

State of Arizona
PM_{2.5} Exceptional Event Documentation Supplement for
the Previously Submitted August 25-28, 2011
PM₁₀ Windblown Dust Exceptional Event

Produced by:

Arizona Department of Environmental Quality
Maricopa County Air Quality Department
Maricopa Association of Governments

Final Report
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1. INTRODUCTION

During the period of August 25-28, 2011, numerous high wind dust storm events affected the southern and central deserts of Arizona. The following air quality monitors exceeded both¹ the 24-hour and annual PM_{2.5} standards as a result of a high wind exceptional event during this period: South Phoenix (04-013-4003-88101-1) on August 25th, Durango Complex (04-013-9812-88101-3) on August 25th and 27th, Glendale (04-013-2001-88101-3) on August 27th, and Apache Junction Fire Station (04-021-3002-88101-1) on August 28th. The PM₁₀ Exceptional Event documentation for the August 25-28, 2011 period was submitted to EPA on January 28, 2013 and the exceedances included therein received concurrence from EPA on May 6, 2013. This supplemental document related to PM_{2.5} exceedances that occurred during the same time period builds upon the initial documentation for the high wind exceptional events that caused many Phoenix area monitors to exceed the PM₁₀ standard during the August 25-28, 2011 period.

The information provided in the following sections of this supplemental document show that the PM_{2.5} exceedances at the South Phoenix, Durango Complex, Glendale, and Apache Junction Fire Station monitors occurring from August 25-28, 2011 were due to a high wind exceptional event by showing that:

- a. The event satisfies the criteria set forth in 40 CFR 501(j) that:
 - (1) the event affected air quality,
 - (2) the event was not reasonably controllable or preventable, and
 - (3) the event was caused by human activity unlikely to recur in a particular location or was a natural event;
- b. There is a clear causal relationship between the measurement under consideration and the event;
- c. The event is associated with a measured concentration in excess of normal historical fluctuations; and
- d. There would have been no exceedance or violation but for the event.

¹ As stated in EPA's *Interim Exceptional Events Rule Frequently Asked Questions*, May 2013, on pages 34-35, "The preamble [to the Exceptional Events Rule] states that in the particular case of PM_{2.5}, the direct comparison of a single 24-hour average concentration (determined from a single filter-based measurement or by averaging 24 1-hour measurements from a continuous equivalent instrument) to the level of the annual NAAQS can be the basis for meeting the 'but for' criterion for exceedances or violations of the annual NAAQS.²⁴ In context, it is clear that based on this comparison, a 24-hour concentration can be excluded from the calculation of the annual PM_{2.5} design value, if other rule criteria are also met. It is therefore not necessary to show that the annual average PM_{2.5} concentration was above 12 or 15 µg/m³ with the event and would have been below 12 or 15 µg/m³ 'but for' the single event at issue."

2. CONCEPTUAL MODEL

As explained in detail in Section II of the previously approved PM₁₀ main document, the week of August 25-28, 2011 was characterized by frequent monsoonal thunderstorm activity throughout the desert areas of southern Arizona and northern Mexico. These thunderstorms were severe in nature and caused numerous significant dust-carrying outflow boundaries that propagated into the Phoenix Metropolitan area.

A total of three separate windblown dust events produced 25 PM₁₀ exceedances in the Phoenix PM₁₀ nonattainment area during the four day span. In addition to generating and transporting high hourly and five-minute concentrations of PM₁₀, windblown dust carried by the outflows produced excessive hourly PM_{2.5} concentrations. The transported PM_{2.5} from multiple dust storms ultimately caused five monitors to exceed the PM_{2.5} standard during this period. Within Maricopa County, four PM_{2.5} exceedances occurred at the following monitoring sites: South Phoenix monitor on the August 25th (38 µg/m³), Durango Complex monitor on both August 25th and 27th (39.5 and 43 µg/m³), and Glendale monitor on August 27th (42.7 µg/m³). An additional PM_{2.5} exceedance in Pinal County at the Apache Junction monitoring site that occurred on August 28th (58.5 µg/m³) was included in this documentation because of its location within the eastern boundary of the Phoenix PM₁₀ nonattainment area. A map of current PM_{2.5} monitors in Maricopa County is provided in Figure 1. As a summary of the event, Tables 1 through 3 contains PM_{2.5} concentration data from recording monitors, as well as PM₁₀ concentrations co-located at PM_{2.5} monitoring sites. Figure 2 and 3 display hourly graphs of the PM_{2.5} and PM₁₀ concentrations, respectively, observed throughout the Phoenix Metropolitan area before, during, and after the August 25-28, 2011 period.

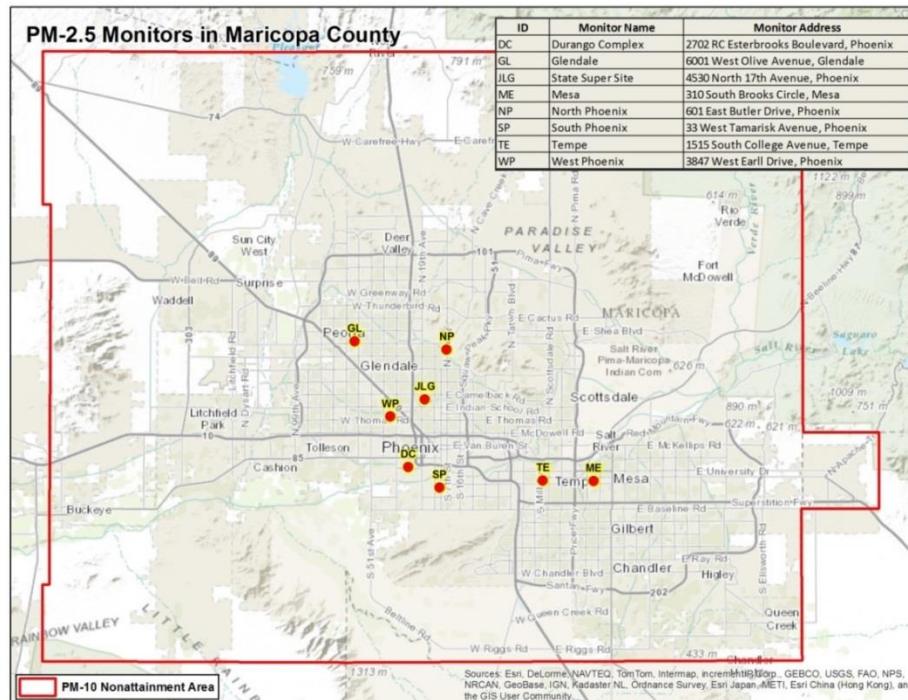


Figure 1. PM_{2.5} monitors in Maricopa County (2013).

Table 1. Summary of PM_{2.5} and PM₁₀ measurements in Maricopa County and Pinal County on August 25, 2011.

MARICOPA COUNTY ¹ AND PINAL COUNTY ¹						
Monitor	AQS Monitor ID	24-Hour Average PM _{2.5} Concentration (µg/m ³)	1-Hour Maximum PM _{2.5} Concentration (µg/m ³)	Maximum PM _{2.5} Concentration Time	24-Hour Average PM ₁₀ Concentration (µg/m ³)	AQS Qualifier Flag
Durango Complex	04-013-9812-88101-3	39.4	365	0200	437.5	RJ
Glendale	04-013-2001-88101-3	24.1	182.5	0200	241.2	
JLG Supersite*	04-013-9997-88101-1	25.2	NA	NA	NA	
JLG Supersite	04-013-9997-88101-3	26.6	253	0200	207	
Mesa*	04-013-1003-88101-1	15.3	NA	NA	NA	
South Phoenix*	04-013-4003-88101-1	38	NA	NA	NA	RJ
South Phoenix	04-013-4003-88101-3	23.7	206.1	0200	421.5	
West Phoenix*	04-013-0019-88101-1	29.6	NA	NA	NA	
West Phoenix	04-013-0019-88101-3	31.5	301.6	0200	589.7	
Apache Junction FS*	04-021-3002-88101-1	4.9	NA	NA	23	

SOURCE: ¹ Data as reported in EPA's Air Quality System (AQS) database. *Monitors are 24-hour filter based and not continuous.

Table 2. Summary of PM_{2.5} and PM₁₀ measurements in Maricopa County and Pinal County on August 27, 2011.

MARICOPA COUNTY ¹ AND PINAL COUNTY ²						
Monitor	AQS Monitor ID	24-Hour Average PM _{2.5} Concentration (µg/m ³)	1-Hour Maximum PM _{2.5} Concentration (µg/m ³)	Maximum PM _{2.5} Concentration Time	24-Hour Average PM ₁₀ Concentration (µg/m ³)	AQS Qualifier Flag
Durango Complex	04-013-9812-88101-3	43.0	540	2200	261.4	RJ
Glendale	04-013-2001-88101-3	42.7	506	2200	220.4	RJ
JLG Supersite*	04-013-9997-88101-1	NA	NA	NA	NA	
JLG Supersite	04-013-9997-88101-3	9.83	36	2300	127.4	
Mesa*	04-013-1003-88101-1	NA	NA	NA	NA	
South Phoenix*	04-013-4003-88101-1	NA	NA	NA	NA	
South Phoenix	04-013-4003-88101-3	30.6	257.7	2300	301.5	
West Phoenix*	04-013-0019-88101-1	NA	NA	NA	NA	
West Phoenix	04-013-0019-88101-3	8.1	17.3	2200	164.6	
Apache Junction FS*	04-021-3002-88101-1	NA	NA	NA	NA	

SOURCE: ¹ Data as reported in EPA's Air Quality System (AQS) database. *Monitors are 24-hour filter based and not continuous.

Table 3. Summary of PM_{2.5} and PM₁₀ measurements in Maricopa County on August 28, 2011.

