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Project Number
1940112228-001

February 2025

WELD COUNTY MONITORING NETWORK

AIR QUALITY AND METEOROLOGICAL MONITORING DATA: 2024 ANNUAL SUMMARY REPORT

RAMBOLL

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ACRONYMS AND ABBREVIATIONS

Above Ground Level	agl
Acidity	pH
Air Quality System	AQS
Ammonia	NH_3
Ammonia Monitoring Network	AMoN
Ammonium	NH_4
Bromide	Br
Calcium	Ca
Chloride	Cl
Colorado Ambient Air Quality Standards	CAAQS
Greenhouse Gas	GHG
Hazard Mapping System	HMS
Lab	L
Magnesium	Mg
Meter	m
Micrograms per meter cubed	$\mu g/m^3$
Micro-Siemens per centimeter	µS/cm
Milligrams per meter cubed	mg/m^3
Missile Site Park	MSP
National Ambient Air Quality Standards	NAAQS
National Ambient Air Quality Standards and Ambient Air Quality Standards	AAQS
National Institutes of Technology and Standard	NIST
National Trends Network	NTN
National Environmental Satellite, Data, and Information Science	NESDIS
Nitrate	NO_3

Nitrogen Dioxide	NO_2
Nitrogen Oxide	NO
Oxides of Nitrogen	NOx
Particulate Matter of Aerodynamic Diameter of 2.5 Microns or Less	$PM_{2.5}$
Parts per billion	ppb
Parts per million	ppm
Phosphate	PO_4
Potassium	K
Quality Assurance Project Plan	QAPP
Relative Humidity	RH
Sodium	Na
Sulfate	SO_4
Teledyne Advanced Pollution Instrumentation	TAPI
United States Environmental Protection Agency	USEPA
US EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Monitoring Program	QA Handbook

1. 2024 MONITORING HIGHLIGHTS

Data Completeness

- Data completeness goals were met for all parameters at Hereford and Orchard; for MSP all goals were met besides NO_2, which did not meet the targets for Q4.

Ozone

- **Annual Concentrations:** 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, in 2023, 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:** The 2008 ozone standard was exceeded nine times at MSP, four times at Hereford, and once at Orchard. The 2015 standard was exceeded 20 times at MSP, eight times at Hereford, and five times at Orchard. Ozone exceedance days occurred in July and August at all three monitors.
- **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 in the NAA ranged between 71 to 89 ppb.[1] The controlling monitor in the nonattainment area (NREL) had a 4th highest MDA8 that was 9 ppb greater than MSP's 4th highest value. 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.
- **Design Values:** The 2022-2024 design value is 0.074 ppm (74 ppb) at MSP, which exceeds the 2015 standard, but not the 2008 standard. The 2022-2024 design values at Hereford and Orchard are 0.068 ppm (68 ppb) at both sites, which is below both ozone standards.

Nitrogen Dioxide (NO_2)

- **Values:** Annual concentrations at MSP are well below federal annual and 1-hour health-based standards.
- **Annual trend:** The 2024 annual mean NO_2 value is 6.5 ppb, which is below previous values.

[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: February 2025.

Annual Events

- **Climate trends:** While the sites have been operating for four (4) years, this is too short a period to evaluate climate trends, so the 2024 meteorological conditions were evaluated using longer-term data produced by the High Plains Regional Climate Center. For Quarter 4 2024, temperatures in Weld County were 4-5°F warmer than normal, while precipitation was 0-2 inches below average.[2] In 2024, temperatures in Weld County were approximately 1-4°F warmer than normal, while precipitation was about 1-3 inches below average.[3]
- **Wildfire smoke:** There were more than 72 days where smoke was present aloft over at least one of the sites.[4,5] Both out-of-state and in-state fires likely contributed to the smoke. Out of state fires were primarily located burning in Wyoming, Oregon, Washington, Alaska, and Canada, while in-state fires included Alexander Mountain (Larimer County), Stone Canyon (Boulder County), and Quarry (Jefferson County).[6,7] Based on a smoke screening assessment, there were 11 days that smoke impacted monitored, ground-level ozone concentrations at the sites in 2024.
- **Summary of non-routine site visits:** MSP had approximately 11 visits to troubleshoot parts of the gas analyzer systems and the precipitation gauge, and to oversee installation of methane systems that were deployed for a separate project not affiliated with Weld County monitoring objectives. Orchard had approximately seven visits to replace the battery in the National Atmospheric Deposition Program (NADP) precipitation gauge, to troubleshoot the air conditioning system and ozone analyzer, and to oversee installation of methane systems that were deployed for a separate project not affiliated with Weld County monitoring objectives. Hereford had one visit to oversee the installation of the methane system.

[2] High Plains Regional Climate Center, *ACIS Climate Maps*. Available at: https://hprcc.unl.edu/maps.php?map=ACISClimateMaps Accessed: February 2025.

[3] Id.

[4] 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: February 2025.

[5] NOAA Hazard Mapping System Smoke Detection. Available at: https://noaa.maps.arcgis.com/home/item.html?id=ab7a5fbd76e3499296350eabf599fc63. Accessed: February 2025.

[6] McKee, Spencer. *Here's why it's so dang smoky in Colorado today*, Denver Gazette, July 22 2024. Available at: https://denvergazette.com/outtherecolorado/news/heres-why-its-so-dang-smoky-in-colorado-today/article_f00b792e-4841-11ef-8a98-870705764581.html. Accessed February 2025.

[7] Colorado Public Radio, *Colorado wildfires: Sunday coverage*, August 2024 https://www.cpr.org/2024/08/04/colorado-wildfires-coverage-august-4/. Accessed: February 2025.

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.

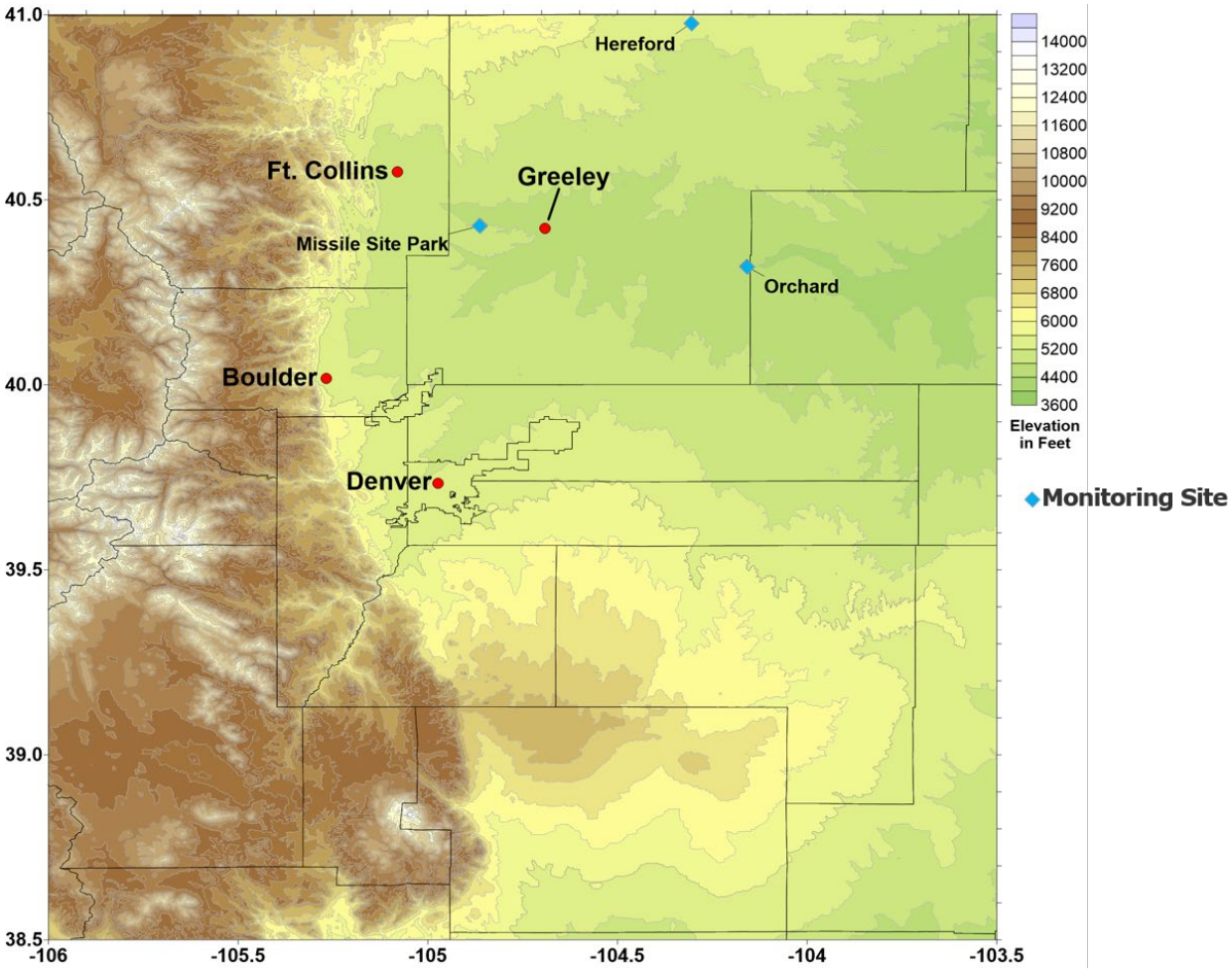

Figure 1. Weld County Monitoring Station Locations

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 1** 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,[8] 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[9] considered locations of existing monitors, concentration trends, and spatial distributions of emissions.

Ramboll Americas Engineering Solutions, Inc. (Ramboll) has prepared this Annual 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 2024 provides an annual summary of all air quality and meteorological data collected at Weld County's monitoring stations during the period from January 1, 2024 through December 31, 2024. In addition, for completeness, Quarter 4 2024 tables and plots are available in **Appendix A** as this information is not available in other stand-alone reports. 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 2024 data is 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 2024 were all within normal ranges for the area. At all three stations, average temperatures were coldest Quarter 1 and warmest during Quarter 3. Average solar radiation was highest in Quarter 2 and lowest in Quarter 1 at all sites. The maximum hourly precipitation occurred during Quarter 2 at all sites.

Continuous gaseous pollutant measurements for Quarter 3 2024 indicate that all three stations experienced several multi-day periods with elevated ozone daily maxima. The first maximum 8-hour average O_3 concentration at each site was 0.091 ppm on July 24th at Hereford, 0.087 ppm on July 23rd at MSP, and 0.078 ppm on August 3rd at Orchard. Through a smoke screening assessment, it was determined that there were 11 days in 2024 that were impacted by ground-level smoke. When smoke impacts are excluded from consideration, the 4th highest ozone concentrations are reduced significantly at both MSP and Hereford, decreasing by 4 ppb and 8 ppb, respectively, but Orchard was

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

[9] Id.

only minimally affected by smoke. Concentrations remained below the AAQS values for NO_2. At MSP, the highest hourly average NO_2 concentration recorded during 2024 was 45.8 ppb on January 17th.

It is important to note that O_3 and NO_2 measurements have now been collected for four 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	ppb	Parts per billion
NO_2	Nitrogen dioxide	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* 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 site 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, NO_x, wet deposition via the National Trends Network (NTN), gaseous ammonia via the Ammonia Monitoring Network (AMoN), and meteorological parameters on a 10-meter (m) tower;
- Hereford is a secondary station located in north-central Weld County and monitors O_3 and meteorological parameters on 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 on 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.[10] Weld County's monitoring program is conducted in accordance with the QAPP.

[10] Ramboll, Weld County Ambient Air Monitoring Program Quality Assurance Project Plan (QAPP) Verizon 5, December 20th, 2024. Available by request.

Table 2 and **Table 3** summarize the key air quality and meteorological monitoring equipment and measurement specifications for the Weld County stations. The monitoring system, sampling frequency, quality assurance program, and data management aspects of the monitoring program are described in the QAPP.[11]

[11] 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
Zero Air Generator	TAPI	T701	1961	NO/NO_2 < 0.1 ppb; O_3 < 0.4 ppb	N/A	N/A	N/A	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	05305	209492[4]	±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] The sensor was replaced on 10/26/2024. The original sensor was an RM Young 05305V, serial number 180187.

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 on a daily basis. 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, wind direction, surface temperature, relative humidity, barometric pressure, 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 and *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").[12,13] 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 calibration visits and once a year independent audits in accordance with the QAPP.[14] Semi-annual calibration visits were performed in calendar Quarters 2 and 4. Independent audits were performed in Quarter 4. The Quarter 4 semi-annual calibration and independent audit results are available in this report in **Appendix B.**

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

[12] 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 2025.

[13] 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 February 2025.

[14] Ramboll, Weld County Ambient Air Monitoring Program Quality Assurance Project Plan (QAPP) Verizon 5, December 20th, 2024. Available by request.

check is once every 14 days, per Appendix D of the Quality Assurance Handbook, Volume II.[15] **Table 4** below highlights periods 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 criteria and the two calibration checks surrounding this period are passing, then no data is required to be invalided. Since each calibration check surrounding the dates in **Table 5** was passing, no data was invalided. Maintenance is performed as necessary in response to measured deviations during calibrations and as part of planned routine activities during station inspections. A summary of calibration data for 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			
09/15/2024 – 10/01/2024	16	NO_2: GPT/Converter Efficiency	Calibration zero air generator failed to hold pressure due to a broken part.

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 2024 included data collection, equipment programming and calibrations, station inspections, routine maintenance, semi-annual calibration visits, equipment troubleshooting and repair, routine data acquisition, data screening and validation, audits, and report preparation. Significant events that resulted in invalidation of data during Quarter 4 2024 are documented in **Appendix A2. Appendix A3** contains the site log for Quarter 4 2024.

Consistent with data completeness requirements specified in the QA Handbook, the quarterly data completeness goals are greater than (≥) 75% for NO_2 data, and ≥ 90% for meteorological data. For O_3, the data completeness goals are ≥ 90% of the daily maximum 8-hour average O_3 during the O_3 season, which in Colorado is January to December.[16] A summary of data completeness by quarter and for the year (2024) is presented in **Table 5**. In 2024 data recovery met requirements for all parameters for all quarters, except for NO_2 at MSP during Quarter 4. On November 9th the NO_x analyzer at MSP exhibited a shift in response during a routine nightly check. The issue was not resolved until November 20th, with a multipoint calibration confirming the fix on November 22nd. Again, on December 17th the NO_x analyzer at MSP exhibited a shift in response. The issue was not resolved until January 2nd, 2025.

[15] USEPA, Quality Assurance Handbook for Ambient Air Quality Monitoring. Volume II Ambient Air Quality Monitoring Program, Appendix D, March 2017. Available at: https://www.epa.gov/sites/default/files/2020-10/documents/app_d_validation_template_version_03_2017_for_amtic_rev_1.pdf. Accessed: February 2025.

[16] USEPA Ozone Seasons, February 13 2025. Available at: https://aqs.epa.gov/aqsweb/documents/codetables/ozone_seasons.html. Accessed: February 2025.

Additionally, a smoke screening assessment was completed for 2024 data and is detailed in **Section 4.2.4** below. In 2024, 11 days were determined to be smoke impacted and data from those days have been flagged with the "IT" informational flag. Days that were impacted by smoke are not invalidated, and thus do not adversely affect data completeness. The "IT" flag is applied to inform subsequent use of the data and aid in future interpretation. There were more days that were smoke impacted in 2024 than in 2023 which had five days that were impacted.

In addition to data completeness requirements, the QA Handbook has 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 Quarter 2 and Quarter 4 2024 semi-annual calibrations and during the Quarter 4 independent audit.

Table 5. 2024 Annual Data Completeness for Continuous Measurement Devices

Measurement	Time Period	Completeness Target [1-6]	Site Completeness					Target Met? (Y/N)
			Q1	Q2	Q3	Q4	2024	
Missile Site Park								
NO_2[1]	Quarterly	≥75%	91%	92%	94%	64%	85%	Yes Except for Q4
NO_x, NO	N/A	N/A	91%	92%	94%	64%	85%	N/A
O_3[1]	O_3 Season	≥90%	86%	98%	98%	91%	93%	Yes
Wind Direction[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Wind Speed[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Temperature[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Delta Temperature[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Relative Humidity	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Solar Radiation[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Barometric Pressure[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Precipitation[2]	Quarterly	≥90%	100%	100%	93%	100%	98%	Yes
Hereford								
O_3[1]	O_3 Season	≥90%	100%	99%	100%	98%	99%	Yes
Wind Direction[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Wind Speed[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Temperature[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Delta Temperature[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes

Measurement	Time Period	Completeness Target [1-6]	Site Completeness					Target Met? (Y/N)
			Q1	Q2	Q3	Q4	2024	
Relative Humidity	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Solar Radiation[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Barometric Pressure[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Precipitation[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Orchard								
O_3[1]	O_3 Season	≥90%	100%	92%	92%	96%	95%	Yes
Wind Direction[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Wind Speed[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Temperature[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Delta Temperature[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Relative Humidity	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Solar Radiation[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Barometric Pressure[2]	Quarterly	≥90%	100%	100%	100%	100%	100%	Yes
Precipitation[2]	Quarterly	≥90%	100%	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%, per the rules for an annual standard concentration. there is no data completeness target for NO or NO_x. For O_3 the data completeness target is 90% of daily maximum 8-hour averages during the ozone season. In Colorado, the Ozone season is January through December (https://aqs.epa.gov/aqsweb/documents/codetables/ozone_seasons.html).
[2] 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.

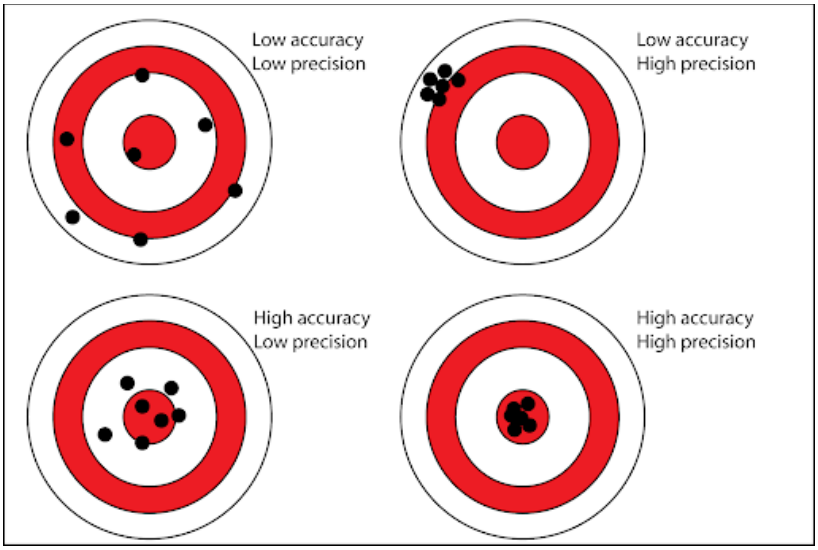

Figure 2. Graphical Representation of Accuracy and Precision

Table 6. 2024 Annual Accuracy and Precision

Measurement	Target Accuracy	Target Precision	Q2 Calibration Results[1]	Q4 Calibration Results[2]	Independent Audit Results[3]
Missile Site Park					
NO_x/NO/NO_2	±15%	±15.1%	PASS[4]	PASS[5]	PASS
O_3	±15%	±7.1%	PASS	PASS	PASS
Wind Direction	±5°	±5°	PASS	PASS	PASS
Wind Speed	±0.2 m/s	±0.2 m/s	PASS	PASS	PASS
Temperature	±0.5 °C	±0.5 °C	PASS	PASS	PASS
Delta Temperature	±0.1 °C	±0.1 °C	PASS	PASS	PASS
Relative Humidity	±7%	±7%	PASS	PASS	PASS
Solar Radiation	±5%	±5%	PASS	PASS	PASS
Barometric Pressure	±2.25 mm	±2.25 mm	PASS	PASS	PASS
Precipitation	±10%	±10%	PASS	PASS	PASS
Hereford					
O_3	±15%	±7.1%	PASS	PASS	PASS
Wind Direction	±5°	±5°	PASS	PASS	PASS
Wind Speed	±0.2 m/s	±0.2 m/s	PASS	PASS	PASS
Temperature	±0.5 °C	±0.5 °C	PASS	PASS	PASS

Measurement	Target Accuracy	Target Precision	Q2 Calibration Results[1]	Q4 Calibration Results[2]	Independent Audit Results[3]
Delta Temperature	±0.1 °C	±0.1 °C	PASS	PASS	PASS
Relative Humidity	±7%	±7%	PASS	PASS	PASS
Solar Radiation	±5%	±5%	PASS	PASS	PASS
Barometric Pressure	±2.25 mm	±2.25 mm	PASS	PASS	PASS
Precipitation	±10%	±10%	PASS	PASS	PASS
Orchard					
O_3	±15%	±7.1%	PASS	PASS	PASS
Wind Direction	±5°	±5°	PASS	PASS	PASS
Wind Speed	±0.2 m/s	±0.2 m/s	FAIL[6]	PASS	PASS
Temperature	±0.5 °C	±0.5 °C	PASS	PASS	PASS
Delta Temperature	±0.1 °C	±0.1 °C	PASS	PASS	PASS
Relative Humidity	±7%	±7%	PASS	PASS	PASS
Solar Radiation	±5%	±5%	PASS	PASS	PASS
Barometric Pressure	±2.25 mm	±2.25 mm	PASS	PASS	PASS
Precipitation	±10%	±10%	PASS	PASS	PASS

Notes:
[1] Results are found in Quarter 2 Report.
[2] Results are found in Appendices B1 through B3 of this report.
[3] Results are found in Appendices B4 through B6 of this report.
[4] 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.
[5] The lowest two flow set points on the low-flow mass flow controller (MFC) were found to be outside of acceptance criteria during the Q4 2024 audit check and were 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 B1 of this report for more detail.
[6] 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.

4.2.4 Smoke Screening Assessment

A smoke screening assessment was completed for Q2 and Q3 2024 data given the smoke impacts from Canadian and western U.S. wildfires.[17] Smoke can lead to enhancements in gaseous pollutant concentrations even if the source is several states away.[18,19] To support future use of the air quality monitoring data, gaseous pollutant concentrations in 2024 were evaluated to identify which data were impacted by smoke. This section describes the method used to identify smoke impacted data and how these data are qualified in the final validated dataset. The process is based on a methodology developed by Brey and Fischer.[20] Based on the smoke screening assessment, 11 days were found to be smoke impacted in 2024: July 21st – 26th, July 31st, August 1st, August 9th – 10th, and September 6th. On these days data were given the "IT" informational flag from the AQS, which has the "Wildfire-U.S." description.[21] The addition of an IT flag does not change the final validated data or affect the data completeness calculations.

To assist with data interpretation and further the use of measured data, we conducted a smoke screening assessment. Impacted days were identified and then flagged based on a combination of ground-level particulate matter of aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$) data and National Environmental Satellite, Data, and Information Science (NESDIS) Hazard Mapping System (HMS) smoke maps.

To apply the Brey and Fischer[22] methodology, the $PM_{2.5}$ concentrations measured at the Greeley Hospital were used as the first step to identify days that were potentially impacted by smoke.[23] The Greeley Hospital $PM_{2.5}$ monitoring station was selected as it has the shortest average distance to the three Weld County Monitoring Network stations compared to all other regulatory $PM_{2.5}$ monitors in the Northern Front Range (see **Figure 3**). Hence the Greeley Hospital station is likely the most representative of potential $PM_{2.5}$ concentrations at the other Weld County Monitoring Network stations. $PM_{2.5}$ data between June 1st and September 30th for the years of 2018, 2019, and 2022 were used to establish a summertime threshold $PM_{2.5}$ concentration and standard deviation. Those years were selected because of the relatively low smoke impacts. The daily mean summertime $PM_{2.5}$ concentration plus one standard deviation during this three-year period was 12.2 $\mu g/m^3$. This value was used to establish a threshold for anomalous conditions since this could be indicative of potential smoke impacts at ground level, the level at which the monitors collect air samples.

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[17] McKee, Spencer. "Here's why it's so dang smoky in Colorado today" Denver Gazette, July 22 2024. Available at: https://denvergazette.com/outtherecolorado/news/heres-why-its-so-dang-smoky-in-colorado-today/article_f00b792e-4841-11ef-8a98-870705764581.html. Accessed February 2025.

[18] S. J. Brey and E. V. Fischer, "Smoke in the City: How Often and where Does Smoke Impact Summertime Ozone in the United States?", Environmental Science & Technology, February 2 2016. Available at: https://pubs.acs.org/doi/abs/10.1021/acs.est.5b05218. Accessed February 2025.

[19] 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 (2018). Accessed February 2025.

[20] S. J. Brey and E. V. Fischer, "Smoke in the City: How Often and where Does Smoke Impact Summertime Ozone in the United States?", Environmental Science & Technology, February 2 2016. Available at: https://pubs.acs.org/doi/abs/10.1021/acs.est.5b05218. Accessed February 2025.

[21] AQS Data Qualifier information. Available at: https://aqs.epa.gov/aqsweb/documents/codetables/qualifiers.html. Accessed February 2025.

[22] S. J. Brey and E. V. Fischer, "Smoke in the City: How Often and where Does Smoke Impact Summertime Ozone in the United States?", Environmental Science & Technology, February 2 2016. Available at: https://pubs.acs.org/doi/abs/10.1021/acs.est.5b05218. Accessed February 2025.

[23] The Weld County Monitoring Network does not include a $PM_{2.5}$ monitor to confirm that the elevated $PM_{2.5}$ conditions monitored at Greeley Hospital also occurred at each station.

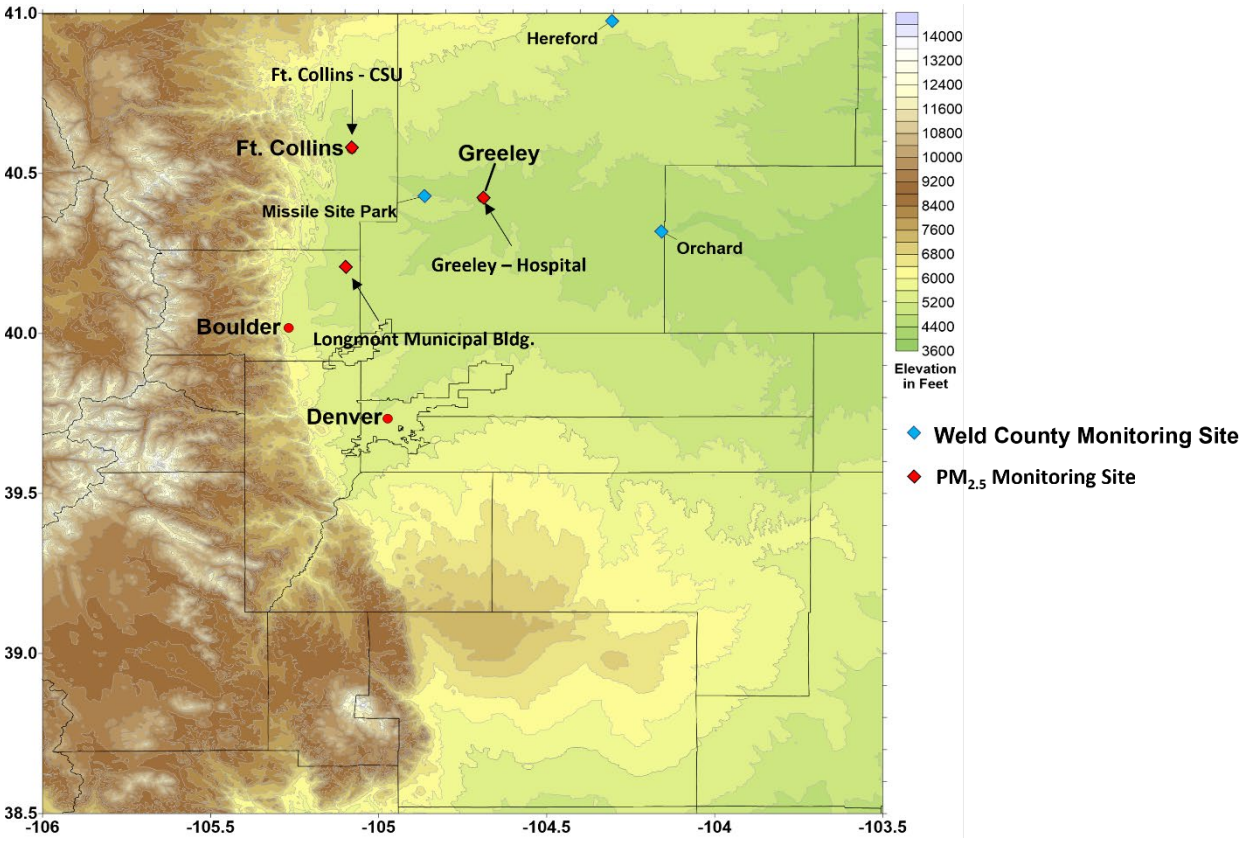

Figure 3. Weld County and Northern Front Range Regulatory $PM_{2.5}$ Monitoring Stations

On days where measured $PM_{2.5}$ at the Greeley Hospital was greater than the threshold defined above, HMS smoke maps, which are based on visible satellite imagery, were then used to confirm the presence or absence of smoke over Weld County.[24,25] The smoke extent and approximate concentration in the HMS smoke maps are determined by trained analysts.[26] There are some limitations to the use of HMS smoke maps since the presence of clouds affects satellite measurements and since visible satellite imagery is used only when daylight can be assessed.[27,28] As a further limitation, HMS smoke maps do not discern between smoke at the surface and smoke higher in the atmosphere. For days that had both ground-level $PM_{2.5}$ concentrations above the established threshold

[24] G.D. Rolph et al, "Description and Verification of the NOAA Smoke Forecasting System: The 2007 Fire Season", Weather and Forecasting, 2009. Available at: https://journals.ametsoc.org/view/journals/wefo/24/2/2008waf2222165_1.xml. Accessed February 2025.

[25] M. Ruminski et al, "Recent Changes to the Hazard Mapping System" Presented at the 15th International Emissions Inventory Conference, 2006. Available at: https://www3.epa.gov/ttnchie1/conference/ei15/session10/ruminski_pres.pdf. Accessed February 2025.

[26] G.D. Rolph et al, "Description and Verification of the NOAA Smoke Forecasting System: The 2007 Fire Season", Weather and Forecasting, 2009. Available at: https://journals.ametsoc.org/view/journals/wefo/24/2/2008waf2222165_1.xml. Accessed February 2025.

[27] Id.

[28] M. Ruminski et al, "Recent Changes to the Hazard Mapping System" Presented at the 15th International Emissions Inventory Conference, 2006. Available at: https://www3.epa.gov/ttnchie1/conference/ei15/session10/ruminski_pres.pdf. Accessed February 2025.

and HMS smoke maps confirmed the presence of smoke in Weld County, the informational "IT" flag was applied to the final validated data. Informational flags indicate potential external influences on the data, but do not invalidate the data.

5. AIR QUALITY DATA SUMMARY

Air quality data collected includes O_3 at all three stations and NO_x at the MSP station. In addition, wet deposition and gaseous ammonia are measured in accordance with the NADP program standard operating procedures at MSP and Orchard. The full 2024 wet deposition and gaseous ammonia data from NADP are not yet available. When the remaining 2024 wet deposition and gaseous ammonia data are available, a separate memorandum will be issued. This section summarizes the O_3 and NO_x data collected during 2024.

5.1 Gaseous O_3 Data Summary

O_3 data collected for 2024 at all three stations were compared against the 2008 O_3 AAQS (0.075 ppm) and 2015 O_3 AAQS (0.070 ppm). Both the 2008 and 2015 O_3 AAQS are based on the fourth highest daily maximum 8-hour O_3 concentration averaged over 3 years. The daily maximum 8-hour average ozone concentrations measured at all three stations during 2024 were above the levels of both the 2008 and 2015 AAQS values. During 2024, MSP recorded 20 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 daily maximum 8-hour O_3 concentrations for 2024 and dates that they occurred are presented in **Table 7** for all three stations. Days determined to be to be impacted by smoke were flagged with the "IT" flag used by AQS. In total, 11 days were flagged as smoke-impacted during 2024 and these dates are detailed in Section 4.2.4 above. The four highest maximum daily 8-hour average O_3 concentrations at all three stations are shown in **Table 8** for days that were not impacted by smoke. As shown by comparison between **Table 7** and **Table 8**, when smoke impacts are excluded, the 4th highest ozone concentrations are reduced significantly at both MSP and Hereford, but Orchard was only minimally affected by smoke. **Table 9** 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. Note there is no exclusion of smoke-impacted periods here. Values are color-coded according to the AAQS values; yellow indicates values above only the 2015 AAQS, while orange indicates values above both the 2015 and 2008 AAQS. The highest daily maximum 8-hour O_3 concentrations in 2024 all occurred during Q3. The daily maximum 8-hour average O_3 concentrations for 2024 at MSP, Hereford, and Orchard are presented in **Figure 4** through **Figure 6**, respectively. For detailed information about Q4 2024 data, see **Appendix A**.

5.1.1 MSP O_3 Data Summary

At MSP during 2024, measured daily maximum 8-hour O_3 concentrations were above the 2008 standard nine times and were above the 2015 standard 20 times. Data collected during days when there were smoke impacts have been flagged accordingly, but not invalidated. When smoke-impacted days were excluded, measured daily maximum 8-hour O_3 concentrations were significantly lower and only above the 2008 standard four times and above the 2015 standard 13 times. Based on 2022 through 2024 data, the design value for MSP is 0.074 ppm, which is above the 2015 standard but below the 2008 standard. Note, the gap in the data from January 30th through February 9th is due to a cracked glass cover on the analyzer sample filter housing, see the annotation in **Figure 4**.

5.1.2 Hereford O_3 Data Summary

At Hereford during 2024, measured daily maximum 8-hour O_3 concentrations were above the 2008 standard four times and were above the 2015 standard eight times. Data collected during days when there were smoke impacts have been flagged accordingly, but not invalidated. When smoke-impacted days were excluded, measured daily maximum 8-hour O_3 concentrations were significantly lower and no days were above the 2008 standard, but three days were above the 2015 standard. Based on 2022 through 2024 data, the design value for Hereford is 0.068 ppm, which is below both the 2008 and 2015 standards.

5.1.3 Orchard O_3 Data Summary

At Orchard during 2024, measured daily maximum 8-hour O_3 concentrations were above the 2008 standard once and were above the 2015 standard five times. Data collected during days when there were smoke impacts have been flagged accordingly, but not invalidated. When smoke-impacted days were excluded, measured daily maximum 8-hour O_3 concentrations did not change appreciably. There was one day above the 2008 standard and four days above the 2015 standard. Based on 2022 through 2024 data, the design value for Orchard is 0.068 ppm, which is below both the 2008 and 2015 standards. Note, the gap in the data from June 13th through June 18th is due to an issue with insects clogging the airflow and is indicated by the annotation in **Figure 6**. Also note that the gap in data from July 18th through July 24th in **Figure 6** was due to the failure of the shelter air conditioning system during which the instrument was shut down to avoid operating above its safe temperature threshold.

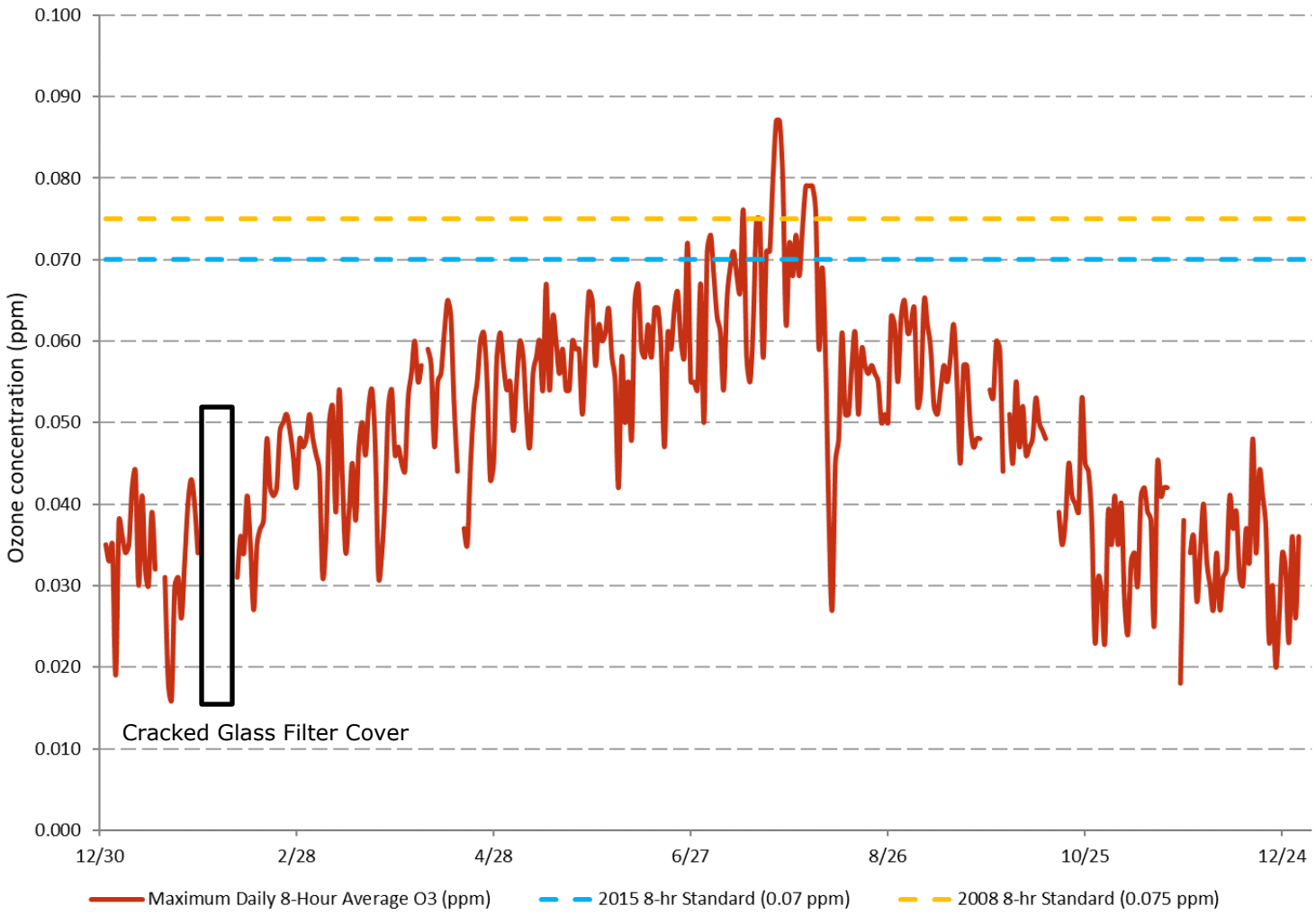

Figure 4. MSP 2024 Maximum Daily 8-hour Averaged O_3.

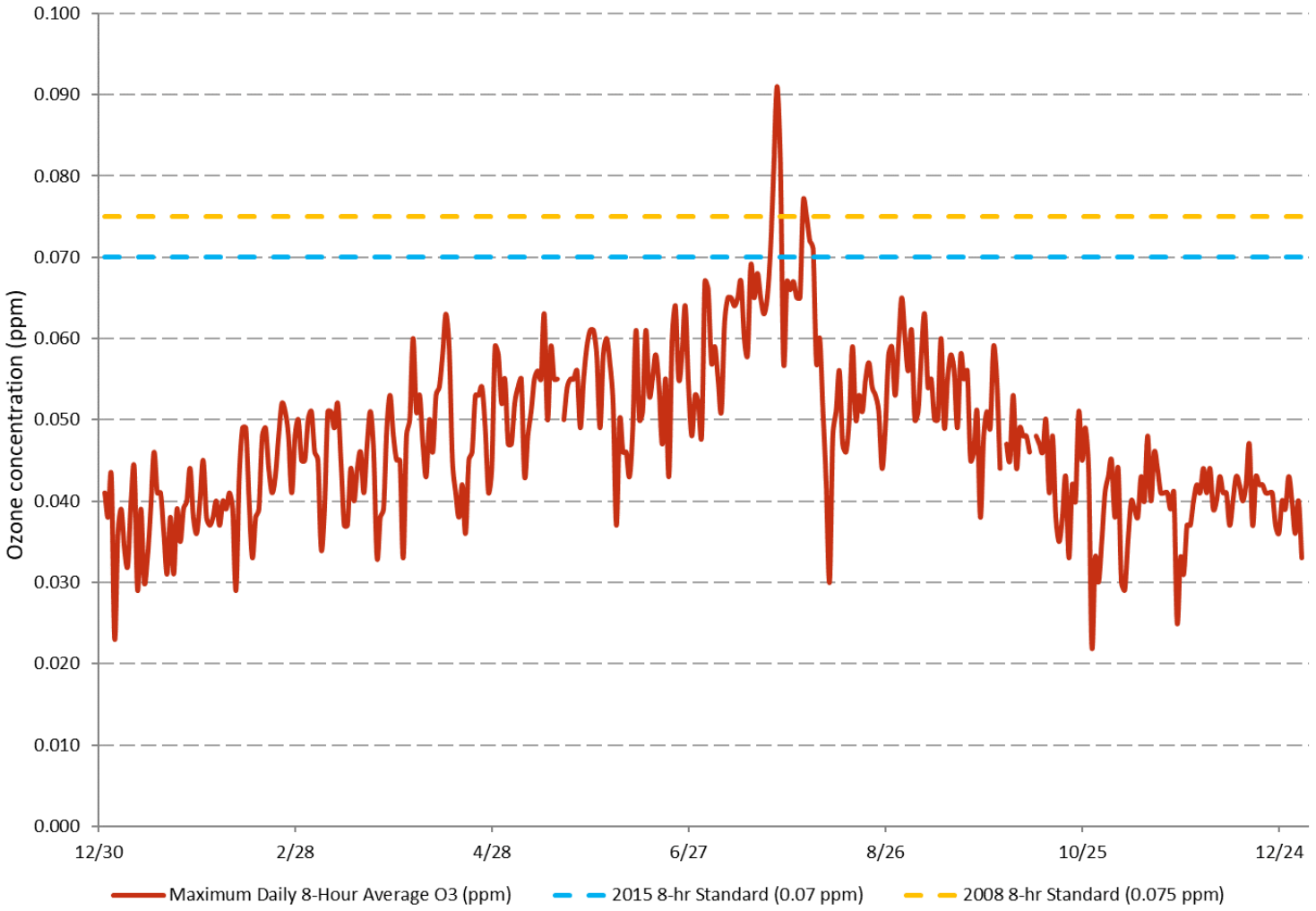

Figure 5. Hereford 2024 Maximum Daily 8-hour Averaged O_3.

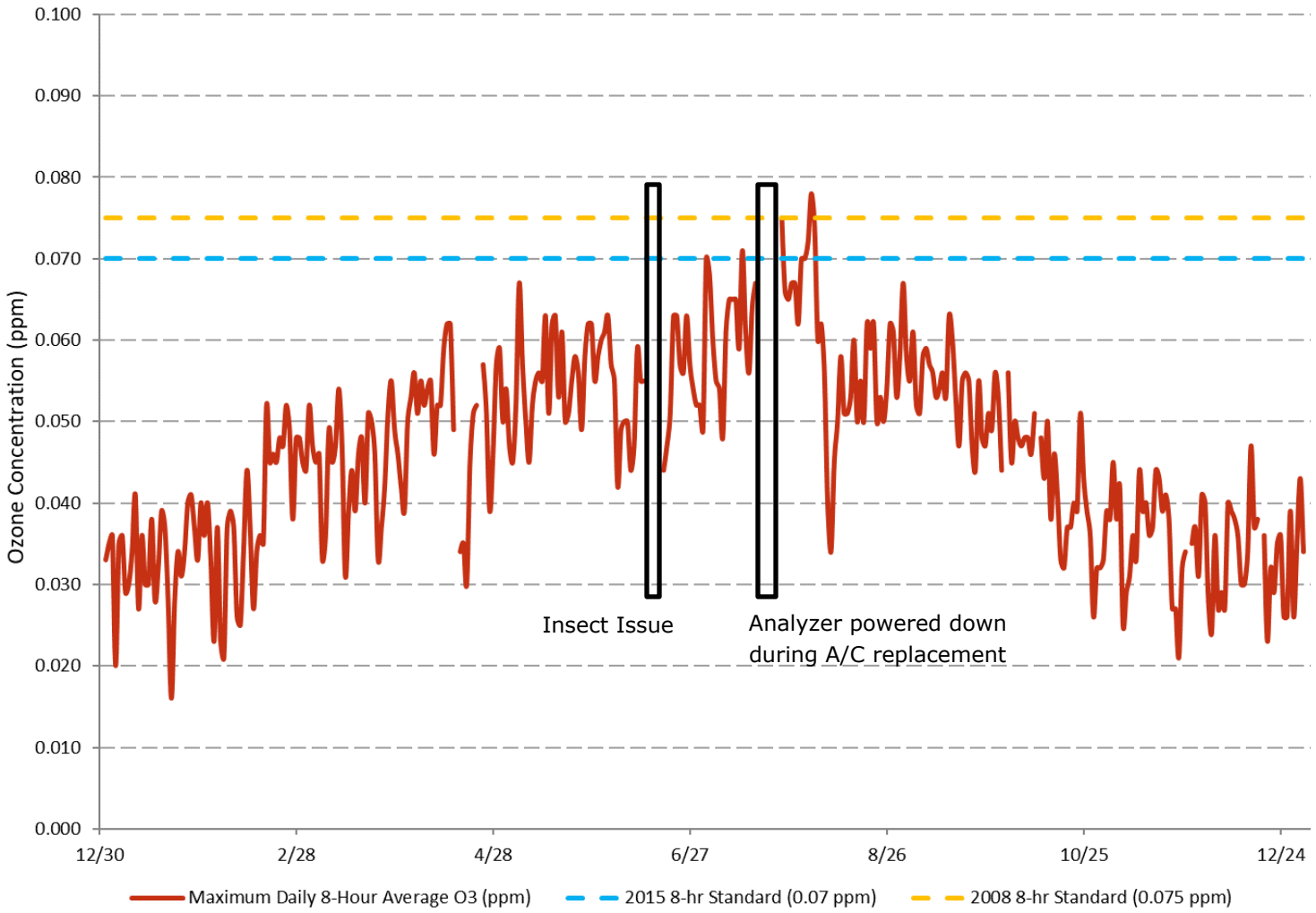

Figure 6. Orchard 2024 Maximum Daily 8-hour Averaged O_3.

Table 7. Weld County Network 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 available in **Table 9** below.

[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 Highest Daily Maximum 8-hour Average O3 with Smoke Periods Excluded

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	0.079	8/2/2024	0.079	8/3/2024	0.076	7/13/2024	0.076	8/4/2024	4	13
Hereford	0.075	8/2/2024	0.072	8/3/2024	0.071	8/4/2024	0.069	7/16/2024	0	3
Orchard	0.078	8/3/2024	0.074	8/4/2024	0.072	8/2/2024	0.071	7/13/2024	1	4

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.

[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 9. Weld County Network Historical and 2024 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	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] 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) and to the annual standard (53 ppb). The 1-hour average NO_2 standard is based on the 98th percentile of 1-hour daily maximum concentrations, averaged over 3-years. MSP has not recorded any values exceeding the 1-hour average or annual NO_2 standards during its three years of operation. The maximum 1-hour average concentration during 2024 was 45.8 ppb, recorded on January 17th. The annual average NO_2 concentration was 6.5 ppb. According to 40 CFR Part 50 Appendix S, the 1-hour design value for NO_2 is calculated using three years of complete data. A complete year encompasses four complete quarters, and a quarter is considered complete if at least 75% of the days are valid. A day is considered valid if at least 75% of the hours in that day are valid. At MSP, there are only two complete years, 2022 and 2023. 2024 is not a complete year because data completeness was not met during Q4 2024. According to Section 3.2 of 40 CFR Part 50 Appendix S, there is a substitution test can be used to determine if the design value is valid, despite not meeting data completeness criteria. We performed the substitution test with the MSP NO_2 data and the test design value was 53 ppb. Since the test design value is below the 1-hour NAAQS, according to Section 3.2 of 40 CFR Part 50 Appendix S, the valid data can be used to calculate the measured design value. Based on 2022 through 2024 data, the measured design value for the 1-hour NAAQS is 47 ppb.

The 2024 annual design value is 6.5 ppb. Both the annual and 1-hour design values are below their respective AAQS. A summary of daily maximum 1-hour average NO_2 data for 2024 is presented in **Figure 7**. A comparison to the 1-hour and annual standard are available in **Table 10** and **Table 11**, respectively. Note, data was invalidated between February 9th and February 12th due to emergency instrument maintenance, between May 28th and May 31st due to a filter leak, and several periods in December for emergency maintenance. See the annotations in **Figure 7**.

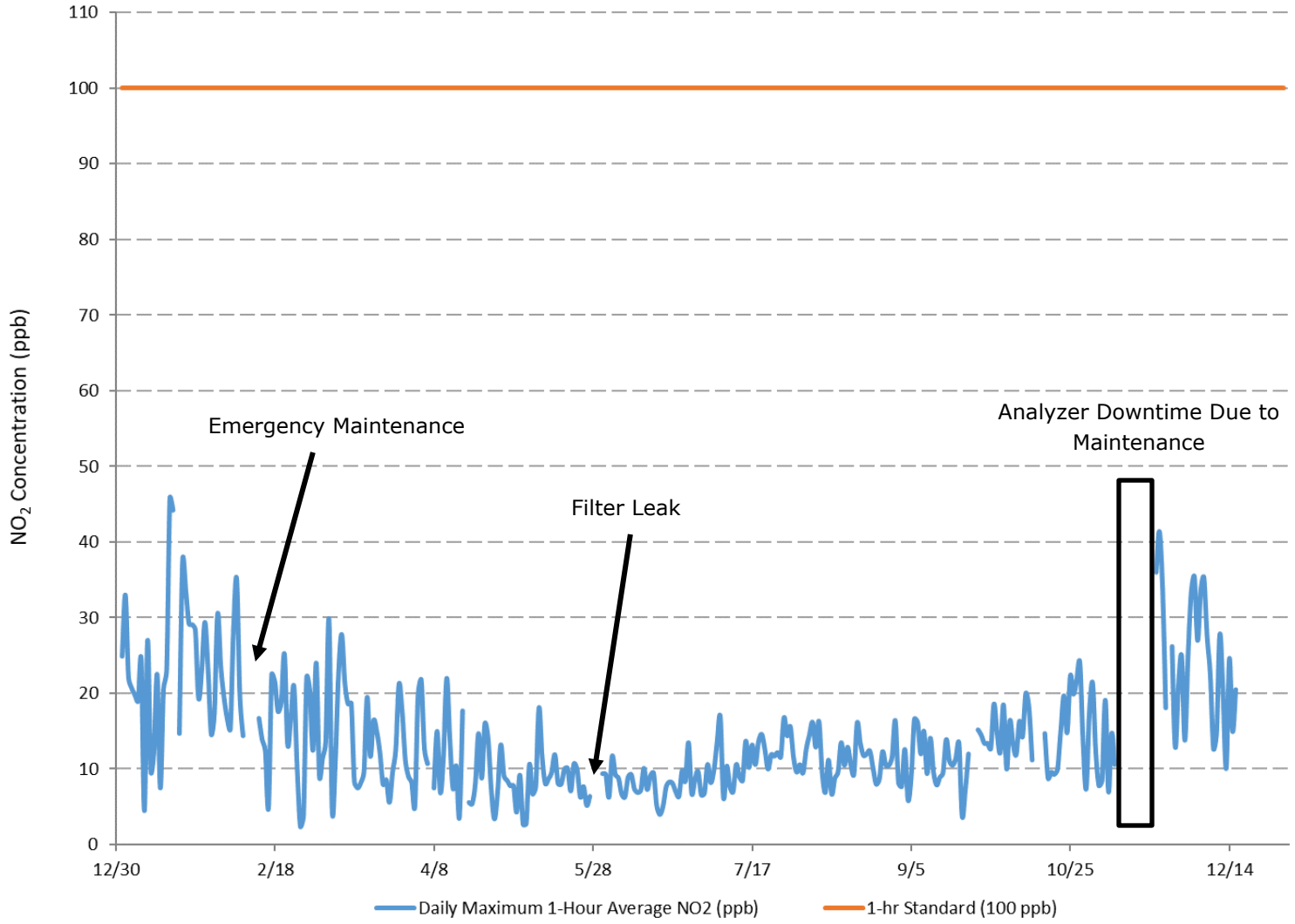

Figure 7. MSP 2024 Maximum Daily 1-hour Average NO_2.

Table 10. MSP 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)[2]	45.8	44.2	41.4	37.6	36.0	35.4	35.3	35.1	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.

[2] Data completeness was not met for Q4 2024.

Table 11. MSP 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	9.1[2]	6.5	No

Notes:

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

[2]Quarter did not meet data completeness requirements.

6. METEOROLOGICAL DATA SUMMARY

This section summarizes the meteorological data collected during 2024.

6.1 Wind Data Summary

The 2024 average wind speed at the three stations at 10-m above ground level (agl) was 3.03 meters per second (m/s), 4.46 m/s, and 3.39 m/s at MSP, Hereford, and Orchard, respectively. The maximum hourly average wind speed for 2024 was 14.75 m/s at MSP, 20.43 m/s at Hereford, and 17.64 m/s at Orchard. **Figure 8** through **Figure 13** present wind rose plots for each station for the entirety of 2024 and as quarterly breakdowns. These wind roses are a graphical representation of how the wind speed and direction were distributed for 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 that varied depending on the time of year.

At the MSP station, winds tended to be strongest from the north and west over the course of the year but there was not a strong directional pattern. During all four quarters the winds were generally distributed in all directions, with the strongest winds from the north and west in quarters 1, 2, and 4. During Quarter 3, the winds were weaker and primarily came from the northwest and southeast. At the Hereford station winds tended to be strongest and come mostly from the northwest during the year. During the fall and winter (Quarter 1 and Quarter 4) winds were rarely from the east. During Quarter 2 winds came from the north, west, and southeast and were stronger from the northwest. During Quarter 3 winds were generally weaker than the other quarters and came most frequently from the north-northwest and south-southeast. At the Orchard station winds tended to have an east-west pattern, with the strongest winds coming from the north-northwest. During Quarter 1 and Quarter 4 winds more frequently came from the west and were strongest from the north-northwest. During Quarter 2 winds were broadly distributed except for the southwest/northeast axis, with the strongest winds from the northwest. During Quarter 3 winds were weaker and most frequently along the east/west axis. Hereford's wind patterns are likely driven by its proximity to the Cheyenne Ridge (north of the station), while Orchard's wind patterns are likely driven by its proximity to the South Platte River Basin (which is south of the station and is a west-to-east drainage direction). Average hourly and maximum wind speeds per quarter and for the year at each station are listed in **Table 12** along with all other measured meteorological parameters.

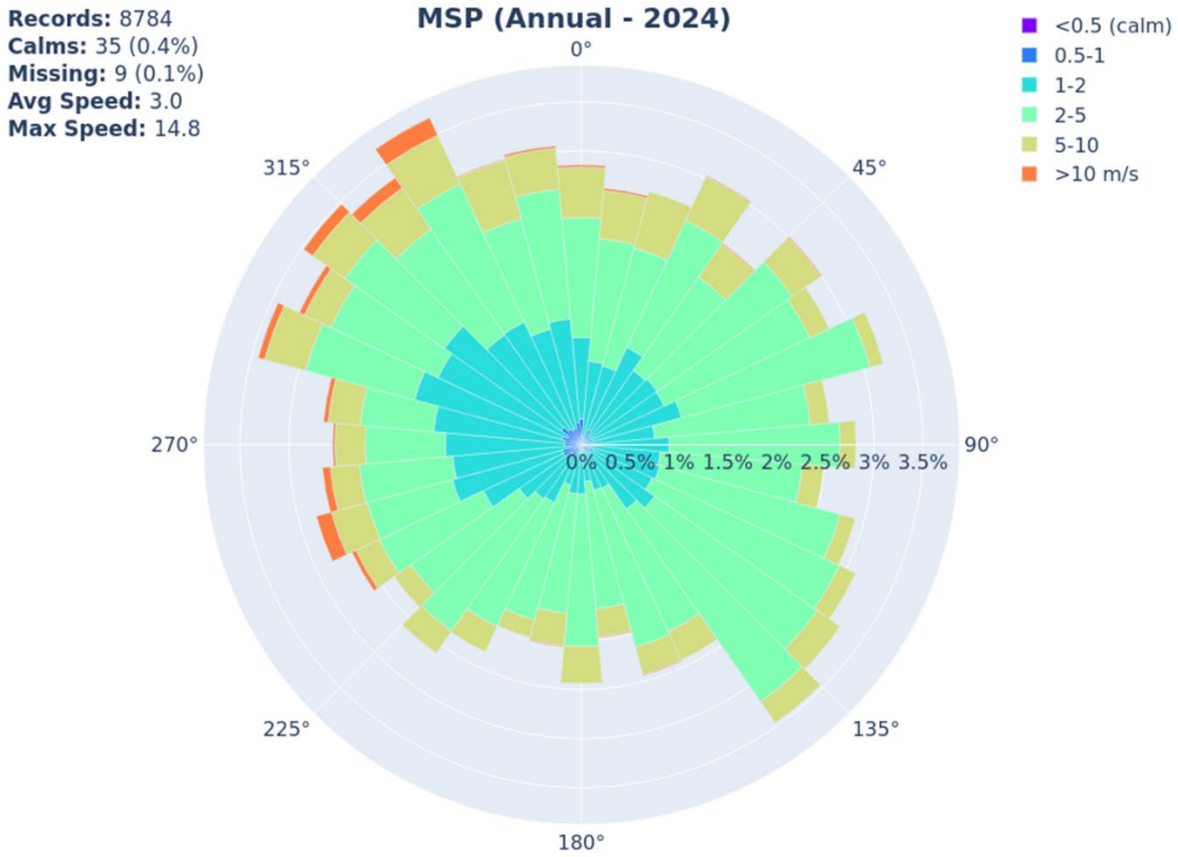

Figure 8. MSP 2024 Wind Rose

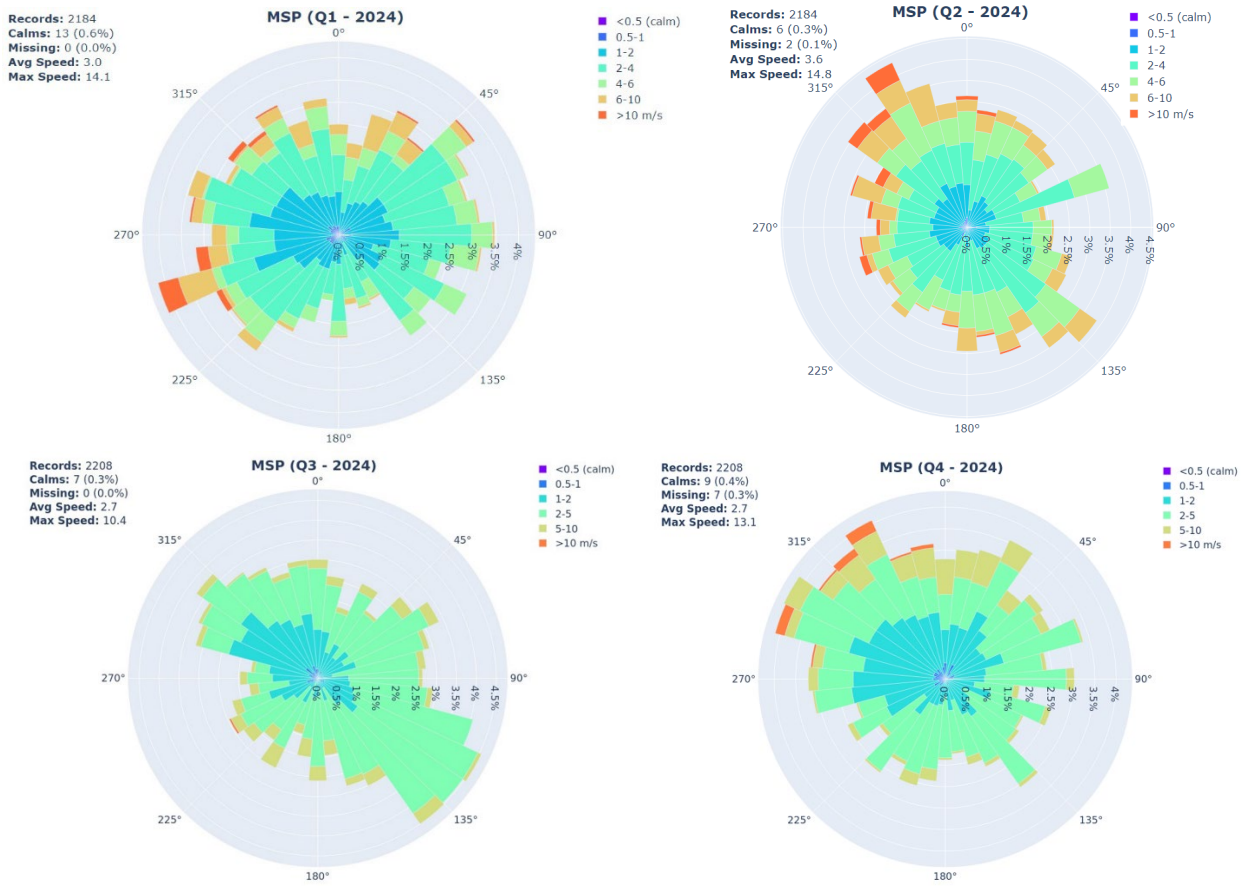

Figure 9. MSP 2024 Quarterly Wind Roses

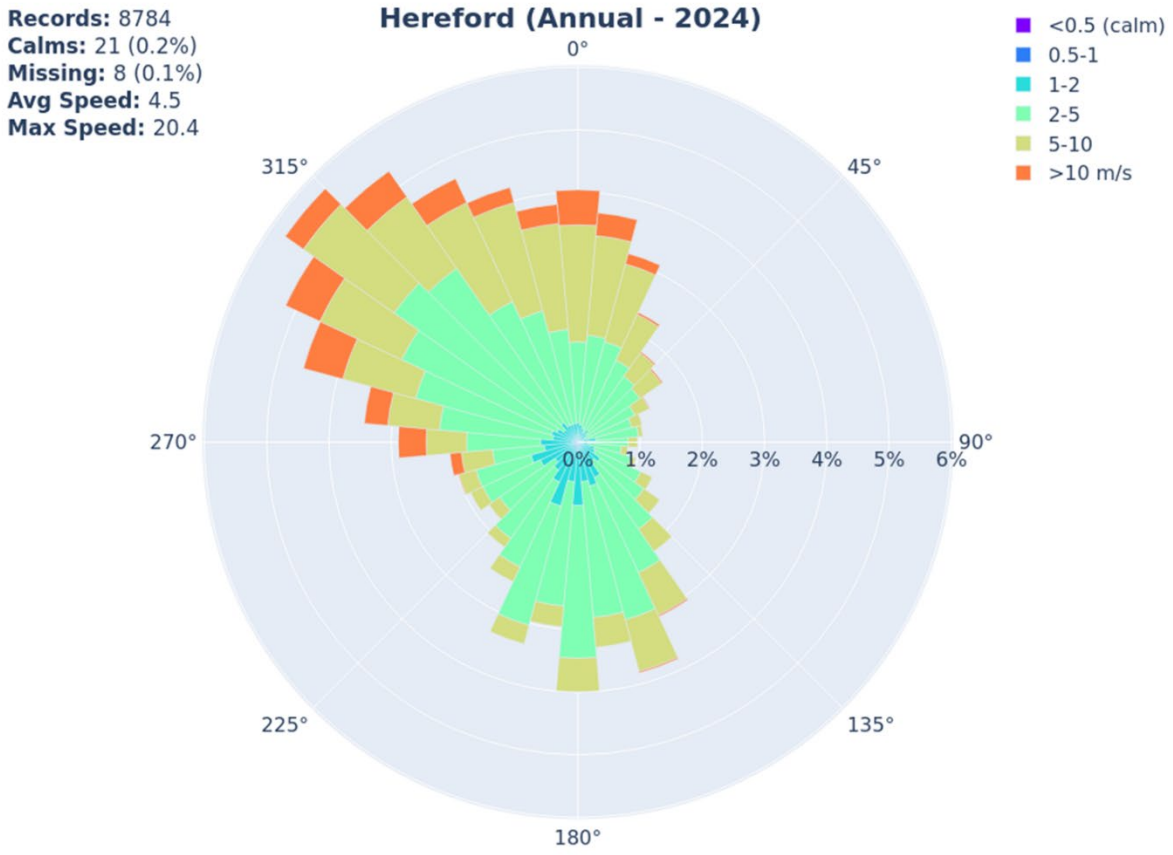

Figure 10. Hereford 2024 Wind Rose

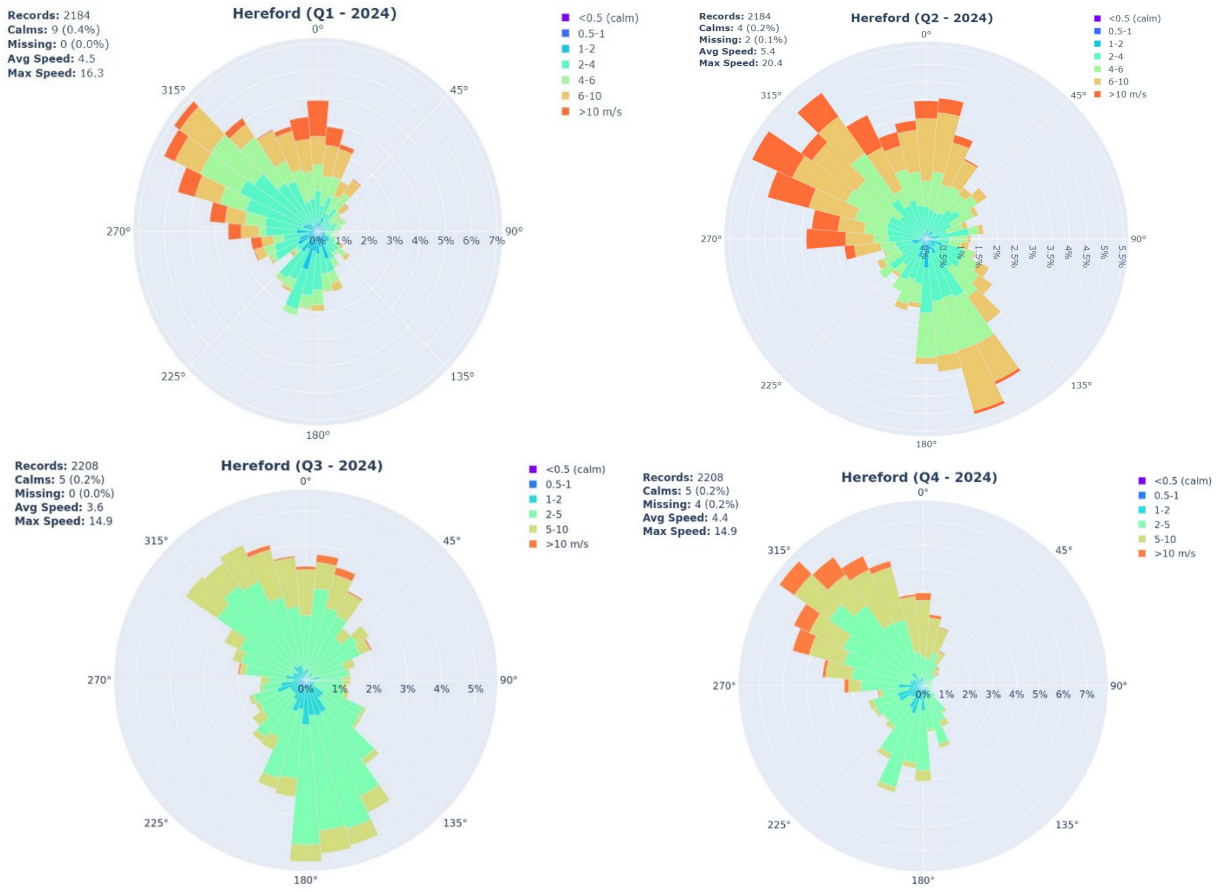

Figure 11. Hereford 2024 Quarterly Wind Roses

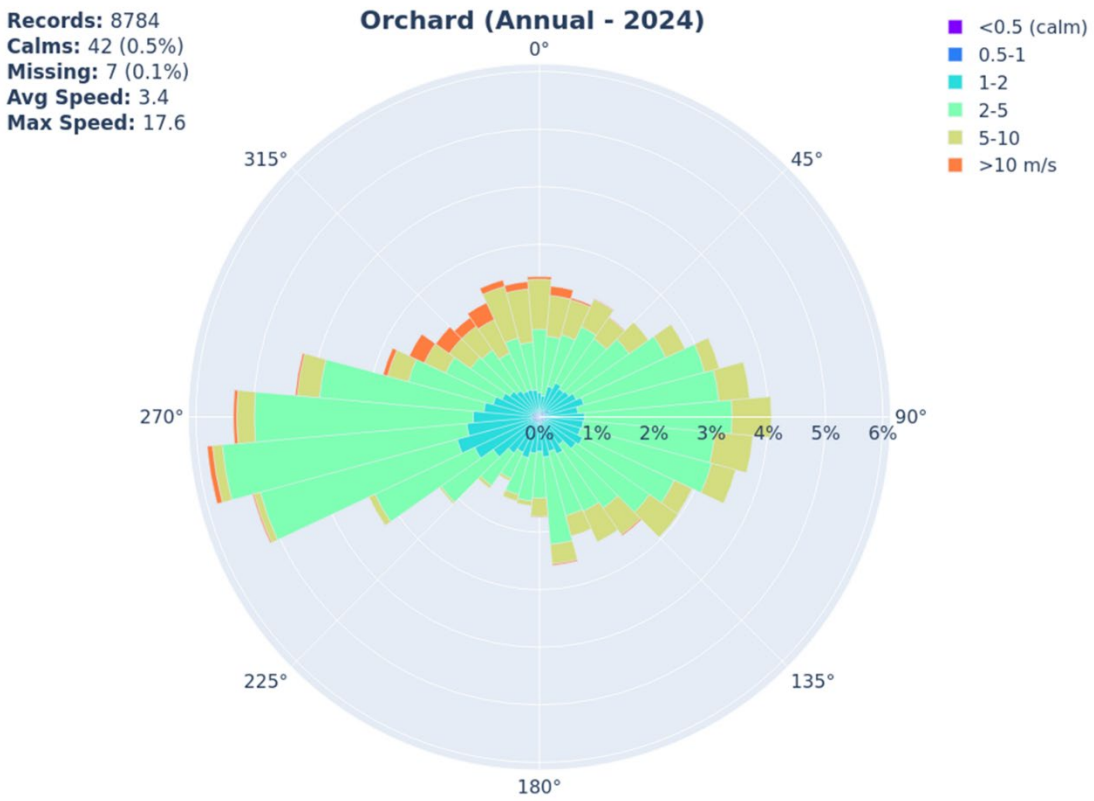

Figure 12. Orchard 2024 Wind Rose

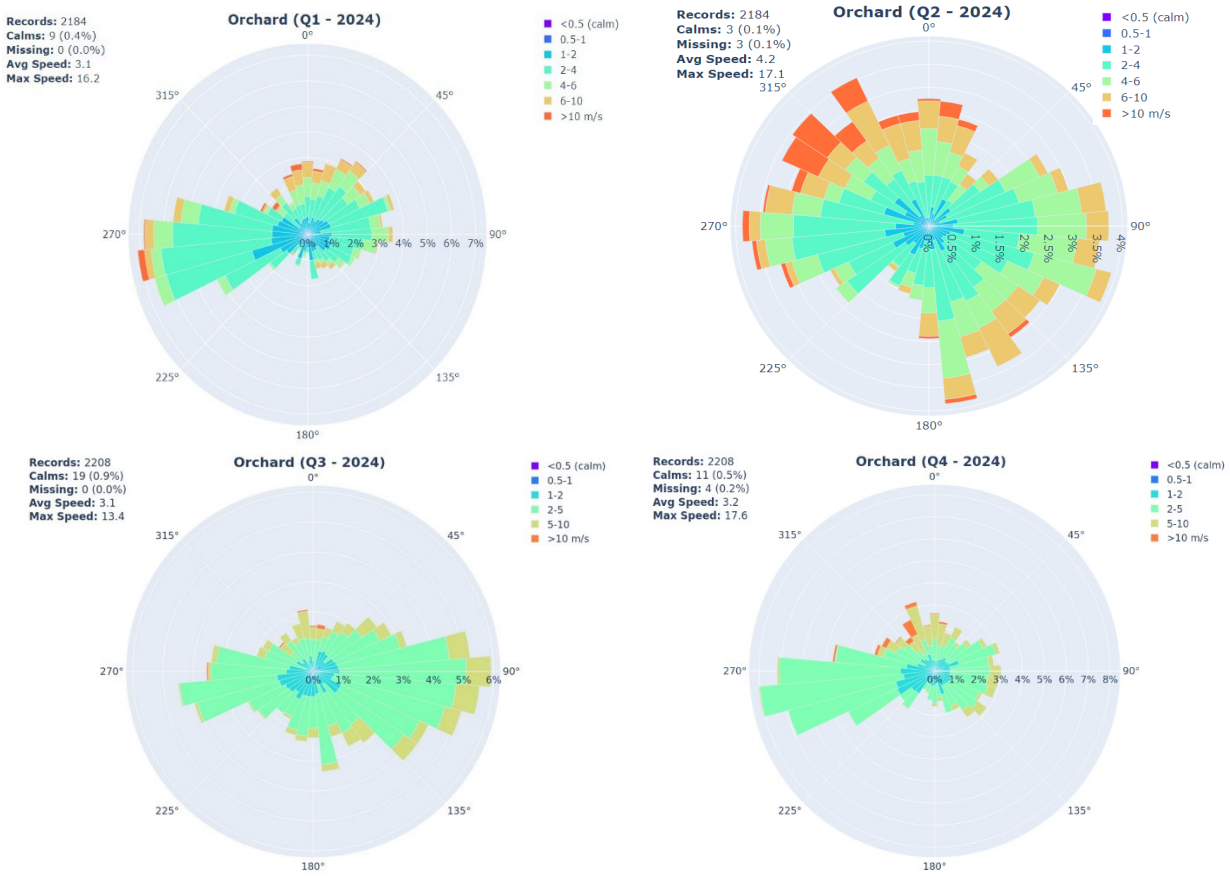

Figure 13. Orchard 2024 Quarterly Wind Roses

Table 12. 2024 Meteorological Data Summary

Parameter	Units	Form	Q1[1]	Q2[1]	Q3[1]	Q4[1]	Annual[1]
Missile Site Park							
2-M Temperature	°C	Quarterly Average	1.3	15.6	22.1	6.5	11.4
		Maximum Hourly Average	19.9	36.0	38.5	31.7	38.5
		Minimum Hourly Average	-28.1	-2.6	5.6	-8.2	-28.1
10-M Temperature	°C	Quarterly Average	1.6	15.4	22.0	6.8	11.5
		Maximum Hourly Average	18.9	34.8	37.0	30.6	37.0
		Minimum Hourly Average	-25.9	-2.2	6.1	-7.7	-25.9
Delta Temperature	°C	Quarterly Average	0.3	-0.1	-0.1	0.4	0.1
		Maximum Hourly Average	4.3	2.9	2.8	3.5	4.3
		Minimum Hourly Average	-1.6	-2.1	-2.0	-1.9	-2.1
10-M Horizontal Wind Speed	m/s	Quarterly Average	3.0	3.6	2.7	2.7	3.0
		Maximum Hourly Average	14.1	14.8	10.4	13.1	14.8
2-M Relative Humidity	Percent	Quarterly Average	62.8	50.7	49.2	54.5	54.3
		Maximum Hourly Average	100.0	100.0	100.0	100.0	100.0
Station Barometric Pressure	mm Hg	Quarterly Average	633.4	634.0	638.2	636.4	635.5
		Maximum Hourly Average	643.5	643.8	646.3	645.8	646.3
Station Precipitation	in	Quarterly Total	2.989	4.161	3.218	1.595	11.963
	in/hr	Maximum Hourly Total	0.122	0.599	0.500	0.106	0.599
2-M Solar Radiation	W/m^2	Quarterly Average	149	275	265	122	203
		Maximum Hourly Average	961	1,077	1,059	793	1,077
Hereford							
2-M Temperature	°C	Quarterly Average	-0.5	13.2	20.2	4.8	9.4
		Maximum Hourly Average	18.7	34.2	36.7	31.3	36.7
		Minimum Hourly Average	-29.1	-6.0	4.1	-13.1	-29.1
10-M Temperature	°C	Quarterly Average	0.1	13.3	20.5	5.7	9.9
		Maximum Hourly Average	17.7	33.2	35.1	30.2	35.1
		Minimum Hourly Average	-29.0	-4.7	5.0	-10.7	-29.0
Delta Temperature	°C	Quarterly Average	0.7	0.1	0.3	1.0	0.5
		Maximum Hourly Average	8.9	7.5	6.1	9.2	9.2
		Minimum Hourly Average	-1.8	-2.1	-1.9	-1.6	-2.1
10-M Horizontal Wind Speed	m/s	Quarterly Average	4.5	5.4	3.6	4.4	4.5
		Maximum Hourly Average	16.3	20.4	14.9	14.9	20.4
2-M Relative Humidity	Percent	Quarterly Average	66.6	57.4	53.1	54.4	57.9
		Maximum Hourly Average	100.0	100.0	100.0	100.0	100.0
Station Barometric Pressure	mm Hg	Quarterly Average	625.0	626.0	630.3	628.1	627.4
		Maximum Hourly Average	634.5	634.9	638.0	637.2	638.0
Station Precipitation	in	Quarterly Total	1.807	6.033	5.353	0.867	14.060
	in/hr	Maximum Hourly Total	0.087	0.961	0.918	0.099	0.961

Table 12. 2024 Meteorological Data Summary

Parameter	Units	Form	Q1[1]	Q2[1]	Q3[1]	Q4[1]	Annual[1]
2-M Solar Radiation	W/m^2	Quarterly Average	144	266	262	121	198
		Maximum Hourly Average	878	1,053	1,070	797	1,070
Orchard							
2-M Temperature	°C	Quarterly Average	-0.2	15.5	21.6	4.3	10.3
		Maximum Hourly Average	22.2	39.2	39.2	32.4	39.2
		Minimum Hourly Average	-35.5	-7.7	2.7	-12.7	-35.5
10-M Temperature	°C	Quarterly Average	0.7	15.7	22.0	5.3	10.9
		Maximum Hourly Average	20.8	37.2	37.5	31.5	37.5
		Minimum Hourly Average	-32.9	-3.9	3.8	-11.5	-32.9
Delta Temperature	°C	Quarterly Average	0.8	0.2	0.4	1.1	0.6
		Maximum Hourly Average	8.0	7.3	5.9	7.2	8.0
		Minimum Hourly Average	-1.9	-2.2	-2.1	-1.8	-2.2
10-M Horizontal Wind Speed	m/s	Quarterly Average	3.1	4.2	3.1	3.2	3.4
		Maximum Hourly Average	16.2	17.1	13.4	17.6	17.6
2-M Relative Humidity	Percent	Quarterly Average	67.9	55.1	55.5	63.9	60.6
		Maximum Hourly Average	100.0	100.0	100.0	100.0	100.0
Station Barometric Pressure	mm Hg	Quarterly Average	645.6	645.7	649.6	648.4	647.3
		Maximum Hourly Average	656.3	656.1	657.9	657.9	657.9
Station Precipitation	in	Quarterly Total	1.662	3.814	4.789	1.469	11.734
	in/hr	Maximum Hourly Total	0.173	0.906	0.682	0.079	0.906
2-M Solar Radiation	W/m^2	Quarterly Average	147	276	266	125	204
		Maximum Hourly Average	915	1,048	1,029	778	1,048

[1]There are small differences in precision relative to the finalized valid data due to rounding.

