Protecting the air we share
Air Quality
CLARK COUNTY • DEPARTMENT OF AIR QUALITY
4701 W. Russell Road Suite 200 • Las Vegas, NV 89118-2231
(702) 455-5942 • Fax (702) 383-9994
Lewis Wallenmeyer Director

Exceptional Event Documentation for the July 3, 2013, 8-Hour Ozone NAAQS Exceedance in Clark County Caused by a Wildland Fire Event

September, 2015

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

Acronyms

AOD	Aerosol Optical Depth
AOT	Aerosol Optical Thickness
AQI	Air Quality Index
CAA	Clean Air Act
CFR	Code of Federal Regulations
DAQ	Clark County Department of Air Quality
EER	Exceptional Events Rule
EPA	U.S. Environmental Protection Agency
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory Model
MDA8	Maximum Daily 8-hr Average
NAAQS	National Ambient Air Quality Standards
PST	Pacific standard time
VOC	volatile organic compound

Abbreviations

°C	degrees Celsius
CO	carbon monoxide
mb	millibars
MSL	mean sea level
NO_x	oxides of nitrogen
O_3	ozone
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
ppb	parts per billion

1.0 INTRODUCTION

1.1 STATEMENT OF PURPOSE

Clark County has determined that ozone (O_3) concentrations exceeding the National Ambient Air Quality Standards (NAAQS) on July 3, 2013, qualify as an exceptional event under Title 40, Part 50 of the Code of Federal Regulations (40 CFR 50), the final Exceptional Events Rule (EER). The purpose of this document is to petition the Regional Administrator for Region 9 of the U.S. Environmental Protection Agency (EPA) to exclude air quality monitoring data from specific monitors for ozone from the normal planning and regulatory requirements under the Clean Air Act (CAA) in accordance with the EER.

On July 3, 2013, Clark County recorded elevated ozone concentrations and exceedances of the ozone NAAQS across its air quality monitoring network because smoke plumes from the Carpenter 1 fire in the Spring Mountains, NV impacted Clark County. This document demonstrates, in accordance with the EER, that these NAAQS violations would not have occurred without the wildfire impacts. This exceptional event demonstration underwent public review and comment before submittal to EPA.

1.2 SCOPE OF DEMONSTRATION

The EER governs the review and handling of air quality monitoring data influenced by exceptional events (e.g., wildfires). Exceptional events are "events for which the normal planning and regulatory process established by the CAA is not appropriate" (*Federal Register,* Volume 72, p. 13560). In its final rule, EPA intended to:

> Implement section 319(b)(3)(B) and 107(d)(3) authority to exclude air quality monitoring data from regulatory determinations related to exceedances or violations of the National Ambient Air Quality Standards (NAAQS) and avoid designating an area as nonattainment, redesignating an area as nonattainment, or reclassifying an existing nonattainment area to a higher classification if a State adequately demonstrates that an exceptional event has caused an exceedance or violation of a NAAQS.

The EER contains procedures and criteria whereby states can petition EPA to exclude data from regulatory considerations because of an exceptional event that caused an area to exceed the NAAQS for a particular pollutant. The term "exceedance" refers to a measured or modeled concentration greater than the level of one or more NAAQS at a specific air quality monitoring location.

EPA requires states to take reasonable measures to mitigate the impacts of an exceptional event. In accordance with Section 319 of the CAA, EPA defines the term "exceptional event" to mean an event that:

(i) Affects air quality;
(ii) Is not reasonably controllable or preventable;

(iii) Is an event caused by human activity that is unlikely to recur at a particular location or a natural event; and

(iv) Is determined by EPA through the process established in the regulations to be an exceptional event. (*Federal Register*, Vol 72, p. 13562, Section IV.D)

EPA notes that natural events, which are one form of exceptional events, may recur, sometimes frequently. This is certainly true for natural events such as western wildfires.

The ozone concentrations for July 3, 2013, were flagged in EPA's AQS on March 11, 2014, to indicate that NAAQS exceedances were likely caused by ozone precursor emissions produced by smoke plumes from a wildfire.

In this exceptional event demonstration, Section 2 addresses a conceptual model for ozone air pollution and wildfire impacts in Clark County based on technical studies completed to date. That section describes topography, land use, and meteorology in the context of conditions leading to elevated ozone concentrations, then summarizes the role of local emissions and transport into southern Nevada.

Section 3 describes the Clear Causal Relationship between the NAAQS concentrations and the exceptional event, including laboratory speciation, historical fluctuation, smoke trajectories, and the wildfire impacts on the pollutant concentrations. The EER requires a demonstration of the following criteria to exclude air quality data from the normal planning and regulatory process established by the CAA:

1. The event satisfies the criteria set forth in 40 CFR 50.1(j), which defines an exceptional event.

2. There is a clear causal relationship between the measurements under consideration and the event that is claimed to have affected the air quality in the area.

3. The event is associated with measured concentrations in excess of normal historical fluctuations, including background.

4. There would have been no exceedance or violation but for the event.

5. Documentation is provided with the submission of the demonstration that the public comment process was followed.

Section 4 provides evidence for the "but for" argument; this section outlines concentration calculations in lieu of measured concentrations to show that the exceedance would not have occurred but for the event.

The EER further requires that Clark County prove it took reasonable and appropriate actions to inform the public of deteriorating air quality caused by wildfire smoke plumes and a possible exceedance of the ozone NAAQS.

An effort was made to identify separate documentation or explanation for each element of the EER; however, some of the explanation can and should overlap with different elements.

Table 1-1. EER Required Elements and Demonstration

Element	Section Containing Explanation
Regional background and conceptual model	Section 2.0
Clear causal relationship between exceedance and the event	Section 3.0
Concentration is in excess of historical fluctuation	Section 3.3
But For demonstration	Section 4.0
Public participation	Section 5.0

1.3 COMPLIANCE WITH CRITERIA FOR EXCEPTIONAL EVENTS

An exceptional event, as defined in 40 CFR 50.1(j), is

> an event that affects air quality, is not reasonably controllable or preventable, is an event caused by human activity that is unlikely to recur at a particular location or a natural event, and is determined by the Administrator in accordance with 40 CFR 50.14 to be an exceptional event. It does not include stagnation of air masses or meteorological inversions, a meteorological event involving high temperatures or lack of precipitation, or air pollution relating to source noncompliance.

1.3.1 Wildfire Season in the West.

The wildfire season in 2013 was somewhat mild, with 5.6 million acres burned in the US. According to the National Interagency Fire Center, approximately 2.7 million acres were burned in the Western US. Table 1-2 shows the number of fires and acreage burned per state (http://www.nifc.gov/fireInfo/fireInfo_stats_YTD2013.html). The Carpenter 1 Fire was a catastrophic fire that raged through the Spring Mountains. It started on July 1 and lasted until mid-September, consuming 28,000 acres.

Table 1-2. Fires in the West in 2013

State	# Fires	# Acres
AZ	1,694	136,296
CA	8,457	590,391
CO	1,244	201,243
ID	1,560	754,549
MT	1,930	141,610
NM	1,064	233,037
NV	710	189,314
OR	2,164	250,009
UT	1,321	80,301
WA	1,200	105,402
WY	458	48,667
Totals	**21,802**	**2,730,819**

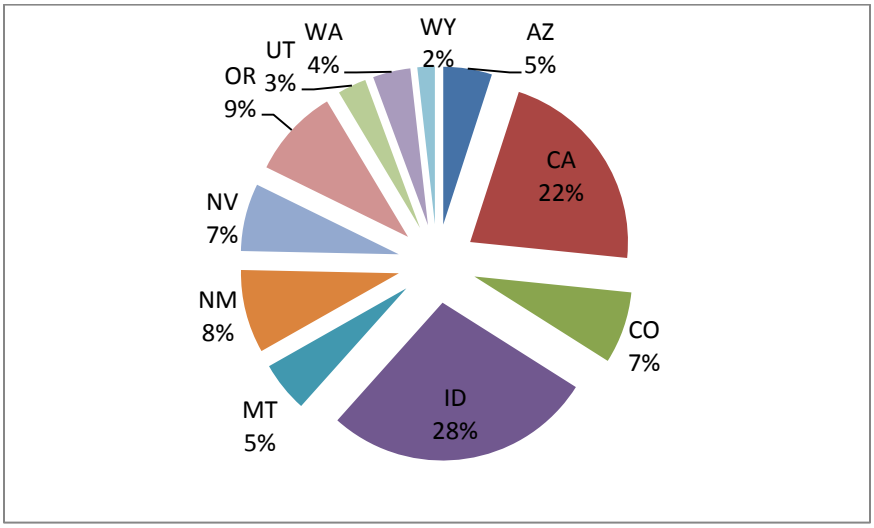


Figure 1-1. Percentage acres burned per state.

1.3.2 Carpenter 1 Fire on Mount Charleston, NV.

The **Carpenter 1 Fire** was a large wildfire on Mount Charleston, 25 miles (40 km) northwest of Las Vegas, Nevada. The fire began on July 1, 2013 near Pahrump, Nevada, before spreading eastward. Carpenter 1 was seen for miles across the Las Vegas metropolitan area, and was the largest fire to occur on Mount Charleston in decades. After eight weeks of battling the fire, Carpenter 1 was fully contained on August 18, 2013. The fire consumed nearly 28,000 acres (11,000 ha), causing parts of Nevada State Route 156 and 157 to be closed, resulting in the evacuation of residents and closure of businesses and portions of the Spring Mountains National Recreation Area. The fire, stretching between 5,000–11,000 feet (1,500–3,400 m) elevations, was fought by hundreds of firefighters and eight Hotshot crews, as well helicopters, fire engines, wa-

ter tenders, and a DC-10 tanker plane. According to the National Interagency Fire Center, the Carpenter 1 fire was considered "the highest ranked priority fire in the nation" at the time of its occurrence.[1]

DAQ recorded elevated ozone concentrations throughout the duration of the fire event, however, the ozone NAAQS was only exceeded once during the fire event. On July 3, 2013, smoke impacts from the Carpenter 1 fire overwhelmed any local contribution to elevated ozone levels at several ozone monitors in the network. The most westerly monitors in the LVV were impacted the most and exceeded the O_3 NAAQS. The highest ozone concentrations reached 87 ppb (maximum daily 8-hour average – MDA8) during this one-day episode.

On July 2, a well-established Pacific Ridge dominated the southwest causing an easterly flow, at all levels, into Clark County. By July 3, the ridge – or high-pressure system – moved enough to the south to cause a directional change in flow from the northeast at all levels.

Surface smoke impacts were documented through laboratory analysis of samples of particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) to determine concentrations of wildfire markers (e.g., levoglucosan).

Table 1-3 lists maximum ozone levels by monitoring site for July 3, as well as the days before and after. Figure 1-2 depicts the diurnal cycles for July 1 – July 5.

Table 1-3. Maximum 8-Hour Ozone Concentrations (ppb)

Site	July-13				
	1	2	3	4	5
Apex	56	62	66	62	52
Mesquite	50	52	51	53	52
Paul Meyer	66	59	87	64	64
Walter Johnson	71	60	87	64	64
Palo Verde	71	60	83	65	66
Joe Neal	69	70	81	68	63
Winterwood	53	60	60	59	49
Jerome Mack				59	49
Boulder City	51	56	64	59	49
Jean	58	60	64	59	66
JD Smith	64		71	63	55

Figure 1-3 depicts the O_3 and $PM_{2.5}$ concentrations for July 1 through July 3. The $PM_{2.5}$ concentrations on July 3th were extremely high, compared to the previous days. Figure 1-4 shows the carbon monoxide concentrations for July 1 through July 5. The concentrations almost doubled on July 3. Additionally, figures 1-5 and 1-6 show particle cross sections from the HYSPLIT

[1] Wikipedia

model at 13:00 and 16:00 on July 3. The plume covers most of Las Vegas and reaches the valley floor. The NOx concentrations for July 1 through July 5 are shown on Figure 1-6. On July 3, the concentrations were higher than expected, due to the abundance of NOx most likely generated by the fire. NOx is a precursor for ozone, and contributed to the high ozone concentrations.

The combination of these data shows that the Las Vegas Valley was clearly impacted by the smoke plume from the Carpenter 1 fire. The following sections will add information to the "but for" and the weight of evidence portions of the EER. They will show that Clark County was impacted by an exceptional event on July 3 and that the ozone monitoring data should be excluded from any regulatory requirements.

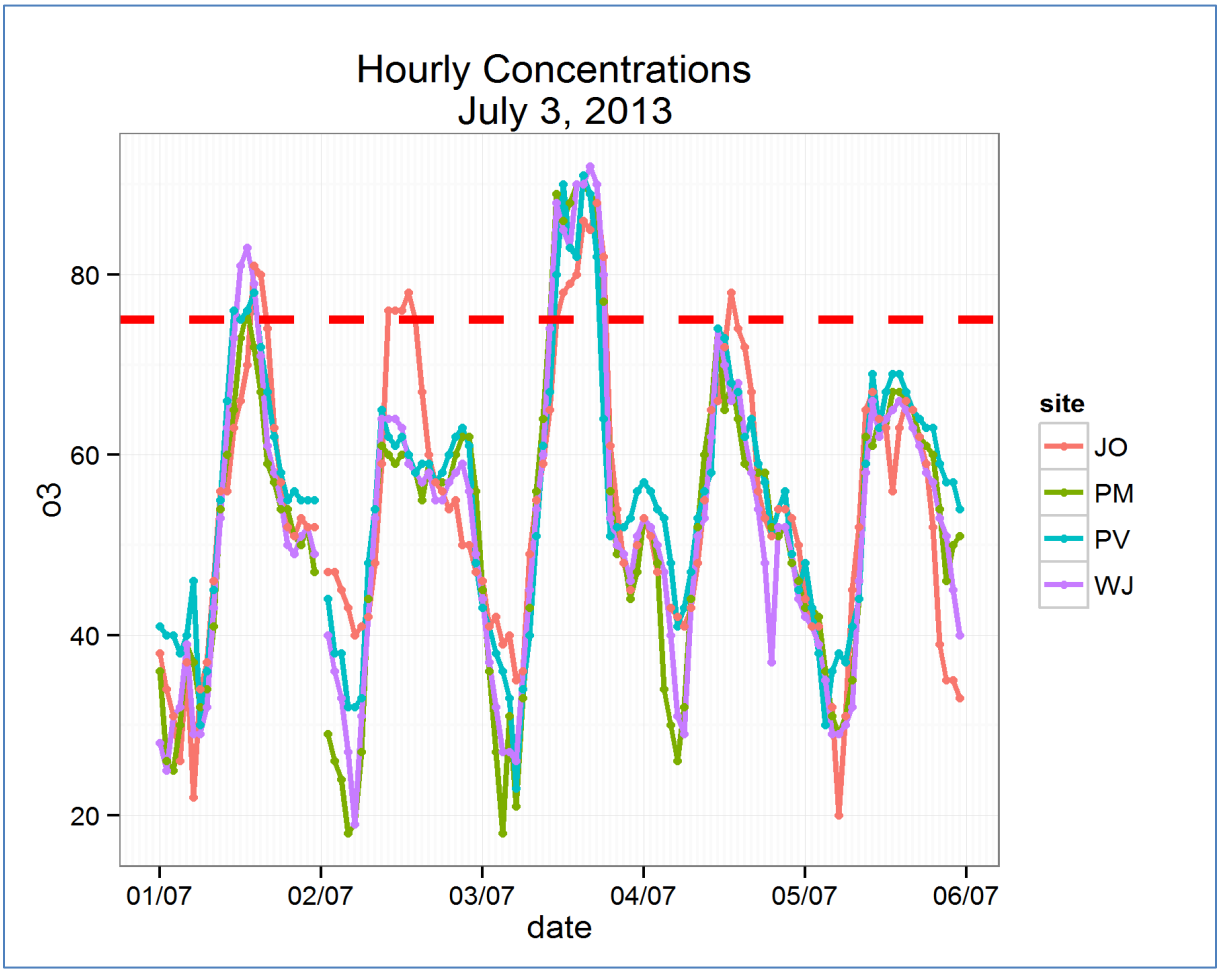


Figure 1-2. Diurnal Ozone Patterns around July 3.

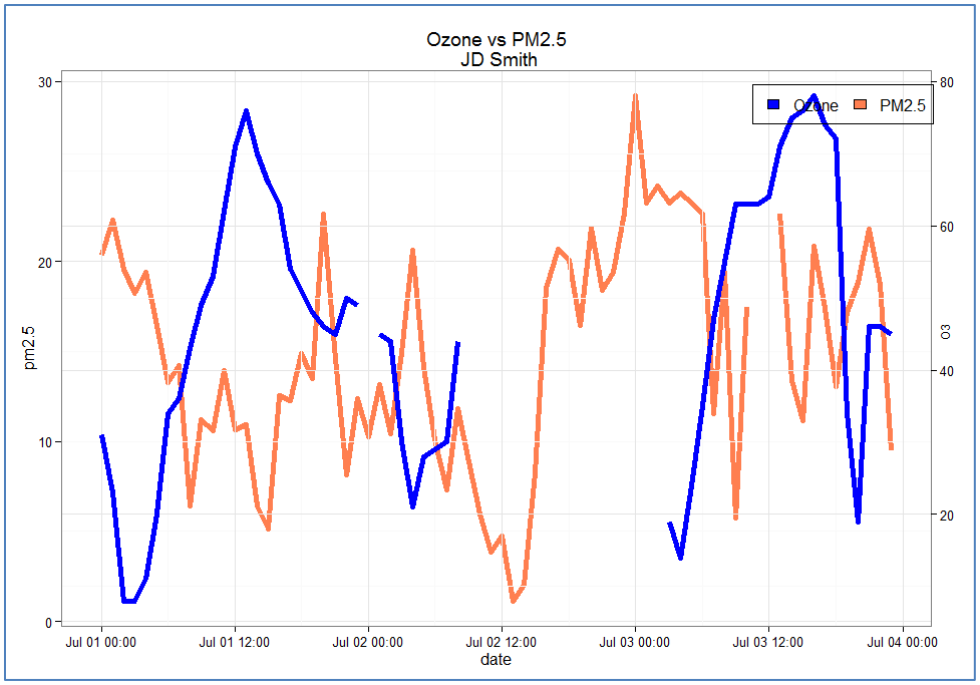


Figure 1-3. Ozone and $PM_{2.5}$ Diurnal Patterns

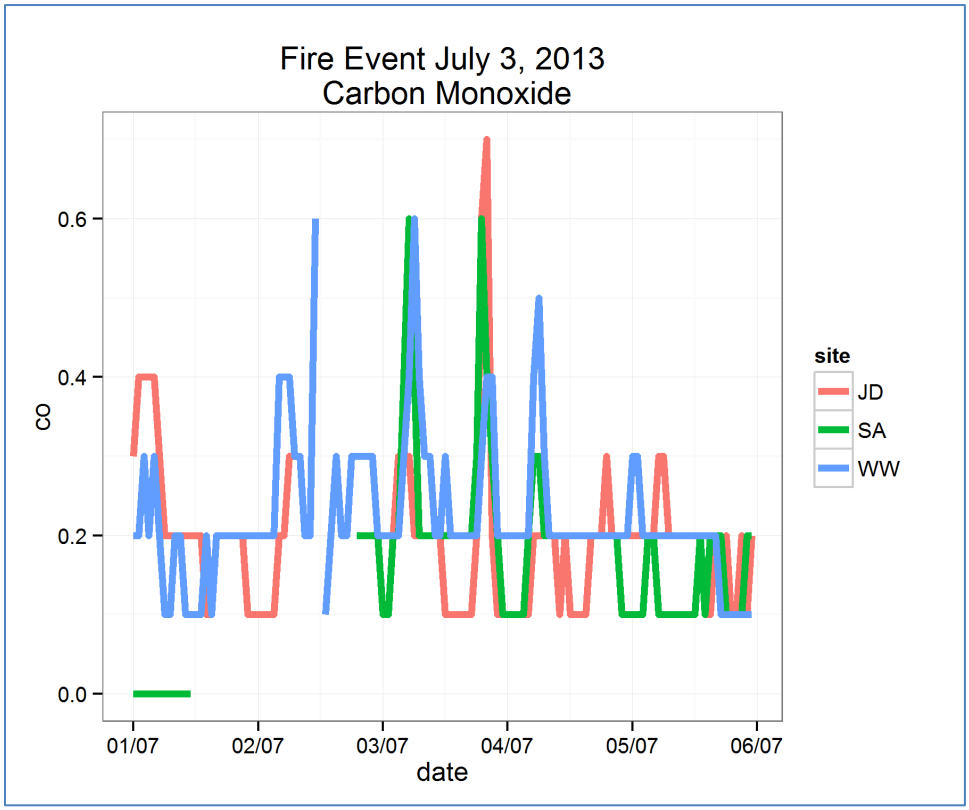


Figure 1-4. Carbon Monoxide Diurnal Patterns

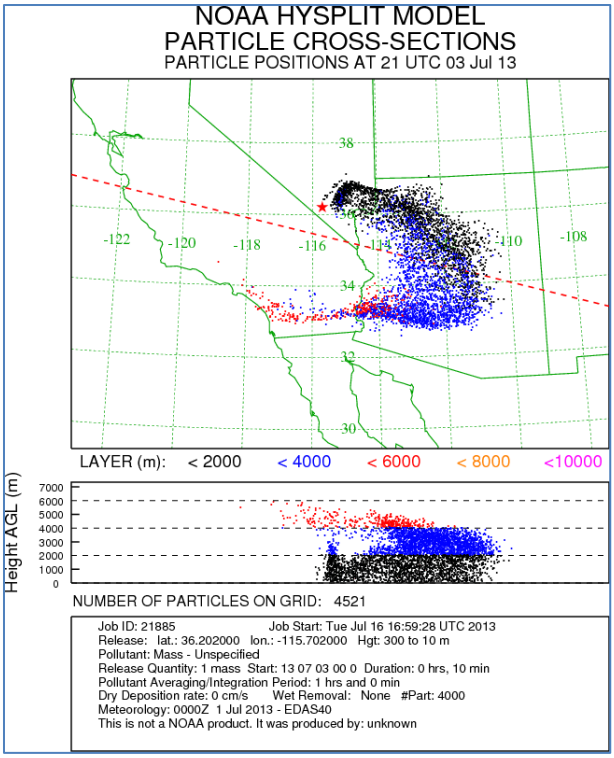


Figure 1-5. Particle Distribution in Smoke Plume at 13:00

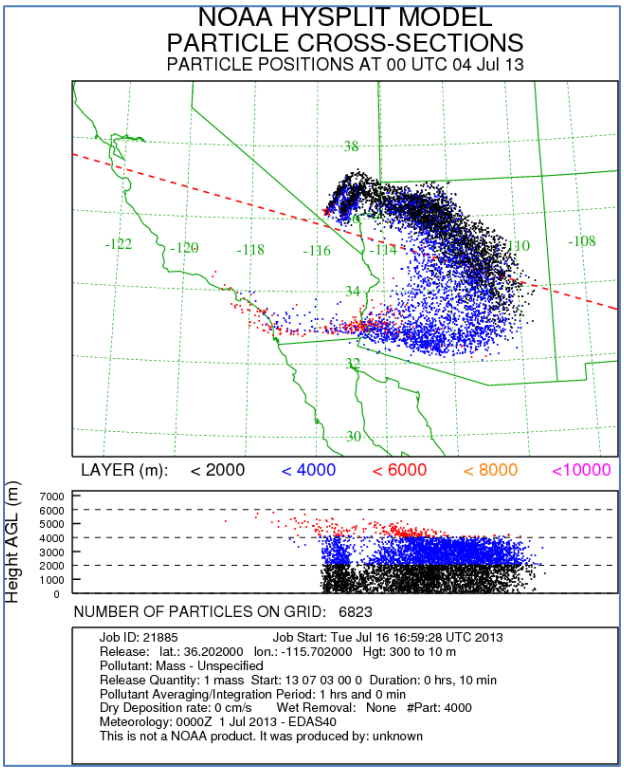


Figure 1-6. Particle Distribution in Smoke Plume at 16:00

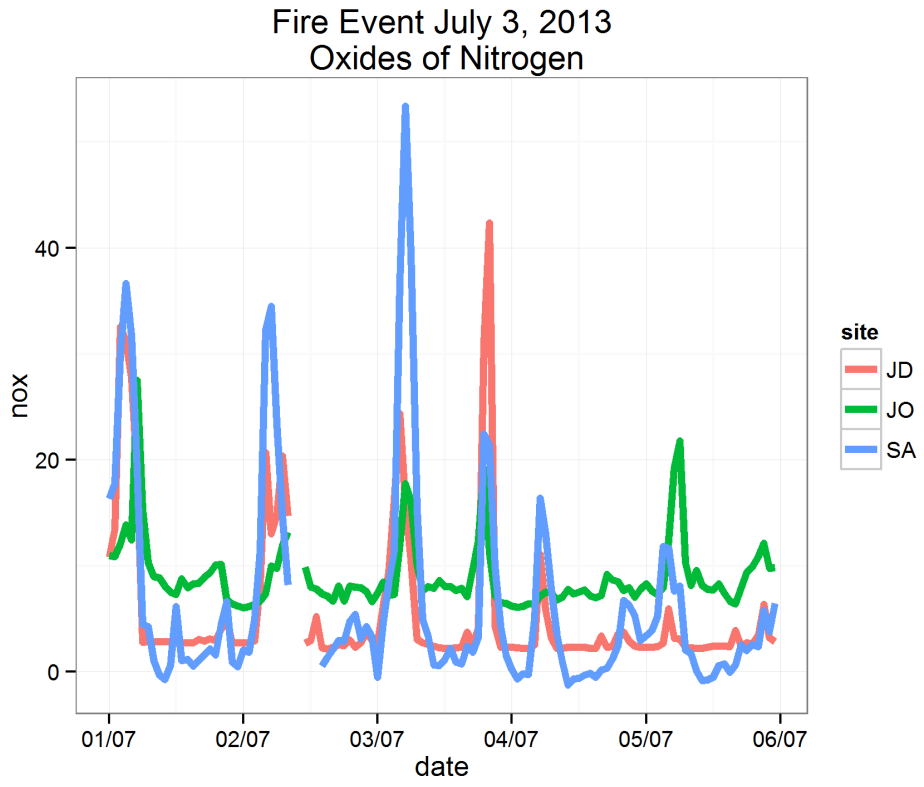


Figure 1-7. NOx Concentrations

Figure 1-8. Smoke Plume.

