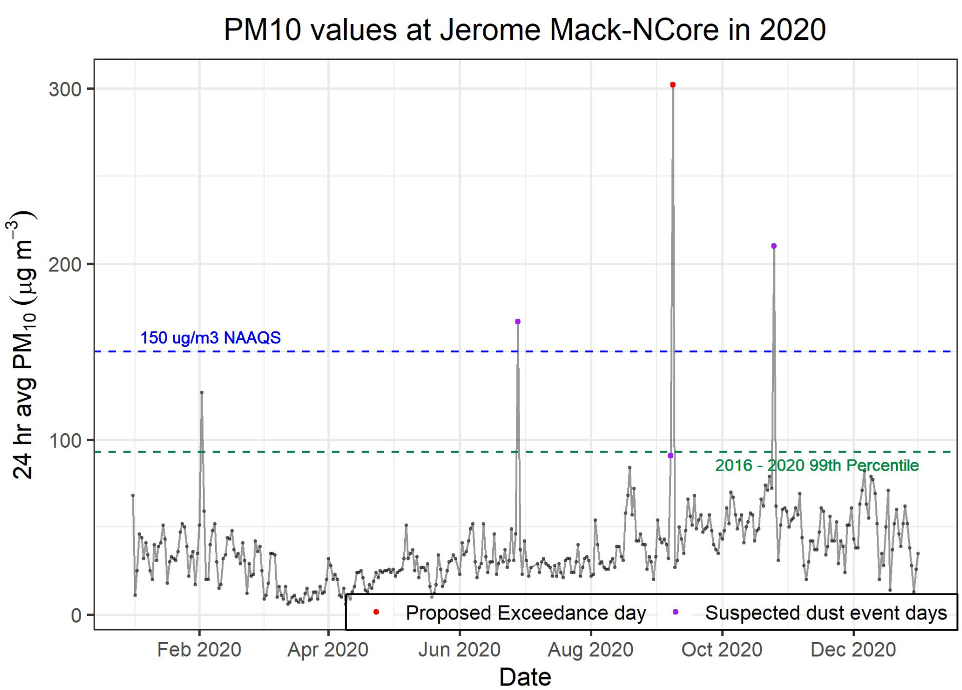

Figure 3.4-1. Jerome Mack 24-hour PM_{10} measurements in µg/m^3 for 2020 with (green dash) 2016-2020 99th percentile, (blue dash) NAAQS, (purple points) suspected dust event days, and (red point) proposed exceedance day indicated.

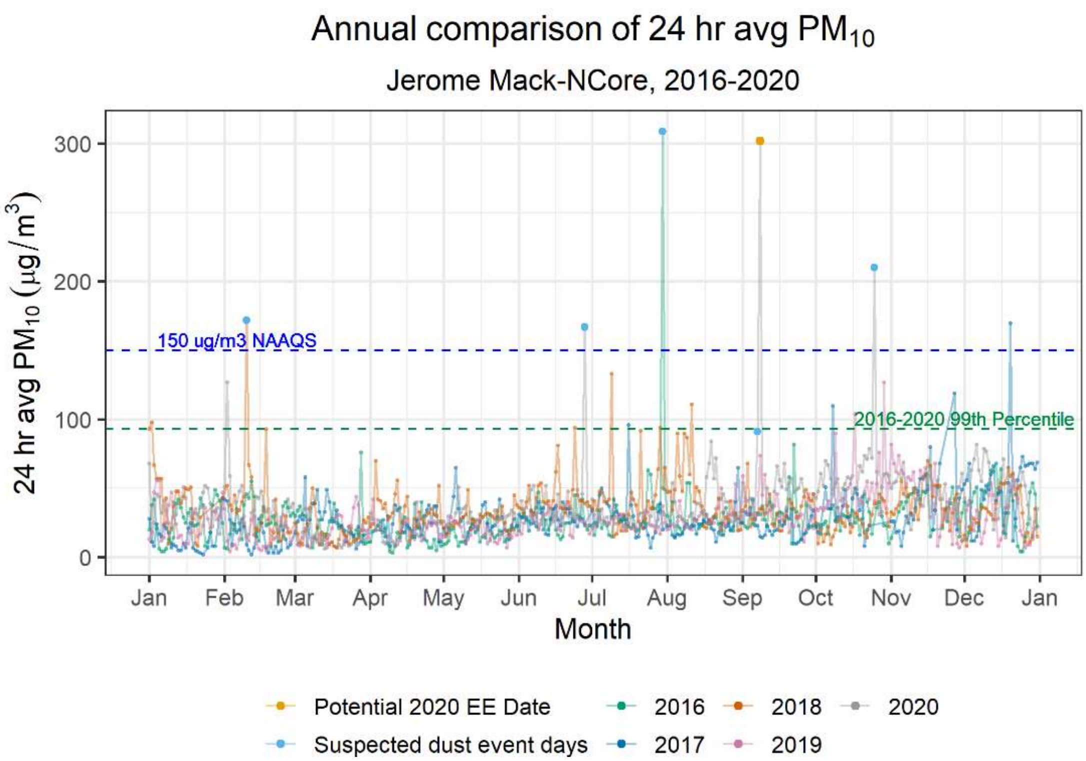

Figure 3.4-2. Jerome Mack 24-hour PM_{10} measurements in µg/m³ from 2016-2020 by year with 99th percentile (green dash) and NAAQS (grey dash) indicated.

The 24-hour average PM_{10} concentrations observed on September 8, 2020, ranked as the 99.94 percentile of all concentrations from the five-year period 2016-2020 at Jerome Mack (**Table 3.4-1**). The only higher value (309 µg/m³) was recorded on July 30, 2016, when evidence from satellite imagery and visibility cameras show a dust layer moved over the Las Vegas valley. The next highest value after September 8, 2020 was recorded on October 25, 2020, at 210 µg/m³, which is also a suspected dust event day. On this day, northwesterly wind gusts from across the Mojave Desert of up to 50 mph were recorded in the source region, 30-40 mph locally. Clark County visibility cameras atop the M Resort Hotel showed periods obscured by dust that correlated with times when the highest PM_{10} concentrations were observed. A third suspected 2020 dust event occurred on June 28, when a 24-hour average PM_{10} concentration of 167 µg/m³ was recorded. During this event, westerly wind speeds were above 40 mph locally and visibility cameras captured periods obscured by dust that correlated with the times when the highest PM_{10} concentrations occurred. Supporting information for the suspected dust event days is available in **Appendix B**.

Table 3.4-1. Five-year percentile of PM_{10} values at Jerome Mack measurement station.

Rank	Date	Arithmetic mean ($\mu g/m^3$)	Data Percentile	Notes
1	2016-07-30	309	100	Suspected dust event, a mesoscale convective complex
2	2020-09-08	302	99.94	Designated 'IJ – High Winds' in AQS Record
3	2020-10-25	210	99.89	Suspected dust event, high winds, cameras show dust
4	2018-02-10	172	99.83	Suspected dust event, cameras show dust
5	2017-12-20	170	99.77	Suspected dust event, high winds
6	2020-06-28	167	99.72	Suspected dust event, high winds, cameras show dust
7	2018-07-09	133	99.66	Suspected dust event, high winds due to thunderstorms
8	2020-02-02	127	99.55	High winds from the south/southwest
9	2019-10-29	127	99.55	High winds from the north
10	2017-11-27	119	99.49	Suspected dust event, high winds from the north-northwest

3.4.2 Event Comparison with Diurnal/Seasonal Patterns

Figure 3.4-3 shows hourly PM_{10} concentrations compared to the five-year (2016-2020) hourly average and 5th - 95th percentile. Beginning on September 7, 2020, at 01:00 PST, hourly PM_{10} concentrations began having periods enhanced above the hourly 95th percentile, with hourly concentrations ranging from 65 to 133 $\mu g/m^3$. This resulted in up to a 2.4-times increase in PM_{10} concentrations from the 95th percentile (observed 116 $\mu g/m^3$ at 16:00 PST compared to five-year hourly 95th percentile of 48 $\mu g/m^3$) and was likely due to regional wildfire smoke, which is visible in the true color satellite imagery from NOAA-20 VIIRS (Figure 3.1-18). On September 8, 2020, hourly concentrations quickly increased over a two-hour period to reach a 24-times increase compared to the hourly 95th percentile, an order of magnitude increase from the effects observed on the previous day. The event began at 03:00 PST, reached a maximum of 1,676 $\mu g/m^3$ at 05:00 PST, and returned to being within the 5th - 95th percentile range at 18:00 PST.

