Nuiqsut Ambient Air Quality and Meteorological Monitoring Program

January 1, 2017 – December 31, 2017

ConocoPhillips Alaska, Inc.
Nuiqsut, Alaska

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AKreports@SLRconsulting.com
(907) 563-2137

2017 Annual Data Report

Prepared for:

ConocoPhillips Alaska, Inc.
700 G St.
Anchorage, AK 99501

This document has been prepared by SLR International Corporation (SLR). The material and data in this report were prepared under the supervision and direction of the undersigned.

Brad Broker
SLR Project Manager

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EXECUTIVE SUMMARY

On behalf of ConocoPhillips Alaska, Inc. (CPAI), SLR International Corporation (SLR) is collecting ambient air and meteorological data in the village of Nuiqsut, Alaska. Since April 9, 1999 (prior to construction of the Alpine Central Processing Facility), CPAI has operated an ambient air quality and dispersion meteorology monitoring station in Nuiqsut, Alaska, which is located on the Alaskan North Slope. The Nuiqsut Ambient Air Quality and Meteorological Monitoring Program is comprised of one station located at the northern edge of Nuiqsut approximately 400 meters north-northwest of the community electrical generators. The Nuiqsut Monitoring Program is being conducted to document air quality in Nuiqsut and data may also be used to support various ambient air quality impact analyses conducted for oil field development in the Colville Delta region.

The Nuiqsut monitoring program is designed and operated in accordance with applicable Environmental Protection Agency (EPA) Prevention of Significant Deterioration (PSD) regulations and guidance documents. This report provides details of ambient air and meteorological measurements collected during the 2017 monitoring year, spanning from January 1, 2017, to December 31, 2017, at the Nuiqsut monitoring station.

Table E-1 details Quality Assurance Project Plan (QAPP) variations documented for this project during the monitoring year. Any QAPP variations are explained in more detail in Section 1. The Nuiqsut QAPP Revision 2.1 was approved by the Alaska Department of Environmental Conservation (ADEC) in September 2012. Table E-2 provides a summary of quarterly and annual measured data for the monitored pollutants and the respective ratios of measured pollutants to National Ambient Air Quality Standards and Alaska Ambient Air Quality Standards (NAAQS/AAAQS). Tables E-3 and E-4 provide monthly, quarterly, and annual valid hours and percent data capture for the Nuiqsut meteorological monitoring station. Data not meeting QAPP and PSD precision and accuracy criteria were invalidated and are discussed in Section 2.

Table E-1-1: QAPP Variation Table

Item / Procedure	Summary of QAPP Variation	Reason for Variation
During the monitoring period there were no variations from the approved procedures and criteria specified in the Nuiqsut Ambient Air Quality and Meteorological Monitoring Program Quality Assurance Project Plan.		

Table E-1-2: Nuiqsut Ambient Air Monitoring Summary Data

Pollutant	National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS)		Nuiqsut Ambient Air Monitoring – Pollutant Data						
	Concentration	Averaging Period	Averaging Period	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual	YTD % of NAAQS/ AAAQS
Nitrogen Dioxide (NO_2)	53 ppb (100 µg/m^3)	Annual	Average of Period	3	2	1	1	2	**3.8%**
	100.0 ppb (190 µg/m^3)	1-Hour [2]	Daily Max 1-Hour Averages (98th Percentile)	--	--	--	--	27.4	**27.4%**
			1st Highest, 1-Hour Average	37.3	21.7	19.4	24.0	37.3	**37.3%**
			2nd Highest, 1-Hour Average	35.3	21.3	10.8	16.0	35.3	**35.3%**
Ozone (O_3)	0.070 ppm (150 µg/m^3)	8-Hour [3]	4th Highest, 8-Hour Average	0.045	0.0441	0.031	0.042	0.045	**64.3%**
			1st Highest, 8-Hour Average	0.046	0.044	0.035	0.043	0.046	**65.7%**
			2nd Highest, 8-Hour Average	0.046	0.043	0.033	0.043	0.046	**65.7%**
Carbon Monoxide (CO)	35 ppm (40,000 µg/m^3)	1-Hour [1]	1st Highest, 1-Hour Average	1	1	0	1	1	**2.9%**
			2nd Highest, 1-Hour Average	1	0	0	1	1	**2.9%**
	9 ppm (10,000 µg/m^3)	8-Hour [1]	1st Highest, 8-Hour Average	1	0	0	1	1	**11.1%**
			2nd Highest, 8-Hour Average	1	0	0	1	1	**11.1%**

[1] Not to be exceeded more than once each year.
[2] To attain this standard, the 3-year average of the 98th percentile of the annual daily maximum 1-hour average must not exceed 100 ppb.
[3] To attain this standard, the 3-year average of the annual fourth-highest daily maximum 8-hour average must not exceed 0.075 ppm.

Table E-2 (Continued): Nuiqsut Ambient Air Monitoring Summary Data

Pollutant	National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS)		Nuiqsut Ambient Air Monitoring – Pollutant Data						
	Concentration	Averaging Period	Averaging Period	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual	YTD % of NAAQS/ AAAQS
Sulfur Dioxide (SO_2)	0.030 ppm (80 μg/m^3)	Annual	Average of Period	0.000	0.001	0.002	0.000	0.001	**3.3%**
	0.14 ppm (365 μg/m^3)	24-Hour [5]	1st Highest, 1-Hour Average	0.00	0.00	0.00	0.00	0.00	**0.0%**
			2nd Highest, 1-Hour Average	0.00	0.00	0.00	0.00	0.00	**0.0%**
	0.5 ppm (1,300 μg/m^3)	3-Hour [5]	1st Highest, 3-Hour Average	0.0	0.0	0.0	0.0	0.0	**0.0%**
			2nd Highest, 3-Hour Average	0.0	0.0	0.0	0.0	0.0	**0.0%**
	75.0 ppb (196 μg/m^3)	1-Hour [4]	Daily Max 1-Hour Averages (99th Percentile)	--	--	--	--	3.5	**4.7%**
			1st Highest, 1-Hour Average	3.4	1.9	3.6	1.1	3.6	**4.8%**
			2nd Highest, 1-Hour Average	3.0	1.9	3.5	1.1	3.5	**4.7%**

[4] To attain this standard, the 3-year average of the 99th percentile of the annual daily maximum 1-hour average must not exceed 75.0 ppb.
[5] Not to be exceeded more than once each year.

Table E-2 (Continued): Nuiqsut Ambient Air Monitoring Summary Data

Pollutant	National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS)		Nuiqsut Ambient Air Monitoring – Pollutant Data						
	Concentration	Averaging Period	Averaging Period	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual	YTD % of NAAQS/ AAAQS
Particulate Matter <2.5 microns ($PM_{2.5}$)	12.0 μg/m^3	Annual [7]	Average of Period	2.7	2.1	0.9	0.6	1.6	**13.3%**
	35 μg/m^3	24-Hour [6]	98th Percentile, 24-Hour Average	--	--	--	--	7	**20.0%**
			1st Highest, 24-Hour Average	16	6	9	12	16	**45.7%**
			2nd Highest, 24-Hour Average	8	6	7	8	12	**34.3%**
Particulate Matter <10 microns (PM_{10})	150 μg/m^3	24-Hour [8,9]	1st Highest, 24-Hour Average	10	90	50	20	90	**60.0%**
			2nd Highest, 24-Hour Average	10	50	40	10	50	**33.3%**

[6] To attain this standard, the 3-year average of the 98th percentile of the 24-hour concentration must not exceed 35.0 μg/m^3.
[7] To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentration must not exceed 12.0 μg/m^3.
[8] Not to be exceeded more than once per year on average over three years.
[9] 40 CFR Appendix K requires that reportable concentrations of PM_{10} be rounded to the nearest 10 μg/m^3; actual measurement results are within Appendix C.

Table E-1-3: Meteorological Data Capture – Valid Hours per Month

Period	Meteorological Parameters – Valid Hours per Month [1]								
	Vertical Wind Speed	Vertical Wind Speed Std. Dev. (Sigma Omega)	Horizontal Wind Speed [2]	Horizontal Wind Direction [2]	Wind Direction Std. Dev. (Sigma Theta) [2]	2-M Temp	10-M Temp	Delta-Temp	Solar Radiation
January	0 [2]	0 [2]	744	744	744	744	744	744	744
February	513 [2]	513 [2]	672	672	672	672	672	672	672
March	744	744	744	744	744	744	744	744	738
1st Quarter	1257 [2]	1257 [2]	**2160**	**2160**	**2160**	**2160**	**2160**	**2160**	**2154**
April	716	716	716	716	716	716	716	716	714
May	49 [2]	49 [2]	724	724	724	724	724	724	693
June	201 [2]	201 [2]	698	698	698	699	699	699	664
2nd Quarter	966 [2]	966 [2]	**2138**	**2138**	**2138**	**2139**	**2139**	**2139**	**2071**
July	744	744	744	744	744	744	744	744	744
August	744	744	744	744	744	744	744	744	744
September	720	720	720	720	720	720	720	720	720
3rd Quarter	**2208**	**2208**	**2208**	**2208**	**2208**	**2208**	**2208**	**2208**	**2208**
October	661 [3]	661 [3]	722	722	722	744	744	744	744
November	720	720	720	720	720	720	720	720	720
December	741	741	741	741	741	741	741	741	742
4th Quarter	**2122**	**2122**	**2183**	**2183**	**2183**	**2205**	**2205**	**2205**	**2206**
Annual	6553	6553	**8689**	**8689**	**8689**	**8712**	**8712**	**8712**	**8639**

[1] EPA PSD-quality meteorological monitoring standards require data capture of 90 percent or greater per quarter for four consecutive quarters.
[2] Vertical wind speed data invalidated due to sensor damage. The sensor was repaired on February 7 and June 22, 2017. Due to the data loss, DQOs were not met for vertical wind speed for the first and second quarter and monitoring year. Vertical wind speed is an optional parameter for AERMOD dispersion modeling.
[3] Data invalidated due to ice riming on sensor.

Table E-1-4: Meteorological Data Capture – Percent Data Capture

Period	Meteorological Parameters – Data Recovery [1]								
	Vertical Wind Speed	Vertical Wind Speed Std. Dev. (Sigma Omega)	Horizontal Wind Speed	Horizontal Wind Direction	Wind Direction Std. Dev. (Sigma Theta)	2-M Temp	10-M Temp	Delta-Temp	Solar Radiation
January	0% [2]	0% [2]	100%	100%	100%	100%	100%	100%	100%
February	76% [2]	76% [2]	100%	100%	100%	100%	100%	100%	100%
March	100%	100%	100%	100%	100%	100%	100%	100%	99%
1st Quarter	**58%** [2]	**58%** [2]	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
April	99%	99%	99%	99%	99%	99%	99%	99%	99%
May	7% [2]	7% [2]	97%	97%	97%	97%	97%	97%	93%
June	28% [2]	28% [2]	97%	97%	97%	97%	97%	97%	92%
2nd Quarter	**44%** [2]	**44%** [2]	**98%**	**98%**	**98%**	**98%**	**98%**	**98%**	**95%**
July	100%	100%	100%	100%	100%	100%	100%	100%	100%
August	100%	100%	100%	100%	100%	100%	100%	100%	100%
September	100%	100%	100%	100%	100%	100%	100%	100%	100%
3rd Quarter	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
October	89% [3]	89% [3]	97%	97%	97%	100%	100%	100%	100%
November	100%	100%	100%	100%	100%	100%	100%	100%	100%
December	100%	100%	100%	100%	100%	100%	100%	100%	100%
4th Quarter	**96%**	**96%**	**99%**	**99%**	**99%**	**100%**	**100%**	**100%**	**100%**
Annual	**75%**	**75%**	**99%**	**99%**	**99%**	**99%**	**99%**	**99%**	**99%**

[1] EPA PSD-quality meteorological monitoring standards require data capture of 90 percent or greater per quarter for four consecutive quarters.
[2] Vertical wind speed data invalidated due to sensor damage. The sensor was repaired on February 7 and June 22, 2017. Due to the data loss, DQOs were not met for vertical wind speed for the first and second quarter and monitoring year. Vertical wind speed is an optional parameter for AERMOD dispersion modeling.
[3] Data invalidated due to ice riming on sensor.

1. INTRODUCTION

1.1 PROJECT SUMMARY

Since April 9, 1999 (prior to construction of the Alpine Central Processing Facility), CPAI has operated an ambient air quality and meteorology monitoring station in Nuiqsut, Alaska, which is located on the Alaska North Slope. One station located at the northern edge of Nuiqsut, approximately 400 meters north-northwest of the community electrical generators, comprises the Nuiqsut Ambient Air Quality and Meteorological Monitoring Program. Currently, the Nuiqsut Monitoring Program is being conducted to document air quality in Nuiqsut and the data may also be used to support various ambient air quality impact analyses conducted for oil field development in the Colville Delta region.

The monitoring program consists of an ambient air quality monitoring station and a meteorological monitoring tower directly mounted to the air quality monitoring structure. The program is designed and operated in accordance with applicable PSD regulations and guidance documents. The specific project objectives of the Monitoring Program are to:

- Collect data to document Nuiqsut air quality and address community concerns related to regional oilfield development.
- Establish a monitoring system to measure, with known accuracy and precision, meteorological parameters at the project site from ground level up to 10 meters.
- Provide required and relevant optional meteorological data for American Meteorological Society/EPA Regulatory Model Improvement Committee Model (AERMOD) modeling system.
- Establish a monitoring system to measure, with known bias and precision, the ambient concentrations of the criteria air quality pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter with an aerodynamic diameter of 10 microns or less (PM_{10}), and particulate matter with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$) to establish National Ambient Air Quality Standards (NAAQS) compliance status for the monitoring location.

The Nuiqsut station collects the following ambient air data:

- Carbon monoxide (CO)
- Oxides of nitrogen (NO_2, NO_X, and NO)
- Ozone (O_3)
- Sulfur dioxide (SO_2)
- Inhalable particulate matter less than 2.5 microns ($PM_{2.5}$)
- Inhalable particulate matter less than 10 microns (PM_{10})

The Nuiqsut station measures the following meteorological parameters:

- Horizontal wind speed (meters per second [m/s])
- Horizontal wind direction (degrees [°])
- Vertical wind speed (meters per second [m/s])
- Air temperature, two and ten meters above ground level (degrees Celsius [°C])
- Solar radiation (Watts per square meter [W/m^2])

The Nuiqsut station calculates the following meteorological parameters:

- Horizontal wind direction standard deviation (Sigma Theta [σ_θ])
- Vertical wind speed standard deviation (Sigma Omega [σ_ω])
- Temperature difference ((ΔT, "Delta T" (degrees Celsius [°C]), is calculated as temperature at 10 meters minus temperature at 2 meters)

Data review and validation procedures and monitoring program data and measurement quality objectives (MQO's) are provided in the Nuiqsut Ambient Air Quality and Meteorological Monitoring Station Quality Assurance Project Plan Revision 2.1 approved by ADEC in September 2012.

The community of Nuiqsut is located in the Colville River Delta region of the North Slope of Alaska. Figure 1-1 shows a detailed map of Nuiqsut while Figure 1-2 provides an aerial view of the Nuiqsut village and depicts the location of the monitoring station. Figure 1-3 depicts the general location of the project area.

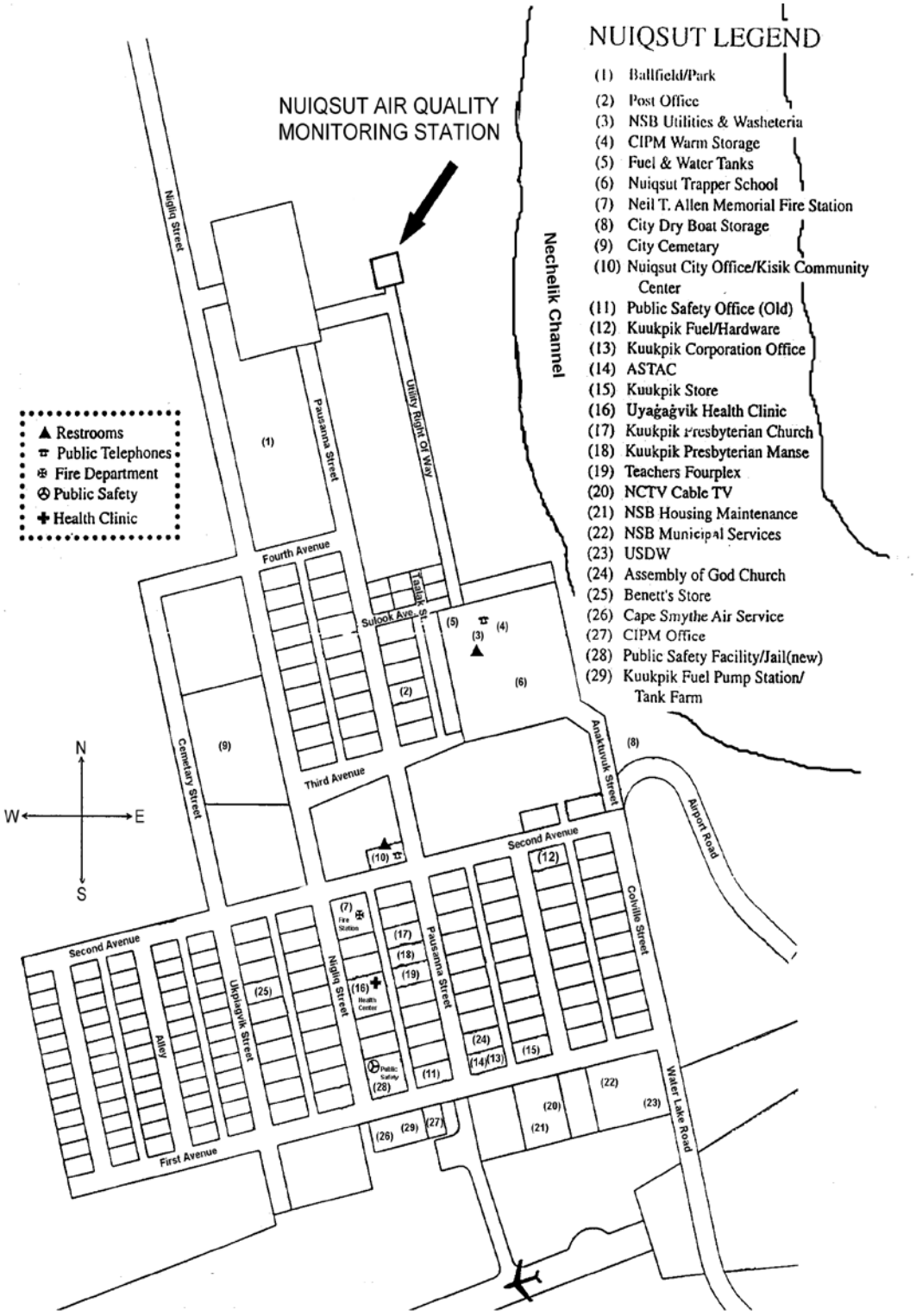


Figure 1-1: Local Map of Nuiqsut

Figure 1-2: Aerial Photo Showing Site Location

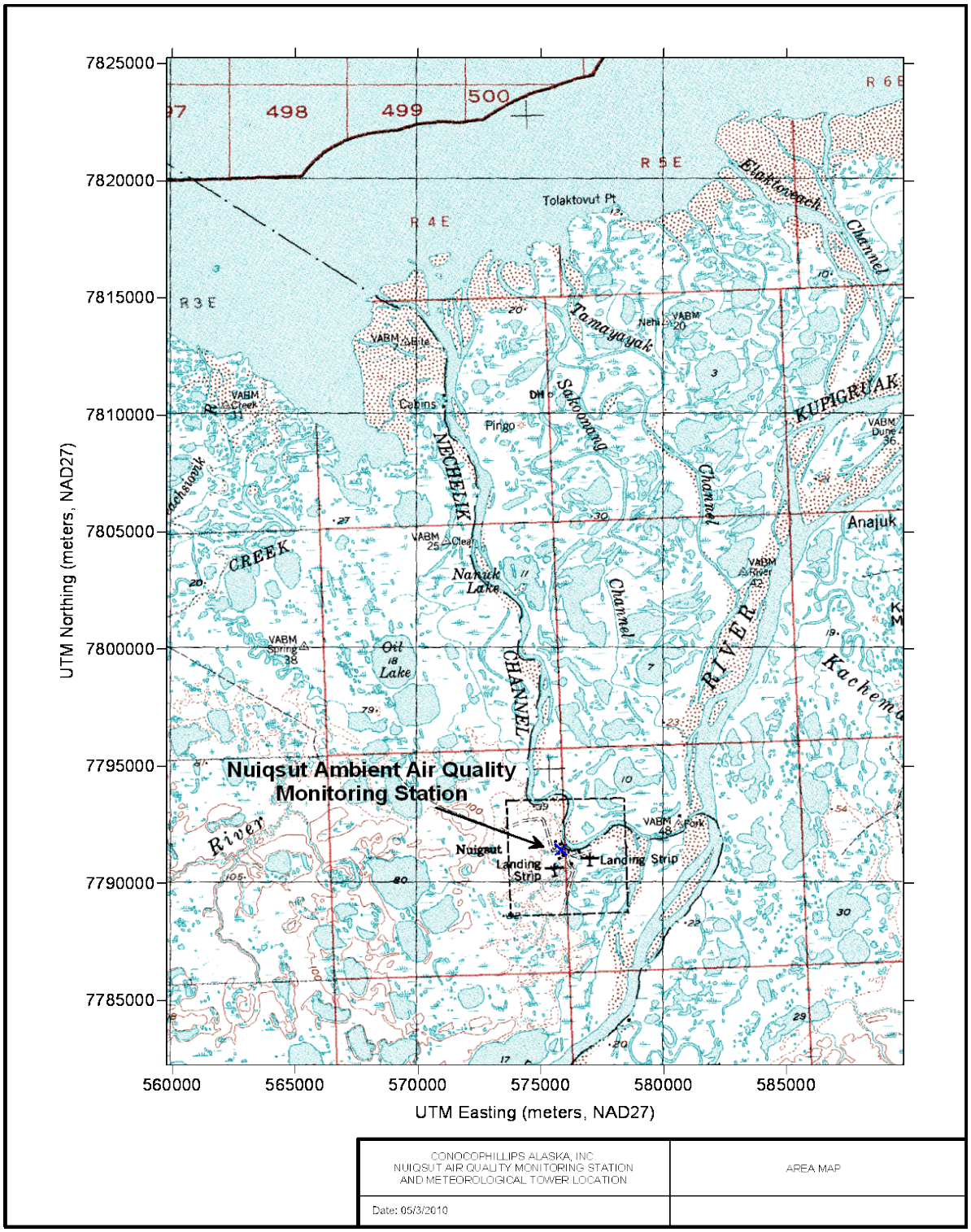


Figure 1-3: Map of Nuiqsut Project Area

1.2 MEASUREMENT METHODS TABLE

All instruments meet or exceed the U.S. Environmental Protection Agency (EPA) PSD requirements for range accuracies, thresholds, response times, resolutions, damping ratios, and other measures of instrument performance.