Figure 1-8 is a satellite image showing the smoke plume on July 3. Wind direction during the duration of the event was coming from the South; however, on July 3 winds shifted and blew the plume over the Las Vegas Valley. Figure 1-9 show the location of the fire on Mt Charleston.

Figure 1-9. Fire Location.

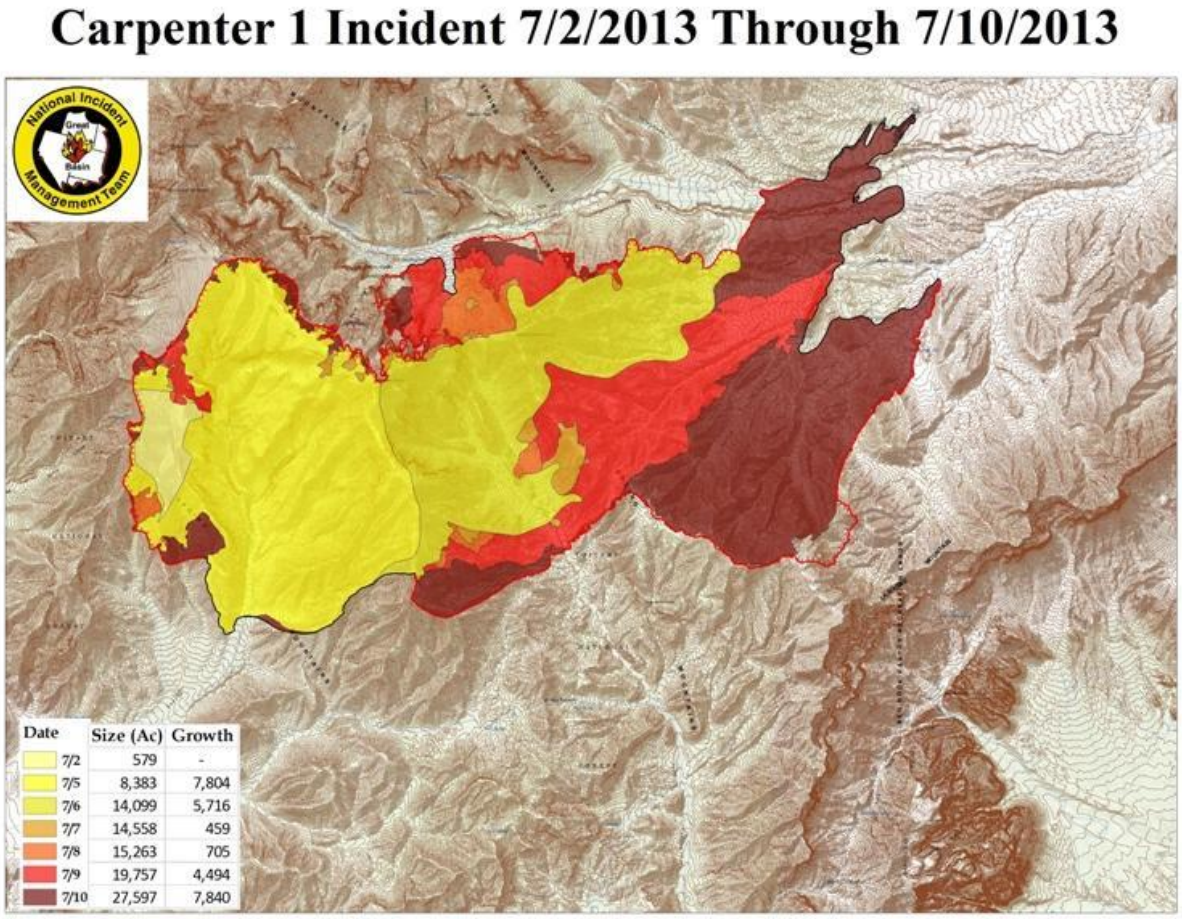


Figure 1-10. Carpenter 1 Burned Area.

The Carpenter 1 fire was fully contained after 8 weeks, and consumed almost 28,000 acres. Figure 1-10 depicts the burned area as the fire progressed.

Figure 1-11 is a map showing the highest Max 8-hr values across the Clark County monitoring network on July 3. It also includes the Pauite monitoring site just outside the valley, with a concentration of 92 ppb.

Figures 1-12 and 1-13 are the pollution roses for Paul Meyer and Joe Neal respectively.

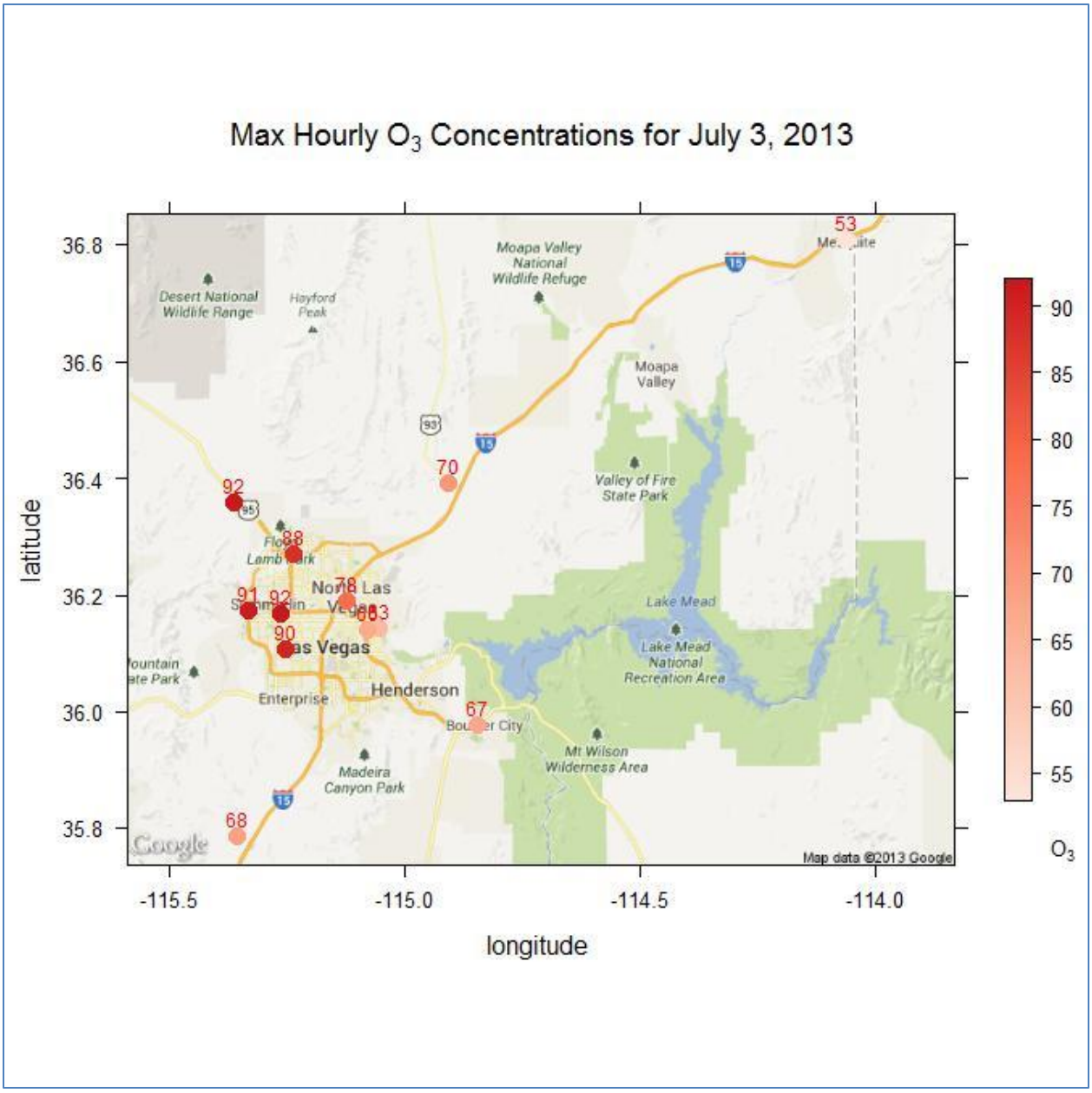


Figure 1-11. Ozone Concentrations on July 3, 2013.

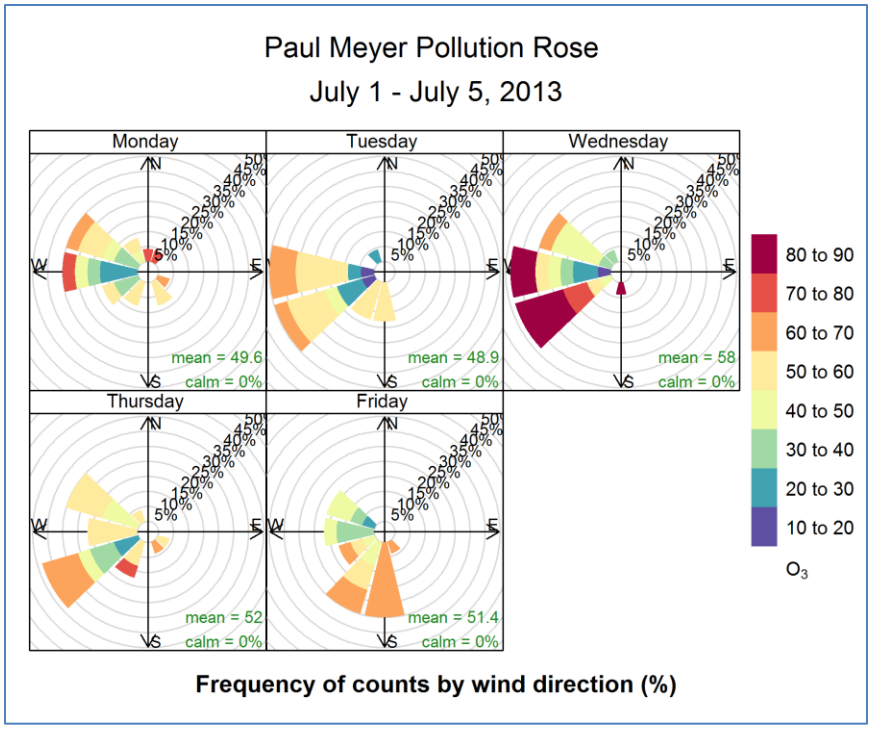


Figure 1-12. Pollution Rose for Paul Meyer.

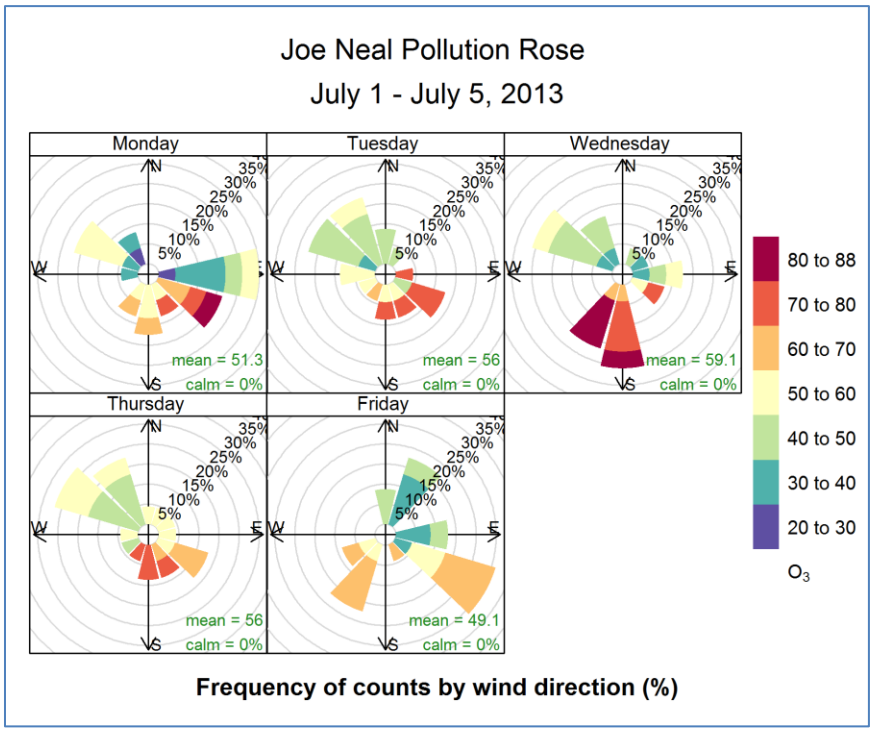


Figure 1-13. Pollution Rose for Joe Neal.

1.4 PREVIOUS RESEARCH ON OZONE FORMATION AND SMOKE IMPACTS[2]

Wildfires can generate both NOx and Volatile Organic Carbon (VOC) emissions, with different burning stages generating different types of emissions. Biogenic VOCs are generated by vegetation throughout the burning cycle. NOx is generated primarily during the hot, flaming stage of the fire, and small reactive hydrocarbons, such as ethane and acetylene, are generated during the smoldering phase (Finlayson-Pitts and Pitts, 2000; Jaffe et al., 2008).

Very near fires, ozone concentrations can potentially be suppressed, despite the increase in ozone precursors generated by the wildfires. Bytnerowicz et al. (2010), Finlayson-Pitts and Pitts (2000), and Sandberg et al. (2002) explain several reasons why ozone can potentially be low at the fire sites: 1) thick smoke can prevent sufficient UV light from reaching the surface, thereby inhibiting photochemical reactions, and 2) the wildfire plume typically contains high NOx concentrations, which can titrate ozone concentrations. Downwind of the fire (or at the top of the plume (Sith et al., 1981, qtd in Sandberg et al., 2002), away from fresh NOx sources and with reduced aerosol optical depth, considerable amounts of ozone can be generated. The plume does not need to be very far downwind of fire emissions to generate ozone. Sith et al. (1981) found ozone beginning 10 km downwind of wildfires, in plumes less than one hour old (quoted in Sandberg et al., 2002). Ozone and ozone precursors can also be transported quite far from a wildfire site (Finlayson-Pitts and Pitts, 2000 and Jaffe et al., 2008). Therefore, similar to the impacts of anthropogenic emissions in urban airsheds, the highest ozone concentrations due to wildfires are often found downwind of the area of greatest precursor emissions.

The impact of wildfires on ozone concentrations at both the local and regional level has been extensively evaluated in recent years. Field observations of ozone formation in smoke plumes from fires date back nearly 25 years when aircraft measurements detected elevated ozone at the edge of forest fire smoke plumes far downwind (see *Wildland Fire in Ecosystems Effects of Fire on Air*). More recently, aircraft flights through smoke plumes have demonstrated increased ozone concentrations of 15 to 30 ppb in California (Bush, 2008), while ozonesonde measurements in Texas found enhanced ozone aloft ranging from 25 to 100 ppb attributable to long-range transport of smoke plumes from Canada and Alaska (Morris, 2006).

In addition, air quality modeling has shown increased levels of ozone from a number of large fires. McKeen (2002) found that Canadian fires in 1995 enhanced ozone concentrations by 10 to 30 ppb throughout a large region of the central and eastern United States. Lamb (2007) found similar results simulating the impacts of fires in the Pacific Northwest in 2006, with increases of over 30 ppb. Junquera (2005) further found that within 10 km of a fire, ozone concentrations could be enhanced by up to 60 ppb. Finally, in one of the most recent studies, Pfister (2008) simulated the large 2007 fires in both northern and southern California. The author found ozone increases of approximately 15 ppb in many locations and concluded that "Our findings demonstrate a clear impact of wildfires on surface ozone nearby and potentially far downwind from the fire location, and show that intense wildfire periods frequently can cause ozone levels to exceed current health standards."

[2] Exceptional Events Demonstration for 1-Hour Ozone Exceedances in the Sacramento Regional Nonattainment Area Due to 2008 Wildfires, CARB 2011

2.0 CONCEPTUAL MODEL OF OZONE AIR POLLUTION

2.1 TOPOGRAPHY AND METEOROLOGY

Located in southern Nevada, Clark County consists of 8,091 square miles characterized by basin and range topography. It is one of the nation's largest counties, with an area bigger than the states of Connecticut and Delaware combined. The Las Vegas Valley sits in a broad desert basin surrounded by mountains rising from 2,000 feet to over 10,000 feet above the valley floor. The relief map in Figure 2-1 illustrates the basins and mountain ranges surrounding the valley. Terrain within the Las Vegas Valley rises significantly, from approximately 1,200 feet at Lake Mead to 2,000 feet in downtown Las Vegas to over 2,800 feet in the suburbs on the west side of the valley, near the Spring Mountain Range.

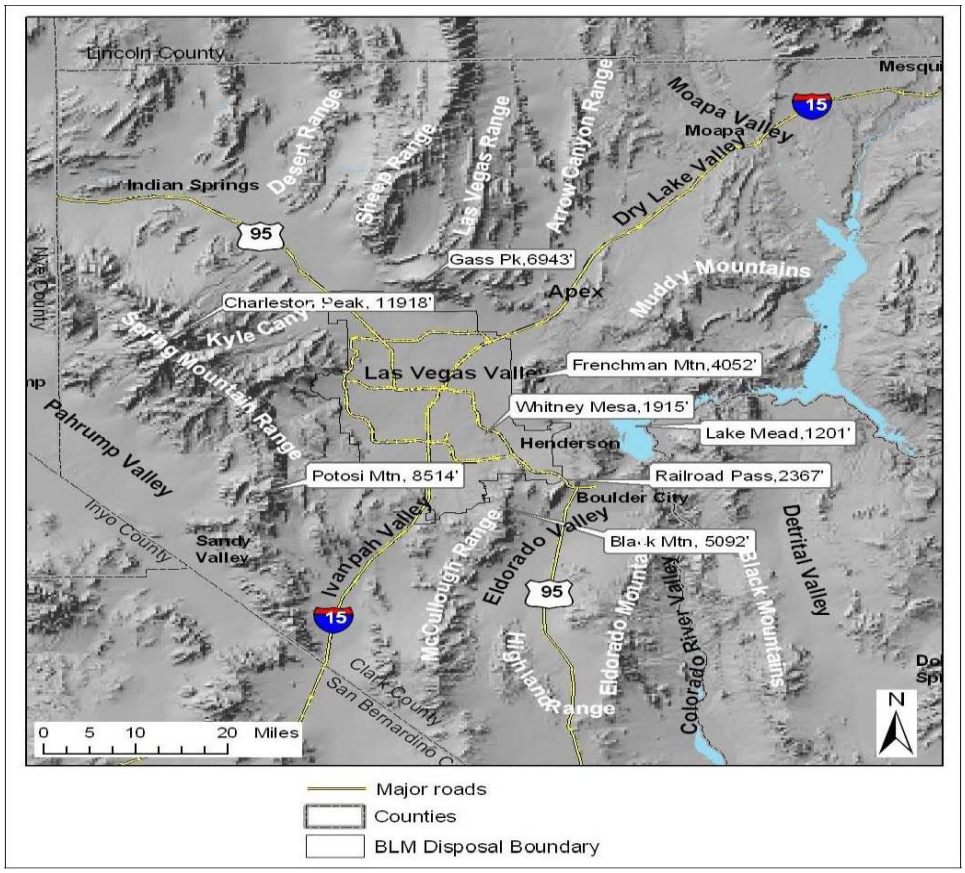


Figure 2-1. Mountain ranges and basins surrounding the Las Vegas Valley.

Although located in the Mojave Desert, Clark County has four well-defined seasons. Summers display the classic characteristics of the desert Southwest: daily high temperatures in the lower elevations often exceed 100ºF, with lows in the 70s. The summer heat is usually tempered by low relative humidity, which may increase for several weeks during July and August in association with moist monsoonal wind flows from the south. Average annual rainfall in the valley, measured at McCarran International Airport, is approximately 4.5 inches. Table 2-1 lists temperature and rainfall averages in Clark County from 1981 - 2010.

Table 2-1. Monthly Averages for Temperature and Rainfall (1981-2010)

Month	Maximum (°F)	Minimum (°F)	Average (°F)	Rainfall (inch)
January	58	39.4	48.7	0.54
February	62.5	43.4	52.9	0.76
March	70.3	49.4	59.9	0.44
April	78.3	56.1	67.2	0.15
May	88.9	65.8	77.3	0.12
June	98.7	74.6	86.7	0.07
July	104.2	80.9	92.5	0.4
August	102	79.3	90.6	0.33
September	94	71.1	82.6	0.25
October	80.6	58.5	69.5	0.27
November	66.3	46.5	56.4	0.36
December	56.6	38.7	47.7	0.5

http://www.ncdc.noaa.gov

2.2 POPULATION AND LAND USE

The population of Clark County is just over two million people. More than 95 percent reside in the Las Vegas Valley, which encompasses the cities of Las Vegas, North Las Vegas, and Henderson, along with portions of Boulder City near Hoover Dam. Figure 2-2 depicts land use and vegetation in Clark County along with the two major transportation routes, Interstate 15 and U.S. Highway 95.

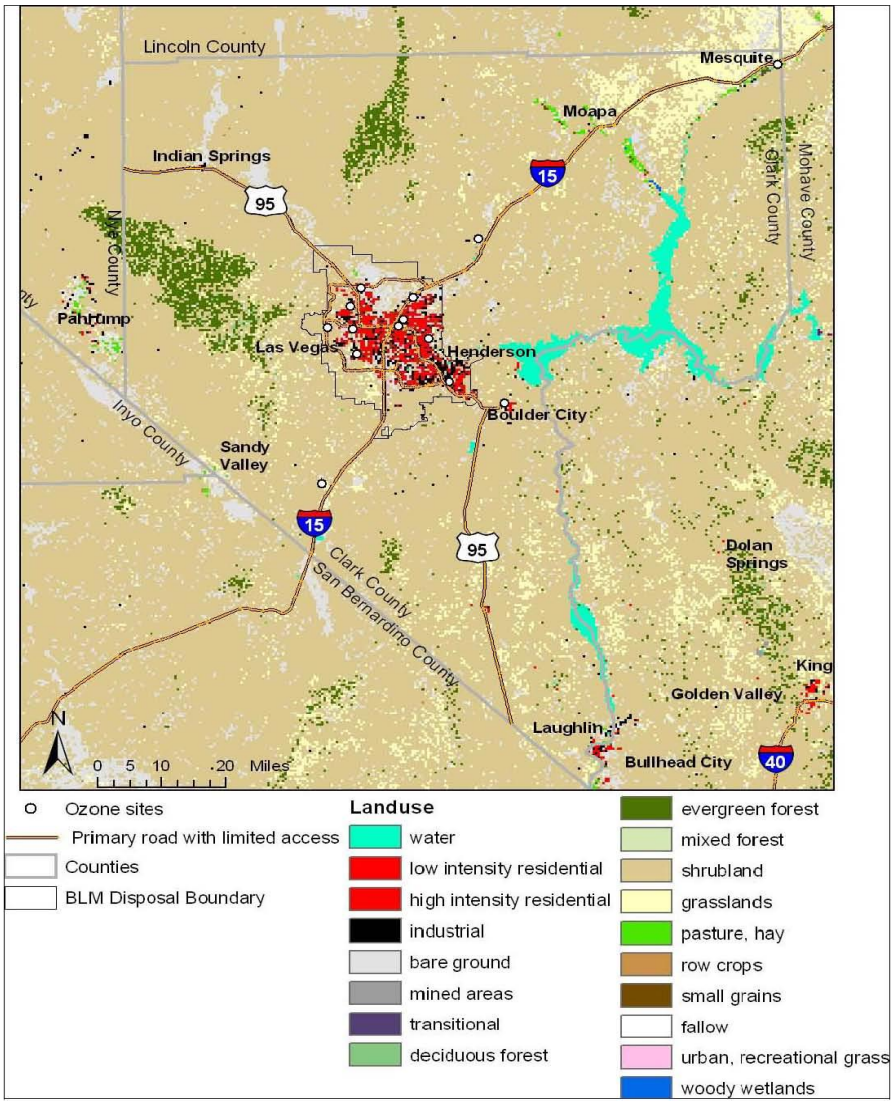


Figure 2-2. Land Use and Vegetation in Clark County.

