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WELD COUNTY MONITORING NETWORK

AIR QUALITY AND METEOROLOGICAL MONITORING DATA: 3RD QUARTER 2024 SUMMARY REPORT

RAMBOLL

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ACRONYMS AND ABBREVIATIONS

agl	Above Ground Level
pH	Acidity
NH3	Ammonia
AMoN	Ammonia Monitoring Network
NH4	Ammonium
Br	Bromide
Ca	Calcium
Cl	Chloride
CAAQS	Colorado Ambient Air Quality Standards
GHG	Greenhouse Gas
GPT	Gas Phase Titration
GPTZ	Gas Phase Titration Zero
L	Lab
Mg	Magnesium
m	Meter
µg/m3	Micrograms per meter cubed
µS/cm	Micro-Siemens per centimeter
mg/m3	Milligrams per meter cubed
MDT	Mountain Daylight Time
MSP	Missile Site Park
NAAQS	National Ambient Air Quality Standards
AAQS	National Ambient Air Quality Standards and Colorado Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NIST	National Institute of Standards and Technology
NTN	National Trends Network
NO3	Nitrate
NO2	Nitrogen Dioxide
NO	Nitrogen Oxide
NOx	oxides of nitrogen
ppb	parts per billion
ppm	parts per million

PO4	Phosphate
K	Potassium
QAPP	Quality Assurance Project Plan
RH	Relative Humidity
Na	Sodium
SO4	Sulfate
TAPI	Teledyne Advanced Pollution Instrumentation

1. QUARTER 3 2024 MONITORING HIGHLIGHTS

Data Completeness

- All data completeness goals were met for all parameters at all three sites.

Ozone

- **Values to date:** The 4th highest maximum daily 8-hour average (MDA8) ozone concentration at MSP (80 ppb) and Hereford (77 ppb) are above both the 2008 and 2015 federal health-based standards, while at Orchard the value (72 ppb) is below the 2008 standard, but above the 2015 standard.
- **Spatial trends:** Consistent with previous years, MSP measured the highest ozone concentrations. Usually, Orchard and Hereford have similar values with Orchard being slightly higher. However, Hereford values were higher than Orchard and more like MSP values.
- **Annual trends:** Sites measured some of the highest ozone concentrations relative to prior years. For comparison, at this time last year, there was only a single day above the 2015 standard at MSP and no days were greater than the 2008 standard at any station.
- **Exceedances:** To date, the 2008 ozone standard was exceeded 9 times at MSP, 4 times at Hereford, and once at Orchard. The 2015 standard was exceeded at MSP 20 times, Hereford 8 times, and Orchard 5 times. Ozone exceedance days primarily occurred in July and August at all three monitors. MSP and Hereford both recorded exceedances consecutively from July 23-25. Orchard's exceedance days were primarily in early August.
- **Comparison to NAA monitors:** Ozone values tend to be lower at Weld County monitors compared to other monitors in the nonattainment area, and 2024 was no exception. The 4th highest MDA8 for other sites ranged between 73 to 89 ppb.[1] The controlling monitor in the nonattainment area (NREL) was 9 ppb higher than MSP. Notably, the 4th highest MDA8 at MSP was identical to the new Timnath monitor, which is the closest monitor to MSP. Orchard had the lowest 4th highest MDA8 of any monitor in the nonattainment area that was operational for the full year.

Nitrogen Dioxide (NO_2)

- **Values:** Q3 concentrations at MSP are well below federal annual and 1-hour health-based standards.
- **Annual trend:** Annual mean NO_2 value to date is 6.2 ppb, similar to values measured in previous Q3s.

Quarterly Events

- **Climate trends:** Q3 2024 was warmer and dryer than normal with temperatures in Weld County approximately 3°F warmer and 2-3 less inches of precipitation.[2]

[1] Regional Air Quality Council, *Up Next…Solving the Ozone Problem and Improving Air Quality – 2024 end of season Ozone Report and Attainment Planning*, RAQC Board Meeting, October 2024. Available at: https://raqc.egnyte.com/dl/aGHWtTnekd/2024_Ozone_Season_End-of-Year_Review_Presentation.pdf_. Accessed: November 2024.

[2] National Weather Service, *Summer 2024 climate plots*. Available at: https://www.weather.gov/pub/climate2024SummerReviewFallPreview#:~:text=June%20of%202024%20featured%20a,its%20second%20warmest%20and%20second. Accessed: November 2024.

- **Wildfire smoke:** There were more than 60 days where smoke was present aloft over at least one of the sites.[3,4] Local fires that likely contributed to the smoke include Alexander Mountain (Larimer County), Stone Canyon (Boulder County), and Quarry (Jefferson County). Smoke also traveled south from Wyoming.
- **Summary of non-routine site visits:** MSP had 10 visits to troubleshoot parts of the gas analyzer systems and the precipitation gauge. Orchard had 6 visits to replace the battery in the NADP precipitation gauge and to troubleshoot the air conditioning system and ozone analyzer.

[3] S.J. Brey et al, *Connecting smoke plumes to sources using Hazard Mapping System (HMS) smoke and fire location data over North America*, Atmospheric Chemistry and Physics, February 2018. Available at: https://acp.copernicus.org/articles/18/1745/2018/. Accessed: November 2024.

[4] NOAA Hazard Mapping System Smoke Detection. Available at: https://noaa.maps.arcgis.com/home/item.html?id=ab7a5fbd76e3499296350eabf599fc63. Accessed: November 2024.

2. INTRODUCTION AND REPORT SUMMARY

Weld County has commissioned the installation and operation of an air quality and meteorological monitoring network consisting of three monitoring stations located in areas that do not have existing air quality monitoring stations. The purpose of the monitoring network is to collect ambient air quality and meteorological data to inform current and future air quality management actions and policies. Weld County monitoring objectives support a wide variety of air quality management goals that were developed in consideration of current and expected future regulatory drivers related to ozone (O_3), greenhouse gases (GHG), and nitrogen air pollutants. The three stations are named Missile Site Park (MSP), Hereford, and Orchard and their locations are shown in **Figure 1**. MSP was operational and began collecting data on November 16, 2020. Hereford was operational and began collecting data on December 16, 2020. Orchard was operational and began collecting data on December 30, 2020.

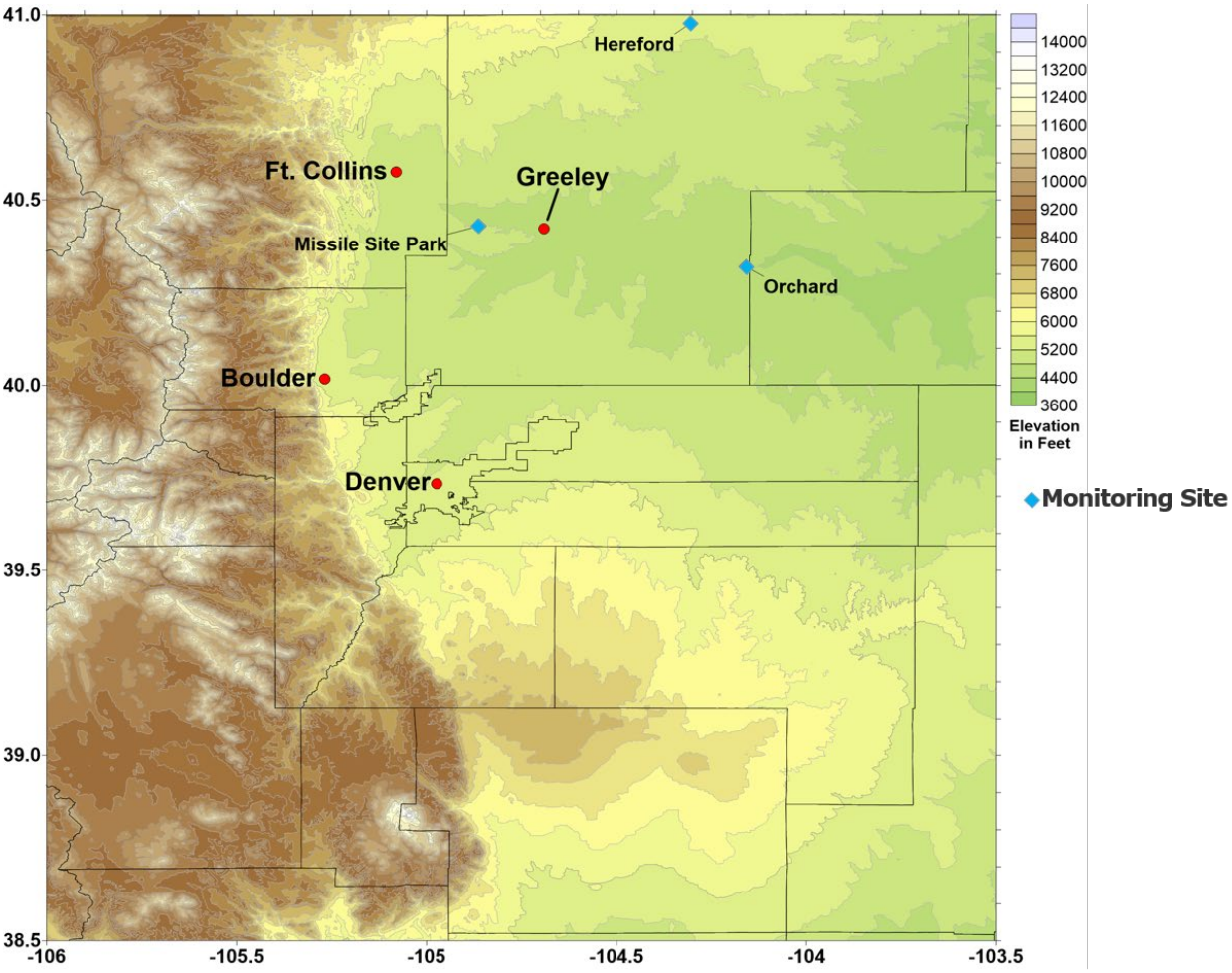


Figure 1. Weld County Monitoring Station Locations

All three monitoring stations measure O_3 concentrations and a full suite of meteorological parameters. A complete list of all collected meteorological measurements is included in **Chapter 3** of this report. In addition, oxides of nitrogen (NO_X) concentrations, measured as NO_X, nitrogen dioxide (NO_2) and

nitrogen oxide (NO) are measured at MSP. Lastly, gaseous ammonia and precipitation chemistry are measured at MSP and Orchard. Based on an air monitoring network assessment conducted for Weld County,[5] it was recommended to monitor these compounds at these locations to best support Weld County's near-term data needs and air quality management goals. The Weld County Air Monitoring Network Assessment[6] considered locations of existing monitors, concentration trends, and spatial distributions of emissions.

Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Quarterly Report for Weld County's air quality and meteorological monitoring program to summarize the final, validated data and provide transparent, publicly available documentation regarding the quality assurance and quality control procedures. This report for the 3rd quarter of 2024 (Q3 2024) provides a monthly, quarterly, and year-to-date summary of all air quality and meteorological data collected at Weld County's monitoring stations during the period from July 1, 2024 through September 30, 2024. Details regarding the monitoring program, the three monitoring station locations, equipment specifications, and quality assurance procedures are included in the following sections. Lastly, a comprehensive summary of Q3 2024 data are presented in comparison to National Ambient Air Quality Standards (NAAQS) and Colorado Ambient Air Quality Standards (CAAQS) to help readers understand how measurements compare to federal and state air quality standards.

NAAQS and CAAQS are collectively referred to as "AAQS". The AAQS for O_3 and NO_2 are listed in **Table 1** below. For O_3 there are two different AAQS: one standard of 0.075 part per million (ppm), which was established in 2008, and a more restrictive O_3 standard of 0.070 ppm, which was established in 2015. Both standards are still in effect; therefore, measured O_3 concentrations are compared to both standards. Similarly, for NO_2 there are two different AAQS: one standard is 100 parts per billion (ppb) for a 1-hr average and another standard is 53 ppb for a yearly average.

Both O_3 and NO_2 AAQS have both a "Primary" standard and a "Secondary" standard. The Primary standard is for protection of public health while the Secondary standard is for protection of public welfare (such as protection against damage to crops, animals, and vegetation). For O_3 and NO_2, the level of the Primary and the Secondary standards are the same.

Meteorology measurements for Q3 2024 were all within normal ranges for the area and season. At all three stations, average temperatures were coldest during September and warmest during July. Average solar radiation gradually decreased as the quarter progressed at all three sites while maximum solar radiation occurred in July. Precipitation peaked at both Hereford and MSP in August and was highest in September at Orchard. Continuous gaseous pollutant measurements for Q3 2024 indicate that all three stations experienced several multi-day periods with elevated ozone daily maxima. During Q3 2024 MSP experienced 19 instances of daily maximum 8-hour average O_3 concentrations that were above the 2015 ozone AAQS value, while Hereford had eight and Orchard recorded five. There were nine instances above the 2008 AAQS value at MSP, four at Hereford, and one at Orchard. The maximum 8-hour average O_3 concentration at each site was 0.091 ppm on July 24th at Hereford, 0.078 ppm on August 3rd at Orchard, and 0.087 ppm on July 23rd at MSP.

[5] Ramboll, Air Monitoring Network Assessment, 2020. Available by request.

[6] Id.

Concentrations remained below the AAQS values for NO_2. At MSP, the highest hourly average NO_2 recorded during Q3 2024 was 16.9 ppb on July 7th.

It is important to note that O_3 and NO_2 measurements have now been collected for three years, enabling measurements to be compared to AAQS. The measured concentrations are compared to AAQS for informational purposes in Chapter 4 of this report.

Table 1. AAQS for O_3 and NO_2

Pollutant (Year)	Primary/ Secondary	Averaging Time	Level	Form
O_3 (2015)	Primary & Secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentrations, averaged over 3 years
O_3 (2008)	Primary & Secondary	8 hours	0.075 ppm	Annual fourth-highest daily maximum 8-hour concentrations, averaged over 3 years
NO_2	Primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Primary & Secondary	1 year	53 ppb	Annual Mean

Notes
O_3 ozone
NO_2 nitrogen dioxide
ppb parts per billion
ppm parts per million

Adapted from the NAAQS Table available here: https://www.epa.gov/criteria-air-pollutants/naaqs-table

3. SUMMARY OF MONITORING PROGRAM

3.1 Monitoring Station Locations

The three Weld County air quality station locations were guided by the *Weld County Air Monitoring Network Assessment*[7] which analyzed Weld County's monitoring objectives, existing monitoring stations, and emissions source locations to determine high priority areas to conduct monitoring. Final station locations were determined in consideration of logistical requirements such as accessibility, availability of power, and proximity of large emissions sources which could affect the representativeness of station measurements. Weld County's monitoring network consists of three stations:

- MSP is the primary monitoring station and is located northwest of Greeley, CO. MSP monitors O_3, oxides of nitrogen (NO_x), wet deposition via the National Trends Network (NTN), gaseous ammonia via the Ammonia Monitoring Network (AMoN), and meteorological parameters from a 10-meter (m) tower;
- Hereford is a secondary station located in north-central Weld County and monitors O_3 and meteorological parameters from a 10-m tower; and
- Orchard is also a secondary station located in eastern Weld County to monitor O_3, wet deposition via the NTN, ammonia via the AMoN, and meteorological parameters from a 10-m tower.

3.2 Monitoring Instrumentation

The installation, configuration, calibration, and integration of the monitoring network along with technical specifications for all equipment and monitoring systems are summarized in the *Weld County Ambient Air Monitoring Program Quality Assurance Project Plan* (QAPP), referred to hereafter as the QAPP[8]. Weld County's monitoring program is conducted in accordance with the QAPP.

Table 2 and **Table 3** summarize the key air quality and meteorological monitoring equipment and measurement specifications for the Weld County stations. The monitoring systems, sampling frequencies, quality assurance program, and data management aspects of the monitoring program are described in the QAPP.[9]

[7] Id.

[8] Ramboll, Weld County Ambient Air Monitoring Program Quality Assurance Project Plan (QAPP), September 18th 2023. Available by request.

[9] Id.

Table 2. Weld County Air Quality Monitoring Station Equipment Specifications

Measurement	Manufacturer	Model	Serial Number	Zero and Span Noise	Detection Limit	Drift Over 24-hour Period	Response Time	Units
Missile Site Park								
O_3	TAPI	T400	5986	<0.2 ppb @ 0 ppb & <0.5% reading above 100 ppb	<0.4 ppb	<1 ppb @ 0 ppb & <1% of reading @ span	<30 seconds to 95%	ppb, ppm, $\mu g/m^3$, mg/m^3
NO_x	TAPI	T200 (w/ sample conditioner; part number KIT000262)	6727	<0.1 ppb @ 0 ppb & <0.2% reading above 50 ppb	<0.2 ppb	<0.5 ppb @ 0 ppb & <0.5% of reading @ full scale	<80 seconds to 95%	ppb, ppm, $\mu g/m^3$, mg/m^3
Gas Dilution/O_3 Transfer Standard	TAPI	T700	4969	1% of reading (linearity)	N/A	<1.0 ppb @ 0 ppb	<20 seconds to 95% (photometer response)	N/A
NH_3	Radiello	N/A	N/A	N/A	0.083 mg/L (Network) 0.013 mg/L (Lab)	N/A	N/A	N/A

Measurement	Manufacturer	Model	Serial Number	Zero and Span Noise	Detection Limit	Drift Over 24-hour Period	Response Time	Units
National Trends Network	N/A	N/A	N/A	N/A	Ca (0.023 mg/L) Mg (0.006 mg/L) K (0.005 mg/L) Na (0.010 mg/L) Br (0.006 mg/L) NH_4 (0.017 mg/L) NO_3 (0.018 mg/L) Cl (0.018 mg/L) SO_4 (0.018 mg/L) PO_4 (0.010 mg/L) Conductance (µS/cm) pH	N/A	N/A	N/A
Orchard								
O_3	TAPI	T400	5985	<0.2 ppb @ 0 ppb & <0.5% reading above 100 ppb	<0.4 ppb	<1 ppb @ 0 ppb & <1% of reading @ span	<30 seconds to 95%	ppb, ppm, $\mu g/m^3$, mg/m^3
O_3 Transfer Standard	TAPI	T703	824	±1% of full scale (linearity)	N/A	<1 ppb @ 0 ppb (7 days) & <1% @ span	<20 seconds to 95% (photometer response)	N/A
NH_3	Radiello	N/A		N/A	0.083 mg/L (Network) 0.013 mg/L (Lab)	N/A	N/A	N/A

Measurement	Manufacturer	Model	Serial Number	Zero and Span Noise	Detection Limit	Drift Over 24-hour Period	Response Time	Units
National Trends Network	N/A	N/A	N/A	N/A	Ca (0.023 mg/L) Mg (0.006 mg/L) K (0.005 mg/L) Na (0.010 mg/L) Br (0.006 mg/L) NH_4 (0.017 mg/L) NO_3 (0.018 mg/L) Cl (0.018 mg/L) SO_4 (0.018 mg/L) PO_4 (0.010 mg/L) Conductance (µS/cm) pH	N/A	N/A	N/A
Hereford								
O_3	TAPI	T400	5984	<0.2 ppb @ 0 ppb & <0.5% reading above 100 ppb	<0.4 ppb	<1 ppb @ 0 ppb & <1% of reading @ span	<30 seconds to 95%	ppb, ppm, $\mu g/m^3$, mg/m^3
O_3 Transfer Standard	TAPI	T703	825	±1% of full scale (linearity)	N/A	<1 ppb @ 0 ppb (7 days) & <1% @ span	<20 seconds to 95% (photometer response)	N/A

Measurement	Manufacturer	Model	Serial Number	Zero and Span Noise	Detection Limit	Drift Over 24-hour Period	Response Time	Units

Notes:

O_3	Ozone	ppb	parts per billion	Mg	Magnesium	NH_4	Ammonium
NO_x	Oxides of nitrogen	ppm	parts per million	K	Potassium	NO3	Nitrate
NH_3	Ammonia	$\mu g/m^3$	Micrograms per meter cubed	Na	Sodium	Cl	Chloride
mg/m^3	Milligrams per meter cubed			Br	Bromide	SO_4	Sulfate
PO_4	Phosphate	Ca	Calcium	pH	Acidity	TAPI	Teledyne Advanced Pollution Instrumentation
		µS/cm	Micro-Siemens per centimeter				

Table 3. Weld County Meteorological Monitoring Station Equipment Specifications

Measurement	Count	Tower Location (m)	Manufacturer	Model	Serial Number	Accuracy	Range	Description
Missile Site Park								
Wind speed & direction	1	10	R.M. Young	05305V	180188	±0.2 m/s & ±3 degrees	0-50 m/s 0-355 deg	Wind monitor
Ambient temperature/Vertical temperature difference	2	2m and 10m	R.M. Young	41342VC	32951 (2 m) 32952 (10 m)	±0.1 °C	-50 to 50°C	Temperature probe with radiation shield
Relative humidity (RH)	1	2	Campbell Scientific/E+E Elektronik	EE181	20151600125038	±1.3% RH [1]	0-100%	Relative humidity and temperature sensor
Solar radiation	1	2	Hukseflux	LP02	48019	<0.15% per °C	0-2000 W/m^2	Thermal pyranometer
Barometric pressure	1	2	Setra	278	7563464	±1.5 hPa[2]	450-825 mmHg	Barometric pressure sensor
Precipitation	1	Ground	R.M. Young	52202	TB16137	2%-3% [3]	0-50 mm/hr	Heated tipping bucket rain gauge
Precipitation-NTN	1	Ground	ETI Instrument Systems	NOAH IV	4310	±0.254 mm	0-280 in/hour	Weight-based rain gauge
Collection bucket-NTN	1	Ground	N-CON	00-120-2N	60441	N/A	N/A	Wet deposition collection buckets
Orchard								
Wind speed & direction	1	10	R.M. Young	05305V	180186	±0.2 m/s & ±3 degrees	0-50 m/s 0-355 deg	Wind monitor
Ambient temperature/Vertical temperature difference	2	2m and 10m	R.M. Young	41342VC	32953 (2 m) 32954 (10 m)	±0.1 °C	-50 to 50°C	Temperature probe with radiation shield

Measurement	Count	Tower Location (m)	Manufacturer	Model	Serial Number	Accuracy	Range	Description
Relative humidity	1	2	Campbell Scientific/E+E Elektronik	EE181	201516001269F1	±1.3% RH [1]	0-100%	Relative humidity and temperature sensor
Solar radiation	1	2	Hukseflux	LP02	48014	<0.15% per °C	0-2000 W/m^2	Thermal pyranometer
Barometric pressure	1	2	Setra	278	7563445	±1.5 hPa [2]	450-825 mmHg	Barometric pressure sensor
Precipitation	1	Ground	R.M. Young	52202	TB16138	2% - 3% [3]	0-50 mm/hr	Heated tipping bucket rain gauge
Precipitation-NTN	1	Ground	ETI Instrument Systems	NOAH IV	4311	±0.254 mm	0-280 in/hour	Weight-based rain gauge
Collection bucket-NTN	1	Ground	N-CON	00-120-2N	60442	N/A	N/A	Wet deposition collection buckets
Hereford								
Wind speed & direction	1	10	R.M. Young	05305V	180187	±0.2 m/s & ±3 degrees	0-50 m/s 0-355 deg	Wind monitor
Ambient temperature/Vertical temperature difference	2	2m and 10m	R.M. Young	41342VC	32950 (2 m) 32869 (10 m)	±0.1 °C	-50 to 50°C	Temperature probe with radiation shield
Relative humidity	1	2	Campbell Scientific/E+E Elektronik	EE181	2015160012638F	±1.3% RH [1]	0-100%	Relative humidity and temperature sensor
Solar radiation	1	2	Hukseflux	LP02	48015	<0.15% per °C	0-2000 W/m^2	Thermal pyranometer
Barometric pressure	1	2	Setra	278	7573233	±1.5 hPa [2]	450-825 mmHg	Barometric pressure sensor
Precipitation	1	Ground	R.M. Young	52202	TB16139	2% - 3% [3]	0-50 mm/hr	Heated tipping bucket rain gauge

Notes:

%	Percent	m/s	Meters per second	W/m^2	Watts per meter squared
ºC	Degrees Celsius	RH	Relative humidity	mmHg	Millimeters of mercury
mm/hr	Millimeters per hour	deg	Degrees	in/hour	Inches per hour

[1] The manufacturer specifies an accuracy range based on a temperature range -15 to 40 °C and RH between 0 and 90%. Above 90% RH, the accuracy decreases to ±2.3% RH

[2] This accuracy range is achieved when the temperature is between -20 to 50 °C.

[3] This accuracy is 2% when the precipitation rate is 25 mm/hr or less and the accuracy is 3% when the precipitation rate is between 25 mm/hr and 50 mm/hr.

4. MONITORING METHODOLOGY

4.1 Data Collection, Management and Storage

All meteorological and gas analyzer data are collected on a continuous basis using a Campbell Scientific Inc. (Campbell) CR3000 data logger. Data are then output to files on 15-minute, 60-minute, and 24-hour frequency. Custom 1-minute and 15-minute tables are also stored by the logger for gaseous calibration tracking and public access of meteorology, respectively. Data files are stored on the CR3000. All three stations are programmed to automatically download and save files from the CR3000 to a Ramboll computer daily. Data files are also manually saved to a separate Ramboll computer several times per week.

Real-time meteorological data for all three stations are also available on the Weld County Public Health Department website. Plots on the Weld County website provide wind speed, maximum wind gusts, wind direction, surface temperature, and precipitation for 15-minute intervals. Data are shown for the previous three days and are updated every 30 minutes.

4.2 Quality Assurance/Quality Control

The quality assurance objectives for this monitoring program are documented in the QAPP. These objectives are designed to be consistent with those outlined in 40 CFR Part 58 Appendix A, *US EPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume II: Ambient Air Monitoring Program*, and *US EPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV: Meteorological Measurements* (together, the "QA Handbooks").[10,11] The QA Handbooks specify the minimum system requirements applicable to data collection and quality assurance requirements for ambient air quality pollutants and meteorological measurements.

4.2.1 Accuracy and Performance Audits

The audit procedures for this monitoring program include semi-annual audits in accordance with the QAPP.[12] An audit was performed in Quarter 2, and a subsequent audit will be performed in calendar Quarter 4. Results from the Quarter 2 2024 audits and calibrations are available in Appendix A of the Q2 2024 Summary Report for the Weld County Monitoring Network. Note, a mistake was found in the Q2 2024 Summary Report's section on the Quarter 2 2024 audits. In Appendix A of that report, in the Table A1-7 as left checks, under T200 Diagnostics, the T200 NO and T200 NOx Slope and Offset parameters were reported the same as in the as found checks of Table A1-6. This means those parameters were not updated in the report. There are no data or instrument performance implications associated with this discrepancy. The most recent and correct values will be reported in Appendix B of the 2024 Annual Report.

[10] USEPA, *Quality Assurance Handbook for Ambient Air Quality Monitoring Volume II: Ambient Air Quality Monitoring Program*, January 2017. Available at: https://www.epa.gov/sites/default/files/2020-10/documents/final_handbook_document_1_17.pdf. Accessed February 2024.

[11] USEPA, *Quality Assurance Handbook for Ambient Air Quality Monitoring Volume IV: Meteorological Measurements*, March 2008. Available at: https://www.epa.gov/sites/default/files/2021-04/documents/volume_iv_meteorological_measurements.pdf. Accessed July 2024.

[12] Ramboll, Weld County Ambient Air Monitoring Program Quality Assurance Project Plan (QAPP), September 18th 2023. Available by request.

4.2.2 Calibration Protocol

The calibration procedures utilized for the project included automated routine calibration checks in accordance with the QAPP. For O_3 analyzers, calibration checks include Precision-Span-Zero checks at all three stations three times per week. For the NO_x analyzer at MSP, calibration checks include Precision-Span-Zero checks and gas-phase titration checks twice per week. Note that the Precision-Span-Zero check and titration checks occur on different days. The minimum frequency required per check is once every 14 days, per Appendix D of the Quality Assurance Handbook, Volume II[10]. **Table 4** below highlights periods during the quarter when the minimum frequency was not met and provides an explanation. Note, if the period between two calibration checks does not meet the 14-day criterion, but the two calibration checks surrounding this period are passing then no data invalidation is required. Since the calibration checks surrounding the dates in **Table 4** were passing, no data invalidation was required. A summary of calibration data for Q3 2024 is available in **Appendix C**. Maintenance is performed as necessary in response to measured deviations during calibrations and as part of planned routine activities during station inspections.

Table 4. Periods When Minimum Calibration Frequency Not Met

Period	Number of Days	Calibration Check	Reason
Missile Site Park			
Sept 15 – Oct 1	16	NO2: GPT/Converter Efficiency	Zero air generator not building pressure due to leak

4.2.3 Data Completeness and Significant Events

Data completeness is calculated as the amount of valid data divided by the amount of potential data possible over a specified period, expressed as a percentage. In accordance with the QAPP, data are reviewed to determine that data are valid. Any data that is affected by known and qualifiable instrument performance problems, periods of routine maintenance, power failures, and/or site visits, or calibration/audit checks are invalidated. Hours with invalid data are removed from the final valid dataset and lower the calculated data completeness statistics. Program activities conducted during Q3 2024 included data collection, equipment programming and calibrations, station inspections, routine maintenance, equipment troubleshooting and repair, routine data acquisition, data screening and validation, and report preparation. Significant events that resulted in invalidation of data are documented in **Appendix A**, along with corrective reports detailing troubleshooting, maintenance, and repairs that occurred during the quarter. **Appendix B** contains the site access logs.

