Technical Support Document For the August 22, 2015, Lamar Exceptional Event

Prepared by the
Air Pollution Control Division
Colorado Department of Public Health and Environment

December 13, 2017

Executive Summary

In 2005, Congress identified a need to account for events that result in exceedances of the National Ambient Air Quality Standards (NAAQS) that are exceptional in nature[1] (e.g., not expected to reoccur or caused by acts of nature beyond man-made controls). In response, EPA promulgated the Exceptional Events Rule (EER) to address exceptional events in 40 CFR Parts 50 and 51 on March 22, 2007 (72 FR 13560). On May 2, 2011, in an attempt to clarify this rule, EPA released draft guidance documents on the implementation of the EER to State, tribal and local air agencies for review. The EER allows for states and tribes to "flag" air quality monitoring data as an exceptional event and exclude those data from use in determinations with respect to exceedances or violations of the NAAQS, if EPA concurs with the demonstration submitted by the flagging agency.

Due to the semi-arid nature of large parts of the state, Colorado is highly susceptible to windblown dust events. These events are often captured by various air quality monitoring equipment throughout the state, sometimes resulting in exceedances or violations of the 24-hour PM_{10} NAAQS. This document contains detailed information about the large regional windblown dust event that occurred on August 22, 2015. The Colorado Department of Public Health and Environment (CDPHE) Air Pollution Control Division (APCD) has prepared this report for the U.S. Environmental Protection Agency (EPA) to demonstrate that the elevated PM_{10} concentrations were caused by a natural event.

EPA's June 2012 draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule states "the EPA will accept a threshold of a sustained wind of 25 mph for areas in the west provided the agencies support this as the level at which they expect stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed…". In addition, in both eastern and western Colorado it has been shown that wind speeds of 30 mph or greater and gusts of 40 mph or greater can cause blowing dust (see the Lamar, Colorado, Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx). For these blowing dust events, it has been assumed that sustained winds of 30 mph and higher or wind gusts of 40 mph and higher can cause blowing dust in Colorado and the surrounding states.

The PM_{10} exceedance in Lamar, Colorado, on August 22, 2015, would not have occurred if not for meteorological conditions that caused strong surface winds over the area of concern. This PM_{10} exceedance was due to an exceptional event associated with regional windstorm-caused emissions from erodible soil sources outside the monitored areas. These sources are not reasonably controllable during significant windstorms.

APCD is requesting concurrence on exclusion of the exceedance PM_{10} value from the Lamar Municipal Building (08-099-0002) monitor on August 22, 2015.

[1] Section 319 of the Clear Air Act (CAA), as amended by section 6013 of the Safe Accountable Flexible Efficient-Transportation Equity Act: A Legacy for Users (SAFE-TEA-LU of 2005, required EPA to propose the Federal Exceptional Events Rule (EER) no later than March 1, 2006.

Table of Contents

Figures

Tables

1.0 Exceptional Events Rule 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 discusses how the APCD addressed those requirements.

1.1 Procedural Criteria

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 APCD 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), 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. APCD has addressed all of these procedural and documentation requirements.

Public notification that event was occurring (40 CFR 50.14(c)(1)(i))
Although the APCD did not issue a specific Blowing Dust Advisory on August 22, 2016 due to unforeseen and/or sudden weather changes, the APCD has developed and implemented processes and measures within the 2012 Natural Events Action Plan (NEAP) for Lamar (See http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=LamarNaturalEventsActionPlan2012.pdf), including public education programs and Best Available Control Measures (BACM). APCD asserts that continual public outreach and notification in the Lamar area is adequate on dates when drastic weather patterns prevented meteorologists from issuing timely advisories.

Place informational flag on data in AQS (40 CFR 50.14(c)(2)(ii))
APCD and other applicable agencies in Colorado submit data into EPA's AQS. Data from both filter-based and continuous monitors operated in Colorado are submitted to AQS.

When APCD and/or another agency operating monitors in Colorado suspects that data may be influenced by an exceptional event, APCD 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. APCD and/or other operating agencies also submit data from continuous monitors into AQS after quality assurance is complete.

If APCD and/or the applicable operating agency have determined a potential exists that the sample value has been influenced by an exceptional event, a preliminary flag is submitted for the measurement when the data is uploaded to AQS. The data are not official until they are certified 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))
In early 2011, APCD and EPA Region 8 staff agreed that the notification of the intent to flag data as an exceptional event would be done by submitting data to AQS with the proper flags

and the initial event descriptions. This was deemed acceptable, since Region 8 staff routinely pull the data to review for completeness and other analyses.

On August 22, 2015, one sample value greater than 150 μg/m^3 was taken at the Lamar Municipal monitor (SLAMS, 08-099-0002) in southern Colorado during the high wind event that occurred that day. This monitor is operated by APCD in partnership with a local operator.

Document that the public comment process was followed for event documentation (40 CFR 50.14(c)(3)(iv))
APCD posted this report on the Air Pollution Control Division's webpage for a 30-day public review period on December 13, 2017. A copy of comments received will be submitted to EPA, consistent with the requirements of 40 CFR 50.14(c)(3)(iv).

Submit demonstration supporting exceptional event flag (40 CFR 50.14(a)(1-2))
At the close of the comment period, and after APCD has had the opportunity to consider any comments submitted on this document, APCD will submit this document, along with any comments received (if applicable), and APCD's responses to those comments to EPA Region VIII headquarters in Denver, Colorado.

1.2 Documentation Requirements

Section 50.14(c)(3)(iv) 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.

2.0 Meteorological Analysis of the August 22, 2015, Blowing Dust Event and PM_{10} Exceedance – Conceptual Model and Wind Statistics

On August 22, 2015, strong surface winds in the wake of a cold front caused an exceedance of the 24-hour PM_{10} standard in Lamar, Colorado, at the Municipal Building monitor with a concentration of 423 $\mu g/m^3$. This highly elevated reading and the location of the monitor are plotted on a map of the Greater Lamar area in Figure 1. These surface features were associated with a strong upper-level trough that was moving across the western United States. The surface winds were predominantly out of a northeasterly direction which moved through southeastern Colorado and produced significant blowing dust.

EPA's June 2012, Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule states, "the EPA will accept a threshold of a sustained wind of 25 mph for areas in the west provided the agencies support this as the level at which they expect stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed…". In addition, in Colorado it has been shown that wind speeds of 30 mph or greater and gusts of 40 mph or greater can cause blowing dust (see the Lamar Blowing Dust Climatology available at http://www.colorado.gov/airquality/tech_doc_repository.aspx). For these blowing dust events, it has been assumed that sustained winds of 30 mph and higher or wind gusts of 40 mph and higher can cause blowing dust in Colorado.

High PM10 Natural Event in Colorado (August 22, 2015)

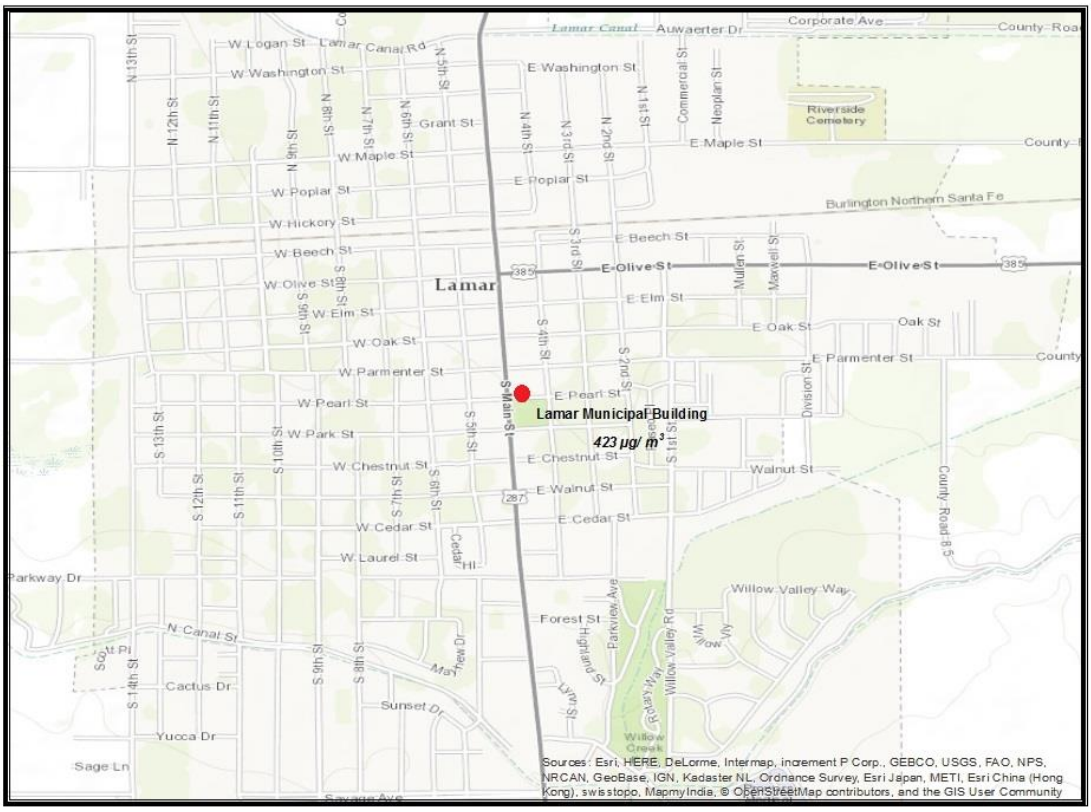

Figure 1: 24-hour PM_{10} concentration for the Lamar Municipal Building monitor, August 22, 2015.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10**)**

The upper-level trough associated with this storm system is shown on the 700 mb and 500 mb height analysis maps at 5:00 AM MST, August 22, 2015 in Figure 2 and Figure 3, respectively. The 700 mb level is located roughly 3 kilometers above mean sea level (MSL) while the 500 mb level is approximately 6 kilometers above MSL. The two charts show that a deep trough of low pressure was present at both the 700 and 500 mb level just a few hours before the blowing dust event of August 22, 2015, and that it was moving over the western United States. This is a typical upper-air pattern for blowing dust events in Colorado (see the Lamar Blowing Dust Climatology available at http://www.colorado.gov/airquality/tech_doc_repository.aspx).

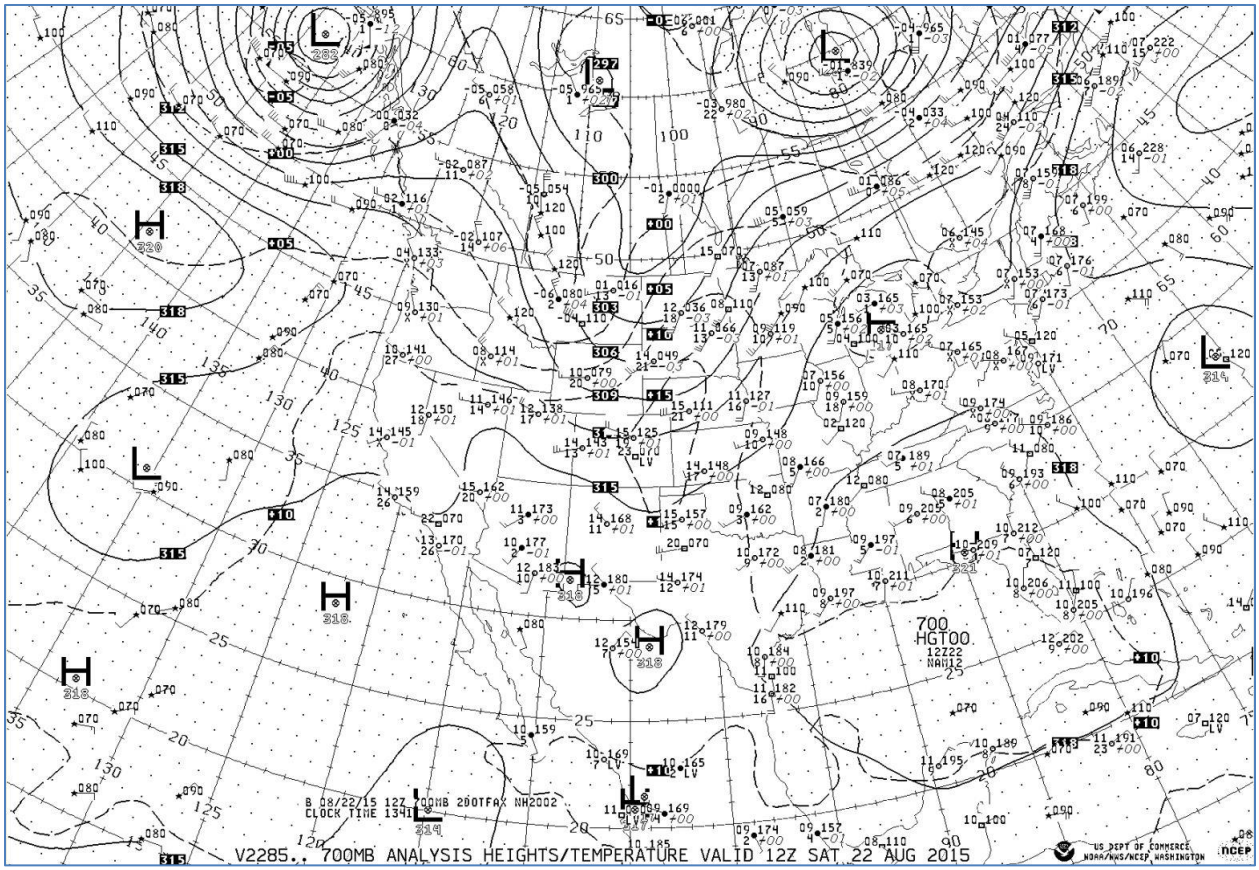

Figure 2: 700 mb (about 3 kilometers above mean sea level) analysis for 12Z August 22, 2015, or 5:00 AM MST August 22, 2015.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

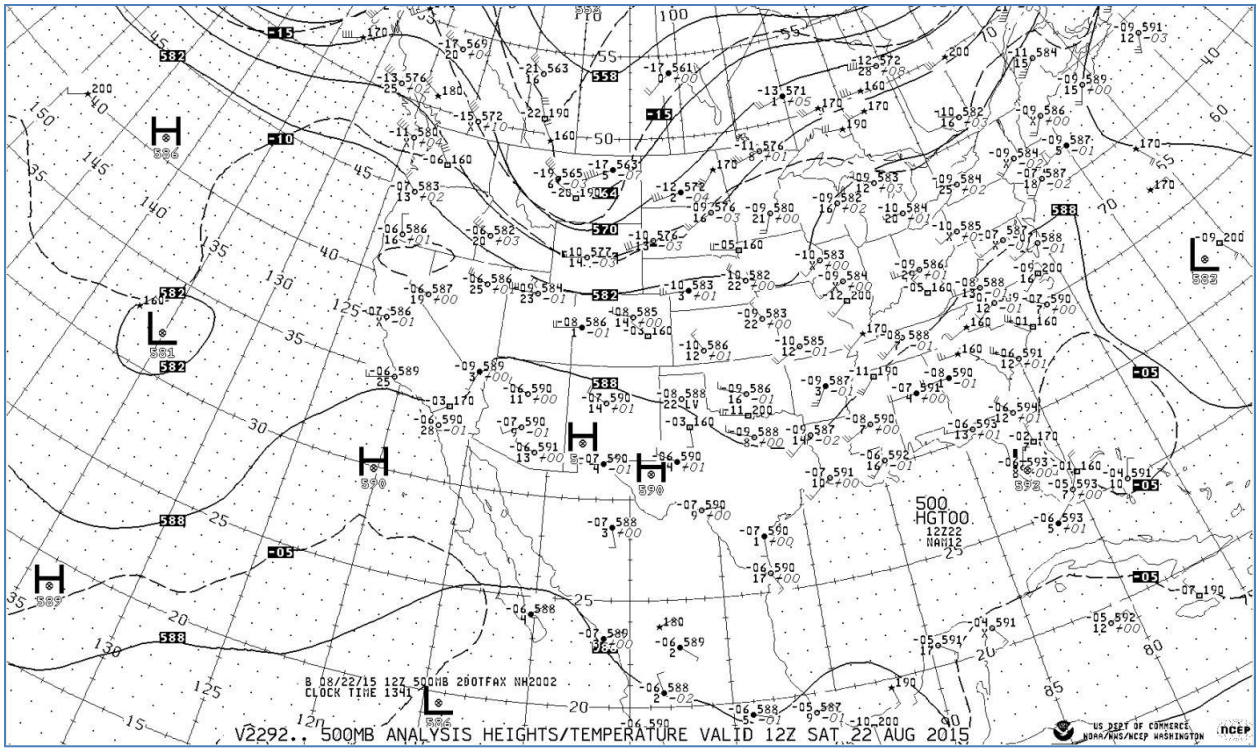

Figure 3: 500 mb (about 6 kilometers above mean sea level) analysis for 12Z August 22, 2015, or 5:00 AM MST August 22, 2015.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP**)**

The surface weather associated with the storm system of August 22, 2015 is presented in Figure 4, Figure 5, and Figure 6. Significant surface features at 11:00 AM MST, August 22, 2015 (Figure 4) included a strong cold front that was moving southward through eastern Colorado. By 5:00 PM MST (Figure 5) the cold front had moved directly over southern Colorado, and by 8:00 PM MST it had cleared southeastern Colorado, leaving behind closely spaced isobars (Figure 6). This indicates that a significant pressure gradient was in place. Wind speed is directly proportional to the pressure gradient, so a greater pressure gradient will produce stronger winds (see the following link for additional information on pressure gradient and its relationship to wind speed from the National Oceanic and Atmospheric Administration (NOAA): source: http://www.srh.noaa.gov/jetstream/synoptic/wind.htm). The strong pressure gradient was in response to a building ridge of high pressure in eastern Montana and Wyoming interacting with an area of low pressure moving southward through Colorado and into western Texas.