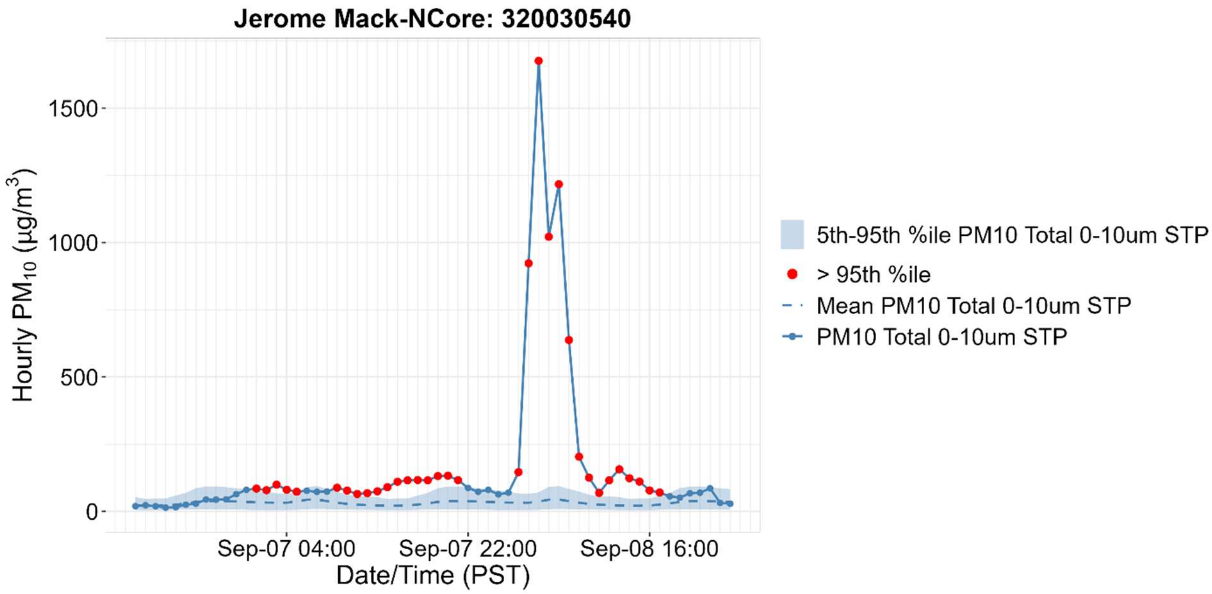

Figure 3.4-3. Hourly PM_{10} concentrations compared to the seasonal average (dashed line) and 5th - 95th percentile (shaded area) for 1-hour PM_{10} concentrations at Jerome Mack from 2016-2020.

The 24-hour average PM_{10} concentrations were compared to five-year (2016-2020), monthly, and seasonal averages in boxplots shown in **Figure 3.4-4 and Figure 3.4-5.** The lower and upper edges of the boxes correspond to the interquartile range (the 25th and 75th percentiles respectively), and the middle bar is the median value. The whiskers extend to the smallest and largest value within 1.5 times the interquartile range. Points beyond this range are considered outliers. The concentrations recorded on September 8 are shown to be the highest recorded outlier for both September and autumn during the entire five-year period.

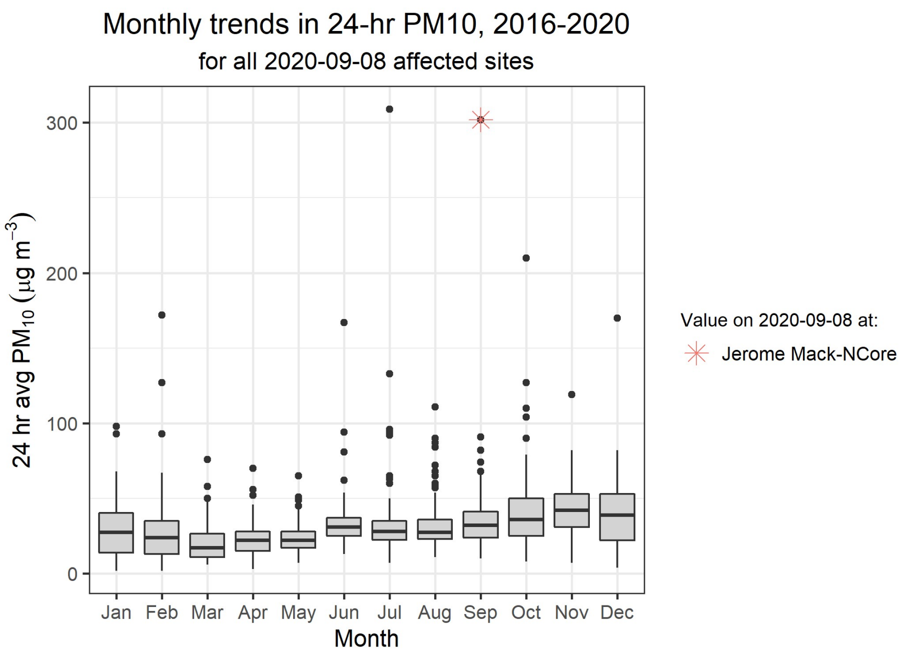

Figure 3.4-4. Monthly trend in 24-hour PM_{10} concentrations at Jerome Mack for 2016-2020, including outliers and highlighting the potential exceedance event day.

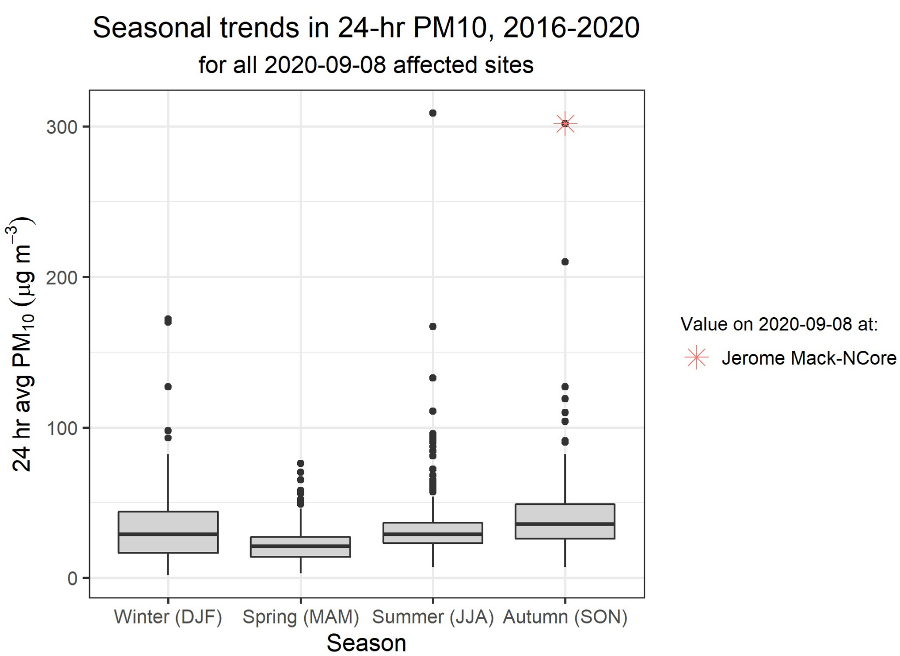

Figure 3.4-5. Seasonal trend in 24-hour PM_{10} concentrations at Jerome Mack for 2016-2020, including outliers and highlighting the potential exceedance event day.

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, and 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 3.4-6** shows the climatology compared with the event date for the source region. On the event date, the source region is experiencing ground level temperatures at or greater than 15° F above the long-term average, considerably lower-than-normal soil moisture, and max ground level wind speeds were well above average. **Figure 3.4-7** shows the climatology compared with the event date for Clark County. On the event date Clark County is experiencing ground level temperatures greater than 20 °F above the long-term average, lower-than-normal soil moisture, and max ground level wind speeds exceeding 5 m/s (11 mph) above the typical climatological average. This climatological evidence provides proof that the conditions on the event date were abnormally hot, dry, and windy in both the source region and Clark County, leading to a windblown dust event.

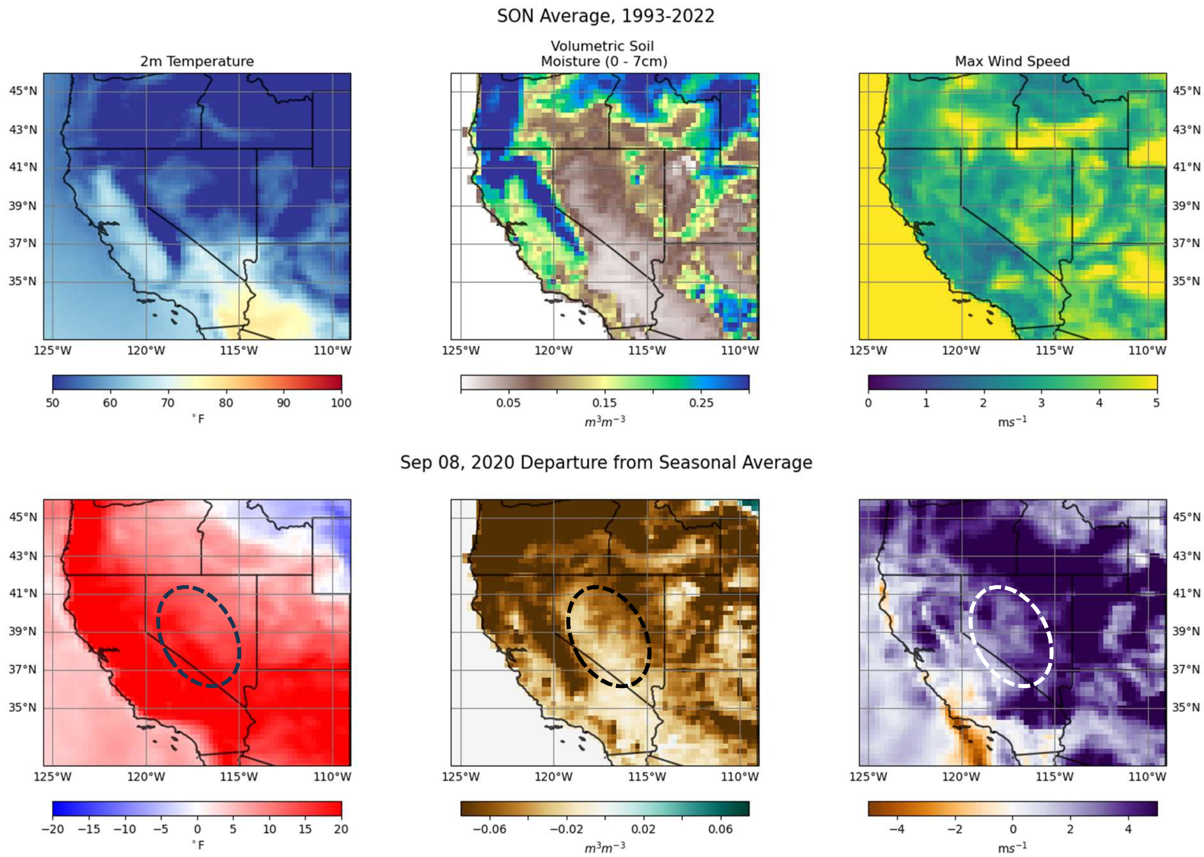

Figure 3.4-6. The 30-year September-November seasonal climatological average based on ERA5 reanalysis for 2-meter temperature, volumetric soil moisture of the first 7 centimeters, and maximum 10-meter wind speed (top row), as well as the daily departure for September 8, 2020 from the 30-year average (bottom row). The source region is circled.

