Annual Report

North Dakota
Air Quality Monitoring
Data Summary
2013

NORTH DAKOTA
DEPARTMENT *of* HEALTH

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Air Quality Monitoring
Data Summary
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EXECUTIVE SUMMARY

The North Dakota Department of Health operated eight ambient air quality monitoring sites and industry operated eight source-specific air quality monitoring sites. The National Park Service maintains a monitoring site at the Theodore Roosevelt National Park – South Unit's Painted Canyon Overlook. The ambient monitoring data from this site is included in this report. There were no sulfur dioxide, nitrogen dioxide, ozone or particulate matter exceedances of either the state or federal ambient air quality standards measured at any State operated sites during 2013. North Dakota is one of thirteen states that are in attainment for all criteria pollutants.

INTRODUCTION

The North Dakota Department of Health, Environmental Health Section, Division of Air Quality, henceforth known as "the department," has the primary responsibility for protecting the health and welfare of North Dakotans from the harmful effects of air pollution. The department ensures that the ambient air quality in North Dakota is better than the levels required by the state and federal Ambient Air Quality Standards and the "Prevention of Significant Deterioration of Air Quality Rules." To address this responsibility, the department operates a network of ambient air quality monitors.

In addition to the state-operated ambient air quality monitoring sites, three industrial sources operated air quality monitoring sites within their immediate spheres of influence. These site locations are selected based on computer dispersion modeling and prevailing wind directions.

This report provides an overview of air quality monitoring activities conducted by the department and industry during the 12-month period beginning Jan. 1, 2013, and ending Dec. 31, 2013. The report includes data summaries for the monitored pollutants and significant changes that occurred to the monitoring program. Also included are wind and pollution star charts and trend graphs. The pollution star charts (Appendix 3) indicate the percentage of time a pollutant is detected when the wind is from each direction. The trend graphs (Appendix 4) show the maximum concentration for each pollutant standard.

NETWORK DESCRIPTION

Department Sites

During 2013, the department operated eight air quality monitoring sites. Table 1 lists the department monitoring sites that were active during the year.

In general, department ambient air quality monitoring (AAQM) sites obtain air quality data to meet six monitoring objectives: (1) to determine the highest pollutant concentrations expected to occur in the area covered by the network; (2) to measure typical concentrations in area of high population density; (3) to determine the impact of significant sources or class categories; (4) to determine general background concentration levels, (5) to determine the impact on air quality by regional transport; and, (6) to determine welfare-related impacts (such as visibility impacts and vegetation effects). The department has determined that three sites are required to satisfy these six monitoring objectives. They are identified as "Required" in Table 1, in the "Station Type" column. The remaining four sites collect data used to support and/or supplement the department's dispersion modeling activities

The department's ambient air quality monitoring network normally does not include source-specific monitoring; i.e., monitoring a single, specific source. However, the department, in issuing Permits to Construct and Permits to Operate for major sources, may require those sources to operate ambient air quality monitoring programs to assess impacts on local air quality.

The ambient monitoring site at Theodore Roosevelt National Park – South Unit (TRNP – SU) is a part of the National Park Service's national network. However, the Park Service has asked the department to install and operate sulfur dioxide and ozone analyzers and a $PM_{2.5}$ manual sampler on their behalf. Also installed at this site are a continuous $PM_{2.5}$ analyzer, and various meteorological parameters. These data are included in this report to present a better and more complete picture of the air quality in the State.

Industry Sites

Industry operated eight source-specific air quality monitoring sites during 2013. Table 1 also lists the industry networks and monitoring sites active during the year.

In general, industry air quality monitoring sites obtain data at locations expected to show high concentrations of pollution from a specific source or group of sources. These source specific sites are selected using computer dispersion modeling programs and annual wind patterns. The distance a monitoring site is located from a source is determined by the primary pollutant monitored, if the site is a multi-pollutant site.

Figure 1 displays department and industry monitoring sites. If an industry has more than one site, only the approximate location within the county is indicated.

TABLE 1

State AAQM Network Description

Site Name AQS Site #	Station Type	Parameter Monitored[1]	Operating Schedule	Monitoring Objective[2]
1 Beulah North 380570004	SLAMS Required	$PM_{2.5}$ SO_2, NO_2, O_3, MET NH_3 cont. $PM_{2.5}$ PM_{10}	6th Day cont. cont. cont. cont.	Population Exposure & Significant Source
2 Bismarck Residential 380150003	SLAMS	SO_2, NO_2, O_3, MET cont $PM_{2.5}$(BAMM) PM10 [5] $PM_{2.5}$	cont. cont. cont. 3rd Day	Population Exposure
3 Dunn Center 380250003	SLAMS Required	SO_2[4],NO_2, O_3, MET cont. $PM_{2.5}$, PM_{10}	cont.	General Background
4 Fargo NW 380171004	SLAMS Required	SO_2,NO_2, O_3, CO, NOY,MET Cont. $PM_{2.5}$ (BAMM) $PM_{2.5}$ $PM_{2.5}$ Speciation	cont. cont. cont. 3rd Day 3rd Day	Population Exposure
5 Hannover 380650002	SLAMS	SO_2, NO_2, O_3, MET cont $PM_{2.5}$	cont. cont.	Significant Source
6 Lostwood 380130004	SLAMS	SO_2[4],NO_2, O_3, NH_3, MET, PM_{10} cont $PM_{2.5}$,(BAMM)	cont.	General Background & Significant Source
7 TRNP - NU 380530002	SLAMS Required	SO_2[4],NO_2, O_3, MET cont. $PM_{2.5}$, (BAMM) PM10	cont.	General Background, Long range Transport, Welfare-Related
8 Williston 381050003	SLAMS	O_3, MET, PM_{10} cont $PM_{2.5}$,(BAMM)	Cont.	Population Exposure
Company	**Site Name** AQS Site #			
9 Amerada Hess Corporation	TIOGA #1 381050103 TIOGA #3 381050105	SO_2 SO_2	cont. cont.	Source Impact Source Impact
10 Bear Paw Energy, Inc.	MGP #3 380530104 MGP #5 380530111	SO_2, MET SO_2, MET	cont. cont.	Source Impact Source Impact
11 Dakota Gasification Company	DGC #12 380570102 DGC #14 380570118 DGC #16 380570123 DGC #17 380570124	SO_2, NO_2, MET SO_2 SO_2 SO_2, NO_2	cont. cont. cont. cont.	Source Impact Source Impact Source Impact Source Impact

