clarity

EXECUTIVE SUMMARY

Fireworks drove Washington, DC air pollution to “Unhealthy” levels on July 4, 2026

Prepared by Clarity Movement
Issued July 6, 2026

PM2.5 in micrograms per cubic meter (µg/m³)
All times America/New_York

HOW TO CITE

How to cite

Data from Clarity sensors

Air quality data provided by Clarity Movement Co. Measured using Clarity Node-s air quality sensors and accessed via the Clarity platform. Learn more at www.clarity.io.

Data from the SDSU TARTA device

Metals concentration data collected with the TARTA (Toxic-metal Aerosol Real Time Analysis) lent to Clarity by Professor Hanyang Li's SDSU Air Quality Monitoring Lab, data provided by Clarity Movement Co. Learn more at www.clarity.io.

AT A GLANCE

July 4, 2026 air quality impact, Washington, DC

- Hourly PM2.5 concentrations rose to more than 6 times pre-fireworks baseline levels
- Network-mean PM2.5 AQI reached the “Unhealthy” US EPA AQI category
- All 26 sites reached AQI in the “Unhealthy for Sensitive Groups” or worse category
- Pollution exhibited a high spatial variability: PM2.5 concentrations at different locations varied by more than a factor of 5 in the hours following the fireworks display.
- Hourly PM2.5 concentration peaked at 4:00 AM on July 5 and remained elevated for 5 hours
- Particulate magnesium concentrations increased by at least a factor of ninety-six (96x) over pre-firework levels

Headline stats

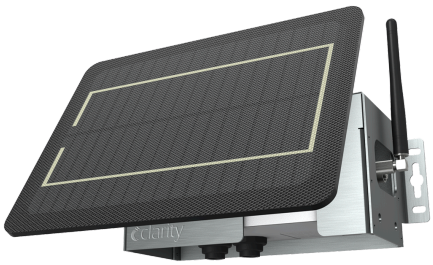
Air pollution peaked at more than 6 times normal levels

Particle pollution reached the "Unhealthy" AQI category

Every site reached “Unhealthy for Sensitive Groups” or worse

Overview

DC DOEE operates a network of Clarity air quality sensors at 26 sites across Washington, DC that measures fine particulate matter, known as PM2.5, at hourly resolution. PM2.5 is the pollutant most closely tied to the short-term health effects of smoke. Clarity analyzed measurements from the network across the July 4, 2026 holiday to quantify how far, and for how long, the Freedom 250 fireworks display pushed air pollution above normal levels.



KEY FINDING

On the night of July 4, 2026, the network-average PM2.5 pollution rose into the U.S. EPA Air Quality Index (AQI) Unhealthy category, peaking between 4:00 and 5:00 AM on July 5. At that peak, hourly PM2.5 concentrations were 6.7 times the baseline average from the preceding days.

How the event unfolded

Prior to July 4, local air quality sat in the Moderate AQI category. Local fireworks began pushing PM2.5 above baseline on the evening of July 4, with several sites reaching “Unhealthy” levels. The Freedom 250 display, which began at midnight, produced a further spike that carried the network-average into the Unhealthy AQI category. PM2.5 peaked between 4:00 and 5:00 AM on July 5 at roughly 6.7 times the baseline hourly average. Concentrations then decayed as smoke dispersed. The network fell back into the Moderate range by 9:00 AM, about five hours after the peak.

The elevated pollution was widespread rather than isolated to one location. Measured with the EPA NowCast, the smoothed concentration the EPA uses to report the current AQI, every hour of the 12-hour recovery window (12:00 AM to 12:00 PM on July 5th) sat above the “Good” category. NowCast held above “Moderate” for 10 of those 12 hours and above “Unhealthy for Sensitive Groups” for four hours.

Impact varied widely across the city. Each site’s average hourly PM2.5 during the fireworks window differed by a factor of 5.4 between the most and least affected locations, and individual site peaks spanned a factor of 3.8. However, all 26 sites reached at least one hour in the “Unhealthy for Sensitive Groups” category or worse.

