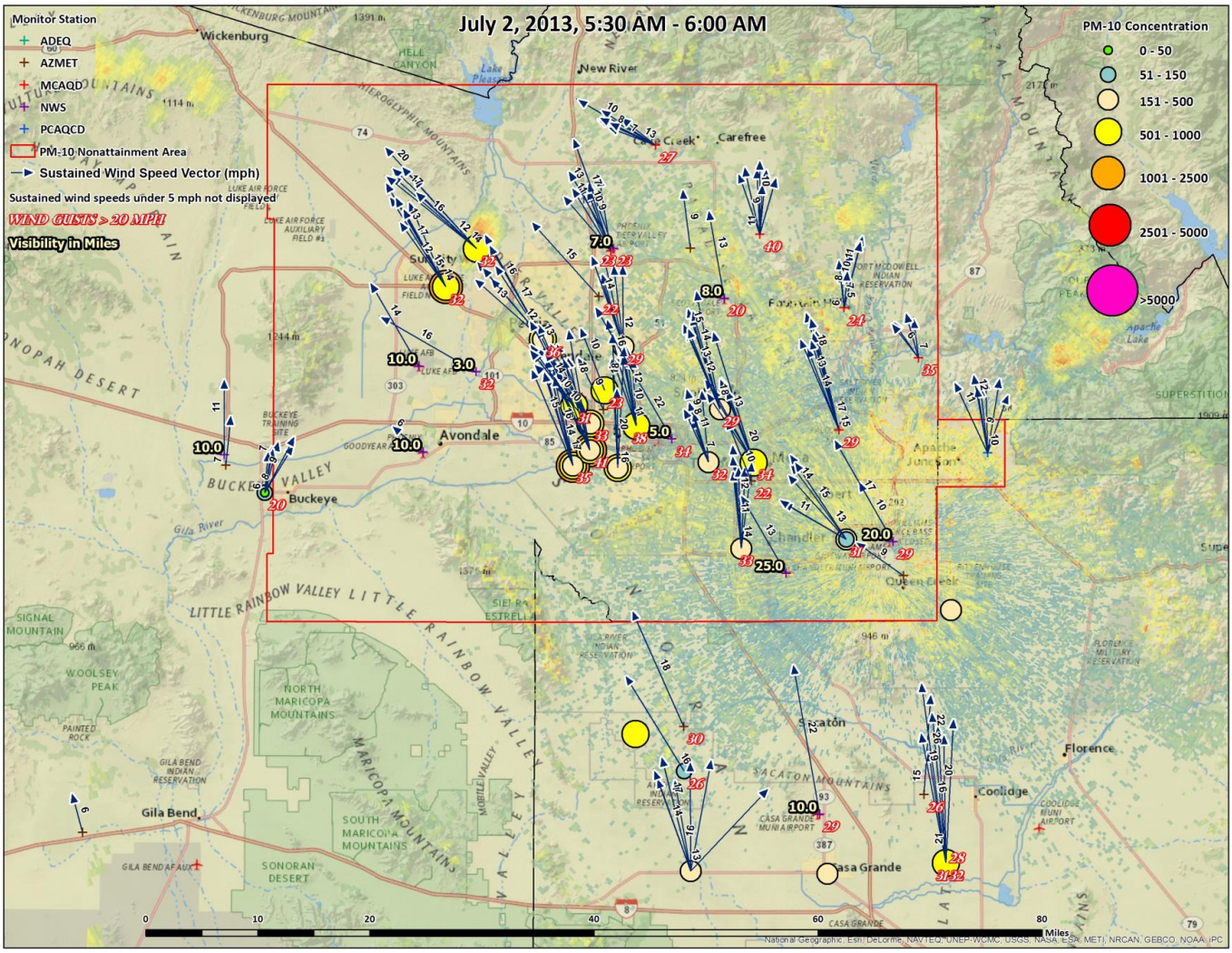
# State of Arizona Exceptional Event Documentation for July 2, 2013, for the Maricopa PM10 Nonattainment Area

Produced by:

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

FINAL Report
December, 2013



# Table of Contents

# List of Figures

# List of Figures (continued)

# List of Tables

# List of Appendices

# I. EXCEPTIONAL EVENT RULE (EER) REQUIREMENTS

In addition to the technical requirements that are contained within the EER, procedural requirements must also be met in order for EPA to concur with the flagged air quality monitoring data. This section of the report lays out the requirements of the EER and associated guidance, and discusses how the Arizona Department of Environmental Quality (ADEQ) addressed those requirements.

## Procedural Requirements

This section presents a review of the procedural requirements of the EER as required by 40 CFR 50.14 (Treatment of Air Quality Monitoring Data Influenced by Exceptional Events) and explains how ADEQ fulfills them. The Federal EER requirements include public notification that an event was occurring, the placement of informational flags on data in EPA's Air Quality System (AQS), the notification of EPA of the intent to flag through submission of initial event description, the documentation that the public comment process was followed, and the submittal of a demonstration supporting the exceptional events flag. ADEQ has addressed all of these procedural and documentation requirements.

### *Public notification that event was occurring (40 CFR 50.14(c)(1(i))*

ADEQ issued Dust Control Action Forecasts and Ensemble Forecasts for the Greater Phoenix area advising citizens of the potential for high wind / dust events on July 2, 2013. More information on ADEQ's forecasting program can be found in Section IV. The forecast products that were issued for July 2, 2013 are included in Appendix A.

### *Place informational flag on data in AQS (40 CFR 50.14(c)(2)(ii))*

ADEQ and other operating agencies in Arizona submit data into EPA's AQS. Data from both filter-based and continuous monitors operated in Arizona are submitted to AQS.

When ADEQ and/or another agency operating monitors in Arizona suspects that data may be influenced by an exceptional event, ADEQ and/or the other operating agency expedites analysis of the filters collected from the potentially-affected filter-based air monitoring instruments, quality assures the results and submits the data into AQS. ADEQ and/or other operating agencies also submit data from continuous monitors into AQS after quality assurance is complete.

If ADEQ and/or the operating agency have determined a potential exists that the monitor reading has been influenced by an exceptional event, a preliminary flag is submitted for the measurement in the AQS. The data are not official until they undergo more thorough quality assurance and quality control, leading to certification by May 1st of the year following the calendar year in which the data were collected (40 CFR 58.15(a)(2)). The presence of the flag can be confirmed in AQS.

### *Notify EPA of intent to flag through submission of initial event description by July 1 of calendar year following event (40 CFR 50.14(c)(2)(iii))*

ADEQ submitted a letter to EPA Region 9 Air Division Director, Deborah Jordan, on September 11, 2013, notifying EPA of ADEQ's intent to flag data in AQS and submit documentation to EPA by February 2014 for the July 2, 2013 exceptional event. This assessment report serves as the demonstration

supporting the flagging of these data. Two Maricopa County monitors have been flagged as exceeding the 24-hour PM10 standard as a result of the high wind exceptional event:

Durango Complex (04-013-9812-81102-1) and West 43rd Avenue (04-013-4009-81102-1).

***Document that the public comment process was followed for event documentation (40 CFR 50.14(c)(3)(iv))***

ADEQ posted this assessment report on the ADEQ webpage and placed a hardcopy of the report in the ADEQ Records Management Center for public review. ADEQ opened a 30-day public comment period on 01/13/2014. A copy of the public notice certification, along with any comments received, will be submitted to EPA, consistent with the requirements of 40 CFR 50.14(c)(3)(iv). See Appendix C for a copy of the affidavit of public notice.

***Submit demonstration supporting exceptional event flag (40 CFR 50.14(a)(1-2))***

At the close of the comment period, and after ADEQ has had the opportunity to consider any comments submitted on this document, ADEQ will submit this document, the comments received, and ADEQ's responses to those comments to EPA Region IX headquarters in San Francisco, California. The deadline for the submittal of this demonstration package is September 30, 2016.

**Documentation Requirements**

Section 50.14(c)(3)(iii) of the EER states that in order to justify excluding air quality monitoring data, evidence must be provided for the following elements:

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.

Section II of this assessment introduces the conceptual model of a thunderstorm outflow wind event that transpired on July 2, 2013, providing a background narrative of the exceptional event and an overall explanation that 'the event affected air quality'. Further evidence that 'the event affected air quality' is provided in Section V.

Section IV of this assessment details the existing area control measures and demonstrates that despite the presence and enforcement of these controls, the event on July 2, 2013, was not reasonably controllable or preventable.

Section V of this assessment establishes a clear causal connection between the natural event on July 2, 2013, and the exceedances of the 24-hour PM10 standard. The evidence in this section (and the previous section on historical fluctuations) also confirms that the event in question both affected air quality and was the result of a natural event.

Section III of this assessment provides data summaries and time series graphs which help illustrate that the event on July 2, 2013, produced PM10 concentrations in excess of normal historical fluctuations.

Section VI of this assessment builds upon the demonstration showing a clear causal connection between the natural event and the exceedance and concludes there would have been no exceedance on July 2, 2013, but for the presence of the natural event.

# II. CONCEPTUAL MODEL

## Geographic Setting and Climate

### *Geographic Setting*

Phoenix is located in the Salt River Valley in south-central Arizona. It lies at a mean elevation of 1,090 feet above mean sea level (msl) in the northeastern part of the Sonoran Desert. Other than the mountains in and around the city, the topography of Phoenix is generally flat. The Phoenix area is surrounded by the McDowell Mountains (~4,200 ft msl) to the northeast, the foothills of the Bradshaw (~7,900 ft msl) and Mazatzal (~7,900 ft msl) ranges to the north, the White Tank Mountains (~4,500 ft msl) to the west, the Sierra Estrella (~4,450 ft msl) to the southwest, and the Superstition Mountains (~5,000 ft msl) far to the east. Within the City are the Phoenix Mountains (~2,600 ft msl) and South Mountain (~2,600 ft msl). Current development is pushing north, west, and south into Pinal County. The Phoenix metropolitan area contains a fairly dense network of PM10 monitors throughout the area, with a much less dense network of monitors located throughout the rest of the state. Figure 2–1 shows the general geographic setting of Phoenix, as well as the locations of PM10 monitors throughout the state. It should be noted that some of the monitors shown in Figure 2-1 are filter-based monitors; therefore, monitoring data from all locations may only be available for select days (i.e., 1-in-6 run days).

Figure 2–2 depicts the drainage systems or watersheds for the State of Arizona. Many of the rivers that form Arizona's drainage system are dry for most of the year and, consequently, are sources of silt and fine soils that become suspended and add to regional PM10 loadings during high wind events. Much of this alluvial matter and fine soil is deposited in the low lying areas of central and southern Arizona, with larger depositional areas focused in and around the confluences of dry river channels.

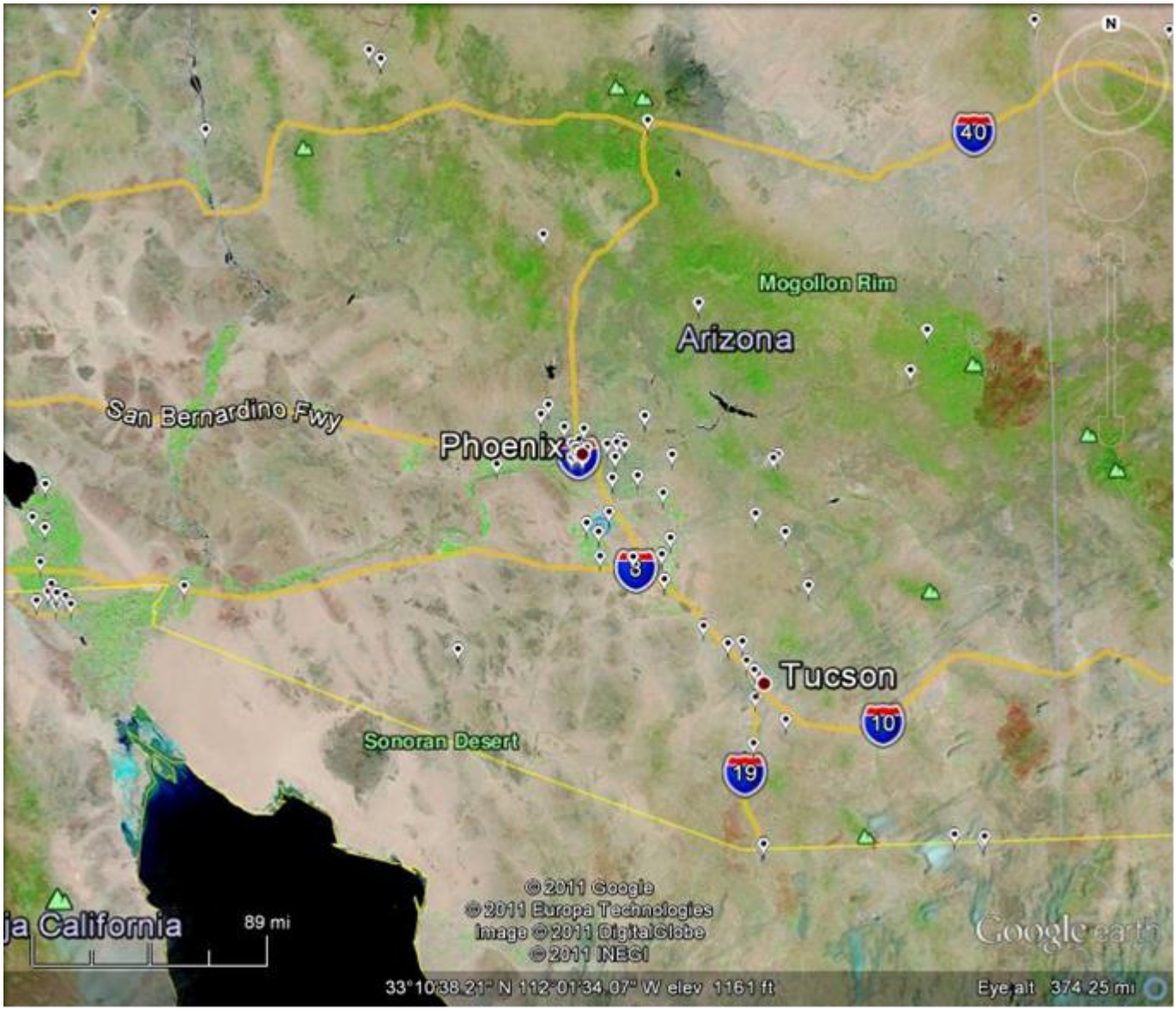



**Figure 2-1**. Phoenix Geographic Setting and PM10 Monitor Locations (source: EPA AQS DataMart, NASA MODIS Satellite, and Google Earth). PM10 monitor locations are indicated by white markers.

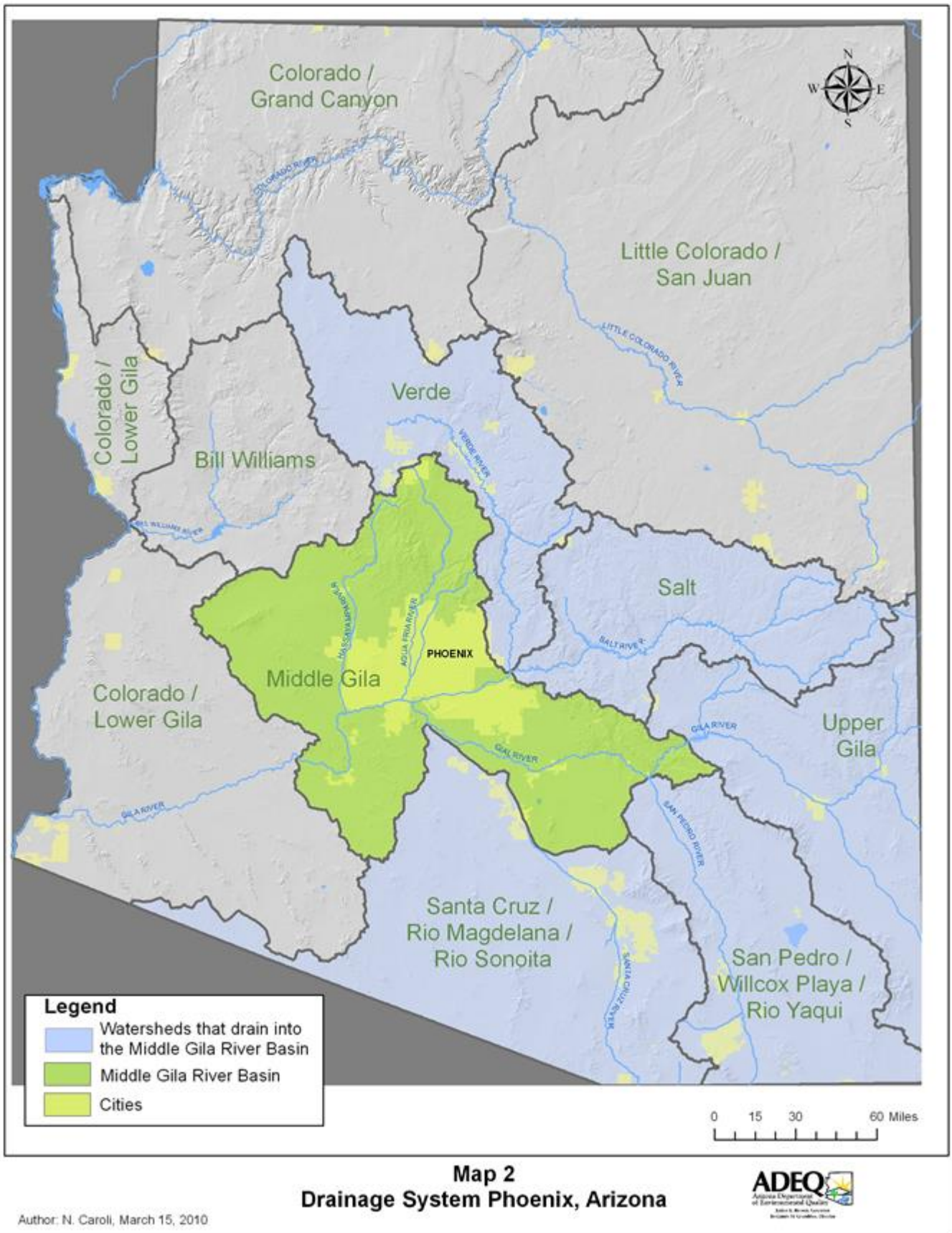



**Figure 2-2.** Drainage System of Phoenix, Arizona.

***Climate***

Phoenix has an arid climate, with very hot summers and temperate winters. The average summer high temperature is among the hottest of any populated area in the United States. The temperature reaches or exceeds 100ºF an average of 110 days during the year and highs top 110ºF an average of 18 days during the year. Phoenix receives an average of 7.66 inches of rain per year.

Precipitation is sparse during the first part of the summer, but the influx of monsoonal moisture, which generally begins in early July and lasts until mid-September, raises humidity levels and can cause heavy localized precipitation and flooding. Although thunderstorms are possible at any time of the year, they are most common during the monsoon season from July to mid-September as humid air is advected from the Gulf of California, Gulf of Mexico, and large thunderstorm complexes from the Sierra Madre Occidental Mountains in Mexico. This influx in moisture, combined with intense solar heating, often creates a very unstable environment that is ripe for thunderstorm development. These thunderstorms can bring strong winds and blowing dust, large hail, and heavy rain. Dust storms associated with these thunderstorms typically occur in the early part of the monsoon season (July) before soaking rains help keep soil particles bound to one another. However, depending on the amount of precipitation received during the monsoon season, extremely hot temperatures act to dry out the surface quickly, and dust storms can occur at any time. During the December through March period, winter storms moving inland from the Pacific Ocean can bring strong winds, blowing dust and significant rains throughout Arizona. This December – March time period, and July – August time period are typically the wettest parts of the year. Meanwhile, a distinct dry season occurs during the period April through June for Phoenix and the rest of Arizona. While these weather patterns describe the general climatology for the Phoenix area over a long period of time, Phoenix and the entire state of Arizona is also prone to a high degree of variability in these weather patterns from year to year.

