AECOM

Environment

Submitted to:
ConocoPhillips Alaska, Inc.
Anchorage, Alaska

Submitted by:
AECOM
Fort Collins, CO
60136613.450
March 2011

Nuiqsut Ambient Air Quality Monitoring Program

2008 Monitoring Year Data Summary

April 1, 2008 through December 31, 2008

Final

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Executive Summary

This report summarizes data collected at the Nuiqsut Ambient Air Quality Monitoring Station (Nuiqsut Station) during the 2008 monitoring year (April 2008 through December 2008). Only three quarters of data are presented because the station was transitioned to operating on a calendar year rather than a monitoring year during 2008, and the first quarter of 2008 was considered part of the 2007 monitoring year based on the original install date.

The Nuiqsut Station was established in April 1999 to address air quality concerns raised by citizens of Nuiqsut and the North Slope Borough, and has fulfilled the Alaska Department of Environmental Conservation (ADEC) year monitoring requirement in the ConocoPhillips Alaska, Inc. Alpine construction permit. This station is part of the Nuiqsut Ambient Air Quality Monitoring Program (Monitoring Program), which is primarily designed to characterize ambient air in Nuiqsut as regional oilfield development continues. Currently, the Monitoring Program is being conducted on a voluntary basis to document air quality in Nuiqsut. Monitoring Program data also is used to support various ambient air quality impact analyses conducted for oilfield development in the Colville Delta region.

The Nuiqsut Station is equipped to continuously measure ambient air quality (oxides of nitrogen [NO_X], sulfur dioxide [SO_2], particulate matter with an aerodynamic diameter of 10 micrometers or less [PM_{10}], and ozone [O_3]) and dispersion meteorology parameters). Air quality and meteorology data collected at the Nuiqsut Station follow strict Quality Assurance (QA) and data capture requirements of the United States Environmental Protection Agency (USEPA) Prevention of Significant Deterioration program as administered by ADEC and other specific ADEC ambient monitoring QA requirements. Protocols used to collect data at the Nuiqsut Station are fully described in the project Monitoring and Quality Assurance Project Plan (QAPP).

There were no procedures used during the monitoring year that differed from those specified in the QAPP.

As shown in **Table ES-1**, air quality and meteorological quarterly data capture exceeded QAPP goals for all parameters except those shown in bold. The TEOM PM_{10} instrument was unavailable for much of the monitoring year due to mechanical failure of the original instrument. Periods with invalidated data, their causes, and the resolution actions are detailed in Chapter 2.0.

The data record along with the prior years of data collection gives a history that characterizes typical air quality conditions experienced in Nuiqsut and the likelihood of any air quality exceedances. **Tables ES-2** through **ES-5** summarize average nitrogen dioxide [NO_2], SO_2, PM_{10}, and O_3 concentrations measured during the monitoring year. Measured concentrations of NO_2, SO_2, and O_3 were well below Alaska Ambient Air Quality Standards (AAAQS), which are the same as the national standards for the pollutants measured.

The typical hourly NO_2 concentrations were just above instrument detection, and the annual average was well below applicable AAAQS.

Measured SO_2 concentrations were at or below instrument detection the entire year. The low concentrations measured are consistent with an airshed containing relatively few and widely dispersed SO_2 sources. This trend has been typical of SO_2 measurements since monitoring began.

The annual average of hourly PM_{10} concentrations was well below the applicable AAAQS and reflective of global background levels.

O_3 concentrations measured during this monitoring year were typical of seasonal averages measured on the Alaskan North Slope (Prudhoe Bay, Kuparuk River Unit, and Barrow). In the absence of large combustion sources, frontal boundaries and high incoming solar radiation, ambient O_3 levels will be spatially homogeneous and representative of a regional background.

Table ES-1 Data Recovery Statistics, 2008 Annual Summary

Parameter	2nd Quarter 2008 (%)	3rd Quarter 2008 (%)	4th Quarter 2008 (%)	Required Capture Rates (%)
Meteorological				
10-m Horizontal Wind Speed	99.6	99.6	98.1	90
10-m Horizontal Sigma-u (σ_u)	99.6	99.6	98.1	
10-m Horizontal Wind Direction	99.6	99.6	98.1	
10-m Sigma-Theta (σ_θ)	99.6	99.6	98.1	
10-m Vertical Wind Speed	94.4	97.6	90.4	
10-m Vertical Sigma-u (σ_w)	94.4	97.6	90.4	
10-m Temperature	**70.9**	**37.5**	99.6	
2-m Temperature	**70.9**	**37.5**	99.6	
10-2-m Temperature Lapse	**70.9**	**37.5**	99.6	
Total Solar Radiation	99.5	99.6	99.6	
Air Quality				
NO_2	89.7	**58.6**	92.2	80
SO_2	97.0	94.3	**70.8**	
O_3	97.0	97.3	**75.5**	
PM_{10} (TEOM)	**0.0**	**37.5**	**66.1**	

Table ES-2 Measured NO_2, 2008 Annual Data Summary

Monitoring Period	Year	Period Mean (parts per million [ppm])	Number of Exceedances
2nd Quarter	2008	0.002	None
3rd Quarter	2008	0.001	None
4th Quarter	2008	0.001	None
Annual	2008	0.002	None

National Ambient Air Quality Standards (NAAQS)/AAAQS:
Annual – 0.053 ppm (100 micrograms per cubic meter [µg/m^3]) – Compared to the annual arithmetic mean.

Table ES-3 Measured SO_2, 2008 Annual Data Summary

Monitoring Period	Year	3-hour (ppm)		24-hour (ppm)		Period Mean (ppm)	Number of Exceedances
		1st High	2nd High	1st High	2nd High		
2nd Quarter	2008	0.001	0.001	0.001	0.001	0.001	None
3rd Quarter	2008	0.007	0.007	0.004	0.003	0.001	None
4th Quarter	2008	0.003	0.003	0.003	0.003	0.000	None
Annual	2008	0.007	0.007	0.004	0.003	0.001	None

NAAQS/AAAQS:
3-hour – 0.5 ppm (1,300 µg/m^3) – Rolling average not to be exceeded more than once per year.
24-hour – 0.14 ppm – Midnight to midnight average not to be exceeded more than once per year.
Annual – 0.03 ppm – Compared to the annual arithmetic mean.

Table ES-4 Measured PM_{10} Data, 2008 Annual Data Summary

Monitoring Period	Year	24-hour (µg/m^3)		Period Mean (µg/m^3)	Number of Exceedances
		1st High	2nd High		
2nd Quarter	2008	NA	NA	NA	NA
3rd Quarter	2008	60.2	38.3	7.7	None
4th Quarter	2008	13.0	12.5	1.0	None
Annual	2008	60.2	38.3	3.4	None

NAAQS/AAAQS:
24 hour – 150 µg/m^3 – Not to be exceeded more than once per year measured from midnight to midnight at USEPA Standard Conditions.
Annual – 50 µg/m^3 – Compared to the 3 year average of the weighted annual arithmetic mean concentration measured at USEPA Standard Conditions.

Table ES-5 Measured O_3 Data, 2008 Annual Data Summary

Monitoring Period	Year	8-hour (ppm)			Period Mean (ppm)	Number of Exceedances
		1st High	2nd High	4th High		
2nd Quarter	2008	0.033	0.033	0.032	0.017	None
3rd Quarter	2008	0.029	0.029	0.029	0.016	None
4th Quarter	2008	0.034	0.034	0.033	0.020	None
Annual	2008	0.034	0.034	0.033	0.017	None

NAAQS/AAAQS: 8 hour – 0.08 ppm – Compared to the 3-year average of the fourth-highest daily maximum rolling 8-hour average concentrations.

1.0 Introduction

1.1 Project Summary

Since April 9, 1999 (prior to Alpine Central Processing Facility startup), ConocoPhillips Alaska, Inc. (CPAI) has operated an air quality and dispersion meteorology monitoring station in Nuiqsut, Alaska (Nuiqsut Station), which is located on the Alaskan North Slope. This station is part of the Nuiqsut Ambient Air Quality Monitoring Program (Monitoring Program), which is primarily designed to characterize ambient air in Nuiqsut as regional oilfield development continues. This Monitoring Program has been administered according to United States Environmental Protection Agency (USEPA) Prevention of Significant Deterioration (PSD) protocols; therefore, data collected is considered PSD quality.

Currently, the Monitoring Program is being conducted on a voluntary basis to document air quality in Nuiqsut. Monitoring Program data also is used to support various ambient air quality impact analyses conducted for oilfield development in the Colville Delta region.

Since the beginning, the Monitoring Program has been modified to enhance Quality Assurance (QA) and Quality Control (QC) and increase program utility through the addition of monitored parameters. Major Monitoring Program modifications include:

- Collocated Federal Reference Method (FRM) particulate matter with an aerodynamic diameter of 10 micrometers or less (PM_{10}) sampling initiated to evaluate the Monitoring Program Federal Equivalent Method sampling methodology (July 14, 2000). Collocated FRM PM_{10} sampling was discontinued in the fall 2002.
- Enhanced dispersion meteorology characterization through the addition of 10-meter (m) temperature, vertical wind speed, and solar radiation monitoring (July 24, 2001).
- Expanded background air quality evaluation through the addition of ozone (O_3) monitoring (November 19, 2004).

Since inception, the specific technical objectives of the Monitoring Program are to:

- Collect data meeting QA and data capture requirements of the USEPA PSD Program and other specific Alaska Department of Environmental Conservation (ADEC) ambient monitoring QA requirements (ADEC 1996);
- Document preconstruction air quality impacts at Nuiqsut prior to operation of Alpine (fulfilled);
- Document air quality conditions after Alpine is operational;
- Meet air quality and meteorological monitoring requirements listed in Alpine Permit No. 0073-AC060 (fulfilled); and
- Document dispersion meteorology conditions in Nuiqsut to support refined modeling of potential impacts in the region.

1.2 Measurement Methods

To meet project technical objectives, the Nuiqsut Station is instrumented and equipped to continuously measure the parameters listed in **Table 1-1**. **Table 1-1** also details the methods and instruments used for measurement. A complete description of the Monitoring Program, including the QA plan, is contained in the ADEC approved Monitoring and Quality Assurance Project Plan (QAPP), which consists of:

- The original project monitoring plan (SECOR 2000), approved by ADEC in April 2000;
- The Partisol Addendum to the original monitoring plan (SECOR 2001), approved by ADEC in October 2001;
- The draft Expanded Meteorology Addendum to the original monitoring plan (SECOR 2002), final ADEC approval pending; and
- The draft Ozone Monitoring Addendum to the original monitoring plan (SECOR 2004), final ADEC approval pending.

1.3 Variations from Quality Assurance Project Plan

There were no procedures used during the monitoring year that differed from those specified in the QAPP.