6.2 Precipitation Data Summary

Hourly precipitation data was collected at all three stations with a tipping bucket sensor at 1-m agl. Quarter 2 had the highest total precipitation at MSP and Hereford, while at Orchard Quarter 3 had the highest total precipitation. Quarter 2 had the highest maximum hourly precipitation at all three sites. The spring rainy season likely explains why the highest total precipitation occurred during Quarter 2 at MSP and Hereford, while convective storms during the summer months may explain why the highest total precipitation occurred in Quarter 3 instead for Orchard. The precipitation sensor at MSP was clogged by an insect during Quarter 3 which resulted in the invalidation of data between August 15th and 21st. A summary of total quarterly and maximum hourly precipitation for each quarter of 2024 and for the year at all three stations is presented in **Figure 14** through **Figure 16** and in **Table 12**.

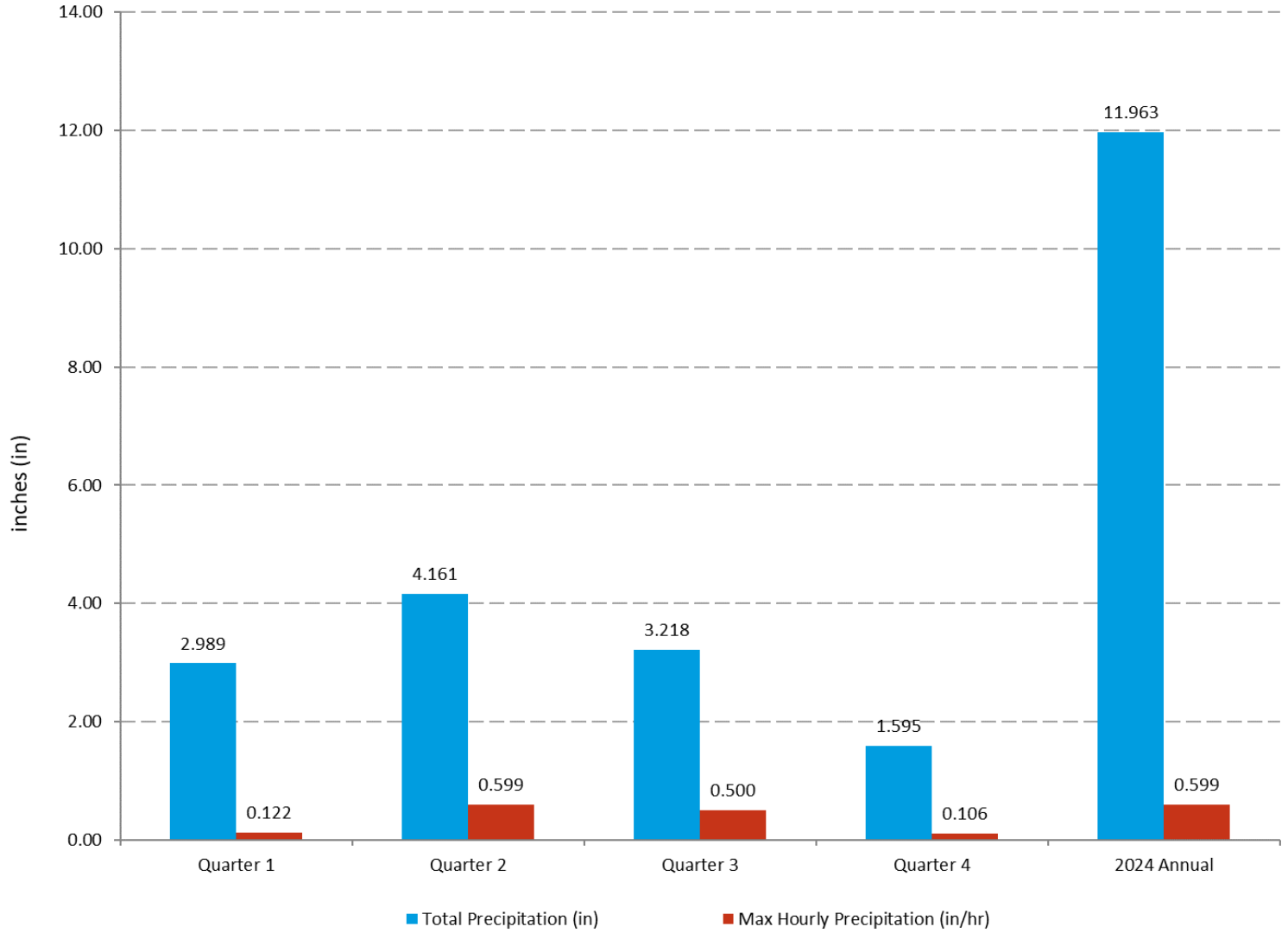

Figure 14. MSP 2024 Precipitation Summary

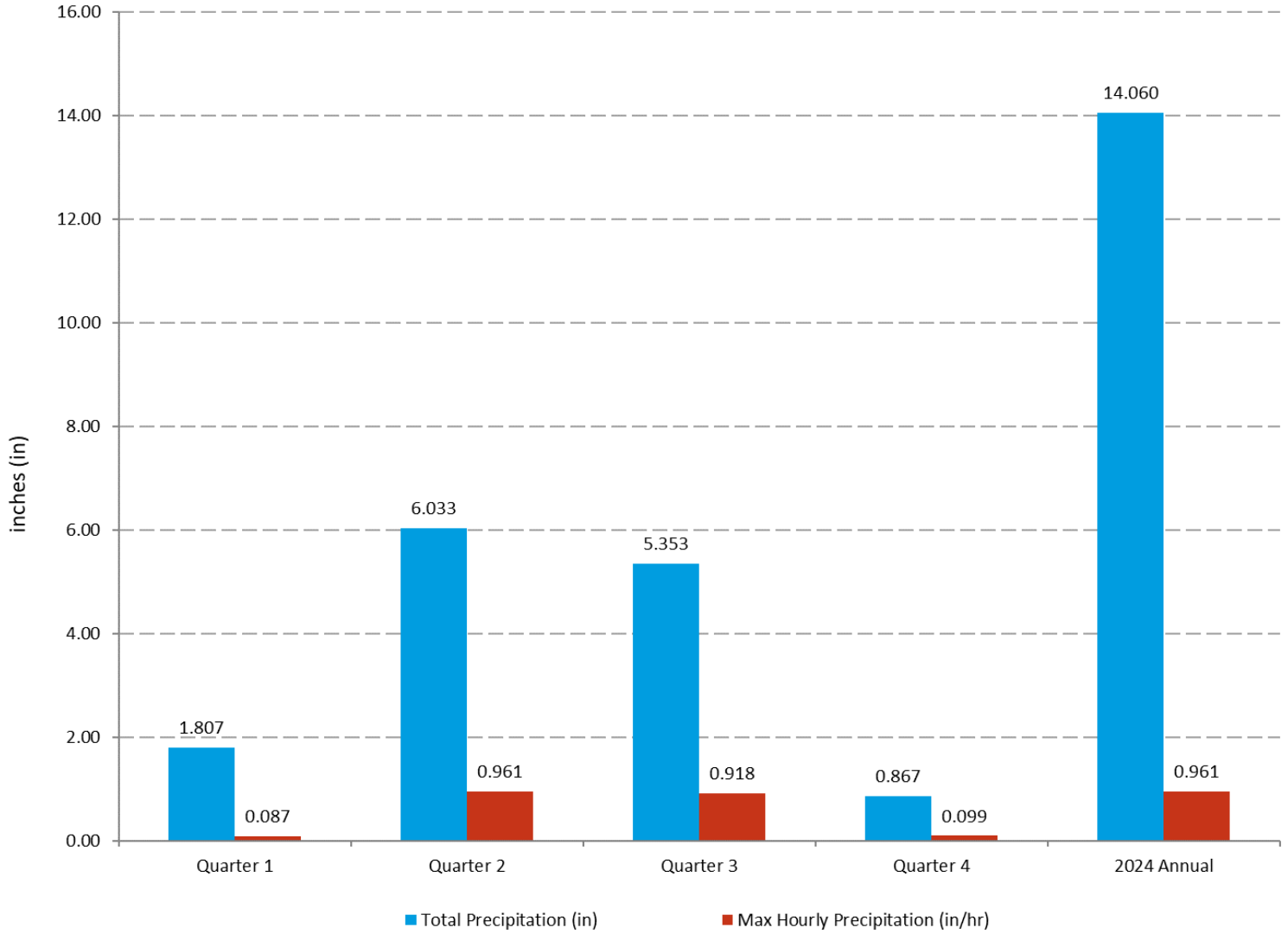

Figure 15. Hereford 2024 Precipitation Summary

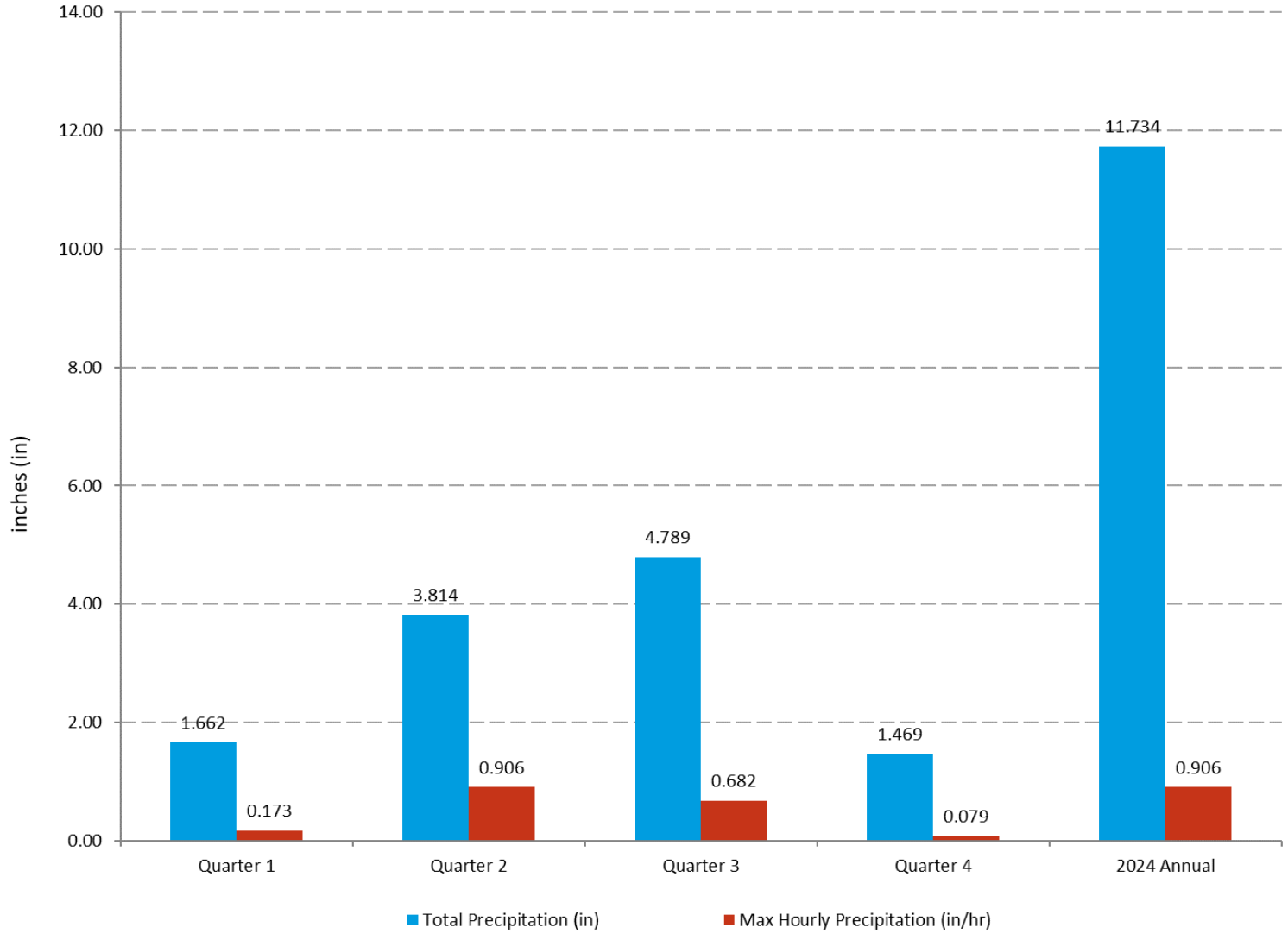

Figure 16. Orchard 2024 Precipitation Summary

6.3 Temperature Data Summary

Temperature data was collected at all three stations at heights of 2 and 10-m agl. At all three stations for 10-m agl, the maximum measured temperature occurred during Quarter 3. For 2-m agl, the maximum temperatures at MSP and Hereford were during Quarter 3, while Orchard recorded its maximum during Quarter 2. The highest average temperature, for both sensor heights, also occurred during Quarter 3 for all three stations. The minimum temperature occurred during Quarter 1 for all three stations for each sensor height. A summary of quarterly average and hourly maximum and minimum temperatures (for both 2 and 10-m probes) for each quarter of 2024 and for the year at all three stations is presented in **Figure 17** through **Figure 22** and **Table 12**.

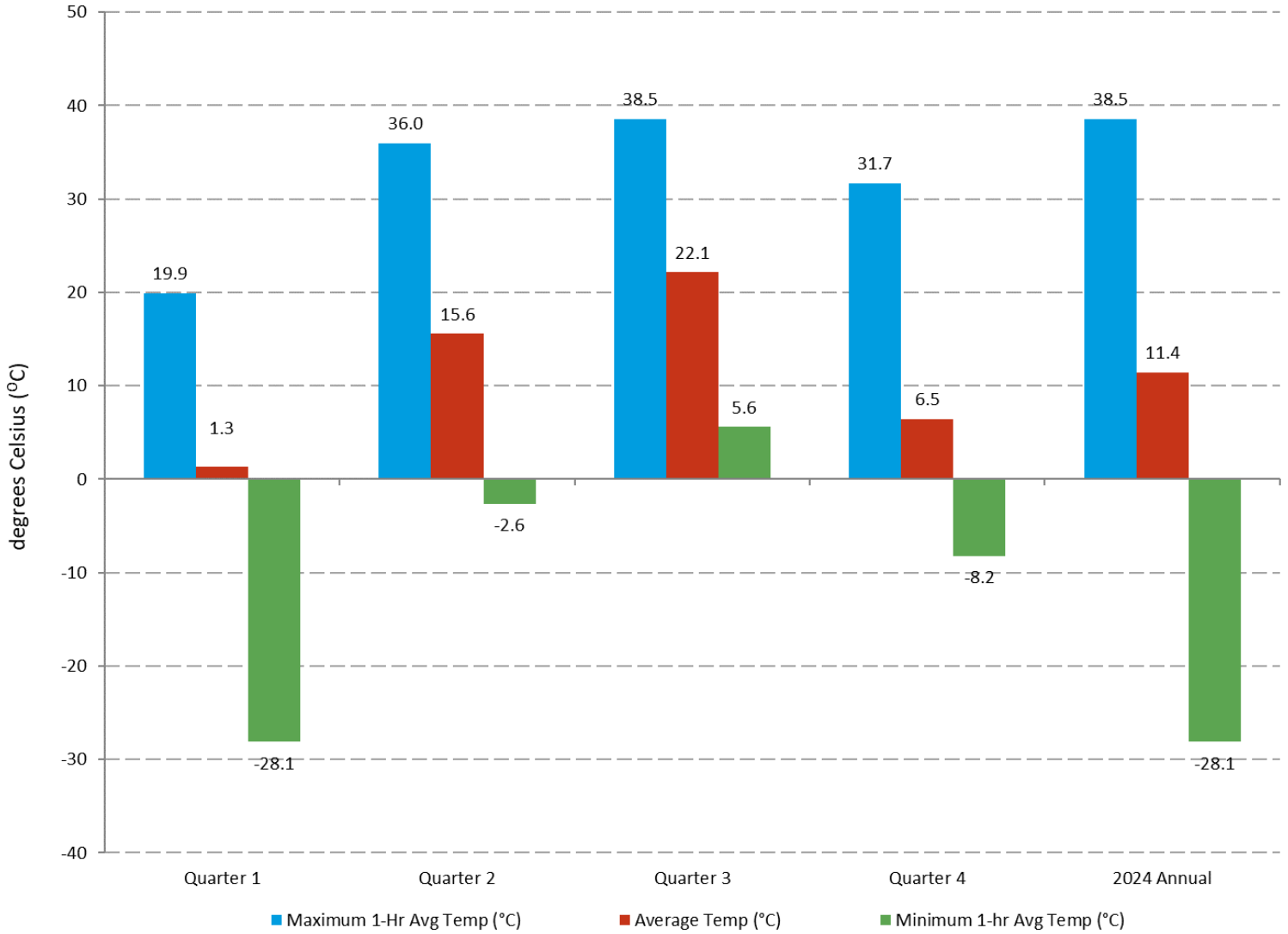

Figure 17. MSP 2024 2-Meter Temperature Summary

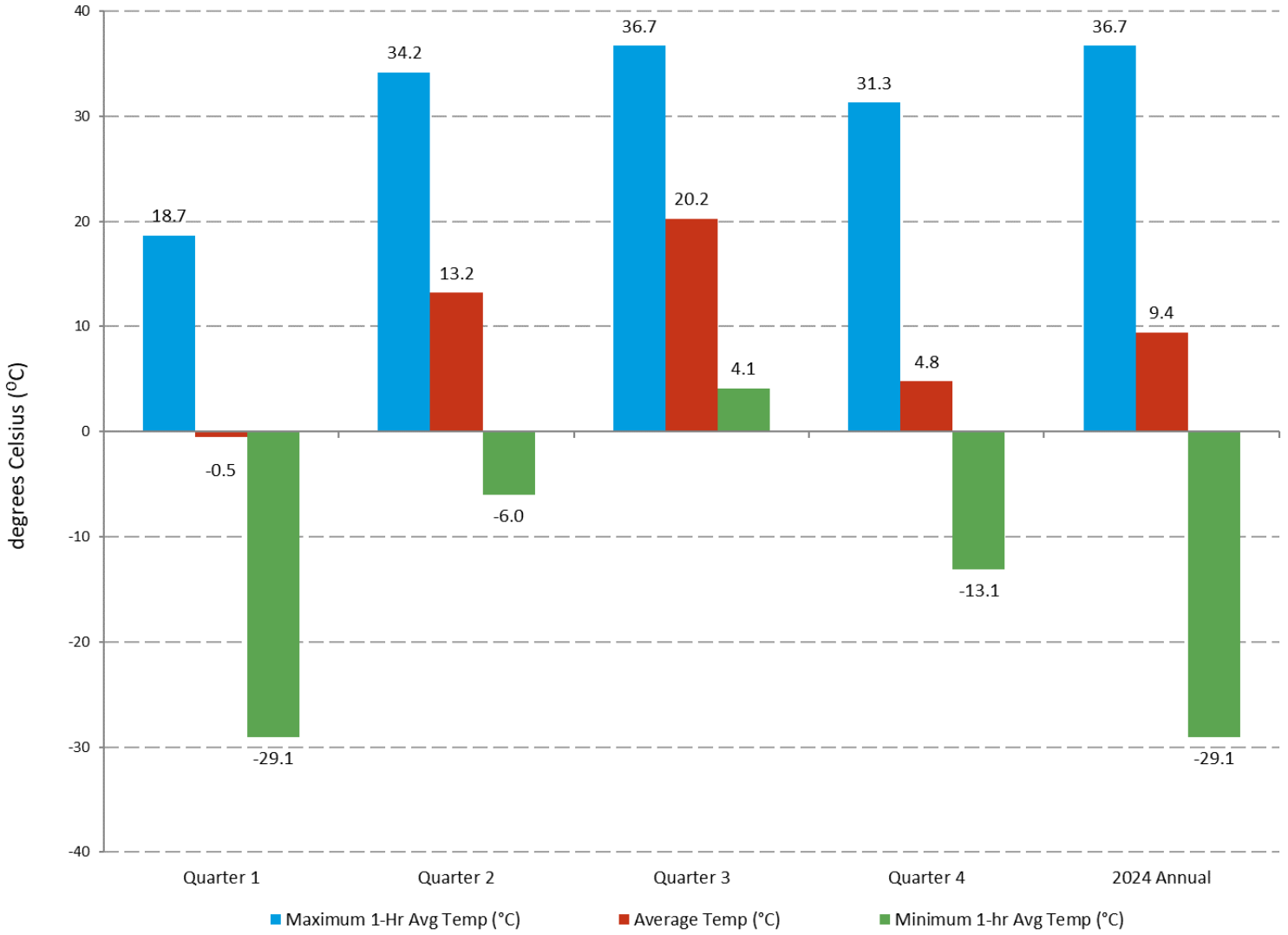

Figure 18. Hereford 2024 2-Meter Temperature Summary

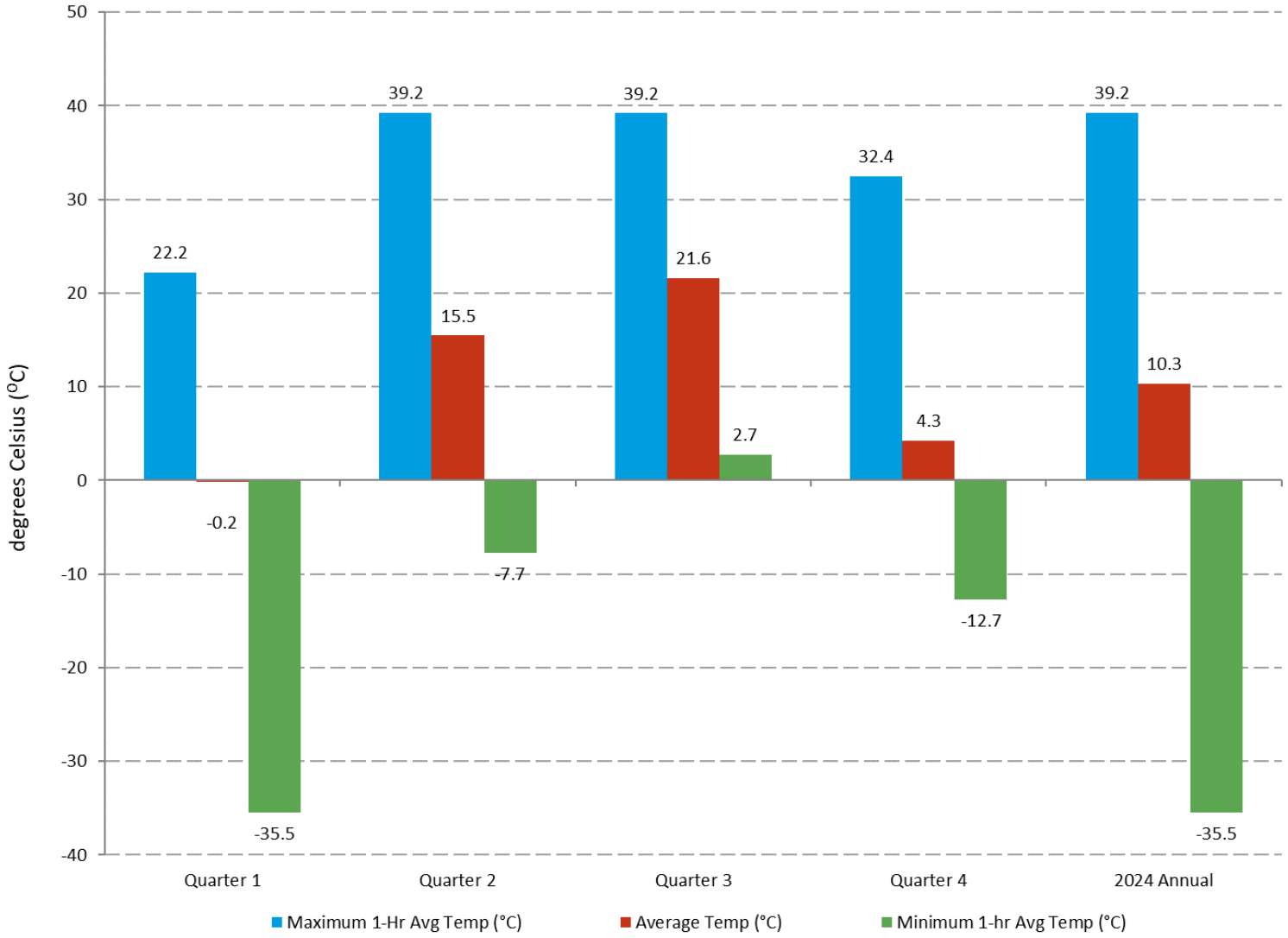

Figure 19. Orchard 2024 2-Meter Temperature Summary

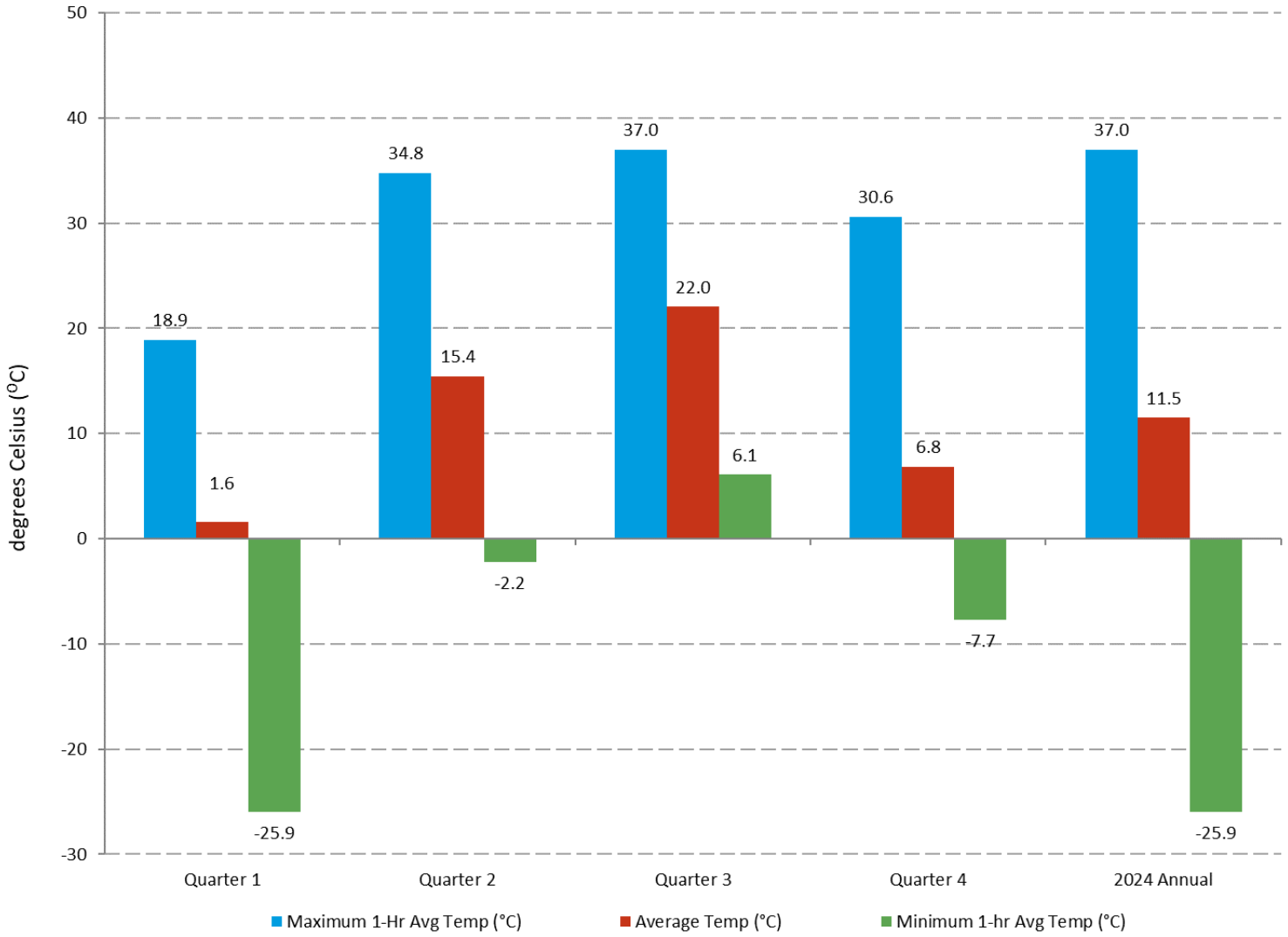

Figure 20. MSP 2024 10-Meter Temperature Summary

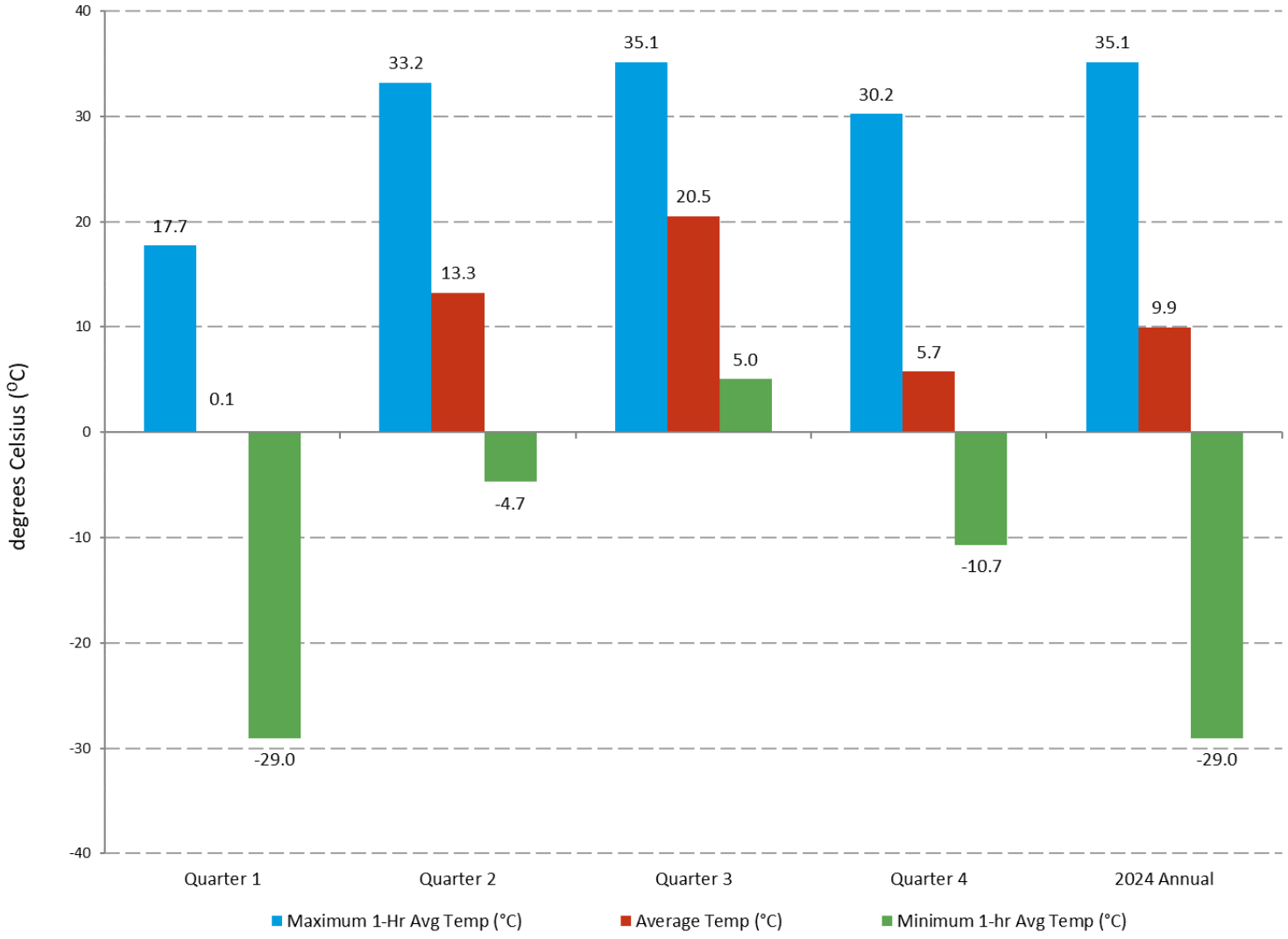

Figure 21. Hereford 2024 10-Meter Temperature Summary

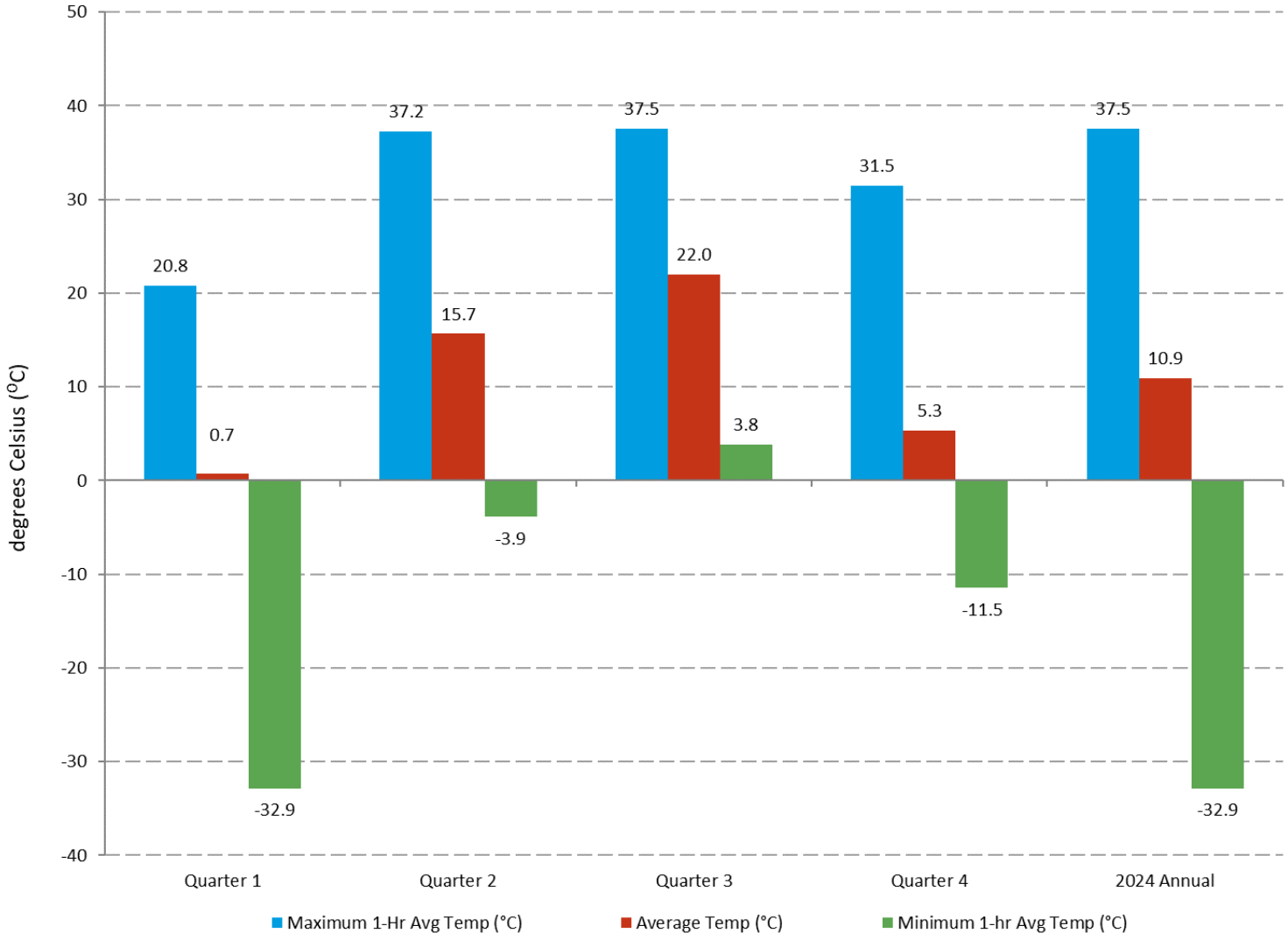

Figure 22. Orchard 2024 10-Meter Temperature Summary

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 maximum delta temperature measurements for each quarter at Hereford and Orchard were approximately twice those measured at MSP, which means that Hereford and Orchard experienced stronger temperature inversions than MSP. The 2024 average delta temperature measured at both Hereford and Orchard were also more positive than at MSP. The minimum delta temperature measurements at each station were generally on par with one another for each quarter. A summary of quarterly average and hourly maximum and minimum delta temperature for each quarter of 2024 and for the year at all three stations is presented in **Figure 23** through **Figure 25** and **Table 12**.

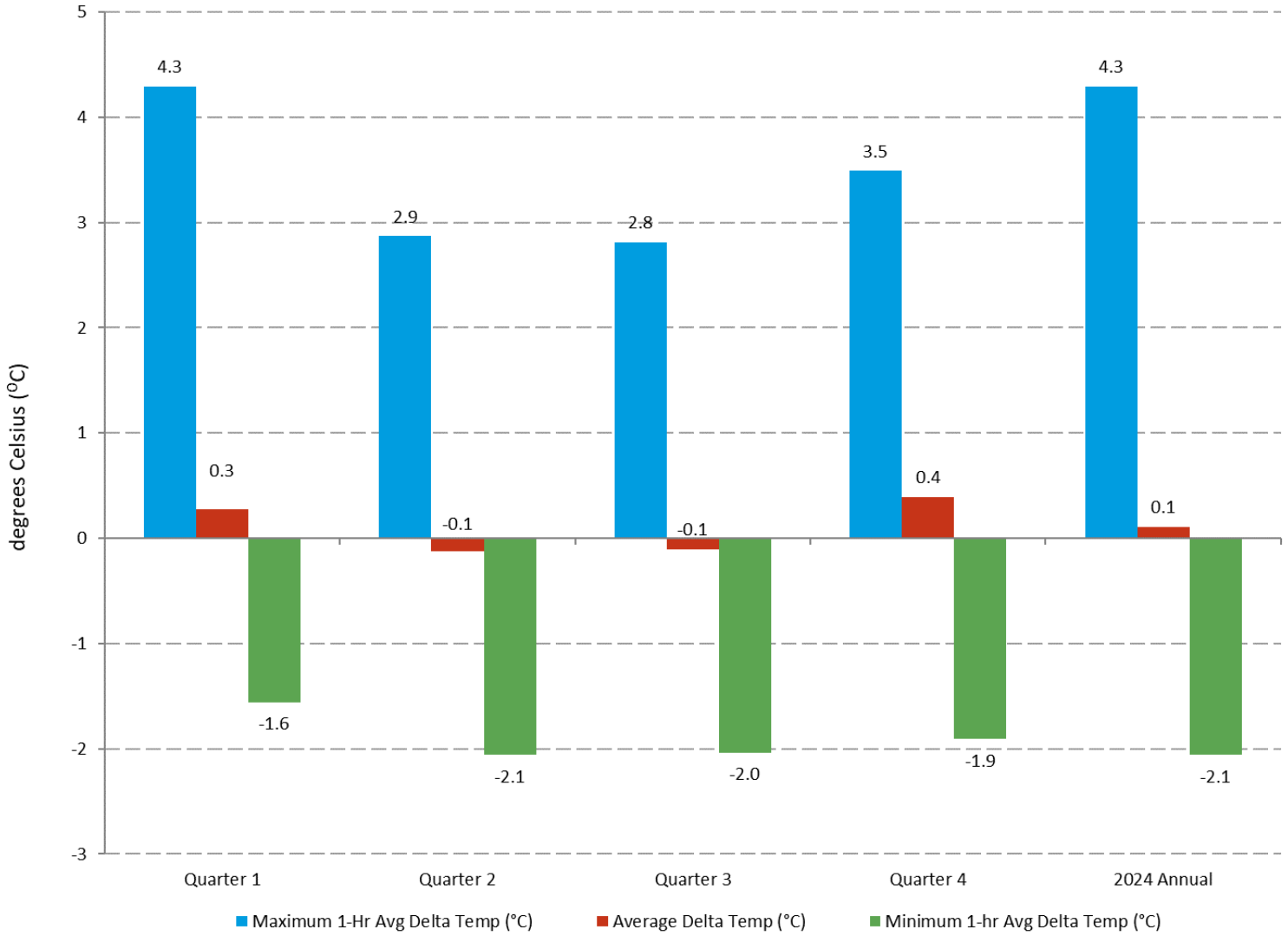

Figure 23. MSP 2024 Delta Temperature Summary

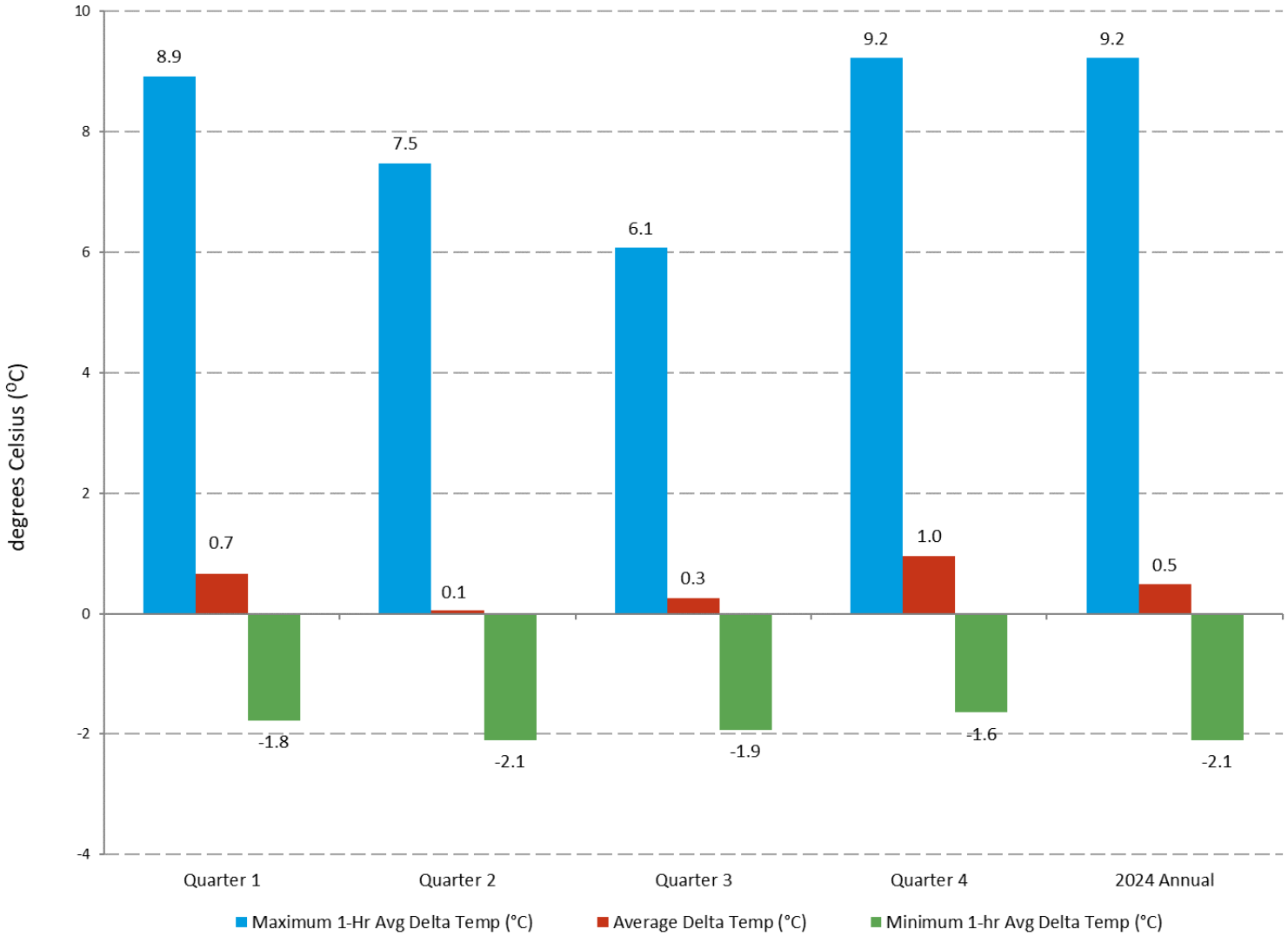

Figure 24. Hereford 2024 Delta Temperature Summary

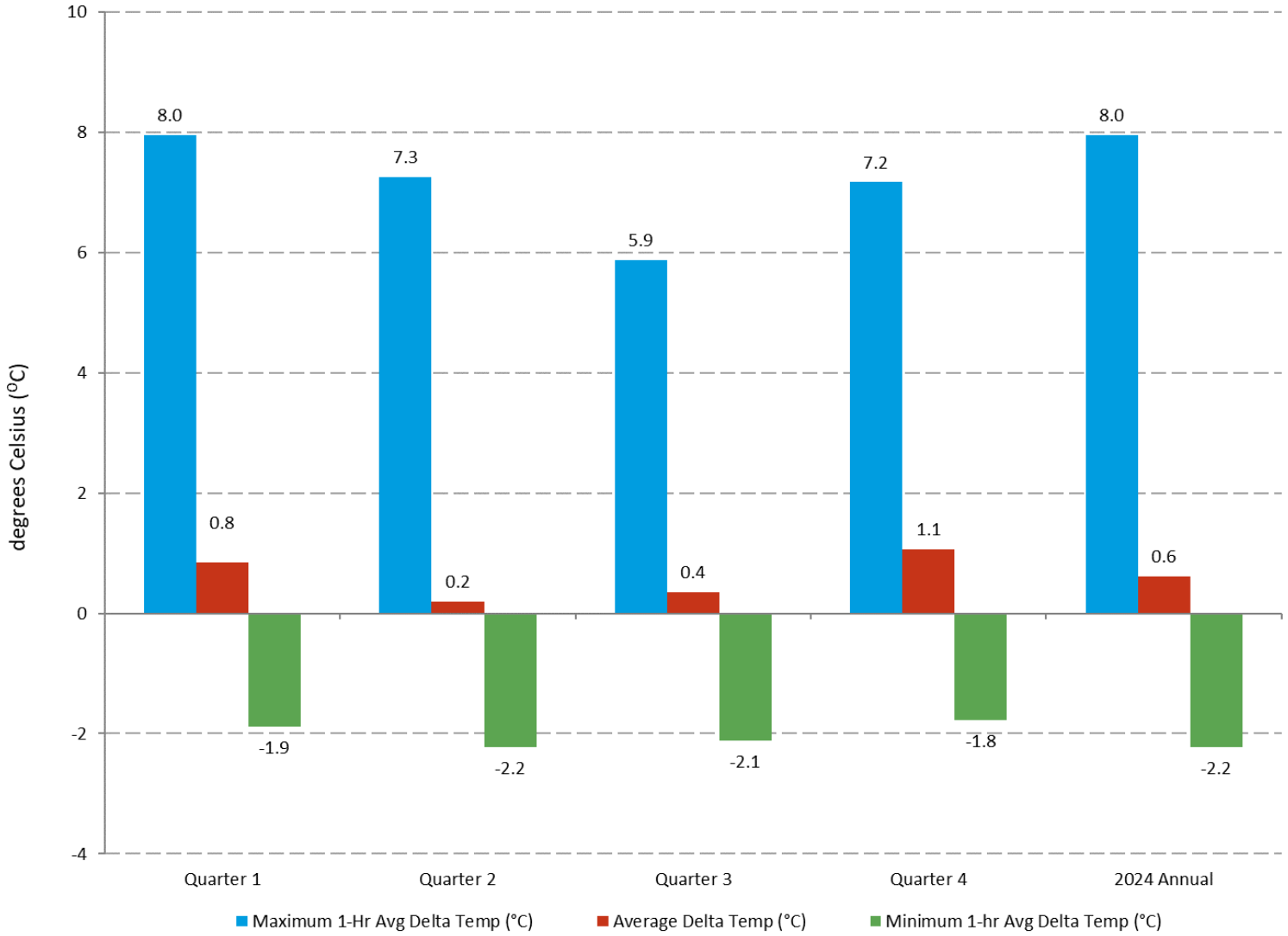

Figure 25. Orchard 2024 Delta Temperature Summary

6.5 Barometric Pressure Data Summary

Barometric pressure data is collected using a barometric pressure sensor located inside each station shelter. The average quarterly barometric pressure at each station was correlated with the elevation at each location, with the highest elevation station having the lowest quarterly average barometric pressure (Hereford) and the lowest elevation station having the highest quarterly average barometric pressure (Orchard). Maximum hourly average and quarterly average barometric pressures for each quarter of 2024 and for the year at all three stations are summarized in **Figure 26** through **Figure 28** and **Table 12**.

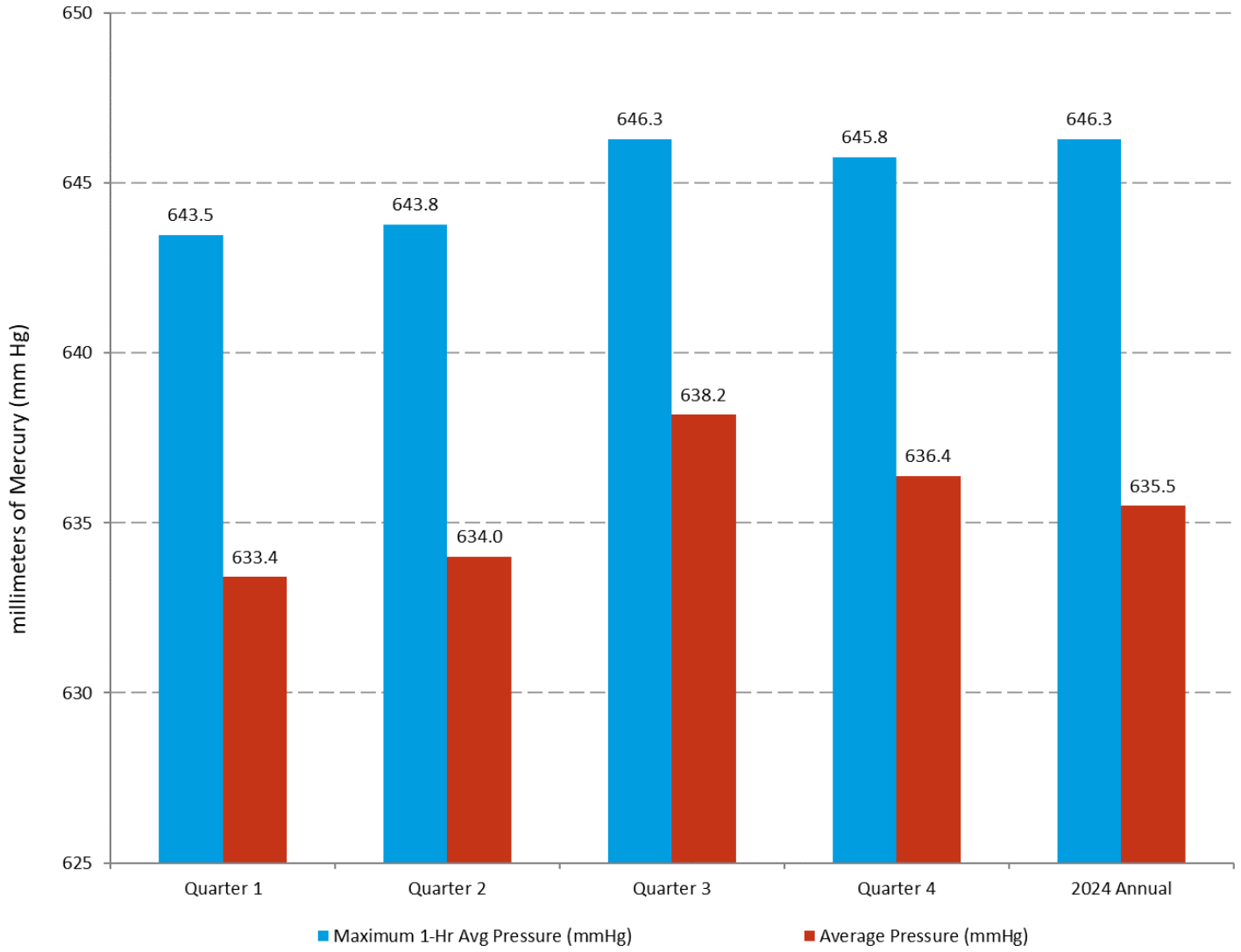

Figure 26. MSP 2024 Barometric Pressure Summary

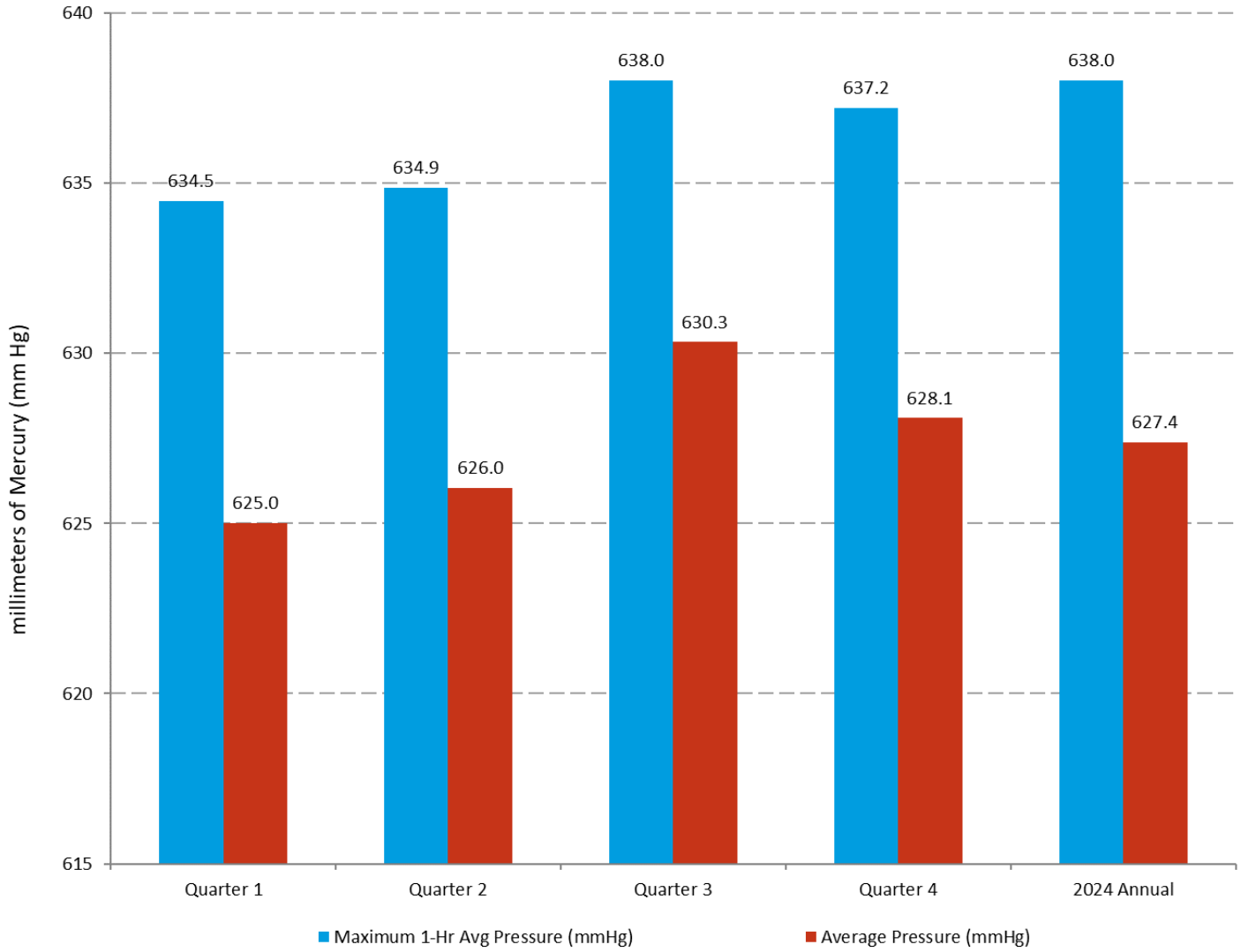

Figure 27. Hereford 2024 Barometric Pressure Summary

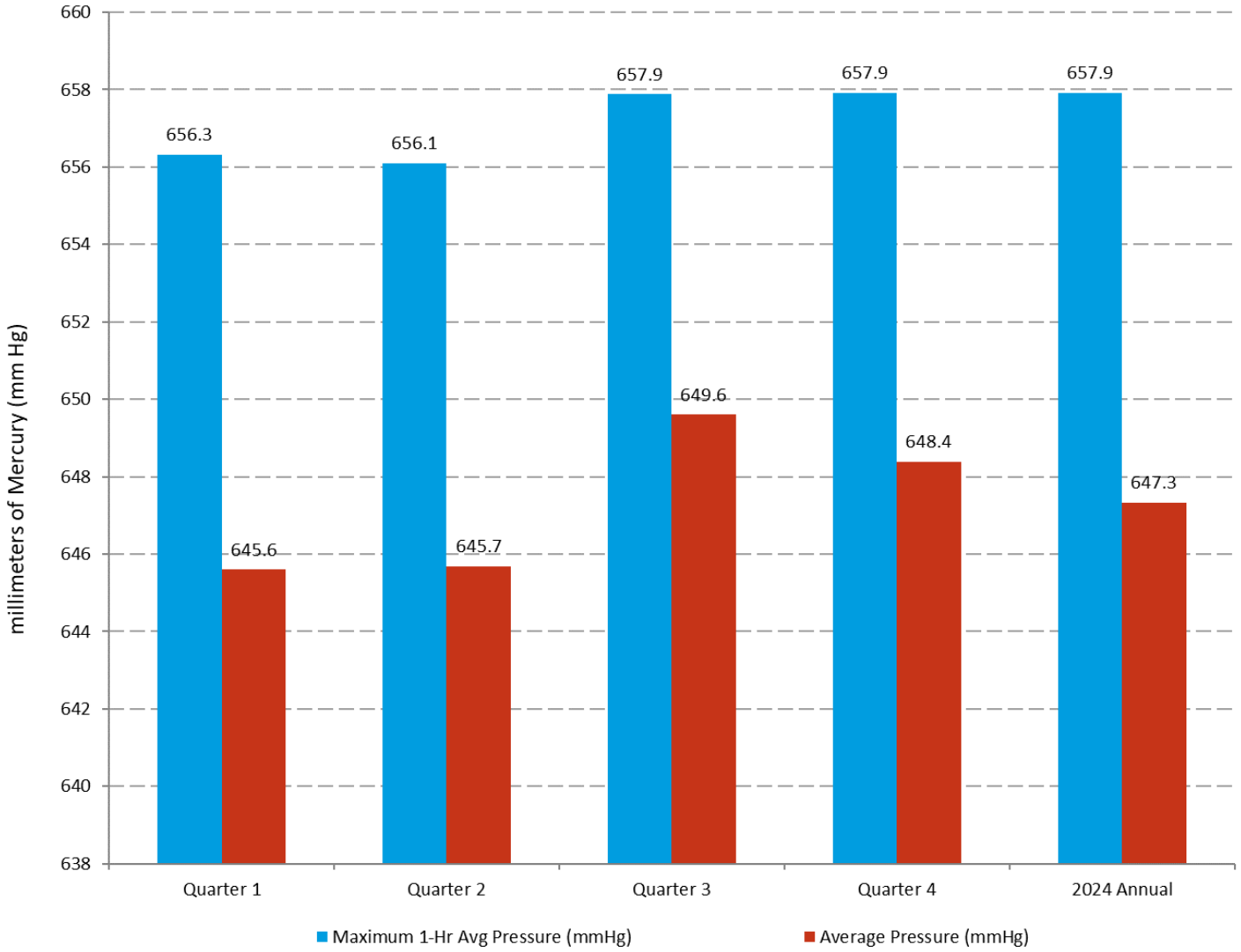

Figure 28. Orchard 2024 Barometric Pressure Summary

6.6 Relative Humidity Data Summary

Relative humidity data was collected at all three stations at 2-m agl. The average quarterly relative humidity at each station was generally highest during Quarter 1 and lowest during Quarter 3, although at Orchard the average was slightly lower for Quarter 2. Maximum hourly average and quarterly average relative humidity for each quarter of 2024 and for the year at all three stations is summarized in **Figure 29** through **Figure 31** and **Table 12**.

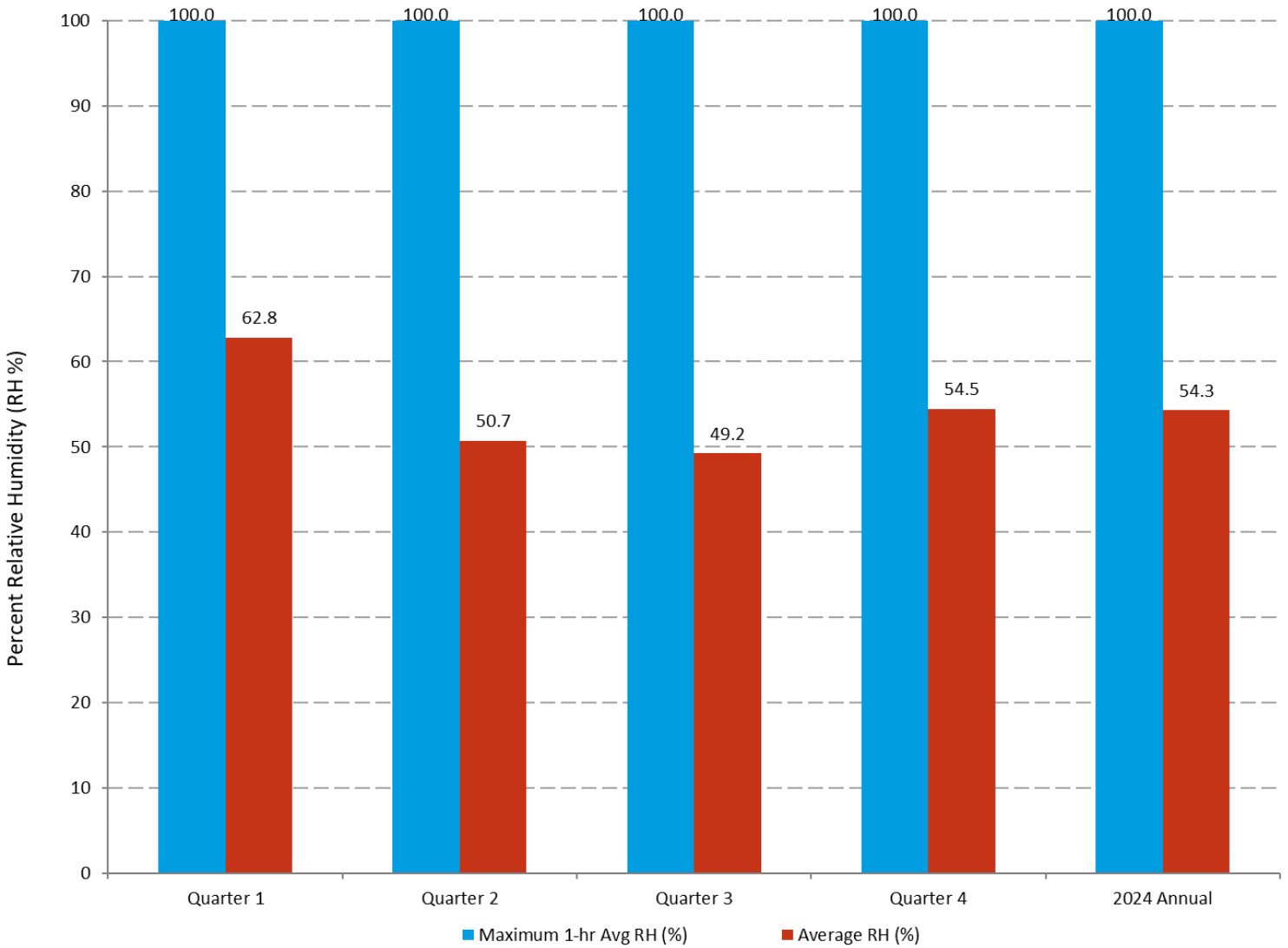

Figure 29. MSP 2024 Relative Humidity Summary

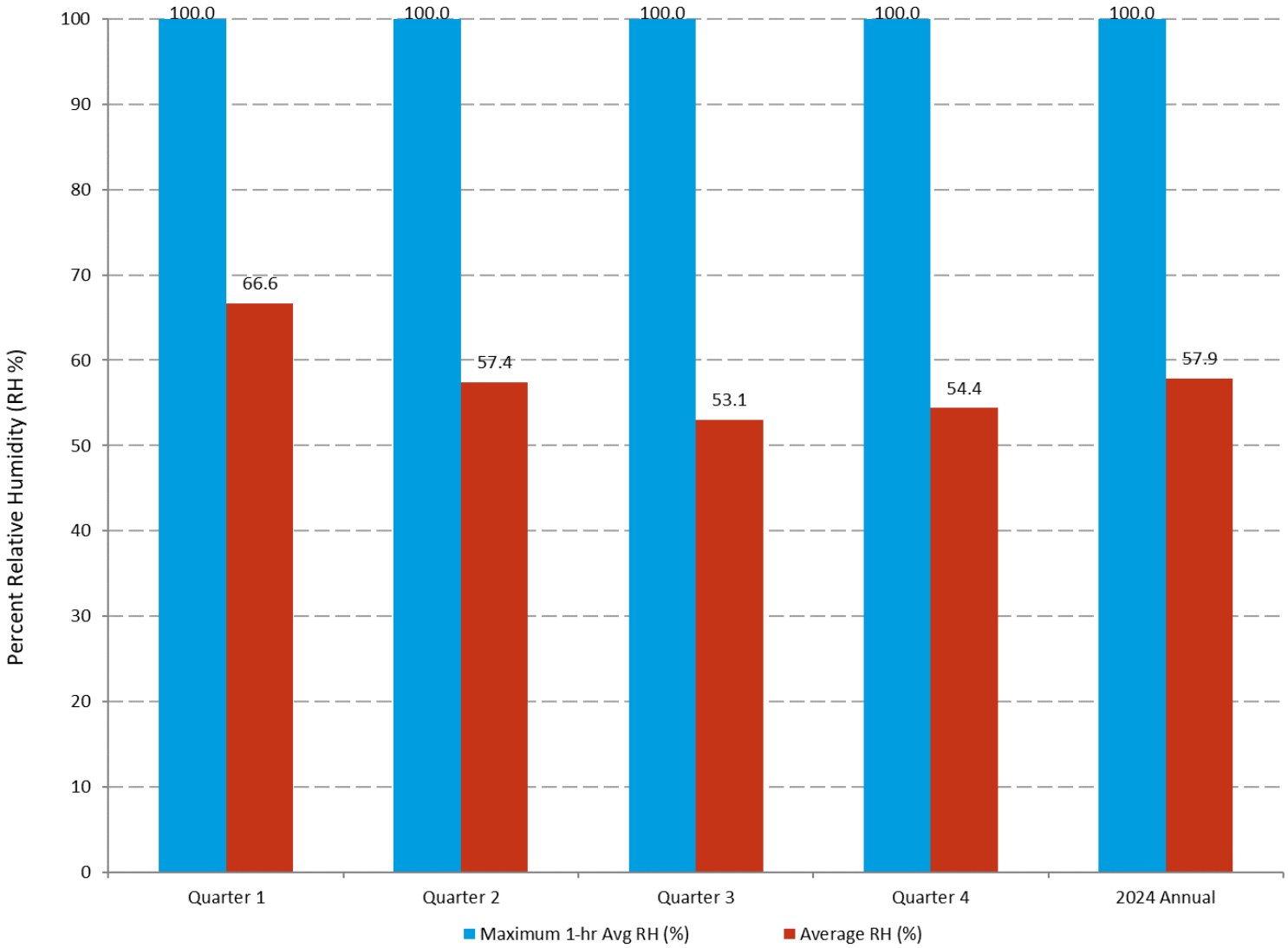

Figure 30. Hereford 2024 Relative Humidity Summary

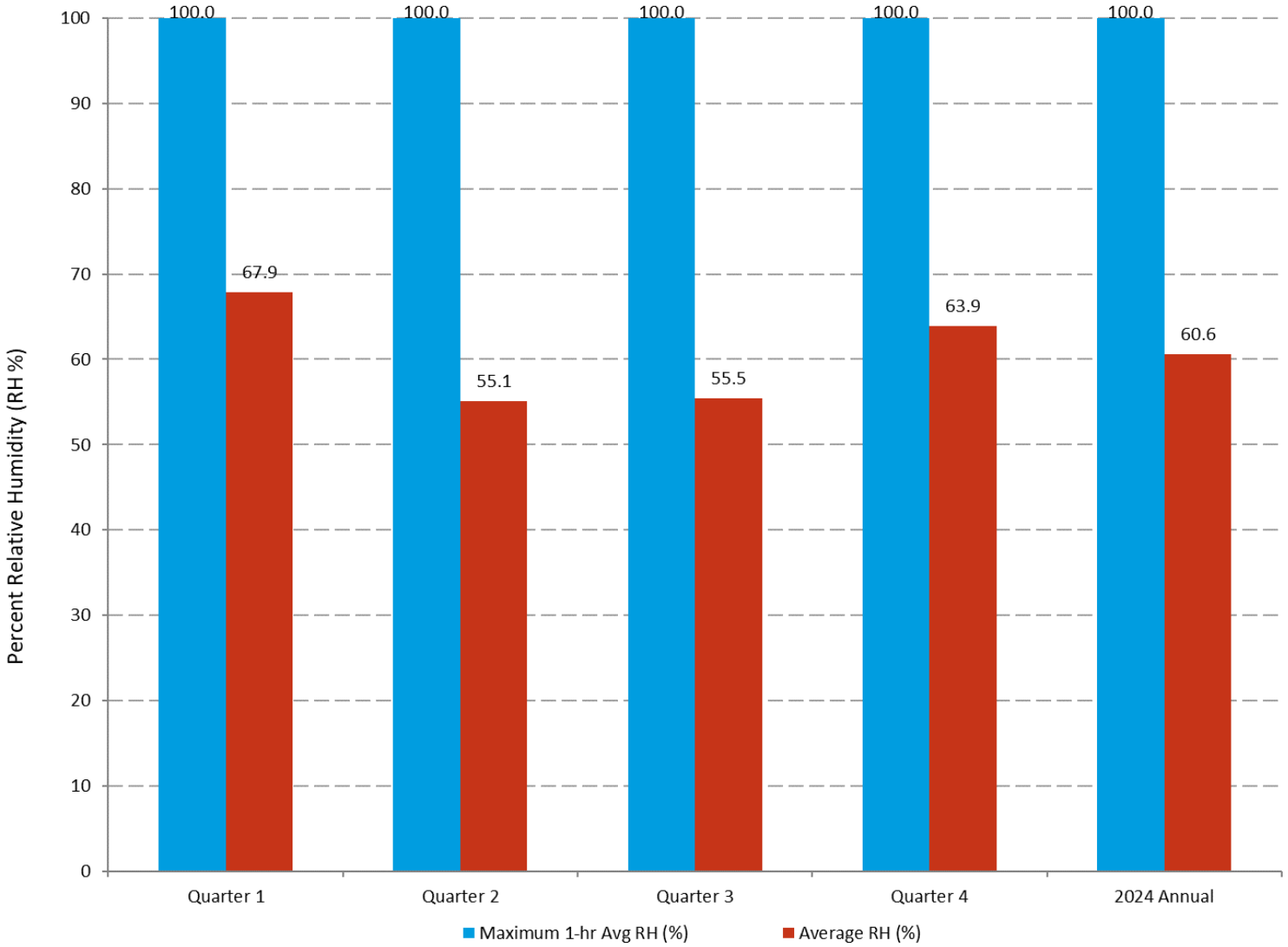

Figure 31. Orchard 2024 Relative Humidity Summary

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. At MSP and Orchard, the maximum solar radiation measured occurred during Quarter 2, while at Hereford the maximum solar radiation measured occurred during Quarter 3. Maximum hourly average and quarterly average solar radiation for each quarter of 2024 and for the year at all three stations is summarized in **Figure 32** through **Figure 34** and **Table 12**.