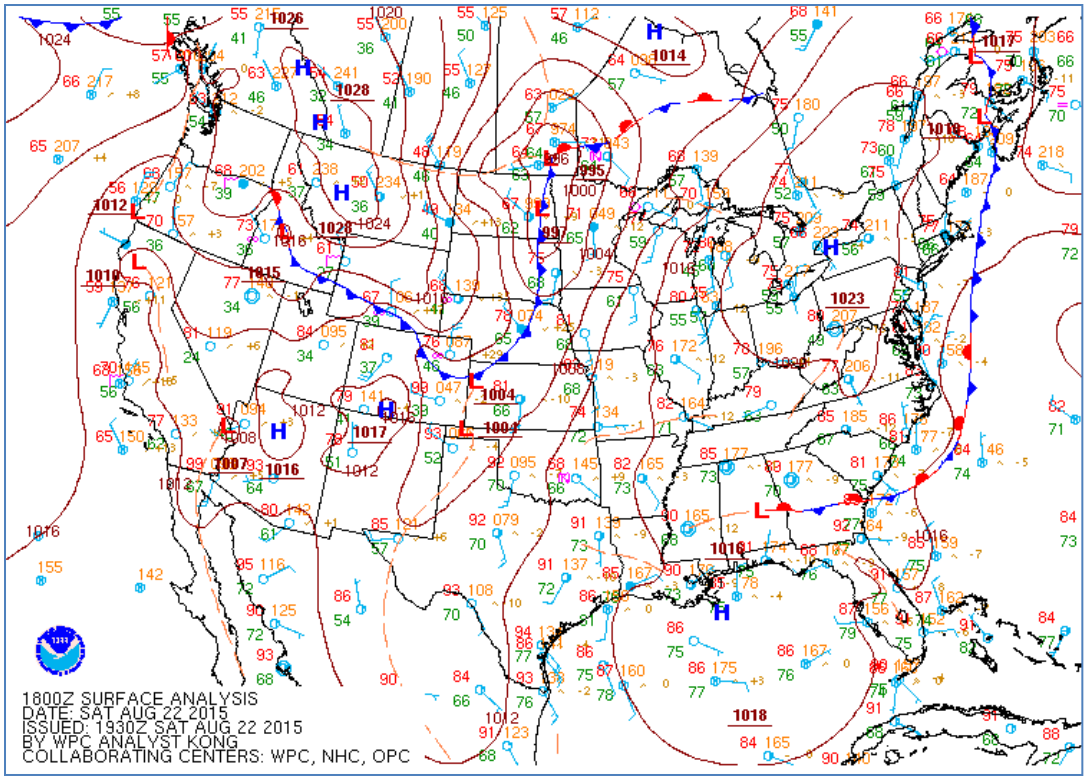

Figure 4: Surface Analysis for 18Z August 22, 2015, or 11:00 AM MST August 22, 2015. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

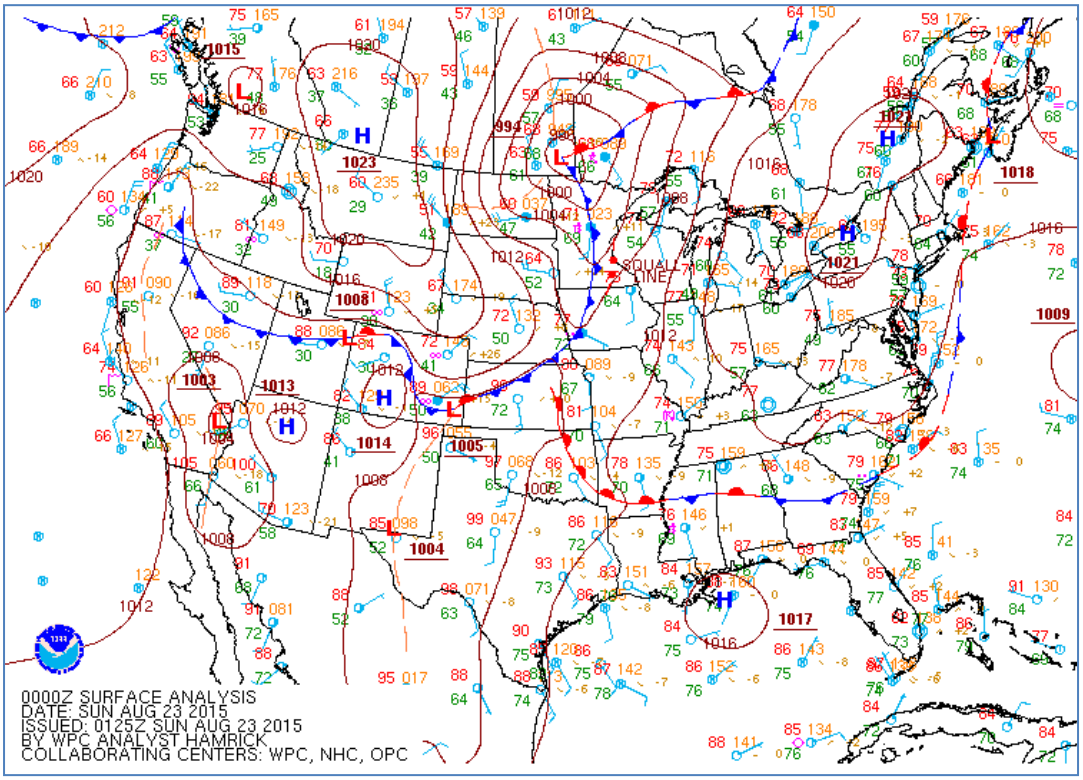

Figure 5: Surface Analysis for 0Z August 23, 2015, or 5:00 PM MST August 22, 2015. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

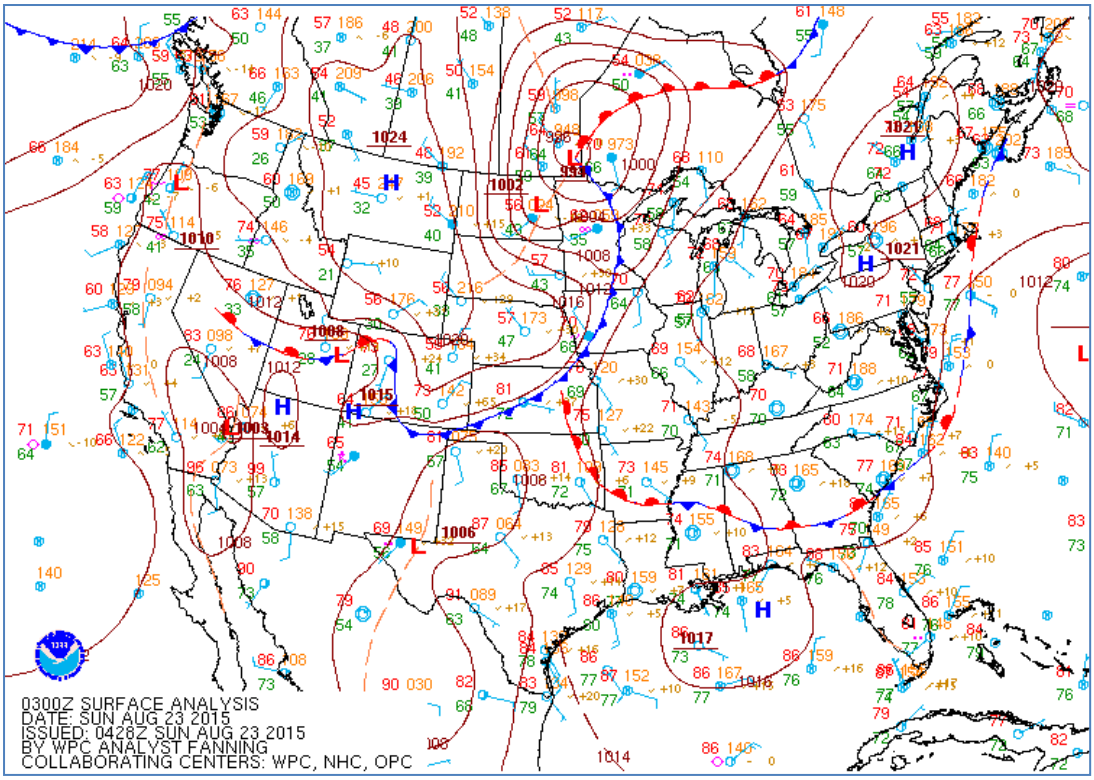

Figure 6: Surface Analysis for 03Z August 23, 2015, or 8:00 PM MST August 22, 2015. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP**)**

In order to fully evaluate the synoptic meteorological scenario of August 22, 2015, a regional surface weather map is provided showing individual station observations during the height of the event in question. Figure 7 presents weather observations for eastern Colorado and adjacent states at 3:48 PM MST, August 22, 2015. The station observation for Lamar (LAA) shows winds sustained at 25 knots (29 mph), gusts to 36 knots (41 mph), and a reduced visibility of 0.75 statute miles with the weather symbol of infinity (∞). The infinity sign is the weather symbol for haze. Haze is often reported during dust storms, and in dry and windy conditions haze typically refers to solid fine particles that are airborne, also known as blowing dust (see the following link for the description of haze published by the National Oceanic and Atmospheric Administration (NOAA): http://w1.weather.gov/glossary/index.php?word=haze). Also note that to the north of Lamar in nearby Burlington (ITR), similar weather conditions were reported with strong winds, haze and reduced visibility. Similar conditions were also reported just to the east of Burlington at Goodland, Kansas (GLD) with strong winds, haze, and reduced visibility. This collection of weather observations indicates that a regional blowing dust event was indeed occurring on August 22, 2015.

Hourly surface observations, in table form, from Lamar and other regional weather stations provide supporting evidence that there was an extended period of high winds and haze (blowing dust) across eastern Colorado and adjacent states. Table 1 lists observations for the PM_{10} exceedance location of Lamar while Burlington, Goodland, La Junta and Pueblo observations can be found in Table 2 through Table 5, respectively. Observations that are climatologically consistent with blowing dust conditions (see the Lamar Blowing Dust Climatology available at http://www.colorado.gov/airquality/tech_doc_repository.aspx) are highlighted in yellow. Collectively, these sites experienced many hours of reduced visibility

along with periods of sustained wind speeds and gusts at or above the thresholds for blowing dust.

Surface weather maps and hourly observations show that a regional dust storm occurred under northeasterly flow in the wake of a cold front. This data provides clear evidence of blowing dust and winds at or above the threshold speeds for blowing dust on August 22, 2015.

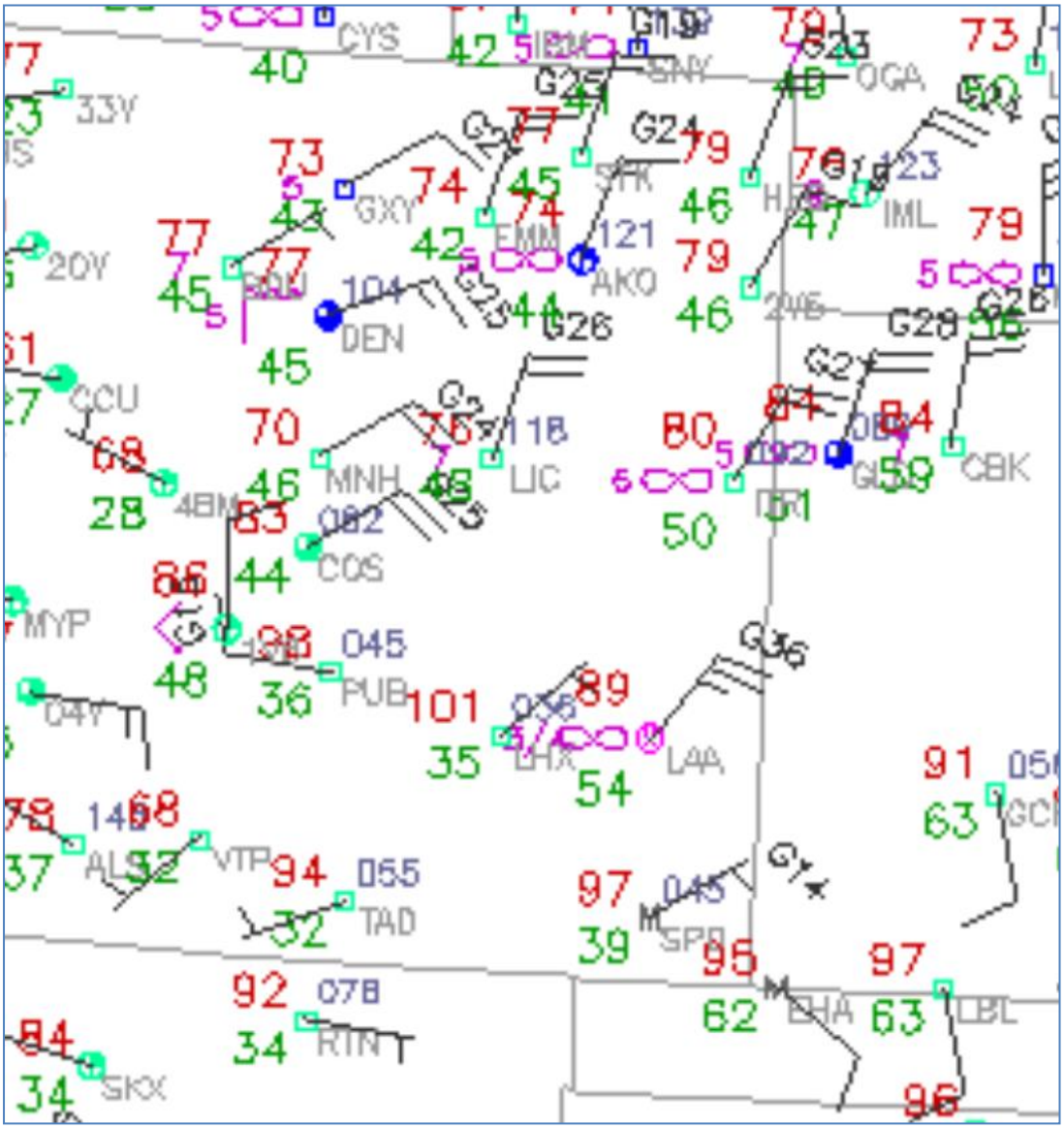

Figure 7: High Plains regional surface analysis for 3:48 PM MST, August 22, 2015. (Source: http://www.mmm.ucar.edu/imagearchive/)

Time MST August 22	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
13:53	98	15	6		150		8
14:53	99	14	7		140		7
15:15	94	24	15	33	30	Haze	1.75
15:18	90	30	30	40	40	Haze	1
15:20	89	30	30	41	40	Haze	0.75
15:33	89	32	20	32	40	Haze	1
15:41	89	32	25	33	40	Haze	1.5
15:53	88	33	20	30	40	Haze	1.75
16:17	88	32	21	31	50	Haze	2.5
16:37	86	34	22	35	50	Haze	1.5
16:53	85	34	21	35	50	Haze	1.5
17:16	84	35	20	28	40	Haze	1.25
17:45	82	38	17	28	40	Haze	2
17:53	81	39	21	31	40	Haze	2.5
18:53	76	47	18	28	50	Haze	4
19:53	71	51	15		40	Haze	4
20:32	70	49	14	23	40	Haze	4
20:53	69	51	12	22	40	Haze	4
21:53	67	52	8		40	Haze	4
22:53	66	56	7		10	Haze	4
23:53	66	50	12	23	40	Haze	5

Table 1: Weather observations for Lamar, Colorado, on August 22, 2015.
(Source: http://mesowest.utah.edu/)

Time MST August 22	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
9:53	90	27	5				10
10:53	94	16	8		80		10
11:53	85	28	22	30	20	Partly Cloudy	10
12:14	82	32	21	28	20	Thunder	10
12:53	84	30	21	32	30	Thunder	6
13:03	84	29	21	30	40	Haze	6
13:53	82	33	24	31	30	Haze	6
14:53	80	35	24	31	30	Haze	6
15:53	78	39	18	28	40		7
16:53	73	44	20	33	40	Haze	6
17:53	70	44	17	28	40	Haze	5
18:53	67	49	14		40	Haze	6
19:53	65	56	12		20	Haze	6
20:53	63	60	9		10	Haze	6
21:53	61	50	14		20		9
22:53	59	51	13		10		10

Table 2: Weather observations for Burlington, Colorado, on August 22, 2015. (Source: http://mesowest.utah.edu/)

Time MST August 22	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
9:53	93	20	9		310		10
10:53	99	15	15	22	20		10
11:53	91	20	21	32	10		10
12:53	88	24	23	37	10	Haze	5
13:53	88	26	17	25	10	Haze	6
14:53	84	33	24	32	20	Haze	5
15:53	81	37	26	32	40		7
16:53	75	41	22	30	10	Haze	6
17:53	72	43	17	25	10	Haze	4
18:53	70	46	16		30	Haze	6
19:03	66	56	15		20	Light Rain/T-storm	6
19:18	66	52	14		20	Haze	6
19:53	64	56	12		20	Haze	6
20:53	64	60	10		10	Haze	6
21:53	63	48	17	26	360		9
22:53	61	48	16		360		10

Table 3: Weather observations for Goodland, Kansas, on August 22, 2015. (Source: http://mesowest.utah.edu/)

Time MST August 22	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
9:53	92	17	18		280	Clear	10
10:53	99	13	12	24	280	Clear	10
11:53	100	11	10		270	Clear	10
12:53	101	10	7				10
13:53	100	10	3				10
14:53	101	10	8		50		10
15:53	92	23	30	37	60	Mostly Clear	8
16:46	90	25	23	36	50	Haze	6
16:53	89	26	29	36	50	Haze	6
17:53	82	34	26	33	50	Haze	6
18:53	77	42	23	32	50		7
19:53	73	44	14	25	30		7
20:53	70	46	18	28	30	Haze	6
21:53	69	47	9		30	Haze	6
22:53	69	45	13	22	40	Haze	6
23:53	68	47	9		30	Haze	6

Table 4: Weather observations for La Junta, Colorado, on August 22, 2015. (Source: http://mesowest.utah.edu/)

Time MST August 22/23	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
9:53	93	14	23	29	280		10
10:53	97	14	22	29	280		10
11:53	97	13	17		280		10
12:53	99	12	18	24	270		10
13:53	99	12	9		300		10
14:53	99	11	13	17	280		10
15:53	97	14	14	31	30		10
16:53	84	29	25	36	40	Haze	6
17:53	82	30	15		50	Haze	6
18:53	79	32	14	25	50	Haze	6
19:53	75	39	17		30		7
20:53	73	38	12		60	Haze	6
21:53	72	41	7		60	Haze	6
22:53	70	40	5		40		7
23:53	68	40	9		70		7

Table 5: Weather observations for Pueblo, Colorado, on August 22, 2015. (Source: http://mesowest.utah.edu/)

Satellite imagery from August 22, 2015 provides strong evidence that dust caused the PM_{10} exceedance in Lamar. Specifically, the Geostationary Operational Environmental Satellite, East (GOES-East) imagery shows dust plumes blowing across southeast Colorado minutes before, and concurrent with Lamar's reports of high winds, haze and reduced visibility. Additional information on GOES Satellites can be found at the National Oceanic and Atmospheric Administration (NOAA) website: http://noaasis.noaa.gov/NOAASIS/ml/genlsatl.html.