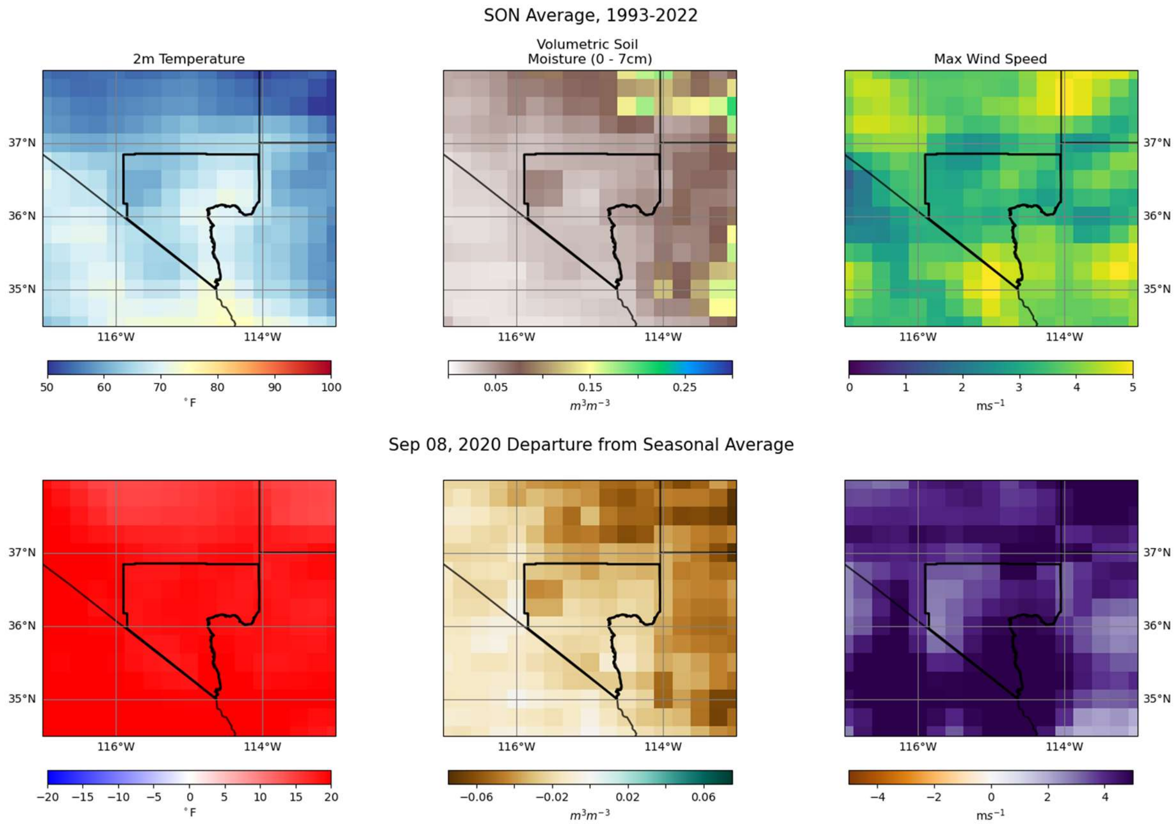

Figure 3.4-7. The 30-year September-November seasonal climatological average for Clark County based on ERA5 reanalysis for 2-meter temperature, volumetric soil moisture of the first 7 centimeters, and maximum 10-meter wind speed (top row), as well as the daily departure for September 8, 2020 from the 30-year average (bottom row). Clark County is outlined in black.

Overall, we find overwhelming evidence that the September 8, 2020, high-wind dust event in Clark County was well outside normal conditions. This suggests that Clark County was impacted by a high-wind dust exceptional event. The evidence corroborating this assertion includes (1) the event rank was above the 99.9th percentile, (2) the abrupt increase in PM_{10} was well outside the typical diurnal profile, (3) the PM_{10} 24-hour average event concentration was well outside the typical monthly or seasonal norms, and (4) 30-year climatology shows high temperatures, low soil moisture, and high winds on the event date in the source region and Clark County.

3.5 Meteorological Similar Analysis

Enhanced surface-level wind speeds and frequent wind gusts on September 8, 2020, created prime conditions to maintain the suspension of dust particles in the air in the midst of regional drought. The sustained wind speed was above 20 mph for most of the high-PM_{10} time period, and many wind gusts greater than 40 mph were recorded. The maximum gust for the day reached 54 mph. The strongest winds, between 03:00 and 09:00 PST, came from the northwest-to-northeast direction, between 345 and 75 compass degrees. The timing of the highest wind speeds and wind gusts aligns with the timing of enhanced PM_{10} concentrations. Visibility at LAS dropped to 2 miles in the early morning on September 8, 2020, during peak wind gusts.

The following sections compare surface-level wind and visibility on September 8, 2020, to dates that show (1) comparable wind profiles that did not show PM_{10} concentrations above the NAAQS and (2) a PM_{10} concentration above the NAAQS but a lack of notable wind speeds. All PM_{10} concentrations in the subsequent two sections reference observations recorded at Jerome Mack, and all wind speed, wind direction, and visibility values were measured at LAS and downloaded from the Iowa Environmental Mesonet (IEM) data portal. (http://mesonet.agron.iastate.edu/)

3.5.1 Wind-Event Days without High Concentration

The comparison of the event date to specific non-event high-wind days without enhanced PM concentrations shows key differences between each comparable wind event and the event date, September 8, 2020. All dates in 2016-2020 were considered when identifying days with a wind event comparable to September 8, 2020. Two criteria descriptive of the magnitude of the wind event on September 8, 2020, were applied to identify comparable dates: (1) daily average surface-level wind speed greater than 15 mph, and (2) wind gusts greater than 50 mph. Additionally, dates were filtered to those without enhanced PM_{10} (less than 100 ug/m^3) in Clark County. Days associated with other suspected PM_{10} exceptional events were excluded. Two dates identified as comparable wind events without high PM_{10} concentrations are listed in Table 3.5-1.

Table 3.5-1. Similar meteorological event days without enhanced PM_{10} concentrations identified by days with average daily wind speed >15 mph and wind gusts >50 mph. PM_{10} concentrations are reported at Jerome Mack (JM), Parul Meyer (PM), Walter Johnson (WJ), Joe Neal (JN), Green Valley (GV) and Sunrise Acres (SA).

			Daily PM_{10} (µg/m^3)					
Date	Daily Wind Speed (mph)	Peak Wind Gust (mph)	JM	PM	WJ	JN	GV	SA
2020-09/08 (Event date)	17	54	302	198	159	181	209	222
2019-10-10	17	53	36	36	31	30	29	38
2022-03-20	16	62	41	38	37	47	29	50

On each of the comparable events listed above, visibility remained high at mostly 9 miles or higher. In contrast, the event date saw a marked drop in visibility to 2 miles. Another key condition that distinguishes the event date from identified comparable dates is low-altitude transport of air into the region that facilitated entrainment of dust from the source region along the course of travel. Air transport into Clark County on all comparable dates occurred at high altitudes, hindering surface-level transport from bare-ground sources of dust surrounding Las Vegas.

A specific comparison between the event date and the first comparable date, October 10, 2019, is outlined below. Comparisons between the event date and the other comparable date can be found in Appendix B.

Figure 3.5-1 through Figure 3.5-3 below compare surface-level wind and visibility conditions on the event date and October 10, 2019. The wind profile on October 10, 2019, matches the intensity of winds experienced on the event date well, with wind gusts greater than 50 mph and a prolonged period where sustained winds were near 20 mph (Figure 3.5-1). Figure 3.5-2 shows that the strongest hourly surface-level winds with speeds between 20-40 mph came from a northeasterly direction on October 10, 2019, similar to on the event date. On October 10, 2019, visibility remained at the maximum value of 10 miles throughout the day, even during peak winds. The maintenance of high visibility on October 10, 2019, confirms that the wind event did not dramatically affect levels of suspended dust particles. Daily PM_{10} concentration was relatively low, less than 40 µg/m^3 across sites in Clark County. **Figure 3.5-4** compares 24-hour HYSPLIT back-trajectories from Las Vegas ending at 04:00 PST on September 8, 2020, the start of the event, and 03:00 PST on October 19, 2019, the time of maximum PM_{10} concentration. On the event date, transport paths below 200 m indicate near-surface transport towards Las Vegas, which facilitated entrainment and transport of dust from the source region. On October 10, 2019, the transport paths towards Las Vegas occurred at high altitudes mostly greater than 500 m, inhibiting surface-level transport from dust sources surrounding Las Vegas.