1.2.1 CONTINUOUS NO_2, O_3, CO AND SO_2 MONITORING

The gas analyzers used for the Nuiqsut Air Monitoring Station have been designated by EPA as either a Federal Equivalent Method (FEM) or Federal Reference Method (FRM) as defined in 40 CFR 53. Table 1-1 provides a summary of the measurement methods and parameters used for the Nuiqsut Ambient Air Monitoring Program.

Table 1-1: Gaseous Pollutant Measurement Parameters

Parameter	Instrument	References	Units	Sampling Frequency	Sample Averaging
Carbon Monoxide (CO)	Thermo 48i Gas filter correlation analyzer	EPA reference method RFCA-0981-054	Parts per million (ppm)	Continuous	1-hour
Nitrogen Dioxide (NO_2)	API T200U Chemiluminescent NO_X gas analyzer	EPA reference method RFNA-1194-099	Parts per billion (ppb)		
Ozone (O_3)	API T400 UV Photometric Ozone analyzer	EPA equivalent method EQOA-0992-087			
Sulfur Dioxide (SO_2)	Thermo 43i Pulsed fluorescence SO_2 gas analyzer	EPA equivalent method EQSA-0486-060			

[1] Total oxides of nitrogen (NO_X) and nitrogen oxide (NO) are also measured.

1.2.2 CONTINUOUS PM_{10} AND $PM_{2.5}$ MONITORING

Monitoring for PM_{10}/$PM_{2.5}$ data was conducted in accordance with the requirements and guidance in 40 CFR Parts 50, 53, and 58. PM_{10} and $PM_{2.5}$ monitoring were conducted using Met One Instruments, Inc. Model BAM-1020 Beta Attenuation Mass Monitors, which continuously measure ambient particulate concentrations using beta ray attenuation. The US EPA designations for these units are PM_{10}: FEM EQPM-0798-122 and $PM_{2.5}$ Class III FEM EQPM-0308-170. For EPA reference method sampling, the $PM_{2.5}$ sampler inlet system was configured with a BGI VSCC™ (Very Sharp Cut Cyclone) particle size separator.

CPAI participates in the North Slope air monitoring network that contains a $PM_{2.5}$ collocation station at the nearby Alpine CD1 pad. As such, filter-based samplers for assessing precision were not run at Nuiqsut. Network $PM_{2.5}$ precision statistics were evaluated using collocated sampling at CD1.

Block daily averages (24-hours) were obtained from the hourly measurements with the BAM-1020 samplers. Table 1-2 lists the particulate matter parameters measured and the frequency at which samples collected and recorded.

Table 1-2: PM Monitoring Measurement Parameters

Parameter	Units	Sampling Schedule	Sample Period	Averaging Time
$PM_{2.5}$	Micrograms per cubic meter ($\mu g/m^3$)	Continuous	1-Hour [(1)]	24-Hour (Average) [(1)]
PM_{10}	Micrograms per cubic meter ($\mu g/m^3$)	Continuous	1-Hour [(1)]	24-Hour (Average) [(1)]
Sample Volume	Cubic meters (m^3)	Every sampling event	Continuously up to 30 days (hourly checks)	Total volume over sample period
Flow Rate	Liters per min (LPM)			Average over sampling period
Ambient Temperature	Degrees Celsius (°C)			
Barometric Pressure	Millimeters of mercury (mm Hg)			

[1] 24-hour averages are obtained from the 1-hour measurements each day. A minimum of 18 hours must be available for a valid 24-hr average to be calculated.

1.2.3 METEOROLOGICAL MONITORING

The meteorological monitoring (wind speed, wind direction, vertical wind speed, ambient air temperature, and solar radiation) were conducted in a manner consistent with PSD criteria for surface meteorological data collection. The meteorological sensors meet or exceed the performance specifications stated in *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/R-99-005). Table 1-3 lists the parameters measured, their reported units, sampling frequency, and sample averaging time.

Table 1-3: Meteorological Measurement Methods

Parameter	Measurement Method	Sensor Manufacturer/ Model Number	Range	Accuracy	Resolution	Sampling Frequency	Averaging Period
Ambient Temperature	Triple element thermistor	Climatronics Model 100093-2	-50 to +50°C	± 0.10°C	0.01°C	1 second	1 hour
Horizontal Wind Speed	Propeller, magnetically induced AC sine wave	RM Young Co. 05305-AQ	0 to 50 m/s	0.2 m/s and three upscale points over sensor range, ±(0.2 m/s + 5% of actual), Starting torque ≤0.25 m/s	0.1 m/s	1 second	1 hour
Wind Direction	Light-weight vane, Low torque potentiometer	RM Young Co. 05305-AQ	0 to 360°	Alignment within ±5°, Starting torque ≤0.5 m/s, Normalized linearity within ±3° (every 30 or 45 degrees)	1.0°	1 second	1 hour
Vertical Wind Speed	Propeller anemometer	Climatronics Model 102236-G0	0 to 49 m/s	±(0.2 m/s + 5% of actual), Starting torque ≤0.25 m/s	0.1 m/s	1 second	1 hour
Solar Radiation	Thermopile sensing element	Kipp & Zonen CMP 11	0 to 2,800 W/m^2	± 2%	10 W/m^2	1 second	1 hour

1.3 VARIATIONS FROM THE QAPP

Any QAPP variations that have occurred throughout the monitoring period are discussed in Table 1-4 and below.

During the monitoring period, there were no variations from the approved Nuiqsut Ambient Air Quality and Meteorological Monitoring Quality Assurance Project Plan (QAPP).

Table 1-4: QAPP Variation Table

Item / Procedure	Summary of QAPP Variation	Reason for Variation
During the monitoring period there were no variations from the approved procedures and criteria specified in the Nuiqsut Ambient Air Quality and Meteorological Monitoring Program Quality Assurance Project Plan.		

2. STATION PERFORMANCE SUMMARY

2.1 SIGNIFICANT PROJECT EVENTS

Table 2-1 summarizes the significant events that occurred at the Nuiqsut station relevant to the 2017 ambient air and meteorological monitoring year.

Table 2-1: Chronology of Significant Events

Date	Event
January 1, 2017	Start of the monitoring year.
January 1 – February 7, 2017	Vertical wind speed sensor damaged after severe weather. Sensor was repaired on February 7, 2017. 903 hours of vertical wind data invalidated in total.
January 7, 8, 16, 18, and 19, 2017	Daily average $PM_{2.5}$ concentration less than -2 µg/m^3. 120 hours of BAM $PM_{2.5}$ data invalidated.
January 9, 2017	Monthly QC checks performed on PM samplers. All instruments passed.
February 7, 2017	Multipoint calibrations of ambient air analyzers as well as monthly QC checks on PM samplers conducted by SLR. Independent performance audit of ambient air analyzers and PM samplers conducted by AMS Tech, LLC. All instruments found to be operating within EPA PSD measurement quality limits. Seven hours of gas data invalidated during calibrations and audit.
February 16, 2017	Calibrations performed on O_3 analyzer; analyzer passed.
February 19, 2017	Daily average PM_{10} concentration less than -2 µg/m^3. 24 hours of BAM PM_{10} data invalidated.
March 8, 2017	Monthly QC checks performed on PM samplers. All instruments passed.
March 26, 2017	Daily average $PM_{2.5}$ concentration less than -2 µg/m^3. 24 hours of BAM $PM_{2.5}$ data invalidated.
March 28, 2017	Calibrations performed on O_3 analyzer; analyzer passed. Five hours of O_3 data invalidated during calibration.
April 4-5, 2017	Multipoint calibrations of ambient air analyzers and meteorological sensors, as well as monthly QC checks on PM samplers conducted by SLR. Independent performance audit of meteorological, ambient air analyzers and PM samplers conducted by AMS Tech, LLC. All instruments found to be operating within EPA PSD measurement quality limits. Four hours of meteorological, seven hours of ozone, and eight hours of other gas data invalidated during calibrations and audit.
April 28, 2017	Calibrations performed on CO and SO_2 analyzers; all passed.
May 3, 2017	Monthly QC checks performed on PM samplers. All instruments passed.
May 3 – June 22, 2017	Vertical wind speed sensor damaged after severe weather. Sensor was repaired on June 22, 2017. 1,214 hours of vertical wind data invalidated in total.

Date	Event
May 29 – 30, 2017	Datalogger error resulted in the loss of 18 hours of meteorological data.
May 29 – June 2, 2017	Solar radiation sensor communication error resulted in the loss of 86 hours of solar radiation data.
June 8, 2017	Monthly QC checks performed on PM samplers. All instruments passed. Pump replaced on $PM_{2.5}$ BAM.
June 21 – 22, 2017	Communication error resulted in the loss of 18 hours of ambient air data, 19 hours of horizontal wind data, 17 hours of temperature and solar data, and 4 hours of PM_{10} BAM data.
July 13, 2017	Independent performance audit of ambient air analyzers and PM samplers conducted by AMS Tech, LLC. All instruments found to be operating within EPA PSD measurement quality limits.
July 19, 2017	Monthly QC checks performed on PM samplers. Four hours of $PM_{2.5}$ data invalidated during checks. All instruments passed.
August 23, 2017	Monthly QC checks performed on PM samplers. All instruments passed.
September 11, 2017	Gas analyzers left in maintenance mode after check; five hours gases invalid.
September 13, 2017	Quarterly calibration performed on MFC calibrator; instrument passed.
September 13, 2017	Monthly QC checks performed on PM samplers. All instruments passed.
September 13 – 14, 2017	Daily average $PM_{2.5}$ concentration less than -2 µg/m^3. 48 hours of BAM $PM_{2.5}$ data invalidated.
September 15, 2017	Annual Technical Systems Audit performed by AMS Tech, LLC.
September 27, 2017	Quarterly calibration performed on NO_2, SO_2, and CO analyzers; all instruments passed.
September 28, 2017	Quarterly calibration performed on ozone analyzer; instrument passed.
October 5 – 6 and 19 – 21, 2017	The BAM $PM_{2.5}$ 24 hour average concentration was reported as less than -2 µg/m. 120 hours of BAM data invalidated.
October 9 – 12, 2017	Snow and ice buildup on the vertical wind speed sensor. 83 hours of data invalidated.
October 22 – 23, 2017	Snow and ice buildup on wind sensor. 22 hours of wind speed and wind direction data invalidated.
October 26, 2017	Monthly QC checks performed on PM samplers. All instruments passed.
November 9, 2017	Monthly QC checks and multipoint calibrations performed on PM samplers. All instruments passed. Six hours of $PM_{2.5}$ data and five hours of PM_{10} data invalidated during calibrations.
November 15, 2017	Calibrations performed on CO analyzer; analyzer passed.
December 13 – 14, 2017	Quarterly calibration of MFC calibrator; monthly QC checks on PM samplers; Independent performance audit of ambient air analyzers and PM samplers conducted by AMS Tech, LLC. All instruments found to be operating within EPA PSD measurement quality limits. Six hours of gas data and five hours of PM data invalidated during calibrations and audit.
December 31, 2017	End of the monitoring year.

2.2 MISSING, INVALID AND ADJUSTED DATA

The data collected at the Nuiqsut station were carefully reviewed during the quality assurance process. Some data were removed as a result of planned site activities, including data collected during station system and performance audits and calibrations. Data known or suspected to be invalid have been removed from the data set after verifying that the removed data values do not represent actual ambient air quality conditions at the sampling station.

Periods of 4 or fewer records that were invalidated are considered to be due to routine operations and maintenance activities and are generally not described in detail. Events impacting larger periods of time are described above in Table 2-1: Chronology of Significant Events. Additionally, those events meriting more detailed explanation of data validation decisions are as follows:

The vertical wind speed sensor was damaged after severe weather in December 2016. The sensor was repaired on February 7, 2017. A total of 903 hours of vertical wind data were invalidated during the first quarter. Due to the data loss, DQOs for vertical wind speed were not met for the first quarter. Vertical wind speed is an optional parameter for AERMOD dispersion modeling.

Manufacturer specifications for $PM_{2.5}$ and PM_{10} measurements indicate that the uncertainty for 24-hour average concentrations is +/- 2 $\mu g/m^3$. Accordingly, 24-hour average concentrations less than -2 $\mu g/m^3$ for $PM_{2.5}$ resulted in the invalidation of data for the entire day on January 7, 8, 16, 18, 19 and March 27, 2017 and for PM_{10} on February 19, 2017. A total of 144 hours of $PM_{2.5}$ and 24 hours of PM_{10} data were invalided during the first quarter.

Calibrations and an independent performance audit were performed on all gas analyzers on February 7, 2017; all instruments passed. Seven hours of gas data were invalidated during the calibrations and audit.

Calibrations were performed on the O_3 analyzer on March 28, 2017; analyzer passed. Five hours of O_3 data were invalidated during the calibrations.

Calibrations and an independent performance audit were performed on all meteorological, gas, and PM analyzers on April 4, 2017; all instruments passed. Four hours of meteorological, seven hours of ozone, and eight hours of other gas data were invalidated during the calibrations and audit.

The vertical wind speed sensor was damaged May 3 through June 22, 2017. The sensor was repaired on June 22, 2017. A total of 1,214 hours of vertical wind data were invalidated during the second quarter. Due to the data loss, DQOs for vertical wind speed were not met for the second quarter. Vertical wind speed is an optional parameter for AERMOD dispersion modeling.

A datalogger error resulted in the loss of 18 hours of meteorological data May 29 – 30, 2017.

A communication error with the solar radiation sensors led to the loss of 86 hours of solar radiation data May 29 through June 2, 2017.

A communication error resulted in the loss of 18 total hours of gas data, 19 hours of horizontal wind data, 17 hours of temperature and solar data between June 21 and June 22, 2017 and four hours of PM_{10} data on June 21, 2017.

Four hours of $PM_{2.5}$ data were invalidated July 19, 2017 during monthly QC checks.

Gas analyzers were left in maintenance mode after a check on September 11, 2017, resulting in five hours of invalid data.

$PM_{2.5}$ data were invalidated for the entire day on September 13 and 14, 2017 due to 24-hour average concentrations less than -2 $\mu g/m^3$. 48 hours of data invalidated during the third quarter.

$PM_{2.5}$ data were invalidated for the entire day on October 5 – 6 and 19 – 21, 2017 due to 24-hour average concentrations less than -2 $\mu g/m^3$. 120 hours of data invalidated during the fourth quarter.

Snow and ice buildup on the vertical wind speed sensor resulted in the invalidation of 83 hours of data October 9 through 12, 2017.

Snow and ice buildup on the horizontal wind speed sensor resulted in the invalidation of 22 hours of wind speed and wind direction data October 22 – 23, 2017. Multipoint calibrations performed on PM samplers on November 9, 2017; all instruments passed. Six hours of $PM_{2.5}$ data and five hours of PM_{10} data invalidated during calibrations.

Calibrations and an independent performance audit were performed on all gas and PM analyzers December 13 and 14, 2017; all instruments passed. Six hours of gas data and five hours of PM data were invalidated during the calibrations and audit.

Table 2-2 lists the quantities of data that were flagged according to EPA criteria, yet not removed from the refined final data set. All flagged data were carefully examined, but generally remained in the reduced data unless dictated by certain circumstances, including: values outside the normal range of variation; consecutive repetitive values recorded for an unidentified reason; maintenance activity at the site, and impairing damage to sensors.

Table 2-2: Percentage of Final Data Set Flagged

Parameter	Flagging Criteria[(1)]	Percent Flagged
Wind Speed	Value is < 0 m/s	0.0%
	Value is > 25 m/s	0.0%
	< 0.1 m/s variation for 3 consecutive hours	1.8%
	< 0.5 m/s variation for 12 consecutive hours	0.2%
Wind Direction	Value is < 0°, > 360°	0.0%
	< 1° variation over 3 consecutive hours	0.0%
	< 10° variation over 18 consecutive hours	2.8%
Temperature (2 meters)	> 5°C variation from previous hour	0.1%
	< 0.5°C variation for 12 consecutive hours	1.3%
	Value is > record high, < record low	0.0%
Temperature (10 meters)	> 5°C variation from previous hour	0.1%
	< 0.5°C variation for 12 consecutive hours	1.3%
	Value is > record high, < record low	0.0%
Temperature Difference, ΔT	Value is > 0.8°C during the daytime	0.7%
	Value is < -0.8°C during the night	0.3%
	Value is > 5°C, < -3°C	0.0%
Solar Radiation	> 0 w/m^2 at night	1.1%
	Greater than the maximum possible value for date and latitude	0.1%

[1] Based upon Table 8-4: Suggested Data Screening Criteria in *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/R-99-005).

2.3 NETWORK DATA COMPLETENESS

Data completeness is a measure of the amount of data actually collected compared to the amount of data that could have been collected. Data completeness was calculated by dividing the number of valid hours of data by the total number of hours during the monitoring period. The data quality objective (DQO) for data completeness for air quality data is 80 percent per calendar quarter, and 90 percent for meteorological data per calendar quarter. The Nuiqsut ambient air and meteorological monitoring station met all PSD requirements during the monitoring year with the exception of vertical wind speed. Vertical wind speed is an optional parameter for AERMOD dispersion modeling.

Quarterly and annual data completeness for ambient air and meteorological parameters are provided in Tables 2-3 and 2-4, respectively. Calculations for determining data completeness are provided in Appendix A. Fully validated data for all parameters are provided in Appendix D.

Table 2-3: Ambient Air Quality Data Capture Percent

Period	Pollutants – Data Recovery [1]					
	CO	NO_2	O_3	SO_2	$PM_{2.5}$ [2]	PM_{10} [2]
January	99%	99%	99%	99%	84%	100%
February	98%	97%	98%	98%	100%	96%
March	99%	99%	98%	99%	97%	100%
1st Quarter	**99%**	**99%**	**98%**	**99%**	**93%**	**99%**
April	98%	98%	98%	98%	100%	100%
May	99%	99%	99%	99%	100%	100%
June	95%	95%	95%	95%	100%	100%
2nd Quarter	**97%**	**97%**	**97%**	**97%**	**100%**	**100%**
July	99%	99%	99%	99%	100%	100%
August	98%	98%	98%	98%	100%	100%
September	96%	96%	97%	96%	93%	100%
3rd Quarter	**98%**	**98%**	**98%**	**98%**	**98%**	**100%**
October	99%	99%	99%	99%	84%	100%
November	99%	99%	99%	99%	97%	100%
December	99%	99%	99%	99%	100%	100%
4th Quarter	**99%**	**99%**	**99%**	**99%**	**93%**	**100%**
Annual	**98%**	**98%**	**98%**	**98%**	**96%**	**100%**

[1] EPA PSD-quality ambient air monitoring standards require data capture of 80 percent or greater per quarter for four consecutive quarters.
[2] Data recovery for PM monitors is based on the number of valid 24-hour average particulate matter samples collected divided by the total number of 24-hour periods during the sampling period. 24-hour average data recovery percentages in Table 2-2 differ from the 1-hour average data recovery percentage summaries presented in Appendix C.