2.3 OZONE AIR POLLUTION IN CLARK COUNTY

In 2006, DAQ embarked on a research study to characterize and identify the meteorological features that affect the timing and locations of elevated ozone levels in Clark County (see *Ozone Characterization Study*, DAQEM 2006a).

In the study, synoptic weather patterns during the ozone season (May through August) were analyzed using 500 millibar (mb) constant-pressure maps. Specific measured weather parameters including the 500 mb height and the ambient air temperature at the 700 mb level at the Desert Rock NWS upper-air site were used. Temperatures aloft at the 700 mb level are indicative of the mixing potential (stability) of the regional air mass presiding in the area at the time of measurement. That is, warmer air at 700 mb (~10,000 feet or 3,000 meters) is indicative of a stable atmosphere and poor dispersion conditions, while cooler air aloft is associated with more vigorous vertical mixing of pollutants and thus better dispersion. Based on the analysis, it was determined

that weather patterns could be characterized into five basic weather types: Pacific Trough, Interior Trough, Pacific Ridge, Interior Ridge, and Flat Ridge. The characteristics and criteria for each weather type are described below.

Pacific Trough

The axis of the long-wave 500 mb trough, or series of short wave troughs, is located off or along the Pacific Coast, producing falling 500 mb heights and increases from a westerly to southwesterly flow. By convention, it was decided that the lowest 500 mb heights during this weather type are west of the Sierra Nevada Mountains. This type of trough influences atmospheric dispersion conditions in the interior southwestern U.S. by slowly eroding the strength and longevity of stable anti-cyclonic air masses; this results in the breaking down of the broad scale subsidence needed to sustain poor dispersion conditions. The Pacific Trough designated weather type, also by convention, includes zonal flow situations characterized by light to moderate straight west to east flow across the western U.S. The southerly component of the onshore flow characteristic of the Pacific Trough weather type may also allow for increased moisture aloft over the interior regions. In general, the 700 mb temperature at the Desert Rock upper-air station is less than 10^{o} C (degrees Celsius) during Pacific Trough occurrences.

Interior Trough

When the axis of a long or short wave trough, or a closed cyclonic system, resides in the interior of the southwestern U.S., the synoptic weather type is designated to be an Interior Trough. In this type, the lowest 500 mb heights are east of the Sierra Nevada Mountains. The most significant characteristic of this pattern is the advent of cool air aloft in the interior southwest, and the resultant well-mixed dispersion conditions. Temperatures at 700 mb are usually below 8^{o} C, and may be as low as 0^{o} C during the early part of the ozone season. When advected moisture is available aloft, considerable cloudiness and escalated precipitation potential may also accompany the Interior Trough synoptic type.

Pacific Ridge

The Pacific Ridge synoptic weather type is directly associated with the mean eastern Pacific ridge, with the axis of highest pressure situated along or west of the Pacific coast. The convention for this feature requires that the highest 500 mb heights be located west of the Sierra Nevada Mountains. The maximum 500 mb heights usually exceed 5,900 meters near the core of the ridge, but at the Desert Rock upper-air site, heights may be considerably lower. Another convention for the Pacific Ridge designation requires that the 500 mb flow over southern Nevada be from a northerly direction (west-northwesterly to northeasterly), reflecting the counterclockwise motion around the anti-cyclonic air mass to the west. During the first half of the ozone season, the northerly flow aloft will result in the advection of cooler, less stable air into the region, while during the latter half of the season, the northerly flow often brings in warmer, drier air. The Desert Rock 700 mb temperature may be as high as 12^{o} C (late season), or as low 5^{o} C (early season). The Pacific Ridge weather type usually marks the beginning of an anti-cyclonic situation, and often will follow a cyclonic event, especially in the earlier part of the season. It is also not unusual for this type to be the result of the retro-gradating of a ridge located farther east. The Pa-

cific Ridge weather type is usually more transient than other ridging situations, and thus tends to occur for shorter durations, often as a transition into other longer-lived anti-cyclonic regimes.

Interior Ridge

The primary characteristic of the Interior Ridge weather type is the existence of a discernible high-pressure ridge at the 500 mb level over the interior southwestern U.S. The convention for this feature is that the highest 500 mb heights be located east of the Sierra Nevada Mountains. Typically, the interior ridge occupies the Great Basin and Inter-Mountain region and is often centered near the Four Corners area east of Las Vegas. The height of the 500 mb surface over the Desert Rock upper-air site is usually greater than 5,900 m, and sometimes as high as 5,990 meters. The 700 mb temperature in this situation usually exceeds 12^{o} C, and can be as high as 16^{o} C. The warm temperatures aloft are indicative of strong air mass subsidence in the interior region, and thus valley capping and limited thermodynamic mixing are prevalent; however, because of the lack of cool air advection, the hottest local surface temperatures of the year are usually recorded during Interior Ridge events, but mixing-layer depths may sometimes be deeper due to intense surface heating. Flow aloft at Desert Rock is usually very light and possibly variable when the ridge axis is over southern Nevada and easterly to southeasterly when the ridge center is farther east.

Flat Ridge

When the eastern pacific ridge broadens to extend over the ocean and the interior west, with little transitory movement, this weak anti-cyclonic air mass is classified as a Flat Ridge. In this pattern, all of the synoptic scale energy is well to the north and the pressure gradients, both at the surface and aloft, are very weak. The 500 mb surface may not always be as high as in the stronger ridging types (such as the Pacific Ridge and Interior Ridge), but they still are typically greater than 5,900 meters over most of the region. Because this is still a weak anti-cyclonic situation, significant air mass subsidence is prevalent, and as a result, the interior valleys remain capped and stable. This scenario is the most conducive to increased episodic pollution carryover from one day to the next.

SYNOPTIC WEATHER PATTERNS ASSOCIATED WITH THE EVENT IN JULY 2013

The 250, 500 and 850 mb time-series images for July 2-3, 2013 and the 500 mb chart for July 4, 2013 were examined to determine the synoptic weather patterns prior, during and after the July 3, 2013 event. The synoptic weather patterns are as follows.

<u>July 2</u>
Prior to the event the four 250 mb, 500 mb and 850 mb time-series images in Figures 2-1 through 2-3 show a high pressure Pacific ridge centered primarily over Nevada. All levels show an easterly flow into Clark County.

<u>July 3</u>
During the event, the Pacific ridge slightly weakened and retrogressed to the south. (See 200mb time-series images #1-3 in Figure 2-4). As a result, the directional flow repositioned from the

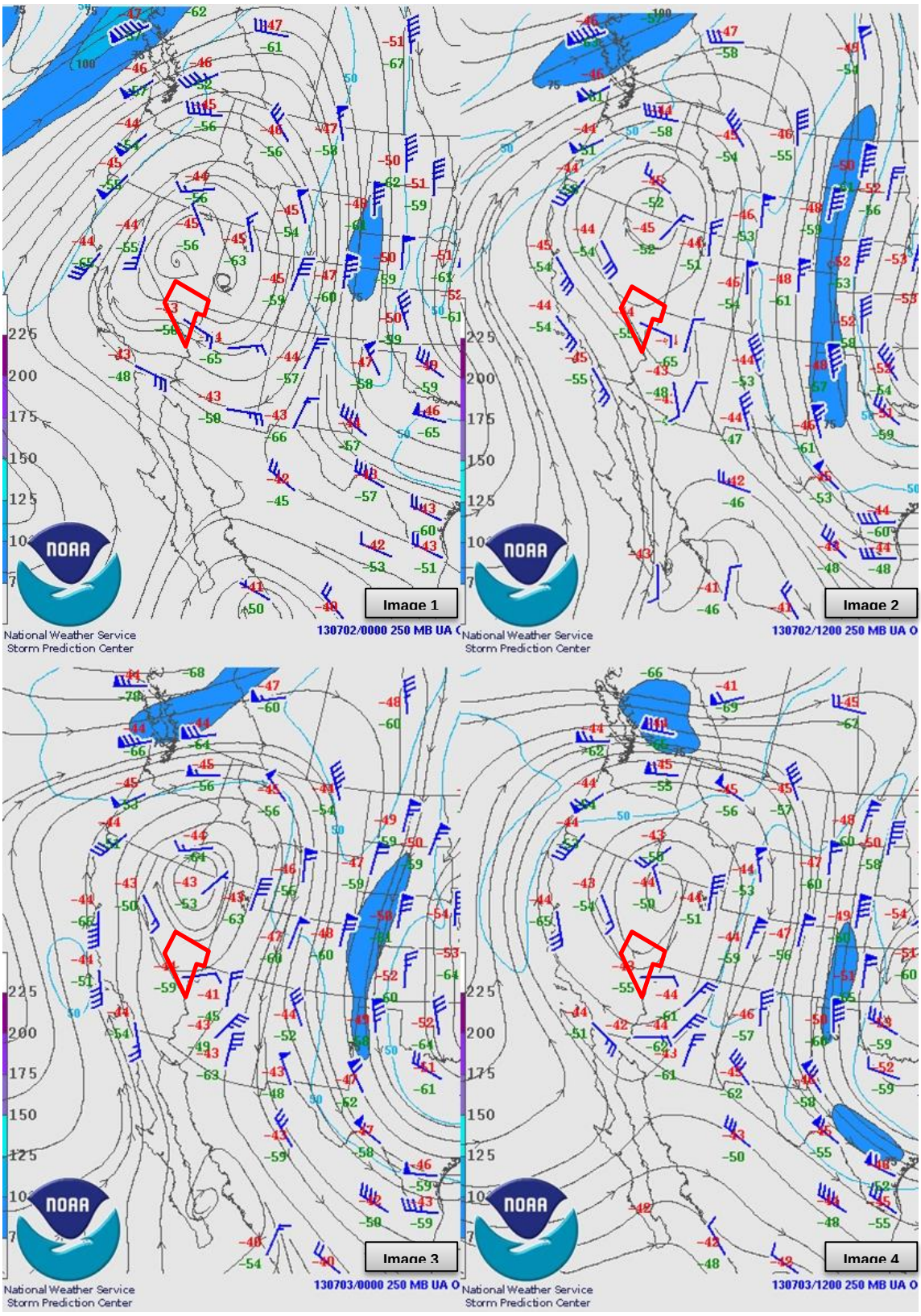
northeast. The three 500 mb time-series images #1-3 in Figure 2-5 show the weakening of a closed high to a ridge, which has retrograded to the south. The 850 mb time-series images #1-3 in Figure 2-6 show the pacific ridge retrograding to the west off the California coastline. All levels show northeast to easterly regional airflow giving way to a southwesterly airflow at the end of the period.

July 4

After the event, the four 500 mb time-series images in Figure 2-7 show the pacific ridge continued to weaken and slowly retrograde south. The weakening and retrogression of the pacific ridge resulted in a slight shift of the directional airflow from southwesterly to south southwesterly.

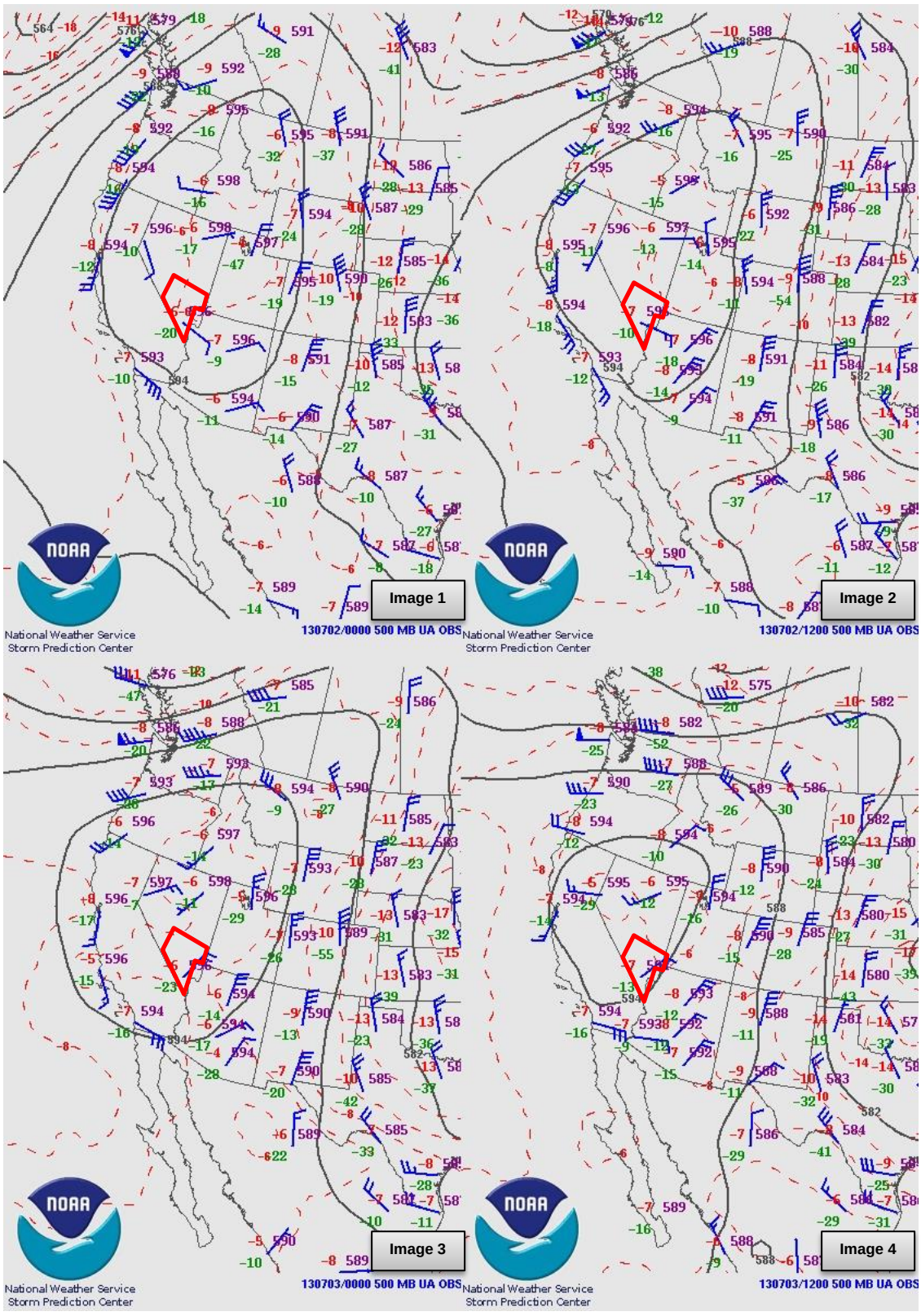
Conclusion

On July 2, a well-established Pacific Ridge dominated the southwest causing an easterly flow, at all levels, into Clark County. By July 3, the ridge – or high-pressure system – moved enough to the south to cause a directional change in flow from the northeast at all levels.



Represents Clark County, NV

Figure 2-1. 250mb Weather images for 7/2/13.



Represents Clark County, NV

Figure 2-2. 500mb Weather images for 7/2/13.

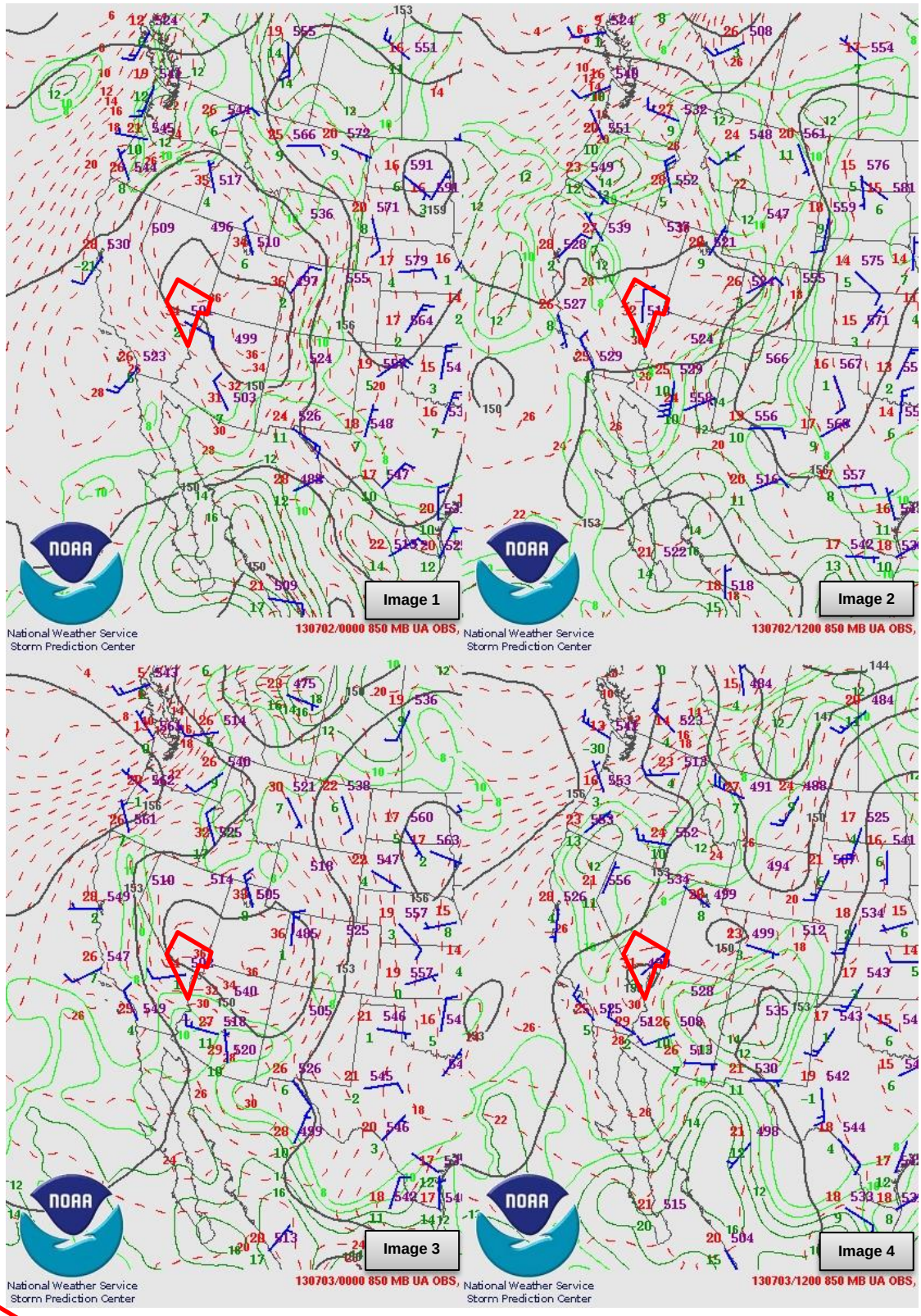


Figure 2-3. 850mb Weather images for 7/2/13.

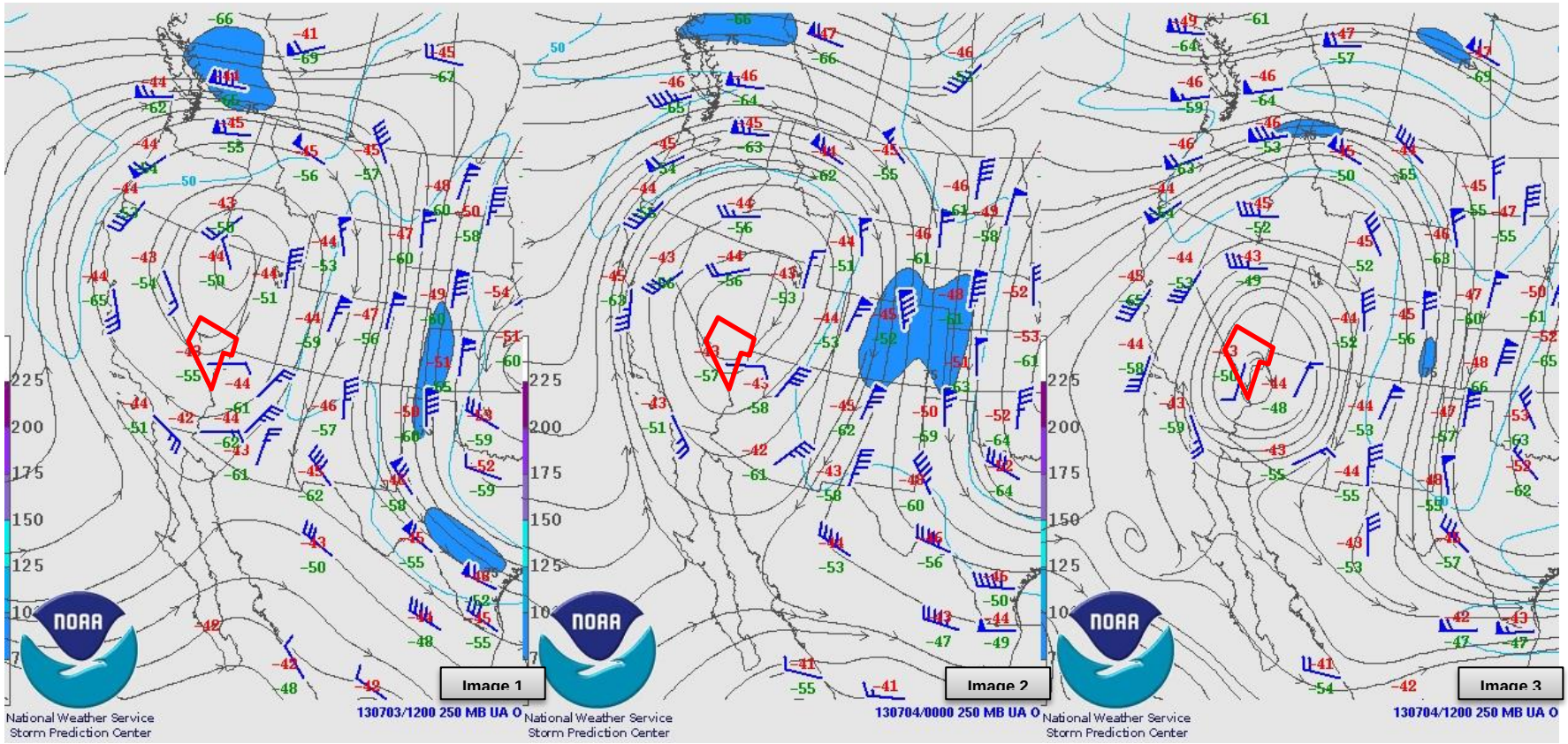


Figure 2-3. 250 mb Weather images for 7/3/13

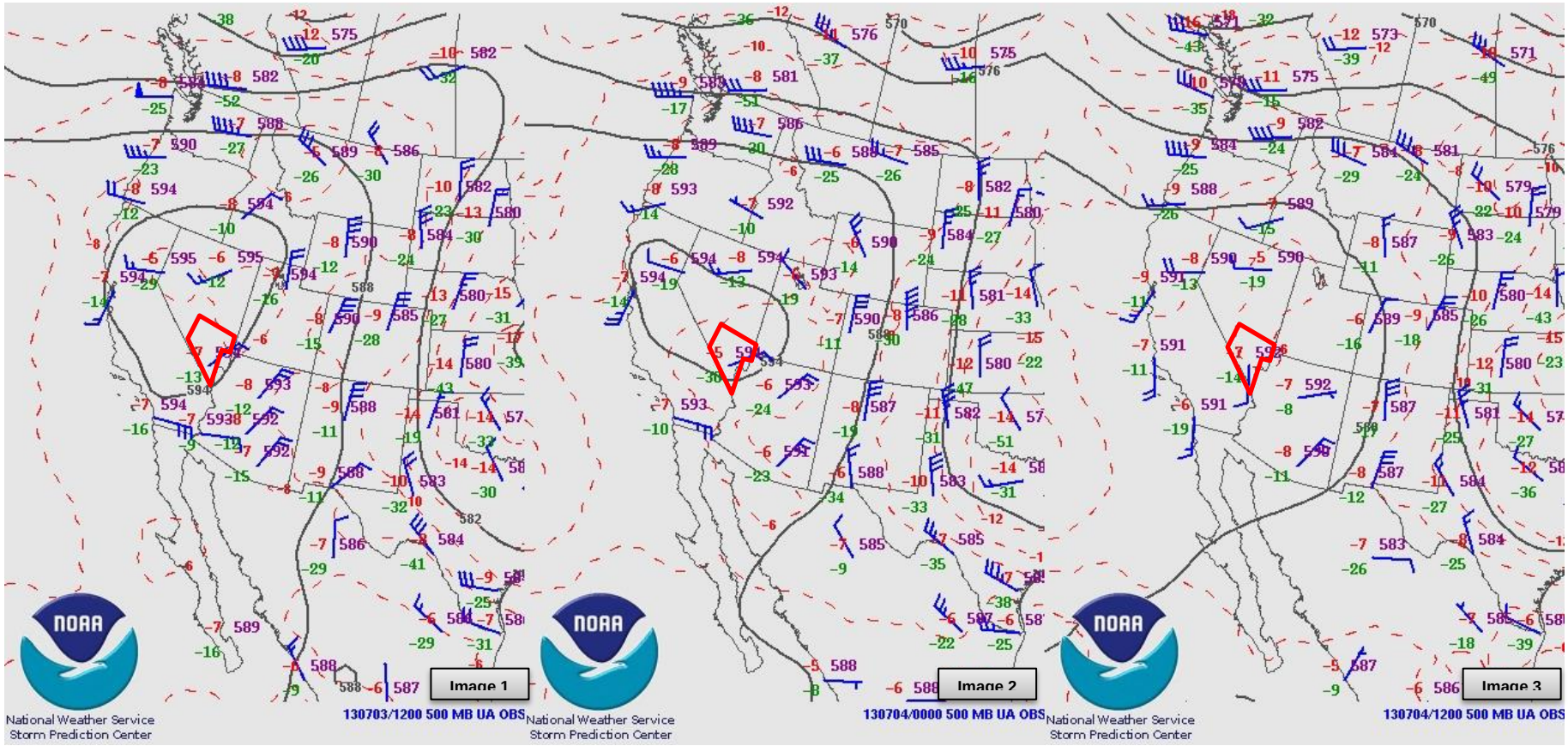


Figure 2-4. 500mb Weather images for 7/3/13.