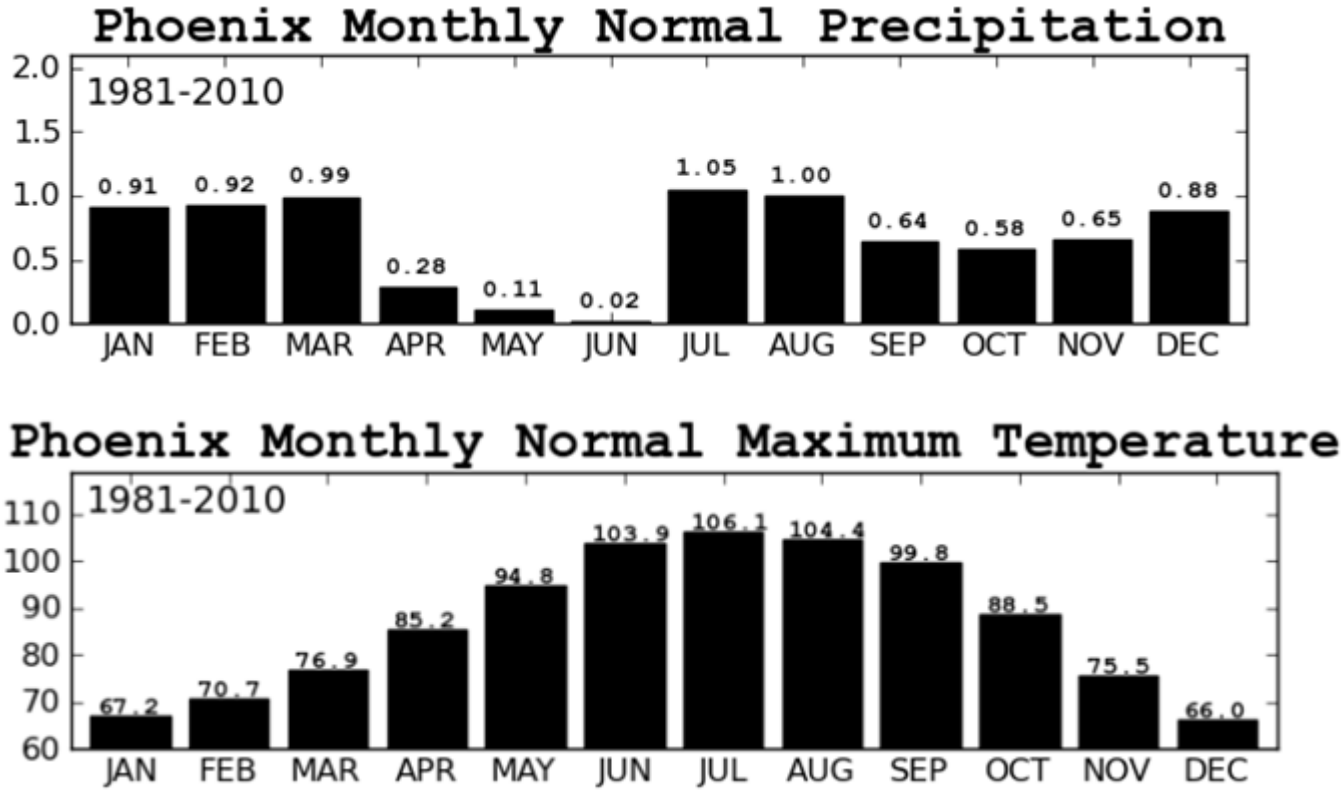



**Figure 2-3** Phoenix Monthly Precipitation (top) and Maximum Temperature (bottom) Climatology (source: National Weather Service).

**Monsoon Season Thunderstorm Outflow Dust Storm Event Summary**

The North American Monsoon is a shift in wind patterns in the summer which occurs as Mexico and the southwest U.S. warm under intense solar heating. As this happens, low level moisture is transported primarily from the Gulf of California and eastern Pacific Ocean into the southwestern U.S. Mid and upper level moisture is also transported into the region, mainly from the Gulf of Mexico by easterly winds aloft. This combination causes a distinct rainy season over large portions of western North America, which develops rather quickly and sometimes dramatically. There are usually distinct "burst" periods of heavy rain during the monsoon, and "break" periods with little or no rain. Even during active monsoon periods, some areas can go without receiving any significant precipitation while other nearby areas experience heavy rains and flooding.

In addition to bringing precipitation, active thunderstorms can produce downbursts, or sometimes more concentrated and severe microbursts, which are rapidly descending bursts of air spreading away from the thunderstorm clouds. These downward bursts of air hit the ground and then disperse away from the storms as areas of outflow. These outflow boundaries from the thunderstorms can generate large walls of dust, sometimes called haboobs, and transport that dust for long distances from the initiating thunderstorms (see Figure 2–4).

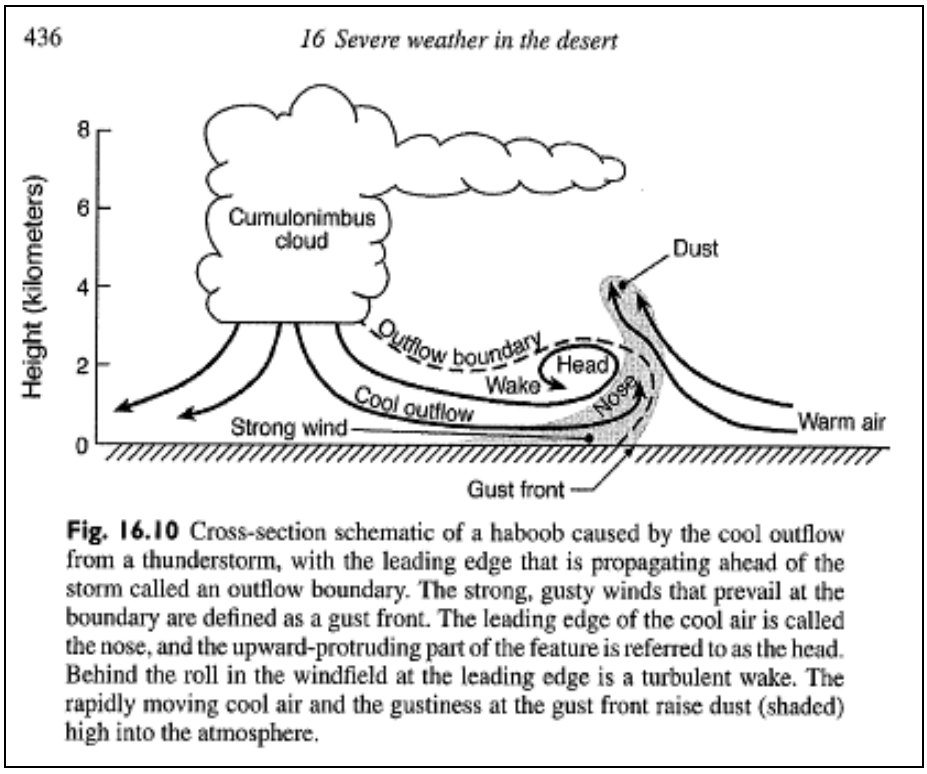



**Fig. 16.10** Cross-section schematic of a haboob caused by the cool outflow from a thunderstorm, with the leading edge that is propagating ahead of the storm called an outflow boundary. The strong, gusty winds that prevail at the boundary are defined as a gust front. The leading edge of the cool air is called the nose, and the upward-protruding part of the feature is referred to as the head. Behind the roll in the windfield at the leading edge is a turbulent wake. The rapidly moving cool air and the gustiness at the gust front raise dust (shaded) high into the atmosphere.

**Figure 2-4.** Cross-section of a thunderstorm creating an outflow boundary and haboob (Source: Desert Meteorology. Thomas T. Warner. 2004.)

On July 2, 2013, two dust storms generated by thunderstorm outflow winds were recorded in the Maricopa County area. The first dust storm impacted the Maricopa County area from approximately 2:30 am to 8:00 am. The National Weather Service (NWS) issued an aviation weather warning at 4:58 am for the Phoenix Sky Harbor International Airport, predicting gusts of 35 to 40 mph and reduced visibilities down to three to five miles. During the first dust storm event, monsoon winds from the southeast produced recorded gusts as high as 45 mph, sustained winds as high as 28 mph and visibilities as low as 4.0 miles.

The second dust storm impacted the Maricopa County area beginning at approximately 9:30 pm and ending at approximately 1:30 am on July 3, 2013. At 8:51 pm, the NWS issued a dust storm warning for northwest Pinal County and the Phoenix metro areas to remain in effect until 11:00 pm, with predicted visibilities as low as one-quarter mile for the affected area. The monsoon winds associated with this thunderstorm outflow dust storm produced recorded gusts in Pinal County as high as 36 mph, sustained winds as high as 28 mph and visibilities as low as 2.5 miles at Casa Grande airport. In Maricopa County the thunderstorm outflow dust storm produced recorded gusts as high as 34 mph, sustained winds as high as 23 mph and visibilities as low as six miles.

Originating in the natural and open desert areas of Pinal and Maricopa counties, the thunderstorms brought only minimal precipitation to Pinal County, but they produced intense outflow winds that generated and transported significant quantities of blowing dust north-northwest through the Maricopa County nonattainment area. Both events produced wind speeds high enough to overwhelm controls designed to reduce PM10 from high winds. Five-minute average PM10 concentrations during the first thunderstorm outflow event reached over 3,500 $\mu g/m^3$ in response to gusty winds from the outflow event, while PM10 concentrations during the second outflow reached as high as 1,762 $\mu g/m^3$. The PM10 from the dust storms ultimately caused two Maricopa County monitors to exceed the 24-hour PM10 standard on July 2, 2013, with an additional three Maricopa County monitors within 15 $\mu g/m^3$ of exceeding the standard.

A contributing factor that led to this dust storm was the on-going drought across the region. The U.S. Drought Monitor as of July 2, 2013, categorized the source area of the thunderstorm winds as either D1 (Moderate) drought level or D2 (Severe) drought level. This level of drought helps to show how the natural desert areas of Pinal and Maricopa County are vulnerable to dust storms generated by thunderstorm outflow winds.

A more detailed explanation and time series visualization of the thunderstorm outflow dust storm event is available in Section V, describing the clear causal connection between the approaching outflow and the exceeding PM10 concentrations recorded in the nonattainment area.

As a summary of the event, Figure 2–6 displays an hourly graph of the PM10 concentrations throughout Maricopa County and the nonattainment area. Table 2–1 contains PM10 concentration data from all recorded monitors throughout the State of Arizona.

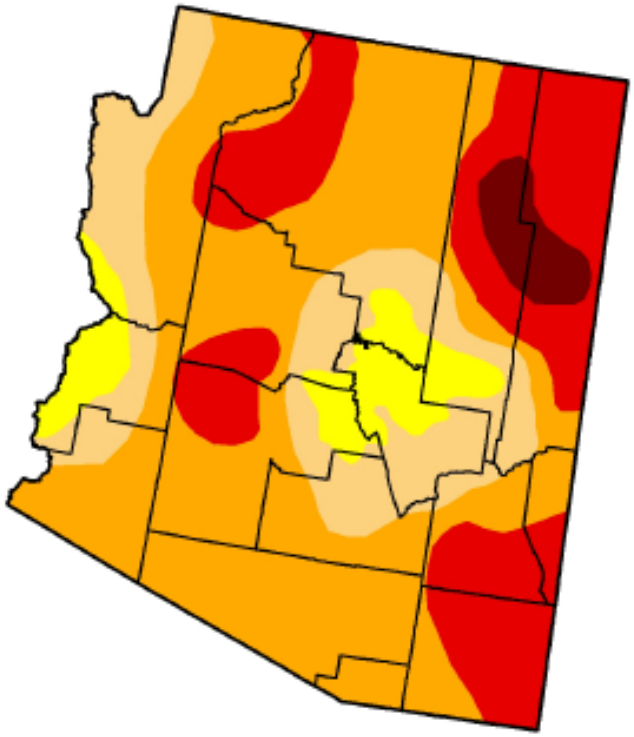
# U.S. Drought Monitor

**July 2, 2013**
Valid 7 a.m. EST

## Arizona

*Drought Conditions (Percent Area)*

| | None | D0-D4 | D1-D4 | D2-D4 | D3-D4 | D4 |
|---|---|---|---|---|---|---|
| Current | 0.00 | 100.00 | 92.46 | 74.35 | 27.40 | 3.04 |
| Last Week (06/25/2013 map) | 0.00 | 100.00 | 92.49 | 74.44 | 23.48 | 0.00 |
| 3 Months Ago (04/02/2013 map) | 3.06 | 96.94 | 80.11 | 29.72 | 2.03 | 0.00 |
| Start of Calendar Year (01/01/2013 map) | 0.00 | 100.00 | 97.91 | 37.78 | 8.68 | 0.00 |
| Start of Water Year (09/25/2012 map) | 0.00 | 100.00 | 100.00 | 31.93 | 5.67 | 0.00 |
| One Year Ago (06/26/2012 map) | 0.00 | 100.00 | 100.00 | 93.72 | 25.07 | 0.00 |



*Intensity:*

- *D0 Abnormally Dry*
- *D1 Drought - Moderate*
- *D2 Drought - Severe*
- *D3 Drought - Extreme*
- *D4 Drought - Exceptional*

*The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.*

USDA

***Released Wednesday, July 3, 2013***

**http://droughtmonitor.unl.edu**

*Matthew Rosencrans, NOAA/NWS/NCEP/Climate Prediction Center*

**Figure 2-5**. U.S. Drought Monitor analysis of Arizona released around the time period of the exceedance described in this report.

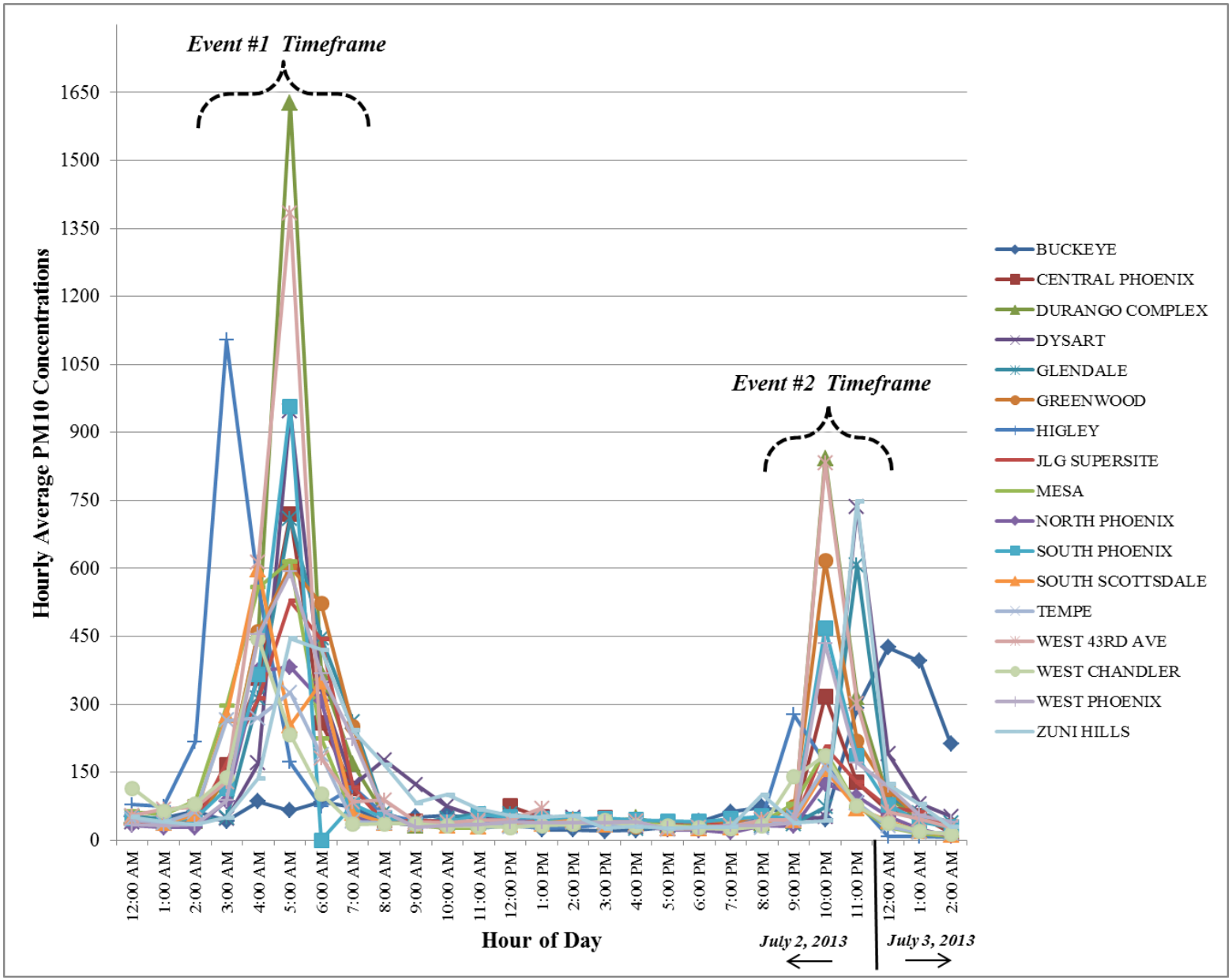



**Figure 2-6.** Timeline of PM10 concentrations at monitors in Maricopa County and the PM10 nonattainment area on July 2, 2013.

**Table 2-1.** Summary of Statewide PM10 Measurements for July 2, 2013.

| Monitor | Monitor Type | Operator | AQS Monitor ID | 24-hr Avg PM10 (µg/m$^3$) | 1-hr Max PM10 (µg/m$^3$) | Max Time | AQS Qualifier Flag |
|---|---|---|---|---|---|---|---|
| **Apache County[1]** | | | | | | | |
| N/A | N/A | WMAT | 04-001-1003-81102-1 | 9 | 32 | 1500 | |
| **Coconino County** | | | | | | | |
| N/A | N/A | ADEQ | 04-005-1237-81102-1 | N/A | N/A | N/A | |
| **Gila County[2]** | | | | | | | |
| Hayden Old Jail | TEOM | ADEQ | 04-007-1001-81102-3 | 61 | 556 | 1900 | |
| **Maricopa County[1]** | | | | | | | |
| Buckeye | TEOM | MC | 04-013-4011-81102-1 | 60 | 292 | 2300 | |
| Central Phoenix | TEOM | MC | 04-013-3002-81102-4 | 120 | 719 | 0500 | |
| **Durango Complex** | **TEOM** | **MC** | **04-013-9812-81102-1** | **192** | **1,627** | **0500** | **RJ** |
| Dysart | TEOM | MC | 04-013-4010-81102-1 | 143 | 946 | 0500 | |
| Fort McDowell/ Yuma Frank | TEOM | FMIR | 04-013-5100-81102-3 | N/A | N/A | N/A | |
| Glendale | TEOM | MC | 04-013-2001-81102-1 | 132 | 709 | 0500 | |
| Greenwood | TEOM | MC | 04-013-3010-81102-1 | 146 | 616 | 2200 | |
| Higley | TEOM | MC | 04-013-4006-81102-1 | 141 | 1,103 | 0300 | |
| JLG Supersite[2] | BAM | ADEQ | 04-013-9997-81102-3 | 107 | 528 | 0500 | |
| JLG Supersite | TEOM | ADEQ | 04-013-9997-81102-4 | N/A | N/A | N/A | |
| Lehi Air Monitoring Station | N/A | SRP-MIC | 04-013-7022-81102-1 | N/A | N/A | N/A | |
| Mesa | TEOM | MC | 04-013-1003-81102-1 | 118 | 615 | 0500 | |
| North Phoenix | BAM | MC | 04-013-1004-81102-1 | 83 | 381 | 0500 | |
| Senior Center Air Monitoring Station | N/A | SRP-MIC | 04-013-7020-81102-1 | N/A | N/A | N/A | |
| Senior Center Air Monitoring Station | N/A | SRP-MIC | 04-013-7020-81102-2 | N/A | N/A | N/A | |
| South Phoenix | TEOM | MC | 04-013-4003-81102-1 | 90 | 469 | 2200 | |
| South Scottsdale | TEOM | MC | 04-013-3003-81102-1 | 99 | 597 | 0400 | |
| Tempe | TEOM | MC | 04-013-4005-81102-1 | 81 | 325 | 0500 | |
| West Chandler | TEOM | MC | 04-013-4004-81102-1 | 84 | 444 | 0400 | |
| **West Forty Third** | **TEOM** | **MC** | **04-013-4009-81102-1** | **186** | **1,383** | **0500** | **RJ** |
| West Phoenix | TEOM | MC | 04-013-0019-81102-1 | 122 | 592 | 0500 | |
| Zuni Hills | TEOM | MC | 04-013-4016-81102-1 | 127 | 748 | 2300 | |
| **Navajo County[1]** | | | | | | | |
| N/A[1] | N/A | WMAT | 04-017-1002-81102-1 | 15 | 86 | 0000 | |
| **Pima County[2]** | | | | | | | |
| Ajo | TEOM | ADEQ | 04-019-0001-81102-3 | 41 | 382 | 0500 | |
| Orange Grove | FRM | PCDEQ | 04-019-0011-81102-2 | N/A | N/A | N/A | |
| Prince Road | FRM | PCDEQ | 04-019-1009-81102-1 | N/A | N/A | N/A | |
| Rillito | TEOM | ADEQ | 04-019-0020-81102-3 | 422 | 5,627 | 2100 | RJ |
| Santa Clara | FRM | PCDEQ | 04-019-1026-81102-1 | N/A | N/A | N/A | |
| Tangerine | FRM | PCDEQ | 04-019-1018-81102-1 | N/A | N/A | N/A | |
| **Pinal County[3]** | | | | | | | |
| Apache Junction Fire Station | FRM | PCAQCD | 04-021-3002-81102-1 | N/A | N/A | N/A | |
| Bapchule | FRM | GRIC | 04-021-7004-81102-1 | N/A | N/A | N/A | |
| Bapchule | FRM | GRIC | 04-021-7004-81102-2 | N/A | N/A | N/A | |
| Casa Grande Downtown | TEOM | PCAQCD | 04-021-0001-81102-3 | 122 | 1,651 | 2200 | |
| Combs School | TEOM | PCAQCD | 04-021-3009-81102-3 | 95 | 421 | 0400 | |
| Cowtown | TEOM | PCAQCD | 04-021-3013-81102-3 | 185 | 980 | 2200 | |
| Maricopa | TEOM | PCAQCD | 04-021-3010-81102-3 | 145 | 678 | 0500 | |
| Pinal Air Park | TEOM | PCAQCD | 04-021-3007-81102-1 | 95 | 750 | 0400 | |
| Pinal County Housing | TEOM | PCAQCD | 04-021-3011-81102-3 | 193 | 943 | 2200 | |
| Stanfield | TEOM | PCAQCD | 04-021-3008-81102-3 | 322 | 3,033 | 2200 | |
| **Santa Cruz County[2]** | | | | | | | |

| Monitor | Monitor Type | Operator | AQS Monitor ID | 24-hr Avg PM10 (µg/m$^3$) | 1-hr Max PM10 (µg/m$^3$) | Max Time | AQS Qualifier Flag |
|---|---|---|---|---|---|---|---|
| Nogales Post Office | BAM | ADEQ | 04-023-0004-81102-3 | 18 | 68 | 2200 | |
| **Yuma County[2]** | | | | | | | |
| Yuma Supersite | TEOM | ADEQ | 04-027-8011-81102-3 | 124 | 814 | 0800 | |

SOURCE: [1]EPA's Air Quality System (AQS) database. [2]ADEQ's AZURITE database. [3]Data for Pinal County were estimated by ADEQ staff. AZURITE data and data from Pinal County should be considered preliminary until they are entered into (AQS).