MARICOPA COUNTY ¹ AND PINAL COUNTY ²						
Monitor	AQS Monitor ID	24-Hour Average PM _{2.5} Concentration (µg/m ³)	1-Hour Maximum PM _{2.5} Concentration (µg/m ³)	Maximum PM _{2.5} Concentration Time	24-Hour Average PM ₁₀ Concentration (µg/m ³)	AQS Qualifier Flag
Durango Complex	04-013-9812-88101-3	13.5	25.8	0400	61.8	
Glendale	04-013-2001-88101-3	15.2	40.6	0000	67.6	
JLG Supersite*	04-013-9997-88101-1	17.3	NA	NA	NA	
JLG Supersite	04-013-9997-88101-3	27	45	0300	78.0	
Mesa*	04-013-1003-88101-1	20.7	NA	NA	NA	
South Phoenix*	04-013-4003-88101-1	15	NA	NA	NA	
South Phoenix	04-013-4003-88101-3	8.6	19.2	0400	71.6	
West Phoenix*	04-013-0019-88101-1	12.6	NA	NA	NA	
West Phoenix	04-013-0019-88101-3	13.3	25.8	0300	71.9	
Apache Junction FS*	04-021-3002-88101-1	58.5	NA	NA	283**	RJ

SOURCE: ¹Data as reported in EPA's Air Quality System (AQS) database. *Monitors are 24-hour filter based and not continuous. **24-hour average PM₁₀ concentration value recorded by the Apache Junction Fire Station TEOM (04-021-3002-81102-3).

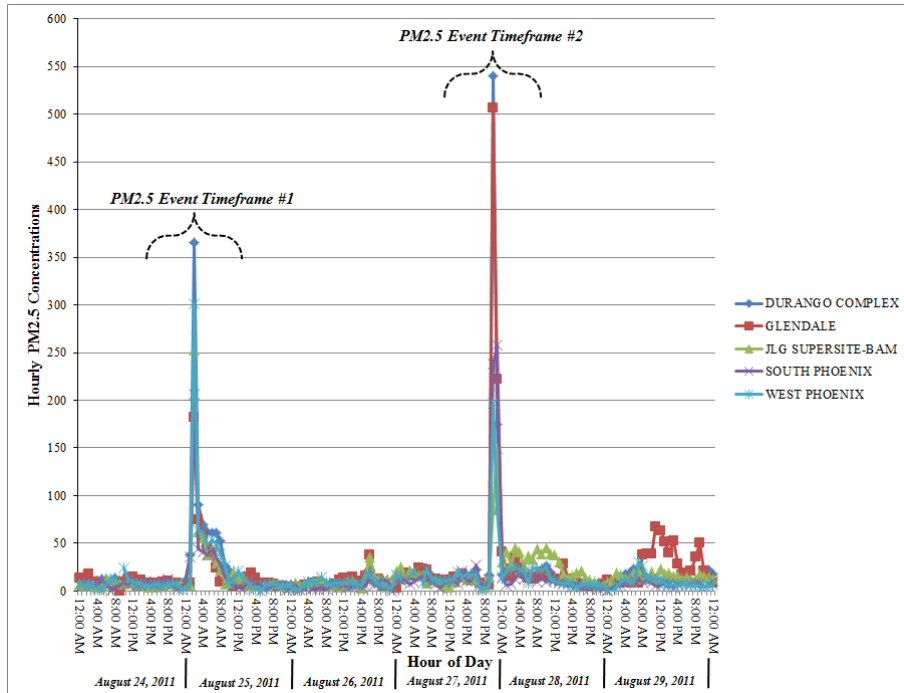


Figure 2. Timeline of hourly average PM_{2.5} concentrations observed throughout the Phoenix Metropolitan area before, during, and after the August 25-28, 2011 period.

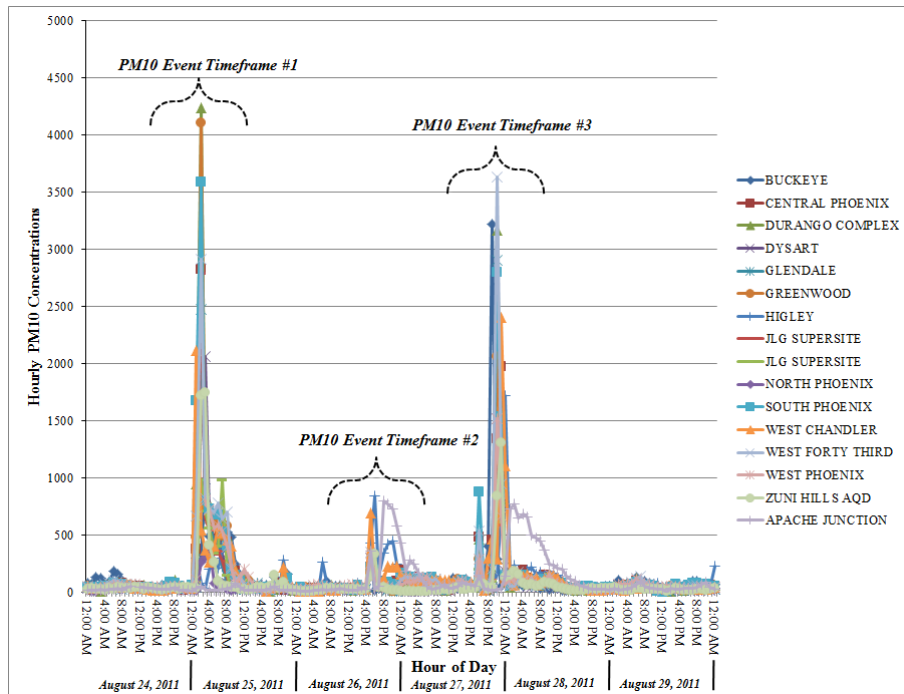


Figure 3. Timeline of hourly average PM₁₀ concentrations observed throughout the Phoenix Metropolitan area before, during, and after the August 25-28, 2011 period.

3. HISTORICAL FLUCTUATIONS

PM_{2.5} concentrations measured at the South Phoenix, Durango Complex, Glendale, and Apache Junction Fire Station monitors observed from August 25-28, 2011 were unusual and in excess of normal historical fluctuations. Figures 4 through 7 display time series plots of 24-hour PM_{2.5} concentrations for each monitor's respective period of record. All four figures indicate that exceedances of the 24-hour PM_{2.5} standard have occurred during the monsoon season when high winds from thunderstorm outflows produce dust storms. Additionally, for monitors located within the densely populated Phoenix Metropolitan, PM_{2.5} exceedances outside of the monsoon season have only occurred during the winter holiday season (result of residential and recreational wood burning). As such, the PM_{2.5} exceedances from August 25-28, 2011 were in excess of normal historical fluctuations.

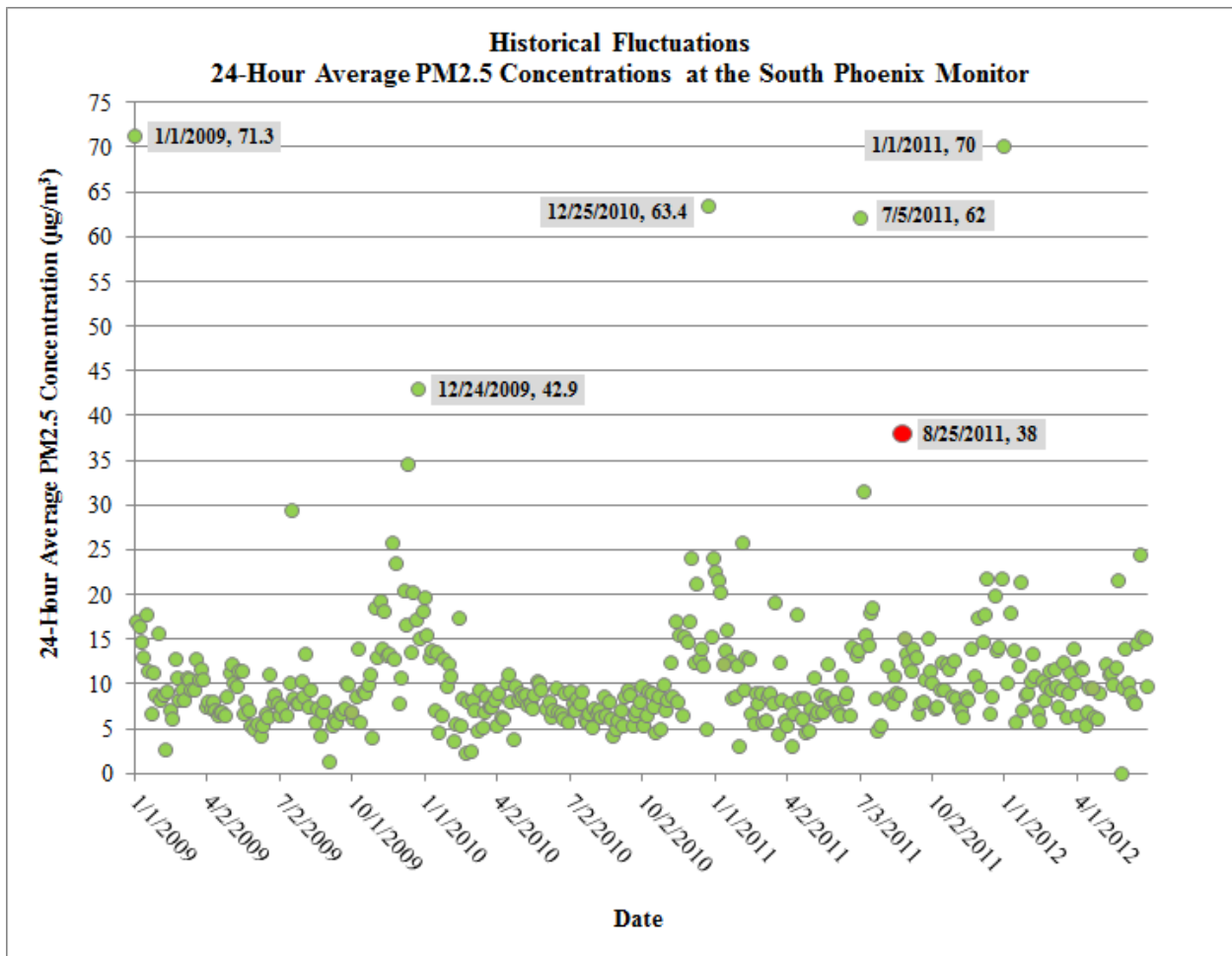


Figure 4. Plot of 24-Hour average PM_{2.5} concentrations (January 2009 - June 2012) at the South Phoenix monitor. Note: this monitor samples on a three day cycle and was replaced with a continuous monitor during July 2012.