Figure 9 shows four GOES satellite images zoomed on Colorado spanning from approximately 2:55 to 3:15 PM MST (2155 to 2215Z) on August 22, 2015. A wall of dust can be easily identified (indicated by red arrows in Figure 9a-d) approaching Lamar and La Junta from the north. At the same time as the image in Figure 9d, the surface observations for Lamar at 3:15 PM MST and 3:18 PM MST (Table 1) show that sustained winds sharply increased from 15 mph to 30 mph, accompanied by wind gusts increasing from 33 mph to 40 mph. Reports of haze and drastically reduced visibility, decreasing from 7 statute miles down to 0.75 statute miles in less than 30 minutes, also started at this time. These observations are consistent with blowing dust conditions in southeast Colorado (30 mph sustained winds, 40 mph gusts; see the Lamar Blowing Dust Climatology available at http://www.colorado.gov/airquality/tech_doc_repository.aspx). Similarly in both Burlington, CO and Goodland, KS reports beginning at 12:53 PM MST (Table 2 and Table 3 respectively) show that the wind speed abruptly increased, and haze and reduced visibility began to be reported. The reports of these conditions approximately 2 hours prior to the onset of similar

conditions in Lamar, at two locations at the same time, both to the north (upwind) of Lamar, help to reveal a consistent set of data that confirm the presence of a dust storm moving southward along the Colorado-Kansas border.

The National Oceanic and Atmospheric Administration (NOAA) Satellite Services Division and the National Weather Service (NWS) office in Pueblo agreed with the conclusion that blowing dust was occurring in southeast Colorado. The Smoke Text Product from NOAA at 9:43 PM MST on August 22, 2015 stated:

> "An area of blowing dust was observed over southeast Colorado. The dust was being kicked up by gusty northeast winds behind a frontal system which was blowing the dust toward the southwest. The heaviest dust seemed to be in a corridor from northeast to southwest through Lamar. Detection of the full extent of the dust in this portion of the country was limited due to the extensive smoke over the area." (Source: http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2015/2015H230643.html)

While a Special Weather Statement issued by NWS Pueblo at 5:03 PM MST on August 22, 2015 stated:

> "A COLD FRONT MOVING THROUGH SOUTHEAST COLORADO WILL CONTINUE TO PRODUCE NORTHEAST WINDS OF 20 TO 30 MPH...WITH A FEW GUSTS TO 40 MPH POSSIBLE THROUGH 8 PM MDT. THESE WINDS WILL PRODUCE AREAS OF BLOWING DUST AND REDUCED VISIBILITY...ESPECIALLY ALONG HIGHWAY TWO EIGHTY SEVEN BETWEEN LAMAR AND SPRINGFIELD."(Source: https://mesonet.agron.iastate.edu/wx/afos/p.php?pil=SPSPUB&e=201508230003)

Additionally, the APCD mentioned the potential for blowing dust in southeast Colorado in the Colorado Smoke Outlook, issued at 1:20 PM MST (2:20 MDT) on August 22, 2015. Included in the advisory text:

> "Moderate to heavy smoke and blowing dust are moving into eastern Colorado this afternoon and evening." (Source: http://www.colorado.gov/airquality/forecast_archive.aspx?seeddate=08%2f22%2f2015)

Further, a news story in The Denver Post reported on a multiple-vehicle accident that was caused by poor visibility due to blowing dust in the late afternoon on August 22, 2015 (source: http://www.denverpost.com/2015/08/22/dust-storm-causes-multiple-vehicle-crash-on-u-s-287-near-lamar/) . This is confirmed by a tweet from the Colorado State Patrol (CSP) that refers to the closure of Highway 287 in southern Colorado, due to multiple accidents caused by reduced visibility. The text of this tweet can be seen in Figure 8.

Satellite products combined with reports and observations from southeast Colorado on August 22, 2015 clearly reveal that a dust storm occurred which was regional in scale and therefore not controllable or preventable.

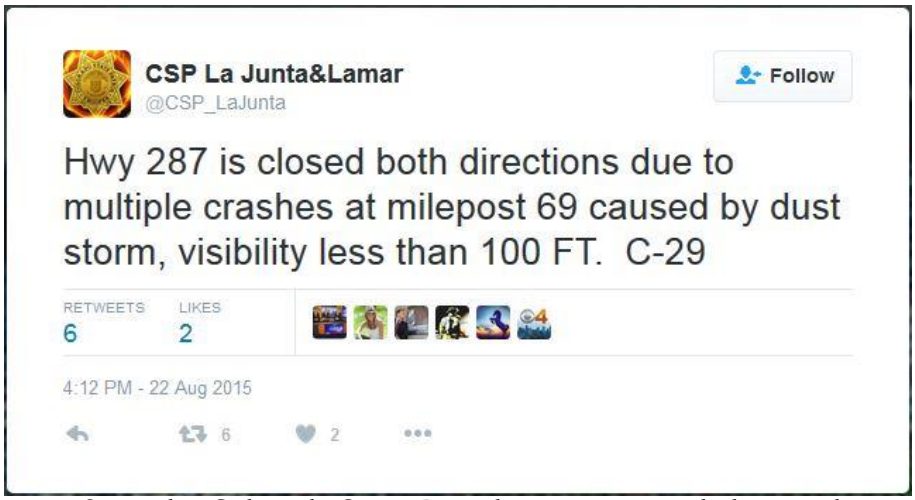

Figure 8: A tweet from the Colorado State Patrol reports a road closure due to an accident caused by blowing dust and reduced visibility.
(Source: https://twitter.com/CSP_LaJunta/status/635228030416216065)

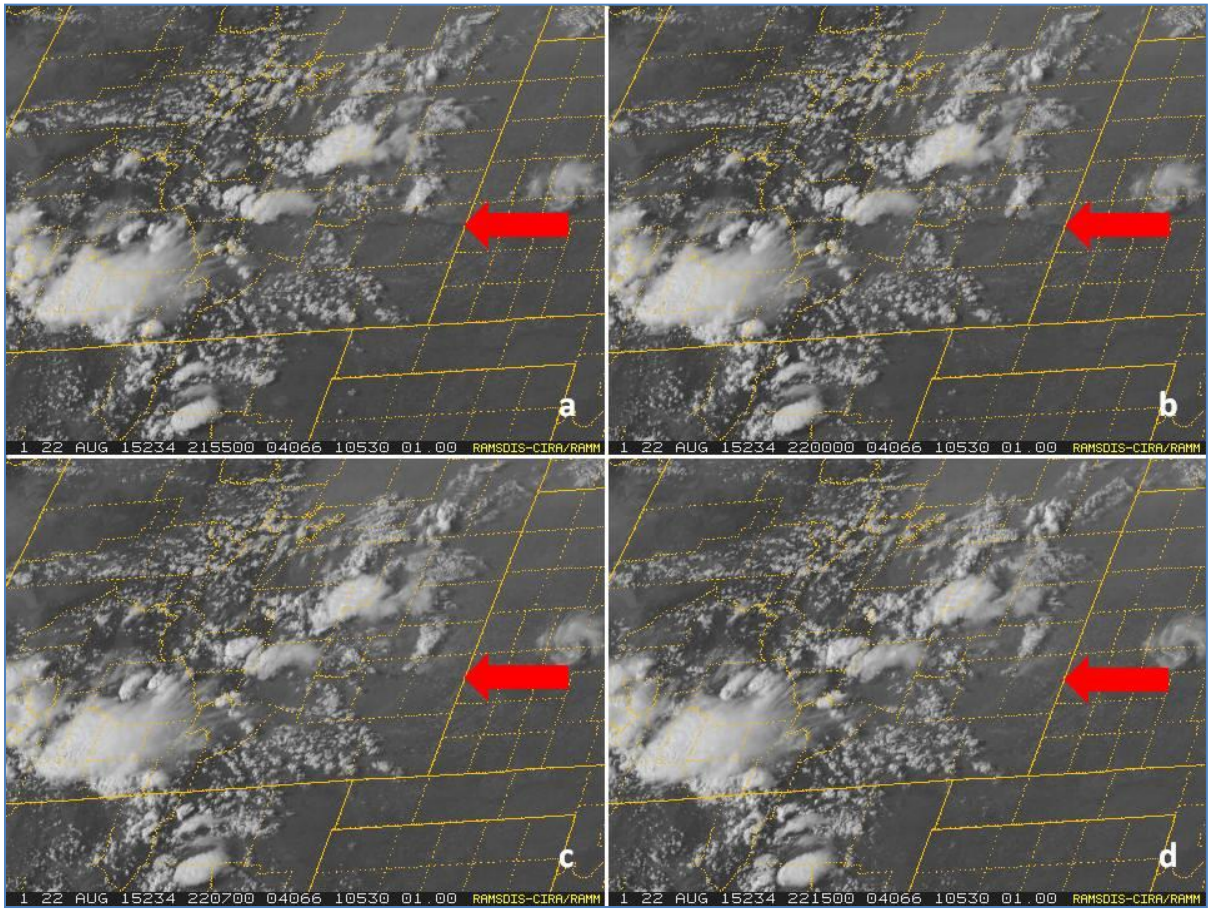

Figure 9: GOES East satellite images at (a)2:55 PM, (b)3:00 PM, (c) 3:07 PM, and (d) 3:15 PM MST (2155Z, 2200Z, 2207Z, and 2215Z, respectively) August 22, 2015.
(Source: http://rammb.cira.colostate.edu/ramsdis/online/goes-west_goes-east.asp)

The data and imagery presented thus far yield a great deal of evidence in support of the assertion that blowing dust, lofted by strong winds associated with a cold frontal passage, caused the PM_{10} exceedance recorded in Lamar, Colorado, on August 22, 2015. Additional factors can also be addressed in the examination of this case regarding additional aspects of weather and soil interactions related to blowing dust storms.

In the Lamar, Colorado, Blowing Dust Climatology's analysis (see the Lamar Blowing Dust Climatology available online at http://www.colorado.gov/airquality/tech_doc_repository.aspx), guidance thresholds for meteorological variables are provided. For precipitation, a 30-day accumulation of 0.6 inches or less in Lamar was identified as a base value, conducive to dust storms. While the precipitation record for this case fails to strictly meet this threshold value, additional considerations should be taken into account when reviewing this data. The first of these considerations relates to the nature of precipitation, its formation and delivery mechanisms, and their effect on the spatial distribution of precipitation. The second consideration relates the ability of soil to absorb precipitation as it falls and convert this water to soil moisture, thereby reducing the soil's propensity for wind erosion in the form of blowing dust. The nature of precipitation and the mechanism of delivery begins the discussion of these considerations.

Although the map in Figure 10**Error! Reference source not found.** of precipitation for the 30 days preceding the event under examination here shows areas near the site of the exceedance that received more precipitation than the threshold of 0.6 inches identified in the Lamar Blowing Dust Climatology, it also shows many areas nearby that received less than this amount. However it is the fine-scale gradients of precipitation, i.e. the close proximity in which relatively large and small amounts of rain fell, that are telling in this case. The pocketed nature of the distribution of precipitation that is depicted on this map suggests that a significant amount of the rainfall was produced by convective clouds, and was likely delivered by thunderstorms. By their very nature, thunderstorms are highly localized weather features, and are capable of delivering significant amounts of rainfall in one location, while another nearby location receives little or none at all. This is consistent with the expected weather patterns for the Great Plains of the United States during the summer months.

A review of satellite imagery (not included here) throughout this time period (July 20-August 21, 2015) confirms that no large, precipitating, synoptic scale systems moved through this region during this time. Further evidence of this is provided by analysis of the tabular precipitation record for the same time period. In a review of this hourly record it can be seen that two locations that are relatively near to one another, such as Lamar, Colorado and Springfield, Colorado, separated by only approximately 47 miles, received greatly differing amounts of precipitation during the same time frame. One instance of this was on August 10th, when the 17:00 MDT (1600 MST) reading from Lamar reports that 0.89 inches of rain fell during the previous hour, while Springfield reported a value of only 0.08 inches in that same hour. A subset of the full precipitation record can be seen in Table 6, showing hourly precipitation including the reading at the time of this example (highlighted in yellow), for several sites within the area of interest for this analysis. This difference in precipitation amounts illuminates the stark contrast that can be seen in precipitation fields during this type of weather. It should additionally be noted that Lamar received 0.00 inches of precipitation in both the hour preceding and the hour following this reading. This is once again characteristic of convective precipitation. Generally known as thunderstorms and colloquially

referred to as cloudbursts, convective storms are well known for dropping copious amounts of precipitation in very short time periods, in extremely localized areas.

Time and Date (MDT)	Burlington, CO (KITR) Precipitation	Lamar, CO (KLAA) Precipitation	Pueblo, CO (KPUB) Precipitation	Springfield, CO (KSPD) Precipitation	Colby, KS (KCBK) Precipitation	Elkhart, KS (KEHA) Precipitation	Goodland, KS (KGLD) Precipitation	Saint Francis, KS (KSYF) Precipitation
8/10/2015 12:00	0	0	0	0	0	0	0	0
8/10/2015 13:00	0	0	0	0	0	0	0	0
8/10/2015 14:00	0	0	0	0	0	0	0	0
8/10/2015 15:00	0	0	0	0	0	0	0	0
8/10/2015 16:00	0	0	0	0.01	0	0	0	0
8/10/2015 17:00	0	0.89	0.01	0.08	0	0	0	0
8/10/2015 18:00	0	0	0	0	0	0	0	0
8/10/2015 19:00	0	0	0.2	0	0	0	0	0
8/10/2015 20:00	0	0	1.27	0	0	0	0	0
8/10/2015 21:00	0	0	0.06	0	0	0	0	0
8/10/2015 22:00	0	0	0.05	0	0	0	0	0
8/10/2015 23:00	0	0	0	0.01	0	0	0	0

Table 6. A sub-set of the full precipitation record for several sites within the area of interest showing uncorrected hourly precipitation amounts. (Source: https://mesonet.agron.iastate.edu/request/asos/hourlyprecip.phtml)

In this context, the discussion of precipitation amounts must be considered for all areas within a reasonable proximity of the location of the exceedance, not solely at the location of the exceedance itself. It can be reasoned that while one location may receive ample precipitation and thereby have a greatly decreased likelihood for soil erosion by wind (e.g. blowing dust), another location that may be immediately adjacent to the first may remain dry and retain soil moisture characteristics conducive to blowing dust events. By this rationale it is quite easy to recognize the potential for dust to be blown from one location, where the precipitation threshold defined in the climatology is not met or exceeded, into another location where greater precipitation amounts have recently fallen. This may cause an exceedance of the PM_{10} standard at the latter location even though the precipitation at that location has exceeded the climatological precipitation threshold.

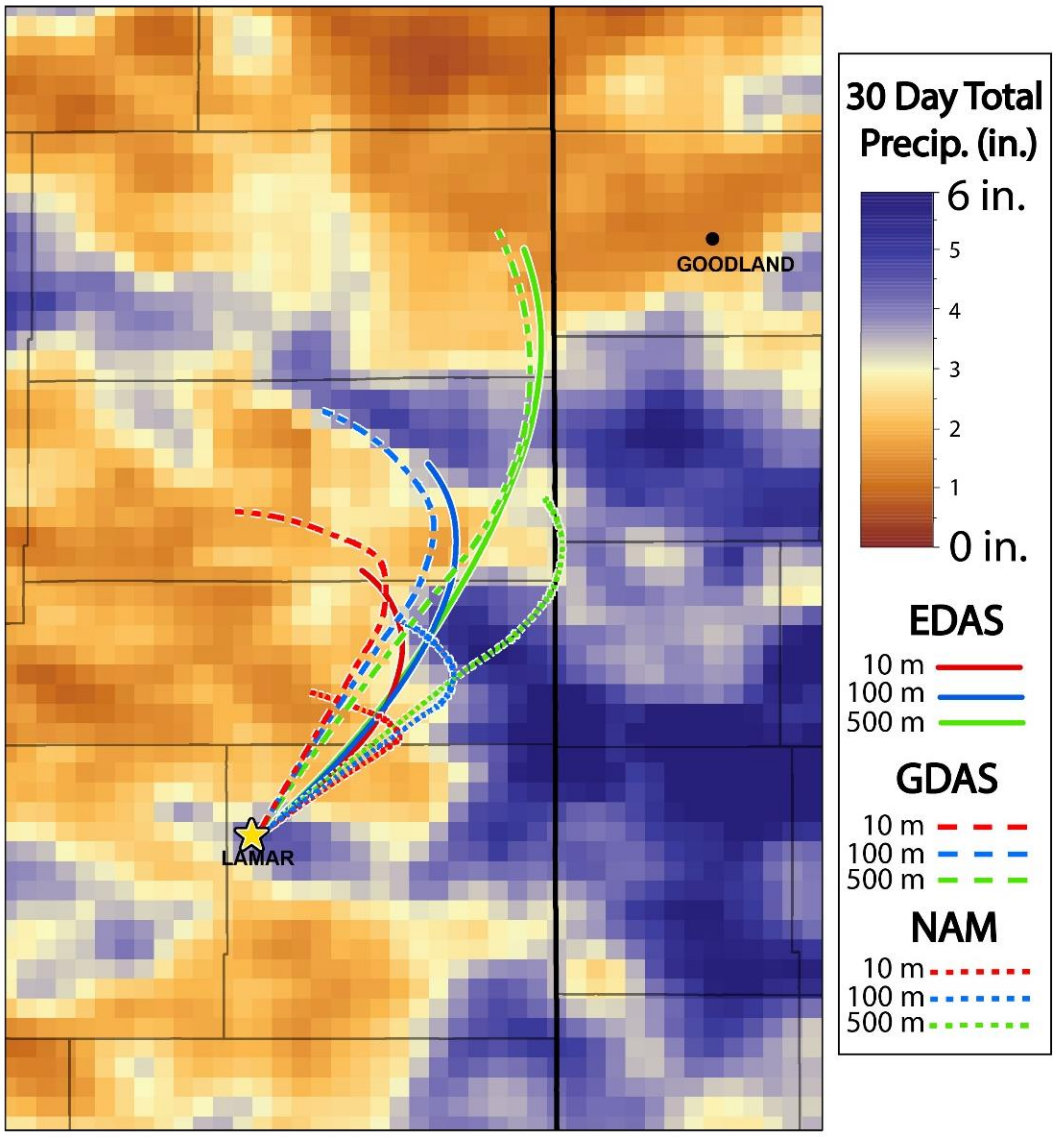

Figure 10. Map showing the accumulated precipitation for areas of eastern Colorado and western Kansas from July 20-August 21, 2015 with HYSPLIT back trajectories overlaid.