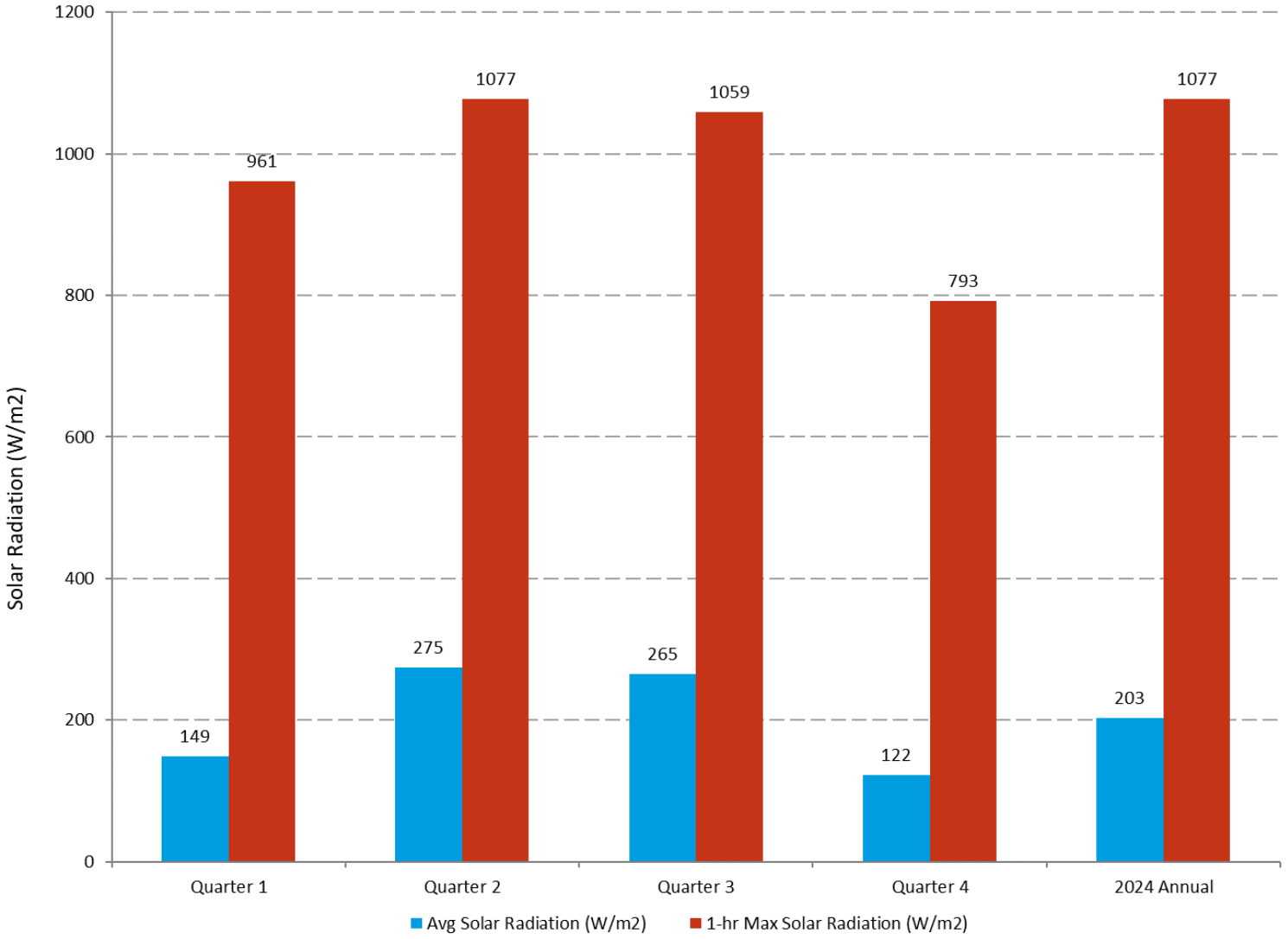

Figure 32. MSP 2024 Solar Radiation

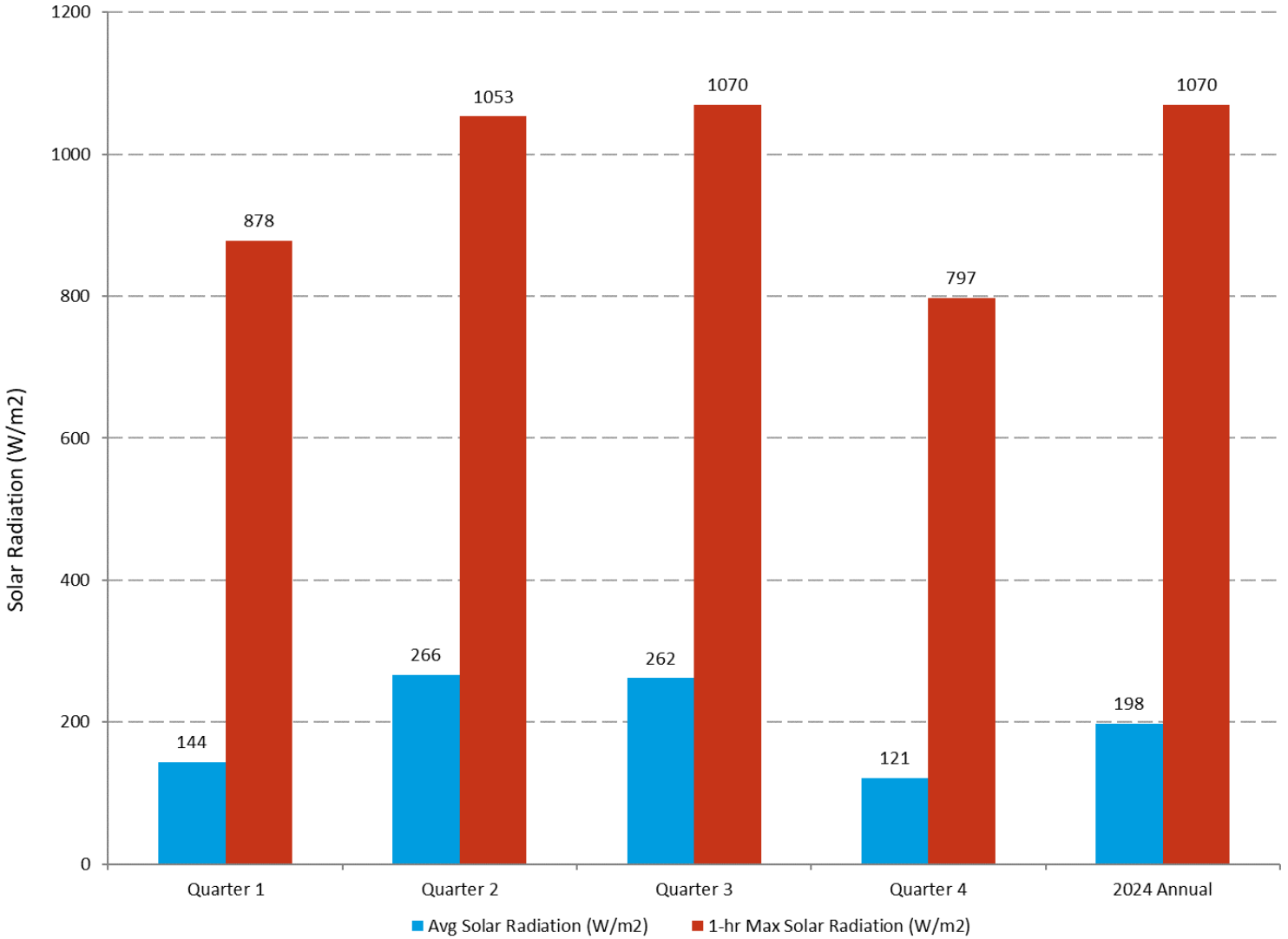

Figure 33. Hereford 2024 Solar Radiation Summary

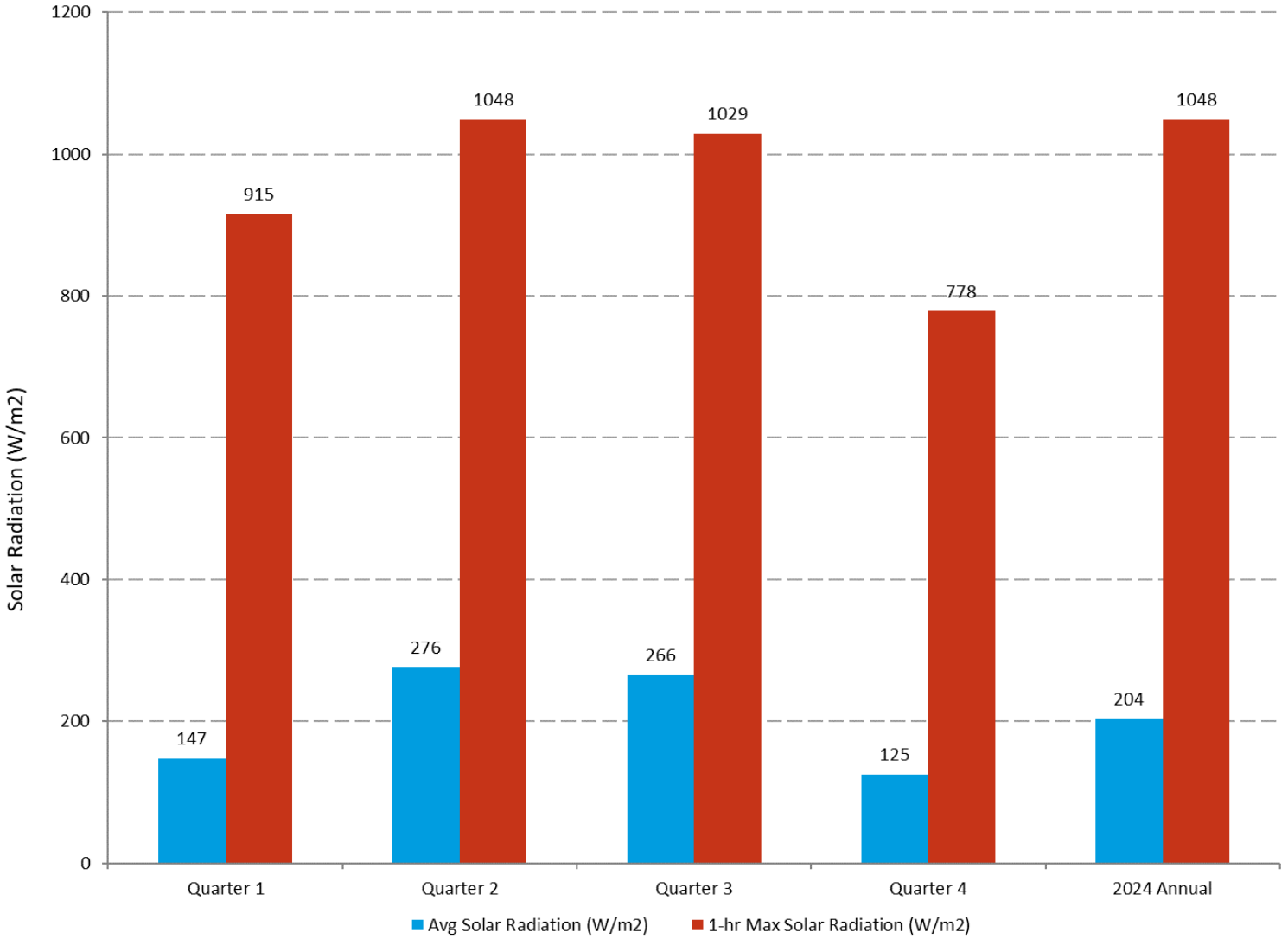

Figure 34. Orchard 2024 Solar Radiation Summary

7. ANNUAL REPORT DATA SUMMARY

Program activities conducted during 2024 included data collection, equipment programming and calibrations, station inspections, routine maintenance, equipment troubleshooting and repair, routine data acquisition, data screening and validation, audits, and report preparation. Data completeness goals were met for all parameters for all stations, except for NO_2 at MSP during Quarter 4. For 2022, 2023, and 2024, data completeness for ozone for each station met the requirements of at least 90% for the ozone season.

Air quality data collected includes O_3 at all three stations and NO_x at the MSP station. The daily maximum 8-hour average O_3 concentrations were above the 2015 AAQS 20 times during the year at MSP, eight times at Hereford, and five times at Orchard. The daily maximum 8-hour average O_3 concentrations were above the 2008 AAQS nine times during the year at MSP, four times at Hereford, and once at Orchard. Since more than three years of data have been collected, we can compare the three-year design values at each site to the AAQS. MSP, Hereford, and Orchard design values for the 2022-2024 period are 0.074 ppm, 0.068 ppm, and 0.068 ppm respectively, see **Table 13** for more information. MSP is the only site with a 2022-2024 design value that exceeds either AAQS which was the 2015 AAQS of 0.070 ppm.

The maximum 1-hr average concentration of NO_2 measured at MSP for 2024 was 45.8 ppb, which was below the AAQS standard of 100 ppb. The annual average NO_2 measured at MSP was 6.5 ppb, which is below the annual standard (53 ppb). Note that, Quarter 4 did not meet data completeness requirements for NO_2, with a quarterly data completeness of 64%. The 1-hour average NO_2 standard is based on the 98th percentile of 1-hour daily maximum concentrations, averaged over 3-years. Since we did not meet data completeness for Q4 2024, a test design value was calculated per 40 CFR 50 Appendix S. The test design value was 53 ppb, which is lower than the 1-hour NO_2 NAAQS. Therefore, we can use the data collected to calculate a 2022-2024 design value, which is 47 ppb. The annual design value is 6.5 ppb. Both are below their respective AAQS. See **Table 14** and **Table 15** for the 1-hour and annual NO_2 design values.

Meteorological data were all within normal ranges for the area and season with the exception of precipitation, which was elevated for all sites when compared to 2021 and 2022, and similar to 2023 which was also high precipitation year. While still within normal ranges, annual average 2 and 10m temperature at all three sites was higher than 2022 and 2023, but nearer to equal with 2021 which also relatively warm.

Table 13. Current Ozone Design Value, All Sites.

Site	4th Highest Year 1, 2022 (ppm)	4th Highest Year 2, 2023 (ppm)	4th Highest Year 3, 2024 (ppm)	Design Value (2022-2024) (ppm)
MSP	0.073	0.069	0.080	0.074
Hereford	0.065	0.063	0.077	0.068
Orchard	0.069	0.064	0.072	0.068

Notes:
[1] The O_3 standard is based on the three-year average of the fourth-highest daily maximum 8-hour O_3 average.
[2] Orange highlighting means that the value is above the 2008 O_3 standard. Yellow highlighting means that the value is above the 2015 O_3 standard.

Table 14. Current 1-Hour NO_2 Design Value, MSP.

Period	98th Percentile Year 1, 2022 (ppb)	98th Percentile Year 2, 2023 (ppb)	98th Percentile Year 3, 2024 (ppb)	Design Value 2022-2024 (ppb)
1-Hour	54.5	50.2	35.3	47

Table 15. Current Annual NO_2 Design Value, MSP.

Period	Design Value 2024 (ppb)
Annual	6.5

APPENDIX A: QUARTER 4 MATERIALS

Prepared for:
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Denver, Colorado, U.S.A.

Project Number
1940112228-001

February 2025

WELD COUNTY MONITORING NETWORK

APPENDIX A1: 4TH QUARTER 2024 SUMMARY TABLES & FIGURES

RAMBOLL

CONTENTS

TABLES

FIGURES

APPENDICES

1. QUARTER 4 SUMMARY

The Weld County Monitoring Network Quarter 4 2024 data tables and figures are presented in this appendix. Quarter 4 2024 data is presented as an abbreviated report to avoid reproducing efforts between a Quarter 4 report and an annual report. All tables and figures presenting monthly and quarterly data for Quarter 4 are presented here but no text descriptions are included. Gaseous tables are available in the main body report text. No major program or instrument changes were made during Quarter 4 2024 besides the replacement of the wind speed and wind direction sensor at Hereford. For a list of site instrumentation, see the main body text of the annual report.

The Quarter 4 2024 semi-annual calibration visits took place in early and mid-October, for gasses and meteorology respectively. All parameters passed. The independent site audits, performed by the Colorado Department of Public Health & Environment and Air Resource Specialists, occurred in late November. All parameters passed their respective audits. Audit and calibration reports are available as Appendix B. During the semi-annual calibration visits, the Hereford wind speed and wind direction sensor was replaced as a preventative measure. In October, two days of ozone data was conservatively invalidated at MSP because the post maintenance response was not confirmed. In November a shift in NO_2 analyzer response occurred, which was confirmed by a multipoint check that failed operational criteria[1]. As a result, the NO_2 analyzer at MSP had additional maintenance performed including replacement of the ozone cleanser media, replacement of flow orifice filters, a flow orifice replacement, and a reaction cell cleaning. A subsequent multi-point check was performed which confirmed valid data collection. However, in December, another shift in response of the NO_2 analyzer at MSP occurred. Further maintenance was performed, including replacement of the NO/NO_x valve and the ozone dryer, however, this maintenance was not performed until January 2025. Due to these issues, NO, NO_2, and NO_x did not meet data completeness targets for Q4 2024. Corrective action reports for Quarter 4 2024 are available as Appendix A4.

Below are the Quarter 4 data completeness statistics, air quality data summaries, and meteorological data summaries. Also available are the data invalidation periods, site visitation log, and corrective action reports.

[1] USEPA, *Quality Assurance Handbook Volume II, Appendix D, Measurement Quality Objectives and Validation Templates*. Available at: https://www.epa.gov/sites/default/files/2020-10/documents/app_d_validation_template_version_03_2017_for_amtic_rev_1.pdf. Accessed: February 2025.

Table 1. Fourth Quarter 2024 Data Completeness for Continuous Measurement Devices

Measurement	Time Period	Completeness Target [1-6]	Site Completeness				Target Met? (Y/N)
			Oct	Nov	Dec	Q4 2024	
Missile Site Park							
NO_2[1]	Quarterly	≥75%	89%	55%	49%	64%	No
NO_x, NO	N/A	N/A	89%	55%	49%	64%	N/A
O_3[1]	O_3 Season	≥90%	87%	90%	97%	91%	N/A
Wind Direction[2]	Quarterly	≥90%	100%	99%	100%	100%	Yes
Wind Speed[2]	Quarterly	≥90%	100%	99%	100%	100%	Yes
Temperature[2]	Quarterly	≥90%	100%	99%	100%	100%	Yes
Delta Temperature[2]	Quarterly	≥90%	100%	99%	100%	100%	Yes
Relative Humidity	Quarterly	≥90%	100%	99%	100%	100%	Yes
Solar Radiation[2]	Quarterly	≥90%	100%	99%	100%	100%	Yes
Barometric Pressure[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Precipitation[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Hereford							
O_3[1]	O_3 Season	≥90%	94%	100%	100%	98%	N/A
Wind Direction[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Wind Speed[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Temperature[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Delta Temperature[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Relative Humidity	Quarterly	≥90%	99%	100%	100%	100%	Yes
Solar Radiation[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Barometric Pressure[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes

Measurement	Time Period	Completeness Target [1-6]	Site Completeness				Target Met? (Y/N)
			Oct	Nov	Dec	Q4 2024	
Precipitation[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Orchard							
O_3[1,5]	O_3 Season	≥90%	94%	97%	97%	96%	N/A
Wind Direction[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Wind Speed[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Temperature[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Delta Temperature[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Relative Humidity	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%	99%	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 90% of daily maximum 8-hour averages during the ozone season. In Colorado, the Ozone season is January through December (https://aqs.epa.gov/aqsweb/documents/codetables/ozone_seasons.html).

[2] 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.

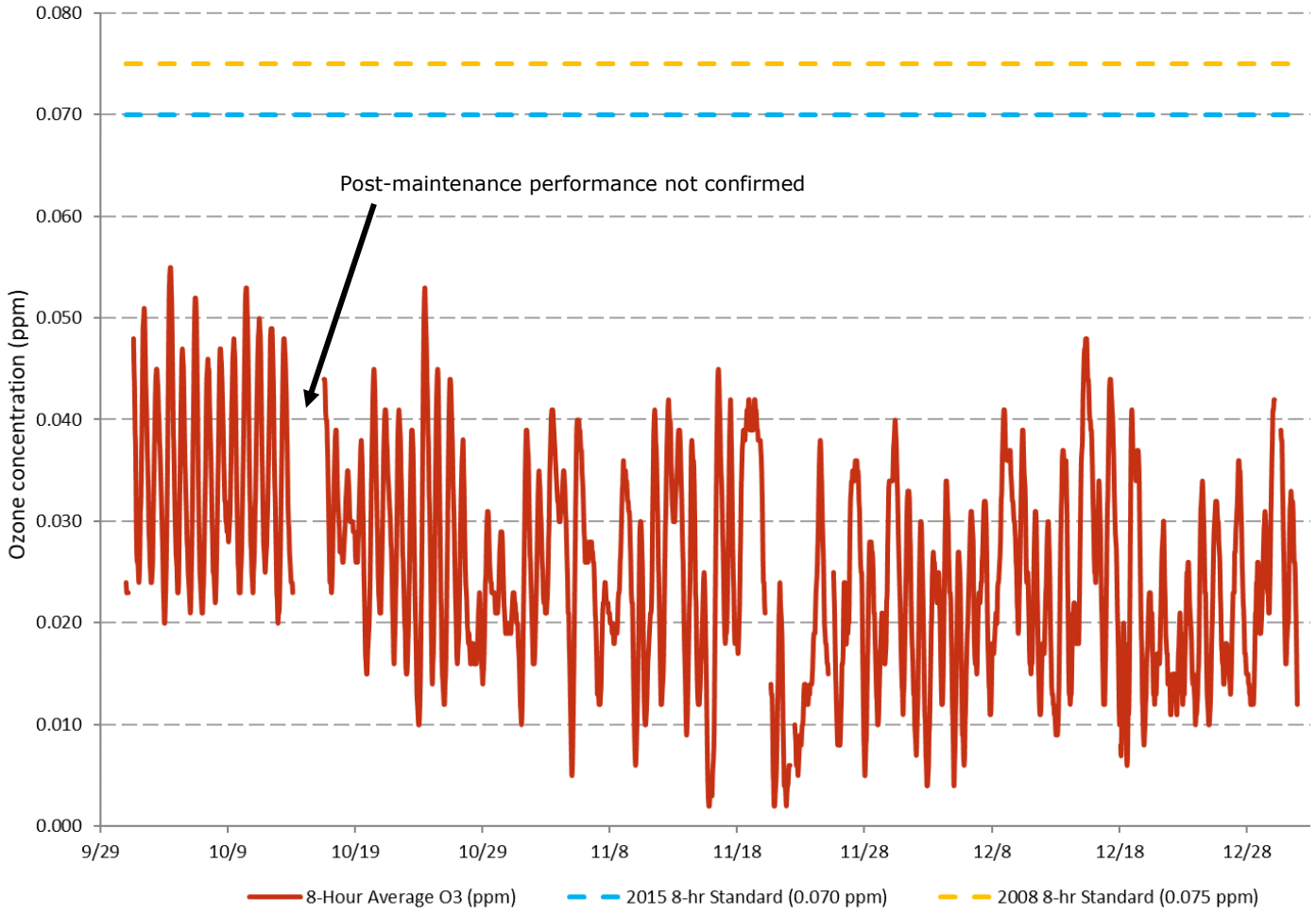

Figure 1. MSP Q4 2024 Rolling 8-hour Averaged O_3

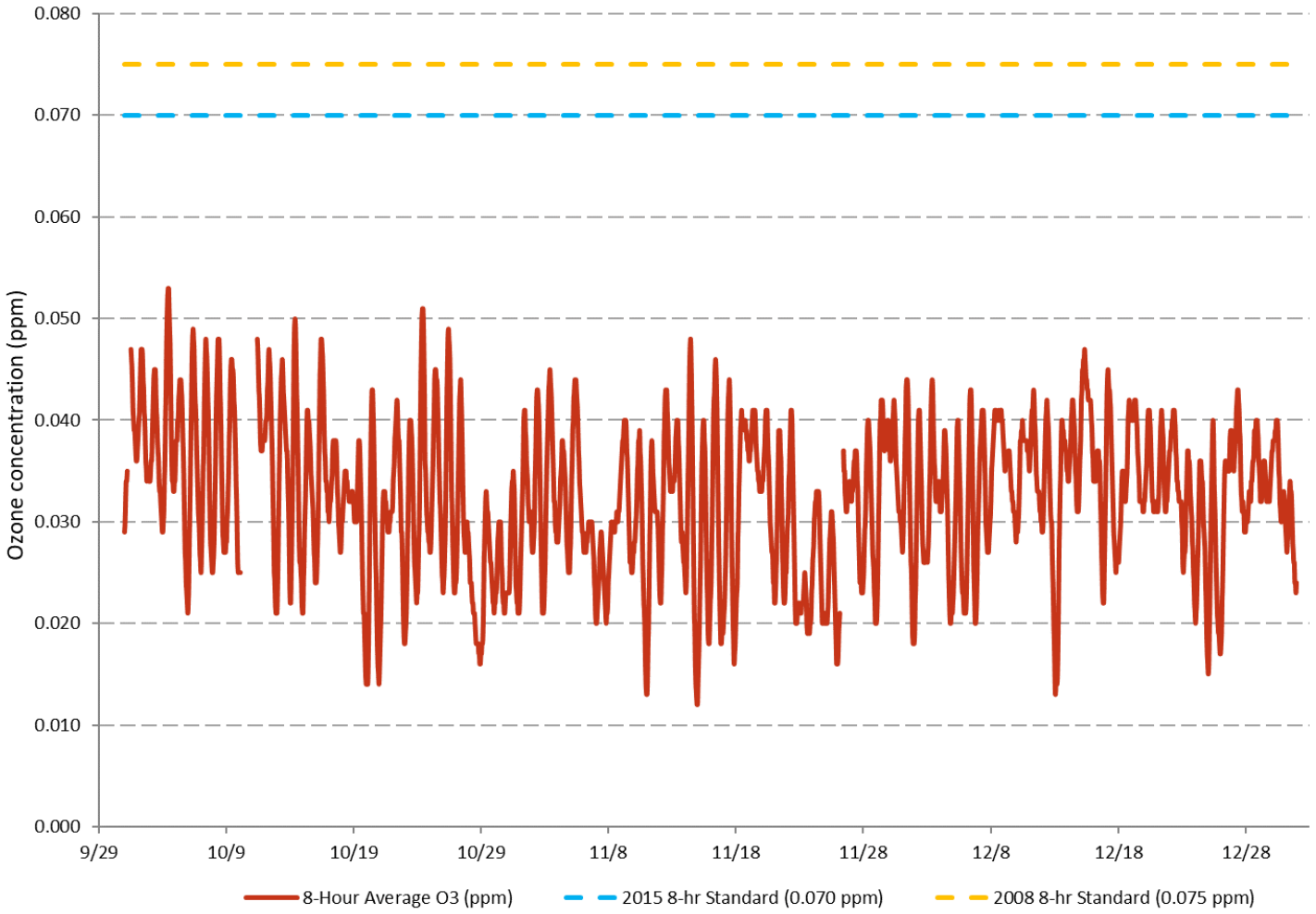

Figure 2. Hereford Q4 2024 Rolling 8-hour Averaged O_3

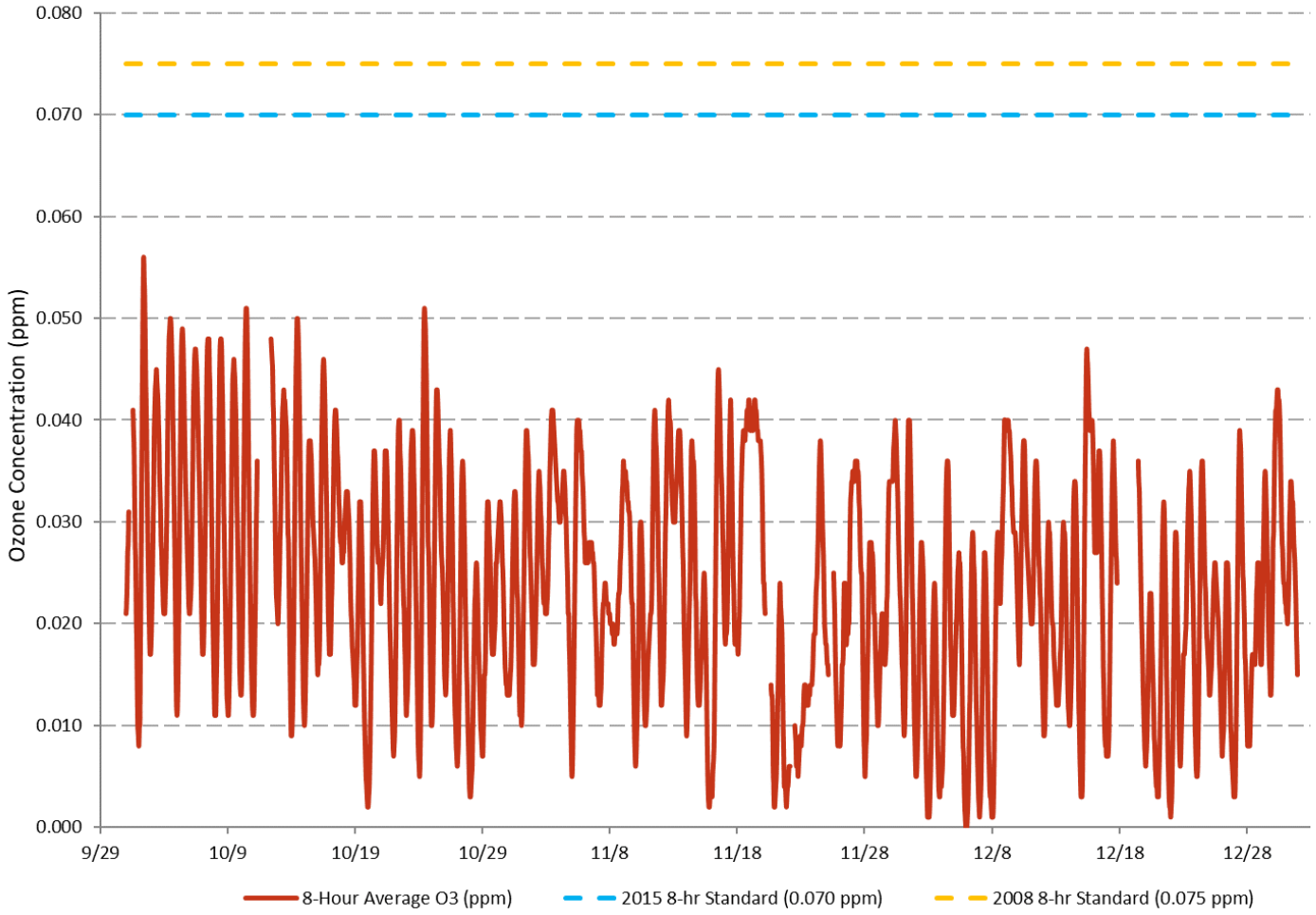

Figure 3. Orchard Q4 2024 Rolling 8-hour Averaged O_3

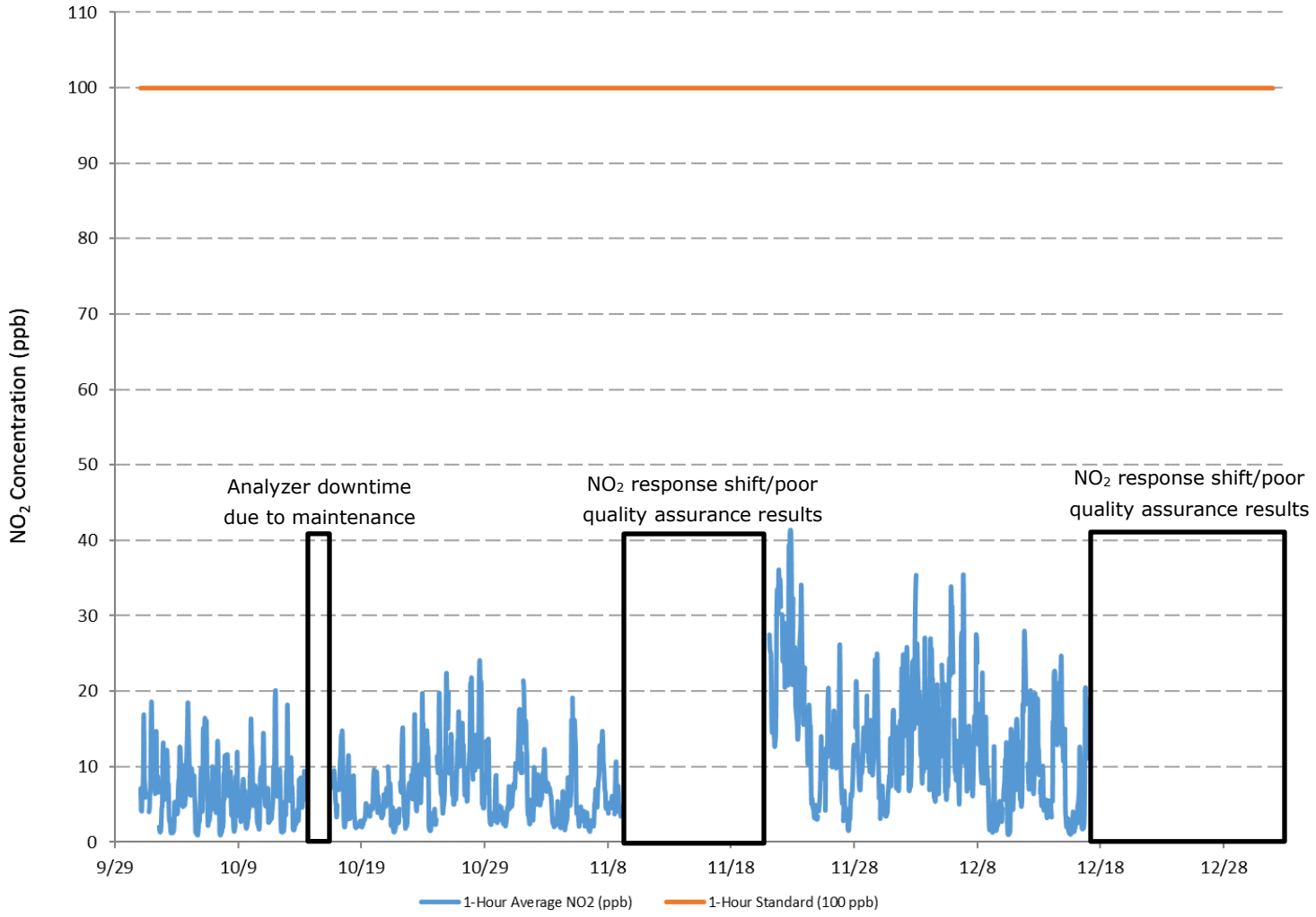

Figure 4. MSP Q4 2024 NO_2 1-Hour Summary

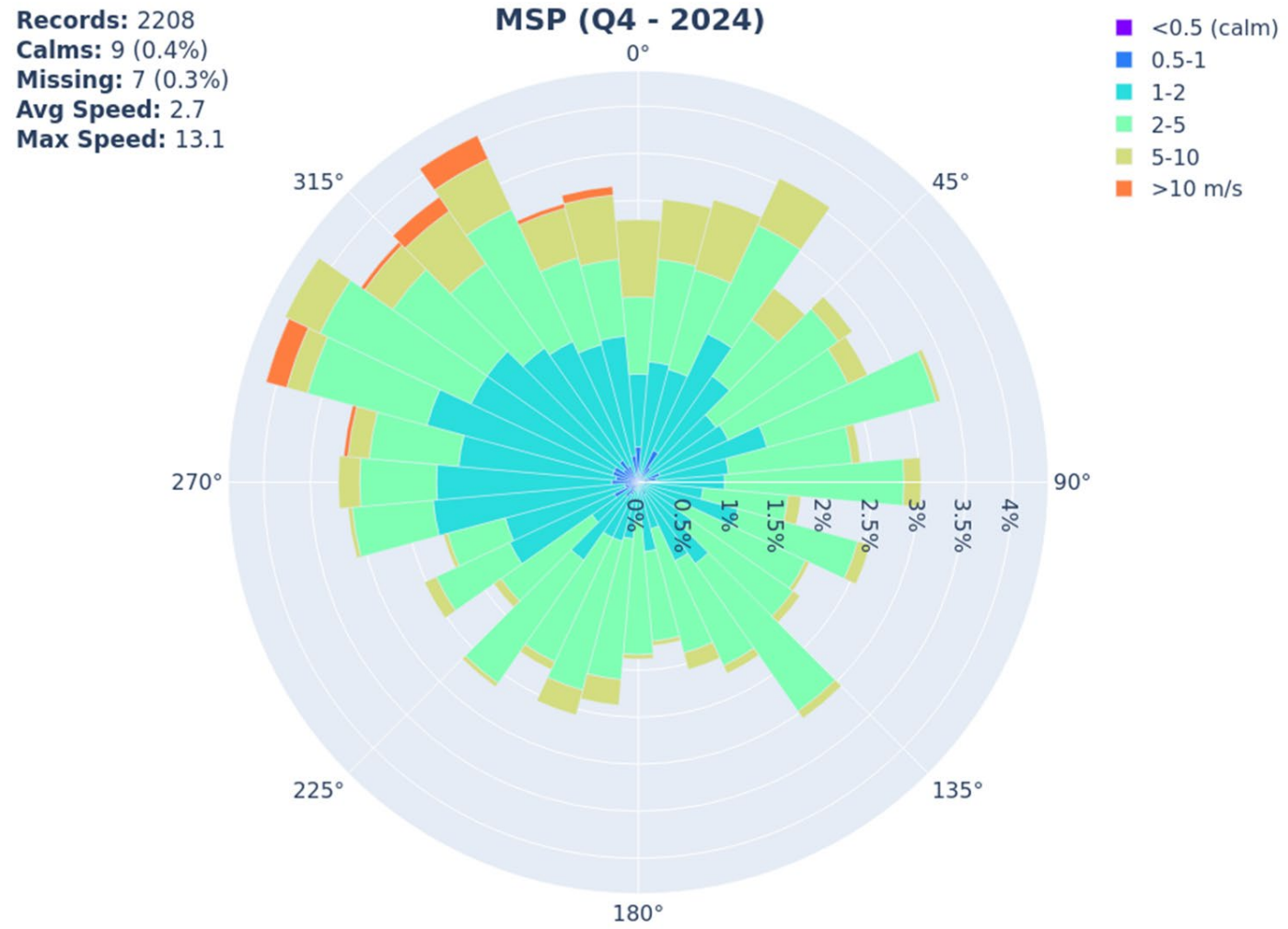

Figure 5. MSP Q4 2024 Wind Rose

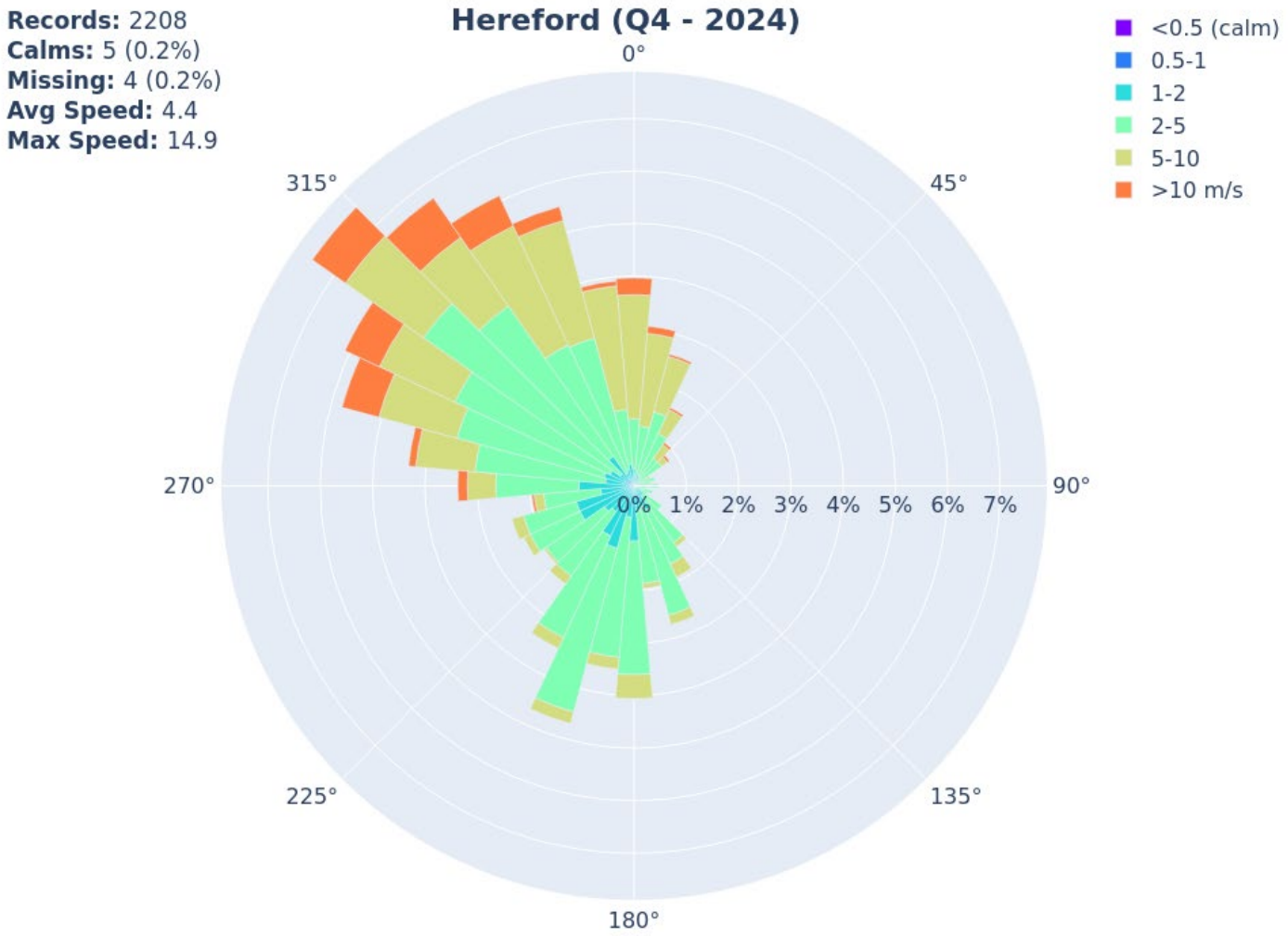

Figure 6. Hereford Q4 2024 Wind Rose

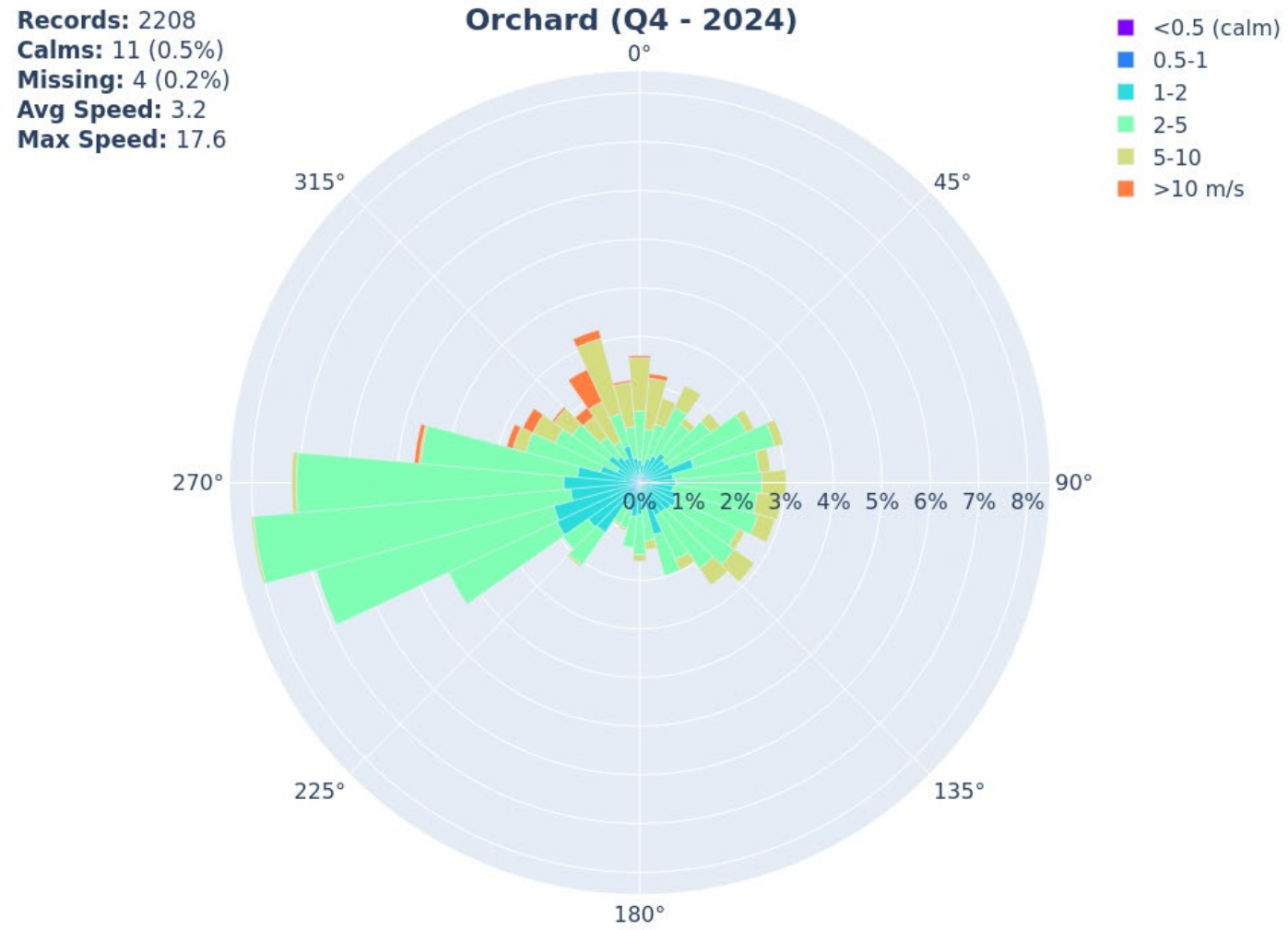

Figure 7. Orchard Q4 2024 Wind Rose

Table 2. Fourth Quarter 2024 Meteorological Data Summary

Parameter	Units	Form	October[1]	November[1]	December[1]
Missile Site Park					
2-M Temperature	°C	Monthly Average	13.4	3.1	2.9
		Maximum Hourly Average	31.7	16.2	15.7
		Minimum Hourly Average	-0.1	-7.9	-8.2
10-M Temperature	°C	Monthly Average	13.6	3.4	3.5
		Maximum Hourly Average	30.6	15.9	15.1
		Minimum Hourly Average	-0.3	-7.6	-7.7
Delta Temperature	°C	Monthly Average	0.2	0.3	0.6
		Maximum Hourly Average	3.3	2.6	3.5
		Minimum Hourly Average	-1.9	-1.1	-1.0
10-M Horizontal Wind Speed	m/s	Monthly Average	2.5	2.9	2.9
		Maximum Hourly Average	13.1	12.2	12.5
2-M Relative Humidity	Percent	Monthly Average	47.5	62.8	53.4
		Maximum Hourly Average	100.0	100.0	95.1
Station Barometric Pressure	mm Hg	Monthly Average	637.9	634.7	636.5
		Maximum Hourly Average	645.8	643.1	644.6
Station Precipitation	in	Monthly Total	0.296	1.299	0.000

Parameter	Units	Form	October[1]	November[1]	December[1]
	in/hr	Maximum Hourly Total	0.099	0.106	0.000
2-M Solar Radiation	W/m^2	Monthly Average	163	111	92
		Maximum Hourly Average	793	671	524
Hereford					
2-M Temperature	°C	Monthly Average	11.3	1.6	1.4
		Maximum Hourly Average	31.3	18.2	18.1
		Minimum Hourly Average	-3.0	-13.0	-13.1
10-M Temperature	°C	Monthly Average	12.1	2.6	2.5
		Maximum Hourly Average	30.2	17.6	17.6
		Minimum Hourly Average	-2.8	-9.2	-10.7
Delta Temperature	°C	Monthly Average	0.8	1.0	1.1
		Maximum Hourly Average	7.0	8.8	9.2
		Minimum Hourly Average	-1.6	-1.4	-1.1
10-M Horizontal Wind Speed	m/s	Monthly Average	4.0	4.3	4.7
		Maximum Hourly Average	14.9	13.9	14.8
2-M Relative Humidity	Percent	Monthly Average	48.8	61.2	53.4
		Maximum Hourly Average	100.0	100.0	91.3
	mm Hg	Monthly Average	629.8	626.3	628.1

Parameter	Units	Form	October[1]	November[1]	December[1]
Station Barometric Pressure		Maximum Hourly Average	637.2	634.3	635.6
Station Precipitation	in	Monthly Total	0.059	0.808	0.000
	in/hr	Maximum Hourly Total	0.039	0.099	0.000
2-M Solar Radiation	W/m^2	Monthly Average	163	112	89
		Maximum Hourly Average	797	624	529
Orchard					
2-M Temperature	°C	Monthly Average	11.5	1.3	-0.1
		Maximum Hourly Average	32.4	18.2	17.5
		Minimum Hourly Average	-3.6	-12.6	-12.7
10-M Temperature	°C	Monthly Average	12.6	2.1	1.2
		Maximum Hourly Average	31.5	17.3	16.8
		Minimum Hourly Average	-2.0	-10.1	-11.5
Delta Temperature	°C	Monthly Average	1.0	0.8	1.4
		Maximum Hourly Average	7.2	5.9	6.8
		Minimum Hourly Average	-1.8	-1.6	-1.3
10-M Horizontal Wind Speed	m/s	Monthly Average	3.3	3.4	2.9
		Maximum Hourly Average	17.6	13.7	14.3
	Percent	Monthly Average	56.6	70.7	64.7

Parameter	Units	Form	October[1]	November[1]	December[1]
2-M Relative Humidity		Maximum Hourly Average	100.0	99.9	94.2
Station Barometric Pressure	mm Hg	Monthly Average	649.7	646.8	648.7
		Maximum Hourly Average	657.9	655.8	657.2
Station Precipitation	in	Monthly Total	0.150	1.319	0.000
	in/hr	Maximum Hourly Total	0.055	0.079	0.000
2-M Solar Radiation	W/m^2	Monthly Average	168	112	95
		Maximum Hourly Average	778	629	500
[1] There are small differences in precision relative to the finalized valid data due to rounding.					