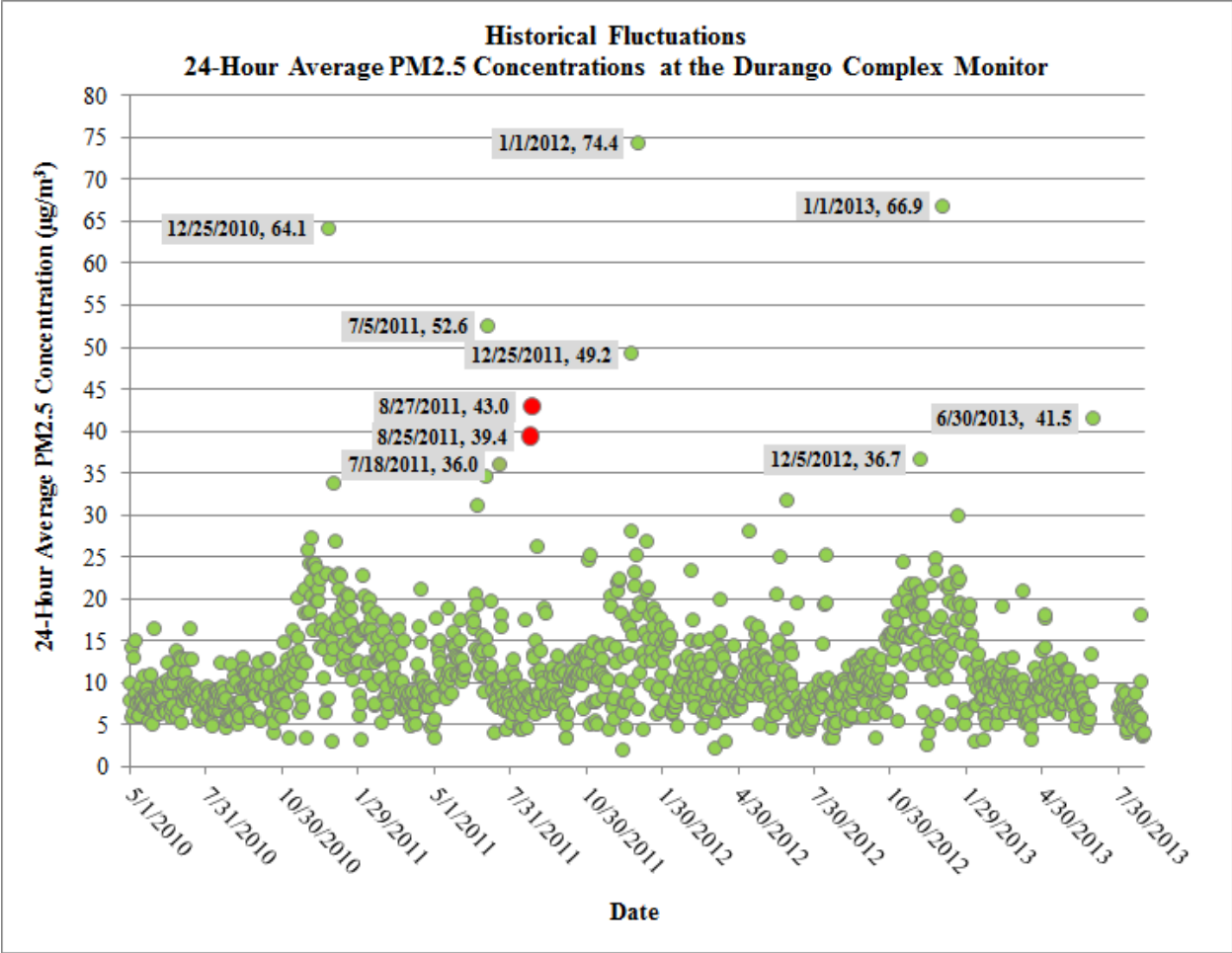


Figure 5. Plot of 24-Hour average PM_{2.5} concentrations (May 2010 - September 2013) at the Durango Complex monitor.

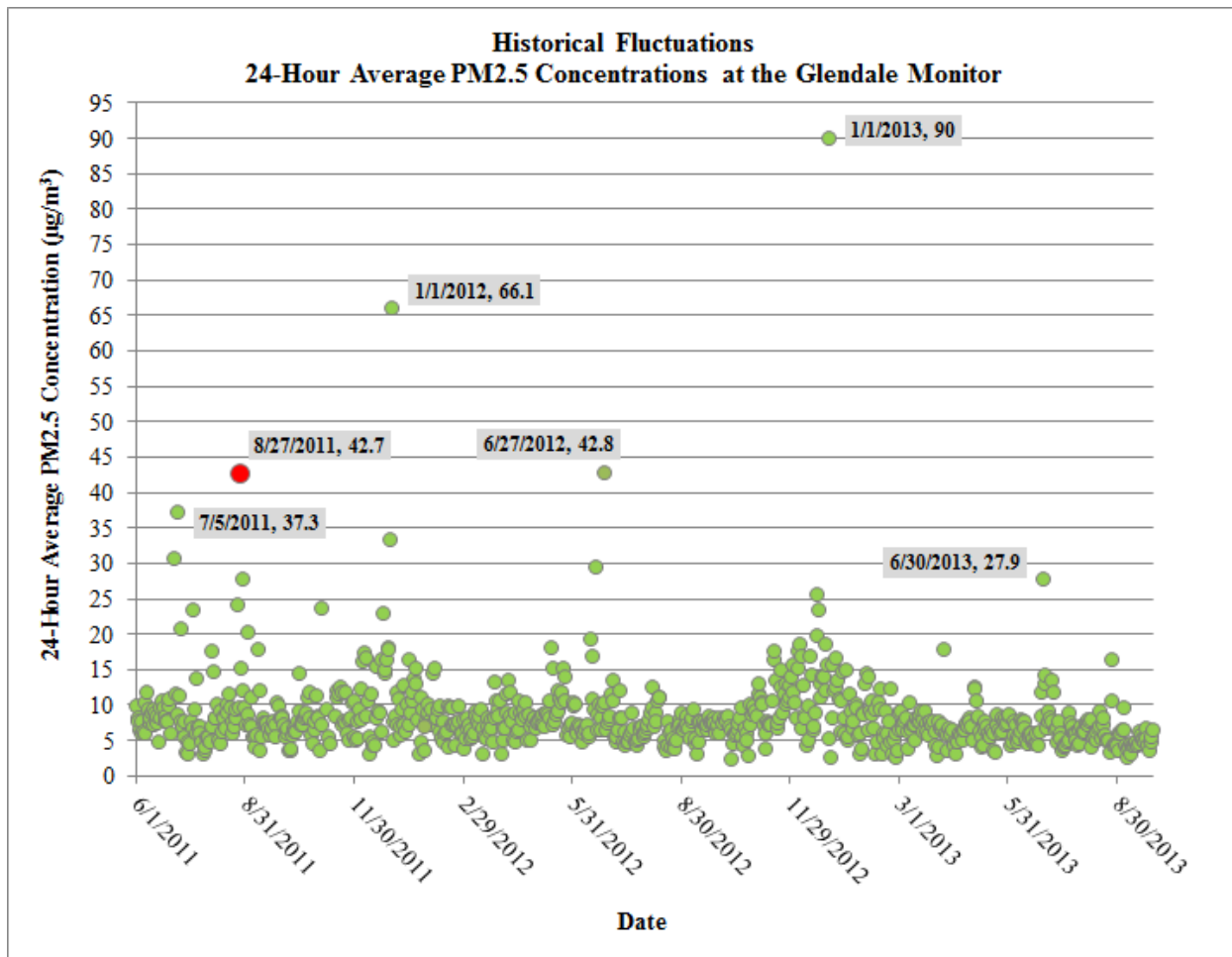


Figure 6. Plot of 24-Hour average PM_{2.5} concentrations (June 2011 - September 2013) at the Glendale monitor.