Table 1-1 Measurement Methods, 2008 Annual Data Summary

Parameter	Manufacturer/Model	Sample Frequency	Averaging Period	Measurement Range	Lower Detection Limit	Method
Nitrogen Oxides (NO_X, nitrogen dioxide (NO_2), nitric oxide [NO])	Thermo Environmental Instruments (TECO) Model 42C	Continuous	1-hour	1-500 parts per billion (ppb)	0.5 ppb	Chemiluminescence (USEPA reference method RFNA-1289-074)
Sulfur Dioxide (SO_2)	Thermo Environmental Instruments (TECO) Model 43C	Continuous	1-hour	2-500 ppb	2 ppb	Pulsed Fluorescence (USEPA equivalent method EQSA-0486-060)
PM_{10}	Rupprecht & Patashnick (R&P) Model 1400ab TEOM PM_{10}	Continuous	1-hour	<5 micrograms per cubic meter (µg/m^3) to several g/m^3	<5 µg/m^3	Tapered Element Oscillating Microbalance (USEPA equivalent method EQPM-1090-079)
O_3	Thermo Environmental Model 49	Continuous	1-hour	0-1,000 ppb	2 ppb	Pulsed UV Photometric (USEPA equivalent method EQOA-0880-047)
Horizontal Wind Speed (u) (10-m)	R.M. Young Wind Monitor AQ – 05305	Continuous	1-hour	0 to 50 meters per second (m/s)	0.4 m/s	Propeller/Magnetically Induced AC
Wind Speed Standard Deviation (σ_u) (10-m)	Campbell Scientific 23X	Continuous	1-hour	N.A.	N.A.	Computed by data logger
Wind direction (θ) (scalar) (10-m)	R.M. Young Wind Monitor AQ – 05305	Continuous	1-hour	0 to 360º	0.5 m/s at 10º displacement	Lightweight vane and precision potentiometer
Sigma-Theta (σ_θ) (10-m)	Campbell Scientific Model 23X	Continuous	1-hour	0 to 103.9 degrees	N.A.	Single Pass Estimator of Wind Direction Standard Deviation (Yamartino 1984)
Temperature (2-m)	YSI 44020	Continuous	1-hour	-50 degrees Celsius (°C) to 50°C	N.A.	Motor aspirated/shielded thermistor (triple-element)
Temperature (10-m)	YSI 44020	Continuous	1-hour	-50°C to 50°C	N.A.	Motor aspirated/shielded thermistor (triple-element)
10-m – 2-m Temperature Lapse (ΔT)	Campbell Scientific Model 23X	Continuous	1-hour	-100°C to 100°C	N.A.	Numerical Subtraction
Vertical Wind Speed (w) (10-m)	RM Young Propeller Anemometer Model 27106T	Continuous	1-hour	-35 m/s to 35 m/s	$\pm$0.25 m/s	Four blade helicoid propeller/AC
Sigma-w (σ_w) (10-m)	Campbell Scientific Model 23X	Continuous	1-hour	0 to 35 m/s	N.A.	Standard Deviation

N.A. = Not Applicable.

2.0 Station Performance Summary

2.1 Significant Project Events

Table 2-1 summarizes significant project events occurring during the year and detailed discussions of project events affecting data capture are presented in Section 2.2.

Table 2-1 Significant Project Events, 2008 Annual Data Summary

Date	Event/Comment
April 1 through August 27	PM_{10} data were invalidated due to the instrument being inoperable from April 1 through August 27, 2008. Beginning in the previous quarter, the instrument auxiliary flow decreased and shortly thereafter, the instrument primary flow began decreasing. The low flow problems were initially diagnosed as the result of a failing sample pump. Installation of a new sample pump failed to resolve the low flow issue and it became clear that the sample flow issues were likely the result of a failing sample flow controller, which could not be repaired in the field. The instrument was shipped back to Fort Collins for repairs in the laboratory. A replacement instrument shipped to Nuiqsut in June was damaged beyond repair in transit and thus could not be installed. The original instrument was repaired in Fort Collins and returned to Nuiqsut. The site tech installed the instrument in early August but was incapable of completely configuring and calibrating it. The repaired instrument was configured, fully calibrated, and brought back online on August 27, 2008, following the third quarter calibration visit.
June 3 through June 4	The second quarter calibration of the air quality measurement systems was conducted by AECOM. The calibration and routine site maintenance visit confirmed all air quality measurement systems were operating within acceptable limits, except for the SO_2 analyzer. Throughout the quarter, the SO_2 analyzer experienced a slow upward trend in the zero air measurement, which resulted in a zero check of 10 ppb on the day of the calibration. Data was corrected and validated, following prescribed USEPA methods, to address this issue. The second quarter independent performance audit of the air quality and meteorological measurement systems was conducted by AMSTech. The audit confirmed all air quality and meteorological measurement systems were operating within acceptable limits.
June 4 through August 27	The third quarter calibration of the meteorological measurement system determined that the 2- and 10-m temperature probes were not operating within acceptable limits. In accordance with the Monitoring Program, data dating back to the previous valid audit was invalidated. The temperature probes were replaced immediately and calibrations performed after installation showed that the probes were operating within acceptable limits.
June 24 through August 5	All oxides of nitrogen (NO_X), NO_2, and NO data were invalidated due to the instrument being non-operational. This was caused by a faulty sample intake pump, which was replaced on August 5, 2008. The SO_2 analyzer's intake pump was also serviced at this time.
August 26	The third quarter calibration of the air quality measurement systems was conducted by AECOM. The calibration and routine site maintenance visit confirmed all air quality and meteorological measurement systems were operating within acceptable limits except for 2-m and 10-m temperature probes. The third quarter independent performance audit of the air quality and solar radiation measurement systems was conducted by AMSTech. The audit confirmed all air quality and solar radiation measurement systems were operating within acceptable limits.
August 27 through December 31	A review of the Fourth Quarter 2008 monitoring program data revealed that the clock on the TEOM was inadvertently set 1 hour ahead of local standard time. This did not cause any of the data to be lost and/or invalidated, and the clock was re-adjusted during the first quarterly calibration in 2009.
October 7 through October 23	O_3 data was invalidated due to a failure of the sample intake pump causing the analyzer to go offline. The analyzer was replaced on October 23, 2008.

Table 2-1 Significant Project Events, 2008 Annual Data Summary

Date	Event/Comment
October 23 through October 27	During the O_3 analyzer replacement activities, tubing connecting the zero-air supply to all of the air quality analyzers was inadvertently disconnected. This may have allowed the analyzers to sample station air during this time. In response all NO_x, NO, NO_2, SO_2, and O_3 data was invalidated during the times the zero-air supply tubing was open to indoor station air.
December 2	The fourth quarter calibration of the air quality measurement systems was conducted by AECOM. As-found calibration checks determined that all calibrated air quality measurement systems, except for the NO_X analyzer, were operating within accepted limits. The as-found calibration checks also determined that the TEOM did not pass the leak test. However, the TEOM did pass all flow tests and it was determined that the leak was not significantly impacting instrument performance. In the case of the NO_X analyzer, the weeks leading up to the calibration saw an increase in span drift that led to the eventual as-found calibration failure. Data was corrected, according to prescribed USEPA methods, to account for the span drift and did not require invalidation. An as-left calibration check indicated that the NO_X analyzer was operating within acceptable limits. The fourth quarter independent performance audit of the air quality and meteorological measurement systems was conducted by AMSTech. The audit confirmed all air quality and meteorological measurement systems were operating within acceptable limits except for solar radiation, which could not be audited due to insufficient solar radiation.
December 2 through December 31	During the fourth quarter calibration, a leak-check device was left installed on the TEOM. This resulted in the invalidation of all PM_{10} data beginning with the first hour that the TEOM was brought back online after the fourth quarter calibration (December 2, 2008 at 2400) through December 31, 2008.
December 3 through December 23	SO_2 data was invalidated due to the SO_2 analyzer being offline. While performing routine maintenance on the SO_2 analyzer on December 3, 2008, the flash-lamp controller board failed. Repairs were unsuccessful at that time. The analyzer was replaced on December 23, 2008.

2.2 Missing, Invalid and Adjusted Data

All hourly NO_X, SO_2, and O_3 data is routinely adjusted for instrument drift according to the procedure outlined in the USEPA Quality Assurance Handbook for Air Pollution Measurement Systems Vol. II: Part 1 (USEPA 1998) as presented in **Appendix A**, Section A.3. After instrument drift corrections are applied, all hourly NO_X, SO_2, and O_3 data less than 0.000 parts per million (ppm) have been investigated and then set to 0.000 ppm to conservatively remove any remaining negative bias.

2.3 Network Data Completeness

Table 2-2 provides a summary of quarterly data capture for each parameter during the monitoring year. Data capture rates for each continuous air quality and meteorological parameter have been calculated according to the procedure discussed in Appendix A, Section A.1.

Network data capture that failed to achieve QAPP goals are indicated in **Table 2-2** with bold characters. All data losses were thoroughly detailed in **Table 2-1**. In summary the following events resulted in data capture rates below QAPP goals:

- 10-m, 2-m and 10-2 m temperature difference losses were the result of the temperature probes not operating within acceptable limits;
- NO_2 data losses were the result of the instrument being offline due to a faulty sample intake pump;
- SO_2 data losses were the result of the instrument being offline, because the flash-lamp control board failed;

- O_3 data loses were the result of the instrument being off-line due to a failure of the sample intake pump; and
- PM_{10} data losses were the result of a failing sample pump/sample flow controller and the result of a leak-check device remaining in place after the fourth quarter calibration.

Table 2-2 Data Recovery Statistics, 2008 Annual Data Summary

Parameter	2nd Quarter 2008 (%)	3rd Quarter 2008 (%)	4th Quarter 2008 (%)	Required Capture Rates (%)
Meteorological				
10-m Horizontal Wind Speed	99.6	99.6	98.1	90
10-m Horizontal Sigma-u (σu)	99.6	99.6	98.1	
10-m Horizontal Wind Direction	99.6	99.6	98.1	
10-m Sigma-Theta (σθ)	99.6	99.6	98.1	
10-m Vertical Wind Speed	94.4	97.6	90.4	
10-m Vertical Sigma-w (σw)	94.4	97.6	90.4	
10-m Temperature	**70.9**	**37.5**	99.6	
2-m Temperature	**70.9**	**37.5**	99.6	
10-2m Temperature Lapse	**70.9**	**37.5**	99.6	
Total Solar Radiation	99.5	99.6	99.6	
Air Quality				
NO_2	89.7	**58.6**	92.2	80
SO_2	97.0	94.3	**70.8**	
O_3	97.0	97.3	**75.5**	
PM_{10} (TEOM)	**0.0**	**37.5**	**66.1**	

2.4 Precision Statistics

2.4.1 Monitoring Network Precision Statistics

Quarterly NO_2, NO, SO_2, and O_3 precision check statistics shown in **Tables 2-3** through **2-5** indicate all air quality systems were reporting measurements to within QAPP established tolerances. Precision statistics have been calculated for NO_2, NO, SO_2, and O_3 instruments based on USEPA methods, which are summarized in Appendix A, Section A.2. Individual results from each precision check conducted are listed in Appendix B, **Tables B-1** through **B-3**.