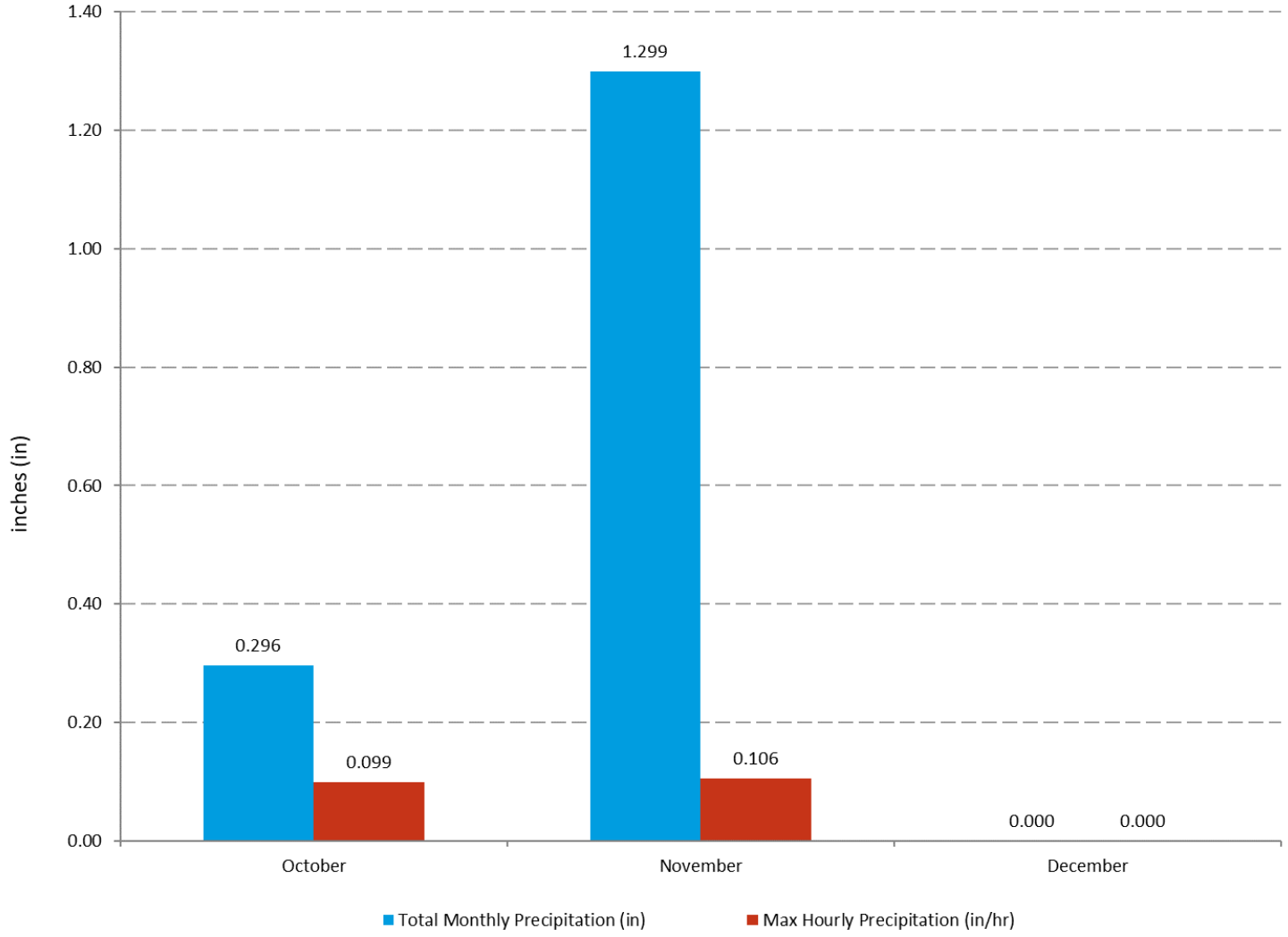

Figure 8. MSP Q4 2024 Precipitation Summary

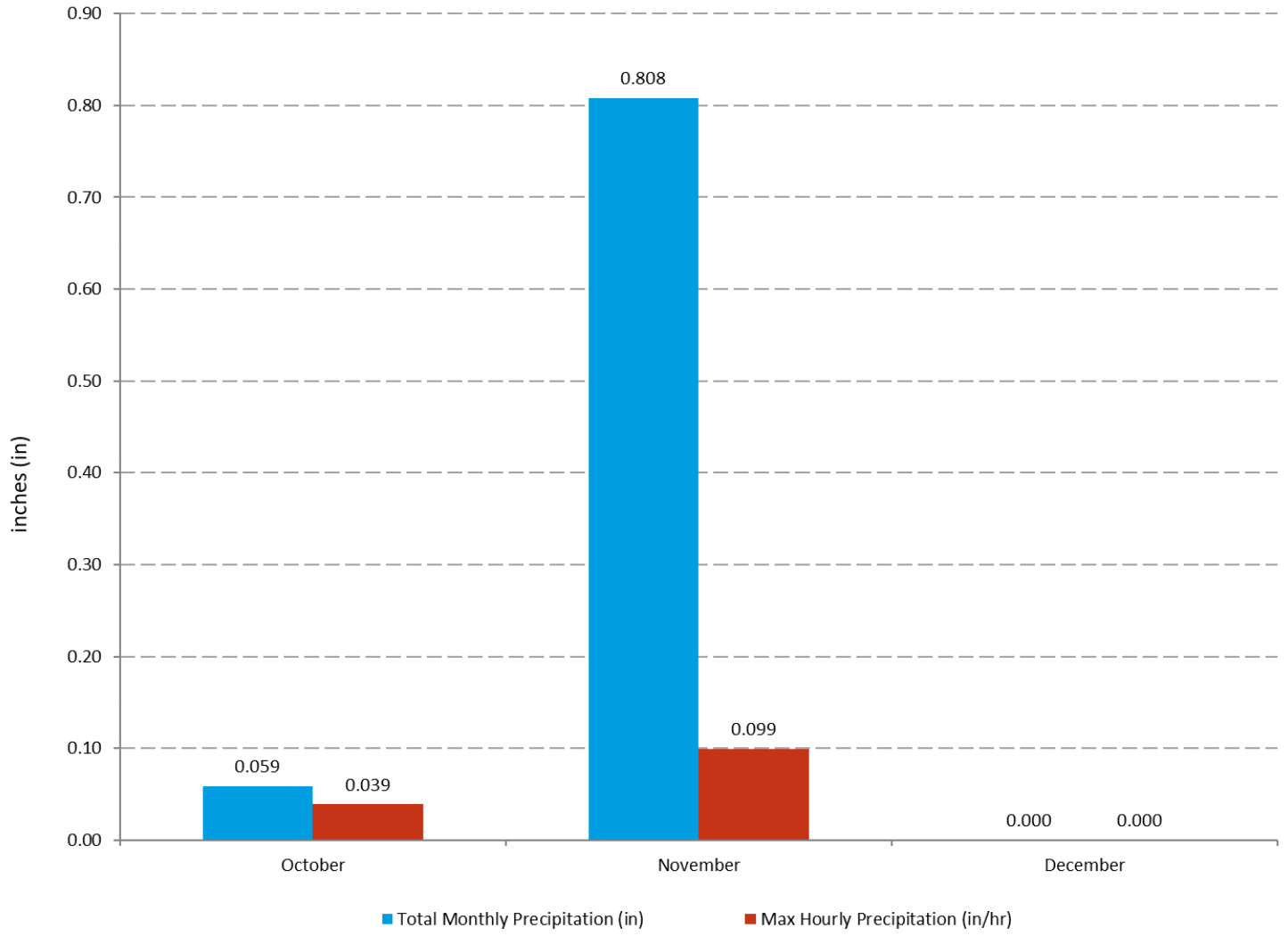

Figure 9. Hereford Q4 2024 Precipitation Summary

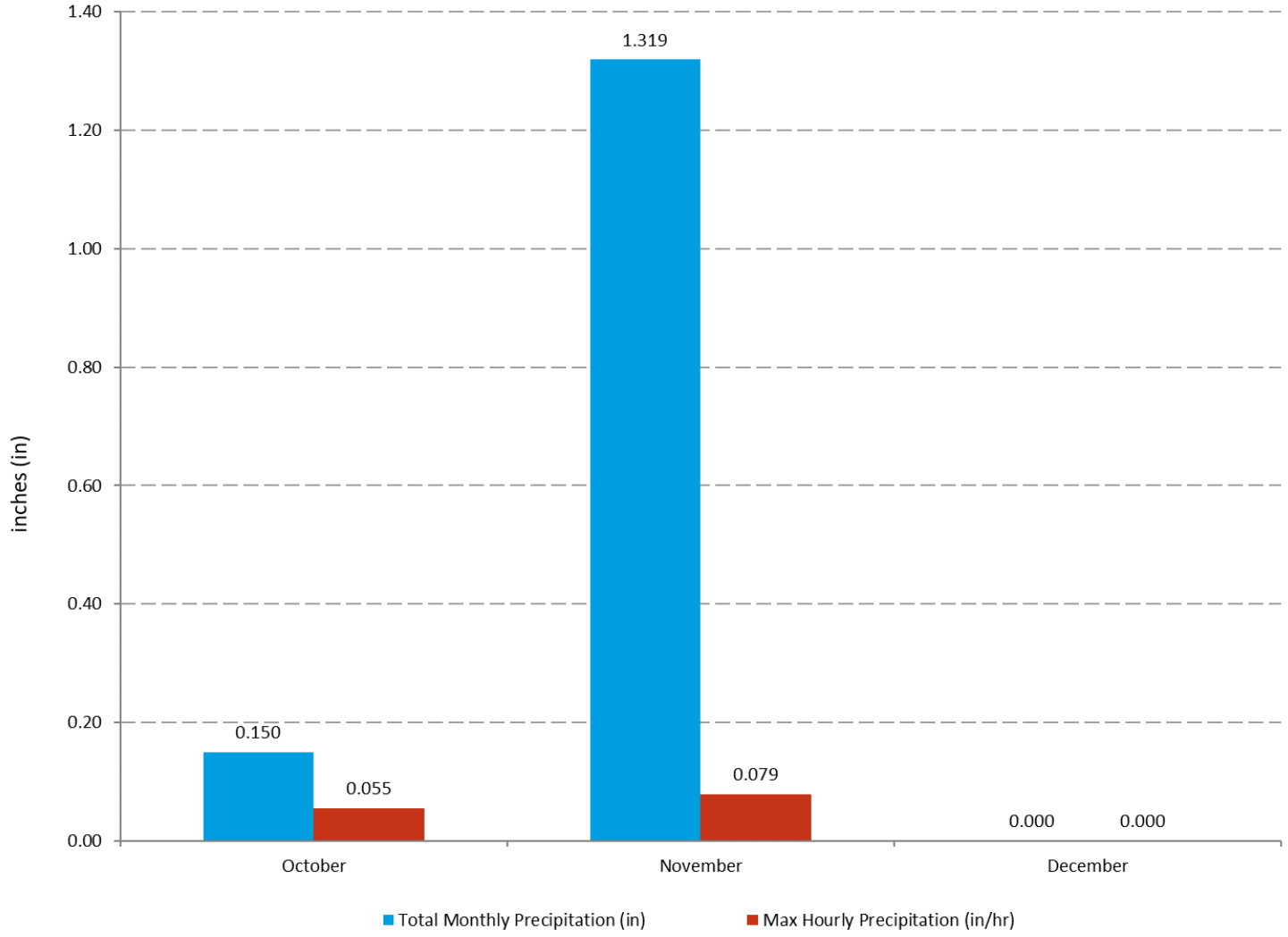

Figure 10. Orchard Q4 2024 Precipitation Summary

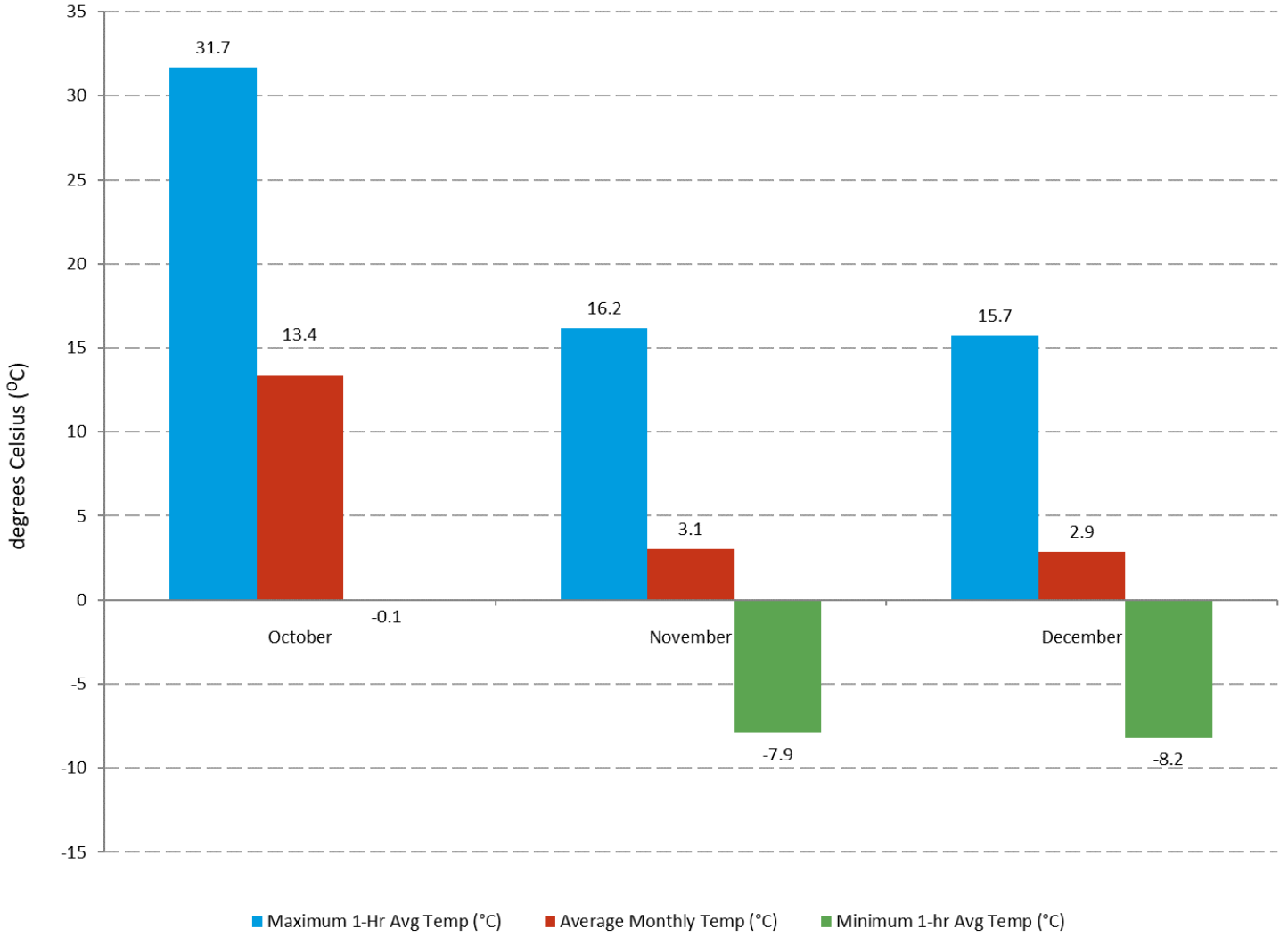

Figure 11. MSP Q4 2024 2-Meter Temperature Summary

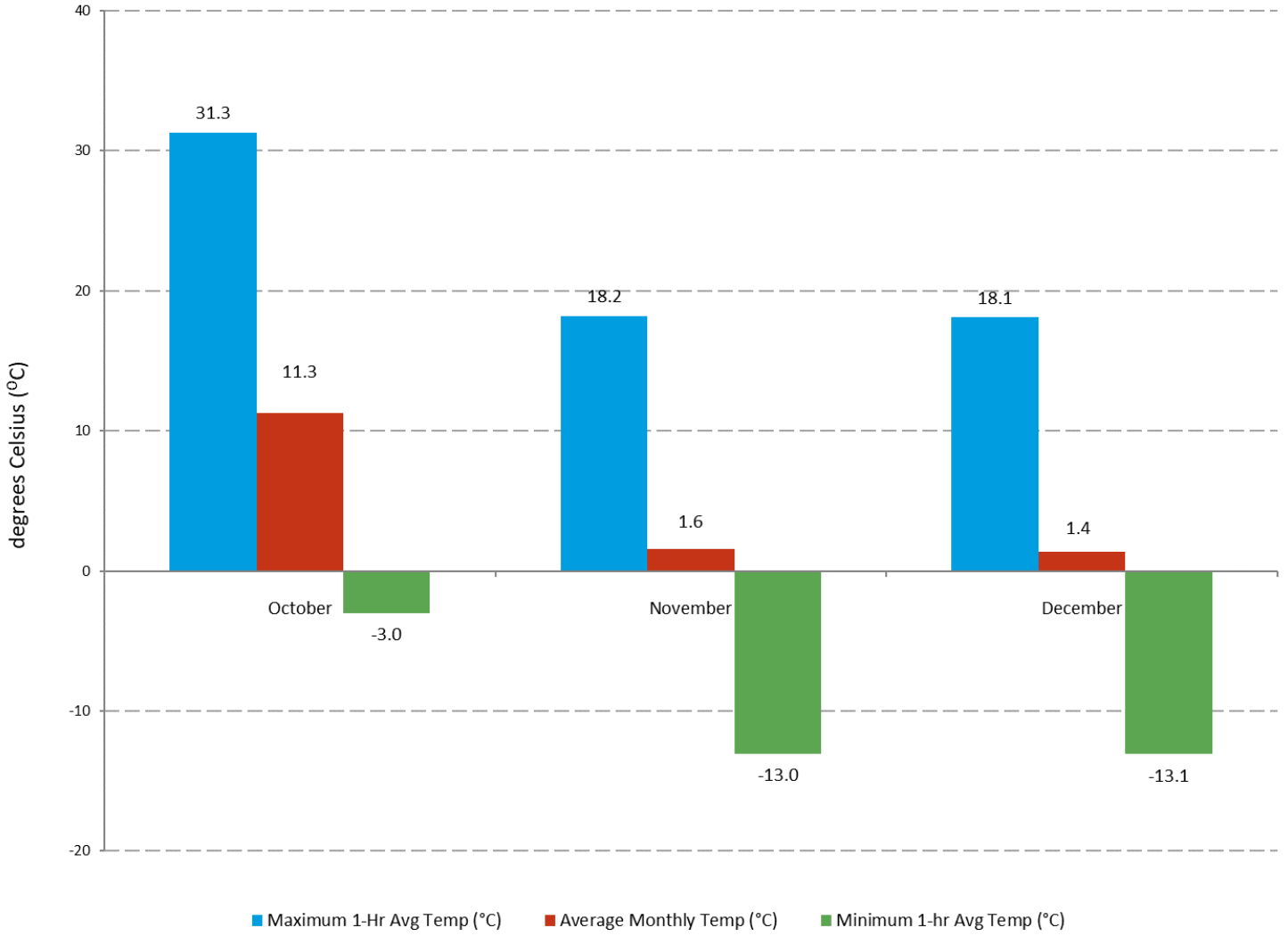

Figure 12. Hereford Q4 2024 2-Meter Temperature Summary

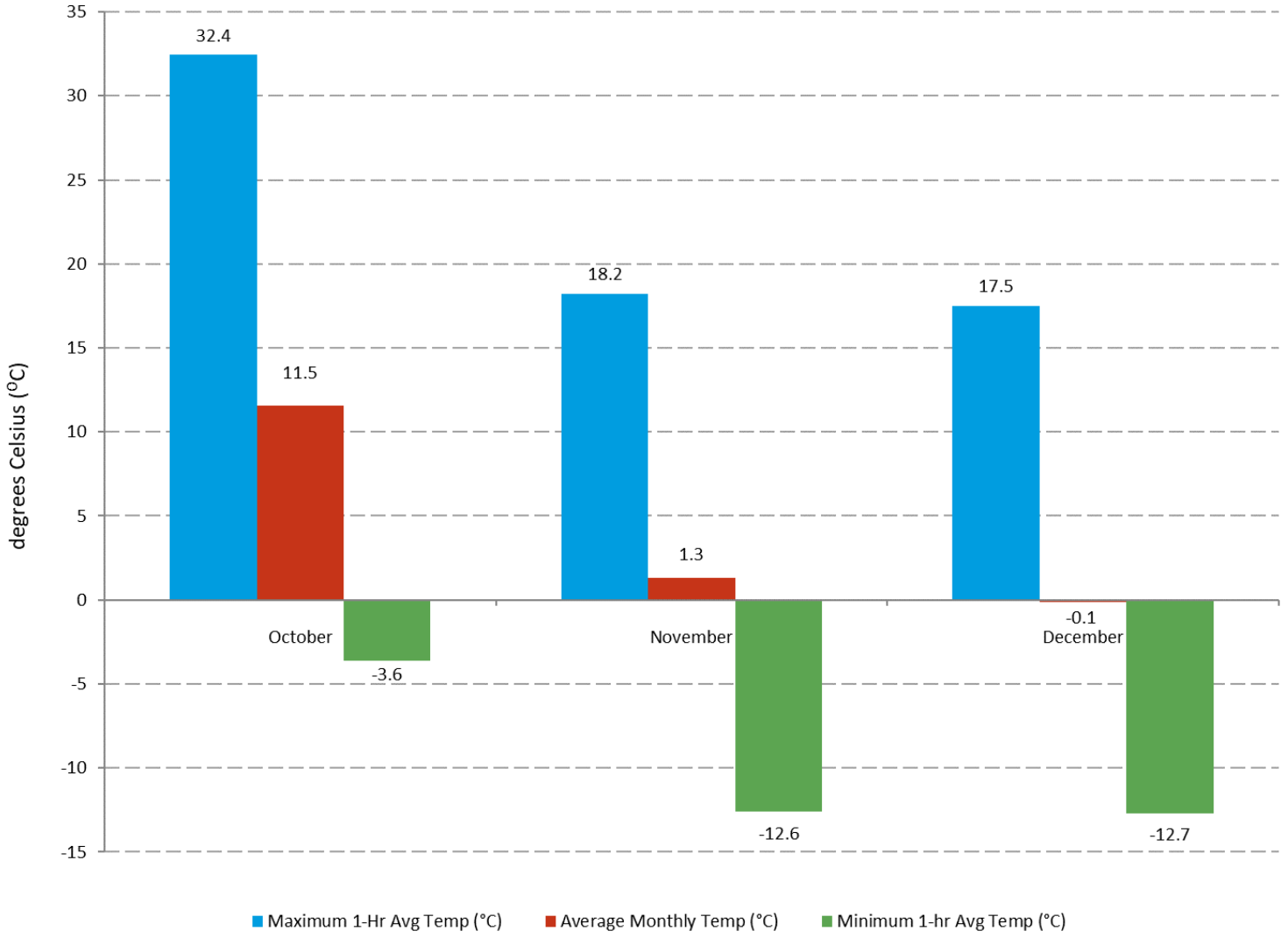

Figure 13. Orchard Q4 2024 2-Meter Temperature Summary

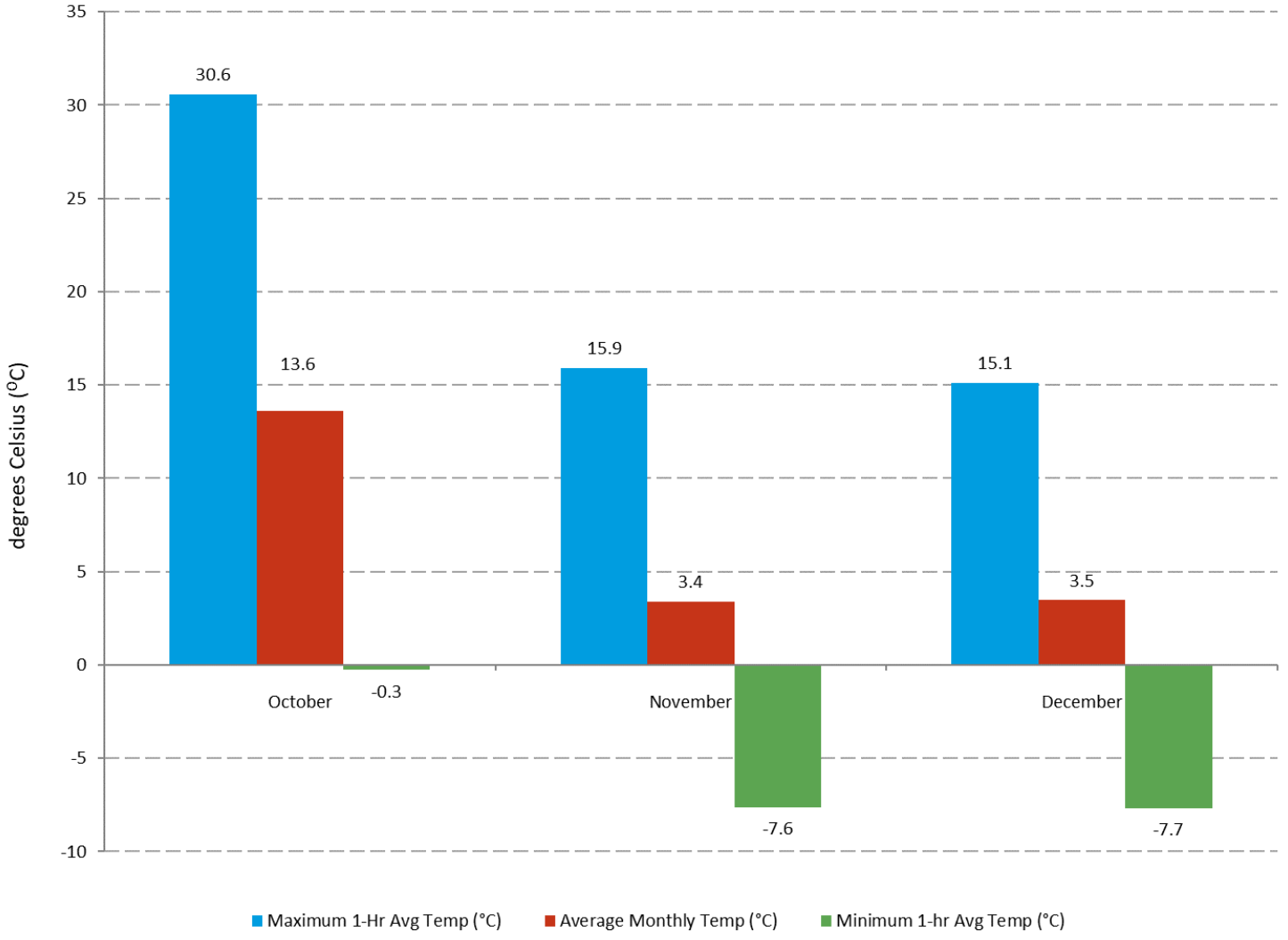

Figure 14. MSP Q4 2024 10-Meter Temperature Summary

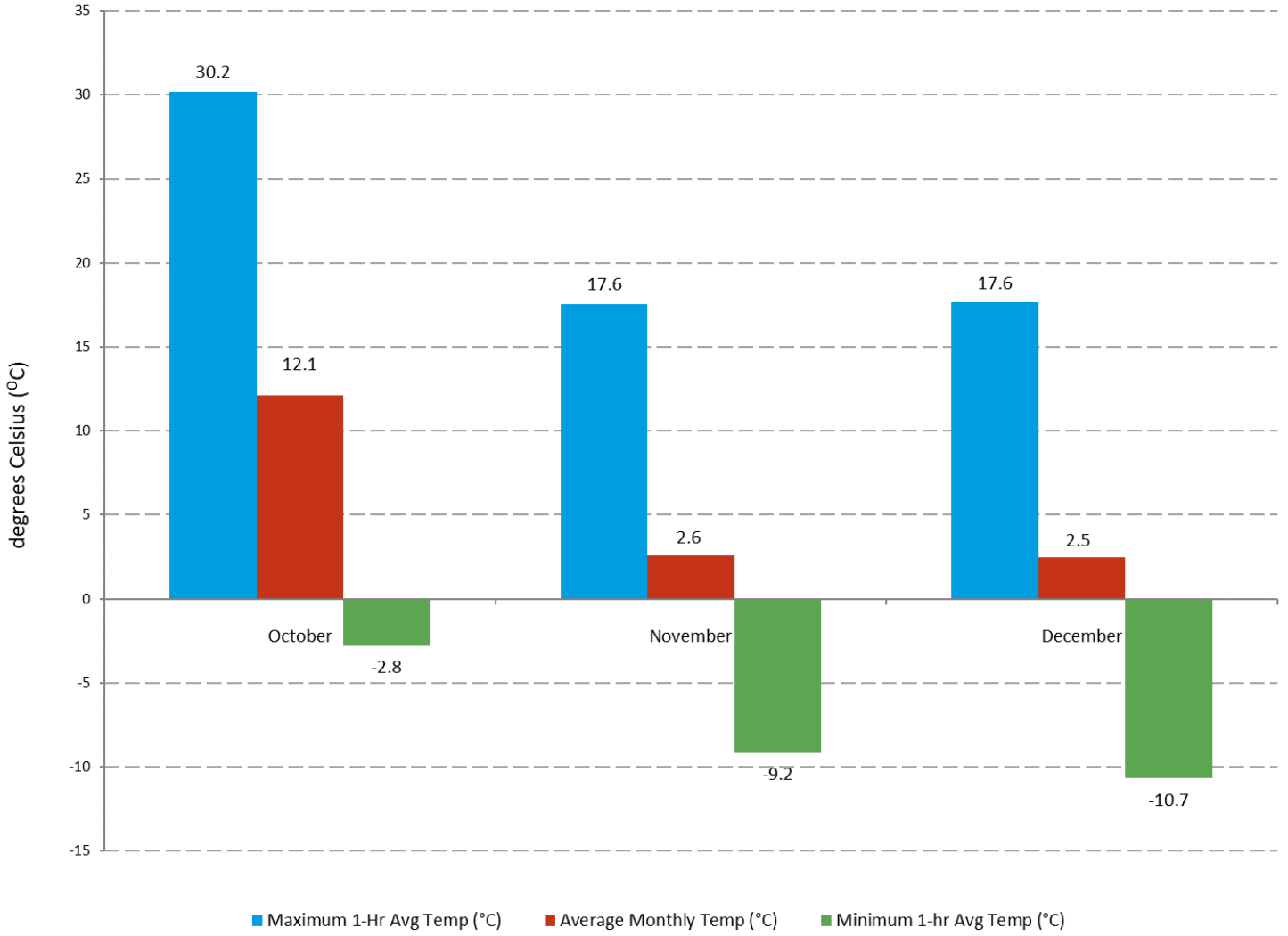

Figure 15. Hereford Q4 2024 10-Meter Temperature Summary

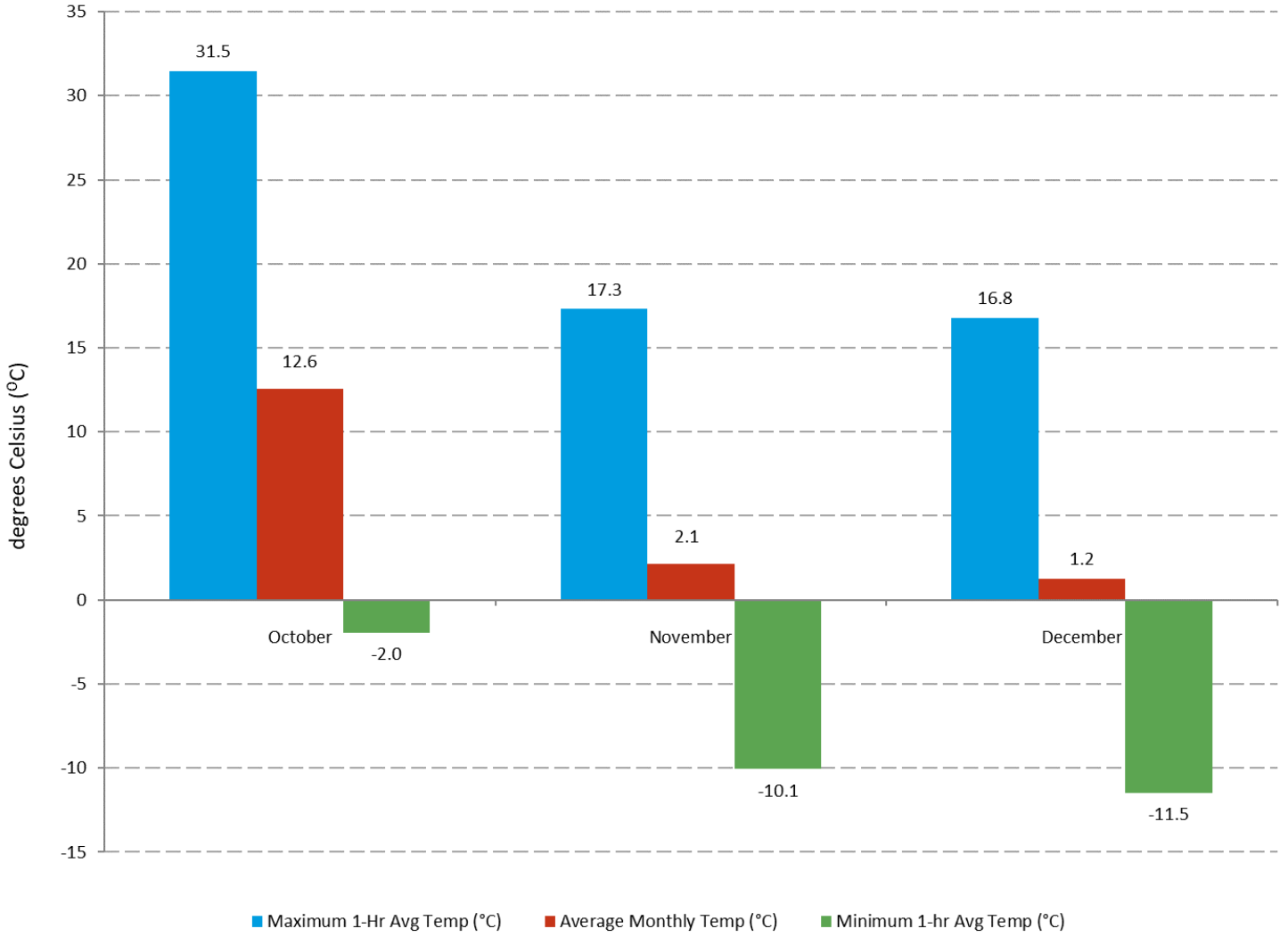

Figure 16. Orchard Q4 2024 10-Meter Temperature Summary

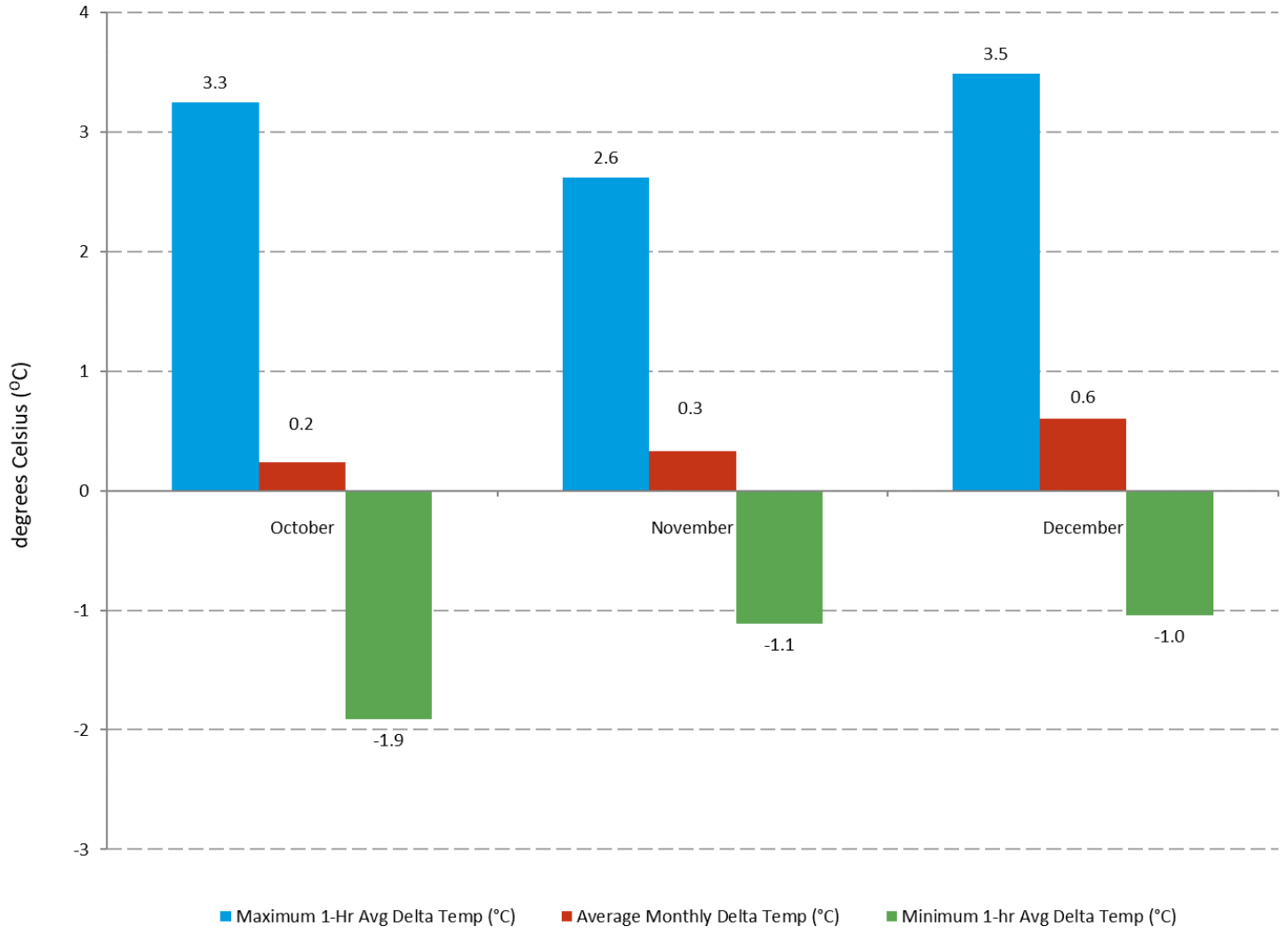

Figure 17. MSP Q4 2024 Delta Temperature Summary

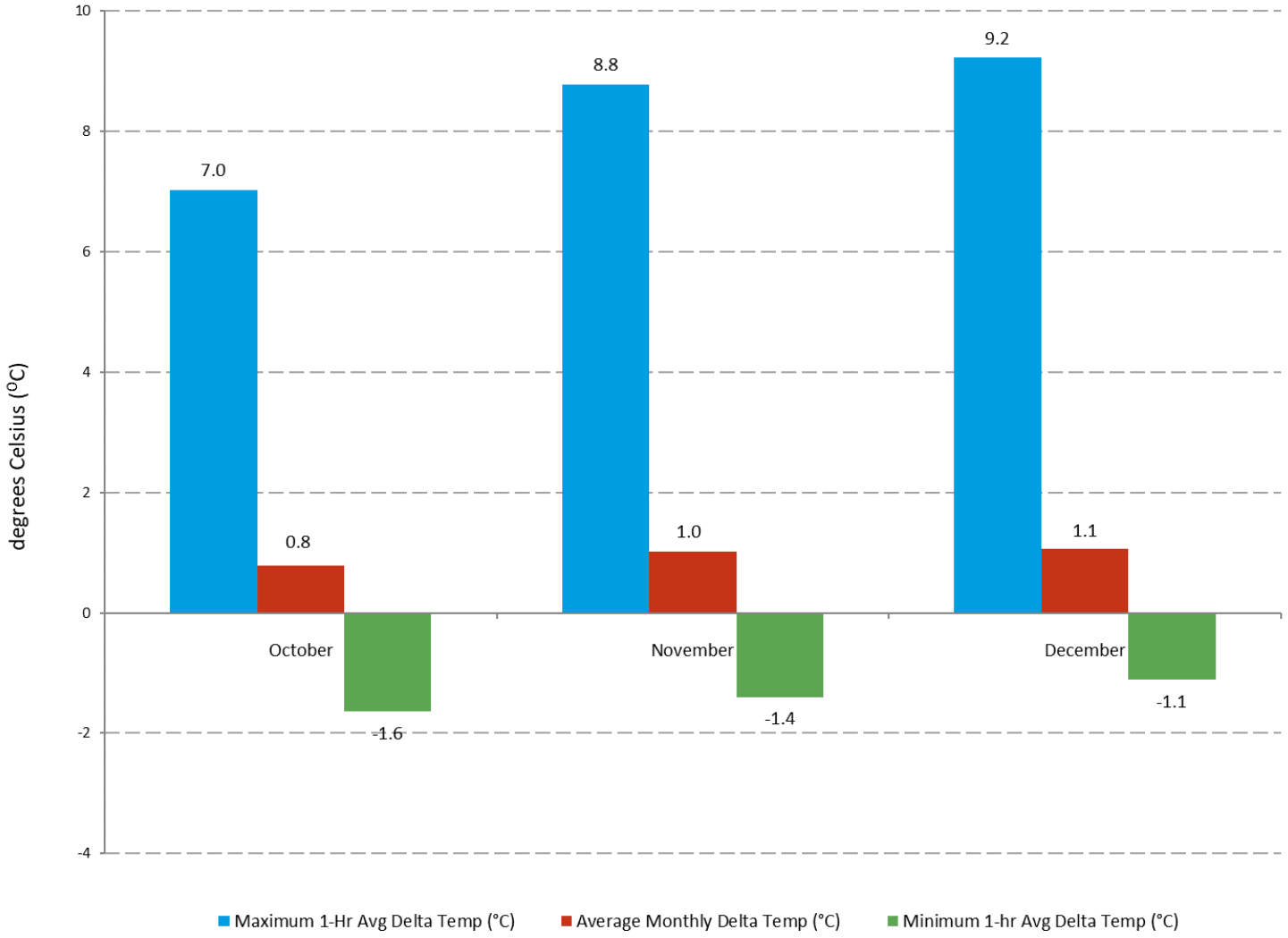

Figure 18. Hereford Q4 2024 Delta Temperature Summary

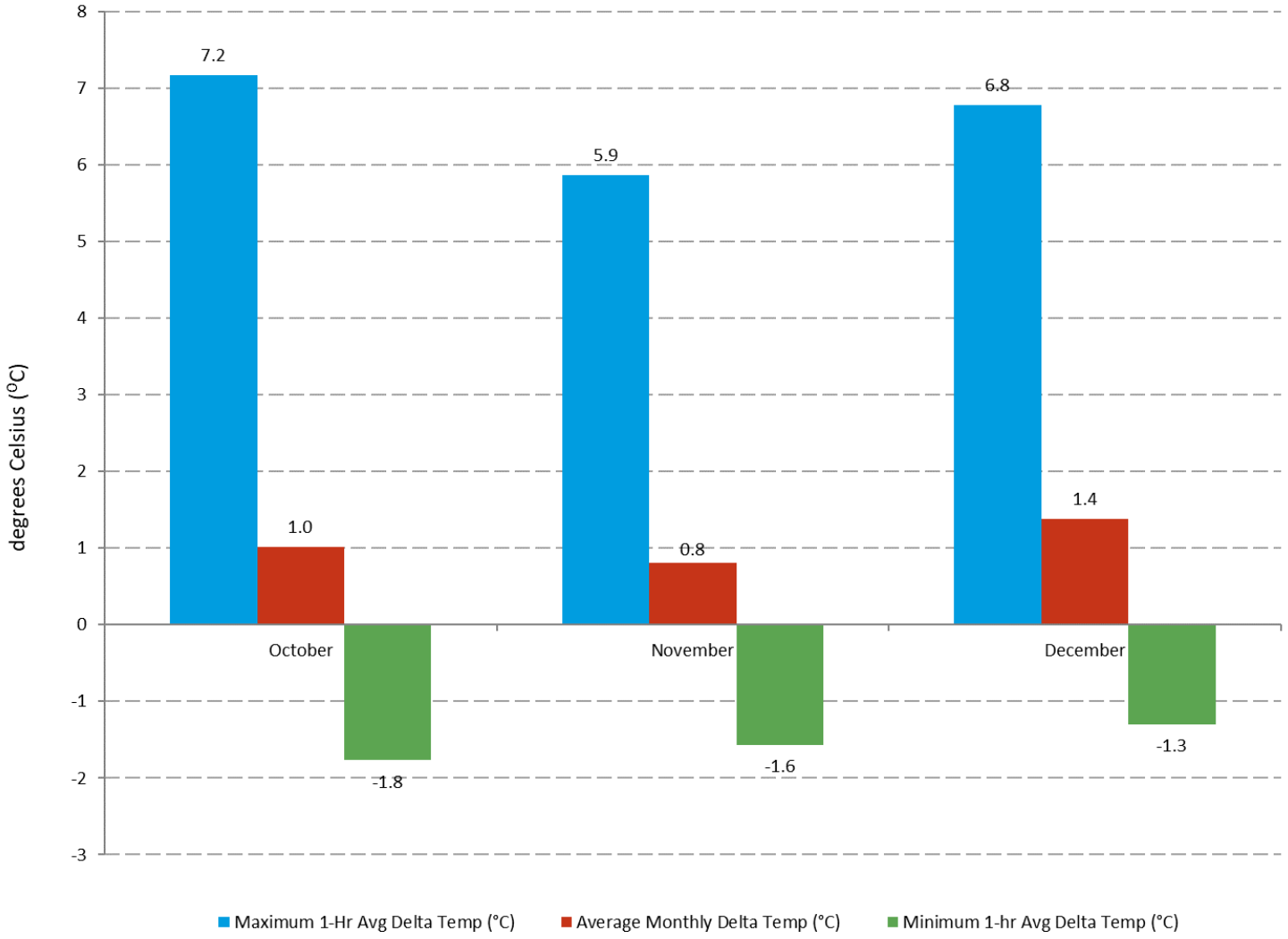

Figure 19. Orchard Q4 2024 Delta Temperature Summary

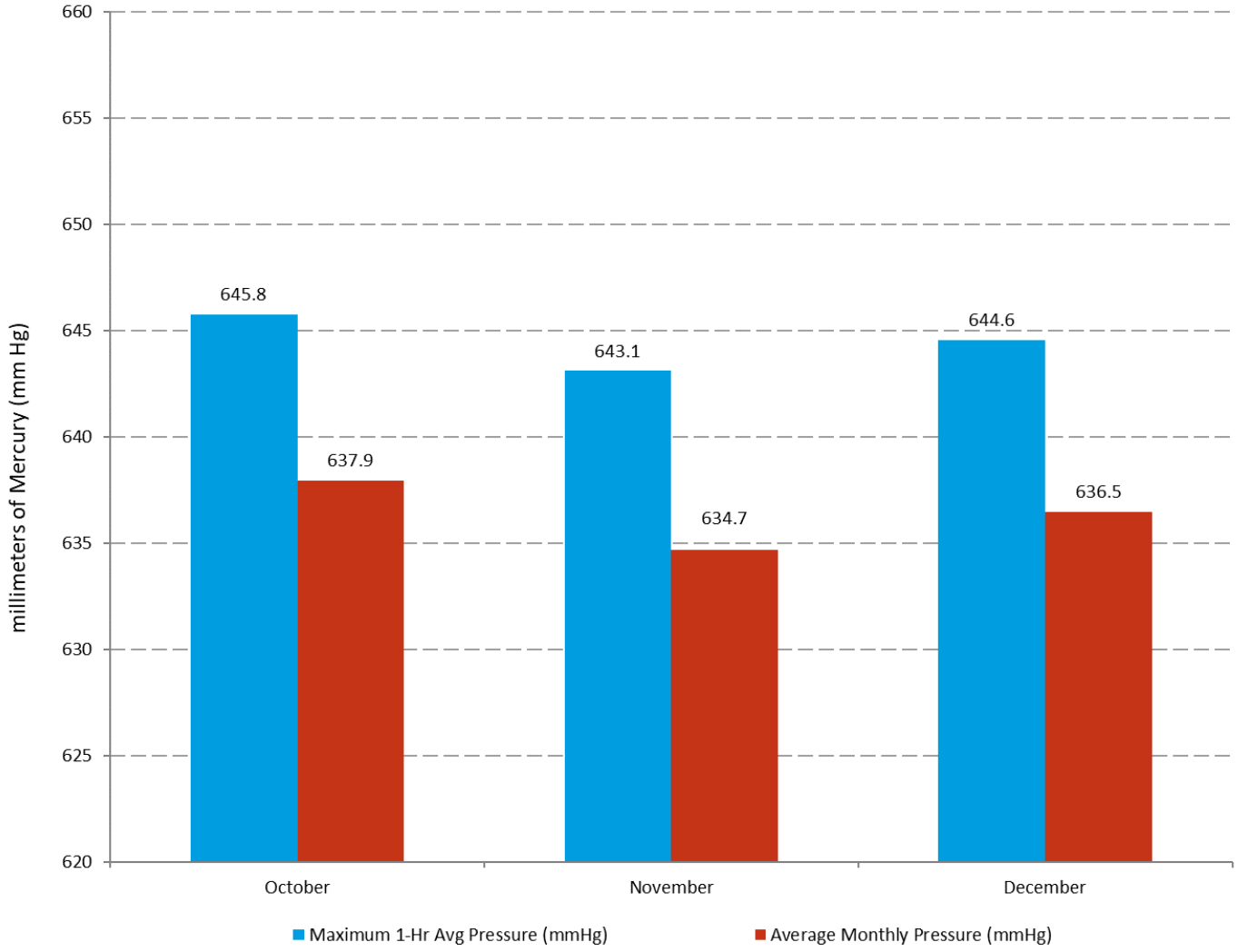

Figure 20. MSP Q4 2024 Barometric Pressure Summary

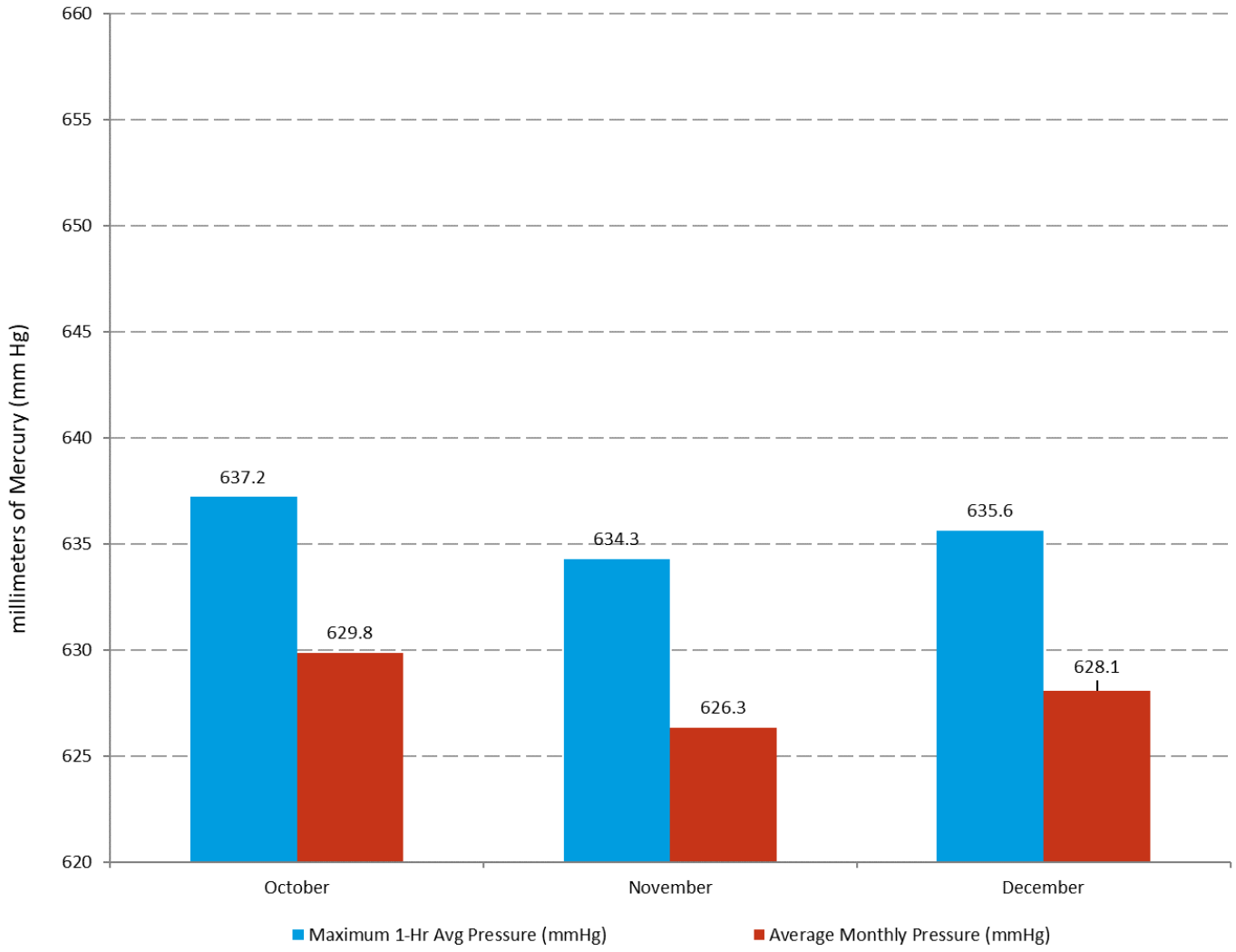

Figure 21. Hereford Q4 2024 Barometric Pressure Summary

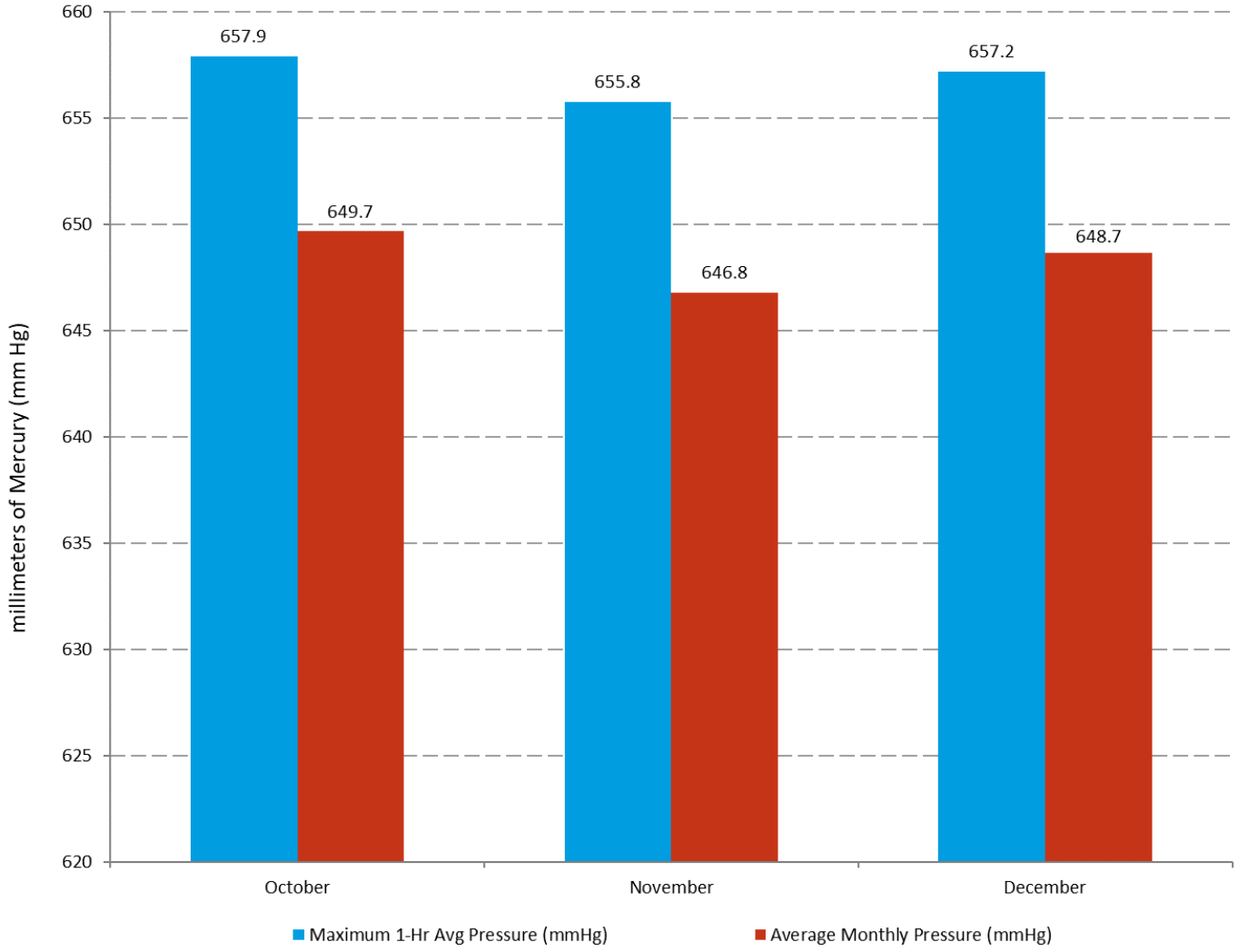

Figure 22. Orchard Q4 2024 Barometric Pressure Summary

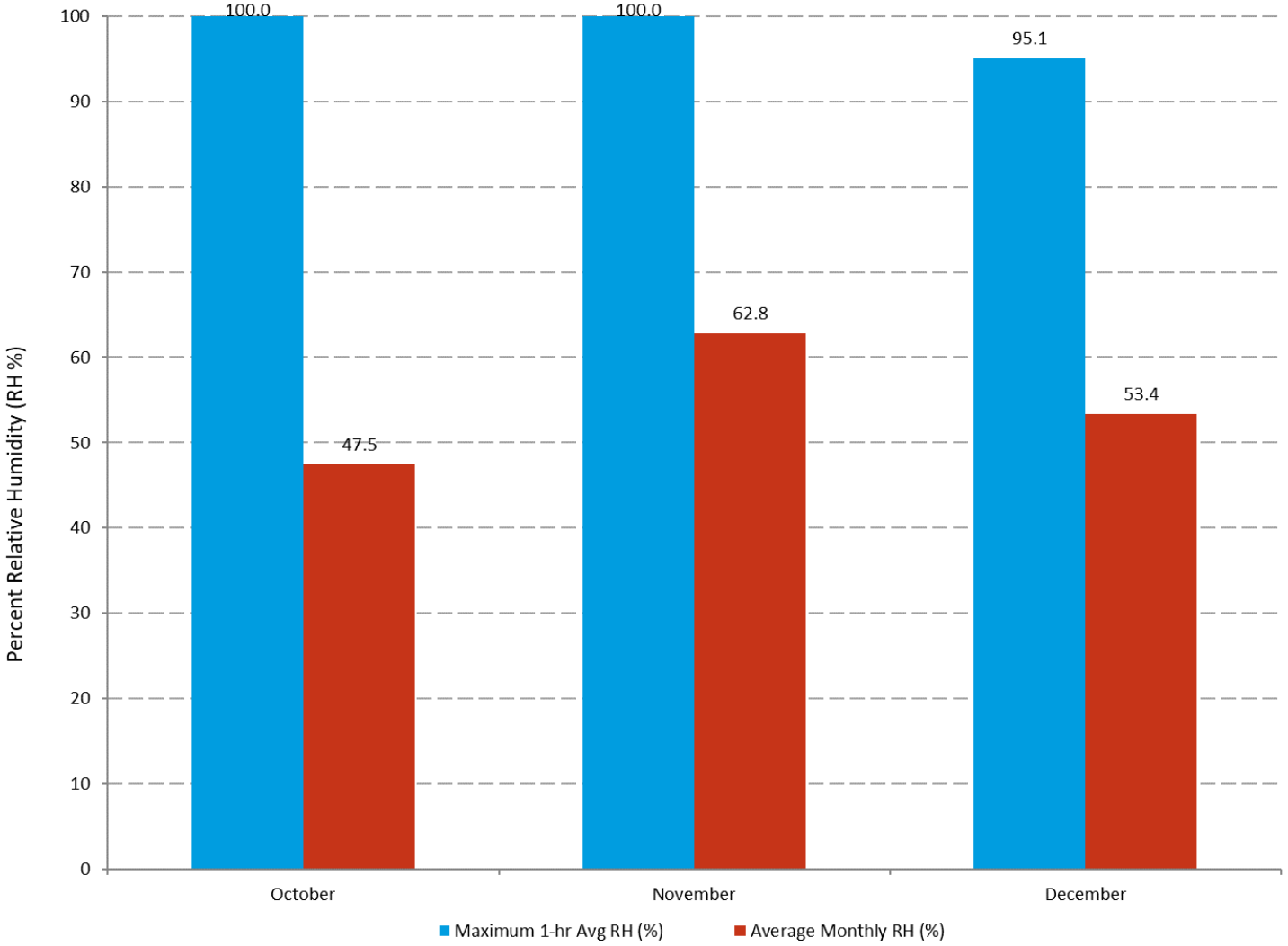

Figure 23. MSP Q4 2024 Relative Humidity Summary

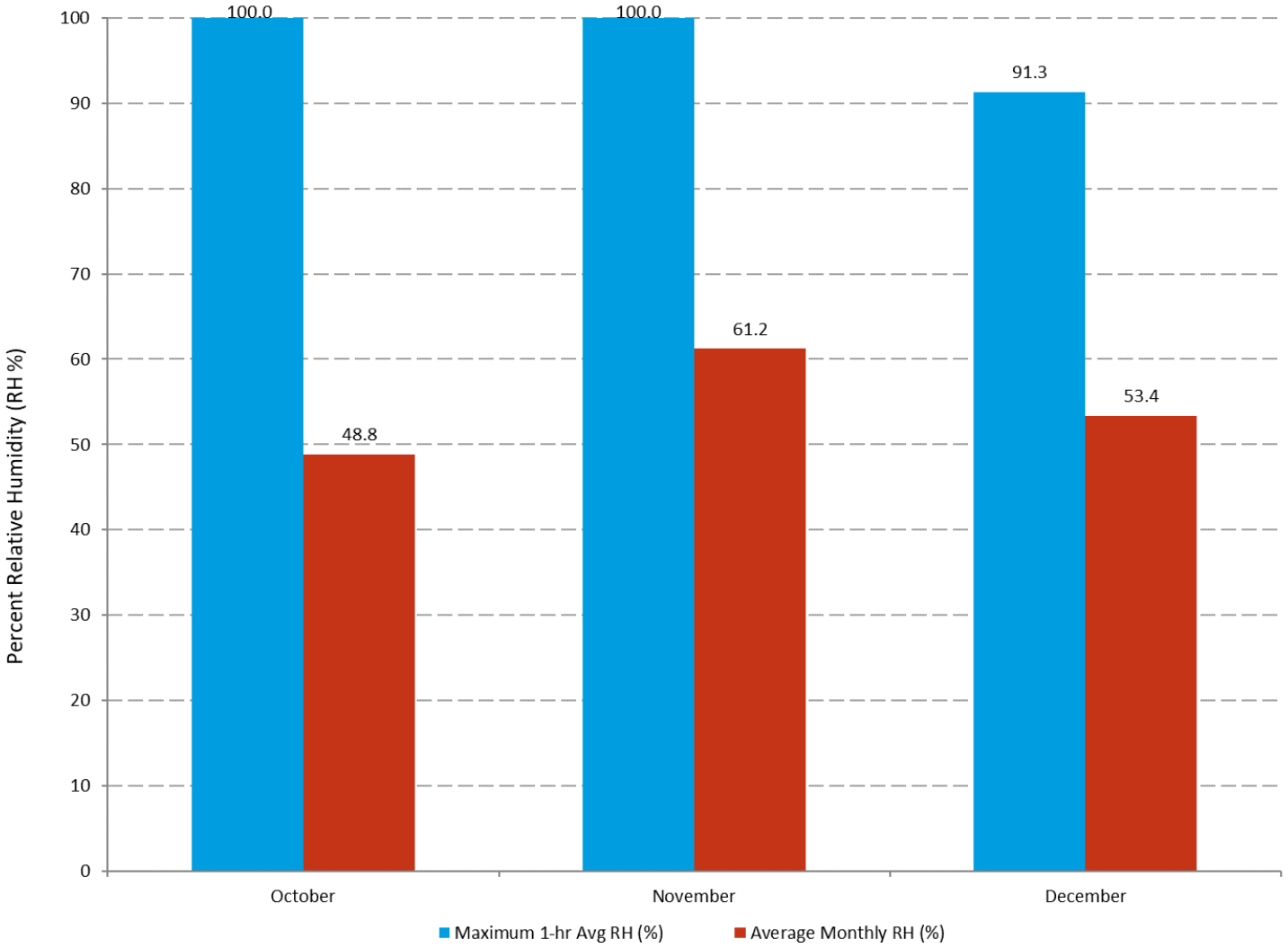

Figure 24. Hereford Q4 2024 Relative Humidity Summary

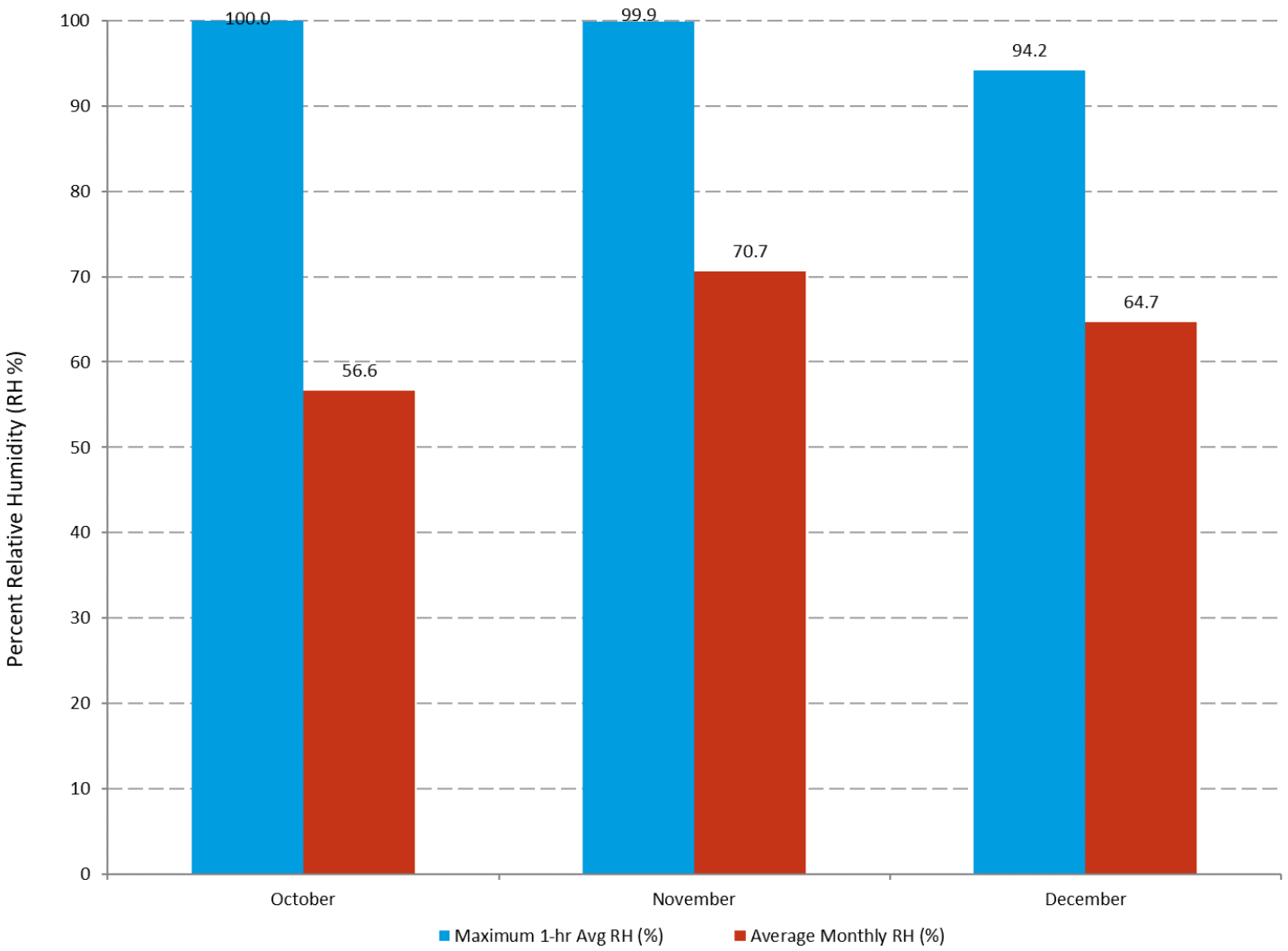

Figure 25. Orchard Q4 2024 Relative Humidity Summary

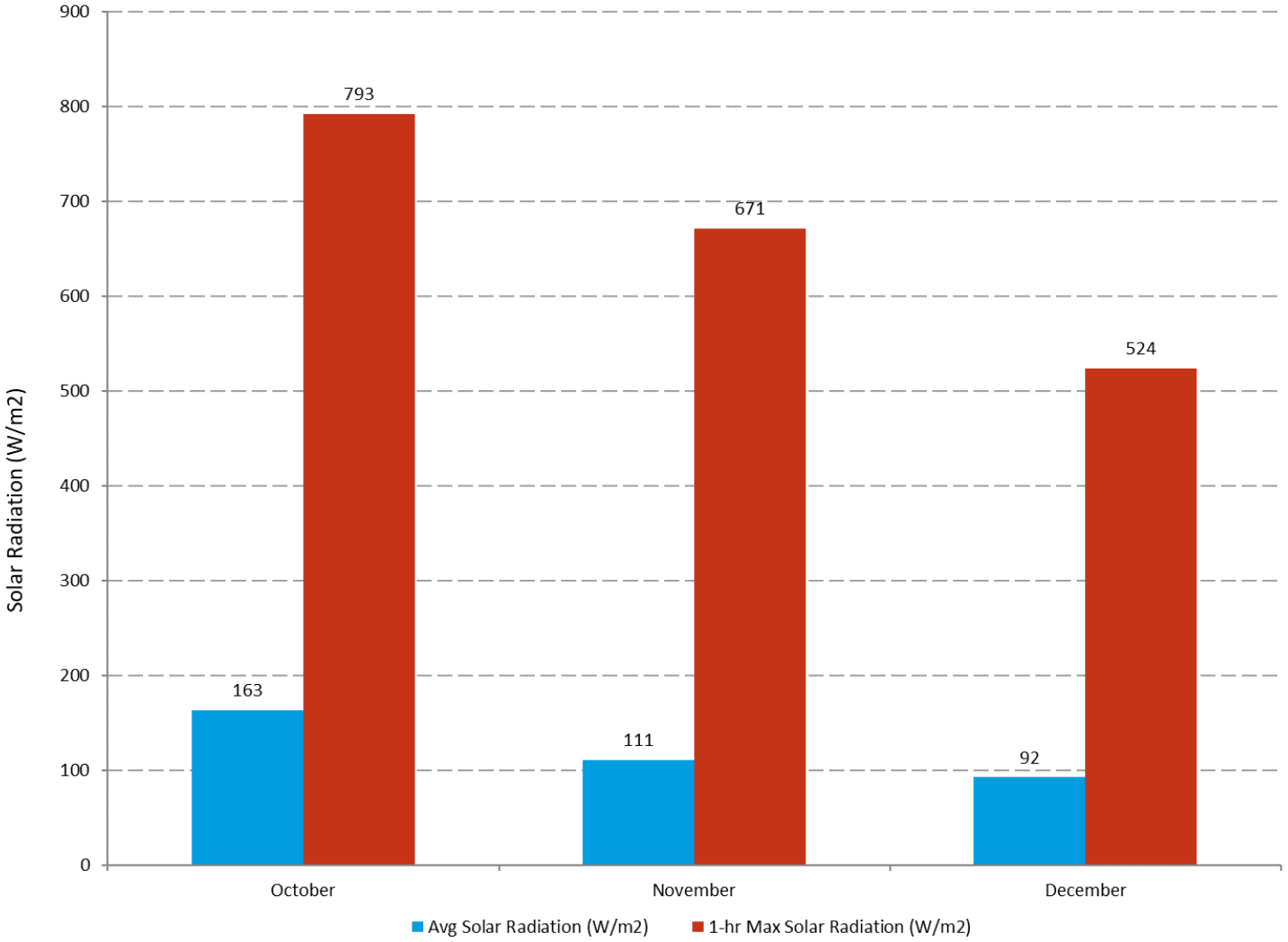

Figure 26. MSP Q4 2024 Solar Radiation Summary

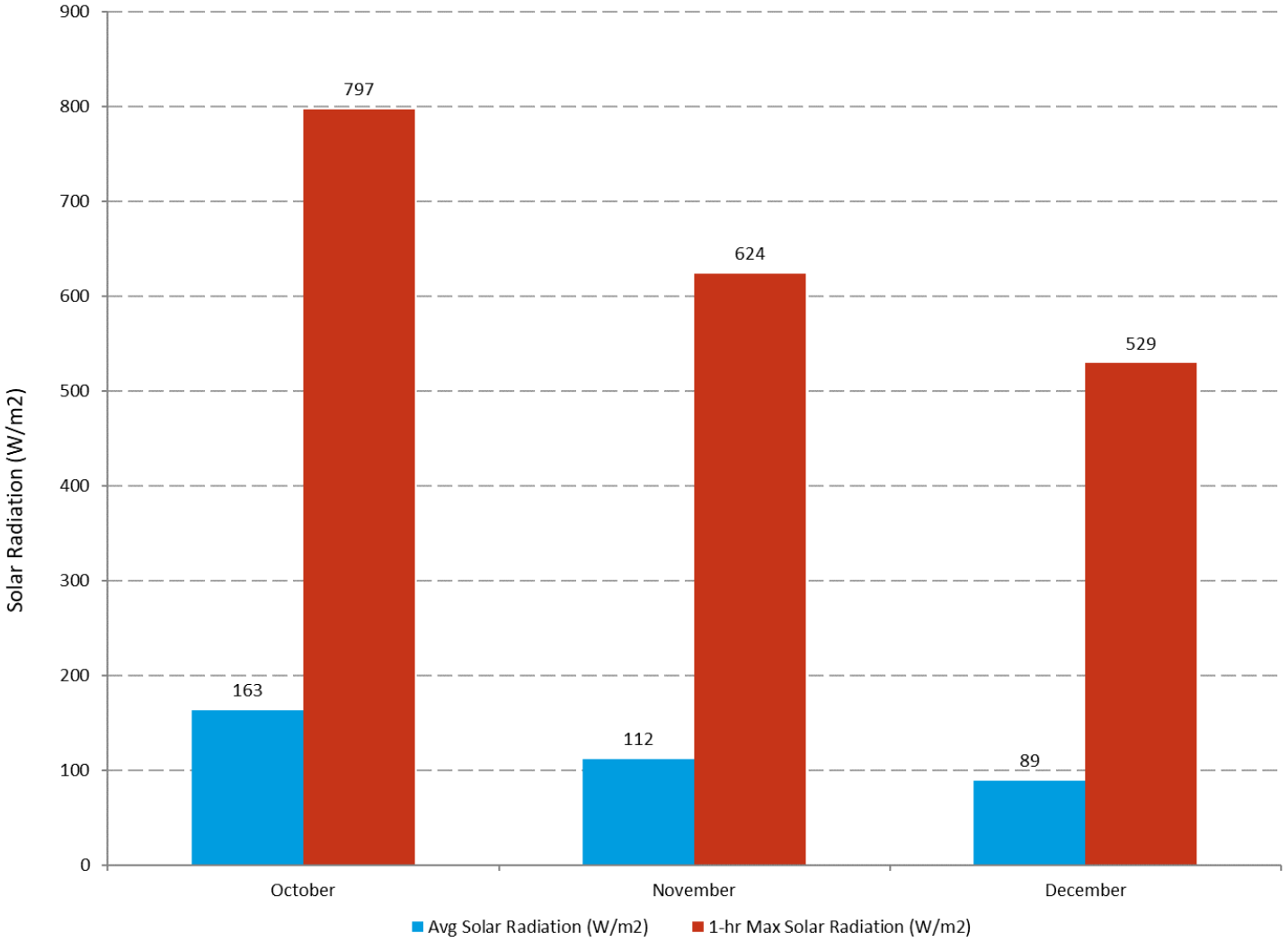

Figure 27. Hereford Q4 2024 Solar Radiation Summary

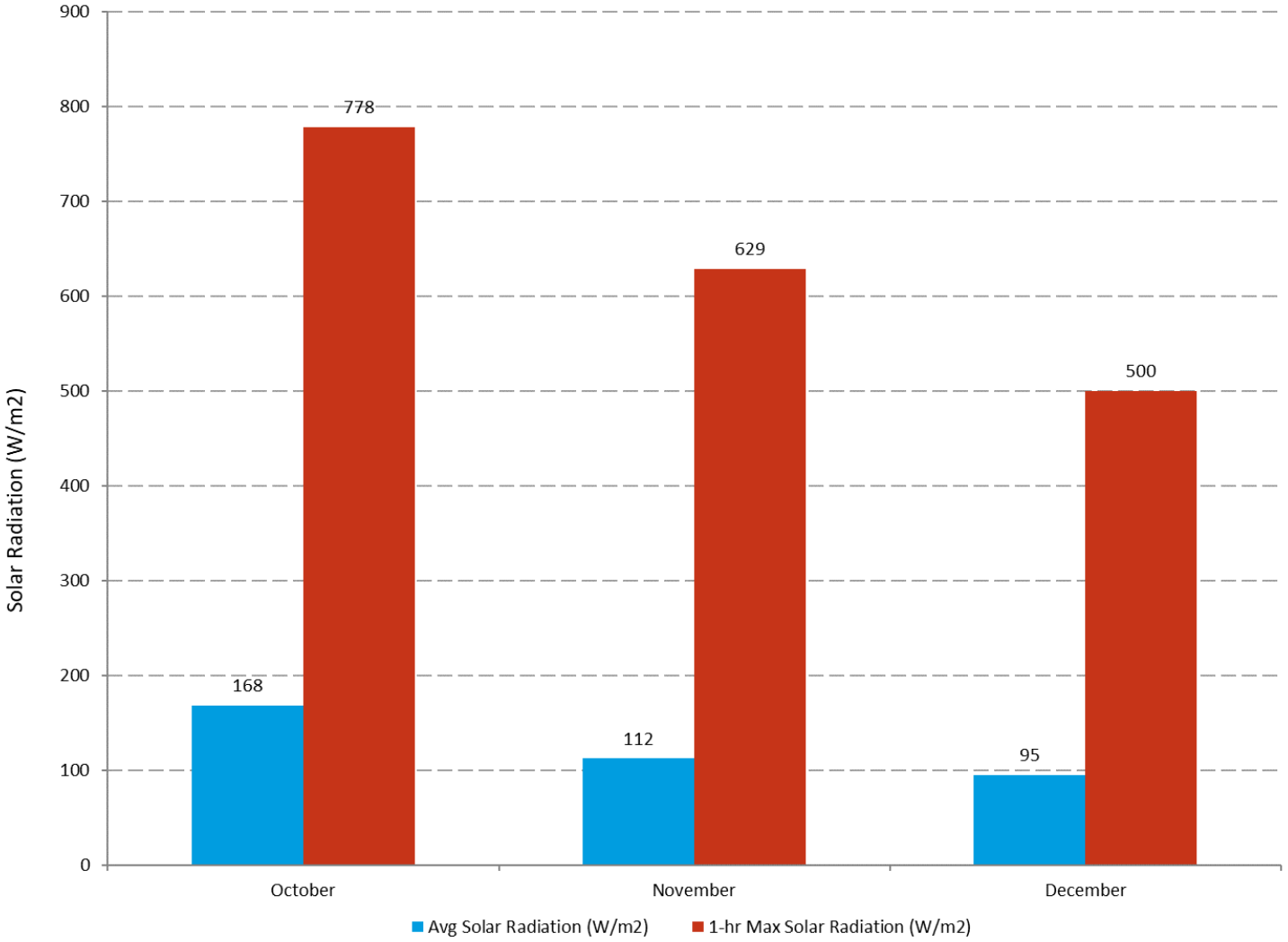

Figure 28. Orchard Q4 2024 Solar Radiation Summary

APPENDIX A2: INVALIDATION DOCUMENT

APPENDIX A2: 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	AZ	QC Audit
AL	Voided by Operator	BA	Maintenance / Routine Repairs
AM	Miscellaneous Void	BC	Multi-point Calibration
AS	Poor Quality Assurance Results.	BD	Auto Calibration
AT	Calibration	V	Value Validated
AV	Power Failure		

Periods of Invalidation				
Month	**Parameter**	**Code**	**Date and Time**	**Description**
MISSILE SITE PARK				
October	Wind Speed & Direction	BC	10/14/2024 10:00-12:00	Quarter 4 multi-point calibration
	2-m, 10-m, & Delta Temperature	BC	10/14/2024 10:00-12:00	Quarter 4 multi-point calibration
	Relative Humidity & Air Temperature	BC	10/14/2024 10:00-12:00	Quarter 4 multi-point calibration
	Solar Radiation	BC	10/14/2024 10:00-12:00	Quarter 4 multi-point calibration
	Precipitation	BC	10/14/2024 09:00-13:00	Quarter 4 multi-point calibration
	Ozone/NO/NO2/NOx	BC	10/01/2024 11:00-16:00	Quarter 4 multi-point calibration
		V	10/01/2024 17:00	Value validated. Partial hour due to multi-point calibration.
		BD	10/02/2024 02:00	Overnight calibration
		V	10/02/2024 11:00	Value validated. Partial hour due to manual calibration.
		AT	10/02/2024 12:00	Manual calibration
		V	10/02/2024 13:00	Value validated. Partial hour due to manual calibration.
		BA	10/14/2024 09:00	Calibrator maintenance affecting gases
		AT	10/14/2024 10:00-12:00	Manual calibration
		BA	10/14/2024 13:00-18:00	Analyzer maintenance
		BA	10/14/2024 19:00-10/16/2024 08:00	Analyzer settling post-maintenance - NO/NO2/NOx ONLY

		AL	10/14/2024 19:00-10/16/2024 08:00	Operator void. Post-maintenance performance not confirmed. - OZONE ONLY
		BD	10/15/2024 02:00	Overnight calibration - OZONE ONLY
		BD	10/16/2024 02:00	Overnight calibration - OZONE ONLY
		BC	10/16/2024 09:00-15:00	Quarter 4 multi-point calibration.
		V	10/16/2024 16:00	Value validated. Partial hour due to multi-point calibration.
		BD	10/17/2024 01:00-02:00	Overnight calibration
		BD	10/18/2024 02:00	Overnight calibration
		BD	10/19/2024 02:00	Overnight calibration
		BD	10/20/2024 01:00-02:00	Overnight calibration
		BD	10/21/2024 02:00	Overnight calibration
		BD	10/22/2024 02:00	Overnight calibration
		BD	10/23/2024 02:00	Overnight calibration
		BD	10/24/2024 01:00-02:00	Overnight calibration
		BD	10/25/2024 02:00	Overnight calibration
		BD	10/26/2024 02:00	Overnight calibration
		BD	10/27/2024 01:00-02:00	Overnight calibration
		BD	10/28/2024 02:00	Overnight calibration
		BD	10/29/2024 02:00	Overnight calibration
		V	10/29/2024 13:00	Value validated. Partial hour due to filter change.
		AM	10/29/2024 14:00	Filter change
		BD	10/30/2024 02:00	Overnight calibration
		BD	10/31/2024 01:00-02:00	Overnight calibration
November	Wind Speed & Direction	AZ	11/25/2024 09:00-12:00	Independent audit
	2-m, 10-m, & Delta Temperature	AZ	11/25/2024 09:00-12:00	Independent audit
	Relative Humidity & Air Temperature	AZ	11/25/2024 09:00-12:00	Independent audit
	Solar Radiation	AZ	11/25/2024 09:00-12:00	Independent audit
	Precipitation	AZ	11/21/2024 09:00-10:00	Independent audit
	Ozone/NO/NO2/NOx	BD	11/01/2024 02:00	Overnight calibration
		BD	11/02/2024 02:00	Overnight calibration

		BD	11/03/2024 01:00-02:00	Overnight calibration
		BD	11/04/2024 02:00	Overnight calibration
		BD	11/05/2024 02:00	Overnight calibration
		BD	11/06/2024 02:00	Overnight calibration
		2	11/06/2024 16:00-23:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/07/2024 01:00-02:00	Overnight calibration
		BD	11/08/2024 02:00	Overnight calibration
		AT	11/08/2024 12:00	Manual calibration
		BD	11/09/2024 02:00	Overnight calibration
		AS	11/09/2024 03:00-11/21/2024 00:00	Poor quality assurance result - NO/NO2/NOx ONLY
		BD	11/10/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		BD	11/11/2024 02:00	Overnight calibration - OZONE ONLY
		V	11/11/2024 12:00	Value validated. Partial hour due to manual calibration - OZONE ONLY
		AT	11/11/2024 13:00-14:00	Manual calibration - OZONE ONLY
		BD	11/12/2024 02:00	Overnight calibration - OZONE ONLY
		BD	11/13/2024 02:00	Overnight calibration - OZONE ONLY
		BD	11/14/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		AT	11/14/2024 14:00-15:00	Manual calibration - OZONE ONLY
		BD	11/15/2024 02:00	Overnight calibration - OZONE ONLY
		BD	11/16/2024 02:00	Overnight calibration - OZONE ONLY
		BD	11/17/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		BD	11/18/2024 02:00	Overnight calibration - OZONE ONLY
		BD	11/19/2024 02:00	Overnight calibration - OZONE ONLY
		BD	11/20/2024 02:00	Overnight calibration - OZONE ONLY
		BC	11/20/2024 11:00-16:00	Multi-point calibration - OZONE ONLY
		BA	11/20/2024 17:00	Inlet maintenance - OZONE ONLY

		V	11/20/2024 19:00	Value validated. Partial hour due to open inlet - OZONE ONLY
		BD	11/21/2024 01:00-02:00	Overnight calibration
		BD	11/22/2024 02:00	Overnight calibration
		BC	11/22/2024 10:00-14:00	Multi-point calibration
		BD	11/23/2024 02:00	Overnight calibration
		BD	11/24/2024 01:00-02:00	Overnight calibration
		BD	11/25/2024 02:00	Overnight calibration
		V	11/25/2024 09:00	Value validated. Partial hour due to independent audit.
		AZ	11/25/2024 10:00-15:00	Independent audit
		2	11/25/2024 16:00-20:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/26/2024 02:00	Overnight calibration
		AM	11/26/2024 14:00-15:00	Filter change
		BD	11/27/2024 02:00	Overnight calibration
		BD	11/28/2024 01:00-02:00	Overnight calibration
		BD	11/29/2024 02:00	Overnight calibration
		BD	11/30/2024 02:00	Overnight calibration
December	Ozone/NO/NO2/NOx	BD	12/01/2024 01:00-02:00	Overnight calibration
		BD	12/02/2024 02:00	Overnight calibration
		BD	12/03/2024 02:00	Overnight calibration
		BD	12/04/2024 02:00	Overnight calibration
		BD	12/05/2024 01:00-02:00	Overnight calibration
		BD	12/06/2024 02:00	Overnight calibration
		BD	12/07/2024 02:00	Overnight calibration
		BD	12/08/2024 01:00-02:00	Overnight calibration
		BD	12/09/2024 02:00	Overnight calibration
		BD	12/10/2024 02:00	Overnight calibration
		BD	12/11/2024 02:00	Overnight calibration
		BD	12/12/2024 01:00-02:00	Overnight calibration
		BD	12/13/2024 02:00	Overnight calibration
		BD	12/14/2024 02:00	Overnight calibration
		BD	12/15/2024 01:00-02:00	Overnight calibration
		BD	12/16/2024 02:00	Overnight calibration

		BD	12/17/2024 02:00	Overnight calibration
		AS	12/17/2024 03:00-01/01/2025 00:00	Poor quality assurance results - NO/NO2/NOx ONLY
		BD	12/18/2024 02:00	Overnight calibration - OZONE ONLY
		AT	12/18/2024 08:00-09:00	Manual calibration - OZONE ONLY
		V	12/18/2024 15:00	Value validated. Partial hour due to NOx testing - OZONE ONLY
		AM	12/18/2024 16:00	NOx testing impacting ozone measurement - OZONE ONLY
		V	12/18/2024 17:00-18:00	Value validated. Partial hours due to NOx testing - OZONE ONLY
		BD	12/19/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		BD	12/20/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/21/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/22/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		BD	12/23/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/24/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/25/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/26/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		BD	12/27/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/28/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/29/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		BD	12/30/2024 02:00	Overnight calibration - OZONE ONLY
		BC	12/30/2024 11:00-16:00	Multi-point calibration check - OZONE ONLY
		AM	12/30/2024 17:00	NOx testing impacting ozone measurement - OZONE ONLY
		AT	12/30/2024 18:00	Manual calibration - OZONE ONLY
		BD	12/31/2024 02:00	Overnight calibration - OZONE ONLY

		V	12/31/2024 12:00	Value validated. Partial hour due to calibration testing - OZONE ONLY
		AT	12/31/2024 13:00	Manual calibration - OZONE ONLY
		AM	12/31/2024 14:00	Filter change
		V	12/31/2024 15:00	Value validated. Partial hour due to filter change - OZONE ONLY
Hereford				
October	Wind Speed & Direction	BC	10/10/2024 09:00-10:00	Quarter 4 multi-point calibration
		BA	10/10/2024 11:00-12:00	Data logger reprogram timing issues
	2-m, 10-m, & Delta Temperature	BC	10/10/2024 09:00-10:00	Quarter 4 multi-point calibration
		BA	10/10/2024 11:00-12:00	Data logger reprogram timing issues
	Relative Humidity & Air Temperature	BC	10/10/2024 09:00-10:00	Quarter 4 multi-point calibration
		BA	10/10/2024 11:00-12:00	Data logger reprogram timing issues
	Solar Radiation	BC	10/10/2024 09:00-10:00	Quarter 4 multi-point calibration
		BA	10/10/2024 11:00-12:00	Data logger reprogram timing issues
	Barometric Pressure	BA	10/10/2024 11:00-12:00	Data logger reprogram timing issues
	Precipitation	BC	10/10/2024 08:00-13:00	Quarter 4 multi-point calibration
		BA	10/10/2024 11:00-12:00	Data logger reprogram timing issues
	Ozone	BC	10/01/2024 12:00-14:00	Quarter 4 multi-point calibration
		V	10/01/2024 17:00	Value validated. Partial hour due to calibration testing.
		BD	10/02/2024 02:00	Overnight calibration
		AT	10/02/2024 08:00	Manual calibration
		2	10/04/2024 09:00	Standard deviation of shelter temperature greater than 2.1°C
		AT	10/10/2024 09:00	Manual calibration
		BA	10/10/2024 10:00-12:00	Analyzer maintenance & data logger reprogram timing issues
		AL	10/10/2024 13:00-10/11/2024 08:00	Operator void. Post-maintenance performed not confirmed.
		BD	10/11/2024 02:00	Overnight calibration

		BC	10/11/2024 09:00-12:00	Quarter 4 multi-point calibration
		BD	10/14/2024 02:00	Overnight calibration
		BD	10/16/2024 02:00	Overnight calibration
		BD	10/18/2024 02:00	Overnight calibration
		2	10/18/2024 11:00-21:00	Standard deviation of shelter temperature greater than 2.1°C
		2	10/19/2024 19:00-10/20/2024 05:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	10/21/2024 02:00	Overnight calibration
		BD	10/23/2024 02:00	Overnight calibration
		V	10/24/2024 14:00	Value validated. Partial hour due to calibration testing.
		AT	10/24/2024 15:00	Minor analyzer maintenance and calibration testing
		BD	10/25/2024 02:00	Overnight calibration
		BD	10/28/2024 02:00	Overnight calibration
		AM	10/29/2024 10:00-11:00	Filter change
		BD	10/30/2024 02:00	Overnight calibration
November	Wind Speed & Direction	AZ	11/26/2024 10:00-11:00	Independent audit
	2-m, 10-m, & Delta Temperature	AZ	11/26/2024 10:00-11:00	Independent audit
	Relative Humidity & Air Temperature	AZ	11/26/2024 10:00-11:00	Independent audit
	Solar Radiation	AZ	11/26/2024 10:00-11:00	Independent audit
	Precipitation	AZ	11/21/2024 14:00-15:00	Independent audit
	Ozone	BD	11/01/2024 02:00	Overnight calibration
		2	11/01/2024 20:00-11/02/2024 01:00	Standard deviation of shelter temperature greater than 2.1°C
		2	11/02/2024 23:00-11/03/2024 01:00	Standard deviation of shelter temperature greater than 2.1°C
		2	11/03/2024 14:00-17:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/04/2024 02:00	Overnight calibration
		BD	11/06/2024 02:00	Overnight calibration
		BD	11/08/2024 02:00	Overnight calibration
		2	11/10/2024 18:00-11/11/2024 05:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/11/2024 02:00	Overnight calibration
		2	11/11/2024 09:00-22:00	Standard deviation of shelter temperature greater than 2.1°C
		2	11/12/2024 01:00-06:00	Standard deviation of shelter temperature greater than 2.1°C

		BD	11/13/2024 02:00	Overnight calibration
		2	11/14/2024 20:00-23:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/15/2024 02:00	Overnight calibration
		2	11/15/2024 05:00-16:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/18/2024 02:00	Overnight calibration
		BD	11/20/2024 02:00	Overnight calibration
		BD	11/22/2024 02:00	Overnight calibration
		2	11/22/2024 20:00-11/23/2024 01:00	Standard deviation of shelter temperature greater than 2.1°C
		2	11/23/2024 07:00-14:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/25/2024 02:00	Overnight calibration
		AZ	11/26/2024 10:00-11:00	Independent audit
		AM	11/26/2024 12:00	Filter change
		BD	11/27/2024 02:00	Overnight calibration
		BD	11/29/2024 02:00	Overnight calibration
December	Ozone	BD	12/02/2024 02:00	Overnight calibration
		2	12/03/2024 19:00-12/04/2024 17:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	12/04/2024 02:00	Overnight calibration
		BD	12/06/2024 02:00	Overnight calibration
		BD	12/09/2024 02:00	Overnight calibration
		BD	12/11/2024 02:00	Overnight calibration
		BD	12/13/2024 02:00	Overnight calibration
		BD	12/16/2024 02:00	Overnight calibration
		BD	12/18/2024 02:00	Overnight calibration
		BD	12/20/2024 02:00	Overnight calibration
		BD	12/23/2024 02:00	Overnight calibration
		BD	12/25/2024 02:00	Overnight calibration
		BD	12/27/2024 02:00	Overnight calibration
		BD	12/30/2024 02:00	Overnight calibration
		AM	12/31/2024 12:00	Filter change
		V	12/31/2024 13:00	Value validated. Partial hour due to filter change.
Orchard				
	Wind Speed & Direction	BC	10/10/2024 15:00-16:00	Quarter 4 multi-point calibration
	2-m, 10-m, & Delta Temperature	BC	10/10/2024 15:00-16:00	Quarter 4 multi-point calibration
	Relative Humidity & Air Temperature	BC	10/10/2024 15:00-16:00	Quarter 4 multi-point calibration
	Solar Radiation	BC	10/10/2024 15:00-16:00	Quarter 4 multi-point calibration

	Precipitation	BC	10/10/2024 14:00-17:00	Quarter 4 multi-point calibration
	Ozone	BC	10/01/2024 12:00-15:00	Quarter 4 multi-point calibration
		V	10/01/2024 17:00	Value validated. Partial hour due to calibration testing.
		BD	10/02/2024 02:00	Overnight calibration
		AT	10/02/2024 10:00	Manual calibration
		AT	10/11/2024 14:00-15:00	Manual calibration
		BA	10/11/2024 16:00	Analyzer maintenance
		AL	10/11/2024 17:00-10/12/2024 10:00	Operator void. Post-maintenance performance not confirmed.
		BC	10/12/2024 11:00	Quarter 4 multi-point calibration
		V	10/12/2024 12:00	Value validated. Partial hour due to multi-point calibration
		BD	10/14/2024 02:00	Overnight calibration
		BD	10/16/2024 02:00	Overnight calibration
		BD	10/18/2024 02:00	Overnight calibration
		BD	10/21/2024 02:00	Overnight calibration
		BD	10/23/2024 02:00	Overnight calibration
		BD	10/25/2024 02:00	Overnight calibration
		2	10/26/2024 00:00-04:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	10/28/2024 02:00	Overnight calibration
		AM	10/29/2024 12:00-13:00	Filter change
		BD	10/30/2024 02:00	Overnight calibration
November	Wind Speed & Direction	AZ	11/26/2024 13:00-14:00	Independent audit
	2-m, 10-m, & Delta Temperature	AZ	11/26/2024 13:00-14:00	Independent audit
	Relative Humidity & Air Temperature	AZ	11/26/2024 13:00-14:00	Independent audit
	Solar Radiation	AZ	11/26/2024 13:00-14:00	Independent audit
	Precipitation	AZ	11/21/2024 11:00-12:00	Independent audit
	Ozone	BD	11/01/2024 02:00	Overnight calibration
		2	11/01/2024 08:00-11/02/2024 05:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/04/2024 02:00	Overnight calibration
		2	11/05/2024 14:00-17:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/06/2024 02:00	Overnight calibration

		BD	11/08/2024 02:00	Overnight calibration
		2	11/10/2024 19:00-11/11/2024 14:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/11/2024 02:00	Overnight calibration
		2	11/11/2024 17:00-18:00	Standard deviation of shelter temperature greater than 2.1°C
		2	11/12/2024 20:00-11/13/2024 05:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/13/2024 02:00	Overnight calibration
		2	11/14/2024 08:00-11/15/2024 19:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/15/2024 02:00	Overnight calibration
		2	11/16/2024 18:00-11/17/2024 21:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/18/2024 02:00	Overnight calibration
		2	11/18/2024 03:00-11/19/2024 17:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/20/2024 02:00	Overnight calibration
		BD	11/22/2024 02:00	Overnight calibration
		2	11/22/2024 21:00-11/23/2024 04:00	Standard deviation of shelter temperature greater than 2.1°C
		2	11/23/2024 09:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/25/2024 02:00	Overnight calibration
		AM	11/26/2024 12:00	Filter change
		AZ	11/26/2024 13:00-14:00	Independent audit
		BD	11/27/2024 02:00	Overnight calibration
		BD	11/29/2024 02:00	Overnight calibration
December	Ozone	BD	12/02/2024 02:00	Overnight calibration
		BD	12/04/2024 02:00	Overnight calibration
		BD	12/06/2024 02:00	Overnight calibration
		V	12/06/2024 13:00	Value validated. Partial hour due to calibration testing.
		AT	12/06/2024 14:00	Manual calibration
		BD	12/09/2024 02:00	Overnight calibration
		BD	12/11/2024 02:00	Overnight calibration
		BD	12/13/2024 02:00	Overnight calibration
		BD	12/16/2024 02:00	Overnight calibration
		AV	12/18/2024 02:00-12/19/2024 13:00	Power failure
		V	12/19/2024 14:00	Value validated. Partial hour due to power failure.
		BD	12/20/2024 02:00	Overnight calibration
		BD	12/23/2024 02:00	Overnight calibration
		BD	12/25/2024 02:00	Overnight calibration

		BD	12/27/2024 02:00	Overnight calibration
		BD	12/30/2024 02:00	Overnight calibration
		AM	12/31/2024 11:00-12:00	Filter Change

APPENDIX A3: SITE VISITATION LOG

Missile Site Park Site Access Log								
Name	Date	Arrival	Departure	Last Filter change		Pump off	Pump on	Notes
				NOx	Ozone			
Zaragoza	10/1/2024	9:09	11:00					On site to replace 4 way valve for zero air generator. Valve replaced at 10:10 logger time. Performed leak check from 10:13 to 10:20 logger time (gases not impacted). Started zero event at 10:22 logger time. Started NO span at 10:29 logger time. Calibration event left running for Q4 'as found' checks.
Dearden (Remote)	10/1/2024	10:29	16:05					Remote multipoint calibrations. 10:29-14:40 MST for NOx, and 14:40 - 16:05 MST for Ozone. Both gasses invalid for the entire duration.
Dearden (Remote)	10/2/2024	10:45	12:05					Manual calibration check before site visit, gasses invalid. MST
Christman	10/2/2024	13:17	14:00					Removed T700 calibrator for semi-annual verification; plugged calibration output line, capped T701 outlet, plugged audit gas outlet line, closed gas cylinder valves at regulator and tank; increased T700 UV lamp intensity to max level
Zaragoza/Christman	10/14/2024	7:55	18:00					Onsite for Q4 calibration checks. Precipitation down for pre/post checks and maintenance between 8:26 and 13:00 logger time. Tower down from 9:33 to 11:04 logger time. T700 reinstalled 8:30; backpressure comp at 8:58. Zero check ran at 9:05-9:21. Ozone Span and precision check ran from 9:21-9:53. NO span check initiated at 9:55-10:36. NO precision checks initiated at 10:36-10:52 (60 ppb) and 12:01-12:12 (100 ppb). NO2 GPT initiated at 11:43-12:00. Ozone down for maintenance from 8:30-18:00. Ozone maintenance included flow orifice rebuild, Nafion line filter replacement, and Nafion pump rebuild. Ozone post maintenance leak check was 0 cc/min and 1.6 inHg. NOx down for maintenance from 8:30 until system stabilizes in the next day or two when the multi-point calibration can be performed. NOx maintenance included ozone cleanser replacement, DFU filter replacement, rxn cell orifice rebuilds for both flow orifices, Moly converter replacement, and reaction cell cleaning. NOx post maintenance leak check was 2.1 inHg in the rcell and 2.2 inHg in the sample pressure. Inlet also replaced. ZAG media replaced.
Dearden (Remote)	10/16/2024	7:46	15:14					Remote multipoint calibrations. 7:46-11:25 MST for O3 and 11:25 - 15:14 MST for NOx. Both gasses invalid for the entire duration.
Christman/Emerson	10/24/2024	8:00	10:20					On site to oversee the installation of gas monitoring equipment by STI. Gas inlet and anemometer pole was mounted on roof railing, new 3-cylinder rack was installed in place of existing rack; CDPHE equipment was lowered in the rack and a new rack shelf was installed for the new equipment in the rack; a new penetration was made in the LB for cable passthrough.
Clemments	10/29/2024	13:44	14:13	10/29/2024	10/29/2024	13:59	14:07	NOx & O3 filters swapped, NADP sample retrieved and set up.
Dearden (Remote)	11/8/2024	11:05	12:00					Remote Ozone ZSP check. Passing results, calibrator ran steady the entire duration. (Gasses offline)
Dearden (Remote)	11/11/2024	11:46	13:55					Remote NO ZSP check and Span GPT check. Passing values.
Dearden (Remote)	11/14/2024	13:08	15:45					Remote GPT precision check. Passing values.
Dearden (Remote)	11/20/2024	10:02	16:13					Remote Multipoint calibration for NOx. Non-linear response resulted in a failing calibration. Maintenance to be performed. Gasses offline.
Zaragoza	11/20/2024	16:13	18:40					On site to troubleshoot non-linear NOx response. NO/NO2/NOx analyzer down from 16:13 to 18:40. Ozone down from 16:13 - 16:30. NOx maintenance included replacement of sintered filter on both flow orifices. Replacement of spring in ozone flow orifice. Reinstallation of previously installed (used) orifice into ozone flow orifice holder. Reasoning includes signs of corrosion on spring of ozone flow orifice. Ozone cleanser media replaced. Reaction cell opened and wiped down with kim wipes and isopropyl alcohol. Final leak check: reaction cell 2.0 and sample press 2.2. Ozone down from 18:30-18:40.
Zaragoza/Orth	11/21/2024	8:04	9:35					On site for ARS audit of solar and precip. Precip down from 8:15 to 9:15
Dearden (Remote)	11/22/2024	9:20	13:45					Remote multipoint calibration for NOx, passing results, slope and offset did not change. Gasses offline.
Zaragoza/CDPHE	11/25/2024	8:21	14:52					On site for CDPHE audit of gas and meteorology. Gases down from 8:54 to 14:46. Tower down from 8:59 to 11:21 (winds, solar, 2 and 10 m temp, RH impacted). Wind speed prop replaced with Hereford spare due to small crack found in existing one. No data implications, this was preventative work.
Clemments	11/26/2024	13:30	13:58	11/26/2025	11/26/2024	13:33	13:37	NOx & O3 filters swaped. NADP sample retrieved and set up.
Dearden (Remote)	12/18/2024	7:39	8:50					Manual NOx ZSP calibration

Missile Site Park Site Access Log								
Name	Date	Arrival	Departure	Last Filter change		Pump off	Pump on	Notes
				NOx	Ozone			
Zaragoza	12/18/2024	14:46	19:05					On site to troubleshoot NOx. Leak check from 14:47 - 14:55 (both gases impacted). Auto zero testing 15:12-15:13. Span generated from 15:15 to 15:29 for NOx diagnostic review (both gases impacted). Autozero and NO/NOx valves cleaned between 15:30 and 17:18 (NOx down and ozone impacts apparent in data, ozone down from 15:30-16:08. NOx leak check from 17:52 to 17:57 (both gases impacted).
Zaragoza	12/30/2024	10:29	18:10					Multipoint calibration check on NO/NO2/NOx from 10:29 to 16:04. Replacement of ozone dryer and NO/NOx valve from 16:08 to 17:08. NO/NO2/NOx PSZ from 17:38 to 17:58. All gases down from 10:29 to 16:04. 16:08 to 16:25. 17:00-18:00.
Zaragoza	12/31/2024	11:57	14:55	12/31/2024	12/31/2024	12:30	12:33	On site to further troubleshoot NOx. PSZ performed 11:57 to 12:33. NOx and ozone filter change 12:30-12:33. NOx turned off for ozone cleanser media replacement and rxn cell cleaning from 12:33 to 14:15. Ozone and sample flow orifices inspected. Ozone flow orifice replaced after signs of corrosion. Leak check from 14:40 to 14:48 (both gases impacted)

Hereford Site Access Log							
Name	**Date**	**Arrival**	**Departure**	**Last Filter change**	**Pump off**	**Pump on**	**Notes**
				Ozone			
Dearden (Remote)	10/1/2024	11:33	13:40				Remote multipoint calibration, ozone offline for the duration of the visit (MST)
Dearden (Remote)	10/1/2024	16:28	16:29				Quick sanity check to ensure calibrator is on standby mode. Minutes 16:28 & 16:29 invalid for Ozone.
Dearden (Remote)	10/2/2024	7:07	7:40				Manual calibration check before site visit. MST
Christman	10/2/2024	9:36	10:07				Removed T703 calibrator for semi-annual verification; plugged calibration output line and isolated desiccant inlet from ambient air; increased UV lamp intensity
Zaragoza/Christman	10/10/2024	7:30	12:30				On site for calibrator reinstall, site maintenance, and calibration checks. Ozone down from 0820-1117. Initial PSZ performed from 0838-0922. T703 back pressure compensation performed at 0925. Ozone flow orifice rebuilt and sample conditioner pump rebuilt. Post-maintenance Span/Zero performed at 1048-1116. Installed new 05305 wind sensor. Precip down for pre/post checks and maintenance between 7:48 and 12:30 logger time. Tower down from 8:33 to 11:52 logger time.
Dearden (Remote)	10/11/2024	8:28	11:25				Remote multi-point as-left calibrations. Ozone offline 8:28 - 11:25
Christman/Emerson	10/24/2024	14:15	16:00		13:46	14:14	On site to oversee the installation of gas monitoring equipment by STI. Gas inlet and anemometer pole was mounted on roof railing; new cylinder rack was installed; new rack shelf was installed for the new equipment in the rack; a new penetration was made in the LB for cable passthrough. Sample flow orifice was re-oriented in the T400; leak check passed following change at <10cc/min, 1.8"Hg. Performed Span/Precision/Zero following leak check with good results. Ozone offline from 13:46-14:53
Clemments	10/29/2024	10:33	10:52	10/29/2024	10:38	10:48	Desiccant and NOx/O3 filter change.
Zaragoza/Orth	11/21/2024	13:15	14:50				On site for ARS audit of solar and precip. Precip down from 13:24 to 14:20
Zaragoza/CDPHE	11/26/2024	9:12	10:55	11/26/2024	10:43	10:44	On site for CDPHE audit. Ozone down from 9:15 to 10:44; filter change then occurred at 10:44. Tower down from 9:21 to 10:18.
Clemments	11/26/2024	10:22	10:39		10:29	10:32	Desiccant changed out
Garcia	12/31/2024	11:10	11:25	12/31/2024	11:14	11:22	Desiccant changed, O3 filter changed

Orchard Site Access Log							
Name	**Date**	**Arrival**	**Departure**	**Last Filter change**	**Pump off**	**Pump on**	**Notes**
				Ozone			
Dearden (Remote)	10/1/2024	11:21	14:40				Remote multipoint calibration, ozone offline for the duration of the visit (MST)
Clemments	10/1/2024	13:00	13:40				Replaced Shell on precipitation bucket for NADP
Dearden (Remote)	10/1/2024	16:24	16:24				Quick sanity check to ensure calibrator is on standby mode. Minute 16:24 invalid for Ozone.
Dearden (Remote)	10/2/2024	9:20	9:55				Manual calibration check before site visit. MST
Christman	10/2/2024	11:17	11:53				Removed T703 calibrator for semi-annual verification; plugged calibration output line and isolated desiccant inlet from ambient air; increased UV lamp intensity
Zaragoza/Christman	10/10/2024	13:30	17:47				On site for calibrator reinstall, site maintenance, and calibration checks. No power cord was returned with the ozone calibrator so no ozone maintenance could be performed. T703 was reinstalled in rack and ozone maintenance was delayed until follow up site visit. Precip start at 13:56 logger time. Two as left checks performed at 15:00 and 16:00. Precip back online at 16:45. Tower down between 14:08 and 15:13.
Zaragoza	10/11/2024	13:00	15:55				On site to power on T703 and performed analyzer maintenance. Back pressure compensation performed 13:22-13:30. Ozone gen cal performed 13:30-14:30. ZSP performed 14:31 - 14:58. Analyzer maintenance performed between 14:58 and 15:55. Ozone down from 13:22-15:55
Zaragoza (remote)	10/12/2024	9:51	11:06				As left check for ozone. No calibration performed. Ozone down on 10/12 between 951 and 1106 logger time. Ozone data valid between maintenance on 10/11 and multi-point on 10/12
Christman/Emerson	10/24/2024	11:20	13:30				On site to oversee the installation of gas monitoring equipment by STI. Gas inlet and anemometer pole was mounted on roof railing; new cylinder rack was installed; new rack shelf was installed for the new equipment in the rack; a new penetration was made in the LB for cable passthrough.
Clemments	10/28/2024	12:00	12:33	10/28/24	12:19	12:28	Desiccant changed, NOx/O3 filter changed. NADP sample retrieved and set up.
Zaragoza/Orth	11/21/2024	10:45	12:05				On site for ARS audit of solar and precip. Precip down from 10:45 to 11:51
Clemments	11/26/2024	11:42	12:03	11/26/24	10:44	10:49	Desiccant changed, NOx/O3 filter changed, NADP sample retrieved (no precip) and set up.
Zaragoza/CDPHE	11/26/2024	12:03	14:00				On site for CDPHE audit. Ozone down from 12:10 to 13:25. Tower down from 12:23 to 13:40; RH remained down for aspirator cleaning until 13:50.
Dearden (Remote)	12/6/2024	12:56	13:44				Remote ZSP check for ozone. Passing results.
Clemments	12/19/2024	12:46	13:15				On-site for a power failure, found power strip switch had been tripped. Flipped switch and verified with Abe that all instruments are connected again.
Clemments	12/31/2024	10:15	10:53	12/31/24	10:38	10:40	Desiccant changed, O3 filter changed, NADP sampled retrieved, AMoN retrieved

APPENDIX A4: CORRECTIVE ACTION REPORTS

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Project Number
1940112228-001

February 2025

WELD COUNTY MONITORING NETWORK

APPENDIX A1: 4TH QUARTER 2024 SUMMARY TABLES & FIGURES

RAMBOLL

CONTENTS

TABLES

FIGURES

APPENDICES

1. QUARTER 4 SUMMARY

The Weld County Monitoring Network Quarter 4 2024 data tables and figures are presented in this appendix. Quarter 4 2024 data is presented as an abbreviated report to avoid reproducing efforts between a Quarter 4 report and an annual report. All tables and figures presenting monthly and quarterly data for Quarter 4 are presented here but no text descriptions are included. Gaseous tables are available in the main body report text. No major program or instrument changes were made during Quarter 4 2024 besides the replacement of the wind speed and wind direction sensor at Hereford. For a list of site instrumentation, see the main body text of the annual report.