Table 2-4: Meteorological Data Capture Percent

Period	Meteorological Parameters – Data Recovery [1]								
	Vertical Wind Speed	Vertical Wind Speed Std. Dev. (Sigma Omega)	Horizontal Wind Speed	Horizontal Wind Direction	Wind Direction Std. Dev. (Sigma Theta)	2-M Temp	10-M Temp	Delta-Temp	Solar Radiation
January	0% [2]	0% [2]	100%	100%	100%	100%	100%	100%	100%
February	76% [2]	76% [2]	100%	100%	100%	100%	100%	100%	100%
March	100%	100%	100%	100%	100%	100%	100%	100%	99%
1st Quarter	58% [2]	58% [2]	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
April	99%	99%	99%	99%	99%	99%	99%	99%	99%
May	7% [2]	7% [2]	97%	97%	97%	97%	97%	97%	93%
June	28% [2]	28% [2]	97%	97%	97%	97%	97%	97%	92%
2nd Quarter	44% [2]	44% [2]	**98%**	**98%**	**98%**	**98%**	**98%**	**98%**	**95%**
July	100%	100%	100%	100%	100%	100%	100%	100%	100%
August	100%	100%	100%	100%	100%	100%	100%	100%	100%
September	100%	100%	100%	100%	100%	100%	100%	100%	100%
3rd Quarter	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
October	89% [3]	89% [3]	97%	97%	97%	100%	100%	100%	100%
November	100%	100%	100%	100%	100%	100%	100%	100%	100%
December	100%	100%	100%	100%	100%	100%	100%	100%	100%
4th Quarter	**96%**	**96%**	**99%**	**99%**	**99%**	**100%**	**100%**	**100%**	**100%**
Annual	75%	75%	**99%**	**99%**	**99%**	**99%**	**99%**	**99%**	**99%**

[1] EPA PSD-quality meteorological monitoring standards require data capture of 90 percent or greater per quarter for four consecutive quarters.
[2] Vertical wind speed data invalidated due to sensor damage. The sensor was repaired on February 7 and June 22, 2017. Due to the data loss, DQOs were not met for vertical wind speed for the first and second quarter and monitoring year. Vertical wind speed is an optional parameter for AERMOD dispersion modeling.
[3] Vertical wind speed data invalidated due to ice riming.

2.4 PRECISION STATISTICS

2.4.1 MONITORING NETWORK PRECISION STATISTICS

Precision statistics were determined using the methods outlined in Title 40 Code of Federal Regulations, Part 58 (40 CFR 58), Appendix A. Valid precision data for ambient air monitors (CO, NO_2, O_3, and SO_2) were collected at least once every two weeks, meeting the critical validation criteria outlined in the monitoring program QAPP. Quarterly precision statistics for each criteria pollutant are provided in Tables 2-5 through 2-20.

Precision statistics for the continuous $PM_{2.5}$ monitor were determined using the monitoring network QA station, located at the Alpine CD1 monitoring station. EPA recommends that precision statistics for $PM_{2.5}$ should only be calculated for collocated samples if both the collocated and the primary sample concentrations are greater than or equal to 3 µg/m^3. As proposed in the CD1 $PM_{2.5}$ Monitoring Program QAPP, $PM_{2.5}$ precision statistics for this monitoring project were calculated for collocated samples if both the collocated and the primary sample concentrations were greater than or equal to 3 µg/m^3. Secondary precision statistics were used when collocated samples did not meet the minimum concentration threshold. Quarterly network $PM_{2.5}$ precision statistics are presented in Table 2-21.

Table 2-5: 1st Quarter CO Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
1/5/2017	8.0	8.0	-0.4	15	2.24	1.41	5.01	-0.53	1.90
1/12/2017	8.0	8.0	0.3						
1/19/2017	8.2	8.0	1.9						
1/26/2017	8.2	8.0	2.4						
2/2/2017	8.2	8.0	2.3						
2/7/2017	8.3	8.0	3.6						
2/9/2017	8.3	8.0	3.8						
2/16/2017	8.4	8.0	4.4						
2/21/2017	8.1	8.0	1.1						
2/23/2017	8.1	8.0	0.7						
3/2/2017	8.1	8.0	1.7						
3/9/2017	8.2	8.0	1.9						
3/16/2017	8.2	8.0	2.7						
3/23/2017	8.2	8.0	3.1						
3/30/2017	8.3	8.0	4.1						

[1] Acceptance criteria: ≤ 10%

Table 2-6: 2nd Quarter CO Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
4/4/2017	8.4	8.0	4.5	15	1.53	1.07	3.63	-0.57	1.44
4/6/2017	8.1	8.0	0.9						
4/13/2017	8.1	8.0	1.1						
4/20/2017	8.1	8.0	1.6						
4/27/2017	8.2	8.0	2.0						
4/28/2017	8.0	8.0	0.1						
5/4/2017	8.0	8.0	0.5						
5/11/2017	8.1	8.0	1.1						
5/18/2017	8.1	8.0	1.2						
5/25/2017	8.1	8.0	1.5						
6/1/2017	8.0	8.0	0.4						
6/8/2017	8.2	8.0	2.2						
6/15/2017	8.2	8.0	2.5						
6/22/2017	8.1	8.0	1.7						
6/29/2017	8.1	8.0	1.8						

[1]Acceptance criteria: ≤ 10%

Table 2-7: 3rd Quarter CO Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
7/6/2017	8.1	8.0	1.4	13	1.66	0.83	3.28	0.05	1.14
7/13/2017	8.2	8.0	2.0						
7/20/2017	8.1	8.0	1.0						
7/27/2017	8.1	8.0	1.3						
8/3/2017	8.1	8.0	1.1						
8/10/2017	8.1	8.0	1.0						
8/17/2017	8.1	8.0	1.3						
8/24/2017	8.1	8.0	0.8						
8/31/2017	8.2	8.0	3.0						
9/7/2017	8.3	8.0	3.1						
9/14/2017	8.1	8.0	0.8						
9/21/2017	8.2	8.0	2.3						
9/28/2017	8.2	8.0	2.5						

[1]Acceptance criteria: ≤ 10%

Table 2-8: 4th Quarter CO Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
10/5/2017	8.2	8.0	2.5	15	2.43	2.74	7.81	-2.95	3.68
10/12/2017	8.2	8.0	2.9						
10/19/2017	8.3	8.0	3.9						
10/26/2017	8.4	8.0	5.0						
11/2/2017	8.4	8.0	4.7						
11/9/2017	8.4	8.0	5.2						
11/15/2017 [2]	8.7	8.0	9.0						
11/15/2017 [3]	7.9	8.0	-1.0						
11/16/2017	7.9	8.0	-1.2						
11/23/2017	8.0	8.0	-0.1						
11/30/2017	8.0	8.0	0.4						
12/7/2017	8.1	8.0	0.8						
12/14/2017	8.1	8.0	1.4						
12/21/2017	8.1	8.0	1.3						
12/28/2017	8.1	8.0	1.6						

[1] Acceptance criteria: ≤ 10%
[2] As-found; pre-calibration
[3] As-left; post calibration.

Table 2-9: 1st Quarter NO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
1/5/2017	79.1	80.0	-1.1	14	1.47	1.68	4.75	-1.82	2.28
1/12/2017	80.2	80.0	0.3						
1/19/2017	80.1	80.0	0.1						
1/26/2017	79.7	80.0	-0.4						
2/2/2017	79.2	80.0	-1.0						
2/7/2017	82.9	80.0	3.6						
2/9/2017	81.9	80.0	2.4						
2/16/2017	82.1	80.0	2.6						
2/23/2017	82.7	80.0	3.4						
3/2/2017	81.7	80.0	2.1						
3/9/2017	81.9	80.0	2.4						
3/16/2017	82.9	80.0	3.6						
3/23/2017	81.4	80.0	1.8						
3/30/2017	80.6	80.0	0.8						

[1]Acceptance criteria: ≤ 15%

Table 2-10: 2nd Quarter NO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
4/4/2017	80.8	80.0	1.0	14	-0.42	2.03	3.55	-4.39	2.75
4/6/2017	81.5	80.0	1.9						
4/13/2017	82.1	80.0	2.6						
4/20/2017	82.0	80.0	2.5						
4/27/2017	80.5	80.0	0.6						
5/4/2017	80.0	80.0	0.0						
5/11/2017	80.2	80.0	0.3						
5/18/2017	79.3	80.0	-0.9						
5/25/2017	78.2	80.0	-2.3						
6/1/2017	79.7	80.0	-0.4						
6/8/2017	77.7	80.0	-2.9						
6/15/2017	77.7	80.0	-2.9						
6/22/2017	77.9	80.0	-2.6						
6/29/2017	77.7	80.0	-2.9						

[1]Acceptance criteria: ≤ 15%

Table 2-11: 3rd Quarter NO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
7/6/2017	77.1	80.0	-3.6	13	-4.41	0.84	-2.77	-6.05	1.16
7/13/2017	77.2	80.0	-3.5						
7/20/2017	76.5	80.0	-4.4						
7/27/2017	76.6	80.0	-4.3						
8/3/2017	76.3	80.0	-4.6						
8/10/2017	76.1	80.0	-4.9						
8/17/2017	76.2	80.0	-4.8						
8/24/2017	76.3	80.0	-4.6						
8/31/2017	75.4	80.0	-5.8						
9/7/2017	75.4	80.0	-5.8						
9/14/2017	76.5	80.0	-4.4						
9/21/2017	76.8	80.0	-4.0						
9/28/2017	77.8	80.0	-2.8						

[1]Acceptance criteria: ≤ 15%

Table 2-12: 4th Quarter NO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
10/5/2017	76.8	80.0	-4.0	13	-2.54	0.73	-1.11	-3.97	1.01
10/12/2017	77.2	80.0	-3.5						
10/19/2017	77.8	80.0	-2.8						
10/26/2017	77.9	80.0	-2.6						
11/2/2017	78.1	80.0	-2.4						
11/9/2017	78.9	80.0	-1.4						
11/16/2017	78.1	80.0	-2.4						
11/23/2017	78.0	80.0	-2.5						
11/30/2017	78.2	80.0	-2.3						
12/7/2017	78.0	80.0	-2.5						
12/14/2017	77.7	80.0	-2.9						
12/21/2017	77.9	80.0	-2.6						
12/28/2017	79.0	80.0	-1.3						

[1] Acceptance criteria: ≤ 15%

Table 2-13: 1st Quarter O_3 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
1/2/2017	79.6	80.0	-0.5	17	0.68	0.88	2.41	-1.04	1.15
1/5/2017	80.2	80.0	0.2						
1/12/2017	80.2	80.0	0.2						
1/19/2017	79.9	80.0	-0.2						
1/26/2017	81.1	80.0	1.4						
2/2/2017	81.1	80.0	1.4						
2/7/2017	81.4	80.0	1.8						
2/9/2017	80.8	80.0	1.0						
2/16/2017 [2]	82.1	80.0	2.7						
2/16/2017 [3]	80.9	80.0	1.2						
2/23/2017	79.9	80.0	-0.1						
3/2/2017	80.4	80.0	0.5						
3/9/2017	80.9	80.0	1.1						
3/16/2017	79.5	80.0	-0.6						
3/23/2017	80.7	80.0	0.9						
3/28/2017	80.0	80.0	0.0						
3/30/2017	80.5	80.0	0.6						

[1] Acceptance criteria: ≤ 7%
[2] As-found; pre-calibration
[3] As-left; post calibration.

Table 2-14: 2nd Quarter O_3 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
4/4/2017	81.8	80.0	2.3	15	1.21	1.54	4.23	-1.80	2.06
4/6/2017	82.7	80.0	3.4						
4/13/2017	81.7	80.0	2.2						
4/20/2017	80.9	80.0	1.1						
4/27/2017	81.7	80.0	2.2						
5/4/2017 [2]	83.4	80.0	4.3						
5/4/2017 [3]	80.7	80.0	0.8						
5/11/2017	80.5	80.0	0.6						
5/18/2017	80.2	80.0	0.3						
5/25/2017	80.5	80.0	0.6						
6/1/2017	80.3	80.0	0.4						
6/8/2017	79.7	80.0	-0.4						
6/15/2017	80.3	80.0	0.4						
6/22/2017	78.5	80.0	-1.8						
6/29/2017	81.7	80.0	2.2						

[1] Acceptance criteria: ≤ 7%
[2] As-found; pre-calibration
[3] As-left; post calibration.

Table 2-15: 3rd Quarter O_3 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
7/6/2017	81.7	80.0	2.2	13	-0.20	1.30	2.35	-2.76	1.80
7/13/2017	80.7	80.0	0.9						
7/20/2017	79.2	80.0	-1.0						
7/27/2017	79.0	80.0	-1.3						
8/3/2017	78.8	80.0	-1.5						
8/10/2017	79.5	80.0	-0.6						
8/17/2017	79.6	80.0	-0.5						
8/24/2017	80.0	80.0	0.0						
8/31/2017	79.8	80.0	-0.2						
9/7/2017	81.0	80.0	1.3						
9/14/2017	80.9	80.0	1.1						
9/21/2017	79.8	80.0	-0.3						
9/28/2017	77.9	80.0	-2.6						

[1]Acceptance criteria: ≤ 7%

Table 2-16: 4th Quarter O_3 Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
10/5/2017	80.3	80.0	0.4	13	3.35	1.96	7.20	-0.49	2.71
10/12/2017	80.3	80.0	0.3						
10/19/2017	80.9	80.0	1.1						
10/26/2017	81.5	80.0	1.9						
11/2/2017	82.3	80.0	2.9						
11/9/2017	82.9	80.0	3.7						
11/16/2017	83.1	80.0	3.8						
11/23/2017	82.4	80.0	3.0						
11/30/2017	83.7	80.0	4.6						
12/7/2017	84.4	80.0	5.5						
12/14/2017	84.7	80.0	5.9						
12/21/2017	84.7	80.0	5.9						
12/28/2017	83.7	80.0	4.7						

[1]Acceptance criteria: ≤ 7%

Table 2-17: 1st Quarter SO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
1/5/2017	77.9	78.0	-0.1	15	-0.54	1.22	1.85	-2.93	1.63
1/12/2017	77.2	78.0	-1.0						
1/19/2017	77.4	78.0	-0.8						
1/26/2017	77.2	78.0	-1.1						
2/2/2017	78.4	78.0	0.5						
2/7/2017	78.1	78.0	0.1						
2/9/2017	77.8	78.0	-0.3						
2/16/2017	78.7	78.0	0.8						
2/21/2017	75.9	78.0	-2.7						
2/23/2017	76.0	78.0	-2.5						
3/2/2017	77.1	78.0	-1.2						
3/9/2017	77.4	78.0	-0.8						
3/16/2017	79.7	78.0	2.2						
3/23/2017	77.5	78.0	-0.6						
3/30/2017	77.6	78.0	-0.6						

[1]Acceptance criteria: ≤ 10%

Table 2-18: 2nd Quarter SO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
4/4/2017	78.8	78.1	0.9	15	0.43	1.22	2.82	-1.95	1.63
4/6/2017	77.3	78.0	-0.9						
4/13/2017	79.0	78.0	1.3						
4/20/2017	79.3	78.0	1.7						
4/27/2017	78.2	78.0	0.2						
4/28/2017	76.9	78.2	-1.7						
5/4/2017	76.9	78.0	-1.4						
5/11/2017	78.6	78.0	0.7						
5/18/2017	77.4	78.0	-0.7						
5/25/2017	77.5	78.0	-0.6						
6/1/2017	78.5	78.0	0.6						
6/8/2017	79.4	78.0	1.8						
6/15/2017	79.1	78.0	1.4						
6/22/2017	78.9	78.0	1.1						
6/29/2017	79.6	78.0	2.1						

[1]Acceptance criteria: ≤ 10%

Table 2-19: 3rd Quarter SO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
7/6/2017	79.6	78.0	2.1	13	3.32	1.19	5.65	1.00	1.64
7/13/2017	80.5	78.0	3.2						
7/20/2017	79.9	78.0	2.5						
7/27/2017	79.9	78.0	2.5						
8/3/2017	80.2	78.0	2.8						
8/10/2017	80.2	78.0	2.8						
8/17/2017	82.5	78.0	5.7						
8/24/2017	81.0	78.0	3.8						
8/31/2017	82.2	78.0	5.4						
9/7/2017	81.3	78.0	4.2						
9/14/2017	80.5	78.0	3.2						
9/21/2017	79.5	78.0	1.9						
9/28/2017	80.5	78.0	3.2						

[1]Acceptance criteria: ≤ 10%

Table 2-20: 4th Quarter SO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
10/5/2017	80.5	78.0	3.2	13	2.26	0.79	3.81	0.72	1.09
10/12/2017	79.4	78.0	1.9						
10/19/2017	80.6	78.0	3.4						
10/26/2017	79.9	78.0	2.5						
11/2/2017	80.0	78.0	2.5						
11/9/2017	80.6	78.0	3.4						
11/16/2017	79.9	78.0	2.4						
11/23/2017	79.2	78.0	1.5						
11/30/2017	80.1	78.0	2.8						
12/7/2017	79.5	78.0	1.9						
12/14/2017	79.4	78.0	1.8						
12/21/2017	78.6	78.0	0.8						
12/28/2017	79.1	78.0	1.5						

[1]Acceptance criteria: ≤ 10%

Table 2-21: Network $PM_{2.5}$ Monitoring Precision

Period	Samplers [1]	Concentration Levels	Number of Collocated Samples	Average Percent Difference	Standard Deviation [2] ($\mu g/m^3$)	Precision [3] (%CV)
1st Quarter (January 1 – March 31)	BAM $PM_{2.5}$ Primary against BAM $PM_{2.5}$ Collocated	≥3 $\mu g/m^3$	55	-8.2	27.4	22.2
2nd Quarter (April 1 – June 30)	BAM $PM_{2.5}$ Primary against BAM $PM_{2.5}$ Collocated	≥3 $\mu g/m^3$	26	-3.5	25.0	21.8
3rd Quarter (July 1 – September 30)	BAM $PM_{2.5}$ Primary against BAM $PM_{2.5}$ Collocated	≥3 $\mu g/m^3$	3	-19.3	49.1	107.0
4th Quarter (October 1 – December 31)	BAM $PM_{2.5}$ Primary against BAM $PM_{2.5}$ Collocated	≥3 $\mu g/m^3$	11	20.0	26.9	27.3
Year to Date	BAM $PM_{2.5}$ Primary against BAM $PM_{2.5}$ Collocated	≥3 $\mu g/m^3$	95	-4.0	28.5	22.3

[1] $PM_{2.5}$ network precision statistics represent data from the CD1 monitoring station $PM_{2.5}$ samplers.
[2] Standard deviation of the absolute concentration differences for the population.
[3] Standard deviation of the absolute concentration difference for the population divided by 2 with a goal of ≤ 10%CV per quarter. If the precision estimate exceeds 10%CV, alternate precision statistics of ±3 $\mu g/m^3$ apply. See CD1 summary report for additional information.

2.4.2 ANALYTICAL LABORATORY PRECISION STATISTICS

Not applicable.

2.4.3 ANALYTICAL LABORATORY PRECISION STATISTICS FOR LEAD ANALYSIS OF PARTICULATE SAMPLES

Not applicable.

2.5 ACCURACY STATISTICS

The ambient air and meteorological monitoring systems are subjected to periodic calibrations and independent quality assurance performance audits. All calibration and audit equipment are documented as traceable to authoritative standards. The purpose of these calibration and audit checks is to challenge the monitoring systems with known inputs or collocate traceable authoritative standards with them to verify that each instrument response is accurate to within established tolerances.

Tables 2-22 through 2-39 summarize the accuracy statistics obtained during the project.

2.5.1 INSTRUMENT CALIBRATION STATISTICS

Single-point calibration verifications were performed on a daily basis on all gas pollutant analyzers throughout the monitoring year. The single-point calibration verifications consisted of challenging each instrument response with air scrubbed of all pollutants (“zero air”) and air containing a National Institute of Standards and Technology (NIST) traceable standard gas concentration equal to 80 percent (span check) of the instrument’s upper range limit (URL). If zero or span drift limits are exceeded, ambient measurements are invalidated back to the most recent point in time where such measurements were known to be valid. Single-point calibration verification data for each parameter are provided in Appendix C.

Multi-point calibrations were performed on a biannual basis as recommended by the EPA (EPA-454/R-98-004). Additionally, multi-point calibrations were conducted under specific circumstances including: indication of analyzer malfunction, repairs or service that affected its calibration, and following significant interruptions in station operations. Multi-point calibrations consisted of challenging each instrument response with air scrubbed of all pollutants (“zero air”) and at least four concentrations spanning 80 to 90 percent of the URL. The NO_2 converter efficiency was determined following the guidelines provided in the 40 CFR 50 – Appendix F.