Table 2-3 Second Quarter 2008 Precision Statistics Summary

Parameter	Number of Precision Checks (N)	Average Percent Difference ($\bar{d}_j$)	Standard Deviation (S_j)	Upper 95% Probability Limit (U_{95})	Lower 95% Probability Limit (L_{95})
NO	28	0.5	1.1	2.6	-1.5
NO_2	20	1.6	5.9	13.1	-10.0
SO_2	30	2.2	1.4	4.9	-0.5
O_3	29	-0.1	1.2	2.2	-2.4
Precision Goal	N/A	±15	N/A	15	-15

Remarks: Six valid precision checks are required per quarter by the QAPP, 30 were performed and the valid number is indicated in the table

Table 2-4 Third Quarter 2008 Precision Statistics Summary

Parameter	Number of Precision Checks (N)	Average Percent Difference ($đ_j$)	Standard Deviation (S_j)	Upper 95% Probability Limit (U_{95})	Lower 95% Probability Limit (L_{95})
NO	18	0.8	1.2	3.1	-1.5
NO_2	14	0.0	1.6	3.1	-3.1
SO_2	30	2.2	1.8	5.8	-1.4
O_3	29	0.6	1.4	3.4	-2.1
Precision Goal	N/A	±15	N/A	15	-15

Remarks: Six valid precision checks are required per quarter by the QAPP, 30 were performed and the valid number is indicated in the table

Table 2-5 Fourth Quarter 2008 Precision Statistics Summary

Parameter	Number of Precision Checks (N)	Average Percent Difference ($đ_j$)	Standard Deviation (S_j)	Upper 95% Probability Limit (U_{95})	Lower 95% Probability Limit (L_{95})
NO	30	1.8	2.5	6.7	-3.2
NO_2	24	0.9	3.1	7.0	-5.2
SO_2	24	2.0	2.0	5.8	-1.9
O_3	24	0.0	1.2	2.3	-2.3
Precision Goal	N/A	±15	N/A	15	-15

Remarks: Six valid precision checks are required per quarter by the QAPP, 30 were performed and the valid number is indicated in the table

2.5 Accuracy Statistics

Meteorological and ambient air quality measurement systems are subjected to periodic calibrations/QC checks and independent QA performance audits to document measurement system accuracy. All calibration/QC check and audit equipment is traceable to NIST or other traceable standards. The purpose of calibration/QC and audit checks is to challenge measurement systems with known inputs, verifying the response of each system is accurate to within USEPA established tolerances listed in the QAPP. A complete copy of all calibration/QC check data, independent QA performance audits, and technical systems audits is included in **Appendix C** and are summarized below.

2.5.1 Instrument Calibration Statistics

A description of quarterly calibration/QC checks is presented below by quarter. These quarterly calibration/QC check descriptions are summarized in **Tables 2-6** through **2-8** for each measurement parameter during the monitoring year. Summarized results characterize an as-left instrument state. If as-found results were significantly different or failed QA criteria, they are discussed below and as part of the summary table.

2.5.1.1 Second Quarter 2008

The second quarter calibration of the air quality measurement system was conducted by AECOM June 3 through 4, 2008. The TEOM was not operational at the time of the calibration. The SO_2 instrument was adjusted based on as-found calibration. Results of this QA activity are summarized in **Table 2-6**, which shows all air quality systems were left reporting measurements to within acceptable limits.

2.5.1.2 Third Quarter 2008

The third quarter calibration of the air quality measurement systems was conducted by AECOM on August 26, 2008. Results of this QA activity are summarized in **Table 2-7**, which shows all air quality and meteorological systems were reporting measurements to within acceptable limits.

2.5.1.3 Fourth Quarter 2008

The fourth quarter air quality measurement system calibration was conducted by AECOM on December 2, 2008. Results of this QA activity are summarized in **Table 2-8**, which shows all air quality systems were reporting measurements to within acceptable limits.

2.5.2 Deviations from the QAPP

There were no deviations from the QAPP.

2.5.3 Independent Quality Assurance Audits

A written description of quarterly independent QA performance audits and the technical systems audit is presented below. Quarterly performance audit results also are summarized in **Tables 2-9** through **Table 2-11** for each measurement parameter.

2.5.3.1 Second Quarter 2008

The second quarter 2008 air quality and meteorological measurement system performance audit was conducted by Air Monitoring Services and Technology (AMSTech) June 4 through 5, 2008. Audit results showed all systems were reporting measurements to within required accuracy limits, except for the TEOM, which was not operational at the time of the audit.

2.5.3.2 Third Quarter 2008

The third quarter 2008 performance audit of the air quality measurement systems was conducted by AMSTech August 26 through 27, 2008. Audit results showed all systems were reporting measurements to within required accuracy limits, except for the TEOM's poor leak test results for the unit's main and auxiliary flow lines.

2.5.3.3 Fourth Quarter 2008

The fourth quarter 2008 performance audit of the air quality and meteorological measurement systems was conducted by AMSTech December 2, 2008. The solar radiation measurement system was audited in the third quarter when sufficient solar radiation was available. Audit results showed all systems were reporting measurements to within required accuracy limits.

2.5.3.4 Technical Systems Audit

The annual Technical Systems Audit (TSA) of data handling, validation, processing, reporting procedures, and monitoring station siting and operation was conducted during September 2008 at the Nuiqsut Station and at the AECOM Air Resources Laboratory in Fort Collins, Colorado. TSA results showed the monitoring station has been installed and is operating in accordance with the QAPP and USEPA recommended guidelines. The audit also showed AECOM has the necessary organization, practical field experience, work facilities, and data processing procedures in place to accurately collect and report project ambient air quality and meteorological data.

Table 2-6 Second Quarter 2008 Calibration Results

Parameter	QC Check Category	QC Check Criteria	Measured Response	Results (Pass/Fail)	Comments
Air Quality Calibration June 3 through 4, 2008					
SO_2	Slope	≥ 0.85 and ≤ 1.15	1.06	Pass	The calibration confirmed all operational air quality systems were reporting measurements to within acceptable limits. * The PM_{10} instrument was not operational and could not be calibrated.
	Intercept	≤ ±3% full scale	0.012 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO_X	Slope	≥ 0.85 and ≤ 1.15	1.00	Pass	
	Intercept	≤ ±3% full scale	0.004 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO	Slope	≥ 0.85 and ≤ 1.15	1.00	Pass	
	Intercept	≤ ±3% full scale	0.004 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO_2	Converter Eff.	≥ 96%	107.7%	Pass	
O_3	Slope	≥ 0.85 and ≤ 1.15	1.00	Pass	
	Intercept	≤ ±3% full scale	-0.004 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
PM_{10}	Sample Flow	≤ ±10%	*	*	
	Total Flow	≤ ±10%	*	*	
	Mass Determination	≤ ±2.5%	*	*	
Meteorological Calibration					
Conducting a calibration of meteorological measurement systems is required semiannually and was conducted during the third calendar quarter 2008.					

Table 2-7 Third Quarter 2008 Calibration Results

Parameter	QC Check Category	QC Check Criteria	Measured Response	Results (Pass/Fail)	Comments
Air Quality Calibration August 25 through 27, 2008					
SO_2	Slope	≥ 0.85 and ≤ 1.15	1.00	Pass	The calibration confirmed all air quality systems were reporting measurements to within acceptable limits.
	Intercept	≤ ±3% full scale	0.002 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO_X	Slope	≥ 0.85 and ≤ 1.15	1.00	Pass	
	Intercept	≤ ±3% full scale	0.001 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO	Slope	≥ 0.85 and ≤ 1.15	1.00	Pass	
	Intercept	≤ ±3% full scale	0.001 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO_2	Converter Eff.	≥ 96%	99.7%	Pass	
O_3	Slope	≥ 0.85 and ≤ 1.15	1.00	Pass	
	Intercept	≤ ±3% full scale	0.00 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
PM_{10}	Sample Flow	≤ ±10%	3.2%	Pass	
	Total Flow	≤ ±10%	2.2%	Pass	
	Mass Determination	≤ ±2.5%	0.22%	Pass	
Meteorological Calibration August 25 through 27, 2008					
10-m Horizontal Wind Speed	Accuracy	≤ ±5%	0.0%	Pass	The calibration confirmed all meteorological systems were reporting measurements to within acceptable limits.
	Starting Torque	≤ 1 g-cm	0.1 g-cm	Pass	
10-m Horizontal Wind Direction	Accuracy	≤ ±5 deg.	-0.9 deg.	Pass	
	Linearity	≤ ±3 deg.	0.0 deg.	Pass	
	Starting Torque	≤ 11.0 g-cm	8.0 g-cm	Pass	
10-m Vertical Wind Speed	Accuracy	≤ ±2.5 m/s	0.0 m/s	Pass	
	Starting Torque	≤ 1 g-cm	0.3 g-cm	Pass	
10-m Temperature	Accuracy	≤ ±0.5 °C	0.0 °C	Pass	
2-m Temperature	Accuracy	≤ ±0.5 °C	0.02 °C	Pass	
10-2m Temperature Lapse	Accuracy	≤ ±0.1 °C	-0.02 °C	Pass	
Total Solar Radiation	Accuracy	≤ ±25 W/m^2	1.8 W/m^2	Pass	

Table 2-8 Fourth Quarter 2008 Calibration Results

Parameter	QC Check Category	QC Check Criteria	Measured Response	Results (Pass/Fail)	Comments
Air Quality Calibration December 2 through 4, 2008					
SO_2	Slope	≥ 0.85 and ≤ 1.15	0.99	Pass	The calibration confirmed all air quality systems were reporting measurements to within acceptable limits.
	Intercept	≤ ±3% full scale	0.002 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO_X	Slope	≥ 0.85 and ≤ 1.15	1.01	Pass	
	Intercept	≤ ±3% full scale	0.002 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO	Slope	≥ 0.85 and ≤ 1.15	1.01	Pass	
	Intercept	≤ ±3% full scale	0.002 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO_2	Converter Eff.	≥ 96%	98.6%	Pass	
O_3	Slope	≥ 0.85 and ≤ 1.15	1.00	Pass	
	Intercept	≤ ±3% full scale	-0.001%	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
PM_{10}	Sample Flow	≤ ±10%	5.4%	Pass	
	Total Flow	≤ ±10%	6.2%	Pass	
	Mass Determination	≤ ±2.5%	1.5%	Pass	
Meteorological Calibration					
Conducting a calibration of meteorological measurement systems is required semiannually and was conducted during the third calendar quarter 2008.					

Table 2-9 Second Quarter 2008 Audit Results

Parameter	QC Check Category	QC Check Criteria	Measured Response	Results (Pass/Fail)	Comments
Air Quality Audit June 4 through 5, 2008					
SO_2	Slope	≥ 0.85 and ≤ 1.15	0.99	Pass	The audit confirmed all operational air quality systems were reporting measurements to within acceptable limits. * The PM_{10} instrument was not operational and could not be calibrated.
	Intercept	≤ ±3% full scale	-0.007 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO_X	Slope	≥ 0.85 and ≤ 1.15	0.98	Pass	
	Intercept	≤ ±3% full scale	0.001 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO	Slope	≥ 0.85 and ≤ 1.15	0.98	Pass	
	Intercept	≤ ±3% full scale	0.001 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO_2	Converter Eff.	≥ 96%	98.8%	Pass	
O_3	Slope	≥ 0.85 and ≤ 1.15	1.02	Pass	
	Intercept	≤ ±3% full scale	0.000 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
PM_{10}	Sample Flow	≤ ±10%	*	*	
	Total Flow	≤ ±10%	*	*	
	Mass Determination	≤ ±2.5%	*	*	
Meteorological Audit June 4 through 5, 2008					
10-m Horizontal Wind Speed	Accuracy	≤ ±5%	0.0%	Pass	The audit confirmed all meteorological monitoring systems were reporting measurements to within acceptable limits.
	Starting Torque	≤ 1 g-cm	0.2 g-cm	Pass	
10-m Horizontal Wind Direction	Accuracy	≤ ±5 deg.	1.0 deg.	Pass	
	Linearity	≤ ±3 deg.	0.2 deg.	Pass	
	Starting Torque	≤ 11.0 g-cm	4.0 g-cm	Pass	
10-m Vertical Wind Speed	Accuracy	≤ ±2.5 m/s	0.05 m/s	Pass	
	Starting Torque	≤ 1 g-cm	0.3 g-cm	Pass	
10-m Temperature	Accuracy	≤ ±0.5 °C	0.22 °C	Pass	
2-m Temperature	Accuracy	≤ ±0.5 °C	0.28 °C	Pass	
10-2m Temperature Lapse	Accuracy	≤ ±0.1 °C	0.02 °C	Pass	
Total Solar Radiation	Accuracy	≤ ±5% full scale	0.4%	Pass	

Table 2-10 Third Quarter 2008 Audit Results

Parameter	QC Check Category	QC Check Criteria	Measured Response	Results (Pass/Fail)	Comments
Air Quality Audit August 26 through 27, 2008					
SO_2	Slope	≥ 0.85 and ≤ 1.15	0.96	Pass	The audit confirmed all air quality systems were reporting measurements to within acceptable limits.
	Intercept	≤ ±3% full scale	0.004 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO_X	Slope	≥ 0.85 and ≤ 1.15	0.96	Pass	
	Intercept	≤ ±3% full scale	0.003 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO	Slope	≥ 0.85 and ≤ 1.15	0.96	Pass	
	Intercept	≤ ±3% full scale	0.003 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO_2	Converter Eff.	≥ 96%	99.7%	Pass	
O_3	Slope	≥ 0.85 and ≤ 1.15	0.99	Pass	
	Intercept	≤ ±3% full scale	-0.001 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
PM_{10}	Sample Flow	≤ ±10%	-3.9%	Pass	
	Total Flow	≤ ±10%	-0.06%	Pass	
	Mass Determination	≤ ±2.5%	1.44%	Pass	
Meteorological Calibration					
Total Solar Radiation	Accuracy	≤ ±5% full scale	0.2%	Pass	
Conducting a meteorological measurement systems audit is required semiannually and was conducted during the second and fourth calendar quarters of 2008.					