Consistent with data completeness requirements specified in the QA Handbooks, the quarterly data completeness goals are greater than or equal to (≥) 75% for NO_2 data, and ≥ 90% for meteorological data. For O_3, the data completeness goals are ≥ 75% of the daily maximum 8-hour averages of O_3 during the O_3 season, which in Colorado is January to December[13]. However, over three consecutive ozone seasons the overall data completeness must be ≥ 90% on average, thus we have set a goal of

[13] USEPA Ozone Seasons, February 13 2024. Available at: https://aqs.epa.gov/aqsweb/documents/codetables/ozone_seasons.html. Accessed: February 2024.

≥ 90% for the monitoring network. A summary of data completeness targets and program results by month and for the quarter is presented in **Table 5** for all continuous monitoring systems. During Q3 2024, data losses occurred from regularly scheduled gas calibrations (496 hours), power outages (14 hours), manual gas calibrations (29 hours), instrument maintenance (22 hours), wildlife impact (156 hours), shelter temperature issues (141), and other miscellaneous issues (101 hours).

Notable events that occurred during the quarter that resulted in data loss include: (1) MSP's precipitation sensor experienced an issue caused by a spider web interference from August 15th through August 21st, (2) MSP's O_3 and NO_x analyzers had loose sample filter holders following filter change from September 24th through September 25th, (3) the air conditioner required replacement at Orchard, which interrupted data collection from July 19th through July 25th, and (4) the zero air generator at MSP began to fail resulting in intermittent data losses of O_3, NO, NO_2, and NO_x between September 18th and September 20th as a result of manual calibration check attempts. Despite these data losses, all data completeness goals were met at each of the three sites during Q3 2024.

Figure 5 shows the extended period during which the Orchard ozone analyzer was powered down while the air conditioner unit was repaired from July 19th through July 25th. Data completeness for O_3 will be evaluated once the O_3 season is complete in December 2024 in accordance with the data completeness targets.

The QA Handbooks have also established goals for instrument accuracy and precision. **Figure 2** presents a graphic that depicts the importance of accuracy and precision. **Table 6** presents the instrument accuracy and precision targets and the accuracy and precision achieved by the instruments deployed at each station during the most recent semi-annual calibrations in Q2 2024. No calibration checks took place during Q3 2024.

Table 5. 3rd Quarter 2024 Data Completeness for Continuous Measurement Devices

Measurement	Time Period	Completeness Target	Site Completeness				Target Met? (Y/N)
			Jul	Aug	Sep	Q3 2024	
Missile Site Park							
NO_2[1]	Quarterly	≥75%	95%	94%	92%	94%	Yes
NO_x, NO[1]	N/A	N/A	95%	94%	92%	94%	N/A
O_3[1]	O_3 Season	≥90%	100%	100%	93%	98%	N/A
Wind Direction[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Wind Speed[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Temperature[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Delta Temperature[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Relative Humidity[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Solar Radiation[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Barometric Pressure[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Precipitation[2,3]	Quarterly	≥90%	100%	79%	100%	93%	Yes

Measurement	Time Period	Completeness Target	Site Completeness				Target Met? (Y/N)
			Jul	Aug	Sep	Q3 2024	
Hereford							
O_3[1]	O_3 Season	≥90%	100%	100%	100%	100%	N/A
Wind Direction[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Wind Speed[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Temperature[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Delta Temperature[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Relative Humidity[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Solar Radiation[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Barometric Pressure[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Precipitation[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Orchard							
O_3[1]	O_3 Season	≥90%	77%	100%	100%	92%	N/A
Wind Direction[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Wind Speed[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Temperature[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Delta Temperature[2,3]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Relative Humidity[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Solar Radiation[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Barometric Pressure[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Precipitation[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes

Notes:

[1] USEPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume II: Ambient Air Quality Monitoring Program, recommends three consecutive response concentrations be within +/- 15% of the audit concentration for quarterly audits. For bi-weekly QC checks acceptable monitor responses are +/-15.1% for NO_2 and 7.1% for O_3. The data completeness target for NO_2 is ≥75%; there is no data completeness target for NO or NO_x. For O_3, the data completeness target is met for a 3-year period with an average of 90% of daily maximum 8-hour averages available for a 3-year ozone season period. In Colorado, the Ozone season is January through December (https://aqs.epa.gov/aqsweb/documents/codetables/ozone_seasons.html).

[2] Table 0-9, USEPA Quality Assurance Handbook for Air Pollution Measurement Systems (Volume IV: Meteorological Measurements, Version 2.0).

[3] Table 0-10, USEPA Quality Assurance Handbook for Air Pollution Measurement Systems (Volume IV: Meteorological Measurements, Version 2.0). Temperature is measured at 2 meters above ground level.

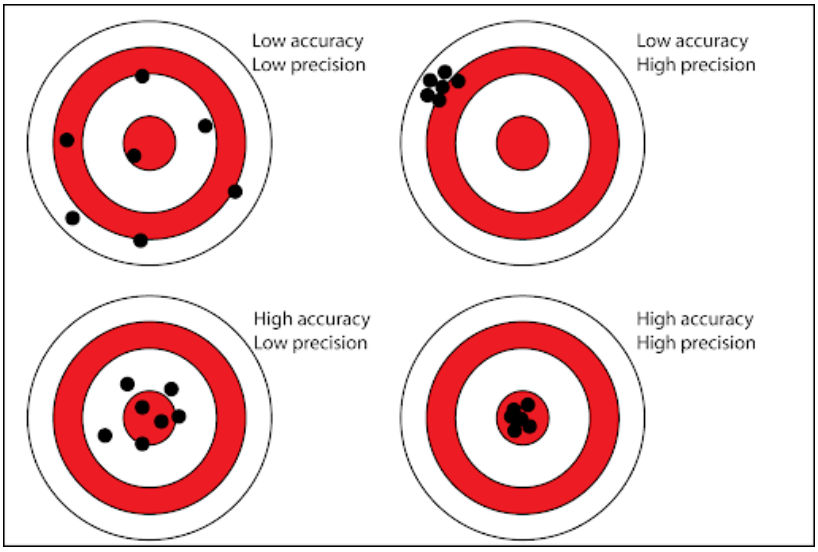


Figure 2. Graphical Representation of Accuracy and Precision

Table 6. 2nd Quarter 2024 Accuracy and Precision

Measurement	Target Accuracy	Target Precision	Q2 2024 Calibration Results[1]
Missile Site Park			
$NO_x/NO/NO_2$	±15%	±15.1%	PASS[2]
O_3	±15%	±7.1%	PASS
Wind Direction	±5°	±5°	PASS
Wind Speed	±0.2 m/s	±0.2 m/s	PASS
Temperature	±0.5 °C	±0.5 °C	PASS
Delta Temperature	±0.1 °C	±0.1 °C	PASS
Relative Humidity	±7%	±7%	PASS
Solar Radiation	±5%	±5%	PASS
Barometric Pressure	±2.25 mm Hg	±2.25 mm Hg	PASS
Precipitation	±10%	±10%	PASS
Hereford			
O_3	±15%	±7.1%	PASS
Wind Direction	±5°	±5°	PASS
Wind Speed	±0.2 m/s	±0.2 m/s	PASS
Temperature	±0.5 °C	±0.5 °C	PASS
Delta Temperature	±0.1 °C	±0.1 °C	PASS
Relative Humidity	±7%	±7%	PASS
Solar Radiation	±5%	±5%	PASS
Barometric Pressure	±2.25 mm Hg	±2.25 mm Hg	PASS
Precipitation	±10%	±10%	PASS

Measurement	Target Accuracy	Target Precision	Q2 2024 Calibration Results[1]
Orchard			
O_3	±15%	±7.1%	PASS
Wind Direction	±5°	±5°	PASS
Wind Speed	±0.2 m/s	±0.2 m/s	FAIL[3]
Temperature	±0.5 °C	±0.5 °C	PASS
Delta Temperature	±0.1 °C	±0.1 °C	PASS
Relative Humidity	±7%	±7%	PASS
Solar Radiation	±5%	±5%	PASS
Barometric Pressure	±2.25 mm Hg	±2.25 mm Hg	PASS
Precipitation	±10%	±10%	PASS

Notes:

[1] Results of calibrations are found in Appendix A of the Quarter 2 2024 report.

[2] The lowest flow set point on the low-flow mass flow controller (MFC) was found to be outside of acceptance criteria during the Q2 2024 audit check and was subsequently re-calibrated to be within specification. It was determined that this result did not impact data since this flow rate is outside the range of flows that the MFC operates in during all calibration checks. See Appendix A of the Q2 2024 report for more detail.

[3] The highest wind speed audit point was found to be outside of the acceptance criteria during the Q2 2024 audit check and was subsequently re-calibrated to be within specification. Data points at or above this threshold were invalidated during the Q1-Q2 period, resulting in a partial loss of data during two hourly periods. This result did not impact Q3 2024 data.

5. AIR QUALITY DATA SUMMARY

Air quality data collected includes O_3 at all three stations and $NO/NO_x/NO_2$ at the MSP station. In addition, wet deposition and gaseous ammonia are measured in accordance with the National Atmospheric Deposition Program (NADP) standard operating procedures at MSP and Orchard. Q3 2024 wet deposition and gaseous ammonia data from NADP are not yet available. When Q3 2024 wet deposition and gaseous ammonia data are available a separate memorandum will be issued. This section summarizes the O_3 and NO_2 data collected during Q3 2024.

5.1 Gaseous O_3 Data Summary

O_3 data collected for Q3 2024 at all three stations was compared against the 2008 O_3 AAQS (0.075 ppm) and 2015 ozone AAQS (0.070 ppm). Both the 2008 and 2015 ozone AAQS are based on the fourth highest daily maximum 8-hour ozone concentration averaged over 3 years. The daily maximum 8-hour average ozone concentrations measured at all three stations during Q3 2024 were above the levels of both the 2008 and 2015 AAQS values. During Q3 2024, MSP recorded 19 instances above the 2015 ozone AAQS value, while Hereford recorded eight, and Orchard recorded five. There were nine instances above the 2008 AAQS value at MSP, four at Hereford, and one at Orchard. The four highest year-to-date daily maximum 8-hour average ozone concentrations at all three stations for 2024 are presented in **Table 7**. **Table 8** shows the 3-year average of the fourth highest daily maximum 8-hour average ozone concentrations at each site for historical data and for 2024 year-to-date. Values are color-coded according to the AAQS values; yellow indicates values above only the 2015 AAQS value, while orange indicates value above both the 2015 and 2008 AAQS values. The rolling 8-hour average ozone concentrations at MSP, Hereford, and Orchard are presented in **Figure 3**, **Figure 4**, and **Figure 5**, respectively. Comparison to the AAQS standard for the full year of monitoring data collected in 2024 will be done as part of the 2024 annual report.

5.1.1 MSP Year-to-Date O_3 Data Summary

For year-to-date 2024 at MSP, the measured daily maximum 8-hour average ozone concentrations were above the 2008 standard nine times and above the 2015 standard 20 times. All but one of these instances occurred during Q3 2024. Year-to-date, the 4th highest daily maximum 8-hour average was 0.080 ppm, which occurred on July 22nd. This gives a year-to-date 3-year average of the 4th highest daily maximum 8-hour average of 0.074 ppm, which is above the 2015 AAQS standard, but below the 2008 AAQS standard.

5.1.2 Hereford Year-to-Date O_3 Data Summary

For year-to-date 2024 at Hereford, measured daily maximum 8-hour average ozone concentrations were above the 2008 standard four times and above the 2015 standard eight times. All of these instances occurred during Q3 2024. Year-to-date, the 4th highest daily maximum 8-hour average was 0.077 ppm, which occurred on August 1st. This gives a year-to-date 3-year average of the 4th highest daily maximum 8-hour average of 0.068 ppm, which is below both the 2015 and 2008 AAQS standards.

5.1.3 Orchard Year-to-Date O_3 Data Summary

For year-to-date 2024 at Orchard, measured daily maximum 8-hour average ozone concentrations were above the 2008 standard one time and above the 2015 standard 5 times. All of these instances occurred during Q3 2024. Year-to-date, the 4th highest daily maximum 8-hour average was 0.072 ppm, which occurred on August 2nd. This gives a year-to-date 3-year average of the 4th highest daily maximum 8-hour average of 0.068 ppm, which is below both the 2015 and 2008 AAQS standards.

Note that the gap in data from July 18th through July 24th in **Figure 5** was due the failure of the shelter air conditioning system during which the instrument was shut down to avoid operating above its safe temperature threshold. See Section 3.2.3 and Appendix A-1 for more information about the air conditioner repair.

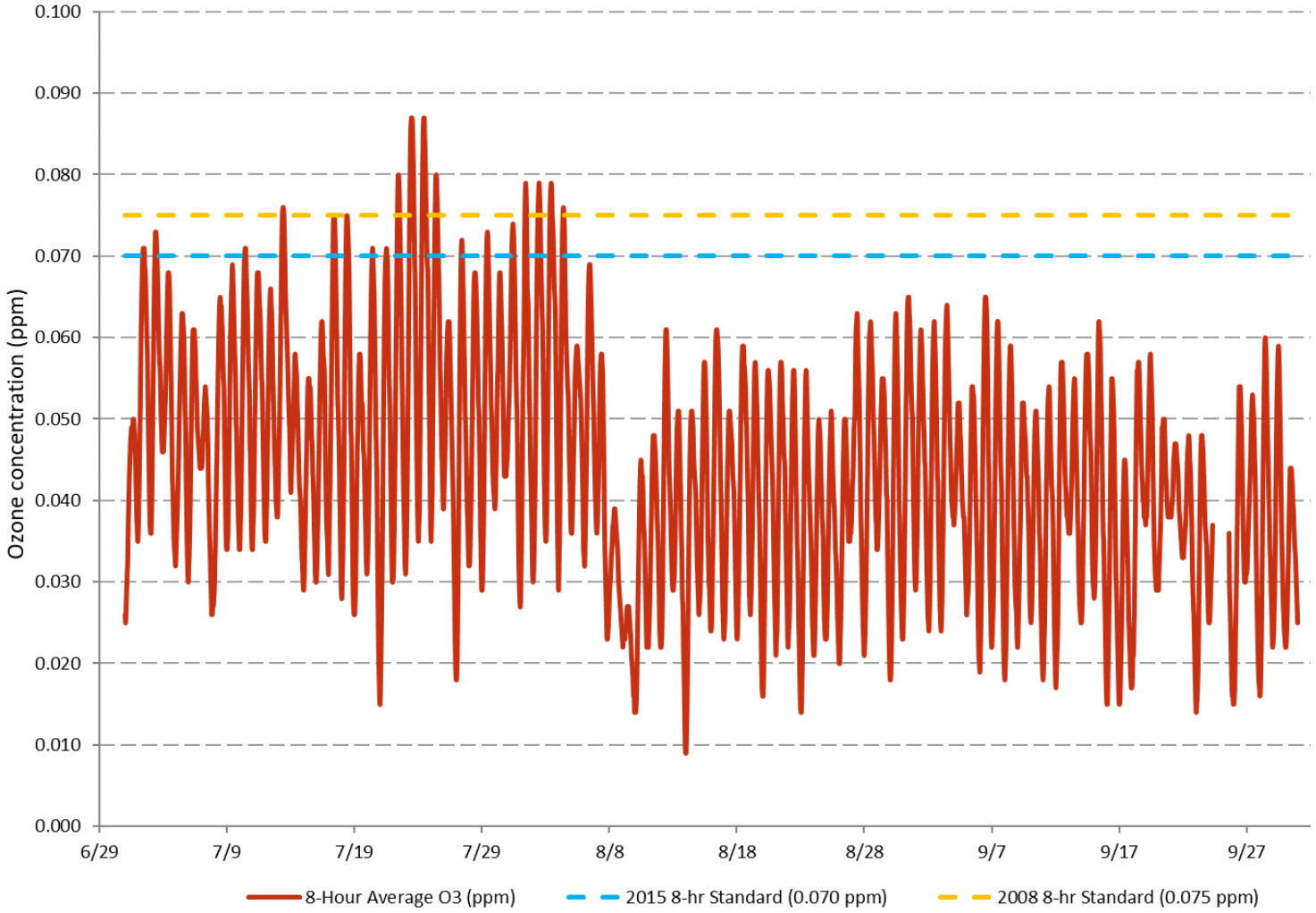


Figure 3. MSP Q3 2024 Rolling 8-hour averaged O_3

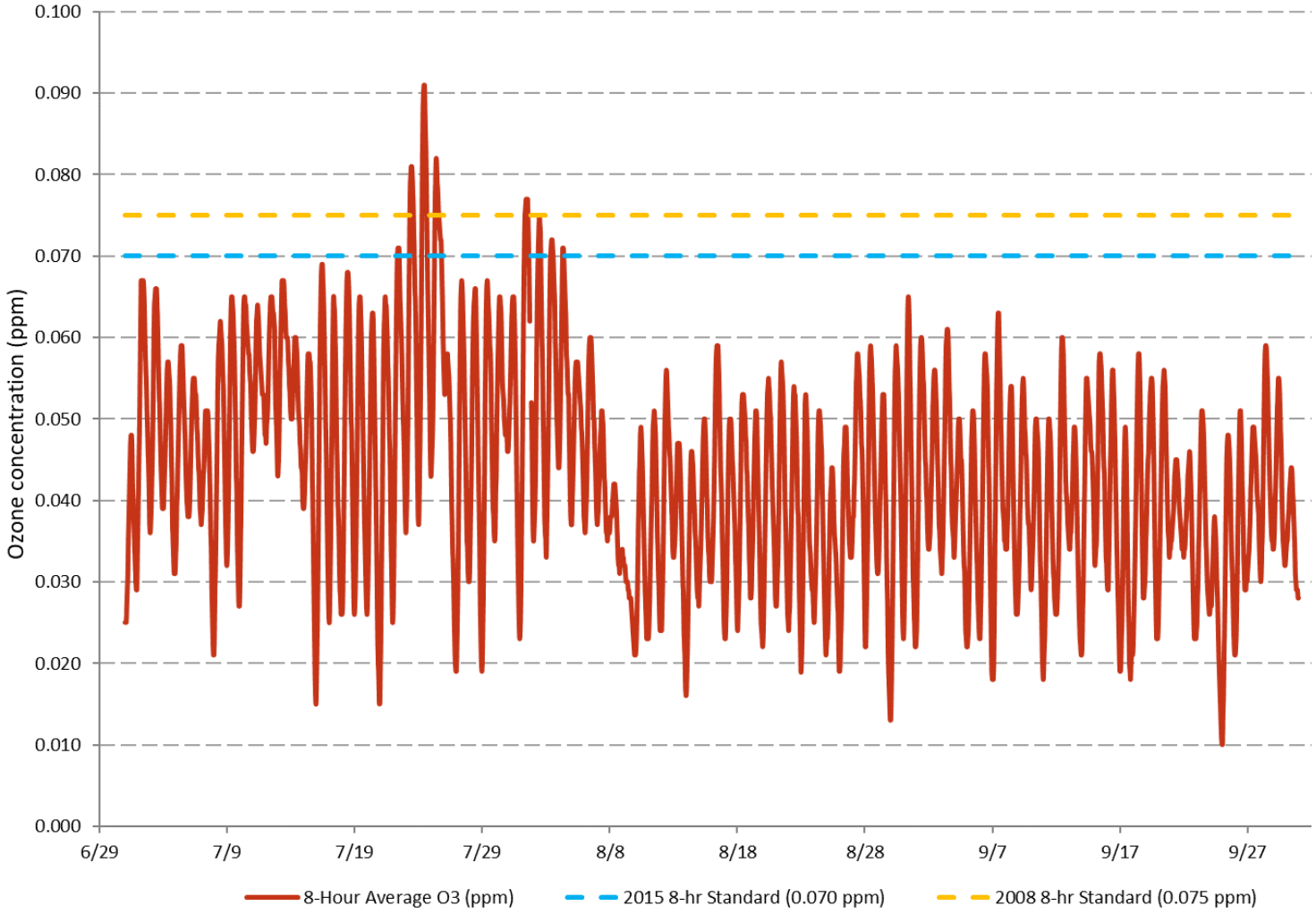


Figure 4. Hereford Q3 2024 Rolling 8-hour averaged O_3

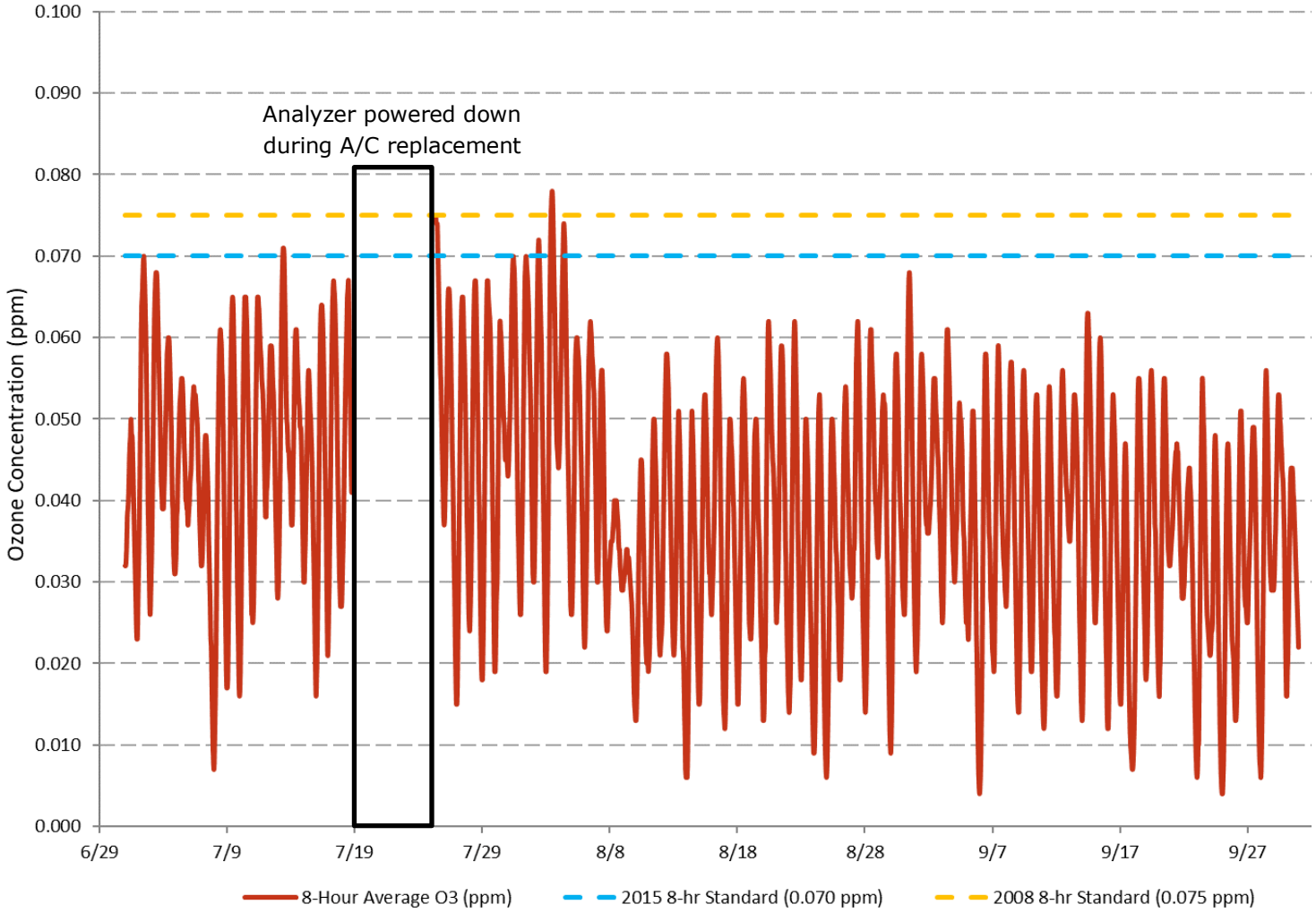


Figure 5. Orchard Q3 2024 Rolling 8-hour averaged O_3

Table 7. Weld County Network Year-to-Date Highest Daily Maximum 8-hour Average O_3

Site Name	1st Max 8-Hour (ppm)	Date 1st Max 8-Hour	2nd Max 8-Hour (ppm)	Date 2nd Max 8-Hour	3rd Max 8-Hour (ppm)	Date 3rd Max 8-Hour	4th Max 8-Hour (ppm)	Date 4th Max 8-Hour	Max 8-Hour Averages Exceeding the 2008 AAQS Value[1]	Max 8-Hour Averages Exceeding the 2015 AAQS Value[1]
MSP	0.087	7/23/2024	0.087	7/24/2024	0.080	7/22/2024	0.080	7/25/2024	9	20
Hereford	0.091	7/24/2024	0.082	7/25/2024	0.081	7/23/2024	0.077	8/1/2024	4	8
Orchard	0.078	8/3/2024	0.075	7/25/2024	0.074	8/4/2024	0.072	8/2/2024	1	5

Notes:
[1] The O_3 AAQS value is based on the 3-year average of the 99th percentile (4th highest) of 8-hour daily maximum concentrations. Comparison with the O_3 AAQS for 2024 will be made at the conclusion of the calendar year.
[2] Orange highlighting indicates that the value is above the 2008 O_3 standard. Yellow highlighting indicates that the value is above the 2015 O_3 standard.

Table 8. Weld County Network Historical and 2024 Year-to-Date Comparison to O_3 AAQS

Year	MSP 4th Max 8-Hour (ppm)	3-Year Average (ppm)	AAQS[1] Exceeded?	Hereford 4th Max 8-Hour (ppm)	3-Year Average (ppm)	AAQS[1] Exceeded?	Orchard 4th Max 8-Hour (ppm)	3-Year Average (ppm)	AAQS[1] Exceeded?
2021	0.079	-	-[2]	0.075	-	-[2]	0.075	-	-[2]
2022	0.073	-	-[2]	0.065	-	-[2]	0.069	-	-[2]
2023	0.069	0.073	Yes	0.063	0.067	No	0.064	0.069	No
2024[3]	0.080	0.074	Yes	0.077	0.068	No	0.072	0.068	No

Notes:
[1] The O_3 AAQS value is based on the 3-year average of the 99th percentile (4th highest) of 8-hour daily maximum concentrations. Comparison with the O_3 AAQS for 2024 will be made at the conclusion of the calendar year.
[2] Three years of data are required for computation of the AAQS value and comparison to the standard.
[3] Results for 2024 utilize year-to-date values for the 4th highest 8-hour daily maximum concentrations.
[4] Orange highlighting indicates that the value is above the 2008 O_3 standard. Yellow highlighting indicates that the value is above the 2015 O_3 standard.

5.2 Gaseous NO_2 Data Summary

NO_2 data collected at MSP was compared against the AAQS standard for 1-hour averaged NO_2 (100 ppb). Once a full year of data has been collected, measurements will be compared to the annual standard (53 ppb). The 1-hour average NO_2 standard is based on the 98th percentile (8th highest) 1-hour daily maximum concentrations, averaged over 3-years. The daily maximum 1-hour average concentration in Q3 2024 was 16.9 ppb, recorded on July 7th at 22:00 Mountain Daylight Time. A timeseries of hourly NO_2 data collected in Q3 2024 is presented in **Figure 6**. A summary of NO_2 data collected year-to-date is presented in **Table 9** and **Table 10**.