1. MET refers to meteorological and indicates wind speed and wind direction monitoring equipment.
2. Not applicable to MET.
3. This analyzer will serve a dual role of population exposure and general background.
4. The analyzer was changed to a SO2 Trace Level affective June 1,2007

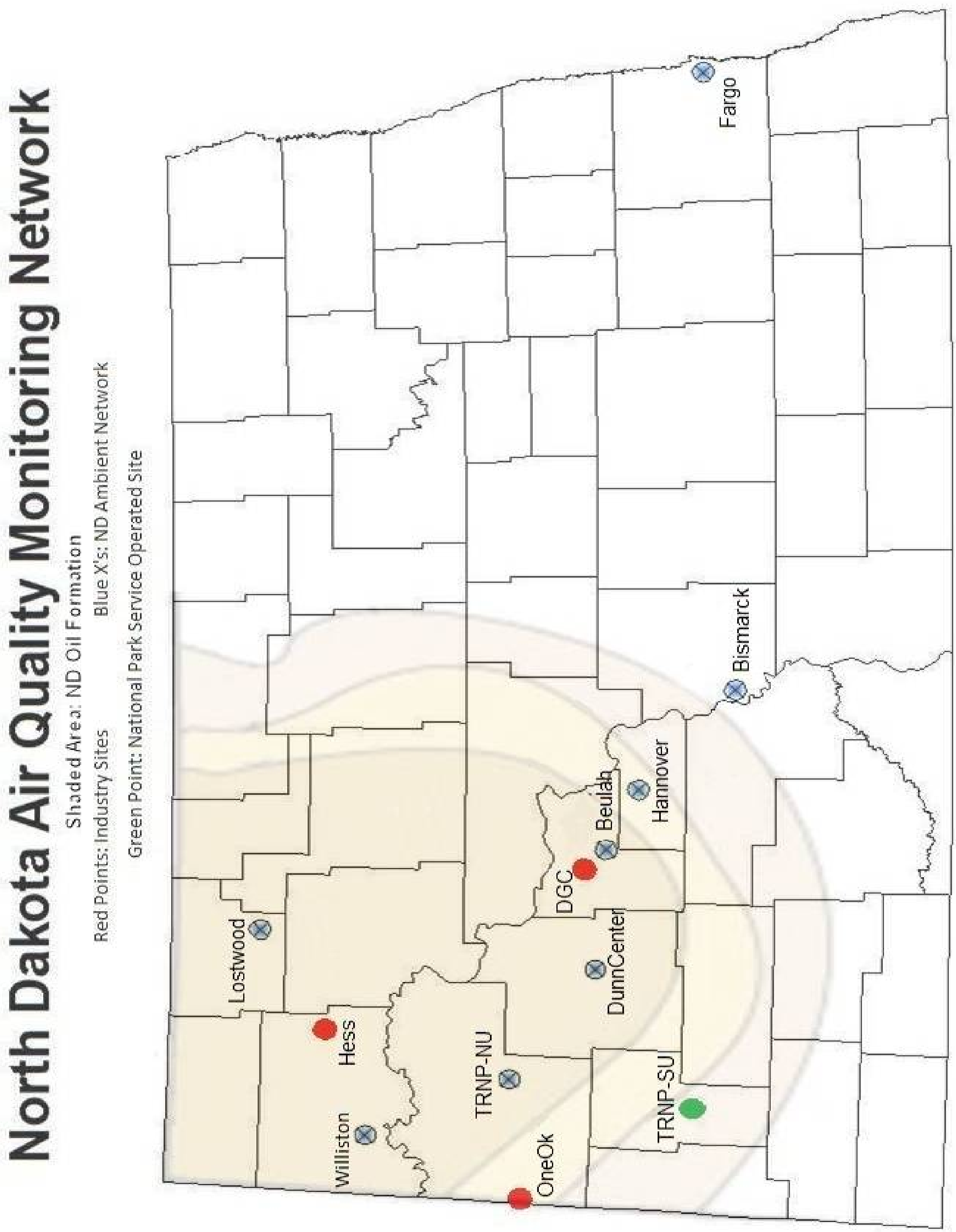

Figure 1 North Dakota Air Quality Monitoring Network

NETWORK CHANGES

Department Changes

The department moved the equipment located at the Makoti site to a new monitoring site in the city of Williston to better classify the oil field impacts on air quality.

Industry Changes

There were no Industry changes.

MONITORING RESULTS

Introduction

Ambient and source-specific air quality data collected during the year at monitoring sites operated by the department and industry are summarized in tables for the following pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), ammonia (NH_3), inhalable 2.5 particulates ($PM_{2.5}$) and inhalable particulates (PM_{10}). Each section contains a description of the physical characteristics and health effects, a comparison to the State standards and a data summary.

The data summaries for gaseous pollutants include maximum concentrations, arithmetic and means for the analytical method used for each parameter. Where applicable, the number of times a State standard was exceeded is indicated. The concentrations for gaseous pollutants are reported in parts per billion (ppb).

The $PM_{2.5}$ data summaries contain the three highest 24-hour average concentrations; annual arithmetic mean; the number of times the 24-hour standard was exceeded, if applicable; and an asterisk (*) if the annual standard is exceeded, if applicable. The concentrations are reported in micrograms per cubic meter ($\mu g/m^3$).

Continuous $PM_{2.5}$ and PM_{10} data summaries contain the two highest 1-hour averages and the four highest 24-hour averages; the annual average; the number of times the 24-hour standard was exceeded, if applicable; and an asterisk (*) if the annual standard is exceeded, if applicable. The concentrations are reported in micrograms per cubic meter ($\mu g/m^3$). Since the $PM_{2.5}$ data are not collected with a reference or equivalent method the data cannot be used for comparison for any regulatory purpose. If this data indicates an exceedance, then a reference or equivalent method sampler must be installed at the site of the possible air quality standard exceedance.

For statistical purposes, pollutant concentrations less than the minimum detectable value (MDV) for the analytical method used are assigned a value equal to one-half the MDV. The MDV for SO_2 is 2 ppb; SO_2 – trace level is 0.2 ppb; NO_2 is 1 ppb; O_3 is 4 ppb; manual $PM_{2.5}$ is 2.0 $\mu g/m^3$; and manual PM_{10} is 4 $\mu g/m^3$. The MDV for the continuous $PM_{2.5}$ is -10.0 $\mu g/m^3$ and for continuous PM_{10} is -50.0 $\mu g/m^3$. Annual means are calculated for SO_2, NO_2, $PM_{2.5}$, and PM_{10}. However, only those means with more than 75 percent of data greater than the MDV are unbiased calculations.