The second consideration that relates to the precise location of where precipitation is received and how said precipitation falls, is the amount of precipitation that can be converted into soil moisture. The varied nature of soil types and characteristics means that they will receive precipitation differently, allowing the water that falls as rain to enter the soil at different rates based upon many factors. The rate at which water is allowed to penetrate the surface or to some depth within the soil is known as the infiltration rate (Hillel, 1982, 1998) and has been examined extensively for various soils, and for different compositions and layering patterns (Hillel 1982, 1998; McCuen 1998; USDA 2014; NRCS 2017). When precipitation rate exceeds the maximum infiltration rate of the soil it falls upon, the excess water becomes surface runoff and rapidly enters streams and rivers (Hillel 1998; McCuen 1998). For many purposes, including hydrology, engineering, and resource conservation, the National Resource Conservation Service (NRCS), a division of the United States Department of Agriculture (USDA), has defined groupings of soil types based on their

runoff characteristics (NRCS, 2017) and designated 4 categories of Hydrologic Soil Groups (HSG's).

Figure 11 shows the HSG's for portions eastern Colorado and western Kansas. The USDA describes a hydrologic group as "a group of soils having similar runoff potential under similar storm and cover conditions," (USDA, 2014). This figure shows that in the areas along the Colorado-Kansas border, situated generally in between Goodland, Kansas and Lamar, Colorado (the general area of origin and transport of the blowing dust) are classified primarily as HSG types B and C. These HSG's can be referred to in terms of their runoff potential, or as is perhaps more fitting in this scenario, in terms of their infiltration rates, which can be found in Table 7. Then, by examining the precipitation record within the context of HSG grouping and allowing the consideration of the infiltration rate based on HSG, a different picture of the precipitation, or the amount of precipitation that can potentially be effective in moistening soil and reducing the likelihood of blowing dust, is allowed to emerge. This consideration will allow the establishment and computation of the 'effective precipitation' that an area has received.

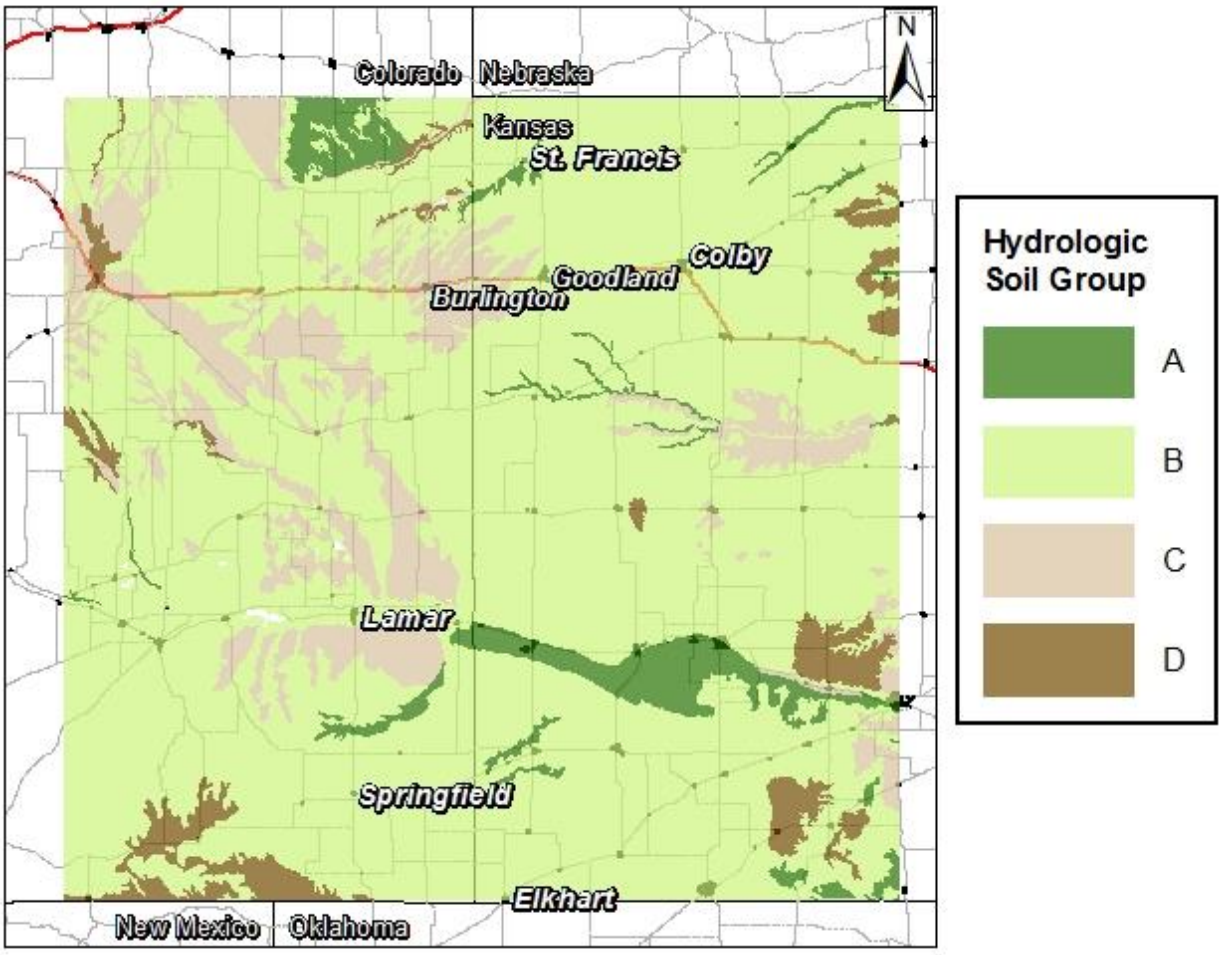

Figure 11. Map showing Hydrologic Soil Group classification as ascribed by the NRCS/USDA for areas in eastern Colorado and western Kansas.

Hydrologic Soil Group	Minimum Infiltration Rate
A	0.30-0.45
B	0.15-0.30
C	0.05-0.15
D	0-0.05

Table 7. Infiltration rate by Hydrologic Soil Group (adapted from McCuen, 1998).

To put this into the proper perspective, prior to analysis or conclusions, a distinction is drawn between three aspects of soil-water interaction: infiltration, hydraulic conductivity, and surface runoff. Infiltration is the rate at which water moves across the surface plane of the soil profile; this is closely related to the hydraulic conductivity of the surface layer only (Hillel 1998). McCuen (1998) states that 'the ability to pass water through a geologic formation…is called the permeability of a soil,' and that '…the term hydraulic conductivity is currently used to represent the permeability of a soil.' Therefore, the hydraulic conductivity of the top layer of soil affects the rate at which water can penetrate the soil surface and determine how much water is permitted to enter as soil moisture and groundwater, and how much is lost to runoff. Runoff can be basically stated as being the difference between the amount of precipitation that fell, and the amount that is allowed to move into the soil; and is largely governed by the previously mentioned factors. More specifically, this is described by McCuen (1998), stating that 'Water stored in depressions, water intercepted by vegetation, and water that infiltrates into the soil…is water that does not appear as runoff during or immediately following a rainfall event.' Further distinctions concerning runoff can be found when delving deeper into soil science and when considerations such as groundwater, aquifers, and other factors are considered, however here it is only the surface interaction between these influences that is of interest.

For this application it is primarily the interaction at the surface between water, soil, and wind that is of concern. For this reason, the focus here will be upon the USDA reported infiltration rate for a given soil group (Table 7). This emphasis is because it is only the topmost portion of the surface layer that is a factor in wind erosion. Though the surface layer may extend downward several inches or more, it is only the portion of this layer that is exposed to wind that is of influence during blowing dust events. Thus, only infiltration rate, contrasted against hydraulic conductivity and surface runoff, will be applied to the precipitation record. Re-stated, the perspective from which this methodology has emerged is: when precipitation falls, it is only the amount that is taken up by the soil that is effective at moistening the soil, thereby reducing the soils propensity to be carried by the wind. If precipitation rate exceeds infiltration rate, runoff occurs. In this scenario hydraulic conductivity of soil layers beneath the surface is not of concern as any excess water is limited in its access to deeper soil layers by surface infiltration rationing and subsequent surface runoff.

The information above makes it clear that there is a large impact on soil moisture that is governed by the soil type, and therefore its infiltration rate. However, also clear is that the rate of uptake of water by the soil it falls upon is not a simple assessment. The metrics that have been presented here are broad categories and are intended to account for typical conditions for the soil covering large areas. The USDA and NRCS HSG classification takes into

account the intake and transmission of water under conditions of maximum yearly wetness (thoroughly wet [soil]), unfrozen soil, a bare soil surface, and maximum swelling of expansive clays. These are static and measurable characteristics that are not likely to change on a short term basis. Yet in addition to these factors, it is acknowledged here that many more influences, both transient and constant, may be discounted in this broad approach to estimating the effectiveness of precipitation in the reduction of the likelihood of blowing dust. Factors such as evapotranspiration, something that fluctuates on a daily cycle as well as with irrigation and precipitation trends; the slope of the ground and the average or expected grain size within the soil; along with the compactness of the soil, a factor that may be affected by crop stage and plowing activities, are not applied to this classification scheme.

Table 7 reports a range of minimum infiltration rates for each HSG. The maximum value for these ranges will be used here to allow for the maximum amount of soil uptake, given the unknown factors and inexact nature of the identification of precise soil type. For HSG B, as the classification for all observing locations (with the exception of Burlington, CO, which is HSG C), an infiltration rate of 0.30 (0.15) inches/hour will be applied to the precipitation record, establishing a value of effective precipitation. Any hour in which less than 0.30 inches of precipitation fell will have the full precipitation amount applied to the cumulative total, and for any hour that received more than 0.30 inches of precipitation, only 0.30 of this amount will be used in the cumulative total. This value is then reconsidered within the context of the threshold established in the blowing dust climatology.

Error! Reference source not found. presents the accumulated precipitation for several sites in the area of interest for this event, along with the calculated effective precipitation totals. This method significantly reduces the amount of precipitation that is considered at all measurement sites, barring those that had no precipitation at all. For data collected during the 30 days preceding the PM_{10} exceedance in Lamar on August 22, 2015 (between July 20, 2015 and August 21, 2015), the application of this method does not yield effective precipitation amounts that meet or fall below the climatological precipitation threshold. However, the data produced by this method still adds value and insight to the review of this case, and underscores the importance of recognizing the difference between precipitation received, and the amount of precipitation that may be 'used' at the location where it has fallen. This method found that precipitation totals were reduced to effective precipitation amounts that were between 37-50% of their former values.

Station	Precipitation	Effective Precipitation	% Change
Burlington, CO (KITR)	3.26	1.63	-50.00
Lamar, CO (KLAA)	5.15	2.69	-47.77
Pueblo, CO (KPUB)	4.31	2.32	-46.17
Springfield, CO (KSPD)	1.4	0.85	-39.29
Colby, KS (KCBK)	0	0	N/A
Elkhart, KS (KEHA)	0	0	N/A
Goodland, KS (KGLD)	1.49	0.93	-37.58
Saint Francis, KS (KSYF)	0	0	N/A

Table 8. Precipitation and effective precipitation totals, and percent change for various observing sites in eastern Colorado and western Kansas. (Source: https://mesonet.agron.iastate.edu/request/asos/hourlyprecip.phtml)

This analysis makes clear several points. First, that the amount of precipitation that is effective in moistening soil and is not lost to runoff is only a fraction (only 50-63% for the data examined here) of the total precipitation that is received at a given location. Second, the reduction that is seen in the effective precipitation assessment, as compared to the total accumulated precipitation, is indicative of relatively large rainfall amounts in short time periods. If this precipitation had been delivered by long lasting, slow moving, synoptic scale precipitating systems, thus allowing infiltration rates to 'keep up' with precipitation rates, this reduction would not be as great. Third, this precipitation record also elucidates the spotty and pocketed nature of the precipitation itself. Similar to the earlier comparison of hourly precipitation amounts, cumulative (total) precipitation amounts show a difference of 3.75 inches between Lamar and Springfield, two locations separated by less than 50 miles. Further, a precipitation difference of more than 5 inches was recorded between Lamar, Colorado and Elkhart, Kansas. This disparity stands quite stark considering that during the 30 day period of examination Lamar received 5.15 inches of precipitation (24.5% of its yearly total of 20.99 inches) and Elkhart, only 85 miles away, received none at all.

This review of the precipitation record and the application of the considerations provided by soil science does well to support the idea that while rainfall does reduce the likelihood of blowing dust, the accumulated rainfall at a location is not the only component, nor is it a simple one, that should be taken into account when assessing the feasibility of a blowing dust events occurrence. As mentioned within the context of the type of precipitation that takes place, the location of exactly where the rain falls, or doesn't, can have a great impact on neighboring areas where precipitation quantities may be very different. It has been pointed out that great disparities in precipitation amounts are seen in the area of this exceedance, and that this is one element of the additional consideration(s) that must be applied to the assessment of this event. To properly determine the effect of this influence, an evaluation of the source location of the blowing dust must be completed.

For this task, the HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model was run using various input datasets (Stein et al. 2015; Rolph 2017). HYSPLIT uses meteorological data from sources of the user's choosing to re-create the airflow patterns within the models' predictions, originating at a specific place and time. HYSPLIT then outputs 3-dimensional trajectories, either forward or backward in time, based on the time, place, and height specified by the user. For this event HYSPLIT was run using the North American Model (NAM), the Global Data Assimilation System (GDAS), and the Eta Data Assimilation System (EDAS). The GDAS and EDAS consist of programs and algorithms that are at the heart of data ingest and population for the Global Forecast System (GFS) and the Eta (the predecessor to the North American Model, NAM) models respectively. Both of these systems ingest current weather data and act to 'find the best fit of both observational data and the model first-guess forecast' (Nelson 1999). Essentially, these data systems help to put data into each grid point, both horizontally and vertically, that is needed to run these meteorological forecast models. As implied in the description above, this 'initialization' process involves high level interpolation and assignment of data to each grid point within the model domain. Using these datasets, the motion of air is then recreated and depicted as it likely would have traveled at the time and place specified by the user. The trajectories conducted for this case are presented in Figure 12, which shows the trajectories in both a map view and a cross-sectional view, and Figure 10, which shows these trajectories overlaid on the map of accumulated precipitation.

Back-trajectories initialized at the Lamar Municipal Airport (KLAA) were run for the 6 hour period between 17:00-23:00 UTC (10:00-16:00 MST) to show likely areas of origin of air parcels arriving at KLAA around 4 PM MST on August 22nd, 2015. All three of these back trajectories show that the location of origin for this event were to the north-northeast of Lamar and either begin in, or traverse areas where precipitation totals were minimal. Furthermore, HYSPLIT trajectories can be run for different heights of the atmosphere, and for this case these heights were selected to be for parcels ending at 10, 100, and 500 m. In each of the three model depictions, the height analysis shows that parcels originated near the surface. This suggests that not only did the wind that carried dust to Lamar come from a location(s) that had received far less precipitation than Lamar, but also that these winds were able to loft parcels from near the surface to a height of at least 500 m, supporting further the implication that blowing dust was carried to the southwest, and into Lamar.

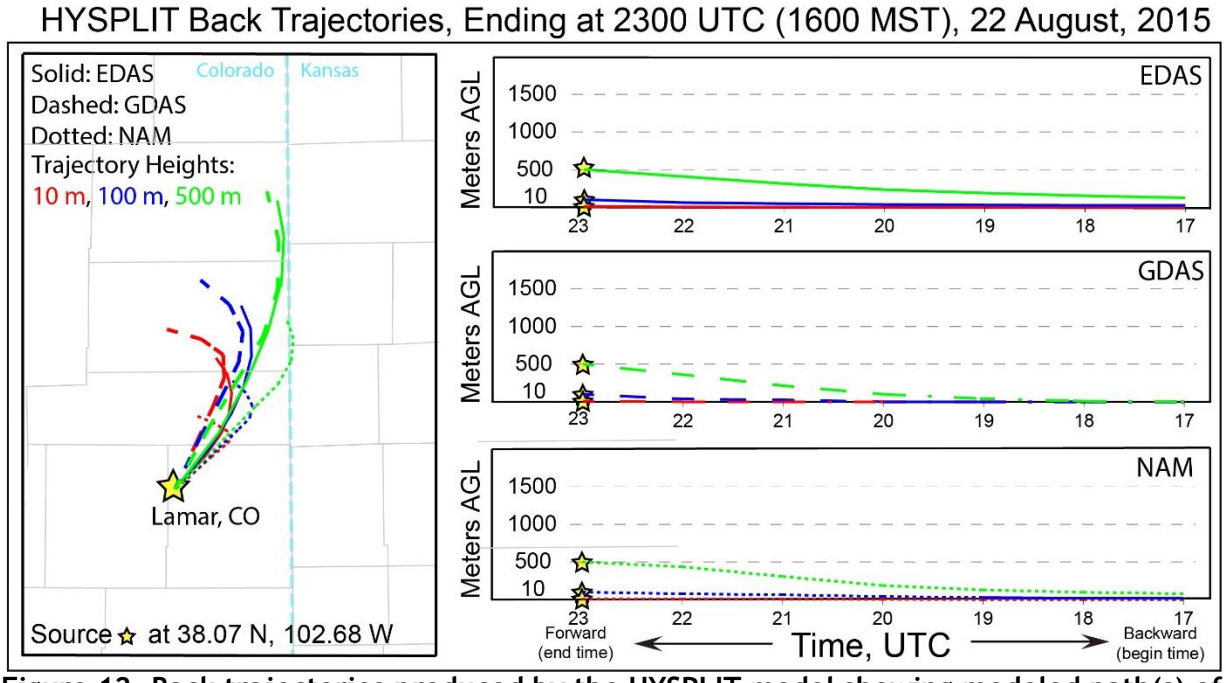

Figure 12. Back trajectories produced by the HYSPLIT model showing modeled path(s) of air parcels arriving at the Lamar Municipal Airport (KLAA) at 1600 MST (2300 UTC) on August 22, 2015.