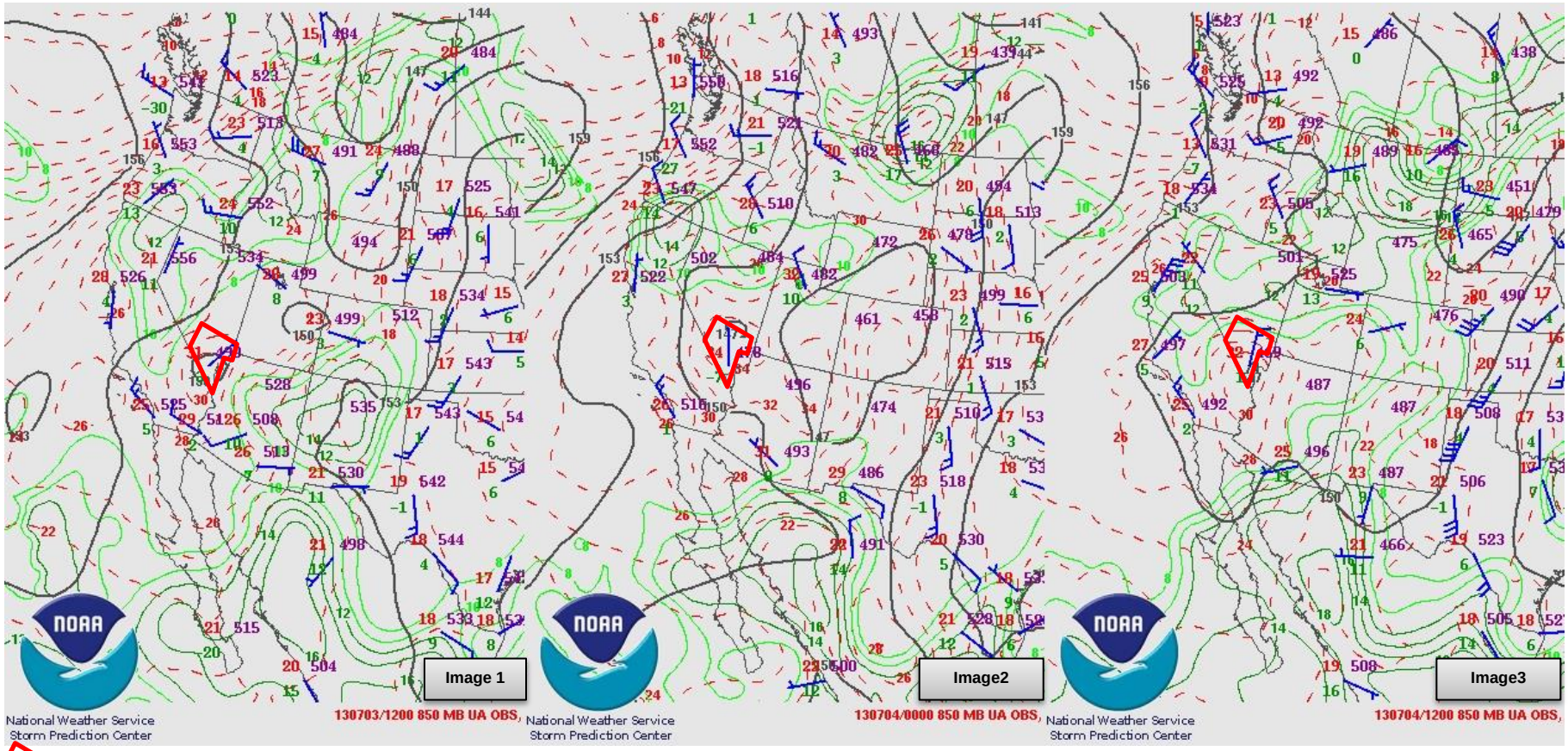
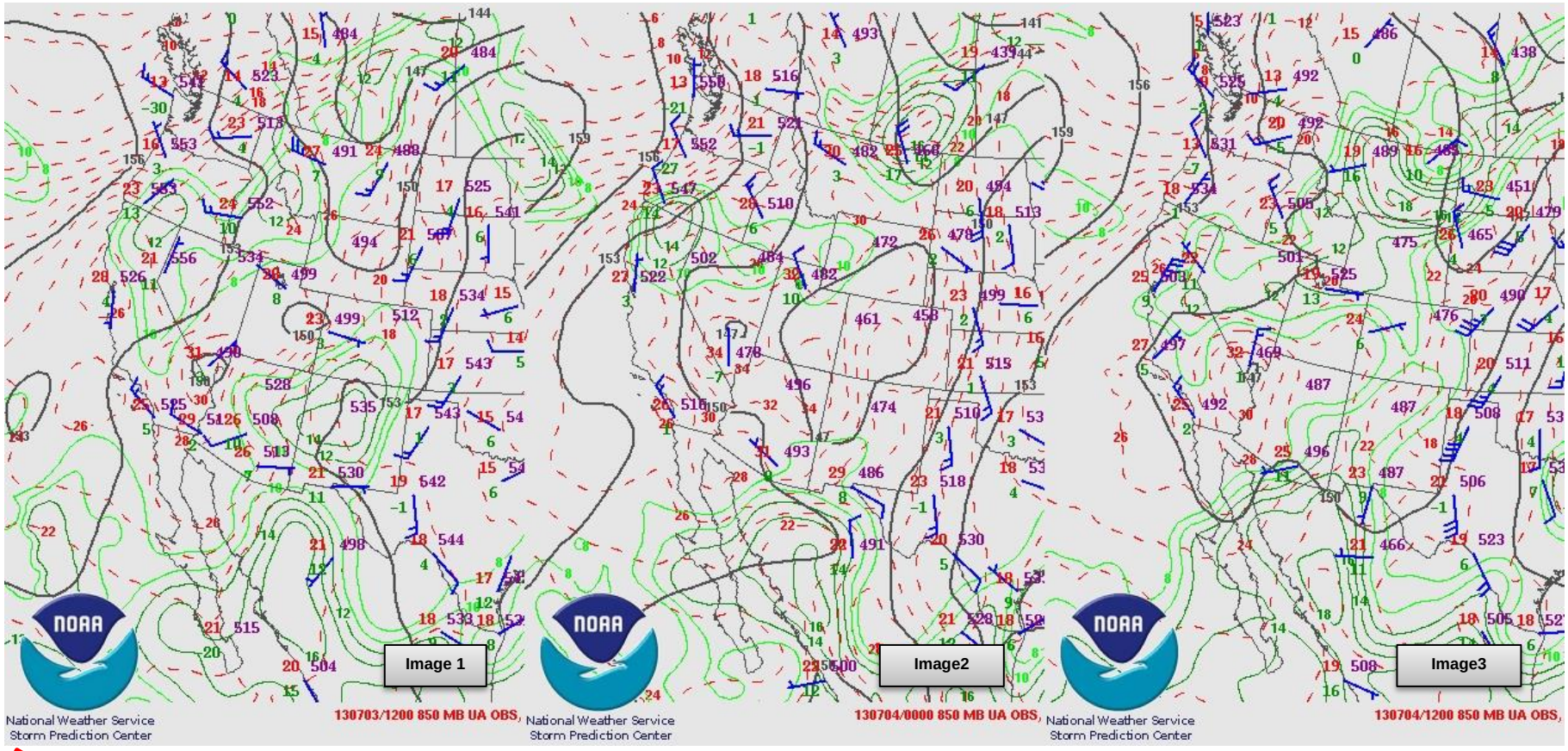
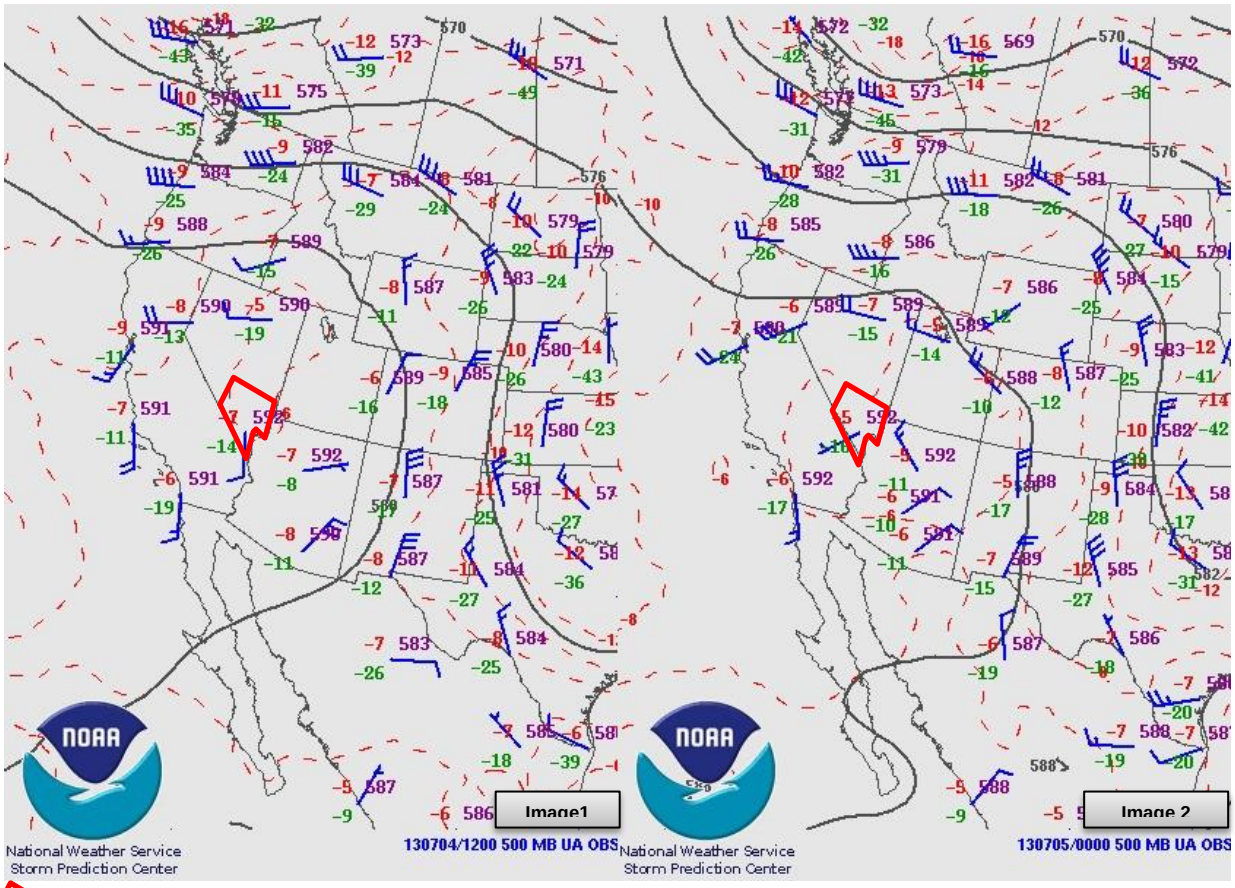


Figure 2-5. 850mb Weather images for 7/3/13.



Represents Clark County, NV

Figure 2-6. 850mb Weather Images for 7/3/13.



Represents Clark County, NV

Figure 2-7. NOAA 500mb storm prediction images for 7/4/13.

3.0 CLEAR CAUSAL RELATIONSHIP

3.1 INTRODUCTION

Smoke plumes from wildfires contain a variety of pollutants, including volatile organic compounds (VOCs) and oxides of nitrogen (NO_x)—precursor pollutants in the formation of ozone—and particulate organic and inorganic compounds. Wildfire smoke plumes affect air quality not only through the emissions of primary pollutants, such as CO (carbon monoxide), particulate matter, VOCs, and NO_x, but also through the production of secondary pollutants (i.e., ozone and secondary organic aerosols) when VOCs and NO_x undergo photochemical processing during atmospheric transport. Table 3-1 lists a range of pollutants emitted, expressed as emission factors, which are defined as the mass of compounds released per mass of dry fuel consumed. The table demonstrates that significant amounts of VOCs are released during wildfires. Total VOC emissions exceed those of $PM_{2.5}$, and account for 1 to 2 percent of the carbon fuel burned.

Table 3-1. Chemical compositions and emission factors for wildfires

Compound or Compound Class	Emission Factors (g/kg)	
	Temperate Forest	Temperate Rangeland
$PM_{2.5}$	11.7	9.7
Organic carbon (wt. percent of $PM_{2.5}$)	45 - 55	40 - 70
Elemental carbon (wt. percent of $PM_{2.5}$)	4 - 8	4 - 10
Elemental Species (wt. percent of $PM_{2.5}$):	~ 3	~ 6
• Potassium (K, wt. percent of $PM_{2.5}$)	~ 1	~ 3
• Chloride (Cl, wt. percent of $PM_{2.5}$)	0.3	2
CO	89.6 ± 13.2	69 ± 17
CO_2	1619 ± 112	1684± 45
Alkanes (C2-C10)	0.8	0.4
Alkenes (C2-C9)	2.2	1.8
Aromatics (BTEX)	0.64	0.42
Oxygenated VOCs:	10.9 – 12.9	N/A
• Methanol	0.31 – 2.03	0.14
• Formic acid	1.17	N/A
• Acetic acid	3.11	N/A
• Formaldehyde	2.25	N/A
• Acetaldehyde	0.24	0.25
• Acetone	0.347	0.25
• Acrolein (propenal)	0.123	0.08
• Furan	0.445	0.1
• 2-methyl-furan	0.521	N/A
• 3-methyl-furan	0.052	N/A
• 2,5-dimethyl-furan	0.053	N/A
• Benzofuran	0.038	N/A

N/A = not available; BTEX = benzene, toluene, ethylbenzene, and xylenes.

3.2 CAUSAL RELATIONSHIP

3.2.1 Meteorological Conditions

On July 2, a well-established Pacific Ridge dominated the southwest causing an easterly flow, at all levels, into Clark County. By July 3, the ridge – or high-pressure system – moved enough to the south to cause a directional change in flow from the northeast at all levels.

3.2.2 Laboratory Analysis of $PM_{2.5}$ Samples

Smoke plume impacts at the surface during the study period were determined by wildfire markers detected through laboratory analysis of $PM_{2.5}$ samples obtained from the Clark County monitoring network. Figure 3-1 shows the air quality monitoring sites within the County.

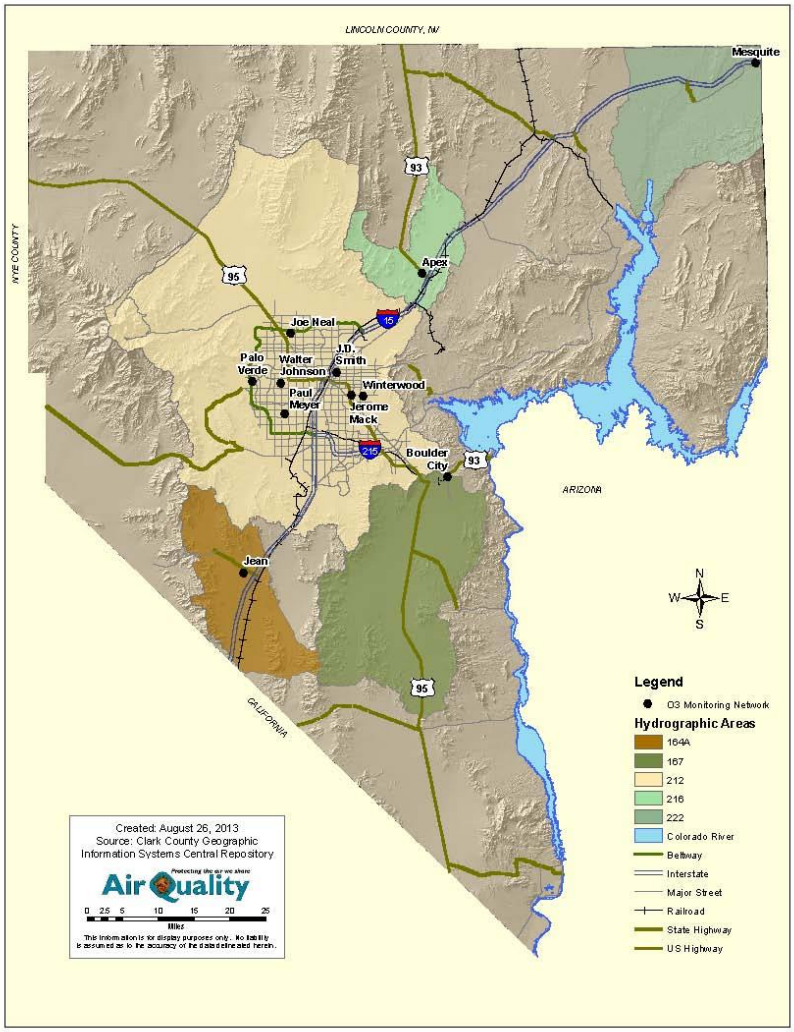


Figure 3-1. Clark County ozone monitoring network.

Levels of $PM_{2.5}$ track closely with those of levoglucosan, a unique tracer for burning biomass due to its relationship to cellulose. When heated to more than 300 °C, cellulose undergoes various pyrolytic processes that yield tarry anhydro-sugars and volatile products; these give rise to source-specific molecular tracers, primarily the 1,6-anhydride of glucose known as levoglucosan.

Although levoglucosan is widely reported to be abundant in biomass smoke compared to other organic compounds (Fine et al. 2001; Nolte et al. 2001; Schauer et al. 2001; Fine et al. 2002; Hays et al. 2002; Sheesley et al. 2003; Mazzolini et al. 2007), concentrations are highly variable. In Mazzoleni et al. (2007), the overall range of levoglucosan varied from 3 percent to 36 percent of $PM_{2.5}$ mass. The highest percentage was observed for grasses, white pine needles, straws, and mixed woods. Since wildfires typically consume a high percentage of these materials, the concentration of levoglucosan in wildfire emissions is significant in determining where a wildfire originated.

In addition to levoglucosan, methoxylated phenols (methoxyphenols) are often found in biomass combustion emissions and can be significant in determining where a smoke plume originated. Cellulose fibers in plants are bound together in lignin, a complex polymer. The pyrolysis of wood lignins gives rise to methoxyphenols, most often guaiacols and syringols. In the lignin of hardwoods, structural units of guaiacol and syringol are present in even proportions. In the lignin of softwoods, guaiacols are the predominant structural unit.

Mazzoleni et al. (2007) reported that sagebrush and grasses, like hardwoods, emit guaiacols and syringols in similar quantities; however, Mazzoleni noted that pine needles have a high particulate fraction of guaiacols with very few syringols, similar to softwoods. The prescribed burn samples he collected in mixed coniferous forests—Yosemite National Park, California and the Toiyabe National Forest near Lake Tahoe, Nevada—had a high percentage of particulate represented by guaiacols and a very low percentage represented by syringols, as hardwoods do. The prescribed burn samples of desert brushes from central rural Nevada had even percentages of guaiacols and syringols, similar to sagebrush. Mazzoleni et al. (2007) also identified methoxy acids originating from pyrolysis of wood lignin (e.g., vanillic, homovanillic, and syringic acids) in biomass combustion source samples and in-field prescribed burn samples. In general, methoxy acids were found in low abundance in wildland fuels.

In 2011, RTI International, in Research Triangle Park, North Carolina, analyzed six $PM_{2.5}$ filters for traces of levoglucosan to determine the background concentrations at the Jean and Jerome Mack monitoring sites. Three days (one in June, one in July, and one in August) without any fire impacts were chosen for the analysis. Table 3-2 shows the filter numbers and dates.

Table 3-2. Filter and Sample Days

Jerome Mack	Jean
FD-T0728928-110620	FD-T0728929-110620
FD-T0728978-110720	FD-T0728979-110720
FD-T0729017-110810	FD-T0729018-110810

The results of the analysis (outlined in Table 3-3) showed that there were no detectable levoglucosan concentrations for non-fire days, and therefore the background concentration for levoglucosan during non-fire days is zero.

Table 3-3. Filter Analysis Results

Sample Name	µg/mL
FD-T0728928-110620	0.000
FD-T0728929-110620	0.000
FD-T0728978-110720	0.000
FD-T0728979-110720	0.000
FD-T0729017-110810	0.000
FD-T0729018-110810	0.000

During the 2013 wildfire event, DAQ collected ambient $PM_{2.5}$ samples at Jerome Mack, Jean and Sunrise Acres; filter samples collected on July 3 were sent to RTI for analysis. Results of the analyses are listed in Table 3-4. Levoglucosan concentrations were elevated on July 3. The results show that the monitors were impacted at ground level by the smoke plume from the Carpenter 1 fire.

Table 3-4. Analyses Results for July 3

Sample ID	Site	Levoglucosan (µg)
T3536396	SA	0.000
T3536397	SA (col)	0.000
T3536398	JN	0.000
T3536399	JM	0.103

Levoglucocan levels were detected on the $PM_{2.5}$ filter from Jerome Mack, however, there were major technical problems at the Jerome Mack monitoring station. No values for CO, PM_{10} and $PM_{2.5}$ were recorded during the day, while only limited readings were recorded for O_3. Since levoglucosan is the most abundant, stable, and universal biomass burning emission marker, and levoglucosan concentrations were detected on the filters, it shows that the Las Valley Valley was impacted by smoke plumes from the Carpenter 1 fire.

3.2.3 Smoke Plume Trajectory Model

The Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model computes simple air parcel trajectories. Its calculation method is a hybrid between the Lagrangian approach, which uses a moving frame of reference as the air parcels move from their initial location, and the Eulerian approach, which uses a fixed three-dimensional grid as a frame of reference.

HYSPLIT back-trajectories show the path an air parcel took to reach an area. Applications include tracking and forecasting the release of radioactive material, volcanic ash, and wildfire smoke.

The HYSPLIT plots in Figures 3-2 show 24-hour back-trajectories for July 3. The 24-hour back-trajectories demonstrate that the air masses went directly over the fire and smoke plume and doubled back over Las Vegas.