The particle chemistry pointed to fireworks rather than ordinary haze. At the EPA McMillan Reservoir site, particulate magnesium, a metal burned to produce the bright white flashes in pyrotechnics, rose steeply over its pre-event level during the July 5 morning hours.

What this means

- Fireworks smoke spread across the city, reaching sites well beyond the launch site
- Air quality stayed elevated for hours after the display ended, into the morning of July 5
- Even people far from the launch site breathed degraded air, and the sites closest to the launch were not the worst affected

The DC DOEE Clarity air quality network across Washington, DC.

KEY NUMBERS

Key numbers

Concentrations are 1-hour means; AQI categories are derived from the EPA NowCast concentration

Metric	Value
Baseline network mean, hourly concentration	14.5 µg/m³ (1-hour mean)
Baseline network NowCast AQI category	Moderate
Fireworks-night peak, hourly network mean	96.9 µg/m³ (1-hour mean)
Peak time (1-hour mean)	Jul 5, 2026, 4:00 - 5:00 AM
Fireworks-night peak, NowCast AQI category	Unhealthy
Increase over baseline (1-hour mean)	6.7×
Network hourly mean fell to ≤ 35.4 µg/m³	Jul 5, 2026, 9:00 AM (5.0 h after peak)
Highest single-site concentration (1-hour mean)	252.3 µg/m³
Highest sub-hourly instantaneous measurement (minute-level data)	438 µg/m³
Highest single-site AQI	Very Unhealthy
Spatial variation, fireworks-window average (max/min across sites)	5.4× (19.8 to 107.3 µg/m³)
Spatial variation, per-site peaks (max/min across sites)	3.8× (66.0 to 252.3 µg/m³)
Hours NowCast above Good (> 9.0 µg/m³)	12 of 12 h
Hours NowCast above Moderate (> 35.4 µg/m³)	10 of 12 h
Hours NowCast above Unhealthy for Sensitive Groups (> 55.4 µg/m³)	4 of 12 h
Sites that reached unhealthy air (NowCast USG or worse)	26 of 26
Sites that reached the Hazardous AQI category (NowCast)	0 of 26 (0%)
Increase over a normal July evening (1-hour mean)	+349%
Fireworks-window average vs. prior 4-year average (EPA reference sites)	0.89× (ranked 2nd of 5 years)
Relative increase particulate magnesium levels	At least 96x