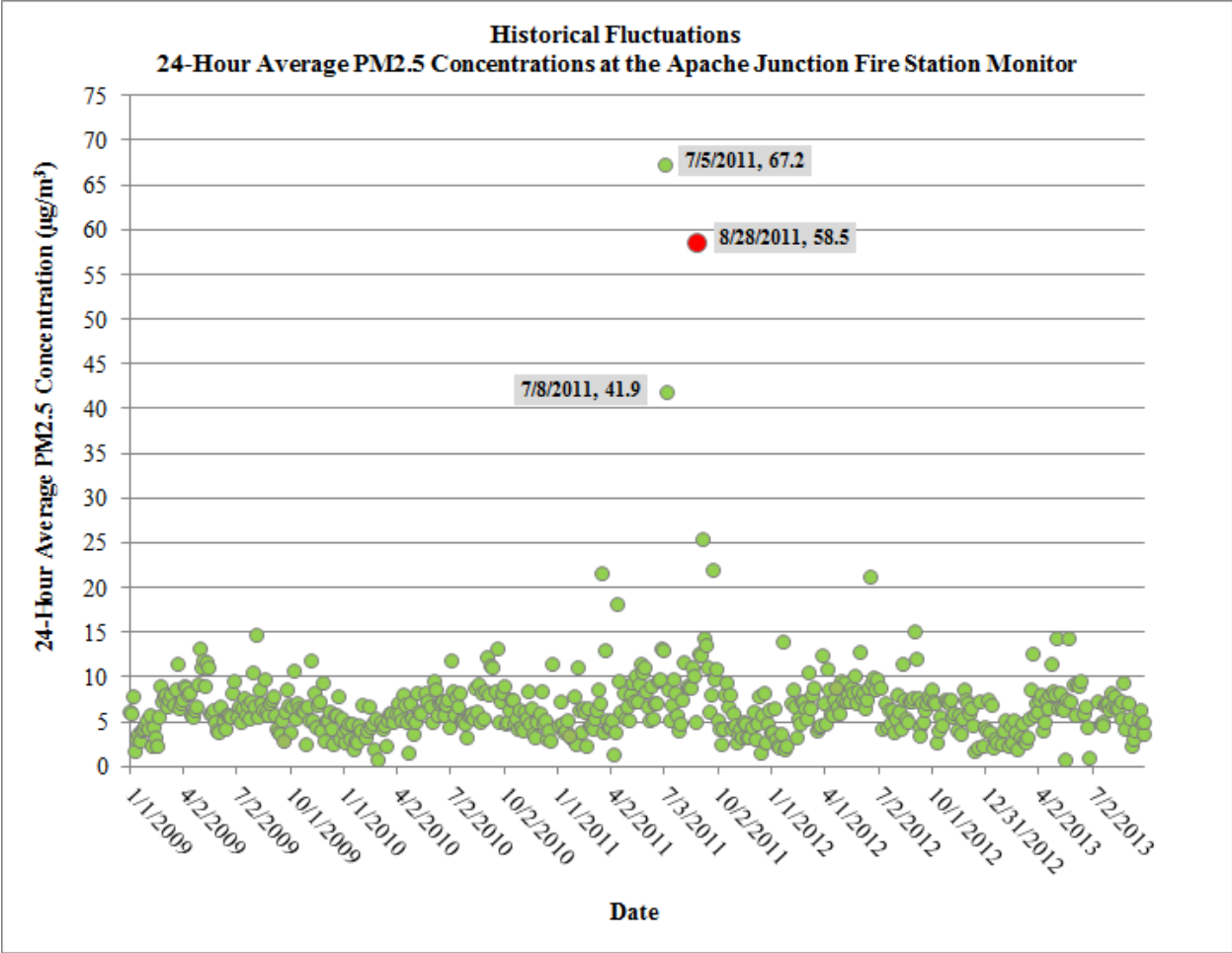


Figure 7. Plot of 24-Hour average PM_{2.5} concentrations (January 2009 - September 2013) at the Apache Junction Fire Station monitor. Note: this monitor samples on a three day cycle.

4. NOT REASONABLY CONTROLLABLE OR PREVENTABLE

Maricopa County currently attains both the 24-hour and annual PM_{2.5} National Ambient Air Quality Standards. During a high wind event, PM_{2.5} is generated from windblown fugitive dust sources. The extensive fugitive dust PM₁₀ controls described in Section III of the PM₁₀ main document also control the amount of PM_{2.5} generated during a high wind event. When these controls are overwhelmed during a high wind event, exceedances of both PM₁₀ and PM_{2.5} standards can occur due to fugitive dust emissions that are no longer reasonably controllable or preventable. The PM_{2.5} exceedances from August 25-28, 2011 were directly related to strong and gusty winds generated by thunderstorm outflows. The gusty outflow winds over multiple days overwhelmed all reasonably available controls, and were also responsible for the transport of particulate matter emissions into Maricopa and Pinal Counties.

For August 25th and 28th, Maricopa County Dust Control Forecasts were issued indicating a moderate risk level for unhealthy PM₁₀. On August 26th, a Maricopa County Dust Control Forecast was issued indicating a high risk level for unhealthy PM₁₀. The Dust Control Forecasts also indicated a potential for blowing dust. For the events from August 25-28, 2011, MCAQD responders evaluated each situation when concentrations were elevated. During most of the alerts MCAQD observed weather system activity and noted that many monitors were simultaneously impacted by the high winds. In instances where strong winds were not present, or only a single monitor was affected, MCAQD issued broadcast alerts to nearby stakeholders and local governments, and also deployed MCAQD inspectors to investigate possible causes of the elevated readings.

During the time period of August 22 through August 31, 2011, MCAQD inspectors conducted a total of 197 inspections on permitted facilities, of which 142 were at fugitive dust sources. Additionally, MCAQD conducted 114 inspections on vacant lots and unpaved parking lots. An evaluation of inspection reports and compliance records indicate no evidence of unusual anthropogenic-based particulate emissions or significant violations of particulate matter rules being observed in Maricopa County before, during, or after the high wind blowing dust events that would have impacted PM_{2.5} readings. Detailed information on regulatory measures, control programs, and enforcement activities are described in section III of the main PM₁₀ document.

The *WRAP Fugitive Dust Handbook* (September, 2006), estimates the PM_{2.5}/PM₁₀ ratio of windblown fugitive dust to be 0.15. Figures 8 through 11 show historical 24-hour average ratios of PM_{2.5}/PM₁₀ observed at the Southern Phoenix, Durango Complex, Glendale, and Apache Junction Fire Station monitors. On August 25, 2011, the PM_{2.5}/PM₁₀ ratios for the exceeding South Phoenix and Durango Complex monitors were observed to be 0.09. Both Durango Complex and Glendale monitors exceeded the PM_{2.5} standard on August 27th with ratios of 0.16 and 0.19, respectively. On August 28th, only the Apache Junction Fire Station monitor exceeded with an observed ratio of 0.21. The resultant PM_{2.5}/PM₁₀ ratios provide evidence that the 24-hour average PM_{2.5} exceedances recorded from August 25-28 during the multiple high wind events were the result of windblown dust emissions, as opposed to other common sources of PM_{2.5} such as combustion and industrial activities.

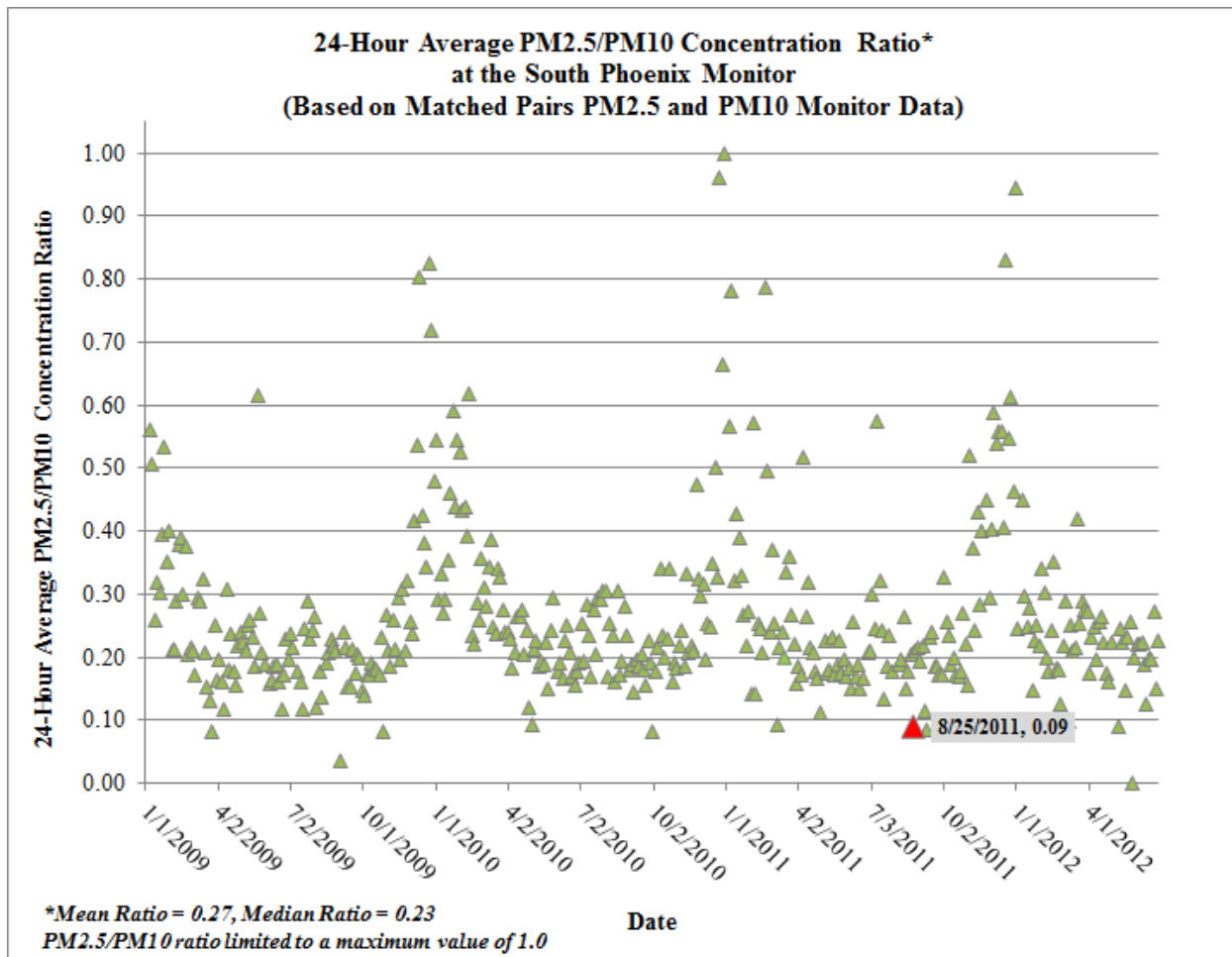


Figure 8. 24-Hour average PM_{2.5}/PM₁₀ concentration ratios (January 2009 - June 2012) at the South Phoenix monitor. Note: this monitor samples on a three day cycle and was replaced with a continuous monitor during July 2012.