TEOM: Tapered Element Oscillating Microbalance monitor
FRM: Federal Reference Method
WMAT: White Mountain Apache Tribe of Fort Apache Reservation, AZ
SRP-MIC: Salt River Pima-Maricopa Indian Community of Salt River Reservation, AZ
PCDEQ: Pima County Department of Environmental Quality
PCAQCD: Pinal County Air Quality Control District
GRIC: Gila River Indian Community
RJ: qualifier flag for high winds

# III. HISTORICAL FLUCTUATIONS

PM10 concentrations measured at the Durango Complex and West 43rd Avenue monitors on July 2, 2013, were unusual and in excess of normal historical fluctuations. Figure 3–1 displays a time series plot of the 24-hour PM10 concentrations for the period of January 1, 2008 through July 31, 2013 for the Durango Complex monitor; while Figure 3–2 displays the same historical range of data for the West 43rd Avenue monitor. The figures indicate that the PM10 concentrations seen at the Durango Complex and West 43rd Avenue monitors on July 2, 2013 were in excess of normal historical fluctuations.

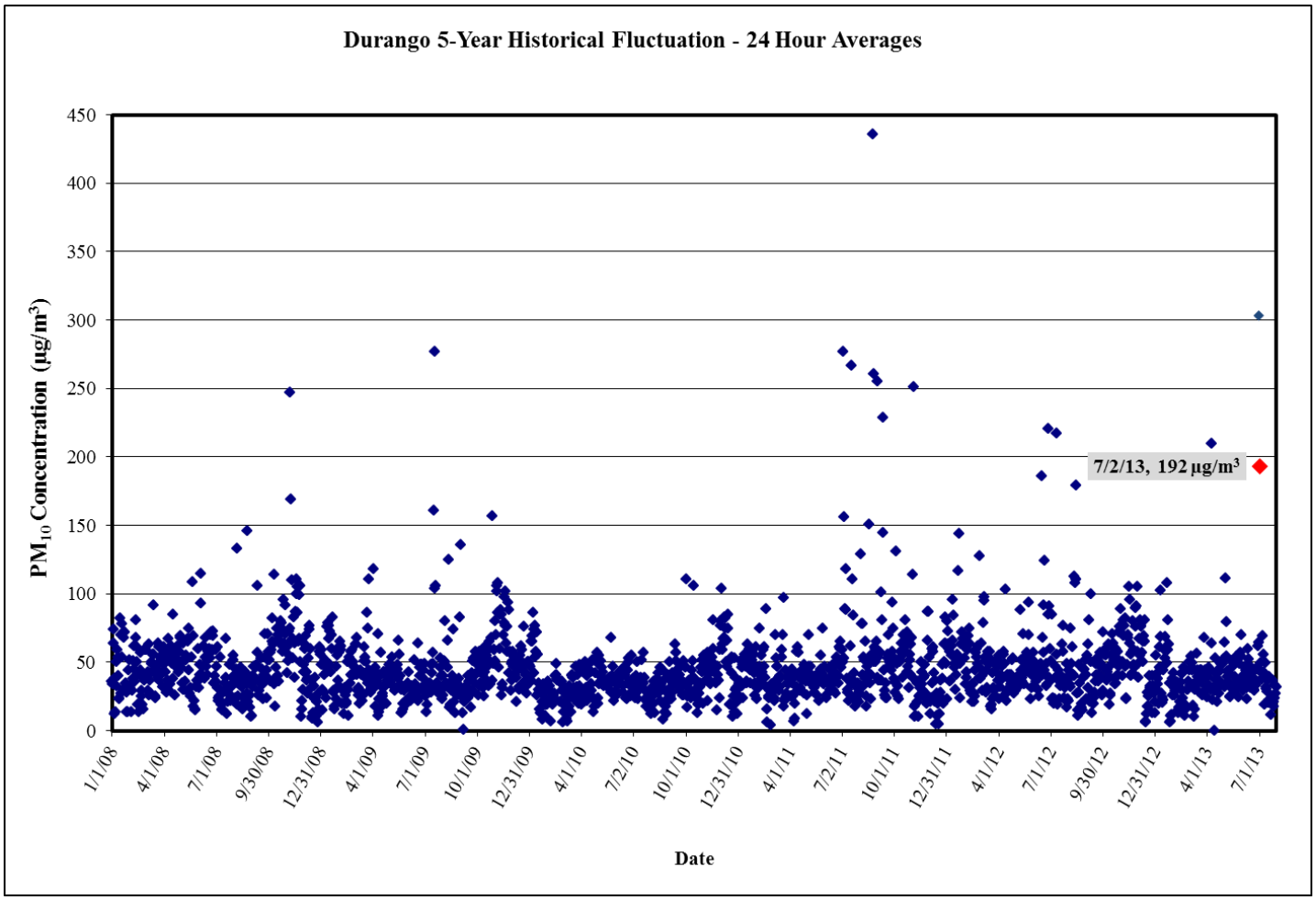



**Figure 3-1.** Plot of 24-hour average PM10 concentrations (2008 – July 2013) at the Durango Complex monitor.

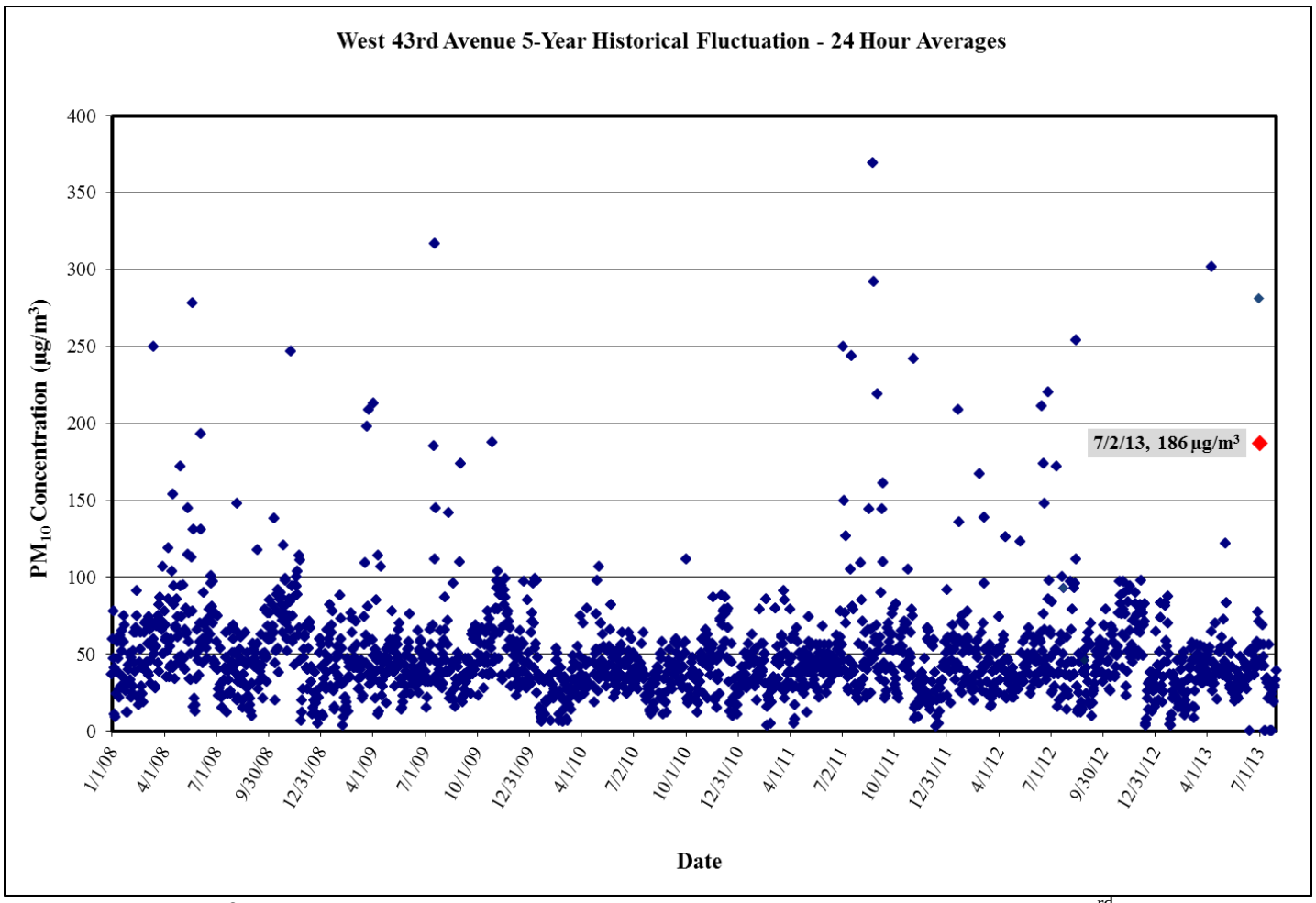



**Figure 3-2.** Plot of 24-hour average PM10 concentrations (2008 – July 2013) at the West 43rd Avenue monitor.

# IV. 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 the PM10 nonattainment area, high wind conditions overwhelmed all reasonably available controls. The event occurring on July 2, 2013, was directly related to strong and gusty winds generated by thunderstorm outflows. The gusty outflow winds overwhelmed all reasonably available controls within the Maricopa County PM10 nonattainment area, and also contributed to the transport of PM10 into the nonattainment area from areas outside of the nonattainment area. As shown in section V, both the natural and open desert areas of Maricopa and Pinal counties were source regions for dust created by the two thunderstorm outflow wind events that occurred on July 2, 2013. Strict controls on local sources of fugitive dust were in place and enforced during the event on July 2, 2013, but were not capable of controlling dust and PM10 generated and transported by the gusty and turbulent thunderstorm outflow winds on this date.

The following sections describe the BACM- and MSM-level PM10 control measures in place on July 2, 2013, and the robustness of the programs designed to enforce these measures. Inspections of local sources performed before, during and after July 2, 2013, confirmed that no unusual anthropogenic PM10-producing activities contributed to the exceedances on July 2, 2013.

## Regulatory Measures and Control Programs

The Arizona Department of Environmental Quality (ADEQ) and the Maricopa County Air Quality Department (MCAQD) are responsible for implementing regulatory measures to control emissions from agricultural sources, stationary sources, fugitive dust sources, and open burning within Maricopa County. Three major programs provide or contribute to air pollution control measures for the Greater Phoenix area. These programs include:

1.) ADEQ's Agricultural Best Management Program (AgBMP)
2.) Maricopa County's Inspection and Compliance Program
3.) ADEQ's Air Quality Forecasting Program

Specifically, ADEQ is responsible for compliance assistance and enforcement of Agricultural Best Management Practices developed by the Governor's Agricultural Best Management Practices Committee, while MCAQD is responsible for compliance assurance for all other significant sources of PM10 emissions. In addition to routine inspections and inspections driven by complaints, inspections are often increased when 1.) ADEQ forecasters issue a High Risk for the Maricopa County Dust Control Forecast, 2.) ADEQ forecasters issue a High Pollution Advisory, or 3.) near real-time monitoring data indicate unique activity via high PM concentrations. The forecasting program and inspection / compliance programs work together so that resources can be best utilized during days that are of greatest risk for elevated PM emissions.

On July 25, 2002, EPA took initial action to finalize approval of the Best Available Control Measure (BACM) and the Most Stringent Measure (MSM) demonstrations in the Serious Area PM10 plan for the Maricopa County portion of the metropolitan Phoenix PM10 nonattainment area (67 FR 48718). These BACM and MSM demonstrations were again approved by EPA on July 14, 2006 (71 FR 43979). The

Agricultural Best Management Practices General Permit rule and related definitions have been approved into the Arizona Administrative Code as R18-2-610 and R18-2-611 pursuant to Arizona Revised Statutes § 49-457[1] . Maricopa County regulations of PM10 emissions are listed in Table 4-1.

**Table 4-1.** Rules and Ordinances Regulating Particulate Matter Emissions in Maricopa County.

| Rule/Ordinance Number & Title | Description |
|---|---|
| **Rule 300:** Visible Emissions | Establishes standards for visible emissions and opacity. |
| **Rule 310:** Fugitive Dust from Dust-Generating Operations | Establishes limits for the emissions of particulate matter into the ambient air from any property, operations, or activity that may serve as a fugitive dust source. |
| **Rule 310.01:** Fugitive Dust from Non-Traditional Sources of Fugitive Dust | Establishes limits for the emissions of particulate matter into the ambient air from open areas, vacant lots, unpaved parking lots, and unpaved roadways which are not regulated by Rule 310 and which are not required to have either a permit or a dust control plan. |
| **Rule 311:** Particulate Matter from Process Industries | Establishes emission rates based on process weight applicable to any affected operations not subject to Rule 316. |
| **Rule 312:** Abrasive Blasting | Establishes limits for particulate emissions from abrasive blasting operations. |
| **Rule 314:** Open Outdoor Fires and Indoor Fireplaces at Commercial and Institutional Establishments | Establishes limits for the emissions of air contaminants produced from open burning. |
| **Rule 316:** Nonmetallic Mineral Processing | Establishes limits for the emissions of particulate matter into the ambient air from any nonmetallic mining operation or rock product processing plant. |
| **Rule 317:** Hospital/Medical/ Infectious Waste Incinerators | Establishes limits for the emissions of air pollutants from medical waste incinerators. |
| **Rule 322:** Power Plant Operations | Establishes limits for the emissions of nitrogen oxides, sulfur oxides, carbon monoxide and particulate matter from existing power plants and cogeneration plants. |
| **Rule 323:** Fuel Burning Equipment from Industrial/Commercial/ Institutional (ICI) Sources | Establishes limits for the emissions of nitrogen oxides, sulfur oxides, carbon monoxide and particulate matter from ICI sources. |
| **Rule 324:** Stationary Internal Combustion (IC) Engines | Establishes limits for the emissions of carbon monoxide, nitrogen oxides, sulfur oxides, volatile organic compounds, and particulate matter from stationary internal combustion engines, including stationary IC engines used in cogeneration. |
| **Rule 325:** Brick and Structural Clay Products (BSCP) Manufacturing | Establishes limits for particulate matter emissions from the use of tunnel kilns for curing in the brick and structural clay product (BSCP) manufacturing processes. |
| **Ordinance P-25:** Leaf Blower Restriction | Establishes restrictions for leaf blowers in incorporated and unincorporated sections of Area A in Maricopa County. |

[1] Updates to the AgBMP program in December, 2011, clarified BMPs for crop and added BMPs for animal operations. Effective 12/29/2011, R18-2-611 was renumbered to R18-2-610.0,1 **Agricultural PM10 General Permit for Crop Operations** and R18-2-611.01, **Animal Operations PM10 General Permit** was added. Definitions for Crop Operations were revised at R18-2-610 and new definitions for Animal Operations were added at R18-2-611.

| Rule/Ordinance Number & Title | Description |
|---|---|
| **Ordinance P-26:** Residential Woodburning Restriction | Establishes restrictions for residential woodburning. |
| **Ordinance P-27:** Vehicle Parking and Use on Unstabilized Vacant Lots | Establishes restrictions for vehicle parking and use on unstabilized vacant lots in unincorporated sections of Area A in Maricopa County. |
| **Ordinance P-28:** Off-Road Vehicle Use in Unincorporated Areas of Maricopa County | Establishes restrictions for operating vehicles on unpaved property in unincorporated areas of Maricopa County. |
| **Arizona Administrative Code R18-2-611 & 610:** Agricultural PM10 General permit | Establishes a requirement for commercial farmers to implement best management practices and maintain a record demonstrating compliance |

In addition to the rules and regulations listed in the above table, other PM10 reducing control measures (e.g., paving of unpaved roads, PM10 certified street sweepers, controlling unpaved parking lots, etc.) have been committed to, and implemented by, local jurisdictions throughout the PM10 nonattainment area, and incorporated into the Arizona SIP through PM10 plans such as the Revised MAG 1999 Serious Area Particulate Plan for PM10 for the Maricopa County Nonattainment Area. The Pinal County Air Quality Control District (PCAQCD) also implements regulatory control measures on emissions from existing and new non-point sources within Pinal County (see Table 4-2). Additionally, the PCAQCD implements specific nonattainment rules for that part of the Phoenix PM10 nonattainment area that resides in Pinal County (see Table 4-3).

**Table 4-2.** Pinal County Rules Regulating Existing and New Non-point Sources in Pinal County.

| Article Number & Title | Description |
|---|---|
| **Article 2:** Fugitive Dust | Provides a mechanism to reasonably regulate operations which periodically may cause fugitive dust emissions into the atmosphere |
| **Article 3:** Construction Sites – Fugitive Dust | Improves the control of excessive fugitive dust emissions that have been traditionally associated with construction, earthwork, and land development, and thereby minimize nuisance impacts |

**Table 4-3.** Pinal County Rules Regulating Fugitive Dust in Pinal County Portion of MC PM10 NAA.

| Article Number & Title | Description |
|---|---|
| **Article 4:** Nonattainment Area Rules; Dustproofing for Commercial Parking, Drives and Yards | Establishes rules to avoid violations of the prevailing PM10 standard and additionally minimize nuisance impacts by improving control of excessive fugitive dust emissions from unpaved parking lots |
| **Article 5:** Nonattainment Area Rules; Stabilization for Residential Parking and Drives | Establishes rules for stabilizing residential properties |
| **Article 6:** Restrictions on Vehicle Parking and Use on Vacant Lots | Establishes rules for unpaved or unstabilized vacant lots |
| **Article 7:** Construction Sites in Nonattainment Areas – Fugitive Dust | Establishes rules to avoid violations of the prevailing PM10 standard and additionally minimize nuisance impacts by improving control of excessive fugitive dust emissions from activities associated with construction, earthwork, or land development. |

| Article Number & Title | Description |
|---|---|
| **Article 8:** Nonattainment Area Rules, Requirement for Stabilization of Disturbed Areas at Vacant Lots | Establishes rules for stabilizing disturbed areas at vacant lots |

**PM10 Rule Effectiveness**

MCAQD analyzed the effectiveness of its fugitive dust rules (Rules 310, 310.01 and 316) in terms of source compliance rates. The rule effectiveness study was designed to assess how many sources regulated by MCAQD during the subject time period received no PM10 emissions-related violations. As a basis for comparison, the percentage of sources that did not receive a PM10 emissions-related violation during calendar year 2007 was 76% for sources subject to Rule 310, 85% for sources subject to Rule 310.01, and 40% for sources subject to Rule 316. In early 2008, Rules 310, 310.01, and 316 were strengthened and new ordinances (covering additional source categories such as leaf blowers, vacant lots, and off-road vehicles) were adopted. These enhancements resulted from MCAQD's obligations under such agreements as the 2005 Revised PM10 State Implementation Plan for the Salt River Area and the Maricopa Association of Governments (MAG) 2007 Five Percent Plan for PM10 for the Maricopa County Nonattainment Area. Three major areas that contributed to increased compliance were an increase in departmental staffing (especially inspectors), a robust training program, and regulatory changes that broadened and strengthened control measures under Rules 310, 310.01, and 316.

Rule effectiveness rates were re-assessed for FY 2009 (July 2008–June 2009), a period that allowed time for the new and revised regulations to take effect. The results showed significant increases in compliance compared with the earlier period: to 90% (from 76%) for Rule 310 sources, to 95% (from 85%) for Rule 310.01 sources, and to 65% (from 40%) for Rule 316 sources. These improvements continued into calendar year 2010 with rule effectiveness rates of 94% for Rule 310 sources, 96% for Rule 310.01, and 73% for Rule 316 sources.

Additional rule effectiveness increases were observed for Rule 310.01 and Rule 316 in calendar year 2012. The increase in rule effectiveness for Rule 310.01 was attributed to ADEQ's Dust Action General Permit, which was a new dust measure contained in the 2012 Five Percent Plan for PM10 for the Maricopa County Nonattainment Area. The rule effectiveness for Rule 310.01 was 98%, an increase of 2% in 2012. The rule effectiveness for Rule 316 had a considerable increase to 83%, which is an increase of 10% compared to 2010.