Precipitation and soil infiltration products combined with back trajectories from southeast Colorado on August 22, 2015 clearly reveal that a dust storm occurred which was regional in scale and therefore not controllable or preventable.

3.0 Evidence-Ambient Air Monitoring Data and Statistics

On August 22, 2015, a powerful spring storm in southeast Colorado caused an exceedance of the twenty-four hour PM_{10} standard in Lamar, Colorado. The passing cold front resulted in intense surface winds resulting in significant blowing dust in the Lamar area. During this event a sample in excess of 150 $\mu g/m^3$ was recorded at Lamar Municipal Building (423 $\mu g/m^3$).

3.1 Historical Fluctuations of PM_{10} Concentrations in Lamar

This evaluation of PM_{10} monitoring data for sites affected by the August 22, 2015, event was made using valid samples from PM_{10} samplers in Lamar from 2011 through 2015; APCD has been monitoring PM_{10} concentrations in Lamar since 1985. The overall data summary for the affected site is presented in Table 9, with all data values being presented in $\mu g/m^3$:

Table 9: August 22, 2015, Event Data Summary

Evaluation	*Lamar Municipal*
08/22/2015	**423**
Mean	26.2
Median	19
Mode	11
St. Dev	43.4
Var.	1883.11
Minimum	2
Maximum	1220
Percentile	99.9%
Count	1783

Lamar Municipal – 08-099-0002
The PM_{10} sample on August 22, 2015, at Lamar Municipal of 423 $\mu g/m^3$ exceeds the 99th percentile value for all evaluation criteria and is the 2nd largest sample of the dataset. The only sample greater than the event sample is associated with a high wind event. There are 1,783 samples in this dataset. The sample of August 22 clearly exceeds the typical samples for this site.

Figure 13 and Figure 14 graphically characterize the Lamar Municipal PM_{10} data. The first, Figure 13, is a simple time series; every sample in this dataset (2011 - 2015) greater than 150 $\mu g/m^3$ is identified. Note the overwhelming number of samples occupying the lower end of the graph. Of the 1,783 samples in this data set slightly more than 1% are greater than 150 $\mu g/m^3$.

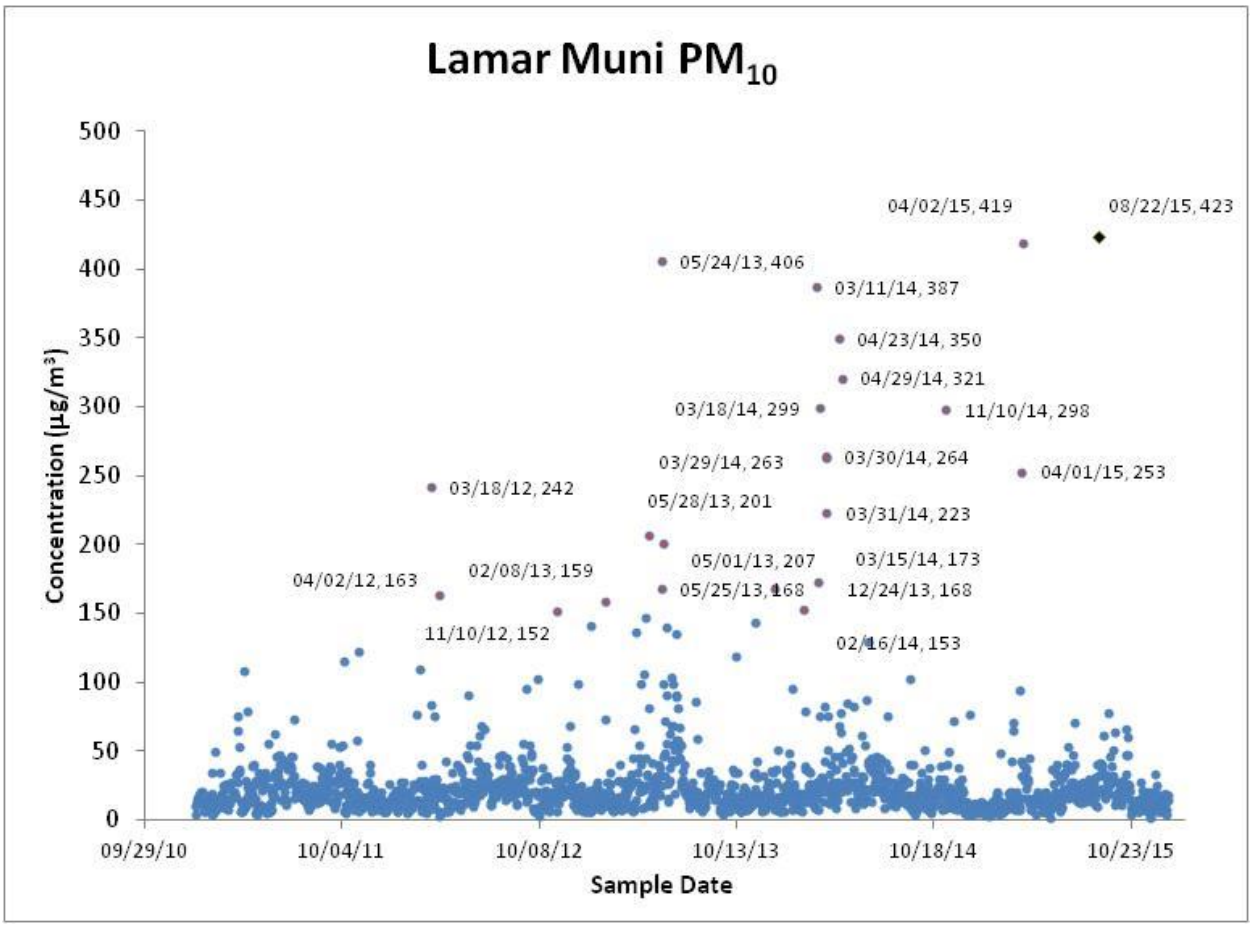

Figure 13: Lamar Municipal PM_{10} Time Series, 2010 - 2015

The monthly box-whisker plot in Figure 14 highlights the consistency of the majority of data from month to month. Note the greater variability (wider inner-quartile range) and greater range of the data through the winter and early spring months that's accompanied by typically greater monthly maxima. Recall, this time period experiences a greater number of days with meteorological conditions similar to those experienced on August 22, 2015. Although these high values affect the variability and central tendency (average) of the dataset they are not representative of what is typical at the site.

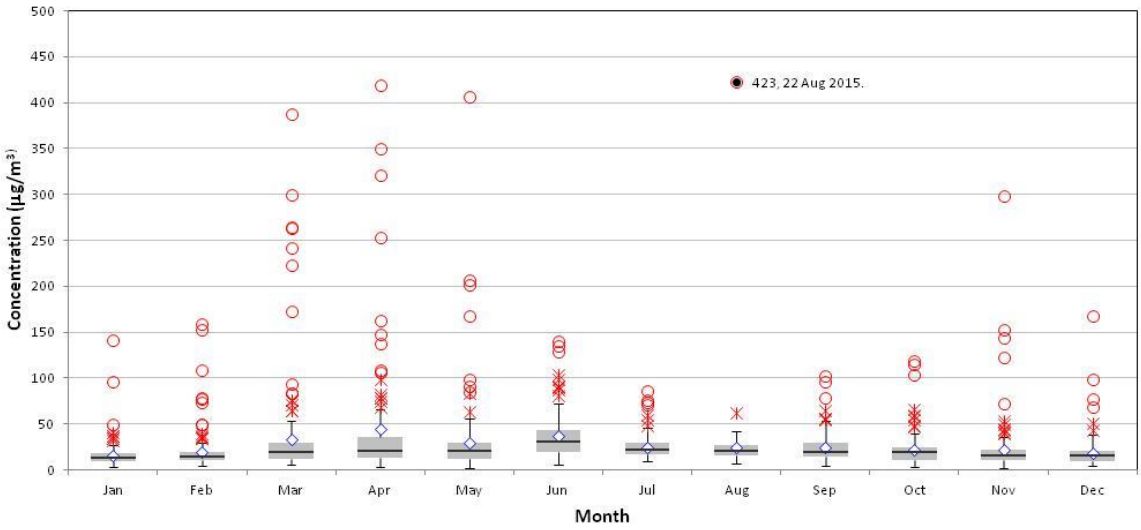

Figure 14: Lamar Municipal PM_{10} Box-Whisker Plot, 2010 - 2015

Note the degree to which the data in the months of fall through spring, beginning in October and extending through May, are skewed. The August mean (24.7 µg/m^3) is greater than the August median value (21.0 µg/m^3) and is greater than 63% of all samples in any August. The skew in the data is due to the presence of a handful of extreme values and can create the perception that those months experiencing these high wind events are somehow 'dirtier' than other months of the year. This data exposes that perception as flawed, typical data subject to local sources of variation are similar to every other month of the year. Figure 14 suggests that typical, day to day PM_{10} concentrations exposures for the months of June and September are highest among all months. The sample of August 22, 2015, clearly exceeds the typical data at this site.

3.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased late morning of August 22, 2015 and stayed elevated through the early morning of August 23, 2015, gusting to speeds in excess of 40 mph with sustained hourly averages exceeding 25 mph. The two charts in Figure 15 display wind speed (mph) as a function of date from meteorological sites within the Lamar area for a number of days before and after the event.

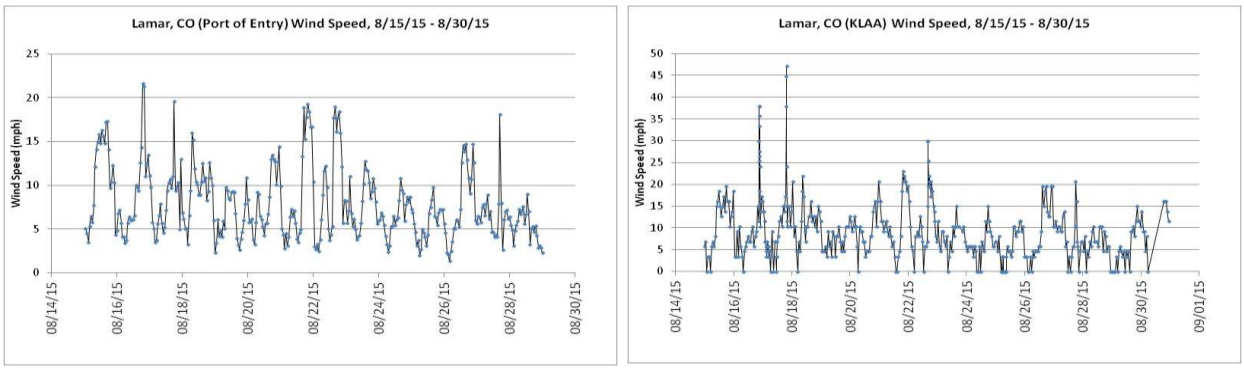

Figure 15: Wind Speed (mph) Lamar, CO, 08/15/2015 – 08/30/2015

Figure 16 plots PM_{10} concentrations from Lamar Municipal for the period for seven days prior to and following the sample of August 22, 2015.

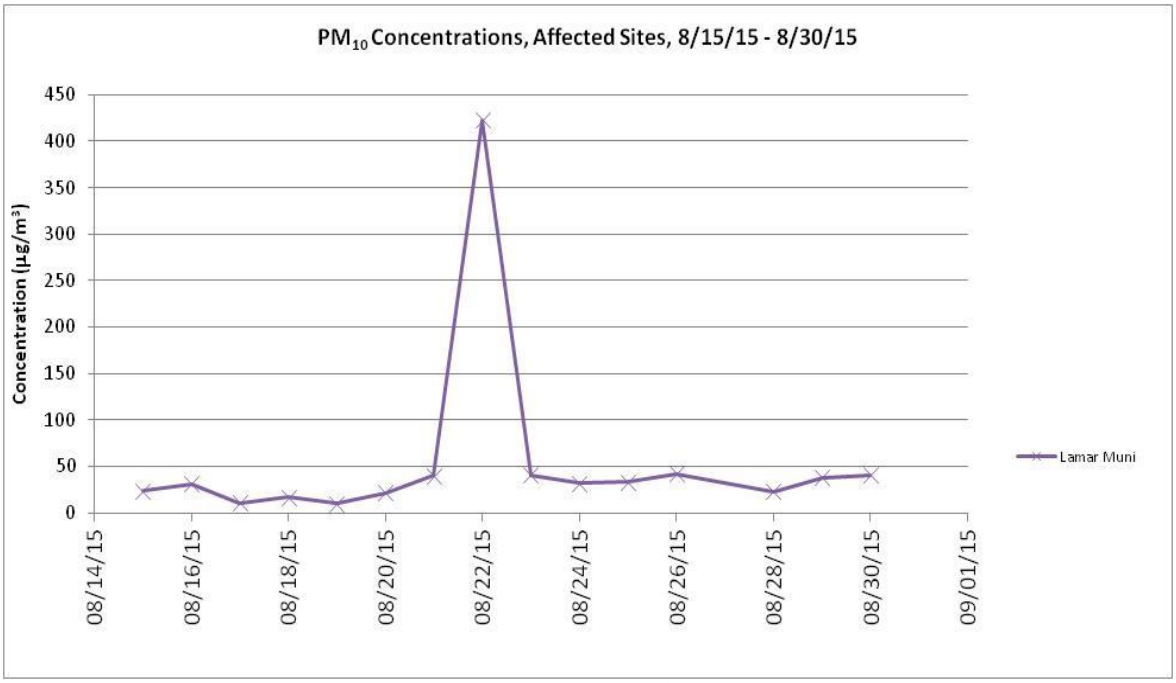

Figure 16: PM_{10} Concentrations, Lamar Municipal, 08/15/2015 – 08/30/2015

Figure 16 mimics the plots for wind speed, suggesting an association between the high winds and PM_{10} concentrations at the affected site, even to the extent the wind continued to blow through the early hours of August 22, 2015 contributing to that day's high sample of 423 $\mu g/m^3$ (exceeding the 99th percentile for the entire data set). Although the samples were affected to differing degrees by the high winds (possibly reflecting the variation in contribution from local sources) the elevated concentrations are clearly associated with the elevated wind speeds. The relationship between the two data sets would suggest that the regional high winds had an affect on PM_{10} samples in Lamar on August 22, 2015.

3.3 Percentiles

The monthly percentile plot in Figure 17 demonstrates a high degree of association between monthly median values and relatively high monthly percentile values, e.g. the Pearson's r value between the monthly 90th percentile value at Lamar Muni and the monthly median is 0.65. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

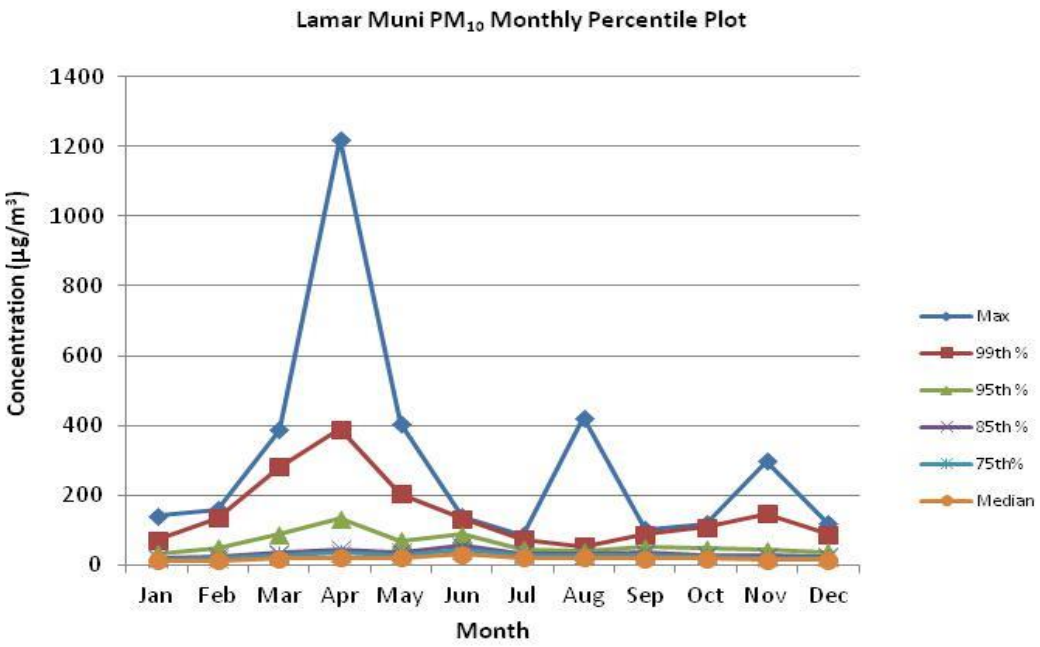

Figure 17: Monthly PM_{10} Percentile Plot, 2010 - 2015

It is certainly the case that monthly median values are indicative of typical, day to day concentrations. Additionally, there is a range of samples that are a product of normal variation subject to typical, day to day local effects. This range may be restricted to percentile values that are well correlated with the median. For the data set of concern a conservative estimate of the percentile value that is reflective of typical, day to day variation is the 75th percentile value. Nearly all of the variation in the monthly 75th percentile values of this data set can be explained by the variation in monthly medians; for Lamar Municipal the correlation between the median and monthly 75th percentile values is $r^2 = 0.9$. A reasonable estimate of the contribution to the event from local sources for this data set may be the monthly 85th percentile values the correlation between the median and the monthly 85th percentile values is $r^2 = 0.80$. If these percentile values are taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from these monthly percentile values would be the sample contribution due to the event.