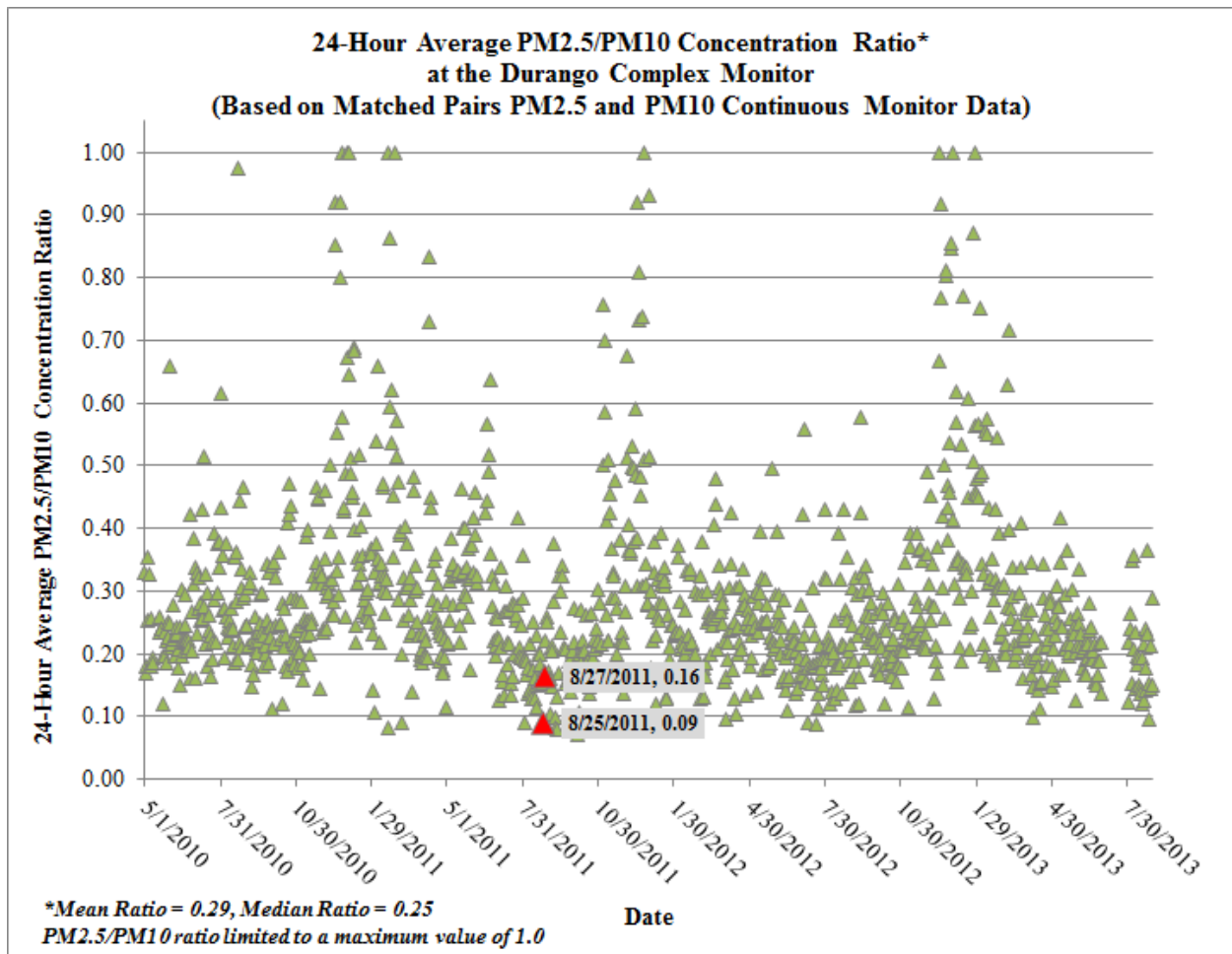


Figure 9. 24-Hour average PM_{2.5}/PM₁₀ concentration ratios (May 2010 - September 2013) at the Durango Complex monitor.

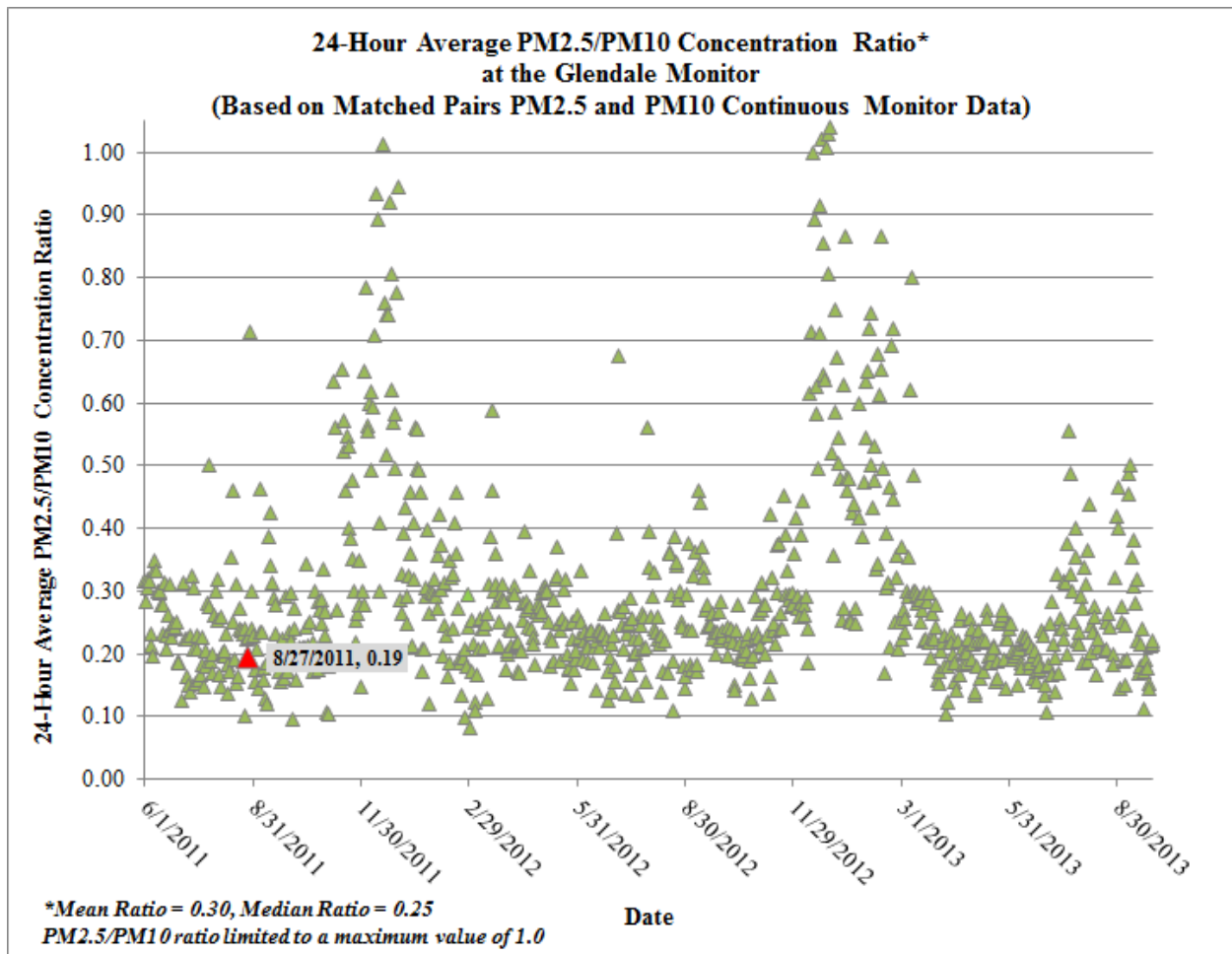


Figure 10. 24-Hour average PM_{2.5}/PM₁₀ concentration ratios (June 2011 - September 2013) at the Glendale monitor.