The timeline below illustrates the improvements in rule effectiveness over the last several years, and also points out significant revisions to previous rules, as well as newly adopted rules, ordinances and measures. Since the first study of 2007, the rule effectiveness has increased for Rule 310, Rule 310.01, and Rule 316 by 17%, 13%, and 43%, respectively.

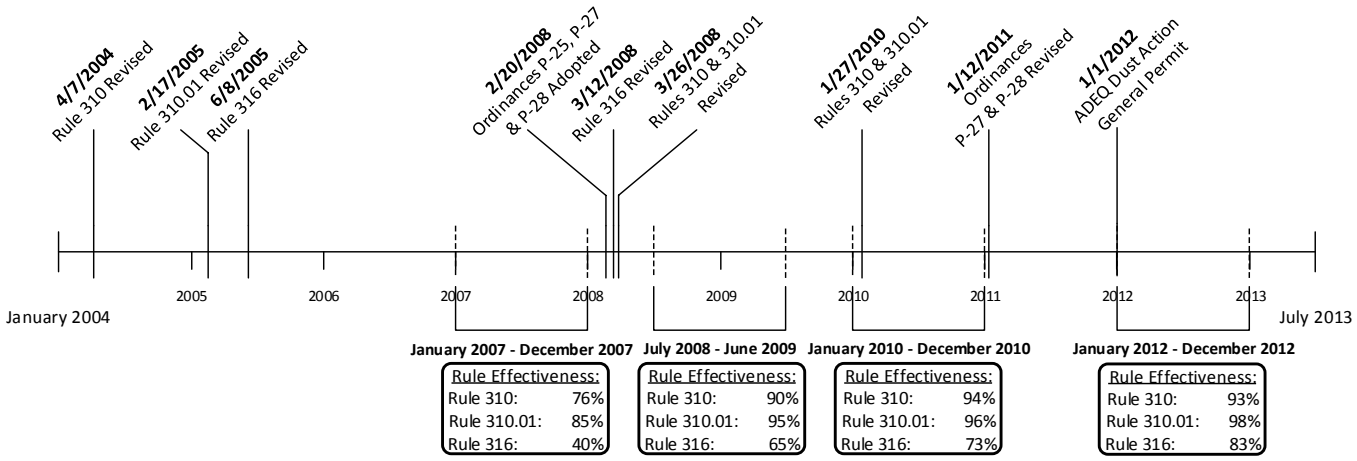



**Figure 4-1.** Timeline of Maricopa County fugitive dust rules and ordinances.

## Compliance and Enforcement Activities

MCAQD is prepared to proactively respond to high wind events and protect human health and well-being. MCAQD's approach consists of two primary components: routine proactive inspections, as well as surveillance inspections, conducted both during and after significant events. MCAQD routinely inspects dust control-permitted sites and increases the frequency of inspections for permits covering areas of 10 acres or more. Non-metallic surface mining sources under Rule 316 are also regularly inspected multiple times every year. Maricopa County also responds to the majority of air quality complaints within 24 hours.

Maricopa County monitors the ADEQ Five-Day Dust Control Forecast to identify the potential for elevated PM10 pollution levels due to high winds or stagnant conditions. When a High Pollution Advisory (HPA) is issued for Maricopa County, MCAQD conducts additional increased surveillance before, during, and after the forecast event(s). MCAQD also conducts event surveillance and post-event activities after an exceptional event that had not been forecast (i.e., those instances in which an HPA had not been issued).

Pre-event surveillance consists of surveying high-risk areas for any dust-generating activities, educating sources of the impending HPA event, and issuing violations for failure to comply with local, state, or federal regulations. During the event, MCAQD inspectors survey high-risk areas to confirm that control measures are in place, document any violations, and contact other regulatory agencies if necessary. Post-event activities include continued surveys of high-risk areas, re-inspecting sources within two business days of receiving a violation, and an internal MCAQD debriefing of event activities.

Currently, a total of 16 MCAQD air monitoring sites were upgraded with new equipment to allow the monitoring sites to automatically report monitored readings at 5-minute intervals. Previously, hourly readings were only available. The real-time data reporting system includes a mechanism to alert MCAQD inspectors when PM10 concentrations are elevated. The system allows MCAQD inspectors to review concentrations at the monitor and to consult the National Weather Service website to check for weather event activity. This capability allows the MCAQD responder to identify regional events and monitor specific issues. If necessary, the MCAQD responders can inform nearby stakeholders and local governments of the elevated PM10 concentrations.

For July 1, 2013, a Maricopa County Dust Control Forecast was issued indicating a moderate risk level for unhealthy PM10 on July 2, 2013. The Dust Control Forecast indicated winds of 10-20 mph with higher gusts possible during the afternoon and strong and gusty winds possible due to outflow from thunderstorms. The forecast also advised of "an ongoing potential for strong thunderstorm outflow winds and areas of dense blowing dust" due to "an active summer monsoon circulation pattern" that had established over Arizona.

An evaluation of all inspection reports, air quality complaints, compliance reports, and other documentation indicate no evidence of unusual anthropogenic-based PM10 emissions. During the time period of June 29, 2013 through July 5, 2013, MCAQD inspectors conducted a total of 180 inspections of permitted facilities, of which 156 were at fugitive dust sources. Additionally, MCAQD conducted 317 inspections on vacant lots and unpaved parking lots during this period.

During this 7-day period, a total of 41 violations were issued county-wide for PM10- and non-PM10-related violations. One violation was issued for PM10 emissions within a 4-mile radius of an exceeding monitor.

MCAQD issued a violation for a mulch fire that occurred on June 30. The mulch fire was located 2.05 miles northeast of the Durango Complex monitor and 3.97 miles northeast of the West 43rd Ave. monitor. The City of Phoenix Fire Department responded to the mulch fire and extinguished the major flames within a few hours. The mulch fire was completely exhausted by July 2. The mulch fire was also not in the wind profile of the exceeding monitors and would not have contributed to the exceedances on July 2.

MCAQD was prepared for any complaints received due to the high wind event. During the 7 day period from June 29 through July 5, 2013, MCAQD received 50 complaints, of which 29 were windblown dust or PM10 related. Each complaint was assigned to and investigated by a MCAQD inspector. A review of all pertinent records from this period indicates that MCAQD inspectors observed no PM10 violations of local, state, or federal regulations resulting from complaints within a 4-mile radius of the exceeding monitor.

In addition to MCAQD's efforts in pre-event surveillance and proactive inspections, ADEQ's Agricultural Best Management Practice Program (Ag BMP) inspector also monitors the ADEQ Five-Day Dust Control Forecast and the MCAQD air monitoring sites that include real-time data. The ADEQ Ag BMP inspector uses specific knowledge of seasonal activities and associations with the local growers and dairymen to communicate the importance of limiting dust-generating activities, especially during high-wind events. Additional outreach is conducted with facility representatives prior to forecasted high-wind alert days. Should the PM10 readings at a MCAQD air monitoring site show notable increases, the ADEQ Ag BMP inspector is dispatched to contact the owners and operators of agriculture fields in the area to discern if their activities are causing negative impacts. The Ag BMP inspector is prepared to respond to most agriculture complaints within 24 hours.

Based on a review of the inspection reports and site visit documentation, there is no evidence to suggest that agricultural activities produced unusual or significant PM10 emissions. From June 29 through July 5, 2013, the ADEQ Ag BMP inspector received no complaints and no site inspections occurred. The agriculture fields in Maricopa County during that time of year have established crops of corn and would not have significantly contributed to PM10 emissions.

## Conclusions

The thunderstorm outflow event on July 2, 2013, produced strong gusts and turbulent wakes that generated and transported dust and PM10 into the Maricopa County PM10 nonattainment area. The source region of the outflow winds that caused the exceedances were the natural and open desert areas of Maricopa and Pinal counties. The Maricopa County area is designated as a serious nonattainment area for PM10 and is required to have BACM for all significant sources of PM10. BACM-approved control measures on significant anthropogenic sources were in place and enforced during the events, and pro-active tracking and response to the events by regulatory agencies and local governments confirmed the uncontrollable nature of the dust emissions; therefore, these pre-existing/prior approved required controls are adequate for meeting the requirements of an exceptional event and should be considered "reasonable" for these purposes.

Despite the deployment of comprehensive control measures and sophisticated response programs, high wind conditions associated with thunderstorms and thunderstorm outflow winds overwhelmed controls within the nonattainment area and contributed to the transport of PM10 into the nonattainment area. Strong thunderstorm outflows with gusts up to 45 mph, and sustained winds up to 28 mph, were more than enough to overwhelm all available efforts to limit PM10 concentrations from the event. The fact that this was a natural event involving strong thunderstorm outflow winds that generated and transported PM10 emissions from outside and within the nonattainment area provides strong evidence that the event and exceedances of July 2, 2013, recorded at two Maricopa County monitors, were not reasonably controllable or preventable.

# V. CLEAR CAUSAL RELATIONSHIP

## Introduction

A demonstration of the clear causal connection between windblown dust generated and transported by thunderstorm outflow winds and the exceedances at two Maricopa County monitors on July 2, 2013, is provided in this section. Two separate dust storms, one in the early morning hours and one in the late evening hours, produced wind gusts as high as 45 mph and sustained winds as high as 28 mph. The two dust storms produced National Weather Service aviation and dust storm alerts to indicate the presence of strong, gusty winds between 30 and 40 mph, and reduced visibilities as low as one-quarter mile. Two Maricopa County monitors exceeded the 24-hour PM10 standard as a result of the PM10 generated and transported by the thunderstorm outflow winds, with three other Maricopa County monitors recording 24-hour average PM10 concentrations within 15 $\mu g/m^3$ of the standard. Drought conditions in Pinal and Maricopa County likely exacerbated the amount of the dust the thunderstorm outflow was able to entrain.

A detailed description of the meteorology that caused the natural windblown dust exceedance event at the Maricopa County monitors is described below in a series of time-stamped maps. Visibility photos from within the nonattainment area are not available for this event due to issues with the server that stores the images. The weight of evidence presented in this section provides the clear causal connection between the windblown dust generated and transported by thunderstorm outflow winds and the exceedances at the Maricopa County monitors on July 2, 2013.

## Time Series Maps and Visibility Photos

Figures 5–1 through 5–20 provide a time series GIS-based visualization of the meteorology and PM10 concentrations associated with the thunderstorm outflows. The data displayed in the following maps were gathered from five data sources. All available meteorological and air quality data was used in order to present the most complete story of the event. Table 5–1 displays the types of data used from each agency in creating the maps.

**Table 5-1**. Data Sets Used in the Creation of Time Series GIS Maps.

| Agency | Data Sets |
|---|---|
| Arizona Department of Environmental Quality (ADEQ) | Hourly PM10 Concentrations, Wind Speed, Wind Direction and Wind Gusts |
| Arizona Meteorological Network (AZMET) | Hourly Wind Speed, Wind Direction and Wind Gusts |
| Maricopa County Air Quality Department (MCAQD) | 5-Minute PM10 Concentrations, Wind Speed, Wind Direction, and Wind Gusts (hourly data used when 5-minute was unavailable) |
| Pinal County Air Quality Control District (PCAQCD) | Hourly PM10 Concentrations, 5-Minute and Hourly Wind Speed, Wind Direction and Wind Gusts |
| National Weather Service (NWS) | Point in Time Wind Speed, Wind Direction, Wind Gusts, Visibility and Base Reflectivity Radar* |

*Radar data not available for all hours of this event.

### *Map Description*

A description of each time series map is provided to highlight important data in each map and explain the progression of the meteorology and PM10 concentrations through time. Taken as a whole, the maps and

associated explanatory text describe the clear causal connection between the windblown dust generated and transported by the thunderstorm outflow winds and the PM10 exceedances at the Maricopa County monitors.

July 2, 2:00 AM – 2:30 AM

This map shows the low PM10 concentrations in the Maricopa PM10 nonattainment area before the first dust storm arrives. A region of active thunderstorms is visible on base reflectivity radar in Pinal County. Initial signs of blowing dust are also visible in Pinal County in the form of reduced visibility (8.0 miles) at the Casa Grande airport.

July 2, 2:30 AM – 3:00 AM

Outflow winds have intensified in the southeast portion of Maricopa County and have begun to cause elevated PM10 concentrations at the Higley monitor.

July 2, 3:00 AM – 3:30 AM

As outflow winds increase in strength, almost half of the PM10 monitors in Maricopa County now record five minute average PM10 concentrations above 150 $\mu g/m^3$, with the Higley monitor recording concentrations above 500 $\mu g/m^3$. Gusts as high as 36 mph are recorded at the Higley monitor with sustained winds as high as 19 mph recorded in the region.

July 2, 3:30 AM – 4:00 AM

Winds from the outflow continue to strengthen as it moves northwest across Maricopa County. Visibility has been reduced to 4.0 miles at the Williams Gateway airport and sustained winds have increased up to 28 mph.

July 2, 4:00 AM – 4:30 AM

Dust from the outflow has begun to move beyond the Higley monitor and now impacts all but the westernmost Buckeye monitor in Maricopa County. Peak gusts of 45 mph are recorded at the exceeding Durango monitor, and visibility has been reduced to 5.0 miles at the northeastern Scottsdale airport, showing that dust from the outflows is widespread across the Maricopa nonattainment area.

July 2, 4:30 AM – 5:00 AM

Wind direction begins to shift more to the north and continues to intensify in the central region of Maricopa County. Sustained winds in the low 20's and gusts in the high 30's are common throughout the region during this period.

July 2, 5:00 AM – 5:30 AM

Highest concentrations at the exceeding monitors (Durango and West 43rd Ave) are produced during this period, with five-minute average PM10 concentrations over 2,500 $\mu g/m^3$ at both sites. Impact from the dust storm continues to move north through the nonattainment area, with the northern Dysart and Glendale monitors recording concentrations over 1,000 $\mu g/m^3$.

July 2, 5:30 AM – 6:00 AM

Impacts form the dust storm have started to decline in the southeast portion of Maricopa County, but remain present in the central and western portions of Maricopa County. Visibilities have been reduced to 5.0 miles at Phoenix Sky Harbor International airport at 3.0 miles at Glendale Municipal airport. Nine monitors in the nonattainment area still record concentrations over 500 $\mu g/m^3$.

July 2, 6:00 AM – 6:30 AM

As the dust storm begins to exit the nonattainment area to the north and northwest, PM10 concentrations begin to fall throughout the nonattainment area. Winds are still elevated during this period with gusts as high as 28 mph and sustained winds as high as 15 mph. Visibility at the northern Deer Valley airport remains reduced at 7.0 miles.

July 2, 6:30 AM – 7:00 AM

Elevated gusts and wind speeds are still active throughout the nonattainment area, but most of the remaining suspended dust from the thunderstorm outflow is depositing or is transported north of the nonattainment area. All but one Maricopa County monitors record PM10 concentrations less than 500 $\mu g/m^3$.

July 2, 7:30 AM – 8:00 AM

Visibilities have returned to normal levels at all but the northern most and western most airports. Sustained winds are less than 13 mph throughout the nonattainment area and gusts over 20 mph are present at only five area monitors. The majority of PM10 monitors in Maricopa County record PM10 concentrations less than 150 $\mu g/m^3$.

July 2, 8:30 AM – 9:00 AM

PM10 concentrations have returned to pre-dust storm levels at all but the northwestern most Dysart monitor. PM10 concentrations will remain low throughout the day until the second dust storm begins to arrive at approximately 9:00 PM.

July 2, 9:00 PM – 9:30 PM

The beginning of a thunderstorm outflow originating in the desert areas of Pinal County is visible on base reflectivity radar. Visibility at the Casa Grande airport has been reduced to 2.5 miles due to gusts of 36 mph and sustained winds of 28 mph. The northern edge of this outflow has just begun to affect the Higley monitor, elevating PM10 concentrations under gusts of 32 mph and sustained winds of 17 mph.

July 2, 9:30 PM – 10:00 PM

The signature of the outflow grows larger on radar as it proceeds west and north across the deserts of Maricopa and Pinal counties. Visibility is reduced to 7.0 miles at the Williams Gateway airport near the Higley monitor.

July 2, 10:00 PM – 10:30 PM

Winds from the outflow shift to the north during this period, concentrating the dust generated by the outflow winds at the central Maricopa County monitors, raising PM10 concentrations to over 1,000 $\mu g/m^3$ at three monitors and over 500 $\mu g/m^3$ at two additional area monitors.

July 2, 10:30 PM – 11:00 PM

Dust from the thunderstorm outflow remains concentrated in the central portion of Maricopa County, with the outflow still producing gusts as high as 34 mph and sustained winds as high as 23 mph. The direction of the outflow and associated dust is moving north across the nonattainment area under prevailing winds.

July 2, 11:00 PM – 11:30 PM

The northern most monitors in Maricopa County record the highest PM10 concentrations during this period, with three monitors recording concentrations over 1,000 $\mu g/m^3$. Visibility has been reduced to 6.0 miles at the western Luke Air Force Base. PM10 concentrations decline from their highs in the central portion of Maricopa County and have returned to almost pre-storm levels at monitors located in the southeastern portion of Maricopa County.

July 2, 11:30 PM – 12:00 AM

The thunderstorm outflow continues to generate gusts as high as 28 mph and sustained winds as high as 22 mph as dust from the outflow exits the nonattainment area to the west and the north. PM10 concentrations remain elevated at the northern and western most monitors, are close to pre-storm levels at the central monitors, and are at pre-storm levels at the southeastern monitors.

July 3, 12:00 AM – 12:30 AM

PM10 concentrations continue to decline across the nonattainment area, but do elevate slightly in response to some limited spikes in wind speeds with gusts up to 33 mph.

July 3, 12:30 AM – 1:00 AM

Dust from the thunderstorm outflow now only impacts the western most Buckeye monitor, with all monitors in the nonattainment area returned to pre-storm level PM10 concentrations.