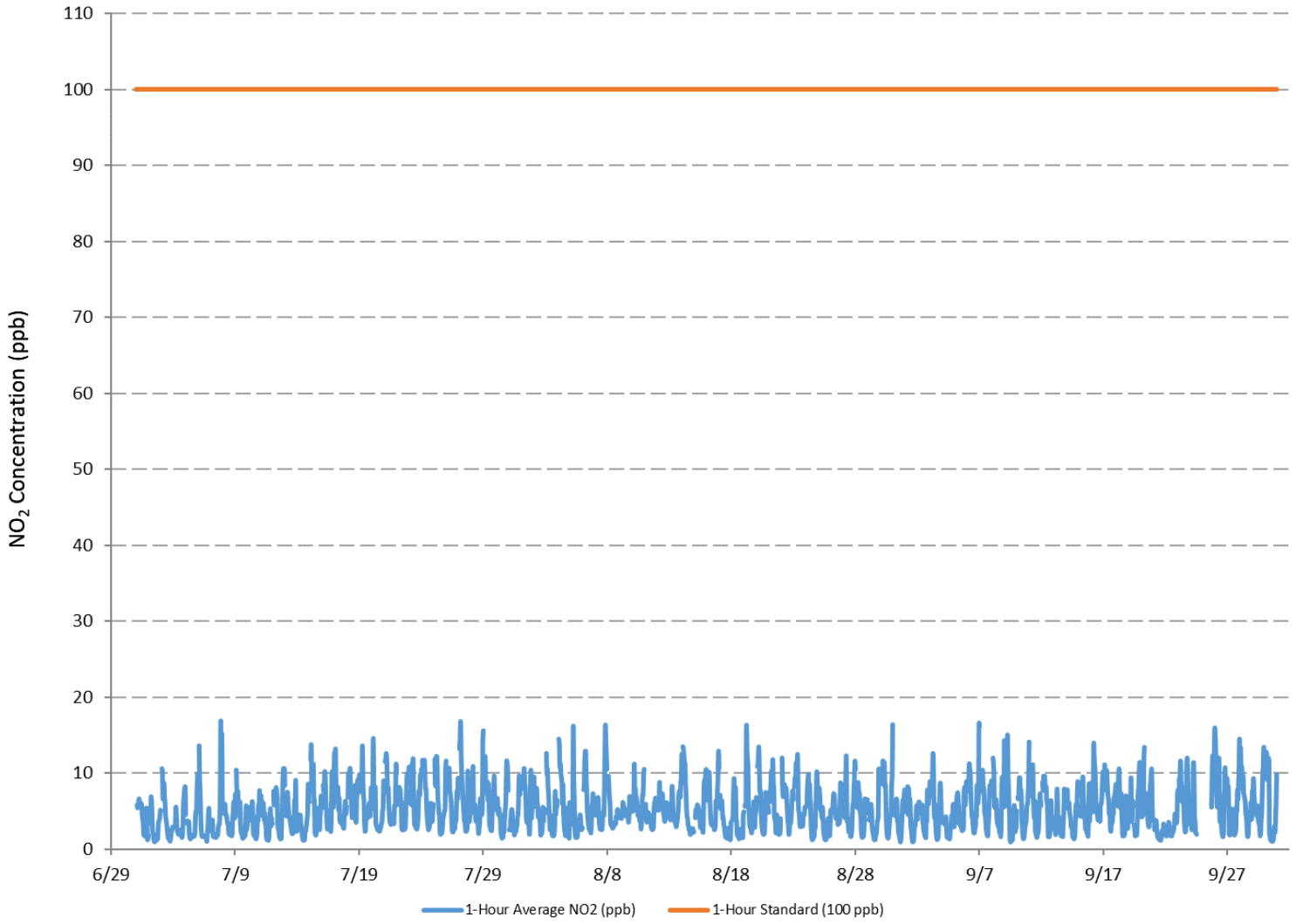


Figure 6. MSP Q3 2024 1-Hour Averaged NO_2

Table 9. MSP Year-to-Date Highest Daily Maximum 1-Hour Average NO_2

Period	1st Maximum	2nd Maximum	3rd Maximum	4th Maximum	5th Maximum	6th Maximum	7th Maximum	8th Maximum	Max 1-Hour Averages Exceeding the AAQS Value[1]
2022 NO_2 (ppb)	67.2	63.4	62.0	58.0	57.4	56.9	54.5	54.5	0
2023 NO_2 (ppb)	64.9	58.3	52.4	51.7	51.5	51.2	50.2	49.4	0
2024 NO_2 (ppb)	45.8	44.2	37.6	35.1	33.6	33	30.5	29.8	0

Notes:

[1] The 1-hour NO_2 AAQS standard is based on the 3-year average of the 98th percentile (8th highest) of 1-hour daily maximum concentrations. Comparison with the 1-hour AAQS standard (100 ppb) for 2024 will be made at the conclusion of the calendar year.

Table 10. MSP Year-to-Date 1-Hour NO_2 Quarterly and Annual Averages

Period	Q1 Quarterly Average	Q2 Quarterly Average	Q3 Quarterly Average	Q4 Quarterly Average	Annual Mean	Annual AAQS Design Value[1] Exceeded?
2022 NO_2 (ppb)	13.6	4.3	5.7	10.3	8.5	No
2023 NO_2 (ppb)	13.4	4.8	4.8	9.7	8.0	No
2024 NO_2 (ppb)	8.6	3.9	5.2	-[2]	-[2]	-[2]

Notes:

[1] The annual NO_2 standard is based on the annual mean of 1-hour average NO_2 concentrations.

[2] Insufficient data is available to calculate the value. Comparison with the annual AAQS standard (53 ppb) for 2024 will be made at the conclusion of the calendar year.

6. METEOROLOGICAL DATA SUMMARY

This section summarizes the meteorological data collected during Q3 2024.

6.1 Wind Data Summary

The Q3 2024 average wind speed at the three stations at 10-m above ground level (agl) was 2.74 meters per second (m/s), 3.64 m/s, and 3.14 m/s at MSP, Hereford, and Orchard, respectively. The maximum hourly average wind speed for Q3 2024 was 10.36 m/s at MSP, 14.87 m/s at Hereford, and 13.37 m/s at Orchard. **Figure 7** through **Figure 9** present wind rose plots for each station during Q3 2024. These wind roses are a graphical representation of how the wind speed and direction were distributed for Q3 2024. On each wind rose, the bars at 0 degrees (°) correspond to wind coming from the North and the bars at 180° correspond to wind coming from the South. The size of each bar is an indication of how frequently the wind comes from a particular direction. The color of the bars represents the corresponding wind speed when the wind was blowing from a particular direction. Each station had a unique wind profile during Q3 2024. At the MSP station, wind direction had little directional trend and came more or less equally from all directions, with a slightly higher frequency of southeasterly and northwesterly winds. At the Hereford station winds mostly came from the south, north, and northwest and were also the fastest from the north. At the Orchard station winds mostly came from the east and west and were the strongest from the east and north. Monthly average hourly and maximum wind speeds per month at each station are listed in **Table 11** along with all other measured meteorological parameters.

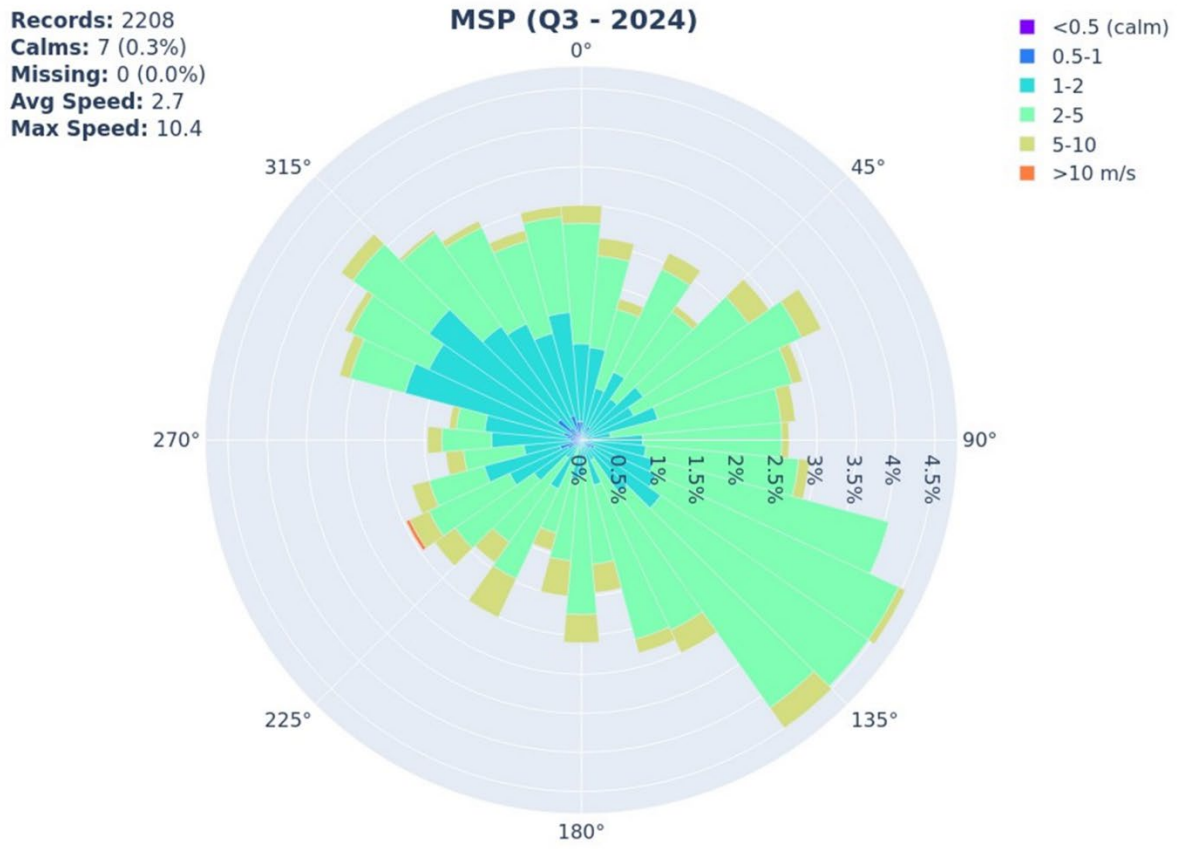


Figure 7. MSP Q3 2024 Wind Rose

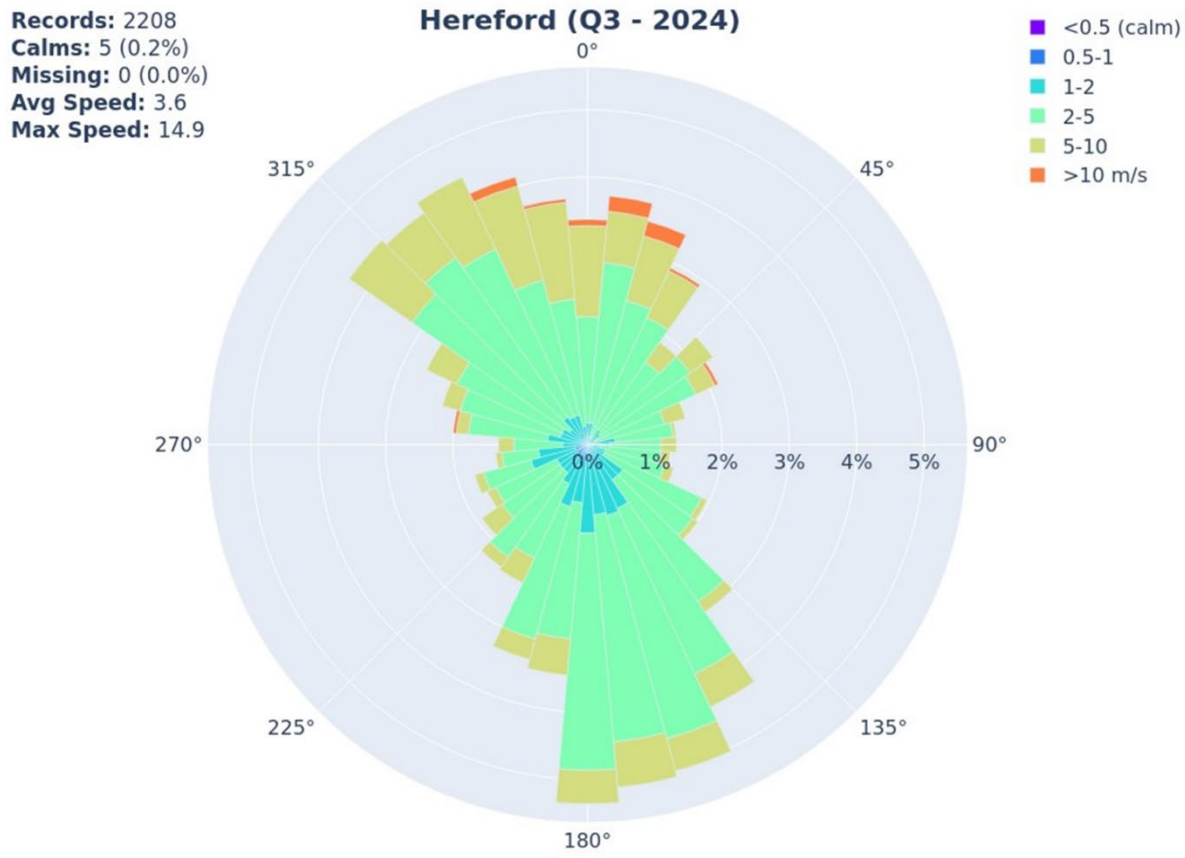


Figure 8. Hereford Q3 2024 Wind Rose

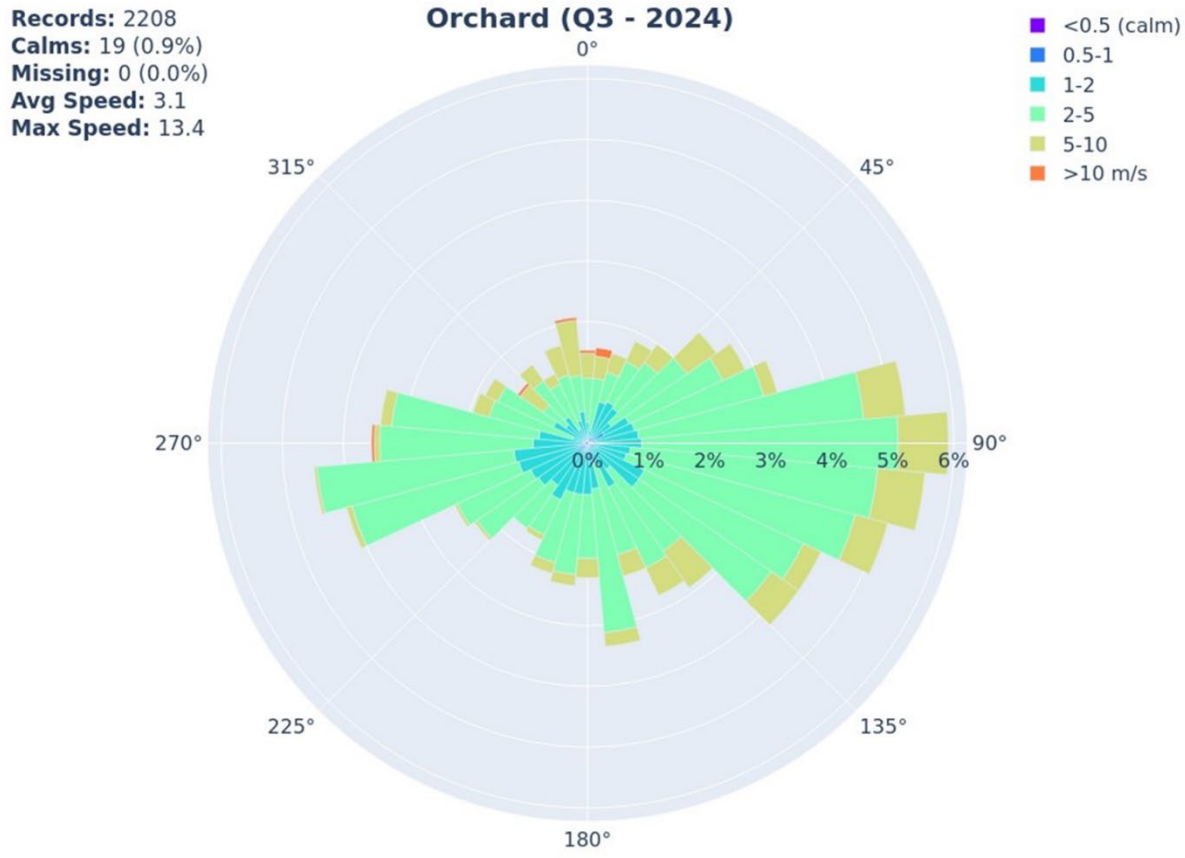


Figure 9. Orchard Q3 2024 Wind Rose

Table 11. Q3 2024 Meteorological Data Summary

Parameter	Units	Form	July	August	September
Missile Site Park					
2-M Temperature	°C	Monthly Average	23.57	22.81	19.97
		Maximum Hourly Average	38.53	36.83	34.02
		Minimum Hourly Average	11.42	11.68	5.59
10-M Temperature	°C	Monthly Average	23.41	22.62	20.01
		Maximum Hourly Average	37.01	35.53	32.49
		Minimum Hourly Average	11.86	11.77	6.09
Delta Temperature	°C	Monthly Average	-0.16	-0.19	0.04
		Maximum Hourly Average	2.81	2.59	2.80
		Minimum Hourly Average	-1.90	-2.04	-1.89
10-M Horizontal Wind Speed	m/s	Monthly Average	2.74	2.90	2.59
		Maximum Hourly Average	9.51	10.36	8.71
2-M Relative Humidity	Percent	Monthly Average	45.49	56.31	45.77
		Maximum Hourly Average	97.30	100.00	99.70
Station Barometric Pressure	mm Hg	Monthly Average	638.21	639.07	637.23
		Maximum Hourly Average	643.43	643.13	646.30
Station Precipitation	in	Monthly Total	0.931	1.347	0.940
	in/hr	Maximum Hourly Total	0.248	0.500	0.110
2-M Solar Radiation	W/m^2	Monthly Average	302.2	258.4	234.2
		Maximum Hourly Average	1059.0	1023.0	927.0
Hereford					
2-M Temperature	°C	Monthly Average	21.90	20.78	17.98
		Maximum Hourly Average	36.70	35.52	33.22
		Minimum Hourly Average	6.05	6.08	4.08

Parameter	Units	Form	July	August	September
10-M Temperature	°C	Monthly Average	22.00	20.91	18.52
		Maximum Hourly Average	35.14	34.20	31.79
		Minimum Hourly Average	7.19	7.41	5.04
Delta Temperature	°C	Monthly Average	0.11	0.13	0.54
		Maximum Hourly Average	5.91	5.62	6.07
		Minimum Hourly Average	-1.93	-1.80	-1.87
10-M Horizontal Wind Speed	m/s	Monthly Average	3.69	3.60	3.62
		Maximum Hourly Average	14.87	11.18	12.63
2-M Relative Humidity	Percent	Monthly Average	48.92	62.06	48.05
		Maximum Hourly Average	100.00	100.00	97.80
Station Barometric Pressure	mm Hg	Monthly Average	630.36	631.27	629.34
		Maximum Hourly Average	635.01	635.01	638.03
Station Precipitation	in	Monthly Total	0.960	4.034	0.359
	in/hr	Maximum Hourly Total	0.197	0.918	0.110
2-M Solar Radiation	W/m^2	Monthly Average	291.3	255.9	237.3
		Maximum Hourly Average	1070.0	989.0	1055.0
Orchard					
2-M Temperature	°C	Monthly Average	23.21	22.53	18.98
		Maximum Hourly Average	39.20	39.05	35.28
		Minimum Hourly Average	8.89	6.06	2.73
10-M Temperature	°C	Monthly Average	23.42	22.68	19.69
		Maximum Hourly Average	37.52	37.43	33.71
		Minimum Hourly Average	9.56	8.50	3.81
Delta Temperature	°C	Monthly Average	0.20	0.15	0.71
		Maximum Hourly Average	4.93	5.88	5.59
		Minimum Hourly Average	-2.10	-2.11	-2.07

Parameter	Units	Form	July	August	September
10-M Horizontal Wind Speed	m/s	Monthly Average	3.26	3.20	2.95
		Maximum Hourly Average	13.37	9.41	10.91
2-M Relative Humidity	Percent	Monthly Average	51.51	61.83	53.00
		Maximum Hourly Average	98.90	100.00	100.00
Station Barometric Pressure	mm Hg	Monthly Average	649.53	650.52	648.71
		Maximum Hourly Average	654.31	655.00	657.88
Station Precipitation	in	Monthly Total	1.382	1.646	1.761
	in/hr	Maximum Hourly Total	0.642	0.682	0.374
2-M Solar Radiation	W/m^2	Monthly Average	302.3	260.0	233.5
		Maximum Hourly Average	1029.0	995.0	897.0

6.2 Precipitation Data Summary

Hourly precipitation data was collected at all three stations with a tipping bucket sensor at 1-m agl. August had the highest total monthly precipitation at Hereford and MSP, while September had the highest total monthly precipitation at Orchard. A summary of total monthly and maximum hourly precipitation for Q3 2024 at all three stations is presented in **Figure 10** - **Figure 12** and in **Table 11**.

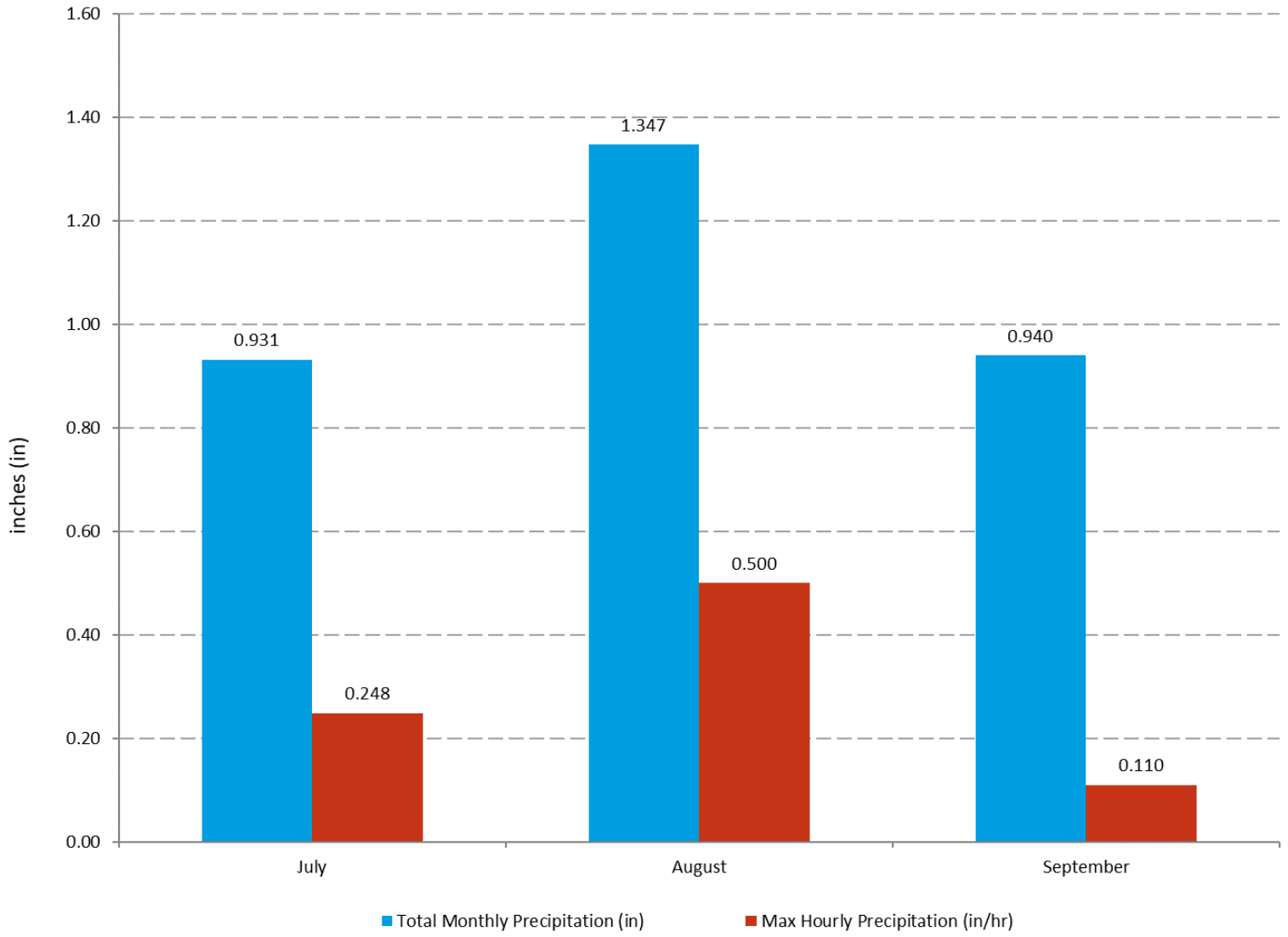


Figure 10. MSP Q3 2024 Precipitation Summary

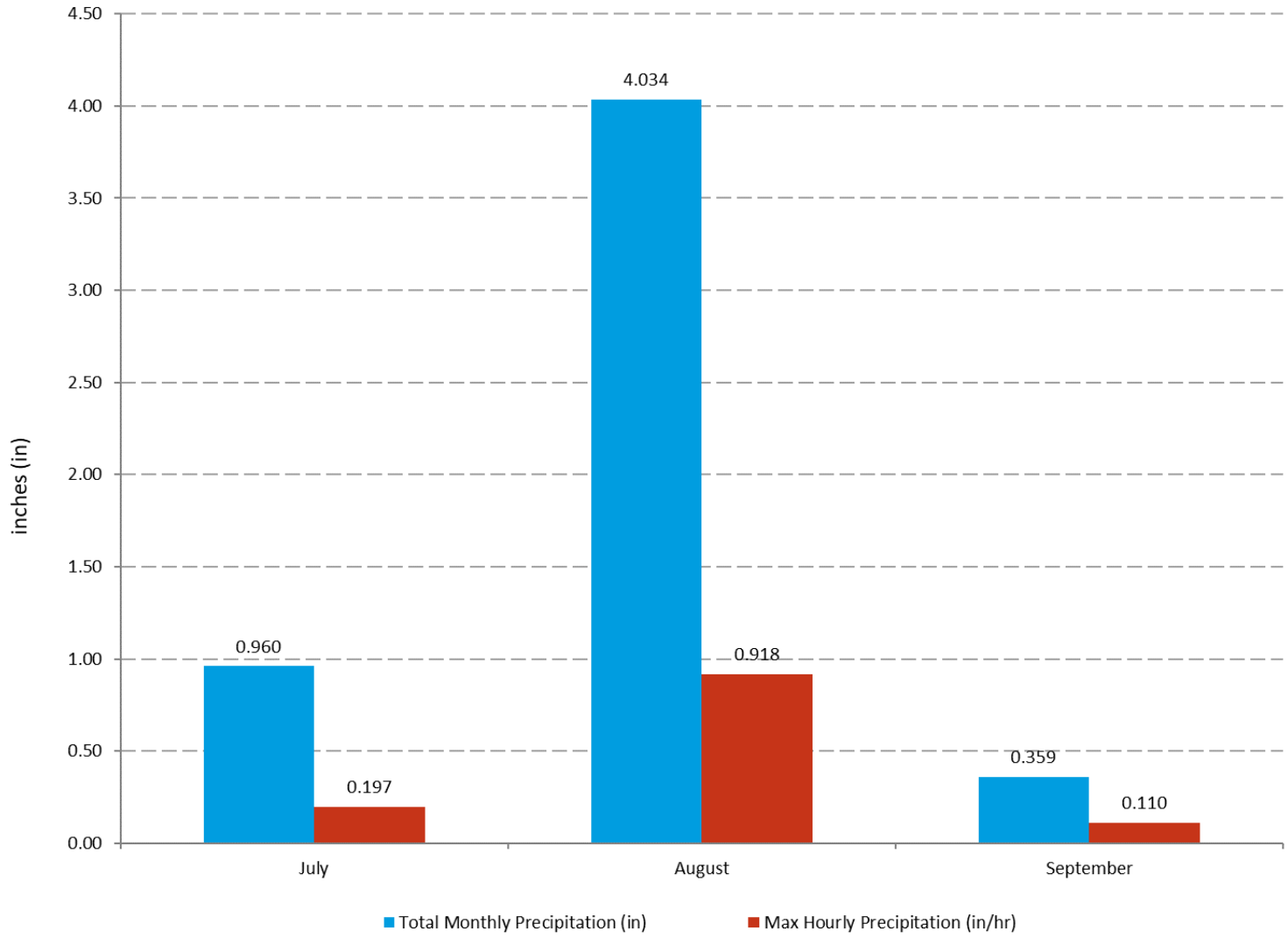


Figure 11. Hereford Q3 2024 Precipitation Summary

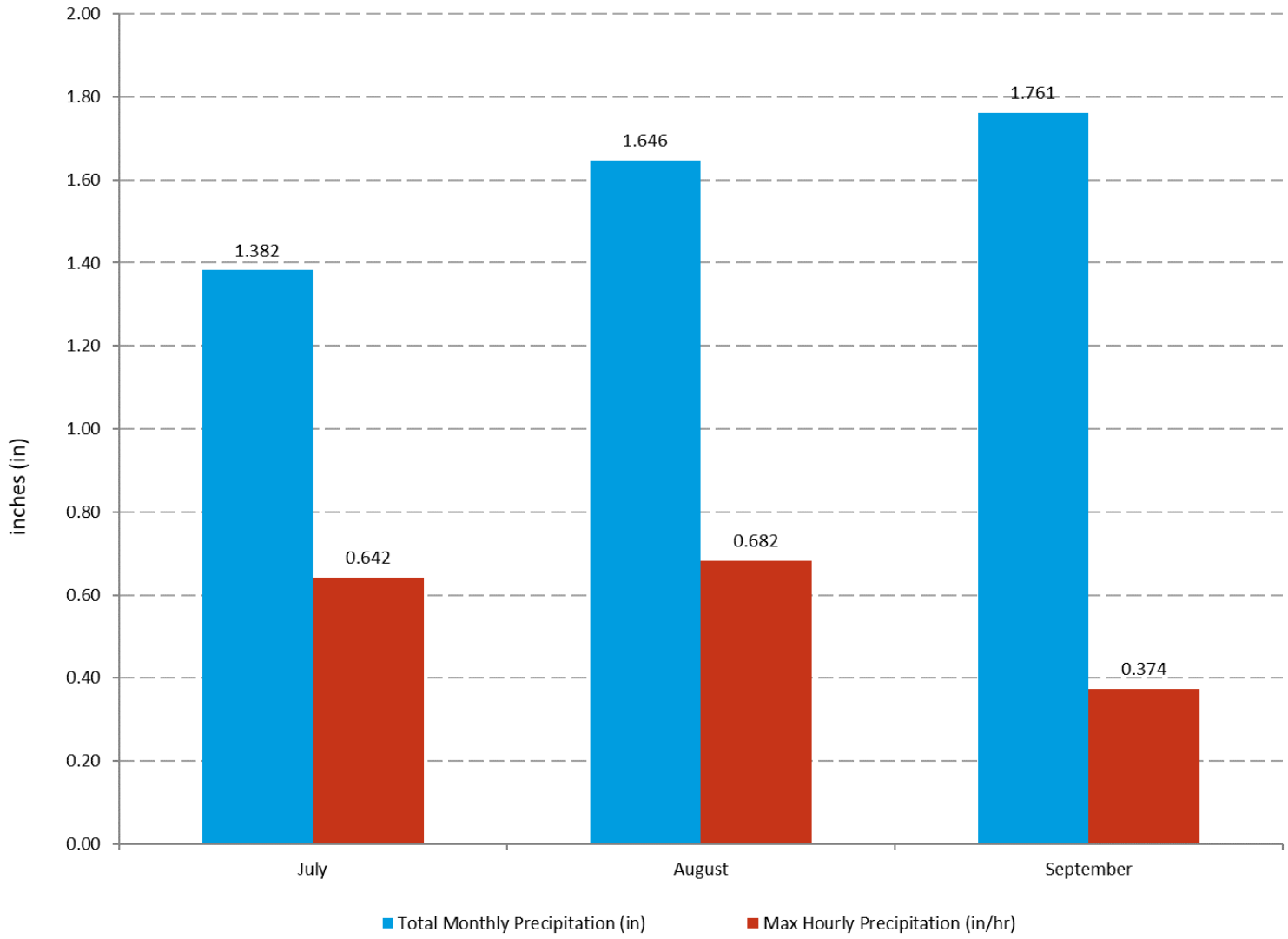


Figure 12. Orchard Q3 2024 Precipitation Summary

6.3 Temperature Data Summary

Temperature data was collected at all three stations at heights of 2-m and 10-m agl. The highest temperatures occurred in July for 2-m and 10-m agl at all three stations. The lowest temperatures occurred in September for 2-m and 10-m agl at all three stations. A summary of monthly average and hourly maximum and minimum temperatures (for both 2-m and 10-m probes) for Q3 2024 at all three stations is presented in **Figure 13** - **Figure 18** and **Table 11**.