The Quarter 4 2024 semi-annual calibration visits took place in early and mid-October, for gasses and meteorology respectively. All parameters passed. The independent site audits, performed by the Colorado Department of Public Health & Environment and Air Resource Specialists, occurred in late November. All parameters passed their respective audits. Audit and calibration reports are available as Appendix B. During the semi-annual calibration visits, the Hereford wind speed and wind direction sensor was replaced as a preventative measure. In October, two days of ozone data was conservatively invalidated at MSP because the post maintenance response was not confirmed. In November a shift in NO_2 analyzer response occurred, which was confirmed by a multipoint check that failed operational criteria[1]. As a result, the NO_2 analyzer at MSP had additional maintenance performed including replacement of the ozone cleanser media, replacement of flow orifice filters, a flow orifice replacement, and a reaction cell cleaning. A subsequent multi-point check was performed which confirmed valid data collection. However, in December, another shift in response of the NO_2 analyzer at MSP occurred. Further maintenance was performed, including replacement of the NO/NO_x valve and the ozone dryer, however, this maintenance was not performed until January 2025. Due to these issues, NO, NO_2, and NO_x did not meet data completeness targets for Q4 2024. Corrective action reports for Quarter 4 2024 are available as Appendix A4.

Below are the Quarter 4 data completeness statistics, air quality data summaries, and meteorological data summaries. Also available are the data invalidation periods, site visitation log, and corrective action reports.

[1] USEPA, *Quality Assurance Handbook Volume II, Appendix D, Measurement Quality Objectives and Validation Templates*. Available at: https://www.epa.gov/sites/default/files/2020-10/documents/app_d_validation_template_version_03_2017_for_amtic_rev_1.pdf. Accessed: February 2025.

Table 1. Fourth Quarter 2024 Data Completeness for Continuous Measurement Devices

Measurement	Time Period	Completeness Target [1-6]	Site Completeness				Target Met? (Y/N)
			Oct	Nov	Dec	Q4 2024	
Missile Site Park							
NO_2[1]	Quarterly	≥75%	89%	55%	49%	64%	No
NO_x, NO	N/A	N/A	89%	55%	49%	64%	N/A
O_3[1]	O_3 Season	≥90%	87%	90%	97%	91%	N/A
Wind Direction[2]	Quarterly	≥90%	100%	99%	100%	100%	Yes
Wind Speed[2]	Quarterly	≥90%	100%	99%	100%	100%	Yes
Temperature[2]	Quarterly	≥90%	100%	99%	100%	100%	Yes
Delta Temperature[2]	Quarterly	≥90%	100%	99%	100%	100%	Yes
Relative Humidity	Quarterly	≥90%	100%	99%	100%	100%	Yes
Solar Radiation[2]	Quarterly	≥90%	100%	99%	100%	100%	Yes
Barometric Pressure[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Precipitation[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Hereford							
O_3[1]	O_3 Season	≥90%	94%	100%	100%	98%	N/A
Wind Direction[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Wind Speed[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Temperature[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Delta Temperature[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Relative Humidity	Quarterly	≥90%	99%	100%	100%	100%	Yes
Solar Radiation[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Barometric Pressure[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes

Measurement	Time Period	Completeness Target [1-6]	Site Completeness				Target Met? (Y/N)
			Oct	Nov	Dec	Q4 2024	
Precipitation[2]	Quarterly	≥90%	99%	100%	100%	100%	Yes
Orchard							
O_3[1,5]	O_3 Season	≥90%	94%	97%	97%	96%	N/A
Wind Direction[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Wind Speed[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Temperature[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Delta Temperature[2]	Quarterly	≥90%	100%	100%	100%	100%	Yes
Relative Humidity	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%	99%	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 90% of daily maximum 8-hour averages during the ozone season. In Colorado, the Ozone season is January through December (https://aqs.epa.gov/aqsweb/documents/codetables/ozone_seasons.html).

[2] 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.

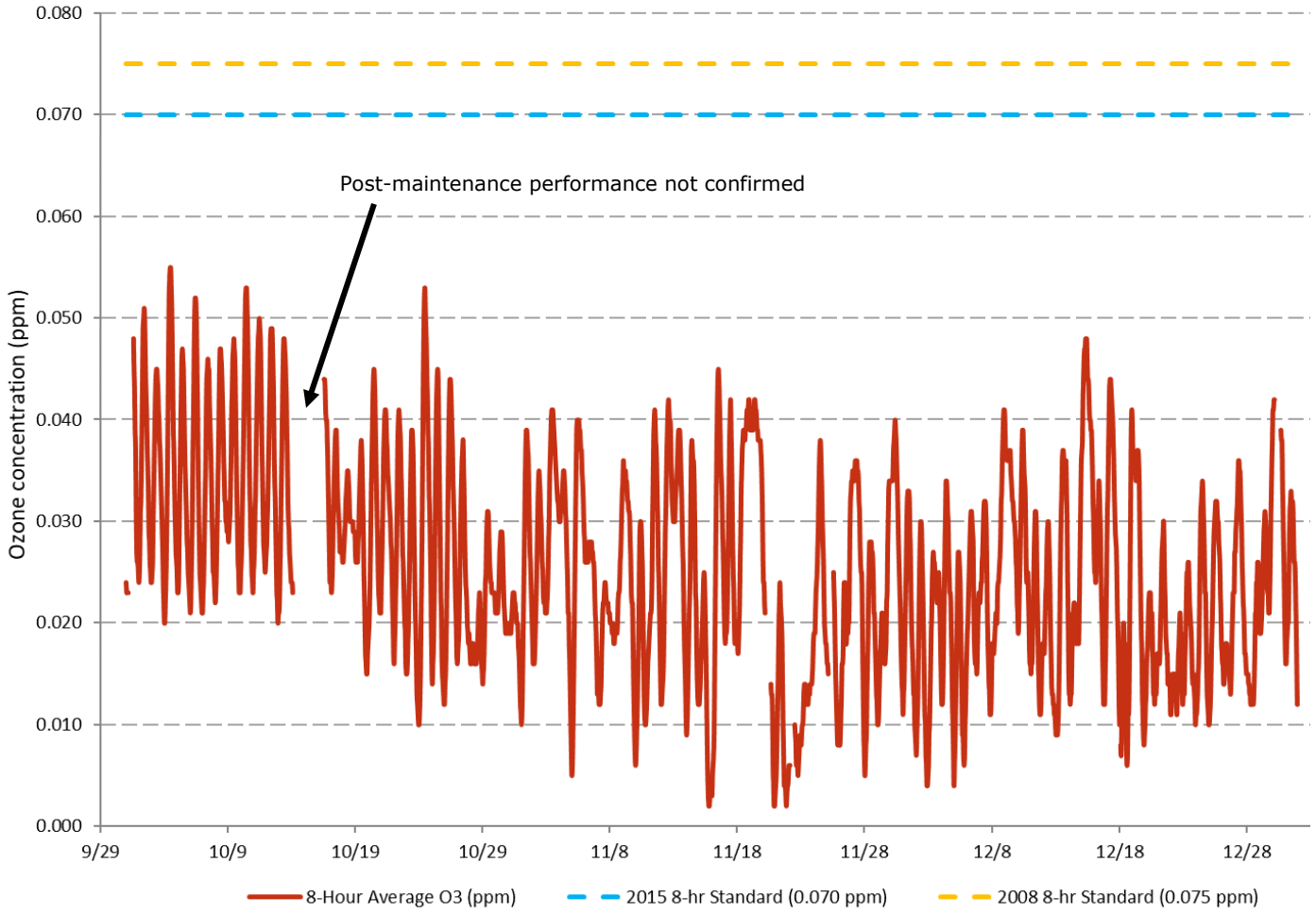


Figure 1. MSP Q4 2024 Rolling 8-hour Averaged O_3

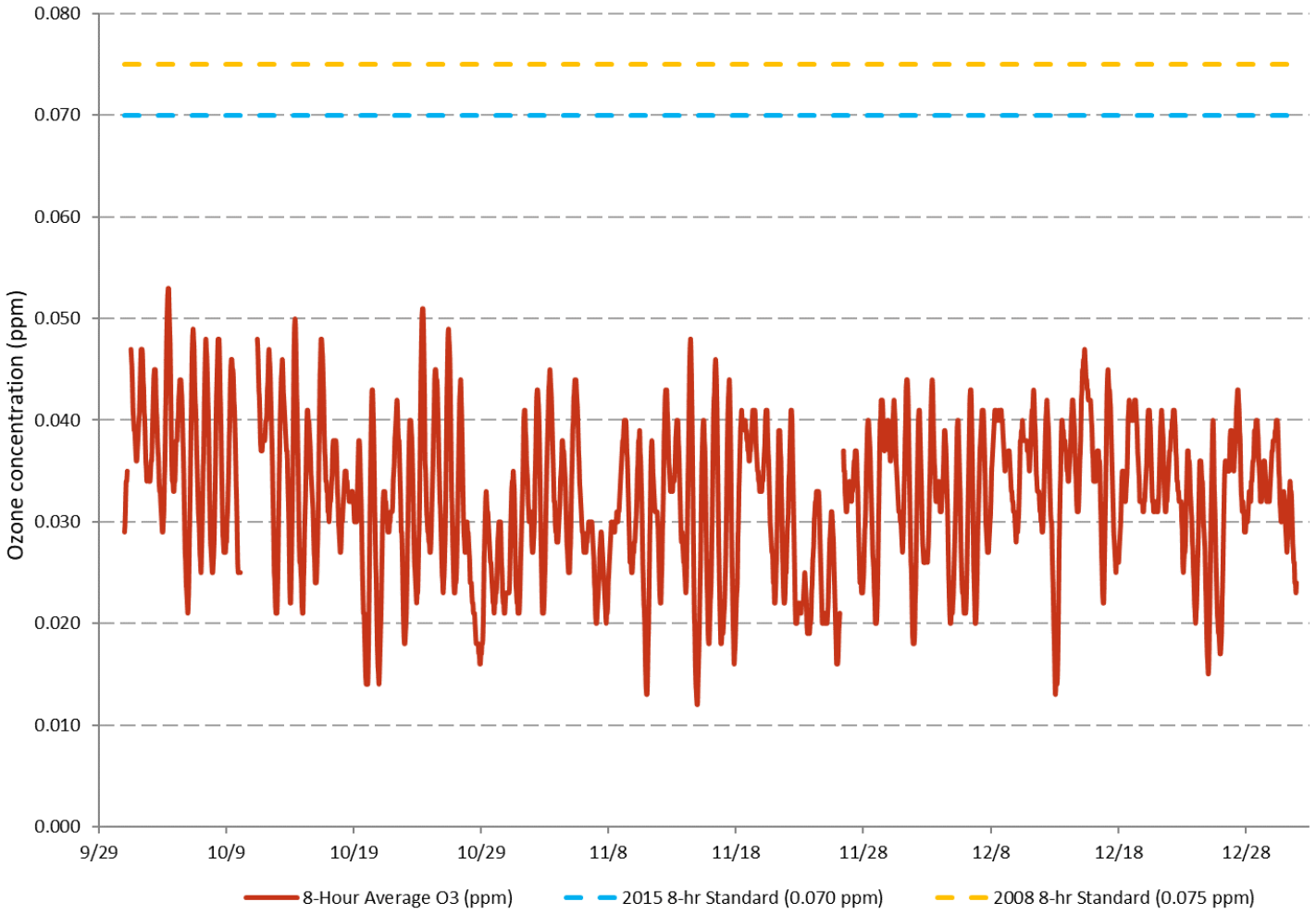


Figure 2. Hereford Q4 2024 Rolling 8-hour Averaged O_3

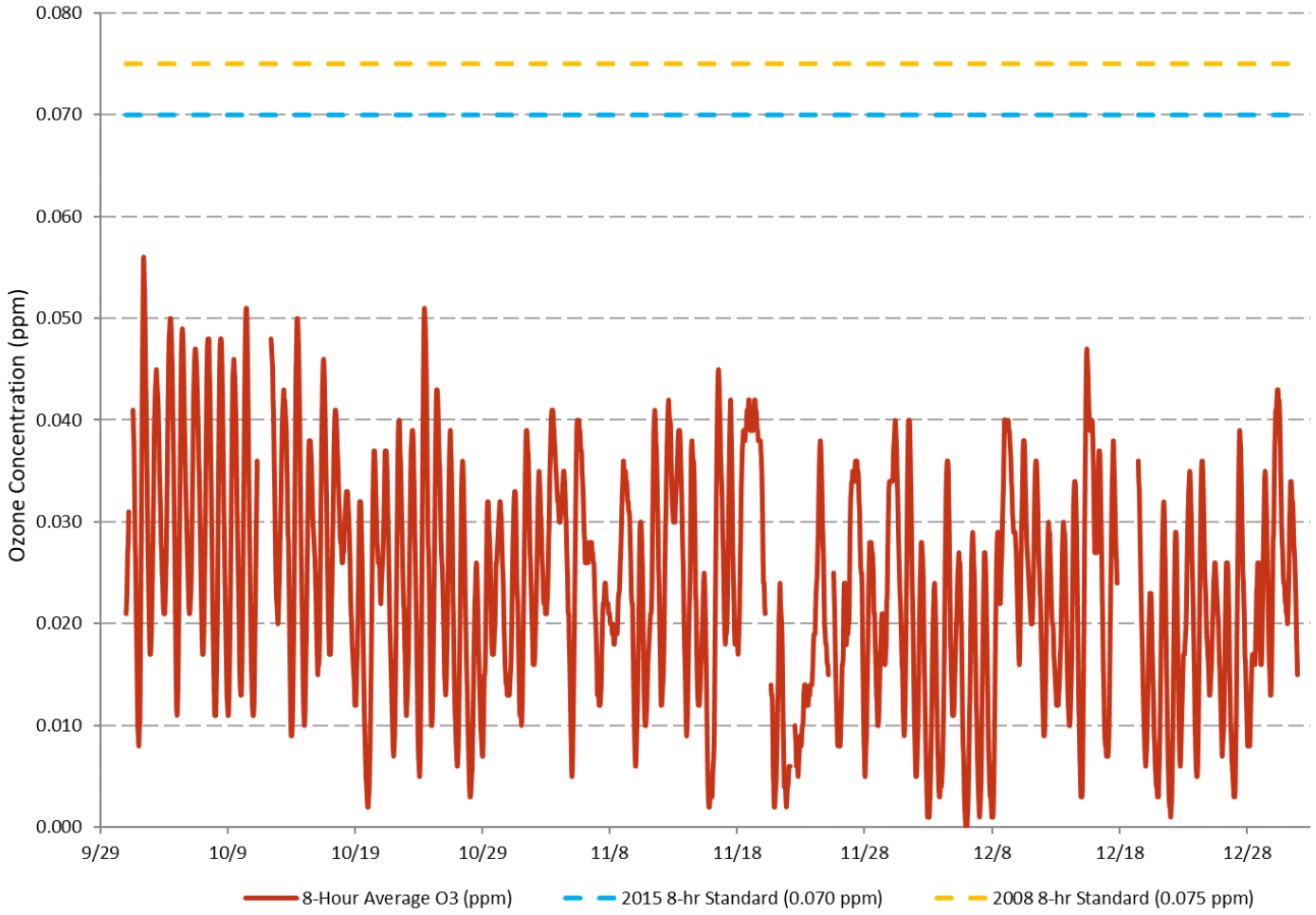


Figure 3. Orchard Q4 2024 Rolling 8-hour Averaged O_3

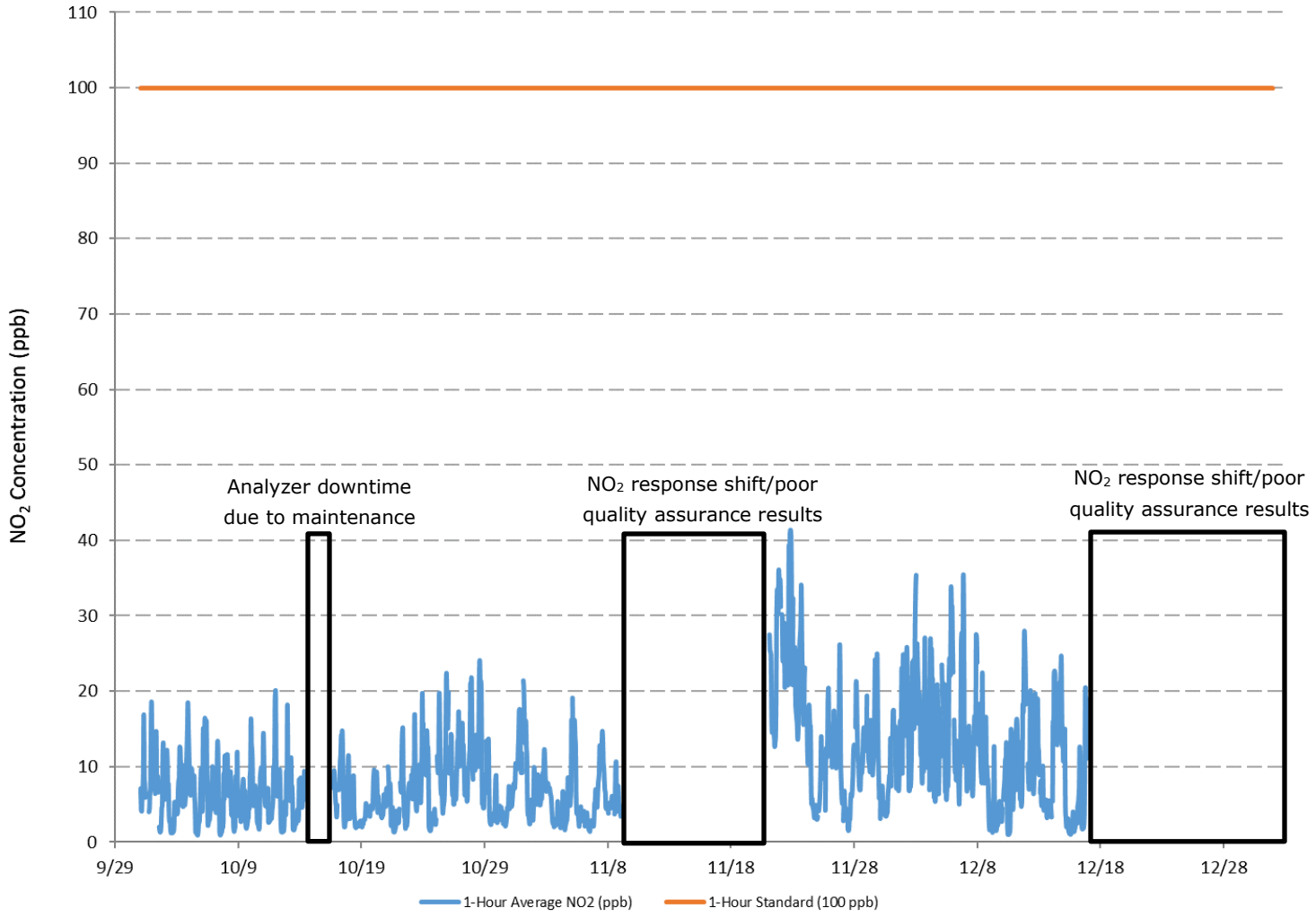


Figure 4. MSP Q4 2024 NO_2 1-Hour Summary

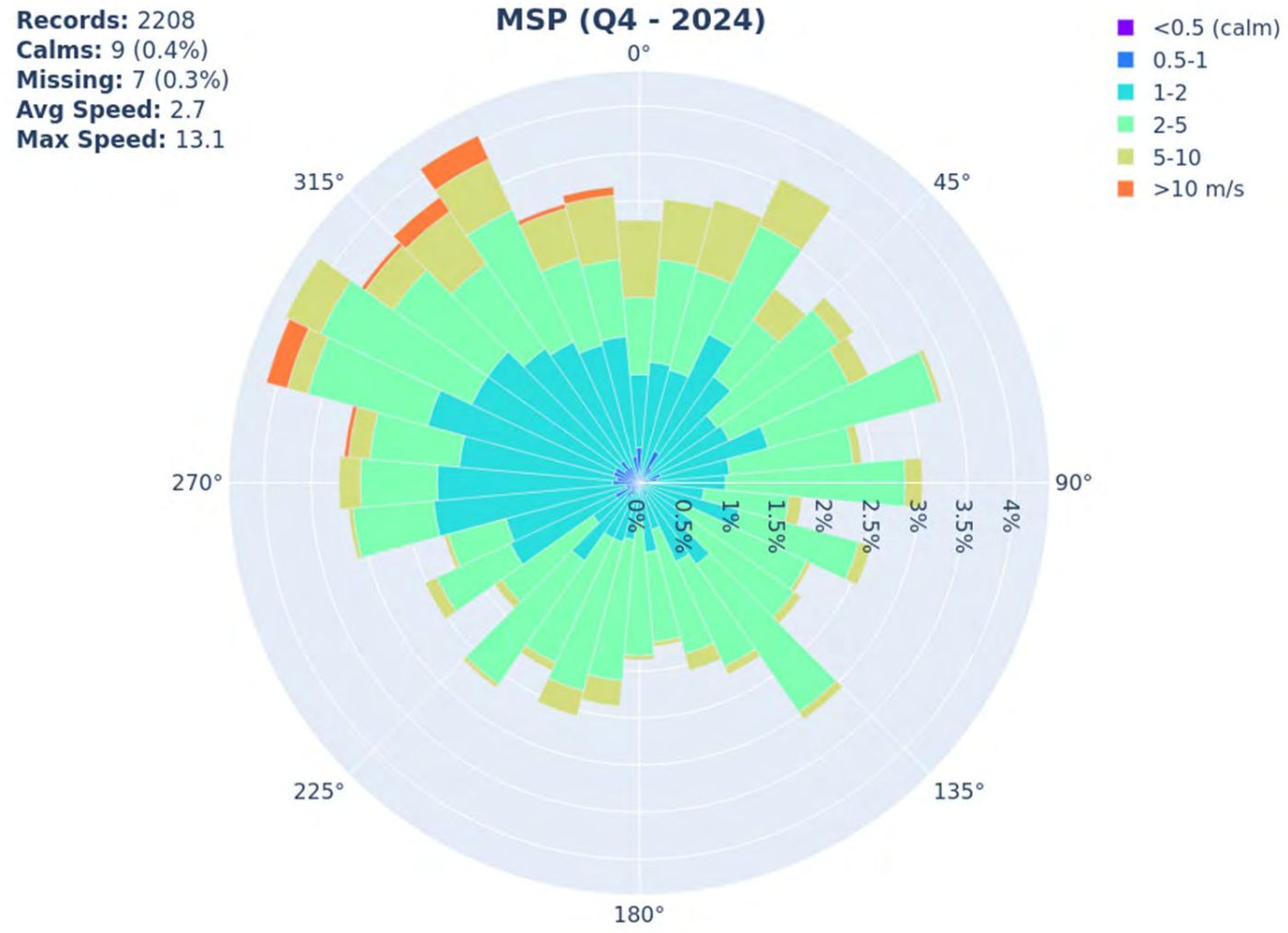


Figure 5. MSP Q4 2024 Wind Rose

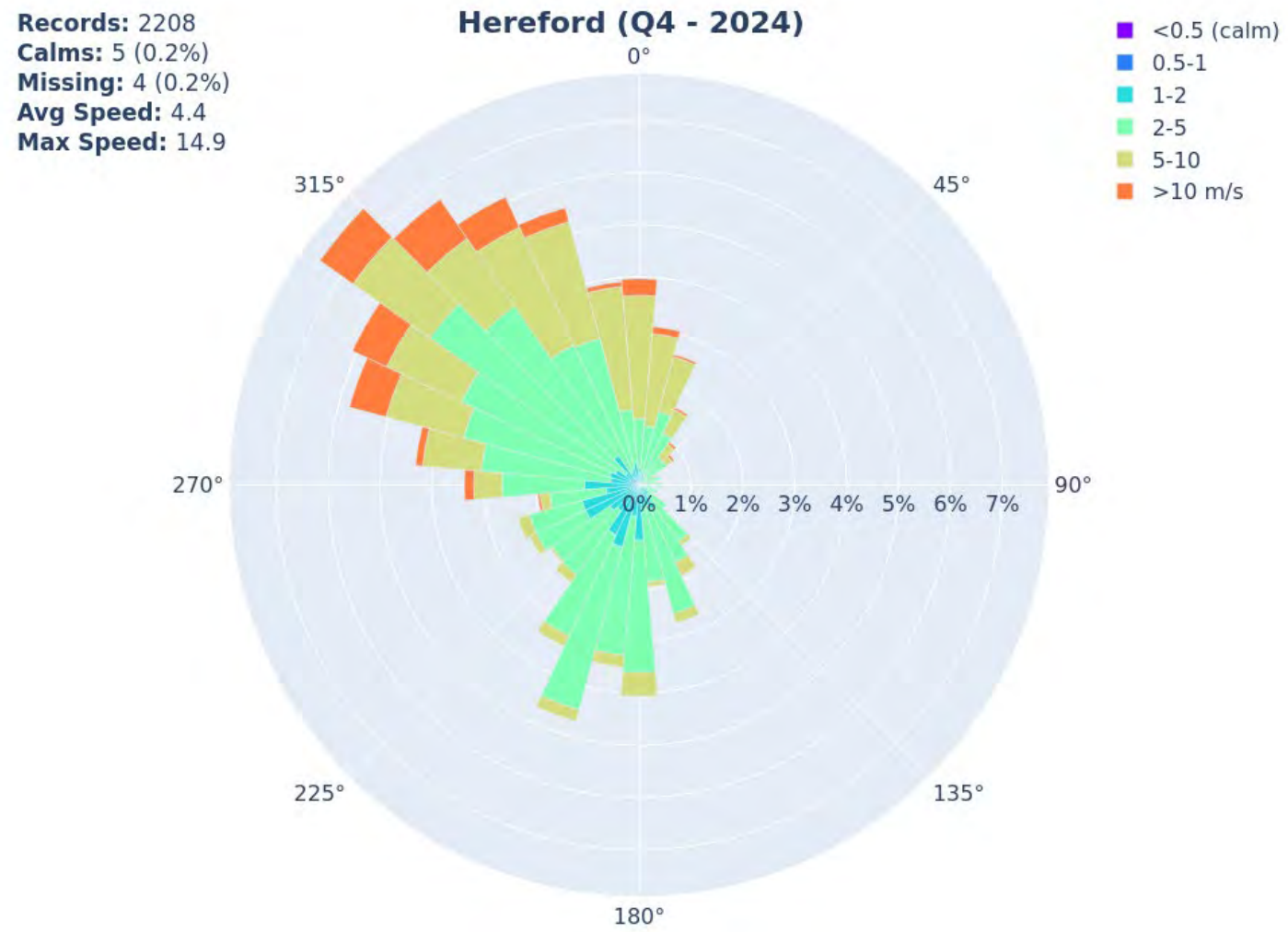


Figure 6. Hereford Q4 2024 Wind Rose

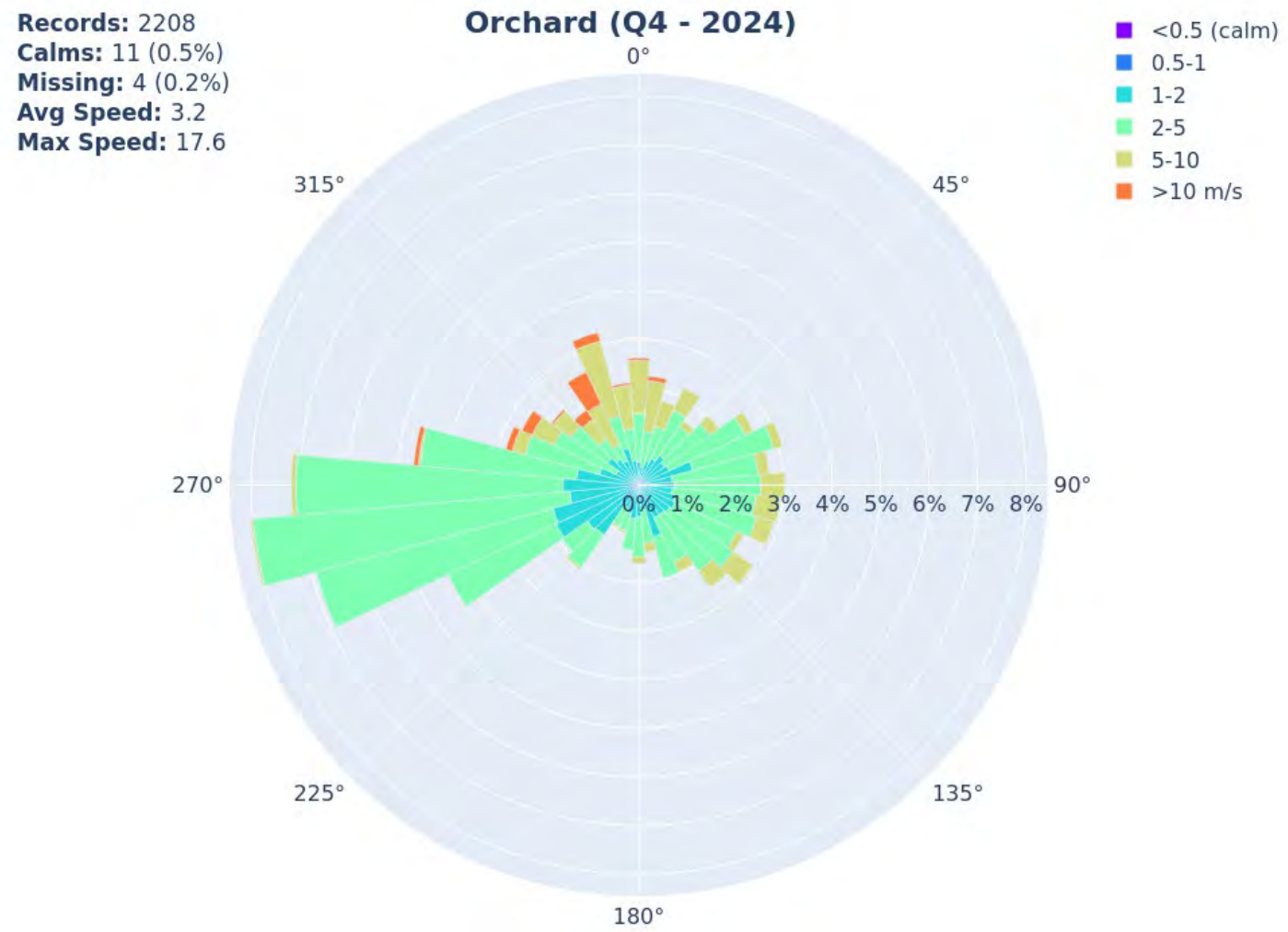


Figure 7. Orchard Q4 2024 Wind Rose

Table 2. Fourth Quarter 2024 Meteorological Data Summary

Parameter	Units	Form	October[1]	November[1]	December[1]
Missile Site Park					
2-M Temperature	°C	Monthly Average	13.4	3.1	2.9
		Maximum Hourly Average	31.7	16.2	15.7
		Minimum Hourly Average	-0.1	-7.9	-8.2
10-M Temperature	°C	Monthly Average	13.6	3.4	3.5
		Maximum Hourly Average	30.6	15.9	15.1
		Minimum Hourly Average	-0.3	-7.6	-7.7
Delta Temperature	°C	Monthly Average	0.2	0.3	0.6
		Maximum Hourly Average	3.3	2.6	3.5
		Minimum Hourly Average	-1.9	-1.1	-1.0
10-M Horizontal Wind Speed	m/s	Monthly Average	2.5	2.9	2.9
		Maximum Hourly Average	13.1	12.2	12.5
2-M Relative Humidity	Percent	Monthly Average	47.5	62.8	53.4
		Maximum Hourly Average	100.0	100.0	95.1
Station Barometric Pressure	mm Hg	Monthly Average	637.9	634.7	636.5
		Maximum Hourly Average	645.8	643.1	644.6
Station Precipitation	in	Monthly Total	0.296	1.299	0.000

Parameter	Units	Form	October[1]	November[1]	December[1]
	in/hr	Maximum Hourly Total	0.099	0.106	0.000
2-M Solar Radiation	W/m^2	Monthly Average	163	111	92
		Maximum Hourly Average	793	671	524
Hereford					
2-M Temperature	°C	Monthly Average	11.3	1.6	1.4
		Maximum Hourly Average	31.3	18.2	18.1
		Minimum Hourly Average	-3.0	-13.0	-13.1
10-M Temperature	°C	Monthly Average	12.1	2.6	2.5
		Maximum Hourly Average	30.2	17.6	17.6
		Minimum Hourly Average	-2.8	-9.2	-10.7
Delta Temperature	°C	Monthly Average	0.8	1.0	1.1
		Maximum Hourly Average	7.0	8.8	9.2
		Minimum Hourly Average	-1.6	-1.4	-1.1
10-M Horizontal Wind Speed	m/s	Monthly Average	4.0	4.3	4.7
		Maximum Hourly Average	14.9	13.9	14.8
2-M Relative Humidity	Percent	Monthly Average	48.8	61.2	53.4
		Maximum Hourly Average	100.0	100.0	91.3
	mm Hg	Monthly Average	629.8	626.3	628.1

Parameter	Units	Form	October[1]	November[1]	December[1]
Station Barometric Pressure		Maximum Hourly Average	637.2	634.3	635.6
Station Precipitation	in	Monthly Total	0.059	0.808	0.000
	in/hr	Maximum Hourly Total	0.039	0.099	0.000
2-M Solar Radiation	W/m^2	Monthly Average	163	112	89
		Maximum Hourly Average	797	624	529
Orchard					
2-M Temperature	°C	Monthly Average	11.5	1.3	-0.1
		Maximum Hourly Average	32.4	18.2	17.5
		Minimum Hourly Average	-3.6	-12.6	-12.7
10-M Temperature	°C	Monthly Average	12.6	2.1	1.2
		Maximum Hourly Average	31.5	17.3	16.8
		Minimum Hourly Average	-2.0	-10.1	-11.5
Delta Temperature	°C	Monthly Average	1.0	0.8	1.4
		Maximum Hourly Average	7.2	5.9	6.8
		Minimum Hourly Average	-1.8	-1.6	-1.3
10-M Horizontal Wind Speed	m/s	Monthly Average	3.3	3.4	2.9
		Maximum Hourly Average	17.6	13.7	14.3
	Percent	Monthly Average	56.6	70.7	64.7

Parameter	Units	Form	October[1]	November[1]	December[1]
2-M Relative Humidity		Maximum Hourly Average	100.0	99.9	94.2
Station Barometric Pressure	mm Hg	Monthly Average	649.7	646.8	648.7
		Maximum Hourly Average	657.9	655.8	657.2
Station Precipitation	in	Monthly Total	0.150	1.319	0.000
	in/hr	Maximum Hourly Total	0.055	0.079	0.000
2-M Solar Radiation	W/m^2	Monthly Average	168	112	95
		Maximum Hourly Average	778	629	500
[1] There are small differences in precision relative to the finalized valid data due to rounding.					