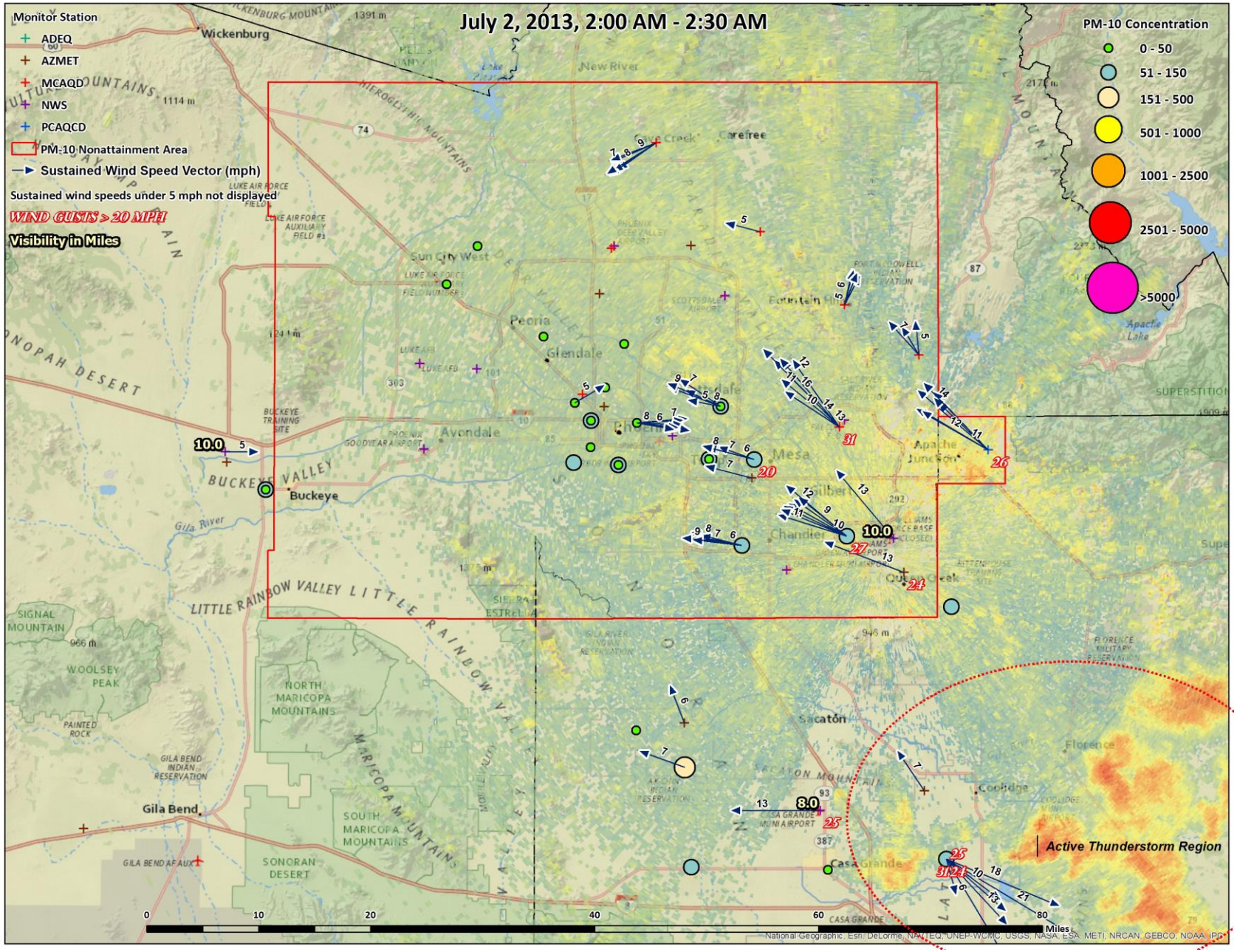



**Figure 5-1.** July 2, 2013, 2:00 AM – 2:30 AM.

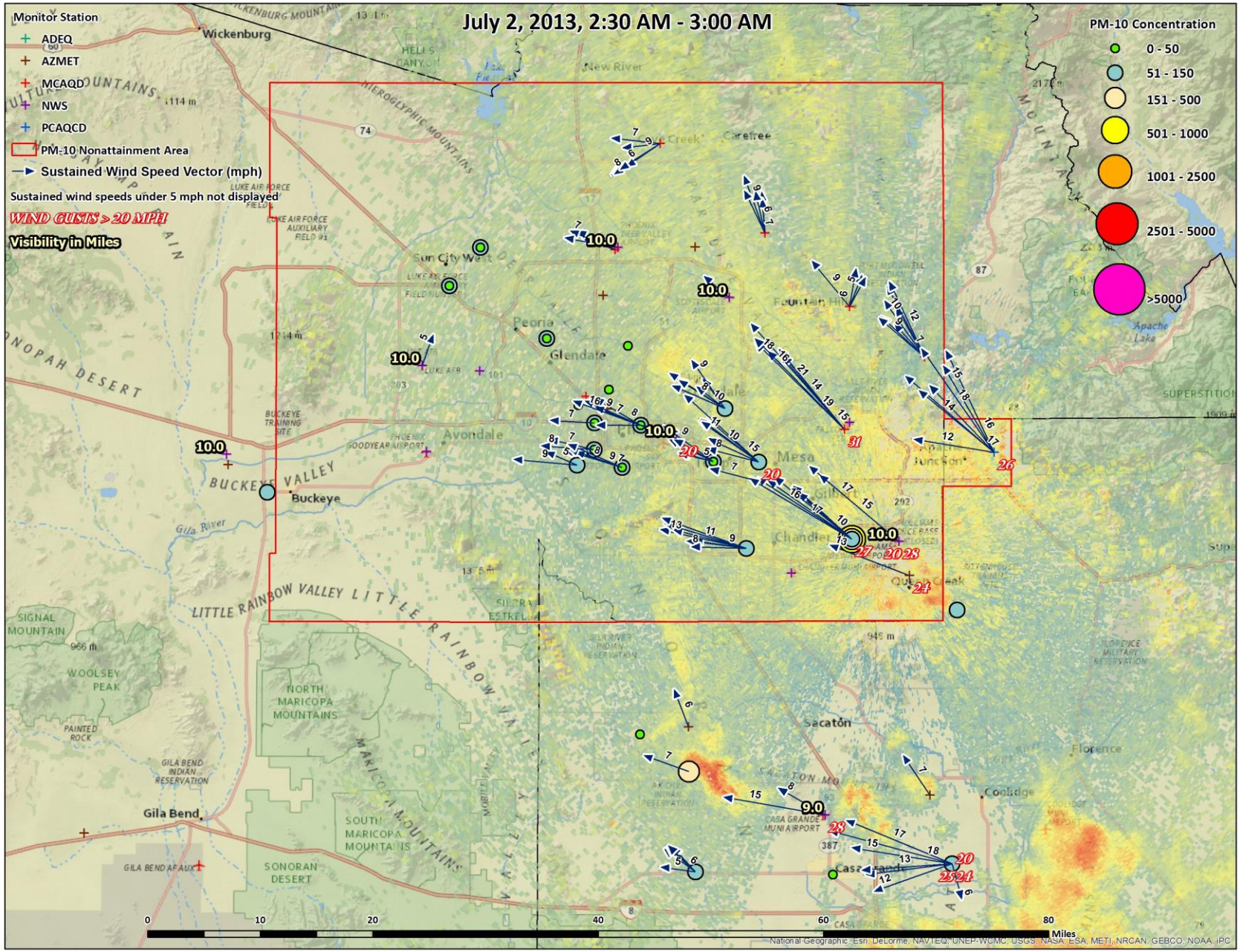



**Figure 5-2.** July 2, 2013, 2:30 AM – 3:00 AM.

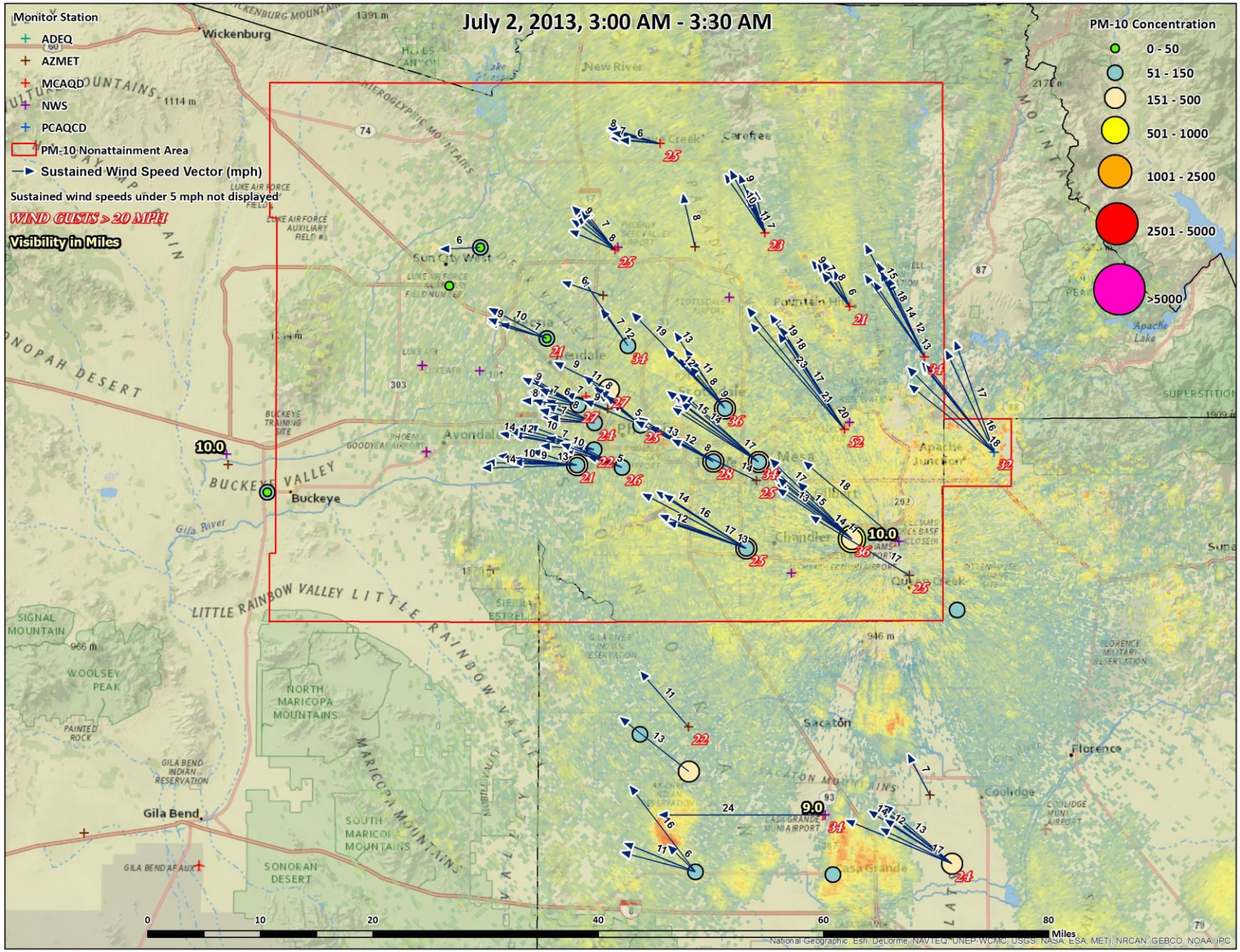



**Figure 5-3.** July 2, 2013, 3:00 AM – 3:30 AM.

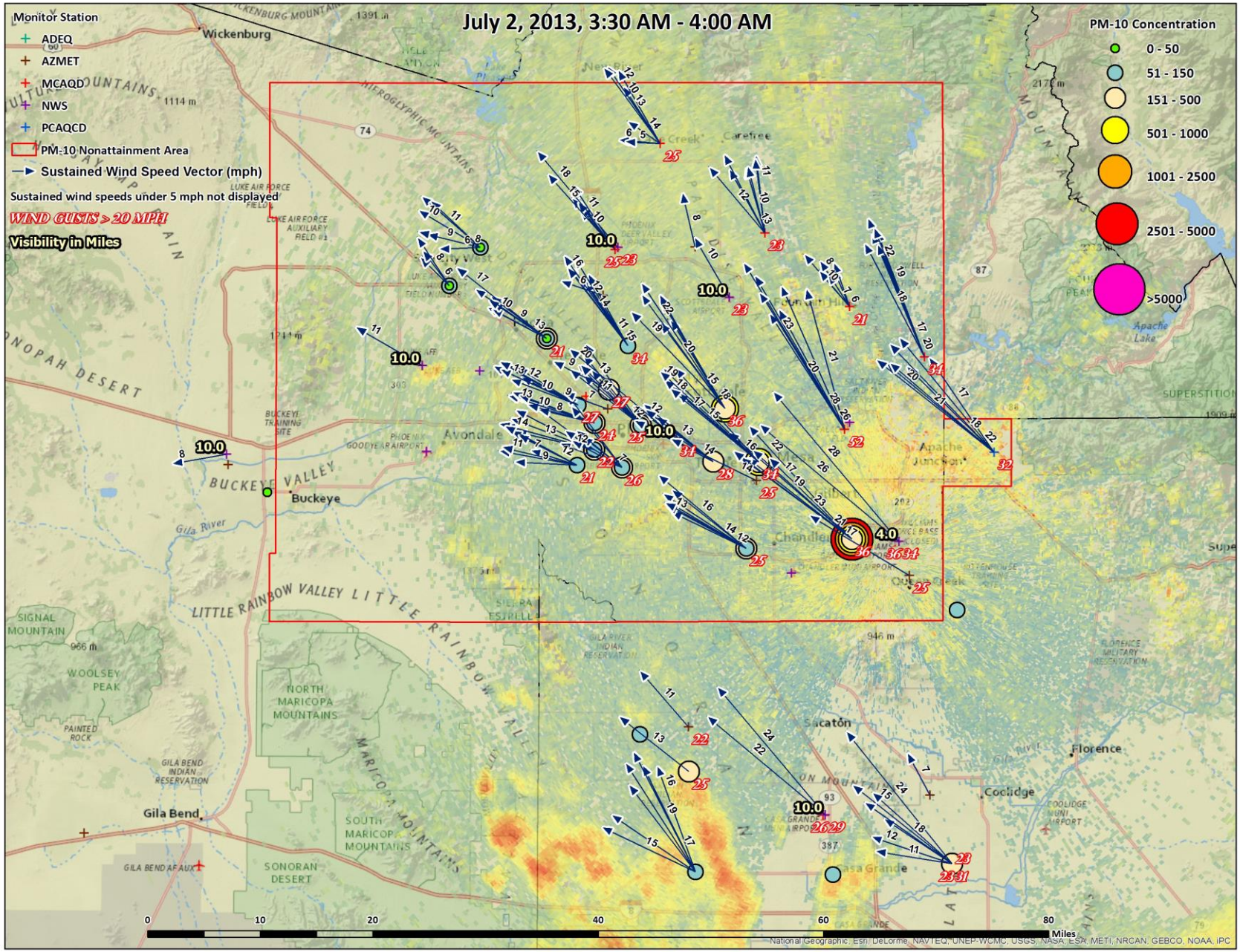



**Figure 5-4.** July 2, 2013, 3:30 AM – 4:00 AM.

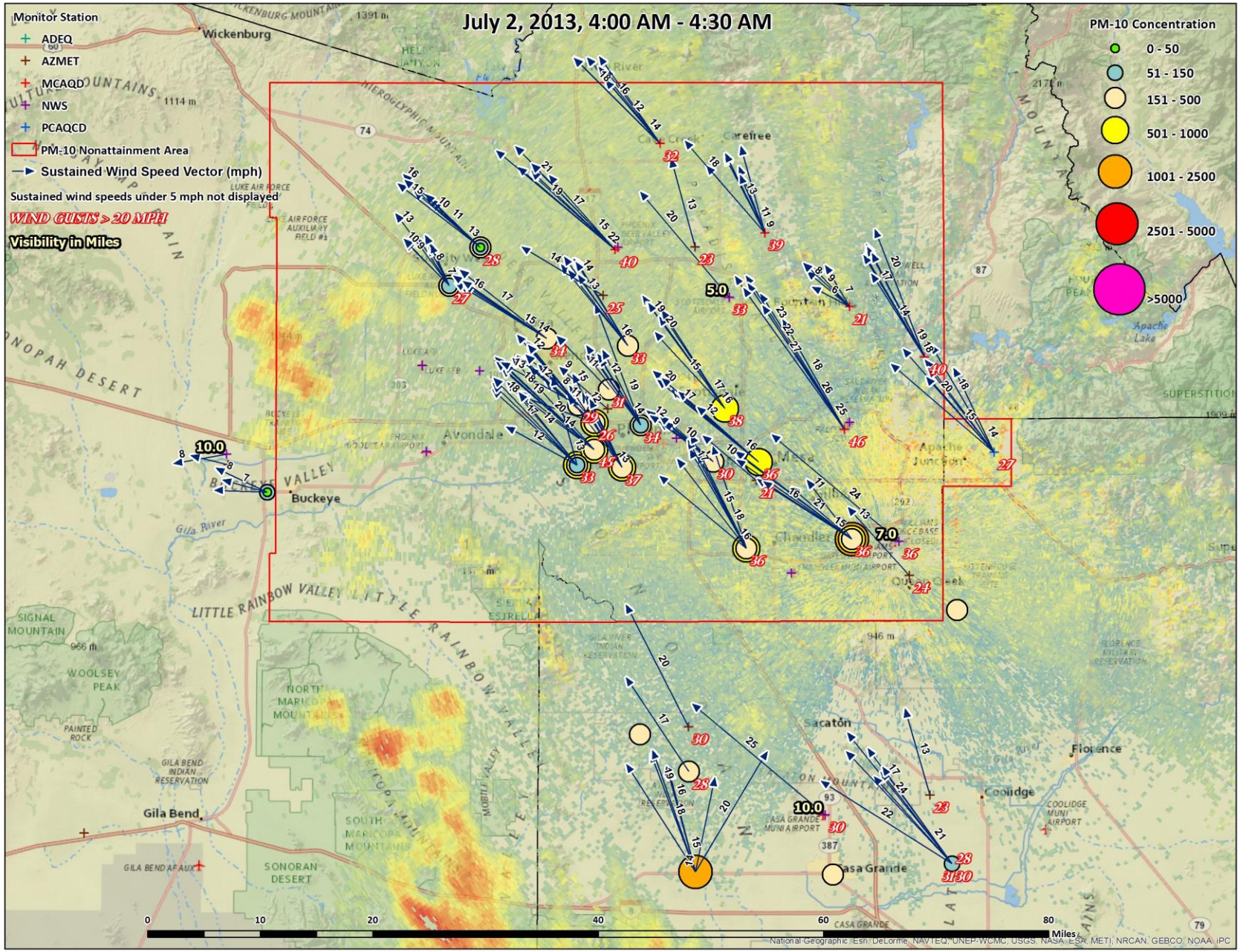



**Figure 5-5.** July 2, 2013, 4:00 AM – 4:30 AM.

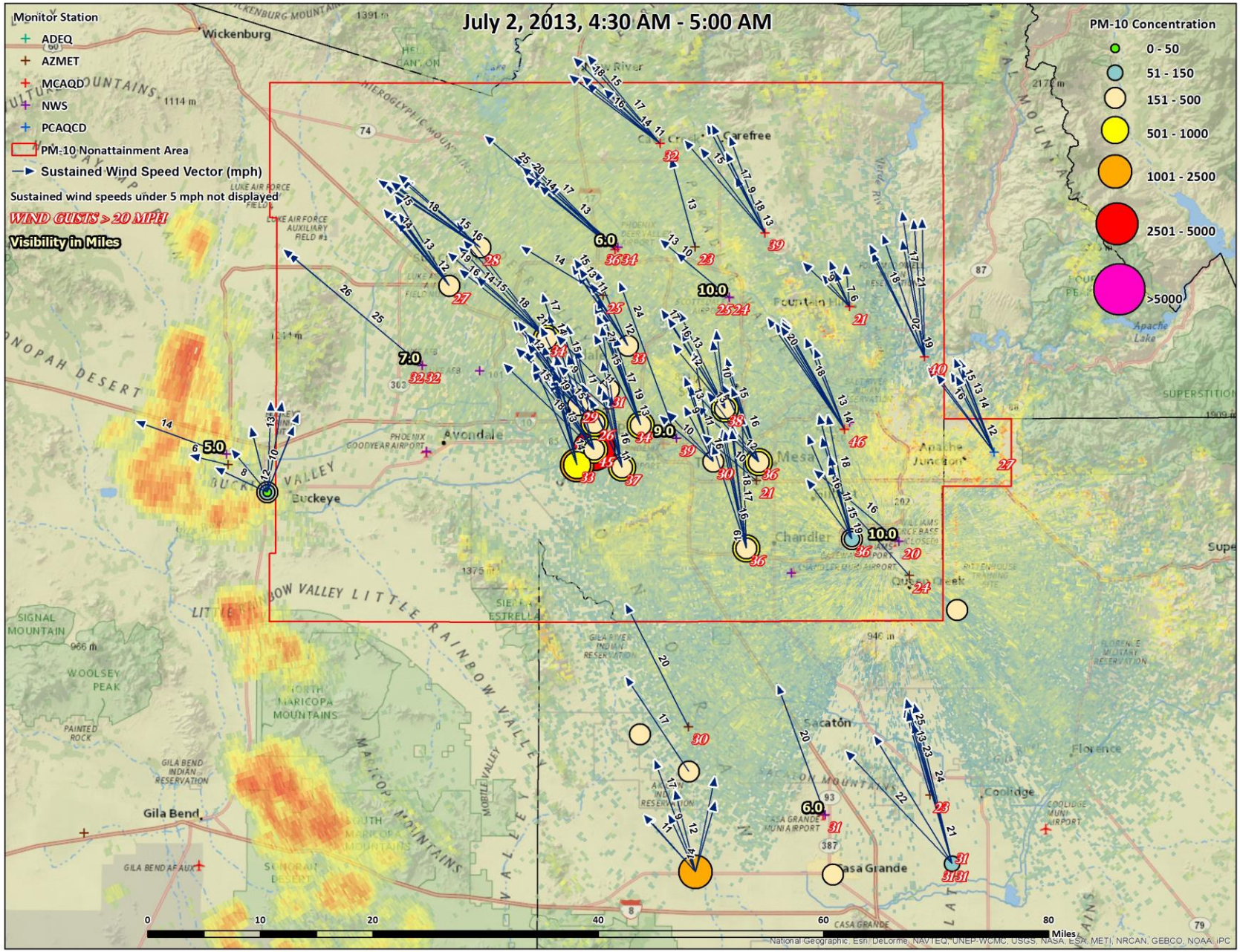



**Figure 5-6.** July 2, 2013, 4:30 AM – 5:00 AM.

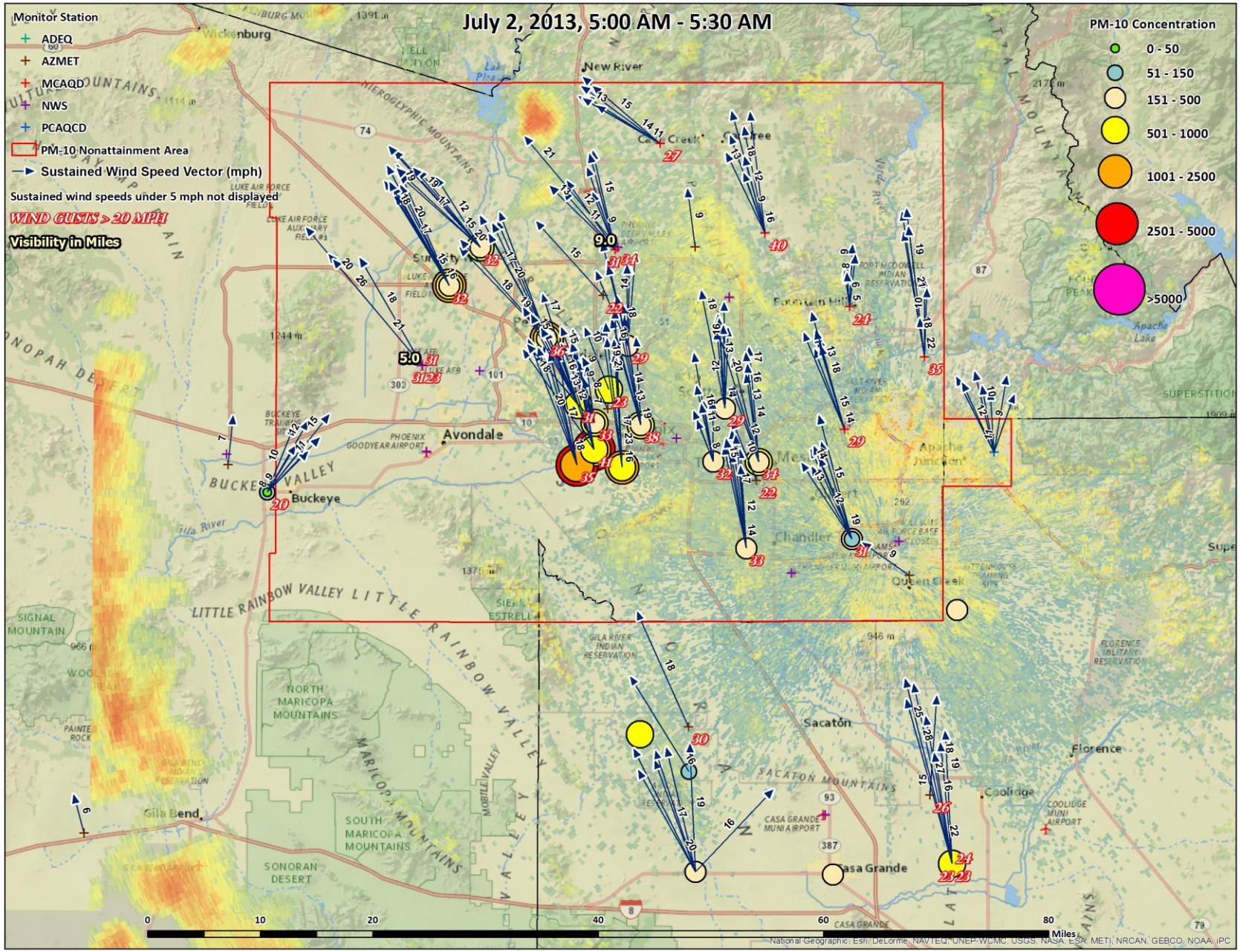



**Figure 5-7.** July 2, 2013, 5:00 AM – 5:30 AM.

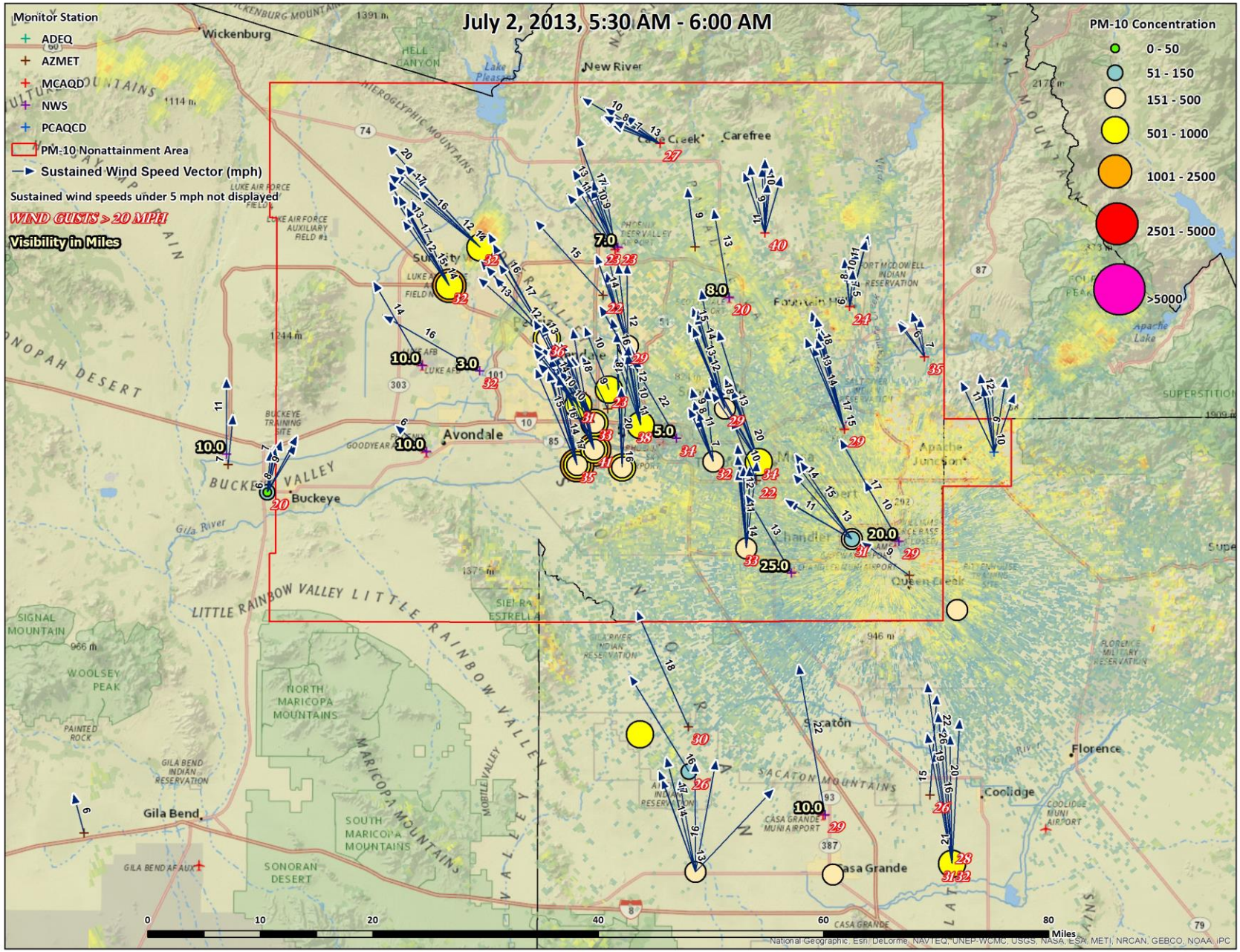



**Figure 5-8.** July 2, 2013, 5:30 AM – 6:00 AM.

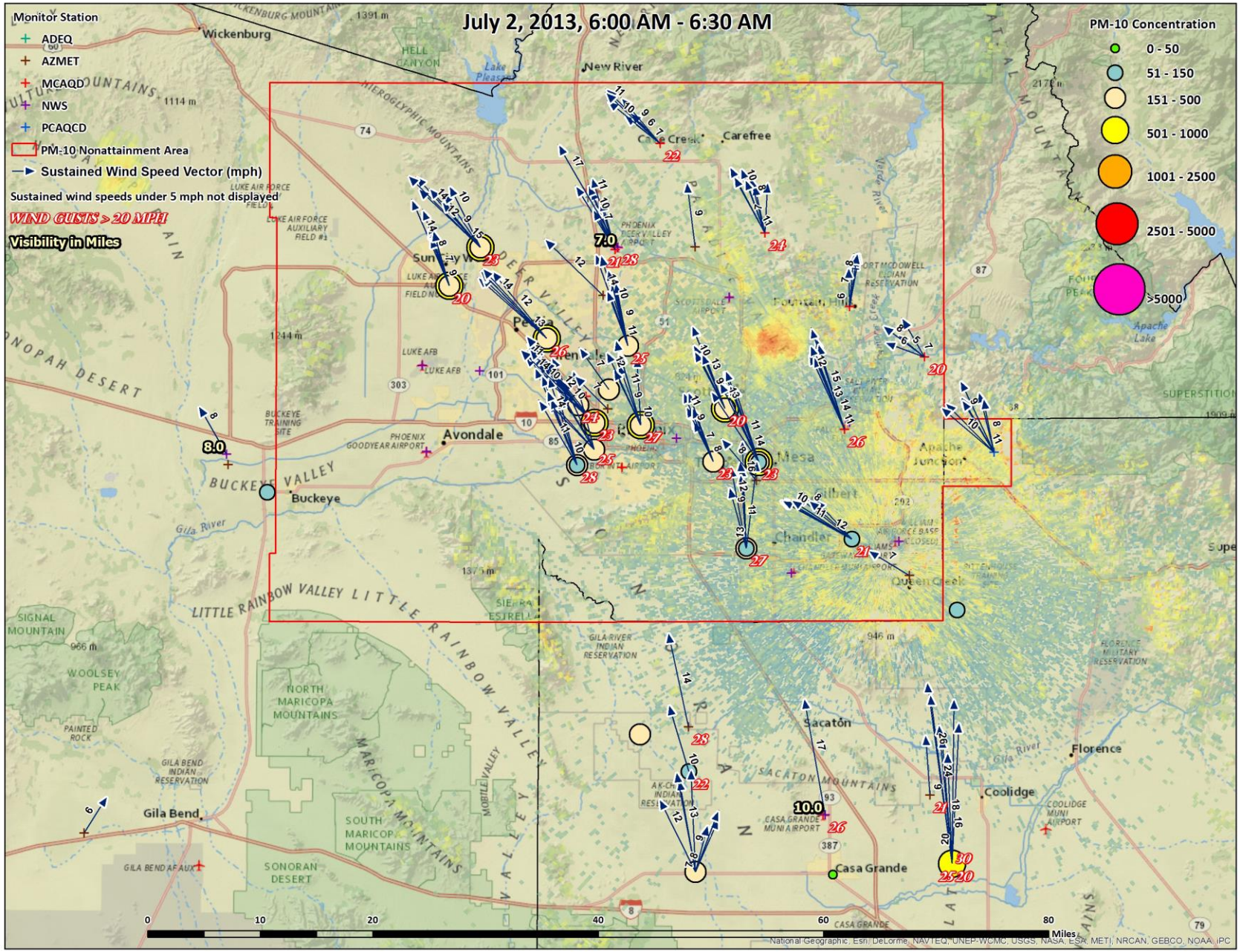



**Figure 5-9.** July 2, 2013, 6:00 AM – 6:30 AM.

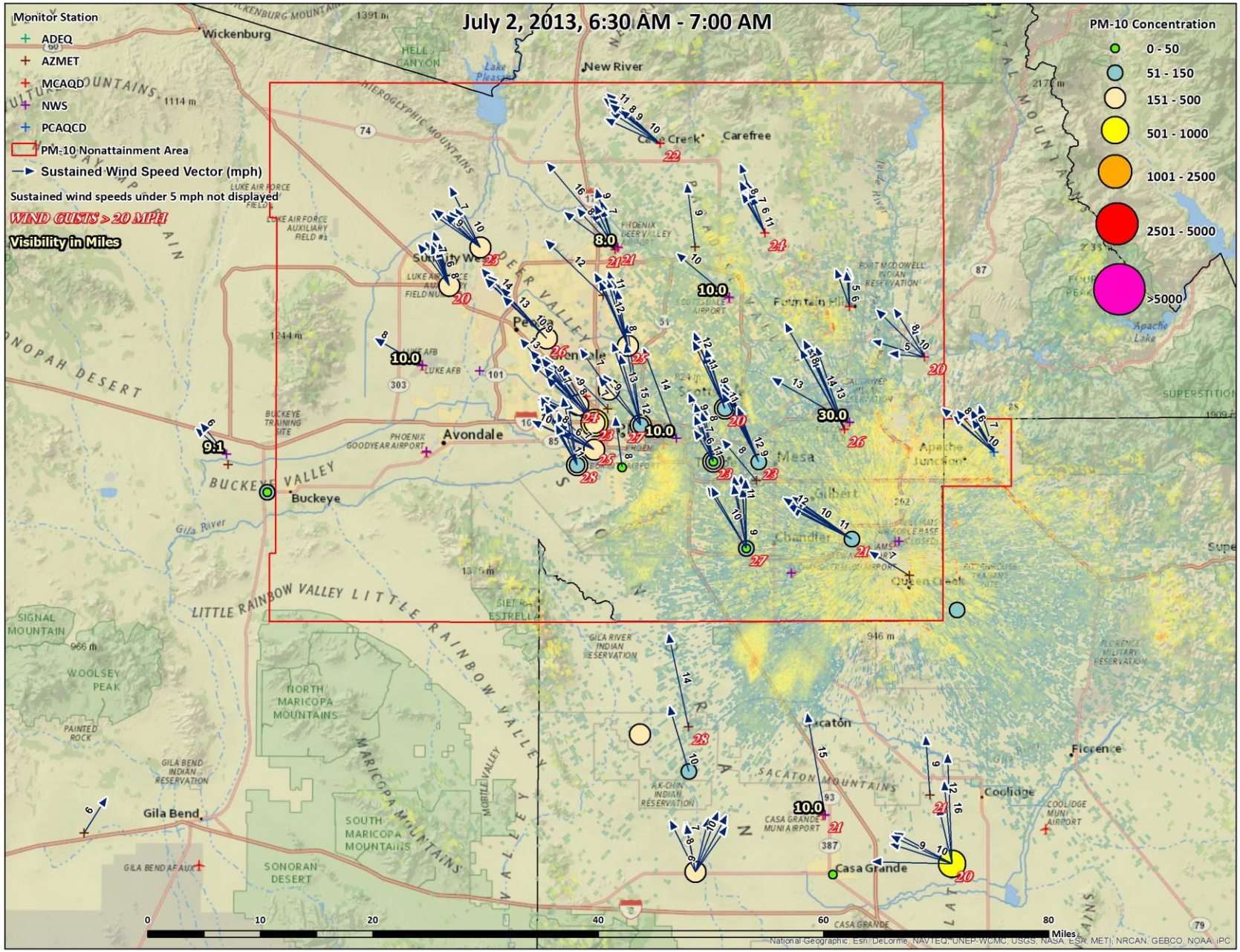



**Figure 5-10.** July 2, 2013, 6:30 AM – 7:00 AM.

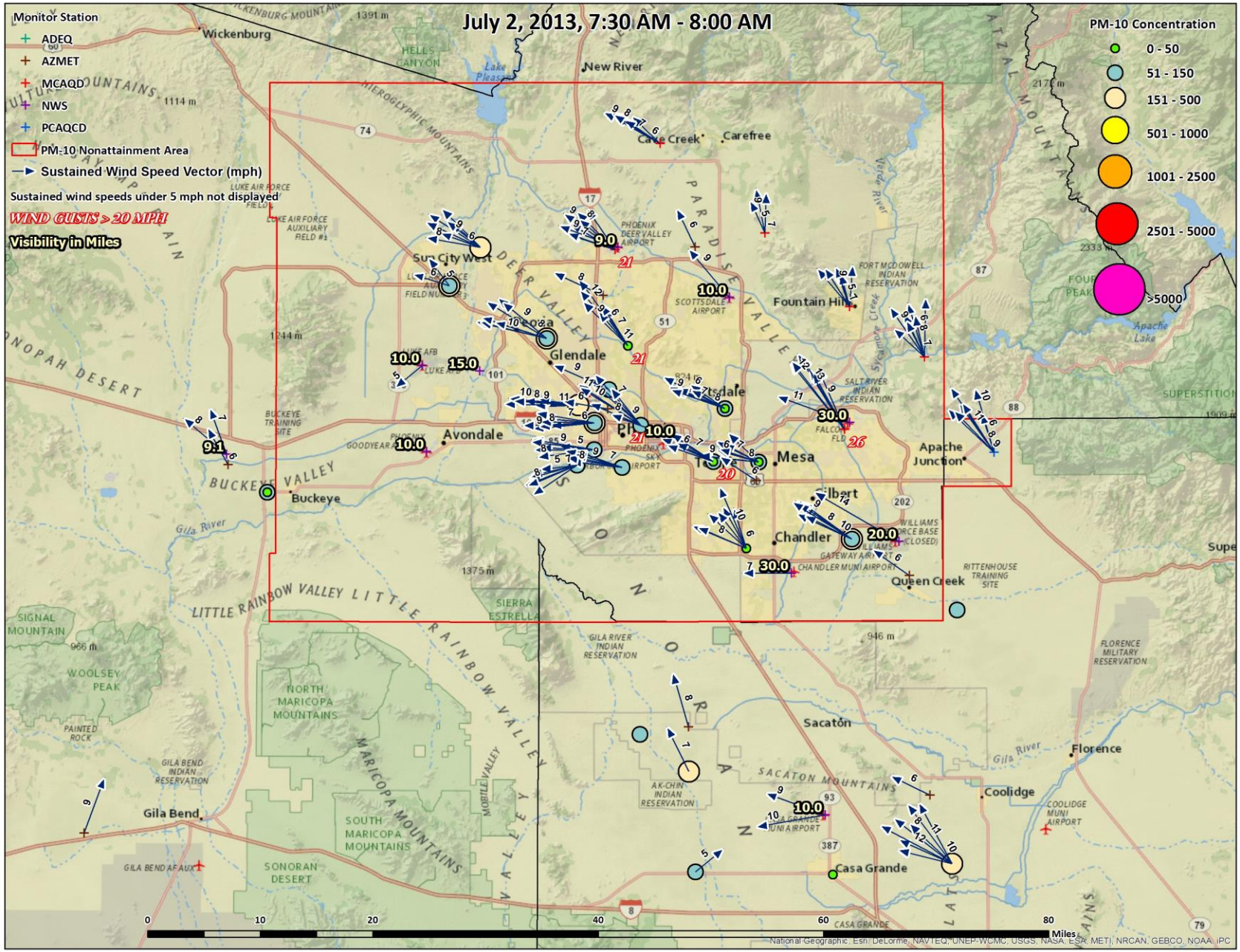



**Figure 5-11.** July 2, 2013, 7:30 AM – 8:00 AM.

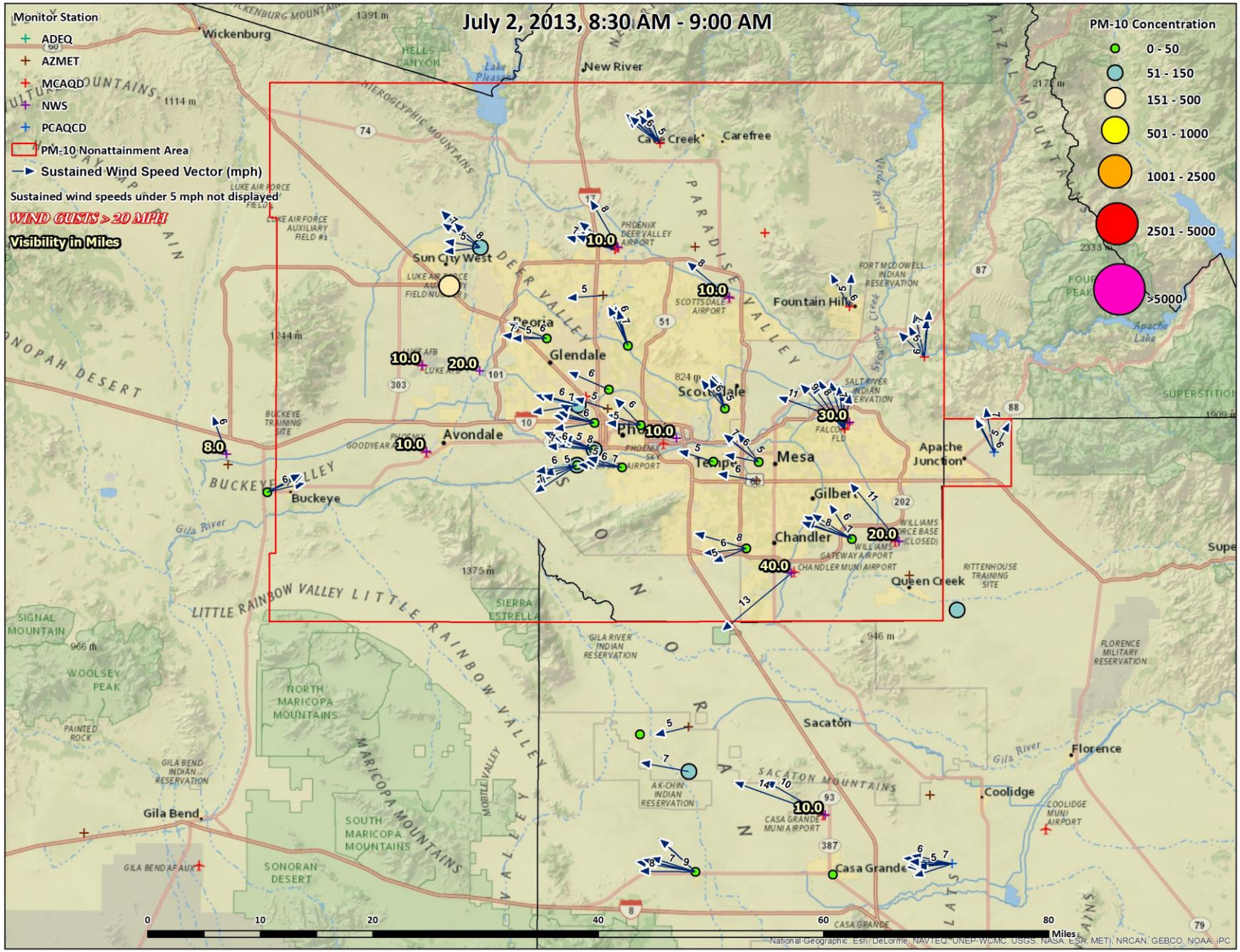



**Figure 5-12.** July 2, 2013, 8:30 AM – 9:00 AM.

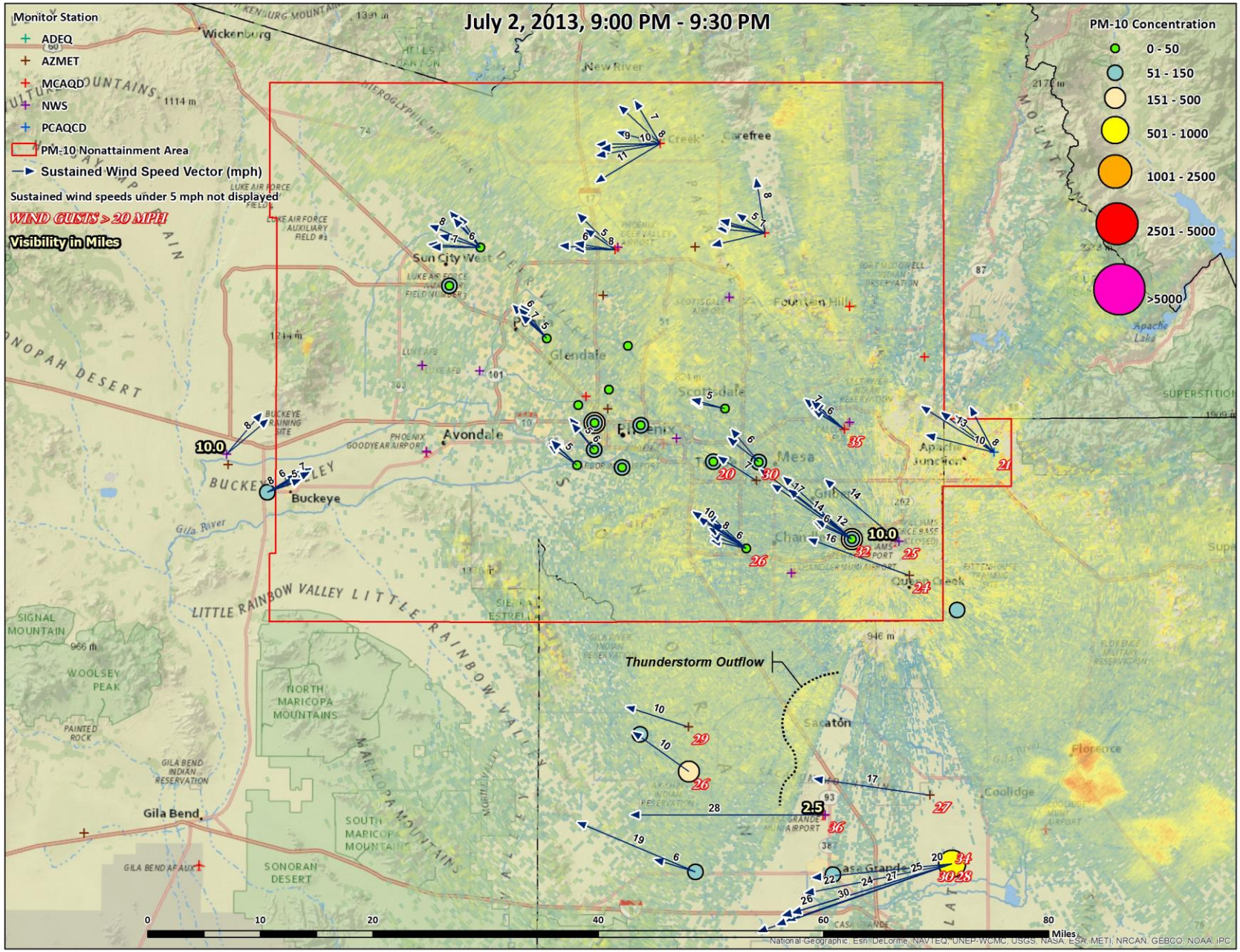



**Figure 5-13.** July 2, 2013, 9:00 PM – 9:30 PM.

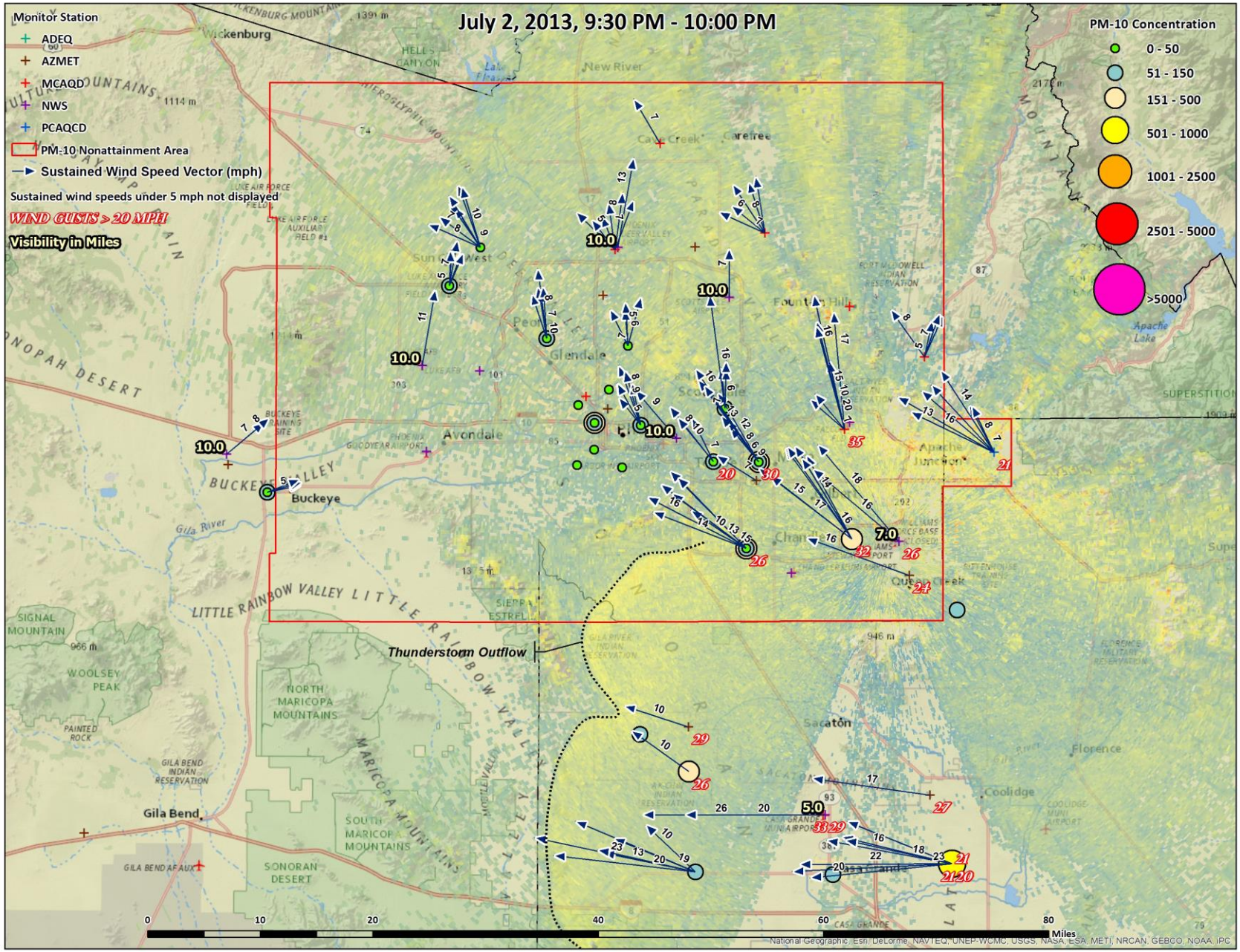



**Figure 5-14.** July 2, 2013, 9:30 PM – 10:00 PM.

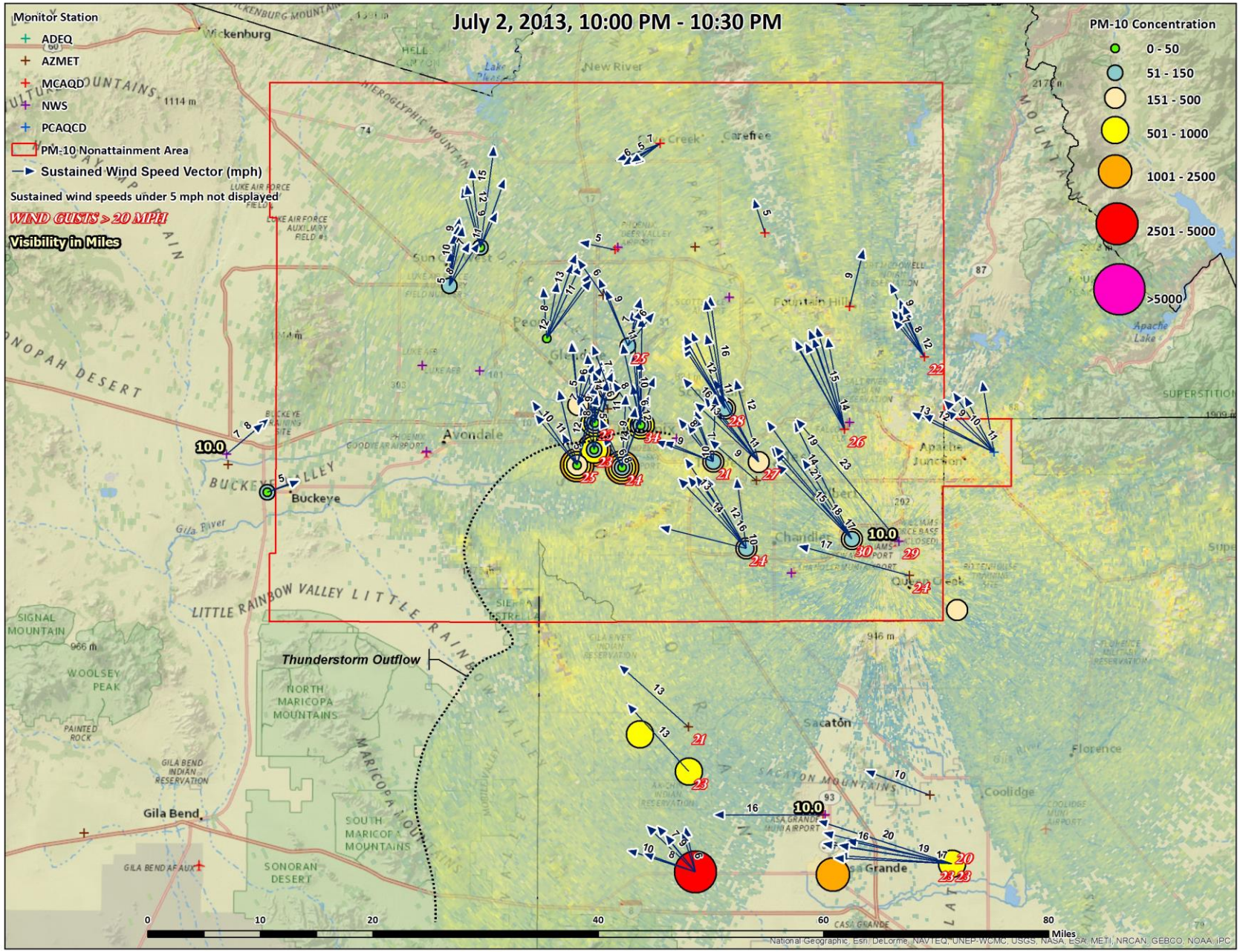



**Figure 5-15.** July 2, 2013, 10:00 PM – 10:30 PM.

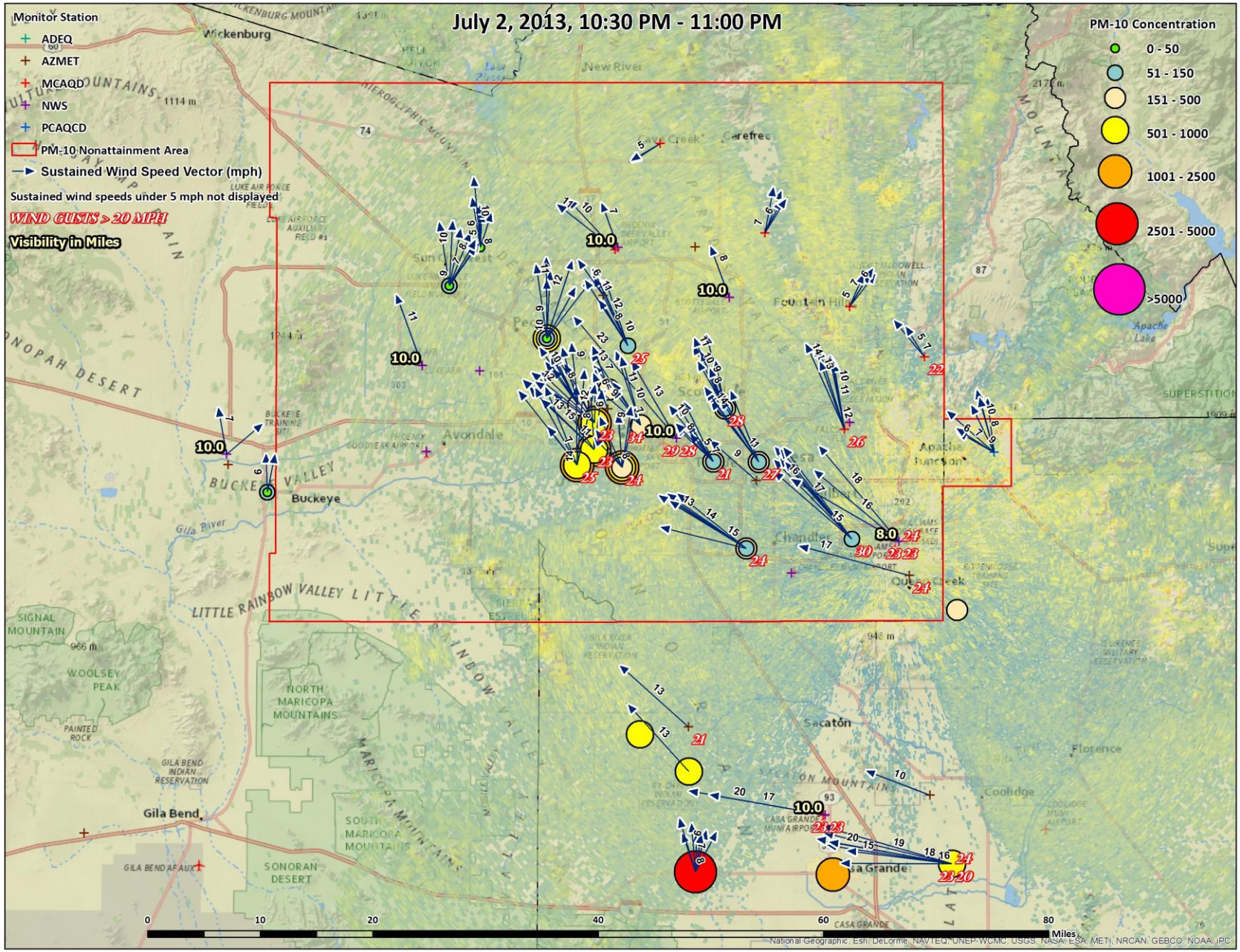



**Figure 5-16.** July 2, 2013, 10:30 PM – 11:00 PM.

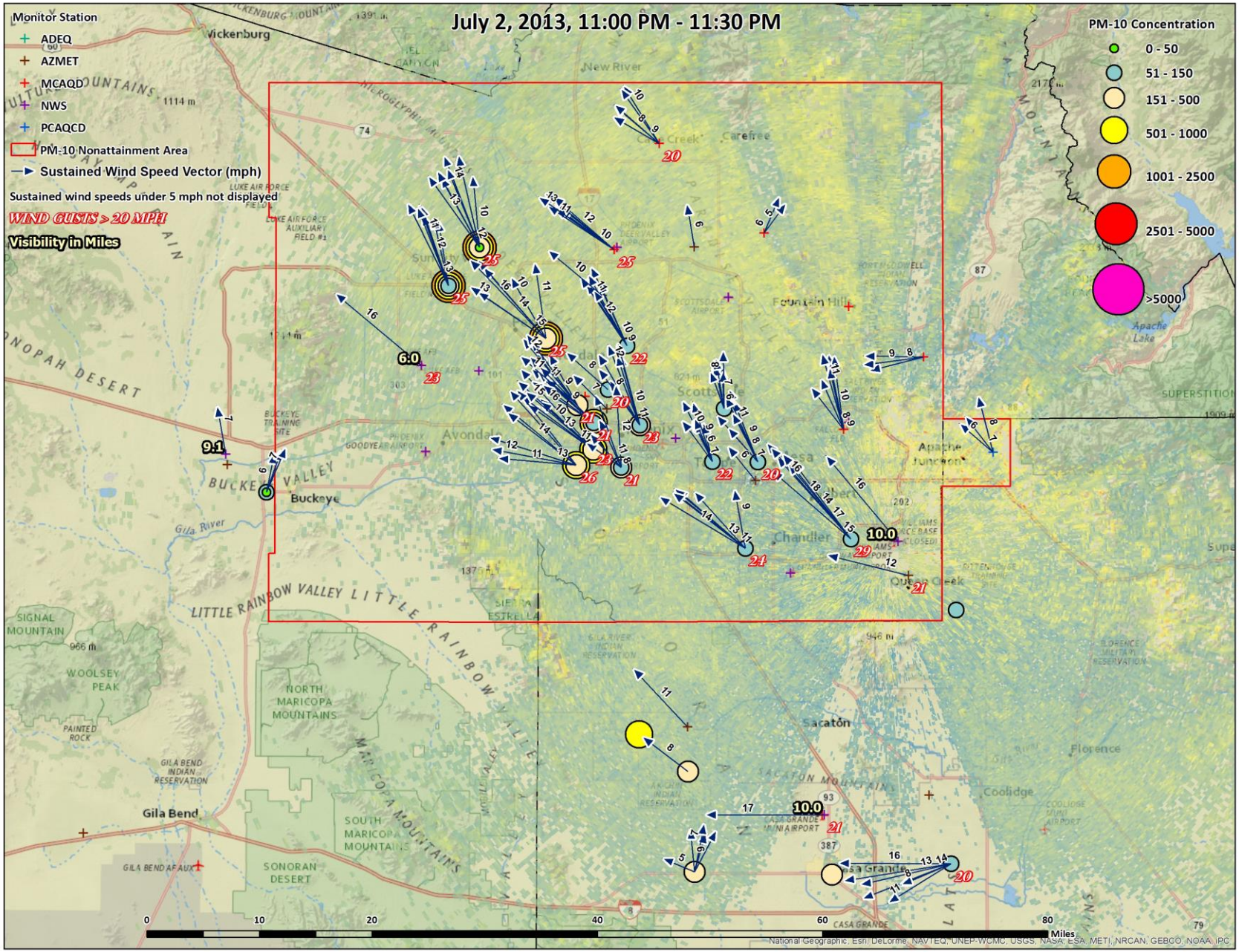



**Figure 5-17.** July 2, 2013, 11:00 PM – 11:30 PM.

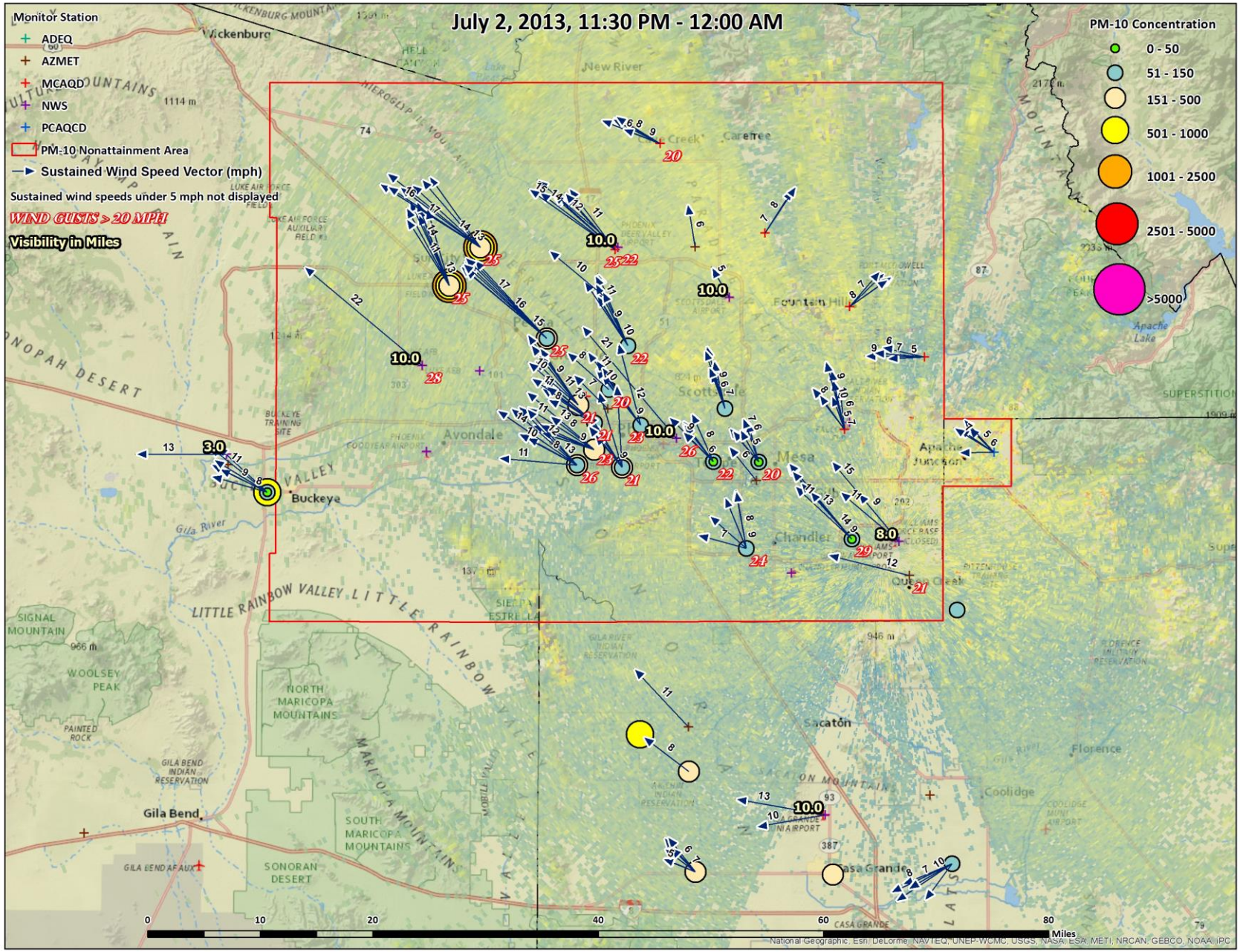



**Figure 5-18.** July 2, 2013, 11:30 PM – 12:00 AM.

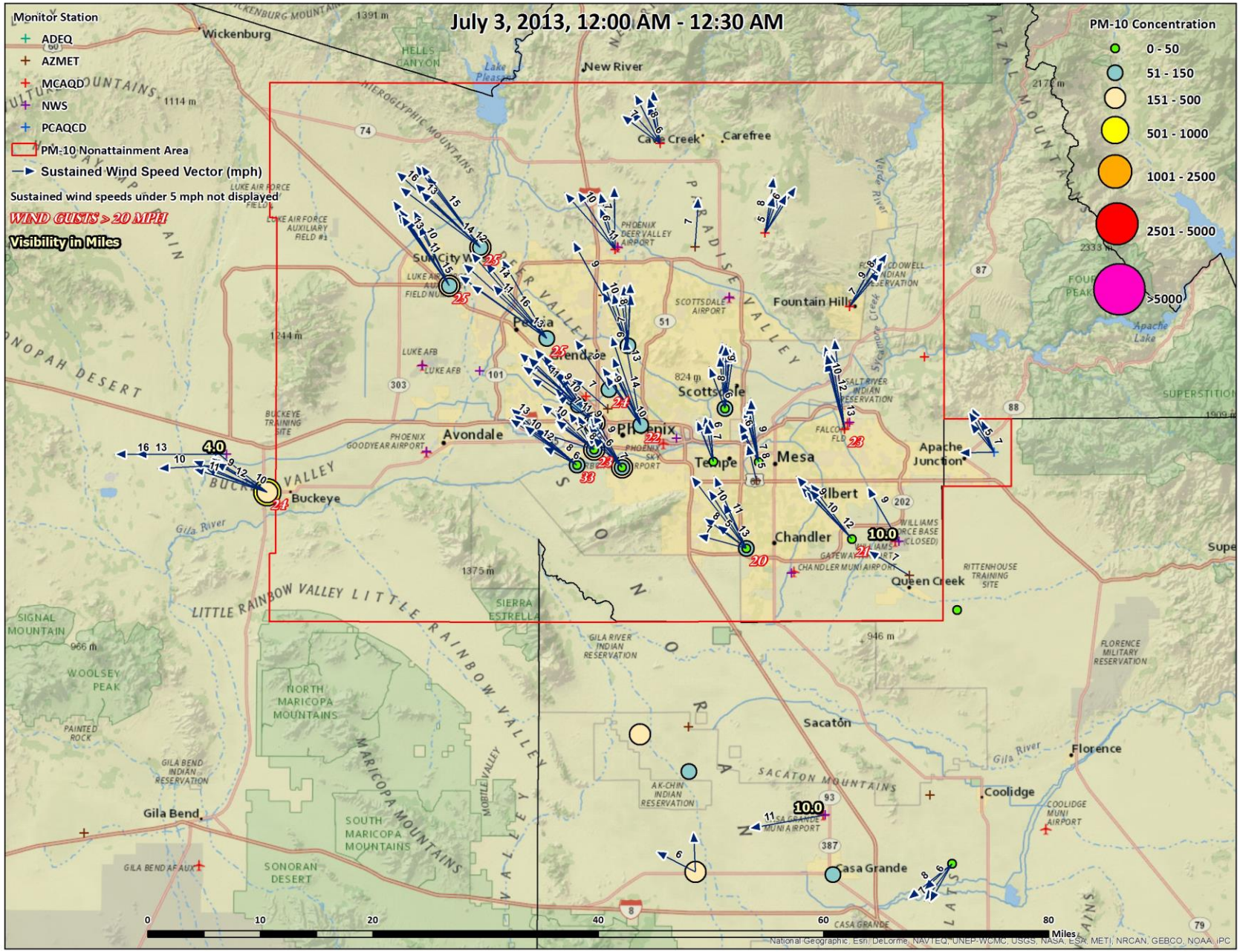



**Figure 5-19.** July 3, 2013, 12:00 AM – 12:30 AM.

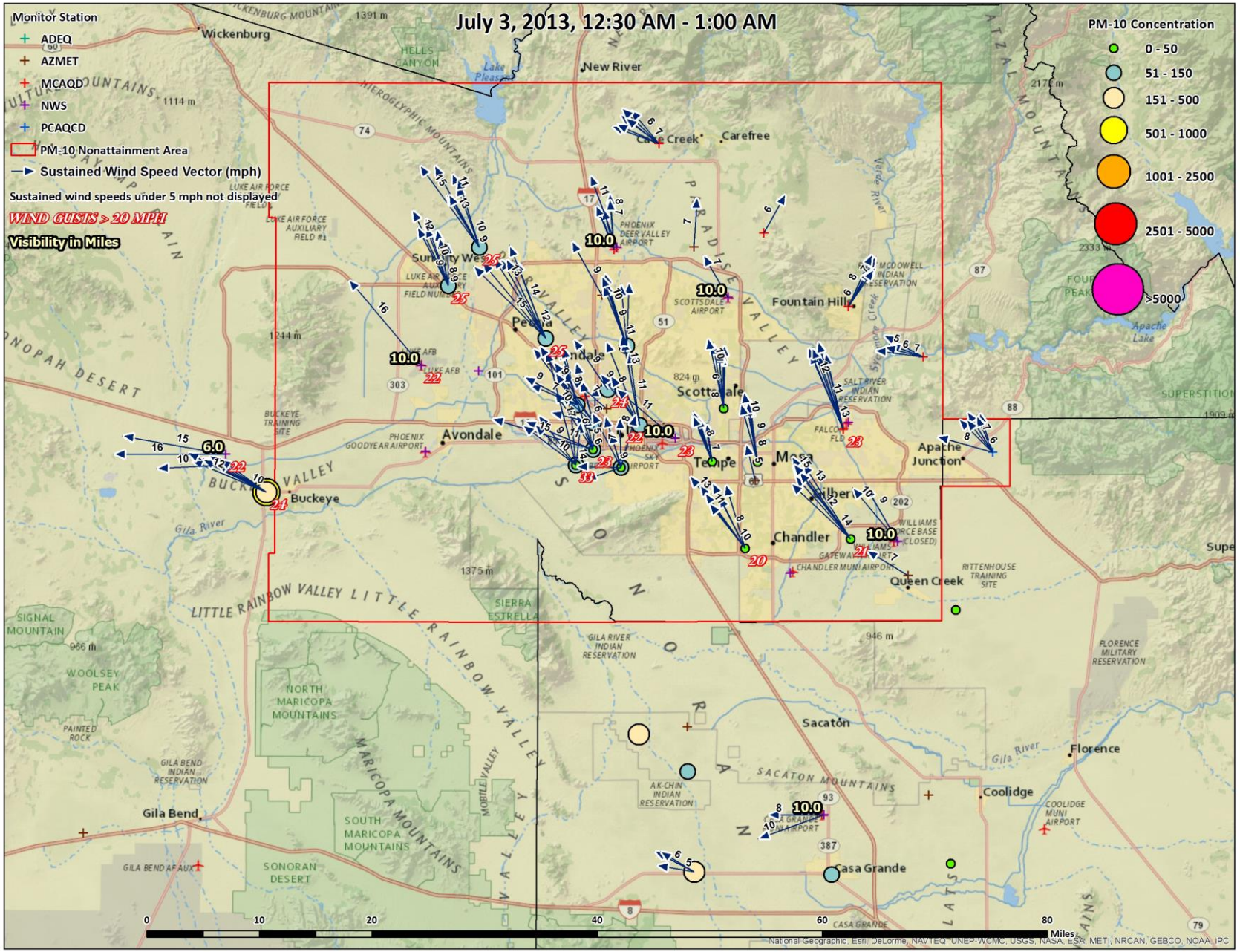



**Figure 5-20.** July 3, 2013, 12:30 AM – 1:00 AM.

### *Visibility Photos*

Visibility photos are unavailable for this event due to issues with the server that stores the images.