FIGURES

The fireworks impact visualized

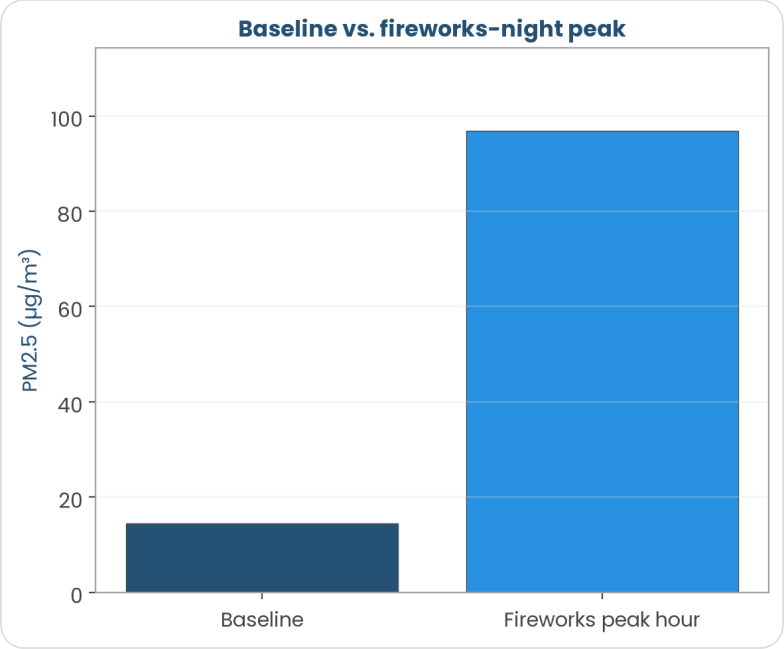


Figure 1. Mean network PM2.5 across the baseline days before the event, next to the peak hourly network PM2.5 on the fireworks night, about 6.7 times higher. Each bar is labeled with its NowCast AQI category (Moderate at baseline, Unhealthy at the peak); the category comes from the NowCast concentration, not the 1-hour bar height. The dashed line marks the Unhealthy for Sensitive Groups threshold of 35.5 µg/m³.

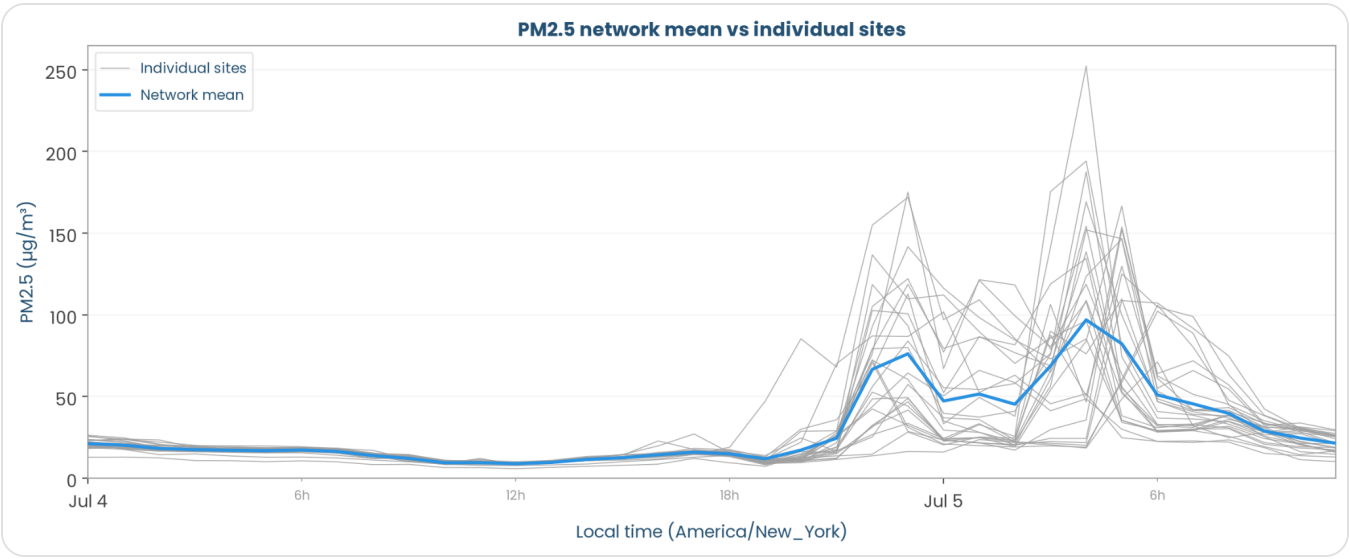


Figure 2. Hourly PM2.5 from 12:00 am July 4 through 12:00 pm July 5, 2026. The blue line is the network mean and each grey line is one site. There is an initial spike late on July 4, with a secondary spike that peaks in the early hours of July 5, and clears through the morning of July 5. The spread between grey lines shows how much stations differed hour to hour.