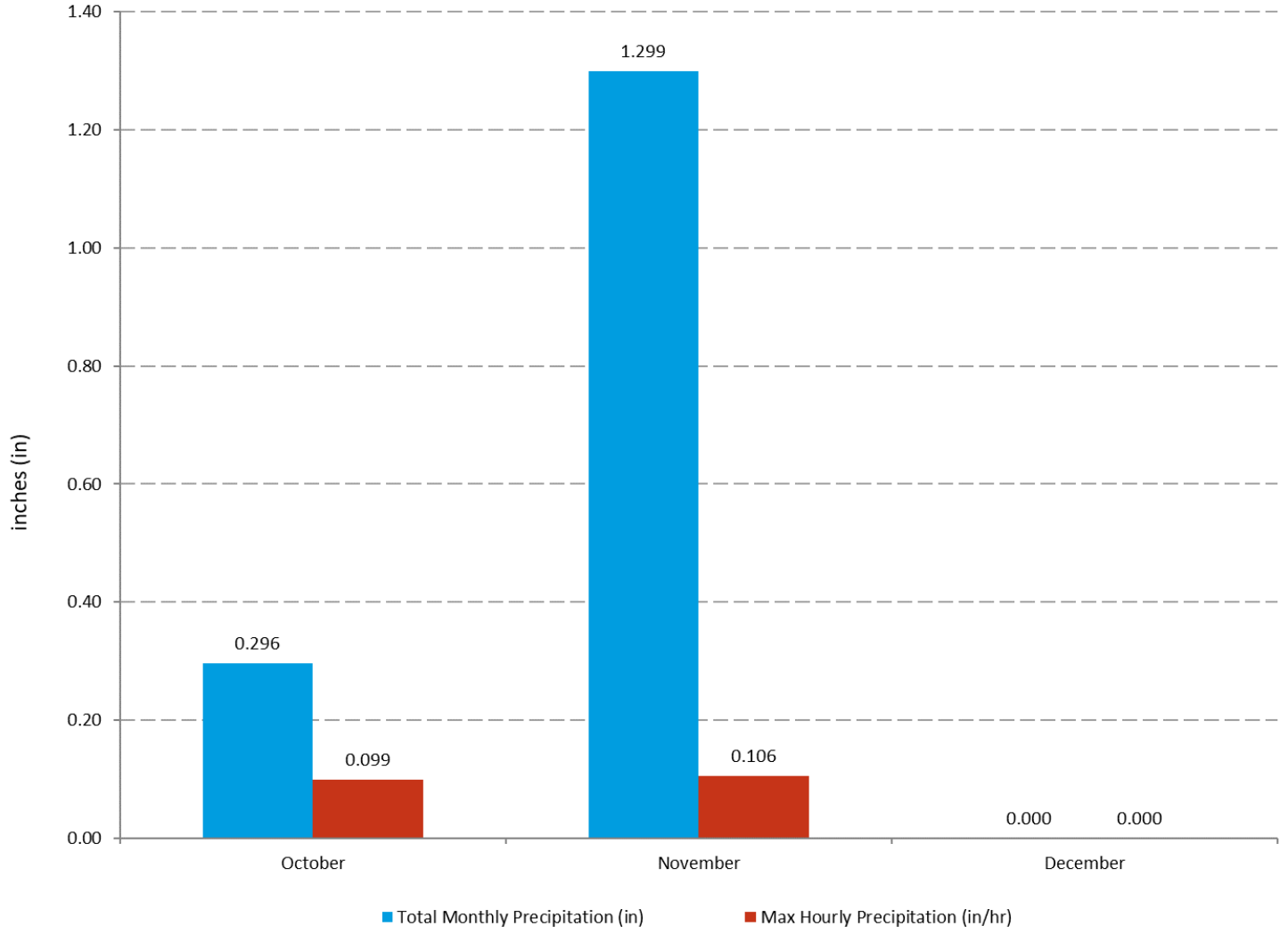


Figure 8. MSP Q4 2024 Precipitation Summary

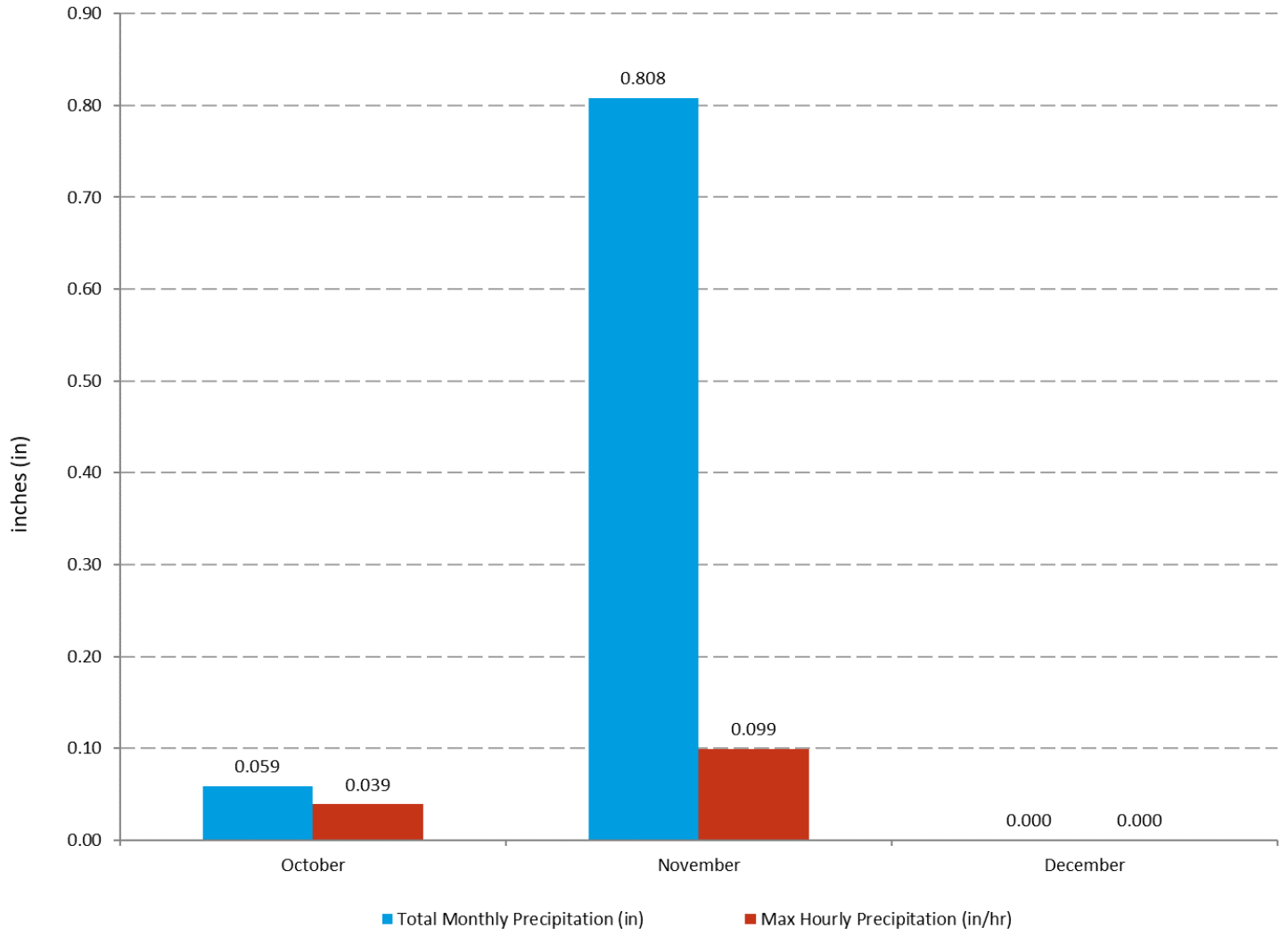


Figure 9. Hereford Q4 2024 Precipitation Summary

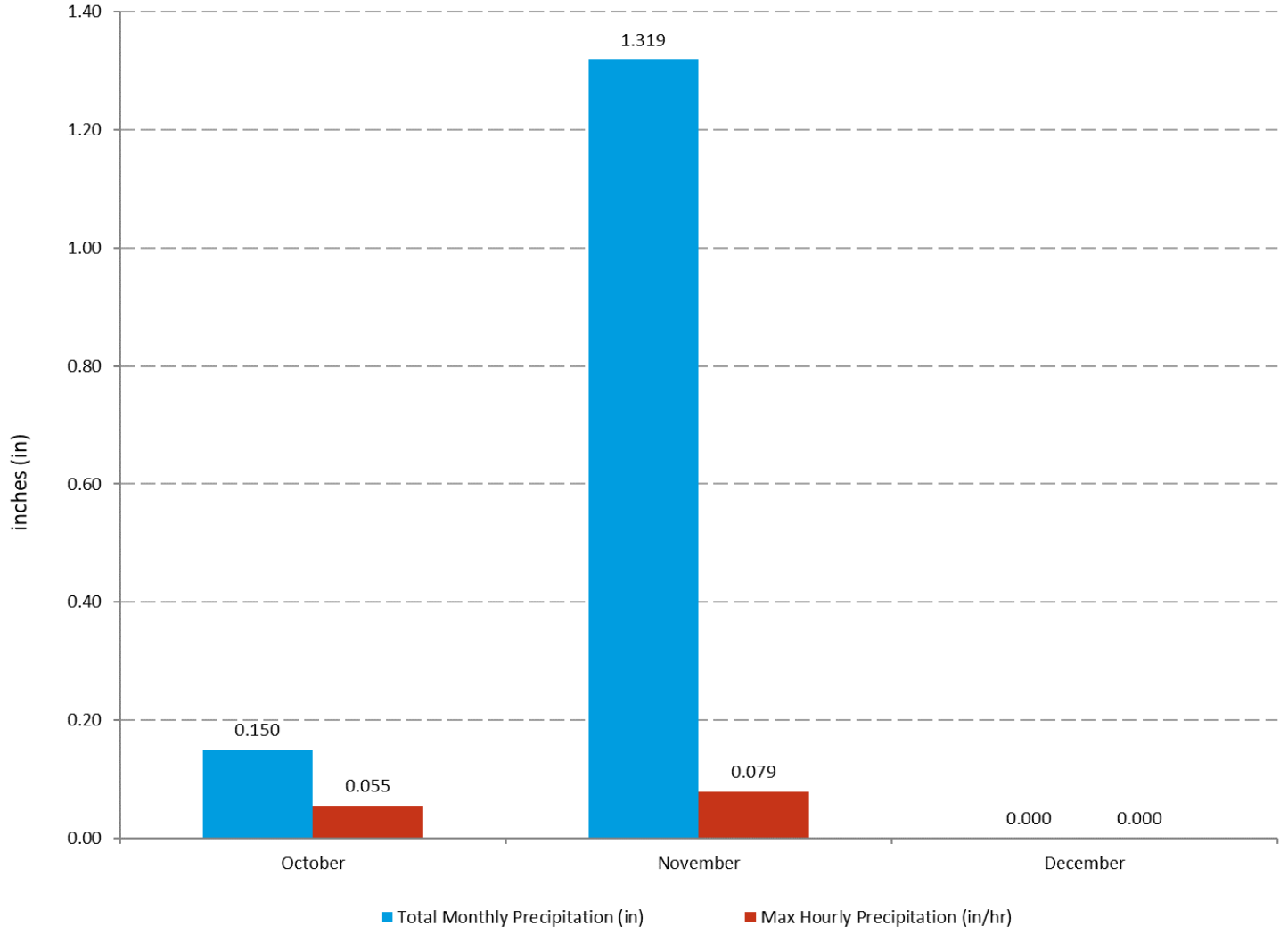


Figure 10. Orchard Q4 2024 Precipitation Summary

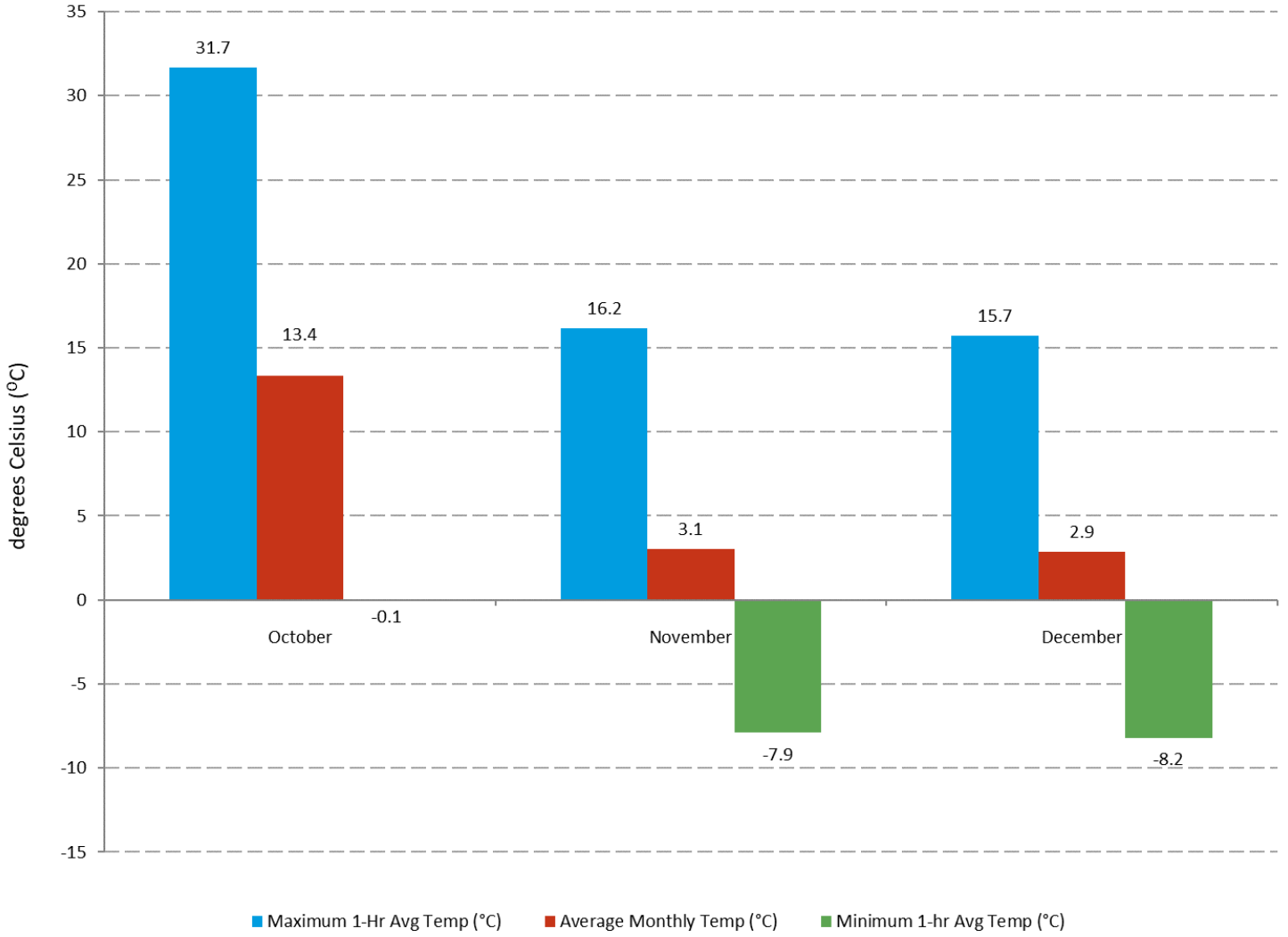


Figure 11. MSP Q4 2024 2-Meter Temperature Summary

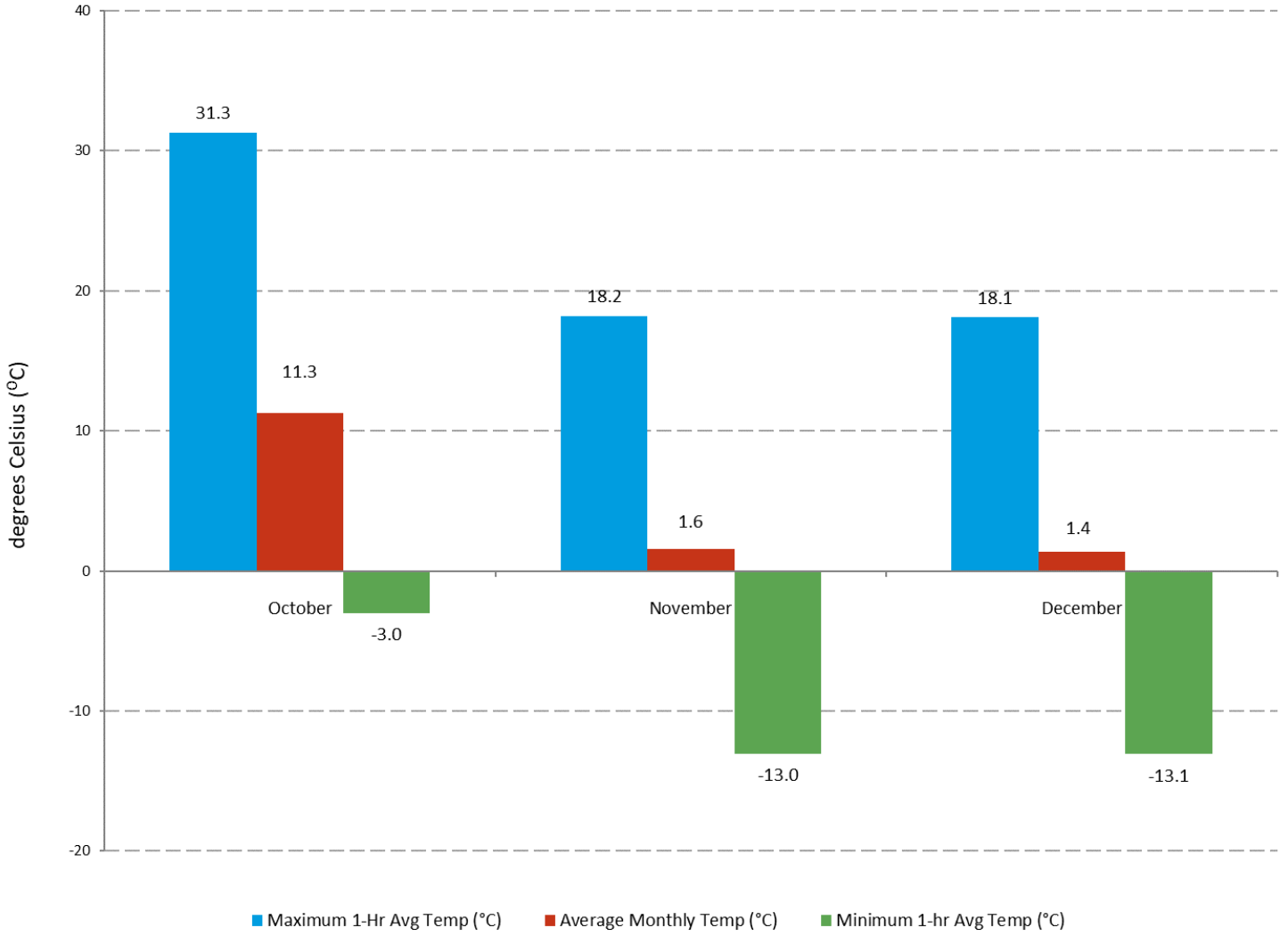


Figure 12. Hereford Q4 2024 2-Meter Temperature Summary

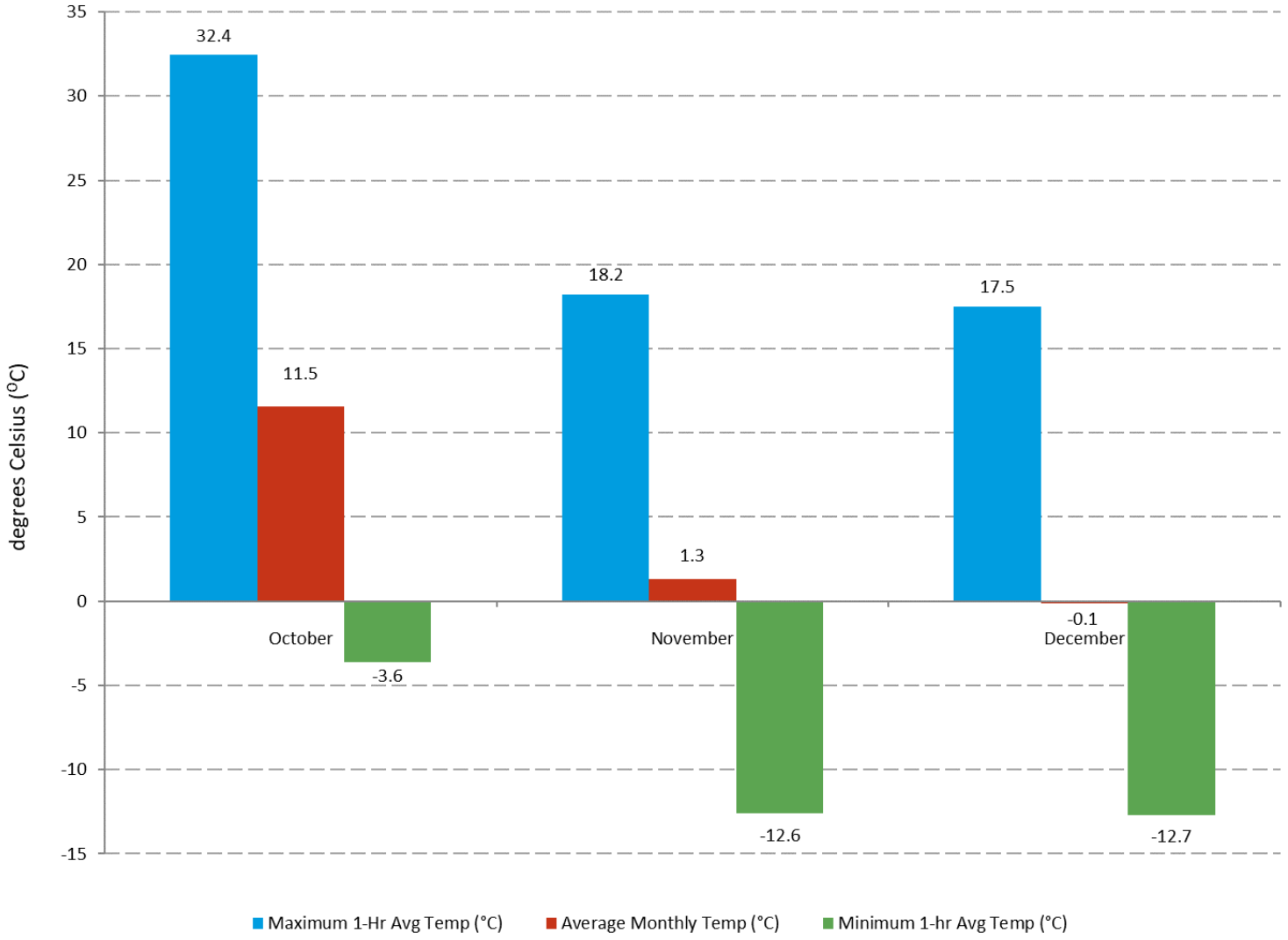


Figure 13. Orchard Q4 2024 2-Meter Temperature Summary

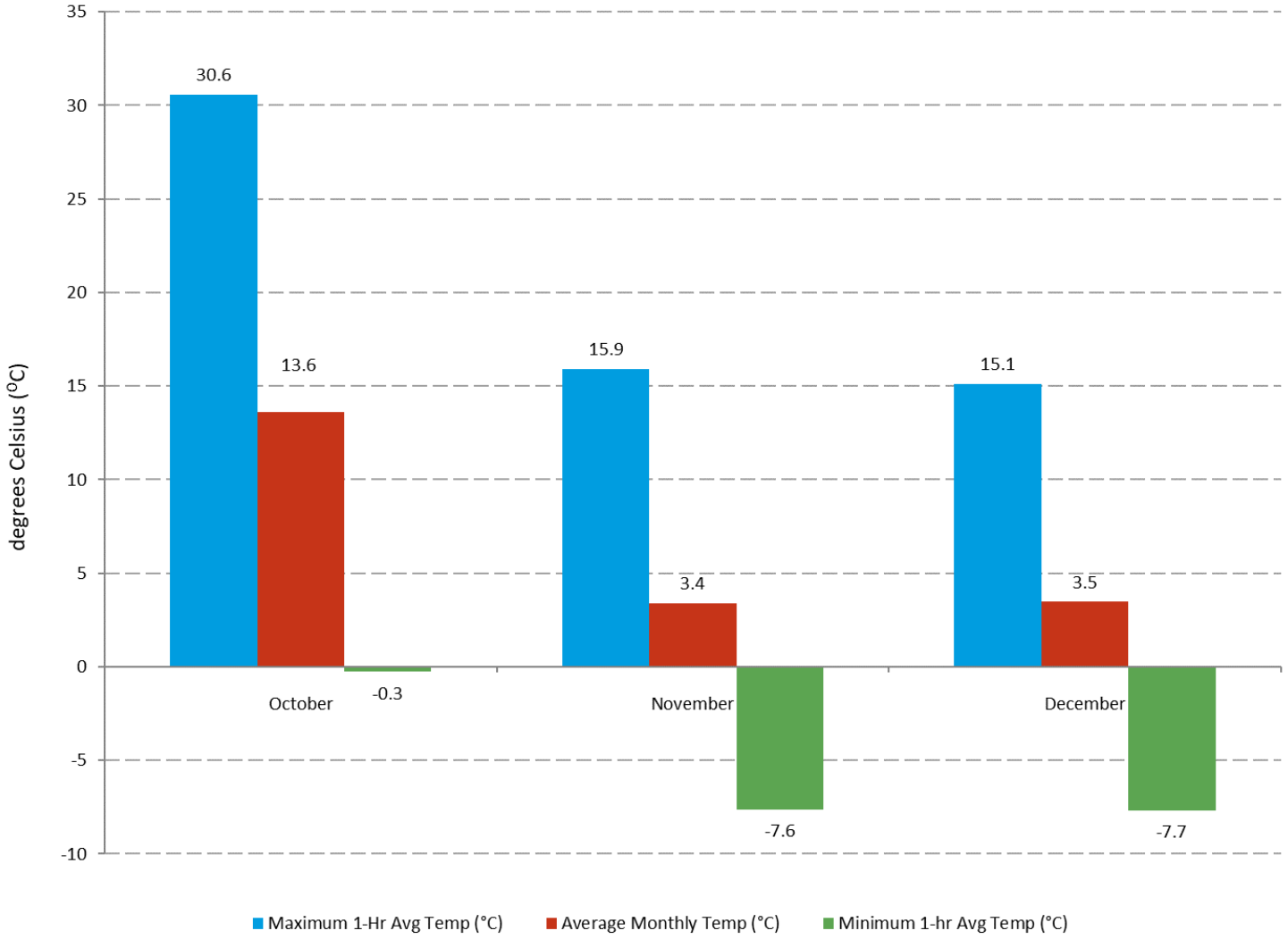


Figure 14. MSP Q4 2024 10-Meter Temperature Summary

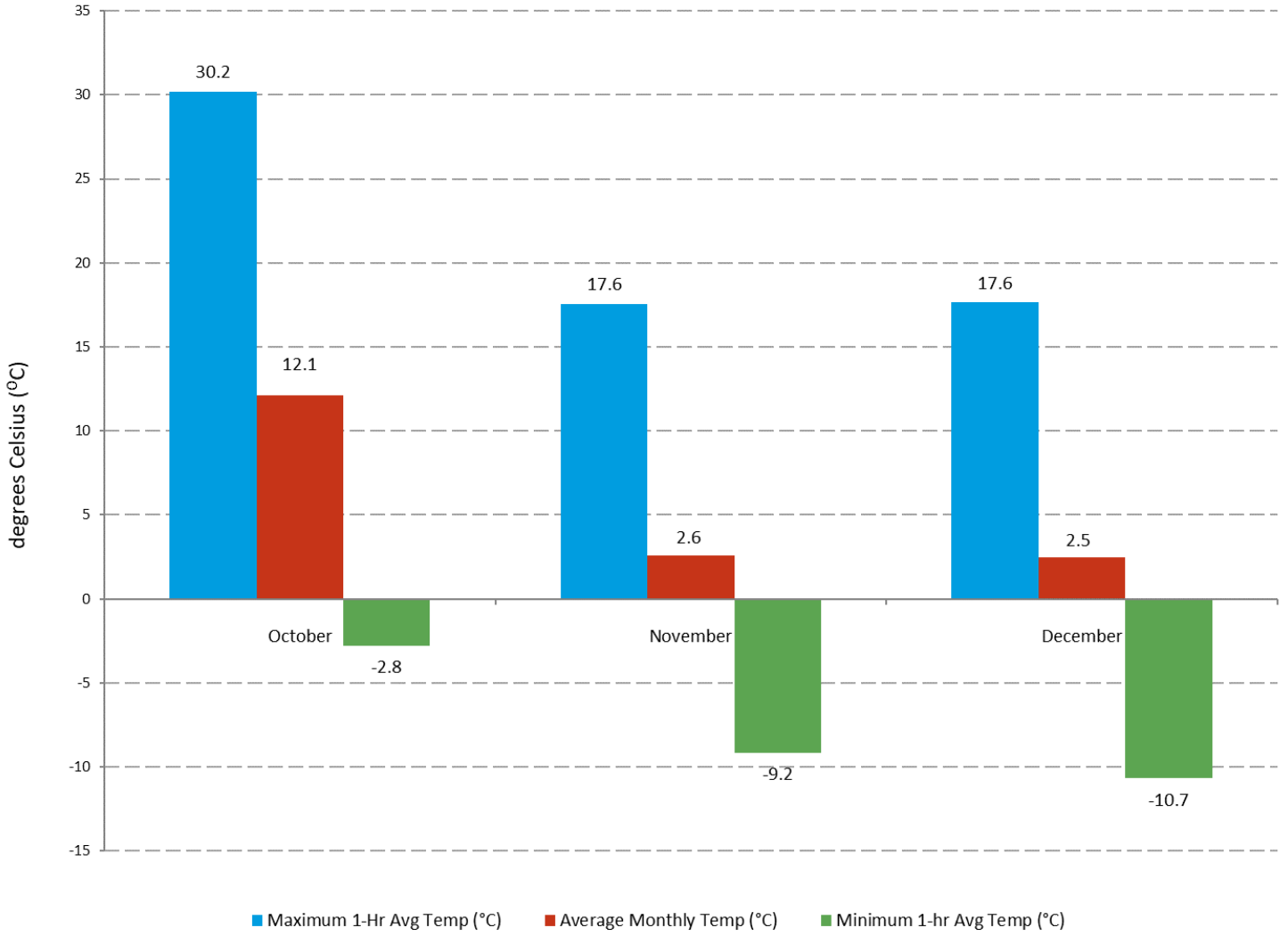


Figure 15. Hereford Q4 2024 10-Meter Temperature Summary

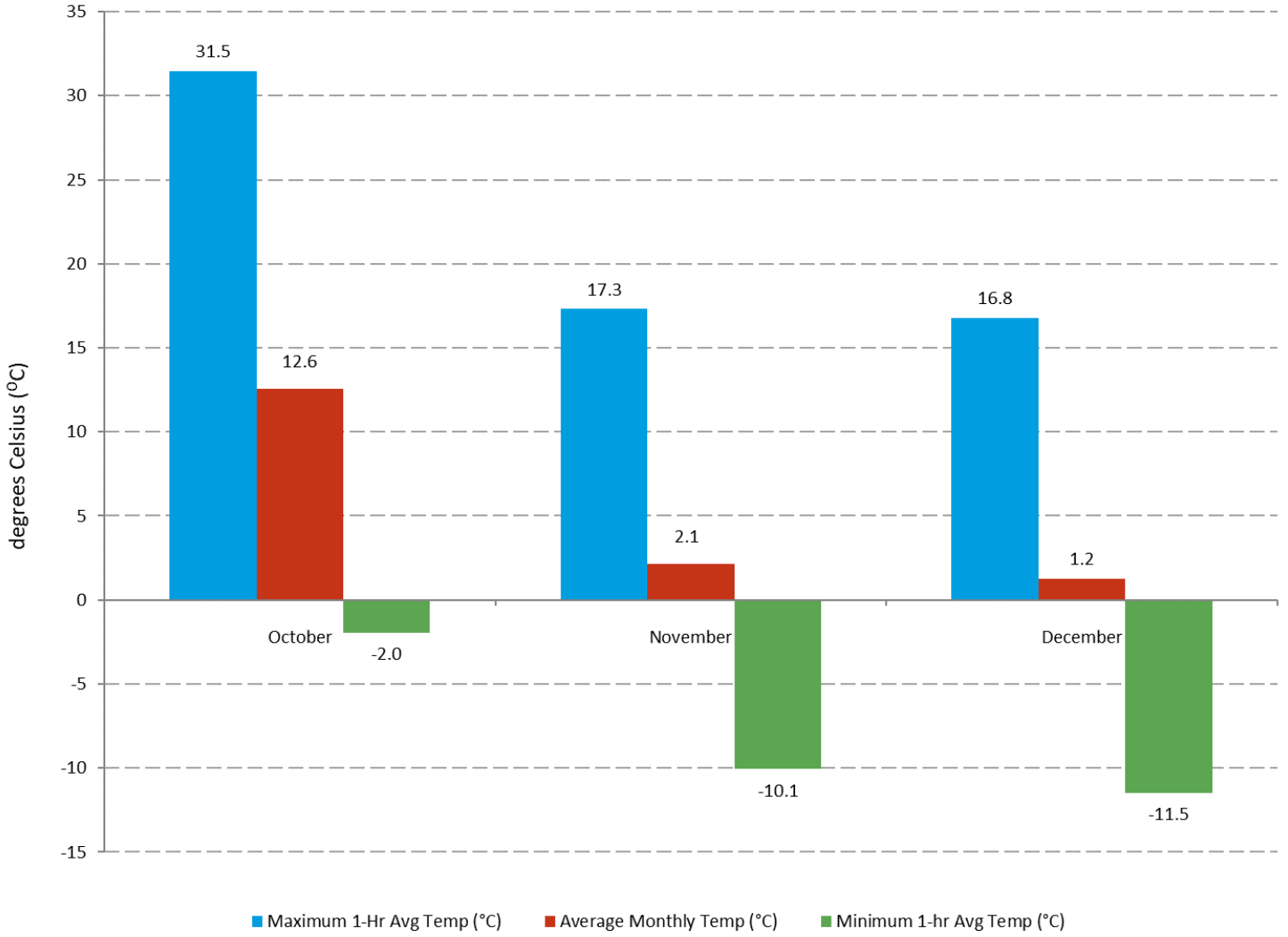


Figure 16. Orchard Q4 2024 10-Meter Temperature Summary

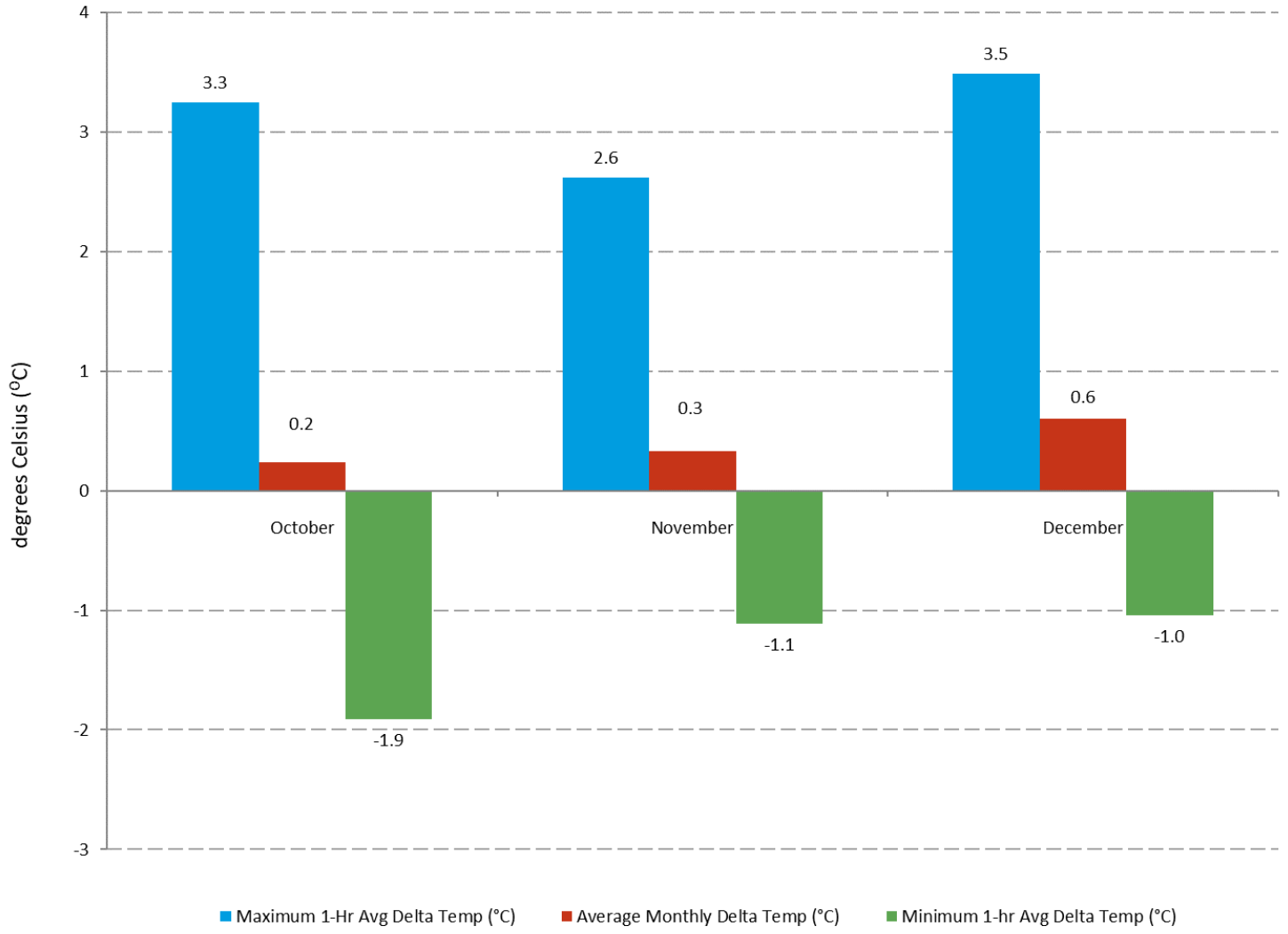


Figure 17. MSP Q4 2024 Delta Temperature Summary

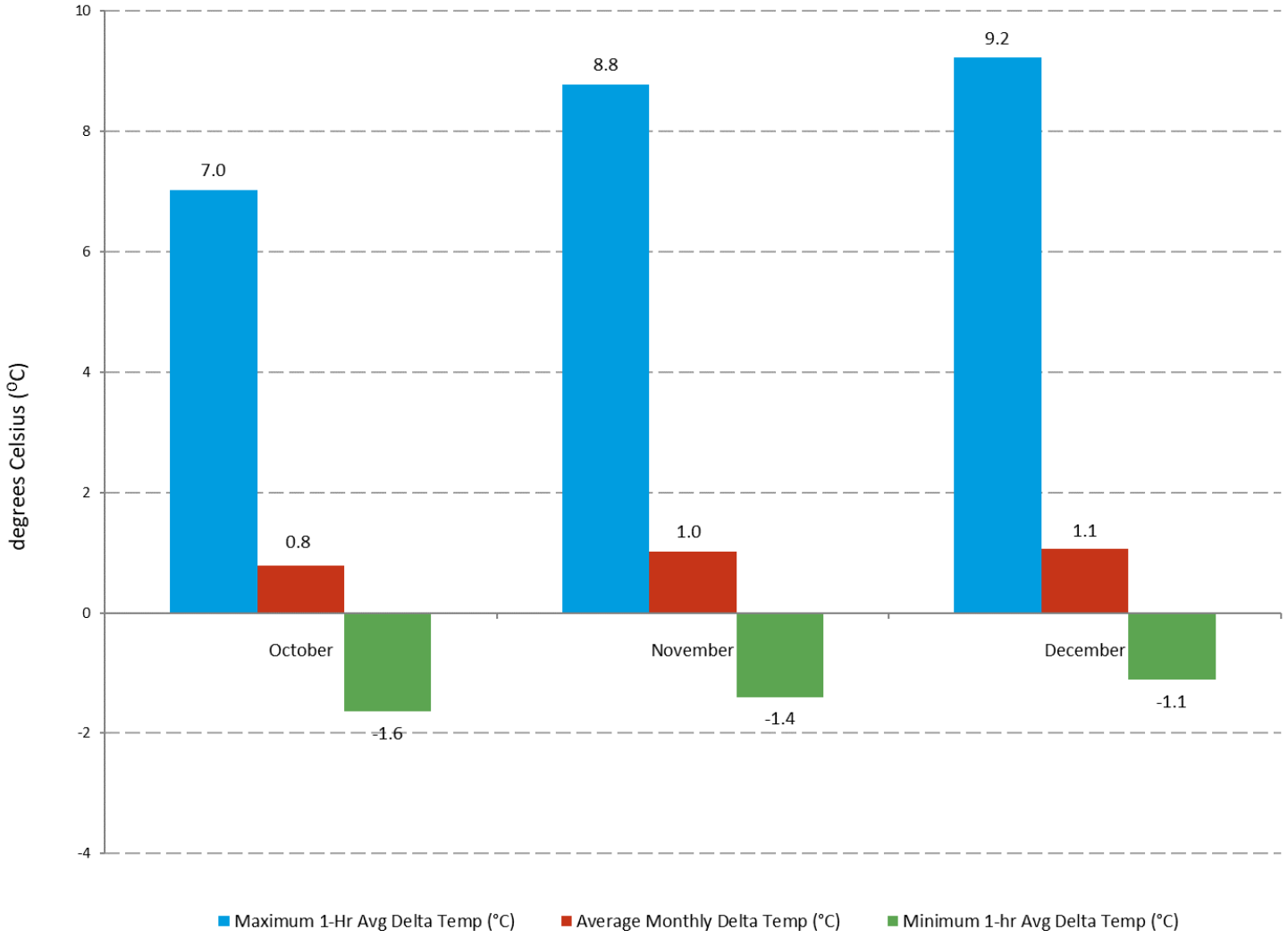


Figure 18. Hereford Q4 2024 Delta Temperature Summary

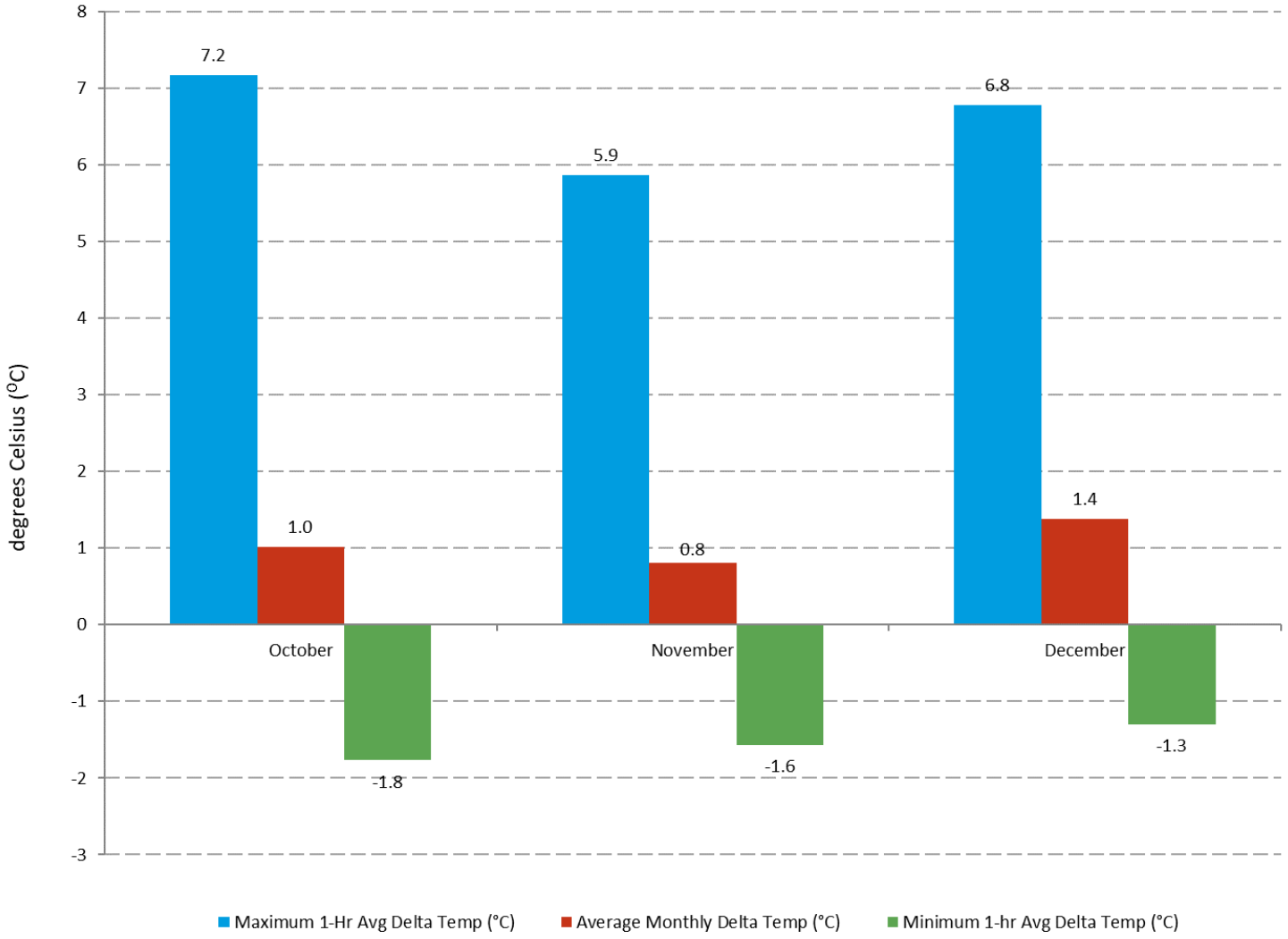


Figure 19. Orchard Q4 2024 Delta Temperature Summary

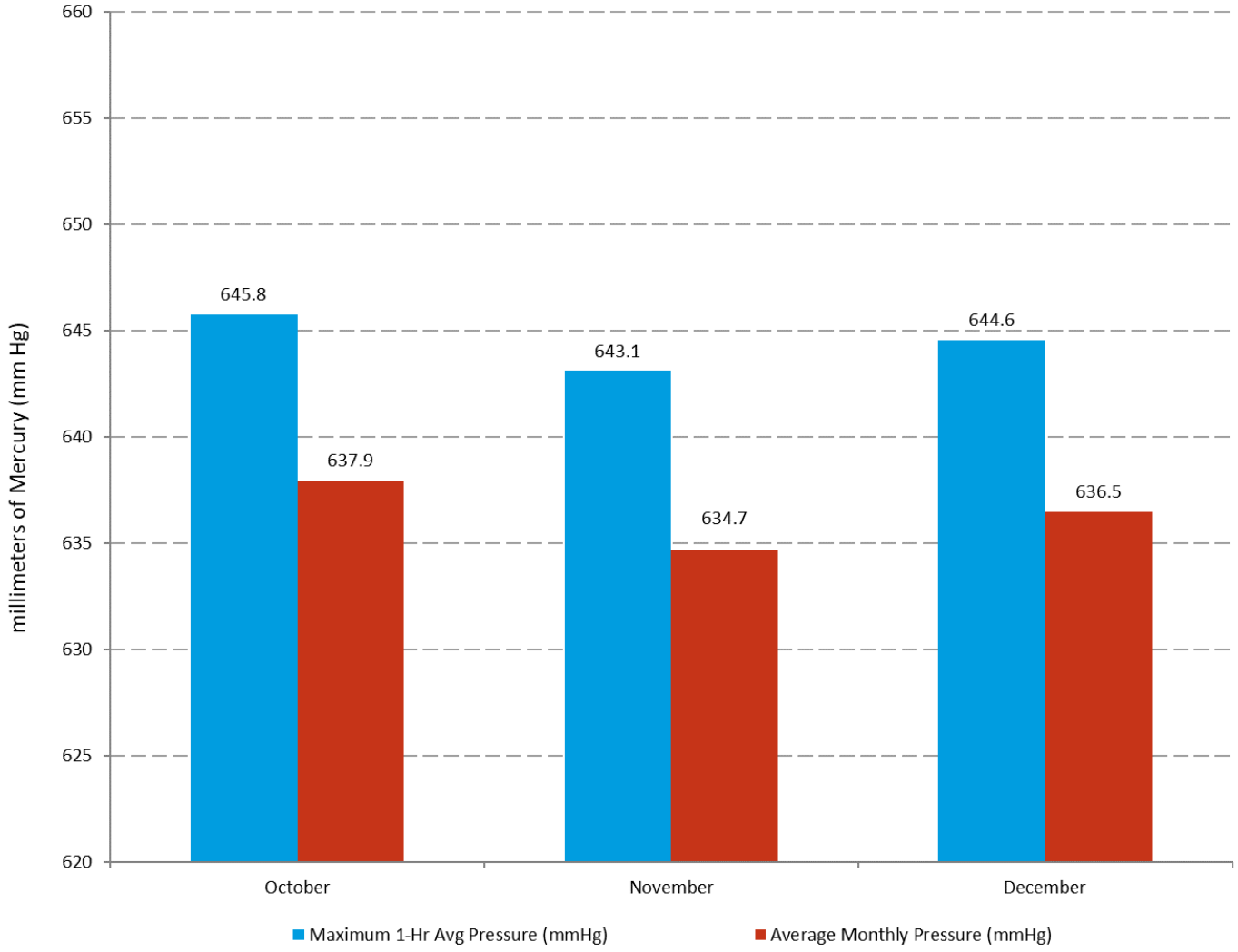


Figure 20. MSP Q4 2024 Barometric Pressure Summary

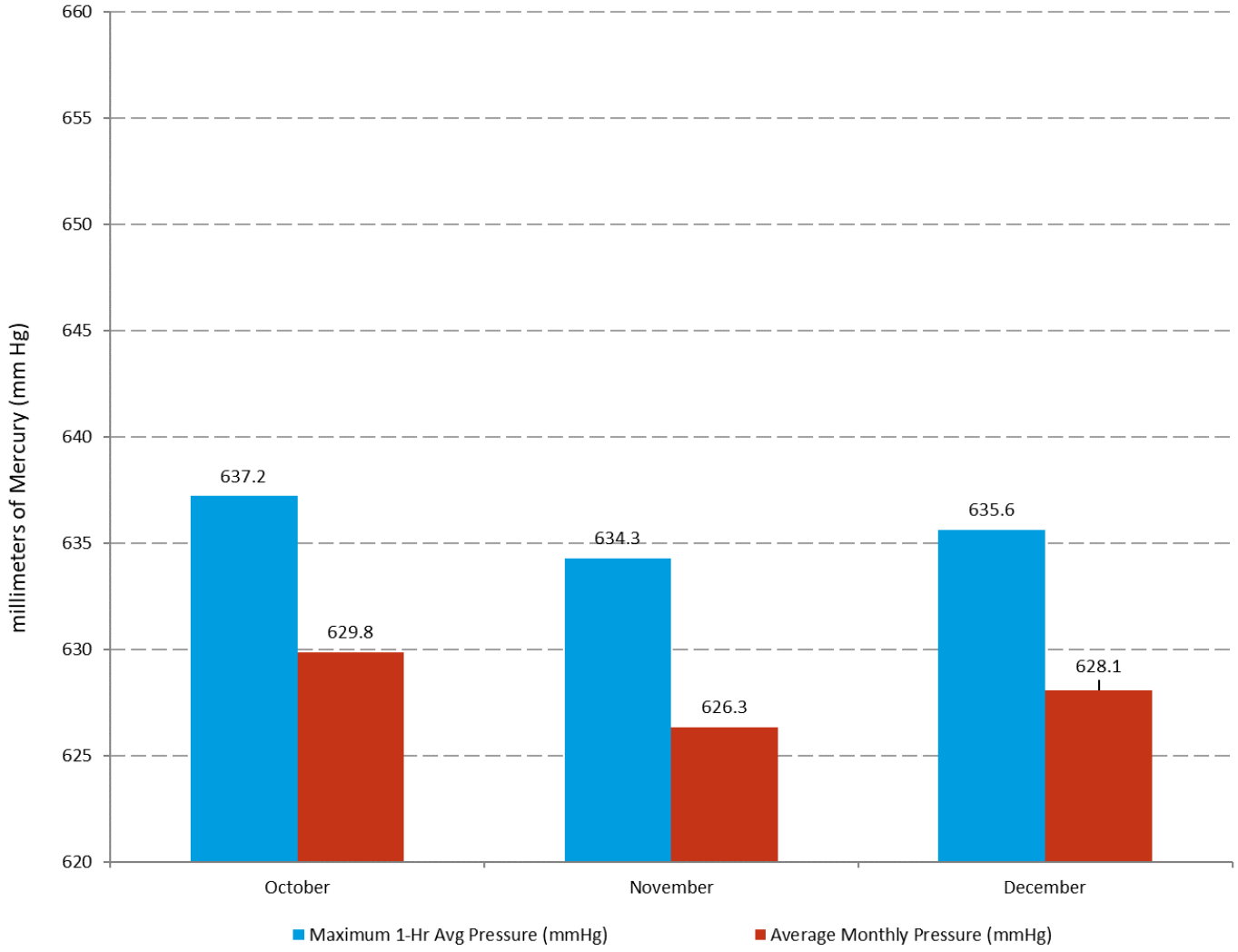


Figure 21. Hereford Q4 2024 Barometric Pressure Summary

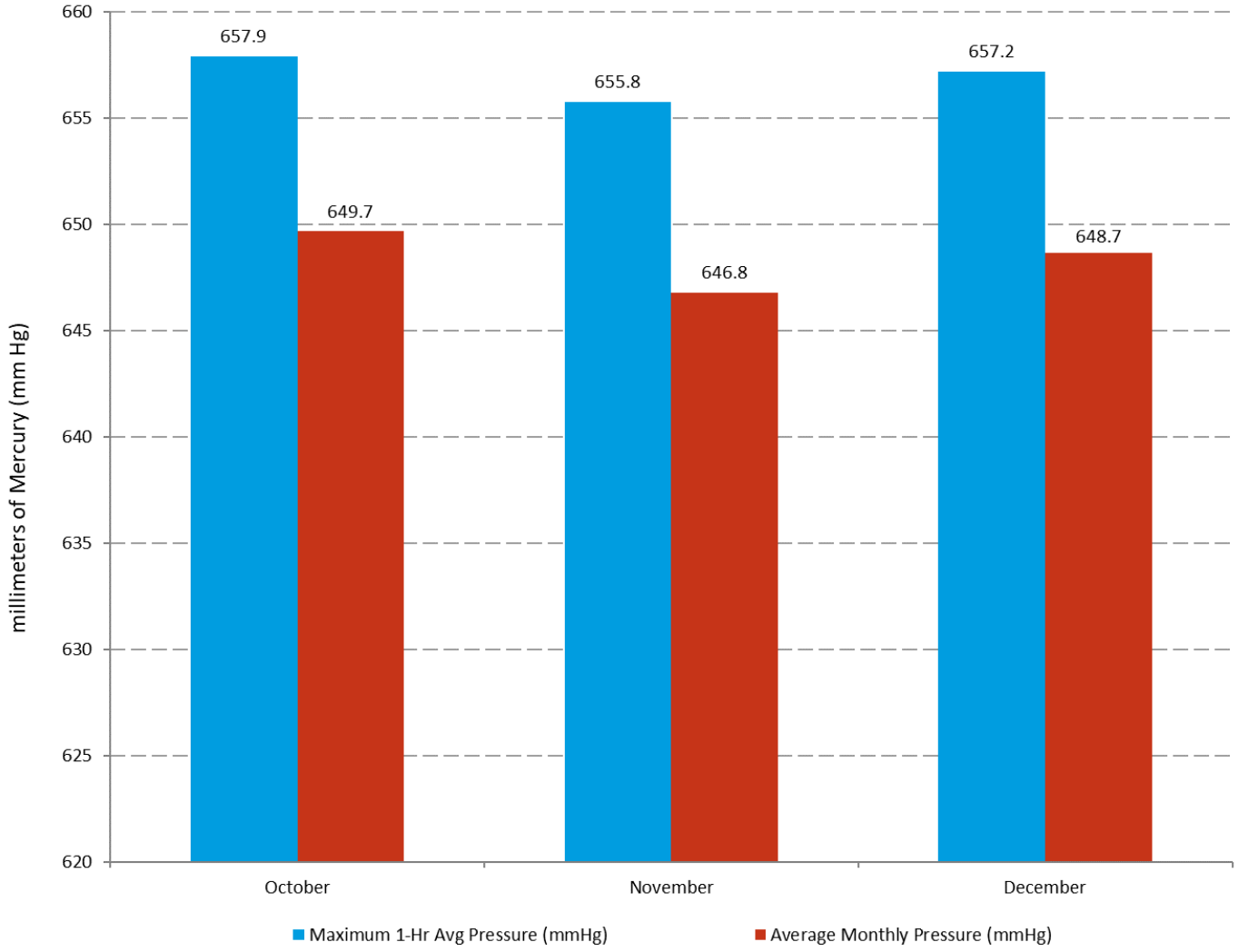


Figure 22. Orchard Q4 2024 Barometric Pressure Summary

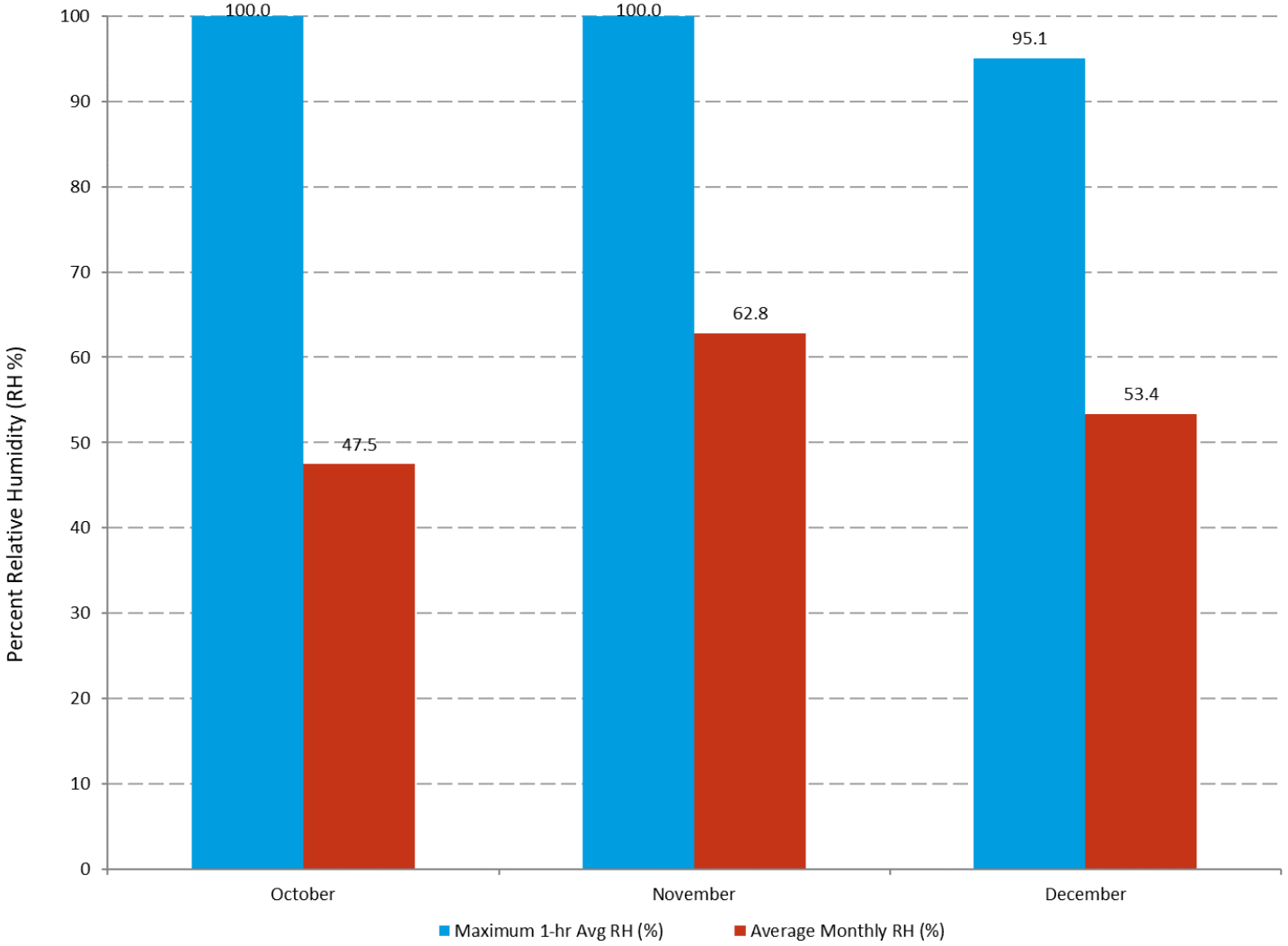


Figure 23. MSP Q4 2024 Relative Humidity Summary

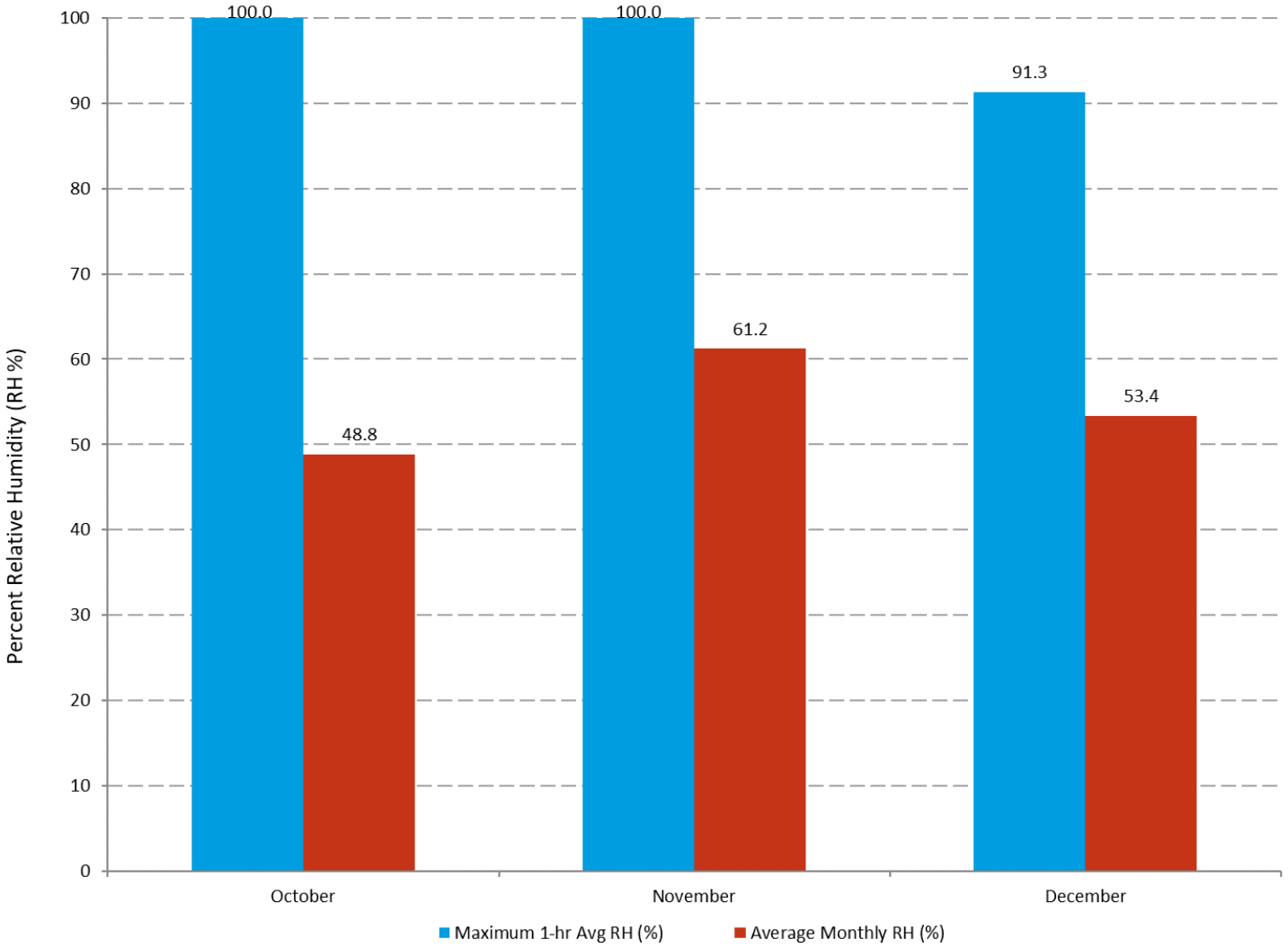


Figure 24. Hereford Q4 2024 Relative Humidity Summary

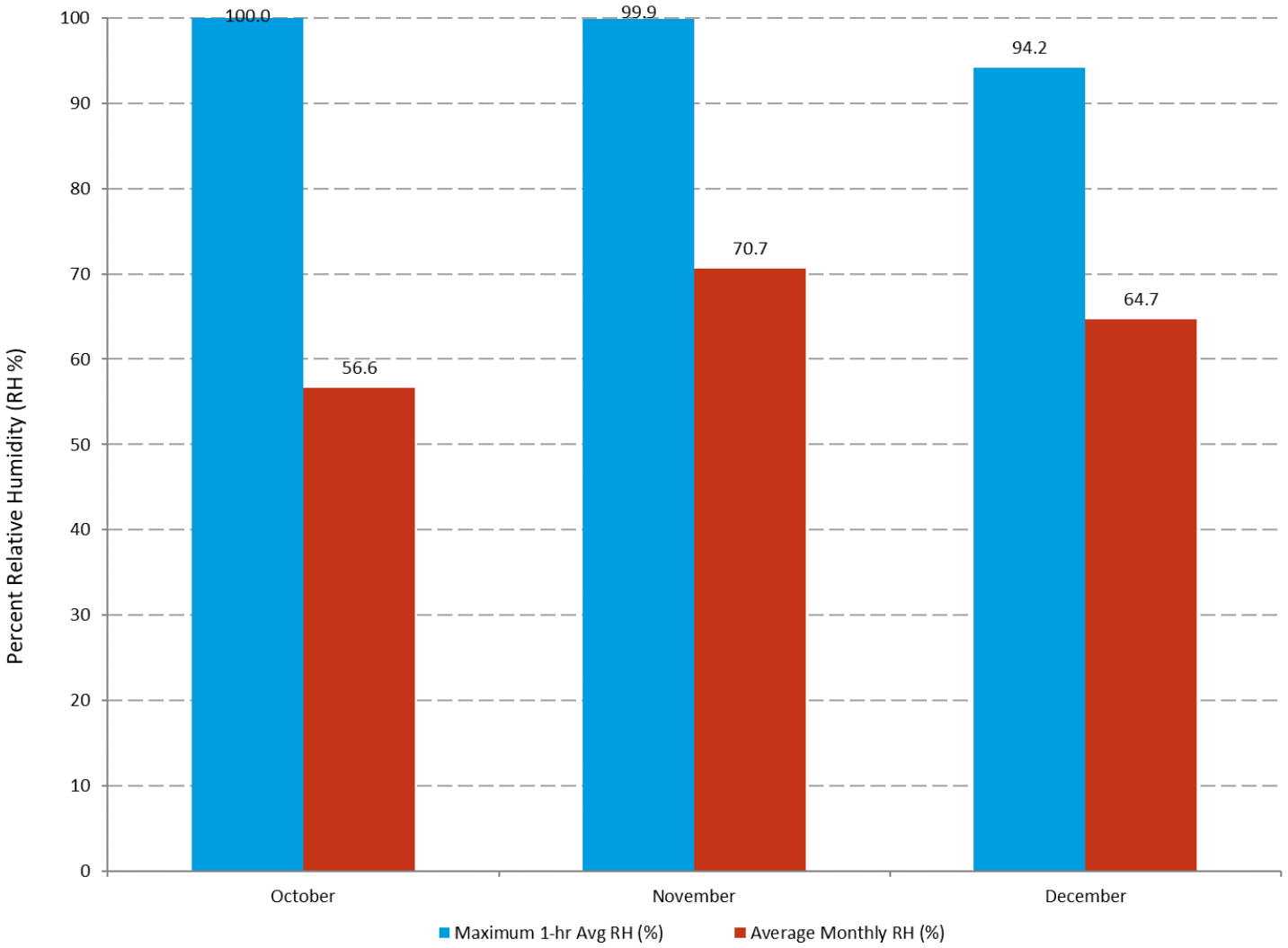


Figure 25. Orchard Q4 2024 Relative Humidity Summary

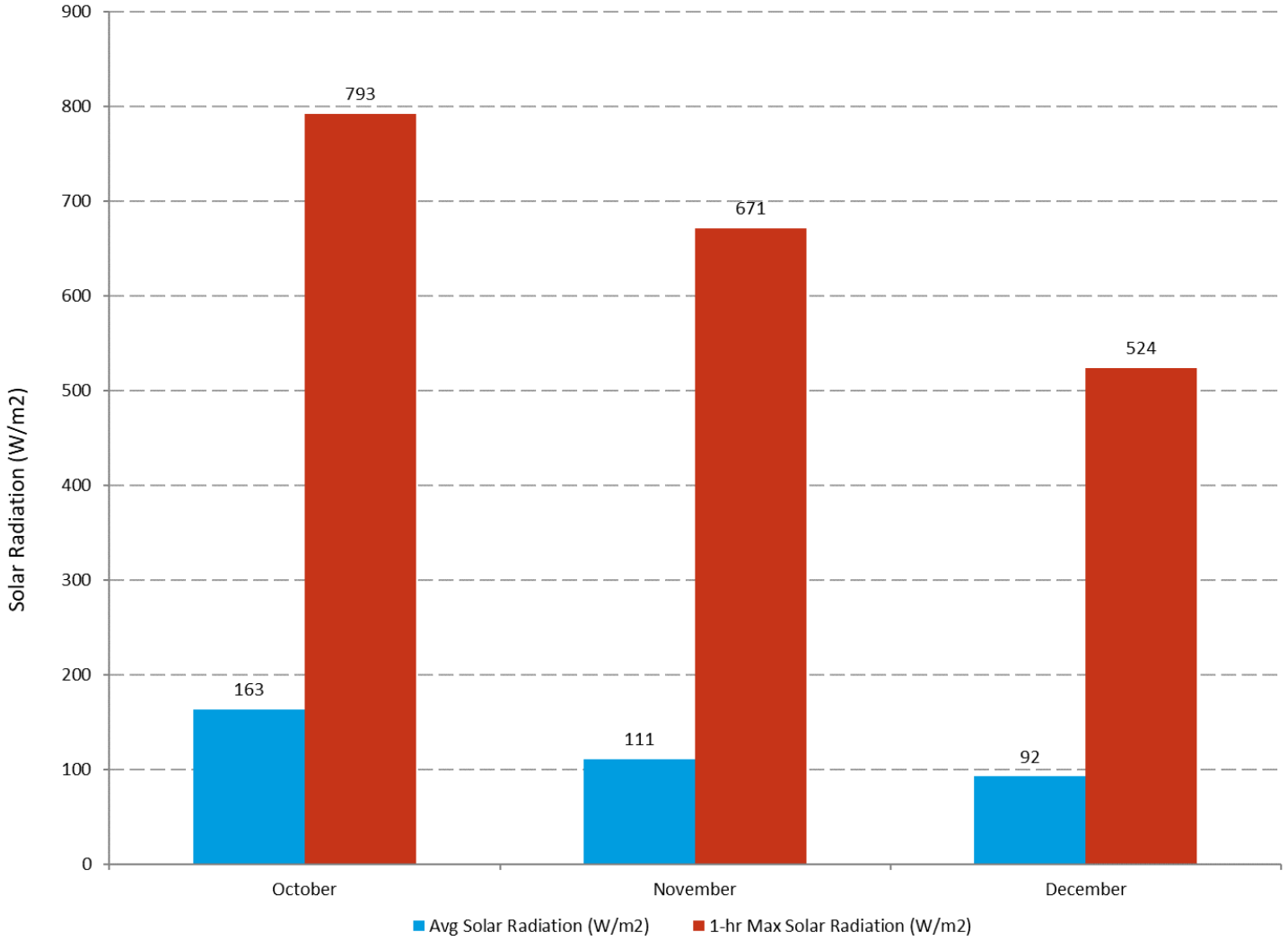


Figure 26. MSP Q4 2024 Solar Radiation Summary

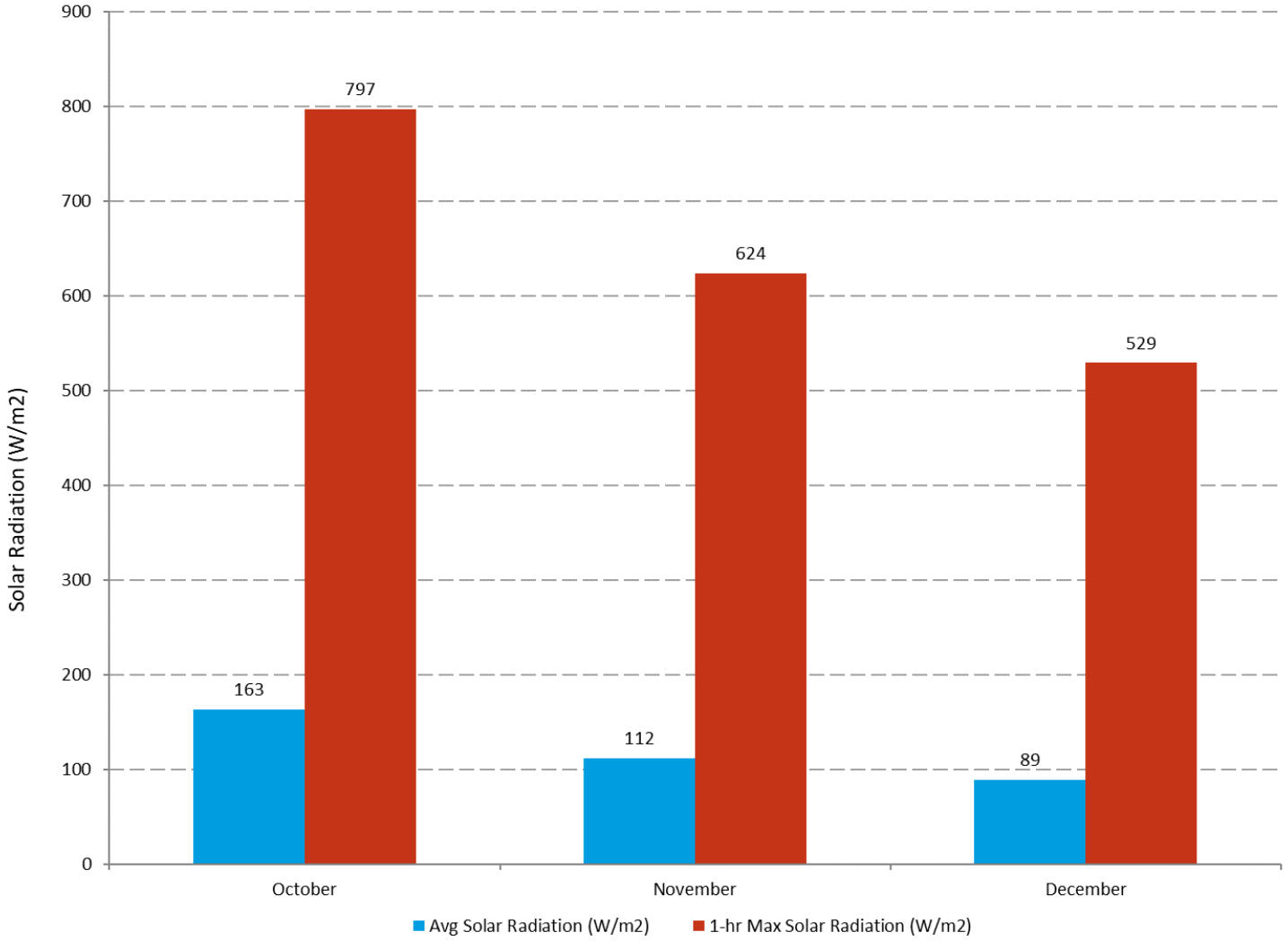


Figure 27. Hereford Q4 2024 Solar Radiation Summary

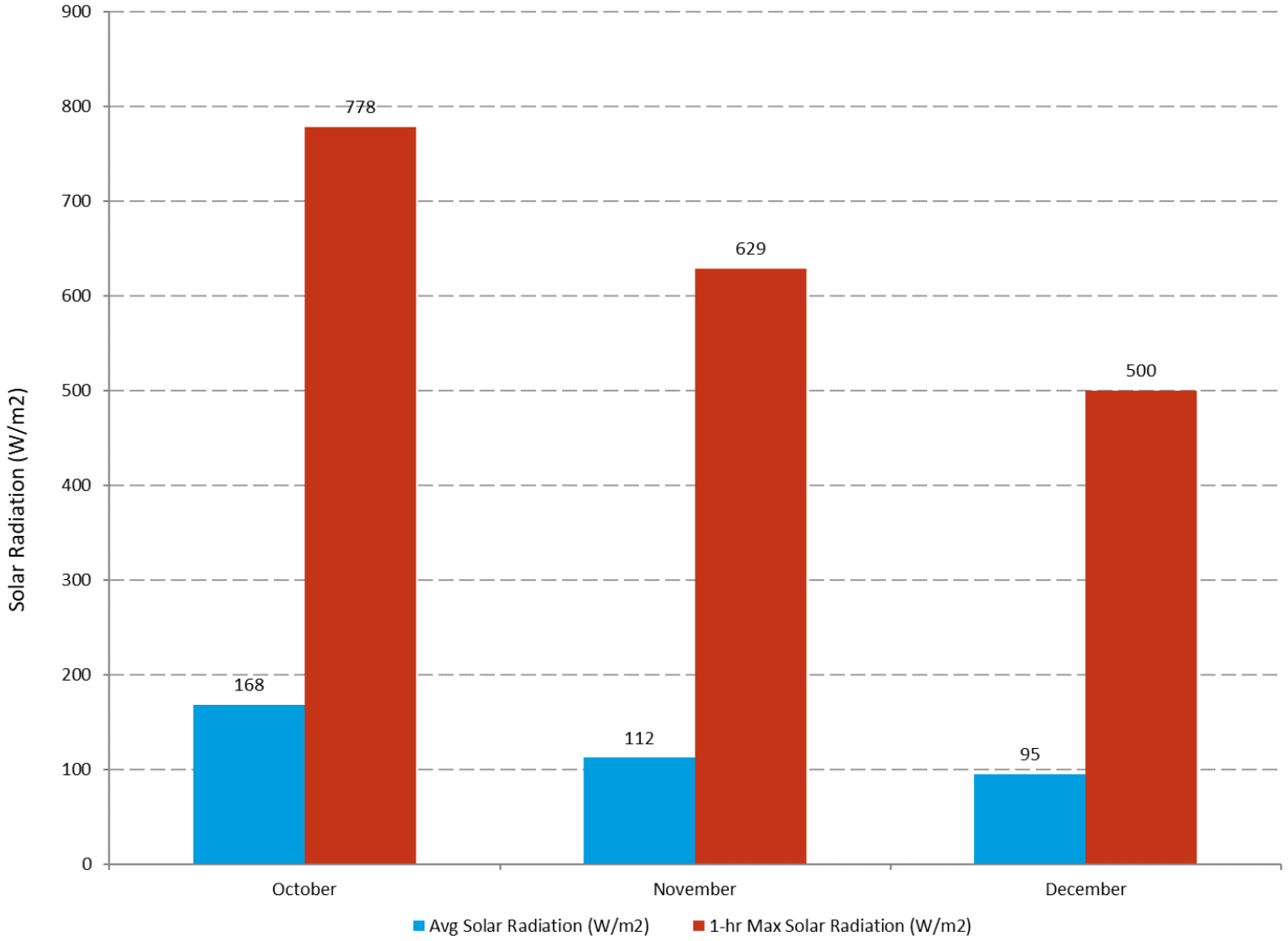


Figure 28. Orchard Q4 2024 Solar Radiation Summary

APPENDIX A2: INVALIDATION DOCUMENT

APPENDIX A2: 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	AZ	QC Audit
AL	Voided by Operator	BA	Maintenance / Routine Repairs
AM	Miscellaneous Void	BC	Multi-point Calibration
AS	Poor Quality Assurance Results.	BD	Auto Calibration
AT	Calibration	V	Value Validated
AV	Power Failure		

Periods of Invalidation				
Month	**Parameter**	**Code**	**Date and Time**	**Description**
MISSILE SITE PARK				
October	Wind Speed & Direction	BC	10/14/2024 10:00-12:00	Quarter 4 multi-point calibration
	2-m, 10-m, & Delta Temperature	BC	10/14/2024 10:00-12:00	Quarter 4 multi-point calibration
	Relative Humidity & Air Temperature	BC	10/14/2024 10:00-12:00	Quarter 4 multi-point calibration
	Solar Radiation	BC	10/14/2024 10:00-12:00	Quarter 4 multi-point calibration
	Precipitation	BC	10/14/2024 09:00-13:00	Quarter 4 multi-point calibration
	Ozone/NO/NO2/NOx	BC	10/01/2024 11:00-16:00	Quarter 4 multi-point calibration
		V	10/01/2024 17:00	Value validated. Partial hour due to multi-point calibration.
		BD	10/02/2024 02:00	Overnight calibration
		V	10/02/2024 11:00	Value validated. Partial hour due to manual calibration.
		AT	10/02/2024 12:00	Manual calibration
		V	10/02/2024 13:00	Value validated. Partial hour due to manual calibration.
		BA	10/14/2024 09:00	Calibrator maintenance affecting gases
		AT	10/14/2024 10:00-12:00	Manual calibration
		BA	10/14/2024 13:00-18:00	Analyzer maintenance
		BA	10/14/2024 19:00-10/16/2024 08:00	Analyzer settling post-maintenance - NO/NO2/NOx ONLY

		AL	10/14/2024 19:00-10/16/2024 08:00	Operator void. Post-maintenance performance not confirmed. - OZONE ONLY
		BD	10/15/2024 02:00	Overnight calibration - OZONE ONLY
		BD	10/16/2024 02:00	Overnight calibration - OZONE ONLY
		BC	10/16/2024 09:00-15:00	Quarter 4 multi-point calibration.
		V	10/16/2024 16:00	Value validated. Partial hour due to multi-point calibration.
		BD	10/17/2024 01:00-02:00	Overnight calibration
		BD	10/18/2024 02:00	Overnight calibration
		BD	10/19/2024 02:00	Overnight calibration
		BD	10/20/2024 01:00-02:00	Overnight calibration
		BD	10/21/2024 02:00	Overnight calibration
		BD	10/22/2024 02:00	Overnight calibration
		BD	10/23/2024 02:00	Overnight calibration
		BD	10/24/2024 01:00-02:00	Overnight calibration
		BD	10/25/2024 02:00	Overnight calibration
		BD	10/26/2024 02:00	Overnight calibration
		BD	10/27/2024 01:00-02:00	Overnight calibration
		BD	10/28/2024 02:00	Overnight calibration
		BD	10/29/2024 02:00	Overnight calibration
		V	10/29/2024 13:00	Value validated. Partial hour due to filter change.
		AM	10/29/2024 14:00	Filter change
		BD	10/30/2024 02:00	Overnight calibration
		BD	10/31/2024 01:00-02:00	Overnight calibration
November	Wind Speed & Direction	AZ	11/25/2024 09:00-12:00	Independent audit
	2-m, 10-m, & Delta Temperature	AZ	11/25/2024 09:00-12:00	Independent audit
	Relative Humidity & Air Temperature	AZ	11/25/2024 09:00-12:00	Independent audit
	Solar Radiation	AZ	11/25/2024 09:00-12:00	Independent audit
	Precipitation	AZ	11/21/2024 09:00-10:00	Independent audit
	Ozone/NO/NO2/NOx	BD	11/01/2024 02:00	Overnight calibration
		BD	11/02/2024 02:00	Overnight calibration

		BD	11/03/2024 01:00-02:00	Overnight calibration
		BD	11/04/2024 02:00	Overnight calibration
		BD	11/05/2024 02:00	Overnight calibration
		BD	11/06/2024 02:00	Overnight calibration
		2	11/06/2024 16:00-23:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/07/2024 01:00-02:00	Overnight calibration
		BD	11/08/2024 02:00	Overnight calibration
		AT	11/08/2024 12:00	Manual calibration
		BD	11/09/2024 02:00	Overnight calibration
		AS	11/09/2024 03:00-11/21/2024 00:00	Poor quality assurance result - NO/NO2/NOx ONLY
		BD	11/10/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		BD	11/11/2024 02:00	Overnight calibration - OZONE ONLY
		V	11/11/2024 12:00	Value validated. Partial hour due to manual calibration - OZONE ONLY
		AT	11/11/2024 13:00-14:00	Manual calibration - OZONE ONLY
		BD	11/12/2024 02:00	Overnight calibration - OZONE ONLY
		BD	11/13/2024 02:00	Overnight calibration - OZONE ONLY
		BD	11/14/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		AT	11/14/2024 14:00-15:00	Manual calibration - OZONE ONLY
		BD	11/15/2024 02:00	Overnight calibration - OZONE ONLY
		BD	11/16/2024 02:00	Overnight calibration - OZONE ONLY
		BD	11/17/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		BD	11/18/2024 02:00	Overnight calibration - OZONE ONLY
		BD	11/19/2024 02:00	Overnight calibration - OZONE ONLY
		BD	11/20/2024 02:00	Overnight calibration - OZONE ONLY
		BC	11/20/2024 11:00-16:00	Multi-point calibration - OZONE ONLY
		BA	11/20/2024 17:00	Inlet maintenance - OZONE ONLY

		V	11/20/2024 19:00	Value validated. Partial hour due to open inlet - OZONE ONLY
		BD	11/21/2024 01:00-02:00	Overnight calibration
		BD	11/22/2024 02:00	Overnight calibration
		BC	11/22/2024 10:00-14:00	Multi-point calibration
		BD	11/23/2024 02:00	Overnight calibration
		BD	11/24/2024 01:00-02:00	Overnight calibration
		BD	11/25/2024 02:00	Overnight calibration
		V	11/25/2024 09:00	Value validated. Partial hour due to independent audit.
		AZ	11/25/2024 10:00-15:00	Independent audit
		2	11/25/2024 16:00-20:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/26/2024 02:00	Overnight calibration
		AM	11/26/2024 14:00-15:00	Filter change
		BD	11/27/2024 02:00	Overnight calibration
		BD	11/28/2024 01:00-02:00	Overnight calibration
		BD	11/29/2024 02:00	Overnight calibration
		BD	11/30/2024 02:00	Overnight calibration
December	Ozone/NO/NO2/NOx	BD	12/01/2024 01:00-02:00	Overnight calibration
		BD	12/02/2024 02:00	Overnight calibration
		BD	12/03/2024 02:00	Overnight calibration
		BD	12/04/2024 02:00	Overnight calibration
		BD	12/05/2024 01:00-02:00	Overnight calibration
		BD	12/06/2024 02:00	Overnight calibration
		BD	12/07/2024 02:00	Overnight calibration
		BD	12/08/2024 01:00-02:00	Overnight calibration
		BD	12/09/2024 02:00	Overnight calibration
		BD	12/10/2024 02:00	Overnight calibration
		BD	12/11/2024 02:00	Overnight calibration
		BD	12/12/2024 01:00-02:00	Overnight calibration
		BD	12/13/2024 02:00	Overnight calibration
		BD	12/14/2024 02:00	Overnight calibration
		BD	12/15/2024 01:00-02:00	Overnight calibration
		BD	12/16/2024 02:00	Overnight calibration

		BD	12/17/2024 02:00	Overnight calibration
		AS	12/17/2024 03:00-01/01/2025 00:00	Poor quality assurance results - NO/NO2/NOx ONLY
		BD	12/18/2024 02:00	Overnight calibration - OZONE ONLY
		AT	12/18/2024 08:00-09:00	Manual calibration - OZONE ONLY
		V	12/18/2024 15:00	Value validated. Partial hour due to NOx testing - OZONE ONLY
		AM	12/18/2024 16:00	NOx testing impacting ozone measurement - OZONE ONLY
		V	12/18/2024 17:00-18:00	Value validated. Partial hours due to NOx testing - OZONE ONLY
		BD	12/19/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		BD	12/20/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/21/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/22/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		BD	12/23/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/24/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/25/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/26/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		BD	12/27/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/28/2024 02:00	Overnight calibration - OZONE ONLY
		BD	12/29/2024 01:00-02:00	Overnight calibration - OZONE ONLY
		BD	12/30/2024 02:00	Overnight calibration - OZONE ONLY
		BC	12/30/2024 11:00-16:00	Multi-point calibration check - OZONE ONLY
		AM	12/30/2024 17:00	NOx testing impacting ozone measurement - OZONE ONLY
		AT	12/30/2024 18:00	Manual calibration - OZONE ONLY
		BD	12/31/2024 02:00	Overnight calibration - OZONE ONLY

		V	12/31/2024 12:00	Value validated. Partial hour due to calibration testing - OZONE ONLY
		AT	12/31/2024 13:00	Manual calibration - OZONE ONLY
		AM	12/31/2024 14:00	Filter change
		V	12/31/2024 15:00	Value validated. Partial hour due to filter change - OZONE ONLY
Hereford				
October	Wind Speed & Direction	BC	10/10/2024 09:00-10:00	Quarter 4 multi-point calibration
		BA	10/10/2024 11:00-12:00	Data logger reprogram timing issues
	2-m, 10-m, & Delta Temperature	BC	10/10/2024 09:00-10:00	Quarter 4 multi-point calibration
		BA	10/10/2024 11:00-12:00	Data logger reprogram timing issues
	Relative Humidity & Air Temperature	BC	10/10/2024 09:00-10:00	Quarter 4 multi-point calibration
		BA	10/10/2024 11:00-12:00	Data logger reprogram timing issues
	Solar Radiation	BC	10/10/2024 09:00-10:00	Quarter 4 multi-point calibration
		BA	10/10/2024 11:00-12:00	Data logger reprogram timing issues
	Barometric Pressure	BA	10/10/2024 11:00-12:00	Data logger reprogram timing issues
	Precipitation	BC	10/10/2024 08:00-13:00	Quarter 4 multi-point calibration
		BA	10/10/2024 11:00-12:00	Data logger reprogram timing issues
	Ozone	BC	10/01/2024 12:00-14:00	Quarter 4 multi-point calibration
		V	10/01/2024 17:00	Value validated. Partial hour due to calibration testing.
		BD	10/02/2024 02:00	Overnight calibration
		AT	10/02/2024 08:00	Manual calibration
		2	10/04/2024 09:00	Standard deviation of shelter temperature greater than 2.1°C
		AT	10/10/2024 09:00	Manual calibration
		BA	10/10/2024 10:00-12:00	Analyzer maintenance & data logger reprogram timing issues
		AL	10/10/2024 13:00-10/11/2024 08:00	Operator void. Post-maintenance performed not confirmed.
		BD	10/11/2024 02:00	Overnight calibration

		BC	10/11/2024 09:00-12:00	Quarter 4 multi-point calibration
		BD	10/14/2024 02:00	Overnight calibration
		BD	10/16/2024 02:00	Overnight calibration
		BD	10/18/2024 02:00	Overnight calibration
		2	10/18/2024 11:00-21:00	Standard deviation of shelter temperature greater than 2.1°C
		2	10/19/2024 19:00-10/20/2024 05:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	10/21/2024 02:00	Overnight calibration
		BD	10/23/2024 02:00	Overnight calibration
		V	10/24/2024 14:00	Value validated. Partial hour due to calibration testing.
		AT	10/24/2024 15:00	Minor analyzer maintenance and calibration testing
		BD	10/25/2024 02:00	Overnight calibration
		BD	10/28/2024 02:00	Overnight calibration
		AM	10/29/2024 10:00-11:00	Filter change
		BD	10/30/2024 02:00	Overnight calibration
November	Wind Speed & Direction	AZ	11/26/2024 10:00-11:00	Independent audit
	2-m, 10-m, & Delta Temperature	AZ	11/26/2024 10:00-11:00	Independent audit
	Relative Humidity & Air Temperature	AZ	11/26/2024 10:00-11:00	Independent audit
	Solar Radiation	AZ	11/26/2024 10:00-11:00	Independent audit
	Precipitation	AZ	11/21/2024 14:00-15:00	Independent audit
	Ozone	BD	11/01/2024 02:00	Overnight calibration
		2	11/01/2024 20:00-11/02/2024 01:00	Standard deviation of shelter temperature greater than 2.1°C
		2	11/02/2024 23:00-11/03/2024 01:00	Standard deviation of shelter temperature greater than 2.1°C
		2	11/03/2024 14:00-17:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/04/2024 02:00	Overnight calibration
		BD	11/06/2024 02:00	Overnight calibration
		BD	11/08/2024 02:00	Overnight calibration
		2	11/10/2024 18:00-11/11/2024 05:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/11/2024 02:00	Overnight calibration
		2	11/11/2024 09:00-22:00	Standard deviation of shelter temperature greater than 2.1°C
		2	11/12/2024 01:00-06:00	Standard deviation of shelter temperature greater than 2.1°C

		BD	11/13/2024 02:00	Overnight calibration
		2	11/14/2024 20:00-23:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/15/2024 02:00	Overnight calibration
		2	11/15/2024 05:00-16:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/18/2024 02:00	Overnight calibration
		BD	11/20/2024 02:00	Overnight calibration
		BD	11/22/2024 02:00	Overnight calibration
		2	11/22/2024 20:00-11/23/2024 01:00	Standard deviation of shelter temperature greater than 2.1°C
		2	11/23/2024 07:00-14:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/25/2024 02:00	Overnight calibration
		AZ	11/26/2024 10:00-11:00	Independent audit
		AM	11/26/2024 12:00	Filter change
		BD	11/27/2024 02:00	Overnight calibration
		BD	11/29/2024 02:00	Overnight calibration
December	Ozone	BD	12/02/2024 02:00	Overnight calibration
		2	12/03/2024 19:00-12/04/2024 17:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	12/04/2024 02:00	Overnight calibration
		BD	12/06/2024 02:00	Overnight calibration
		BD	12/09/2024 02:00	Overnight calibration
		BD	12/11/2024 02:00	Overnight calibration
		BD	12/13/2024 02:00	Overnight calibration
		BD	12/16/2024 02:00	Overnight calibration
		BD	12/18/2024 02:00	Overnight calibration
		BD	12/20/2024 02:00	Overnight calibration
		BD	12/23/2024 02:00	Overnight calibration
		BD	12/25/2024 02:00	Overnight calibration
		BD	12/27/2024 02:00	Overnight calibration
		BD	12/30/2024 02:00	Overnight calibration
		AM	12/31/2024 12:00	Filter change
		V	12/31/2024 13:00	Value validated. Partial hour due to filter change.
Orchard				
	Wind Speed & Direction	BC	10/10/2024 15:00-16:00	Quarter 4 multi-point calibration
	2-m, 10-m, & Delta Temperature	BC	10/10/2024 15:00-16:00	Quarter 4 multi-point calibration
	Relative Humidity & Air Temperature	BC	10/10/2024 15:00-16:00	Quarter 4 multi-point calibration
	Solar Radiation	BC	10/10/2024 15:00-16:00	Quarter 4 multi-point calibration

	Precipitation	BC	10/10/2024 14:00-17:00	Quarter 4 multi-point calibration
	Ozone	BC	10/01/2024 12:00-15:00	Quarter 4 multi-point calibration
		V	10/01/2024 17:00	Value validated. Partial hour due to calibration testing.
		BD	10/02/2024 02:00	Overnight calibration
		AT	10/02/2024 10:00	Manual calibration
		AT	10/11/2024 14:00-15:00	Manual calibration
		BA	10/11/2024 16:00	Analyzer maintenance
		AL	10/11/2024 17:00-10/12/2024 10:00	Operator void. Post-maintenance performance not confirmed.
		BC	10/12/2024 11:00	Quarter 4 multi-point calibration
		V	10/12/2024 12:00	Value validated. Partial hour due to multi-point calibration
		BD	10/14/2024 02:00	Overnight calibration
		BD	10/16/2024 02:00	Overnight calibration
		BD	10/18/2024 02:00	Overnight calibration
		BD	10/21/2024 02:00	Overnight calibration
		BD	10/23/2024 02:00	Overnight calibration
		BD	10/25/2024 02:00	Overnight calibration
		2	10/26/2024 00:00-04:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	10/28/2024 02:00	Overnight calibration
		AM	10/29/2024 12:00-13:00	Filter change
		BD	10/30/2024 02:00	Overnight calibration
November	Wind Speed & Direction	AZ	11/26/2024 13:00-14:00	Independent audit
	2-m, 10-m, & Delta Temperature	AZ	11/26/2024 13:00-14:00	Independent audit
	Relative Humidity & Air Temperature	AZ	11/26/2024 13:00-14:00	Independent audit
	Solar Radiation	AZ	11/26/2024 13:00-14:00	Independent audit
	Precipitation	AZ	11/21/2024 11:00-12:00	Independent audit
	Ozone	BD	11/01/2024 02:00	Overnight calibration
		2	11/01/2024 08:00-11/02/2024 05:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/04/2024 02:00	Overnight calibration
		2	11/05/2024 14:00-17:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/06/2024 02:00	Overnight calibration

		BD	11/08/2024 02:00	Overnight calibration
		2	11/10/2024 19:00-11/11/2024 14:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/11/2024 02:00	Overnight calibration
		2	11/11/2024 17:00-18:00	Standard deviation of shelter temperature greater than 2.1°C
		2	11/12/2024 20:00-11/13/2024 05:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/13/2024 02:00	Overnight calibration
		2	11/14/2024 08:00-11/15/2024 19:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/15/2024 02:00	Overnight calibration
		2	11/16/2024 18:00-11/17/2024 21:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/18/2024 02:00	Overnight calibration
		2	11/18/2024 03:00-11/19/2024 17:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/20/2024 02:00	Overnight calibration
		BD	11/22/2024 02:00	Overnight calibration
		2	11/22/2024 21:00-11/23/2024 04:00	Standard deviation of shelter temperature greater than 2.1°C
		2	11/23/2024 09:00	Standard deviation of shelter temperature greater than 2.1°C
		BD	11/25/2024 02:00	Overnight calibration
		AM	11/26/2024 12:00	Filter change
		AZ	11/26/2024 13:00-14:00	Independent audit
		BD	11/27/2024 02:00	Overnight calibration
		BD	11/29/2024 02:00	Overnight calibration
December	Ozone	BD	12/02/2024 02:00	Overnight calibration
		BD	12/04/2024 02:00	Overnight calibration
		BD	12/06/2024 02:00	Overnight calibration
		V	12/06/2024 13:00	Value validated. Partial hour due to calibration testing.
		AT	12/06/2024 14:00	Manual calibration
		BD	12/09/2024 02:00	Overnight calibration
		BD	12/11/2024 02:00	Overnight calibration
		BD	12/13/2024 02:00	Overnight calibration
		BD	12/16/2024 02:00	Overnight calibration
		AV	12/18/2024 02:00-12/19/2024 13:00	Power failure
		V	12/19/2024 14:00	Value validated. Partial hour due to power failure.
		BD	12/20/2024 02:00	Overnight calibration
		BD	12/23/2024 02:00	Overnight calibration
		BD	12/25/2024 02:00	Overnight calibration

		BD	12/27/2024 02:00	Overnight calibration
		BD	12/30/2024 02:00	Overnight calibration
		AM	12/31/2024 11:00-12:00	Filter Change

APPENDIX A3: SITE VISITATION LOG

Missile Site Park Site Access Log								
Name	Date	Arrival	Departure	Last Filter change		Pump off	Pump on	Notes
				NOx	Ozone			
Zaragoza	10/1/2024	9:09	11:00					On site to replace 4 way valve for zero air generator. Valve replaced at 10:10 logger time. Performed leak check from 10:13 to 10:20 logger time (gases not impacted). Started zero event at 10:22 logger time. Started NO span at 10:29 logger time. Calibration event left running for Q4 'as found' checks.
Dearden (Remote)	10/1/2024	10:29	16:05					Remote multipoint calibrations. 10:29-14:40 MST for NOx, and 14:40 - 16:05 MST for Ozone. Both gasses invalid for the entire duration.
Dearden (Remote)	10/2/2024	10:45	12:05					Manual calibration check before site visit, gasses invalid. MST
Christman	10/2/2024	13:17	14:00					Removed T700 calibrator for semi-annual verification; plugged calibration output line, capped T701 outlet, plugged audit gas outlet line, closed gas cylinder valves at regulator and tank; increased T700 UV lamp intensity to max level
Zaragoza/Christman	10/14/2024	7:55	18:00					Onsite for Q4 calibration checks. Precipitation down for pre/post checks and maintenance between 8:26 and 13:00 logger time. Tower down from 9:33 to 11:04 logger time. T700 reinstalled 8:30; backpressure comp at 8:58. Zero check ran at 9:05-9:21. Ozone Span and precision check ran from 9:21-9:53. NO span check initiated at 9:55-10:36. NO precision checks initiated at 10:36-10:52 (60 ppb) and 12:01-12:12 (100 ppb). NO2 GPT initiated at 11:43-12:00. Ozone down for maintenance from 8:30-18:00. Ozone maintenance included flow orifice rebuild, Nafion line filter replacement, and Nafion pump rebuild. Ozone post maintenance leak check was 0 cc/min and 1.6 inHg. NOx down for maintenance from 8:30 until system stabilizes in the next day or two when the multi-point calibration can be performed. NOx maintenance included ozone cleanser replacement, DFU filter replacement, rxn cell orifice rebuilds for both flow orifices, Moly converter replacement, and reaction cell cleaning. NOx post maintenance leak check was 2.1 inHg in the rcell and 2.2 inHg in the sample pressure. Inlet also replaced. ZAG media replaced.
Dearden (Remote)	10/16/2024	7:46	15:14					Remote multipoint calibrations. 7:46-11:25 MST for O3 and 11:25 - 15:14 MST for NOx. Both gasses invalid for the entire duration.
Christman/Emerson	10/24/2024	8:00	10:20					On site to oversee the installation of gas monitoring equipment by STI. Gas inlet and anemometer pole was mounted on roof railing, new 3-cylinder rack was installed in place of existing rack; CDPHE equipment was lowered in the rack and a new rack shelf was installed for the new equipment in the rack; a new penetration was made in the LB for cable passthrough.
Clemments	10/29/2024	13:44	14:13	10/29/2024	10/29/2024	13:59	14:07	NOx & O3 filters swapped, NADP sample retrieved and set up.
Dearden (Remote)	11/8/2024	11:05	12:00					Remote Ozone ZSP check. Passing results, calibrator ran steady the entire duration. (Gasses offline)
Dearden (Remote)	11/11/2024	11:46	13:55					Remote NO ZSP check and Span GPT check. Passing values.
Dearden (Remote)	11/14/2024	13:08	15:45					Remote GPT precision check. Passing values.
Dearden (Remote)	11/20/2024	10:02	16:13					Remote Multipoint calibration for NOx. Non-linear response resulted in a failing calibration. Maintenance to be performed. Gasses offline.
Zaragoza	11/20/2024	16:13	18:40					On site to troubleshoot non-linear NOx response. NO/NO2/NOx analyzer down from 16:13 to 18:40. Ozone down from 16:13 - 16:30. NOx maintenance included replacement of sintered filter on both flow orifices. Replacement of spring in ozone flow orifice. Reinstallation of previously installed (used) orifice into ozone flow orifice holder. Reasoning includes signs of corrosion on spring of ozone flow orifice. Ozone cleanser media replaced. Reaction cell opened and wiped down with kim wipes and isopropyl alcohol. Final leak check: reaction cell 2.0 and sample press 2.2. Ozone down from 18:30-18:40.
Zaragoza/Orth	11/21/2024	8:04	9:35					On site for ARS audit of solar and precip. Precip down from 8:15 to 9:15
Dearden (Remote)	11/22/2024	9:20	13:45					Remote multipoint calibration for NOx, passing results, slope and offset did not change. Gasses offline.
Zaragoza/CDPHE	11/25/2024	8:21	14:52					On site for CDPHE audit of gas and meteorology. Gases down from 8:54 to 14:46. Tower down from 8:59 to 11:21 (winds, solar, 2 and 10 m temp, RH impacted). Wind speed prop replaced with Hereford spare due to small crack found in existing one. No data implications, this was preventative work.
Clemments	11/26/2024	13:30	13:58	11/26/2025	11/26/2024	13:33	13:37	NOx & O3 filters swaped. NADP sample retrieved and set up.
Dearden (Remote)	12/18/2024	7:39	8:50					Manual NOx ZSP calibration

Missile Site Park Site Access Log								
Name	Date	Arrival	Departure	Last Filter change		Pump off	Pump on	Notes
				NOx	Ozone			
Zaragoza	12/18/2024	14:46	19:05					On site to troubleshoot NOx. Leak check from 14:47 - 14:55 (both gases impacted). Auto zero testing 15:12-15:13. Span generated from 15:15 to 15:29 for NOx diagnostic review (both gases impacted). Autozero and NO/NOx valves cleaned between 15:30 and 17:18 (NOx down and ozone impacts apparent in data, ozone down from 15:30-16:08. NOx leak check from 17:52 to 17:57 (both gases impacted).
Zaragoza	12/30/2024	10:29	18:10					Multipoint calibration check on NO/NO2/NOx from 10:29 to 16:04. Replacement of ozone dryer and NO/NOx valve from 16:08 to 17:08. NO/NO2/NOx PSZ from 17:38 to 17:58. All gases down from 10:29 to 16:04. 16:08 to 16:25. 17:00-18:00.
Zaragoza	12/31/2024	11:57	14:55	12/31/2024	12/31/2024	12:30	12:33	On site to further troubleshoot NOx. PSZ performed 11:57 to 12:33. NOx and ozone filter change 12:30-12:33. NOx turned off for ozone cleanser media replacement and rxn cell cleaning from 12:33 to 14:15. Ozone and sample flow orifices inspected. Ozone flow orifice replaced after signs of corrosion. Leak check from 14:40 to 14:48 (both gases impacted)

Hereford Site Access Log							
Name	**Date**	**Arrival**	**Departure**	**Last Filter change**	**Pump off**	**Pump on**	**Notes**
				Ozone			
Dearden (Remote)	10/1/2024	11:33	13:40				Remote multipoint calibration, ozone offline for the duration of the visit (MST)
Dearden (Remote)	10/1/2024	16:28	16:29				Quick sanity check to ensure calibrator is on standby mode. Minutes 16:28 & 16:29 invalid for Ozone.
Dearden (Remote)	10/2/2024	7:07	7:40				Manual calibration check before site visit. MST
Christman	10/2/2024	9:36	10:07				Removed T703 calibrator for semi-annual verification; plugged calibration output line and isolated desiccant inlet from ambient air; increased UV lamp intensity
Zaragoza/Christman	10/10/2024	7:30	12:30				On site for calibrator reinstall, site maintenance, and calibration checks. Ozone down from 0820-1117. Initial PSZ performed from 0838-0922. T703 back pressure compensation performed at 0925. Ozone flow orifice rebuilt and sample conditioner pump rebuilt. Post-maintenance Span/Zero performed at 1048-1116. Installed new 05305 wind sensor. Precip down for pre/post checks and maintenance between 7:48 and 12:30 logger time. Tower down from 8:33 to 11:52 logger time.
Dearden (Remote)	10/11/2024	8:28	11:25				Remote multi-point as-left calibrations. Ozone offline 8:28 - 11:25
Christman/Emerson	10/24/2024	14:15	16:00		13:46	14:14	On site to oversee the installation of gas monitoring equipment by STI. Gas inlet and anemometer pole was mounted on roof railing; new cylinder rack was installed; new rack shelf was installed for the new equipment in the rack; a new penetration was made in the LB for cable passthrough. Sample flow orifice was re-oriented in the T400; leak check passed following change at <10cc/min, 1.8"Hg. Performed Span/Precision/Zero following leak check with good results. Ozone offline from 13:46-14:53
Clemments	10/29/2024	10:33	10:52	10/29/2024	10:38	10:48	Desiccant and NOx/O3 filter change.
Zaragoza/Orth	11/21/2024	13:15	14:50				On site for ARS audit of solar and precip. Precip down from 13:24 to 14:20
Zaragoza/CDPHE	11/26/2024	9:12	10:55	11/26/2024	10:43	10:44	On site for CDPHE audit. Ozone down from 9:15 to 10:44; filter change then occurred at 10:44. Tower down from 9:21 to 10:18.
Clemments	11/26/2024	10:22	10:39		10:29	10:32	Desiccant changed out
Garcia	12/31/2024	11:10	11:25	12/31/2024	11:14	11:22	Desiccant changed, O3 filter changed

Orchard Site Access Log							
Name	**Date**	**Arrival**	**Departure**	**Last Filter change**	**Pump off**	**Pump on**	**Notes**
				Ozone			
Dearden (Remote)	10/1/2024	11:21	14:40				Remote multipoint calibration, ozone offline for the duration of the visit (MST)
Clemments	10/1/2024	13:00	13:40				Replaced Shell on precipitation bucket for NADP
Dearden (Remote)	10/1/2024	16:24	16:24				Quick sanity check to ensure calibrator is on standby mode. Minute 16:24 invalid for Ozone.
Dearden (Remote)	10/2/2024	9:20	9:55				Manual calibration check before site visit. MST
Christman	10/2/2024	11:17	11:53				Removed T703 calibrator for semi-annual verification; plugged calibration output line and isolated desiccant inlet from ambient air; increased UV lamp intensity
Zaragoza/Christman	10/10/2024	13:30	17:47				On site for calibrator reinstall, site maintenance, and calibration checks. No power cord was returned with the ozone calibrator so no ozone maintenance could be performed. T703 was reinstalled in rack and ozone maintenance was delayed until follow up site visit. Precip start at 13:56 logger time. Two as left checks performed at 15:00 and 16:00. Precip back online at 16:45. Tower down between 14:08 and 15:13.
Zaragoza	10/11/2024	13:00	15:55				On site to power on T703 and performed analyzer maintenance. Back pressure compensation performed 13:22-13:30. Ozone gen cal performed 13:30-14:30. ZSP performed 14:31 - 14:58. Analyzer maintenance performed between 14:58 and 15:55. Ozone down from 13:22-15:55
Zaragoza (remote)	10/12/2024	9:51	11:06				As left check for ozone. No calibration performed. Ozone down on 10/12 between 951 and 1106 logger time. Ozone data valid between maintenance on 10/11 and multi-point on 10/12
Christman/Emerson	10/24/2024	11:20	13:30				On site to oversee the installation of gas monitoring equipment by STI. Gas inlet and anemometer pole was mounted on roof railing; new cylinder rack was installed; new rack shelf was installed for the new equipment in the rack; a new penetration was made in the LB for cable passthrough.
Clemments	10/28/2024	12:00	12:33	10/28/24	12:19	12:28	Desiccant changed, NOx/O3 filter changed. NADP sample retrieved and set up.
Zaragoza/Orth	11/21/2024	10:45	12:05				On site for ARS audit of solar and precip. Precip down from 10:45 to 11:51
Clemments	11/26/2024	11:42	12:03	11/26/24	10:44	10:49	Desiccant changed, NOx/O3 filter changed, NADP sample retrieved (no precip) and set up.
Zaragoza/CDPHE	11/26/2024	12:03	14:00				On site for CDPHE audit. Ozone down from 12:10 to 13:25. Tower down from 12:23 to 13:40; RH remained down for aspirator cleaning until 13:50.
Dearden (Remote)	12/6/2024	12:56	13:44				Remote ZSP check for ozone. Passing results.
Clemments	12/19/2024	12:46	13:15				On-site for a power failure, found power strip switch had been tripped. Flipped switch and verified with Abe that all instruments are connected again.
Clemments	12/31/2024	10:15	10:53	12/31/24	10:38	10:40	Desiccant changed, O3 filter changed, NADP sampled retrieved, AMoN retrieved

APPENDIX A4: CORRECTIVE ACTION REPORTS

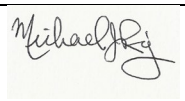
CORRECTIVE ACTION REPORT NO.: 30

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**	
Estimated start date/time	**11/09/2024**	
Problem identified by:	**Blake Himes**	
Problem definition: • **Parameter (s) affected**	**A shift in NO/NO2/NOx response was noticed on the 11/09 routine nightly check. Despite the shift, zero/span/precision and precision and span gas-phase titration checks were within critical criteria. A multi-point check was performed on 11/20 as part of a planned 'as found/as left' so that analyzer maintenance could be performed in response to the shift. The multi-point 'as found' check on 11/20 did not pass.** • **NO/NO2/NOx**	
Planned corrective actions (if necessary):	**Analyzer maintenance and calibration (if necessary)**	
	Expected Completion Date:	**11/22/2024**

Problem Resolution		
Date corrective action taken:	**11/20 and 11/22 2024**	
Action taken by:	**Jake Zaragoza & Abe Dearden**	
Corrective action taken:	**Immediately following the failing 11/20 'as found' check, analyzer maintenance was performed which included a replacement of ozone cleanser media, replacement of flow orifice filters, a flow orifice replacement, and a reaction cell cleaning. A routine nightly check was performed on 11/21 with passing results. A multi-point 'as left' check was performed on 11/22 with passing results. No calibration was performed during the 11/22 multi-point. Data between when the shift was first noticed (11/09) and the first passing nightly check (11/21) was invalidated.**	
Effectiveness of corrective actions:	☒ **Yes, it was resolved**	☐ **No, it was NOT resolved**

Corrective Action Report Author & Date	Signature

Prepared by: Jake Zaragoza **Date: 12/04/2024**	
QA Officer: Michael Ring **Date: 12/04/2024**	

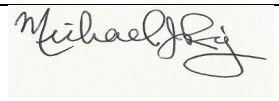
CORRECTIVE ACTION REPORT NO.: 31

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**	
Estimated start date/time	**12/17/2024**	
Problem identified by:	**Blake Himes**	
Problem definition: • **Parameter (s) affected**	**A shift in NO/NO2/NOx response was noticed on the 12/17 routine nightly check. Despite the shift, zero/span/precision and precision and span gas-phase titration checks were within critical criteria. A multi-point check was performed on 12/30 as part of a planned 'as found/as left' so that analyzer maintenance could be performed in response to the shift. The multi-point 'as found' check on 12/30 did not pass.** • **NO/NO2/NOx**	
Planned corrective actions (if necessary):	**Analyzer maintenance and calibration (if necessary)**	
	Expected Completion Date:	**1/2/2025**

Problem Resolution		
Date corrective action taken:	**12/30, 12/31 and 1/2/2025**	
Action taken by:	**Jake Zaragoza & Abe Dearden**	
Corrective action taken:	**Following the shift on 12/17, an emergency visit was made on 12/18 to perform maintenance. The NO/NOx valve was cleaned but there was minimal change in response. Note due to travel schedules a multipoint was not performed at this time. On 12/30 a multi-point was performed but results were failing. Also on 12/30 the NO/NOx valve and the ozone dryer were replaced. On 12/31 the reaction cell was cleaned, the ozone cleanser media replaced, and the ozone flow orifice rebuilt. On 1/2 a multi-point check was performed with passing results. Data invalid between 12/17 and 1/2.**	
Effectiveness of corrective actions:	☒ **Yes, it was resolved**	☐ **No, it was NOT resolved**