## Conclusion

The information presented within this section has adequately demonstrated a clear causal relationship between the emissions generated by uncontrollable natural events and the exceedances measured at the Maricopa County monitors. The maps provided in this section contain an illustration of the event as it unfolded. The series of maps for the event show a spatial and temporal representation of the thunderstorm outflow winds and associated windblown dust as they move throughout Maricopa and Pinal counties. These maps show a clear causal connection between the windblown dust generated and transported by the thunderstorm outflow winds and the exceedance at the Maricopa County monitors. It is clear from these data that thunderstorm outflow winds generated and transported uncontrollable windblown PM10 emissions to the Maricopa County monitors, demonstrating a clear causal connection between the event and the exceedances.

# VI. "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 submittal have provided detailed information that the exceedances on July 2, 2013, 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 Maricopa County 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 exceedance of the 24-Hour PM10 standard.

As detailed in Section IV, all reasonable control measures were in place and actively enforced before, during, and after the exceedances on July 2, 2013. Inspection and compliance data of local fugitive dust sources during this time period revealed that PM10 from anthropogenic activities was well controlled and constant. Local regulatory agencies, industry and the general public were alerted to the arrival of the thunderstorm through dust storm warnings issued by the National Weather Service. Real-time surveillance of PM10 monitoring stations during the event established a clear link between rapidly rising PM10 concentrations and the arrival of the thunderstorm outflow winds. Figures 6–1 and 6–2 show that PM10 concentrations in the hours before the events at the exceeding Durango Complex and West 43rd Avenue monitors were at normal levels, indicating no significant anthropogenic activities[2]. PM10 concentrations in the hours after the event show a quick return to low levels once generated and transported dust from the thunderstorm outflows passed the monitoring stations.