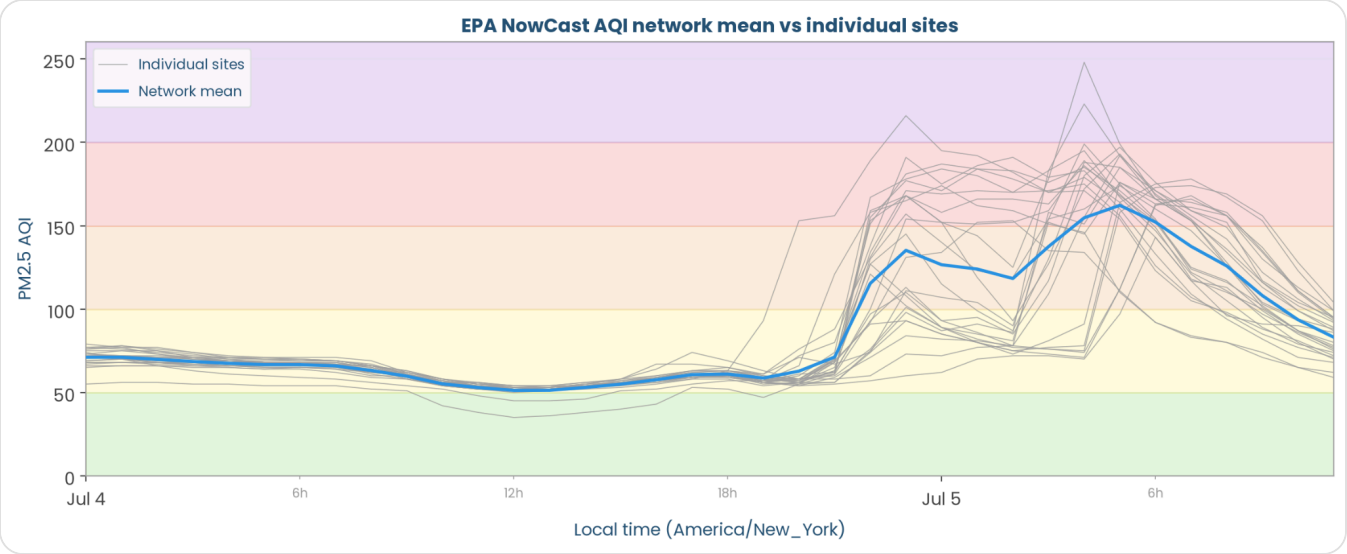


Figure 3. NowCast PM2.5 from 12:00 am July 4 through 12:00 pm on July 5, 2026. The blue line is the network mean NowCast, grey lines are individual sites, and the shaded horizontal bands are EPA AQI categories. The spread between grey lines shows how much stations differed hour to hour.