Table 10 identifies various percentile values that are representative of the maximum contribution due to local sources from all August data (2009 – 2014). In Table 10 the range estimate in the 'Est. Contribution Above Typical' column is derived using the difference between the actual sample value and the 85th percentile as the minimum (reasonable) event contribution estimate and the difference between the actual sample value and the 75th percentile as the maximum (conservative) event contribution estimate. This column represents the range of estimated contribution to the August 22, 2015 Lamar Municipal sample due to the high wind event.

Table 10: Estimated Maximum Event PM_{10} Contribution, Lamar Municipal, 2009 - 2014

Site	Event Day Concentration ($\mu g/m^3$)	August Median ($\mu g/m^3$)	August Average ($\mu g/m^3$)	August 75th % ($\mu g/m^3$)	August 85th % ($\mu g/m^3$)	Est. Conc. Above Typical ($\mu g/m^3$)
Lamar Municipal	423	21.0	24.7	27	31	**392 – 396**

Clearly, there would have been no exceedance but for the additional contribution to the PM_{10} sample provided by the event.

4.0 News and Credible Evidence

NEWS

Dust storm causes multiple-vehicle crash on U.S. 287 near Lamar

By **ALICIA WALLACE** | awallace@denverpost.com
August 22, 2015 at 11:52 am

A dust storm late Saturday afternoon is blamed for a multiple-vehicle crash on U.S. 287 just south of Lamar, state patrol officials said.

The highway was closed in both directions between Lamar to Springfield from after 5 p.m. to 8:10 p.m., officials for the Colorado State Patrol and Colorado Department of Transportation said.

Four vehicles and at least one semi-truck were involved in the accident and one person was transported to the hospital, said Trooper Josh Lewis, of the Colorado State Patrol. Lewis said he did not know the extent of those injuries.

During the storm, visibility was less than 100 feet, Colorado State Patrol officials reported.

Earlier this year, a dust storm south of Lamar caused a seven-vehicle crash on U.S. 287 that killed two people and injured four others.

Alicia Wallace: 303-954-1939, awallace@denverpost.com or twitter.com/aliciawallace

Wallace, A. (2015, August 22). Dust storm causes multiple vehicle crash on U.S. 287 near Lamar. *Denver Post*. Retrieved from http://www.denverpost.com/2015/08/22/dust-storm-causes-multiple-vehicle-crash-on-u-s-287-near-lamar/

Colorado State Patrol. (2015, August 22). HWY 287 is closed both directions due to multiple crashes at milepost 69 caused by dust storm, visibility less than 100 FT. Retrieved from https://twitter.com/CSP_LaJunta/status/635228030416216065

Four Vehicle Pile Up on 287, Dust Closes Hwy S. of Lamar

archives.theprowersjournal.com/2015/08/four-vehicle-pile-up-on-287-dust-closes-hwy-s-of-lamar/

Russ Baldwin

The Colorado State Patrol is currently investigating a four-vehicle injury crash, which occurred on Colorado State Highway 287 near milepost 69.5, approximately 6.5 miles south of Lamar. The accident occurred shortly after 5pm on Saturday, August 22. A white 2000 Peterbuilt tractor trailer driven by Jose Ortiz a 43 year old Texas male collided with a red 1993 Toyota pickup that had a Toyota pickup in tow. The driver was Ramon Baudillio (44 year old male) from Guatemala. The red Toyota was then pushed into another Toyota pickup that was in tow by a 1994 gray Toyota pickup driven by Edgar Rodriguez also from Guatemala (48 year old male). The gray Toyota pickup was pushed into a white 2015 Fed Ex Peterbuilt tractor trailer driven by 36 year old James Benjamin from Texas.

All vehicles involved were traveling southbound on Hwy 287. All vehicles involved began to slow and or come to a stop due to high winds and low visibility due to blowing dirt. The 2000 Peterbuilt came to rest in the center of the southbound lane after the collision along with the 1994 gray Toyota pickup and its load. The red 1993 Toyota and its load came to rest in the west borrow ditch after rolling one time. The 2015 Fed Ex Peterbuilt was driven from the scene. Hwy 287 was closed both north and south bound during investigation and due to the adverse weather conditions for approximately two hours.

Limited View Of House West of Lamar in Dust storm

During the storm, visibility was less than 100 feet, Colorado State Patrol Officials reported. Earlier this year, a dust storm south of Lamar caused a seven-vehicle crash on U.S. 287 that killed two people and injured four others.

Semis in Fairgrounds Parking Lot, Waiting Out the Storm

Ramon Baudillio and Edgar Rodriguez were transported to Prowers Medical Center and treated for non-incapacitating injuries and minor injuries. All parties involved were properly using their seatbelts and alcohol or drugs is not suspected.

Baldwin, R. (2015, August 24). Four Vehicle Pile Up on 287, Dust Closes Hwy S. of Lamar. The *Prowers Journal*. Retrieved from: http://archives.theprowersjournal.com/2015/08/four-vehicle-pile-up-on-287-dust-closes-hwy-s-of-lamar/

5.0 Not Reasonably Controllable or Preventable: Local Particulate Matter Control Measures

While it is likely that some dust was generated within the local communities by gusts from the regional dust storms that passed through the area, the amount of dust generated locally was easily overwhelmed by, and largely unnoticeable as compared to the dust transported in from surrounding areas. The following sections will describe in detail the regulations and programs in place designed to control PM_{10} in each affected community. These sections will demonstrate that the events were not reasonably controllable, as laid out in Section 50.1(j) of Title 40 CFR 50, within the context of reasonable local particulate matter control measures. As shown from the meteorological and monitoring analyses (Sections 2 and 3), the source regions for the associated dust that occurred during the August 22 event in Lamar originated outside of the monitored areas.

The APCD conducted thorough analyses and outreach with local governments to confirm that no unusual anthropogenic PM_{10}-producing activities occurred in these areas and that despite reasonable control measures in place, high wind conditions overwhelmed all reasonably available controls. The following subsections describe in detail Best Available Control Measures (BACM), other reasonable control measures, applicable federal, state, and local regulations, appropriate land use management, and an in-depth analysis of potential areas of local soil disturbance for each affected community during the August 22 event. This information shall confirm that no unusual anthropogenic actions occurred in the local areas of Lamar during this time.

5.1 Regulatory Measures - State

The APCDs regulations on PM_{10} emissions are summarized in Table 11.

Table 11: State Regulations Regulating Particulate Matter Emissions

Rule/Ordinance	Description
Colorado Department of Public Health and Environment Regulation 1- Emission Control For Particulate Matter, Smoke, Carbon Monoxide, And Sulfur Oxides	Applicable sections include but are not limited to: Everyone who manages a source or activity that is subject to controlling fugitive particulate emissions must employ such control measures and operating procedures through the use of all available practical methods which are technologically feasible and economically reasonable and which reduce, prevent and control emissions so as to facilitate the achievement of the maximum practical degree of air purity in every portion of the State. Section III.D.1.a) Anyone clearing or leveling of land greater than five acres in attainment areas or one acre in non-attainment areas from which fugitive particulate emissions will be emitted are required to use all available and practical methods which are

	technologically feasible and economically reasonable in order to minimize fugitive particulate emissions.(Section III.D.2.b) Control measures or operational procedures for fugitive particulate emissions to be employed may include planting vegetation cover, providing synthetic cover, watering, chemical stabilization, furrows, compacting, minimizing disturbed area in the winter, wind breaks and other methods or techniques approved by the APCD. (Section III.D.2.b) Any owner or operator responsible for the construction or maintenance of any existing or new unpaved roadway which has vehicle traffic exceeding 200 vehicles per day in the attainment/maintenance area and surrounding areas must stabilize the roadway in order to minimize fugitive dust emissions (Section III.D.2.a.(i))
Colorado Department of Public Health and Environment Regulation 3- Stationary Source Permitting and Air Pollutant Emission Notice Requirements	Construction Permit required if a land development project exceeds 25 acres and spans longer than 6 months in duration (Section II.D.1.j) All sources with uncontrolled actual PM_{10} emissions equal to or exceeding five (5) tons per year, must obtain a permit. The new source review provisions require all new and modified major stationary sources in non-attainment areas to apply emission control equipment that achieves the "lowest achievable emission rate" and to obtain emission offsets from other stationary sources of PM_{10}.
Colorado Department of Public Health and Environment Regulation 4- New Wood Stoves and the Use of Certain Woodburning Appliances During High Pollution Days	Regulates wood stoves, conventional fireplaces and woodburning on high pollution days. Prohibits the sale and installation a wood-burning stove in Colorado unless it has been tested, certified, and labeled for emission performance in accordance with criteria and procedures specified in the Federal Regulations and meets emission standards. (Section II) Section III regulates pellet stoves. Section IV regulates masonry heaters. Section VII limits the use of stoves on high pollution days.

Colorado Department of Public Health and Environment Regulation 6- Standards of Performance for New Stationary Sources	Implements federal standards of performance for new stationary sources including ones that have particulate matter emissions. (Section I)
Colorado Department of Public Health and Environment Regulation 9- Open Burning, Prescribed Fire, and Permitting	Prohibits open burning throughout the state unless a permit has been obtained from the appropriate air pollution control authority. In granting or denying any such permit, the authority will base its action on the potential contribution to air pollution in the area, climatic conditions on the day or days of such burning, and the authority's satisfaction that there is no practical alternate method for the disposal of the material to be burned. Among other permit conditions, the authority granting the permit may impose conditions on wind speed at the time of the burn to minimize smoke impacts on smoke-sensitive areas. (Section III)
Colorado Department of Public Health and Environment- Common Provisions Regulation	Applies to all emissions sources in Colorado When emissions generated from sources in Colorado cross the state boundary line, such emissions shall not cause the air quality standards of the receiving state to be exceeded, provided reciprocal action is taken by the receiving state. (Section II A)
Federal Motor Vehicle Emission Control Program	The federal motor vehicle emission control program has reduced PM_{10} emissions through a continuing process of requiring diesel engine manufacturers to produce new vehicles that meet tighter and tighter emission standards. As older, higher emitting diesel vehicles are replaced with newer vehicles; the PM_{10} emissions in areas will be reduced.

5.2 Lamar Regulatory Measures and Other Programs

Natural Events Action Plan (NEAP)

In response to exceedances of the PM_{10} NAAQS (two in 1995 and one in 1996), the APCD, in conjunction with the City of Lamar's Public Works Department, Parks and Recreation, and Prowers County Commissioners, the Natural Resources Conservation Services, the Burlington Northern Santa Fe Railroad, and other agencies developed a Natural Events Action Plan. That Plan was presented to EPA in 1998 and subsequently approved. Since 1998, it is this plan that has assisted the area in addressing blowing dust due to uncontrollable winds.

The most recently updated NEAP for High Wind Events in Lamar, Colorado was completed in 2012. The NEAP addresses public education programs, public notification and health advisory

programs, and determines and implements Best Available Control Measures (BACM) for anthropogenic sources of windblown dust in the Lamar area. The City of Lamar, Prowers County, the APCD, and participating federal agencies worked diligently to identify contributing sources and to develop appropriate BACM as required by the Natural Events Policy.

Please refer to the 2012 Revised Natural Events Action Plan For High Wind Events, Lamar, Colorado at http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=LamarNaturalEventsActionPlan2012.pdf for more detail if needed.

Control Measures from the December 2012 Maintenance Plan

Control of Emissions from Stationary Sources
Although there are few stationary sources located in the Lamar attainment/maintenance area, the State's comprehensive permit rules listed in Table 11 will limit emissions from any new source that may, in the future, locate in the area.

The EPA approval of the original PM_{10} Maintenance Plan, effective on 11/25/2005, reinstates the prevention of significant deterioration (PSD) permitting requirements in the Lamar Attainment/Maintenance area. The federal PSD requirements apply to new or modified major stationary sources which must utilize "best available control technology" (BACT).

Federal Motor Vehicle Emission Control Program (FMVECP)
The FMVECP has reduced PM_{10} emissions through a continuing process of requiring diesel engine manufacturers to produce new vehicles that meet tighter and tighter emission standards. As older, higher emitting diesel vehicles are replaced with newer vehicles through fleet turnover; tailpipe PM_{10} emissions in the Lamar area will be further reduced.

Voluntary and State-Only Measures
Additional activities in Lamar that result in the reduction of PM_{10} emissions include:

- The City of Lamar has historically cleaned their streets in town throughout the winter and spring using street sweepers. The frequency of this voluntary effort is determined by weather. In October 2013, the Public Works Director informed APCD that the streets are swept on a weekly basis unless there is snow on the streets.
- The City of Lamar and immediately surrounding areas require that new developments have paved streets. The City's Planning Commission has been working on making this an official city ordinance. In the past, it has been required despite the lack of official rule.

State Implementation Plan Measures
Any owner or operator responsible for the construction or maintenance of any existing or new unpaved roadway which has vehicle traffic exceeding 200 vehicles per day in the Lamar attainment/maintenance area and surrounding areas must stabilize the roadway in order to minimize fugitive dust emissions. These statewide requirements are defined in detail in the AQCC's Regulation No. 1 as listed in Table 11.

City of Lamar

The City of Lamar has been very proactive in addressing potential PM_{10} sources within the Lamar area including the application of grass turf at baseball fields, implementing and enhancing a street sweeping program, and chip-seal paving of many unpaved roads. The City of Lamar Public Works Department has implemented the following BACM controls within the area:

1. *Wind Break*
Beginning in the spring of 1997, a wind break of trees was planted north of the Power Plant monitoring site (080990001). The Russian Olive tree wind break is located approximately one half mile north of the Power Plant monitoring site and will block potential contributing blowing dust sources such as the Lamar Transfer Station and other unpaved equipment traffic areas to the north. The Russian Olive is a quick growing large shrub/small tree that thrives despite the semi-arid and windy climate of Lamar. In October 2013, the Public Works Director stated that most of the trees were still alive and in place. According to section 3.5.2.1 of EPA guidance entitled "*Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures*", dated September 1992, one-row of trees is considered an effective windbreak.

In addition to the plantation of tree wind breaks, a drip irrigation system has been installed to promote sustained tree growth. In October 2013, the Public Works Director stated that the drip system was still operational but due to the drought the City has been on strict water restrictions.

2. *Landfill Controls*

The East Lamar Landfill is located approximately six (6) miles east of the city limits. The landfill has a CDPHE Permit (#09PR1379) which specifies that visible emissions shall not exceed twenty percent (20%) opacity during normal operation of the source and that fugitive PM_{10} cannot exceed 5.77 tons per year. The permit also contains a Particulate Emissions Control Plan that states that:

- No off-property transport of visible emissions shall apply to on-site haul roads.
- There shall be no off-property transport of visible emissions from haul trucks.
- All unpaved roads and other disturbed surface areas on site shall be watered as often as needed to control fugitive particulate emissions.
- Surface area disturbed shall be minimized.
- Exposed land areas to be undisturbed for more than six months shall be revegetated.

According to section 3.5.1 of the "Operations and Closure Plan for the East Lamar Landfill", the Director of the Public Works Department and/or the landfill operator is required to do the following litter control measures under high wind conditions:

- Soil cover is required to be placed on the working face of the landfill daily during periods of wind in excess of 30 mph; and,
- The landfill must be closed down when sustained winds reach 35 mph or greater.

An on-site wind gauge monitors wind speed at the landfill. Operators have radios in their equipment connecting them with the main office so that when the decision to close the

landfill is made, it can take place immediately. According to the Director of Public Works, landfill operators have been directed to close the landfill at their discretion. Because trash debris (paper) begins to lift and blow into the debris fences at wind speeds of 25 to 30 mph, the operator usually closes the landfill prior to wind speeds reaching 30 mph. The City of Lamar has agreed to make the closure of the Lamar landfill mandatory when wind speeds reach 30 mph, which reduces windblown dust from the landfill as earth moving activities are reduced or eliminated during periods of shut down. In October 2013, the Public Works Director stated that all of these practices are still enforced.

In addition, the placement of chain link fencing and various debris fences have been added to the previous litter entrapment cage. These additional fences better minimize the release of materials during high wind conditions. The Public Works Director stated that this is a dynamic process; as the debris moves, the fences are moved too.

3. *Vegetative Cover/Sod*

The Lamar Recreation Department installed 100,000 square feet of turf sod at a recreational open space called Escondido Park in the early 2000s. Escondido Park is located in northwest Lamar at 11th and Logan Streets. A sprinkler system has also been installed by the Parks and Recreation Department. The sod provides a vegetative cover for the open area. This dense turf cover provides an effective control against windblown soil from the open area of the park.

In addition, the Lamar Public Works Department stabilizes the entrance road leading to and from Escondido Park with chemical soil stabilizer and chip-seal to reduce dirt tracked out onto city streets and minimize additional releases of PM_{10}. This is done on an as needed basis.

4. *Additional Public Works Projects*

The Public Works Department implemented the following projects to further reduce emissions of PM_{10}:

- The purchase of a TYMCO regenerative air street sweeper (May 2001) which is much more effective in reducing dust during street sweeping activities. The use of this sweeper allows for improved cleaning of the streets (e.g., sweeps the gutter and street);
- The fencing of an area around the City Shop at 103 North Second Street in 2011 to reduce vehicle traffic that may be responsible for lifting dust off of the dirt area between the railroad tracks and the City Shop;
- The stabilization of a large dirt and mud hole in 2008 on the north side of the City Shop by installing a curb and gutter that allows for better drainage. This project is credited with keeping mud from being tracked out into the street and becoming airborne by vehicular traffic;
- The ongoing commitment to search for other stabilization projects that benefit the community and improve area air quality, and;
- The relocation of the Municipal Tree Dump in the early 2000s (formerly located in the northeastern corner of the city) to approximately six miles east of the city (now housed at the Municipal Landfill). This relocation eliminates a major source of smoke from agricultural burns that may have previously affected the community.