As part of the statistical evaluation, the data recovery (NUM OBS) is evaluated to determine if the data recovery complies with the State's required 80 percent data recovery rate. A continuous analyzer operating fewer than 7,008 hours per year may achieve at least an 80 percent data recovery for the period operated; however, it does not meet the 80 percent data recovery for the full year. Each analyzer at a site not meeting the 80 percent data recovery for the year is flagged in the "NUM OBS" column by placing "***" underneath the number of observations. Particulate matter samplers must collect at least 48 samples per year for 1-in-6 day sampling and 96 samples per year for 1-in-3 day sampling to meet the 80 percent data recovery rate.

Sulfur Dioxide

Physical Characteristics and Sources

Sulfur dioxide is a colorless gas with a pungent odor detectable by the human nose at concentrations of 500 to 800 ppb. It is highly soluble in water where it forms sulfurous acid (H_2SO_3). In the atmosphere, sulfurous acid is easily converted to sulfuric acid (H_2SO_4), the major acidic component of "acid rain," which then may convert to a sulfate. On a worldwide basis, sulfur dioxide is considered to be a major pollutant. It is emitted mainly from stationary sources that burn coal and oil - such as utility boilers. Other sources of sulfur dioxide include refineries, natural gas processing plants, oil well heaters and flares.

Health Effects

Sulfur dioxide can be converted in the atmosphere to sulfuric acid aerosols and particulate sulfate compounds, which are corrosive and potentially carcinogenic (cancer-causing). The major health effects of sulfur dioxide appear when it is associated with high levels of other pollutants, such as particulate. Sulfur dioxide also may play an important role in the aggravation of chronic illnesses, such as asthma. The incidence and intensity of asthma attacks have increased when asthmatics are exposed to higher levels of sulfur dioxide and particulate matter sulfates, which are products of atmospheric sulfur dioxide reactions.[4]

Standards Comparison

Sulfur dioxide was monitored at 16 sites. Seven sites were run by the department, one by NPS, and eight by industry.

The 3-year average 99th percentile 1-hour standard (75 ppb) was not exceeded during the year. The maximum 3-year average 99th percentile 1-hour concentration was 164 ppb at Hess - Tioga #3. (The monitors operated by industry are classified as source specific and required by permit. These monitors are not used for NAAQS comparison.)

The 3-hour federal secondary standard (500 ppb) was not exceeded during the year. The maximum 3-hour average concentration was 226.3 ppb at Hess - Tioga #3.

The 24-hour state standard (140 ppb) was not exceeded during the year. The maximum 24-hour average concentration was 52.6 ppb at Hess – Tioga #3.

Among those sites that collected at least 80 percent of the possible data during the year, the maximum annual arithmetic mean was 3.15 ppb at Hess - Tioga #3.

The sulfur dioxide data are summarized in Table 2 and SO_2 Trace Level in Table 3.

TABLE 2

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : SULFUR DIOXIDE (ppb)

			MAXIMA										
		NUM	1 - HOUR		99TH %	3 - HOUR		24 - HOUR		ARITH	3yr	1HR	24HR
LOCATION	YEAR	OBS	1ST	2ND	1HR	1ST	2ND	1ST	2ND	MEAN	Avg	#>273	#>99
Bear Paw - MGP #3	2013	8645	21	15	12	12.0	12.0	6.9	3.4	0.66	8		
Bear Paw - MGP #5	2013	8663	29	9	8	10.0	5.3	2.4	2.3	0.45	8		
Beulah - North	2013	8664	29	26	18	17.6	15.0	3.0	2.6	0.56	23		
Bismarck Residential	2013	8707	28	25.1	16	19.3	18.6	6.8	5.7	0.57	20		
DGC #12	2013	8702	21	19	17	15.3	14.6	4.1	3.8	0.83	28		
DGC #14	2013	8675	26	23	22	15.0	15.0	4.6	4.4	0.82	27		
DGC #16	2013	8647	33	32	22	29.6	20.3	10.7	7.4	0.80	39		
DGC #17	2013	6483 ***	28	22	19	13.0	12.6	3.5	3.2	0.42	30		
Hannover	2013	8340	25	25	24	17.0	16.0	5.4	4.2	0.91	39		
Hess - Tioga #1	2013	8397	55	55	44	36.6	25.0	8.0	4.9	0.47	51		
Hess - Tioga #3	2013	8604	344	317	264	226.3	200.6	52.6	41.1	3.15	164 ***		
TRNP - SU (Painted Canyon)	2013	8691	8.5	8	4	5.6	5.5	2.6	2.1	0.18	5		

The highest 1-hour concentration is 344 ppb at Hess – Tioga #3
The highest Three year 1-hour 99th percentile concentration is 164 ppb at Hess – Tioga #3
The highest 3-hour maximum concentration is 226.3 ppb at Hess – Tioga #3
The highest 24-hour concentration is 52.6 ppb at Hess – Tioga #3
The highest arithmetic mean is 3.15 ppb at Hess - Tioga #3

* The air quality standards are:

STATE Standards –

1) 75 ppb Three year average of the annual 99th percentile (4th highest) of the daily maximum 1–hour average concentration in a year.
2) 500 ppb highest 3–hour average concentration not to be exceeded more than once per year.

FEDERAL Standards –

1) 75 ppb Three year average of the annual 99th percentile (4th highest) of the daily maximum 1-hour average concentration in a year.
2) 500 ppb highest 3-hour average concentration not to be exceeded more than once per year.
3) 140 ppb highest 24–hour concentration not to be exceeded more than once per year.
4) 30 ppb annual arithmetic mean.

*** The high values show at the Hess site are source specific, non-regulatory values that have been attributed to plant modifications and/or upset conditions.