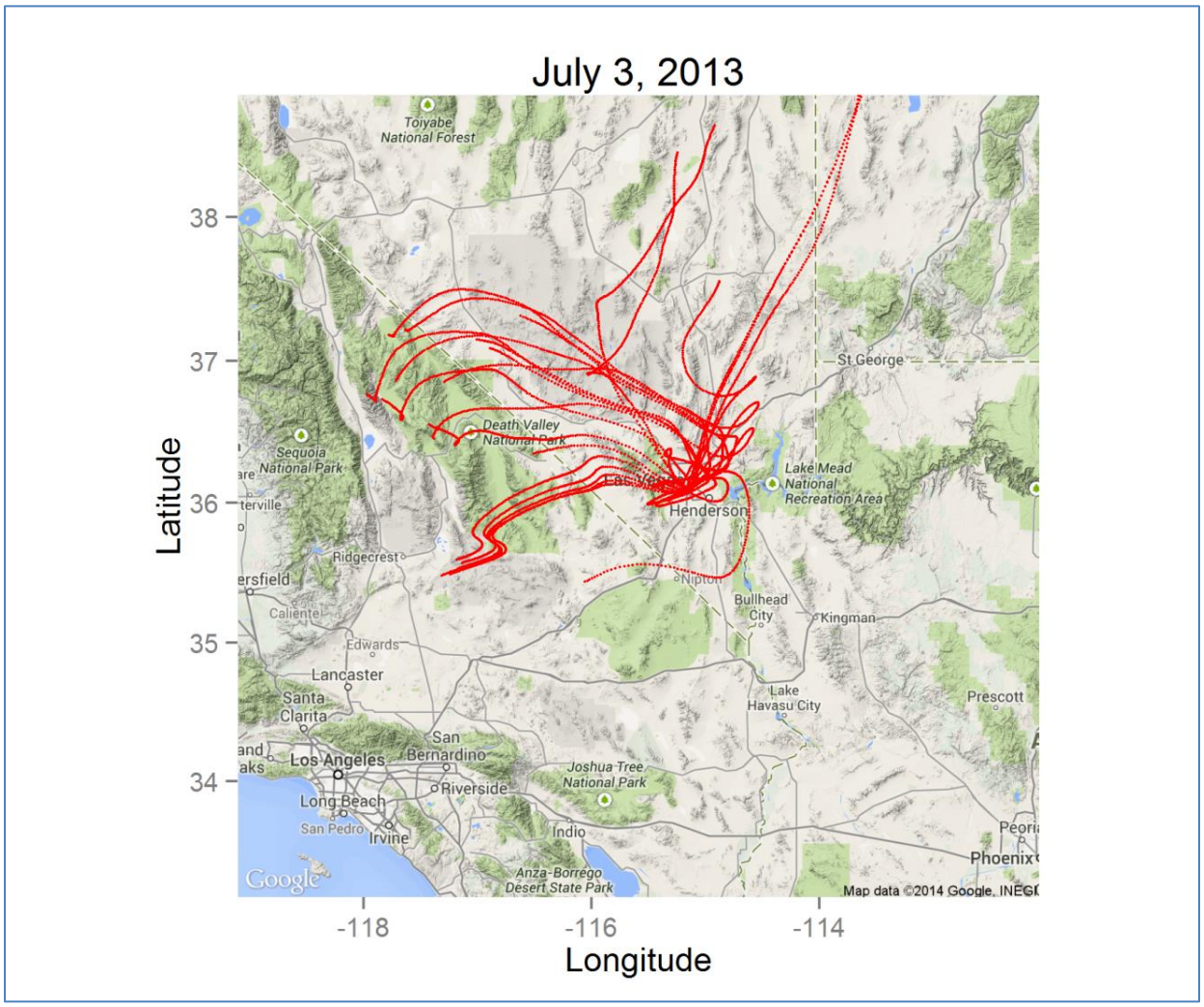


Figure 3-2. Back trajectories.

3.2.4 Pollutant Concentrations and Wildfire Impacts

Ozone concentrations started to increase at 9:00 at most stations within the network, with concentrations reaching 90 ppb at Walter Johnson and Paul Meyer at 14:00. A total of 4 out of eleven stations violated the O_3 NAAQS in Clark County. Table 3-5 lists all the hourly concentrations the ozone monitors in the network.

Table 3-5. Ozone Concentrations for July 3

Site	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Apex	32	30	44	33	30	*28*	31	45	55	60	61	60	66	69	68	70	67	67	61	46	56	47	45	44
Mesquite	42	36	35	*21*	26	23	28	36	45	48	49	52	52	53	53	53	52	51	49	43	49	41	34	21
Paul Meyer	45	36	27	*18*	31	21	33	43	56	64	75	**89**	**86**	**88**	**90**	**90**	**89**	**88**	**77**	56	49	49	44	47
Walter Johnson	44	37	32	27	27	*26*	36	45	54	60	74	**88**	**85**	**83**	**90**	**90**	**92**	**90**	**80**	53	50	49	46	51
Palo Verde	43	41	38	36	33	*23*	34	40	51	61	67	**80**	**90**	**83**	**82**	**91**	**89**	**82**	64	51	52	52	53	56
Joe Neal	46	41	42	39	40	*35*	36	49	55	59	65	75	**78**	**79**	**80**	**86**	**85**	**88**	**82**	61	54	48	45	50
Winterwood	48	51	44	43	35	22	*13*	34	49	52	56	58	58	60	62	62	63	61	59	41	33	34	45	45
Jerome Mack										54	57	60			66	64	66	66	61	37	*28*	36	45	43
Boulder City	49	48	46	44	43	*41*	43	48	51	57	61	62	64	65	67	67	67	66	60	55	57	53	47	47
Jean	55	52	52	51	50	*42*	46	53	54	57	59	63	66	67	67	68	64	61	56	53	49	47	61	52
JD Smith				19	*14*	24	35	47	55	63	63	63	64	71	75	**76**	**78**	74	72	34	19	46	46	45

Through this weight-of-evidence, this report shows that ozone concentrations on July 3 would not have exceeded the NAAQS "but for" the wildfires.

Figures 3-3 thru 3-6 illustrate the diurnal cycle for four ozone monitoring sites from July 1 thru July 7. On a normal day, ozone values climb in the morning, peak around noon, plateau through the afternoon, and recede in the early evening. The highest ozone concentration occurs during the most intense hours of sunlight, often referred to as the prime ozone cooking period. However, on July 3 the highest O_3 concentrations occurred in the early morning and throughout the evening.

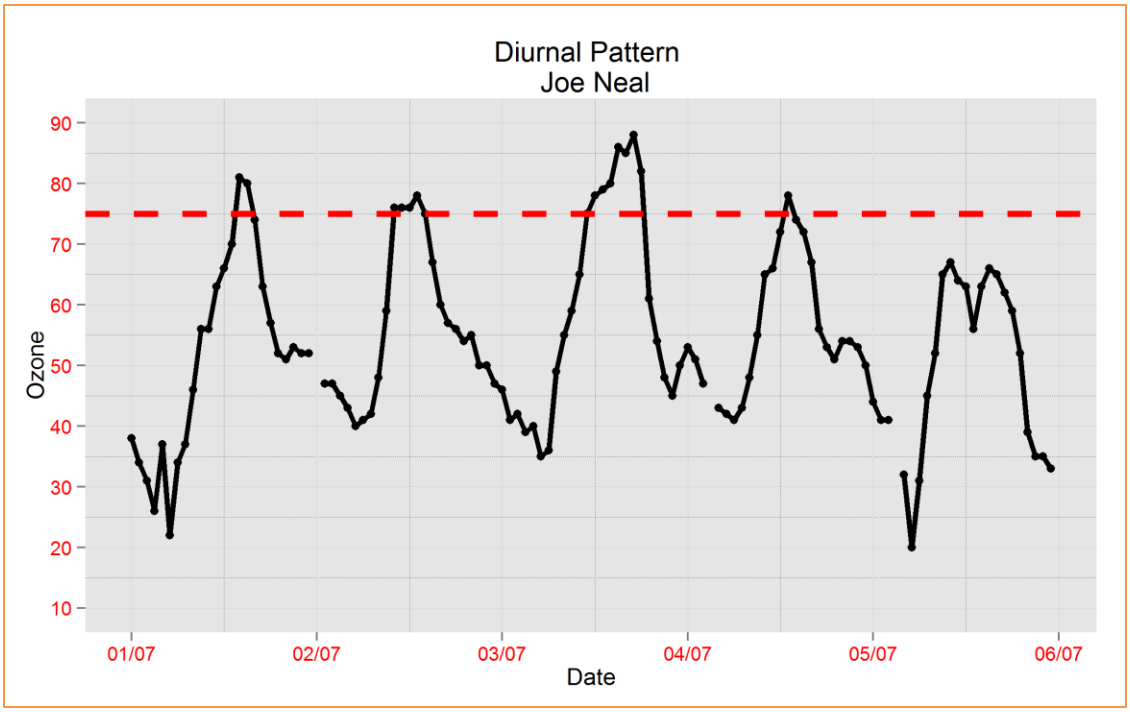


Figure 3-3. Diurnal Cycle for Joe Neal.

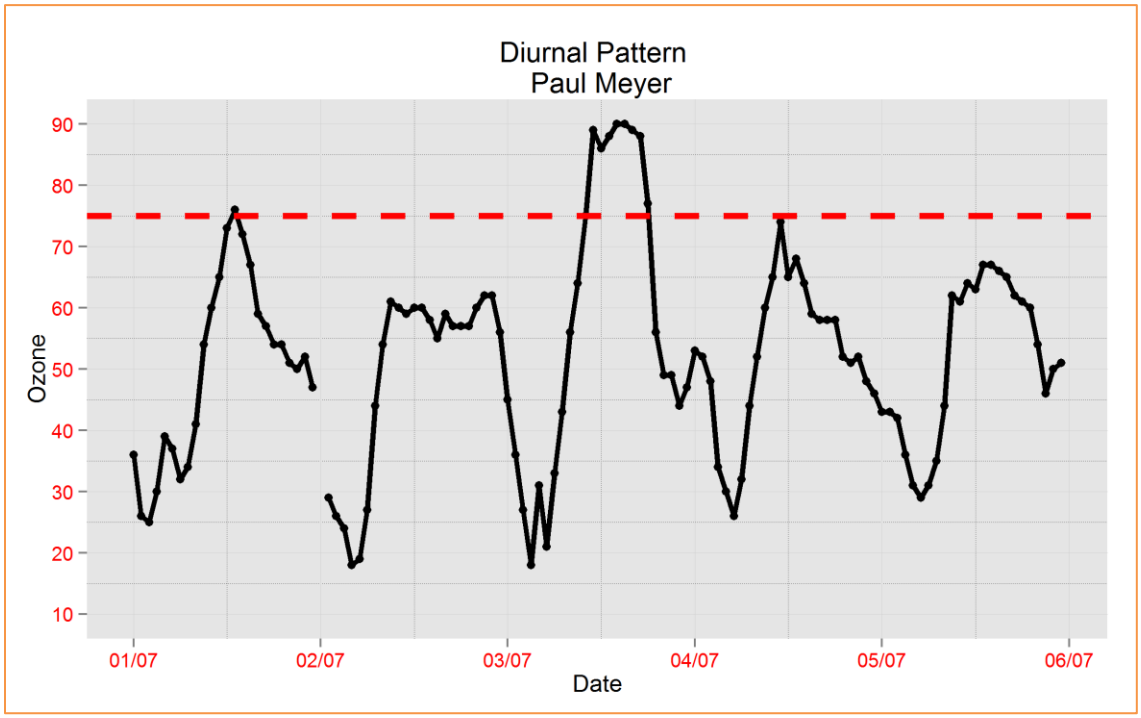


Figure 3-4. Diurnal Cycle for Paul Meyer.

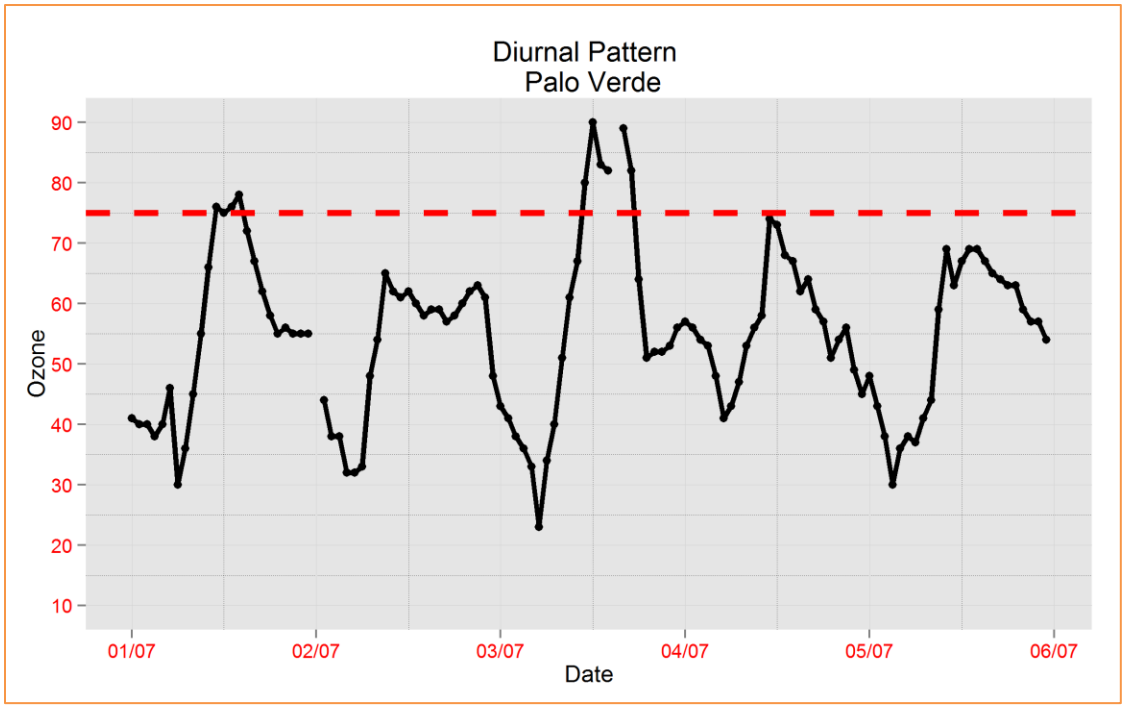


Figure 3-5. Diurnal Cycle for Palo Verde.

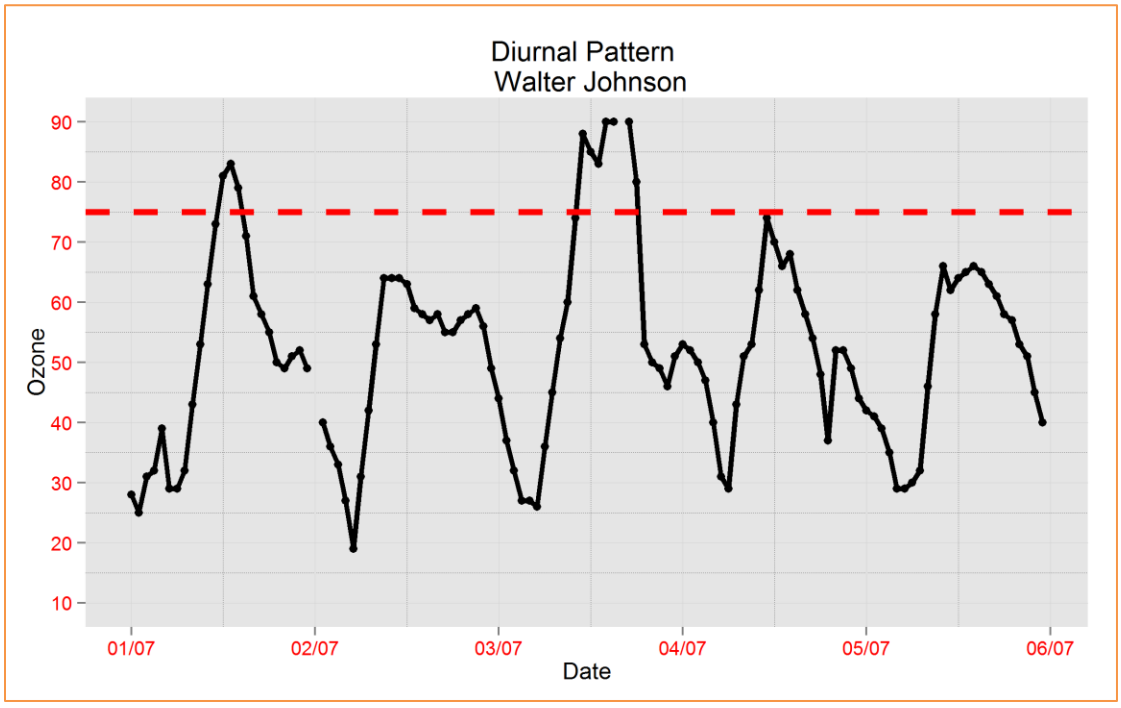


Figure 3-6. Diurnal Cycle for Walter Johnson.

To further illustrate that the ozone concentrations on July 3 were due to an exceptional event, $PM_{2.5}$, CO, O_3 concentrations were compared before, during, and after the event. The data shows the relationship between the different pollutants; this provides strong evidence that the elevated concentrations were due to the smoke from the wildfire, since these pollutants are the products of combustion. Figure 3-7 shows the time series for O_3, CO and $PM_{2.5}$ levels at J.D. Smith. All values were elevated on July 3, and remained high throughout the evening of July 4. The elevated $PM_{2.5}$ levels on July 4 were caused by fireworks during the Fourth of July celebrations.

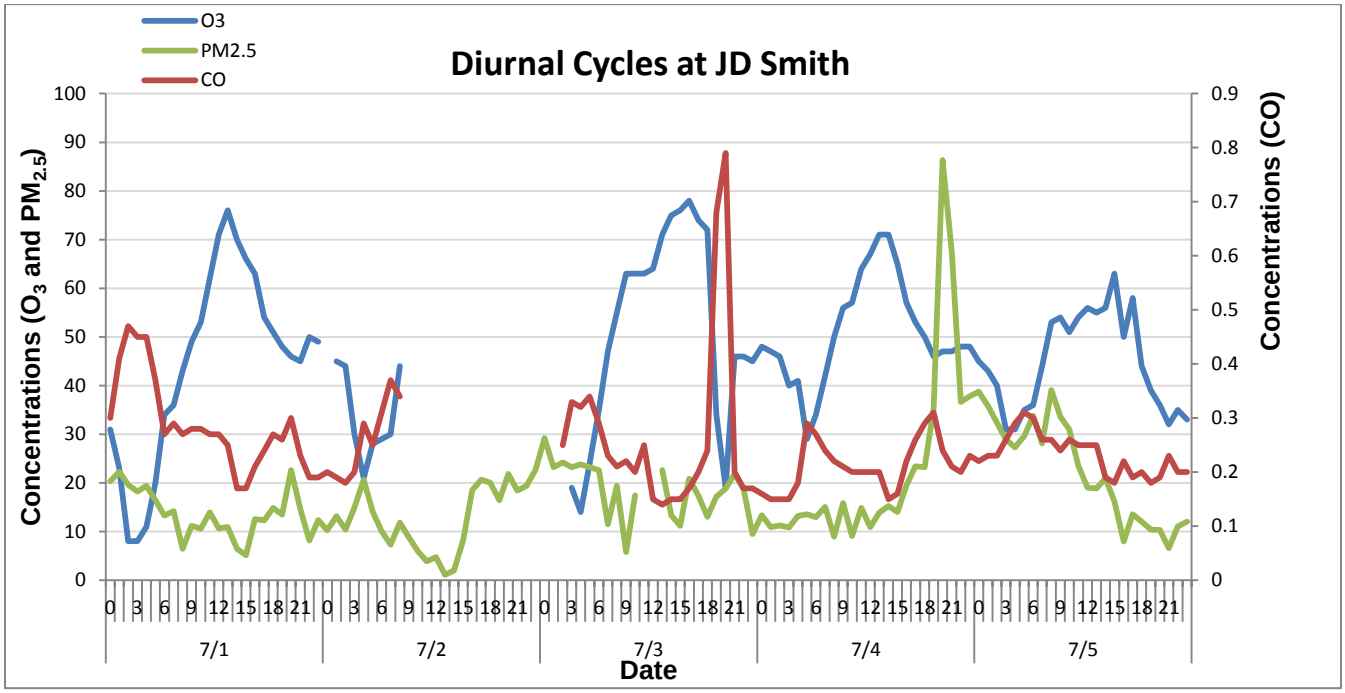


Figure 3-7. Diurnal Cycle at J.D. Smith.

Table 3-6 lists AQI values for O_3, CO, PM_{10} and $PM_{2.5}$ between July 1 and July 5, 2013. Figure 3-8 demonstrates how well the AQI values for ozone**,** $PM_{2.5}$ and CO tracked wildfire impacts. Concentrations of the three pollutants were elevated on wildfire days, providing strong evidence of the causal effect from the wildfires.

Table 3-6. Pollutant AQI Values

Date	PM_{10}	O3	$PM_{2.5}$	CO
1-Jul	40	87	54	3
2-Jul	33	77	58	3
3-Jul	54	129	64	5
4-Jul	52	77	72	5
5-Jul	57	77	73	3

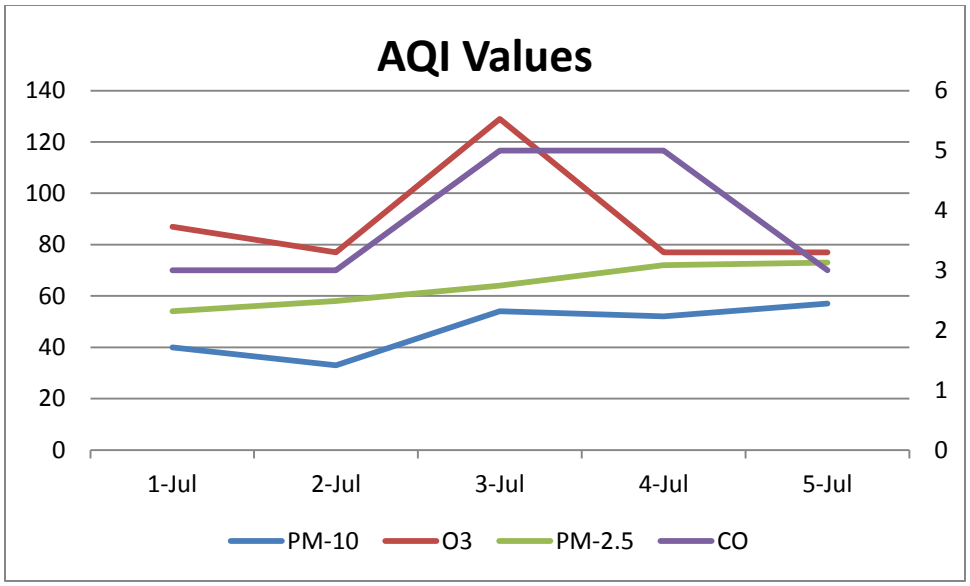


Figure 3-8. Correlation for 7/1/13 through 7/5/13.

3.3 OZONE CONCENTRATIONS RELATIVE TO HISTORICAL FLUCTUATIONS

In the preamble to the final EER, EPA states that the magnitude of measured concentrations on days affected by an exceptional event relative to historical, temporally adjusted air quality levels can guide the level of analysis and documentation needed to demonstrate that the event affected air quality. For example, EPA acknowledges that for extremely high concentrations relative to historical values (e.g., concentrations greater than the 95th percentile), less documentation or evidence may be required to demonstrate that the event affected air quality. This "weight of evidence" approach reflects how the EPA has historically treated exceptional events.

On July 3, smoke plumes from the Carpenter 1 wildfire resulted in some of the highest ozone concentrations for the season for the Clark County air quality monitoring network. Hourly concentrations reached concentrations up to 92 ppb (see Table 3-5), while some of the highest MDA8 of the season were recorded at Paul Meyer and Walter Johnson (see Table 3-7).

Table 3-7. Four Highest Concentrations in 2013

Stations	Highest		Second Highest		Third Highest		Fourth Highest	
	Date	Value	Date	Value	Date	Value	Date	Value
Apex	6/21/2013	**78**	4/30/2013	**74**	5/5/2013	**73**	5/4/2013	**73**
Mesquite	5/22/2013	**68**	5/16/2013	**68**	6/21/2013	**67**	6/18/2013	**67**
Paul Meyer	7/3/2013	**87**	5/4/2013	**80**	5/25/2013	**76**	6/21/2013	**75**
Walter Johnson	7/3/2013	**87**	5/4/2013	**80**	5/25/2013	**75**	7/19/2013	**74**
Palo Verde	7/3/2013	**83**	5/4/2013	**82**	5/25/2013	**76**	7/19/2013	**74**
Joe Neal	7/3/2013	**81**	6/21/2013	**77**	5/4/2013	**77**	7/20/2013	**76**
Winterwood	5/4/2013	**76**	6/21/2013	**75**	5/25/2013	**73**	5/21/2013	**71**
Jerome Mack	5/4/2013	**74**	5/25/2013	**73**	6/21/2013	**72**	5/21/2013	**69**
Boulder City	6/21/2013	**74**	5/22/2013	**72**	5/21/2013	**72**	6/22/2013	**71**
Jean	5/4/2013	**84**	5/21/2013	**78**	5/25/2013	**76**	6/21/2013	**75**
JD Smith	6/21/2013	**76**	5/25/2013	**74**	5/4/2013	**74**	6/5/2013	**72**

Ozone concentrations recorded during the wildfire event were compared with temporally adjusted air quality levels for the previous three years (2010-2012). A four-year historical analysis was considered reasonable because attainment/non-attainment classifications are based on a three-year average, so ozone concentrations before 2010 would not reflect emission control programs implemented recently.

The technical analyses provided in this document, combined with documentation on the location and extent of the wildfire and laboratory analysis of $PM_{2.5}$ samples showing high concentrations of wildfire markers on July 3, 2013, demonstrate that elevated concentrations of ozone on this date is exceptional relative to historical fluctuations and was caused by wildfire impacts.

Figures 3-9 through 3-12 depict four years of MDA8 ozone data from five ozone monitoring sites, and show that concentrations on July 3 reflect an exceptional event.