Table 2-11 Fourth Quarter 2008 Audit Results

Parameter	QC Check Category	QC Check Criteria	Measured Response	Results (Pass/Fail)	Comments
Air Quality Audit December 2, 2008					
SO_2	Slope	≥ 0.85 and ≤ 1.15	0.93	Pass	The audit confirmed all air quality systems were reporting measurements to within acceptable limits.
	Intercept	≤ ±3% full scale	0.000 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO_X	Slope	≥ 0.85 and ≤ 1.15	0.96	Pass	
	Intercept	≤ ±3% full scale	0.001 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO	Slope	≥ 0.85 and ≤ 1.15	0.96	Pass	
	Intercept	≤ ±3% full scale	0.002 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
NO_2	Converter Eff.	≥ 96%	99.1%	Pass	
O_3	Slope	≥ 0.85 and ≤ 1.15	1.0	Pass	
	Intercept	≤ ±3% full scale	0.002 ppm	Pass	
	Correlation Coef.	≥ 0.9950	1.00	Pass	
PM_{10}	Sample Flow	≤ ±10%	-2.9%	Pass	
	Total Flow	≤ ±10%	-0.05%	Pass	
	Mass Determination	≤ ±2.5%	1.28%	Pass	
Meteorological Audit December 2, 2008					
10-m Horizontal Wind Speed	Accuracy	≤ ±5%	0.0%	Pass	The audit confirmed all meteorological systems that could be audited were reporting measurements to within acceptable limits. * The solar radiation measurement system was audited in the Third Quarter when sufficient solar radiation was available.
	Starting Torque	≤ 1 g-cm	0.2 g-cm	Pass	
10-m Horizontal Wind Direction	Accuracy	≤ ±5 deg.	0.0 deg	Pass	
	Linearity	≤ ±3 deg.	-1.0 deg	Pass	
	Starting Torque	≤ 11.0 g-cm	5.0 g-cm	Pass	
10-m Vertical Wind Speed	Accuracy	≤ ±2.5 m/s	0.07 m/s	Pass	
	Starting Torque	≤ 1 g-cm	0.3 g-cm	Pass	
10-m Temperature	Accuracy	≤ ±0.5 °C	0.22 °C	Pass	
2-m Temperature	Accuracy	≤ ±0.5 °C	0.28 °C	Pass.	
10-2m Temperature Lapse	Accuracy	≤ ±0.1 °C	0.02 °C	Pass	
Total Solar Radiation	Accuracy	≤ ±5% full scale	*	*	

3.0 Monitoring Data Network Summary

3.1 Air Quality Data Summary

Criteria pollutants monitored as part of the Monitoring Program are NO_2, SO_2, respirable PM_{10}, and O_3. Criteria pollutants are those air pollutants for which ADEC and USEPA have established standards that provide a threshold above which risk to public health and welfare becomes an issue. These standards are referred to as the Alaska Ambient Air Quality Standards (AAAQS) and are the same as the national standards for the pollutants measured. Applicable AAAQS, along with ambient concentrations measured at the Nuiqsut Station, are summarized by pollutant below.

3.1.1 Nitrogen Dioxide

Table 3-1 shows the annual average NO_2 concentration was 0.002 ppm, and less than 4 percent of the annual NO_2 AAAQS of 0.053 ppm. The typical NO_2 concentrations are just above instrument detection level. The annual average measured this year is lower than the historical Nuiqsut Station average of 0.004 ppm and equal to the annual average measured the previous year.

Table 3-1 Measured NO_2 Data Summary, 2008 Annual Data Summary

Monitoring Period	Year	Period Mean (ppm)	Number of Exceedances
2nd Quarter	2008	0.002	None
3rd Quarter	2008	0.001	None
4th Quarter	2008	0.001	None
Annual	2008	0.002	None

NAAQS/AAAQS: Annual - 0.053 ppm (100 $\mu g/m^3$) – Compared to the annual arithmetic mean.

The distribution of average hourly NO_2 concentration by wind direction this year was typical of past years with the magnitude of the highest values lower than the historical average (**Figure 3-1)**. This offset in magnitude is consistent with the difference between the historical and current year's annual average of the hourly concentrations. As shown in **Figure 3-1**, historically, the lowest concentrations are measured when winds transport background air to the Nuiqsut Station (west-southwest clockwise through east southeast). Slightly higher concentrations occur for wind directions that place the station downwind of Nuiqsut (southeast clockwise through southwest wind directions). In general, measured NO_2 concentrations at Nuiqsut are near detection limits of the instrument.

Monthly average NO_2 concentrations are presented in **Figure 3-2**. Historically, it is typical to observe increases in monthly averaged NO_2 concentrations during late winter. The pattern of higher measured concentrations in late winter has been attributed to differences in atmospheric dispersion characteristics between winter and summer, and potential changes in local emissions. Seasonal differences in atmospheric dispersion characteristics arise because in winter, there is an increase in stable and neutral atmospheric conditions. With the sun up in summer, solar radiation and heating of the surface induces more vertical mixing of the lower atmosphere than in winter, thereby increasing air pollution dispersion. In winter, without the benefit of solar energy, the atmosphere remains relatively stable, reducing vertical pollution dispersion. In addition, the increased local use of heating systems and idling vehicles in winter contribute to the NO_2 load.

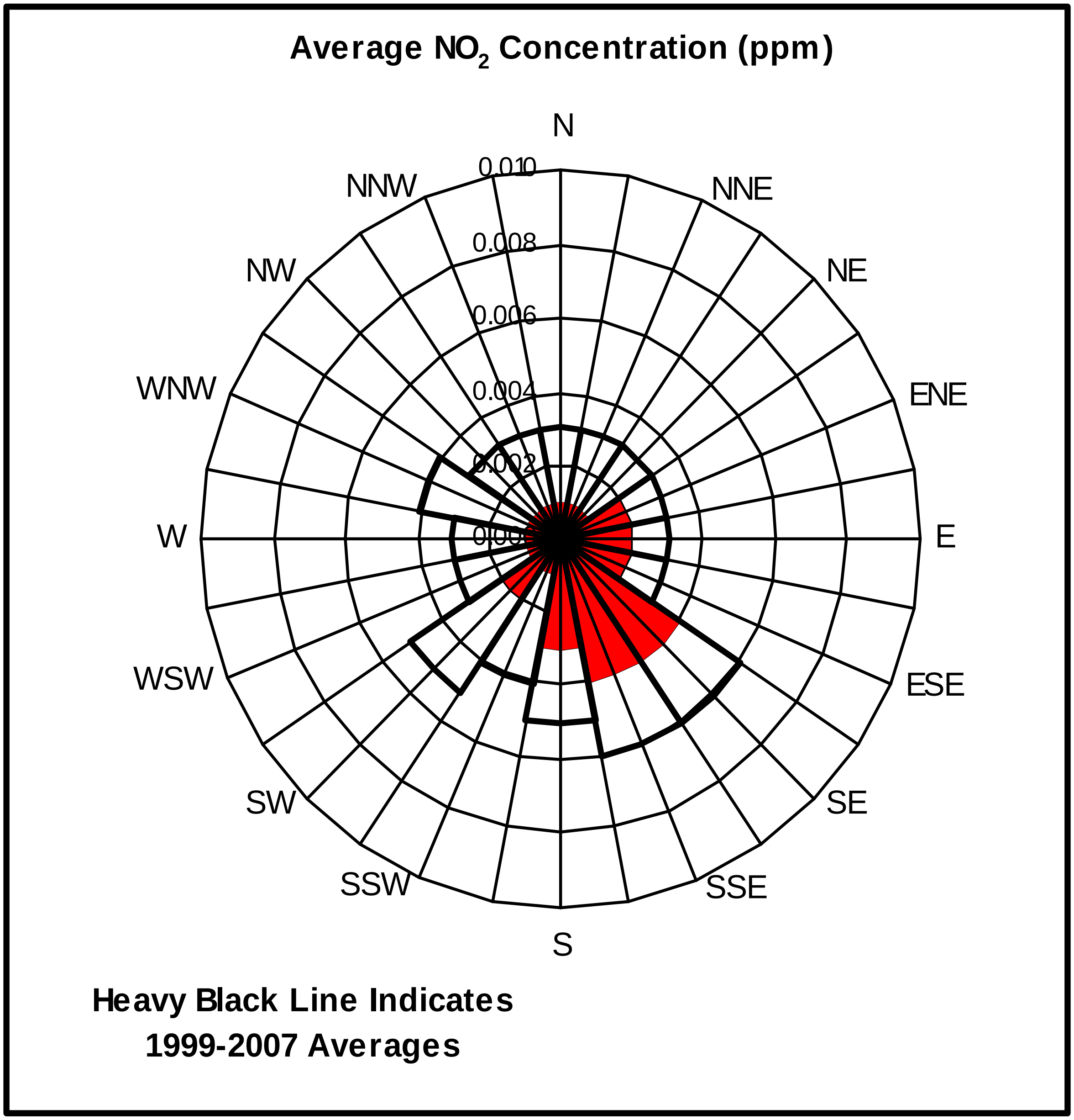


Figure 3-1 Average NO_2 Concentration by Wind Direction, 2008 Annual Data Summary