TABLE 3

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : TRACE LEVEL SULFUR DIOXIDE (ppb)

			M A X I M A											
		NUM	1 — HOUR		99^{TH} %	3 - HOUR		24 — HOUR		ARITH	3yr	1HR	24HR
LOCATION	YEAR	OBS	1ST	2ND	1HR	1ST	2ND	1ST	2ND	MEAN	Avg	#>273	#>99
Dunn Center	2013	8651	8.5	7.0	6.4	4.4	4.4	2.0	1.8	0.36	9		
Fargo NW	2013	6408 ***	6.3	4.3	3.7	3.9	2.3	1.2	1.0	0.24	4		
Lostwood NWR	2013	8659	71.2	36.5	30.5	31.6	26.5	8.5	8.4	0.92	28		
TRNP - NU	2013	8699	9.9	7.3	6.5	6.0	5.9	2.8	2.5	0.61	9		

The highest 1-hour concentration is 71.2 ppb at Lostwood NWR
The highest Three year 1-hour 99th percentile concentration is 30.5 ppb at Lostwood NWR
The highest 3-hour maximum concentration is 31.6 at Lostwood NWR
The highest 24-hour concentration is 8.5 ppb at Lostwood NWR
The highest arithmetic mean is 0.92 ppb at Lostwood NWR

* The air quality standards are:
STATE Standards —
1) 75 ppb Three year average of the annual 99th percentile (4th highest) of the daily maximum 1-hr average concentration in a year.
2) 500 ppb highest 3—hour average concentration not to be exceeded more than once per year.

FEDERAL Standards —
1) 75 ppb Three year average of the annual 99th percentile (4th highest) of the daily maximum 1-hour average concentration in a year.
2) 500 ppb highest 3-hour average concentration not to be exceeded more than once per year.
3) 140 ppb highest 24—hour concentration not to be exceeded more than once per year.
4) 30 ppb annual arithmetic mean.

*** Less than 80% of the possible samples (data) were collected.
** Qualified prescribed burn.

Sulfur Dioxide 5-Minute Average

Sulfur dioxide 5-minute averages were collected at state-operated sites and both the Hess and Bear Paw Energy networks. The maximum 5-minute average was 1123 ppb at Hess - Tioga #3.
The sulfur dioxide 5-minute data are presented in Table 4 and Trace Level data in Table 5.

TABLE 4

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : SO2 5-Minute Averages (ppb)

LOCATION	YEAR	NUM OBS	5 – MINUTE MAXIMA 1ST	2ND	3RD	# HOURS >600
Bear Paw - MGP #3	2012	8686	88	58	38	
Bear Paw - MGP #5	2012	8650	338	29	23	
Beulah - North	2013	8664	55	40	37	
Bismarck Residential	2013	8707	47	44	40	
DGC #12	2012	8691	412	331	65	
DGC #14	2012	8727	78	59	58	
DGC #16	2012	8738	81	71	66	
DGC #17	2012	8709	48	46	45	
Hannover	2013	8177	42	41	40	
Hess - Tioga #1	2012	8644	235	192	183	
Hess - Tioga #3	2012	8656	1123	626	616	
TRNP - SU (Painted Canyon)	2013	8709	13	11	10	

* No Standard is currently in effect:

TABLE 5

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : Trace Level SO2 5-Minute Averages (ppb)

LOCATION	YEAR	NUM OBS	5 – MINUTE MAXIMA 1ST	2ND	3RD	# HOURS >600
Dunn Center	2013	8536	16.4	14.8	11.1	
Fargo NW	2013	6409	13.8	11.2	8.4	
Lostwood NWR	2013	8659	125.5	58.1	50.8	
TRNP - NU	2013	8699	14.0	11.9	9.2	

The maximum 5-minute concentration is 1123 ppb at Hess – Tioga #3
* No Standard is currently in effect:
*** Less than 80% of the possible samples (data) were collected.

Nitrogen Dioxide

Physical Characteristics and Sources

In its pure state, nitrogen dioxide is a reddish-orangish-brown gas with a characteristic pungent odor. It is corrosive and a strong oxidizing agent. As a pollutant in ambient air, however, it is virtually odorless, although it may be an irritant to the eyes and throat. Oxides of nitrogen, nitric oxide and nitrogen dioxide are formed when the nitrogen and oxygen in the air are combined in high-temperature combustion. Nitric oxide released into ambient air combines with oxygen to form nitrogen dioxide. Major nitrogen dioxide sources in North Dakota are coal conversion processes, natural gas processing plants and natural gas compressor stations.

The dark orangish-brown colored plume frequently seen downwind from a major source is most likely the result of the conversion of nitric oxide to nitrogen dioxide. It is the nitrogen dioxide that causes the plume's dark appearance. The speed with which this conversion occurs is dependent on several factors, primarily the relative concentrations of nitric oxide and ozone, the amount of ultraviolet light available and meteorological conditions.

Health Effects

The negative effects of nitrogen dioxide on personal comfort, well-being and the environment include respiratory distress, as well as impacts on vegetation, materials, visibility and acid deposition.

Standards Comparison

Nitrogen dioxide was monitored at nine sites. Seven were operated by the department and two by industry.

The State annual standard (53 ppb) was not exceeded during the year. The maximum annual arithmetic mean of those sites collecting at least 80 percent of the possible data for the year was 5.34 ppb at Bismarck Residential.

The state 1-hour standard (100ppb) was not exceeded during the year. The maximum three year average 98^{th} percentile daily 1-hour was 37 at Fargo NW.

The nitrogen dioxide data are summarized in Table 6.

TABLE 6

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : NITROGEN DIOXIDE (ppb)

LOCATION	YEAR	NUM OBS	MAXIMA 1 — HOUR 1ST	2ND	98TH PCTL	ARITH MEAN	3yr Avg
Beulah - North	2013	8639	35	34	21	2.37	22
Bismarck Residential	2013	8660	38	37.5	34	5.34	35
DGC #12	2013	8657	45	29	20	2.94	20
DGC #17	2013	6488 ***	26	23	18	2.11	20
Dunn Center	2013	8295	12	11	10	1.72	10
Fargo NW	2013	8102	42	41	36	4.37	37
Hannover	2013	8010	25	19	15	2.11	15
Lostwood NWR	2013	7983 ***	89	22	13	1.98	17
TRNP - NU	2013	8218	13	12.7	11	1.16	10

The highest 1-hour concentration is 89 ppb at Lostwood NWR
The highest Three year average of the annual 98th percentile is 5.34 ppb at Bismarck Residential
The highest Arithmetic Mean concentration is 5.34 ppb at Bismarck Residential
The highest Three year 1-hour 98th percentile concentration is 37 ppb at Fargo NW

* The air quality standards are:
STATE Standards —
1) 100 ppb Three year average of the annual 98th percentile (8th highest) of the daily maximum 1-hour average concentration in a year.
2) 53 ppb annual arithmetic mean.

FEDERAL Standards —
1) 100 ppb Three year average of the annual 98th percentile (8th Highest) of the daily maximum 1-hour average concentration in a year.
2) 53 ppb annual arithmetic mean.