Tables 2-22 through 2-25 include calibration statistical summaries for CO, NO_2, O_3, and SO_2 analyzers, respectively. Tables 2-26 and 2-27 summarize the monthly quality control checks of the particulate samplers. These manual QC checks are conducted by SLR or on-site personnel and the data are transmitted to the SLR Anchorage office.

Meteorological calibration is assessed at least semi-annually. Each sensor is assessed by collocating calibration sensors of NIST-traceable accuracy. Calibration results are presented in Tables 2-28 through 2-29. Refer to Appendix C for detailed calibration records for meteorological sensors.

If calibration checks reveal a sampler is operating outside of established quality control criteria, data is invalidated as far back as the most recently passed calibration. Refer to Section 2 for a discussion of any data that was invalidated due to failing accuracy.

Table 2-22: Calibration Summary – CO

Period	Calibration Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Pass/Fail [1]
2/7/2017	0.0	0.3	-	1.47%	0.9900	0.4152	0.9999	PASS
	8.0	8.3	3.7%					
	17.4	17.7	1.6%					
	29.9	30.3	1.4%					
	39.8	39.8	0.1%					
	44.8	44.6	-0.6%					
4/4/2017	0.0	0.2	-	3.07%	1.0125	0.3363	0.9999	PASS
	8.0	8.4	4.7%					
	17.4	18.1	3.6%					
	29.9	30.9	3.5%					
	39.8	40.7	2.1%					
	44.8	45.4	1.4%					
4/28/2017	0.0	0.0	-	0.68%	0.9976	0.1198	0.9999	PASS
	8.0	8.0	0.7%					
	17.4	17.6	0.7%					
	29.9	30.3	1.3%					
	39.8	39.9	0.2%					
	44.8	44.5	-0.6%					
9/27/2017	0.0	0.2	-	1.43%	0.9962	0.3216	0.9999	PASS
	8.0	8.2	2.9%					
	17.5	17.8	1.7%					
	30.0	30.5	1.8%					
	40.0	40.2	0.5%					
	45.1	45.0	-0.2%					
11/15/2017	0.0	0.0	-	1.31%	0.9779	0.1424	0.9999	PASS
	8.0	7.9	-0.7%					
	17.5	17.3	-0.9%					
	30.0	29.8	-0.6%					
	40.0	39.3	-1.9%					
	45.0	43.9	-2.4%					

[1]Acceptance criteria:

1. Measured and audit point difference ≤ ±10%
2. Slope ≥ 0.90 and ≤ 1.10
3. R2 ≥ 0.9955
4. Y-intercept ≤ ±2% of full scale

Table 2-23: Calibration Summary – NO_2

Period	Calibration Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Converter Efficiency	Pass/Fail [1]
2/7/2017	0.0	0.0	-	3.69%	1.0435	-0.9712	0.9999	101.3%	PASS
	80.2	82.9	3.4%						
	169.9	175.2	3.1%						
	268.1	276.7	3.2%						
	373.0	390.6	4.7%						
	445.0	463.0	4.0%						
4/4/2017	0.0	0.0	-	1.68%	1.0194	-0.3236	1.0000	100.9%	PASS
	79.5	80.7	1.5%						
	170.0	171.6	0.9%						
	266.0	271.5	2.1%						
	375.0	383.4	2.3%						
	445.2	452.4	1.6%						
9/27/2017	0.0	0.0	-	2.21%	0.9821	-0.7193	0.9999	100.7%	PASS
	78.6	77.0	-2.0%						
	167.6	163.5	-2.4%						
	264.7	256.5	-3.1%						
	367.1	360.8	-1.7%						
	435.4	427.8	-1.8%						

[1] Acceptance criteria:

1. Measured and audit point difference ≤ ±15%
2. Slope ≥ 0.9 and ≤ 1.10
3. $R^2 \geq 0.9950$
4. Y-intercept ≤ ±3% of full scale
5. Converter efficiency ≥ 96.0%

Table 2-24: Calibration Summary – O_3

Period	Calibration Gas Concentration (ppb)	Analyzer Response (ppb)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Pass/Fail [(1)]
2/7/2017	0.3	2.4	-	0.56%	0.9942	2.0755	1.0000	PASS
	80.1	81.5	1.7%					
	175.2	176.2	0.6%					
	299.6	300.4	0.3%					
	399.3	399.3	0.0%					
	449.2	448.2	-0.2%					
2/16/2017	0.0	0.8	-	0.30%	0.9984	0.7637	1.0000	PASS
	80.1	80.8	0.9%					
	174.9	174.8	-0.1%					
	299.6	300.5	0.3%					
	399.3	399.9	0.2%					
	450.2	449.6	-0.1%					
3/28/2017	0.0	0.3	-	0.12%	0.9984	0.3046	1.0000	PASS
	80.1	80.0	-0.1%					
	174.9	175.1	0.1%					
	299.6	299.9	0.1%					
	399.3	398.7	-0.2%					
	449.2	448.7	-0.1%					
4/4/2017	0.3	1.9	-	0.78%	0.9944	2.1563	1.0000	PASS
	80.1	82.1	2.5%					
	174.9	176.5	0.9%					
	299.6	300.1	0.2%					
	399.3	399.7	0.1%					
	449.7	448.7	-0.2%					
9/28/2017	-2.6	-1.0	-	1.73%	0.9824	0.6656	0.9999	PASS
	80.0	77.9	-2.6%					
	175.0	172.0	-1.7%					
	300.0	296.7	-1.1%					
	400.3	395.2	-1.3%					
	451.0	442.2	-2.0%					

[1]Acceptance criteria:

1. Measured and audit point difference ≤ ±7%
2. Slope ≥ 0.93 and ≤ 1.07
3. $R^2 \geq 0.9955$
4. Y-intercept ≤ ±2% of full scale

Table 2-25: Calibration Summary – SO_2

Period	Calibration Gas Concentration (ppb)	Analyzer Response (ppb)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Pass/Fail [1]
2/07/2017	0.0	0.5	-	0.49%	0.9961	0.4357	1.0000	PASS
	77.9	78.7	1.0%					
	170.6	170.5	-0.1%					
	292.5	290.0	-0.8%					
	390.3	388.6	-0.4%					
	438.4	438.7	0.1%					
4/4/2017	0.0	0.8	-	0.55%	0.9955	0.1623	0.9999	PASS
	78.3	77.9	-0.5%					
	170.8	170.2	-0.3%					
	292.3	290.6	-0.6%					
	390.3	386.0	-1.1%					
	438.7	439.7	0.2%					
4/28/2017	0.0	-0.2	-	0.61%	0.9975	-0.5276	1.0000	PASS
	77.9	77.2	-0.9%					
	170.7	169.1	-0.9%					
	292.5	290.8	-0.6%					
	390.3	390.4	0.0%					
	438.5	435.9	-0.6%					
9/27/2017	0.0	0.8	-	2.39%	1.0233	0.2265	1.0000	PASS
	77.9	80.2	2.9%					
	170.8	173.8	1.8%					
	292.3	299.5	2.5%					
	390.3	398.6	2.1%					
	439.2	450.9	2.7%					

[1]Acceptance criteria:

1. Measured and audit point difference ≤ ±10%
2. Slope ≥ 0.90 and ≤ 1.10
3. $R^2 \geq 0.9955$
4. Y-intercept ≤ ±2% of full scale

Table 2-26: Quality Control Checks $PM_{2.5}$

Date	Ambient Temperature [1] (˚C)			Barometric Pressure [2] (mmHg)			Time (hh:mm:ss)			Flow Rate [3] (L/min)		
	Sampler	QC Check	Diff	Sampler	QC Check	Diff	Sampler	QC Check	Diff	Sampler	QC Check	Diff
1/9/2017	-11.3	-10.5	-0.8	762	762	0	11:49:00	11:47:00	0:02:00	16.7	16.90	-1.2%
2/7/2017	-20.1	-19.5	-0.6	757	755	2	14:47:00	14:45:20	0:01:40	16.7	16.98	-1.6%
3/8/2017	-26.2	-26.3	0.1	775	777	-2	17:10:25	17:09:30	0:00:55	16.7	17.00	-1.8%
4/4/2017	-13.9	-13.4	-0.5	751	752	-1	13:58:14	14:00:20	-0:02:06	16.7	16.75	-0.3%
5/3/2017	-7.3	-7.8	0.5	752	752	0	15:22:00	15:20:00	0:02:00	16.7	16.76	-0.4%
6/8/2017 [4]	1.6	1.2	0.4	762	764	-2	11:49:00	11:47:00	0:02:00	16.9	16.30	3.7%
6/8/2017 [4]	1.6	2.0	-0.4	762	764	-2	12:11:00	12:09:00	0:02:00	16.7	16.74	-0.2%
7/19/2017	18.0	18.3	-0.3	751	753	-2	8:16:00	8:14:00	0:02:00	16.7	16.70	0.0%
8/23/2017	6.4	6.7	-0.3	747	749	-2	10:40:00	10:38:00	0:02:00	16.7	16.71	-0.1%
9/13/2017	11.9	12.3	-0.4	744	747	-3	11:27:00	11:25:00	0:02:00	16.7	16.75	-0.3%
10/26/2017	-5.2	-5.4	0.2	748	751	-3	11:44:00	11:42:00	0:02:00	16.7	16.78	-0.5%
11/9/2017 [5]	-7.1	-7.3	0.2	746	749	-3	18:16:00	18:14:00	0:02:00	16.7	16.85	-0.9%
12/14/2017	-14.7	-14.8	0.1	754	754	0	19:31:00	19:29:00	0:02:00	16.7	16.70	0.0%

[1] Acceptable criteria ±2°C
[2] Acceptable criteria ±10 mmHg
[3] Acceptable criteria ±4% of reference
[4] QC checks performed before and after pump replacement.
[5] QC check and multipoint calibration performed; the multipoint form and results are included in Appendix C.

Table 2-27: Quality Control Checks PM_{10}

Date	Ambient Temperature [1] (˚C)			Barometric Pressure [2] (mmHg)			Time (hh:mm:ss)			Flow Rate [3] (L/min)		
	Sampler	QC Check	Diff	Sampler	QC Check	Diff	Sampler	QC Check	Diff	Sampler	QC Check	Diff
1/9/2017	-10.6	-10.5	-0.1	760	762	-2	11:43:00	11:41:00	0:02:00	16.7	17.10	-2.3%
2/7/2017	-19.8	-19.5	-0.3	754	755	-1	14:47:50	14:46:00	0:01:50	16.7	16.75	-0.3%
3/8/2017	-25.6	-26.2	0.6	769	777	-8	17:07:05	17:08:08	-0:01:03	16.7	16.90	-1.2%
4/4/2017	-13.1	-13.4	0.3	757	752	5	13:59:38	14:01:30	-0:01:52	16.7	16.84	-0.8%
5/3/2017	-7.3	-7.5	0.2	751	752	-1	15:19:00	15:17:00	0:02:00	16.7	16.72	-0.1%
6/8/2017	1.6	1.0	0.6	762	765	-3	11:34:00	11:32:00	0:02:00	16.7	16.65	0.3%
7/19/2017	19.0	19.7	-0.7	750	753	-3	8:16:00	8:14:00	0:02:00	16.7	16.70	0.0%
8/23/2017	7.0	6.6	0.4	746	749	-3	10:40:00	10:38:00	0:02:00	16.7	16.76	-0.4%
9/13/2017	12.3	12.0	0.3	743	746	-3	11:21:00	11:19:00	0:02:00	16.7	16.75	-0.3%
10/26/2017	-5.2	-4.4	-0.8	748	751	-3	11:44:00	11:42:00	0:02:00	16.7	16.78	-0.5%
11/9/2017 [4]	-6.8	-7.8	1.0	744	749	-5	17:04:00	17:02:00	0:02:00	16.7	16.78	-0.5%
12/14/2017	-14.7	-14.8	0.1	754	754	0	19:25:00	19:23:00	0:02:00	16.7	16.73	-0.2%

[1] Acceptable criteria ±2°C
[2] Acceptable criteria ±10 mmHg
[3] Acceptable criteria ±4% of reference
[4] QC check and multipoint calibration performed; the multipoint form and results are included in Appendix C.

Table 2-28: April 5, 2017 Meteorological Calibration Summary

Parameter	Limit	Units	Max Error	Status
Time	≤ ±05:00	mm:ss	00:05	PASS
2-m Temperature Accuracy	≤ ±0.50	°C	0.22	PASS
10-m Temperature Accuracy	≤ ±0.50	°C	0.19	PASS
Air Temperature Difference	≤ ±0.10	°C	0.08	PASS
Wind Speed A Accuracy	≤ ±0.20 ± 5% known input	m/s	0.20	PASS
Wind Speed A Torque	≤ 1.0	g-cm	0.1	PASS
Wind Direction A Alignment	≤ ±5	Degree	- [1]	- [1]
Wind Direction A Accuracy	≤ ±5	Degree	3.2	PASS
Wind Direction A Linearity	≤ ±3	Degree	2.9	PASS
Wind Direction A Torque	≤ 11.0	g-cm	8	PASS
Vertical Wind Speed Accuracy	≤ ±0.20 ± 5% known input	m/s	0.24	PASS
Vertical Wind Speed Torque	≤ 0.310	g-cm	0.1	PASS
Solar Radiation Accuracy	≤ ±10	W/m^2	8.8	PASS

[1] Wind direction alignment was found to be acceptable by the operator but measurements were not recorded on the field worksheet by error. Wind direction alignment was verified and documented as acceptable by the independent auditor during the audit that occurred on the same day.

Table 2-5: June 22, 2017 Wind Direction Calibration

Parameter	Limit	Units	Error	Status
As-Found [1]				
Wind Direction A Alignment	≤ ±5	Degree	2	PASS
Vertical Wind Speed Accuracy	≤ ±0.20 ± 5% known input	m/s	0.20	PASS
As-Left				
Wind Direction A Alignment	≤ ±5	Degree	3	PASS

[1] Tower elevator replaced. Wind direction checked before and after replacement.

Table 2-29: December 14, 2017 Meteorological Calibration Summary

Parameter	Limit	Units	Error	Status
Time	≤ ±05:00	mm:ss	00:08	PASS
2-m Temperature Accuracy	≤ ±0.50	°C	0.10	PASS
10-m Temperature Accuracy	≤ ±0.50	°C	0.09	PASS
Air Temperature Difference	≤ ±0.10	°C	0.01	PASS
Wind Speed A Accuracy	≤ ±0.20 ± 5% known input	m/s	0.00	PASS
Wind Speed A Torque	≤ 1.0	g-cm	0.2	PASS
Wind Direction A Alignment	≤ ±5	Degree	2	PASS
Wind Direction A Accuracy	≤ ±5	Degree	2.1	PASS
Wind Direction A Linearity	≤ ±3	Degree	1.4	PASS
Wind Direction A Torque	≤ 11.0	g-cm	7	FAIL
Vertical Wind Speed Accuracy	≤ ±0.20 ± 5% known input	m/s	0.06	PASS
Vertical Wind Speed Torque	≤ 0.310	g-cm	0.1	PASS
Solar Radiation Accuracy	≤ 10	W/m^2	0.0	PASS

2.5.2 INDEPENDENT QUALITY ASSURANCE AUDITS

Gas analyzer performance audits involve challenging the analyzer with known concentrations of pollutants. For each concentration challenge, the difference between the audit gas concentration and analyzer response is assessed and compared to PSD limits. Results of the gas analyzer audits conducted during the monitoring year are presented in Tables 2-30 to 2-33.

The gas analyzers performance audit acceptance criterion for an individual analyzer is that the mean absolute difference between the audit gas concentration and analyzer response is equal to or less than 15 percent for CO, NO_2, and SO_2 and equal to or less than 10 percent for O_3.

The performance audits of $PM_{2.5}$ and PM_{10} samplers challenge the flow rate of the monitors against independent instruments that are calibrated and traceable to National Institute of Standards and Technology (NIST) transfer standards. Audits of the $PM_{2.5}$ and PM_{10} samplers are conducted using an audit orifice transfer standard (BGI Delta Cal or equivalent). Results of the PM sampler audits are presented in Tables 2-34 and 2-35.

Meteorological performance audits involve challenging the sensors with known inputs or by using calibrated instruments collocated with the sensor. For each reading, the difference between the station value and the expected value is compared with established PSD limits to assess the accuracy of the sensor. Results of the meteorological audits conducted throughout the monitoring year are presented in Tables 2-36 to 2-37.

AMS Tech LLC completed performance audits on all station monitors. All meteorological sensors and ambient air analyzers were found to be operating within acceptable criteria throughout the monitoring year. Complete performance audit findings and details are provided in Appendix C.

Conoco requested and was granted a waiver from ADEC to reduce the network frequency of $PM_{2.5}$ Performance Evaluation Program (PEP) audits to one every three years. A PEP-like audit was conducted at the CD1 $PM_{2.5}$ network QA station with samples collected in July and December, 2017. Samples were collected at two (2) different deployments because of delay in shipment of the audit sampler to the facility. Data from the $PM_{2.5}$ PEP audit are provided in Table 2-38.

EPA recommends that a technical systems audit (TSA) be conducted to serve as a qualitative review of all aspects of a monitoring program. The systems audit includes a review of the program plan, station site, facilities, equipment, personnel, procedures, record keeping, data validation and data reporting. An annual TSA was performed in December 2017 at the Nuiqsut monitoring station. The audit indicated that the monitoring project is staffed with experienced personnel with a defined organization, and that the station is well-planned and properly sited according to criteria recommended by the EPA. Appendix C contains the complete technical systems audit report.

Table 2-30: Performance Audit Summary – CO

Period	Audit Point	Audit Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Linear Regression Statistics			Pass/Fail [(1)]
						Slope	Y-Intercept	R2	
02/07/2017	0	0.00	0.395	-	5.5	1.0122	0.285	1.0000	Pass
	1	2.18	2.37	8.7					
	2	6.84	7.21	5.4					
	3	24.90	25.50	2.4					
04/04/2017	0	0.00	0.020	-	3.0	1.0318	0.003	1.0000	Pass
	1	2.06	2.12	2.9					
	2	6.91	7.12	3.0					
	3	24.90	25.70	3.2					
07/13/2017	0	0.00	0.030	-	2.4	1.0265	-0.002	1.0000	Pass
	1	2.12	2.17	2.4					
	2	6.82	6.96	2.1					
	3	24.90	25.57	2.7					
12/14/2017	0	0.00	0.152	-	4.0	1.0373	0.067	1.0000	Pass
	1	2.16	2.24	3.7					
	2	6.90	7.20	4.3					
	3	24.60	25.60	4.1					

[1]Acceptance criteria: Measured and audit point difference ≤ ±15%

Table 2-31: Performance Audit Summary – NO_2

Period	Audit Point	Audit Gas Concentration (ppb)	Analyzer Response (ppb)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Linear Regression Statistics			Converter Efficiency	Pass/Fail [(1)]
						Slope	Y-Intercept	R2		
02/07/2017	0	0	0	-	0.5	1.0109	-0.326	1.0000	100.0%	Pass
	1	51	51.2	0.4						
	2	61	60.9	-0.2						
	3	201	203.0	1.0						
04/04/2017	0	0	0	-	1.9	0.9930	-0.566	1.0000	100.0%	Pass
	1	38.0	36.9	-2.9						
	2	95.0	93.2	-1.9						
	3	241	239	-0.8						
07/13/2017	0	0	0	-	6.2	0.9359	0.095	1.0000	105.7%	Pass
	1	50.0	47.1	-5.8						
	2	81.0	75.8	-6.4						
	3	298	279	-6.4						
12/14/2017	0	0	0	-	2.2	0.9937	-0.798	1.0000	106.0%	Pass
	1	43.0	41.5	-3.5						
	2	84.0	82.0	-2.4						
	3	242	240	-0.8						

[1]Acceptance criteria: Measured and audit point difference ≤ ±15%

Table 2-32: Performance Audit Summary – O_3

Period	Audit Point	Audit Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Linear Regression Statistics			Pass/Fail [(1)]
						Slope	Y-Intercept	R2	
02/07/2017	0	0.000	0.000	-	1.4	1.0013	0.001	1.0000	Pass
	1	0.030	0.031	3.3					
	2	0.075	0.076	1.3					
	3	0.150	0.151	0.7					
	4	0.400	0.401	0.3					
04/04/2017	0	0.000	0.000	-	3.3	1.0099	0.001	1.0000	Pass
	1	0.030	0.032	6.7					
	2	0.075	0.078	4.3					
	3	0.150	0.153	2.0					
	4	0.400	0.405	1.3					
07/13/2017	0	0.000	0.000	-	0.6	1.0080	-0.000	1.0000	Pass
	1	0.030	0.030	-0.3					
	2	0.075	0.075	0.3					
	3	0.151	0.152	0.7					
	4	0.400	0.403	0.8					
12/14/2017	0	0.000	0.000	-	0.7	0.9944	0.000	1.0000	Pass
	1	0.030	0.031	1.7					
	2	0.076	0.075	-0.3					
	3	0.150	0.150	0.0					
	4	0.400	0.398	-0.5					