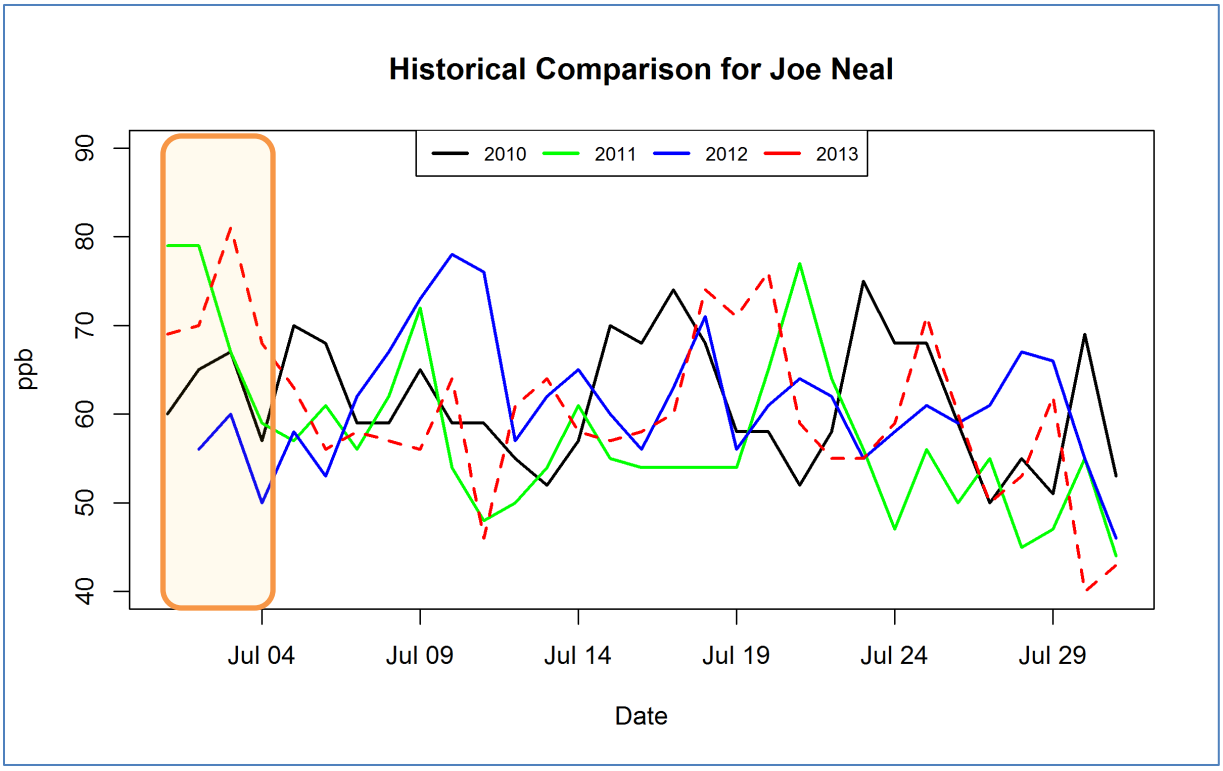


Figure 3-9. Four-Year Comparison for Joe Neal.

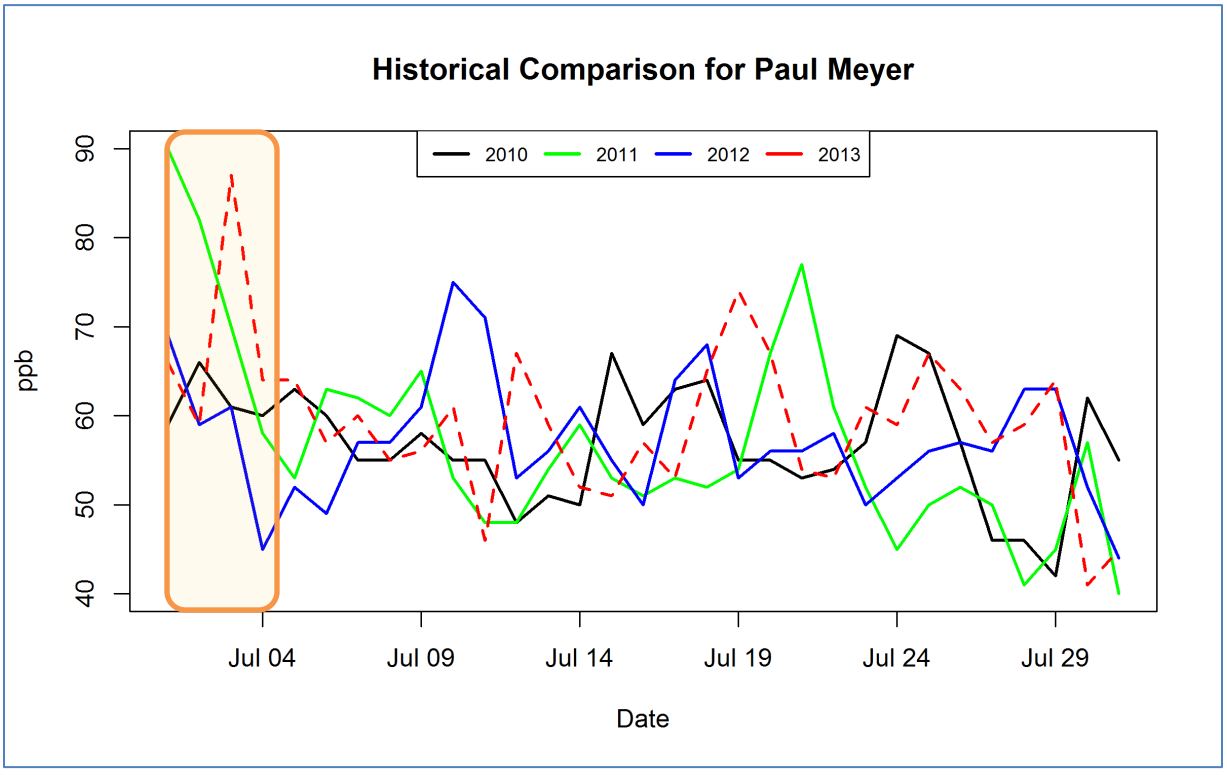


Figure 3-10. Four-Year Comparison for Paul Meyer.

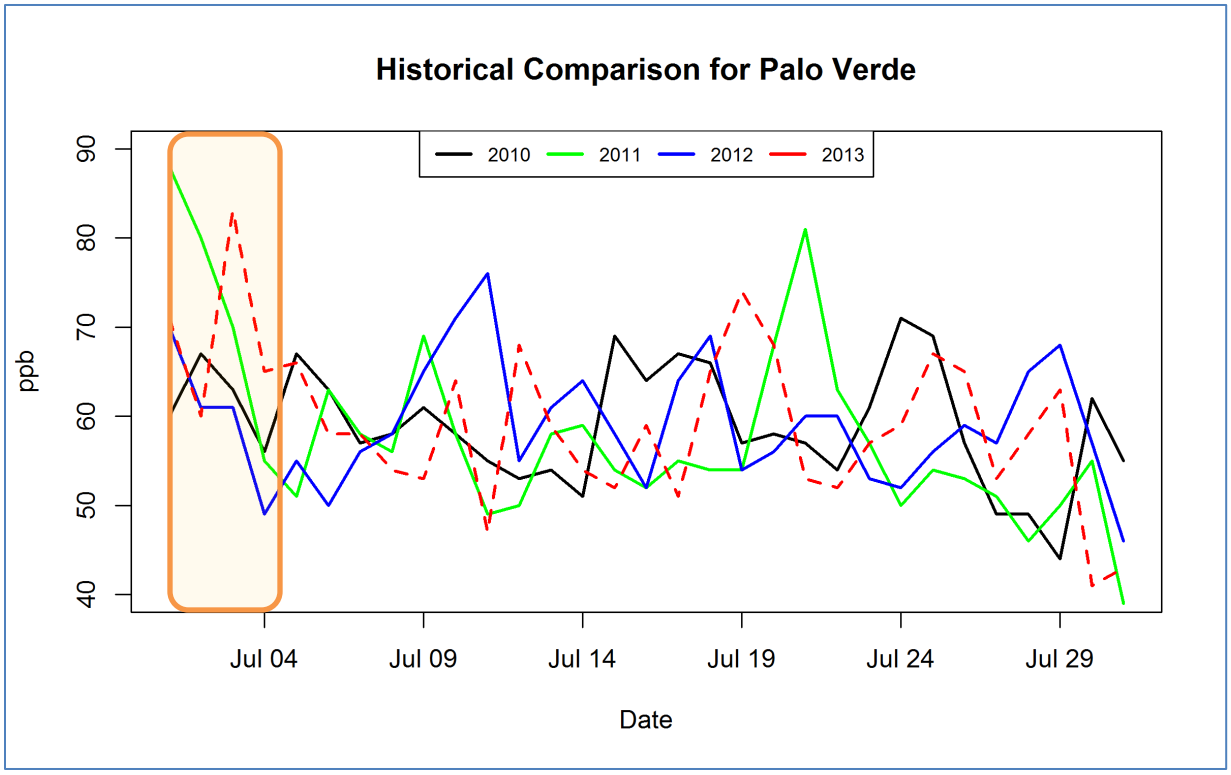


Figure 3-11. Four-Year Comparison for Palo Verde.

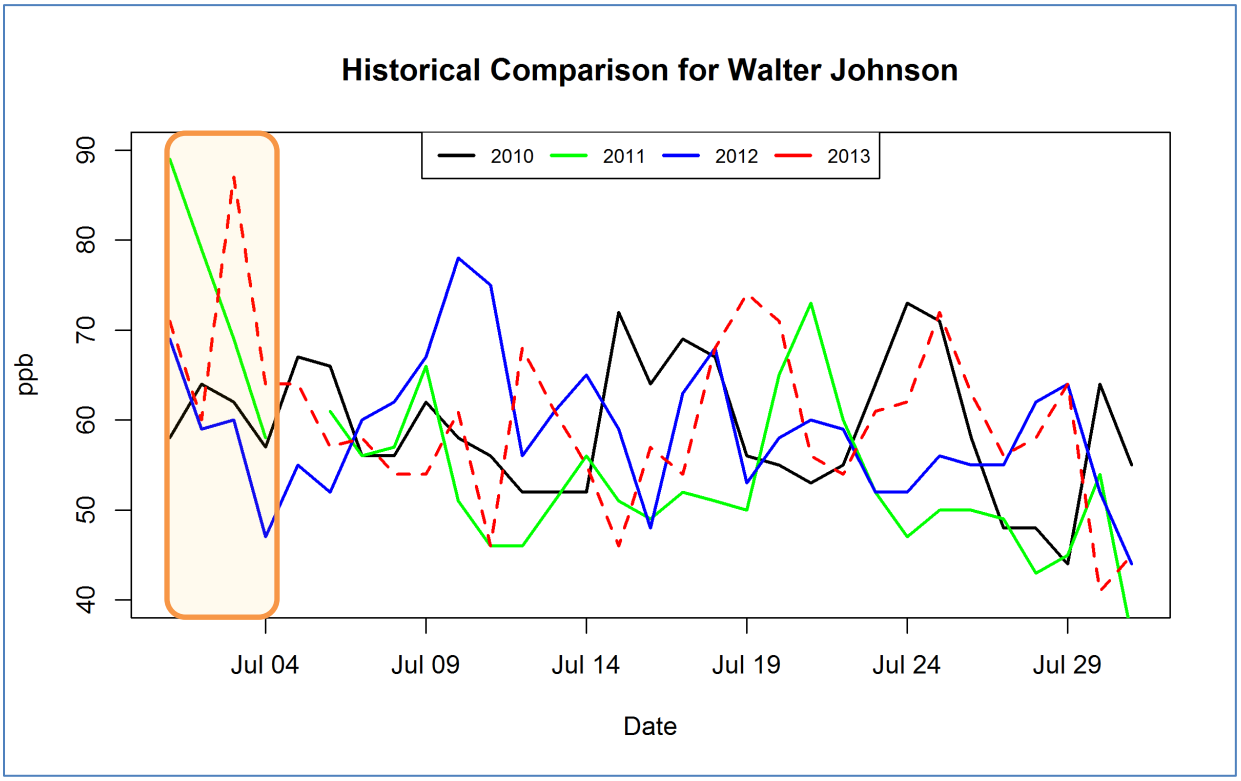


Figure 3-12. Four-Year Comparison for Walter Johnson.

For a statistical perspective, average MDA8 ozone concentrations were calculated for all days in July over the three-year period of 2010–2012. The data is plotted against the MDA8 concentrations for July 2013 (Figure 3-13). The MDA8 values for July 3 were much higher than the average of the three previous years.

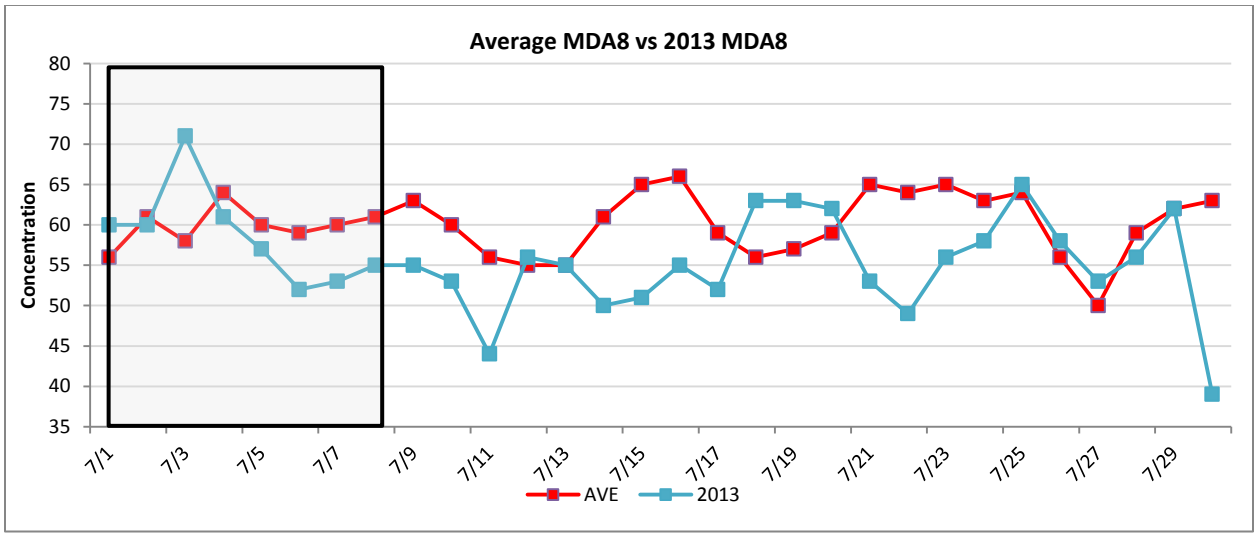


Figure 3-13. Three Year Average vs 2013.

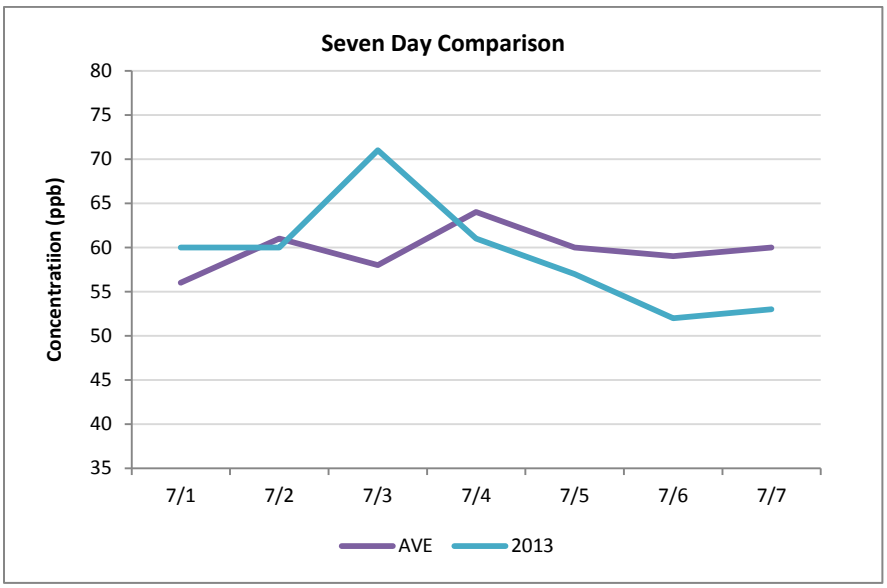


Figure 3-14. Seven Day Period.

During the 7-day period depicted in Figure 3-14, ozone concentrations on July 3 are 10 ppb higher than the average for that day during 2010-2012.

The following figures (3-15 through 3-18) show the AQI values for O_3, $PM_{2.5}$, and CO from July 1 to July 7 of each year during a 4-year period. As noted in previous sections, some years were

impacted by significant regional transport; however, O_3, $PM_{2.5}$, and CO never reached the AQI values they reached in 2013. The data show that concentrations for the event on July 3 were exceptional high.

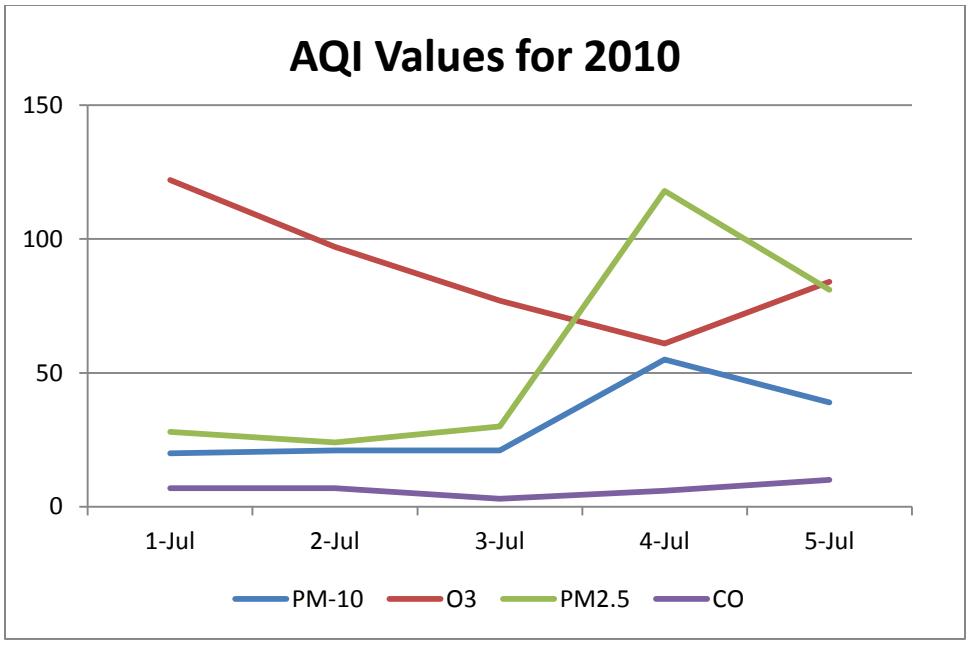


Figure 3-15. O3, CO, and $PM_{2.5}$ Concentrations in 2010.

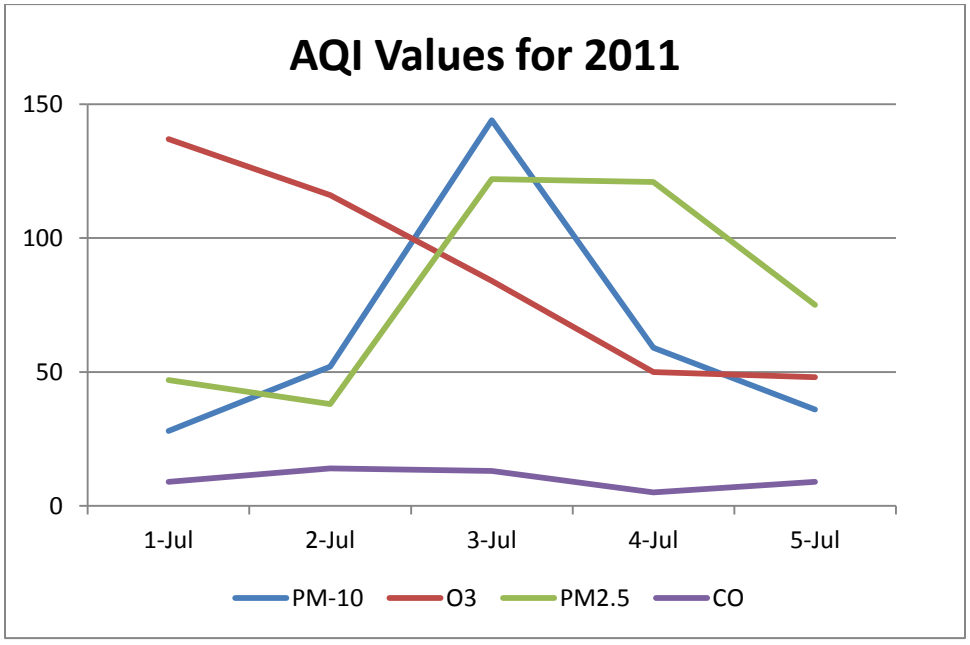


Figure 3-16. O3, CO, and $PM_{2.5}$ Concentrations in 2011.

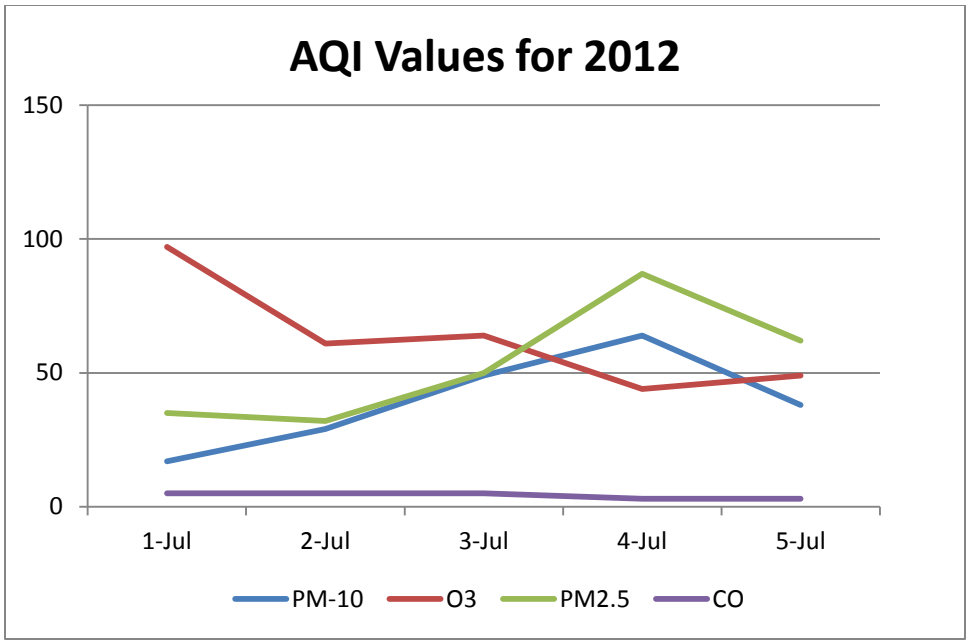


Figure 3-17. O3, CO, and $PM_{2.5}$ Concentrations in 2012.

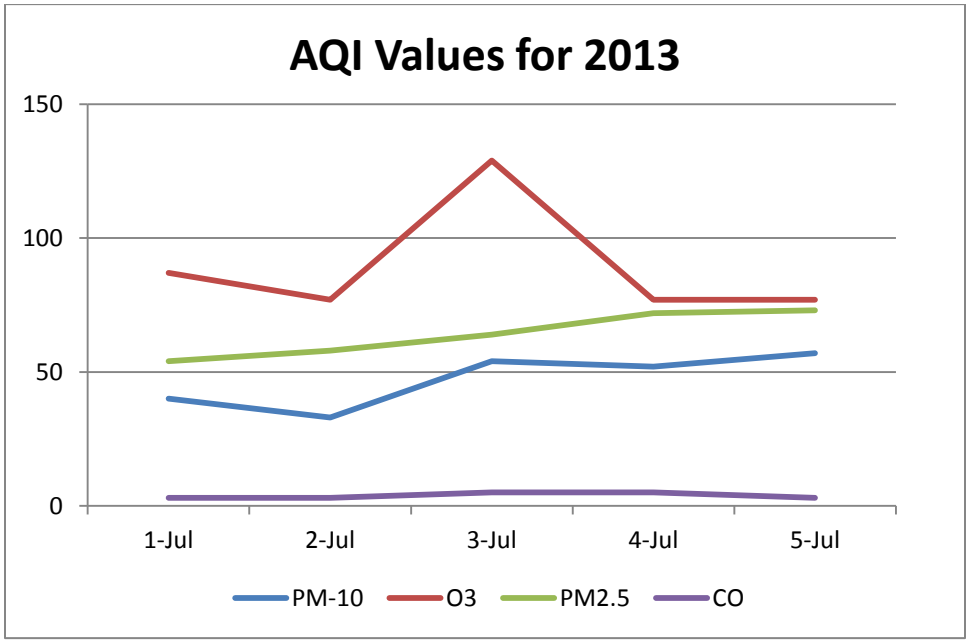


Figure 3-18. O3, CO, and $PM_{2.5}$ Concentrations in 2013.