Ammonia

Physical Characteristics

Ammonia is a corrosive, colorless gas with a strong irritating odor. It is used in making fertilizer, plastics, dyes, textiles, detergents and pesticides. It reacts with acids and oxidizing materials (fluorine, chlorine, etc.). It is corrosive to copper, zinc and many metal surfaces. It reacts with hypochlorite and halogens to form explosive compounds that are pressure and temperature sensitive.

Health Effects

In mild concentrations (<25,000 ppb), ammonia will cause conjunctivitis and dermatitis. At higher concentrations, it will cause swelling, painful burns, lesions, and possible loss of vision. On contact with the skin, it will cause caustic-like burns and inflammation. Toxic level (300,000 ppb) skin exposure may cause skin lesions resulting in early necrosis and scarring. Inhalation is corrosive and irritating to the upper respiratory system and all mucus-type tissue. Depending on the concentration inhaled, it may cause burning sensations, coughing, wheezing, shortness of breath, headache and nausea, with eventual collapse and death.

Standards Comparison

There is no ambient air quality standard for ammonia. Because ammonia is important to the newer air quality dispersion models, the ammonia analyzer is maintained at the Beulah - North site. Long-term average ambient ammonia concentration is a required input to the dispersion modeling system. Chemistry governing the conversion of sulfur oxides to sulfate and the conversion of nitrogen oxides to nitrate in Calpuff is constrained by the availability of ambient ammonia. Therefore, the ambient level of ammonia affects dispersion modeling predictions for SO_2/NO_2 concentrations, general visibility and particulate deposition.

The ammonia data are summarized in Table 7.

TABLE 7

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : AMMONIA (PPB)

			MAXIMA 1 - HOUR			
LOCATION	YEAR	NUM OBS	1ST	2ND	3RD	4TH
Beulah – North	2013	8602	246.0	220.0	127.0	123.0
Lostwood NWR	2013	7041	42.0	41.0	35.0	25.0

The highest 1-hour concentrations is 246.0 at Beulah - North
* No Standard is currently in effect:

Carbon Monoxide

Physical Characteristics and Sources

Carbon monoxide is an odorless, colorless and toxic gas. CO is impossible to see, taste or smell the toxic fumes. At lower levels of exposure, CO causes mild effects that are often mistaken for the flu. These symptoms include headaches, dizziness, disorientation, nausea and fatigue. The effects of CO exposure can vary greatly from person to person depending on age, overall health and the concentration and length of exposure.

Worn or poorly adjusted and maintained combustion devices (e.g., boilers, furnaces) can be significant sources, or if the flue is improperly sized, blocked, disconnected, or is leaking. Auto, truck, or bus exhaust from nearby roads, or parking areas can also be a source.

Health Effects

Carbon monoxide at low concentrations, fatigue in healthy people and chest pain in people with heart disease. Carbon monoxide at higher concentrations, impaired vision and coordination, headaches, dizziness, confusion, and nausea. Can cause flu-like symptoms that clear up after leaving home. Fatal at very high concentrations. Acute effects are due to the formation of carboxyhemoglobin in the blood, which inhibits oxygen intake. At moderate concentrations, angina, impaired vision, and reduced brain function may result. At higher concentrations, CO exposure can be fatal.

Standards Comparison

Carbon monoxide was monitored at one state-run site Fargo NW.

The 1-hour State standard (35,000 ppb) was not exceeded during the year. The maximum 1-hour concentration was 974 ppb at Fargo NW.

The 8-hour standard (9,000 ppb) was not exceeded during the year .
The maximum 8-hour concentration was 400 ppb at Fargo NW.

The carbon monoxide data are summarized in Table 8.

TABLE 8

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : **CARBON MONOXIDE** (PPB)

LOCATION	YEAR	NUM OBS	MAXIMA 1-HOUR 1ST	MAXIMA 1-HOUR 2ND	MAXIMA 8-HOUR 1ST	MAXIMA 8-HOUR 2ND	1HR #>35000	8HR #>9000
Fargo NW	2013	7727	974.0	866.0	400.0	300.0		

* The STATE and FEDERAL air quality standards are:
1) The maximum allowable 1-hour concentration is 35000 ppb not to be exceeded more than once per year.
2) The maximum allowable 8-hour concentration is 9000 ppb not to be exceeded more than once per year.

Ozone

Physical Characteristics and Sources

Ozone is a highly reactive form of oxygen. At very high concentrations, it is a blue, unstable gas with a characteristic pungent odor. It often can be detected around an arcing electric motor, lightning storms or other electrical discharges. However, at ambient concentrations, ozone is colorless and odorless.

At ground level where it can be breathed, ozone is a pollutant. However, ground-level ozone should not be confused with the stratospheric ozone located between 12 and 30 miles above the earth's surface. The stratospheric ozone layer shields the earth from intense cancer-causing ultraviolet radiation. Concentrations of ozone in this layer are approximately 10,000 to 12,000 ppb or 100 times the state's ambient air quality standard for ozone. Occasionally, meteorological conditions can result in stratospheric ozone being brought to ground level. This can increase concentrations by 50 to 100 pbb.

Ozone is not emitted directly from a source like other pollutants, but forms as a secondary pollutant. Its precursors are certain hydrocarbons and nitrogen oxides that react chemically in sunlight to form ozone. The sources for these reactive hydrocarbons are automobile exhaust; gasoline and oil storage and transfer; industrial paint solvents; degreasing agents; cleaning fluids; and ink solvents. Nitrogen oxides are created when nitrogen and oxygen in the air combine during high-temperature combustion. Also, vegetation gives off some reactive hydrocarbons; for example, pine trees give off terpene.

Ozone production is a year-round phenomenon. However, the highest ozone levels generally occur during the summer season when sunlight is stronger and stagnant meteorological conditions can cause reactive pollutants to remain in an area for several days. Ozone produced under these conditions can be transported many miles.

Health Effects

Short-term exposure to ozone in the range of 150 to 250 ppb may impair mechanical functions of the lungs and may induce respiratory difficulties and related symptoms in sensitive individuals (those who have asthma, emphysema or reduced lung function). Symptoms and effects of ozone exposure are more readily induced in people who are exercising.

Ozone is the major component of photochemical "smog," although the haziness and odors of the smog are caused by other components. The deterioration and degradation of material, especially the splitting and cracking of rubber tires and windshield wiper blades, is associated with ozone. Many plants, such as soybeans and alfalfa, are sensitive to ozone and can be damaged by extended exposure to low levels of ozone.

Standards Comparison

Ozone was monitored at seven State-run sites and the National Park Service's TRNP - SU site. These data are used in computer dispersion models as part of both the primary and secondary chemical transformation equations.