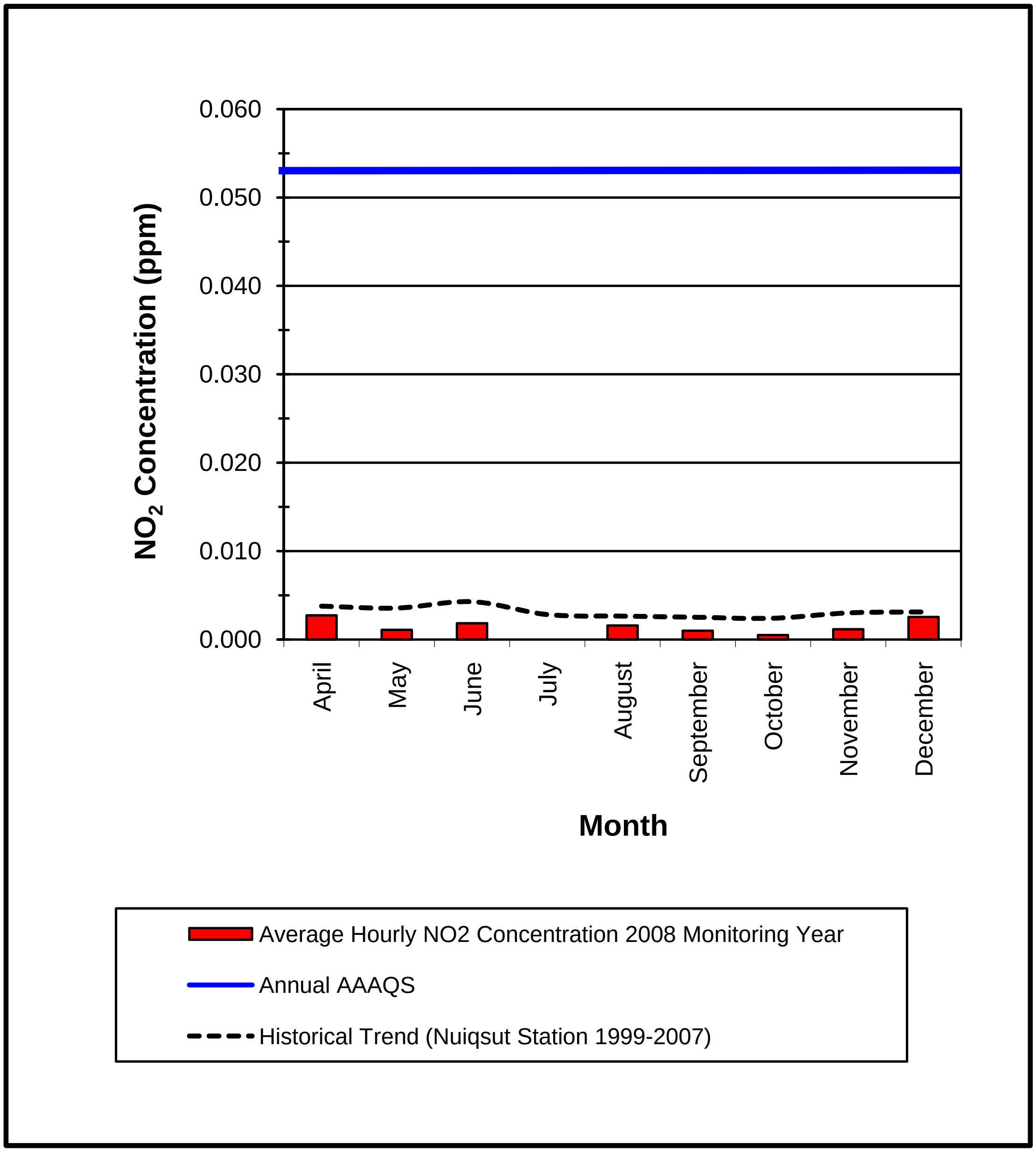


Figure 3-2 Average NO_2 Concentration by Month, 2008 Annual Data Summary

3.1.2 Sulfur Dioxide

Table 3 2 lists measured maximum 3-hour (running), 24-hour (midnight-to-midnight), and the annual average hourly SO_2 concentrations measured this monitoring year. Concentrations for all averaging periods were near or below instrument detection limit and well below applicable AAAQS. Measured SO_2 concentrations were typical of historical (1999-2007) values.

Measured 3-hour average SO_2 concentrations were less than 0.008 ppm throughout the monitoring year. The majority of measured SO_2 concentrations were just above the instrument detection limit making it difficult to discuss significant trends. Simply, there was no single near field or far field measurable SO_2 source observed in the data collected this year. Without identifiable sources, measured concentrations are representative of a regional or global background signature. The low average concentrations measured are consistent with an airshed containing relatively few and widely distributed sources. This trend has been typical of SO_2 measurements since monitoring began.

Table 3-2 Measured SO_2 Data Summary, 2008 Annual Data Summary

Monitoring Period	Year	3-hour (ppm)		24-hour (ppm)		Period Mean (ppm)	Number of Exceedances
		1st High	2nd High	1st High	2nd High		
2nd Quarter	2008	0.001	0.001	0.001	0.001	0.001	None
3rd Quarter	2008	0.007	0.007	0.004	0.003	0.001	None
4th Quarter	2008	0.003	0.003	0.003	0.003	0.000	None
Annual	2008	0.007	0.007	0.004	0.003	0.001	None

NAAQS/AAAQS:
3-hour - 0.5 ppm (1,300 µg/m^3) – Rolling average not to be exceeded more than once per year.
24-hour - 0.14 ppm – Midnight to midnight average not to be exceeded more than once per year.
Annual - 0.03 ppm – Compared to the annual arithmetic mean.

3.1.3 Respirable Particulate Matter

Throughout the monitoring project history, the majority of elevated measured PM_{10} concentrations result from naturally occurring wind-blown fugitive dust from exposed or disturbed areas local to the Nuiqsut Station. Exposed areas identified in the program are:

- The exposed bank of the Nechelik Channel north northeast clockwise through east southeast of the station;
- The exposed gravel mining area southeast of the station;
- Disturbed ground due to residential construction along the utility right-of-way and road southeast clockwise through south southeast of the station; and
- To a lesser degree, disturbed ground associated with dirt roads within Nuiqsut south clockwise through west southwest of the station.

In addition to these local fugitive sources, in the past, elevated particulate has also been measured from remote forest and tundra fires. However, during the current monitoring year, there were no periods identified when measured particulate concentrations could be attributed to forest fires. When particulate material from local fugitive dust and smoke is not present (i.e., during winter), hourly concentrations decrease to near the PSD de minimus levels.

Respirable PM_{10} measured at USEPA standard temperature and pressure, has a 24-hour and annual AAAQS of 150 µg/m^3 and 50 µg/m^3, respectively. As listed in **Table 3-3**, the maximum 24 hour PM_{10} concentration measured during the monitoring year was 60.2 µg/m^3. The yearly average PM_{10} concentration was 3.4 µg/m^3. This is well below the annual AAAQS of 50 µg/m^3 and also less than the historical Nuiqsut Station average of 7.6 µg/m^3.

Table 3-3 Measured PM_{10} Data Summary, 2008 Annual Data Summary

Monitoring Period	Year	24-hour (µg/m^3)		Period Mean (µg/m^3)	Number of Exceedances
		1st High	2nd High		
2nd Quarter	2008	NA*	NA*	NA*	NA*
3rd Quarter	2008	60.2	38.3	7.7	None
4th Quarter	2008	13.0	12.5	1.0	None
Annual	2008	60.2	38.3	3.4	None

* NA = Not available as the PM_{10} measurement did not operate during the 2nd quarter of 2008.
NAAQS/AAAQS:
24 hour – 150 µg/m^3 – Not to be exceeded more than once per year measured from midnight to midnight at USEPA Standard Conditions.
Annual – 50 µg/m^3 – Compared to the 3-year average of the weighted annual arithmetic mean concentration measured at USEPA Standard Conditions.

Figure 3-3 shows annual average hourly PM_{10} concentrations by wind direction measured this year compared to the historical trend. PM_{10} concentrations during this monitoring year were comparable or lower in magnitude than historical data. The directionality of PM_{10} was similar as compared to historical data. It should be noted that the data in this monitoring year includes measurements only in the 3rd and 4th quarters. Directional dependence is related to influence of local fugitive dust sources discussed previously.

Figure 3-4 compares the monthly average hourly PM_{10} concentrations measured this year to Nuiqsut Station historical monthly average PM_{10} concentrations. Historical trends show the fourth and first calendar quarters (October through March) typically experience the lowest average hourly PM_{10} concentrations reflecting snow covered conditions that suppress fugitive dust. In contrast, the second and third calendar quarters (April through September) record higher average hourly concentrations as fugitive dust sources become exposed and active. The variability seen throughout this year and compared to previous years is expected considering PM_{10} concentrations are highly dependent on the interplay of many meteorological characteristics such as wind speed and frequency, precipitation, and temperature.

3.1.4 Ozone

Table 3-4 lists measured 8-hour and annual average hourly O_3 concentrations measured during the monitoring year. Since the AAAQS for O_3 is based on the 3-year average of the fourth highest measured daily maximum 8-hour average O_3 concentration, it is difficult to discuss AAAQS compliance. However, since the maximum 8-hour average O_3 concentration measured was less than half the AAAQS, it is anticipated concentrations measured at the Nuiqsut Station will be well below the AAAQS in future years.

O_3 concentrations measured this year are typical of seasonal averages measured on the Alaskan North Slope (Prudhoe Bay, Kuparuk River Unit, and Barrow). In the absence of large combustion sources, strong frontal passages and high solar radiation, ambient O_3 levels will be spatially homogeneous and representative of a regional background.

