Supporting Materials Demonstrating Increased PM2.5 concentrations in Minnesota Resulting from Canadian Wildfire Influence in 2023-2025

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Summary

Based on the results of ongoing Alpine analyses of exceptional events influence and the widespread impact of wildfire and prescribed fire smoke on monitors throughout Minnesota, including areas within the broader regional airshed, it is recommended that regulatory agencies give full and consistent consideration to the treatment of affected PM2.5 data under the Exceptional Events Rule. The evidence developed and presented here for the 2023, 2024, and 2025 wildfire and prescribed fire smoke episodes demonstrates that transported smoke significantly elevated monitored concentrations across large portions of the region beyond what would reasonably be expected in the absence of wildfire conditions. These impacts were neither isolated nor localized but instead represented widespread regional air quality disturbances affecting both attainment and nonattainment areas alike.

Accordingly, each date and monitor identified as having experienced wildfire or prescribed fire smoke impacts during these periods, where PM2.5 concentrations were demonstrably enhanced by smoke intrusion, should be flagged as influenced by exceptional events and the associated concentration values removed from the regulatory record used in design value calculations and boundary designations. Importantly, the concept of "regulatory significance" should not be narrowly interpreted solely through the lens of whether the exclusion changes an attainment or nonattainment designation. Rather, any concentration demonstrably influenced by wildfire or prescribed fire smoke should be considered appropriate for exclusion regardless of the ultimate attainment outcome. Failure to recognize and remove these influenced concentrations risks embedding atypical and non-representative conditions into long-term regulatory datasets that support multiple Clean Air Act programs, including PSD compliance demonstrations, Good Neighbor State or Federal Implementation Plans (SIPs and FIPs), and State attainment demonstrations, to name a few.

Comparison of Fire-Influenced PM2.5 Exceedances with Historical Concentrations

U.S. EPA's Exceptional Events Guidance and supplemental materials indicate that a clear causal demonstration should include a comparison of the event-related exceedance with historical concentrations measured at each monitor requested for data exclusion. Examples of supporting documentation include time-series plots overlaying five years of data and five-year percentiles or alternate graphical representation of these data using EPA's Tiering Tool[1].

EPA's tiering approach helps tailor the amount of evidence needed in a wildland-fire PM2.5 exceptional-events demonstration. For each monitoring site, EPA sets a threshold using the lower of two statistics from the most recent complete five-year period: the month-specific 98th percentile of daily PM2.5 concentrations or the lowest annual 98th percentile. The event-day concentration is then compared with the site's threshold: Tier 1 is at least 1.5 times the threshold, Tier 2 is at least the threshold but less than 1.5 times it, and Tier 3 is below it.

[1] https://www.epa.gov/air-quality-analysis/pm25-tiering-tool-exceptional-events-analysis

Figure 1 shows the 24-hour PM2.5 concentrations for the Apple Valley monitor (270370470) using EPA's Tiering Tool with clear indication of Tier 1 and Tier 2 dates represented by the red and gold dots, respectively. Increased PM2.5 above the Tier 1 and Tier 2 thresholds is evident on multiple dates.

This monitor recorded multiple 24-hour PM2.5 concentrations above its Tier 1 threshold value during the period of 2023 through 2025, indicating rare PM2.5 episodes. The observations from many of these days were in the top five days of the five-year period between 2023 and 2025, including the single top value.

The significance of this issue is illustrated clearly by the Apple Valley monitor (270370470), currently the only one in Minnesota with a design value above the level of the annual PM2.5 NAAQS. This monitor in Dakota County experienced measurable enhancement on multiple dates from both wildfire and prescribed fire smoke intrusion during the 2023-2025 period. While the monitor's current annual design value remains above the annual PM2.5 National Ambient Air Quality Standard (NAAQS) at 9.1 µg/m3, removal of all identified smoke-influenced Tier 1 dates would reduce the annual design value sufficiently to bring the monitor into attainment (at 7.8 µg/m^3) with the current annual PM2.5 NAAQS.