[1]Acceptance criteria: Measured and audit point difference ≤ ±15%

Table 2-33: Performance Audit Summary – SO_2

Period	Audit Point	Audit Gas Concentration (ppb)	Analyzer Response (ppb)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Linear Regression Statistics			Pass/Fail [(1)]
						Slope	Y-Intercept	R2	
02/07/2017	0	0.0	1	-	3.3	0.9809	-0.194	1.0000	Pass
	1	39.7	37.4	-5.8					
	2	74.1	72.4	-2.3					
	3	248.3	243.6	-1.9					
04/04/2017	0	0.0	3	-	2.8	0.9605	1.537	1.0000	Pass
	1	40.1	39.2	-2.2					
	2	75.0	72.8	-2.9					
	3	251.0	243.0	-3.2					
07/13/2017	0	0.0	2	-	0.9	0.9871	0.909	1.0000	Pass
	1	39.7	39.3	-1.0					
	2	77.5	76.8	-0.9					
	3	250	248	-0.8					
12/14/2017	0	0.0	1	-	1.1	1.0049	0.593	1.0000	Pass
	1	39.7	40.4	1.8					
	2	78.3	78.8	0.6					
	3	251	253	0.8					

[1]Acceptance criteria: Measured and audit point difference ≤ ±15%

Table 2-34: Performance Audit Summary – $PM_{2.5}$

Period	External Leak Check Error (LPM)	Ambient Temperature Error (°C)	Ambient Pressure Error (mmHg)	Flow Rate		Pass/Fail [(1)]
				Flow Rate Accuracy Percent Error (%)	Design Flow Test Percent Error (%)	
02/07/2017	0.0	-0.2	-2	-1.8	1.8	Pass
04/04/2017	0.4	-0.4	-1	3.1	-3.0	Pass
07/13/2017	0.2	-0.1	-3	0.0	0.0	Pass
12/14/2017	0.0	-0.3	1	1.2	-1.2	Pass

[1] Acceptance criteria:
1. Leak check ≤ ±1.0 LPM
2. Temperature ≤ ±2.0 °C
3. Pressure ≤ ± 10 mmHg
4. Flow rate error ≤ ± 4% audit standard
5. Design flow test ≤ ± 5% design flow rate

Table 2-35: Performance Audit Summary – PM_{10}

Period	External Leak Check Error (LPM)	Ambient Temperature Error (°C)	Ambient Pressure Error (mmHg)	Flow Rate		Pass/Fail [(1)]
				Flow Rate Accuracy Percent Error (%)	Design Flow Test Percent Error (%)	
02/07/2017	0.3	0.6	-5	-1.2	1.2	Pass
04/04/2017	0.2	-0.1	3	-1.2	1.2	Pass
07/13/2017	0.0	0.0	-4	0.0	0.0	Pass
12/14/2017	0.1	-0.3	0	0.6	-0.6	Pass

[1] Acceptance criteria:
1. Leak check ≤ ±1.0 LPM
2. Temperature ≤ ±2.0 °C
3. Pressure ≤ ± 10 mmHg
4. Flow rate error ≤ ± 4% audit standard
5. Design flow test ≤ ± 5% design flow rate

Table 2-36: April 4, 2017 Meteorological Performance Audit Summary

Parameter	Limit	Units	Max Error	Status
Wind Speed Accuracy	≤ ±0.20 + 5% known input	m/s	0.00	Pass
Wind Speed Torque	≤ 0.5	m/s	0.16	Pass
Wind Direction Accuracy	≤ ±5	Degree	1	Pass
Wind Direction Linearity	≤ ±3	Degree	-2	Pass
Wind Direction Torque	≤ 0.5	m/s	0.33	Pass
Vertical Wind Speed Accuracy	≤ ±0.20 + 5% known input	m/s	0.17	Pass
Vertical Wind Speed Torque	≤ 0.25	m/s	0.14	Pass
2-m Temperature Accuracy	≤ ±0.50	°C	0.12	Pass
10-m Temperature Accuracy	≤ ±0.50	°C	0.13	Pass
Temperature Difference (ΔT)	≤ ±0.10	°C	0.04	Pass
Solar Radiation Accuracy < 200 W/m^2	≤ ±10	W/m^2	10	Pass

Table 2-37: December 14, 2017 Meteorological Performance Audit Summary

Parameter	Limit	Units	Max Error	Status
Wind Speed Accuracy	≤ ±0.20 + 5% known input	m/s	0.00	Pass
Wind Speed Torque	≤ 0.5	m/s	0.23	Pass
Wind Direction Accuracy	≤ ±5	Degree	2	Pass
Wind Direction Linearity	≤ ±3	Degree	-2	Pass
Wind Direction Torque	≤ 0.5	m/s	0.43	Pass
Vertical Wind Speed Accuracy	≤ ±0.20 + 5% known input	m/s	0.10	Pass
Vertical Wind Speed Torque	≤ 0.25	m/s	0.14	Pass
2-m Temperature Accuracy	≤ ±0.50	°C	-0.10	Pass
10-m Temperature Accuracy	≤ ±0.50	°C	-0.09	Pass
Air Temperature Difference	≤ ±0.10	°C	0.01	Pass
Solar Radiation Accuracy < 200 W/m^2	≤ ±10	W/m^2	0	Pass

Table 2-38: 2017 $PM_{2.5}$ PEP Audit Results

Date	PEP Audit Results (µg/m3)	BAM 1020 Results (µg/m3)	Difference (µg/m3)	Bias [1] (µg/m3)
7/14/2017 – 7/15/2017	5.07	2.1	2.97	1.91
7/15/2017 – 7/16/2017	3.21	0.4	2.81	
7/16/2017 – 7/17/2017	3.43	1.7	1.08	
12/12/2017 – 12/13/2017	2.96	4.0	1.04	
12/13/2017 – 12/14/2017	7.64	6.0	1.64	

[1] Average over the population of the absolute value of the individual pair concentration differences with a goal of ≤ 4 µg/m3 per quarter.

3. MONITORING DATA NETWORK SUMMARY

3.1 AIR QUALITY DATA SUMMARY

Table 3-1 provides quarterly and annual averages of the criteria pollutant concentrations measured from January 1, 2017, through December 31, 2017, and compared to national and Alaska air quality standards (NAAQS/AAAQS). The highest and second highest critical pollutant concentrations are also provided in Table 3-1 and compared to the respective primary and secondary air quality standards. Figures 3-1 through 3-9 provide plots of annual averages of the criteria pollutant concentrations at the Nuiqsut station along with respective NAAQS/AAAQS standards for comparison.

Table 3-1: Nuiqsut Ambient Air Monitoring Summary Data

Pollutant	National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS)		Nuiqsut Ambient Air Monitoring – Pollutant Data						
	Concentration	Averaging Period	Averaging Period	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual	YTD % of NAAQS/ AAAQS
Nitrogen Dioxide (NO_2)	53 ppb (100 µg/m^3)	Annual	Average of Period	3	2	1	1	2	**3.8%**
	100.0 ppb (190 µg/m^3)	1-Hour [2]	Daily Max 1-Hour Averages (98th Percentile)	--	--	--	--	27.4	**27.4%**
			1st Highest, 1-Hour Average	37.3	21.7	19.4	24.0	37.3	**37.3%**
			2nd Highest, 1-Hour Average	35.3	21.3	10.8	16.0	35.3	**35.3%**
Ozone (O_3)	0.075 ppm (150 µg/m^3)	8-Hour [3]	4th Highest, 8-Hour Average	0.045	0.041	0.031	0.042	0.045	**64.3%**
			1st Highest, 8-Hour Average	0.046	0.044	0.035	0.043	0.046	**65.7%**
			2nd Highest, 8-Hour Average	0.046	0.043	0.033	0.043	0.046	**65.7%**
Carbon Monoxide (CO)	35 ppm (40,000 µg/m^3)	1-Hour [1]	1st Highest, 1-Hour Average	1	1	0	1	1	**2.9%**
			2nd Highest, 1-Hour Average	1	0	0	1	1	**2.9%**
	9 ppm (10,000 µg/m^3)	8-Hour [1]	1st Highest, 8-Hour Average	1	0	0	1	1	**11.1%**
			2nd Highest, 8-Hour Average	1	0	0	1	1	**11.1%**

[1] Not to be exceeded more than once each year.
[2] To attain this standard, the 3-year average of the 98th percentile of the annual daily maximum 1-hour average must not exceed 100 ppb. 3 To attain this standard, the 3-year average of the annual fourth-highest daily maximum 8-hour average must not exceed 0.075 ppm.

Table 3-1 Continued: Nuiqsut Ambient Air Monitoring Summary Data

Pollutant	National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS)		Nuiqsut Ambient Air Monitoring – Pollutant Data						
	Concentration	Averaging Period	Averaging Period	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual	YTD % of NAAQS/ AAAQS
Sulfur Dioxide (SO_2)	0.030 ppm (80 μg/m^3)	Annual	Average of Period	0.000	0.001	0.002	0.000	0.001	**3.3%**
	0.14 ppm (365 μg/m^3)	24-Hour [5]	1st Highest, 1-Hour Average	0.00	0.00	0.00	0.00	0.00	**0.0%**
			2nd Highest, 1-Hour Average	0.00	0.00	0.00	0.00	0.00	**0.0%**
	0.5 ppm (1,300 μg/m^3)	3-Hour [5]	1st Highest, 3-Hour Average	0.0	0.0	0.0	0.0	0.0	**0.0%**
			2nd Highest, 3-Hour Average	0.0	0.0	0.0	0.0	0.0	**0.0%**
	75.0 ppb (196 μg/m^3)	1-Hour [4]	Daily Max 1-Hour Averages (99th Percentile)	--	--	--	--	3.5	**4.7%**
			1st Highest, 1-Hour Average	3.4	1.9	3.6	1.1	3.6	**4.8%**
			2nd Highest, 1-Hour Average	3.0	1.9	3.5	1.1	3.5	**4.7%**

[4] To attain this standard, the 3-year average of the 99th percentile of the annual daily maximum 1-hour average must not exceed 75.0 ppb.
[5] Not to be exceeded more than once each year.

Table 3-1 Continued: Nuiqsut Ambient Air Monitoring Summary Data

Pollutant	National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS)		Nuiqsut Ambient Air Monitoring – Pollutant Data						
	Concentration	Averaging Period	Averaging Period	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual	YTD % of NAAQS/ AAAQS
Particulate Matter <2.5 microns ($PM_{2.5}$)	12.0 μg/m^3	Annual [7]	Average of Period	2.7	2.1	0.9	0.6	1.6	**13.3%**
	35 μg/m^3	24-Hour [6]	98th Percentile, 24-Hour Average	--	--	--	--	7	**20.0%**
			1st Highest, 24-Hour Average	16	6	9	12	16	**45.7%**
			2nd Highest, 24-Hour Average	8	6	7	8	12	**34.3%**
Particulate Matter <10 microns (PM_{10})	150 μg/m^3	24-Hour [8,9]	1st Highest, 24-Hour Average	10	90	50	20	90	**60.0%**
			2nd Highest, 24-Hour Average	10	50	40	10	50	**33.3%**

[6] To attain this standard, the 3-year average of the 98th percentile of the 24-hour concentration must not exceed 35.0 μg/m3.
[7] To attain this standard, the 3-year average of the weighted annual mean PM2.5 concentration must not exceed 12.0 μg/m3.
[8] Not to be exceeded more than once per year on average over three years.
[9] 40 CFR Appendix K requires that reportable concentrations of PM_{10} be rounded to the nearest 10 μg/m3; actual measurement results are within Appendix C.