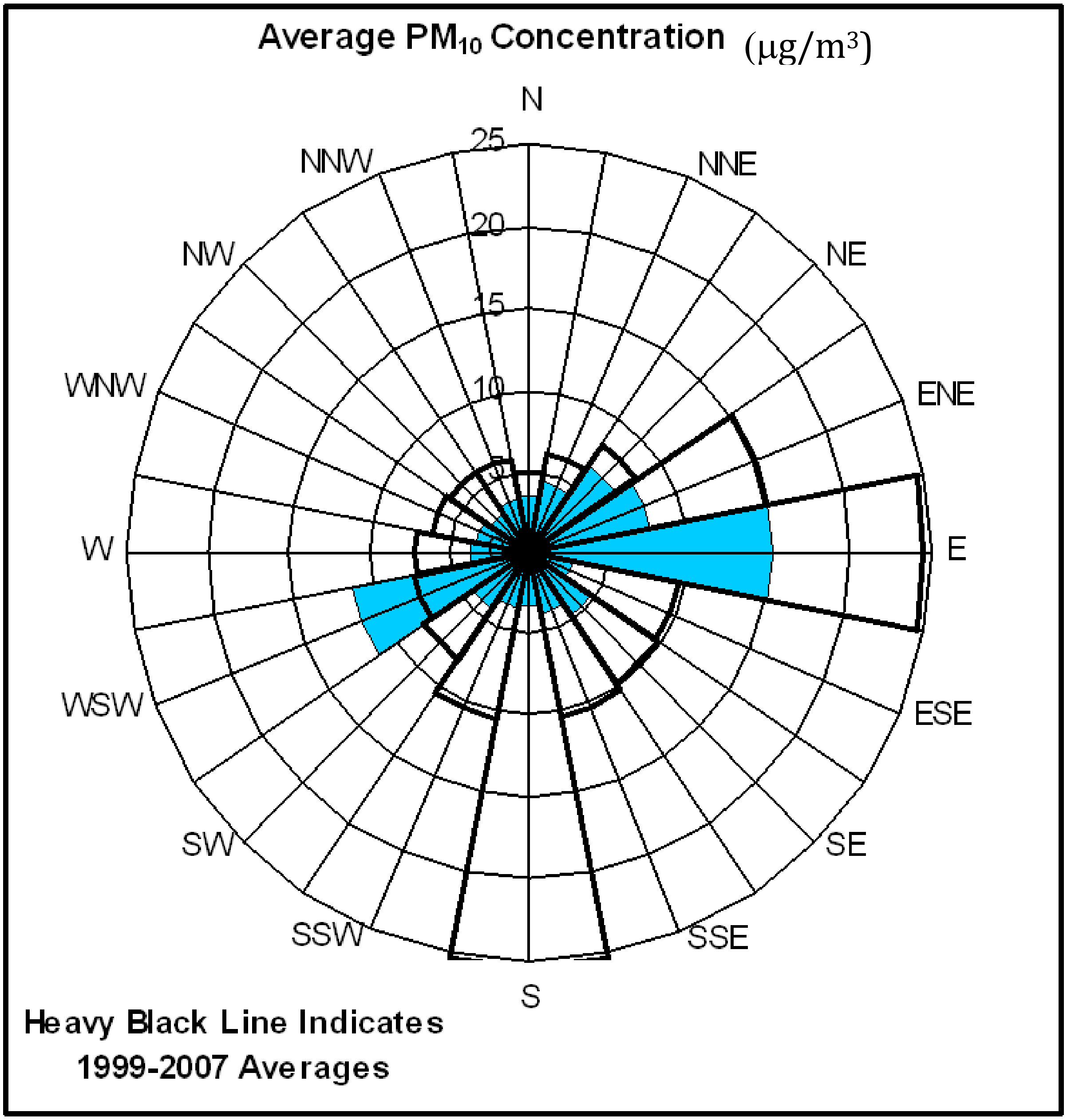
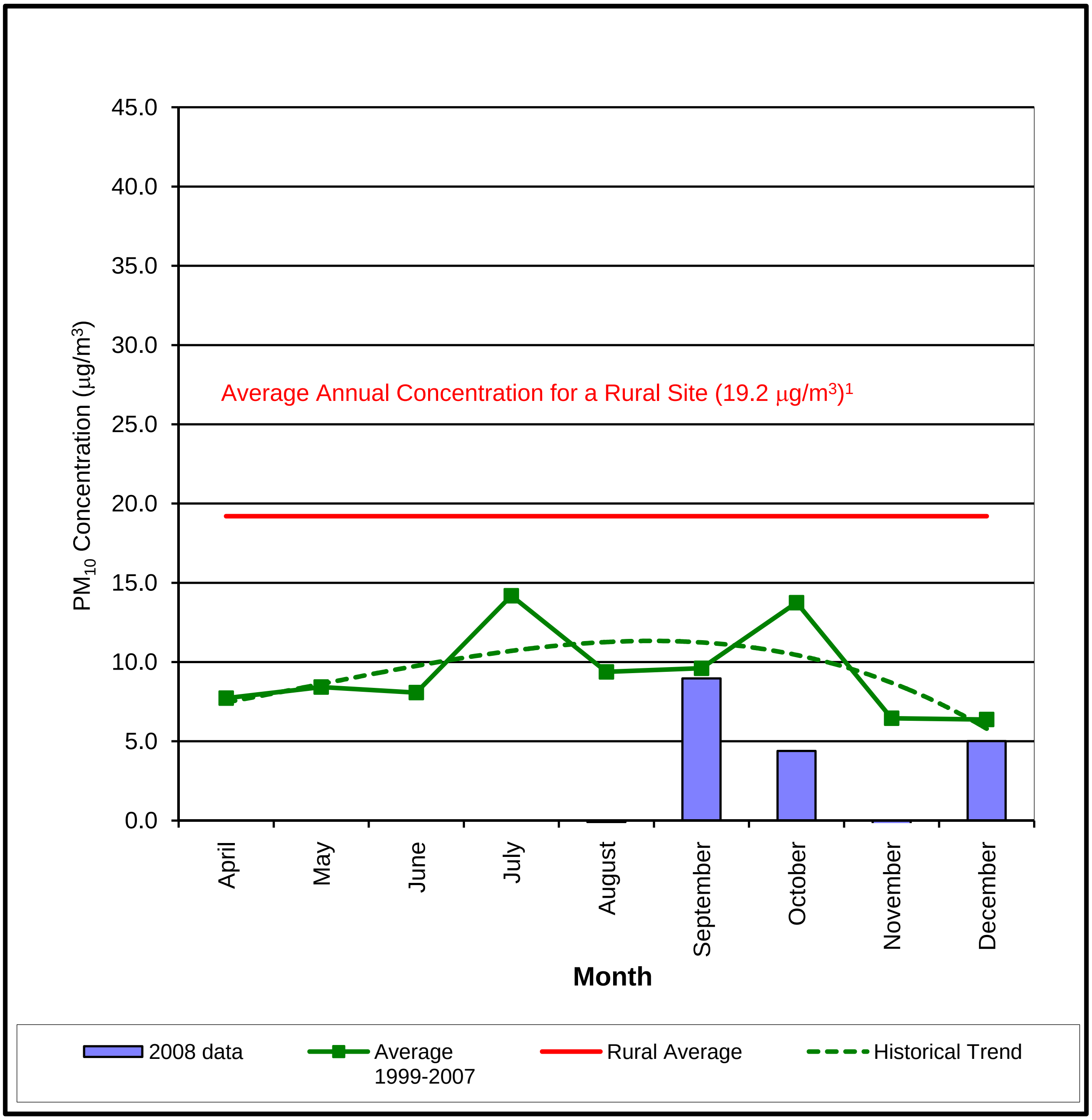


Figure 3-3 Average PM_{10} Concentration by Wind Direction, 2008 Annual Data Summary



[1] Average annual concentration obtained from 153 rural sites in the contiguous United States as summarized in the National Air Quality and Emissions Trend Report, 1999 (USEPA 2001).

Figure 3-4 Average PM_{10} Concentration by Month, 2008 Annual Data Summary

Table 3-4 Measured O_3 Data Summary, 2008 Annual Data Summary

Monitoring Period	Year	8-hour (ppm)			Period Mean (ppm)	Number of Exceedances
		1st High	2nd High	4th High		
2nd Quarter	2008	0.033	0.033	0.032	0.017	None
3rd Quarter	2008	0.029	0.029	0.029	0.016	None
4th Quarter	2008	0.034	0.034	0.033	0.020	None
Annual	2008	0.034	0.034	0.033	0.017	None

NAAQS/AAAQS:
8 hour - 0.08 ppm – Compared to the 3-year average of the fourth highest daily maximum rolling 8 hour average concentrations.

3.2 Meteorological Data Summary

Temperature, wind speed, and wind direction data collected at the Nuiqsut Station during the monitoring year are summarized in the following subsections. Vertical wind speed and solar radiation data also are collected at the Nuiqsut Station, but are not specifically discussed in this section.

3.2.1 Wind Speed and Direction Climatology

The annual Nuiqsut bivariate wind frequency distribution (wind rose) is presented in **Figure 3-5**. Data presented in this figure is consistent with the established North Slope wind climatology and typical of the Nuiqsut bimodal wind direction distribution demonstrated every year since monitoring began. This figure shows winds during the monitoring year were dominated by northeast clockwise through easterly (NE-E) and to a lesser degree south southwest clockwise through westerly (SSW-W). Winds from these 2 sectors occurred nearly 80 percent of the total hours this year and are caused by persistent regional weather patterns. Without respect to direction, the mean 10-m wind speed for the monitoring year was 4.4 m/s and the maximum was 19.6 m/s.

The persistence of weather patterns season to season can be inferred from **Figures 3-6** through **3-8**, which present wind roses by calendar quarter. Typical of the Nuiqsut Station wind climatology, the quarterly wind roses collected this year indicate there is a persistence of NE-E all year long. SSW-W winds are present all year long but only become a significant part of the climatology during the winter months. Mean and maximum wind speeds remain fairly constant over all quarters. The quarterly wind rose depictions are augmented by **Tables 3-5** through **3-7**, which present quarterly wind rose data as a percent of valid hours.

3.2.2 Temperature Climatology

During the monitoring year, the hourly averaged 2-m ambient temperature reached a maximum of 20.3°C (68.5 degrees Fahrenheit [°F]) on June 4, 2008 and a minimum of -36.6°C (-33.9°F) on December 31, 2008. **Table 3-8** shows the monthly hourly minimum and the hourly maximum.

Figure 3-9 compares average hourly temperatures by month measured at Nuiqsut during the current monitoring year to historical data collected at Barrow and Nuiqsut. Comparisons are made to Barrow data because that data, collected over a 49-year period, is less likely influenced by interannual variability.

Monthly average temperatures in 2008 were similar to the historical averages measured at Nuiqsut. Spring temperatures and December temperatures were slightly warmer than average. It is typical to see Nuiqsut Station temperatures consistently higher than those collected at Barrow from June through September and equal to those measured at Barrow from October through May. Differences typically observed during the summer are in part related to the fact that the Nuiqsut Station is located further inland than Barrow and away from moderating effects of the ocean.