In fact, Minnesota Pollution Control Agency has submitted an exceptional events demonstration[2] addressing one event occurring on July 12, 2025, at this monitor which upon EPA concurrence, would bring the monitor into attainment with the NAAQS.

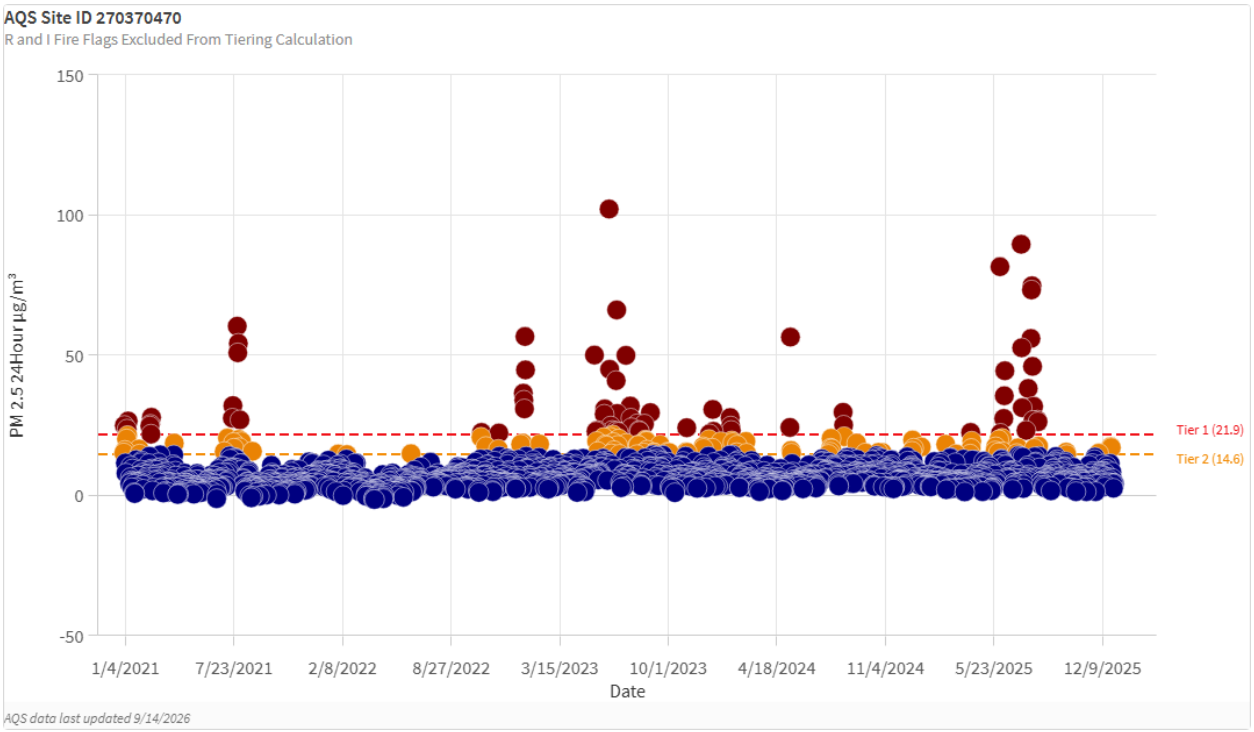


Figure 1. Five-year (2021-2025) time series of 24-hour PM2.5 concentrations, Tier 1 and Tier 2 threshold values at the Apple Valley monitor (270370470).

[2] https://comment.pca.state.mn.us/33980/widgets/120906/documents/85162

Tier 1 / Tier 2 Dates Selected

Table 1 below provides a listing of 2023-2025 monitor-specific EPA Tiering Tool-identified Tier 1 (orange) and Tier 2 (yellow) 24-hour PM2.5 concentrations (µg/m^3) and dates[3] found to also have HMS smoke present during the episode. The values in this table are those removed from design value calculations in the next step of this analysis.