Regulatory Measures - City

Lamar has an ordinance that requires that all off-street parking lots shall have a dust-free surface to control PM_{10} emissions (City of Lamar Charter and Code, ARTICLE XVII, Sec. 16-17-60).

Burlington-Northern/Santa Fe Rail Line

The rail line running east-west of the Lamar Power Plant monitoring site was deemed to be an important PM_{10} source during conditions of high winds and low precipitation. Ground disturbance from vehicle traffic, which damages vegetation and breaks-up the hard soil surfaces, resulted in re-entrainment of dust from traffic, high winds or passing trains. This area is problematic in the two block area immediately west of the Power Plant monitoring site as shown in Figure 19 as Site F. Control of this open area requires a close working agreement between the Burlington-Northern/Santa Fe Railroad Company (BNSF) and the City of Lamar Public Works Department. The purpose of this BACM is to reduce the amount of particulate matter susceptible to wind erosion under high wind conditions and general re-entrainment of dust in the ambient air as a result of local train traffic passing in close proximity of the PM_{10} monitor.

In September 1997, the City chemically stabilized exposed lands north of the rail line between Fourth and Second Street where there was evidence of vehicle traffic. All other lands on either side of the rail road tracks between Main Street (Fifth) and Second Street and extending westward have either natural, undisturbed ground cover or it is used for commercial/recreation purposes that do not allow for significant re-entrainment (BNSF is responsible for maintaining 50 feet of property on either side of the main track). Most of these lands are leased by the City. After September 1997, the City negotiated the lease of these lands. Once acquired, a long term plan will be developed for these lands such as restricting vehicle access, permanently stabilizing lands with vegetation and gravel, increasing park and recreational use, and using the lands for city maintenance and storage activities. In October 2013, the Public Works Director stated that gravel was periodically added to minimize blowing dust.

According to the Manager of Environmental Operations for BNSF, the railroad company owns the main rail line and 200 feet on either side of the track. Much of this property has been sold or leased under private contracts. At this time BNSF is responsible only for the main rail line and for 50 feet of property on either side of the main track. All property sold or under contract is not the responsibility of BNSF. As a result, BNSF has stabilized the railroad corridor 50 feet on either side of the main rail line.

In May 1997, BNSF placed chips (gravel) 50 feet on either side of the main track from Main Street to Second Street (three blocks) to control fugitive dust emissions from this section of the track. Graveling exposed surfaces not exposed to regular vehicle traffic is considered a permanent mitigation measure. Details of this arrangement can be found in the documentation under the 1998 SIP Maintenance Plan submittal.

<u>Prowers County</u>

Prowers County Land Use Plan:

Beginning in 1997, Prowers County with the assistance of local officials, environmental health officers and the general public began preparing a county land use plan. The Prowers County Land Use Plan is designed to have wide-reaching authority over the myriad of land use issues involving building (construction sites), siting, health, fire, environmental codes, and other social concerns associated with the City of Lamar and Prowers County. The county land use plan, entitled "*Guidelines and Regulations for Areas and Activities of State Interest – County of Prowers – State of Colorado*", was adopted on April 19, 2004 and amended on August 17, 2006. The plan incorporates provisions to minimize airborne dust including re-vegetation of disturbance areas associated with land development. The Prowers County Land Use Master Plan can be found on the County's website at: http://www.prowerscounty.net.

Regulations and ordinances of the Land Use Plan specific to reducing blowing dust and its impacts include:

- Additional regulations on development of fragile lands and vegetation to protect topsoil;
- Development of performance standards and best management practices to prevent soil erosion;
- Development of best management practices to reduce blowing sands and movement of area sand dunes across the county;
- Development of new special use permits to address the siting of animal feedlots and feed yards;
- Development of special use permits for other future stationary sources. The special use permits will also likely include the requirement for comprehensive fugitive dust control plans for both construction and operation of facilities;
- Consideration and review of enforcement capabilities through the area zoning ordinances, and;
- Planned public review and comment processes following the legal update of the draft County Land Use Plan.

Windblown Dust from Disturbed Soils

The City of Lamar is located in Prowers County in southeastern Colorado. Situated along the Arkansas River and near the Kansas border, Lamar serves as the largest city and the agricultural center for southeast Colorado. The area surrounding Lamar consists of gently rolling to nearly level uplands where the dominant slopes are less than 3 percent. The climate is generally mild and semiarid. Annual precipitation is about 15 inches. Summers are long and have hot days and cool nights. In winter and spring, windstorms are common, especially in drier years. It is due to these high velocity dust storms and drought conditions that Lamar experiences most of the PM_{10} problems for the area. Figure 18 through Figure 33 illustrate potential areas of local soil disturbance that have been evaluated by the APCD for the Lamar Municipal PM_{10} monitor (08-099-0002).

5.3 Potential Areas of Local Soil Disturbance North of Lamar

Figure 18: North of Lamar Municipal PM_{10} monitor and wind direction. (Google Earth 2012)

Figure 19: Relative positions of Lamar Municipal PM_{10} Monitor and potential disturbed soil (~1 mile distance). (Google Earth 2012)

Site A in Figure 19 is owned by "Heath & Son & Turpin Trucking", a company that repairs large trucks and shared with "HVH Transportation Inc", a freight service trucking company. This site consists of well maintained gravel. The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, is in an economic recession, and is owned by multiple small businesses to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site B in Figure 19 is shared by a few businesses. All businesses have restricted access by fences surrounding the property. "Cowboy Corral Storage" at 102 North 4th Street is one of the businesses on the lot. It has a very small gravel parking lot and is no longer in business according to the previous owner in October 2013. The storage company has a small gravel parking lot with access being restricted by a security fence as shown in Figure 20. The lot is also shared with the "Prowers Area Transit" county bus garage. The bus garage is very small, only four bays. The garage has a concrete slab that runs to the asphalt road to avoid the

buses driving on the gravel in order to mitigate fugitive dust. The gravel lot is watered on an as needed basis. The other business is an old feed supply company with grain storage as shown in Figure 21. The feed supply company is out of business and the grain elevators are not being utilized. The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, is in an economic recession, and is owned by multiple small businesses to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 20: Site B - Cowboy Corral Storage (Google Image 2012)

Figure 21: Site B - Feed Storage Company (Google Image 2012)

Site C in Figure 19 is at about 201 N 2nd Street. The gravel parking lot on site is owned by "Heath & Son & Turpin Trucking" and is shown in Figure 22. The lot is used to store trucks

when not in use. This site consists of well maintained gravel. The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, and is in an economic recession to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 22: Site C - Heath & Son & Turpin Trucking Storage Lot (Google Image 2012)

Site D in Figure 19 is the "Lamar Water Department". Also on site D is the "Lamar-Prowers County Volunteer Fire Department" at 300 E Poplar Street. Both sites have restricted access with security fences. The City of Lamar maintains their gravel lots by grating and watering them on an as needed basis. The APCD considers maintained gravel, limited access, grating, and watering to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years and is in an economic recession to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site E in Figure 19 is the power plant. "Lamar Light and Power" historically operated a natural gas-fired boiler that produced steam for a 25 MW turbine/generator set. This boiler was constructed prior to 1972 and was grandfathered from construction permitting requirements. In the early 2000s, factors such as increasing costs of natural gas made the plant uneconomical to run. As a result, Lamar Light and Power purchased power and ran the natural gas-fired boiler very infrequently or not at all. In February 2006, APCD issued a permit for Lamar Light and Power to replace the existing natural gas-fired boiler with a coal-fired circulating fluidized bed (CFB) boiler rated at approximately 42 MW. The conversion prompted legal challenges from Lamar residents partnered with WildEarth Guardians, a New Mexico-based environmental group. Lamar Light and Power settled and agreed to shut down the coal-fired power plant. The power plant was shut down on November 11, 2011. The settlement also calls for the plant to stay offline until at least 2022, when the current agreement to supply electricity to Lamar and other communities expires.

"Lamar Light and Power" has an air quality permit (CDPHE # 05PR0027). The permit includes the following point and fugitive dust control measures:

- Limestone and ash handling, processing, and storage are controlled by high efficiency baghouses

- Water wash-down-systems are used for flushing down any accumulated dust on walkways, platforms, and other surfaces to prevent re-entrainment of the dust into the atmosphere.
- On-site haul roads are paved, and these surfaces are inspected at least once each day in which hauling activities occur, and cleaned as needed. Various cleaning methods are used depending on the extent of dust accumulations. These activities emit less than 1 ton per year of PM_{10} and are APEN Exempt.
- All transport vehicles containing substances that potentially generate fugitive particulate matter emissions (such as trucks containing limestone, inert material, or ash) are fully enclosed, or covered with a mechanical closing lid or a tight tarp-like cover at all times while on the facility grounds except during loading / unloading operations.
- Emissions from emergency coal stockpile are effectively controlled with a water dust suppression system.

Access to the power plant is restricted by security fences. The APCD considers the enforceable conditions of the permit, including identified Best Available Control Technology (BACT) for limestone and ash handling, paving, wash-down systems, and enclosures, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site. The winds speeds during the 2015 events did exceed the blowing dust thresholds of 30 mph or greater and gusts of 40 mph or greater at which the APCD expects stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed.

Site F in Figure 19 is the Burlington Northern Santa Fe railroad. On either side of the rail road tracks is gravel as shown in Figure 23. In May 1997, Burlington Northern Santa Fe placed chips (gravel) 50 feet on either side of the main track from Main Street to Second Street (three blocks) to control fugitive dust emissions from this section of the track. Graveling exposed surfaces not exposed to regular vehicle traffic is considered a permanent mitigation measure. Also, all the train tracks are raised up on 3 inch diameter rock and tracks. Areas that are not used by the railroad are allowed to be naturally vegetated with Xeriscape. With regard to AQCC Regulation 1 requirements (Section III.D), the APCD considers gravel and 'Xeriscape' vegetation to be the appropriate available and practical method that is technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this type of source.

Figure 23: Site F - Railroad tracks with gravel on each side (Google Image 2012)

Site G in Figure 19 is Colorado Mills LLC a facility that produces sunflower oil and processes the leftover solids combined with grains and additives into feed that used locally for cattle and hogs. APDC issued the initial permit 95PR622 for this facility in 1996 to Cargill, Inc. A final approval permit and two transfers of ownership have since been issued in 1997, 1999 and 2000 respectively and the facility is now owned and operated by Colorado Mills, LLC. The permit includes the following point and fugitive dust control measures:

- Visible emissions shall not exceed 20% opacity during normal operations and 30% opacity at all other times.
- Permit limits on Particulate Matter.
- Requirement to follow the developed Operation and Maintenance plan.

This facility was inspected by the APCD on 2/14/2012 and no visible emissions were observed. Records review revealed that Colorado Mills has been in compliance with their permitted emission limits. An Operating and Maintenance Plan was submitted to the APCD for this facility on November 21, 1996 and approved by the APCD on December 24, 1996. The General Manager of the facility stated during the inspection that Colorado Mills conducts monthly inspections and maintenance on process and control equipment at the facility and no evidence was observed during the inspection to suggest that process and control equipment at the facility are not operated and maintained in a manner consistent with good air pollution control practices for minimizing emissions. Additionally, particulate emissions from oil extraction activities, grinding of grains, extruding and materials conveyance are controlled by several cyclones. The APCD considers the enforceable conditions of the permit, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site.

Site H in Figure 19 is located at about 356 South 4th Street. Part of the property is owned by Century Link. Century Link has a storage lot for fleet vehicles that is well maintained gravel. Access to the storage lot is restricted by a fence as shown in Figure 24. A large part of site H is a free public gravel parking lot for the Prowers County Jail and the Prowers County

Municipal Court as shown in Figure 25. The lot is maintained by the County. The parking lot is chip sealed and covered in crushed gravel. As shown in Figure 24, site H has reasonable dust control measures in place with regard to AQCC Regulation 1 requirements (Section III.D.1(a)). The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, is in an economic recession, and is owned by multiple businesses to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 24: Site H - Century Link Fleet Storage Lot (Google Image 2012)

Figure 25: Site H - Parking lot for the Prowers County Jail and the Prowers County Municipal Court (Google Image 2012)

Site I in Figure 19 is located to the north of the Lamar PM_{10} monitor on the northeast corner of Washington St and 4th St. Site I is at 310 E Washington Street. The site used to be "Big R Warehouse" but is currently owned by Prowers County and is rented out to the Colorado State Patrol for office space. The lot is covered in gravel for dust suppression, drainage, and erosion control. Within the lot, vehicle speeds are restricted to 5 mph. Access to the lot is restricted by a chain link fence. The lot is watered on an as needed basis. Site I, as shown in Figure 26, has reasonable dust control measures in place with regard to AQCC Regulation 1 requirements (Section III.D.1(a)). The APCD considers restricted vehicle speeds in combination with maintained gravel and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 26: Site I - 310 E. Washington St. (Google Image 2012)

Site J in Figure 19 is "Ranco", a heavy duty construction trailer manufacturing company located at 700 Crystal St. All of the property owned by Ranco is covered in pavement, gravel, or natural vegetation. The company informed CDPHE that there are no unnatural, disturbed, areas of dirt on the property that could contribute to the issue of blowing dust. The APCD considers pavement, maintained gravel, natural vegetation, and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site K in Figure 19 is Valley Glass, located at 201 East Washington Street. Valley Glass does commercial and residential glass work including storefronts, windows, siding and railings. The property has restricted access and a well maintained gravel parking area, as shown in Figure 27. The APCD considers pavement, maintained gravel, natural vegetation, and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 27: Site K - Valley Glass, 201 E. Washington St. (Google Image 2012)

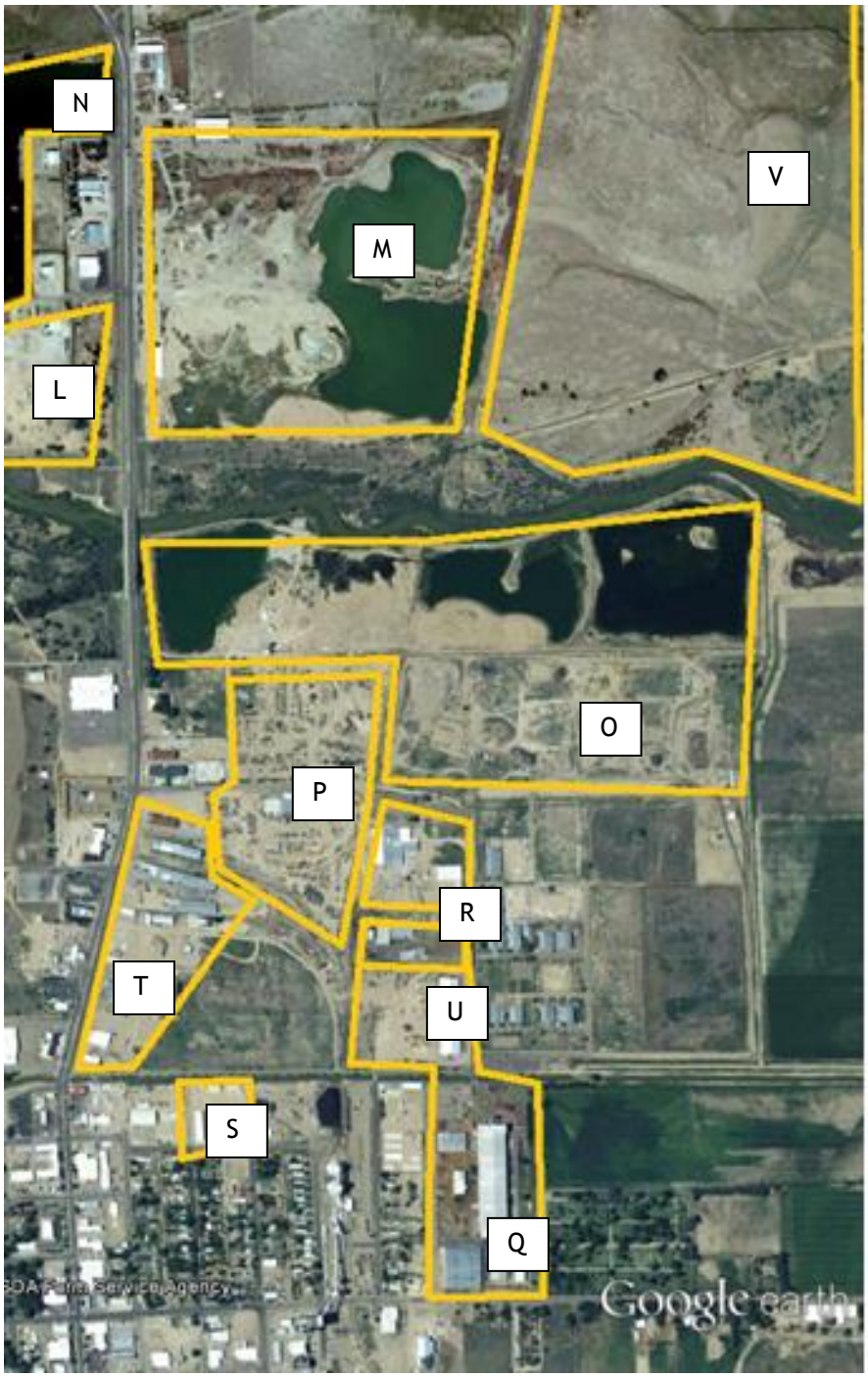

Figure 28: Relative positions of Lamar Municipal PM_{10} Monitor and potential disturbed soil (~2 mile distance). (Google Earth 2012)

Site L in Figure 28 is "All-Rite Paving and Redi-Mix Inc" at 200 Speculator Ave. This is a concrete batch plant with a permit from CDPHE (#12PR1396). However, this facility is considered APEN exempt and emits less than 1 ton per year of PM_{10}. This facility has a particulate matter baghouse collection efficiency of 99%. Water spray and magnesium chloride is used on storage piles and all unpaved roads as needed. The unpaved roads at site L are covered with gravel and the vehicle speed is restricted to 10 mph at all times. The

transfer of aggregate to storage bins and trucks is entirely conducted in enclosed areas. All aggregate is washed prior to storage in order to reduce dust emissions. The APCD considers the enforceable conditions of the permit, including identified continuous controls such as gravel roads with miles per hour restrictions and enclosures, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site.