As shown in Section V, detailed, time series maps establish a clear causal relationship between the arrival of windblown dust generated by thunderstorm outflow winds and elevated PM10 concentrations at the monitors. The body of evidence presented in this submittal confirms that the exceedances on July 2, 2013 were a natural event and that there would have been no exceedance but for the presence of the uncontrollable windblown dust from the thunderstorm outflow winds.

[2] Note: Due to the nature of the thunderstorm outflow-driven events on July 2, 2013, the major source area of the dust storms for both events was south and east of the exceeding Durango and West 43rd Avenue monitors. The strongest winds associated with the outflows occurred in the source region of the thunderstorms, and then began to weaken as the outflows crossed the Maricopa nonattainment area. As such, winds at the exceeding monitors do not reflect the strength of the outflow winds in the source area, but were significant enough to transport the dust from the source areas to and past the exceeding monitors. Sustained winds from the nearby Phoenix Sky Harbor International Airport have been added to Figures 6–1 and 6–2, as these National Weather Service measurements better reflect the strength of the winds (although still diminished somewhat from the source areas) that generated the windblown dust as compared to the hourly average wind speed values seen at the exceeding monitors. See section V, Clear Causal Relationship, for more detail on the outflow-driven dust storms.

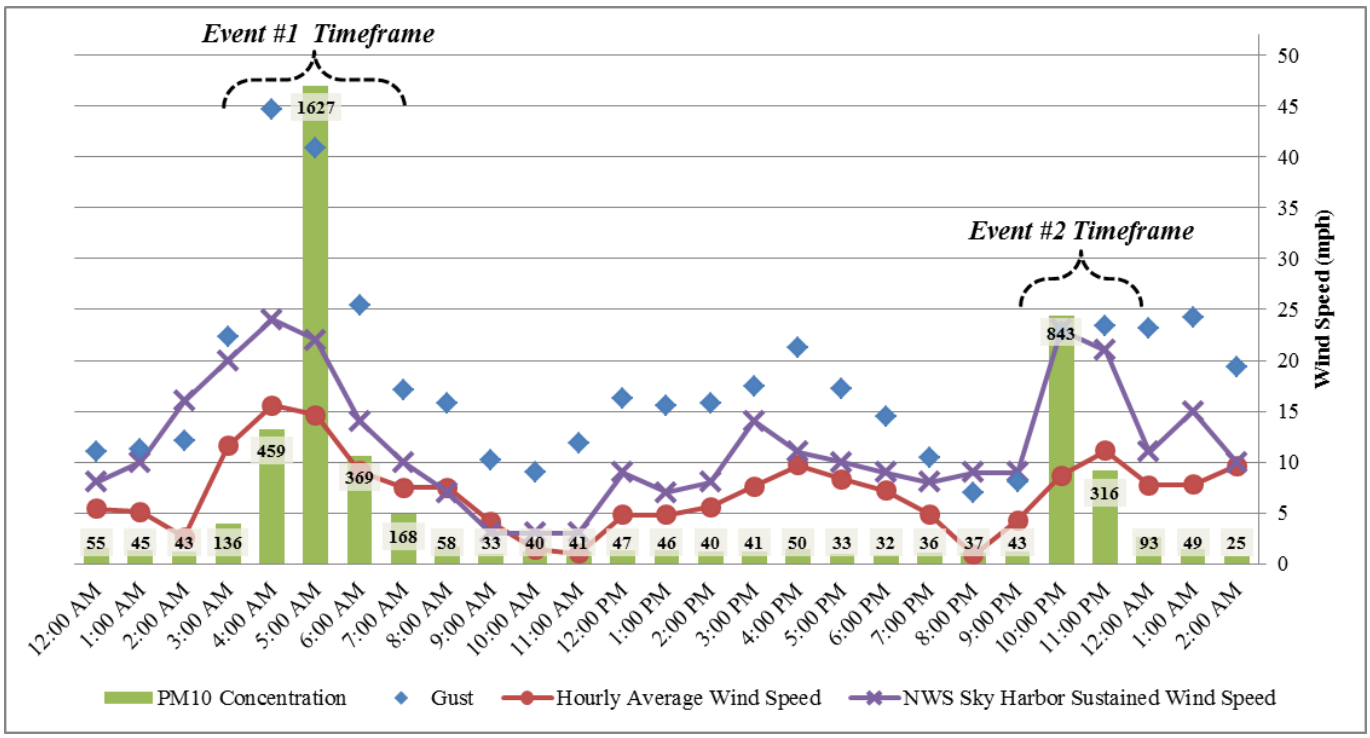



**Figure 6-1.** Hourly PM10 concentration, wind gust, and average wind speed as recorded at the Durango Complex monitor.

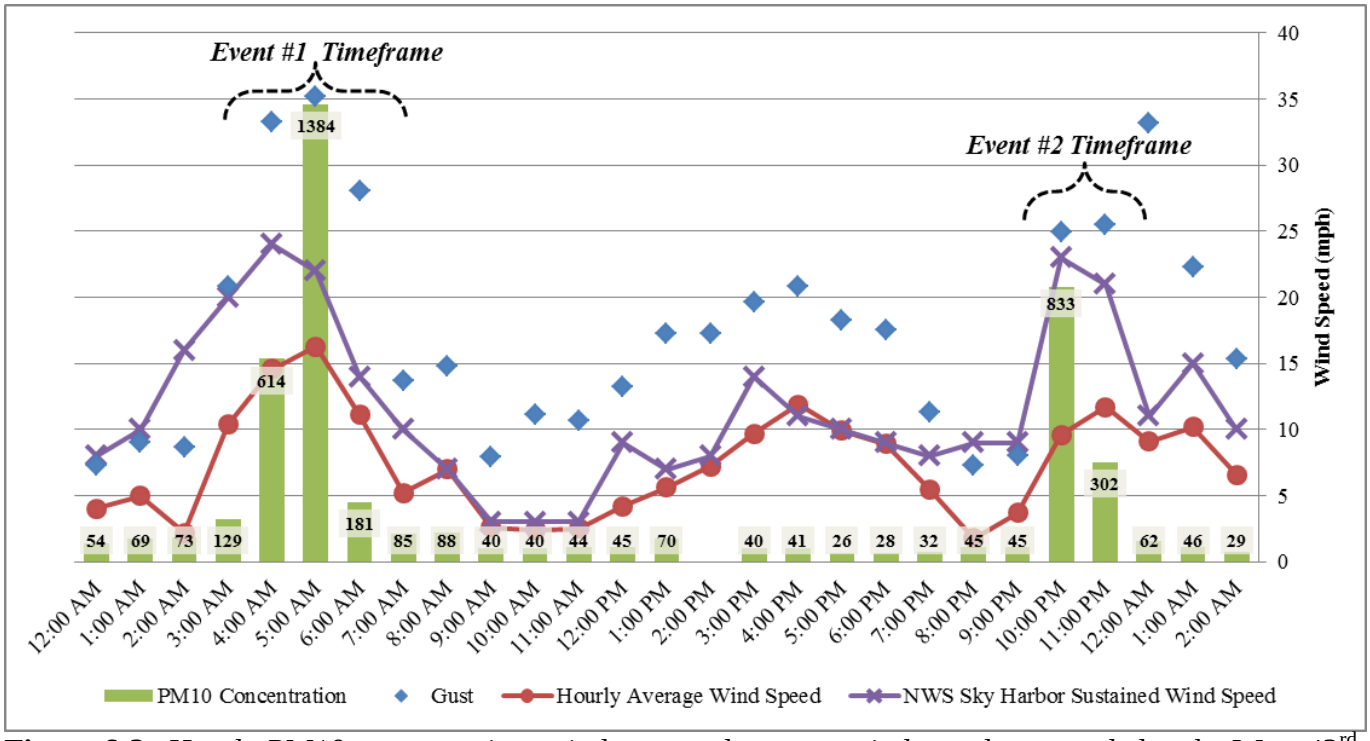



**Figure 6-2.** Hourly PM10 concentration, wind gust, and average wind speed as recorded at the West 43rd Avenue monitor.

# VII. CONCLUSIONS

The exceedances that occurred on July 2, 2013, satisfy the criteria of 40 CFR 50.1(j) and meet 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 Sections II, III, IV and V, 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 the PM10 nonattainment area, 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 PM10 emissions into the PM10 nonattainment area. The event discussed in this document that caused the exceedances in this request (see Sections II and V) was caused by thunderstorm driven