Corrective Action Report Author & Date	Signature

Prepared by: Jake Zaragoza **Date: 1/2/2025**	
QA Officer: Michael Ring **Date: 1/2/2025**	

APPENDIX B: SEMI-ANNUAL CALIBRATION VISITS AND INDEPENDENT AUDIT

APPENDIX B1: MISSILE SITE PARK STATION Q4 SEMI-ANNUAL CALIBRATION

RAMBOLL

TABLE B1-1

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: WELD COUNTY MONITORING NETWORK: MISSILE SITE PARK SITE

AUDIT DATE: 10/14/2024

AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman, Ramboll

HORIZONTAL WIND SPEED/DIRECTION AUDIT

SENSOR MODEL: RM Young 05305V

SENSOR SERIAL #: 180188

AUDIT DEVICE MODEL: RM Young 18802

AUDIT DEVICE SERIAL #: CA5458

AUDIT DEVICE EXPIRATION: 10/26/2024

START TIME	STOP TIME
--	--

PARAMETER	AUDIT METHOD	AUDIT VALUE	SENSOR RESPONSE	DIFFERENCE (M/S)	ACCEPTANCE CRITERIA	VALUE WITHIN ACCEPTANCE CRITERIA
HORIZONTAL WIND SPEED	DC MOTOR RPM	M/S	M/S	M/S	M/S	N/A
	0	0.000	0.001	0.00	0.20	YES
	200	1.024	1.074	-0.05	0.20	YES
	400	2.048	2.068	-0.02	0.20	YES
	600	3.072	3.059	0.01	0.20	YES
	800	4.096	4.097	0.00	0.20	YES
	1000	5.120	5.104	0.02	0.20	YES
	2000	10.240	10.194	0.05	0.20	YES
	3000	15.360	15.317	0.04	0.20	YES
	4000	20.480	20.430	0.05	0.20	YES
	5000	25.600	25.560	0.04	0.20	YES
		TORQUE VERIFICATION	CW =	0.2	≤ 0.3 gm-cm	YES
			CCW =	0.2	≤ 0.3 gm-cm	YES
WIND DIRECTION	ALIGNMENT GAUGE	0	-1.41	1.41	5	YES
		30	29.45	0.55	5	YES
		60	60.86	0.86	5	YES
		90	91.36	1.36	5	YES
		120	121.66	1.66	5	YES
		150	150.93	0.93	5	YES
		180	180.80	0.79	5	YES
		210	209.90	0.10	5	YES
		240	239.69	0.31	5	YES
		270	269.73	0.27	5	YES
		300	299.20	0.80	5	YES
		330	329.55	0.45	5	YES
		360	358.42	1.58	5	YES
		TORQUE VERIFICATION	QUAD.#1 =	7	≤ 9.0 gm-cm	YES
			QUAD.#2 =	7	≤ 9.0 gm-cm	YES

MAG DEC: 7.62

°E CROSS ARM ALIGNMENT: AS FOUND: -1.5

TOLERANCE: +/- 5° (PASSED)

4 QUAD VANE ALIGNMENT:

N=	-1.607
E=	90.88
S=	181.427
W=	272.004

WIND DIRECTION	TRANSIT ALIGNMENT				
		AUDIT =	-1.5	2.0 degrees	YES

KEY:

HWS	Horizontal wind speed
VWS	Vertical wind speed
WD	Wind direction
M/S	Meters per second
N/A	Not applicable
MAG. DEC.	Magnetic Declination
CW	Clockwise
CCW	Counter Clockwise
AGL	Above Ground Level

NOTES: No changes made

RAMBOLL

TABLE B1-2

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: WELD COUNTY MONITORING NETWORK: MISSILE SITE PARK SITE
AUDIT DATE: 10/14/2024
AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman, Ramboll

TEMPERATURE/DELTA TEMERATURE AUDIT

SENSOR MODEL: RM YOUNG 41342VC
SENSOR SERIAL #: 032951 (2M)/032952 (10M)
AUDIT DEVICE: Omega HH42A
AUDIT DEVICE SERIAL #: 23KMM02815
AUDIT DEVICE EXPIRATION: 11/21/2024

START TIME	STOP TIME
--	--

WATER BATH PARAMETER	AUDIT SENSOR VALUE	2-M SENSOR VALUE	2-M VS. AUDIT DIFF.	10-M SENSOR VALUE	10-M VS. AUDIT DIFF.	ACCEPTANCE CRITERIA (+/-)	DELTA T: 10-M VS. 2-M DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA
	DEG. C	DEG. C	DEG. C	DEG. C	DEG. C	DEG. C	DEG. C	DEG. C	N/A
ICE BATH	0.16	0.27	0.11	0.22	0.06	0.50	-0.05	0.1	YES
AMBIENT BATH	26.12	26.17	0.05	26.10	-0.02	0.50	-0.07	0.1	YES
HOT BATH	48.34	48.34	0.00	48.27	-0.07	0.50	-0.07	0.1	YES

NOTES: No changes made

RAMBOLL

TABLE B1-3

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: WELD COUNTY MONITORING NETWORK: MISSILE SITE PARK SITE
AUDIT DATE: ########
AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman, Ramboll

RELATIVE HUMIDITY AUDIT

SENSOR MODEL: EE181
SENSOR SERIAL #: ##########
AUDIT DEVICE MODEL: EE181
AUDIT DEVICE SERIAL #: 214116001537C1
AUDIT DEVICE EXPIRATION: 3/21/2025

START TIME	STOP TIME
--	--

RELATIVE HUMIDITY		AUDIT SENSOR VALUE	2-M SENSOR VALUE	ABSOLUTE % RH DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA?
	UNITS	% RH	% RH	% RH	PERCENT	N/A
AVERAGE:		53.25	57.39	4.14	7.0	YES
		43.91	48.15	4.24	7.0	YES
		34.95	38.89	3.94	7.0	YES
		26.93	29.65	2.72	7.0	YES

NOTES: No changes made

BAROMETRIC PRESSURE AUDIT

SENSOR MODEL: Setra 278
SENSOR SERIAL #: 7563464
AUDIT DEVICE MODEL: BVC10
AUDIT DEVICE SERIAL #: 2972
AUDIT DEVICE EXPIRATION: 11/24/2024

START TIME	STOP TIME
--	--

BAROMETRIC PRESSURE		AUDIT SENSOR VALUE	2-M SENSOR VALUE	ABSOLUTE DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA?
	UNITS	mm Hg	mm Hg	mm Hg	mm Hg	N/A
AVERAGE:		639.87	640.07	0.20	2.25	YES

NOTES: No changes made

PRECIPITATION AUDIT

SENSOR MODEL: RM Young Heated Rain Gauge Model 52202
SENSOR SERIAL: TB16137
AUDIT DEVICE MODEL: Drip Bottle
AUDIT DEVICE SERIAL #: N/A

START TIME	STOP TIME
--	--

PRECIPITATION		AUDIT SENSOR VALUE	2-M SENSOR VALUE	PERCENT DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA?
As Found						
300 ML WATER = 150 TIPS/0.3"	*UNITS*	Inches	Inches	PERCENT	PERCENT	N/A
Volume 1000		1.968505	1.942	-1.3%	10	YES
As Left						
300 ML WATER = 150 TIPS/0.3"	*UNITS*	Inches	Inches	PERCENT	PERCENT	N/A
Volume 1000		1.968505	2.025	2.9%	10	YES

NOTES: Tipping buckets cleaned

PANEL TEMPERATURE AUDIT

SENSOR MODEL: Campbell Scientific CR3000
SENSOR SERIAL #: 13406
AUDIT DEVICE MODEL: Omega HH42A
AUDIT DEVICE SERIAL #: 23KMM02815
AUDIT DEVICE EXPIRATION: 11/21/2024

START TIME	STOP TIME
--	--

PANEL TEMPERATURE		AUDIT SENSOR VALUE	2-M SENSOR VALUE	ABSOLUTE DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA?
	UNITS	DEG. C	DEG. C	DEG. C	ABS. DIFF	N/A
INSTANTANEOUS READING:		22.66	23.92	1.26	2.1	YES

NOTES: No changes made

Table B1-4

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: WELD COUNTY MONITORING NETWORK: MISSILE SITE PARK SITE
AUDIT DATE: 10/14/2024
AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman, Ramboll

SOLAR RADIATION AUDIT

SENSOR MODEL: Hukseflux LP02
SENSOR SERIAL #: 48019
AUDIT DEVICE MODEL: SR05-A1
AUDIT DEVICE SERIAL #: 19771
AUDIT DEVICE EXPIRATION: 11/16/2024

Timestamp	Audit Sensor (w/m2)	Site Sensor (w/m2)
10/13/2024 5:00	0	0
10/13/2024 6:00	0.009	0
10/13/2024 7:00	27.92	26.06
10/13/2024 8:00	165.6	158.7
10/13/2024 9:00	393.5	383.9
10/13/2024 10:00	561.5	545.2
10/13/2024 11:00	676.3	659.4
10/13/2024 12:00	718.4	705.1
10/13/2024 13:00	696.7	684.2
10/13/2024 14:00	614.8	601.5
10/13/2024 15:00	481.1	467.2
10/13/2024 16:00	299.7	287.2
10/13/2024 17:00	77	72.98
10/13/2024 18:00	1.723	1.219
10/13/2024 19:00	0	0
AVG	**314.3**	**306.2**
	% DIFF=	**2.58%**

NOTES: No changes made

TABLE B1-5
GAS CALIBRATION AS FOUND REPORT

AUDIT DATE: 10/1/2024
AUDITED BY: Abraham Dearden, Ramboll
SITE: Missile Site Park

ANALYZER DEVICE: TELEDYNE API T200 NOX ANALYZER RANGE = 0 - 500 PPB NOX
ANALYZER DEVICE: TELEDYNE API T400 O3 ANALYZER, RANGE 0 - 500 PPB O3
AUDIT DEVICE: TELEDYNE API T700 MULTI-GAS CALIBRATOR

NO Audit

Time Keeping	Calibration Gas Flows (LPM)			Audit Point	NO Audit Conc. (PPB)	NO_x Audit Conc. (PPB)	NO (PPB)	NO % diff.	NO_x (PPB)	NO_x % diff.	NO_2 (PPB)	NO_2 % diff.	NO_x Pass/Fail
Calibrations Start Time	Audit Gas		Zero Air										
10:29:00 AM	0.0000		5.0130	Zero	0.0	0.0	0.7	N/A	0.9	N/A	0.5	N/A	N/A
	0.0083		5.0110	2	50.3	50.5	49.6	-1.3	50.1	-0.7	0.5	N/A	PASS
	0.0165		5.0030	3	100.3	100.6	99.5	-0.8	99.5	-1.1	0.4	N/A	PASS
	0.0329		4.9830	4	200.1	200.8	198.5	-0.8	198.6	-1.1	0.3	N/A	PASS
	0.0657		4.9520	5	399.2	400.5	396.6	-0.7	398.6	-0.5	1.8	N/A	PASS

NO_2 Audit (Gas Phase Titration)

	Calibration Gas Flows (LPM)			Audit Point	NO_2 Audit Conc. (PPB)	NO Audit Conc. (PPB)	NO Orig. (PPB)	NO rem. (PPB)	NO_x (PPB)	NO_2 (PPB)	NO_2 % diff.	Molybdenum Converter Efficiency (%); >96% = PASS	NO_2 Pass/Fail
	Audit Gas	Ozone	Zero Air										
	0.0000	0.0000	5.0130	Zero	0.0	0.0	N/A	0.7	0.9	0.5	N/A	101.2%	N/A
	0.0198	0.1050	5.8910	1 (40 PPB O_3)	42.0	100.3	99.5	57.5	99.3	41.7	-0.7	PASS	PASS
Calibrations Stop Time	0.3950	0.1050	5.8720	2 (80 PPB O_3)	80.5	200.5	198.5	117.9	199.3	82.0	1.8		PASS
2:40:00 PM	0.7880	0.1050	5.8310	3 (160 PPB O_3)	161.2	399.5	396.6	235.4	399.8	164.1	1.8		PASS

Ozone Audit

Calibrations Start Time	Audit Point	Uncorrected Audit Conc. (PPB)	Corrected Audit Conc. (PPB)	O_3 (PPB)	O_3 % diff.	Pass/Fail
2:40:00 PM	Zero	0.00	-0.1584	1.53	N/A	N/A
	1	49.80	50.289	50.63963	0.7	PASS
	2	100.80	101.952	101.43	-0.5	PASS
	3	198.90	201.3273	199.08	-1.1	PASS
Calibrations Stop Time	4	300.70	304.4507	297.73	-2.2	PASS
4:05:00 PM	5	400.20	405.2442	396.51	-2.2	PASS

Linear Regression

	NO	NO_x	NO_2 (GPT)	O3
Slope	0.993	0.994	1.018	0.974
Intercept	0.090	0.040	-0.144	1.958
Correlation	1.0000	1.0000	1.0000	1.0000
Avg % diff.	-0.90	-0.84	0.93	-1.06

Diagnostics

	T700	T400		T200	Audit Gas	
Serial Number	4969	5986	Serial Number	6727	Cylinder SN	EB0136191
O_3 Slope	0.9870	1.01	NO_x Slope	0.957	NO Conc (PPM)	30.5
O_3 Offset	0.4000	-0.60	NO_x Offset	-0.5	NO_x Conc (PPM)	30.6
L3 O_3 Slope Correction Factor	1.0130		NO Slope	0.961	NO_2 Impurity (PPM)	0.1
L3 O_3 Offset Correction Factor	-0.1584		NO Offset	-0.7		
Box Temp (C)	30.6	28.4	Box Temp (C)	31.8		
(Photo) Sample Temp (C)		35.5	HVPS (V)	536		
Ph. Lamp Temp (C)	58.0	58.0	Moly Conv Temp. (C)	316.4		
Ozone Gen Lamp Temp (C)	48.0		O_3 Flow (cc/min)	82.0		
Photo Flow (lpm)			PMT Temp. (C)	6.8		
Photo Press (in Hg)	25.2		Rx Cell Press (in Hg)	3.3		
Sample Flow (cc/min)		683.2	Rx Cell Temp (C)	50.00		
Sample Press (in Hg)		22.7	Sample Flow (cc/min)	526.0		
O_3 Ref (mV)	3690.8	4364.8	Sample Press (in Hg)	23.6		

Key:

NO_2	Nitrogen Dioxide	%	Percent
NO_x	Oxides of Nitrogen	TAPI	Teledyne Advanced Pollution Instrumentation
N/A	Not Applicable	Avg	Average
orig.	Original	Conc.	Concentration
PPB	Parts Per Billion	diff.	Difference
slpm	Standard liters per minute	GPT	Gas Phase Titration
rem.	Remaining	NO	Nitrogen Oxide

NOTES:
The Q2 2024 'as left' table T200 NO and NOx slope and offset do not match this table. This is because the final slope and offset were not properly recorded in the Q2 2024 report. There is no cause for concern.

TABLE B1-6
GAS CALIBRATION AS LEFT REPORT

AUDIT DATE: 10/16/2024
AUDITED BY: Abraham Dearden, Ramboll
SITE: Missile Site Park

ANALYZER DEVICE: TELEDYNE API T200 NOX ANALYZER RANGE = 0 - 500 PPB NOX
ANALYZER DEVICE: TELEDYNE API T400 O3 ANALYZER, RANGE 0 - 500 PPB O3
AUDIT DEVICE: TELEDYNE API T700 MULTI-GAS CALIBRATOR

NO Audit

Time Keeping	Calibration Gas Flows (LPM)			Audit Point	NO Audit Conc. (PPB)	NO_x Audit Conc. (PPB)	NO (PPB)	NO % diff.	NO_x (PPB)	NO_x % diff.	NO_2 (PPB)	NO_2 % diff.	NO_x Pass/Fail
Calibrations Start Time	Audit Gas		Zero Air										
11:25:00 AM	0.0000		5.0012	Zero	0.0	0.0	0.1	N/A	0.1	N/A	0.6	N/A	N/A
	0.0083		5.0100	2	50.3	50.5	49.5	-1.6	50.1	-0.7	0.5	N/A	PASS
	0.0165		5.0010	3	100.0	100.3	99.6	-0.4	100.5	0.1	1.1	N/A	PASS
	0.0329		4.9830	4	200.0	200.7	199.1	-0.5	199.8	-0.4	1.0	N/A	PASS
	0.0657		4.9540	5	399.1	400.4	399.2	0.0	400.6	0.0	1.6	N/A	PASS

NO_2 Audit (Gas Phase Titration)

	Calibration Gas Flows (LPM)			Audit Point	NO_2 Audit Conc. (PPB)	NO Audit Conc. (PPB)	NO Orig. (PPB)	NO rem. (PPB)	NO_x (PPB)	NO_2 (PPB)	NO_2 % diff.	Molybdenum Converter Efficiency (%); >96% = PASS	NO_2 Pass/Fail
	Audit Gas	Ozone	Zero Air										
	0.0000	0.0000	5.0012	Zero	0.0	0.0	N/A	0.1	0.1	0.6	N/A	99.5%	N/A
	0.0198	0.1050	5.8930	1 (40 PPB O_3)	42.4	100.2	99.6	57.3	99.7	42.4	0.2	PASS	PASS
Calibrations Stop Time	0.0995	0.1050	5.8700	2 (80 PPB O_3)	82.4	200.3	199.1	116.6	199.0	82.5	0.1		PASS
3:14:00 PM	0.0878	0.1050	5.8340	3 (160 PPB O_3)	170.5	399.5	399.2	228.6	399.2	170.3	-0.1		PASS

Ozone Audit

Calibrations Start Time	Audit Point	Uncorrected Audit Conc. (PPB)	Corrected Audit Conc. (PPB)	O_3 (PPB)	O_3 % diff.	Pass/Fail
7:46:00 AM	Zero	0.00	0	0.33	N/A	N/A
	1	51.30	51.3	51.20	-0.2	PASS
	2	100.80	100.8	100.93	0.1	PASS
	3	200.80	200.8	200.59	-0.1	PASS
Calibrations Stop Time	4	300.10	300.1	299.84	-0.1	PASS
11:25:00 AM	5	400.00	400	398.36	-0.4	PASS

Linear Regression

	NO	NO_x	NO_2 (GPT)	O3
Slope	1.001	1.000	0.996	0.996
Intercept	-0.481	-0.170	0.425	0.393
Correlation	1.0000	1.0000	1.0000	1.0000
Avg % diff.	-0.61	-0.24	0.03	-0.13

Diagnostics

	T700	T400		T200	Audit Gas	
Serial Number	4969	5986	Serial Number	6727	Cylinder SN	EB0136191
O_3 Slope	0.9900	1.04	NO_x Slope	1.025	NO Conc (PPM)	30.5
O_3 Offset	0.6000	0.60	NO_x Offset	-0.5	NO_x Conc (PPM)	30.6
L3 O_3 Slope Correction Factor	1.0000		NO Slope	1.025	NO_2 Impurity (PPM)	0.1
L3 O_3 Offset Correction Factor	0.0000		NO Offset	-0.7		
Box Temp (C)	28.8	28.0	Box Temp (C)	30.7		
(Photo) Sample Temp (C)		35.4	HVPS (V)	536		
Ph. Lamp Temp (C)	58.0	58.0	Moly Conv Temp. (C)	313.8		
Ozone Gen Lamp Temp (C)	48.0		O_3 Flow (cc/min)	79.0		
Photo Flow (lpm)	0.703		PMT Temp. (C)	6.8		
Photo Press (in Hg)	24.3		Rx Cell Press (in Hg)	3.3		
Sample Flow (cc/min)		698.8	Rx Cell Temp (C)	50.00		
Sample Press (in Hg)		22.6	Sample Flow (cc/min)	523.0		
O_3 Ref (mV)	4477.2	4345.9	Sample Press (in Hg)	23.5		

Key:

NO_2	Nitrogen Dioxide	%	Percent
NO_x	Oxides of Nitrogen	TAPI	Teledyne Advanced Pollution Instrumentation
N/A	Not Applicable	Avg	Average
orig.	Original	Conc.	Concentration
PPB	Parts Per Billion	diff.	Difference
slpm	Standard liters per minute	GPT	Gas Phase Titration
rem.	Remaining	NO	Nitrogen Oxide

NOTES:

TABLE B1-7
GAS CALIBRATION AS LEFT REPORT

AUDIT DATE: 11/22/2024
AUDITED BY: Abraham Dearden, Ramboll
SITE: Missile Site Park

ANALYZER DEVICE: TELEDYNE API T200 NOX ANALYZER RANGE = 0 - 500 PPB NOX
ANALYZER DEVICE: TELEDYNE API T400 O3 ANALYZER, RANGE 0 - 500 PPB O3
AUDIT DEVICE: TELEDYNE API T700 MULTI-GAS CALIBRATOR

NO Audit

Time Keeping	Calibration Gas Flows (LPM)			Audit Point	NO Audit Conc. (PPB)	NO_x Audit Conc. (PPB)	NO (PPB)	NO % diff.	NO_x (PPB)	NO_x % diff.	NO_2 (PPB)	NO_2 % diff.	NO_x Pass/Fail
Calibrations Start Time	Audit Gas		Zero Air										
9:20:00 AM	0.0000		6.0120	Zero	0.0	0.0	0.2	N/A	0.4	N/A	0.7	N/A	N/A
	0.1000		6.0050	2	50.4	50.6	50.5	0.3	51.5	1.9	1.2	N/A	PASS
	0.0198		5.9970	3	100.2	100.5	100.1	-0.1	101.7	1.1	1.6	N/A	PASS
	0.0395		5.9760	4	200.4	201.1	200.3	0.0	202.0	0.4	1.8	N/A	PASS
	0.0787		5.9300	5	399.4	400.7	400.0	0.2	404.0	0.8	4.1	N/A	PASS

NO_2 Audit (Gas Phase Titration)

Calibration Gas Flows (LPM)			Audit Point	NO_2 Audit Conc. (PPB)	NO Audit Conc. (PPB)	NO Orig. (PPB)	NO rem. (PPB)	NO_x (PPB)	NO_2 (PPB)	NO_2 % diff.	Molybdenum Converter Efficiency (%); >96% = PASS	NO_2 Pass/Fail
Audit Gas	Ozone	Zero Air										
0.0000	0.0000	6.0120	Zero	0.0	0.0	N/A	0.2	0.4	0.7	N/A	101.3%	N/A
0.0198	0.1050	5.8940	1 (40 PPB O_3)	40.8	100.3	100.1	59.3	101.3	42.1	3.3	PASS	PASS
0.0395	0.1050	5.8710	2 (80 PPB O_3)	80.6	200.5	200.3	119.7	202.1	82.8	2.7		PASS
0.0788	0.1050	5.8320	3 (160 PPB O_3)	162.1	399.3	400.0	237.9	405.2	167.4	3.2		PASS

Calibrations Stop Time: 1:45:00 PM

Linear Regression

	NO	NO_x	NO_2 (GPT)
Slope	1.001	1.007	1.029
Intercept	-0.050	0.368	0.369
Correlation	1.0000	1.0000	1.0000
Avg % diff.	0.06	1.08	3.10

Diagnostics

T700		T200		Audit Gas	
Serial Number	4969	Serial Number	6727	Cylinder SN	EB0136191
O_3 Slope	0.9900	NO_x Slope	1.025	NO Conc (PPM)	30.5
O_3 Offset	0.6000	NO_x Offset	-0.5	NO_x Conc (PPM)	30.6
L3 O_3 Slope Correction Factor	1.0000	NO Slope	1.025	NO_2 Impurity (PPM)	0.1
L3 O_3 Offset Correction Factor	0.0000	NO Offset	-0.7		
Box Temp (C)	31.6	Box Temp (C)	32.4		
(Photo) Sample Temp (C)	41.2	HVPS (V)	536		
Ph. Lamp Temp (C)	58.0	Moly Conv Temp. (C)	316.1		
Ozone Gen Lamp Temp (C)	48.0	O_3 Flow (cc/min)	79.0		
Photo Flow (lpm)		PMT Temp. (C)	6.8		
Photo Press (in Hg)	25.0	Rx Cell Press (in Hg)	3.3		
Sample Flow (cc/min)		Rx Cell Temp (C)	50.00		
Sample Press (in Hg)		Sample Flow (cc/min)	524.0		
O_3 Ref (mV)	4472.4	Sample Press (in Hg)	23.7		

Key:

NO_2	Nitrogen Dioxide	%	Percent
NO_x	Oxides of Nitrogen	TAPI	Teledyne Advanced Pollution Instrumentation
N/A	Not Applicable	Avg	Average
orig.	Original	Conc.	Concentration
PPB	Parts Per Billion	diff.	Difference
slpm	Standard liters per minute	GPT	Gas Phase Titration
rem.	Remaining	NO	Nitrogen Oxide

NOTES: Maintenance performed prior to this check included ozone cleanser media replacement, flow orifice rebuilds, flow orifice replacement, and a reaction cell cleaning.

RAMBOLL

TABLE B1-8

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: MISSILE SITE PARK
AUDIT DATE: 10/14/2024
AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman, Ramboll

HIGH FLOW MASS FLOW CONTROLLER AUDIT

SENSOR MODEL: Hastings HFC-212
SENSOR SERIAL #: 0661178007
AUDIT DEVICE MODEL: Alicat Scientific MB-10SLPM-D
AUDIT DEVICE SERIAL #: 471381
AUDIT DEVICE EXPIRATION: 1/8/2025

START TIME	STOP TIME
13:05	13:44

AUDIT METHOD	AUDIT VALUE	SENSOR RESPONSE	DIFFERENCE (%)	ACCEPTANCE CRITERIA	VALUE WITHIN ACCEPTANCE CRITERIA

DRV	Ref. Flow (SLPM)	Inst. Flow (SLPM)	%	%	N/A
0	0.001	0.000	N/A	1.00	N/A
250	0.552	0.539	-2.36%	1.00	NO
500	1.084	1.071	-1.20%	1.00	NO
750	1.611	1.602	-0.56%	1.00	YES
1000	2.148	2.133	-0.70%	1.00	YES
1250	2.678	2.671	-0.26%	1.00	YES
1500	3.207	3.193	-0.44%	1.00	YES
1750	3.739	3.735	-0.11%	1.00	YES
2000	4.271	4.270	-0.02%	1.00	YES
2250	4.805	4.803	-0.04%	1.00	YES
2500	5.328	5.328	0.00%	1.00	YES
2750	5.860	5.857	-0.05%	1.00	YES
3000	6.396	6.390	-0.09%	1.00	YES
3250	6.925	6.915	-0.14%	1.00	YES
3500	7.453	7.447	-0.08%	1.00	YES
3750	7.986	7.986	0.00%	1.00	YES
4000	8.516	8.515	-0.01%	1.00	YES
4250	9.049	9.055	0.07%	1.00	YES
4500	9.582	9.635	0.55%	1.00	YES
4750	10.116	10.154	0.38%	1.00	YES
5000	10.660	10.690	0.28%	1.00	YES

LOW FLOW MASS FLOW CONTROLLER AUDIT

SENSOR MODEL: Hastings HFC-212
SENSOR SERIAL #: 0763637014
AUDIT DEVICE MODEL: Alicat Scientific MBS-200SCCM-D
AUDIT DEVICE SERIAL #: 471382
AUDIT DEVICE EXPIRATION: 1/8/2025

START TIME	STOP TIME
14:30	15:07

AUDIT METHOD	AUDIT VALUE	SENSOR RESPONSE	DIFFERENCE (%)	ACCEPTANCE CRITERIA	VALUE WITHIN ACCEPTANCE CRITERIA

DRV	Ref. Flow (SCCM)	Inst. Flow (SCCM)	%	%	N/A
0	0.000	0.000	N/A	1.00	N/A
250	5.480	5.500	0.36%	1.00	YES
500	11.090	11.100	0.09%	1.00	YES
750	16.540	16.600	0.36%	1.00	YES
1000	22.090	22.100	0.05%	1.00	YES
1250	27.570	27.600	0.11%	1.00	YES
1500	33.020	33.000	-0.06%	1.00	YES
1750	38.430	38.500	0.18%	1.00	YES
2000	43.800	43.800	0.00%	1.00	YES
2250	49.140	49.200	0.12%	1.00	YES
2500	54.450	54.500	0.09%	1.00	YES
2750	59.800	59.700	-0.17%	1.00	YES
3000	65.060	65.000	-0.09%	1.00	YES
3250	70.300	70.400	0.14%	1.00	YES
3500	75.530	75.600	0.09%	1.00	YES
3750	80.730	80.600	-0.16%	1.00	YES
4000	85.950	85.900	-0.06%	1.00	YES
4250	91.180	91.500	0.35%	1.00	YES
4500	96.410	96.400	-0.01%	1.00	YES
4750	101.680	101.700	0.02%	1.00	YES
5000	106.920	106.900	-0.02%	1.00	YES

RAMBOLL

TABLE B1-9

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: MISSILE SITE PARK
AUDIT DATE: 10/14/2024
AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman, Ramboll

HIGH FLOW MASS FLOW CONTROLLER AUDIT

SENSOR MODEL: Hastings HFC-212
SENSOR SERIAL #: 0661178007
AUDIT DEVICE MODEL: Alicat Scientific MB-10SLPM-D
AUDIT DEVICE SERIAL #: 471381
AUDIT DEVICE EXPIRATION: 1/8/2025

START TIME	STOP TIME
13:44	14:18

AUDIT METHOD	AUDIT VALUE	SENSOR RESPONSE	DIFFERENCE (%)	ACCEPTANCE CRITERIA	VALUE WITHIN ACCEPTANCE CRITERIA

DRV	Ref. Flow (SLPM)	Inst. Flow (SLPM)	%	%	N/A
0	0.001	0.000	N/A	1.00	N/A
250	0.554	0.552	-0.36%	1.00	YES
500	1.087	1.084	-0.28%	1.00	YES
750	1.612	1.611	-0.06%	1.00	YES
1000	2.149	2.148	-0.05%	1.00	YES
1250	2.680	2.671	-0.34%	1.00	YES
1500	3.208	3.207	-0.03%	1.00	YES
1750	3.739	3.735	-0.11%	1.00	YES
2000	4.268	4.270	0.05%	1.00	YES
2250	4.805	4.803	-0.04%	1.00	YES
2500	5.329	5.328	-0.02%	1.00	YES
2750	5.861	5.857	-0.07%	1.00	YES
3000	6.398	6.390	-0.13%	1.00	YES
3250	6.926	6.915	-0.16%	1.00	YES
3500	7.455	7.447	-0.11%	1.00	YES
3750	7.985	7.986	0.01%	1.00	YES
4000	8.518	8.515	-0.04%	1.00	YES
4250	9.052	9.055	0.03%	1.00	YES
4500	9.586	9.583	-0.03%	1.00	YES
4750	10.121	10.154	0.33%	1.00	YES
5000	10.666	10.690	0.23%	1.00	YES

LOW FLOW MASS FLOW CONTROLLER AUDIT

SENSOR MODEL: Hastings HFC-212
SENSOR SERIAL #: 0763637014
AUDIT DEVICE MODEL: Alicat Scientific MBS-200SCCM-D
AUDIT DEVICE SERIAL #: 471382
AUDIT DEVICE EXPIRATION: 1/8/2025

START TIME	STOP TIME
NA	NA

AUDIT METHOD	AUDIT VALUE	SENSOR RESPONSE	DIFFERENCE (%)	ACCEPTANCE CRITERIA	VALUE WITHIN ACCEPTANCE CRITERIA

DRV	Ref. Flow (SCCM)	Inst. Flow (SCCM)	%	%	N/A
0	0.000	0.000	N/A	1.00	N/A
250	5.480	5.500	0.36%	1.00	YES
500	11.090	11.100	0.09%	1.00	YES
750	16.540	16.600	0.36%	1.00	YES
1000	22.090	22.100	0.05%	1.00	YES
1250	27.570	27.600	0.11%	1.00	YES
1500	33.020	33.000	-0.06%	1.00	YES
1750	38.430	38.500	0.18%	1.00	YES
2000	43.800	43.800	0.00%	1.00	YES
2250	49.140	49.200	0.12%	1.00	YES
2500	54.450	54.500	0.09%	1.00	YES
2750	59.800	59.700	-0.17%	1.00	YES
3000	65.060	65.000	-0.09%	1.00	YES
3250	70.300	70.400	0.14%	1.00	YES
3500	75.530	75.600	0.09%	1.00	YES
3750	80.730	80.600	-0.16%	1.00	YES
4000	85.950	85.900	-0.06%	1.00	YES
4250	91.180	91.500	0.35%	1.00	YES
4500	96.410	96.400	-0.01%	1.00	YES
4750	101.680	101.700	0.02%	1.00	YES
5000	106.920	106.900	-0.02%	1.00	YES

APPENDIX B2: HEREFORD STATION Q4 SEMI-ANNUAL CALIBRATION

TABLE B2-1

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: WELD COUNTY MONITORING NETWORK: HEREFORD SITE

AUDIT DATE: AUDIT DATE: 10/10/24

AUDIT CONDUCTED BY: AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman

HORIZONTAL WIND SPEED/DIRECTION AUDIT

SENSOR MODEL: RM Young 05305V

SENSOR SERIAL #: 180187

AUDIT DEVICE MODEL: RM Young 18802

AUDIT DEVICE SERIAL #: CA5458

AUDIT DEVICE EXPIRATION: 10/26/2024

START TIME	STOP TIME
--	--

PARAMETER	AUDIT METHOD	AUDIT VALUE	SENSOR RESPONSE	DIFFERENCE (M/S)	ACCEPTANCE CRITERIA	VALUE WITHIN ACCEPTANCE CRITERIA
HORIZONTAL WIND SPEED	DC MOTOR RPM	M/S	M/S	M/S	M/S	N/A
	0	0.000	-0.001	0.00	0.20	YES
	200	1.024	0.960	0.06	0.20	YES
	400	2.048	2.009	0.04	0.20	YES
	600	3.072	3.062	0.01	0.20	YES
	800	4.096	4.104	-0.01	0.20	YES
	1000	5.120	5.094	0.03	0.20	YES
	2000	10.240	10.189	0.05	0.20	YES
	3000	15.360	15.274	0.09	0.20	YES
	4000	20.480	20.383	0.10	0.20	YES
	5000	25.600	25.507	0.09	0.20	YES
		TORQUE VERIFICATION	CW =	0.2	≤ 0.3 gm-cm	YES
			CCW =	0.2	≤ 0.3 gm-cm	YES
WIND DIRECTION	ALIGNMENT GAUGE	0	3.76	3.76	5	YES
		30	32.48	2.48	5	YES
		60	61.65	1.65	5	YES
		90	89.42	-0.58	5	YES
		120	116.89	-3.11	5	YES
		150	146.07	-3.93	5	YES
		180	176.33	-3.68	5	YES
		210	207.14	-2.86	5	YES
		240	238.52	-1.48	5	YES
		270	268.45	-1.55	5	YES
		300	300.70	0.70	5	YES
		330	333.84	3.84	5	YES
		360	363.79	3.79	5	YES
		TORQUE VERIFICATION	QUAD.#1 =	-	≤ 9.0 gm-cm	N/A
			QUAD.#2 =	-	≤ 9.0 gm-cm	N/A

					N=	3.758
	MAG DEC:	7.34		4 QUAD VANE	E=	89.424
°E CROSS ARM	AS FOUND:	1		ALIGNMENT:	S=	176.325
ALIGNMENT:	RANGE: +/- 5° (PASSED)				W=	268.448

WIND DIRECTION	TRANSIT ALIGNMENT				
		AUDIT =	1	2.0 degrees	YES

KEY:

HWS	Horizontal wind speed
VWS	Vertical wind speed
WD	Wind direction
M/S	Meters per second
N/A	Not applicable
MAG. DEC.	Magnetic Declination
CW	Clockwise
CCW	Counter Clockwise
AGL	Above Ground Level

NOTES: 05305V Sensor removed.
Wind direction torque not performed due to breezy conditions.

TABLE B2-2

QUALITY ASSURANCE CALIBRATION RESULTS-AS LEFT

SITE NAME: WELD COUNTY MONITORING NETWORK: HEREFORD SITE

AUDIT DATE: AUDIT DATE: 10/10/24

AUDIT CONDUCTED BY: AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman

HORIZONTAL WIND SPEED/DIRECTION AUDIT

SENSOR MODEL: RM Young 05305
SENSOR SERIAL #: 209492
AUDIT DEVICE MODEL: RM Young 18802
AUDIT DEVICE SERIAL #: CA5458
AUDIT DEVICE EXPIRATION: 10/26/2024

START TIME	STOP TIME
--	--

PARAMETER	AUDIT METHOD	AUDIT VALUE	SENSOR RESPONSE	DIFFERENCE (M/S)	ACCEPTANCE CRITERIA	VALUE WITHIN ACCEPTANCE CRITERIA
HORIZONTAL WIND SPEED	DC MOTOR RPM	M/S	M/S	M/S	M/S	N/A
	0	0.000	0.000	0.00	0.20	YES
	200	1.024	1.024	0.00	0.20	YES
	400	2.048	2.048	0.00	0.20	YES
	600	3.072	3.072	0.00	0.20	YES
	800	4.096	4.096	0.00	0.20	YES
	1000	5.120	5.120	0.00	0.20	YES
	2000	10.240	10.240	0.00	0.20	YES
	3000	15.360	15.360	0.00	0.20	YES
	4000	20.480	20.480	0.00	0.20	YES
	5000	25.600	25.600	0.00	0.20	YES
		TORQUE VERIFICATION	CW =	0.2	≤ 0.3 gm-cm	YES
			CCW =	0.2	≤ 0.3 gm-cm	YES
WIND DIRECTION	ALIGNMENT GAUGE	0	0.98	0.98	5	YES
		30	30.71	0.71	5	YES
		60	60.56	0.56	5	YES
		90	90.66	0.66	5	YES
		120	120.67	0.67	5	YES
		150	150.69	0.69	5	YES
		180	180.99	0.99	5	YES
		210	210.54	0.54	5	YES
		240	240.15	0.15	5	YES
		270	270.34	0.34	5	YES
		300	300.13	0.13	5	YES
		330	329.63	-0.37	5	YES
		360	360.13	0.13	5	YES
		TORQUE VERIFICATION	QUAD.#1 =	-	≤ 9.0 gm-cm	N/A
			QUAD.#2 =	-	≤ 9.0 gm-cm	N/A

					N=	0.13
	MAG DEC:	7.34		4 QUAD VANE	E=	90.42
°E CROSS ARM	AS FOUND:	1		ALIGNMENT:	S=	179.98
ALIGNMENT:	RANGE: +/- 5° (PASSED)				W=	268.5

WIND DIRECTION	TRANSIT ALIGNMENT				
		AUDIT =	1	2.0 degrees	YES

KEY:

HWS	Horizontal wind speed
VWS	Vertical wind speed
WD	Wind direction
M/S	Meters per second
N/A	Not applicable
MAG. DEC.	Magnetic Declination
CW	Clockwise
CCW	Counter Clockwise
AGL	Above Ground Level

NOTES: New sensor installed (05305).
Wind direction torque not performed due to breezy conditions.
Cert sheet from 9/19/24 indicates passing vane torque

RAMBOLL

TABLE B2-3

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: WELD COUNTY MONITORING NETWORK: HEREFORD SITE
AUDIT DATE: 10/10/2024
AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman, Ramboll

TEMPERATURE/DELTA TEMERATURE AUDIT

SENSOR MODEL: RM YOUNG 41342VC
SENSOR SERIAL #: 032950 (2M)/032869 (10M)
AUDIT DEVICE: Omega HH42A
AUDIT DEVICE SERIAL #: 23KMM02815
AUDIT DEVICE EXPIRATION: 11/21/2024

START TIME	STOP TIME
--	--

WATER BATH PARAMETER	AUDIT SENSOR VALUE	2-M SENSOR VALUE	2-M VS. AUDIT DIFF.	10-M SENSOR VALUE	10-M VS. AUDIT DIFF.	ACCEPTANCE CRITERIA (+/-)	DELTA T: 10-M VS. 2-M DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA
	DEG. C	DEG. C	DEG. C	DEG. C	DEG. C	DEG. C	DEG. C	DEG. C	N/A
ICE BATH	0.10	0.36	0.26	0.33	0.23	0.50	-0.03	0.1	YES
AMBIENT BATH	19.03	19.05	0.02	19.10	0.07	0.50	0.05	0.1	YES
HOT BATH	49.54	49.89	0.35	49.80	0.26	0.50	-0.09	0.1	YES

NOTES: Cleaned aspirator housing units.

RAMBOLL

TABLE B2-4

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: WELD COUNTY MONITORING NETWORK: HEREFORD SITE
AUDIT DATE: ########
AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman, Ramboll

RELATIVE HUMIDITY AUDIT

SENSOR MODEL: EE181
SENSOR SERIAL #: 2015160012638F
AUDIT DEVICE MODEL: EE181
AUDIT DEVICE SERIAL #: 214116001537C1
AUDIT DEVICE EXPIRATION: 3/21/2025

START TIME	STOP TIME
--	--

RELATIVE HUMIDITY		AUDIT SENSOR VALUE	2-M SENSOR VALUE	ABSOLUTE % RH DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA
	UNITS	% RH	% RH	% RH	PERCENT	N/A
AVERAGE:		11.86	14.52	2.66	7.0	YES
		11.55	14.2	2.65	7.0	YES
		11.56	14.58	3.02	7.0	YES
		11.66	14.43	2.78		

NOTES:

BAROMETRIC PRESSURE AUDIT

SENSOR MODEL: Setra 278
SENSOR SERIAL #: 7573233
AUDIT DEVICE MODEL: BVC10
AUDIT DEVICE SERIAL #: 2972
AUDIT DEVICE EXPIRATION: 11/24/2024

START TIME	STOP TIME
--	--

BAROMETRIC PRESSURE		AUDIT SENSOR VALUE	2-M SENSOR VALUE	ABSOLUTE DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA
	UNITS	mm Hg	mm Hg	mm Hg	mm Hg	N/A
AVERAGE:		630.49	630.66	0.17	2.25	YES

NOTES:

PRECIPITATION AUDIT

SENSOR MODEL: RM Young Heated Rain Gauge Model 52202
SENSOR SERIAL: TB16139
AUDIT DEVICE MODEL: Drip Bottle
AUDIT DEVICE SERIAL #: N/A

START TIME	STOP TIME
--	--

PRECIPITATION			AUDIT S VALUE	2-M SENSOR VALUE	PERCENT DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA
As Found							
300 ML WATER = 150 TIPS/0.591"		*UNITS*	Inches	Inches	PERCENT	PERCENT	N/A
Volume	500		0.984	0.922	-6.3%	10	YES
As Left							
300 ML WATER = 150 TIPS/0.591"		*UNITS*	Inches	Inches	PERCENT	PERCENT	N/A
Volume	500		0.984	0.957	-2.8%	10	YES

NOTES: Cleared weeds and grasses around precip concrete pad. Adjusted tippers up 1/2 turn each. Cleaned tippers and surrounds of spider debris and dirt.

PANEL TEMPERATURE AUDIT

SENSOR MODEL: Campbell Scientific CR3000
SENSOR SERIAL #: 13408
AUDIT DEVICE MODEL: Omega HH42A
AUDIT DEVICE SERIAL #: 23KMM02815
AUDIT DEVICE EXPIRATION: 11/21/2024

START TIME	STOP TIME
--	--

PANEL TEMPERATURE		AUDIT SENSOR VALUE	2-M SENSOR VALUE	ABSOLUTE DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA
	UNITS	DEG. C	DEG. C	DEG. C	ABS. DIFF	N/A
INSTANTANEOUS READING:		23.92	25.06	1.14	2.1	YES

NOTES:

Table B2-5

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: WELD COUNTY MONITORING NETWORK: HEREFORD SITE
AUDIT DATE: 10/10/2024
AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman, Ramboll

SOLAR RADIATION AUDIT

SENSOR MODEL: Hukseflux LP02
SENSOR SERIAL #: 48015
AUDIT DEVICE MODEL: SR05-A1
AUDIT DEVICE SERIAL #: 19771
AUDIT DEVICE EXPIRATION: 11/16/2024

Timestamp	Audit Sensor (w/m2)	Site Sensor (w/m2)
10/10/2024 11:30	540.2	518.3
10/10/2024 11:45	491.9	473.9
10/10/2024 12:00	612.3	677.6
10/10/2024 12:15	749.7	742.4
AVG	**598.5**	**603.1**
	% DIFF=	**-0.76%**

NOTES: No changes made

TABLE B2-6
GAS CALIBRATION AS FOUND REPORT

AUDIT DATE: 10/1/2024
AUDITED BY: Abraham Dearden, Ramboll
SITE: Hereford

ANALYZER DEVICE: TELEDYNE API T400 O3 ANALYZER, RANGE 0 - 500 PPB O3
AUDIT DEVICE: TELEDYNE API T703 MULTI-GAS CALIBRATOR

Time Keeping	Ozone Audit						Diagnostics		
Calibrations Start Time	Audit Point	Uncorrected Audit Conc. (PPB)	Corrected Audit Conc. (PPB)	O_3 (PPB)	O_3 % diff.	Pass/Fail		T703	T400
11:33:00 AM	Zero	0.0	-0.1997	0.60	N/A	N/A	Serial Number	825	5984
	1	50.2	50.1258	51.898	3.5	PASS	O_3 Slope	0.9760	0.99
	2	100.4	100.4513	100.26	-0.2	PASS	O_3 Offset	-0.4110	-3.10
	3	200.3	200.60105	200.73	0.1	PASS	L3 O_3 Slope Correction Factor	1.0025	
Calibrations Stop Time	4	300.2	300.7508	300.85	0.0	PASS	L3 O_3 Offset Correction Factor	-0.1997	
1:40:00 PM	5	399.5	400.29905	398.92	-0.3	PASS	Box Temp (C)	32.1	28.5
							Sample Temp (C)	40.6	36.4
							Ph. Lamp Temp (C)	58.0	58.0
							Ozone Gen Lamp Temp (C)	48.0	
							Photo Flow (lpm)	0.671	
							Photo Press (in Hg)	23.9	
							Sample Flow (cc/min)		626.2
							Sample Press (in Hg)		22.0
							O3 Ref (mV)	3547.4	4158.4

Key:

NO_2	Nitrogen Dioxide	%	Percent
NO_x	Oxides of Nitrogen	TAPI	Teledyne Advanced Pollution Instrumentation
N/A	Not Applicable	Avg	Average
orig.	Original	Conc.	Concentration
PPB	Parts Per Billion	diff.	Difference
slpm	Standard liters per minute	GPT	Gas Phase Titration
rem.	Remaining	NO	Nitrogen Oxide

Linear Regression

	O3
Slope	0.995
Intercept	1.152
Correlation	1.0000
Avg % diff.	0.62

NOTES:

TABLE B2-7
GAS CALIBRATION AS LEFT REPORT

AUDIT DATE: 10/11/2024
AUDITED BY: Abraham Dearden, Ramboll
SITE: Hereford

ANALYZER DEVICE: TELEDYNE API T400 O3 ANALYZER, RANGE 0 - 500 PPB O3
AUDIT DEVICE: TELEDYNE API T703 MULTI-GAS CALIBRATOR

Time Keeping	Ozone Audit						Diagnostics		
Calibrations Start Time	Audit Point	Uncorrected Audit Conc. (PPB)	Corrected Audit Conc. (PPB)	O_3 (PPB)	O_3 % diff.	Pass/Fail		T703	T400
8:28:00 AM	Zero	0.00	0	0.69	N/A	N/A	Serial Number	825	5984
	1	50.00	50	51.26	2.5	PASS	O_3 Slope	0.9800	0.994
	2	99.70	99.7	100.67	1.0	PASS	O_3 Offset	-1.1000	-1.70
	3	200.00	200	201.65	0.8	PASS	L3 O_3 Slope Correction Factor	1.0000	
Calibrations Stop Time	4	300.20	300.2	300.93	0.2	PASS	L3 O_3 Offset Correction Factor	0.0000	
11:25:00 AM	5	399.80	399.8	400.64	0.2	PASS	Box Temp (C)	31.3	28.5
							Sample Temp (C)	40.4	36.3
							Ph. Lamp Temp (C)	58.0	58.0
							Ozone Gen Lamp Temp (C)	48.0	
							Photo Flow (lpm)	0.674	
							Photo Press (in Hg)	24.8	
							Sample Flow (cc/min)		639.8
							Sample Press (in Hg)		22.4
							O3 Ref (mV)	4225.2	4134.2

Key:

NO_2	Nitrogen Dioxide	%	Percent
NO_x	Oxides of Nitrogen	TAPI	Teledyne Advanced Pollution Instrumentation
N/A	Not Applicable	Avg	Average
orig.	Original	Conc.	Concentration
PPB	Parts Per Billion	diff.	Difference
slpm	Standard liters per minute	GPT	Gas Phase Titration
rem.	Remaining	NO	Nitrogen Oxide

Linear Regression

	O3
Slope	1.000
Intercept	1.069
Correlation	1.0000
Avg % diff.	0.95

NOTES:

APPENDIX B3: ORCHARD STATION Q4 SEMI-ANNUAL CALIBRATION

TABLE B3-1

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: WELD COUNTY MONITORING NETWORK: ORCHARD SITE
AUDIT DATE: AUDIT DATE: 10/10/24
AUDIT CONDUCTED BY: AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman

10-METER HORIZONTAL WIND SPEED/DIRECTION AUDIT

SENSOR MODEL: RM YOUNG 05305V
SENSOR SERIAL #: 180186
AUDIT DEVICE MODEL: RM Young 18802
AUDIT DEVICE SERIAL #: CA5458
AUDIT DEVICE EXPIRATION: 10/26/2024

START TIME	STOP TIME
--	--

PARAMETER	AUDIT METHOD	AUDIT VALUE	SENSOR RESPONSE	DIFFERENCE (M/S)	ACCEPTANCE CRITERIA	VALUE WITHIN ACCEPTANCE CRITERIA
HORIZONTAL WIND SPEED	DC MOTOR RPM	M/S	M/S	M/S	M/S	N/A
	0	0.000	0.001	0.00	0.20	YES
	200	1.024	1.068	-0.04	0.20	YES
	400	2.048	2.016	0.03	0.20	YES
	600	3.072	3.060	0.01	0.20	YES
	800	4.096	4.093	0.00	0.20	YES
	1000	5.120	5.101	0.02	0.20	YES
	2000	10.240	10.210	0.03	0.20	YES
	3000	15.360	15.316	0.04	0.20	YES
	4000	20.480	20.441	0.04	0.20	YES
	5000	25.600	25.567	0.03	0.20	YES
		TORQUE VERIFICATION	CW =	0.2	≤ 0.3 gm-cm	YES
			CCW =	0.2	≤ 0.3 gm-cm	YES
WIND DIRECTION	ALIGNMENT GAUGE	0	-0.25	0.25	5	YES
		30	29.20	0.80	5	YES
		60	59.05	0.95	5	YES
		90	88.65	1.35	5	YES
		120	118.64	1.36	5	YES
		150	149.54	0.46	5	YES
		180	178.58	1.42	5	YES
		210	208.51	1.49	5	YES
		240	238.21	1.79	5	YES
		270	268.49	1.51	5	YES
		300	298.54	1.46	5	YES
		330	329.09	0.91	5	YES
		360	359.30	0.70	5	YES
		TORQUE VERIFICATION	QUAD.#1 =	7	≤ 9.0 gm-cm	YES
			QUAD.#2 =	7	≤ 9.0 gm-cm	YES

					N=	-0.42
	MAG DEC:	7.2		4 QUAD VANE ALIGNMENT:	E=	87.81
°E CROSS ARM ALIGNMENT:	AS FOUND:	-1			S=	179.17
	TOLERANCE: +/- 5° (PASSED)				W=	270.75

WIND DIRECTION	TRANSIT ALIGNMENT				
		AUDIT=	-1	2.0 degrees	YES

KEY:

HWS	Horizontal wind speed
VWS	Vertical wind speed
WD	Wind direction
M/S	Meters per second
N/A	Not applicable
MAG. DEC.	Magnetic Declination
CW	Clockwise
CCW	Counter Clockwise

NOTES:

RAMBOLL

TABLE B3-2

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: WELD COUNTY MONITORING NETWORK: ORCHARD SITE
AUDIT DATE: AUDIT DATE: 10/10/24
AUDIT CONDUCTED BY: AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman

TEMPERATURE/DELTA TEMERATURE AUDIT

SENSOR MODEL: RM YOUNG 41342VC
SENSOR SERIAL #: 032953 (2M)/032954 (10M)
AUDIT DEVICE: Omega HH42A
AUDIT DEVICE SERIAL #: 23KMM02815
AUDIT DEVICE EXPIRATION: 11/21/2024

START TIME	STOP TIME
--	--

WATER BATH PARAMETER	AUDIT SENSOR VALUE	2-M SENSOR VALUE	2-M VS. AUDIT DIFF.	10-M SENSOR VALUE	10-M VS. AUDIT DIFF.	ACCEPTANCE CRITERIA (+/-)	DELTA T: 10-M VS. 2-M DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA
	DEG. C	DEG. C	DEG. C	DEG. C	DEG. C	DEG. C	DEG. C	DEG. C	N/A
ICE BATH	7.40	7.58	0.18	7.51	0.11	0.50	-0.07	0.1	YES
AMBIENT BATH	20.28	20.39	0.11	20.32	0.04	0.50	-0.07	0.1	YES
HOT BATH	49.44	49.53	0.09	49.46	0.02	0.50	-0.07	0.1	YES

NOTES: Cleaned both aspirator housing units. Limited ice at time of visit, so ice bath points are high.

RAMBOLL

TABLE B3-3

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: WELD COUNTY MONITORING NETWORK: ORCHARD SITE
AUDIT DATE: AUDIT DATE: 10/10/24
AUDIT CONDUCTED BY: AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman

RELATIVE HUMIDITY AUDIT

SENSOR MODEL: EE181
SENSOR SERIAL #: 201516001269F1
AUDIT DEVICE MODEL: EE181
AUDIT DEVICE SERIAL #: 214116001537C1
AUDIT DEVICE EXPIRATION: 3/21/2025

START TIME	STOP TIME
--	--

RELATIVE HUMIDITY		AUDIT SENSOR VALUE	2-M SENSOR VALUE	ABSOLUTE % RH DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA
	UNITS	% RH	% RH	% RH	PERCENT	N/A
AVERAGE:		8.729	11.69	2.96	7.0	YES
		9.26	12.73	3.47	7.0	YES
		10.23	14	3.77	7.0	YES

NOTES:

BAROMETRIC PRESSURE AUDIT

SENSOR MODEL: Setra 278
SENSOR SERIAL #: 7563445
AUDIT DEVICE MODEL: BVC10
AUDIT DEVICE SERIAL #: 2972
AUDIT DEVICE EXPIRATION: 11/24/2024

START TIME	STOP TIME
--	--

BAROMETRIC PRESSURE		AUDIT SENSOR VALUE	2-M SENSOR VALUE	ABSOLUTE DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA
	UNITS	mm Hg	mm Hg	mm Hg	mm Hg	N/A
AVERAGE:		648.66	649.13	0.47	2.25	YES

NOTES:

PRECIPITATION AUDIT

SENSOR MODEL: RM Young Heated Rain Gauge Model 52202
SENSOR SERIAL: TB16138
AUDIT DEVICE MODEL: Drip Bottle
AUDIT DEVICE SERIAL #: N/A

START TIME	STOP TIME
--	--

PRECIPITATION		AUDIT S VALUE	2-M SENSOR VALUE	PERCENT DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA
As Found						
300 ML WATER = 150 TIPS/0.591"	*UNITS*	Inches	Inches	PERCENT	PERCENT	N/A
Volume 500		0.984253	0.942	-4.3%	10	YES
As Left						
300 ML WATER = 150 TIPS/0.591"	*UNITS*	Inches	Inches	PERCENT	PERCENT	N/A
Volume 250		0.492126	0.493	0.2%	10	YES

NOTES: Cleaned tippers and surrounds. Heavy dirt buildup in drain cavity; drain hole had been blocked. Adjusted tipper buckets up 1/2 turn each.

PANEL TEMPERATURE AUDIT

SENSOR MODEL: Campbell Scientific CR3000
SENSOR SERIAL #: 13405
AUDIT DEVICE MODEL: Omega HH42A
AUDIT DEVICE SERIAL #: 23KMM02815
AUDIT DEVICE EXPIRATION: 11/21/2024

START TIME	STOP TIME
--	--

PANEL TEMPERATURE		AUDIT SENSOR VALUE	2-M SENSOR VALUE	ABSOLUTE DIFF.	ACCEPTANCE CRITERIA (+/-)	VALUE WITHIN ACCEPTANCE CRITERIA
	UNITS	DEG. C	DEG. C	DEG. C	ABS. DIFF	N/A
INSTANTANEOUS READING:		22.92	23.08	0.16	2.1	YES

NOTES:

Table B3-4

QUALITY ASSURANCE CALIBRATION RESULTS-AS FOUND

SITE NAME: WELD COUNTY MONITORING NETWORK: ORCHARD SITE
AUDIT DATE: 10/11/2024
AUDIT CONDUCTED BY: Jake Zaragoza/Adam Christman, Ramboll

SOLAR RADIATION AUDIT

SENSOR MODEL: Hukseflux LP02
SENSOR SERIAL #: 48014
AUDIT DEVICE MODEL: SR05-A1
AUDIT DEVICE SERIAL #: 19771
AUDIT DEVICE EXPIRATION: 11/16/2024

Timestamp	Audit Sensor (w/m2)	Site Sensor (w/m2)
10/11/2024 8:30	190.1	186.4
10/11/2024 8:45	360.3	389.9
10/11/2024 9:00	449.2	440.5
10/11/2024 9:15	528.6	519.4
10/11/2024 9:30	612.7	590.7
10/11/2024 9:45	377.7	348.5
10/11/2024 10:00	634.4	605.1
10/11/2024 10:15	576.7	582.5
10/11/2024 10:30	399.1	346.6
10/11/2024 10:45	457.9	446.1
10/11/2024 11:00	526.2	515.6
10/11/2024 11:15	478.8	460.9
10/11/2024 11:30	425.7	394.4
10/11/2024 11:45	356.6	324.6
10/11/2024 12:00	366.9	368.1
10/11/2024 12:15	488.8	510.7
10/11/2024 12:30	632.4	602.5
10/11/2024 12:45	516.8	476.2
10/11/2024 13:00	657.6	645.7
AVG	**475.6**	**460.8**
	% DIFF=	**3.12%**

NOTES: No changes made

TABLE B3-5
GAS CALIBRATION AS FOUND REPORT

AUDIT DATE: 10/1/2024
AUDITED BY: Abraham Dearden, Ramboll
SITE: Orchard

ANALYZER DEVICE: TELEDYNE API T400 O3 ANALYZER, RANGE 0 - 500 PPB O3
AUDIT DEVICE: TELEDYNE API T703 MULTI-GAS CALIBRATOR

Time Keeping	Ozone Audit						Diagnostics		
Calibrations Start Time	Audit Point	Uncorrected Audit Conc. (PPB)	Corrected Audit Conc. (PPB)	O_3 (PPB)	O_3 % diff.	Pass/Fail		T703	T400
11:21:00 AM	Zero	0.00	-0.6714	3.52	N/A	N/A	Serial Number	824	5985
	1	49.40	48.85704	52.15021	6.7	PASS	O_3 Slope	0.9760	0.99
	2	99.80	99.38808	101.02	1.6	PASS	O_3 Offset	-0.7280	-0.10
	3	200.50	200.3499	202.40	1.0	PASS	L3 O_3 Slope Correction Factor	1.0026	
Calibrations Stop Time	4	299.90	300.00834	303.27	1.1	PASS	L3 O_3 Offset Correction Factor	-0.6714	
2:40:00 PM	5	399.50	399.8673	401.86	0.5	PASS	Box Temp (C)	29.6	25.9
							Sample Temp (C)	37.3	34.5
							Ph. Lamp Temp (C)	58.0	58.0
							Ozone Gen Lamp Temp (C)	48.0	
							Photo Flow (lpm)	0.701	
							Photo Press (in Hg)	25.0	
							Sample Flow (cc/min)		640.5
							Sample Press (in Hg)		20.8
							O3 Ref (mV)	3346.3	3591.9

Linear Regression	
	O3
Slope	0.997
Intercept	3.265
Correlation	1.0000
Avg % diff.	2.20

Key:

NO_2	Nitrogen Dioxide	%	Percent
NO_x	Oxides of Nitrogen	TAPI	Teledyne Advanced Pollution Instrumentation
N/A	Not Applicable	Avg	Average
orig.	Original	Conc.	Concentration
PPB	Parts Per Billion	diff.	Difference
slpm	Standard liters per minute	GPT	Gas Phase Titration
rem.	Remaining	NO	Nitrogen Oxide

NOTES:

TABLE B3-6
GAS CALIBRATION AS LEFT REPORT

AUDIT DATE: 10/12/2024
AUDITED BY: Jake Zaragoza, Ramboll
SITE: Orchard

ANALYZER DEVICE: TELEDYNE API T400 O3 ANALYZER, RANGE 0 - 500 PPB O3
AUDIT DEVICE: TELEDYNE API T703 MULTI-GAS CALIBRATOR

Time Keeping	Ozone Audit						Diagnostics		
Calibrations Start Time	Audit Point	Uncorrected Audit Conc. (PPB)	Corrected Audit Conc. (PPB)	O_3 (PPB)	O_3 % diff.	Pass/Fail		T703	T400
9:51:00 AM	Zero	0.00	0	0.30	N/A	N/A	Serial Number	824	5985
	1	50.40	50.4	51.9	3.0	PASS	O_3 Slope	0.9780	0.99
	2	100.10	100.1	100.21	0.1	PASS	O_3 Offset	-1.2000	-0.10
	3	199.50	199.5	200.07	0.3	PASS	L3 O_3 Slope Correction Factor	1.0000	
Calibrations Stop Time	4	299.60	299.6	300.08	0.2	PASS	L3 O_3 Offset Correction Factor	0.0000	
11:06:00 AM	5	399.90	399.9	398.58	-0.3	PASS	Box Temp (C)	28.3	25.4
							Sample Temp (C)	36.3	34.1
							Ph. Lamp Temp (C)	58.0	58.0
							Ozone Gen Lamp Temp (C)	48.0	
							Photo Flow (lpm)	0.714	
							Photo Press (in Hg)	24.6	
							Sample Flow (cc/min)		740.2
							Sample Press (in Hg)		23.1
							O3 Ref (mV)	4402.9	3576.3

Key:

NO_2	Nitrogen Dioxide	%	Percent
NO_x	Oxides of Nitrogen	TAPI	Teledyne Advanced Pollution Instrumentation
N/A	Not Applicable	Avg	Average
orig.	Original	Conc.	Concentration
PPB	Parts Per Billion	diff.	Difference
slpm	Standard liters per minute	GPT	Gas Phase Titration
rem.	Remaining	NO	Nitrogen Oxide

Linear Regression	O3
Slope	0.996
Intercept	0.970
Correlation	1.0000
Avg % diff.	0.64

NOTES:

APPENDIX B4: MISSILE SITE PARK STATION CDPHE AUDIT

Meteorological Tower Audit

COLORADO
Air Pollution Control Division
Department of Public Health & Environment

Site	888888888		
Site Name	SPECIAL PURPOSE MONITOR		
Auditor	Joshua	Time Offline	8:35
Audit Date	11/25/2024	Time Online	9:35

Sensor Information			
Sensor	Serial Number	Make	Model
Wind Speed	180188	RM Young	05103
Wind Direction	180188	RM Young	05103
Temp (Upper)	032952	RM Young	41342VC
Temp (Lower)	032951	RM Young	41342VC
Hygrometer	20151600125038	RM Young	EE181
Barometer		RM Young	61002

Span/Zero Voltages		
Sensor	Zero	Span
Wind Speed		
Wind Direction		
Temp (Upper)		
Temp (Lower)		
Hygrometer		
Barometer		

Magnetic Declination	7.6	Distance to Tower (ft)	100	Subtract magnetic declination? ☐
Crossarm Orientation	N-S	Correction (ft)	3.1	

Pre-Audit Crossarm Alignment Check				
	Degrees	Minutes	Offset	Error
Normal	1	45	-360	1.8
Inverted	181	45	0	1.8

Post-Audit Crossarm Alignment Check				
	Degrees	Minutes	Offset	Error
Normal	1	45	-360	1.8
Inverted	181	45	0	1.8

Wind Speed Sensor Audit (+/- 5%)										
Audit Set Point (RPM)		Wind Speed (mph)	DVM (volts)	DVM (mph)	Error (%)	DCN Actual (volts)	DCN Actual (mph)	Error (%)	DCN Res. (mph)	Error (%)
Zero	0	0.0					0.0		0.0	
CW	600	6.9					6.9	0.9%	6.9	0.9%
CCW	600	6.9					7.0	1.3%	7.0	1.3%
CW	1700	19.5					19.5	0.2%	19.5	0.2%
CCW	1700	19.5					19.5	0.1%	19.5	0.1%
CW	3300	37.8					37.9	0.3%	37.9	0.3%
CCW	3300	37.8					37.9	0.3%	37.9	0.3%
CW	5400	61.8					62.1	0.5%	62.1	0.5%
CCW	5400	61.8					62.1	0.5%	62.1	0.5%

Wind Direction Sensor Audit (+/- 5 Degrees)										
Audit Set Point	Wind Dir. (degrees)	DVM (volts)	DVM (degrees)	DCN Act. (volts)	DCN Act. (degrees)	Offset	DCN Act. Error	DCN Res. (degrees)	DCN Res. Error	Composite Error
South	180				181.6	0.0	1.6	181.6	1.6	3.3
CW West	270				269.7	0.0	-0.3	269.7	-0.3	1.5
CW North	360				-1.0	-360.0	-1.0	-1.0	-1.0	0.8
CW East	90				91.8	0.0	1.8	91.8	1.8	3.5
CCW South	180				181.2	0.0	1.2	181.2	1.2	3.0
CCW East	90				91.6	0.0	1.6	91.6	1.6	3.4
CCW North	360				-1.4	-360.0	-1.4	-1.4	-1.4	0.4
CCW West	270				269.8	0.0	-0.2	269.8	-0.2	1.6

	Temperature (+/- 2 Degrees C)									
Reading	Upper Temp. Sensor					Lower Temp. Sensor				
	DVM (volts)	DCN (volts)	Audit (F)	DCN (F)	Error	DVM (volts)	DCN (volts)	Audit (F)	DCN (F)	Error
Point 1			31.8	31.7	-0.1			32.9	33.2	0.3
Point 2			32.0	31.8	-0.2			32.4	33.2	0.8
Avg.			31.9	31.8	-0.1			32.6	33.2	0.5

	Humidity (+/- 5%)					Pressure (+/- 10 mm Hg)				
Reading	DVM (volts)	DCN (volts)	Audit (%)	DCN (%)	Error	DVM (volts)	DCN (volts)	Audit (mmHg)	DCN (mmHg)	Error
Point 1			64.7	69.2	4.5			640.3	641.2	0.9
Point 2			56.8	60.3	3.5			640.6	641.2	0.6
Avg.			60.8	64.7	4.0			640.5	641.2	0.7

Audit Results

Wind Speed

CW 600 RPM	PASS
CCW 600 RPM	PASS
CW 1700 RPM	PASS
CCW 1700 RPM	PASS
CW 3300 RPM	PASS
CCW 3300 RPM	PASS
CW 5400 RPM	PASS
CCW 5400 RPM	PASS

Wind Direction

South	PASS
CW West	PASS
CW North	PASS
CW East	PASS
CCW South	PASS
CCW East	PASS
CCW North	PASS
CCW West	PASS

Temperature

Upper Avg.	PASS
Lower Avg.	PASS

Humidity

Avg.	PASS

Pressure

Avg.	PASS

Comments

Missle Site Park - Weld County

Ozone Analyzer Audit

COLORADO
Air Pollution Control Division
Department of Public Health & Environment

Site	888888888					
Site Name	MISSILE SITE PARK					
Monitor	44201					
POC	1	Method Code	87	AQS Units	7	(ppm)
Auditor	Joseph	Initial O3	0.0152	Calibrator SN	161	
Audit Type	Performance	Time Offline	8:54	Cal. Slope	1.003528	
Audit Date	11/25/2024	Final O3	0.0417	Cal. Intercept	-1.201699E-03	
Audit Time	8:54	Time Online	14:46			
Station Temp.	21.5	Audit Temp.	20.8			

Analyzer Information

Serial #	Slope	Intercept	Full Scale
5986	1.04	0.0006	0.25

Do you want to zero correct the analyzer? ☐ Upload to AQS? ☐

Audit Set Point	Conc. Out (ppm)	DAS Value (ppm)	Zero Corr. (ppm)	% Relative Error	Display Value (ppm)	% Relative Error
Pre-Audit Precision and Span Evaluation						
Zero						
Span						
Precision						

Raw Audit Data

	1	2	3	4	5	6	7	8	9	10	Average
Zero											
Standard	-0.0010	-0.0009	-0.0010	-0.0010	-0.0012	-0.0014	-0.0015	-0.0016	-0.0016	-0.0015	-0.0013
Analyzer	0.0002	0.0002	0.0002	0.0004	0.0006	0.0008	0.0006	0.0005	0.0004	0.0004	0.0004
Level 5											
Standard	0.1257	0.1255	0.1256	0.1252	0.1250	0.1248	0.1244	0.1243	0.1244	0.1248	0.1250
Analyzer	0.1269	0.1268	0.1265	0.1268	0.1271	0.1267	0.1263	0.1264	0.1268	0.1271	0.1267
Level 4											
Standard	0.0748	0.0752	0.0754	0.0757	0.0751	0.0766	0.0749	0.0748	0.0748	0.0749	0.0752
Analyzer	0.0773	0.0775	0.0777	0.0774	0.0768	0.0753	0.0758	0.0756	0.0757	0.0763	0.0765
Level 3											
Standard	0.0353	0.0355	0.0357	0.0356	0.0354	0.0349	0.0348	0.0349	0.0347	0.0351	0.0352
Analyzer	0.0361	0.0359	0.0354	0.0353	0.0348	0.0349	0.0351	0.0358	0.0357	0.0364	0.0355
Level 2											
Standard	0.0151	0.0148	0.0151	0.0153	0.0153	0.0150	0.0147	0.0145	0.0142	0.0150	0.0149
Analyzer	0.0168	0.0167	0.0170	0.0170	0.0170	0.0162	0.0157	0.0156	0.0161	0.0167	0.0165
Level 1											
Standard											
Analyzer											

Audit Summary				
Audit Set Point	Conc. Out (ppm)	DAS Value (ppm)	Zero Corr. (ppm)	% Relative Error
Zero	-0.0001	0.0004		
Level 5	0.1257	0.1267	0.1267	0.8%
Level 4	0.0762	0.0765	0.0765	0.5%
Level 3	0.0363	0.0355	0.0355	-2.0%
Level 2	0.0160	0.0165	0.0165	2.7%
Level 1				

Audit Results

DAS Results

Zero	PASS
Level 5	PASS
Level 4	PASS
Level 3	PASS
Level 2	PASS
Level 1	

Internal Temp.

Station	PASS
Audit	PASS
Difference	PASS

Regression Results

Slope	1.005579
Intercept	3.17E-05
R-Squared	0.999895

Comments

Nitrogen Dioxide Analyzer Audit

COLORADO
Air Pollution Control Division
Department of Public Health & Environment

Site	888888888				
Site Name	MISSILE SITE PARK				
Monitor	42602				
POC	1	Method Code	200	AQS Units	8 (ppb)
Auditor	Joseph	Initial NO2	7.6	Calibrator SN	886
Audit Type	Performance	Time Offline	8:54	Zero Air SN	469
Audit Date	11/25/2024	Final NO2	2	Station Temp.	21.5
Audit Time	8:54	Time Online	14:46	Audit Temp.	20.8

Analyzer Information

Serial #	6727	Slope	1.025	Intercept	-0.7	Full Scale	

Do you want to zero correct the analyzer? ☐ Upload to AQS? ☐

Pre-Audit Precision and Span Evaluation

Audit Set Point	NO Conc. Out (ppb)	NO Display Value (ppb)	NO Zero Corr. (ppb)	NO % Relative Error	NO2 Display Value (ppb)	NOx Display Value (ppb)	NOx % Relative Error
Zero							
Span							
Precision							

Audit Calibrator Flow Rates

Audit Set Point	Target (ppb)	Cylinder	Source NO (ppm)	Source NOx (ppm)	Dilution Flow (l/min)	Cal. Flow (l/min)	NO Conc. Out (ppb)	NOx Conc. Out (ppb)	NO Indicated (ppb)
Zero	0.000				4.4960	0.0000	0.000	0.000	0.000
Level 6	700.000	FF24038	9.576	9.584	2.3220	0.1830	699.564	700.148	699.000
Level 5	400.000	FF24038	9.576	9.584	3.3590	0.1463	399.672	400.005	399.800
Level 4	250.000	FF24038	9.576	9.584	4.3870	0.1177	250.204	250.413	250.300
Level 3	150.000	FF24038	9.576	9.584	5.4190	0.0864	150.283	150.408	150.300
Level 2	75.000	FF24038	9.576	9.584	6.4550	0.0511	75.212	75.274	75.300
Level 1	15.000	FF24038	9.576	9.584	7.5050	0.0118	15.033	15.045	15.000

Nitric Oxide (NO) Audit Data

Audit Set Point	NO Display Value (ppb)	NO Zero Corr. (ppb)	NO % Relative Error	NO2 Display Value (ppb)	NOx Display Value (ppb)	NOx % Relative Error
Zero	0.000			0.300	0.200	
Level 6	670.700	670.700	-4.1%	6.100	676.800	-3.3%
Level 5	390.100	390.100	-2.4%	2.000	392.000	-2.0%
Level 4	244.400	244.400	-2.3%	1.300	245.700	-1.9%
Level 3	147.800	147.800	-1.7%	0.200	148.100	-1.5%
Level 2	74.000	74.000	-1.6%	0.300	74.300	-1.3%
Level 1	14.500	14.500	-3.5%	0.100	14.600	-3.0%

Regression Results

NO

Slope	0.960603
Intercept	2.024722
R-Squared	0.999879

NOx

Slope	0.967984
Intercept	1.62169
R-Squared	0.999930

NO Results

Zero	PASS
Level 6	PASS
Level 5	PASS
Level 4	PASS
Level 3	PASS
Level 2	PASS
Level 1	PASS

Gas-Phase Titration Data

Audit Set Point	Ozone Conc. Out (ppb)	NO Indicated (ppb)	NO Remaining (ppb)	NOx Indicated (ppb)	NOx Remaining (ppb)	NO2 Indicated (ppb)	NO2 Actual (ppb)
Level 6							
Level 5	320.000	70.000	70.763	391.900	403.187	321.900	332.527
Level 4	170.000	77.200	78.258	245.200	251.635	168.000	173.893
Level 3	70.000	77.000	78.050	148.100	151.323	71.100	73.273
Level 2	15.000	60.300	60.665	74.100	74.876	13.800	14.417
Level 1	4.000	12.600	11.009	14.700	13.511	2.100	2.399

NO2 Relative Error

Level 6	
Level 5	-3.2%
Level 4	-3.4%
Level 3	-3.0%
Level 2	-4.3%
Level 1	-12.4%

NO Conv. Efficiency

Level 6	
Level 5	100.0%
Level 4	100.3%
Level 3	100.0%
Level 2	101.5%
Level 1	95.9%

Internal Temp.