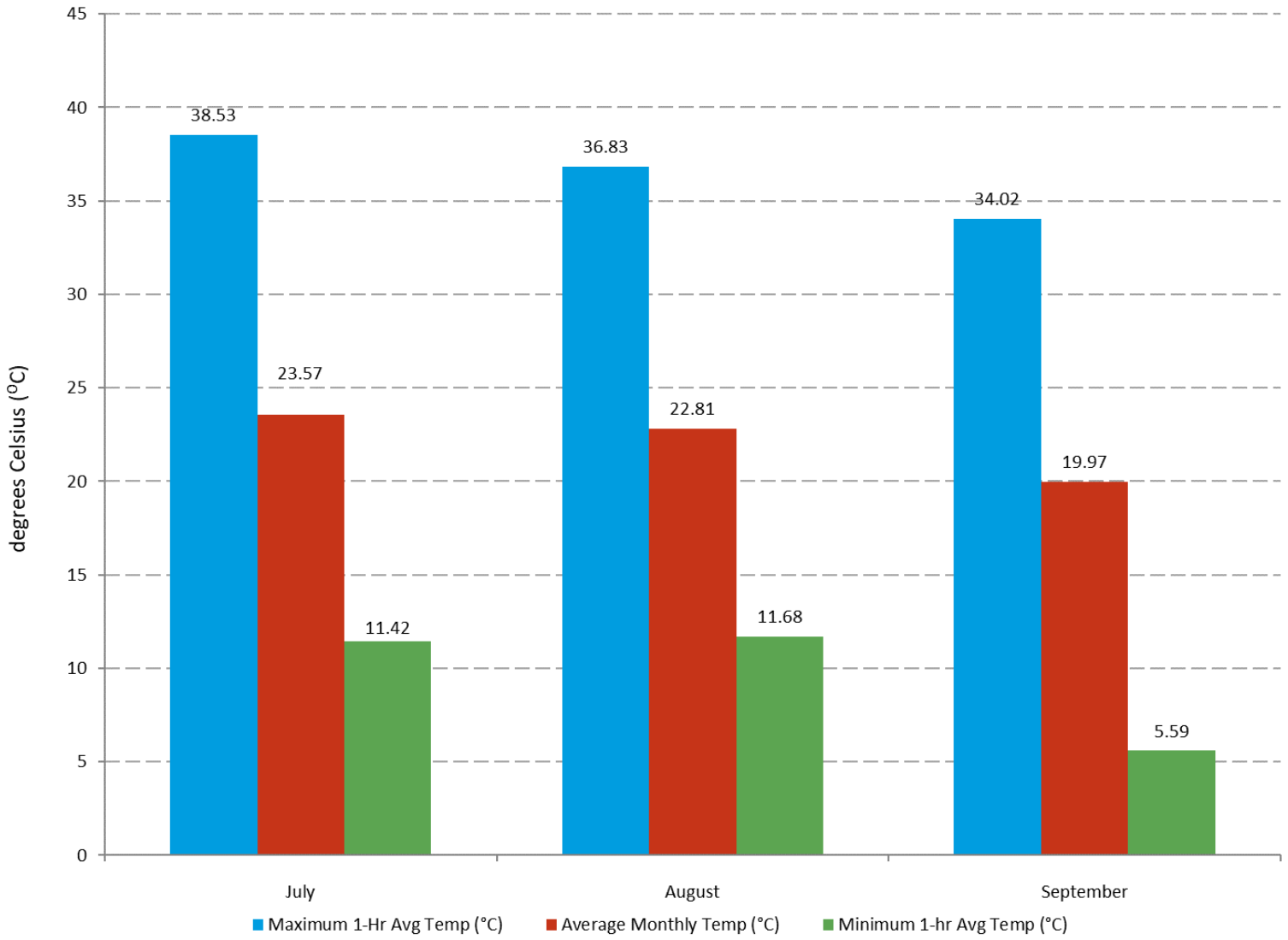


Figure 13. MSP Q3 2024 2-Meter Temperature Summary

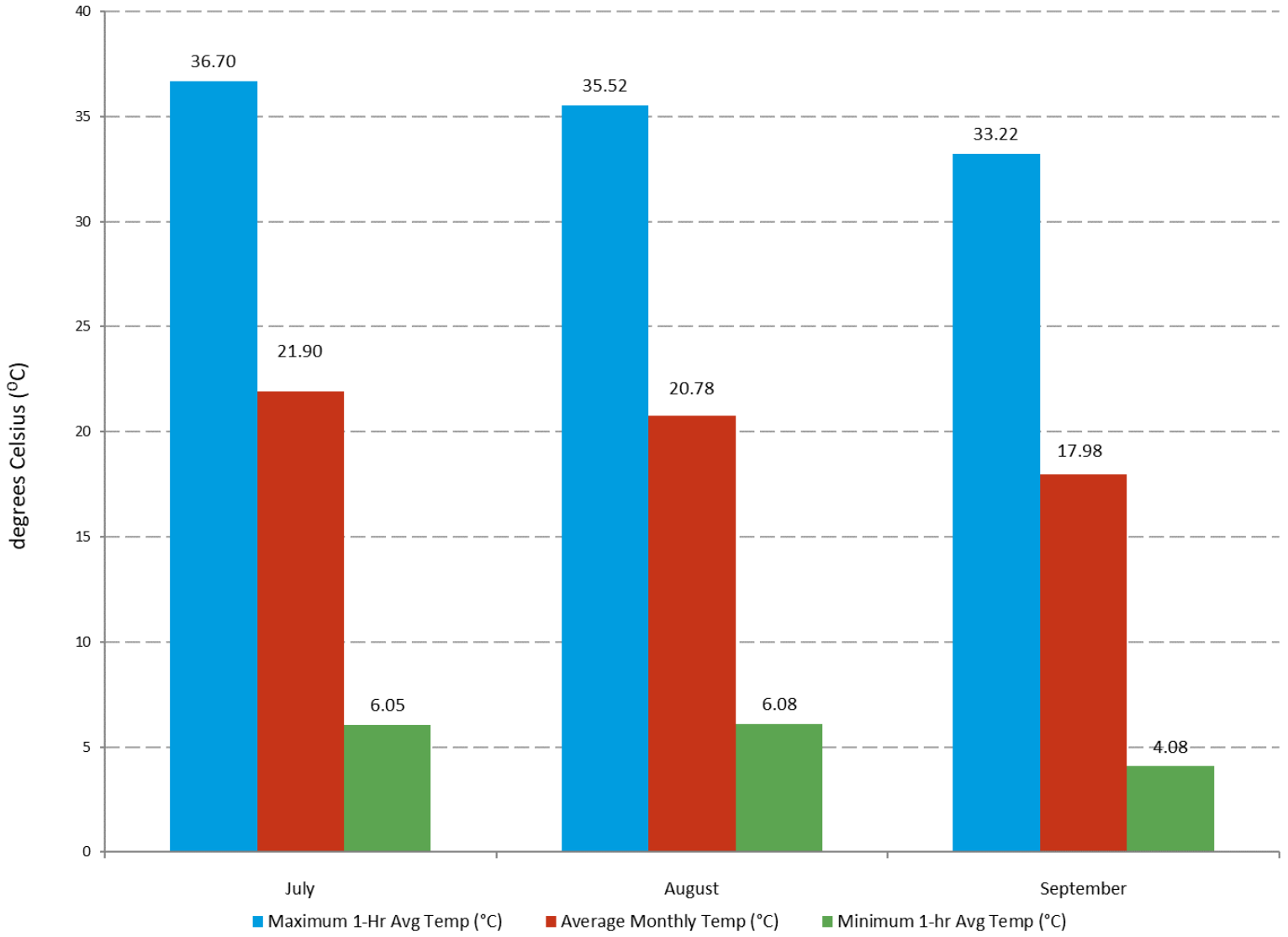


Figure 14. Hereford Q3 2024 2-Meter Temperature Summary

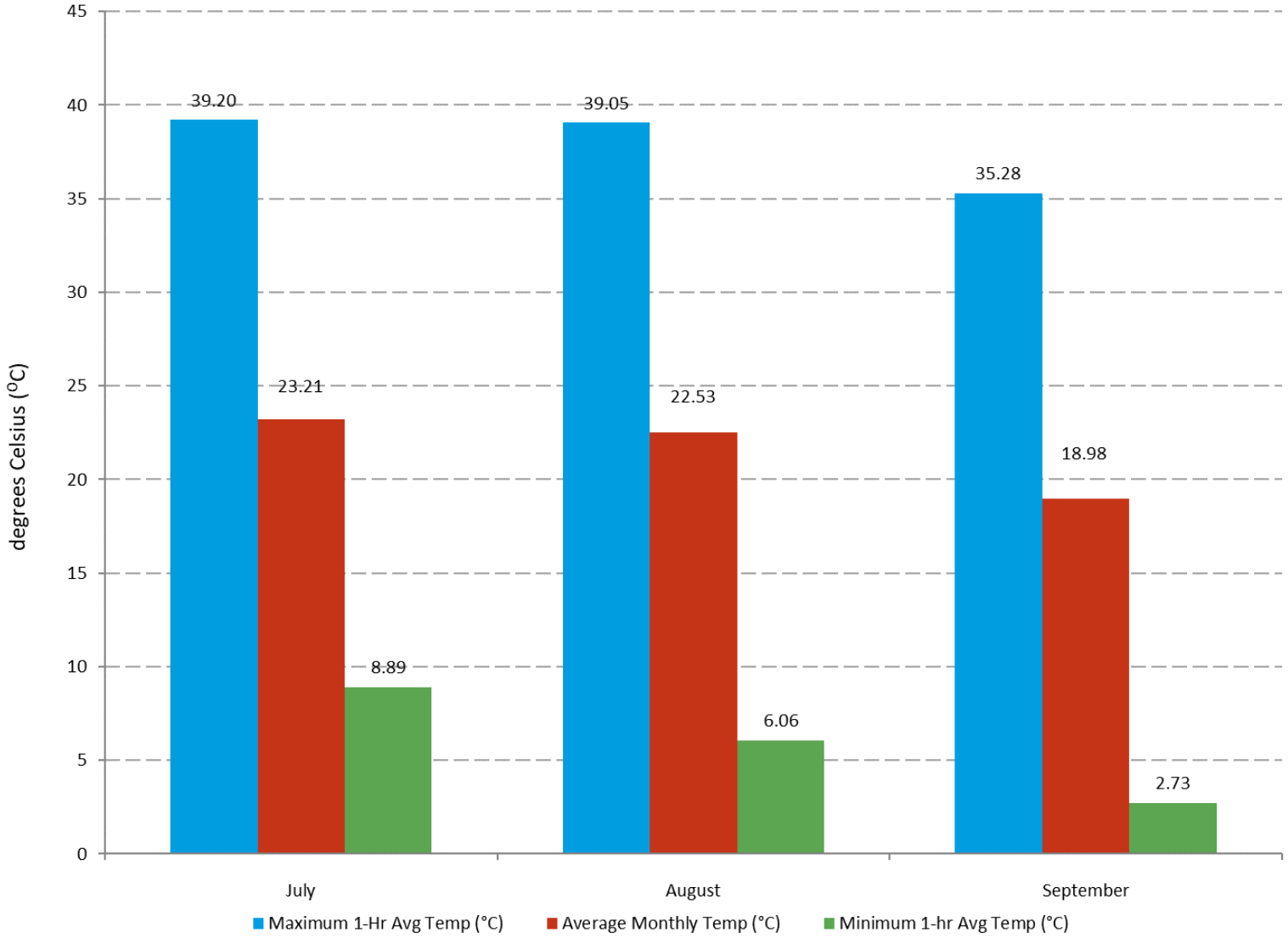


Figure 15. Orchard Q3 2024 2-Meter Temperature Summary

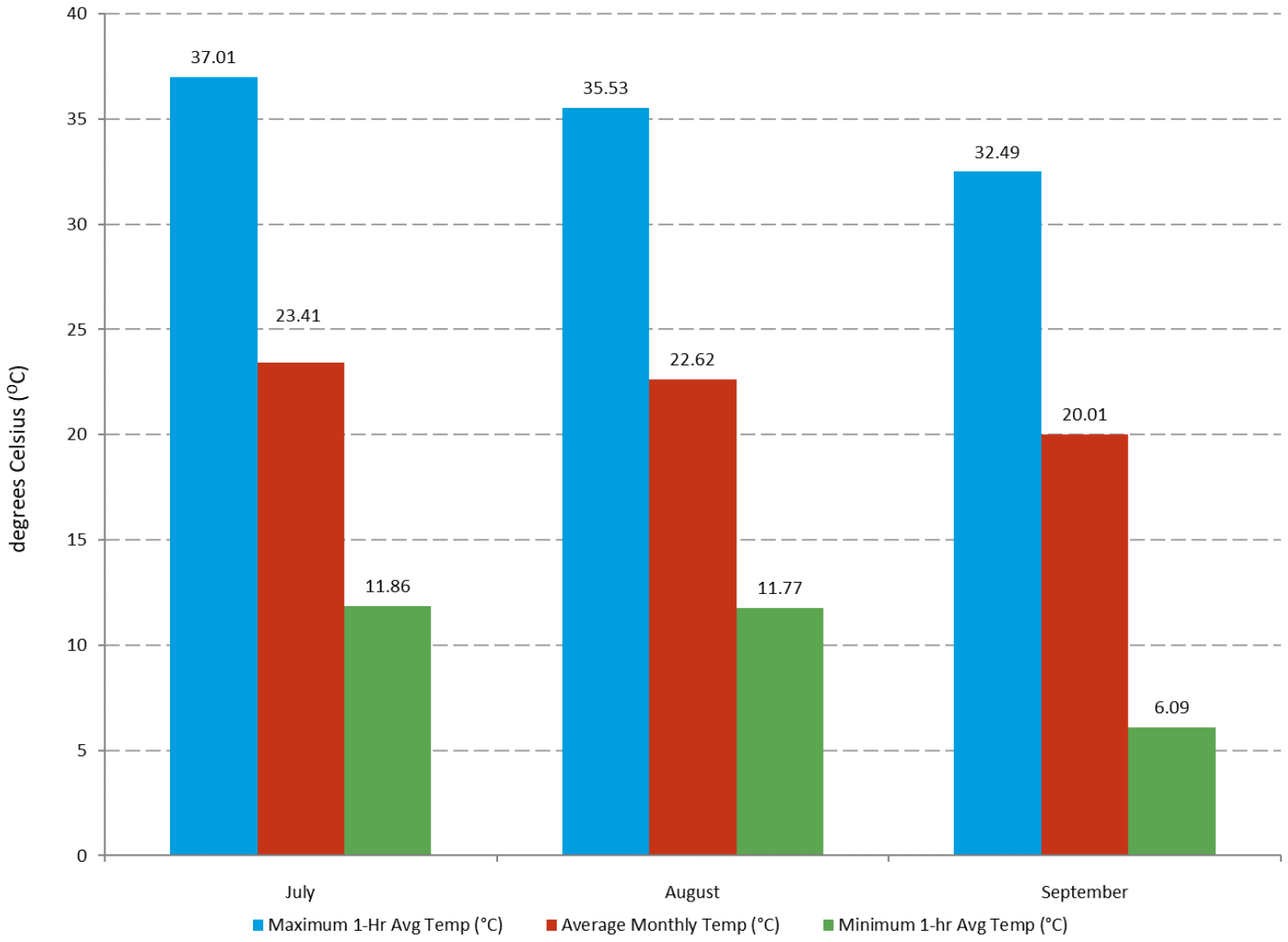


Figure 16. MSP Q3 2024 10-Meter Temperature Summary

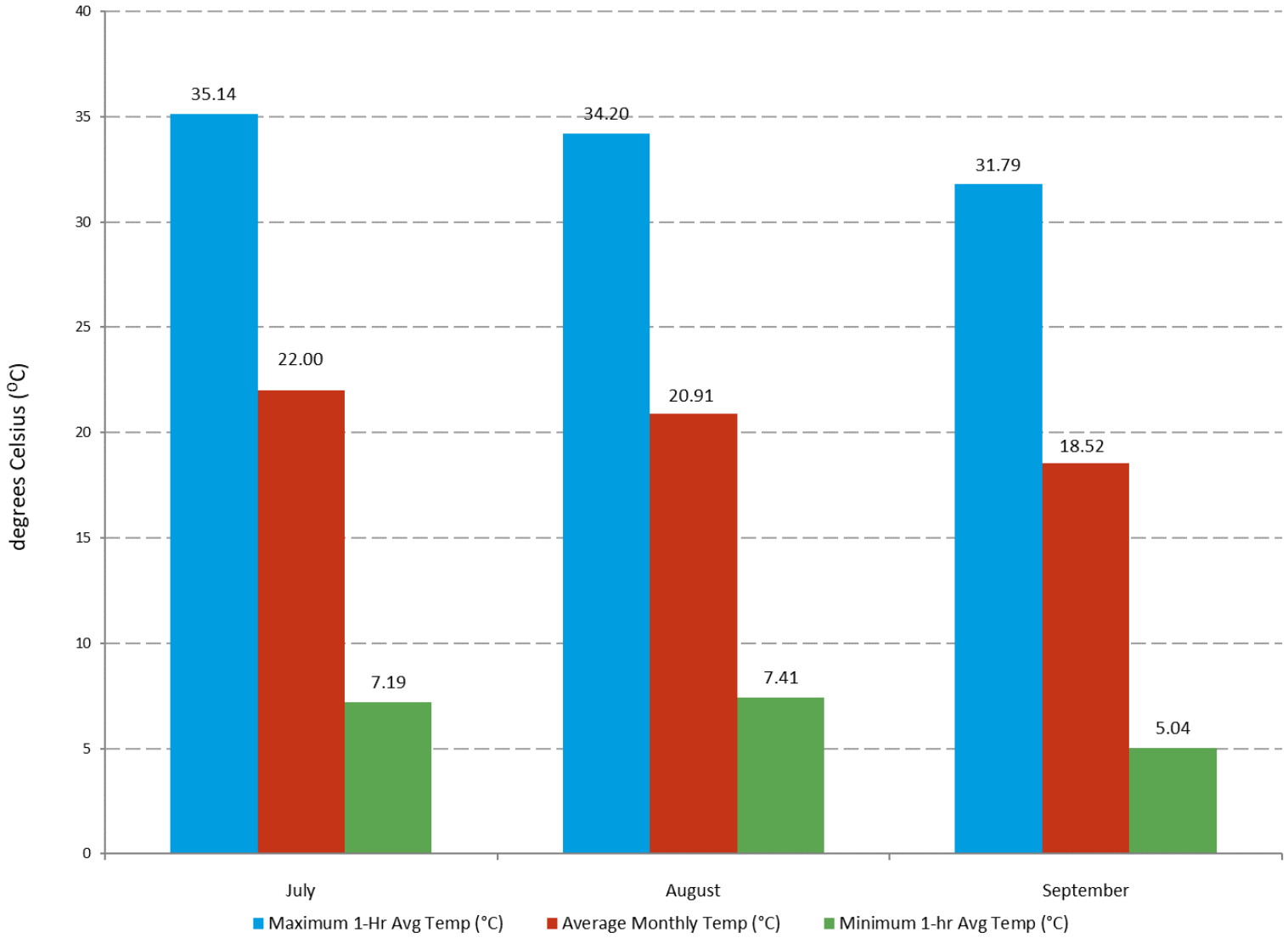


Figure 17. Hereford Q3 2024 10-Meter Temperature Summary

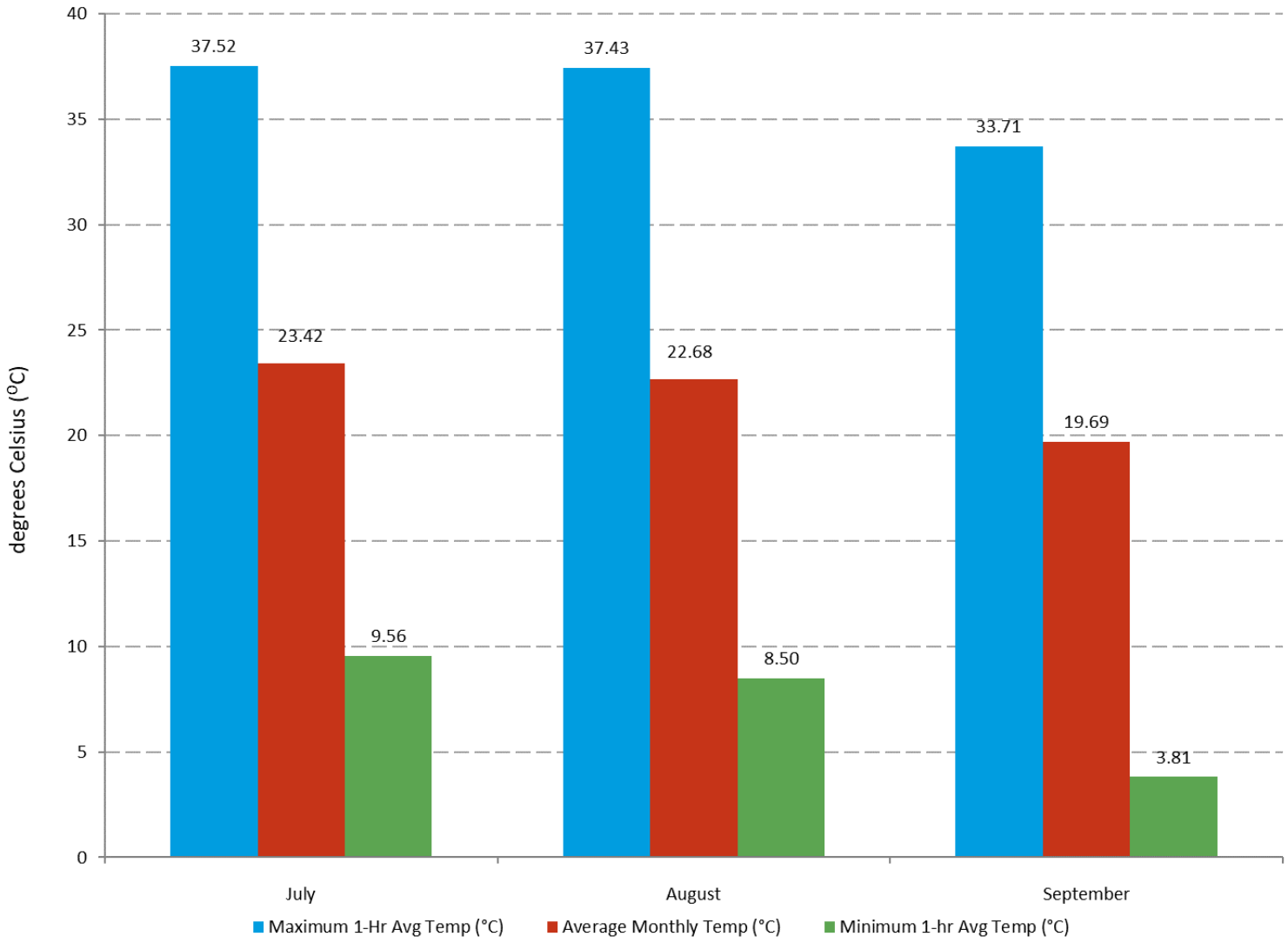


Figure 18. Orchard Q3 2024 10-Meter Temperature Summary

6.4 Delta Temperature Data Summary

Delta temperature is a calculated measurement made by subtracting the 2-m temperature probe reading from the 10-m temperature probe reading (10-m – 2-m). It is an indicator of atmospheric stability and is important for modeling purposes. The two most isolated stations (Hereford and Orchard) exhibited the largest positive delta temperature extremes compared to the more 'urban' station of MSP. A summary of monthly average and hourly maximum and minimum delta temperature for Q3 2024 at all three stations is presented in **Figure 19** - **Figure 21** and **Table 11**.