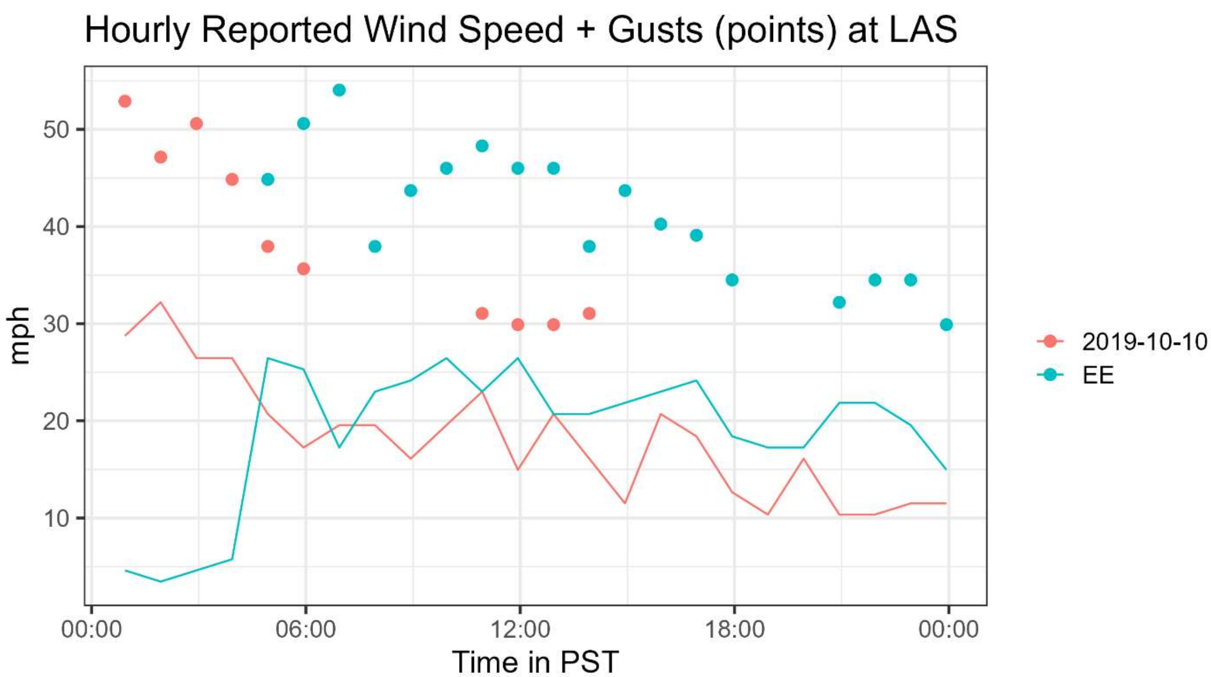

Figure 3.5-1. Wind speed and maximum hourly wind gust in mph at LAS for October 10, 2019, (pink) and the September 8, 2020, suspected exceptional event (EE) day (teal).

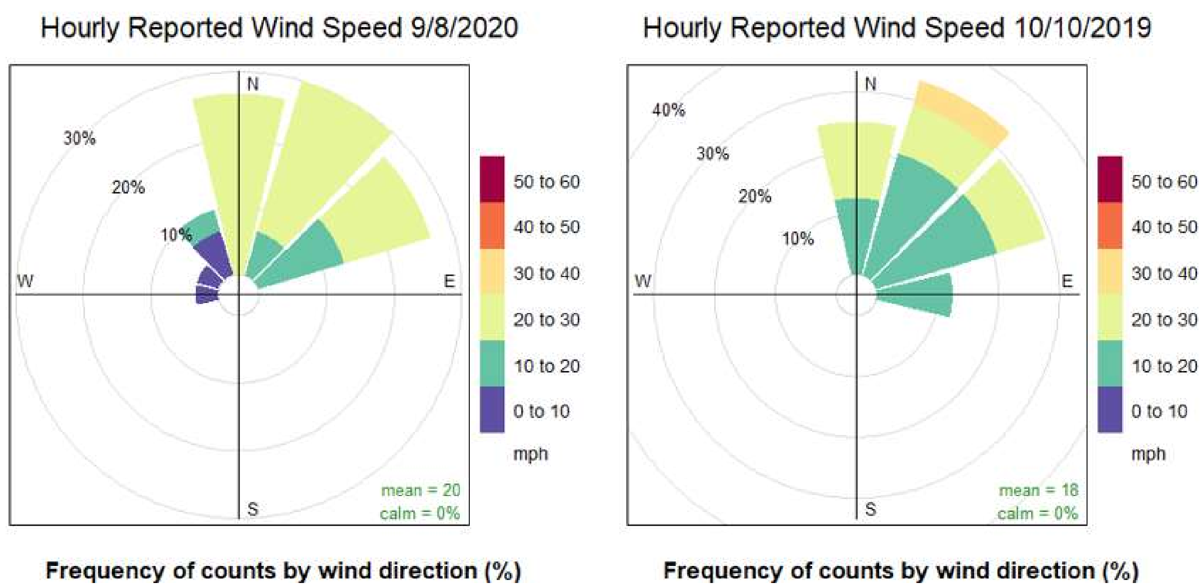

Figure 3.5-2. Wind speed and direction frequency for (left) September 8, 2020, and (right) October 10, 2019.

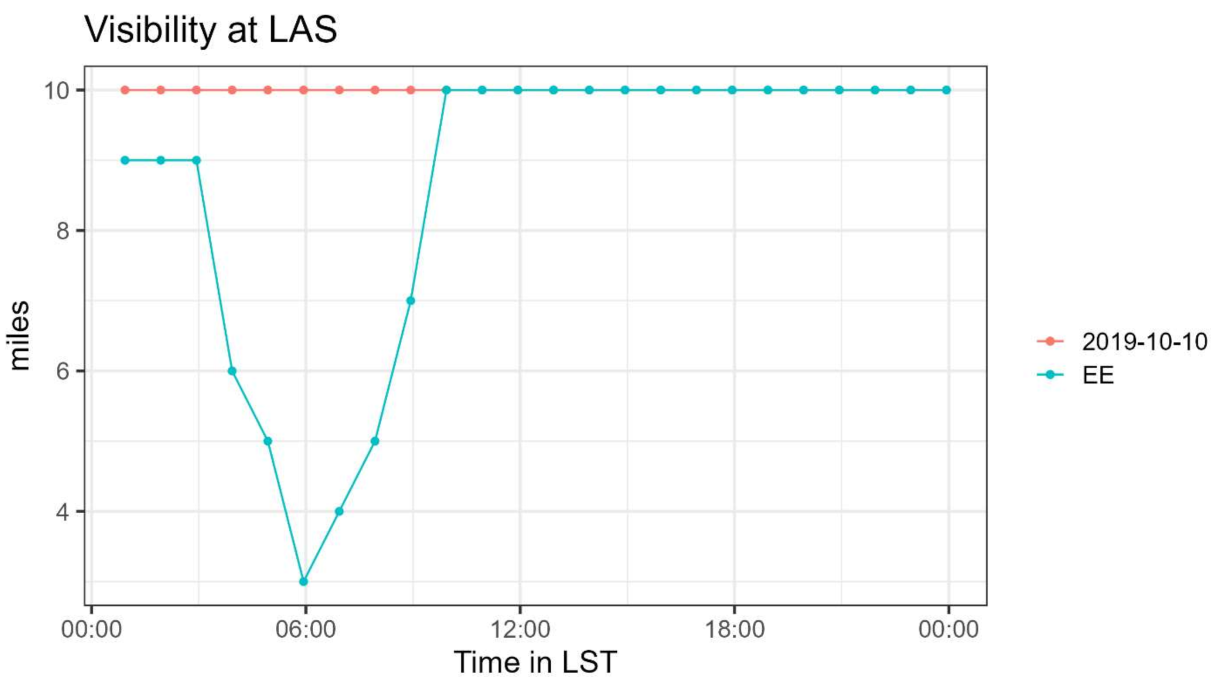

Figure 3.5-3. Hourly visibility in miles at LAS for October 10, 2019 (pink) and the September 8, 2020, suspected exceptional event (EE) day (teal).