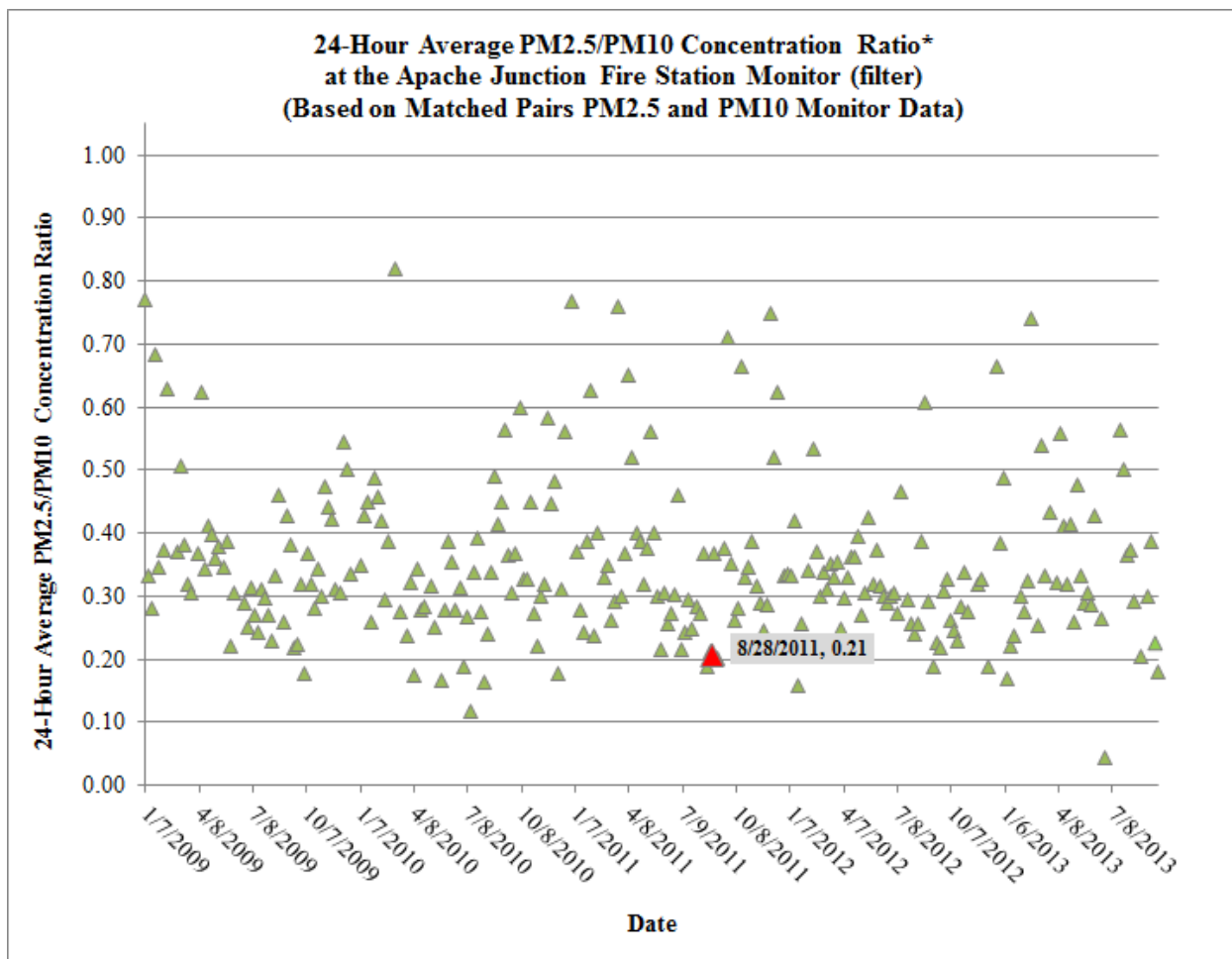


Figure 11. 24-Hour average $PM_{2.5}/PM_{10}$ concentration ratios (January 2009 - September 2013) at the Apache Junction Fire Station monitor. Note: this $PM_{2.5}$ monitor samples on a three day cycle, while PM_{10} is sampled on a six day cycle. Therefore, it was necessary to use the 24-hour average PM_{10} concentration value recorded by the available continuous Apache Junction Fire Station TEOM monitor (04-021-3002-81 102-3) to determine a $PM_{2.5}/PM_{10}$ concentration ratio during the exceedance. The TEOM monitor was operating simultaneously with the filter based sampler during the exceedance. According to the *Pinal County Air Quality Control District 2012 Ambient Monitoring Network Plan and 2011 Data Summary*, “[o]n August 20, 2011, a PM_{10} TEOM began operation at site in response to a recorded exceedance at the filter based PM_{10} sampler.” (29).

In summary, the thunderstorm outflow events of August 25-28, 2011 produced strong gusts and turbulent wakes that transported PM_{10} and $PM_{2.5}$ into the Phoenix PM_{10} nonattainment area. The source region of the outflows that caused the exceedances was largely located in areas outside the Phoenix PM_{10} nonattainment area, primarily the deserts of Pinal, Pima, and southern Maricopa County. Despite the deployment of comprehensive control measures and sophisticated response programs and a few localized, low-impact violations of the dust control rules, high wind conditions associated with thunderstorms and thunderstorm outflows brought high concentrations of PM_{10} and $PM_{2.5}$ emissions into, and also overwhelmed controls within, the Phoenix PM_{10} nonattainment area. Numerous strong thunderstorm outflows with sustained

winds ranging from 20-30 mph, and even greater nearest the source regions, were enough to overwhelm all available efforts to limit PM₁₀ and PM_{2.5} concentrations from the events. The fact that these were natural events involving strong thunderstorm outflow winds that transported particulate matter emissions into Maricopa County and Apache Junction, with a majority of the emissions coming from sources outside of the Phoenix PM₁₀ nonattainment area, provides strong evidence that the PM_{2.5} exceedances from August 25-28, 2011 recorded at the South Phoenix, Durango Complex, Glendale, and Apache Junction Fire Station monitors were not reasonably controllable or preventable.

5. CLEAR CAUSAL RELATIONSHIP

A detailed description of the meteorology that caused the natural windblown dust exceedance events at the South Phoenix, Durango Complex, Glendale, and Apache Junction Fire Station monitors is presented in Section V of the PM₁₀ main document via time series graphs, infrared satellite imagery, radar imagery, links to visibility camera data.

August 25, 2011 Event

On August 24th, between 8 pm Mountain Standard Time (MST) and 11 pm MST, severe thunderstorms developed over the southeastern Arizona and northern Mexico and by 1 am on August 25th, outflows from the thunderstorms entrained dust from desert areas of Pinal County and generated a dust storm that progressed northwestward into Maricopa County, transporting large amounts of PM₁₀ and PM_{2.5}. The dust storm had the following impacts in the Phoenix area: southeasterly winds increased to 18-26 mph, with gusts up to 34 mph; visibility dropped from 10 miles to 2 miles; weather conditions were reported as “haze”; and hourly PM₁₀ concentrations increased from about 30-50 µg/m³ to 2000 µg/m³ at five sites. Additionally, high PM_{2.5} concentrations were observed with average hourly concentrations reaching 365 µg/m³ at the Durango Complex monitor. Sudden increases in PM₁₀ and PM_{2.5} area wide coincide with the arrival of higher winds and diminished visibilities. Once winds subsided, visibility remained below 10 miles and particulate matter concentrations remained elevated for several hours. In total, twelve monitors in the region exceeded the PM₁₀ NAAQS with South Phoenix and Durango Complex monitors exceeding the PM_{2.5} 24-hour standard. Without the existence of particulate matter emissions generated by thunderstorm outflows, there would not have been any exceedances of the 24-hour PM₁₀ or PM_{2.5} standard in the Phoenix PM₁₀ nonattainment area. Figure 12 shows the highest hourly PM_{2.5} concentrations at the Durango Complex monitor coinciding with the arrival of the thunderstorm outflow winds. An hourly analysis is not available for the South Phoenix monitor due to its 24 hour average filter based sampling method, but elevated wind speeds noted at Sky Harbor International Airport in Figure 12 helps indicate that the high winds associated with the dust storm were region wide.

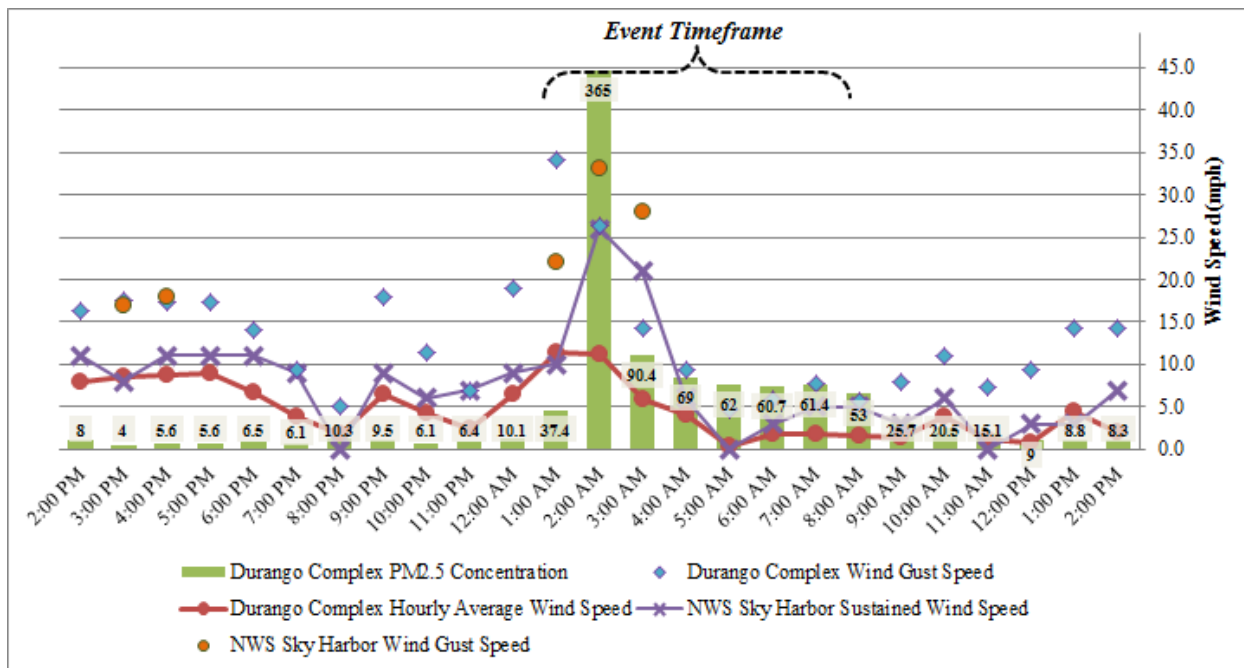


Figure 12. Hourly PM_{2.5} concentrations, wind speeds, and gusts as recorded at the Durango Complex monitor on August 25, 2011. Additionally, sustained wind speeds and gusts at Sky Harbor International Airport are shown.