The 3-year average of the fourth-highest daily maximum 8-hour concentrations. The highest 3-year average fourth-highest 8-hour concentration was 59 ppb at Beulah North, Fargo NW, and Williston.

The ozone data are summarized in Table 9.

TABLE 9

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : Ozone (ppb)

LOCATION	YEAR	VAL DAYS	MAXIMA 1 – HOUR 1ST	MAXIMA 1 – HOUR 2ND	MAXIMA 8 – HOUR 1ST	MAXIMA 8 – HOUR 2ND	MAXIMA 8 – HOUR 3RD	MAXIMA 8 – HOUR 4TH	3yr Avg	1HR #>120	8HR #>75
Beulah North	2013	130	67	65	60	60	60	59	59		
Bismarck Residential	2013	153	71	70	65	62	62	62	58		
Dunn Center	2013	125	69	64	60	60	59	57	56		
Fargo NW	2013	130	71	70	64	60	59	59	59		
Hannover	2013	152	69	69	65	62	62	61	58		
Lostwood NWR	2013	149	72	70	68	66	61	59	58		
TRNP - NU	2013	152	69	63	62	60	60	59	58		
TRNP – SU (Painted Canyon)	2013	153	66	64	63	59	58	57	57		
Williston	2013	138	64	64	60	60	60	59	59		

The highest 1–hour concentration is 72 ppb at Lostwood NWR
The Three year average 4th highest 8–hour concentration is 62 ppb at Bismarck Residential
The highest Three year 8-hour 99th percentile concentration is 59 ppb at Beulah North, Fargo NW and Williston

* The air quality standards for ozone are:

STATE – 75ppb Three year average of the annual 4th highest daily maximum 8-hour concentrations.

FEDERAL Standards - 75 ppb Three year average of the annual 4th highest daily maximum 8-hour concentrations.

Particulate Matter ($PM_{2.5}$ & PM_{10})

Physical Characteristics and Sources

Particulate matter is the term given to the tiny particles of solid or semi-solid material found in the atmosphere. Particulates ranging in size from less than 0.1 micrometer to 50 micrometers are called Total Suspended Particulate (*TSP*). Particles larger than 50 micrometers tend to settle out of the air quickly and are not considered to have a health impact. Particulate matter 10 micrometers (microns) in diameter and smaller is considered inhalable. This particulate matter is called PM_{10}.

The majority of anthropogenic (man-made) particulate are in the 0.1 to 10 micrometer diameter range. Particles larger than 10 micrometers usually are due to Afugitive dust@ (windblown sand and dirt from roadways, fields and construction sites) and contain large amounts of silica (sand-like) materials. PM_{10} particulate, on the other hand, generally is created during a burning process and includes fly ash (from power plants), carbon black (from automobiles and diesel engines) and soot (from fireplaces and wood-burning stoves). PM_{10} particulates from these sources contain a large percentage of elemental and organic carbon, which play a role in both visual haze and health issues.

In addition, particles less than 2.5 micrometers ($PM_{2.5}$) are major contributors to visibility degradation because of their ability to "scatter" light.

Health Effects

The health risk from an inhaled dose of particulate matter depends on the size and concentration of the particulate. Size determines how deeply the inhaled particulate will penetrate into the respiratory tract, where it can persist and cause respiratory damage. Particles less than 10 micrometers in diameter are easily inhaled deeply into the lungs.

Fine particulate ($PM_{2.5}$) pollution affects the health of certain subgroups. Such groups can be identified as potentially at risk of adverse health effects from airborne pollutants. There is very strong evidence that asthmatics are much more sensitive (i.e., respond with symptoms at relatively low concentrations) to the effects of particulates than is the general healthy population.

The effects of particulate exposure may be the most widespread of all pollutants. Because of the potential for extremely long-range transport of 2.5 particles and because of the chemical reactions that occur, no place on earth has been spared from the particulate generated by urban and rural sources. The effects of particulate range from visibility degradation to climate changes to vegetation damage. General soiling, commonly thought to be just a nuisance, can have long-term effects on paint and other materials. Acid deposition can be detected in the most remote areas of the world.

Inhalable $PM_{2.5}$ Particulates

Inhalable $PM_{2.5}$ particulates were monitored at four sites using manual samplers and seven sites now monitor $PM_{2.5}$ on a continuous basis. The sites at Beulah and TRNP - SU collect a sample once every six days. Sites at Bismarck and Fargo collect a sample once every three days. Sites at Beulah, Bismarck, Dunn Center, Fargo, Hannover, Lostwood, and TRNP-NU also monitor $PM_{2.5}$ (BAMM) on a continuous basis.

Standards Comparison

The 24-hour federal standard (35 µg/m^3) was not exceeded during the year. The maximum 24-hour average concentration was 22.2 µg/m^3 at Williston. The federal standard is defined as the 3 year average of the 98th percentile values, not the maximum individual 24-hour average.

The federal annual standard (15 µg/m^3) was not exceeded for the year. The maximum annual average was 9.6 µg/m^3 at Williston.

The inhalable $PM_{2.5}$ data are summarized in Table 10.

TABLE 10

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : Inhalable $PM_{2.5}$ Particulates ($\mu g/m^3$)

LOCATION	YEAR	VAL DAYS	MIN	MAXIMA 24 – HOUR 1ST	2ND	3RD	24-HR 98th%	24-HR 3yr Avg	WTD MEAN	Annual 3yr Avg	#>35	AM>15
Beulah - North	2013	61		22.7	18.1	15.5	18.1	(NA)	6.16	(NA)		
Beulah - North (BAMM)	2012	357		22.4	19.6	19.3	15.8	15.0	6.12	5.9		
Bismarck Residential	2013	119		17.5	17.1	17.0	17.0	(NA)	6.46	(NA)		
Bismarck Residential (BAMM)	2013	359		20.3	20.2	18.4	15.4	15.0	5.74	6.2		
Dunn Center (BAMM)	2013	350		15.9	15.2	14.8	13.2	15.0	4.35	5.5		
Fargo NW	2013	104		29.5	25.3	17.9	17.9	(NA)	7.23	(NA)		
Fargo NW (BAMM)	2013	303 ***		29.0	22.7	20.8	18.2	19.0	6.37	7.0		
Hannover (BAMM)	2013	360		23.7	21.3	17.4	14.4	15.0	4.96	4.9		
Lostwood NWR (BAMM)	2013	358		21.6	20.4	19.4	14.9	15.0	5.69	6.8		
TRNP - NU (BAMM)	2013	360		20.2	14.2	13.9	11.4	15.0	3.62	6.5		
TRNP - SU (Painted Canyon)	2013	61		14.2	11.7	11.2	11.7	11.0	4.67	4.4		
Williston	2013	359		36.1	31.2	25.5	22.2	22.0	9.61	9.6		

The highest 24-hour concentration is 36.1 µg/m3 at Williston
The highest Three year average 24-hour concentration is 22.0 µg/m3 at Williston
The highest Annual Weighted Mean concentration is 9.61 µg/m3 at Williston
The highest Three year average Annual weighted Mean concentration is 9.6 µg/m3 at Williston

* The ambient air quality standards are:
FEDERAL Standards —
1) 24—hour: 3—year average of 98th percentiles not to exceed 35 $\mu g/m^3$.
2) Annual: 3—year average not to exceed 15 $\mu g/m^3$.