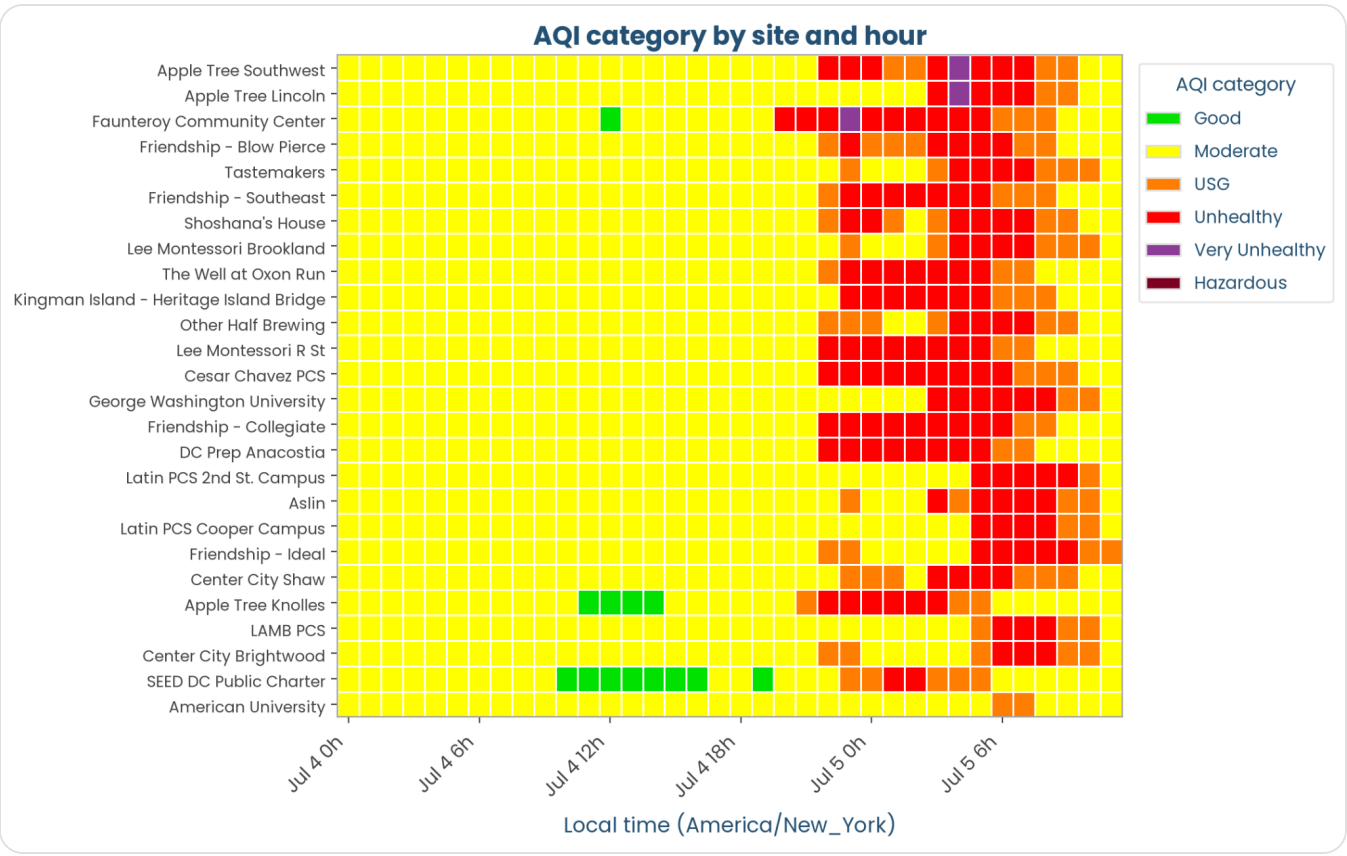


Figure 4. EPA NowCast AQI category for each station (rows) and hour (columns). Colors run from Good (green) and Moderate (yellow) through Unhealthy for Sensitive Groups (USG), Unhealthy, and Very Unhealthy to Hazardous (dark red), showing how widely and for how long stations crossed into unhealthy air.