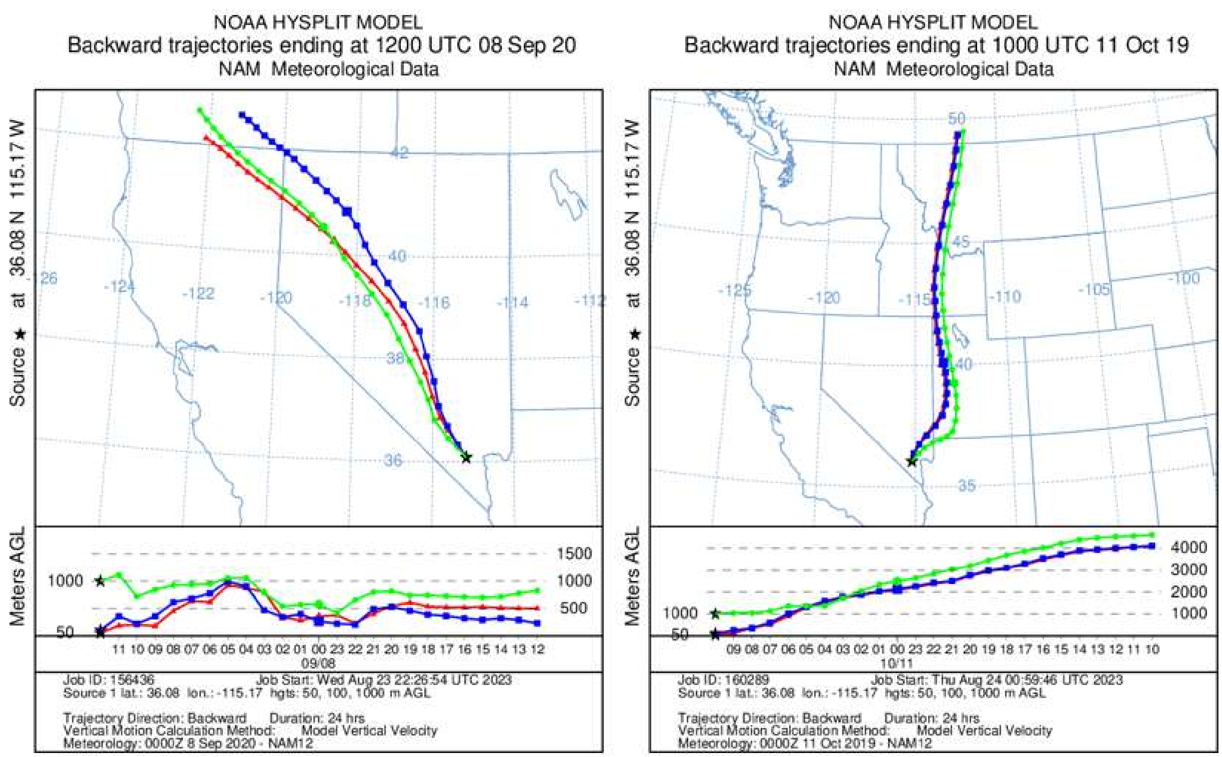

Figure 3.5-4. 24-hour HYSPLIT back-trajectories initiated from Las Vegas at (left) 12:00 UTC on September 8, 2020, (event date) and (right) 10:00 UTC on October 11, 2019, at 50 m (red), 100 m (blue), and 1,000 m (green).

3.5.2 High Concentration Days in the Same Season

Dates in the same season as the suspected exceptional event were screened by daily PM_{10} concentration to compare surface meteorological conditions against conditions on the event date. All dates in the summer and fall seasons, between June and December of 2020, were screened. A single date, June 28, 2020, had a daily PM_{10} concentration greater than 150 µg/m^3 (**Table 3.5-2**).

Table 3.5-2. High concentration days in the same season as September 8, 2020, identified by days in summer or fall 2020 with daily PM_{10} concentrations >150 µg/m^3.

Date	Daily PM_{10} (µg/m^3)
2020-09-08 (Event date)	302
2020-06-28	167

The surface-level wind profile on June 28, 2020, is similar to that on the event date (**Figure 3.5-5**), though peak wind gusts have lower speeds than on September 8, 2020. Winds with the highest speeds blew from the southwesterly direction (**Figure 3.5-6**), which is dominated by rangeland and bare ground (Figure 2.2-1). The prominence of suspended dust on June 28, 2020, is supported by the two drastic drops in visibility between 10:00-11:00 and 13:00-15:00 (**Figure 3.5-7**). Between these downward spikes, visibility recovered to its maximum of 10 miles. In contrast, September 8, 2020, had a single, prolonged decrease in visibility from 05:00-10:00.

Despite the similarities between surface-level wind and visibility profiles, the daily PM_{10} concentration on June 28, though it exceeded the NAAQS, reached only about half the concentration observed on the event date. This disparity can be explained by the increased severity of drought conditions between June and September. Figure 2.2-5 shows that in June 2020 southern Nevada and the surrounding region was “very moist” to “mid-range” on the PDSI. By September 2020, this same region showed moderate-to-severe drought, making soil particles more prone to suspension when disturbed by high winds.

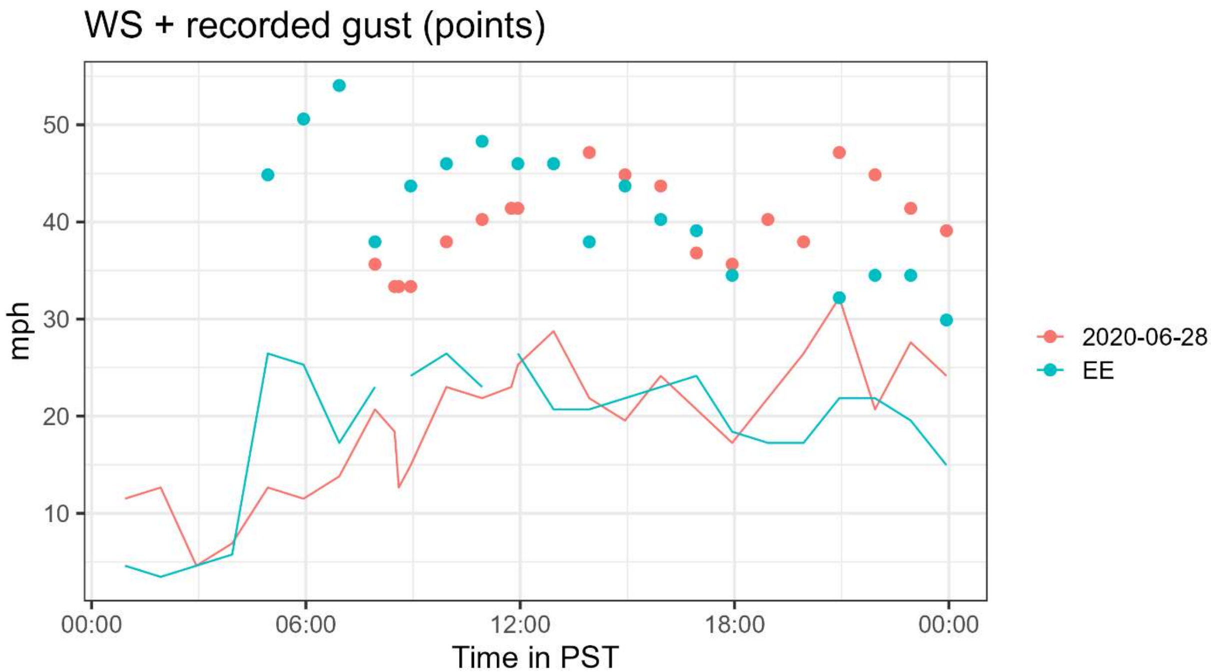

Figure 3.5-5. Wind speed and hourly maximum wind gust in mph at LAS for June 28, 2020 (pink), and the September 8, 2020, suspected exceptional event (EE) day (teal).

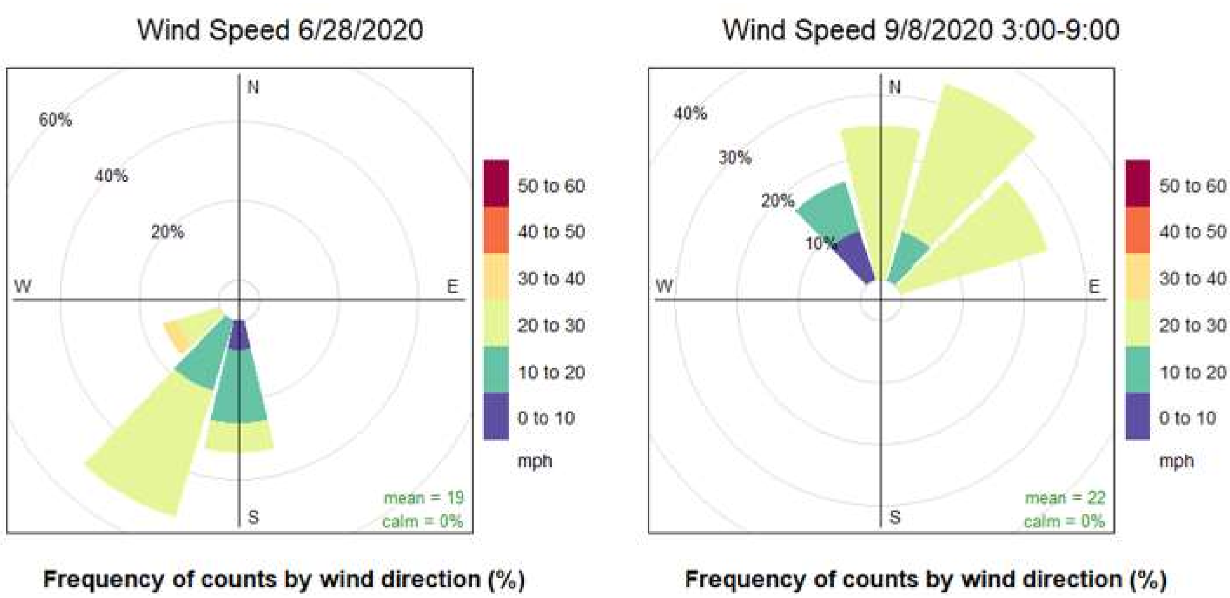

Figure 3.5-6. Wind speed and direction frequency for (left) June 28, 2020, and (right) September 8, 2020, suspected exceptional event (EE) day.