*** Less than 80% of the possible samples (data) were collected.

Inhalable Continuous $PM_{2.5}$ Particulates

Inhalable particulates are monitored continuously at one site. Since these data are not collected by an EPA reference or equivalent method, the data cannot be used for regulatory purposes. However, if these data were to indicate an exceedance of a standard, then a reference or equivalent method sampler must be installed to verify the data collected by these analyzers.

The maximum 1-hour average concentration was 41 μg/m^3 at TRNP - SU. The maximum 24-hour average concentration was 21.8 μg/m^3 at TRNP - SU. The maximum annual average for the year was 5.66 μg/m^3 at TRNP - SU.

The inhalable continuous $PM_{2.5}$ data are summarized in Table 11.

Table 11

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : Inhalable Continuous $PM_{2.5}$ (μg/m^3)

			MAXIMA								
		NUM	1 — HOUR		24 — HOUR					24HR	
LOCATION	YEAR	OBS	1ST	2ND	1ST	2ND	3RD	4TH	MEAN	#>35	AM>15
TRNP - SU (Painted Canyon)	2013	8709	41.0	39.0	21.8	14.5	14.1	13.3	5.66		

* The EPA—required analyzer used to collect this data is not a reference or equivalent method; this data cannot be compared to the $PM_{2.5}$ standards. This data can only be used as an indicator of the actual $PM_{2.5}$ ambient concentrations. If this data were to indicate there may be an exceedance of the ambient standards, then the department could be required to install a designated reference or equivalent sampler.

Inhalable Continuous PM_{10} Particulates

Inhalable continuous PM_{10} particulate concentrations were monitored at seven sites.

Standards Comparison

The 24-hour state standard (150 µg/m^3) was not exceeded during the year. The maximum 24-hour concentration was 91 µg/m^3 at Williston.

The inhalable continuous particulate (PM_{10}) data are summarized in Table 12.

TABLE 12

COMPARISON OF AIR QUALITY DATA WITH
THE NORTH DAKOTA AMBIENT AIR QUALITY STANDARDS *

POLLUTANT : Inhalable Continuous PM_{10} (µg/m^3)

			M A X I M A						
		NUM	24 – HOUR				24HR		
LOCATION	YEAR	OBS	1ST	2ND	3RD	4TH	MEAN	#>150	AM>50
Beulah - North	2013	8662	37.0	28.0	26.0	24.0	9.0		
Bismarck Residential	2013	8490	77.0	71.0	58.0	40.0	13.9		
Dunn Center	2013	8426	76.0	74.0	66.0	63.0	16.8		
Fargo NW	2013	7236	70.0	62.0	58.0	56.0	16.7		
Hannover	2013	*** 8562	40.0	39.0	38.0	38.0	12.3		
Lostwood NWR	2013	8268	51.0	37.0	36.0	36.0	10.8		
TRNP - NU	2013	8692	27.0	19.0	19.0	18.0	7.1		
Williston	2013	8546	91.0	76.0	72.0	70.0	23.0		

The highest 24-hour concentration is 91.0 µg/m3 at Williston
The highest Annual Mean concentration is 23.0 µg/m3 at Williston

FEDERAL air quality standards are:
150 µg/m^3 highest averaged over a 24–hour period with no more than one expected exceedance per year.

SUMMARY AND CONCLUSIONS

The State of North Dakota has relatively clean air. North Dakota is one of only 13 states to comply with all federal ambient air quality standards. The air quality in North Dakota also meets all state ambient air quality standards. Site and pollutant combinations that do not meet the 80 percent data recovery for the full year are reported as a partial year. A summary for each pollutant is provided below.

Sulfur Dioxide

Neither the State nor federal standards were exceeded at any State operated monitoring site. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standard were as follows: 3-year average 1-hour 99th percentile – 164ppb (See page 10); 3-hour – 226.3 ppb; 24-hour – 52.6 ppb; annual 3.15 ppb.

Sulfur Dioxide 5-Minute Averages

There is no SO_2 5-minute standard currently in effect. The maximum 5-minute average was 1123 ppb.

Nitrogen Dioxide

Neither the State nor federal standards were exceeded at any of the monitoring sites. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standard were as follows: Three year average of the 98th percentile 1-hour average concentrations – 37 ppb; annual – 5.34 ppb.

Ammonia

No standard is currently in effect. The maximum 1-hour average was 246.0 ppb.

Carbon Monoxide

Neither the state nor federal standard was exceeded during the year. The 1-hour maximum and maximum 8-hour concentrations and the concentrations expressed as a percentage of the applicable standard are were follows: 1-hour - 974 ppb; highest fourth-highest 8-hour - 400 ppb.

Ozone

Neither the State nor federal standard was exceeded during the year. The highest fourth-highest 8-hour concentrations and the concentrations expressed as a percentage of the applicable standard are were follows: see page 21; highest three year average fourth-highest 8-hour - 59 ppb.

Inhalable $PM_{2.5}$ Particulates

The federal $PM_{2.5}$ standards were not exceeded during the year. The maximum concentrations and maximum concentrations expressed as a percentage of the standard were as follows: highest 3 year average 98th percentile 24-hour - 22 $\mu g/m^3$ see page 23; three year average annual – 9.6 $\mu g/m^3$.

Inhalable Continuous PM_{10} Particulates

Neither the State nor federal PM_{10} standards were exceeded during the year. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable PM_{10} standard were as follows: 24-hour – 91 $\mu g/m^3$.