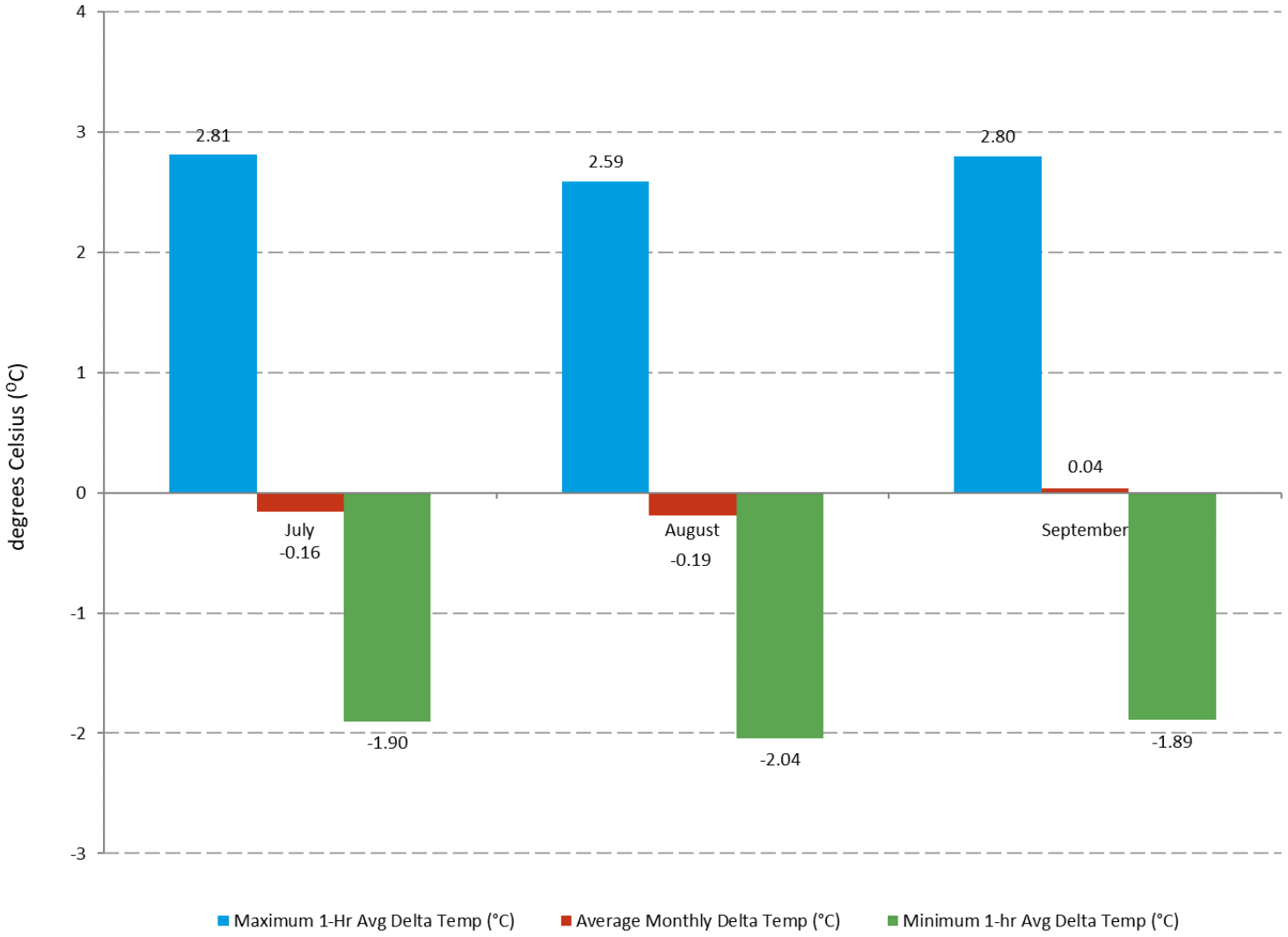


Figure 19. MSP Q3 2024 Delta Temperature Summary

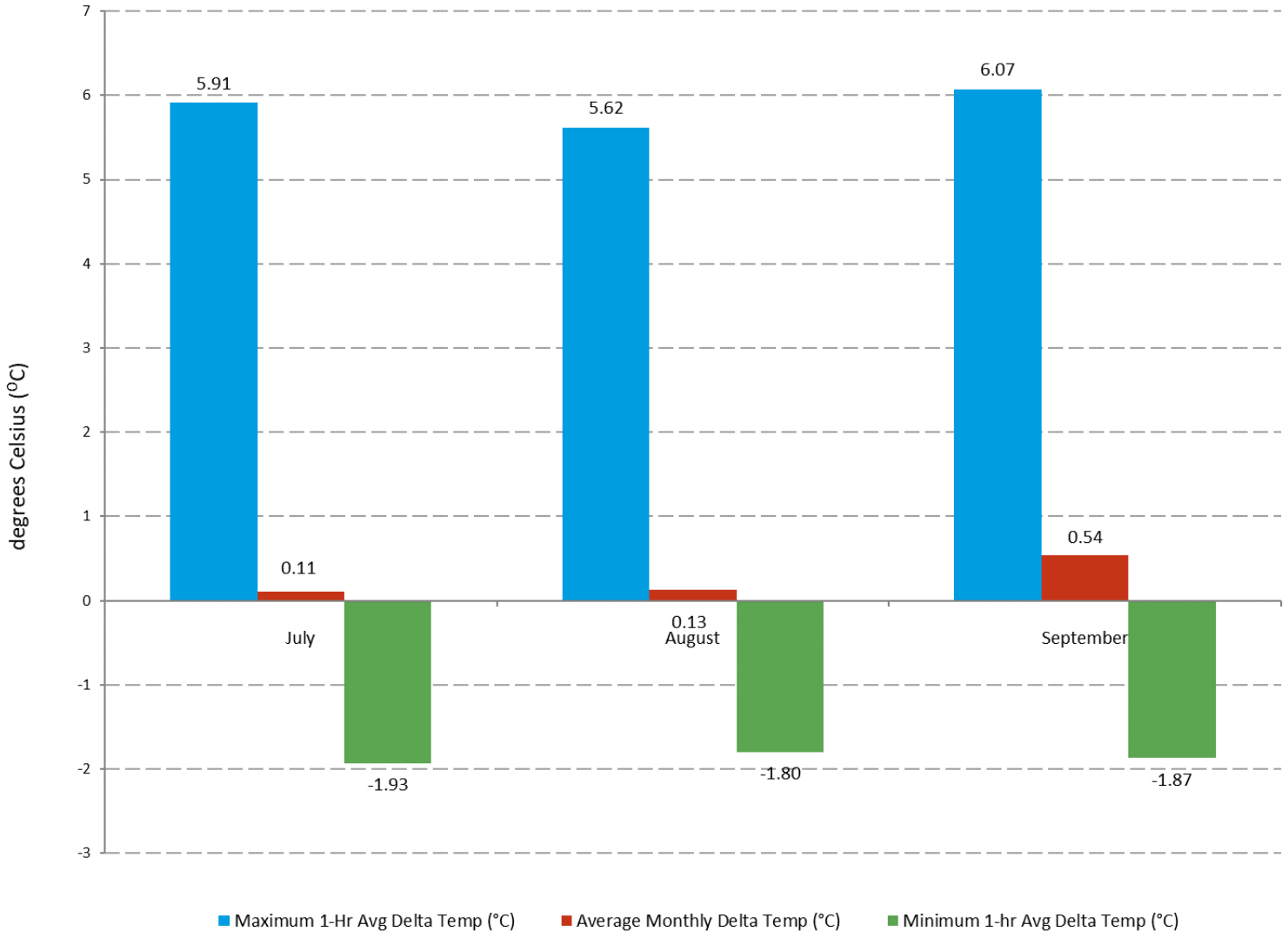


Figure 20. Hereford Q3 2024 Delta Temperature Summary

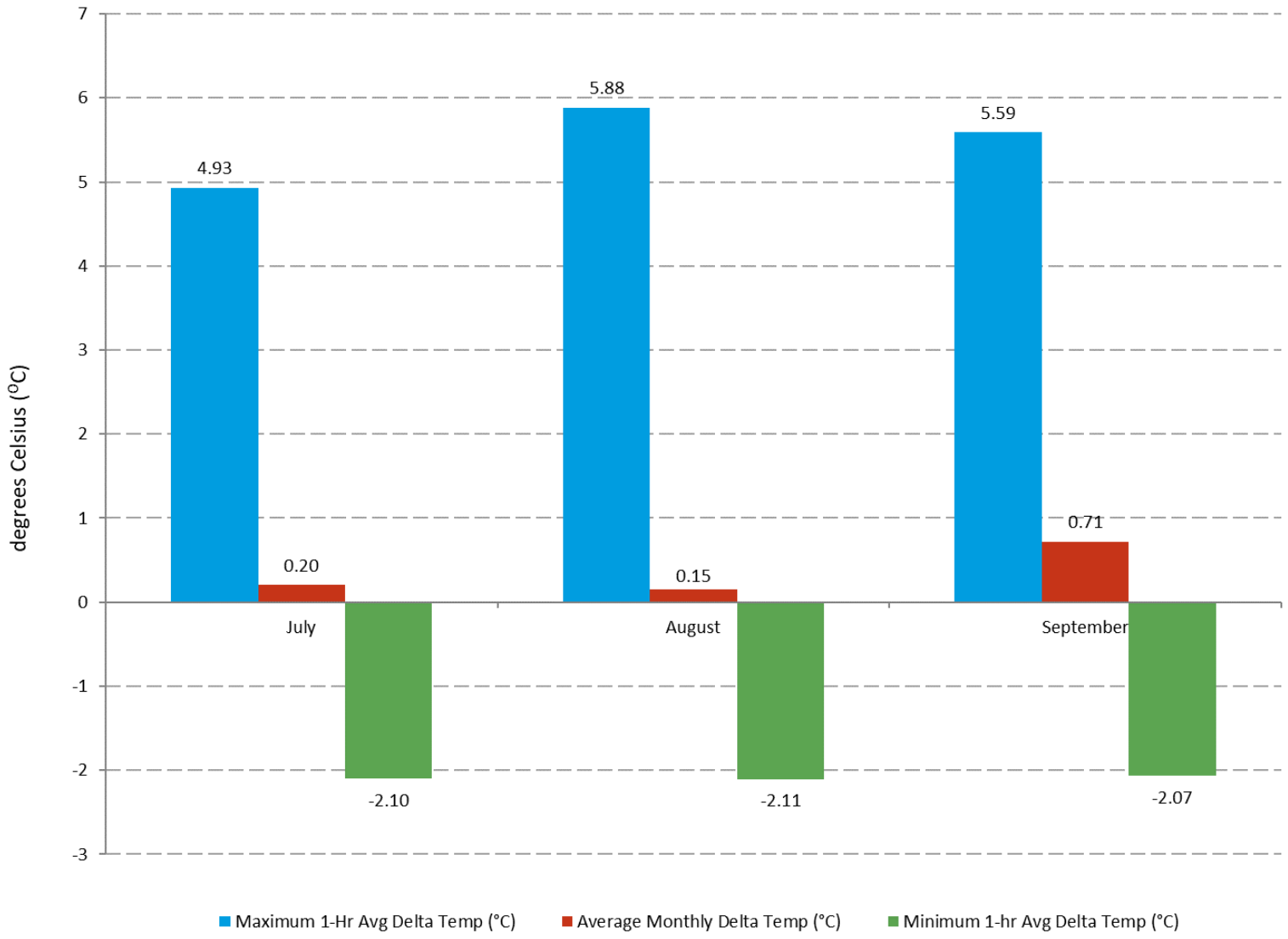


Figure 21. Orchard Q3 2024 Delta Temperature Summary

6.5 Barometric Pressure Data Summary

Barometric pressure data is collected using a barometric pressure sensor located inside each station shelter. The average monthly barometric pressure at each station was correlated with the elevation at each location, with the highest elevation station having the lowest monthly average barometric pressure (Hereford) and the lowest elevation station having the highest monthly average barometric pressure (Orchard). Maximum hourly average and monthly average barometric pressures for Q3 2024 at all three stations are summarized in **Figure 22** - **Figure 24** and **Table 11**.

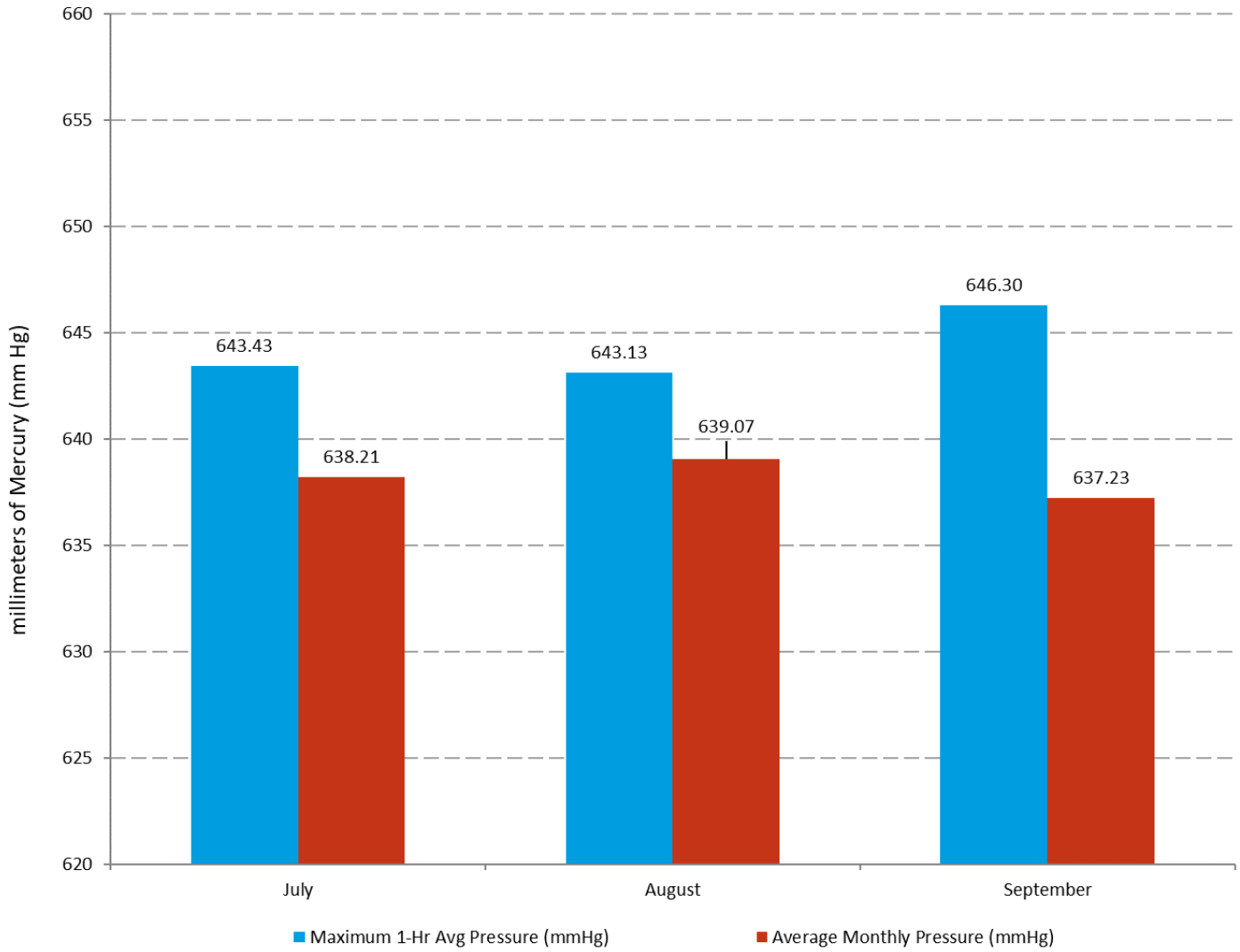


Figure 22. MSP Q3 2024 Barometric Pressure Summary

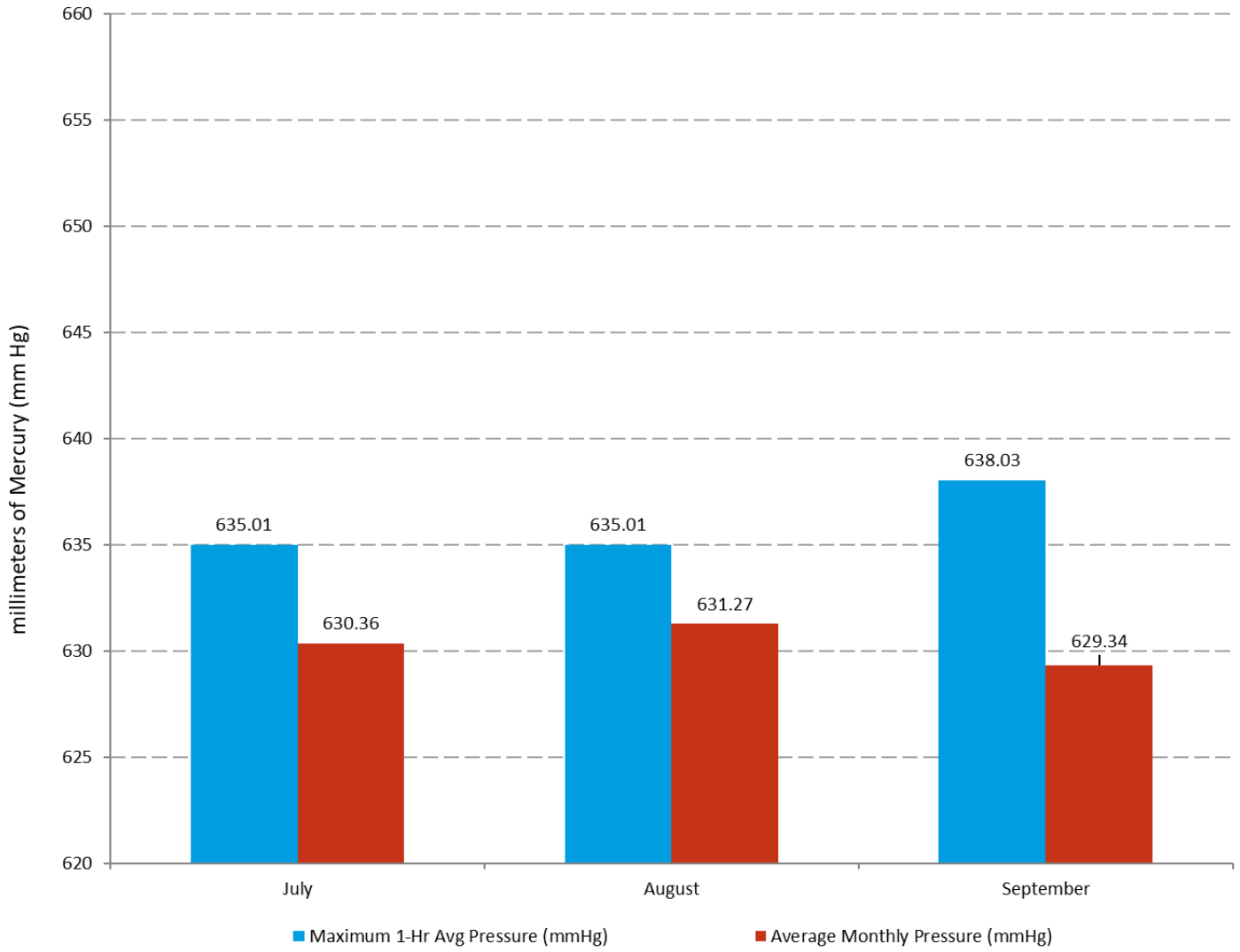


Figure 23. Hereford Q3 2024 Barometric Pressure Summary

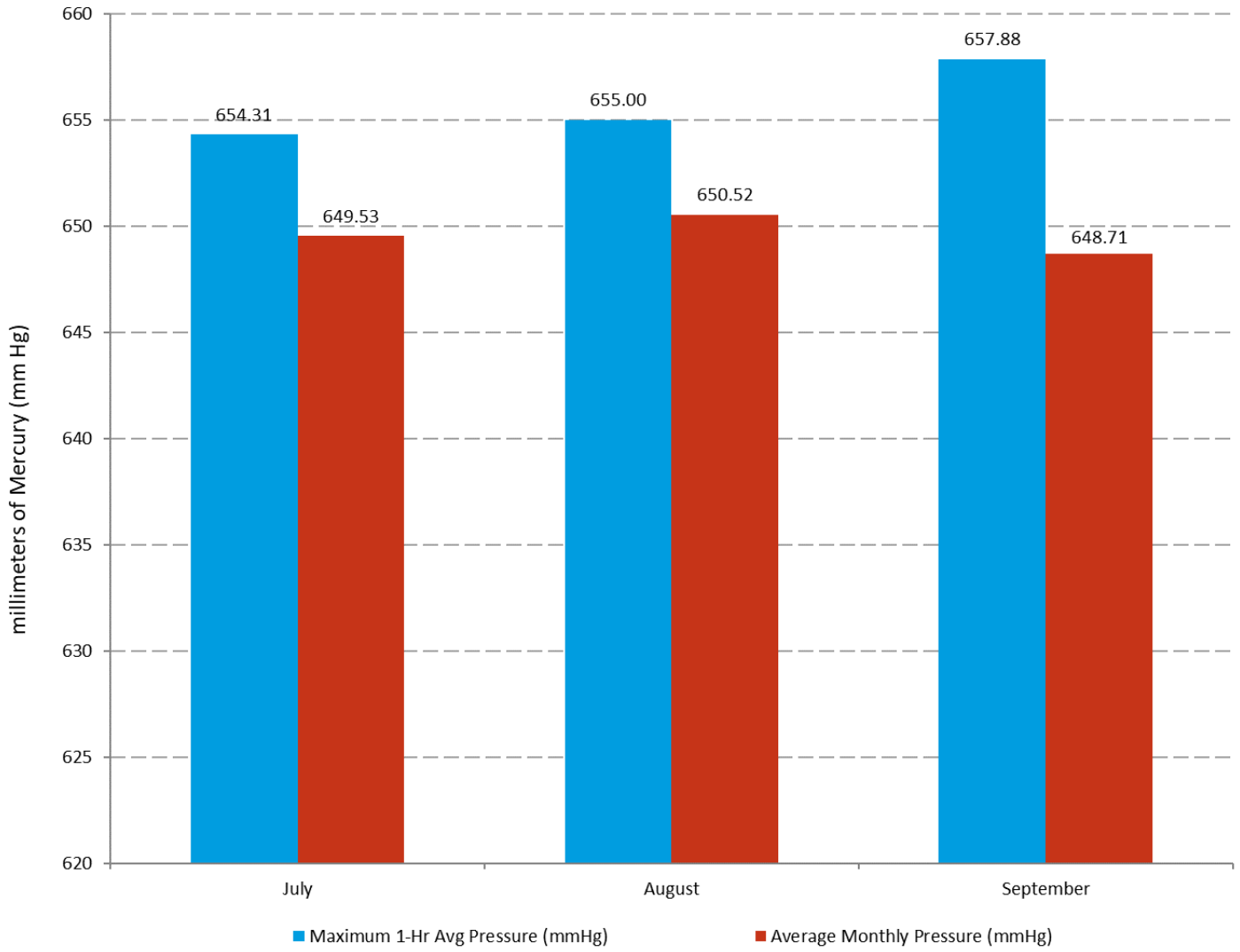


Figure 24. Orchard Q3 2024 Barometric Pressure Summary

6.6 Relative Humidity Data Summary

Relative humidity data was collected at all three stations at 2-m agl. The average monthly relative humidity at all three stations ranged between 45.49-62.06%. Maximum hourly average and monthly average relative humidity for Q3 2024 at all three stations is summarized in **Figure 25 - Figure 27** and **Table 11**.

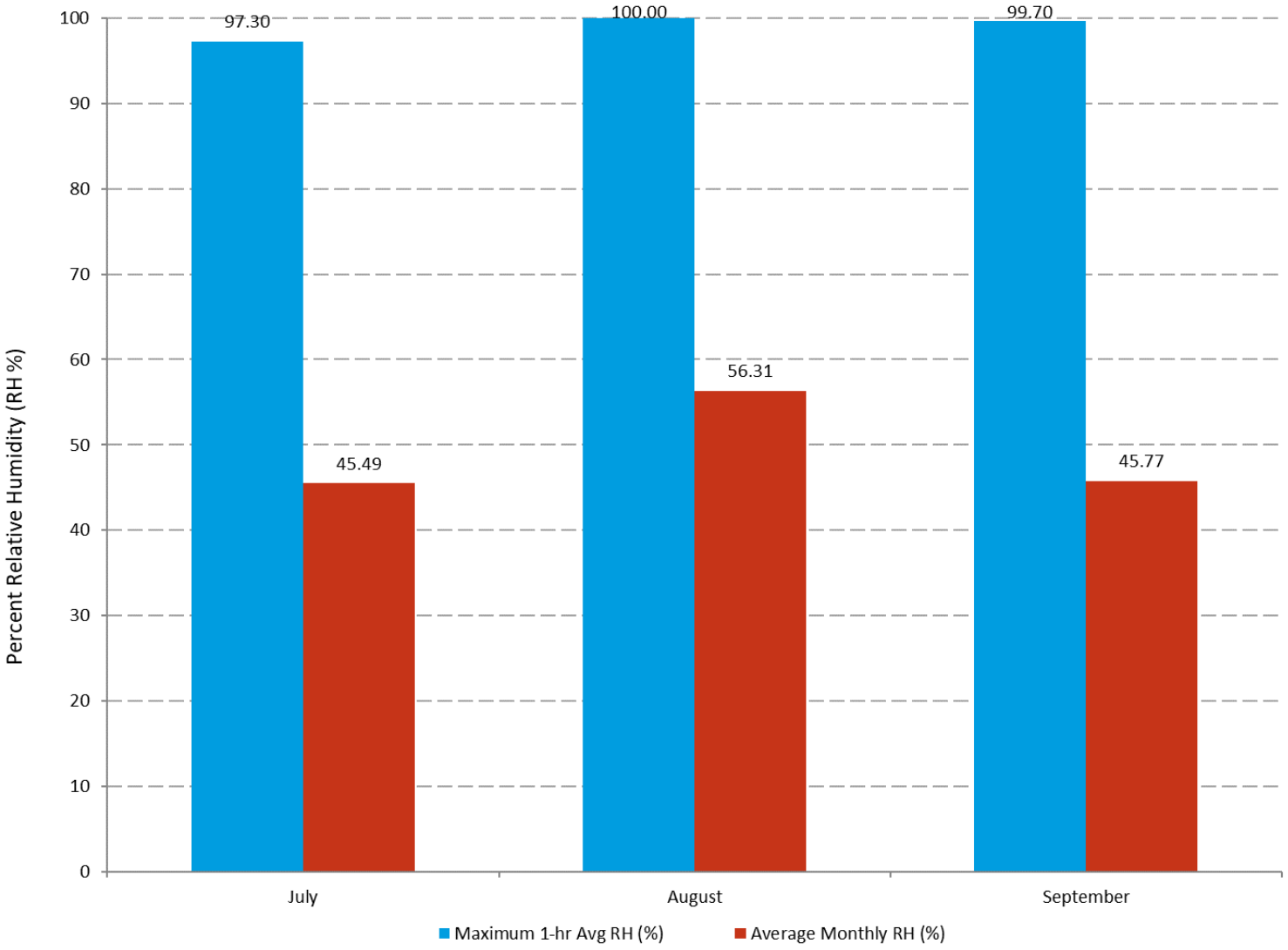


Figure 25. MSP Q3 2024 Relative Humidity Summary

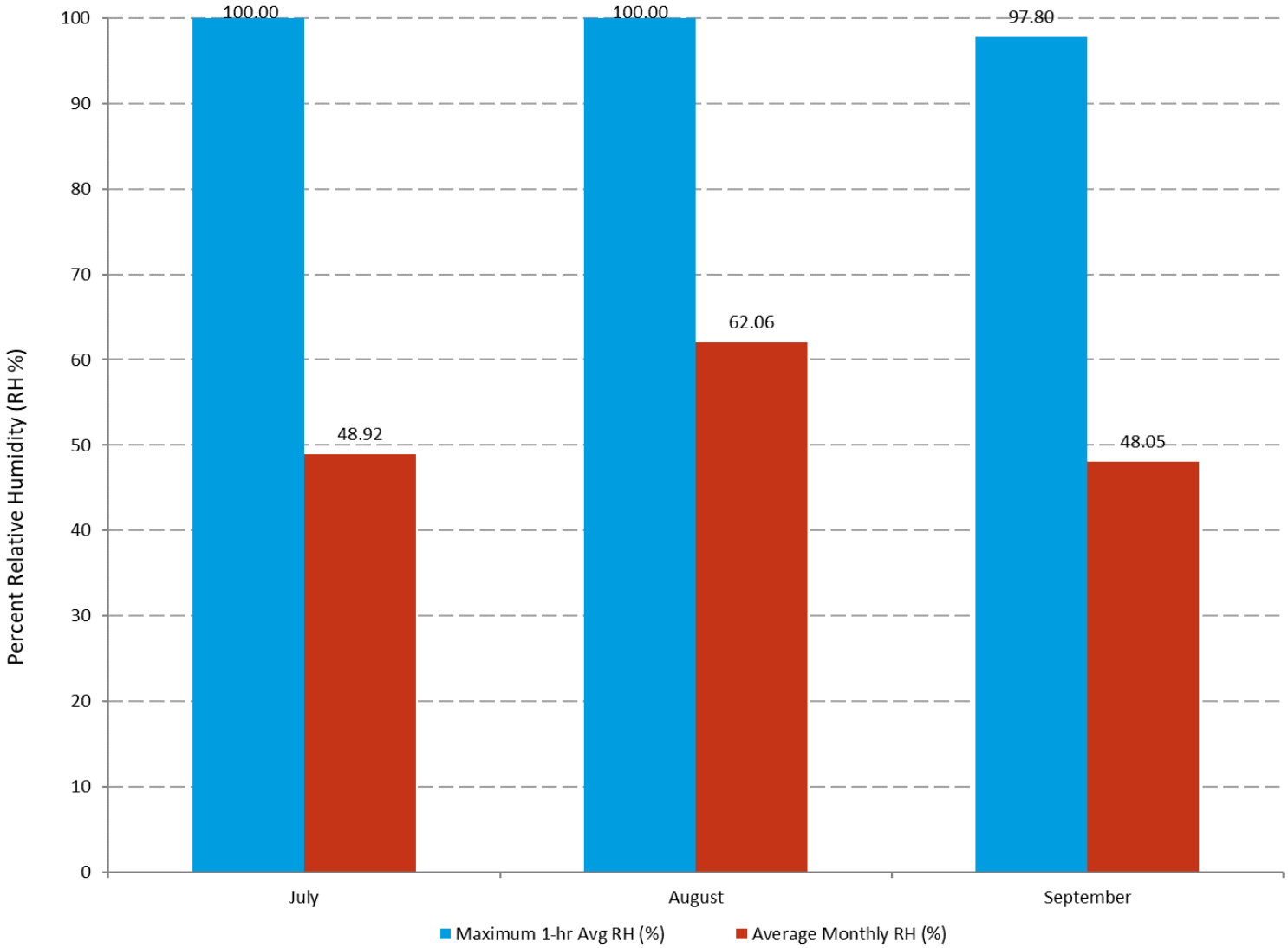


Figure 26. Hereford Q3 2024 Relative Humidity Summary

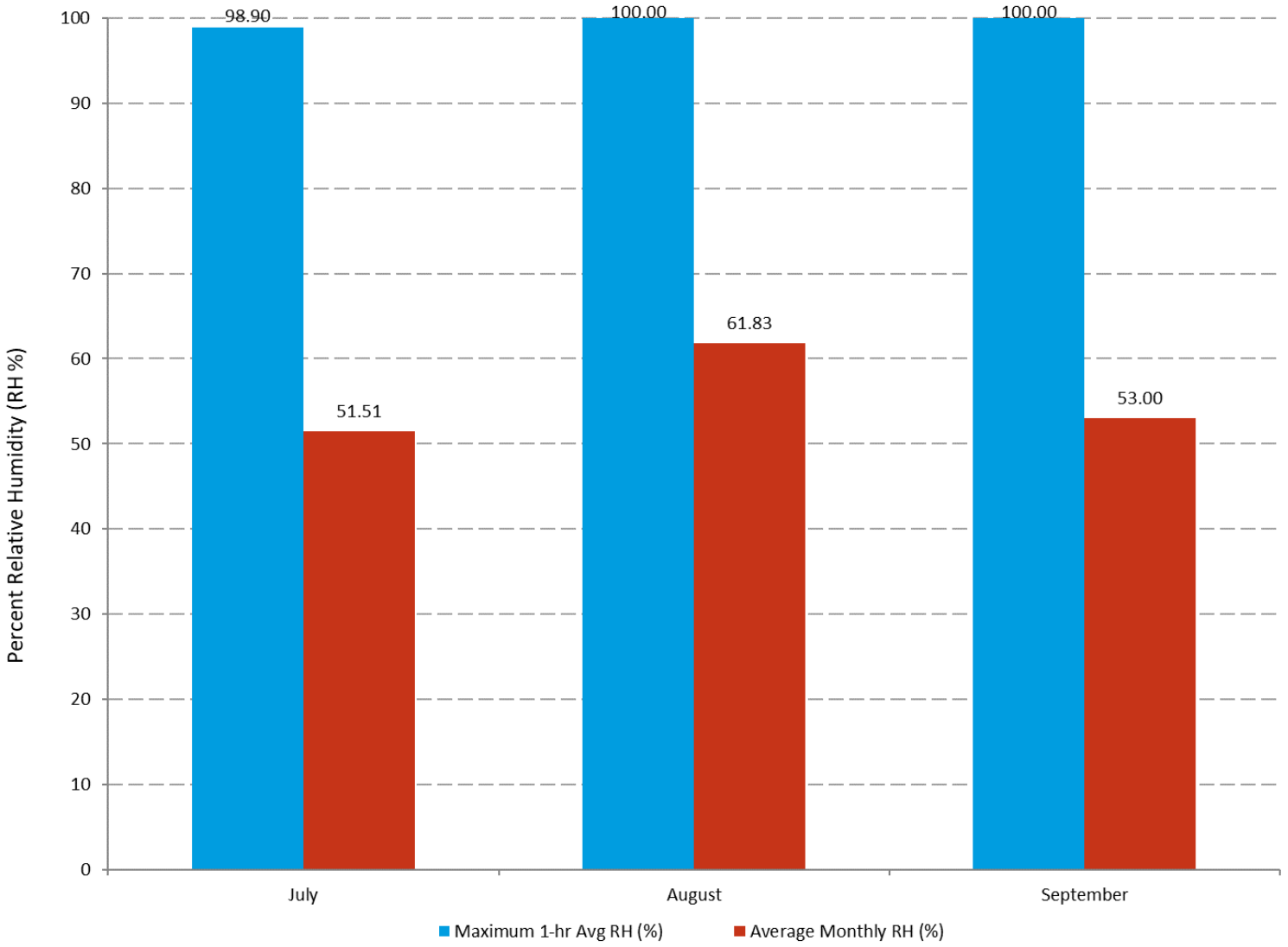


Figure 27. Orchard Q3 2024 Relative Humidity Summary

6.7 Solar Radiation Data Summary

Solar Radiation data was collected at 2-m agl at all three stations using a cross-arm mounted sensor on the meteorology tower. The average solar radiation decreased from July to September at all three stations, with 1-hour maximum solar radiation peaking in July. Maximum hourly average and monthly average solar radiation for Q3 2024 at all three stations is summarized in **Figure 28** - **Figure 30** and **Table 11**.