outflow winds that generated and transported dust into Maricopa County from areas inside and outside of the PM10 nonattainment area. The fact that this was a natural event involving strong thunderstorm outflow winds that transported and generated PM10 emissions into Maricopa County, provides strong evidence that the event and exceedances of July 2, 2013, recorded at the Maricopa County monitors were not reasonably controllable or preventable.

## C. Natural Event

As discussed above, the event shown to cause these exceedances were emissions of PM10 generated by high winds caused by thunderstorm activity and related outflow boundaries on July 2, 2013. The event therefore qualifies as a natural event.

In summary, the exceedances of the federal 24-hour PM10 standard on July 2, 2013, would not have occurred but for the monsoonal thunderstorm driven high winds and windblown dust generated and transported from areas inside and outside the nonattainment area, based on the following weight of evidence:

- Historical Fluctuation data in Section III showing five years of 24-hour average data for the exceeding Maricopa County monitors demonstrates that the values on July 2, 2013 were atypical and in excess of normal historical fluctuations.

- The exceedances of the PM10 standard recorded on July 2, 2013, are tied to thunderstorm activity and thunderstorm generated outflow winds, as can be seen in radar imagery analyses in Section V.

- Figures in Section V show that the timing of thunderstorm generated outflow boundary passage and increases in wind speeds at monitoring locations and National Weather Service stations during the event are consistent with the timing of elevated PM10 concentrations recorded at the monitoring locations in the nonattainment area.

- Wind directions, thunderstorm generated outflow boundary propagation, and concentration patterns showing elevated levels of PM10 in Pinal County help to show that dust originating in Pinal County impacted monitors in the nonattainment area.

- Section IV discusses rules that are in place in the nonattainment area as well as inspections that were conducted in the area to verify compliance with those rules in order to show that the event was not reasonably controllable or preventable.