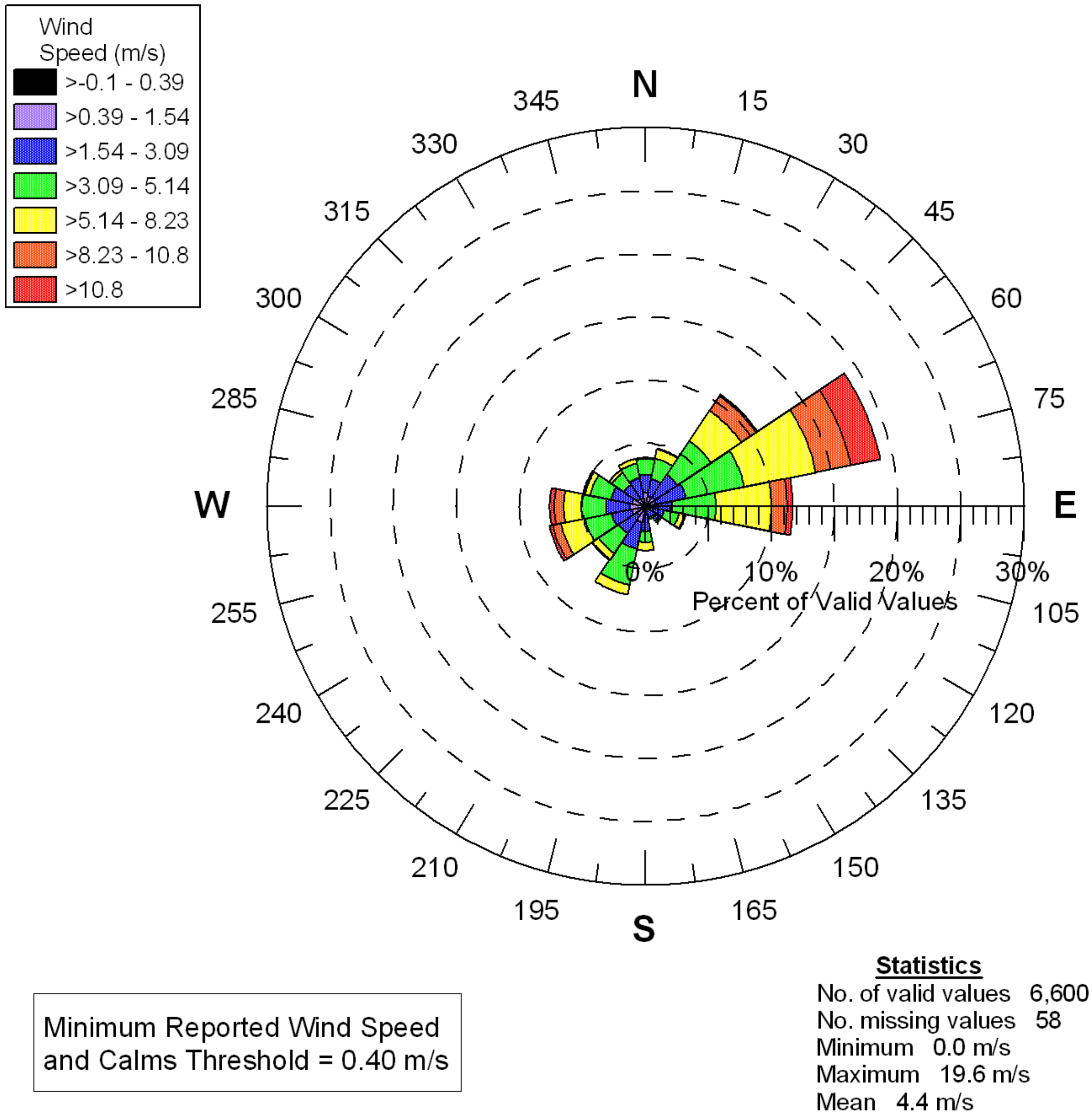


Figure 3-5 2008 Annual Nuiqsut Wind Rose

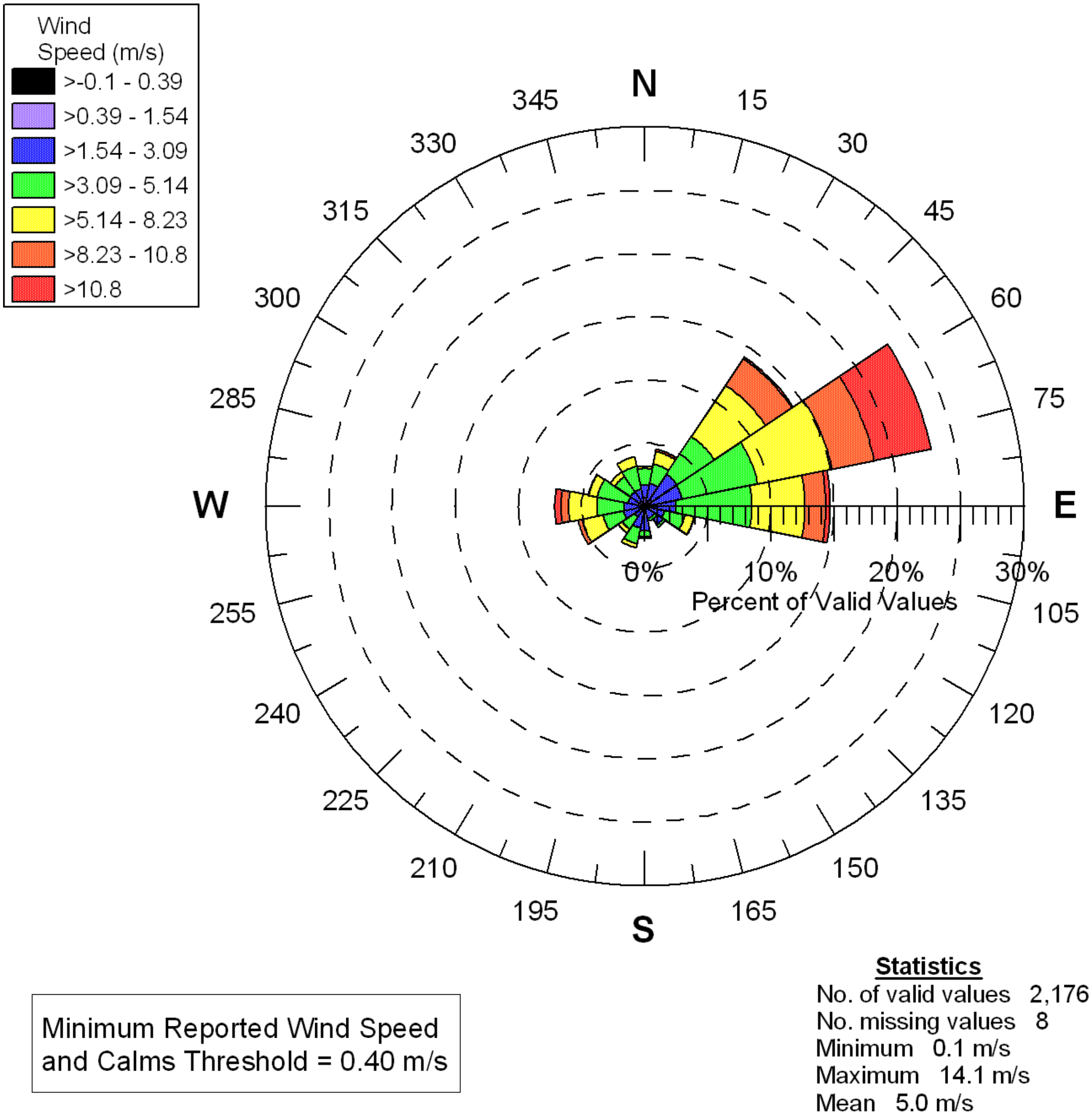


Figure 3-6 Second Quarter 2008 Nuiqsut Wind Rose

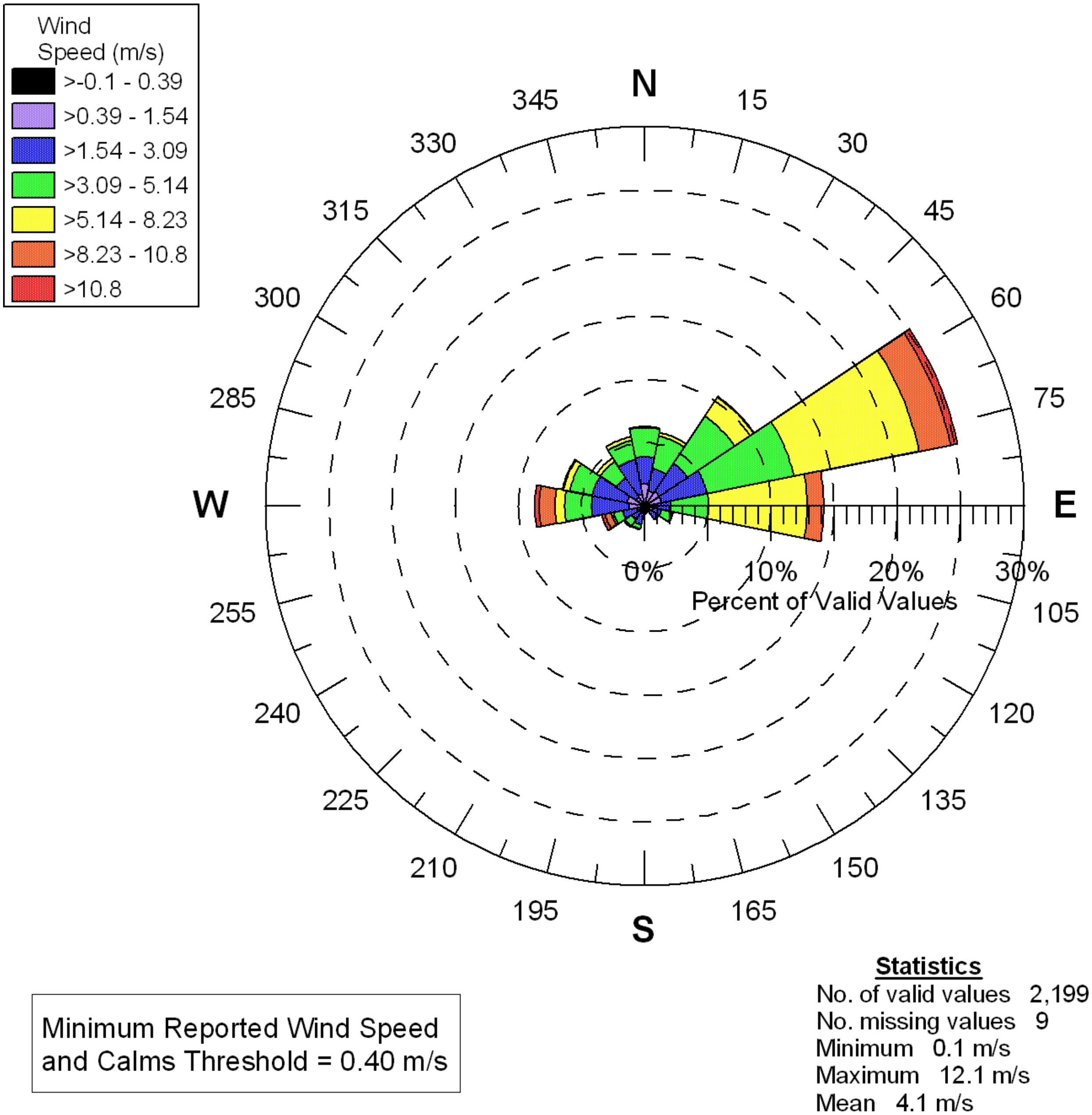


Figure 3-7 Third Quarter 2008 Nuiqsut Wind Rose

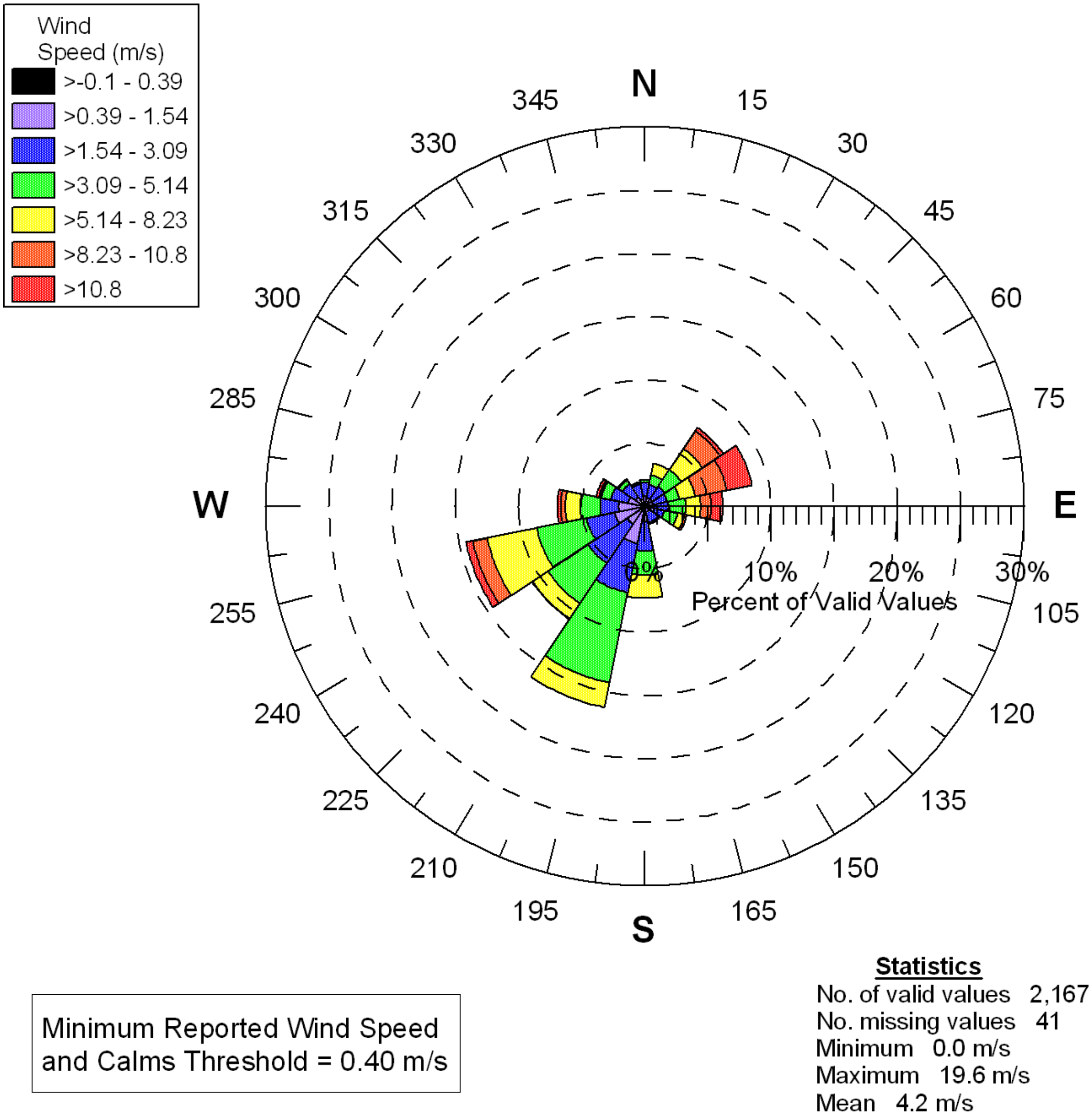


Figure 3-8 Fourth Quarter 2008 Nuiqsut Wind Rose

Table 3-5 Second Quarter 2008 Wind Direction/Speed Frequency Analysis

Wind Rose Analysis – Percent of Valid Hourly Values (2,176 Valid Hours Used)									
Wind Direction	Wind Speed – m/s								Average Speed
	≤ 0.39	≤ 1.54	≤ 3.09	≤ 5.14	≤ 8.23	≤ 10.8	> 10.8	Total	
N		1.10	2.20	3.16	0.60	0.00	0.00	7.09	3.26
NE		1.15	4.45	7.24	8.66	5.36	1.88	28.76	5.91
E		1.10	3.21	10.54	7.93	2.43	3.21	28.44	5.70
SE		0.78	2.25	0.73	0.09	0.00	0.00	3.88	2.47
S		0.82	2.80	1.60	0.27	0.00	0.00	5.53	2.83
SW		0.60	1.65	2.38	1.28	0.00	0.00	5.94	3.82
W		0.78	2.47	4.03	3.39	0.96	0.50	12.17	4.94
NW		1.01	1.83	3.48	1.47	0.00	0.00	7.82	3.74
CALM	0.23								
Total	0.23	7.33	20.85	33.18	23.69	8.75	5.59	100	

Table 3-6 Third Quarter 2008 Wind Direction/Speed Frequency Analysis

Wind Rose Analysis – Percent of Valid Hourly Values (2,199 Valid Hours Used)									
Wind Direction	Wind Speed – m/s								Average Speed
	≤ 0.39	≤ 1.54	≤ 3.09	≤ 5.14	≤ 8.23	≤ 10.8	> 10.8	Total	
N		2.77	4.03	4.40	0.32	0.00	0.00	11.57	2.78
NE		2.86	5.21	9.43	6.21	1.68	0.54	25.99	4.49
E		1.90	3.67	7.07	13.92	2.22	0.00	28.84	5.30
SE		0.82	1.18	0.27	0.00	0.00	0.00	2.32	2.02
S		0.73	0.54	0.41	0.05	0.00	0.00	1.78	2.25
SW		0.91	1.63	1.27	0.14	0.00	0.00	4.00	2.70
W		2.22	5.35	3.35	1.13	1.86	0.63	14.61	4.13
NW		1.81	4.76	3.17	0.68	0.00	0.00	10.48	2.89
CALM	0.45								
Total	0.45	14.01	26.38	29.37	22.44	5.76	1.18	100	

Table 3-7 Fourth Quarter 2008 Wind Direction/Speed Frequency Analysis

Wind Rose Analysis – Percent of Valid Hourly Values (2167 Valid Hours Used)									
Wind Direction	Wind Speed – m/s								Average Speed
	≤ 0.39	≤ 1.54	≤ 3.09	≤ 5.14	≤ 8.23	≤ 10.8	> 10.8	Total	
N		1.50	2.40	0.59	0.23	0.00	0.00	4.90	2.28
NE		1.09	2.31	2.81	3.40	2.77	1.59	14.16	5.95
E		1.04	2.31	2.31	2.09	2.45	1.72	12.11	5.93
SE		0.95	1.36	0.59	0.32	0.00	0.00	3.41	2.60
S		1.95	4.54	5.49	2.90	0.00	0.00	15.06	3.61
SW		5.03	7.12	9.34	3.90	0.18	0.09	25.86	3.42
W		3.85	3.27	4.35	3.72	1.45	0.86	17.69	4.36
NW		1.50	2.18	0.82	0.09	0.09	0.09	4.95	2.53
CALM	1.50								
Total	1.50	16.92	25.49	26.30	16.64	6.94	4.35	98	

Table 3-8 Nuiqsut Temperature Climate Summary, 2008 Annual Data Summary