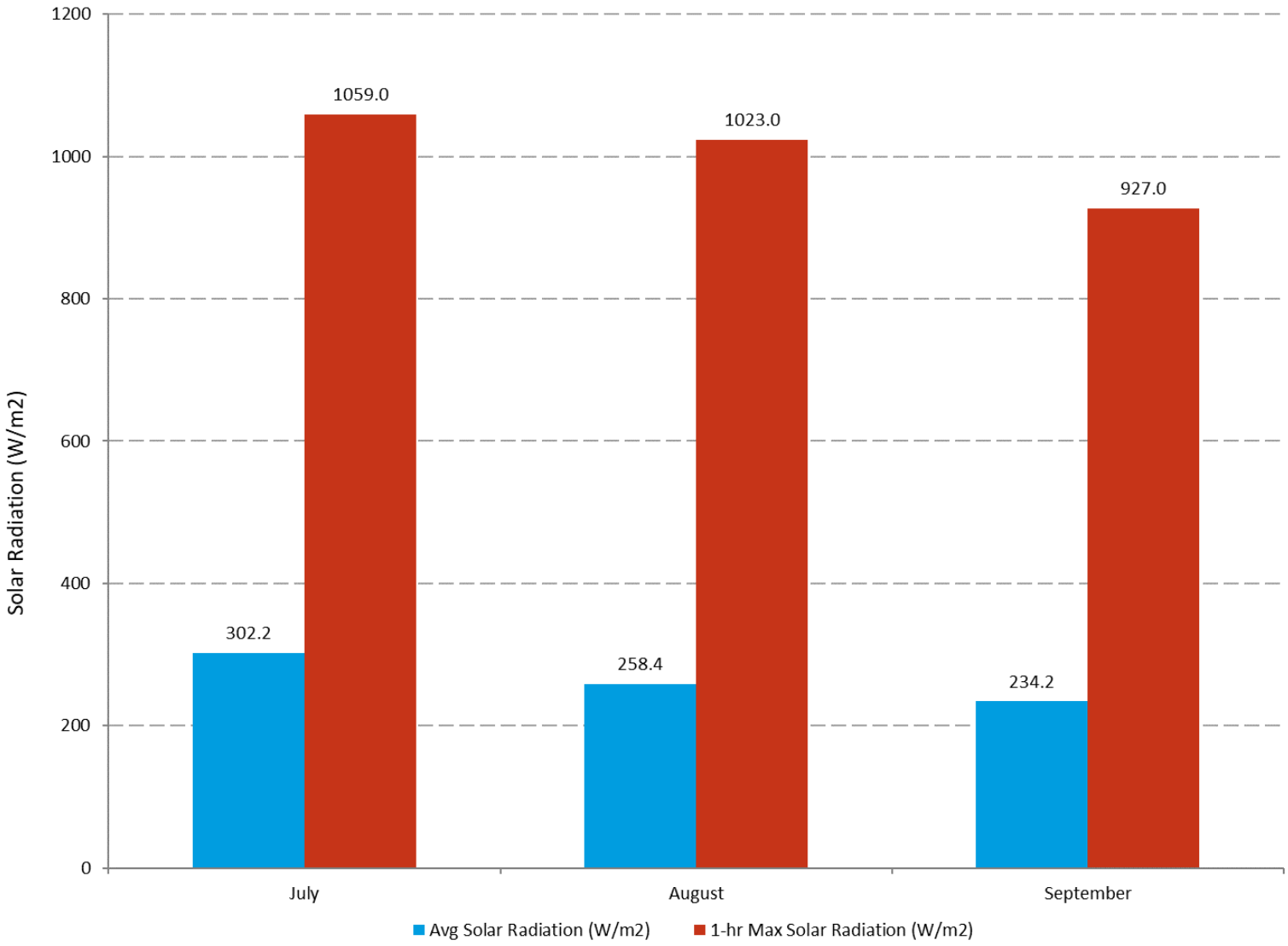


Figure 28. MSP Q3 2024 Solar Radiation Summary

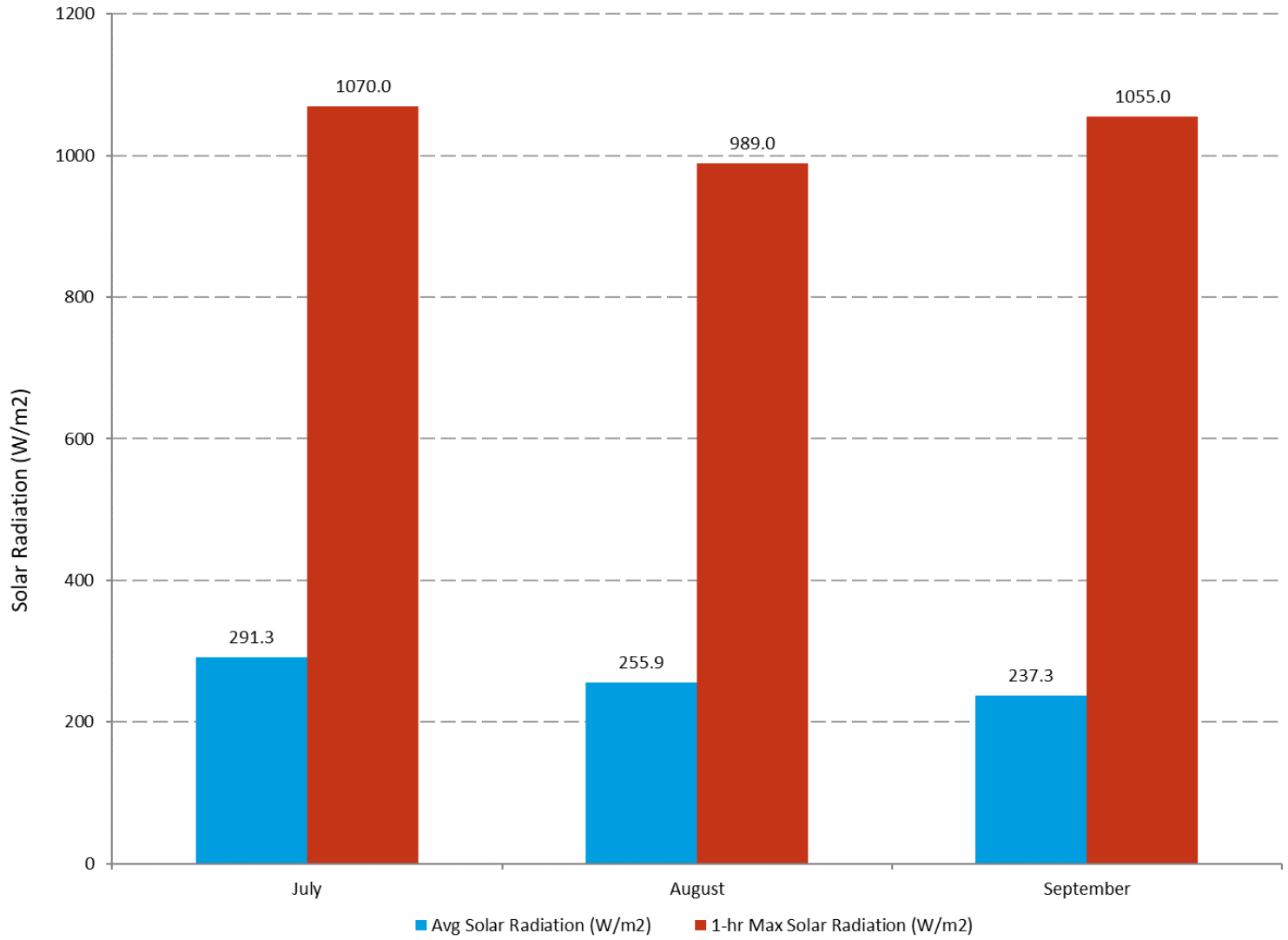


Figure 29. Hereford Q3 2024 Solar Radiation Summary

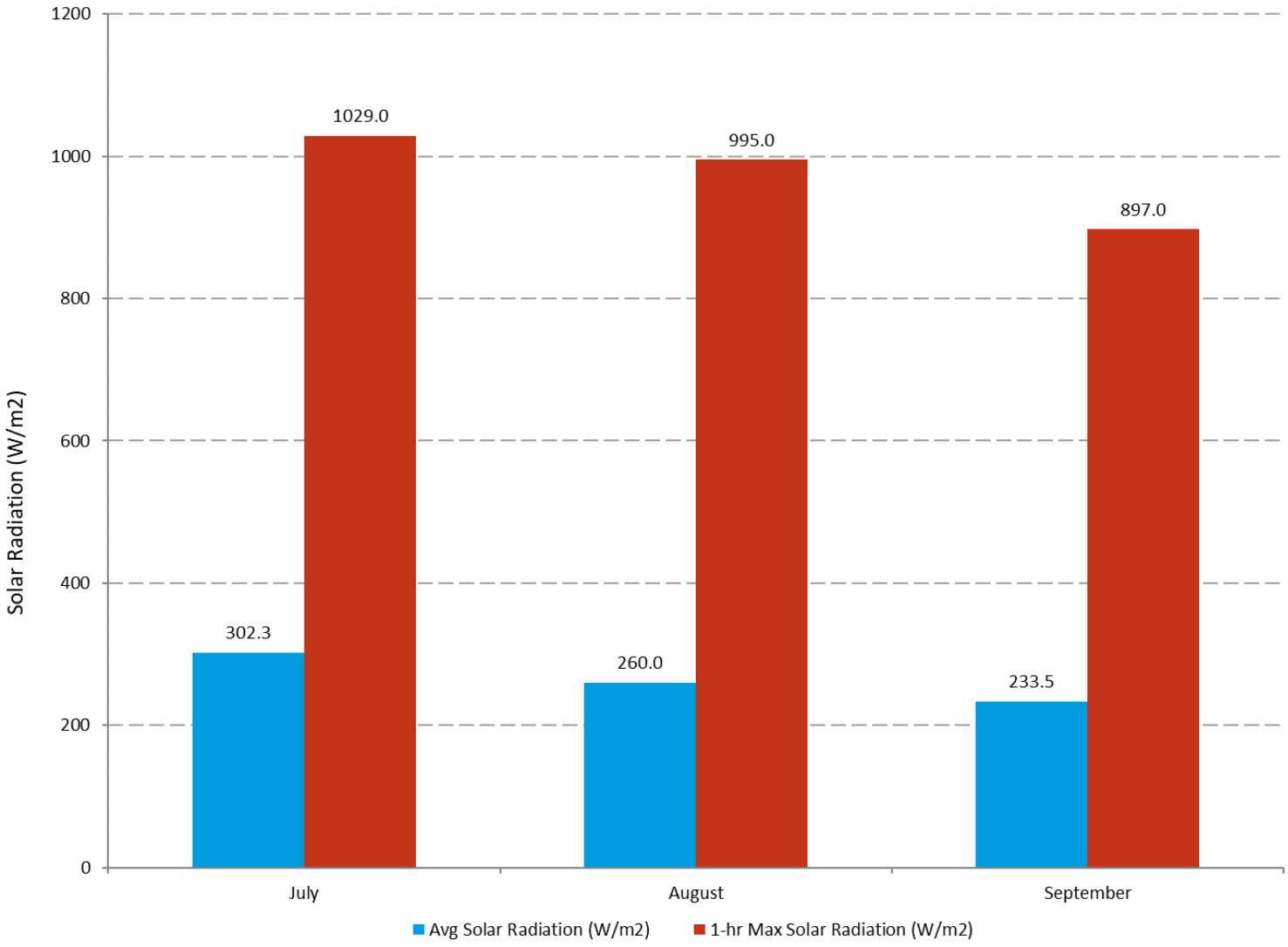


Figure 30. Orchard Q3 2024 Solar Radiation Summary

7. QUARTERLY REPORT DATA SUMMARY

Program activities conducted during Q3 2024 included data collection, equipment programming and calibrations, station inspections, routine maintenance, equipment troubleshooting and repair, routine data acquisition, data screening and validation, and report preparation. Data completeness goals were met for all parameters at all stations. Data completeness for O_3 will be evaluated once the O_3 season is complete in December 2024 in accordance with the data completeness targets.

Air quality data collected includes O_3 at all three stations and $NO/NO_x/NO_2$ at the MSP station. During Q3 2024, MSP had 19 instances that were above the 2015 ozone AAQS value, while Hereford had eight and Orchard recorded five. There were nine instances above the 2008 ozone AAQS value at MSP, four at Hereford, and one at Orchard during Q3 2024. Comparison to the annual AAQS standard for 2024 will be made at the conclusion of the ozone season.

The maximum year-to-date 1-hour average concentration of NO_2 at MSP was 45.8 ppb, which occurred in Q1, and is below the AAQS standard of 100 ppb. The 1-hour average NO_2 standard is based on the 98^{th} percentile of 1-hour daily maximum concentrations, averaged over 3-years. Comparison to the AAQS 1-hour (100 ppb) and annual (53 ppb) NO_2 standards for 2024 will be made at the conclusion of the calendar year, after a full year of data has been collected.

The meteorological data was all within normal ranges for the area and season.

APPENDIX A: Q3 2024 INVALIDATION PERIODS AND CORRECTIVE ACTION REPORTS

APPENDIX A1: INVALIDATION PERIODS

APPENDIX A1: PERIODS OF INVALID DATA AND QUALIFIER CODES

Data is presented by Month, Parameter, Qualifier Code, Date and Time, and Description

Qualifier Codes			
Code	**Description**	**Code**	**Description**
2	Operational Deviation: the standard deviation of shelter temperature was above 2.1°C for the previous 24 hours	AT	Calibration
AC	Construction/Repairs in Area	AV	Power Failure
AE	Shelter Temperature Outside Limits	AW	Wildlife Damage
AM	Miscellaneous Void	BD	Auto Calibration
AK	Filter Leak	V	Value validated

Periods of Invalidation				
Month	**Parameter**	**Code**	**Date and Time**	**Description**
MISSILE SITE PARK				
July	Ozone/ NO/NO2/NOx	BD	07-01-2024 02:00	Overnight Calibration
		BD	07-02-2024 02:00	Overnight Calibration
		BD	07-03-2024 02:00	Overnight Calibration
		BD	07-04-2024 01:00-02:00	Overnight Calibration
		BD	07-05-2024 02:00	Overnight Calibration
		BD	07-06-2024 02:00	Overnight Calibration
		BD	07-07-2024 01:00-02:00	Overnight Calibration
		BD	07-08-2024 02:00	Overnight Calibration
		BD	07-09-2024 02:00	Overnight Calibration
		BD	07-10-2024 02:00	Overnight Calibration
		BD	07-11-2024 01:00-02:00	Overnight Calibration
		BD	07-12-2024 02:00	Overnight Calibration
		BD	07-13-2024 02:00	Overnight Calibration
		BD	07-14-2024 01:00-02:00	Overnight Calibration
		BD	07-15-2024 02:00	Overnight Calibration
		BD	07-16-2024 02:00	Overnight Calibration
		BD	07-17-2024 02:00	Overnight Calibration
		BD	07-18-2024 01:00-02:00	Overnight Calibration
		V	07-18-2024 08:00-09:00	Value validated; partial hour due to calibration testing
		BD	07-19-2024 02:00	Overnight Calibration
		BD	07-20-2024 02:00	Overnight Calibration
		BD	07-21-2024 01:00-02:00	Overnight Calibration
		BD	07-22-2024 02:00	Overnight Calibration
		BD	07-23-2024 02:00	Overnight Calibration
		BD	07-24-2024 02:00	Overnight Calibration
		BD	07-25-2024 01:00-02:00	Overnight Calibration
		BD	07-26-2024 02:00	Overnight Calibration
		BD	07-27-2024 02:00	Overnight Calibration
		BD	07-28-2024 01:00-02:00	Overnight Calibration

Month	Parameter	Code	Date and Time	Description
		BD	07-29-2024 02:00	Overnight Calibration
		BD	07-30-2024 02:00	Overnight Calibration
		AM	07-30-2024 14:00	Miscellaneous void; sample filter change
		V	07-30-2024 15:00	Value validated; partial hour due to filter change
		BD	07-31-2024 02:00	Overnight Calibration
August	Precipitation	AW	08-15-2024 01:00-08-21-2024 12:00	Wildlife impact; spiderweb interfering with sensor operation
	Ozone/ NO/NO2/NOx	BD	08-01-2024 01:00-02:00	Overnight Calibration
		AT	08-01-2024 14:00-15:00	Calibration testing
		BD	08-02-2024 02:00	Overnight Calibration
		BD	08-03-2024 02:00	Overnight Calibration
		BD	08-04-2024 01:00-02:00	Overnight Calibration
		BD	08-05-2024 02:00	Overnight Calibration
		BD	08-06-2024 02:00	Overnight Calibration
		BD	08-07-2024 02:00	Overnight Calibration
		BD	08-08-2024 01:00-02:00	Overnight Calibration
		BD	08-09-2024 02:00	Overnight Calibration
		BD	08-10-2024 02:00	Overnight Calibration
		BD	08-11-2024 01:00-02:00	Overnight Calibration
		BD	08-12-2024 02:00	Overnight Calibration
		BD	08-13-2024 02:00	Overnight Calibration
		BD	08-14-2024 02:00	Overnight Calibration
		BD	08-15-2024 01:00-02:00	Overnight Calibration
		BD	08-16-2024 02:00	Overnight Calibration
		BD	08-17-2024 02:00	Overnight Calibration
		BD	08-18-2024 01:00-02:00	Overnight Calibration
		BD	08-19-2024 02:00	Overnight Calibration
		BD	08-20-2024 02:00	Overnight Calibration
		BD	08-21-2024 02:00	Overnight Calibration
		BD	08-22-2024 01:00-02:00	Overnight Calibration
		BD	08-23-2024 02:00	Overnight Calibration
		BD	08-24-2024 02:00	Overnight Calibration
		BD	08-25-2024 01:00-02:00	Overnight Calibration
		BD	08-26-2024 02:00	Overnight Calibration
		BD	08-27-2024 02:00	Overnight Calibration
		AM	08-27-2024 13:00-14:00	Miscellaneous void; sample filter change
		BD	08-28-2024 02:00	Overnight Calibration
		BD	08-29-2024 01:00-02:00	Overnight Calibration
		BD	08-30-2024 02:00	Overnight Calibration
		BD	08-31-2024 02:00	Overnight Calibration

Month	Parameter	Code	Date and Time	Description
September	Precipitation	AT	09-17-2024 12:00-13:00	Manual instrument testing
	Ozone/ NO/NO2/NOx	BD	09-01-2024 01:00-02:00	Overnight Calibration
		BD	09-02-2024 02:00	Overnight Calibration
		BD	09-03-2024 02:00	Overnight Calibration
		BD	09-04-2024 02:00	Overnight Calibration
		BD	09-05-2024 01:00-02:00	Overnight Calibration
		BD	09-06-2024 02:00	Overnight Calibration
		BD	09-07-2024 02:00	Overnight Calibration
		BD	09-08-2024 01:00-02:00	Overnight Calibration
		BD	09-09-2024 02:00	Overnight Calibration
		BD	09-10-2024 02:00	Overnight Calibration
		BD	09-11-2024 02:00	Overnight Calibration
		BD	09-12-2024 01:00-02:00	Overnight Calibration
		BD	09-13-2024 02:00	Overnight Calibration
		BD	09-14-2024 02:00	Overnight Calibration
		BD	09-15-2024 01:00-02:00	Overnight Calibration
		BD	09-16-2024 02:00	Overnight Calibration
		BD	09-17-2024 02:00	Overnight Calibration
		V	09-18-2024 02:00	Value validated; partial hour due to incomplete calibration run
		V	09-18-2024 10:00, **ozone only**	Value validated; partial hour due to calibration testing
		AT	09-18-2024 10:00, **NO/NO2/NOx only**	Calibration testing; NO/NO2/NOx recovery slower than ozone
		V	09-19-2024 01:00	Value validated; partial hour due to incomplete calibration run
		V	09-19-2024 11:00, **ozone only**	Value validated; partial hour due to calibration testing
		AT	09-19-2024 11:00, **NO/NO2/NOx only**	Calibration testing; NO/NO2/NOx recovery slower than ozone
		V	09-19-2024 13:00	Value validated; partial hour due to calibration testing
		BD	09-20-2024 02:00	Overnight Calibration; incomplete run, unable to revalidate data
		V	09-20-2024 09:00, **ozone only**	Value validated; partial hour due to manual calibration
		AT	09-20-2024 09:00, **NO/NO2/NOx only**	Manual calibration; NO/NO2/NOx recovery slower than ozone
		BD	09-21-2024 02:00	Overnight Calibration; incomplete run, unable to revalidate data
		V	09-22-2024 01:00	Value validated; partial hour due to incomplete calibration run
		V	09-23-2024 02:00, **ozone only**	Value validated; partial hour due to incomplete calibration run

Month	Parameter	Code	Date and Time	Description
		BD	09-23-2024 02:00, **NO/NO2/NOx only**	Overnight Calibration; NO/NO2/NOx recovery slower than ozone
		BD	09-24-2024 02:00	Overnight Calibration; incomplete run, unable to revalidate data
		AK	09-24-2024 14:00-09-25-2024 14:00	Filter leak following filter change due to loose fitting
		AT	09-25-2024 16:00-17:00	Calibration testing
HEREFORD				
July	Ozone	BD	07-01-2024 02:00	Overnight Calibration
		BD	07-03-2024 02:00	Overnight Calibration
		BD	07-05-2024 02:00	Overnight Calibration
		BD	07-08-2024 02:00	Overnight Calibration
		BD	07-10-2024 02:00	Overnight Calibration
		BD	07-12-2024 02:00	Overnight Calibration
		BD	07-15-2024 02:00	Overnight Calibration
		BD	07-17-2024 02:00	Overnight Calibration
		BD	07-19-2024 02:00	Overnight Calibration
		BD	07-22-2024 02:00	Overnight Calibration
		BD	07-24-2024 02:00	Overnight Calibration
		BD	07-26-2024 02:00	Overnight Calibration
		BD	07-29-2024 02:00	Overnight Calibration
		V	07-30-2024 09:00	Value validated; partial hour due to filter change
		AM	07-30-2024 10:00	Miscellaneous void; sample filter change
		BD	07-31-2024 02:00	Overnight Calibration
August	Ozone	AV	08-01-2024 20:00-21:00	Power failure
		BD	08-02-2024 02:00	Overnight Calibration
		BD	08-05-2024 02:00	Overnight Calibration
		BD	08-07-2024 02:00	Overnight Calibration
		BD	08-09-2024 02:00	Overnight Calibration
		BD	08-12-2024 02:00	Overnight Calibration
		V	08-12-2024 22:00	Value validated; partial hour due to power failure
		BD	08-14-2024 02:00	Overnight Calibration
		BD	08-16-2024 02:00	Overnight Calibration
		BD	08-19-2024 02:00	Overnight Calibration
		BD	08-21-2024 02:00	Overnight Calibration
		BD	08-23-2024 02:00	Overnight Calibration
		BD	08-26-2024 02:00	Overnight Calibration
		V	08-27-2024 09:00	Value validated; partial hour due to filter change
		AM	08-27-2024 10:00	Miscellaneous void; sample filter change
		BD	08-28-2024 02:00	Overnight Calibration

Month	Parameter	Code	Date and Time	Description
		BD	08-30-2024 02:00	Overnight Calibration
September	Ozone	BD	09-02-2024 02:00	Overnight Calibration
		BD	09-04-2024 02:00	Overnight Calibration
		BD	09-06-2024 02:00	Overnight Calibration
		BD	09-09-2024 02:00	Overnight Calibration
		BD	09-11-2024 02:00	Overnight Calibration
		BD	09-13-2024 02:00	Overnight Calibration
		BD	09-16-2024 02:00	Overnight Calibration
		BD	09-18-2024 02:00	Overnight Calibration
		BD	09-20-2024 02:00	Overnight Calibration
		BD	09-23-2024 02:00	Overnight Calibration
		AM	09-24-2024 10:00-11:00	Miscellaneous void; sample filter change
		BD	09-25-2024 02:00	Overnight Calibration
		BD	09-27-2024 02:00	Overnight Calibration
		BD	09-30-2024 02:00	Overnight Calibration
ORCHARD				
July	Ozone	2	07-01-2024 01:00-18:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	07-01-2024 02:00	Overnight Calibration
		BD	07-03-2024 02:00	Overnight Calibration
		2	07-03-2024 14:00-07-04-2024 20:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	07-05-2024 02:00	Overnight Calibration
		2	07-06-2024 18:00-07-07-2024 17:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	07-08-2024 02:00	Overnight Calibration
		2	07-09-2024 17:00-07-19-2024 01:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	07-10-2024 02:00	Overnight Calibration
		BD	07-12-2024 02:00	Overnight Calibration
		BD	07-15-2024 02:00	Overnight Calibration
		BD	07-17-2024 02:00	Overnight Calibration
		AE	07-18-2024 20:00	Shelter temperature greater than 40°C
		AV	07-19-2024 02:00-12:00	Power failure
		AC	07-19-2024 13:00-07-25-2024 09:00	Construction/repairs; analyzer powered down during air conditioner procurement and repair
		2	07-25-2024 10:00-07-26-2024 01:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	07-26-2024 02:00	Overnight Calibration
		BD	07-29-2024 02:00	Overnight Calibration

Month	Parameter	Code	Date and Time	Description
		AM	07-30-2024 11:00-12:00	Miscellaneous void; sample filter change
		BD	07-31-2024 02:00	Overnight Calibration
August	Ozone	BD	08-02-2024 02:00	Overnight Calibration
		BD	08-05-2024 02:00	Overnight Calibration
		BD	08-07-2024 02:00	Overnight Calibration
		BD	08-09-2024 02:00	Overnight Calibration
		BD	08-12-2024 02:00	Overnight Calibration
		BD	08-14-2024 02:00	Overnight Calibration
		BD	08-16-2024 02:00	Overnight Calibration
		BD	08-19-2024 02:00	Overnight Calibration
		AV	08-20-2024 12:00	Power failure
		BD	08-21-2024 02:00	Overnight Calibration
		BD	08-23-2024 02:00	Overnight Calibration
		BD	08-26-2024 02:00	Overnight Calibration
		AM	08-27-2024 11:00-12:00	Miscellaneous void; sample filter change
		BD	08-28-2024 02:00	Overnight Calibration
		BD	08-30-2024 02:00	Overnight Calibration
September	Ozone	BD	09-02-2024 02:00	Overnight Calibration
		BD	09-04-2024 02:00	Overnight Calibration
		V	09-04-2024 11:00	Value validated; partial hour due to manual calibration
		AT	09-04-2024 12:00	Manual calibration
		BD	09-06-2024 02:00	Overnight Calibration
		BD	09-09-2024 02:00	Overnight Calibration
		BD	09-11-2024 02:00	Overnight Calibration
		BD	09-13-2024 02:00	Overnight Calibration
		BD	09-16-2024 02:00	Overnight Calibration
		BD	09-18-2024 02:00	Overnight Calibration
		BD	09-20-2024 02:00	Overnight Calibration
		BD	09-23-2024 02:00	Overnight Calibration
		AT	09-23-2024 11:00	Manual calibration
		AM	09-24-2024 12:00-13:00	Miscellaneous void; sample filter change
		BD	09-25-2024 02:00	Overnight Calibration
		BD	09-27-2024 02:00	Overnight Calibration
		BD	09-30-2024 02:00	Overnight Calibration

APPENDIX A2: CORRECTIVE ACTION REPORTS

CORRECTIVE ACTION REPORT NO.: 26

To **Dan Joseph**
From **Adam Christman**
Copy to **Courtney Taylor and Kaitlyn Elkind**