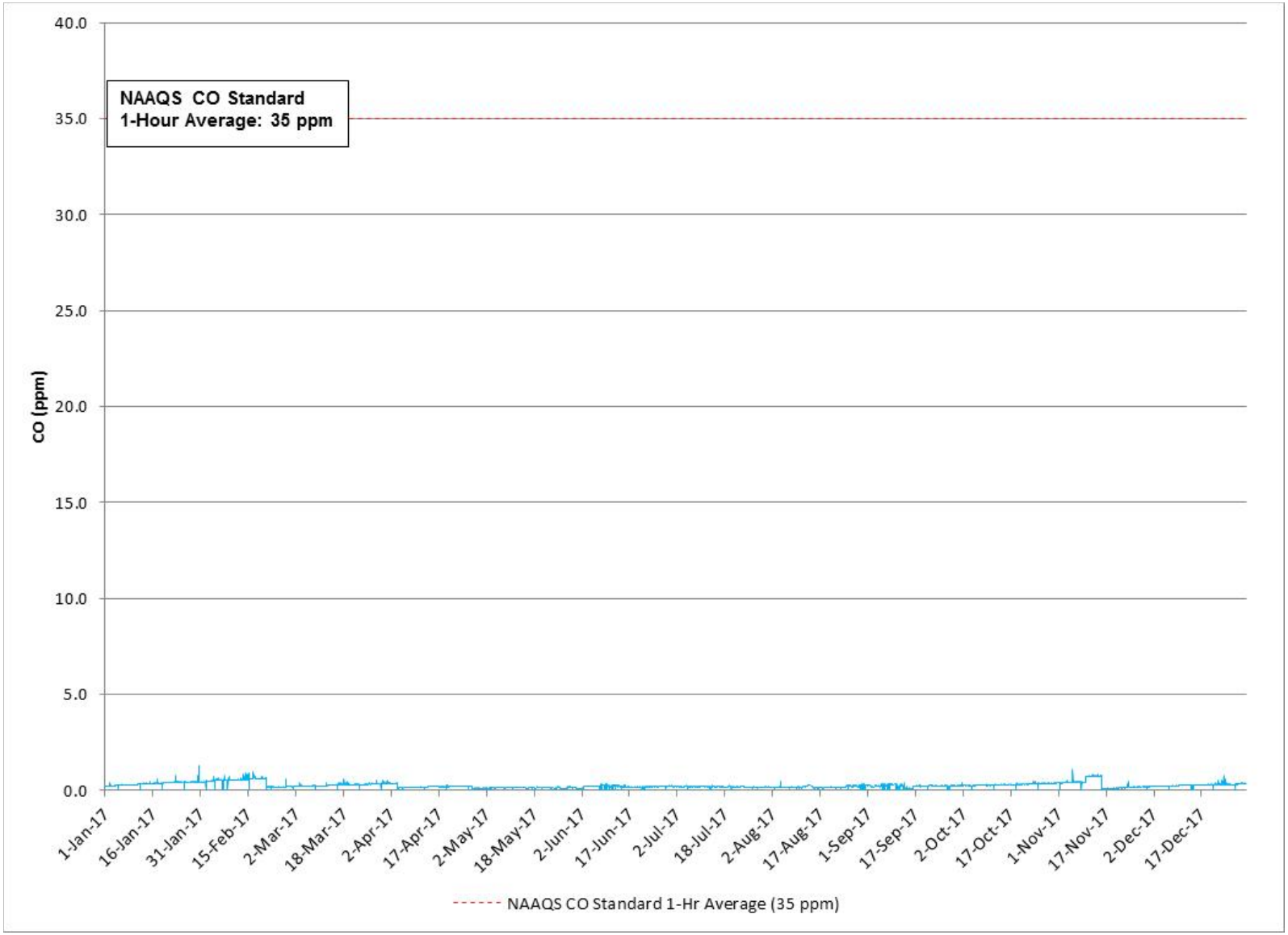


Figure 3-1: 1-Hour Average CO and NAAQS/AAAQS Standard

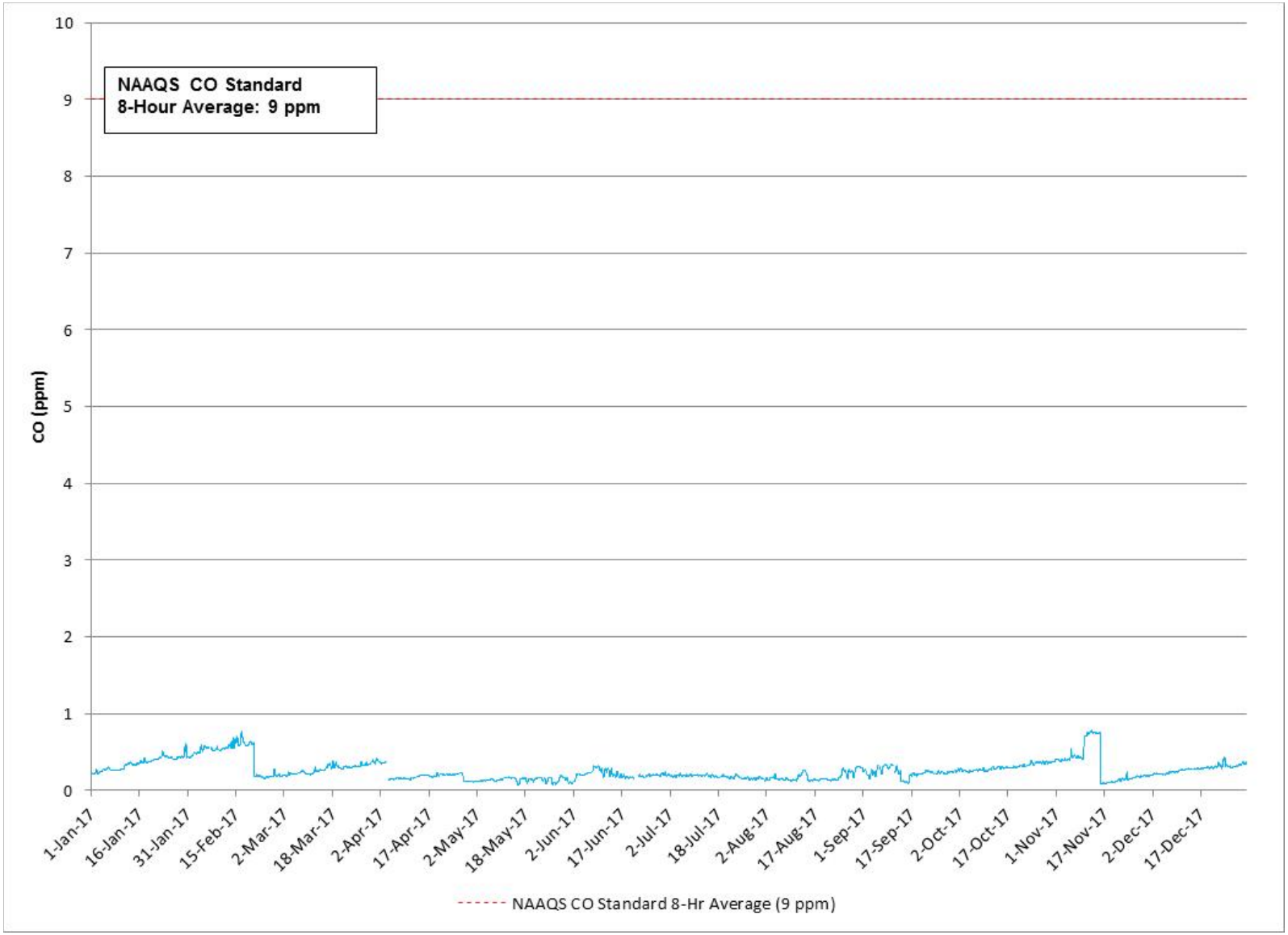


Figure 3-2: 8-Hour Average CO and NAAQS/AAAQS Standard

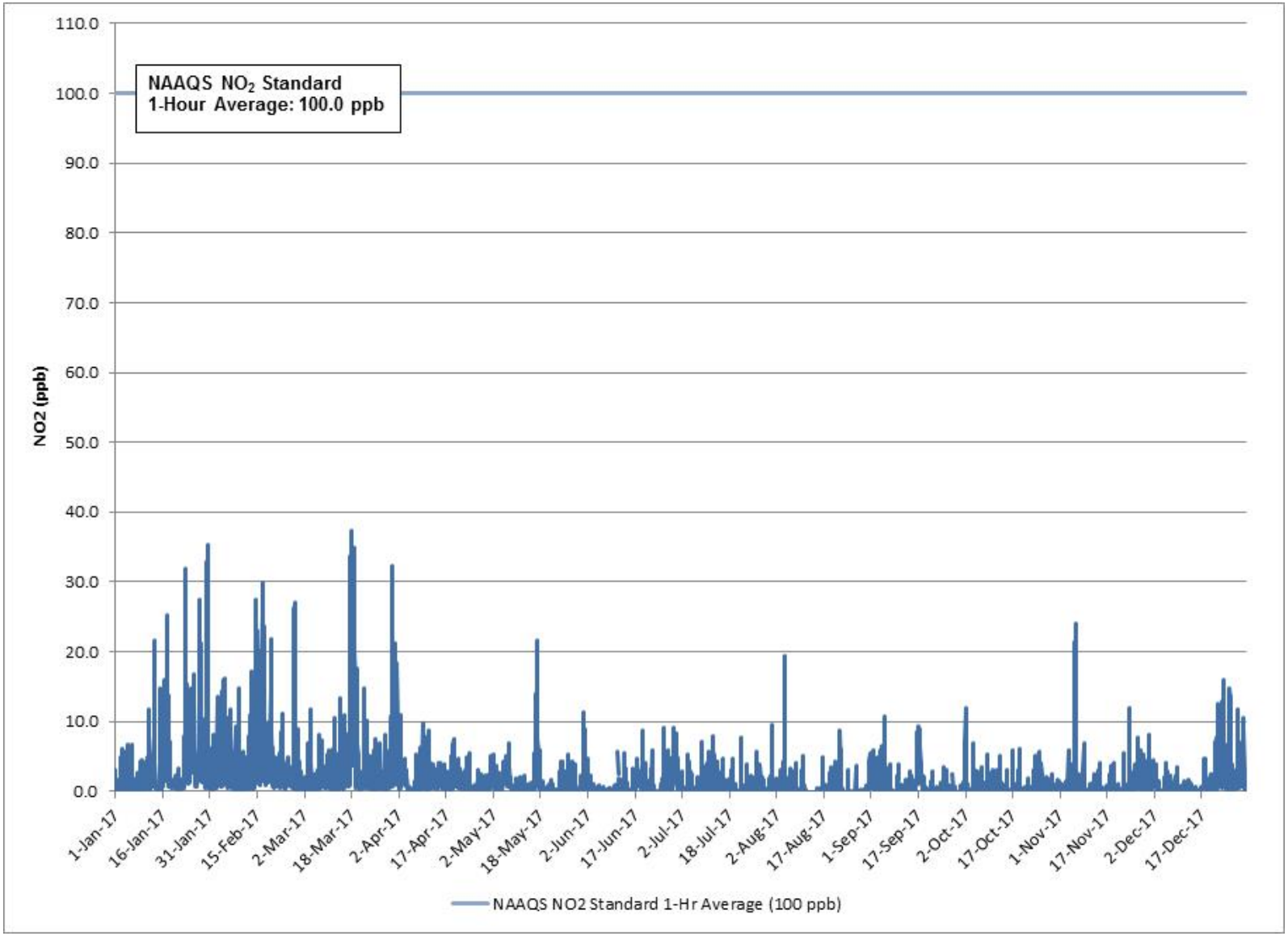


Figure 3-3: 1-Hour Average NO_2 and NAAQS Standard

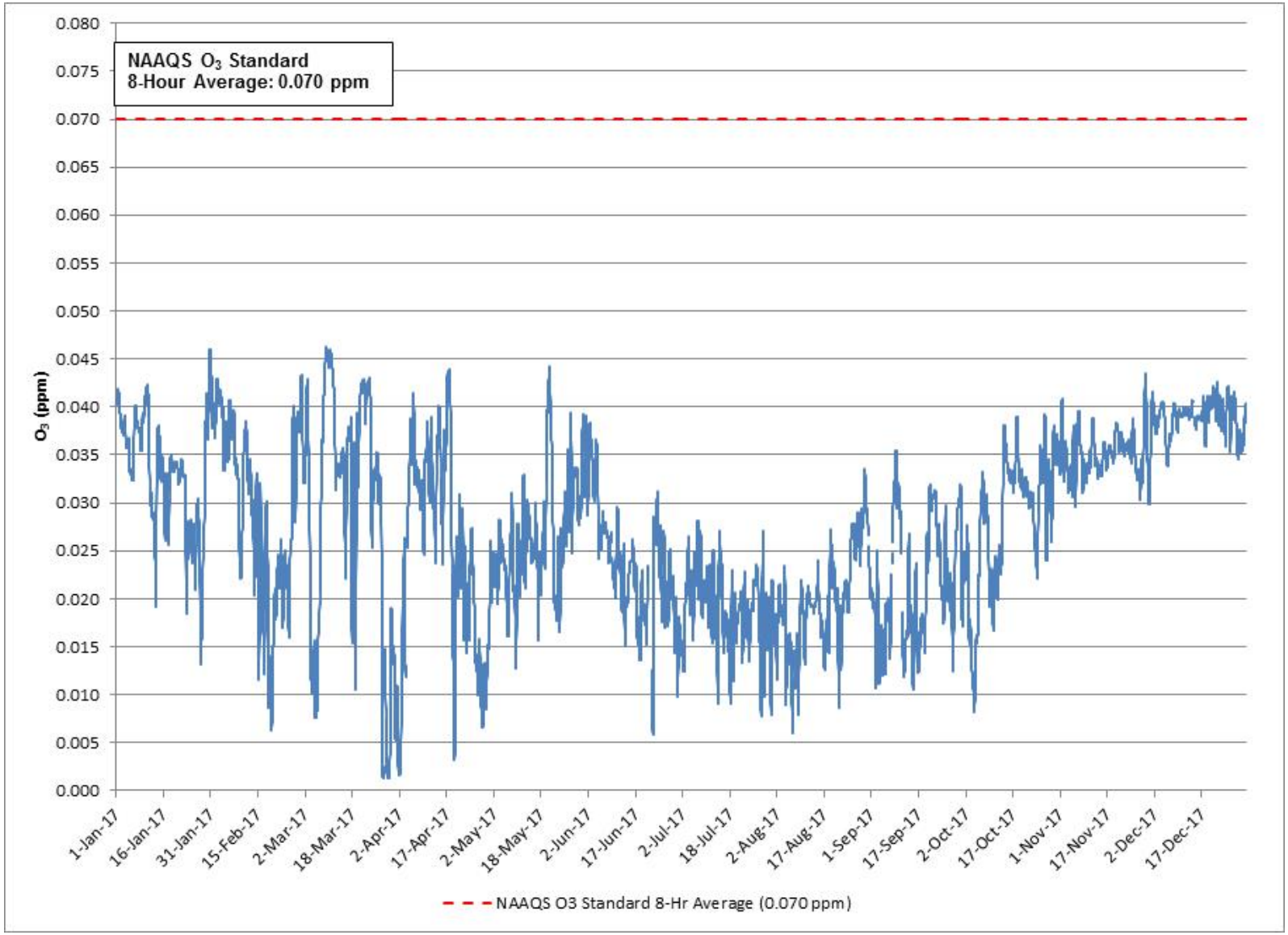


Figure 3-4: 8-Hour Average O_3 and NAAQS/AAAQS Standard

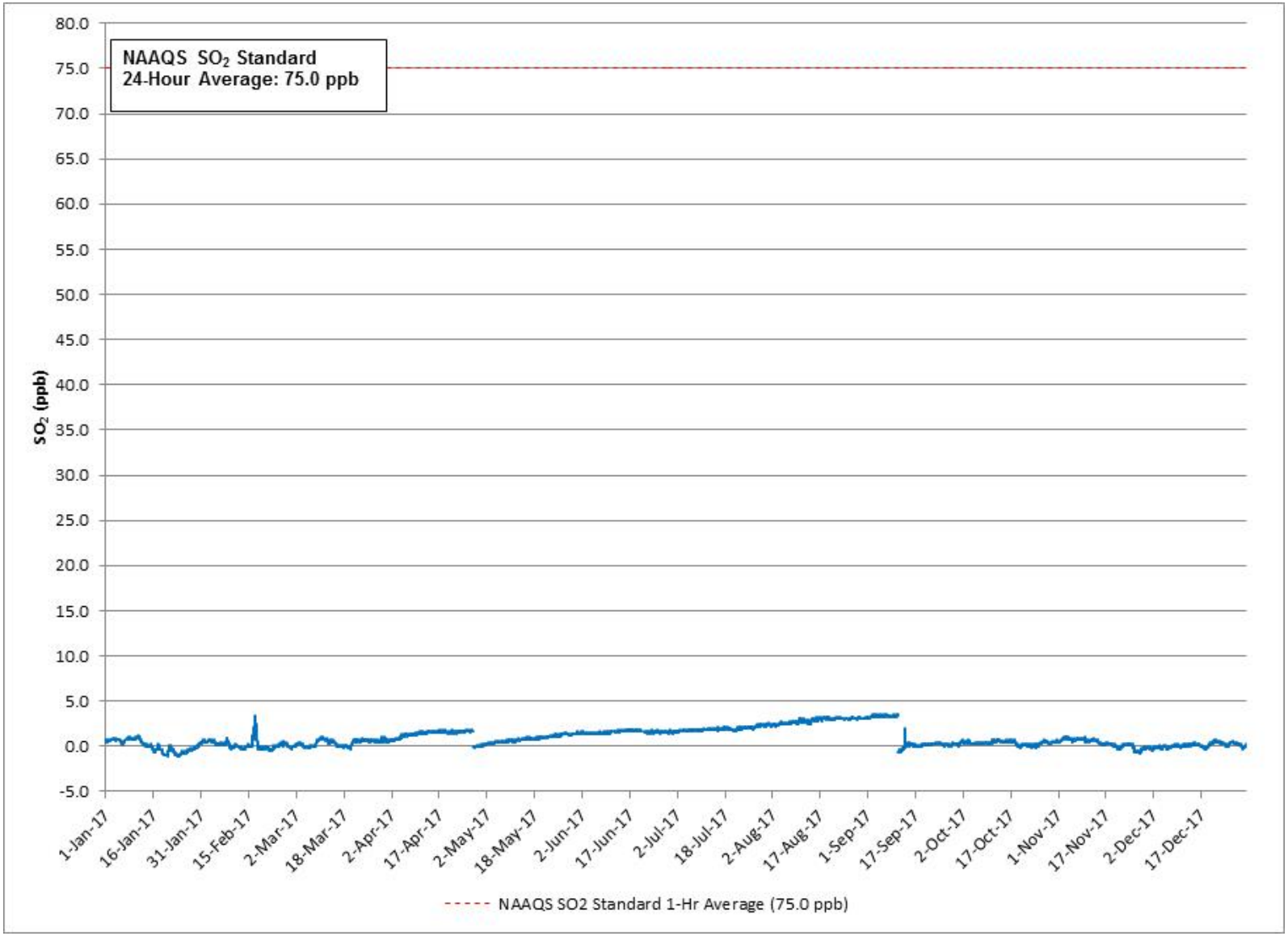


Figure 3-5: 1-Hour Average SO_2 and NAAQS/AAAQS Standard

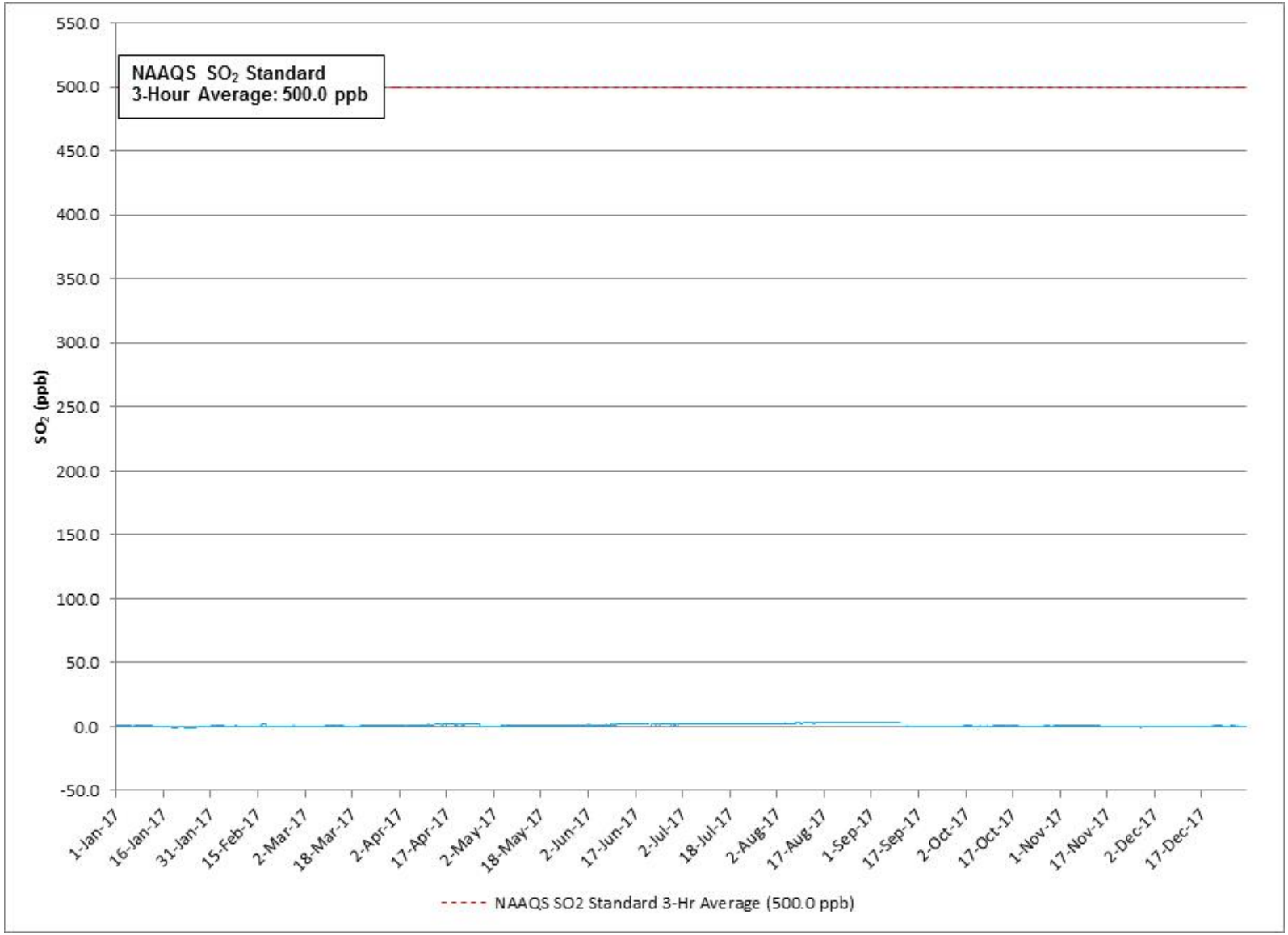


Figure 3-6: 3-Hour Average SO_2 and NAAQS/AAAQS Standard

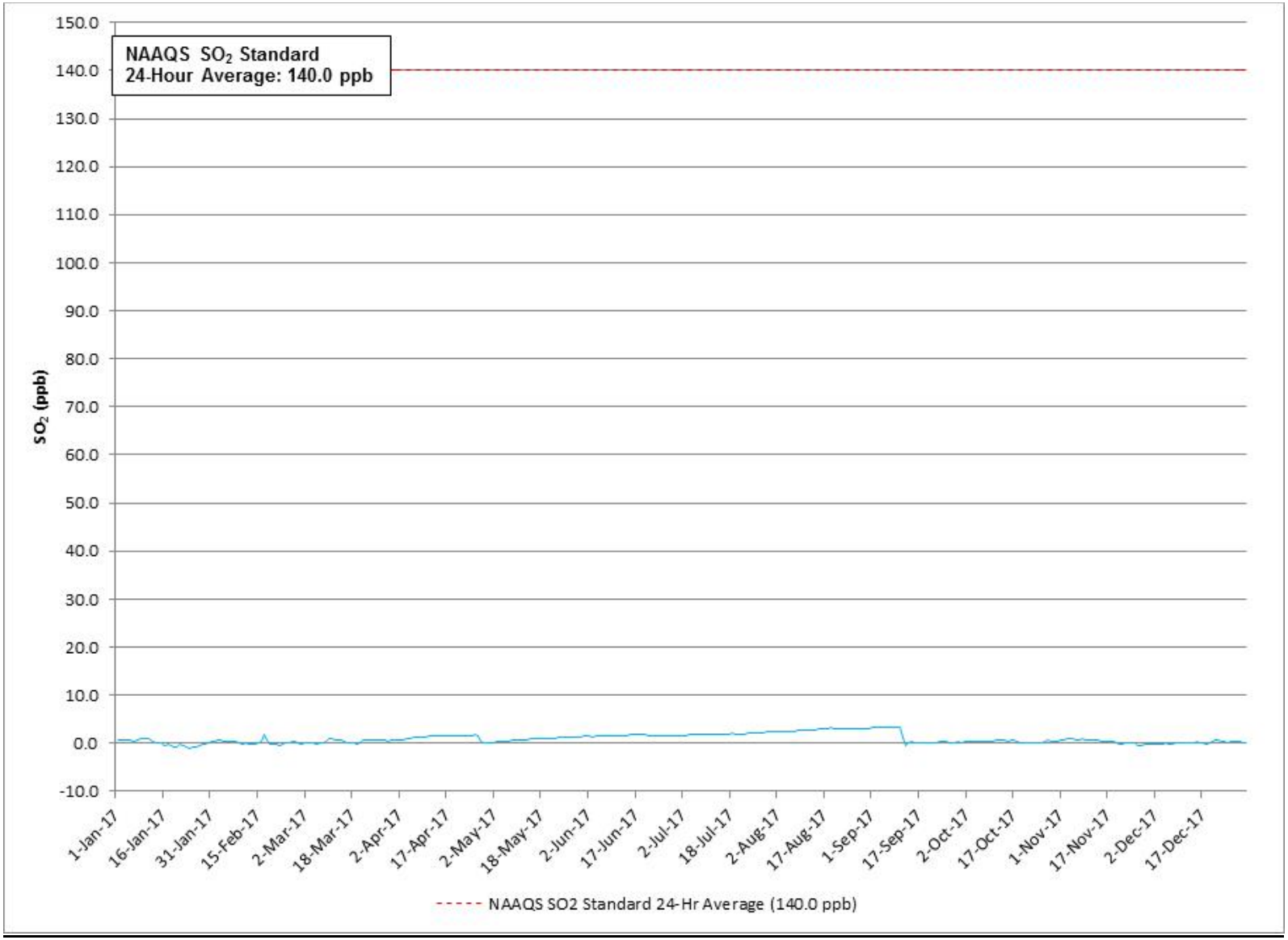


Figure 3-7: 24-Hour Average SO_2 and NAAQS/AAAQS Standard

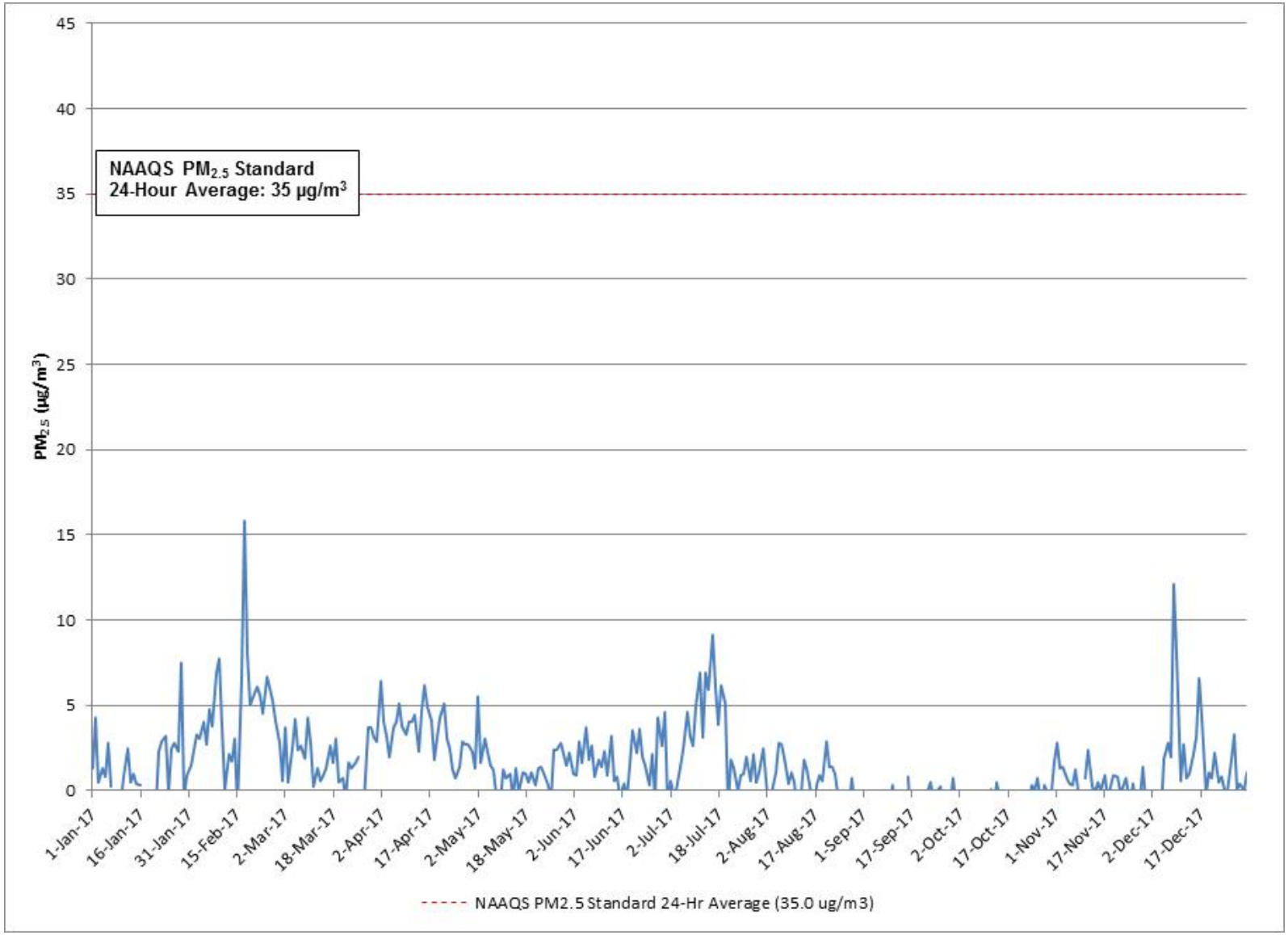


Figure 3-8: 24-Hour Average $PM_{2.5}$ and NAAQS/AAAQS Standard

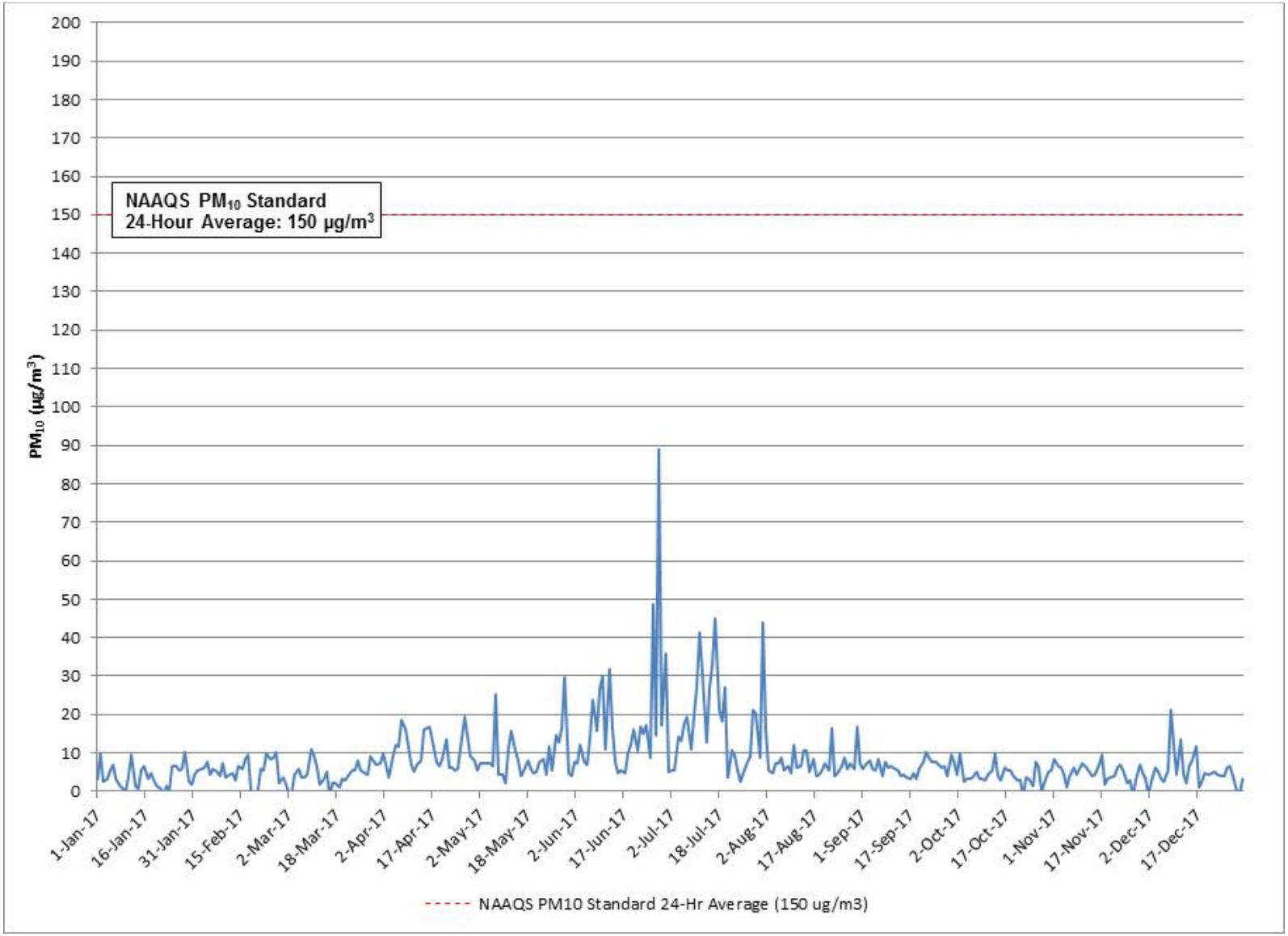


Figure 3-9: 24-Hour Average PM_{10} and NAAQS/AAAQS Standard

3.2 METEOROLOGICAL DATA SUMMARY

3.2.1 WIND SPEED (WS) AND WIND DIRECTION (WD) CLIMATOLOGY

Table 3-2 provides the mean and maximum hourly wind speeds at the nearby Nuiqsut Airport meteorological station, operated by the National Weather Service and located approximately one mile southwest of the Nuiqsut meteorological monitoring station. The summary in Table 3-2 provides summary statistics for data collected at the Nuiqsut airport. Table 3-3 provides a statistical summary of measurements obtained at the Nuiqsut station.

Figure 3-10 provides an annual wind rose for the Nuiqsut station and Figure 3-11 provides quarterly wind roses. Table 3-4 is the annual wind analysis table and Tables 3-5 to 3-8 are the quarterly wind analysis tables. Figure 3-12 provides the annual wind rose superimposed over a Nuiqsut area map, centered at the approximate location of the monitoring station.

Table 3-2: Average and Maximum Wind Speeds at the Nuiqsut Airport

Monitoring Period	Mean Hourly Average Wind Speed (m/s)	Maximum Hourly Average Wind Speed (m/s)
1st Quarter	5.41	21.09
2nd Quarter	5.53	16.98
3rd Quarter	4.57	14.92
4th Quarter	5.40	16.98
Monitoring Year	**5.40**	**21.09**

Table 3-3: Average and Maximum Wind Speeds at Nuiqsut Station

Monitoring Period	Mean Hourly Average Horizontal Wind Speed (m/s)	Maximum Hourly Average Horizontal Wind Speed (m/s)	Mean Hourly Average Vertical Wind Speed (m/s)	Maximum Hourly Average Vertical Wind Speed (m/s)
1st Quarter	5.20	22.09	0.34	1.17
2nd Quarter	5.78	15.61	0.41	1.29
3rd Quarter	4.68	13.42	0.28	0.81
4th Quarter	5.47	16.17	0.29	1.54
Monitoring Year	**5.28**	**22.09**	**0.31**	**1.54**

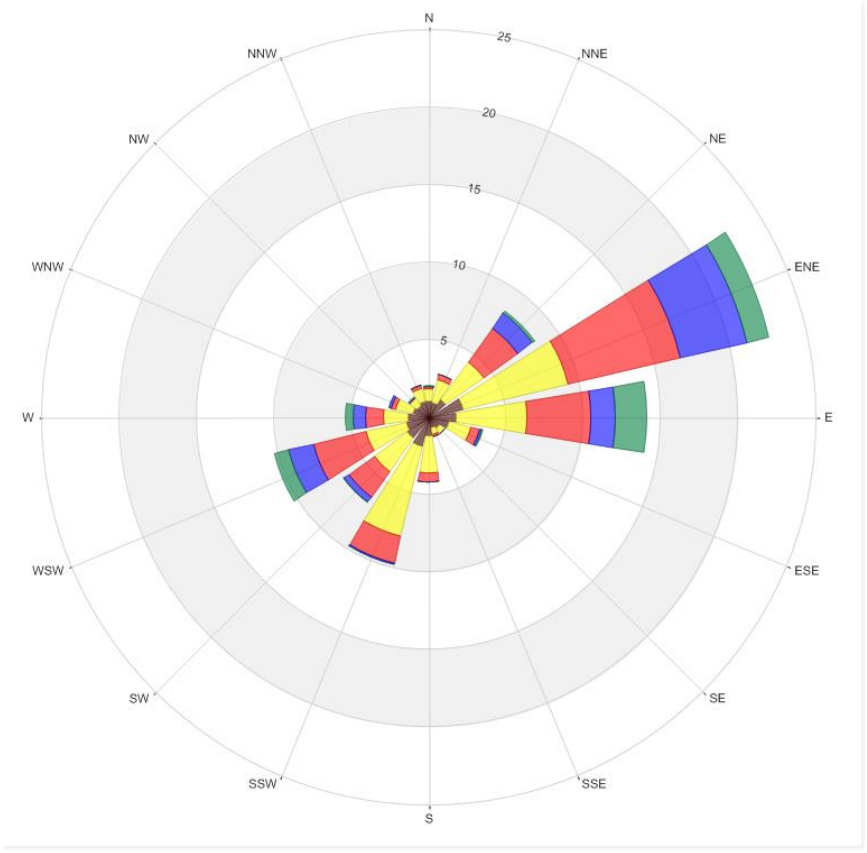
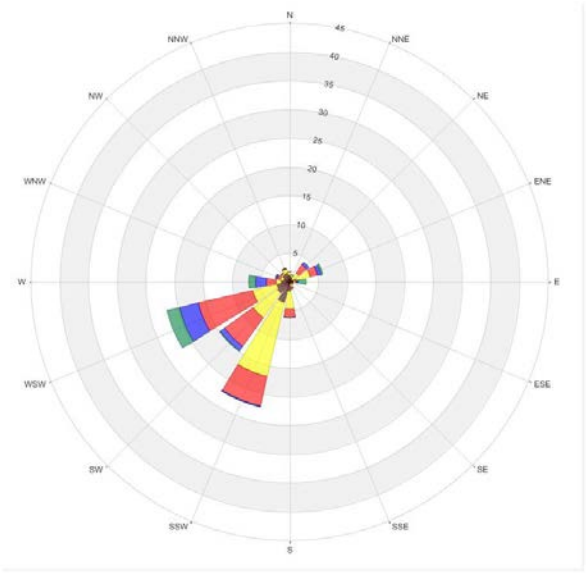
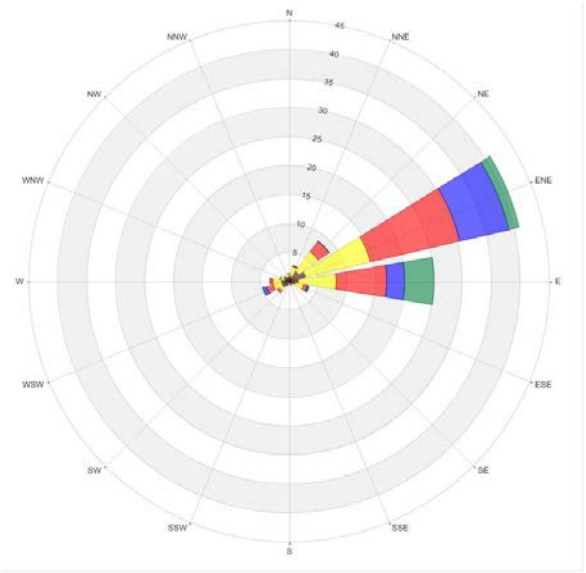


Figure 3-10: Nuiqsut Annual Wind Rose

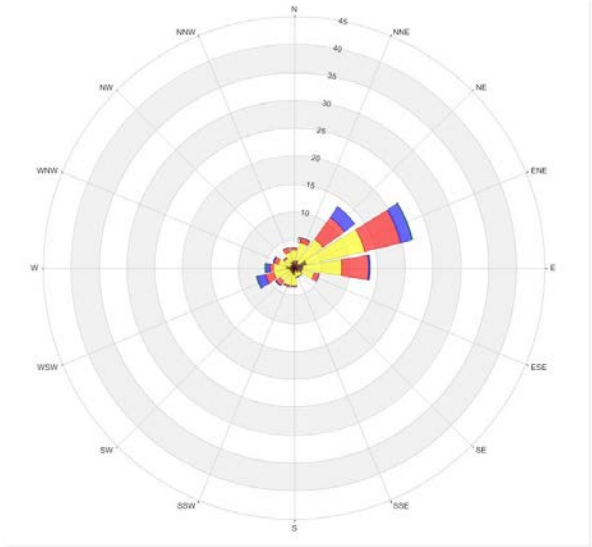
1st Quarter (1/1/17 – 3/31/17)



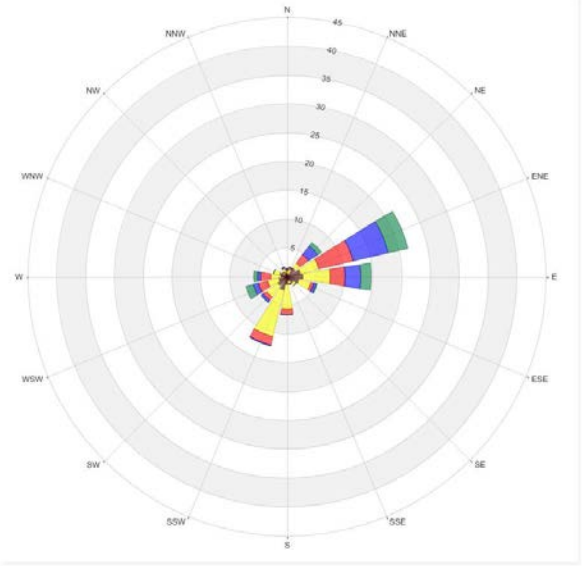
2nd Quarter (4/1/17 – 6/30/17)



3rd Quarter (7/1/17 – 9/30/17)



4th Quarter (10/1/17 – 12/31/17)



Wind Classes (m/s)

%	Icon	Classes (m/s)	25	0.5-2.8	37	2.8-5.5	20	5.5-8.3	11	8.3-11.0	6	>11.0

Figure 3-11: Nuiqsut Quarterly Wind Roses

Table 3-4: Annual Wind Rose Frequency Distribution Table

Frequency Distribution (Percent)						
Direction	**Speed (m/s)**					
	0.5-2.8	**2.8-5.5**	**5.5-8.3**	**8.3-11.0**	**>11.0**	**Total**
N	1.05	0.79	0.17	0.01	0.05	**2.07**
NNE	0.99	1.52	0.33	0.01	0	**2.85**
NE	1.39	3.00	2.68	1.19	0.20	**8.46**
ENE	2.28	6.99	7.47	4.36	1.48	**22.58**
E	1.78	4.58	4.12	1.58	2.05	**14.11**
ESE	1.38	1.44	0.58	0.18	0.06	**3.64**
SE	0.85	0.44	0.01	0	0	**1.30**
SSE	0.69	0.48	0.12	0	0	**1.29**
S	1.20	2.39	0.63	0	0	**4.22**
SSW	1.94	5.98	1.76	0.09	0	**9.77**
SW	1.68	2.64	2.04	0.40	0.02	**6.78**
WSW	1.51	2.62	3.53	1.62	0.96	**10.24**