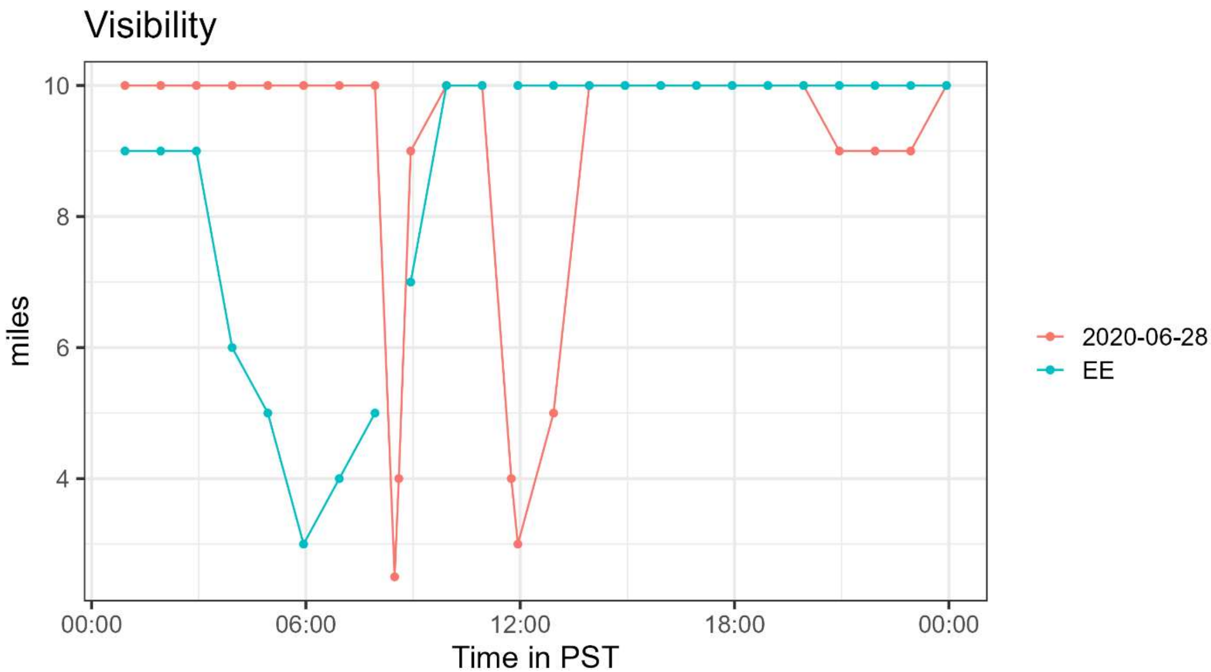

Figure 3.5-7. Visibility in miles at LAS for June 28, 2020 (pink), and the September 8, 2020, suspected exceptional event (EE) day (teal).

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 Jerome Mack site of PM_{10} that could have contributed to the September 8, 2020, exceedance. As shown in Section 3.2, however, the main source of PM_{10} is the large bare ground/land area to the north of Clark County (identified in the rest of the document as the Great Basin 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, 2020, 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 C**.

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 exceed the significance thresholds. Sections 12.2-12.5 requires all major stationary sources to obtain

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

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 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]

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

[3] https://www.epa.gov/system/files/documents/2021-12/chapter-1200-3-7.pdf

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

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[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

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 C), 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.

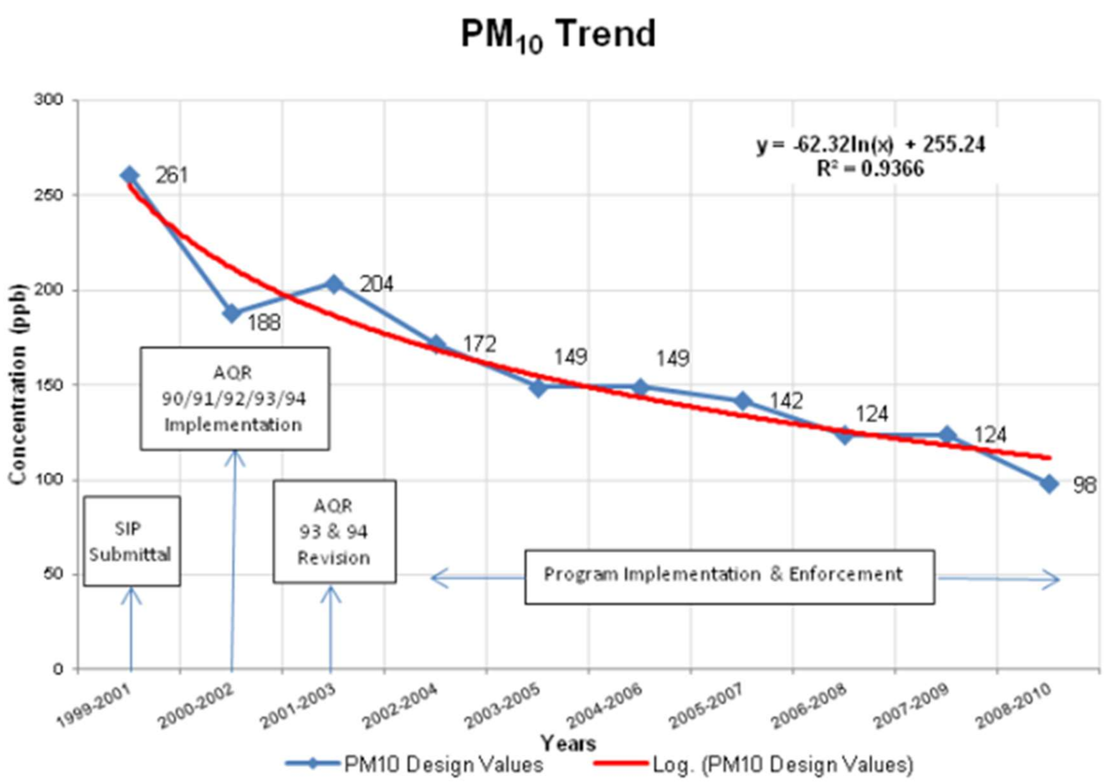

Figure 4.3-1. PM_{10} trends from the 2012 Maintenance Plan.

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.

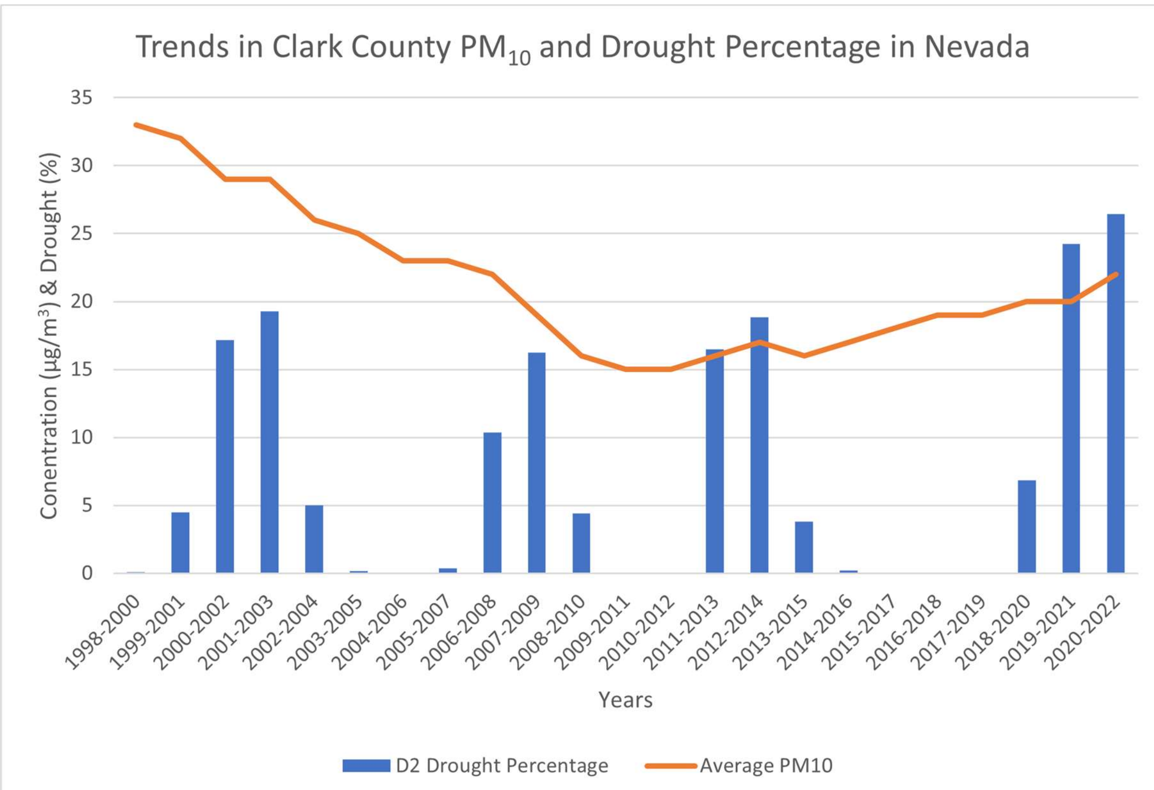

Figure 4.3-2. Three-year running average of PM_{10} concentrations (µg/m^3) at the long-running Paul Meyer monitoring site (AQS: 32-003-0043) (orange line) and the D2 (severe) drought percentage of Nevada (blue bars). Source: **https://www.drought.gov/states/nevada**.