Problem Identification		
Site (Location):	**Orchard**	
System or Instrumentation:	**Air Conditioning Unit**	
Estimated start date/time	**6/25/24**	
Problem identified by:	**Jake Zaragoza/Adam Christman**	
Problem definition: • **Parameter (s) affected**	**Air conditioning unit was beginning to perform poorly and was unable to maintain controlled temperatures in the shelter.** • **Shelter Temperature**	
Planned corrective actions (if necessary):	**Replace the air conditioner with a new unit.**	
	Expected Completion Date:	**7/18/24 & 7/25/24**

Problem Resolution		
Date corrective action taken:	**7/18/24 & 7/25/24**	
Action taken by:	**Adam Christman**	
Corrective action taken:	**Shelter temperature was found to be oscillating substantially prior to the quarterly maintenance checks performed on 6/25/24 and the AC unit compressor was observed to be erratic during the Q2 site visit. A new AC unit was ordered and installed on 7/18/24, however, the unit was faulty and unable to generate cool air. The unit remained installed until a second replacement system could be procured. During this period the shelter temperature exceeded 40°C for 1 hour, during which time ozone data was invalidated. A power loss occurred several hours after this time on 7/19. To prevent any damage to the systems, the gas analyzers were left powered down until the second replacement AC unit was successfully installed on 7/25.**	
Effectiveness of corrective actions:	☒ **Yes, it was resolved**	☐ **No, it was NOT resolved**

Corrective Action Report Author & Date	Signature
Prepared by: Adam Christman **Date: 08/30/24**	

QA Officer: Michael Ring **Date: 09/04/2024**	

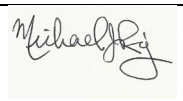
CORRECTIVE ACTION REPORT NO.: 27

To **Dan Joseph**
From **Jake Zaragoza**
Copy to **Courtney Taylor and Kaitlyn Elkind**

Problem Identification		
Site (Location):	**Missile Site Park**	
System or Instrumentation:	**RM Young 52202 Precipitation Sensor**	
Estimated start date/time	**08/15/2024**	
Problem identified by:	**Blake Himes/Abe Dearden**	
Problem definition: • **Parameter (s) affected**	**Precipitation sensor did not record rain during a regional rain event.** • **Precipitation**	
Planned corrective actions (if necessary):	**Ensure there are no clogs and open sensor to investigate tipping bucket motion.**	
	Expected Completion Date:	**08/21/2024**

Problem Resolution		
Date corrective action taken:	**08/21/2024**	
Action taken by:	**Jake Zaragoza**	
Corrective action taken:	**On 8/20 and 8/21, Weld employees tested the precipitation sensor and found that no precipitation was recorded. On 8/21, Jake Zaragoza opened the sensor and found a spiderweb impacting sensor operation. The web was removed, the sensor cleaned, and a test with 250 mL of water was performed. The target was 0.49 inches and the logger recorded 0.512 inches, which was 4.4% high and within the 10% difference allowed. Data was corrected to invalidate precipitation between 8/15 (the date of the regional rain event) and 8/21. The issue was estimated to begin on 8/15 because there was rain recorded on 8/14.**	
Effectiveness of corrective actions:	☒ **Yes, it was resolved**	☐ **No, it was NOT resolved**

Corrective Action Report Author & Date	Signature
Prepared by: Jake Zaragoza **Date: 08/29/2024**	JA

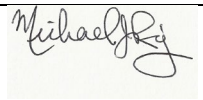
QA Officer: Michael Ring **Date: 08/29/2024**	

CORRECTIVE ACTION REPORT NO.: 28

To **Dan Joseph**
From **Jake Zaragoza**
Copy to **Courtney Taylor and Kaitlyn Elkind**

Problem Identification		
Site (Location):	**Missile Site Park**	
System or Instrumentation:	**Teledyne API T701 Zero Air Generator**	
Estimated start date/time	**09/18/2024**	
Problem identified by:	**Blake Himes/Abe Dearden**	
Problem definition: • **Parameter (s) affected**	**Diluent pressure dropping during calibration events due to failed zero air generator.** • **Routine overnight calibration checks were not able to run for either O3 or NO/NO2/NOx between 9/18 and 10/1.**	
Planned corrective actions (if necessary):	**Repair zero air generator**	
	Expected Completion Date:	**10/01/2024**

Problem Resolution		
Date corrective action taken:	**10/01/2024**	
Action taken by:	**Jake Zaragoza**	
Corrective action taken:	**Three troubleshooting visits were made to diagnose and fix the issues (9/19, 9/25, and 10/1). The failed component was identified on 9/25 and the replacement was installed on 10/1. Multi-point calibrations for all gases occurred on 10/1. No data impacts occurred other than during testing and troubleshooting on 9/18, 9/19, 9/20, and 9/25. Partial overnight calibration runs occurred between 9/18 and 9/25. The zero air generator was turned off from 9/25 until the final fix on 10/1.**	
Effectiveness of corrective actions:	☒ **Yes, it was resolved**	☐ **No, it was NOT resolved**

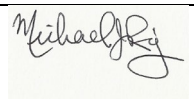
Corrective Action Report Author & Date	Signature
Prepared by: Jake Zaragoza **Date: 10/03/2024**	
QA Officer: Michael Ring **Date: 10/03/2024**	

CORRECTIVE ACTION REPORT NO.: 29

To **Dan Joseph**
From **Jake Zaragoza**
Copy to **Courtney Taylor and Kaitlyn Elkind**

Problem Identification		
Site (Location):	**Missile Site Park**	
System or Instrumentation:	**Teledyne API T200 NO/NO2/NOx and T400 ozone**	
Estimated start date/time	**09/24/2024**	
Problem identified by:	**Blake Himes**	
Problem definition: • **Parameter (s) affected**	**Leak at filter holder for both T200 NO/NO2/NOx and T400 ozone analyzers. A leak was suspected because filter changes were made, and although the calibration system was not running, a significant change in NO response was noticed following the filter change.** • **Ozone and NO/NO2/NOx**	
Planned corrective actions (if necessary):	**Tighten filter holder for both instruments**	
	Expected Completion Date:	**09/25/2024**

Problem Resolution		
Date corrective action taken:	**09/25/2024**	
Action taken by:	**Jake Zaragoza**	
Corrective action taken:	**A site visit was made on 9/25 to troubleshoot the zero air generator. While on-site, the filter holder for both the T200 and T400 were checked. Both were found loose and tightened. Instrument response changed on both following tightening, indicating that a leak was present. Data were invalidated for ozone and NO/NO2/NOx between the filter change and the tightening.**	
Effectiveness of corrective actions:	☒ **Yes, it was resolved**	☐ **No, it was NOT resolved**

Corrective Action Report Author & Date	Signature
Prepared by: Jake Zaragoza **Date: 10/03/2024**	
QA Officer: Michael Ring **Date: 10/03/2024**	

APPENDIX B: Q3 2024 SITE ACCESS LOGS

Missile Site Park Site Access Log								
Name	**Date**	**Arrival**	**Departure**	**Last Filter change**		**Pump off**	**Pump on**	**Notes**
				NOx	Ozone			
Dearden (Remote)	7/18/2024	7:56	8:05					Manual 50ppb calibration check to watch MFC flow of NO. Target flow is 0.0098 LPM for 6LPM cal, 0.0082 for a 5LPM cal.
Clemments	7/30/2024	14:00	14:30	7/30/2024	7/30/2024	14:06	14:11	Instrument turned off during filter change for O3, pump off for NOX 14:16 to 14:19, sample retrieval and AMoN retrieval
Dearden (Remote)	8/1/2024	13:20	14:18					Manual GPT Precision check, passing results in minute data file.
Clemments	8/20/2024							Pour water through precip sensor, no response. This occurred between 13:00 and 13:29 local time
Garcia	8/21/2024	9:50	9:55					Pour water through precip sensor, no response
Zaragoza	8/21/2024	11:55	13:10					Pour water through precip sensor, no response. Opened up sensor and found spider web holding the tipping bucket in place. Web removed, buckets cleaned. No spider found. Sensor tested with 250 mL of water after maintenance. Target was .49 inches of water, logger recorded .512 inches, which is within 10% difference threshold. Sensor down until 12:00 logger time.
Garcia	8/27/2024	13:08	13:25	8/27/2024	8/27/2024	13:17	13:20	NOx filters swapped, NADP sample swapped and retrieved, AMoN sample swapped and retrieved.
Clemments	9/17/2024	11:00	13:00					Estimated log entry. On site to test the precip. sensor by dropping water into the funnel inlet. Precip data invalid for hours 12:00 and 13:00 MST.
Dearden (Remote)	9/18/2024	9:16	9:30					Manual calibration check to diagnose last night's missing ozone calibration. Gasses down from 9:16 through 9:30 MST.
Zaragoza	9/19/2024	9:33	12:40					Troubleshoot zero air generator (ZAG). ZAG was found at 15 PSI with compressor running nonstop. It was also found with a loose circuit board cover. The cover was re-secured and a leak check was performed. The ZAG stabilized at 36 PSI for 15 minutes. The diluent line was reconnected, and the ZAG settled at ~30PSI (setpoint changed) before the compressor turned off. A zero event was started at 30 PSI, 10 SLPM and the pressure dropped to <20 PSI after 2 minutes (10:21-10:23). Another zero was started at 30 PSI, 6 SLPM and the pressure fluctuated between 20 and 30 PSI for 6 minutes (10:26-10:32). Compressor deadhead was tested and found >200 PSI. 4 way valve was tested and both ports tested well (+10LPM/0LPM). There was a slight indication of a leak on the lower port during the warmup but afterwards all cycles were good. A final leak check was performed at 31PSI for 6 min. A final zero check was performed between 12:25 and 12:34. Gases valid by 12:38. All times in logger time.
Dearden (Remote)	9/20/2024	8:19	8:33					Remote Ozone check (precision point only). Passing results, calibrator ran steady the entire duration. (Gasses offline)
Clemments	9/24/2024	13:56	14:30	9/24/2024	9/24/2024	14:20	14:24	Nox and Ozone filters swapped. NADP and AMON samples received and swapped.
Zaragoza	9/25/2024	13:49	19:10					On site to troubleshoot calibration system and check for ozone/NOx filter leaks. Ozone and NOx filter holders found loose, they were both re-tightened at 13:50. Auto Zero performed on T700, process began at 15:06 and ended by 15:38 (ozone and NOx impacted during this process). NO span test started at 15:57 and ended at 16:23 (ozone and NOx impacted). Zero air gen (ZAG) pump deadhead tested again (200 PSI, no issues suspected). Attempt to test between drier and reservoir tank failed because ZAG could not build pressure. Internal pneumatics reset and ZAG could not build pressure. All fittings removed during this troubleshooting 'snooped' and no signs of a leak were present. Rotameter connected to upper muffler of 4 way valve. During 5 minutes, no switching occurred despite control board indicating several switching cycles. ZAG left off while purchase of replacement 4 way valve is made.

Hereford Site Access Log							
Name	**Date**	**Arrival**	**Departure**	**Last Filter change**	**Pump off**	**Pump on**	**Notes**
				Ozone			
Clemments	7/30/2024	9:51	10:03	7/30/2024	9:54	9:59	NOx/O3 filter change
Clemments	7/31/2024	11:40	11:58		11:44	11:50	Dessicant
Garcia	8/27/2024	9:50	10:02	8/27/2024	9:54	10:00	Dessicant, NOx/O3 filter change
Clemments	9/24/2024	10:20	11:04	9/24/2024	10:51	10:59	Dessicant, NOx/O3 Filter change

Orchard Site Access Log							
Name	**Date**	**Arrival**	**Departure**	**Last Filter change**	**Pump off**	**Pump on**	**Notes**
				Ozone			
Christman/Garcia	7/18/2024	8:45	11:15				On site for replacement of AC unit; AC turned off ~09:00; new unit online ~10:30; new unit does not seem to engage compressor to generate cool air; will monitor
Christman	7/19/2024	12:05	12:16				On site to troubleshoot loss of coms; power strip with analyzers/pumps/com switch was found tripped off; power was reset, analyzers and pumps were left unplugged/off, switch power was restored and coms tested good; AC unit has not engaged for cooling; a second replacement unit will be ordered to be installed next week; analyzers were left powered down as precautionary measure as shelter temp was elevated to above 40C during previous 24 hr; power tripped off during the 01:00-02:00 logger time hour during previous night.
Christman/Clemments	7/25/2024	8:40	10:15				On site to reinstall a second replacement AC unit; analyzers were powered back on upon site arrival to allow for warmup; AC unit swapped successfully, climate control active ~9:30; ran test zero/span ~9:45-9:59 MDT; systems sampling ambient in normal mode as of 9:59 MDT
Clemments/Garcia	7/30/2024	11:20	11:50	7/30/24	11:34		O3 filter change, AMoN filter change, NADP sample retreived, no data retrieved
Christman	8/2/2024	13:25	15:21				On site to replace NADP Precip system battery; found GFCI tripped upon arrival; reset switch and replaced battery; cleaned wire leads at connection terminal of charger/batt/logger
Garcia	8/27/2024	11:12	11:45	8/27/24	11:26		AMoN,NOx/O3, NADP, swapped and retrieved. Dessicant swapped and refilled
Dearden (Remote)	9/4/2024	10:52	11:46				Remote ZSP manual calibration for Ozone. Instrument offline 10:52-11:46 logger time.
Dearden (Remote)	9/23/2024	10:15	10:45				Remote ZSP manual calibration for Ozone. Instrument offline 10:15-10:45 logger time. Calibrator was oscillating while attempting to find its target, and may need maintenance.
Clemments	9/24/2024	11:57	12:40	9/24/24	12:26		O3 filter change, AMON and NADP sample retrieval and change.

APPENDIX C: Q3 2024 CALIBRATION STATISTICS

APPENDIX C: Q3 2024 CALIBRATION STATISTICS

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C.1 PREFACE

Appendix D of the Quality Assurance Handbook Volume II (https://www.epa.gov/sites/default/files/2020-10/documents/app_d_validation_template_version_03_2017_for_amtic_rev_1.pdf) specifies the frequency and allowable ranges of the one-point quality control (precision), zero, and span checks for ozone and NO/NO_2/NOx, which are based on the Code of Federal Regulations (CFR). These allowable ranges are mostly percent differences between a measured point and the audit point. At each site, the measured point was taken as a 3-minute average of a stable analyzer reading while receiving calibration gas. The audit point is a preset calibration target that the on-site calibrators produce. For both ozone and NO/NOx, the precision check is 60 ppb and the span check is 400 ppb. For NO_2, the target output concentrations from the calibrator are 48 ppb and 160 ppb for precision and span checks, respectively. Since the calibrator only indirectly calculates NO_2 concentration, the actual target NO_2 output is calculated as the difference in NO between the gas phase titration zero (GPTZ) and the gas phase titration (GPT) phases. The analyzer is then challenged against these actual target NO_2 concentrations. Each figure below highlights the percent difference between the measured point and the audit point, with the upper and lower lines representing the allowable upper and lower limits. NO_2 has an additional requirement for calculation of the converter efficiency in converting NO_2 to NO. Each converter efficiency check is plotted for it.

Additionally, each table below represents the results of the calculations detailed in 40CFR58, Appendix A, Section 4 'Calculations for Data Quality Assessments' (https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-58). They are provided only for informational purposes.

C.2 MISSILE SITE PARK SITE

Ozone (O_3)

Figure C - 1 and **Figure C - 2** below show the calibration span and precision percent differences for ozone at the Missile Site Park site. Due to an issue with the zero-air generator, regularly scheduled automated calibrations did not run on September 18th, September 23rd, September 25th, September 27th, or September 30th. On September 20th the automated calibration was able to complete a zero and span check only; later that morning a manual precision check was run to complete the set. The zero-air generator was repaired on October 1st at which time a full multi-point calibration check occurred, and regularly scheduled calibration checks subsequently resumed. No data loss occurred because of this troubleshooting and maintenance, and all calibration checks were within the upper and lower bounds specified in Appendix D of the Quality Assurance Handbook Volume II. **Table C - 1** highlights the assessment statistics detailed in 40CFR58, Appendix A, Section 4. These values are estimated from a sample of the entire dataset at the site.

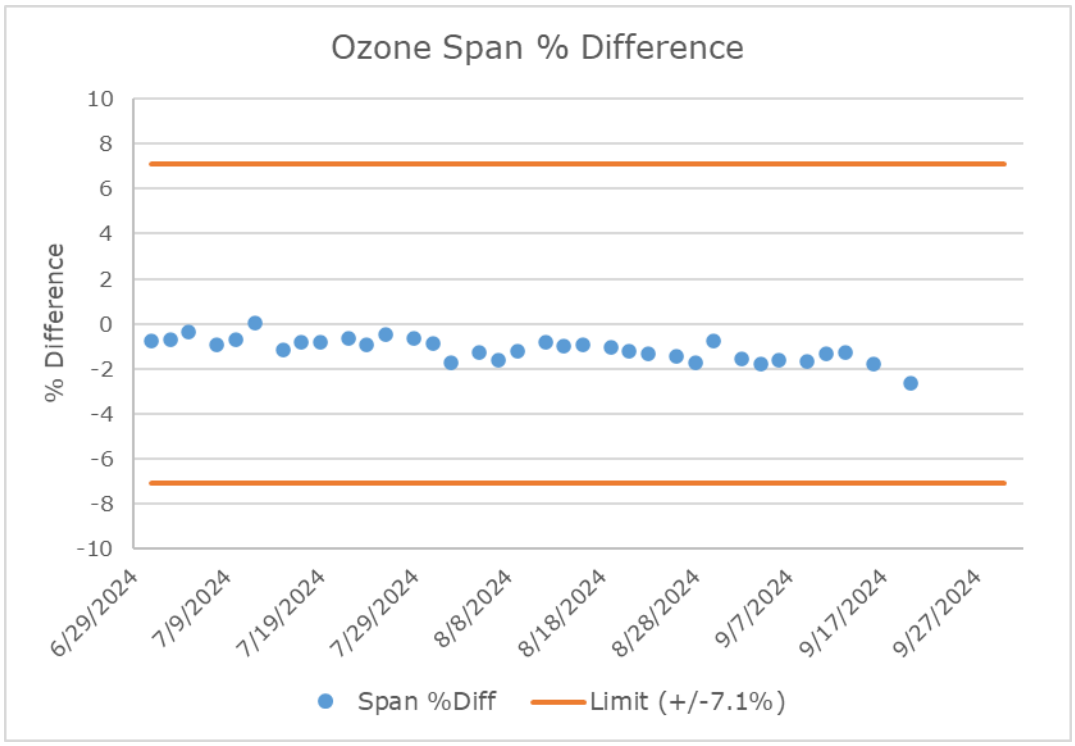

Figure C - 1. 2024 Q3 Calibration span percent difference for O_3 at Missile Site Park.

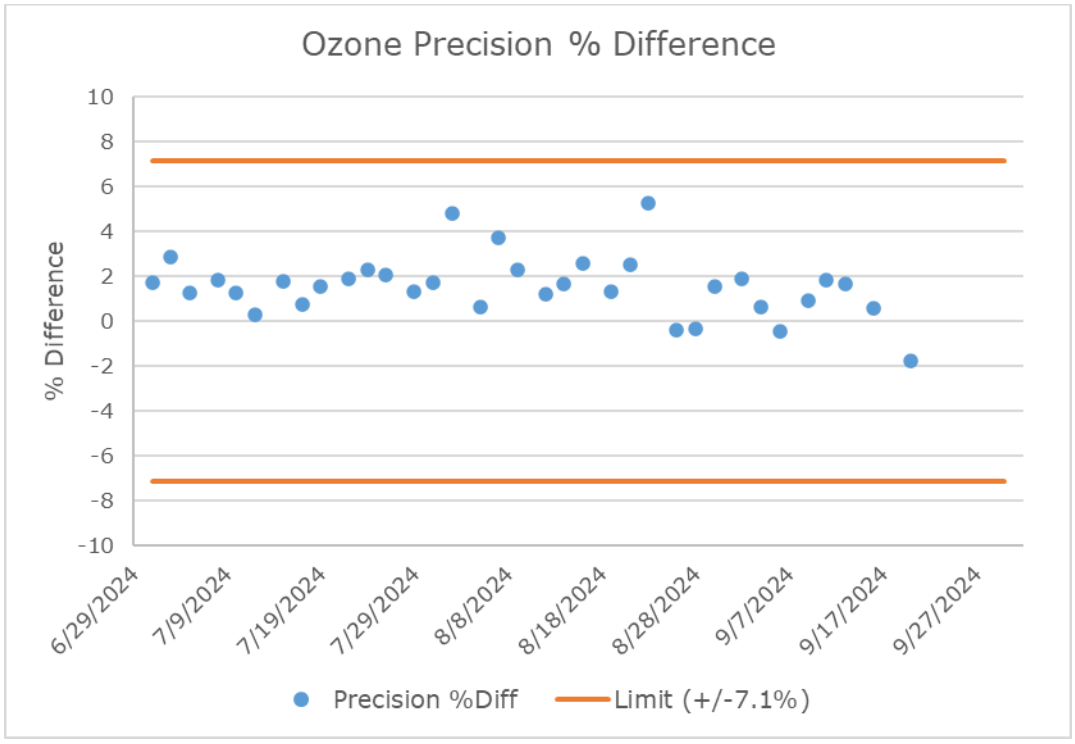

Figure C - 2. 2024 Q3 Calibration precision percent difference for O_3 at Missile Site Park.

Table C - 1. Summary of 2024 Q3 calibration statistics for O_3 at Missile Site Park.

Formula	Precision	Span
STDEV	1.35	0.52
Count	35	35
Chi^2, 0.1, n-1	23.95	23.95
CV	1.61	0.62
Bias	2.04	1.28
Bias (+/-/U)	+	-
AB	1.72	1.13
AS	1.12	0.51
$t_{0.95}$, n-1	1.69	1.69
25^{th}	0.84	-1.48
75^{th}	1.95	-0.79

Nitric Oxide (NO)

Figure C - 3 and **Figure C - 4** below show the calibration span and precision percent differences for NO at the Missile Site Park site. Calibration checks did not occur between the automated check on September 17^{th} and October 1^{st} due to efforts to troubleshoot an issue with the zero-air generator. The zero-air generator was repaired on October 1^{st} at which time a full multi-point calibration check occurred, and regularly scheduled calibration checks subsequently resumed. While more than 14 days passed between the calibration check on September 17^{th} and the subsequent passing multi-point calibration check on October 1^{st}, data was determined to be valid during this period in consideration of the passing results on October 1^{st}. All calibration checks were within the upper and lower bounds specified in Appendix D of the Quality Assurance Handbook Volume II. **Table C - 2** highlights the assessment statistics detailed in 40CFR58, Appendix A, Section 4.

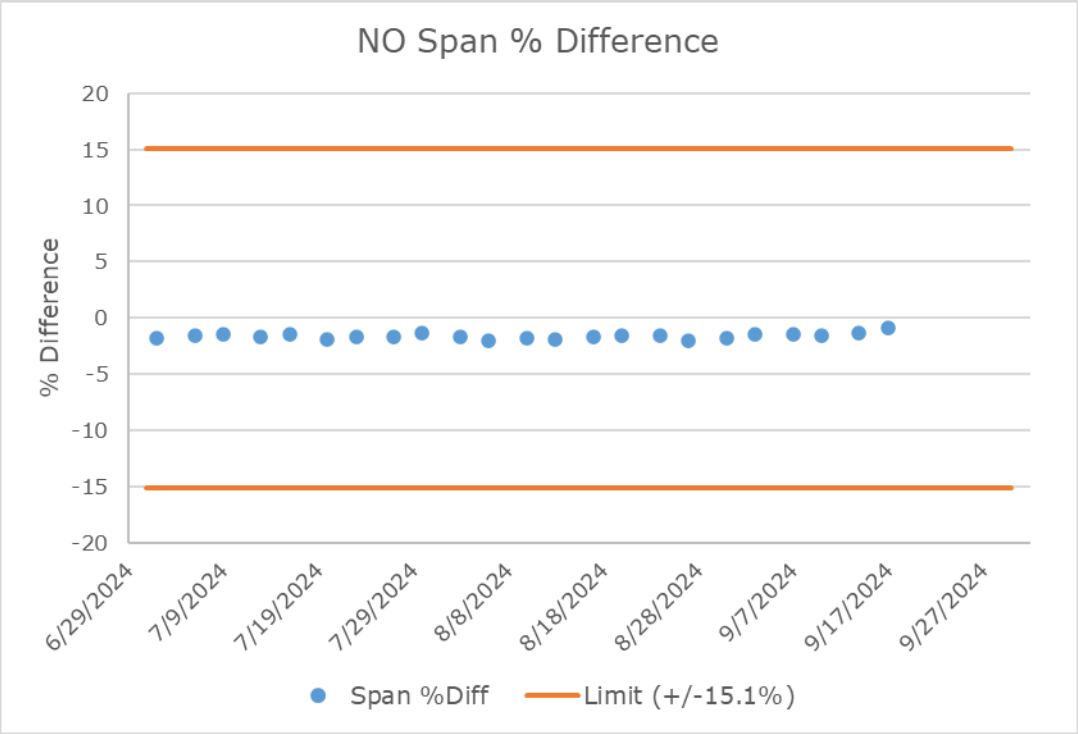

Figure C - 3. 2024 Q3 Calibration span percent difference for NO at Missile Site Park.

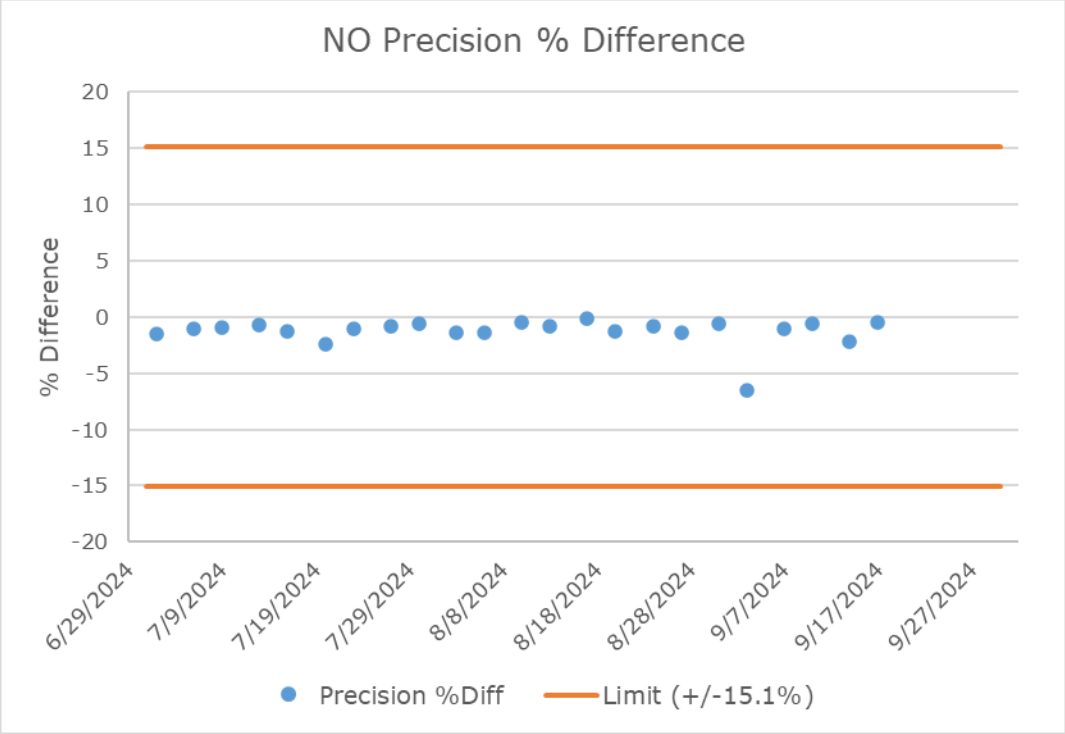

Figure C - 4. 2024 Q3 Calibration precision percent difference for NO at Missile Site Park.

Table C - 2. Summary of 2024 Q3 calibration statistics for NO at Missile Site Park.

Formula	Precision	Span
STDEV	1.26	0.26
Count	23	23
Chi^2, 0.1, n-1	14.04	14.04
CV	1.58	0.32
Bias	1.72	1.73
Bias (+/-/U)	-	-
AB	1.27	1.64
AS	1.26	0.26
$t_{0.95}$, n-1	1.72	1.72
25th	-1.37	-1.82
75th	-0.63	-1.49

Nitrogen Dioxide (NO_2)

Figure C - 5 below shows the converter efficiency (CE) during both precision (shown in blue) and span (shown in gold) calibrations for NO_2. CE has been calculated based on the latest published federal guidance[1]. The federal record requires only a minimum CE rate of 96%, while the upper limit of 104.1% is an EPA recommendation[2] only. Note that the data shown in **Figure C - 5** represent estimates of CE determined from a 1-point precision or span NO_2 gas phase titration (GPT) level only. Furthermore, gas flow rates are not available during the single-point GPT checks so that the correction factor for NO_2 impurity cannot be included in the computation. In contrast, the CE values determined from a multi-point check is computed via a linear fit across multiple GPT points, and flow rates are available so that the impurity correction can be included. The CE determined during the multi-point quarterly calibration checks is therefore expected to be a more accurate assessment of the CE than the values determined during the single-point quality control checks. No Q3 2024 calibration checks took place, so no multi-point CE value has been determined this quarter. The next estimate of CE using the multi-point GPT values will be evaluated during Q4 2024.