August 27-28, 2011 Event

On August 27, 2011, severe thunderstorms developed in the evening hours over southwestern Arizona, and thunderstorm outflows produced a dust storm that began affecting the western Phoenix area late the 27th and continued eastward across the region early on the 28th. The dust storm resulted in the following impacts in the Phoenix area: winds increased to 20-25 mph, with gusts up to 32 mph; visibility dropped from 10 miles to as low as 1 mile; and weather conditions were reported as “blowing dust” and “haze” at multiple airports in the region. Due to two previous days with dust events leading up to this one, broad, ambient PM₁₀ and PM_{2.5} concentrations were already elevated at roughly 50-100 µg/m³ prior to the arrival of the dust storm, but during the hours of peak wind gusts late on August 27th, hourly PM₁₀ concentrations exceeded 2400 µg/m³ at six sites. Once again, high PM_{2.5} concentrations were also observed with average hourly concentrations reaching up to 540 µg/m³ at the Durango Complex monitor. Sudden increases in PM₁₀ and PM_{2.5} area wide coincide with the arrival of higher winds and diminished visibilities. In total, eleven monitors in the region exceeded the PM₁₀ NAAQS with Durango Complex, Glendale, and Apache Junction Fire Station monitors exceeding the PM_{2.5} 24-hour standard. Without the existence of particulate emissions generated by thunderstorm outflows, there would not have been any exceedances of the 24-hour PM₁₀ or PM_{2.5} standard in the Phoenix PM₁₀ nonattainment area. Similar to Figure 12, Figures 13 and 14 show the highest hourly PM_{2.5} concentrations at the Durango Complex and Glendale monitors coinciding with the arrival of the thunderstorm outflow winds. An hourly analysis is not available for the Apache Junction Fire Station monitor due to its 24 hour average filter based sampling method.

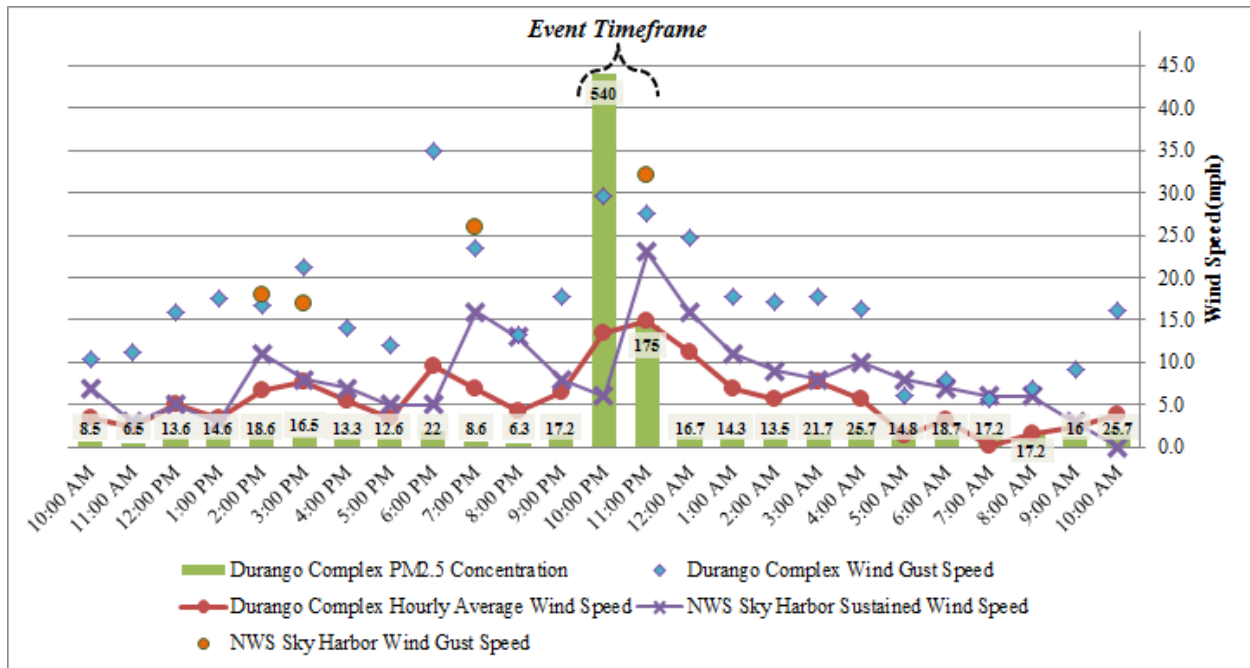


Figure 13. Hourly PM_{2.5} concentrations, wind speeds, and gusts as recorded at the Durango Complex monitor on August 27, 2011. Additionally, sustained wind speeds and gusts at Sky Harbor International Airport are shown.

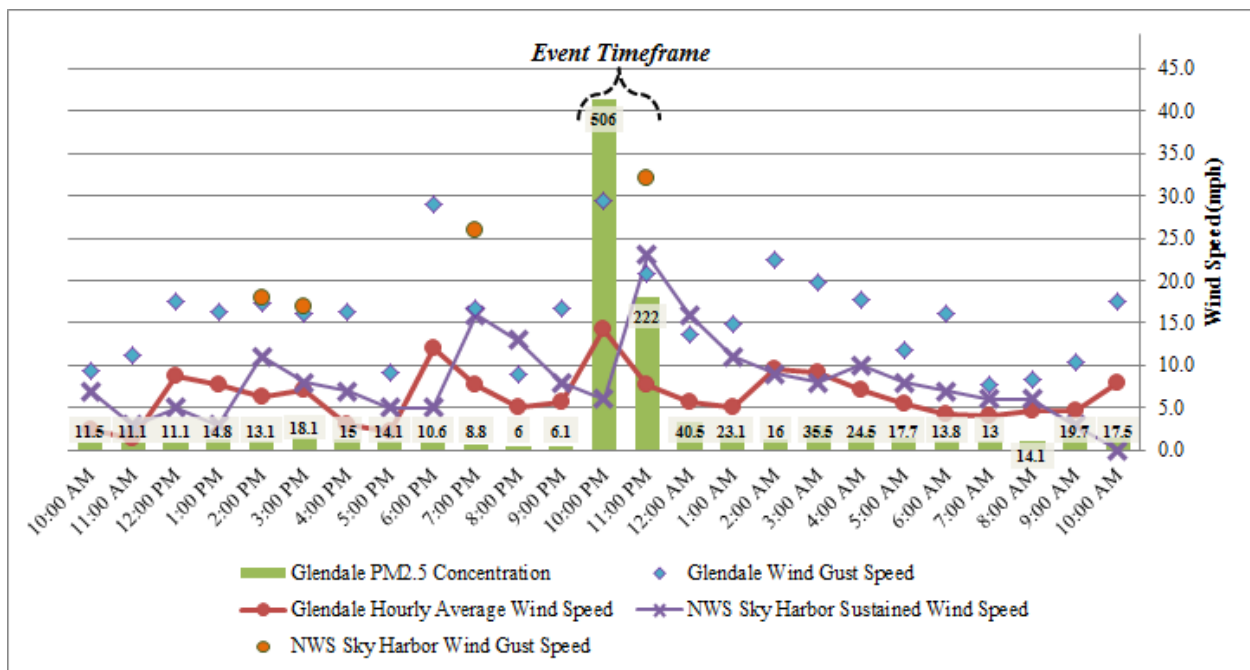


Figure 14. Hourly PM_{2.5} concentrations, wind speeds, and gusts as recorded at the Glendale monitor on August 27, 2011. Additionally, sustained wind speeds and gusts at Sky Harbor International Airport are shown.

6. BUT FOR ANALYSIS

Section 50.14(c)(3)(iv)(D) in 40 CFR part 50 requires that an exceptional event demonstration must satisfy that “[t]here would have been no exceedance or violation but for the event.” The prior sections of this PM_{2.5} supplemental document have provided detailed information that the exceedances from August 25-28, 2011 were not reasonably controllable or preventable and that there is a clear causal relationship between the windblown dust generated and transported by thunderstorm outflow winds and the exceedances at the South Phoenix, Durango Complex, Glendale, and Apache Junction Fire Station monitors. The weight of evidence in these sections demonstrates that but for the existence of windblown dust emissions generated and transported by thunderstorm outflow winds, there would have been no exceedances of the 24-hour PM_{2.5} standard. It is also clear from Figures 12, 13, and 14 that but for the hourly PM_{2.5} concentrations affected by the high wind events at both the Durango Complex and Glendale monitors that the 24-hour average PM_{2.5} concentration for the exceeding monitors would have been substantially under 35.5 µg/m³. The South Phoenix and Apache Junction Fire Station monitors are 24 hour average filter based and are not continuous.

EPA’s *Interim Exceptional Events Rule Frequently Asked Questions* (May, 2013) provides procedures for excluding a 24-hour PM_{2.5} exceedance for comparison against the annual PM_{2.5} NAAQS. On pages 34-35, EPA states,

“The preamble [to the Exceptional Events Rule] states that in the particular case of PM_{2.5}, the direct comparison of a single 24-hour average concentration (determined from a single filter-based measurement or by averaging 24 1-hour measurements from a continuous equivalent instrument) to the level of the annual NAAQS can be the basis for meeting the ‘but for’ criterion for exceedances or violations of the annual NAAQS.²⁴ In context, it is clear that based on this comparison, a 24-hour concentration can be excluded from the calculation of the annual PM_{2.5} design value, if other rule criteria are also met. It is therefore not necessary to show that the annual average PM_{2.5} concentration was above 12 or 15 µg/m³ with the event and would have been below 12 or 15 µg/m³ ‘but for’ the single event at issue.”

Additionally, on page 39, EPA states,

“Also, if the 24-hour average concentration based on 1-hour measurements was above 12.0 µg/m³ (after rounding to one decimal digit, per 40 CFR 50 Appendix N section 4.3(a)) but would have been equal or less than 12.0 µg/m³ in the absence of the event, those 1-hour concentration values that were affected by the single event meet the “but for” test for purposes of comparison to 12 µg/m³ annual PM_{2.5} NAAQS.”

Tables 4 and 5 display hourly PM_{2.5} concentrations at the Durango Complex monitor for both August 25th and August 27th, while Table 6 shows Glendale monitor’s hourly PM_{2.5} concentrations during the August 27th exceedance.

The August 25th high wind event advected very high PM_{2.5} concentrations and strong winds beginning around 1 am. Winds subsided by around 5 am, but particulate matter remained suspended in the boundary layer until the 9 am observation at the Durango Complex monitor indicated near pre-event PM_{2.5} concentrations (see Figure 12). This matches visibility trends at Phoenix Sky Harbor International, where visibility returned to normal (i.e., 10 statute miles) between 8 and 9 am. Therefore, exclusion of PM_{2.5} data from 1 am through 8 am for the August 25th exceedance at this monitor is valid given this time range represents the duration of impact from the high wind event. As a result, the 24-hour average PM_{2.5} concentration would have been below 12.0 µg/m³ (see Table 4). As such, exclusion of the 24-hour average PM_{2.5} exceedances on August 25, 2011 at the Durango Complex monitor for comparison against the annual PM_{2.5} NAAQS is allowed under EPA interim guidance.