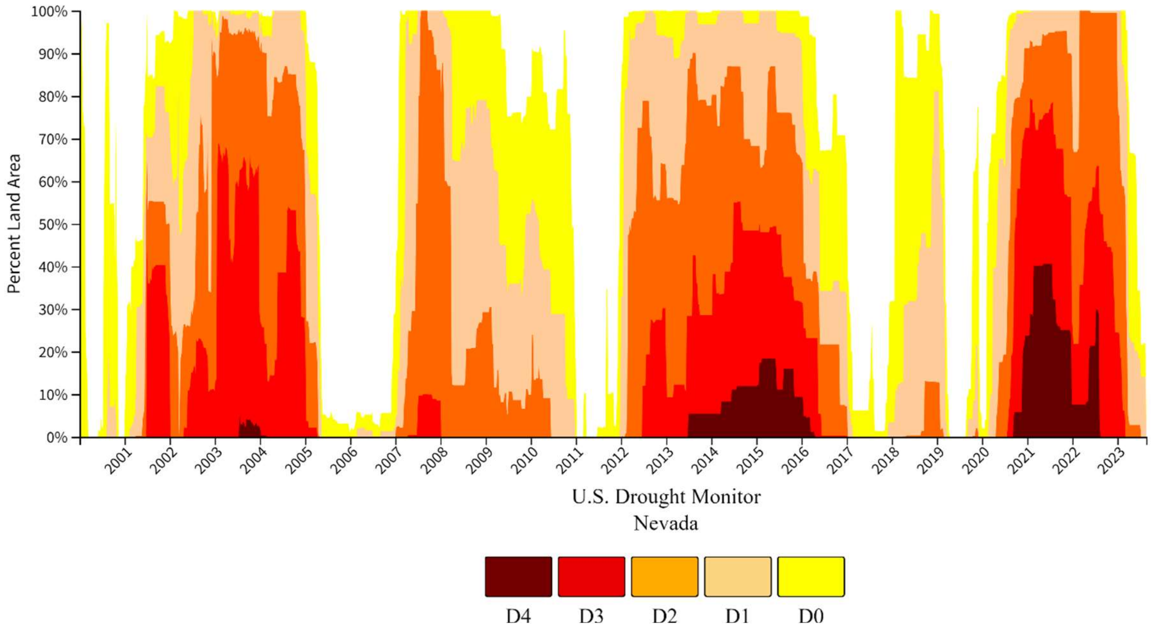

Figure 4.3-3. Drought statistics for Nevada from 2000-2023, colored by drought severity for D0 to D4. Source: https://www.drought.gov/states/nevada.

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.

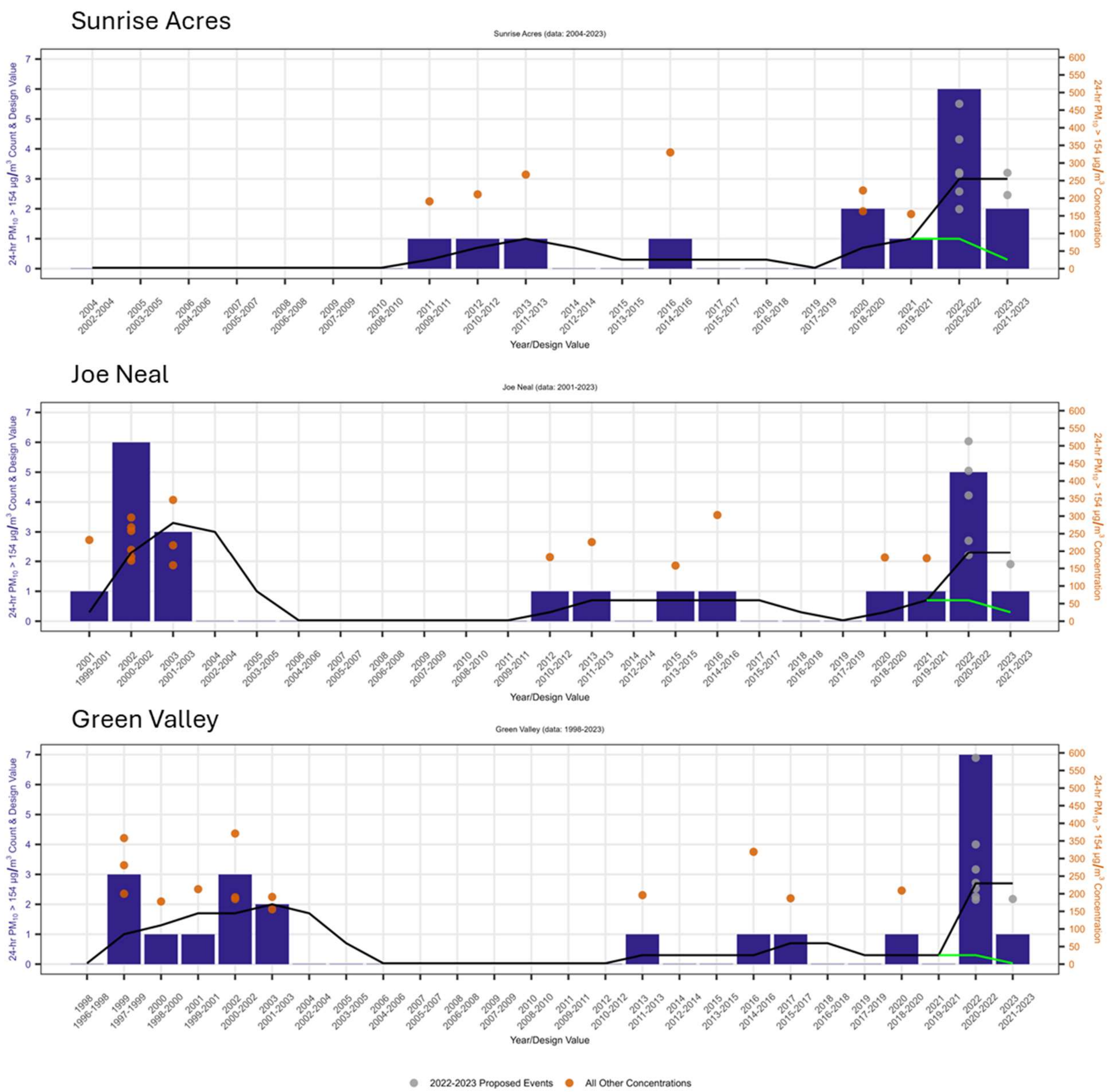

Figure 4.3-4. Historical 24-hour PM_{10} exceedance count (purple bars) and concentration (orange dots) per year/design value period at the Sunrise Acres, Joe Neal, and Green Valley monitoring sites (AQS: 32-003-0561; 32-003-0075; 32-003-0298). The gray dots represent the proposed 2022-2023 PM_{10} exceptional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

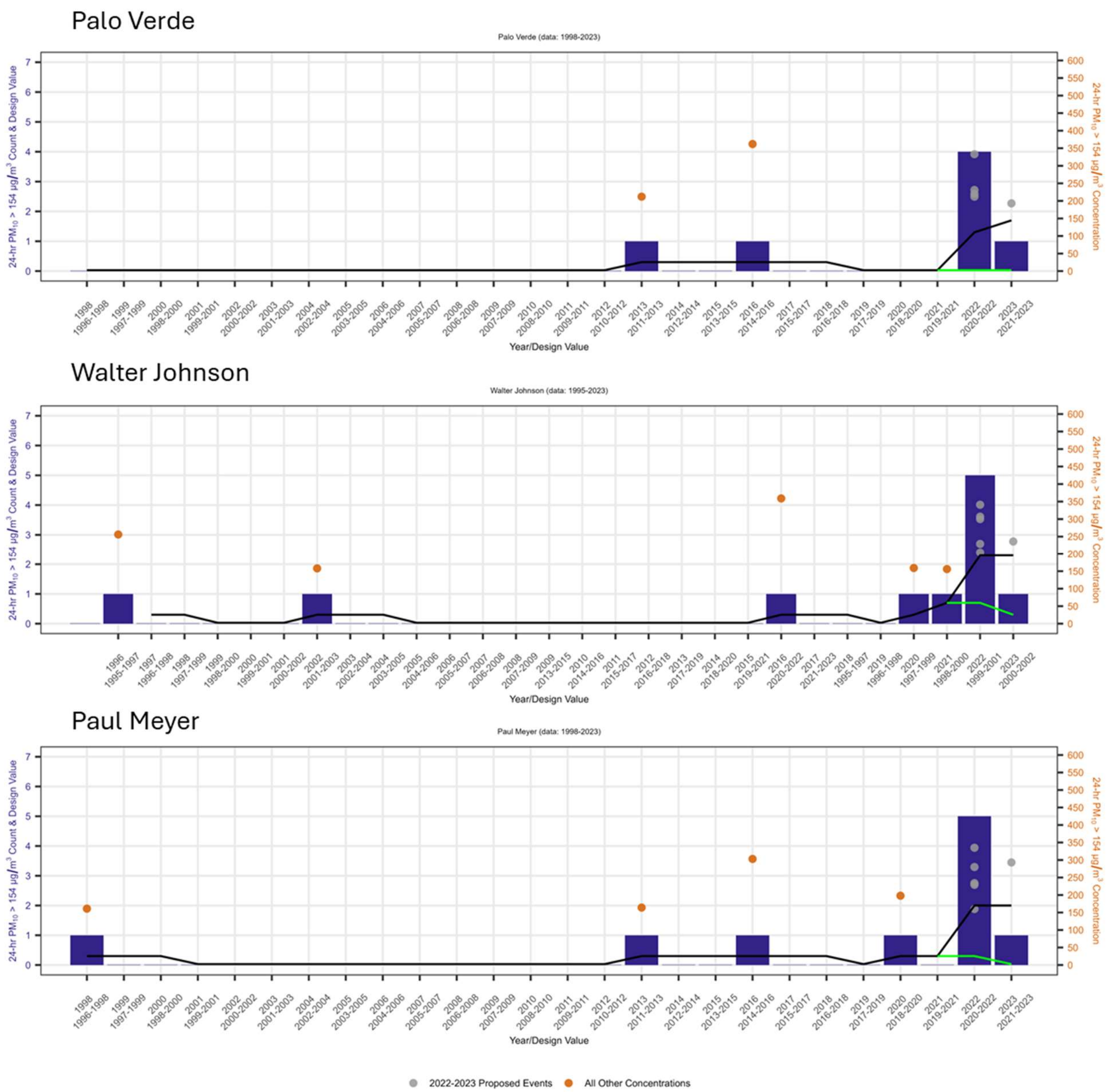

Figure 4.3-5. Historical 24-hour PM_{10} exceedance count (purple bars) and concentration (orange dots) per year/design value period at the Palo Verde, Walter Johnson, and Paul Meyer monitoring sites (AQS: 32-003-0073; 32-003-0071; 32-003-0043). The gray dots represent the proposed 2022-2023 PM_{10}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