Figure C - 6 and **Figure C - 7** below show the calibration percent difference for NO_2 during span and precision calibrations, respectively. Calibration checks did not occur between the automated span GPT check on September 15th and October 1st due to efforts to troubleshoot an issue with the zero-air generator. The zero-air generator was repaired on October 1st, at which time a full multi-point GPT check occurred, and regularly scheduled calibration checks subsequently resumed. While more than 14 days passed between the GPT calibration check on September 15th and the subsequent passing multi-point GPT check on October 1st, data was determined to be valid during this period in consideration of the passing results on October 1st. All calibration checks were within the upper and lower bounds

[1] Converter efficiency calculations follow 40CFR Part 50 Appendix F, Sections 1.5.10 and 2.4.10.

[2] EPA-454/B-17-001, Quality Assurance Handbook for Air Pollution Measurement Systems Volume II: Ambient Air Quality Monitoring Program Appendix D, March 2017.

specified in Appendix D of the Quality Assurance Handbook Volume II. **Table C - 3** highlights the assessment statistics detailed in 40CFR58, Appendix A, Section 4.

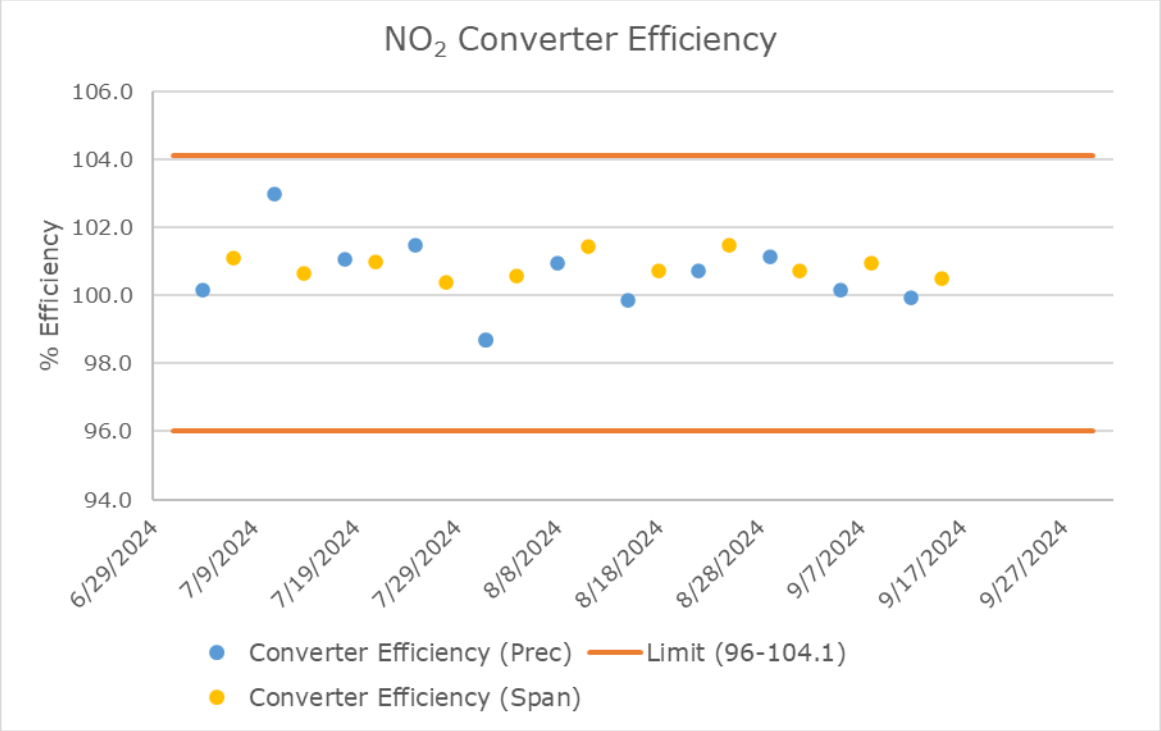

Figure C - 5. 2024 Q3 Converter efficiency for NO_2 at Missile Site Park.

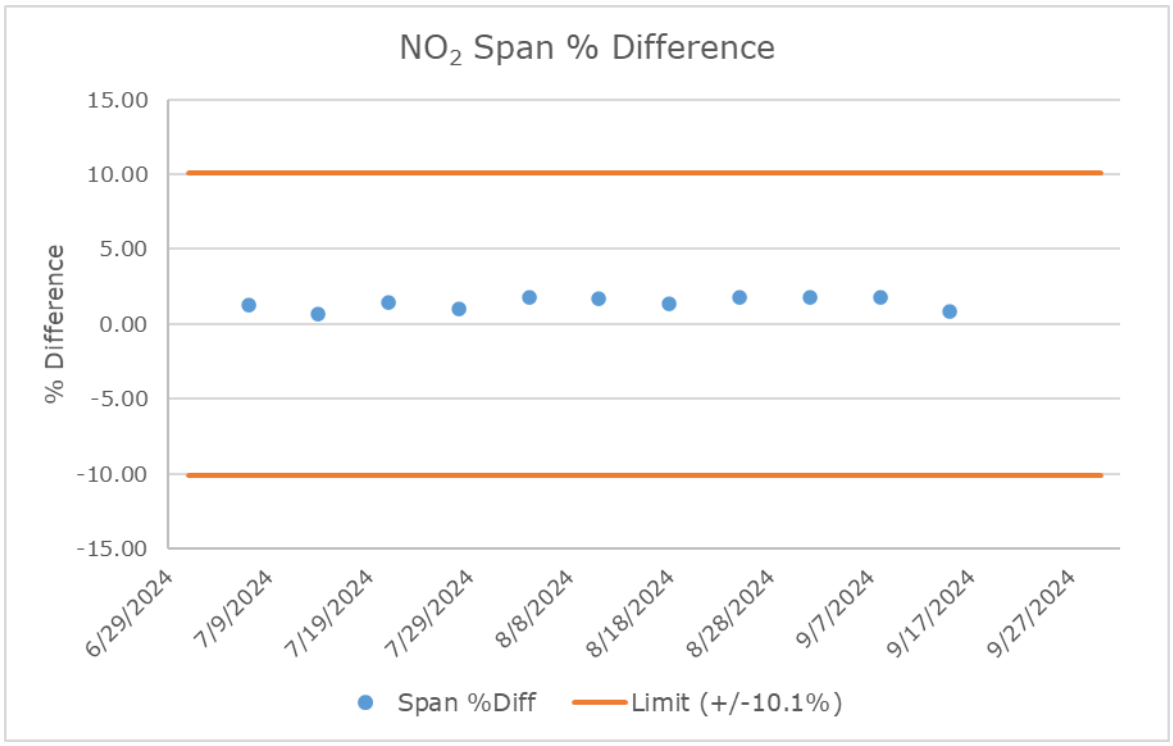

Figure C - 6. 2024 Q3 Calibration span percent difference for NO_2 at Missile Site Park.

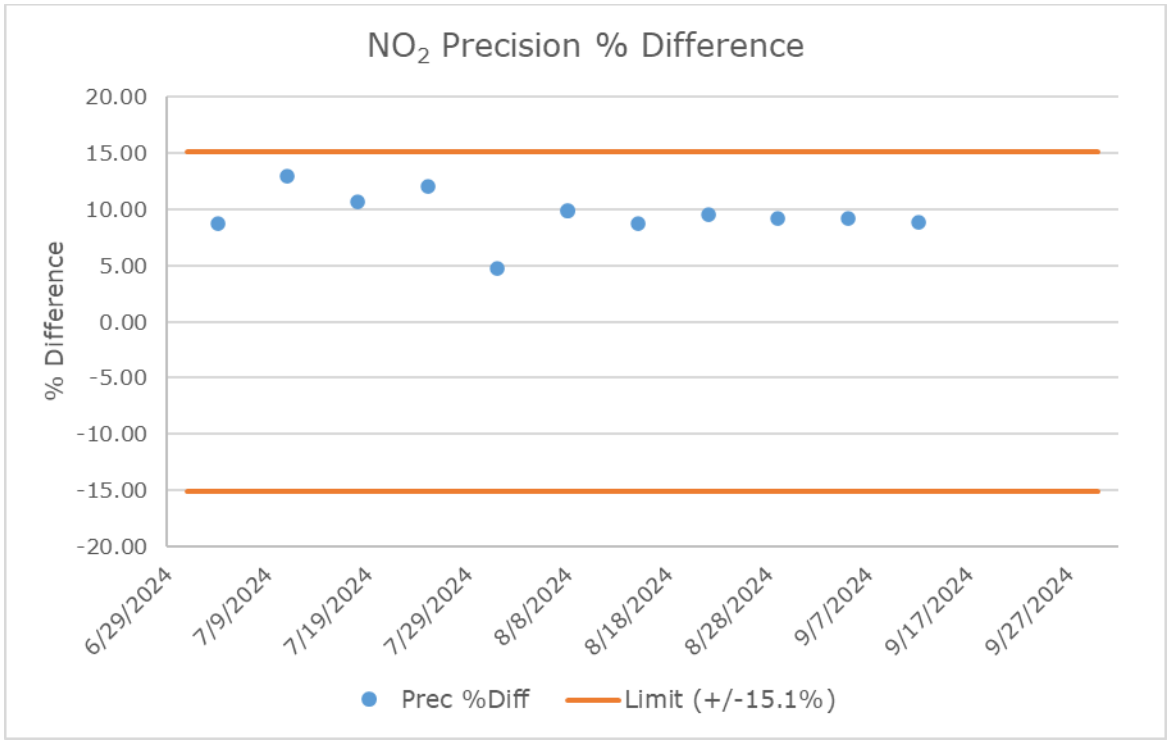

Figure C - 7. 2024 Q3 Calibration precision percent difference for NO_2 at Missile Site Park.

Table C - 3. Summary of 2024 Q3 calibration statistics for NO_2 at Missile Site Park.

Formula	Precision	Span
STDEV	2.10	0.40
Count	11	11
Chi^2, 0.1, n-1	4.87	4.87
CV	3.02	0.58
Bias	10.65	1.63
Bias (+/-/U)	+	+
AB	9.50	1.41
AS	2.10	0.40
$t_{0.95}$, n-1	1.81	1.81
25^{th}	8.80	1.17
75^{th}	10.25	1.76

Nitrogen Oxides (NOx)

Figure C - 8 and **Figure C - 9** below show the calibration span and precision percent differences for NOx at the Missile Site Park site. Calibration checks did not occur between the automated check on September 17th and October 1st due to efforts to troubleshoot an issue with the zero-air generator. The zero-air generator was repaired on October 1st at which time a full multi-point calibration check occurred, and regularly scheduled calibration checks subsequently resumed. While more than 14 days passed between the calibration check on September 17th and the subsequent passing multi-point calibration check on October 1st, data was determined to be valid during this period in consideration of the passing results on October 1st. All calibration checks were within the upper and lower bounds specified in Appendix D of the Quality Assurance Handbook Volume II. **Table C - 4** highlights the assessment statistics detailed in 40CFR58, Appendix A, Section 4.

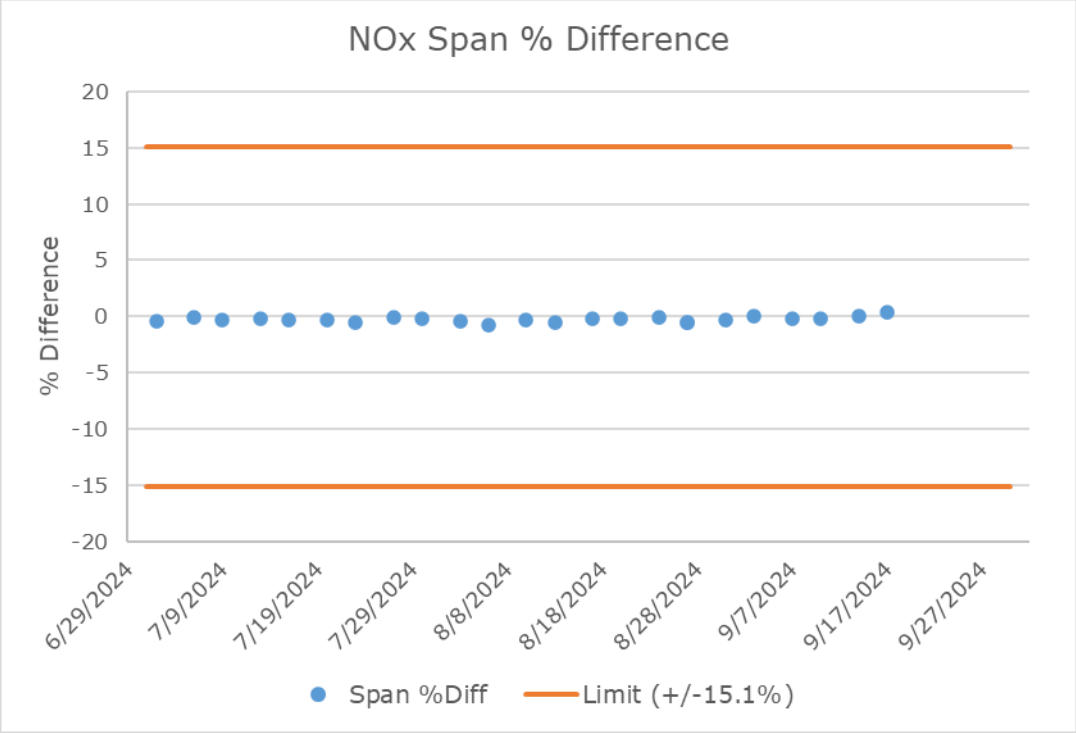

Figure C - 8. 2024 Q3 Calibration span percent difference for NOx at Missile Site Park.

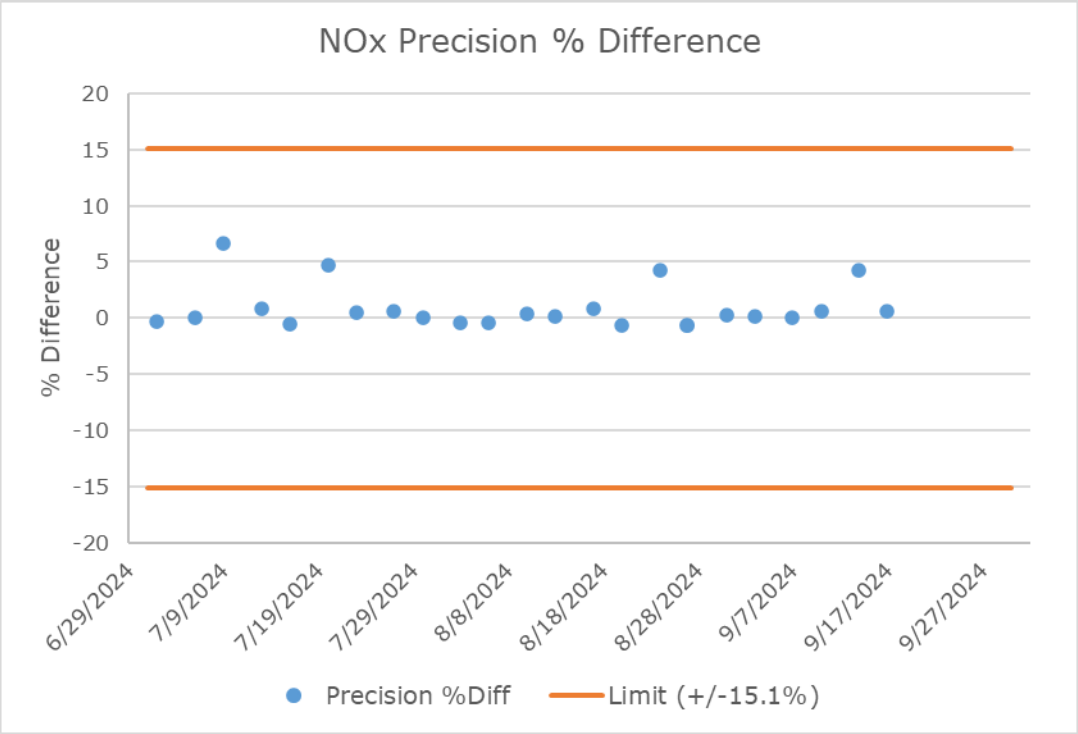

Figure C - 9. 2024 Q3 Calibration precision percent difference for NOx at Missile Site Park.

Table C - 4. Summary of 2024 Q3 calibration statistics for NOx at Missile Site Park.

Formula	Precision	Span
STDEV	1.98	0.24
Count	23	23
Chi^2, 0.1, n-1	14.04	14.04
CV	2.48	0.30
Bias	1.86	0.36
Bias (+/-/U)	U	-
AB	1.21	0.29
AS	1.83	0.19
$t_{0.95}$, n-1	1.72	1.72
25^{th}	-0.12	-0.39
75^{th}	0.75	-0.13

C.3 HEREFORD SITE

Ozone (O_3)

Figure C - 10 and **Figure C - 11** below show the calibration span and precision percent differences for ozone at the Hereford site. Each check is within the upper and lower bounds specified in Appendix D of the Quality Assurance Handbook Volume II. **Table C - 5** highlights the assessment statistics detailed in 40CFR58, Appendix A, Section 4.

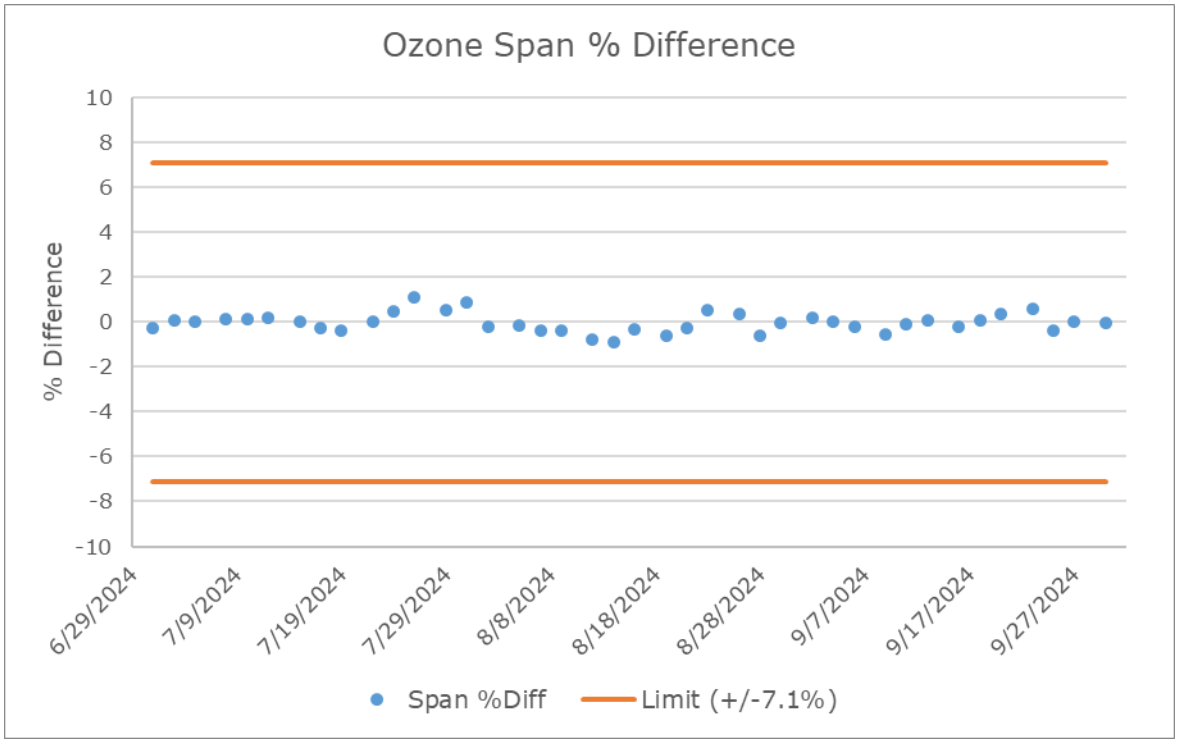

Figure C - 10. 2024 Q3 Calibration span percent difference for O_3 at Hereford.

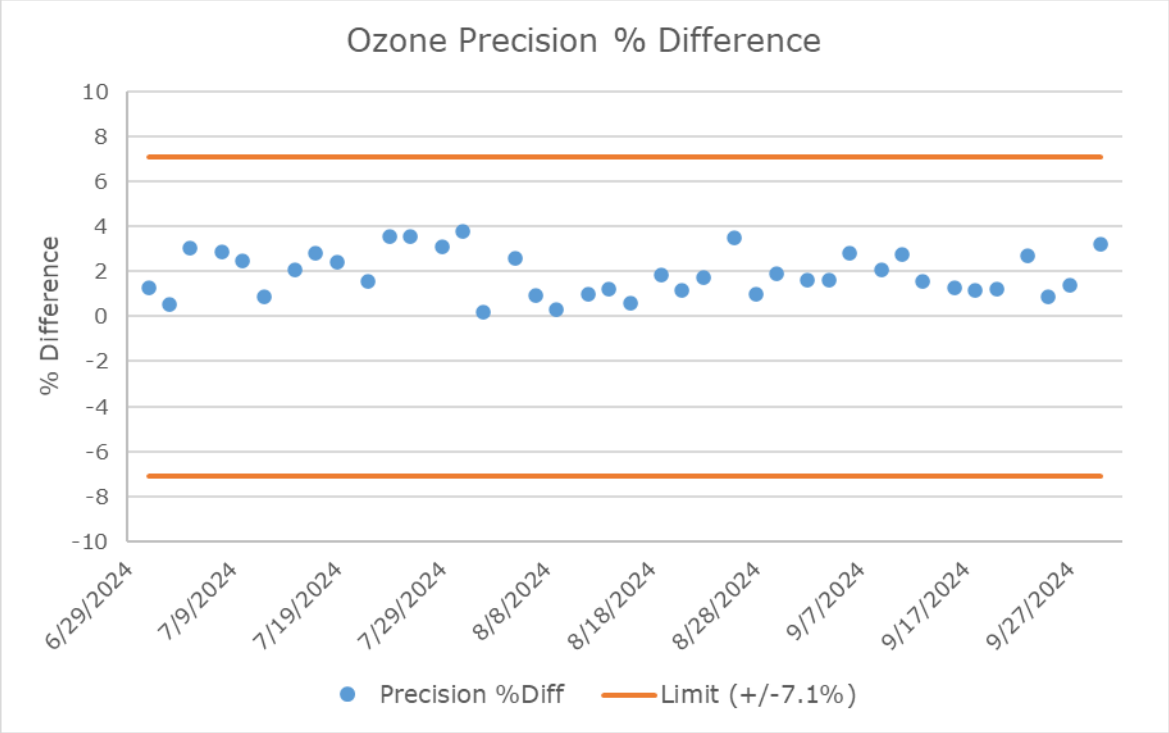

Figure C - 11. 2024 Q3 Calibration precision percent difference for O_3 at Hereford.

Table C - 5. Summary of 2024 Q3 calibration statistics for O_3 at Hereford.

Formula	Precision	Span
STDEV	1.00	0.42
Count	40	40
Chi^2, 0.1, n-1	28.20	28.20
CV	1.17	0.50
Bias	2.17	0.39
Bias (+/-/U)	+	U
AB	1.90	0.32
`AS	1.00	0.28
$t_{0.95}$, n-1	1.68	1.68
25^{th}	1.16	-0.31
75^{th}	2.77	0.13

C.4 ORCHARD SITE

Ozone (O_3)

Figure C - 12 and **Figure C - 13** below show the calibration span and precision percent differences for ozone at Orchard. Each check is within the upper and lower bounds specified in Appendix D of the Quality Assurance Handbook Volume II. **Table C - 6** highlights the assessment statistics detailed in 40CFR58, Appendix A, Section 4 and does not include calibration data from periods that were invalidated or during which the analyzer was offline. The analyzer was powered down between July 19th and July 25th while the shelter air conditioner was being serviced and replaced.

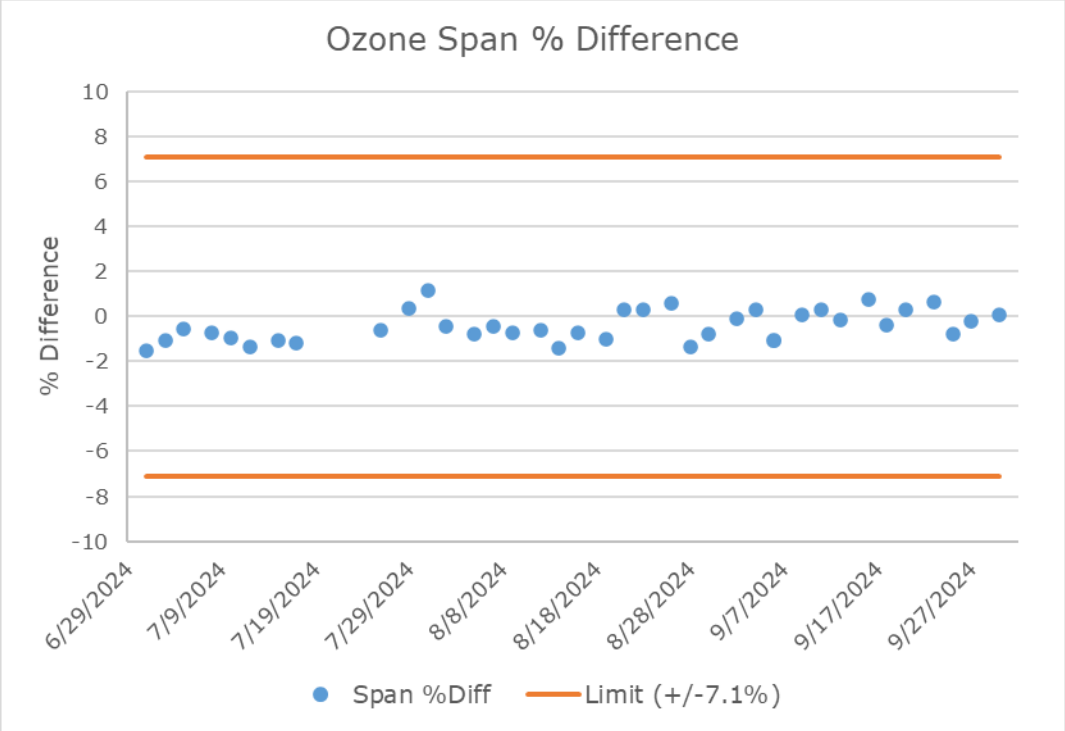

Figure C - 12. 2024 Q3 Calibration span percent difference for O_3 at Orchard.

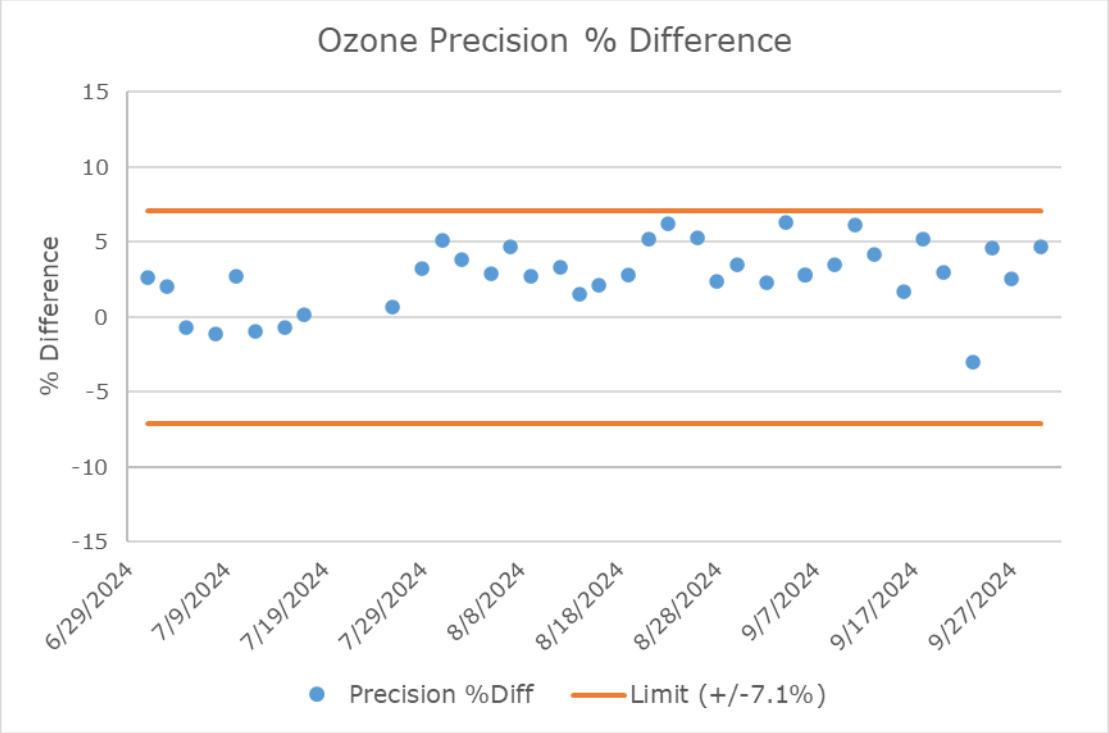

Figure C - 13. 2024 Q3 Calibration precision percent difference for O_3 at Orchard.

Table C - 6. Summary of 2024 Q3 calibration statistics for O_3 at Orchard.

Formula	Precision	Span
STDEV	2.22	0.69
Count	37	37
Chi^2, 0.1, n-1	25.64	25.64
CV	2.63	0.81
Bias	3.60	0.79
Bias (+/-/U)	+	U
AB	3.14	0.68
AS	1.66	0.41
$t_{0.95}$, n-1	1.69	1.69
25^{th}	2.03	-0.98
75^{th}	4.61	0.28