On August 27th both the Durango Complex and Glendale monitors had PM_{2.5} exceedances. The high wind dust event impacted these monitors late in the evening beginning around 10 pm and lasting into the early morning hours of the 28th. The hourly PM_{2.5} concentrations measured between 10 pm and 12 am were high enough to cause a 24-hour exceedance on the 27th. Figures 13 and 14 indicate strong winds coinciding with the arrival and passage of transported dust. Therefore, exclusion of PM_{2.5} data from 10 p.m. through 12 a.m. for the August 27th exceedances at these monitors is valid given this time range represents the duration of impact from the high wind event for this date. Consequently, the 24-hr average PM_{2.5} concentrations for Durango Complex (see Table 5) and Glendale (see Table 6) monitors were 14.4 µg/m³ and 13.5 µg/m³, respectively. These values were found to be slightly above the annual standard of 12.0 µg/m³.

The 24-hr average PM_{2.5} concentrations at both the Durango Complex and Glendale monitors would have been below 12.0 µg/m³ if not for early morning elevated PM_{2.5} readings caused by suspended particulate matter from a dust storm that affected Pinal County and the eastern Phoenix Metropolitan area the evening of August 26th (detailed meteorology for the August 26th windblown dust event is available in section V of the main PM₁₀ document). Based on regional wind observations recorded after the thunderstorm outflow that generated the dust storm weakened, winds became lighter and shifted southeasterly. Light winds likely prevented dust from settling and a southeasterly component would have advected suspended particulate matter from eastern Maricopa County into central and western portions of the Phoenix Metropolitan area overnight, impacting both Durango Complex and Glendale monitors through the early hours of the August 27th. Without the impacts associated with the windblown dust events occurring on the evenings of August 26th and 27th, the 24-hour average PM_{2.5} concentrations at both sites for August 27th would have been below 12.0 µg/m³ making the exclusion of the 24-hour average PM_{2.5} exceedances on August 27, 2011 at the Durango Complex and Glendale monitors for comparison against the annual PM_{2.5} NAAQS allowed under EPA interim guidance.

Table 4. Hourly average PM_{2.5} concentrations at the Durango Complex monitor on August 25, 2011 and resulting 24-hour average PM_{2.5} concentrations with and without hours affected by the high wind exceptional event.

Durango Complex	
Hour	PM_{2.5} Concentration (µg/m³)
12:00 AM	10.1
1:00 AM	37.4
2:00 AM	365
3:00 AM	90.4
4:00 AM	69
5:00 AM	62
6:00 AM	60.7
7:00 AM	61.4
8:00 AM	53
9:00 AM	25.7
10:00 AM	20.5
11:00 AM	15.1
12:00 PM	9
1:00 PM	8.8
2:00 PM	8.3
3:00 PM	4.6
4:00 PM	5.3
5:00 PM	5
6:00 PM	5.4
7:00 PM	4.8
8:00 PM	6
9:00 PM	7.1
10:00 PM	5.5
11:00 PM	5.5
24-Hour Average	39.4
24-Hour Average Excluding Hours Affected by High Wind Event (1:00 AM through 8:00 AM)	9.2

Table 5. Hourly average PM_{2.5} concentrations at the Durango Complex monitor on August 27, 2011 and resulting 24-hour average PM_{2.5} concentrations with and without hours affected by the high wind exceptional event.

Durango Complex	
Hour	PM_{2.5} Concentration (µg/m³)
12:00 AM	11.1
1:00 AM	21.2
2:00 AM	15.5
3:00 AM	15.3
4:00 AM	16.1
5:00 AM	18.3
6:00 AM	20.2
7:00 AM	14.1
8:00 AM	15.5
9:00 AM	11.3
10:00 AM	8.5
11:00 AM	6.5
12:00 PM	13.6
1:00 PM	14.6
2:00 PM	18.6
3:00 PM	16.5
4:00 PM	13.3
5:00 PM	12.6
6:00 PM	22
7:00 PM	8.6
8:00 PM	6.3
9:00 PM	17.2
10:00 PM	540
11:00 PM	175
24-Hour Average	43
24-Hour Average Excluding Hours Affected by High Wind Event (10:00 PM and 11:00 PM)	14.4

Table 6. Hourly average PM_{2.5} concentrations at the Glendale monitor on August 27, 2011 and resulting 24-hour average PM_{2.5} concentrations with and without hours affected by the high wind exceptional event.

Glendale	
Hour	PM_{2.5} Concentration (µg/m³)
12:00 AM	3.5
1:00 AM	11.3
2:00 AM	18.7
3:00 AM	15.6
4:00 AM	16.7
5:00 AM	23.8
6:00 AM	23
7:00 AM	22.3
8:00 AM	10.5
9:00 AM	12
10:00 AM	11.5
11:00 AM	11.1
12:00 PM	11.1
1:00 PM	14.8
2:00 PM	13.1
3:00 PM	18.1
4:00 PM	15
5:00 PM	14.1
6:00 PM	10.6
7:00 PM	8.8
8:00 PM	6
9:00 PM	6.1
10:00 PM	506
11:00 PM	222
24-Hour Average	42.7
24-Hour Average Excluding Hours Affected by High Wind Event (10:00 PM and 11:00 PM)	13.5

7. CONCLUSION

The PM_{2.5} exceedances that occurred from August 25-28, 2011 at the South Phoenix, Durango Complex, Glendale, and Apache Junction Fire Station monitors satisfies the criteria of 40 CFR 50.1(j) and meets the definition of an exceptional event. These criteria are:

- The event affects air quality.
- The event is not reasonably controllable or preventable.
- The event is unlikely to reoccur at a particular location or [is] a natural event.

A. Affects Air Quality

As stated in the preamble to the Exceptional Events Rule, the event in question is considered to have affected air quality if it can be shown that there is a clear causal relationship between the monitored exceedances and the event, and that the event is associated with measured concentrations in excess of normal historical fluctuations. Given the information presented in this PM_{2.5} supplemental document and the PM₁₀ main document, it is reasonable to conclude that the event in question affected air quality.

B. Not Reasonably Controllable or Preventable

Section 50.1(j) of Title 40 CFR Part 50 requires that an event must be “not reasonably controllable or preventable” in order to be defined as an exceptional event. This requirement is met by demonstrating that despite reasonable control measures in place within Maricopa County and Apache Junction, high wind conditions overwhelmed all reasonably available controls. Despite the deployment of comprehensive control measures and sophisticated response programs, high wind conditions associated with thunderstorms and thunderstorm outflows generated and brought high concentrations of PM_{2.5} into Maricopa County and Apache Junction. Examination of the PM_{2.5}/PM₁₀ ratios on August 25th and 27-28th is consistent with windblown dust as the source of the PM_{2.5} emissions. The fact that this was a natural event involving strong thunderstorm outflow winds that transported and generated PM_{2.5} emissions into Maricopa County and Apache Junction, provides strong evidence that the event and exceedances from August 25-28, 2011 recorded at the South Phoenix, Durango Complex, Glendale, and Apache Junction Fire Station monitors were not reasonably controllable or preventable.

C. Natural Event

As discussed above, the event shown to cause these exceedances were emissions of PM_{2.5} generated by high winds caused by thunderstorm activity and related outflow boundaries from August 25-28, 2011. The event therefore qualifies as a natural event.

In summary, the exceedances of the PM_{2.5} standards from August 25-28, 2011 would not have occurred but for the monsoonal thunderstorm driven high winds and windblown dust generated and transported from areas inside and outside of Maricopa County and Apache Junction, based on the following weight of evidence:

- Historical fluctuation data in Section 3 shows the active record of 24-hour average PM_{2.5} data for South Phoenix, Durango Complex, Glendale, and Apache Junction Fire Station monitors and demonstrates that the values for dates exceeding from August 25-28, 2011 were atypical and in excess of normal historical fluctuations.
- The exceedances of the PM_{2.5} standards recorded from August 25-28, 2011 are tied to thunderstorm activity and thunderstorm generated outflow winds, as can be seen in data and analyses in Section V in the PM₁₀ main document.
- Figures and tables in Section V of the PM₁₀ main document show that the timing of multiple thunderstorm generated outflow boundary passages and increases in wind speeds at monitoring locations and National Weather Service stations during each of the events during this period is consistent with the timing of elevated PM₁₀ and PM_{2.5} concentrations recorded at the monitoring locations in the Phoenix PM₁₀ nonattainment area.
- Visibility camera imagery discussed in Section V of the PM₁₀ main document indicates that large quantities of PM₁₀ was transported into the Phoenix Metro area during the August 25-28 timeframe. The timing of the dust storms depicted in the visibility camera imagery is consistent with the PM₁₀ and PM_{2.5} concentration measurements, elevated winds, and reduced visibility reported during the high wind events.
- Wind directions, thunderstorm generated outflow boundary propagation, and concentration patterns showing elevated levels of PM₁₀ in Pinal County prior to levels increasing in Maricopa County, all depicted in Section V of the PM₁₀ main document, help to show that dust originating in Pinal County and other areas located generally south of the Phoenix PM₁₀ nonattainment area was transported to Maricopa County.
- Section III of the PM₁₀ main document discusses that the rules in place to control PM₁₀ from fugitive dust sources in Maricopa County are the same rules that control PM_{2.5} emissions during high wind events. Inspections conducted in the area before, during, and after the event verify that no unusual anthropogenic activities affected the PM_{2.5} concentrations observed at the exceeding South Phoenix, Durango Complex, Glendale, and Apache Junction Fire Station monitors.