During early September, a strong frontal passage through northern Nevada drove a wind-blown dust event that increased PM_{10} concentrations in Clark County, NV, on September 8, 2020. Strong winds well above 25 mph from the frontal passage lofted, entrained, and transported dust into Clark County starting in the early morning on September 8, 2020, at 03:00 and lasting through 10:00 PST. The severe drought conditions affecting the Great Basin Desert in Nevada, as shown in **Section 2.2**, created an ample source of dust from friable soils. Enhanced wind speeds greater than 25 mph in the Las Vegas valley coincided with increased PM_{10} concentrations during the 03:00-10:00 PST period. Within this section, we provide meteorological evidence of lofting, entrainment, and transport of dust from the dust source region, (the Great Basin Desert Region) with the frontal passage, evidence of transport from the source region to Clark County via HYSPLIT trajectory modeling and meteorological analysis, and impacts of the high-wind dust event at the surface in Clark County. We also provide additional evidence using statistical and meteorological similar event analysis to compare this dust event with other high PM_{10} days in Clark County.

4.3.4 Jurisdiction

As detailed in **Section 3.1.1**, on September 8, 2020, dense blowing dust from the Great Basin Desert source region impacted the Las Vegas metropolitan area. Due to the strong frontal passage through northern Nevada, surface wind speeds increased in the Great Basin Desert and Clark County, which produced blowing dust during the early morning hours northwest of Las Vegas on September 8,

2020. Strong winds in the Great Basin Desert source region were well above 25 mph from the frontal passage, which lofted, entrained, and transported dust from the source region to Clark County. The hourly PM_{10} concentrations detailed in **Section 3.2.2** show a southeastward progression of high PM_{10} concentrations and wind speeds consistent with the direction of travel of the cold front. By 05:00 PST, all sites in the Las Vegas Valley showed extremely high concentrations of PM_{10} (> 500 µg/m^3) and caused a 24-hour PM_{10} NAAQS exceedance. 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, 2020. The timeline shown in this exceptional event demonstration highlights the progression of extremely high concentrations of PM_{10} from the source region into Clark County (and HA 212) within a very short period of time. This progression clearly indicates an upwind source of windblown dust. As the strong winds lofted, entrained, and transported dust from the Great Basin Desert in 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

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

complaints within 24 hours or the next business day.[10] Expansive rules and BACM for dust control at construction and temporary commercial activities are included in AQR Section 94. These include requirements for dust control monitors, soil stabilization standards, testing methods, and rules for non-compliance or violations if a permit or Dust Mitigation Plan has been violated. During high-wind dust periods, Clark County compliance officers inspect construction and stationary source sites to ensure BACM are being implemented, and any observed violation may receive a Notice of Non-Compliance or a Notice of Violation.

On September 8, 2020, a Dust Advisory was issued by Clark County to all dust control permit holders, contractors, and stationary sources instructing them to immediately inspect their site(s) and employ BACM to stabilize disturbed soils and reduce blowing dust (see **Appendix E**). In the case of a Dust Advisory, compliance officers inspect construction and stationary source sites during the episode to ensure BACM are being implemented, where any observed violation may receive a Notice of Violation. This and other Clark County public-facing alerts shown in **Section 3.3.1** indicate the implementation of BACM and enforcement procedures. **Appendix D** also provides all inspection information and notices of violation from the September 8, 2020, event.

The Clark County DES is comprised of Monitoring, Compliance and Enforcement, and Planning divisions. The Monitoring Division is primarily responsible for weather and air quality monitoring, forecasting Air Quality Index (AQI) levels and coordinating with other divisions and Clark County more broadly on the issuance of Construction Notices or Advisories. The Compliance and Enforcement Division is responsible for disseminating Construction Notices to appropriate stationary sources, dust control permit holders, and contractors. This department also disseminates Advisories to the public, conducts field inspections of sources before and during a dust event, alerts alleged violators of compliance statuses, and documents observations made in the field of enforcement actions. The Planning Division is responsible for coordinating with the other divisions to prepare exceptional event packages. Full details on these procedures can be found in Appendix E. 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, 2020, PM_{10} event were not reasonably controllable or preventable.

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

5. Natural Event

The September 8, 2020, event is the result of a frontal passage with high winds proceeding directly over the Great Basin Desert source region and into Clark County, NV. In the case when high-wind events pass over natural undisturbed lands, the EPA considers high-wind dust events natural. In addition, there were controls in place for anthropogenic sources (**Section 4.2**) during the high-wind dust event. Therefore, we conclude this event meets the EPA criteria for a natural event.

6. Conclusions

The evidence provided within this report demonstrates that the PM_{10} exceedance on September 8, 2020, was caused by a High Wind Dust Event where dust was lofted, entrained, and transported from the extremely dry Great Basin Desert source region. Key elements and evidence associated with the event timeline include:

1. A strong frontal passage quickly pushed through northern Nevada (and the Great Basin Desert) between 00:00 and 12:00 UTC on September 8, 2020 (i.e., 16:00 PST on September 7 to 04:00 PST on September 8, 2020). With this frontal passage, dust from the Great Basin Desert was lofted, entrained, and transported to Clark County. Meteorological stations along the transport path show winds greater than the 25-mph threshold.

2. Back trajectories and meteorological data along the frontal passage confirm the Great Basin Desert as the source region for the high-wind dust event. The frontal passage descended from the north through the source region enroute to Clark County, NV, within 24 hours of the exceedance. Satellite data, meteorological data, and visual evidence all align to confirm event transport from the Great Basin Desert. PM_{10} concentrations in the Reno and Elko regions confirm high PM_{10} along the timeline and trajectories established.

3. The frontal passage entered Clark County by 11:00 UTC (03:00 PST) and exited Clark County by 15:00 UTC (07:00 PST) on September 8, 2020. Along with the frontal passage, PM_{10} was extremely enhanced, dust alerts were issues, camera images and visibility show extremely dusty conditions, and $PM_{2.5}/PM_{10}$ dropped precipitously (indicating windblow dust).

4. PM_{10} concentrations increased at the same time as wind speeds in Clark County, starting at 03:00 PST on September 8, 2020. 24-hour PM_{10} concentrations were well above the NAAQS threshold of 150 $\mu g/m^3$ (regulatory significance: Jerome Mack at 302 $\mu g/m^3$). Seven other monitoring sites throughout the Las Vegas valley also recorded extremely high PM_{10} concentrations, but were not regulatorily significant in this case.

5. PM_{10} at Jerome Mack exceeded the five-year 99th percentile and the NAAQS on September 8, 2020. PM_{10} concentrations are also significantly outside typical diurnal, monthly, and seasonal ranges.

6. Clark County, NV, and the surrounding source regions were under increasingly severe drought conditions on September 8, 2020. The 30-year climatology shows that temperatures and winds speeds were above normal, while soil moisture was below normal. The barren land cover, including the Great Basin Desert source region, was primed for significant dust production during the high-wind event. PM_{10} control measures within Clark County were quickly overwhelmed and unable to prevent an exceedance event on September 8, 2020.

Dust lofted and transported from this natural, undisturbed area experiencing severe drought is considered to be a natural and not reasonable or controllable event.

7. Analyses comparing other dates similar to September 8, 2020, include dates with (1) comparable wind profiles that did not show PM_{10} concentrations above the NAAQS and (2) PM_{10} concentrations above the NAAQS but a lack of notable wind speeds. Both indicate that in the absence of an extremely dry source region and high surface winds, PM_{10} concentrations would not have been exceptionally high.

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

1. A narrative conceptual model that describes the event(s) causing the exceedance or violation and a discussion of how emissions from the event(s) led to the exceedance or violation at the affected monitor(s),
2. A demonstration that the event affected air quality in such a way that there exists a clear causal relationship between the specific event and the monitored exceedance or violation,
3. Analyses comparing the claimed event-influenced concentration(s) to concentrations at the same monitoring site at other times,
4. A demonstration that the event was neither reasonably controllable nor 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 F**).

The high-wind dust event that occurred on September 8, 2020, caused a 24-hour PM_{10} NAAQS exceedance of 302 µg/m^3 that has regulatory significance at Jerome Mack (Monitor AQS ID 32-003-0540, POC 1). Without EPA concurrence on the September 8, 2020, high-wind dust event, the 2019-2021 design value at Jerome Mack is 1.3. With EPA concurrence on this event, the 2019-2021 design value at Jerome Mack is 1.0, 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, 2020, and agree to exclude the event from regulatory decisions regarding PM_{10} attainment.

7. References

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