Station	PASS
Audit	PASS
Difference	PASS

Regression Results

Slope	0.968258
Intercept	-0.13468
R-Squared	0.999998

Comments

APPENDIX B5: HEREFORD STATION CDPHE AUDIT

Meteorological Tower Audit

COLORADO
Air Pollution Control Division
Department of Public Health & Environment

Site	888888888		
Site Name	SPECIAL PURPOSE MONITOR		
Auditor	Brett	Time Offline	9:20
Audit Date	11/26/2024	Time Online	10:15

Sensor Information

Sensor	Serial Number	Make	Model
Wind Speed	209492	RM Young	05305
Wind Direction	209492	RM Young	05305
Temp (Upper)	032896	RM Young	41342VC
Temp (Lower)	032950	RM Young	41342VC
Hygrometer	2015160072638F	EE Elec	EE181
Barometer	7573233	Sentra	278

Span/Zero Voltages

Sensor	Zero	Span
Wind Speed		
Wind Direction		
Temp (Upper)		
Temp (Lower)		
Hygrometer		
Barometer		

Magnetic Declination	7.33	Distance to Tower (ft)	100	Subtract magnetic declination? ☐
Crossarm Orientation	N-S	Correction (ft)	-0.7	

Pre-Audit Crossarm Alignment Check

	Degrees	Minutes	Offset	Error
Normal	359	37	0	-0.4
Inverted	179	37	0	-0.4

Post-Audit Crossarm Alignment Check

	Degrees	Minutes	Offset	Error
Normal	359	37	0	-0.4
Inverted	179	37	0	-0.4

Wind Speed Sensor Audit (+/- 5%)

Audit Set Point (RPM)		Wind Speed (mph)	DVM (volts)	DVM (mph)	Error (%)	DCN Actual (volts)	DCN Actual (mph)	Error (%)	DCN Res. (mph)	Error (%)
Zero	0	0.0					0.0		0.0	
CW	600	6.9					6.9	0.0%	6.9	0.0%
CCW	600	6.9					6.9	0.0%	6.9	0.0%
CW	1700	19.5					19.5	0.0%	19.5	0.0%
CCW	1700	19.5					19.5	0.0%	19.5	0.0%
CW	3300	37.8					37.8	0.0%	37.8	0.0%
CCW	3300	37.8					37.8	0.0%	37.8	0.0%
CW	5400	61.8					61.8	0.0%	61.8	0.0%
CCW	5400	61.8					61.8	0.0%	61.8	0.0%

Wind Direction Sensor Audit (+/- 5 Degrees)										
Audit Set Point	Wind Dir. (degrees)	DVM (volts)	DVM (degrees)	DCN Act. (volts)	DCN Act. (degrees)	Offset	DCN Act. Error	DCN Res. (degrees)	DCN Res. Error	Composite Error
South	180				180.6	0.0	0.6	180.6	0.6	0.2
CW West	270				270.6	0.0	0.6	270.6	0.6	0.2
CW North	360				0.6	-360.0	0.6	0.6	0.6	0.2
CW East	90				90.1	0.0	0.1	90.1	0.1	-0.3
CCW South	180				181.2	0.0	1.2	181.2	1.2	0.8
CCW East	90				91.0	0.0	1.0	91.0	1.0	0.6
CCW North	360				1.5	-360.0	1.5	1.5	1.5	1.1
CCW West	270				271.8	0.0	1.8	271.8	1.8	1.4

	Temperature (+/- 2 Degrees C)									
Reading	Upper Temp. Sensor					Lower Temp. Sensor				
	DVM (volts)	DCN (volts)	Audit (F)	DCN (F)	Error	DVM (volts)	DCN (volts)	Audit (F)	DCN (F)	Error
Point 1			3.7	3.3	-0.4			4.1	4.2	0.1
Point 2			3.8	3.7	-0.1			4.1	4.3	0.2
Avg.			3.8	3.5	-0.3			4.1	4.3	0.2

	Humidity (+/- 5%)					Pressure (+/- 10 mm Hg)				
Reading	DVM (volts)	DCN (volts)	Audit (%)	DCN (%)	Error	DVM (volts)	DCN (volts)	Audit (mmHg)	DCN (mmHg)	Error
Point 1			51.3	55.9	4.6			625.5	626.8	1.3
Point 2			53.0	55.1	2.1			625.6	626.8	1.2
Avg.			52.1	55.5	3.4			625.5	626.8	1.3

Audit Results

Wind Speed

CW 600 RPM	PASS
CCW 600 RPM	PASS
CW 1700 RPM	PASS
CCW 1700 RPM	PASS
CW 3300 RPM	PASS
CCW 3300 RPM	PASS
CW 5400 RPM	PASS
CCW 5400 RPM	PASS

Wind Direction

South	PASS
CW West	PASS
CW North	PASS
CW East	PASS
CCW South	PASS
CCW East	PASS
CCW North	PASS
CCW West	PASS

Temperature

Upper Avg.	PASS
Lower Avg.	PASS

Humidity

Avg.	PASS

Pressure

Avg.	PASS

Comments

Site Name: Hereford - Weld County

Ozone Analyzer Audit

COLORADO
Air Pollution Control Division
Department of Public Health & Environment

Site	888888888						
Site Name	SPECIAL PURPOSE MONITOR						
Monitor	44201						
POC	1	Method Code	87	AQS Units	7	(ppm)	
Auditor	Joshua	Initial O3	0.0235	Calibrator SN	160		
Audit Type	Performance	Time Offline	9:18	Cal. Slope	1.007624		
Audit Date	11/26/2024	Final O3	0.0262	Cal. Intercept	-1.016461E-03		
Audit Time	9:14	Time Online	10:45				
Station Temp.	21.8	Audit Temp.	20.3				

Analyzer Information

Serial #	Slope	Intercept	Full Scale
5984	0.994	-0.0017	400

Do you want to zero correct the analyzer? ☐ Upload to AQS? ☐

Audit Set Point	Conc. Out (ppm)	DAS Value (ppm)	Zero Corr. (ppm)	% Relative Error	Display Value (ppm)	% Relative Error
Pre-Audit Precision and Span Evaluation						
Zero	-0.0011	0.0007			0.0007	
Span	0.2501	0.2506	0.2506	0.2%	0.2503	0.1%
Precision						

Raw Audit Data

	1	2	3	4	5	6	7	8	9	10	Average
Zero											
Standard	-0.0003	-0.0003	-0.0003	-0.0004	-0.0004	-0.0006	-0.0007	-0.0006	-0.0005	-0.0005	-0.0005
Analyzer	0.0007	0.0006	0.0006	0.0007	0.0007	0.0007	0.0008	0.0008	0.0008	0.0007	0.0007
Level 5											
Standard											
Analyzer											
Level 4											
Standard	0.1260	0.1261	0.1261	0.1261	0.1258	0.1257	0.1259	0.1259	0.1257	0.1256	0.1259
Analyzer	0.1246	0.1245	0.1243	0.1247	0.1242	0.1242	0.1242	0.1242	0.1244	0.1244	0.1244
Level 3											
Standard	0.0760	0.0761	0.0762	0.0762	0.0761	0.0762	0.0761	0.0762	0.0763	0.0762	0.0762
Analyzer	0.0759	0.0759	0.0759	0.0759	0.0761	0.0761	0.0759	0.0755	0.0753	0.0753	0.0758
Level 2											
Standard	0.0353	0.0351	0.0351	0.0350	0.0350	0.0352	0.0352	0.0354	0.0354	0.0353	0.0352
Analyzer	0.0353	0.0354	0.0356	0.0355	0.0352	0.0354	0.0355	0.0354	0.0353	0.0352	0.0354
Level 1											
Standard	0.0154	0.0153	0.0153	0.0153	0.0153	0.0153	0.0152	0.0151	0.0151	0.0149	0.0152
Analyzer	0.0160	0.0160	0.0161	0.0163	0.0163	0.0162	0.0161	0.0162	0.0162	0.0160	0.0161

Audit Summary				
Audit Set Point	Conc. Out (ppm)	DAS Value (ppm)	Zero Corr. (ppm)	% Relative Error
Zero	0.0006	0.0007		
Level 5				
Level 4	0.1259	0.1244	0.1244	-1.2%
Level 3	0.0766	0.0758	0.0758	-1.1%
Level 2	0.0359	0.0354	0.0354	-1.6%
Level 1	0.0161	0.0161	0.0161	0.1%

Audit Results

DAS Results

Zero	PASS
Level 5	
Level 4	PASS
Level 3	PASS
Level 2	PASS
Level 1	PASS

Internal Temp.

Station	PASS
Audit	PASS
Difference	PASS

Regression Results

Slope	0.986934
Intercept	9.36E-05
R-Squared	0.999994

Comments

Hereford Weld County Site

APPENDIX B6: ORCHARD STATION CDPHE AUDIT

Meteorological Tower Audit

COLORADO
Air Pollution Control Division
Department of Public Health & Environment

Site	888888888		
Site Name	SPECIAL PURPOSE MONITOR		
Auditor	Joshua	Time Offline	12:15
Audit Date	11/26/2024	Time Online	13:35

Sensor Information			
Sensor	Serial Number	Make	Model
Wind Speed	180186	RM Young	05103
Wind Direction	180186	RM Young	05103
Temp (Upper)	032954	RM Young	41342VC
Temp (Lower)	032953	RM Young	41342VC
Hygrometer	201516001269F1	RM Young	EE181
Barometer		RM Young	61002

Span/Zero Voltages		
Sensor	Zero	Span
Wind Speed		
Wind Direction		
Temp (Upper)		
Temp (Lower)		
Hygrometer		
Barometer		

Magnetic Declination	7.2	Distance to Tower (ft)	100	Subtract magnetic declination? ☐
Crossarm Orientation	N-S	Correction (ft)	-2.8	

Pre-Audit Crossarm Alignment Check				
	Degrees	Minutes	Offset	Error
Normal	-2	25	-360	-1.6
Inverted	178	25	0	-1.6

Post-Audit Crossarm Alignment Check				
	Degrees	Minutes	Offset	Error
Normal	-2	25	-360	-1.6
Inverted	178	25	0	-1.6

Wind Speed Sensor Audit (+/- 5%)										
Audit Set Point (RPM)		Wind Speed (mph)	DVM (volts)	DVM (mph)	Error (%)	DCN Actual (volts)	DCN Actual (mph)	Error (%)	DCN Res. (mph)	Error (%)
Zero	0	0.0					0.0		0.0	
CW	600	6.9					6.9	0.0%	6.9	0.0%
CCW	600	6.9					6.9	0.1%	6.9	0.1%
CW	1700	19.5					19.5	0.4%	19.5	0.4%
CCW	1700	19.5					19.6	0.5%	19.6	0.5%
CW	3300	37.8					38.0	0.6%	38.0	0.6%
CCW	3300	37.8					38.0	0.6%	38.0	0.6%
CW	5400	61.8					62.3	0.7%	62.3	0.7%
CCW	5400	61.8					62.3	0.8%	62.3	0.8%

Wind Direction Sensor Audit (+/- 5 Degrees)										
Audit Set Point	Wind Dir. (degrees)	DVM (volts)	DVM (degrees)	DCN Act. (volts)	DCN Act. (degrees)	Offset	DCN Act. Error	DCN Res. (degrees)	DCN Res. Error	Composite Error
South	180				179.6	0.0	-0.4	179.6	-0.4	-2.0
CW West	270				269.2	0.0	-0.8	269.2	-0.8	-2.4
CW North	360				-0.1	-360.0	-0.1	-0.1	-0.1	-1.7
CW East	90				89.8	0.0	-0.2	89.8	-0.2	-1.8
CCW South	180				179.3	0.0	-0.7	179.3	-0.7	-2.3
CCW East	90				89.7	0.0	-0.3	89.7	-0.3	-1.9
CCW North	360				-0.2	-360.0	-0.2	-0.2	-0.2	-1.7
CCW West	270				269.8	0.0	-0.2	269.8	-0.2	-1.8

	Temperature (+/- 2 Degrees C)									
Reading	Upper Temp. Sensor					Lower Temp. Sensor				
	DVM (volts)	DCN (volts)	Audit (F)	DCN (F)	Error	DVM (volts)	DCN (volts)	Audit (F)	DCN (F)	Error
Point 1			46.0	46.5	0.5			47.3	47.1	-0.2
Point 2			46.0	46.4	0.4			46.8	47.0	0.3
Avg.			46.0	46.5	0.4			47.0	47.1	0.1

	Humidity (+/- 5%)					Pressure (+/- 10 mm Hg)				
Reading	DVM (volts)	DCN (volts)	Audit (%)	DCN (%)	Error	DVM (volts)	DCN (volts)	Audit (mmHg)	DCN (mmHg)	Error
Point 1			38.9	41.8	2.9			643.4	644.3	0.9
Point 2			38.1	42.9	4.8			643.6	644.4	0.8
Avg.			38.5	42.3	3.9			643.5	644.3	0.9

Audit Results

Wind Speed

CW 600 RPM	PASS
CCW 600 RPM	PASS
CW 1700 RPM	PASS
CCW 1700 RPM	PASS
CW 3300 RPM	PASS
CCW 3300 RPM	PASS
CW 5400 RPM	PASS
CCW 5400 RPM	PASS

Wind Direction

South	PASS
CW West	PASS
CW North	PASS
CW East	PASS
CCW South	PASS
CCW East	PASS
CCW North	PASS
CCW West	PASS

Temperature

Upper Avg.	PASS
Lower Avg.	PASS

Humidity

Avg.	PASS

Pressure

Avg.	PASS

Comments

Orchard Weld County Site

Ozone Analyzer Audit

COLORADO
Air Pollution Control Division
Department of Public Health & Environment

Site	888888888				
Site Name	SPECIAL PURPOSE MONITOR				
Monitor	44201				
POC	1	Method Code	87	AQS Units	7 (ppm)
Auditor	Brett	Initial O3	0.0191	Calibrator SN	160
Audit Type	Performance	Time Offline	12:10	Cal. Slope	1.007624
Audit Date	11/26/2024	Final O3	0.0232	Cal. Intercept	-1.016461E-03
Audit Time	12:10	Time Online	13:20		
Station Temp.	20.2	Audit Temp.	20.3		

Analyzer Information

Serial #	5985	Slope	0.978	Intercept	-1.2	Full Scale	

Do you want to zero correct the analyzer? ☐ Upload to AQS? ☐

Audit Set Point	Conc. Out (ppm)	DAS Value (ppm)	Zero Corr. (ppm)	% Relative Error	Display Value (ppm)	% Relative Error
Pre-Audit Precision and Span Evaluation						
Zero	-0.0012	0.0002			0.0001	
Span	0.2400	0.2375	0.2375	-1.0%	0.2371	-1.2%
Precision	0.0600	0.0618	0.0618	3.0%	0.0610	1.7%

Raw Audit Data

	1	2	3	4	5	6	7	8	9	10	Average
Zero											
Standard	0.0003	0.0005	0.0004	0.0003	0.0002	0.0003	0.0002	-0.0002	-0.0002	-0.0005	0.0001
Analyzer	-0.0005	-0.0004	-0.0003	-0.0001	-0.0003	-0.0004	-0.0006	-0.0003	-0.0004	-0.0001	-0.0003
Level 5											
Standard											
Analyzer											
Level 4											
Standard	0.1250	0.1251	0.1251	0.1252	0.1252	0.1251	0.1252	0.1251	0.1251	0.1250	0.1251
Analyzer	0.1209	0.1209	0.1210	0.1210	0.1212	0.1211	0.1209	0.1208	0.1207	0.1209	0.1209
Level 3											
Standard	0.0753	0.0753	0.0753	0.0756	0.0755	0.0753	0.0750	0.0753	0.0751	0.0752	0.0753
Analyzer	0.0730	0.0731	0.0733	0.0731	0.0731	0.0728	0.0729	0.0730	0.0730	0.0729	0.0730
Level 2											
Standard	0.0350	0.0348	0.0349	0.0350	0.0350	0.0353	0.0354	0.0352	0.0350	0.0350	0.0351
Analyzer	0.0335	0.0335	0.0334	0.0333	0.0335	0.0335	0.0334	0.0333	0.0332	0.0330	0.0334
Level 1											
Standard	0.0148	0.0147	0.0145	0.0148	0.0151	0.0149	0.0149	0.0151	0.0151	0.0151	0.0149
Analyzer	0.0147	0.0146	0.0144	0.0145	0.0146	0.0147	0.0147	0.0149	0.0149	0.0148	0.0147

Audit Summary				
Audit Set Point	Conc. Out (ppm)	DAS Value (ppm)	Zero Corr. (ppm)	% Relative Error
Zero	0.0011	-0.0003		
Level 5				
Level 4	0.1252	0.1209	0.1209	-3.4%
Level 3	0.0757	0.0730	0.0730	-3.6%
Level 2	0.0358	0.0334	0.0334	-6.8%
Level 1	0.0158	0.0147	0.0147	-7.1%

Audit Results

DAS Results

Zero	PASS
Level 5	
Level 4	PASS
Level 3	PASS
Level 2	PASS
Level 1	PASS

Internal Temp.

Station	PASS
Audit	PASS
Difference	PASS

Regression Results

Slope	0.972544
Intercept	-0.00084
R-Squared	0.999868

Comments

Site Name: Orchard - Weld County

APPENDIX B7: NETWORK SOLAR RADIATION & PRECIPITATION ARS AUDIT

AUDIT REPORT

FOR

RAMBOLL US CONSULTING
WELD COUNTY, COLORADO
NOVEMBER 2024

Prepared for

RAMBOLL

Jake Zaragoza
RAMBOLL US CONSULTING
Ramboll Environmental & Health

Prepared by

Air Resource SPECIALISTS

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970-484-7941
www.air-resource.com

Sites Audited: November 21, 2024

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LIST OF TABLES

1.0 INTRODUCTION

Air Resource Specialists, Inc. (ARS) conducted a performance audit of monitoring sites in Weld County, Colorado operated by Ramboll US Consulting on November 21, 2024. The monitoring sites are in Hereford, Orchard, and Greeley, Colorado. The table below documents their specific locations.

Table 1-1

Site Location Information

	Herford Monitoring Site, Hereford, CO	**Orchard Monitoring Site, Orchard, CO**	**Missile Park Monitoring Site, Greeley, CO**
Latitude	40° 58' 38.5" N	40° 19' 11.6" N	40° 25' 44.2" N
Longitude	104° 18' 18.7" W	104° 9' 34.0" W	104° 51' 41.3" W
UTM	13T 558460 4536471	13T 571413 4463598	13T 511753 4475383
Elevation	5,279 feet MSL	4,409 feet MSL	4,675 feet MSL

Audit results for the meteorological measurements are summarized in Tables 1-2 through 1-4. Detailed discussions of performance audit findings and other findings can be found in Section 3.0.

Table 1-2

Summary of Meteorological Audit Results
Hereford Monitoring Site, Hereford, CO

Parameter	**Instrument**	**Within Accuracy Goal**
Precipitation	RM Young 52202	Yes
Solar Radiation	Huskeflux LP02	Yes

Table 1-3

Summary of Meteorological Audit Results
Orchard Monitoring Site, Orchard, CO

Parameter	**Instrument**	**Within Accuracy Goal**
Precipitation	RM Young 52202	Yes
Solar Radiation	Huskeflux LP02	Yes

Table 1-4

Summary of Meteorological Audit Results
Missile Park Monitoring Site, Greeley, CO

Parameter	Sensor	Within Accuracy Goal
Precipitation	RM Young 52202	Yes
Solar Radiation	Huskeflux LP02	Yes

Details of the audit are presented in the following sections:

Section 2.0	Audit Methods and Equipment
Section 3.0	Audit Results
Appendix A	Audit Data Forms
Appendix B	Audit Standards Certifications

Any questions related to this audit or audit report should be addressed to:

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Vice President – Technical Operations
Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite F
Fort Collins, Colorado 80525
Telephone: 970-484-7941
E-mail: ckirk@air-resource.com

2.0 AUDIT METHODS

Audit procedures, audit challenge ranges, and acceptance criteria are described below. These ranges and limits conform to EPA's SLAMS guidelines. Audit results were verbally communicated to the site operator prior to departure from the sites. Audit details are provided in Appendix A.

Guidance from the following EPA documents was used to establish the audit procedures:

- 40 CFR Part 58, Appendix A. *Quality Assurance Requirements for Monitors Used in Evaluations of National Ambient Air Quality Standards*
- EPA *Quality Assurance Handbook for Air Pollution Measurement Systems:*
  - *Volume I. A Field Guide to Environmental Quality Assurance*
  - *Volume II. Ambient Air Quality Monitoring Program*
  - *Volume IV. Meteorological Measurements*
- EPA *Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone*

2.1 METEOROLOGICAL PARAMETERS

Meteorological measurement systems are audited in accordance with (and accuracy goals were obtained from) the EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV – Meteorological Measurements*, (March 2008). ARS uses National Institute of Standards and Technologies (NIST) traceable test equipment for all meteorological parameters. All equipment is recertified annually. Audit ranges and acceptable criteria for each parameter are summarized in Table 2-1.

2.1.1 Solar Radiation

Solar radiation sensors are audited by collocation of the audit sensor under ambient conditions. Collocated comparisons are typically carried out using hourly averages. Audit data are collected by a datalogger provided by the auditor. Data observed from the on-site datalogger are used to assess the accuracy of sensors. Additionally, the level and cleanliness of the sensor is observed, where possible.

2.1.2 Precipitation

The tipping bucket style precipitation gauges are audited with a volumetric precipitation gauge calibrator by transferring a known amount of water through the gauge orifice at a maximum rate equivalent to 2.0 inches/hour of precipitation. The total values from the on-site datalogger values are compared to the actual introduced volume. The level and cleanliness of the sensor is observed where possible.

Table 2-1

Meteorological Sensors
Audit Ranges and Acceptance Criteria

Parameter	Audit Method	Acceptance Criteria
Precipitation	Accuracy via known volume of water	≤ ± 10%
Solar Radiation	Accuracy Via collocation in ambient conditions	≤ ± 10%

Table 2-2

Meteorological Audit Equipment

References	Manufacturer	Model Number	Serial Number	Expiration Date
Precipitation	R.M. Young	52260	N/A	N/A
Solar Radiation	Apogee	CS301	81421	7/24/2025
Solar Radiation	Apogee	CS301	81422	7/24/2025

3.0 AUDIT RESULTS

Audit findings and recommendations are discussed below. Detailed audit results are provided in Appendix A.

3.1 HEREFORD MONITORING SITE

All parameters passed the performance audit. The solar sensor was found loosely attached to its mounting backet and slightly out of level. Post audit adjustment in sensor mounting and leveling led to an improved comparison between audit standards and site sensor when instantaneous compared.

3.2 ORCHARD MONITORING SITE

All parameters passed the performance audit.

3.3 MISSILE PARK MONITORING SITE

All parameters passed the performance audit.

APPENDIX A

AUDIT DATA FORMS

SOLAR RADIATION SENSOR AUDIT

ABBR.	N/A				
CLIENT	Ramboll	FIELD SPECIALIST	B.Orth	DATE	11/21/2024
SITE NAME	Hereford Monitoring Site				

	MANUFACTURER	MODEL	SERIAL NUMBER	EXPIRATION DATE
Solar Radiation Reference #1	Apogee	CS301	81421	7/24/2025
Solar Radiation Reference #2	Apogee	CS301	81422	7/24/2025

Manufacturer	Huskeflux
Model	LP02
Serial Number	48015

Conversions			
Value	Units	Value	Units
1.000	Langley/m	697.80	W/m^2

AUDIT CRITERIA (<=)	
Difference from CTS (%)	10.0%

	Solar Radiation			
Hour	#1 (W/m^2)	#2 (W/m^2)	DAS (W/m^2)	Difference
1345	408	402.3	420	2.9%
1400	393.5	387.7	405	2.9%
1415	351.9	346.6	360	2.3%
1430	314.4	309.6	322	2.3%
	MEAN ABS % DIFF		2.6%	PASS

Sensor found clean?	☑ Yes ☐ No
Sensor found level?	☐ Yes ☑ No

NOTES:	Sensor mounting bolts found loose.

PRECIPITATION SENSOR AUDIT

ABBR.	N/A

CLIENT	Ramboll	FIELD SPECIALIST	B.Orth	DATE	11/21/2024
SITE NAME	Hereford Monitoring Site				

	MANUFACTURER	MODEL	SERIAL NUMBER	EXPIRATION DATE
Precipitation Reference	RM Young	52260	n/a	

Manufacturer	RM Young
Model	52202
Serial Number	TB 16139

AUDIT CRITERIA (<=)	
Difference from Input Volume (%)	10.0%

	Reference Chart			Input Volume (mL)		1000
	Manufacturer	Model	Diameter (in.)	mm/tip	mL/tip	DAS target
	Met One	385	12	0.254	18.53	13.71
x	RM Young	52202	6.2825	0.100	2.00	50.00
	Climatronics	100097-1-G0-H0	8	0.254	8.24	30.84
	Climatronics	100508	9.66	0.100	4.73	21.15

Conversions			
Value	Units	Value	Units
2.010	inch	51.05	mm
25.40	mm	1.000	inch

		Precipitation		
Reference (mL)	Target (mm)	DAS (mm)	Difference	
1000	50.00	51.05	**2.1%**	**PASS**

Heater functional?	☐ Yes	☐ No	☑ N/A

NOTES: Unable to check heater funtionality due to warm ambient temperatures.

SITE INFORMATION

ABBR.	N/A				
CLIENT	Ramboll	FIELD SPECIALIST	B.Orth	DATE	11/21/2024
SITE NAME	Hereford Monitoring Site				

		Deg	Min	Sec		Decimal
LATITUDE	North	40	58	38.5	--CALCULATE->	40.9774
LONGITUDE	West	104	18	18.7		104.3052

NOTES:	

CALIBRATION AND VERIFICATION STANDARDS

ABBR.	N/A				
CLIENT	Ramboll	FIELD SPECIALIST	B.Orth	DATE	11/21/2024
SITE NAME	Hereford Monitoring Site				

	MANUFACTURER	MODEL	SERIAL #	Calibration Expiration Date
Ozone Transfer Standard				
Gas Dilution Transfer Standard				
MFC High Flow Reference				
MFC Low Flow Reference				
Temperature Reference				
AT/RH Sensor Reference				
Barometric Pressure Reference				
Wind Speed Reference (high rpm)				
Wind Speed Reference (low rpm)				
Wind Speed Torque Gauge				
Wind Direction Alignment Reference				
Wind Direction Linearity Reference				
Wind Direction Torque Gauge				
Solar Radiation Reference #1	Apogee	CS301	81421	7/24/2025
Solar Radiation Reference #2	Apogee	CS301	81422	7/24/2025
UV Radiation Reference				
Multiplier	W/m2 / mV			
Precipitation Reference				
Volume 1000 mL	RM Young	52260	n/a	

PM Flow Standard #1				
PM Flow Standard #2				
PM Flow Standard #3				
PM Flow Standard #4				

PM Temperature Standard #1				
PM Temperature Standard #2				
PM Temperature Standard #3				
PM Temperature Standard #4				

PM Barometric Pressure Standard #1				
PM Barometric Pressure Standard #2				
PM Barometric Pressure Standard #3				
PM Barometric Pressure Standard #4				

TEOM MTV Standard				

HiVol Direct Flow Reference				
Orifice				
ΔP orifice manometer				

SOLAR RADIATION SENSOR AUDIT

ABBR.	N/A				
CLIENT	Ramboll	FIELD SPECIALIST	B.Orth	DATE	11/21/2024
SITE NAME	Orchard Monitoring Site				

	MANUFACTURER	MODEL	SERIAL NUMBER	EXPIRATION DATE
Solar Radiation Reference #1	Apogee	CS301	81421	7/24/2025
Solar Radiation Reference #2	Apogee	CS301	81422	7/24/20254

Manufacturer	Huskeflux
Model	LP02
Serial Number	48014

Conversions			
Value	Units	Value	Units
1.000	Langley/m	697.80	W/m^2

AUDIT CRITERIA (<=)	
Difference from CTS (%)	10.0%

	Solar Radiation			
Hour	#1 (W/m^2)	#2 (W/m^2)	DAS (W/m^2)	Difference
1100	516.7	510	516	-0.2%
1115	524.8	517.9	525	0.0%
1130	527.3	520.4	528	0.2%
1145	535	527.9	536	0.2%
	MEAN ABS % DIFF		0.1%	PASS

Sensor found clean?	☑ Yes ☐ No
Sensor found level?	☑ Yes ☐ No

NOTES:	

PRECIPITATION SENSOR AUDIT

ABBR.	N/A

CLIENT	Ramboll	FIELD SPECIALIST	B.Orth	DATE	11/21/2024
SITE NAME	Orchard Monitoring Site				

	MANUFACTURER	MODEL	SERIAL NUMBER	EXPIRATION DATE
Precipitation Reference	RM Young	52260	n/a	

Manufacturer	RM Young
Model	52202
Serial Number	TB 16138

AUDIT CRITERIA (<=)	
Difference from Input Volume (%)	10.0%

	Reference Chart			Input Volume (mL)		1000
	Manufacturer	Model	Diameter (in.)	mm/tip	mL/tip	DAS target
	Met One	385	12	0.254	18.53	13.71
x	RM Young	52202	6.2825	0.100	2.00	50.00
	Climatronics	100097-1-G0-H0	8	0.254	8.24	30.84
	Climatronics	100508	9.66	0.100	4.73	21.15

Conversions			
Value	Units	Value	Units
1.810	inch	45.97	mm
50.00	mm	1.969	inch

		Precipitation		
Reference (mL)	Target (mm)	DAS (mm)	Difference	
1000	50.00	45.97	-8.1%	PASS

Heater functional?	☐ Yes	☐ No	☑ N/A

NOTES:	Unable to assess heater funtionality due to above freezing ambient conditions.

SITE INFORMATION

ABBR.	N/A				
CLIENT	Ramboll	FIELD SPECIALIST	B.Orth	DATE	11/21/2024
SITE NAME	Orchard Monitoring Site				

		Deg	Min	Sec		Decimal
LATITUDE	North	40	19	11.6	--CALCULATE->	40.3199
LONGITUDE	West	104	9	34		104.1594

NOTES:	

CALIBRATION AND VERIFICATION STANDARDS

ABBR.	N/A				
CLIENT	Ramboll	FIELD SPECIALIST	B.Orth	DATE	11/21/2024
SITE NAME	Orchard Monitoring Site				

	MANUFACTURER	MODEL	SERIAL #	Calibration Expiration Date
Ozone Transfer Standard				
Gas Dilution Transfer Standard				
MFC High Flow Reference				
MFC Low Flow Reference				
Temperature Reference				
AT/RH Sensor Reference				
Barometric Pressure Reference				
Wind Speed Reference (high rpm)				
Wind Speed Reference (low rpm)				
Wind Speed Torque Gauge				
Wind Direction Alignment Reference				
Wind Direction Linearity Reference				
Wind Direction Torque Gauge				
Solar Radiation Reference #1	Apogee	CS301	81421	7/24/2025
Solar Radiation Reference #2	Apogee	CS301	81422	7/24/20254
UV Radiation Reference				
Multiplier	W/m2 / mV			
Precipitation Reference				
Volume 1000 mL	RM Young	52260	n/a	

PM Flow Standard #1				
PM Flow Standard #2				
PM Flow Standard #3				
PM Flow Standard #4				

PM Temperature Standard #1				
PM Temperature Standard #2				
PM Temperature Standard #3				
PM Temperature Standard #4				

PM Barometric Pressure Standard #1				
PM Barometric Pressure Standard #2				
PM Barometric Pressure Standard #3				
PM Barometric Pressure Standard #4				

TEOM MTV Standard				

HiVol Direct Flow Reference				
Orifice				
ΔP orifice manometer				

SOLAR RADIATION SENSOR AUDIT

ABBR.	N/A				
CLIENT	Ramboll	FIELD SPECIALIST	B.Orth	DATE	11/21/2024
SITE NAME	Missile Park Monitoring Site				

	MANUFACTURER	MODEL	SERIAL NUMBER	EXPIRATION DATE
Solar Radiation Reference #1	Apogee	CS301	81421	7/24/2025
Solar Radiation Reference #2	Apogee	CS301	81422	7/24/2025

Manufacturer	Huskeflux
Model	LP02
Serial Number	48019

Conversions			
Value	Units	Value	Units
1.000	Langley/m	697.80	W/m^2

AUDIT CRITERIA (<=)	
Difference from CTS (%)	10.0%

	Solar Radiation			
Hour	#1 (W/m^2)	#2 (W/m^2)	DAS (W/m^2)	Difference
830	141.7	143.7	137	-3.2%
845	198.5	201.7	185	-6.8%
900	226.7	230	222	-2.1%
915	203.6	205.9	192	-5.9%
	MEAN ABS % DIFF		4.5%	PASS

Sensor found clean?	☑ Yes ☐ No
Sensor found level?	☑ Yes ☐ No

NOTES:

PRECIPITATION SENSOR AUDIT

ABBR.	N/A				
CLIENT	Ramboll	FIELD SPECIALIST	B.Orth	DATE	11/21/2024
SITE NAME	Missile Park Monitoring Site				

	MANUFACTURER	MODEL	SERIAL NUMBER	EXPIRATION DATE
Precipitation Reference	RM Young	52260	n/a	

Manufacturer	RM Young
Model	52202
Serial Number	TB 16137

AUDIT CRITERIA (<=)	
Difference from Input Volume (%)	10.0%

	Reference Chart			Input Volume (mL)		1000
	Manufacturer	Model	Diameter (in.)	mm/tip	mL/tip	DAS target
	Met One	385	12	0.254	18.53	13.71
x	RM Young	52202	6.2825	0.100	2.00	50.00
	Climatronics	100097-1-G0-H0	8	0.254	8.24	30.84
	Climatronics	100508	9.66	0.100	4.73	21.15

Conversions			
Value	Units	Value	Units
1.982	inch	50.34	mm
25.40	mm	1.000	inch

		Precipitation		
Reference (mL)	Target (mm)	DAS (mm)	Difference	
1000	50.00	50.34	**0.7%**	PASS

Heater functional?	☑ Yes	☐ No	☐ N/A

NOTES:

SITE INFORMATION

ABBR.	N/A				
CLIENT	Ramboll	FIELD SPECIALIST	B.Orth	DATE	11/21/2024
SITE NAME	Missile Park Monitoring Site				

		Deg	Min	Sec		Decimal
LATITUDE	North	40	25	44.2	--CALCULATE->	40.4289
LONGITUDE	West	104	51	41.3		104.8615

NOTES:	

CALIBRATION AND VERIFICATION STANDARDS

ABBR.	N/A				
CLIENT	Ramboll	FIELD SPECIALIST	B.Orth	DATE	11/21/2024
SITE NAME	Missile Park Monitoring Site				

	MANUFACTURER	MODEL	SERIAL #	Calibration Expiration Date
Ozone Transfer Standard				
Gas Dilution Transfer Standard				
MFC High Flow Reference				
MFC Low Flow Reference				
Temperature Reference				
AT/RH Sensor Reference				
Barometric Pressure Reference				
Wind Speed Reference (high rpm)				
Wind Speed Reference (low rpm)				
Wind Speed Torque Gauge				
Wind Direction Alignment Reference				
Wind Direction Linearity Reference				
Wind Direction Torque Gauge				
Solar Radiation Reference #1	Apogee	CS301	81421	7/24/2025
Solar Radiation Reference #2	Apogee	CS301	81422	7/24/2025
UV Radiation Reference				
Multiplier	W/m2 / mV			
Precipitation Reference				
Volume 1000 mL	RM Young	52260	n/a	

PM Flow Standard #1				
PM Flow Standard #2				
PM Flow Standard #3				
PM Flow Standard #4				

PM Temperature Standard #1				
PM Temperature Standard #2				
PM Temperature Standard #3				
PM Temperature Standard #4				

PM Barometric Pressure Standard #1				
PM Barometric Pressure Standard #2				
PM Barometric Pressure Standard #3				
PM Barometric Pressure Standard #4				

TEOM MTV Standard				

HiVol Direct Flow Reference				
Orifice				
ΔP orifice manometer				

APPENDIX B

AUDIT STANDARDS CERTIFICATIONS

apogee
INSTRUMENTS
721 West 1800 North
Logan, UT 84321

Certificate of Calibration
Silicon Cell Pyranometer
SP-100/200/400, CS300, and MP-100/200 Series

Serial Number	:	CS301_81421
Calibration Date	:	Jul-2024
Recommended Recalibration Date	:	Jul-2026
Calibration Factor	:	5 **W m^{-2} per mV**
Calibration Uncertainty	:	± 5 %
Measurement Repeatability	:	< 1 %
Non-stability (Long-term Drift)	:	< 2 % per year
Transfer Standard Mean	:	373.3 **W m^{-2}**
Test Sensor (As Found)	:	376.9 **W m^{-2}**
Change in Output (As Found)	:	1.0 %
Test Sensor (As Left)	:	373.1 **W m^{-2}**
Error (As Left)	:	-0.1 %

Calibration Procedure

Calibration is based on a side-by-side comparison under high intensity discharge metal halide lamps using the mean of (4) Apogee transfer standard pyranometers. Apogee transfer standards are calibrated to the mean of at least (2) ISO-classified reference pyranometers under sunlight (clear sky conditions) in Logan, Utah. Each of the four ISO-classified reference pyranometers are recalibrated on an alternating year schedule (two instruments per year) at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. NREL reference standards are calibrated to the World Radiometric Reference (WRR) in Davos, Switzerland.

Traceability

Reference Instrument	Serial Number	ISO 9060 Classification
EKO Instruments MS80	S16088044	Spectrally Flat Class A
Kipp & Zonen CM11	060089	Spectrally Flat Class A
Kipp & Zonen CMP11	101625	Spectrally Flat Class A
Hukseflux SR20	2497	Spectrally Flat Class A
Apogee SP-110	TS1	Fast Response Class C
Apogee SP-110	TS2	Fast Response Class C
Apogee SP-110	TS3	Fast Response Class C
Apogee SP-110	TS4	Fast Response Class C

Technical Manager : Jacob Bingham

Date : 24-Jul-2024
ARS Expiration: 24-Jul-2025

Please keep this document for your records

apogee
INSTRUMENTS
721 West 1800 North
Logan, UT 84321

Certificate of Calibration
Silicon Cell Pyranometer
SP-100/200/400, CS300, and MP-100/200 Series

Serial Number	:	CS301_81422
Calibration Date	:	Jul-2024
Recommended Recalibration Date	:	Jul-2026
Calibration Factor	:	5 **W m^{-2} per mV**
Calibration Uncertainty	:	± 5 **%**
Measurement Repeatability	:	< 1 **%**
Non-stability (Long-term Drift)	:	< 2 **% per year**
Transfer Standard Mean	:	373.5 **W m^{-2}**
Test Sensor (As Found)	:	375.6 **W m^{-2}**
Change in Output (As Found)	:	0.6 **%**
Test Sensor (As Left)	:	373.7 **W m^{-2}**
Error (As Left)	:	0.1 **%**

Calibration Procedure

Calibration is based on a side-by-side comparison under high intensity discharge metal halide lamps using the mean of (4) Apogee transfer standard pyranometers. Apogee transfer standards are calibrated to the mean of at least (2) ISO-classified reference pyranometers under sunlight (clear sky conditions) in Logan, Utah. Each of the four ISO-classified reference pyranometers are recalibrated on an alternating year schedule (two instruments per year) at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. NREL reference standards are calibrated to the World Radiometric Reference (WRR) in Davos, Switzerland.

Traceability

Reference Instrument	Serial Number	ISO 9060 Classification
EKO Instruments MS80	S16088044	Spectrally Flat Class A
Kipp & Zonen CM11	060089	Spectrally Flat Class A
Kipp & Zonen CMP11	101625	Spectrally Flat Class A
Hukseflux SR20	2497	Spectrally Flat Class A
Apogee SP-110	TS1	Fast Response Class C
Apogee SP-110	TS2	Fast Response Class C
Apogee SP-110	TS3	Fast Response Class C
Apogee SP-110	TS4	Fast Response Class C

Technical Manager : Jacob Bingham

Date : 24-Jul-2024
ARS Expiration: 24-Jul-2025

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APPENDIX C: 2024 CALIBRATION STATISTICS

CONTENTS

Figures

Tables

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. The second quarter semi-annual calibration occurred on April 7th and 18th, and the fourth quarter semi-annual calibration occurred on October 1st and 16th. The calibrator was removed from April 8th through 17th and from October 2nd through 14th for recertification, so no automated calibrations occurred during those periods. In addition, the ozone analyzer's glass filter window was briefly cracked which impacted data and calibrations from January 30th through February 9th, and the zero-air generator developed a malfunction which impacted calibrations on September 18th and again from September 23rd through 30th. No calibration checks are available during these periods. 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.

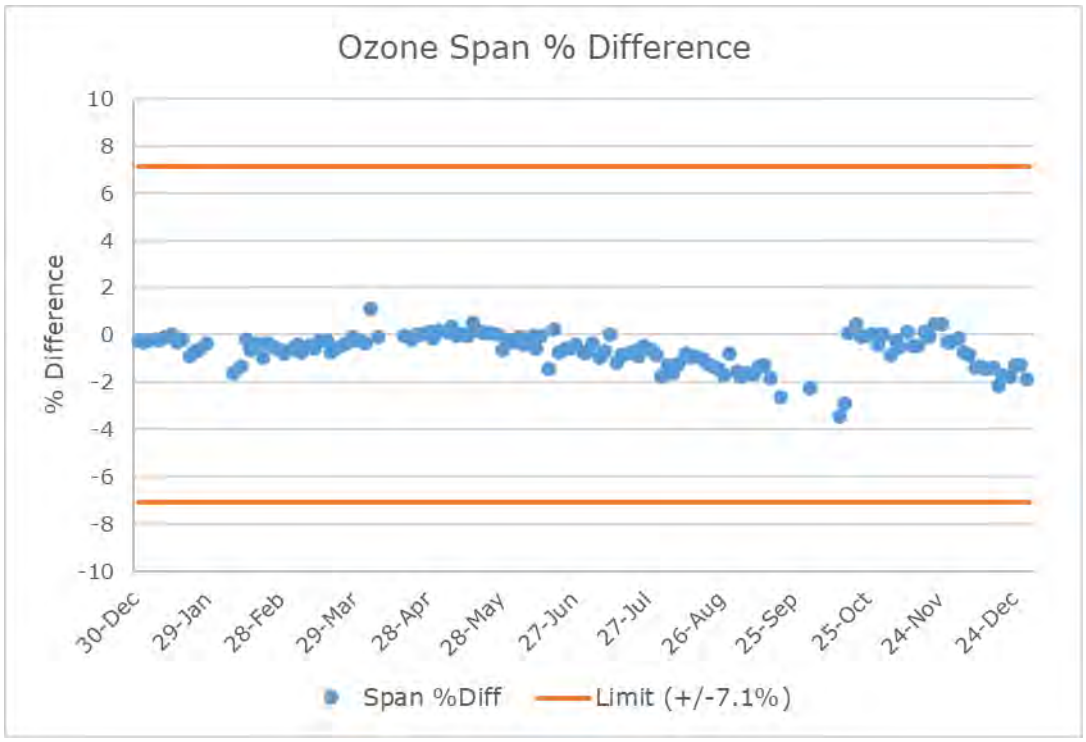

Figure C - 1. 2024 Calibration span percent difference for O_3 at Missile Site Park.

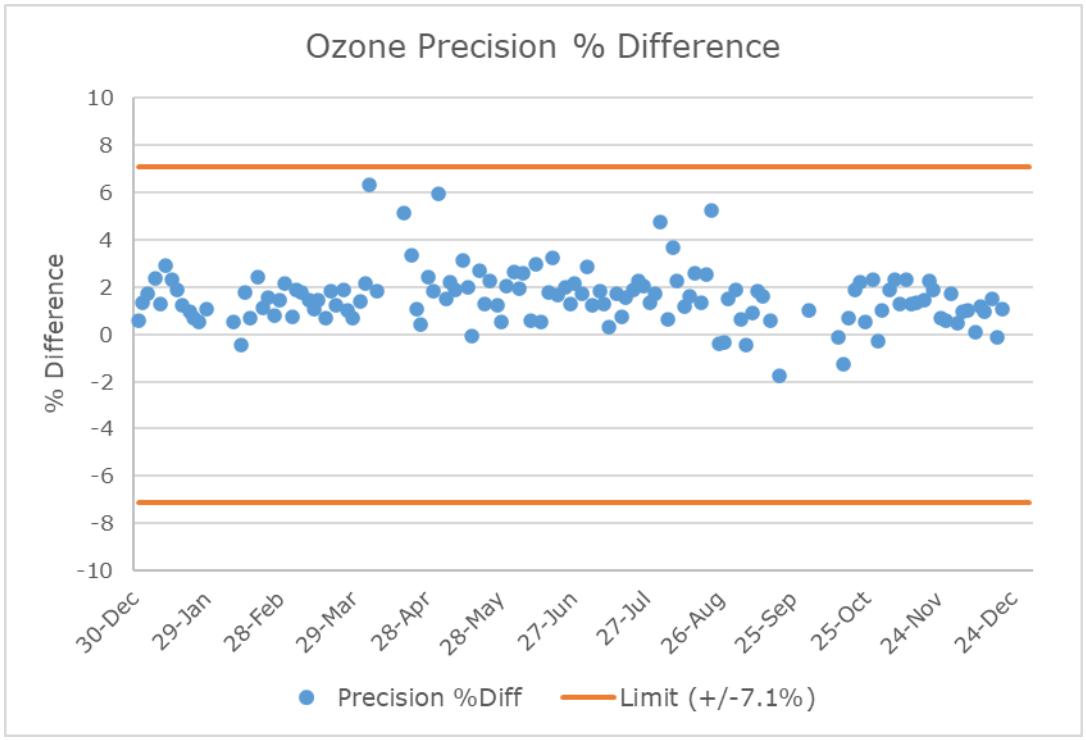

Figure C - 2. 2024 Calibration precision percent difference for O_3 at Missile Site Park.

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

Formula	Precision	Span
STDEV	1.20	0.71
Count	140	140
Chi^2, 0.1, n-1	118.11	118.11
CV	1.30	0.77
Bias	1.74	0.79
Bias (+/-/U)	+	-
AB	1.59	0.70
AS	1.08	0.64
$t_{0.95}$, n-1	1.66	1.66
25th	0.71	-0.95
75th	1.98	-0.11

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. The second quarter semi-annual calibration occurred on April 7th and 18th, and the fourth quarter semi-annual calibration occurred on October 1st and 16th. The calibrator was removed from April 8th through 17th and from October 2nd through 14th for recertification, so no automated calibrations occurred during those periods. In addition, the analyzer's glass filter window was cracked which impacted data and calibrations from February 9th through 12th, and the zero air generator developed a malfunction which impacted calibrations from September 21st through September 30th. No calibration checks are available during these periods. 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.

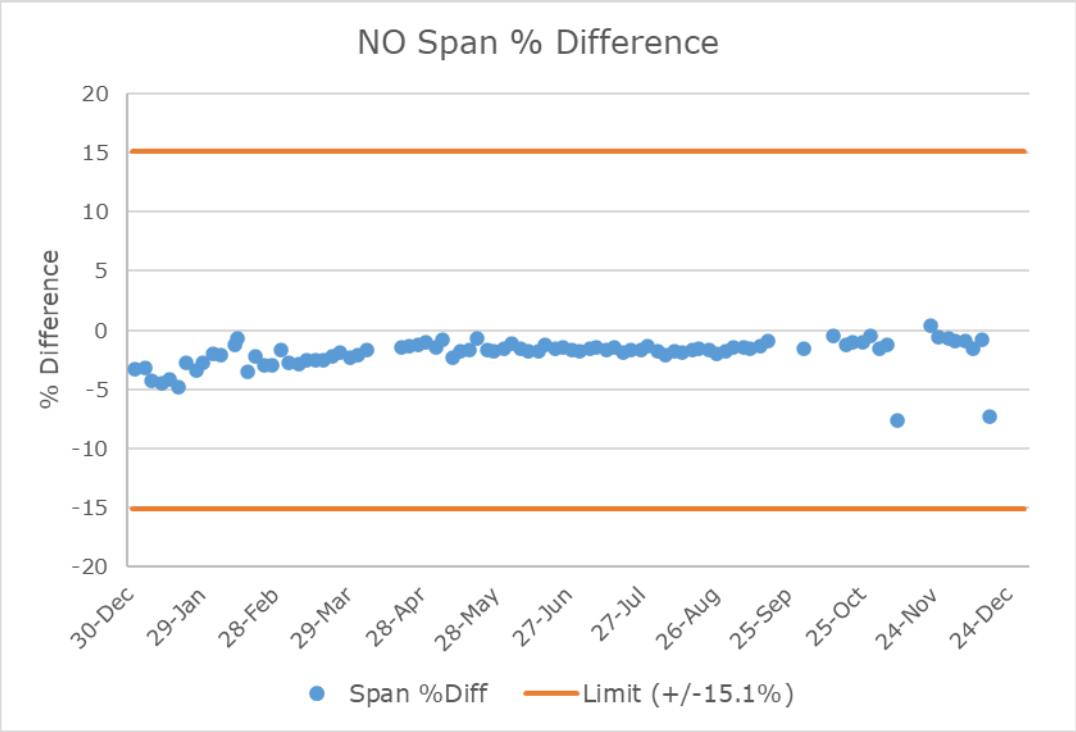

Figure C - 3. 2024 Calibration span percent difference for NO at Missile Site Park.

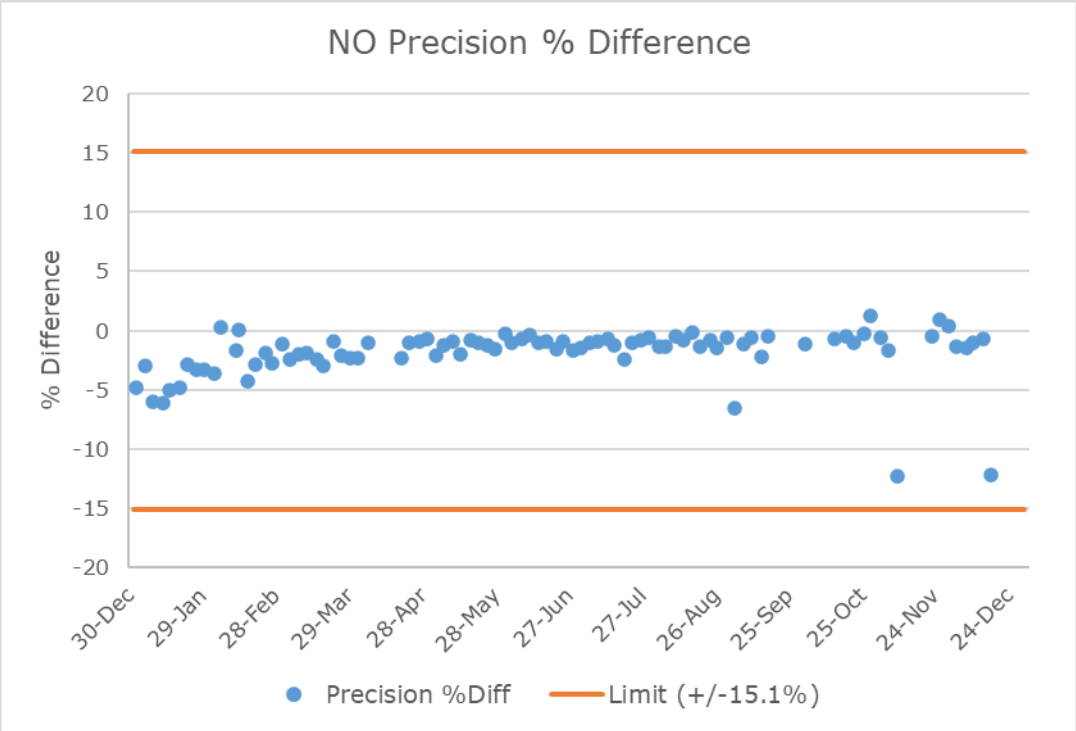

Figure C - 4. 2024 Calibration precision percent difference for NO at Missile Site Park.

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

Formula	Precision	Span
STDEV	2.14	1.23
Count	89	89
Chi^2, 0.1, n-1	71.48	71.48
CV	2.37	1.37
Bias	2.27	2.18
Bias (+/-/U)	-	-
AB	1.90	1.97
AS	2.08	1.22
$t_{0.95}$, n-1	1.66	1.66
25th	-2.28	-2.19
75th	-0.77	-1.37

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. In Q4 2024, the multi-point calibration yielded a CE value of 99.5%.

Figure C - 6 and **Figure C - 7** below show the calibration percent difference for NO_2 during span and precision calibrations, respectively. Note that the calibrator was not programmed to execute span checks for NO_2 until March 3rd, 2024. The second quarter semi-annual calibration occurred on April 7th and 18th, and the fourth quarter semi-annual calibration occurred on October 1st and 16th. The calibrator was removed from April 8th through 17th and from October 2nd through 14th for recertification, so no automated calibrations occurred during those periods. In addition, the analyzer's glass filter window was cracked which impacted data and calibrations from February 9th through 12th, and the zero air generator developed a malfunction which impacted calibrations from September 19th through 30th. No calibration checks are available during these periods. 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.

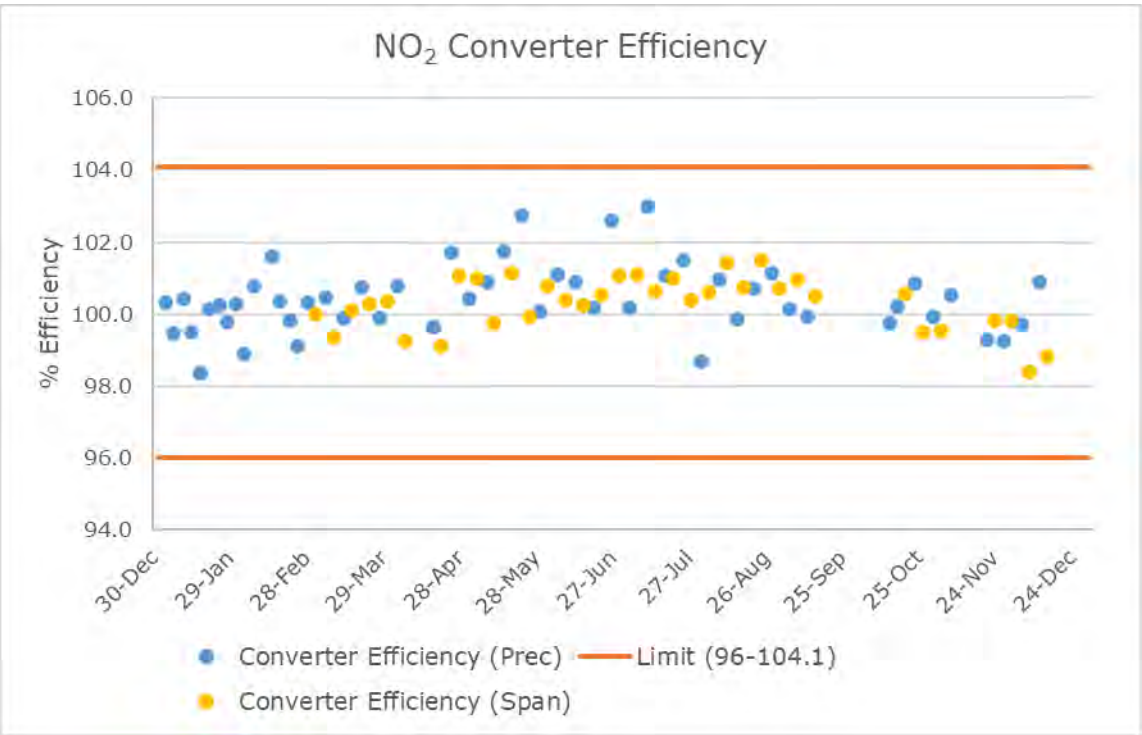

Figure C - 5. 2024 Converter efficiency for NO_2 at Missile Site Park.

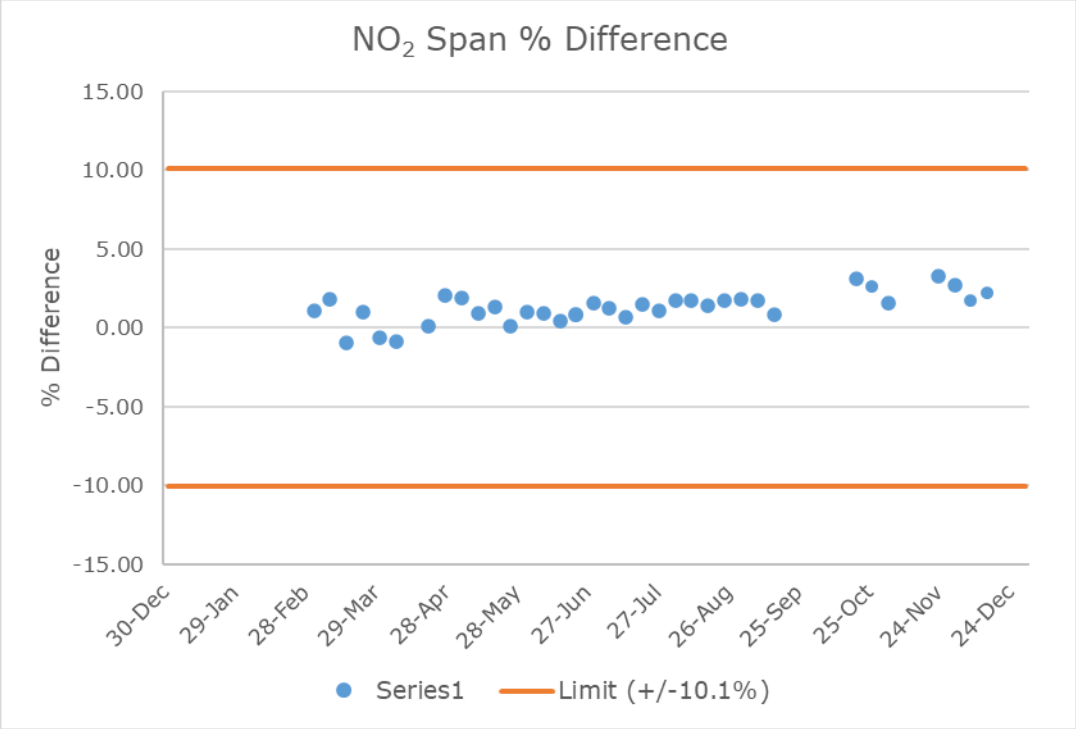

Figure C - 6. 2024 Calibration span percent difference for NO_2 at Missile Site Park.

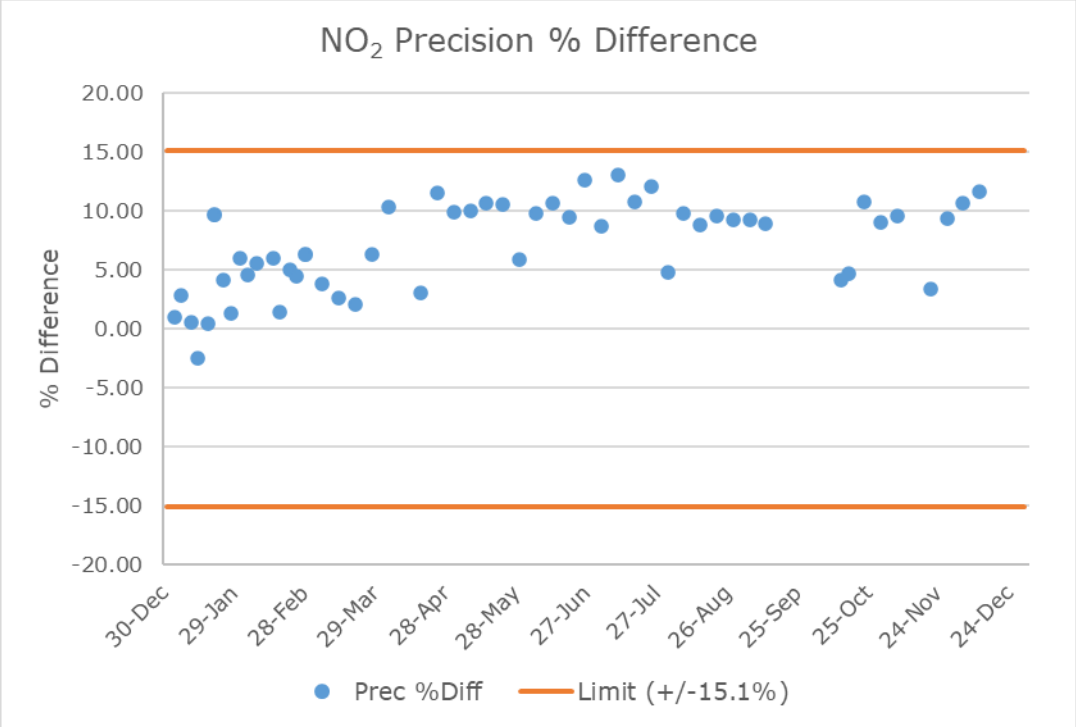

Figure C - 7. 2024 Calibration precision percent difference for NO_2 at Missile Site Park.

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

Formula	Precision	Span
STDEV	3.80	0.98
Count	52	35
Chi^2, 0.1, n-1	38.56	23.95
CV	4.37	1.17
Bias	7.90	1.64
Bias (+/-/U)	+	+
AB	7.06	1.43
AS	3.61	0.76
$t_{0.95}$, n-1	1.68	1.69
25^{th}	4.11	0.86
75^{th}	9.87	1.77

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. The second quarter semi-annual calibration occurred on April 7th and 18th, and the fourth quarter semi-annual calibration occurred on October 1st and 16th. The calibrator was removed from April 8th through 17th and from October 2nd through 14th for recertification, so no automated calibrations occurred during those periods. In addition, the analyzer's glass filter window was cracked which impacted data and calibrations from February 9th through 12th, and the zero air generator developed a malfunction which impacted calibrations from September 21st through 30th. No calibration checks are available during these periods. 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.

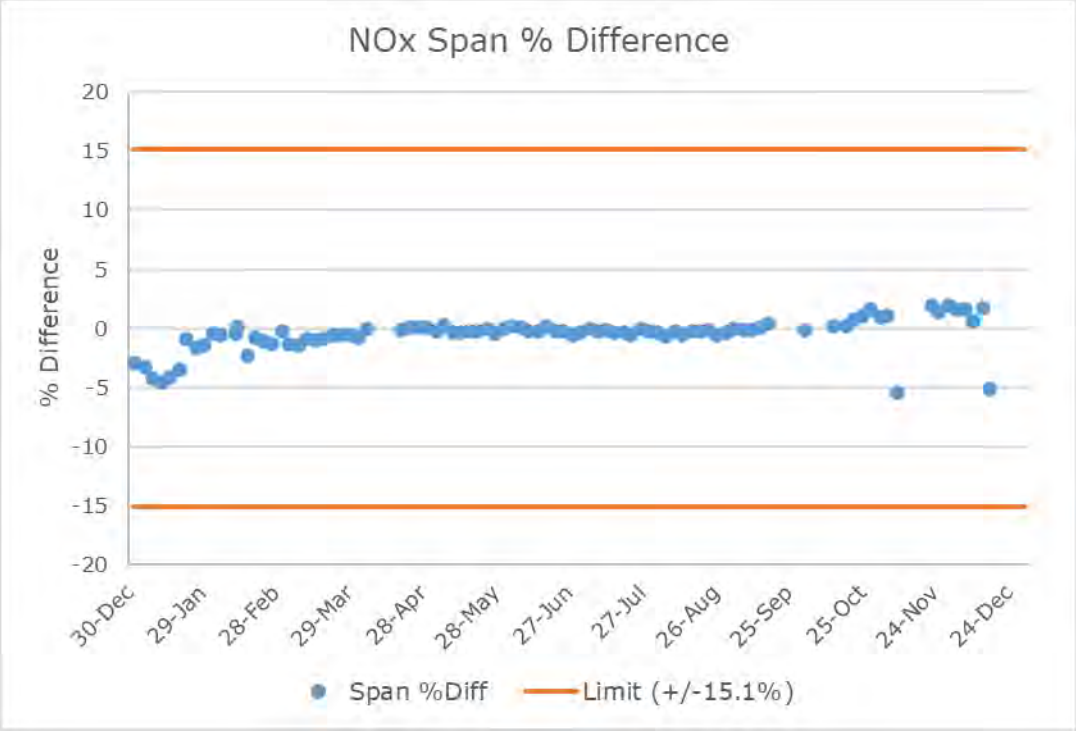

Figure C - 8. 2024 Calibration span percent difference for NOx at Missile Site Park.

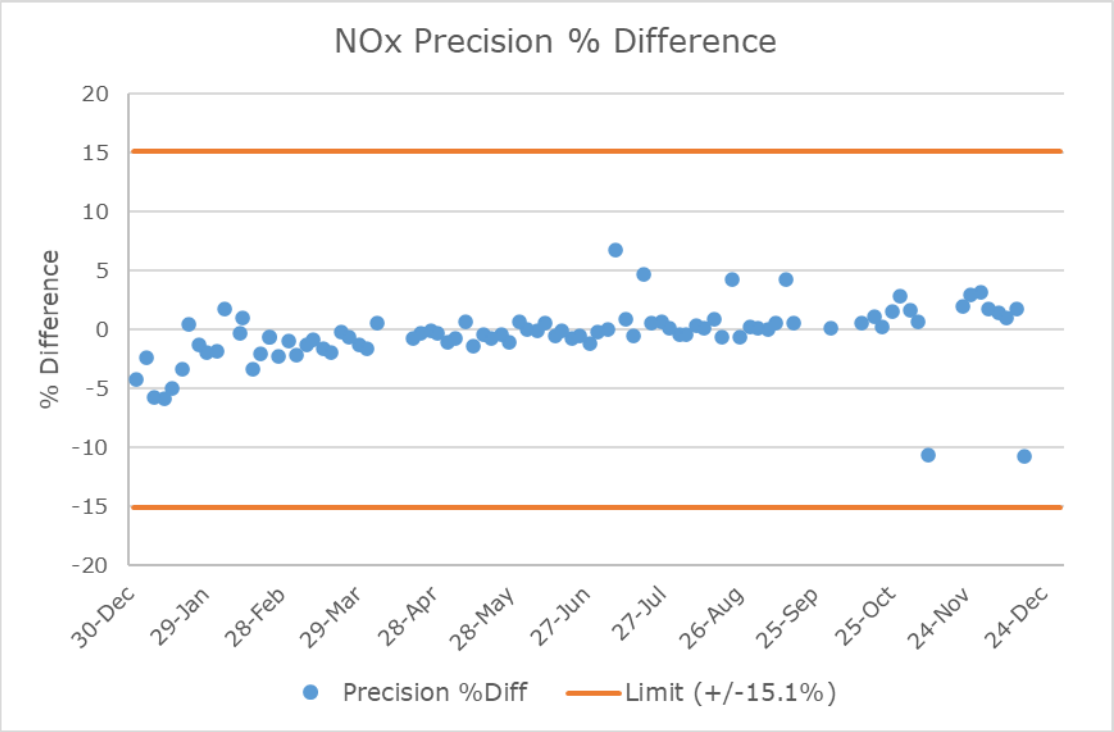

Figure C - 9. 2024 Calibration precision percent difference for NOx at Missile Site Park.

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

Formula	Precision	Span
STDEV	2.51	1.40
Count	89	89
Chi^2, 0.1, n-1	71.48	71.48
CV	2.79	1.55
Bias	1.93	1.12
Bias (+/-/U)	U	U
AB	1.58	0.91
AS	1.99	1.18
$t_{0.95}$, n-1	1.66	1.66
25^{th}	-1.08	-0.61
75^{th}	0.64	0.02

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. The second quarter semi-annual calibration occurred on April 7th and April 18th, and the fourth quarter semi-annual calibration occurred on October 1st and 11th. The calibrator was removed from April 8th through 17th and from October 2nd through 10th for recertification, so no automated calibrations occurred during those periods **Table C - 5** highlights the assessment statistics detailed in 40CFR58, Appendix A, Section 4.

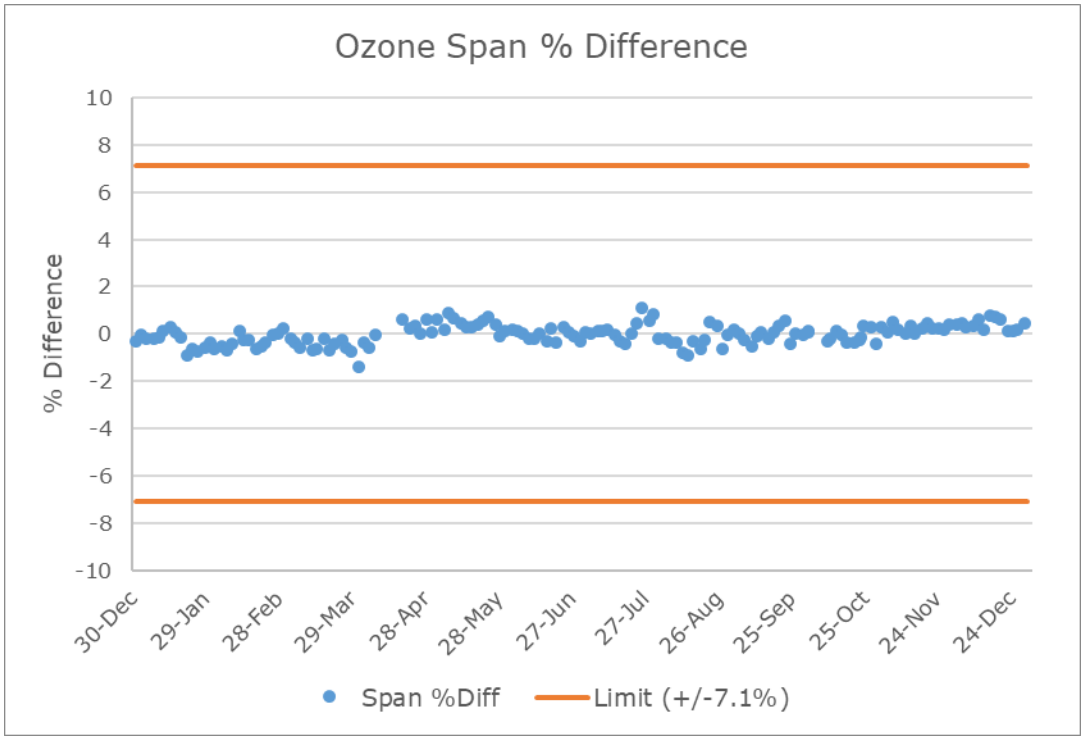

Figure C - 10. 2024 Calibration span percent difference for O_3 at Hereford.

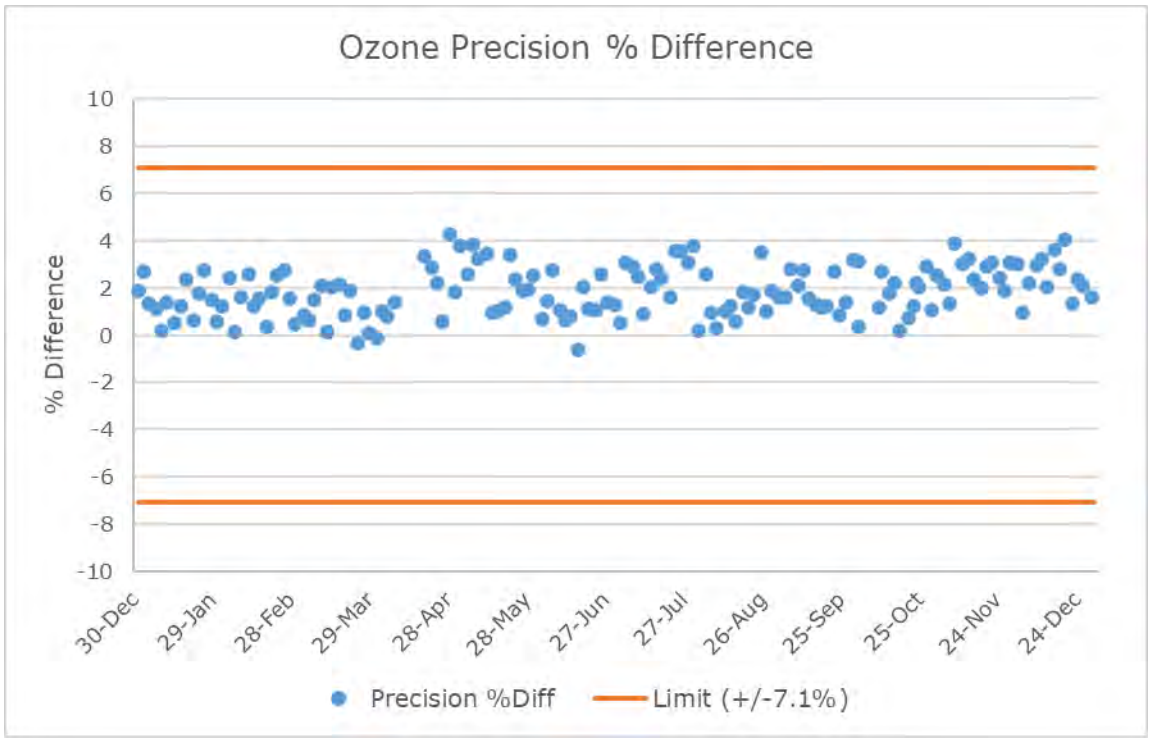

Figure C - 11. 2024 Calibration precision percent difference for O_3 at Hereford.

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

Formula	Precision	Span
STDEV	1.03	0.42
Count	153	153
Chi^2, 0.1, n-1	130.13	130.13
CV	1.12	0.45
Bias	1.99	0.37
Bias (+/-/U)	+	U
AB	1.86	0.34
`AS	1.01	0.25
$t_{0.95}$, n-1	1.65	1.65
25^{th}	1.07	-0.30
75^{th}	2.69	0.27

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. The second quarter semi-annual calibration occurred on April 7th and 18th, and the fourth quarter semi-annual calibration occurred on October 2nd and October 12th. The calibrator was removed from April 8th through 17th and from October 2nd through 10th for recertification so no automated calibrations occurred during those periods. In addition, the analyzer was powered down between July 19th and July 25th while the shelter air conditioner was being serviced and replaced. **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.

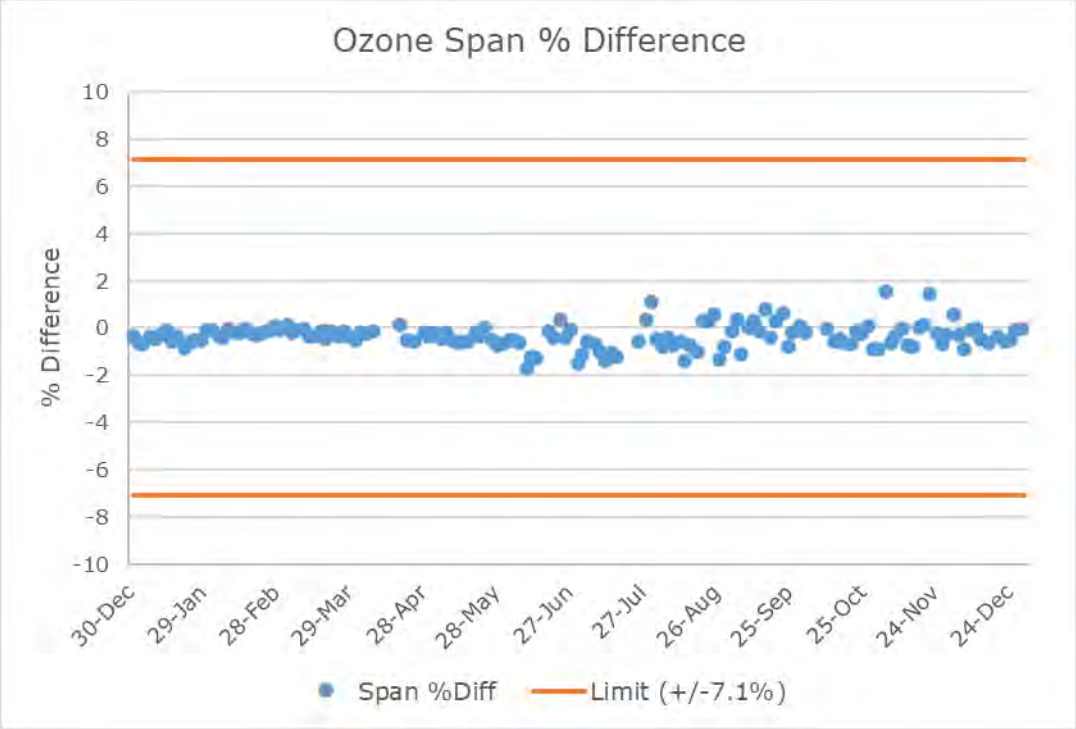

Figure C - 12. 2024 Calibration span percent difference for O_3 at Orchard.

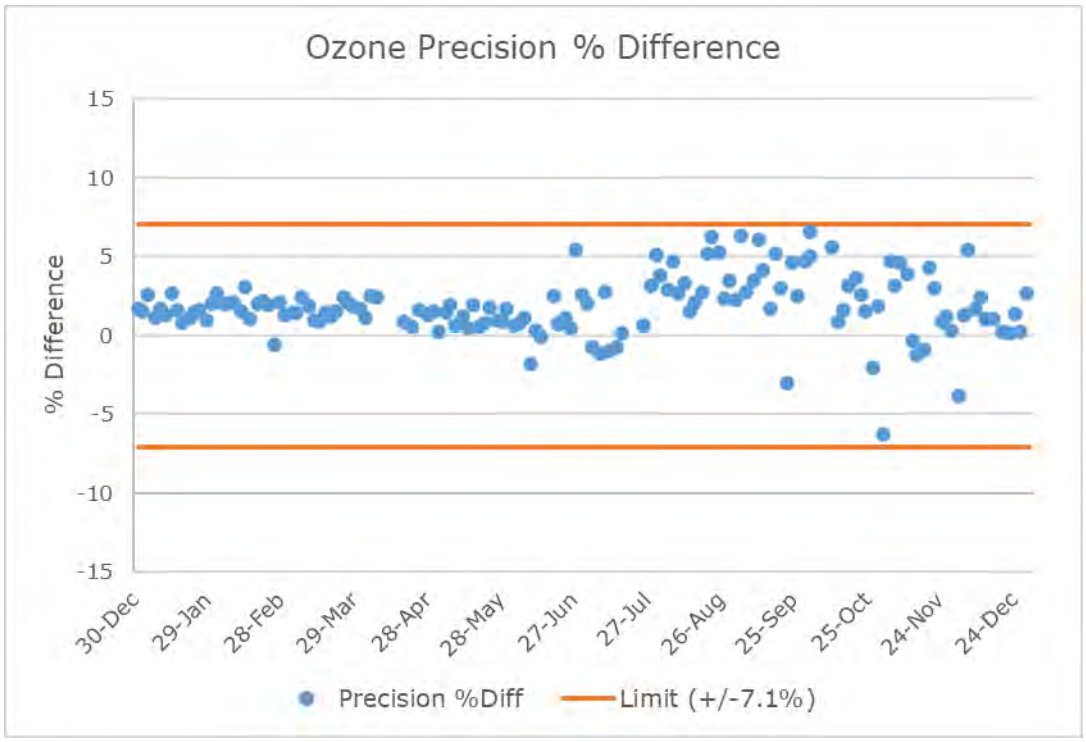

Figure C - 13. 2024 Calibration precision percent difference for O_3 at Orchard.

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

Formula	Precision	Span
STDEV	1.92	0.50
Count	145	145
Chi^2, 0.1, n-1	122.72	122.72
CV	2.08	0.54
Bias	2.39	0.53
Bias (+/-/U)	+	-
AB	2.18	0.47
AS	1.53	0.37
$t_{0.95}$, n-1	1.66	1.66
25^{th}	0.90	-0.61
75^{th}	2.67	-0.09