Table 1. Apple Valley monitor-specific 24-hour PM2.5 concentrations (µg/m^3) and Tier 1 (orange) and Tier 2 (yellow) dates selected for removal from design value calculations.

Date	24-hour PM2.5 Concentration (µg/m3)
2023-05-18	50.1
2023-05-20	12.7
2023-05-21	22.9
2023-05-22	19.3
2023-05-23	23.2
2023-05-24	15.7
2023-05-31	11.2
2023-06-04	20.7
2023-06-05	29
2023-06-06	30.9
2023-06-07	18.1
2023-06-09	17.7
2023-06-14	102.2
2023-06-15	45
2023-06-16	20.8
2023-06-17	24.8
2023-06-18	14.9
2023-06-20	23.2
2023-06-21	21.6
2023-06-22	18.9
2023-06-23	16
2023-06-26	22.9
2023-06-27	41
2023-06-28	66.2
2023-06-29	29.3
2023-06-30	17.9
2023-07-01	22.6
2023-07-02	20.2

Date	24-hour PM2.5 Concentration (µg/m3)
2023-07-03	14.7
2023-07-15	50
2023-07-16	18.6
2023-07-23	31.9
2023-07-24	27.6
2023-07-25	24.2
2023-08-04	14.6
2023-08-05	25.6
2023-08-06	18
2023-08-07	17.9
2023-08-08	23.2
2023-08-09	22.9
2023-08-17	15.2
2023-08-18	25.5
2023-08-20	19.8
2023-08-21	19.4
2023-08-22	19.3
2023-08-23	16.2
2023-08-29	29.6
2023-09-03	14.5
2023-09-04	15.3
2023-09-05	15.1
2023-09-16	18.1
2023-09-30	15.5
2023-10-03	15.3
2023-11-04	24.2
2024-02-22	15.1
2024-05-12	24.3

Date	24-hour PM2.5 Concentration (µg/m3)
2024-05-13	56.5
2024-05-14	16.1
2024-05-15	15.1
2024-05-16	11.4
2024-07-22	14.7
2024-07-25	15.5
2024-07-26	16.9
2024-07-27	20.4
2024-07-28	16.6
2024-08-18	29.7
2024-08-19	25.1
2024-08-20	21
2024-08-25	13.6
2024-09-12	18.7
2024-09-28	15.2
2024-10-22	15.4
2024-10-29	15.4
2025-03-03	13.4
2025-04-11	16.8
2025-04-12	19.4
2025-05-04	12.2
2025-05-09	11.3
2025-05-25	15.9
2025-05-26	17.4
2025-05-31	15.3
2025-06-01	19.9
2025-06-03	81.6
2025-06-04	22.2

Date	24-hour PM2.5 Concentration (µg/m3)
2025-06-07	20.4
2025-06-08	15.6
2025-06-10	27.5
2025-06-11	35.6
2025-06-12	44.5
2025-07-04	15
2025-07-06	17
2025-07-12	89.6
2025-07-13	52.7
2025-07-14	31.3
2025-07-21	23.2
2025-07-25	38.2
2025-07-30	56
2025-07-31	73.3
2025-08-01	74.8
2025-08-02	46.1
2025-08-03	26.8
2025-08-04	31.8
2025-08-05	16.8
2025-08-06	13.8
2025-08-11	26.9
2025-08-12	26.3
2025-08-13	17.6
2025-10-03	15.5
2025-10-04	14.6

[3] Data downloaded from EPA Tiering Tool on October 21, 2026.

Complete Monitor Level Results

A substantial number of days in 2023, 2024, and 2025 were influenced by Canadian wildfire smoke, elevating PM2.5 observations across Minnesota. The smoke's effects extended beyond the state, with elevated concentrations also observed in regional areas in the upper Midwest.

Using EPA tools, dates were identified when Canadian wildfire smoke affected PM2.5 observations. As can be seen in Table 3, when these dates and associated smoke-influenced Tier 1 observations were removed from the record, recalculated annual design values at the Apple Valley monitor fell to levels well below the 9.0 µg/m³ annual PM2.5 NAAQS.