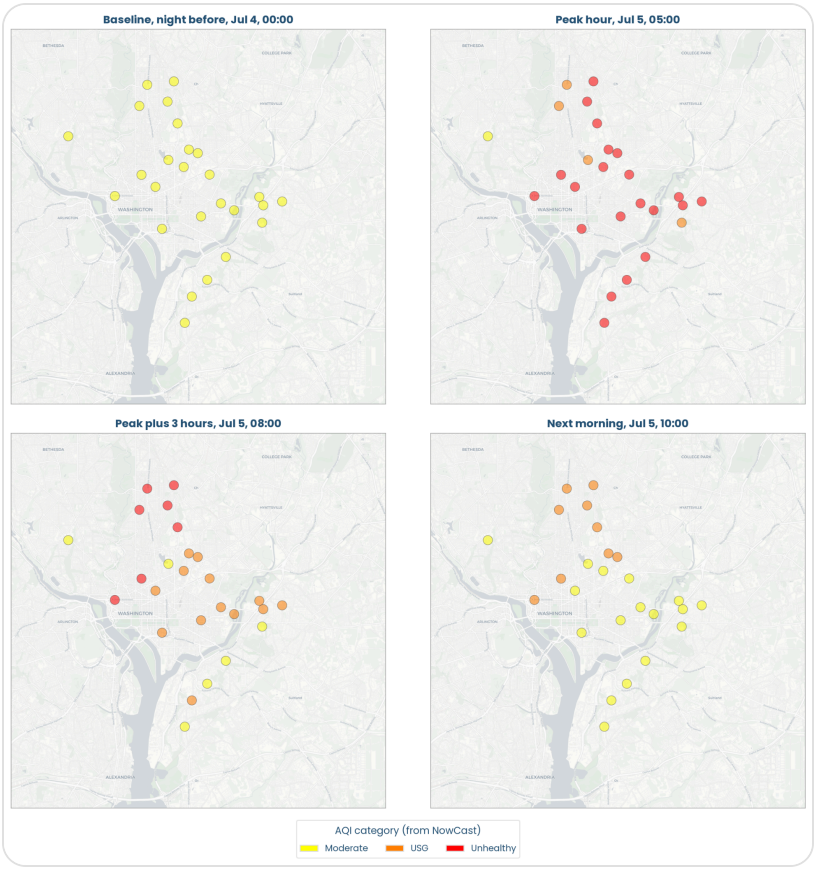


Figure 5. The DC DOEE Clarity air quality network at four moments: a baseline the night before, the peak hour, three hours past the peak, and the next morning. Each dot is a monitored site and is colored by its NowCast AQI category. The maps show the plume spreading across the city at the peak hour and clearing by three hours later; no valid data were available for the final morning panel.

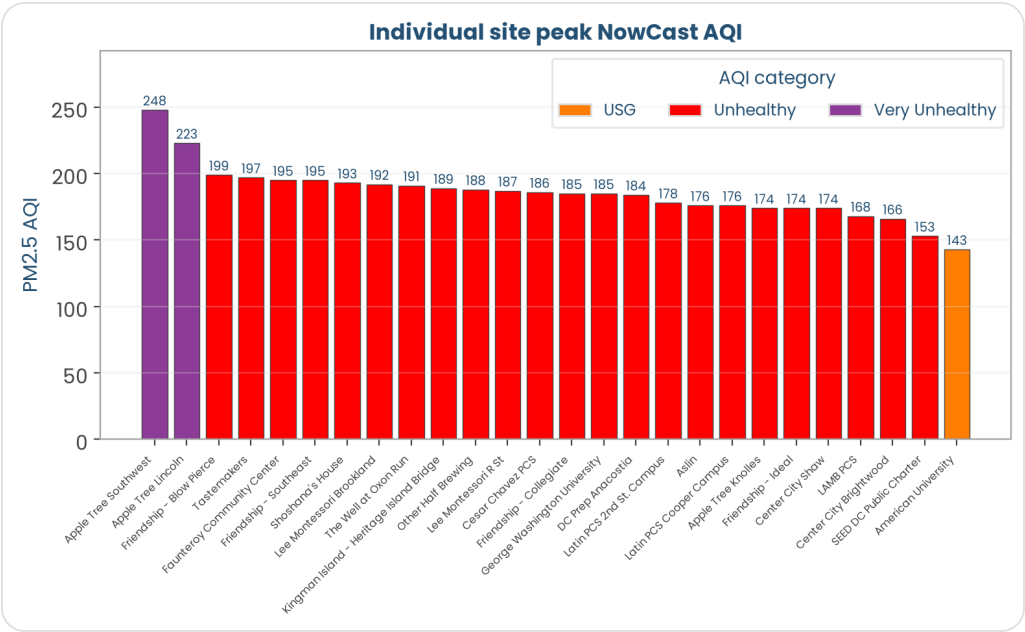


Figure 6. Individual site peak hourly PM2.5 concentration over the period 12:00 am July 4 to 12:00 pm July 5. Peak concentration for each site may occur at different times.

METHODOLOGY

Methodology

This section documents how the figures and headline numbers were produced.

Data source and download

Measurements come from the DC DOEE air quality sensor network, operated with Clarity Node-S air quality sensors. Data was retrieved through the Clarity Data API.