4.0 THE "BUT FOR" ARGUMENT

4.1 METEOROLOGICAL PARAMETERS AND VISIBILITY CAMERAS

Meteorology is an important variable affecting air quality. Wind patterns maintained smoke plume impacts in southern Nevada during the wildfire episode, weather data in Figure 4-1 show a remarkably consistent weather pattern before and after the exceptional event. Local anthropogenic emissions of ozone precursor pollutants did not exceed normal weekday or weekend levels. The difference during this period is the accumulation of the wildfire smoke plume, exacerbating ozone concentrations in Clark County.

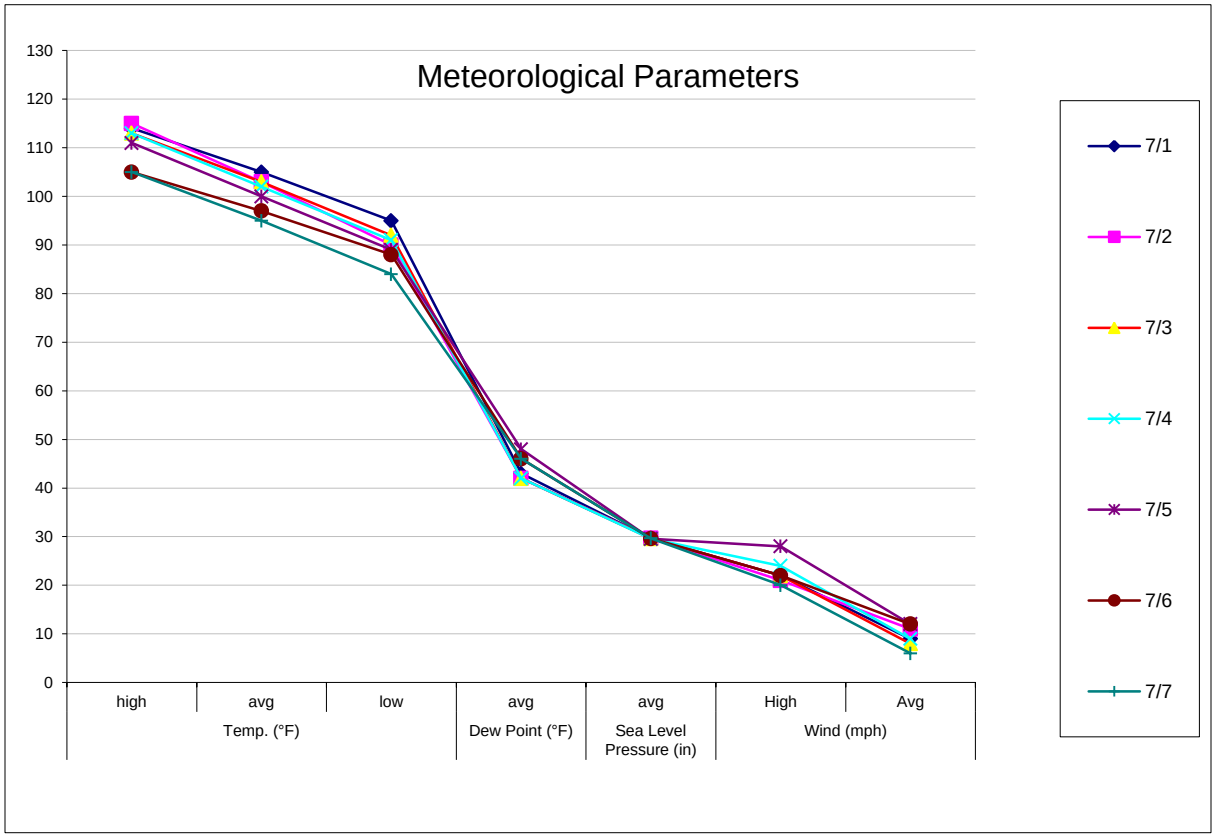


Figure 4-1. Weather Data for July 1 thru July 7, 2013.

Documentation provided in previous sections show that the ozone exceedances on July 3, 2013 would not have occurred but for the Carpenter 1 fire in Clark County NV.

The 24-hour backward trajectory in Figure 4-2 shows air mass on July 3 crossed path with the smoke plume from the fire.

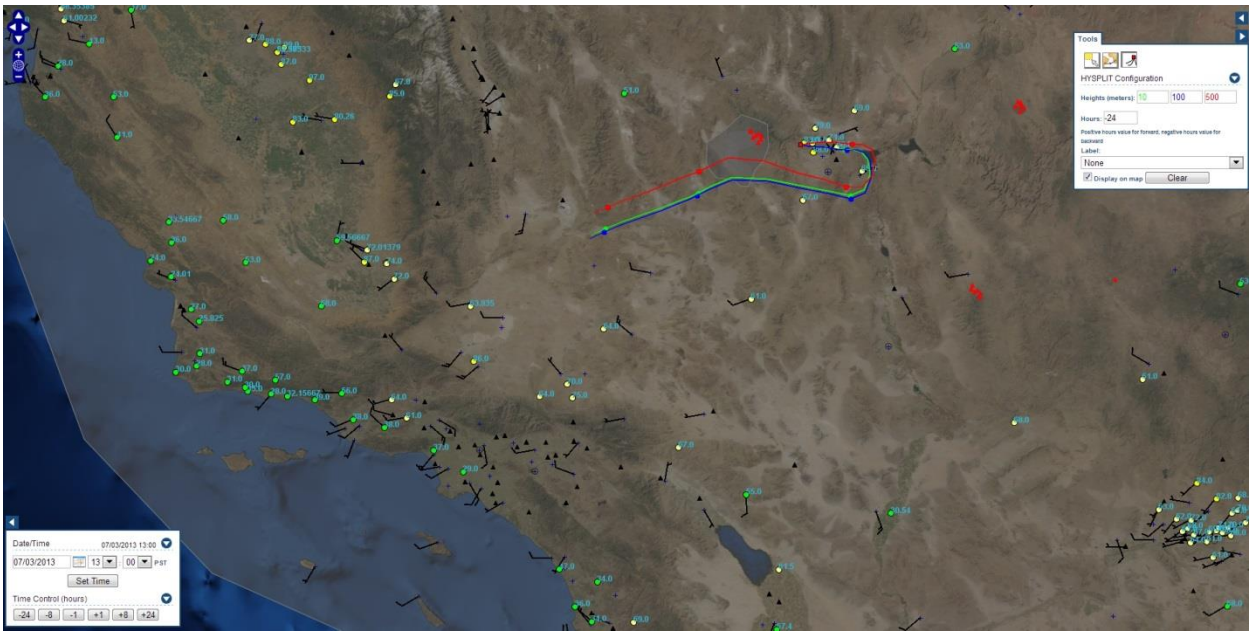


Figure 4-2. Forward Trajectory from Carpenter 1 Fire area.

Visibility cameras at the North Las Vegas Airport capture pictures of the Downtown area every 15 minutes. Figure 4-3 shows a picture taken on a no-fire day (May 14) at 18:00. Landmarks such as the Desert Hills and the Potosi Mountain are clearly visible.

The pictures in Figures 4-4 and 4-5 were taken in the afternoon of July 3. These pictures are taken looking South. The landmarks are not as visible as on a non-fire day.

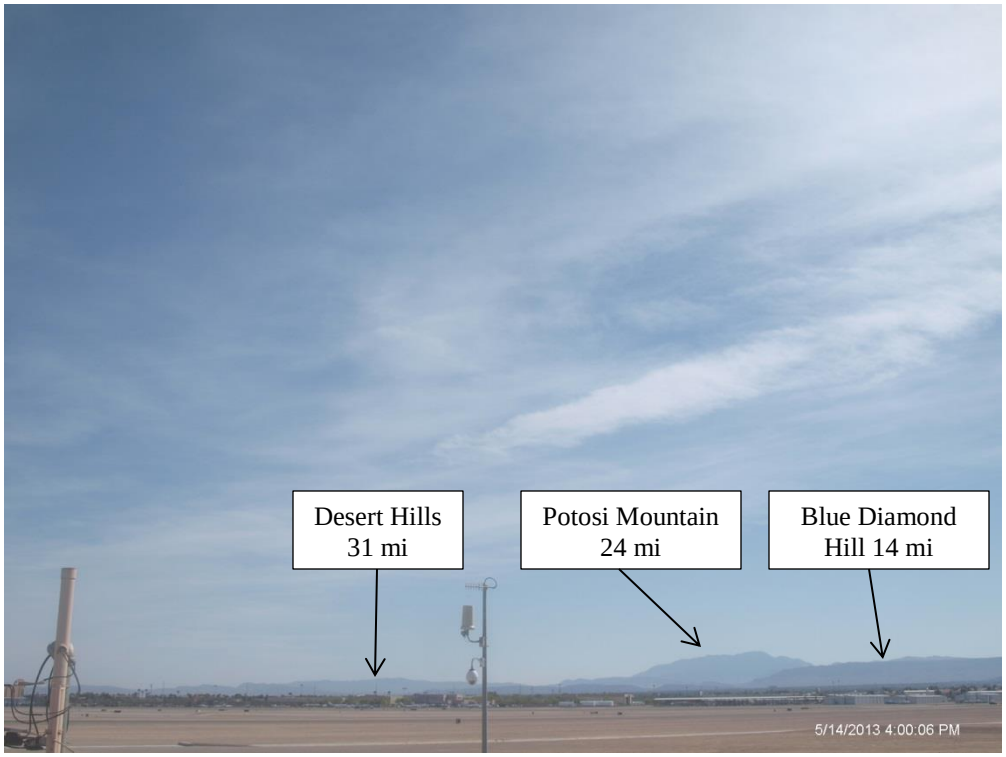


Figure 4-3. Visibility a on No fire Day.

Figure 4-4. Visibility on July 3, at 16:00.

Figure 4-5. Visibility on July 3, at 17:00.

4.2 OZONE CONCENTRATION CALCULATIONS

4.2.1 Average Concentrations

In this method, the average daily ozone concentration is calculated for each monitoring site, excluding July 3, for the period of July 1 to July 5. This calculated average concentration is a reasonable surrogate value for what would have occurred on July 3 given consistent weather patterns and normal local anthropogenic emissions, but no smoke impacts. Table 4-1 provides the average calculated concentration for July 3. Under this approach, average ozone concentrations for the exceptional event day vary from 51–67 ppb throughout the monitoring network.

Table 4-1. Calculated Average for July 3, 2013

Date	AP	MS	PM	WJ	PV	JO	WW	JM	BC	JN	JD
1-Jul	56	50	66	71	71	69	53		51	58	64
2-Jul	62	52	59	60	60	70	60		56	60	64
3-Jul	58	51	63	64	65	67	55	54	53	60	61
4-Jul	62	53	64	64	65	68	59	59	59	59	63
5-Jul	52	52	64	64	66	63	49	49	49	66	55

4.2.2 Interpolation

Interpolation is a method of constructing new data points within the range of a set of known data points. This application assumed that the data points for July 3 were missing and used linear interpolation to estimate their values. As shown in Table 4-2, this method yields a minimum concentration of 53 ppb and a maximum concentration of 69 ppb.

Table 4-2. Interpolated Values for July 3, 2013

Date	AP	MS	PM	WJ	PV	JO	WW	JM	BC	JN	JD
2-Jul	62	52	59	60	60	70	60		56	60	64
3-Jul	62	53	62	62	63	69	60		58	60	64
4-Jul	62	53	64	64	65	68	59	59	59	59	63

4.3 SATELLITE IMAGERY

4.3.1 Aerosol Optical Depth (AOD) and Aerosol Optical Thickness (AOT)[3]

These optical measurements of light extinction are used to represent the aerosol amount in the entire column of the atmosphere. The optical depth expresses the quantity of light removed from a beam by scattering or absorption during its path through a medium. AOD is a unitless quantity.

Sample AOD values		Equivalent $PM_{2.5}$ values
0.02	very clean isolated areas	~ 1 μm^{-3}
0.2	fairly clean urban area	~ 12 μm^{-3}
0.4	somewhat polluted urban area	~ 24 μm^{-3}
0.6	fairly polluted area	~ 36 μm^{-3}
1.5	heavy biomass burning or dust event	~ 90 μm^{-3}

The higher the AOD value, the more polluted the area is. Figures 4-6 and 4-7 show the AOD for July 3, the AOD value for the Las Vegas area is between 0.58 and 0.74 which means it is a fairly polluted area. This is also in agreement with Figure 1-3, which shows the $PM_{2.5}$ concentrations over a three day period.

[3] http://disc.sci.gsfc.nasa.gov/giovanni/

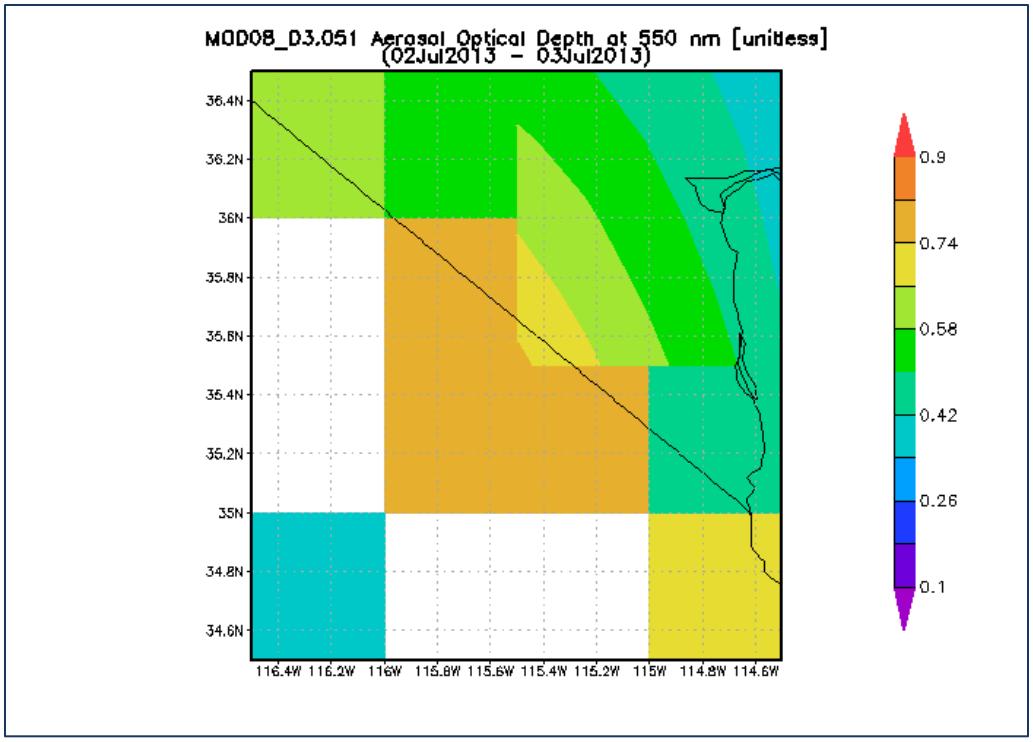


Figure 4-6. AOD for July 3.

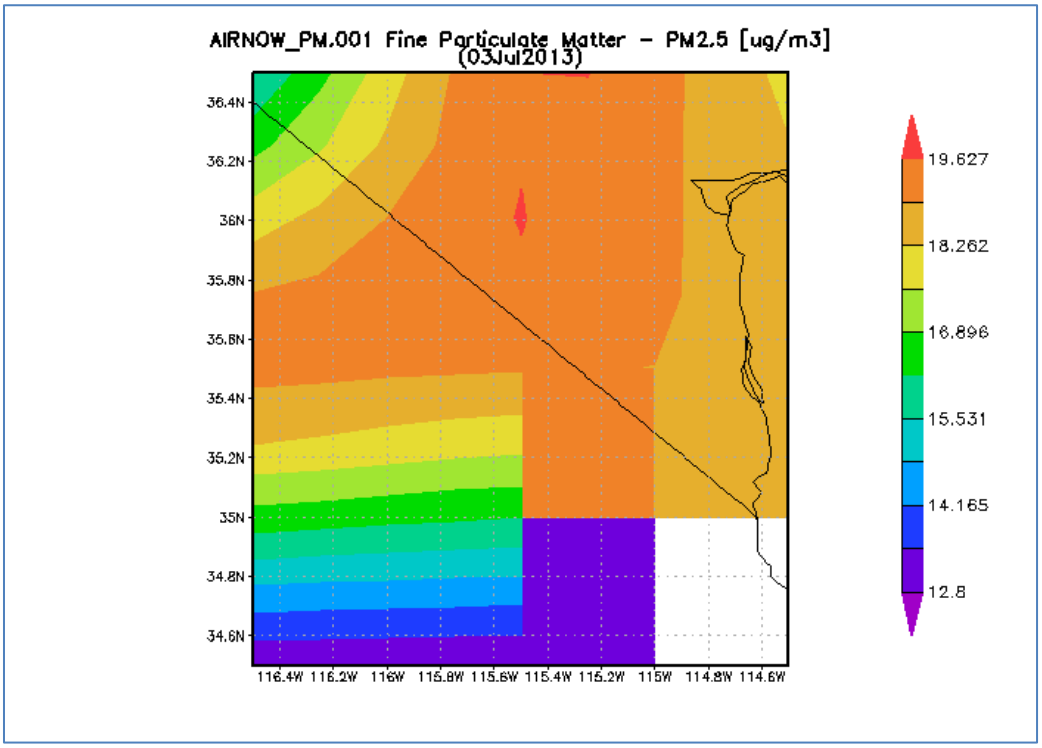


Figure 4-7. The $PM_{2.5}$ AOD for July 3.

4.3.2 AERONET Data

The AERONET (AErosol RObotic NETwork) program is a federation of ground-based remote sensing aerosol networks established by NASA and other institutions. The data shows the AOT for a daily or monthly timeframe. The AERONET site in Southern NV (see Figure 4-8) was severely impacted the smoke plumes from the fire.

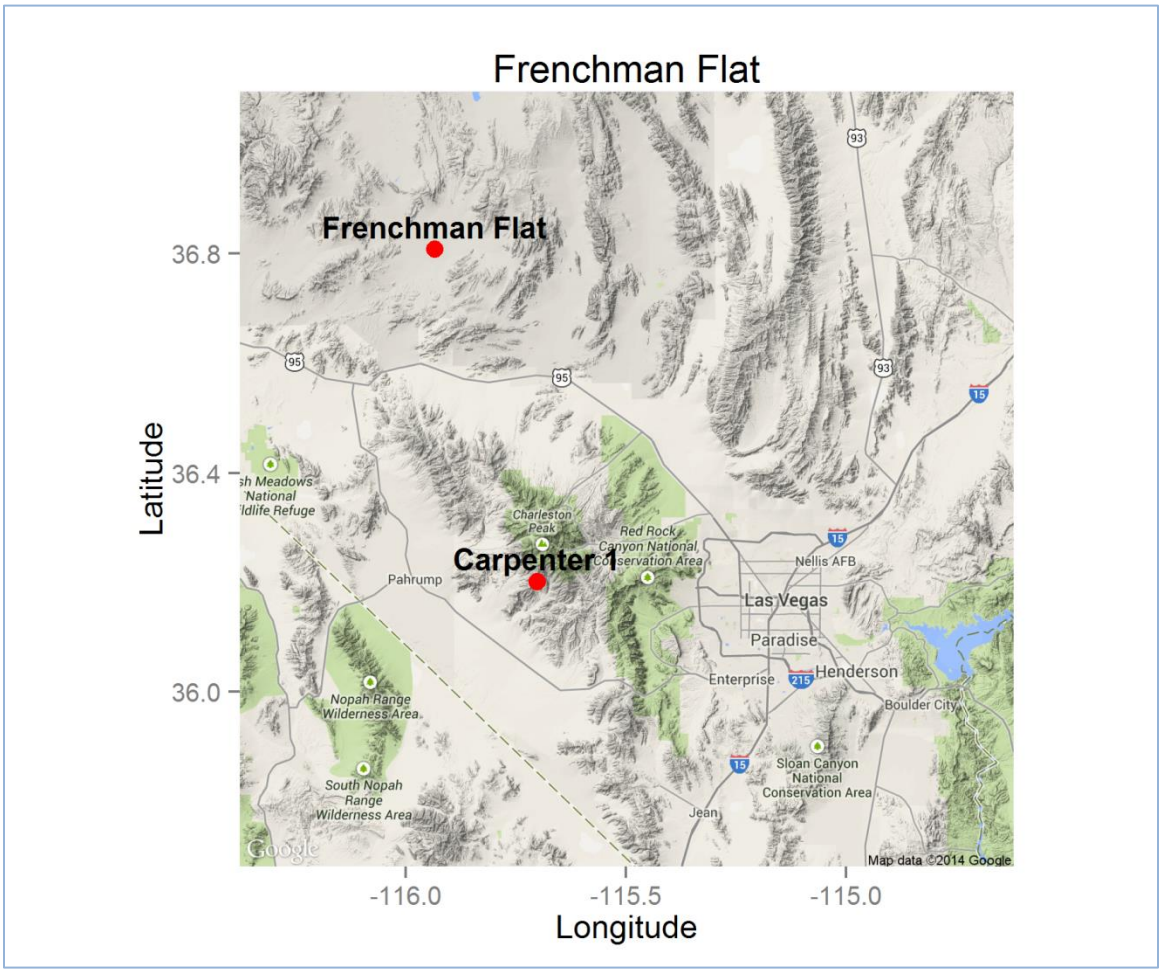


Figure 4-8. Location of Frenchman Flat Station.

http://aeronet.gsfc.nasa.gov/

The $PM_{2.5}$ readings for this station were some of the highest for the month of July.

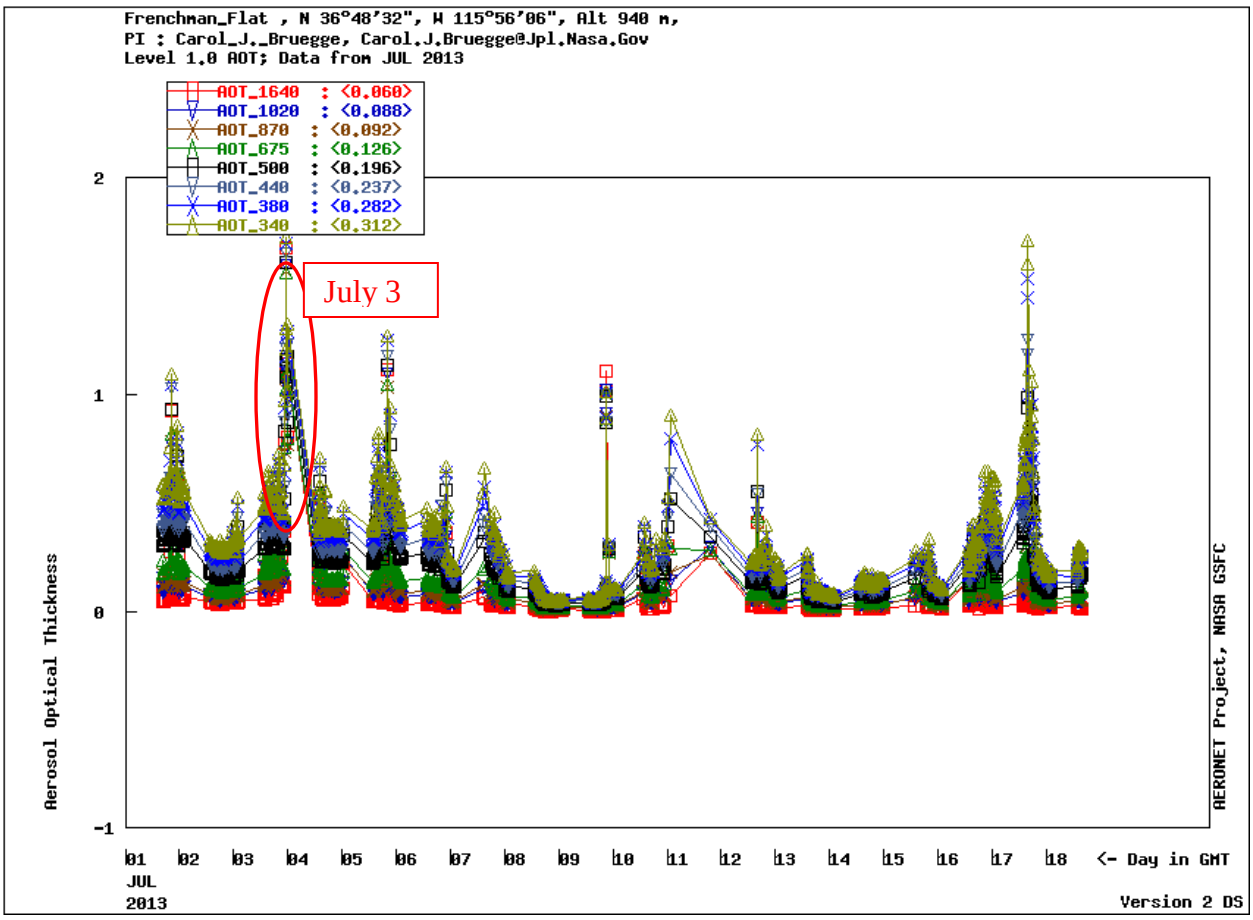


Figure 4-9. AOT for Frenchman Flat.