Site M in Figure 28 is mined by "Carder Inc" for sand and gravel, primarily for road construction. This site has a permit from CDPHE (#99PR0180F) and emits approximately 15 tons per year of PM_{10}. This is a wet mining operation so it produces minimal fugitive dust. The dust control measures that are part of the permit include watering the disturbed area as needed, re-vegetation within one year of disturbance, compacting of piles, mining moist materials, vehicles cannot exceed 10 mph on site at all times, and temporary roads are covered with gravel and watered as needed. The APCD considers the enforceable conditions of the permit, including identified continuous controls such as gravel roads with miles per hour restrictions, compaction, re-vegetation, watering, and extraction limitation, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site.

Site N in Figure 28 are rotating crop fields located south and west of U.S. Highway 287/U.S. Highway 50. As shown in Figure 29 and Figure 30, the crops in these fields are rotated from year to year, allowing fields to lay fallow between plantings.

Figure 29: Site N - Rotating crop fields, 6/2005. (Google Earth 2005)

Figure 30: Site N - Rotating crop fields, 8/2011. (Google Earth 2011)

Site O in Figure 28 is mined by "All-Rite Paving and Redi-Mix Inc" at 1 Valco Road. This is a concrete batch plant with a permit from CDPHE, (#85PR108). However, this facility is considered APEN exempt and emits less than 1 ton per year of PM_{10} This facility has a PM baghouse collection efficiency of 99%. Visible emissions from this source shall not exceed 20% opacity. Water sprays and magnesium chloride are used on storage piles and all unpaved roads as needed. The unpaved roads at site O are covered with gravel and the vehicle speed is restricted to 10 mph at all times. The transfer of aggregate to storage bins and trucks is entirely conducted in enclosed areas. All aggregate is washed prior to storage in order to reduce dust emissions. Access to the site is restricted by a fence. The APCD considers the enforceable conditions of the permit, including identified continuous controls such as gravel roads with miles per hour restrictions and enclosures to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site. Additionally, the City of Lamar took over the concrete plant in the spring of 2013 and is in the process of reseeding it and turning the site into a park for fishing and wildlife with motorized vehicles being prohibited. The City of Lamar and the Division of Wildlife are partners in this effort.

Site P in Figure 28 is "Ranchers Supply Co., Inc." at 400 Crystal Street. The company started in 1961 and their products include used trucks, construction equipment, military vehicles, new and used trailers and other government surplus items. The property is used for inventory storage. To control fugitive dust emissions, onsite vehicle speeds are restricted to 10 mph. The owner states that 90% of the lot is covered in well maintained gravel. The site is watered down on an as needed basis to mitigate dust to protect assets and for pollution prevention. Also, all of the large equipment also acts as a wind block. Access to the site is restricted by a security fence. Site P, as shown in Figure 31, has reasonable dust control measures in place with regard to AQCC Regulation 1 requirements (Section III.D.1(a)). The APCD considers restricted vehicle speeds in combination with maintained gravel to be the appropriate available and practical method that is technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this storage site.

Figure 31: Site P - Ranchers Supply Co., Inc. (Google Image 2012)

Site Q in Figure 28 is "Ranco", a heavy duty construction trailer manufacturing company located at 700 Crystal Street. All of the property owned by Ranco is pavement, gravel, or natural vegetation. The company informed APCD that there are no unnatural, disturbed, areas of dirt on the property that could contribute to the issue of blowing dust. The APCD considers pavement, maintained gravel, natural vegetation, and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site R in Figure 28 is "C.F. Maier Composites Inc" at 500 East Crystal Street. This 57,000 square foot facility has been operating since 1990 and specializes in highly difficult fiber reinforced composites and OEM component application. C.F. Maier offers product design, development, prototype and full production of reinforced composite parts for high stress or high impact uses. The company has a paved parking lot. The rest of the lot is covered in natural vegetation. There is a short (200 ft.) well maintained gravel road that leads up to the loading dock that gets used on average one a day. Site R, as shown in Figure 28, has reasonable dust control measures in place with regard to AQCC Regulation 1 requirements (Section III.D.1(a)). The APCD considers restricted maintained gravel and natural vegetation to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site S in Figure 28 is on the northeast corner of Washington Street and 4th Street at 201 E. Washington Street. The site used to be "Big R Warehouse" but is currently owned by Prowers County and is rented out to the Colorado State Patrol for office space. The lot is covered in gravel for dust suppression, drainage, and erosion control. Within the lot, vehicle speeds are restricted to 5 mph. Access to the lot is restricted by a chain link fence. The lot is watered on an as needed basis. As shown in Figure 28, Site S has reasonable dust control measures in place with regard to AQCC Regulation 1 requirements (Section III.D.1(a)). The APCD considers restricted vehicle speeds in combination with maintained gravel and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site T in Figure 28 is Lamar Feed and Grain – White Stone Farms located at 110 Anderson Street. The facility consists of a grain receiving pit, a grain shipping truck loadout station, grain storage, a grain cleaning scalper, and grain handling and milling systems. In November 2000, APCD issued the initial permit for this source (00PR0431) and at the time of this event, Lamar Feed and Grain, LLC was operating under the Final Approval permit issued on 7/21/2006. The permit includes the following point and fugitive dust control measures:

- Total PM, PM_{10} and $PM_{2.5}$ annual emissions limitations.
- Visible emissions cannot exceed 20%.
- All equipment must be maintained and operated in a manner consistent with good air pollution control practices for minimizing emissions.
- The feed mill must be equipped with a mineral oil spray system for the control of PM emissions.

The APCD considers the enforceable conditions of the permit, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site.

Site U in Figure 28 is Dragon ESP, located at 700 East Crystal Street. This equipment manufacturing facility commenced operation in 1993 and was combined with the Ranco Trailers facility in 2011. The APCD issued a joint permit for these facilities (08PR0603) on 12/21/2011 which consist of paint booths and abrasive blasting units. The permit includes the following point and fugitive dust control measures:

- Permitted annual TSP, PM_{10} and $PM_{2.5}$ emission limits
- High Volume Low Pressure paint spray guns or other APCD-approved surface coating method must be used to meet PM emission limits

- Paint spray booths shall be equipped with exhaust filters or paint arresters to control PM emissions and shall be maintained per manufacturer's recommendations
- Blasting operations shall be done in a complete enclosure with baghouse filters to control PM emissions and blasting shall be done with doors closed. The baghouse shall be maintained per manufacturer's recommendation.
- Visible emissions shall not exceed 20% during normal operations
- Source must follow the APCD approved O&M plan

The facility was last inspected on 11/9/2011 and was found to be in compliance with all the permitted conditions. The APCD considers the enforceable conditions of the permit, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site.

Site V in Figure 28 is restricted access property that lies south of State Highway 196 and north of the Arkansas River, East of Highway 287. The land is naturally vegetated and undisturbed as shown in Figure 32. Figure 32 demonstrates that this site has minimally (if any) disturbed soil as of this writing. The APCD considers pavement, maintained gravel, natural vegetation, and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 32: Site V (Google Image 2012)

Site W in Figure 33 is the Robins Redi-Mix Concrete Batch Plant located at 7355 State Highway 196, approximately 4.5 miles north of the Lamar Municipal PM_{10} site. This batch plant opened in the spring of 2010 and consists of a dry truck mix plant that utilizes a cement and a dry ash silo each of which are operated with pneumatic conveyors and bag houses for the control of emissions. According to Robins Redi-Mix, the bag houses control 98% of the emissions. In April 2010, APCD issued a permit exempt letter for this source (10PR1310.XP). The permit includes the following point and fugitive dust control measures:

- Uncontrolled total PM cannot exceed 10 tpy and uncontrolled PM_{10} cannot exceed 5 tpy.
- Visible emissions cannot exceed 20%.

In addition to these permitted requirements, the source reported in their application that they moisten materials throughout their processes and prior to transferring on an as needed basis and have placed gravel on the road to minimize emissions. The APCD considers the enforceable conditions of the permit, including identified Best Available Control Technology

(BACT) for limestone and ash handling, paving, wash-down systems, and enclosures, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site.

Figure 33: Site W - Robins Redi-Mix Concrete Batch Plant, 7355 State Highway 196 Lamar (Google Earth 2012)

The APCD conducted thorough assessments to determine if the potential soil disturbances shown in Figure 18 through Figure 33 were present during the 2015 exceedances in Lamar. During the course of these assessments, the APCD discovered that these sites were either reasonably controlled or considered to be natural sources during the 2015, high wind events. Therefore, these sites were not significant contributors to fugitive dust in the Lamar area during the April 2015, high wind events.

Colorado State University CO-OP Extension Office

While the following initiatives are not meant to be enforceable, the CSU Co-Op Extension Office has many efforts underway that further reduce blowing dust and its impacts. These include:

- Crop residue efforts that encourage no- or low-till practices. These have been deemed appropriate and useful in reducing blowing dust.
- Ongoing outreach efforts to educate area agricultural producers on soil management programs. These include one-on-one visitations and annual meetings with various corn and wheat programs to discuss crop management.
- Drought workshops to protect topsoil throughout the county.

USDA: Natural Resources Conservation Service (NRCS)

1. *Conservation Reserve Program*

Prowers County is a predominately agricultural area that is made up of 1,048,576 acres of land area – 1,021,915 acres (or 97.5%) of which is land in farms.[2] For comparison, Baca County to the south is 91.9% land in farms, Bent County to the west is 75.0% land in farms, and Kiowa County to the north is 98.4% land in farms. It should be noted that cropland percentage in Bent County is lower than other Southeast Colorado counties at 11%. Figure 34 illustrates the counties of Southeast Colorado. Of the farm land acreage in Prowers County, cropland accounts for approximately half of the total (480,487 acres) and is approximately 46% of the total land in the county. Water, and often the lack of it, coupled with the frequent high winds experienced during late fall and early spring commonly destroy crops, encourage pests, and damage soil surfaces lending them susceptible to wind erosion, especially in recent drought years. Prowers County was classified as being in severe drought in November 2010 and remained so until July 2012 when the county was reclassified as being in an exceptional drought. Prowers County returned to being in a severe drought in October 2014 and remains in this classification. The majority of Prowers County cropland acreage is farmed using dryland practices (versus irrigated) and consists of soils classified as highly-erodible-land (HEL) by the Department of Agriculture.

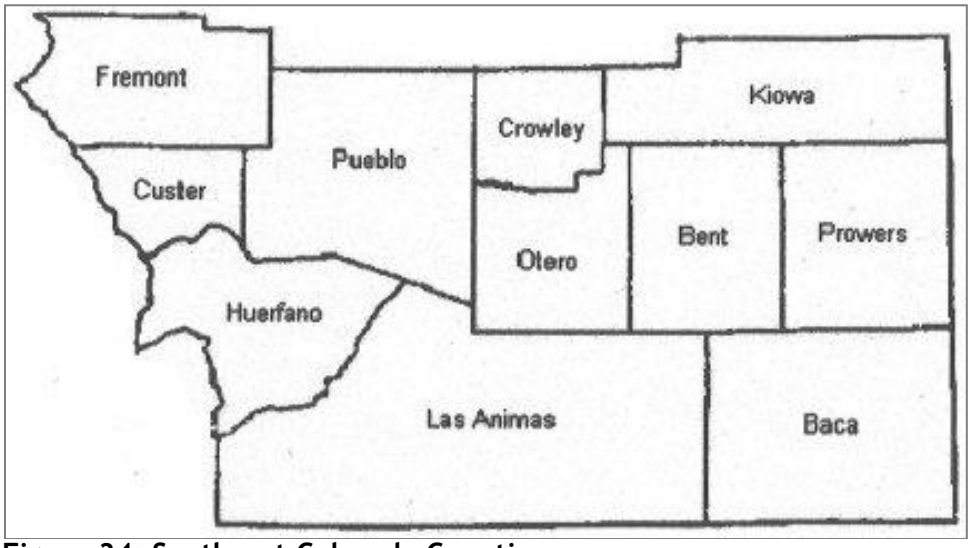

Figure 34: Southeast Colorado Counties

Recognizing the problems associated with erodible land and other environmental-sensitive cropland, the U.S. Department of Agriculture (USDA) included conservation provisions in the Farm Bill. This legislation created the Conservation Reserve Program (CRP) to address these concerns through conservation practices aimed at reducing soil erosion and improving water quality and wildlife habitat.

The CRP encourages farmers to enter into contracts with USDA to place erodible cropland and other environmentally-sensitive land into long-term conservation practices for 10-15 years. In

[2] 2012 Census of Agriculture. Volume 1, Chapter 2: County Level Data. U.S. Dept. Of Agriculture, National Agricultural Statistics Service.

exchange, landowners receive annual rental payments for the land and cost-share assistance for establishing those practices.
The CRP has been highly successful in Prowers County by placing approximately 155,611 acres of Prowers County cropland, or 32% of total cropland, under contract. Most of this land has been planted with a perennial grass cover to protect the soil and retain its moisture.

While the following initiatives are not meant to be enforceable, many efforts are underway that further reduce blowing dust and its impacts. These include:

- The CRP has moved to include all available area lands into area contracts. These contracts are good through 2007. Success of the CRP initiatives is measured through ongoing monitoring of the contracts to ensure ample grass coverage to minimize blowing dust.
- CRP sends out information several times per year through radio and the area newspaper to further reach farmers interested in topsoil protection.
- In response to the significant Colorado drought (2011-2013) the NRCS and FSA are working with multiple parties in extensive annual planning efforts to limit blowing dust and its impacts. These planning efforts change year to year depending on the severity of the drought.

2. *Limestone-Graveyard Creeks Watershed Project*

A watershed improvement project is currently underway in the Limestone-Graveyard Creeks Watershed. This project covers approximately 60,000 acres of land north of the Arkansas River between Hasty (Bent County) and Lamar. An estimated 44,500 acres of the watershed area are classified as priority land due to the highly erodible nature of the soil. Over 2,000 acres of agricultural cropland northwest of Lamar are included in this watershed project. As of 2013, NRCS informed the APCD that this project is approximately 99% complete.

Working with the NRCS, each farmer will create their own conservation plan with costs for improvements split equally between farmers and the federal government. The 15-year project will help reduce soil erosion and improve water quality and efficiency through conservation tillage practices and/or other conservation efforts. In short, the Limestone-Graveyard Creeks Watershed Project will help to reduce soil erosion and lower the impacts of blowing soils during future high wind events.

More recently (since the 1998 NEAP submittal), the Watershed project has been evaluated and is seen as an ongoing successful program as most eligible acres are signed up.

3. *New Initiatives*

While the following initiatives are not meant to be enforceable, the Natural Resources Conservation Service has many efforts underway that further reduce blowing dust and its impacts. These include:

- A comprehensive rangeland management program;
- Tree planting program;
- Drip irrigation purchase program, and;
- A multi-party drought response planning effort coordinated through the State of Colorado Governor's office.

- In 2013, NRCS also tried a proactive approach to drought management by offering producers incentives to mitigate erosion hazard areas before they became an erosion problem.

These are but a few of the efforts at the local, county, and regional level underway to reduce emissions of PM_{10} and limit impacts.

6.0 Summary and Conclusions

APCD is requesting concurrence on exclusion of the exceedance PM_{10} value from the Lamar Municipal Building (08-099-0002) monitor on August 22, 2015.

An elevated 24-hour PM_{10} concentration was recorded at the Lamar Municipal Building monitor on August 22, 2015. The noted twenty-four-hour PM_{10} concentration was above the 90^{th} percentile concentrations for the location (see Section 3) and exceeded the 99^{th} percentile value of any evaluation criteria. The statistical and meteorological data clearly show that but for these high wind blowing dust events, Lamar would not have exceeded the 24-hour NAAQS on August 22, 2015. Since at least 2005, there has not been an exceedance that was not associated with high winds carrying PM_{10} dust from distant sources in these areas. This is evidence that the event was associated with measured concentrations in excess of normal historical fluctuations including background.

The PM_{10} exceedances in Lamar would not have occurred if not for the meteorological conditions that caused strong surface winds over the area of concern.

Surface weather observations provide strong evidence that a dust storm took place on August 22, 2015. The meteorological conditions during this event caused regional surface winds over 25 mph with gusts exceeding 40 mph. These speeds are above the thresholds for blowing dust identified in EPA draft guidance and in detailed analyses completed by the State of Colorado *(*see the Lamar, Colorado, Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx). These PM_{10} exceedances were due to an exceptional event associated with regional windstorm-caused emissions from erodible soil sources over a large source area outside of the monitored areas. These sources are not reasonably controllable during significant windstorms.

Wind speeds in surrounding areas were conducive to the generation of significant blowing dust. Multiple sources of data for the event in question and analyses of past dust storms in this area prove that this was a natural event and, more specifically, a significant natural dust storm originating outside the monitored areas.

As demonstrated in this report, the PM_{10} exceedances in Lamar on August 22, 2015 would not have occurred “but for” the large regional dust storm that occurred on that date.

7.0 References

United States Environmental Protection Agency, June 2012. *Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule*.

Hillel, D., 1982: Introduction to Soil Physics. Academic Press Inc. 364 pp.

Hillel, D., 1998: Environmental Soil Physics. Academic Press. 771 pp.

McCuen, R. H., 1998: Hydrologic Analysis and Design. Prentice-Hall, 817 pp.

Natural Resources Conservation Service (NRCS), cited 2017: National Engineering Handbook Hydrology Chapters. [available online at: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/manage/hydrology/?cid=stelprdb1043063]

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), 2014: SSURGO Metadata – Tables and Columns Report. 102 pp. [Available online at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053631]

Stein, A.F., Draxler, R.R, Rolph, G.D., Stunder, B.J.B., Cohen, M.D., and Ngan, F., 2015: NOAA's HYSPLIT atmospheric transport and dispersion modeling system. Bull. Amer. Meteor. Soc., 96, 2059-2077, [Available online at: http://dx.doi.org/10.1175/BAMS-D-14-00110.1]

Rolph, G.D., 2017: Real-time Environmental Applications and Display sYstem (READY) Website. NOAA Air Resources Laboratory, Accessed 4 April 2017. [Available online at: http://ready.arl.noaa.gov]