2 Meter Temperature (°C)									
	Mean			Extreme					
Month	Maximum Daily (Monthly Average)	Minimum Daily (Monthly Average)	Monthly	Record Highest (Hourly Average)	Year	Day	Record Lowest (Hourly Average)	Year	Day
April 2008	-2.3	-26.3	-13.2	2.5	2002	26	-35.8	2004	2, 3
May 2008	6.6	-11.2	-3.1	18.5	2002	24	-28.7	2001	1
June 2008	6.7	0.8	3.5	27.3	2003	29	-5.0	2000	5
July 2008	-	-	-	28.0	2001	16	-1.6	2002	26
August 2008	6.2	1.9	4.0	27.8	1999	5	-3.3	2000	27
September 2008	3.8	-3.6	0.6	23.4	2007	30	-13.6	1999	30
October 2008	-2.1	-16.5	-8.5	7.4	2003	2	-27.2	1999/2004	31/31
November 2008	-9.3	-27.8	-17.7	0.7	2003	6	-35.5	1999	5
December 2008	-6.1	-34.2	-20.0	-2.5	2001/2006	28/2	-42.1	1999	18
January	-	-	-	0.8	2008	20	-43.1	2002	23
February	-	-	-	1.8	2006	16	-45.9	2004	19
March	-	-	-	-3.1	2004	21	-40.3	2006/2007	11/11
2nd Quarter 2008	3.7	-12.2	-4.3	-	-	-	-	-	-
3rd Quarter 2008	3.3	-0.5	1.6	-	-	-	-	-	-
4th Quarter 2008	-5.8	-26.1	-15.4	-	-	-	-	-	-
Monitoring Year	0.3	-9.8	-4.6	28.0	2001	16	-45.9	2004	19

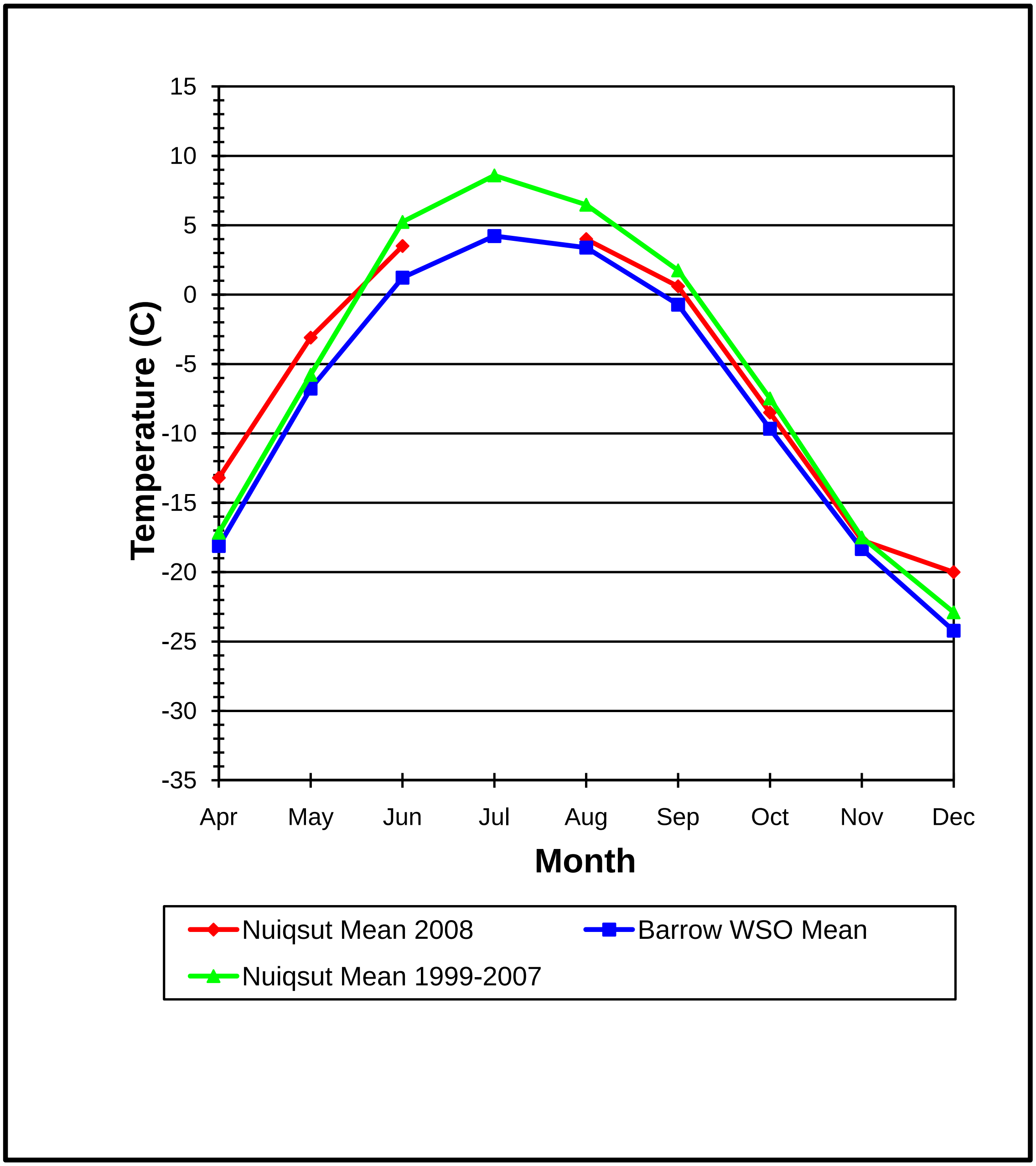


Figure 3-9 Nuiqsut Station Temperature Climatology, 2008 Annual Data Summary

4.0 References

Alaska Department of Environmental Conservation (ADEC). 1996. Alaska Quality Assurance Manual for Ambient Air Quality Monitoring. Revised August 21, 1996.

SECOR International Incorporated. 2004. ConocoPhillips Alaska Inc. Nuiqsut Ambient Air Quality Monitoring Project Ozone Monitoring – Draft Addendum. April 2004.

_______. 2002. Phillips Alaska Inc. Nuiqsut Ambient Air Quality Monitoring Project Expanded Meteorological Monitoring - Draft Addendum. March 2002.

_______. 2001. Phillips Alaska Inc. Nuiqsut Ambient Air Quality Monitoring Project Addition of Federal Reference Method Particulate Monitoring - Final Addendum. January 2001.

_______. 2000. ARCO Alaska Inc. Nuiqsut Ambient Air Quality Monitoring Plan (Revised). April 2000.

United States Environmental Protection Agency (USEPA). 2001. National Air Quality and Emissions Trends Report, 1999. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. EPA 454/R-01-004. March 2001.

_______. 1998. Quality Assurance Handbook for Air Pollution Measurement Systems Volume II: Part 1. Ambient Air Quality Monitoring Program Quality System Development. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. EPA 454/R-98-004. August 1998.

Yamartino, R. J. 1984. A Comparison of Several "Single-Pass" Estimators of the Standard Deviation of Direction. J. Climate Appl. Meteorology, Vol. 23, pp. 1362-1366.