Removing Tier 1 concentrations lowered the 2023-2025 design value by 1.3 µg/m³. When Tier 2 dates were also removed, this design value was 1.8 µg/m³ lower than the unadjusted values. These comparisons show that wildfire-affected days contributed meaningfully to the measured design values.

Table 2. Annual unadjusted mean concentrations and 3-year design values (µg/m3) at Apple Valley monitor, 2023-2025.

				Annual Mean (µg/m3)			2023-2025 Annual Design Value (µg/m3)
State	**County**	**Site ID**	**Local Site Name**	**2023**	**2024**	**2025**	
Minnesota	Dakota	270370470	Apple Valley	10.62	7.84	8.86	9.1

Table 3. Annual mean concentrations and 3-year design values (µg/m3) at Apple Valley monitor with Tier 1 dates removed, 2023-2025.

				Annual Mean (µg/m3)			2023-2025 Annual Design Value (µg/m3)
State	**County**	**Site ID**	**Local Site Name**	**2023**	**2024**	**2025**	
Minnesota	Dakota	270370470	Apple Valley	8.96	7.51	7.00	7.8

Table 4. Annual mean concentrations and 3-year design values (µg/m3) at Apple Valley monitor with Tier 1 and Tier 2 dates removed, 2023-2025.

				Annual Mean (µg/m3)			2023-2025 Annual Design Value (µg/m3)
State	**County**	**Site ID**	**Local Site Name**	**2023**	**2024**	**2025**	
Minnesota	Dakota	270370470	Apple Valley	8.12	7.18	6.53	7.3

Recommendations

Based on the results of this analysis and the widespread impact of Canadian wildfire smoke on Minnesota monitors and regionwide, the following action is recommended.

1. Each date at monitors within Minnesota identified as Tier 1 with wildfire smoke present should be recognized as having been influenced by that smoke during the 2023-2025 timeframe and found to have increased PM2.5 concentrations. As a result, each monitor-date should be flagged as influenced by exceptional events, and the associated pollutant concentration values should be removed from the regulatory record used to determine design values and attainment designations.
2. Given the duration and extent of the wildfires, there are numerous Tier 2 days that should also be flagged as influenced. The "regulatory significant" nomenclature typically applied to concurring with exceptional events demonstrations should not be limited to the attainment / nonattainment determination and instead should include any date or concentration that was enhanced by wildfire smoke, regardless of the attainment outcome of the exceptions.
3. Consideration should be given to excluding dates and concentrations at other monitors outside of Minnesota, but in the same regional airshed, that would have also been impacted by Canadian wildfire smoke during the same 2023-2025 episodes. This may include simply referencing other state exceptional events demonstrations when proximal monitors were impacted on the same dates and by the same wildfire plumes.
4. Consideration should be given to all regional states to allow limited information necessary to support the clear causal relationship criterion for any wildfire date that fell within the 2023-2025 Canadian wildfire episode. Ample evidence has been provided here and elsewhere to support the fact that smoke from Canadian wildfires in select episodes in 2023, 2024, and 2025 had significant impact on PM2.5 observations and enhanced concentrations beyond reasonable and typical conditions. As it is understood that many states are preparing exceptional events demonstrations for monitors and dates affected during the Canadian wildfire episodes of 2023 and 2025, it would be appropriate to allow for information in this document to be adopted to satisfy Tier 1 obligations in those demonstrations.
5. To the extent that EPA believes additional information is needed to remove exceptional even days related to Canadian wildfires to adequately assess air quality conditions and determine whether an area meets applicable NAAQS, areas should be designated as unclassifiable. Assigning an attainment or nonattainment designation without a complete and reliable evidentiary basis could result in an inaccurate characterization of the area's air quality status. An unclassifiable designation provides the opportunity to conduct additional monitoring, refine technical analyses, and resolve outstanding uncertainties, thereby supporting a scientifically defensible and appropriate designation.