W	1.34	1.58	1.20	0.75	0.52	**5.39**
WNW	1.02	1.19	0.30	0.10	0.02	**2.63**
NW	0.93	0.54	0.12	0	0.01	**1.60**
NNW	1.06	0.83	0.24	0.01	0	**2.14**
Summary	**21.09**	**37.01**	**25.30**	**10.30**	**5.37**	**99.07** [1]

[1] The remaining 0.93 percent of data were calms (below 0.5 m/s).

Table 3-5: First Quarter Wind Rose Frequency Distribution Table

Frequency Distribution (Percent)						
Direction	**Speed (m/s)**					
	0.5-2.8	**2.8-5.5**	**5.5-8.3**	**8.3-11.0**	**>11.0**	**Total**
N	1.25	0.51	0.05	0	0	**1.81**
NNE	0.97	0.32	0	0	0	**1.29**
NE	0.60	1.34	1.85	0.46	0	**4.25**
ENE	1.20	2.55	1.34	0.51	0.46	**6.06**
E	0.83	0.19	0.28	0.32	1.25	**2.87**
ESE	0.65	0	0	0	0	**0.65**
SE	0.46	0.19	0.05	0	0	**0.70**
SSE	0.51	0.42	0.37	0	0	**1.30**
S	1.76	3.01	1.44	0	0	**6.21**
SSW	3.75	13.24	5.23	0.23	0	**22.45**
SW	2.59	5.19	6.11	0.97	0.09	**14.95**
WSW	2.27	4.35	9.68	3.43	2.18	**21.91**
W	1.57	0.79	1.71	1.90	1.11	**7.08**
WNW	1.16	0.56	0.42	0.37	0.09	**2.60**
NW	1.48	0.37	0.05	0	0.05	**1.95**
NNW	1.71	0.65	0.05	0	0	**2.41**
Summary	**22.76**	**33.68**	**28.63**	**8.19**	**5.23**	**98.49**

[1] The remaining 1.51 percent of data were calms (below 0.5 m/s).

Table 3-6: Second Quarter Wind Rose Frequency Distribution Table

Frequency Distribution (Percent)						
Direction	**Speed (m/s)**					
	0.5-2.8	**2.8-5.5**	**5.5-8.3**	**8.3-11.0**	**>11.0**	**Total**
N	1.03	0.33	0	0	0	**1.36**
NNE	0.98	1.68	0.19	0	0	**2.85**
NE	2.10	4.21	2.25	0	0.05	**8.61**
ENE	3.04	11.46	15.90	8.61	1.92	**40.93**
E	1.68	6.50	8.79	3.09	5.14	**25.20**
ESE	1.17	1.40	0.70	0.23	0.09	**3.59**
SE	0.47	0.33	0	0	0	**0.80**
SSE	0.47	0.14	0	0	0	**0.61**
S	0.19	0.37	0	0	0	**0.56**
SSW	0.51	0.23	0.05	0	0	**0.79**
SW	1.31	0.75	0.42	0.05	0	**2.53**
WSW	1.36	1.40	1.26	0.56	0.14	**4.72**
W	1.36	1.45	0.51	0	0	**3.32**
WNW	0.84	0.80	0	0	0	**1.64**
NW	0.94	0.23	0	0	0	**1.17**
NNW	0.56	0.14	0	0	0	**0.70**
Summary	**18.01**	**31.42**	**30.07**	**12.54**	**7.34**	**99.38** [(1)]

[1] The remaining 0.62 percent of data were calms (below 0.5 m/s).

Table 3-7: Third Quarter Wind Rose Frequency Distribution Table

Frequency Distribution (Percent)						
Direction	**Speed (m/s)**					
	0.5-2.8	**2.8-5.5**	**5.5-8.3**	**8.3-11.0**	**>11.0**	**Total**
N	1.22	1.99	0.36	0	0	**3.57**
NNE	1.40	3.26	0.86	0	0	**5.52**
NE	1.00	5.39	4.80	2.31	0	**13.50**
ENE	2.40	10.64	6.66	2.13	0.14	**21.97**
E	1.72	6.93	4.85	0.23	0	**13.73**
ESE	1.54	2.22	1.00	0	0	**4.76**
SE	1.00	0.77	0	0	0	**1.77**
SSE	0.82	1.04	0	0	0	**1.86**
S	1.36	1.90	0.18	0	0	**3.44**
SSW	1.04	2.22	0.27	0	0	**3.53**
SW	0.86	2.17	0.91	0.14	0	**4.08**
WSW	0.91	2.81	1.59	1.54	0.14	**6.99**
W	1.31	2.36	0.77	0.59	0.27	**5.30**
WNW	0.68	2.31	0.77	0.05	0	**3.81**
NW	0.72	1.27	0.27	0	0	**2.26**
NNW	1.09	1.90	0.72	0	0	**3.71**
Summary	**19.07**	**49.18**	**24.01**	**6.99**	**0.55**	**100**

Table 3-8: Fourth Quarter Wind Rose Frequency Distribution Table

Frequency Distribution (Percent)						
Direction	**Speed (m/s)**					
	0.5-2.8	**2.8-5.5**	**5.5-8.3**	**8.3-11.0**	**>11.0**	**Total**
N	0.69	0.32	0.27	0.05	0.18	**1.51**
NNE	0.60	0.78	0.27	0.05	0	**1.70**
NE	1.88	1.05	1.79	1.92	0.73	**7.37**
ENE	2.47	3.30	6.09	6.28	3.44	**21.58**
E	2.89	4.67	2.61	2.70	1.88	**14.75**
ESE	2.15	2.11	0.60	0.50	0.14	**5.50**
SE	1.47	0.46	0	0	0	**1.93**
SSE	0.96	0.32	0.09	0	0	**1.37**
S	1.47	4.26	0.92	0	0	**6.65**
SSW	2.47	8.25	1.51	0.14	0	**12.37**
SW	1.97	2.43	0.73	0.46	0	**5.59**
WSW	1.51	1.92	1.65	0.96	1.37	**7.41**
W	1.10	1.69	1.79	0.50	0.69	**5.77**
WNW	1.42	1.05	0	0	0	**2.47**
NW	0.60	0.27	0.14	0	0	**1.01**
NNW	0.87	0.60	0.18	0.05	0	**1.70**
Summary	**24.52**	**33.48**	**18.64**	**13.61**	**8.43**	**98.68** [(4)]

[1] The remaining 1.32 percent of data were calms (below 0.5 m/s).