- Sensors: 26 sites in the network with valid data (see next section) over the event window
- Time resolution: 1-hour means
- Analysis window (local): Jun 28, 2026, 12:00 AM to Jul 5, 2026, 12:00 PM
- Measurements: the 1-hour mean PM2.5 concentration and the EPA NowCast PM2.5 concentration, each with its automated quality-control assessment

Data preparation and quality control

Each measurement's UTC period start is converted to local time (America/New_York), and all filtering and comparisons are done in local time so the event window lines up with the Freedom 250 fireworks start time, roughly 12:00 AM on July 5. Clarity applies an automated quality-control pipeline (documented here) to every measurement and records the result as a QC assessment. Building on those flags, this analysis keeps a sensor-hour only when the 1-hour PM2.5 assessment is valid and the value is present. NowCast is screened independently, so NowCast metrics use only valid NowCast readings. A completeness rule then drops any site with valid PM2.5 for fewer than 75% of the 72 hours around the event, so a site with only a handful of valid hours cannot skew the network mean.

Metric definitions

The units of analysis in this report are the 1-hour mean PM2.5 mass concentration, NowCast AQI, and NowCast AQI category. Because a fireworks plume is a short spike, the analysis leads with 1-hour means rather than a 24-hour average, which would flatten the peak. Every AQI category reported here is derived from the EPA NowCast AQI.

METHODOLOGY

Metric definitions

Baseline network mean

Network-wide average PM2.5 concentration from Jun 28 to Jul 4 (the days leading up the event). The reported concentration is a 1-hour mean. The reported AQI category is taken from the baseline mean of the NowCast AQI over the same period.

Event peak and peak time

The single hour with the highest network-mean PM2.5. The fold increase is the peak concentration divided by the baseline concentration. The NowCast AQI peak is the highest hour of the network-mean NowCast AQI.

Return to normal

The first hour after the peak at which the 1-hour network mean concentration falls at or below 35.4 µg/m³ (the concentration at the upper bound of the Moderate AQI range). This marker is measured on the 1-hour mean and compared against a concentration threshold, not a NowCast AQI category.

Highest single-site reading

The highest 1-hour PM2.5 concentration, NowCast AQI, and individual measurement (reported separately) measured by any individual site within the fireworks window.

Spatial variability

Ratio of the 1-hour mean concentration from the highest site value divided by lowest for each site's fireworks-window average and peak concentration.

METHODOLOGY

Metric definitions, continued

Normal–evening comparison

Compares the fireworks evening against a typical evening over the same clock hours using Jun 19 to Jul 5 as the normal baseline.

NowCast hours above thresholds

Over the 12-hour recovery window, the number of hours the network-mean NowCast AQI sat above the Good, Moderate, and Unhealthy for Sensitive Groups category bounds.

Historical comparison

The average hourly PM2.5 concentration over the fireworks window for the current year compared with prior years, using two US EPA regulatory sites, McMillan Reservoir (AQS Site ID: 11-001-0043) and Anacostia Freeway Near-Road Station (AQS Site ID: 11-001-0051). EPA regulatory sites were used because the DC DOEE Clarity network was not deployed until 2026.

Percent change in particulate magnesium

The percent change in particulate magnesium concentrations from 12:00 am to 10:00 am on July 5th relative to baseline levels from 12:00 am to 8:00 pm on July 4th. Particulate metal concentrations were measured using TARTA (Toxic-metal Aerosol Real Time Analyzer) located at the EPA's McMillian Reservoir site and run by Ehsan Goftari from Professor Hanyang Li's SDSU Air Quality Monitoring Lab.

Limitations

The Clarity Node-S PM2.5 sensors used in this analysis were calibrated on a historical dataset where extreme PM2.5 concentrations mainly come from wildfire smoke. Firework aerosol differs from wildfire smoke in particle composition and size distribution. Reported concentrations during firework events carry additional uncertainty.