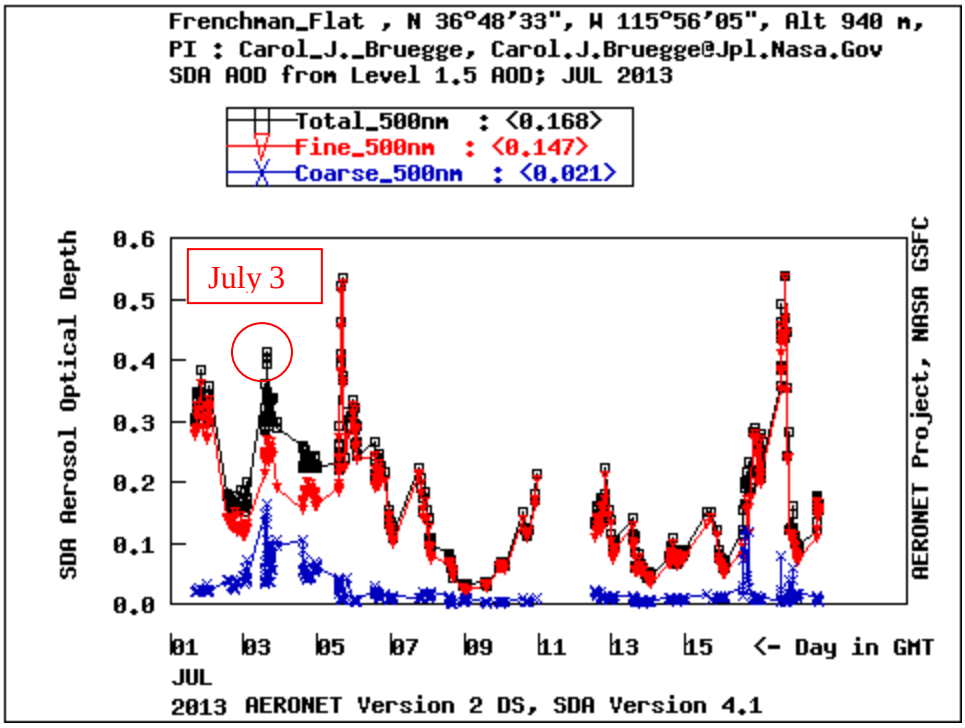


Figure 4-10. AOT for Railroad Valley.

Spectral Deconvolution Algorithm (SDA) effectively computes the Fine mode AOD in mixed cloud-smoke observations.

4.3.3 Site Specific Time-series and Correlations of AOD and Surface $PM_{2.5}$

The site specific MODIS/GASP (GOES Aerosol/Smoke Product) AOD/ $PM_{2.5}$ mass concentration plot details the temporal behavior of the measurements made at a specific monitoring site location. Correlations between the MODIS/GASP AOD observations and $PM_{2.5}$ measurements are also reported. The left vertical axis is mass concentration of $PM_{2.5}$ (scale 0 - 100) and the right vertical axis is MODIS/GASP aerosol optical depth (scale 0.0 - 1.6). The graph in Figure 4-11 shows the data for JD Smith. The graph shows a high concentration of $PM_{2.5}$ and a high AOD on July 3. This data proves that smoke was impacting the monitoring sites. (http://www.star.nesdis.noaa.gov/smcd/spb/aq/)

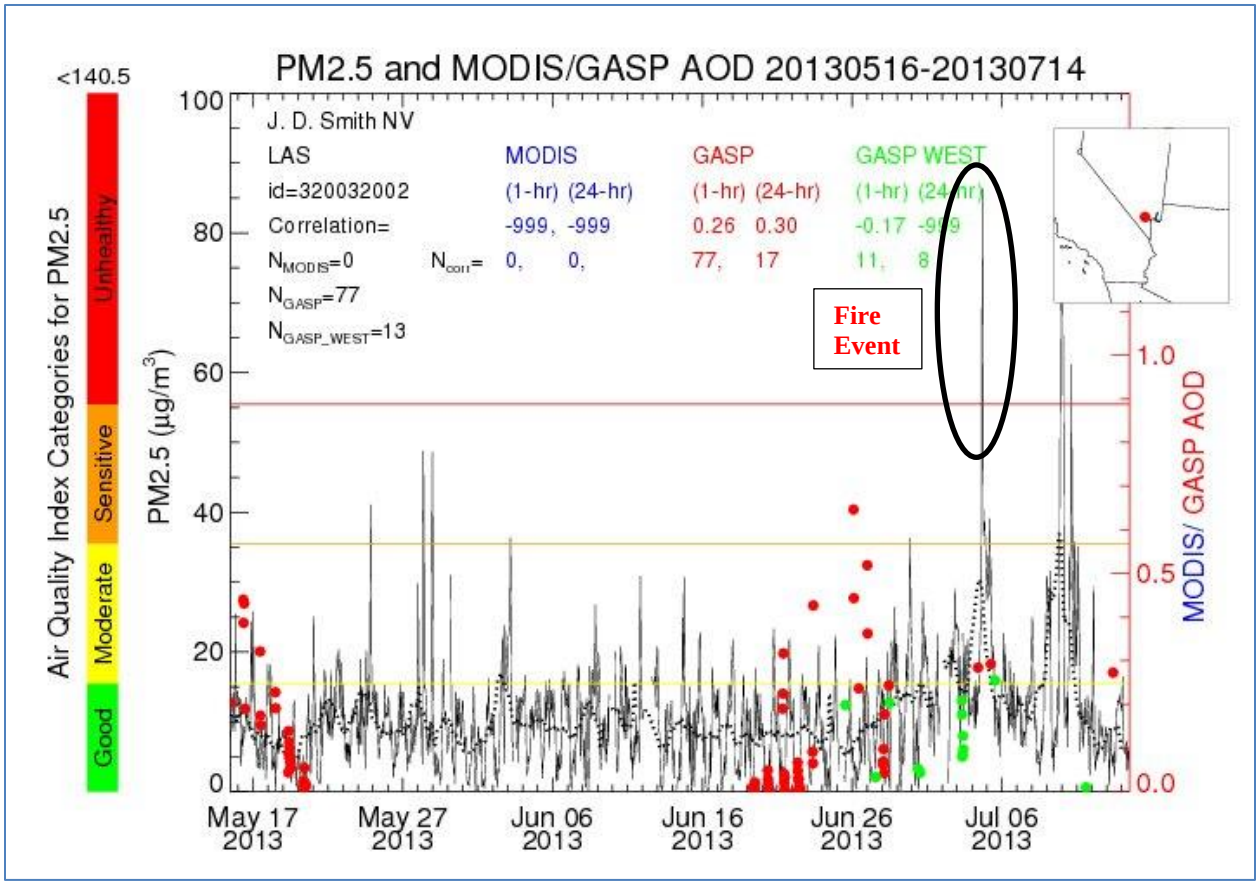


Figure 4-11. Data for JD Smith.

5.0 PUBLIC OUTREACH AND EDUCATION IN RESPONSE TO THE EXCEPTIONAL EVENT

DAQ has an education program to protect the public from adverse health problems associated with elevated pollutant levels. Its goals are to inform and educate the public on topics that include:

- How they can avoid exposure and minimize health impacts.
- How they can reduce their contributions to concentrations of the pollutant.
- What types of exceptional events may affect the area's air quality.
- When an exceptional event is imminent or occurring.

To meet these goals, DAQ conducts a comprehensive program that engages in local outreach events to provide information to the public. These include:

- Media press releases issued to the community as needed.
- School and youth outreach programs with classroom and youth group presentations, teacher training, and air quality information packets.
- Participation in community events (e.g., the Clark County Fair, Henderson Parade, Clark County Health and Wellness Fair).
- Training in air quality reporting for local weather anchors.
- Activities with city, county, and local environmental/health professionals to improve methods for reaching and educating the community.

DAQ also developed a notification system to contact at-risk populations, including:

- The Clark County School District.
- The Southern Nevada Health District.
- The Clark County Parks and Recreation Department.
- Local municipalities, i.e., the cities of Henderson, Las Vegas, North Las Vegas, and Boulder City.
- Local media (e.g., newspapers, radio and television stations).
- Sensitive individuals (through a notification service).

6.0 CONCLUSIONS AND RECOMMENDATION

This demonstration makes a clear and compelling case by weight of evidence that the ozone exceedance on July 3, 2013 was due to the influences of the Carpenter 1 fire on Mount Charleston. The demonstration also meets the requirements of the Exceptional Events Rule allowing the EPA to exclude ozone data for July 3, 2013.

The Tables and Figures used in this report depict the relationships between O_3, $PM_{2.5}$, CO on July 3, as well as days prior and after the event. Figure 4-1 demonstrates that temperature, humidity, and wind speeds had little influence on the ambient levels of ozone, $PM_{2.5}$, and CO during the subject period. Figure 3-7 depicts a clear causal relationship between the ambient levels of O_3, $PM_{2.5}$ and CO during the event. A strong correlation between O_3, $PM_{2.5}$ and levoglucosan prove that the smoke plume reached ground level and impacted the NAAQS. The high AQI for ozone, $PM_{2.5}$, and CO values tracked nearly identically and were elevated proportionately on the wildfire smoke intrusion days.

In addition, this demonstration also analyzed the hourly AQI values for O_3, $PM_{2.5}$, and CO in Figure 3-8. Diurnal patterns depicted in Figures 3-3 thru 3-6 show the variation in diurnal patterns between the non-fire days and the fire day. Section 3.3 shows the historical fluctuation for 4 years, Ozone concentrations were never as high as in 2013 for this episode. Although Clark County experienced high O_3 concentrations in May, several high concentration days are contribute to regional or international transport. Since "transport" is not considered an exceptional event, these days are not addressed in this document.

Furthermore, back trajectories and weather (wind) data show that Clark County was impacted by the smoke plume. Additional satellite imagery shows that Southern Nevada was impacted by high levels of smoke and dust.

This demonstration contains information that Clark County took steps to protect the public health through release of a public advisory and cooperation with the local media.

Based on the information contained within this demonstration, EPA should exclude the ozone data for July 3, 2013 as an exceptional event in accordance with the Exceptional Event Rule.

7.0 REFERENCE

DAQEM 2006a. *Ozone Characterization Study.* Las Vegas, Nevada: Clark County Department of Air Quality and Environmental Management.

DAQEM 2006b. *Clark County Regional Ozone & Precursors Study.* Las Vegas, Nevada: Clark County Department of Air Quality and Environmental Management.

DAQEM 2008. *Southwest Desert/Las Vegas Ozone Transport Study (SLOTS).* Las Vegas, Nevada: Clark County Department of Air Quality and Environmental Management.

Junquera, V.; Russell, M.M; Vizuete, W.; Kimura, Y.; and Allen, D. 2005. "Wildfires in Eastern Texas in August and September 2000: Emissions, Aircraft Measurements, and Impact on Photochemistry." *Atmospheric Environment*, 39(27): 4983-4996. doi:10.1016/j.atmosenv.2005.05.004.

Lamb, B.; Chen, J.; O'Neill, S.; Avise, J.; Vaughan, J.; Larkin, S.; and Solomon, R. 2007. *Real-time Numerical Forecasting of Wildfire Emissions and Perturbations to Regional Air Quality.* Pullman, WA: Washington State University Laboratory for Atmospheric Research. http://lar.wsu.edu/airpact-3/Draft_Wildfires_AQ.pdf.

McKeen, S.A.; Wotawa, G.; Parrish, D.D.; Holloway, J.S.; Buhr, M.P.; Hübler, G.; Fehsenfeld, F.C.; and Meagher, J.F. 2002. "Ozone Production from Canadian Wildfires During June and July of 1995." *Journal of Geophysical Research*, 107(D14), 4192. doi:10.1029/2001JD000697.

Morris, G.A.; Hersey, S.; Thompson, A.M.; Pawson, S.; Nielsen, J.E.; Colarco, P.R.; McMillan, W.W.; Stohl, A.; Turquety, S.; Warner, J.; Johnson, B.J.; Kucsera, T.L.; Larko, D.E.; Oltmans, S.J.; and Witte, J.C. 2006. "Alaskan and Canadian Forest Fires Exacerbate Ozone Pollution over Houston, Texas, on 19 and 20 July 2004." *Journal of Geophysical Research, 111*, D24S03. doi:10.1029/2006JD007090.

Nikolov, N. 2008. "Impact of Wildland Fires and Prescribed Burns on Ground Level Ozone Concentration." Paper presented at the Western Regional Air Partnership Workshop on Regional Emissions & Air Quality Modeling Studies in Denver, CO, on July 30, 2008. http://www.wrapair.org/forums/toc/meetings/080729m/Effect_of_Fires_on_Ozone.pdf.

Pace, T.G., and Pouliot, G. 2007. "EPA's Perspective on Fire Emission Inventories—Past, Present, and Future." Paper presented at the 16th Annual International Emission Inventory Conference, *Emission Inventories: Integration, Analysis, and Communications,* in Raleigh, NC on May 14-17, 2007.

Pfister, G.G.; Wiedinmyer, C.; and Emmons, L.K. 2008. "Impact of the 2007 California Wildfires on Surface Ozone: Integrating Local Observations with Global Model Simulations." *Geophysical Research Letters*, 35, L19814. doi:10.1029/2008GL034747.

Bush, David, 2008: Southwest Desert to Las Vegas Ozone Transport Study (SLOTS), Presentation, 2008 National Air Quality Conference, funded by Clark County Nevada Department of Air

Quality and Environmental Management, conducted by T & B Systems and Clark County, Nevada.
http://www.accessclarkcounty.com/depts/daqem/aq/planning/Pages/ozone.aspx

Junquera, 2005: Wildfires in eastern Texas in August and September 2000: Emissions, Aircraft Measurements, and Impact on Photochemistry, Atmospheric Environment (39).
Lamb, 2007: Real-time Numerical Forecasting of Wildfire Emissions and Perturbations to Regional Air Quality. Unpublished manuscript.

McKeen, 2002: Ozone Production from Canadian Wildfires during June and July of 1995. Journal of Geophysical Research, 107:D14, 4192.

Morris, 2006: Alaskan and Canadian Forest Fires Exacerbate Ozone Pollution over Houston, Texas on 19 and 20 July 2004. Journal of Geophysical Research, 11:D24S03.

Nikolov, 2008: Impact of Wildland Fires and Prescribed Burns on Ground Level Ozone Concentration. Western Regional Air Partnership Workshop on Regional Emissions & Air Quality Modeling Studies, July 29-30, 2008, Denver, CO.

Pfister, 2008: Impacts of the Fall 2007 California Wildfires on Surface Ozone: Integrating Local Observations with Global Model Simulations. Geophysical Research Letters, 35:L19814.

Bytnerowicz, A., D. Cayan, P. Riggan, S. Schilling, P. Dawson, M. Tyree, L. Wolden, R. Tissell, and H. Preisler (2010), Analysis of the effects of combustion emissions and Santa Ana winds on ambient ozone during the October 2007 southern California wildfires, *Atmos. Environ., 44,* 678-687.

Dennis, A., M. Fraser, S. Anderson, and D. Allen (2002), Air pollutant emissions associated with forest, grassland, and agricultural burning in Texas., *Atmos. Environ., 36,* 3779-3792.

Finlayson-Pitts, B.J., and J.N. Pitts, Jr. (2000), *Chemistry of the Upper and Lower Atmosphere.* Academic Press: San Francisco. 84

Jaffe, D., D. Chand, W. Hafner, A. Westerling, and D. Spracklen (2008), Influence of fires on O3 concentrations in the western U.S., *Environ. Sci. Techol., 42,* 5885-5891.

8.0 APPENDIX A – AIR ADVISORIES AND NEWS ARTICLES

Department of Air Quality air quality advisory for Ozone

News Release

Office of Public Communications • (702) 455-3546 • FAX (702) 455-3558 • www.accessclarkcounty.com

Contact: Stacey Welling
Sr. Public Information Officer

Phone: (702) 455-3201
Cell: (702) 249-3823
E-mail: stac@co.clark.nv.us

For Immediate Release **Monday April 1, 2013**

Air Quality Advisory Issued for Ozone from April 1 through Sept. 30

Clark County Department of Air Quality officials are advising residents that weather conditions and levels of pollutants may trigger a build-up of ground-level ozone in Southern Nevada from April through September.

At this time, unhealthy levels of ozone pollution are not occurring. Air Quality officials will continue to monitor conditions and will post an alert on the forecast page of the department's website if unhealthy levels actually occur. A link to the forecast page is located at http://redrock.clarkcountynv.gov/forecast/.

Ozone is a gas that occurs naturally in the upper atmosphere and protects the earth from the sun's harmful ultraviolet rays. At ground level, ozone is a key ingredient of urban smog during the hottest months of the year in Clark County. Ground-level ozone can build up during the afternoon hours due to a combination of several factors, including strong sunlight, hot temperatures, and pollutants from automobiles and other sources such as transport and wildfires from Southern California and other areas. Unhealthy doses of ground-level ozone can reduce lung function and worsen respiratory illnesses such as asthma or bronchitis. Exposure to ozone also can induce coughing, wheezing and shortness of breath even in healthy people. When ozone levels are elevated, everyone should limit strenuous outdoor activity, especially people with respiratory diseases. Officials suggest these tips to help reduce the formation of ground-level ozone:

- Fill up your gas tank after sunset.
- Plan errands so they can be done in one trip
- Try not to spill gasoline when filling up, and don't top off your gas tank.
- Keep your car well maintained.
- Use mass transit or carpool.
- Don't idle your car engine unnecessarily.
- Walk or ride your bike whenever practical and safe.
- Drive an electric or hybrid vehicle, or low-emission scooter or motorcycle.
- Consider low-maintenance landscaping that uses less water and doesn't require the use of gas-powered lawn tools to maintain.
- Turn off lights and electronics when not in use. Less fuel burned at power plants means cleaner air.

Detailed air quality conditions are posted in the monitoring section of the Department of Air Quality's website. You can receive free text and e-mail advisories and air quality forecasts through the U.S. Environmental Protection Agency's EnviroFlash service at www.enviroflash.org.

###

Pictures taken by DAQ staff and from media releases

7-3

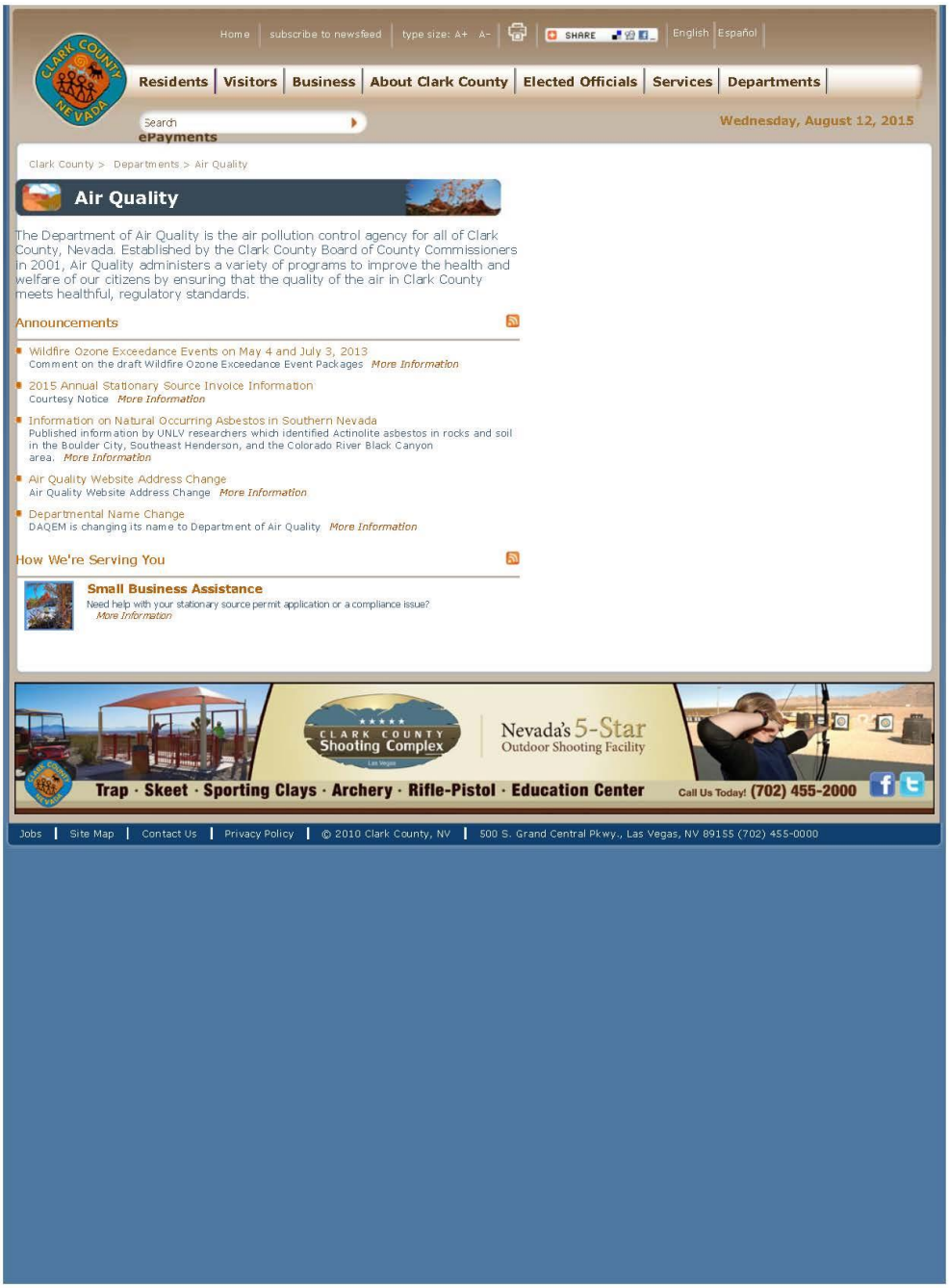

DRIVE
THRU


WELCOME
TO Fabulous
LAS VEGAS
NEVADA

9.0 PUBLIC REVIEW AND COMMENT PERIOD

9.1 DAQ WEB PAGE

DAQ Page 1 of 1



http://www.clarkcountynv.gov/depts/airquality/pages/default.aspx 8/12/2015


Home
subscribe to newsfeed
type size: A+ A-
SHARE
English
Español
Residents
Visitors
Business
About Clark County
Elected Officials
Services
Departments
Search
ePayments
Wednesday, August 12, 2015
Clark County > Departments > Air Quality > WildFire Events
Air Quality
Wildfire Ozone Exceptional Event Packages for May 4 and July 3, 2013
The Clark County Department of Air Quality (DAQ) developed two exceptional event documentation packages for exceedances of the Ozone National Ambient Air Quality Standard (NAAQS). On May 4, 2013, Clark County recorded exceedances of the ozone NAAQS across its air quality monitoring network due to smoke plume impacts from a wildfire in California. On July 3, 2013, exceedances of the ozone NAAQS were recorded due to smoke plume impacts from a wildfire in Clark County, NV. The exceptional event documents were written in accordance with the U. S. Environmental Protection Agency (EPA) Exceptional Event Rule, dated March 22, 2007, which defines exceptional events as "... events for which the normal planning and regulatory process established by the federal Clean Air Act (CAA) is not appropriate."
EPA's exceptional event rule and CAA sections 319(b)(3)(B) and 107(d)(3) grant authority to exclude air quality monitoring data from regulatory determinations related to exceedances or violations of the NAAQS, thus avoiding redesignation of an area to a nonattainment status if the agency adequately demonstrates that an exceptional event has caused an exceedance or violation of the NAAQS.
The documents will undergo a 30-day public comment period commencing on Tuesday July 28, 2015 and ending on Wednesday August 26, 2015 at 5:00 p.m. The Draft documents may be downloaded at: Wildfire Ozone Exceedance Event of May 4, 2013 and Wildfire Ozone Exceedance Event of July 3, 2013
The documents are also available for inspection at the front counter of the DAQ office, located at 4701 W. Russell Road, Suite 200, Las Vegas, NV. 89118. DAQ is located on the second floor of the Clark County Building Department building.
Comments must be submitted in writing to the DAQ at the address above and to the attention of Jean-Paul Huys, Senior Planner. Mr. Huys can be reached at 455-1684. Comments can also be submitted via email to: huys@ClarkCountyNV.gov. All comments must be received by 5:00 pm Wednesday, August 26, 2015, the close of the 30-day comment period. Written comments will be retained and considered prior to the submittal of the Exceptional Event Packages to the EPA, Region 9, San Francisco, California.
CLARK COUNTY Shooting Complex
Nevada's 5-Star Outdoor Shooting Facility
Trap · Skeet · Sporting Clays · Archery · Rifle-Pistol · Education Center
Call Us Today! (702) 455-2000
Jobs | Site Map | Contact Us | Privacy Policy | © 2010 Clark County, NV | 500 S. Grand Central Pkwy., Las Vegas, NV 89155 (702) 455-0000

9.2 PUBLIC COMMENT PERIOD

Public Notice:	DAQ webpage
Public Comment Period:	July 28, 2015 to August 26, 2015
Comments Received:	None