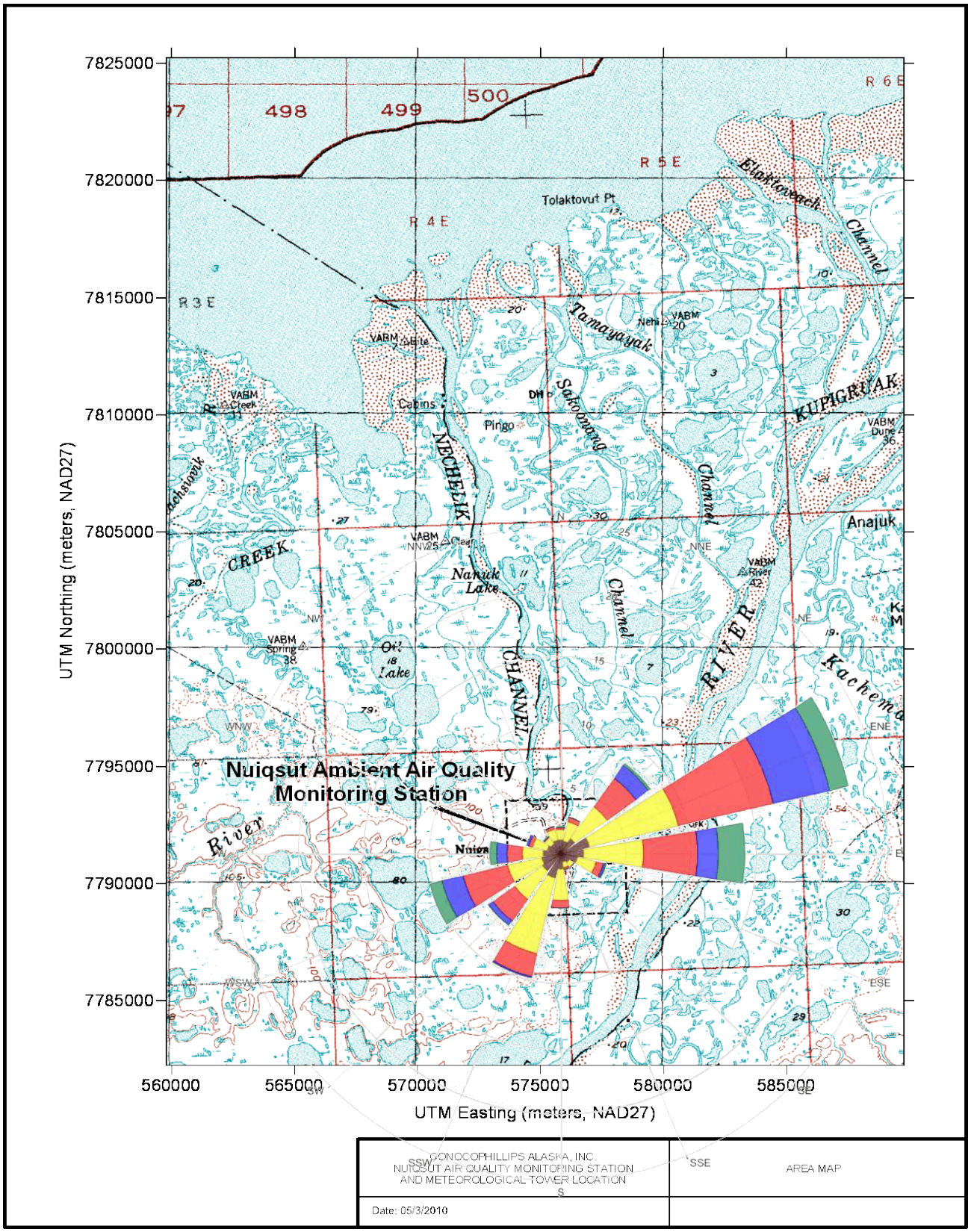


Figure 3-12: Annual Wind Rose Superimposed on Site Map

3.2.2 TEMPERATURE CLIMATOLOGY

Tables 3-9 and 3-10 provide the maximum and minimum daily mean temperatures, monthly mean temperatures, and maximum and minimum hourly average temperatures for the 2-meter and 10-meter temperature measurements, respectively. Figure 3-13 provides a graph of the 2-meter and 10-meter hourly average temperatures at the Nuiqsut station, as well as temperature data from the Nuiqsut Airport for comparative purposes only. Figure 3-14 shows a plot of vertical temperature difference (the difference between 10-meter and 2-meter temperature values) during the monitoring year.

Table 3-9: 2-Meter Temperature Summary

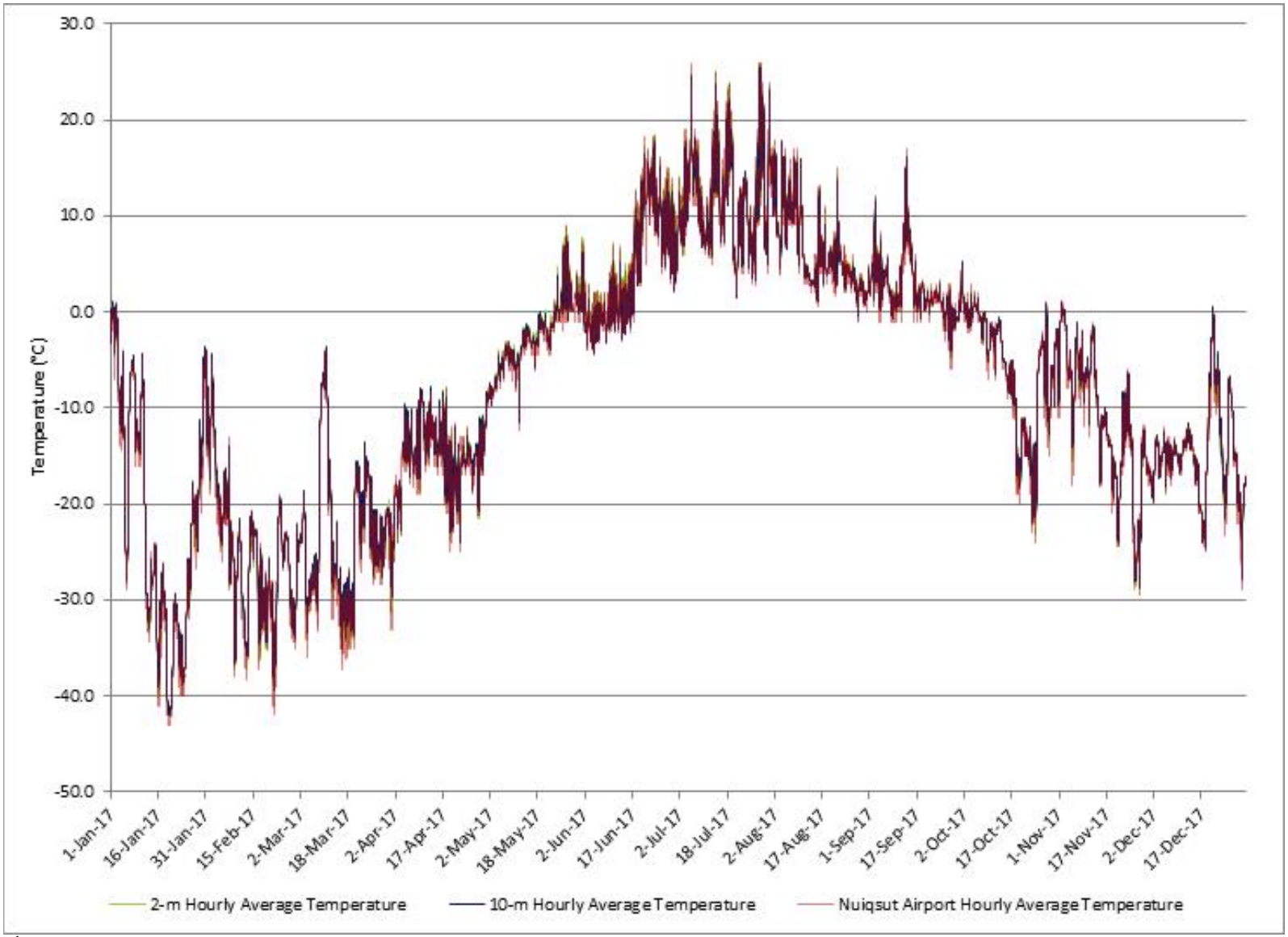
Period	Maximum Daily Mean Temperature (°C)	Minimum Daily Mean Temperature (°C)	Mean Temperature (°C)	Maximum Temperature (°C)	Minimum Temperature (°C)
January	-0.1	-41.3	-21.8	1.0	-42.1
February	-8.5	-36.5	-25.2	-4.7	-39.9
March	-6.9	-32.2	-23.5	-3.7	-35.6
1st Quarter	**-0.1**	**-41.3**	**-23.4**	**1.0**	**-42.1**
April	-10.7	-26.8	-15.2	-7.7	-31.2
May	4.6	-11.0	-2.7	8.9	-14.6
June	14.5	-1.4	4.8	18.6	-4.0
2nd Quarter	**14.5**	**-26.8**	**-4.4**	**18.6**	**-31.2**
July	18.2	6.1	11.9	26.0	1.6
August	14.8	1.7	6.8	17.8	-0.9
September	10.5	-1.7	2.5	16.1	-4.9
3rd Quarter	**18.2**	**-1.7**	**7.1**	**26.0**	**-4.9**
October	2.6	-18.9	-6.0	5.2	-23.1
November	-0.1	-26.8	-11.1	0.8	-28.9
December	-2.6	-23.4	-14.8	0.5	-28.0
4th Quarter	**2.6**	**-26.8**	**-10.6**	**5.2**	**-28.9**
Monitoring Year	**18.2**	**-41.3**	**-7.8**	**26.0** [(1)]	**-42.1** [(2)]

[1] The maximum hourly average temperature occurred on July 28, 2017.
[2] The minimum hourly average temperature occurred on January 19, 2017.

Table 3-10: 10-Meter Temperature Summary

Period	Maximum Daily Mean Temperature (°C)	Minimum Daily Mean Temperature (°C)	Mean Temperature (°C)	Maximum Temperature (°C)	Minimum Temperature (°C)
January	0.0	-41.1	-21.5	1.2	-41.9
February	-8.2	-36.0	-24.9	-4.4	-39.5
March	-6.9	-31.8	-23.2	-3.7	-35.2
1st Quarter	**0.0**	**-41.1**	**-23.1**	**1.2**	**-41.9**
April	-10.8	-25.9	-15.2	-7.8	-29.7
May	4.3	-11.3	-3.0	7.7	-14.4
June	14.3	-2.0	4.2	17.8	-4.3
2nd Quarter	**14.3**	**-25.9**	**-4.7**	**17.8**	**-29.7**
July	18.1	5.2	11.5	25.6	1.6
August	14.8	1.6	6.7	17.7	-0.5
September	10.8	-1.5	2.5	16.2	-4.1
3rd Quarter	**18.1**	**-1.5**	**6.9**	**25.6**	**-4.1**
October	2.7	-18.6	-5.9	5.3	-21.8
November	-0.1	-26.3	-11.0	1.1	-28.7
December	-2.2	-23.2	-14.6	0.6	-27.8
4th Quarter	**2.7**	**-26.3**	**-10.5**	**5.3**	**-28.7**
Monitoring Year	**18.1**	**-41.1**	**-7.8**	**25.6 (1)**	**-41.9 (2)**

[1] The maximum hourly average temperature occurred on July 28, 2017.
[2] The minimum hourly average temperature occurred on January 19, 2017.



[1] Nuiqsut airport data is presented as available through the mesowest.utah.edu website. Outlier measurements are believed to be erroneous measurements in that dataset

Figure 3-13: Hourly Average 2-Meter and 10-Meter Temperatures

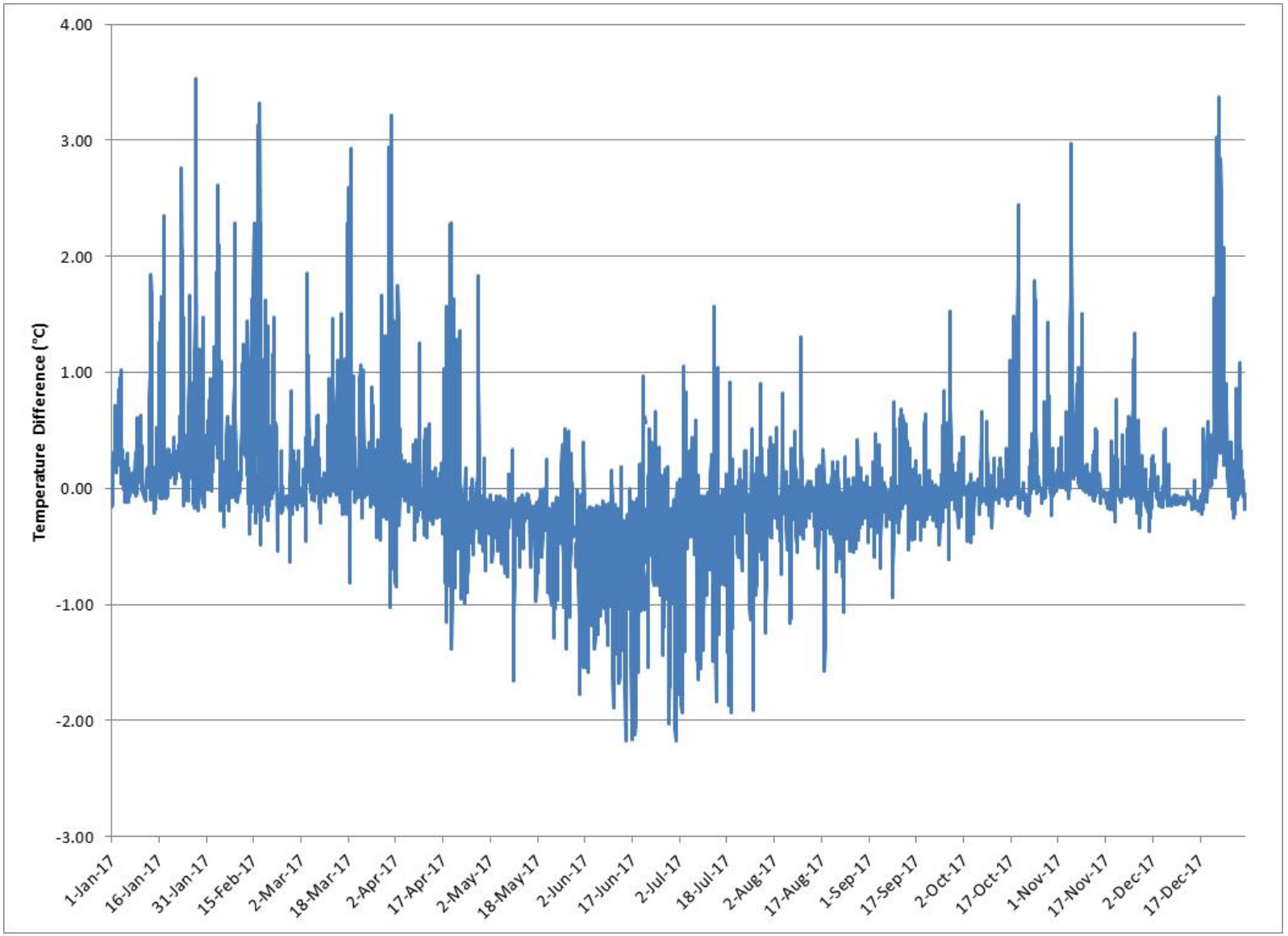


Figure 3-14: Hourly Average Vertical Temperature Difference

3.2.3 OTHER METEOROLOGICAL PARAMETERS

Table 3-11 provides a summary of solar radiation measurements obtained for the 2017 monitoring year. Figure 3-15 is a plot of annual hourly average solar radiation. The solar radiation data are available in monthly tabular format in Appendix D.

Table 3-11: Solar Radiation Summary

Period	Mean Solar Radiation (W/m^2)	Maximum Solar Radiation (W/m^2)
January	1	32
February	17	274
March	94	543
1st Quarter	**38**	**543**
April	195	718
May	199	744
June	277	826
2nd Quarter	**222**	**826**
July	216	690
August	98	558
September	52	452
3rd Quarter	**123**	**690**
October	20	315
November	2	68
December	0	1
4th Quarter	**7**	**315**
Monitoring Year	**96**	**826**

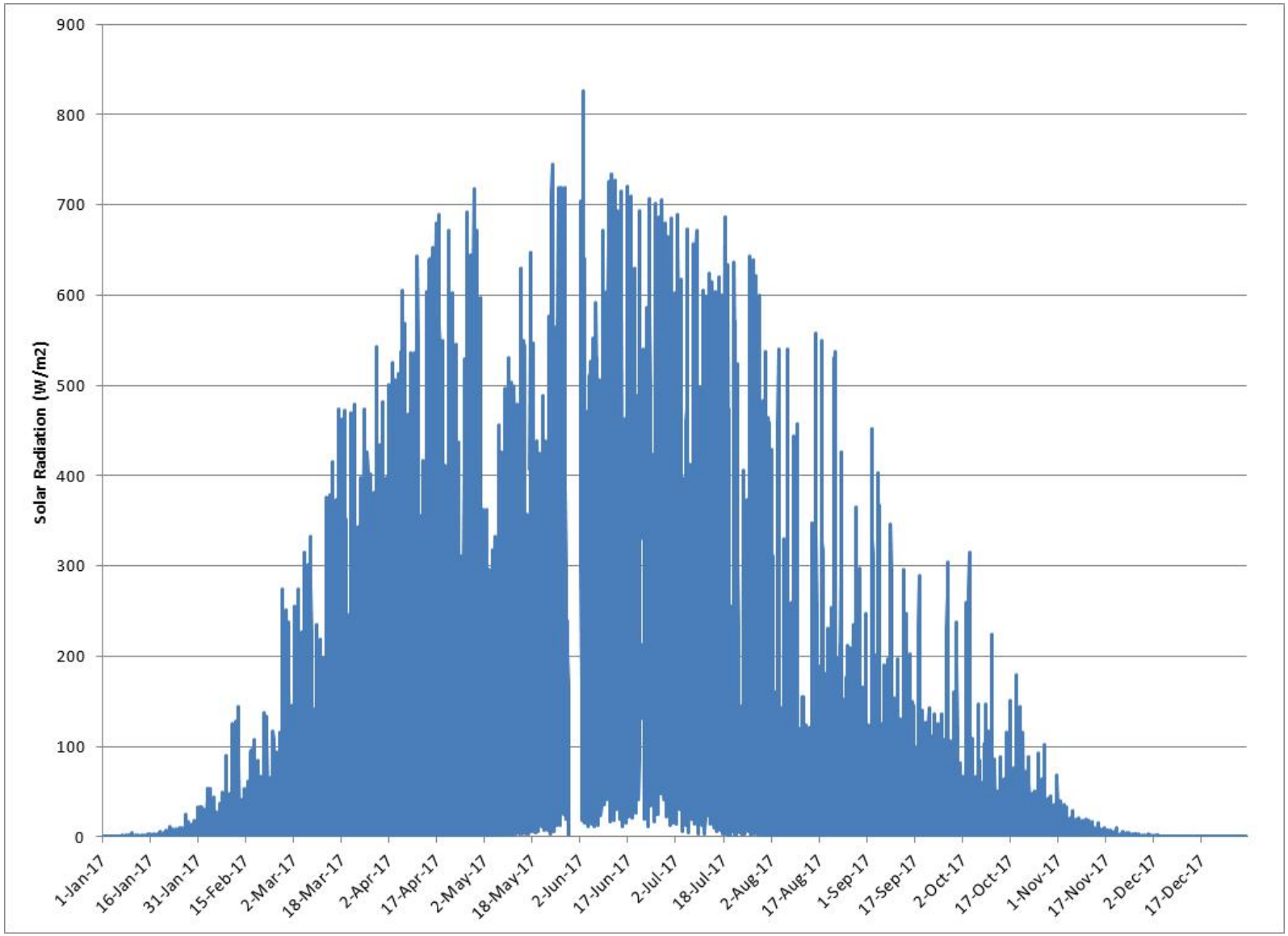


Figure 3-15: Hourly Average Solar Radiation

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