REFERENCES

REFERENCES

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APPENDICES

APPENDIX 1

North Dakota and Federal Ambient Air Quality Standards

STANDARDS

In general, air pollutants are divided into two classes: primary pollutants such as sulfur dioxide, carbon monoxide, nitrogen dioxide, hydrogen sulfide, particulate matter (<2.5 microns) particulate matter (<10 microns); secondary pollutants, which are formed as the result of a chemical reaction. Sources of primary pollutants include power plants, natural gas processing plants, oil wells, oil refineries, asphalt plants, factories, wind-blown dirt, automobiles, fireplaces and incinerators. Secondary pollutants result from a primary pollutant undergoing a chemical reaction; for example, ozone is formed as a result of a photochemical reaction between hydrocarbons and oxides of nitrogen.

Table A1-1 presents the current North Dakota Ambient Air Quality Standards. Table A1-2 presents the federal Ambient Air Quality Standards. State standards must be as stringent as (but may be more stringent than) federal standards.

TABLE A1-1
North Dakota
Ambient Air Quality Standards

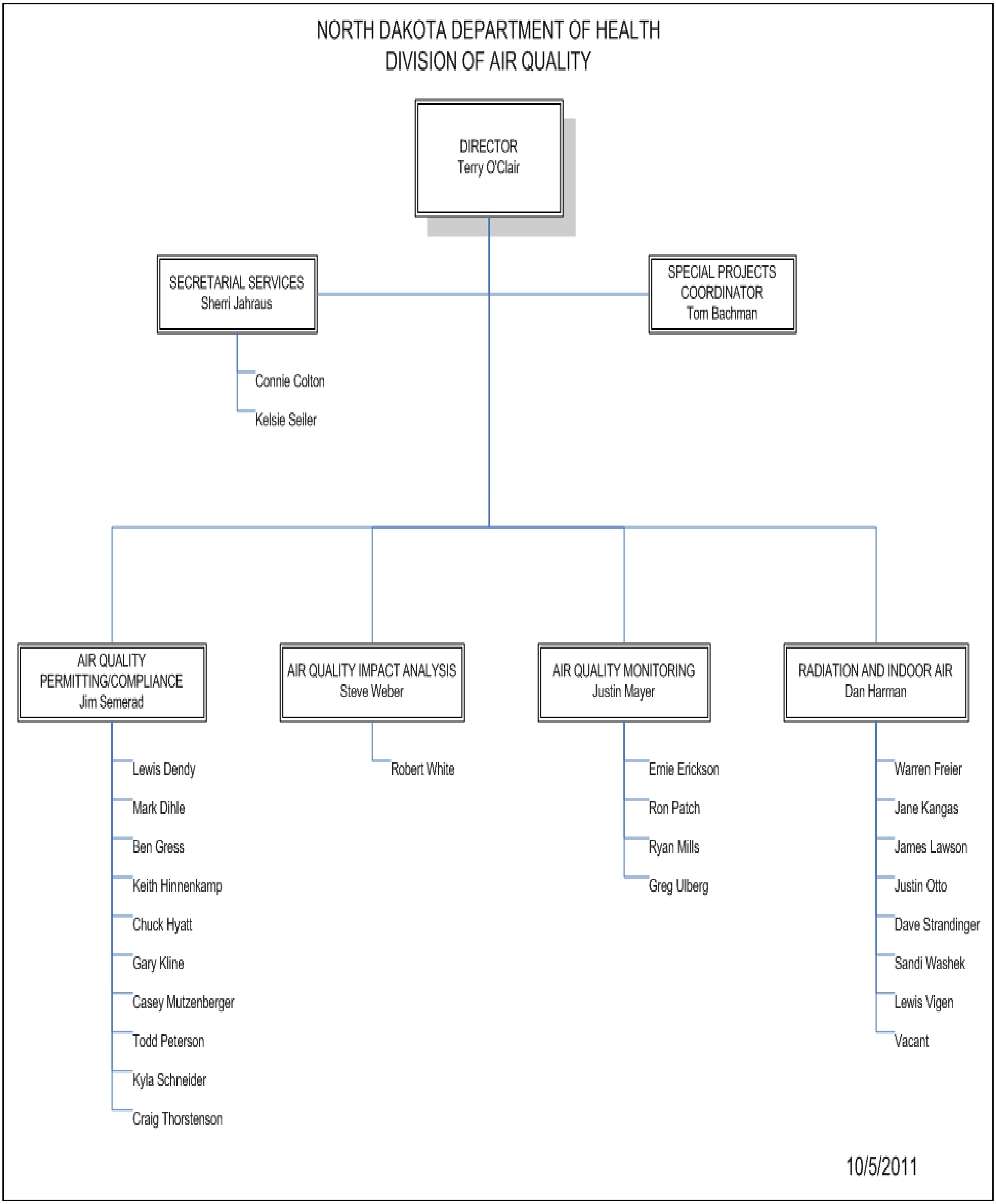
Air Contaminants		Standards (Maximum Permissible Concentrations)
Inhalable Particulate (PM_{10})	150	micrograms per cubic meter of air maximum 24-hour average concentration with no more than one expected exceedance per year
Sulfur Dioxide*	30	parts per billion (80 micrograms per cubic meter of air), maximum annual arithmetic mean concentration
	75	parts per billion (196 micrograms per cubic meter of air), 99th percentile of the daily 1-hour maximum concentrations
	140	parts per billion (365 micrograms per cubic meter of air), maximum 24-hour average concentrations. Not to be exceeded more than once per calendar year
	500	parts per billion (1309 micrograms per cubic meter of air), maximum 3-hr average concentrations. Not to be exceeded more than once per calendar year
Hydrogen Sulfide	10.0	parts per million (14 milligrams per cubic meter of air), maximum instantaneous (ceiling) concentration not to be exceeded
	0.20	parts per million (280 micrograms per cubic meter of air), maximum 1-hour average concentration not to be exceeded more than once per month
	0.10	parts per million (140 micrograms per cubic meter of air), maximum 24-hour average concentration not to be exceeded more than once per year
	0.02	parts per million (28 micrograms per cubic meter of air), maximum arithmetic mean concentration averaged over three consecutive months
Carbon Monoxide	9	parts per million (10 milligrams per cubic meter of air), maximum 8-hour concentration not to be exceeded more than once per year
	35	parts per million (40 milligrams per cubic meter of air), maximum 1-hour concentration not to be exceeded more than once per year
Ozone	75	parts per billion (147 micrograms per cubic meter of air), Three year average of the annual fourth-highest daily maximum 8-hr concentrations
Nitrogen Dioxide	53	parts per billion (100 micrograms per cubic meter of air), maximum annual arithmetic mean
	100	parts per billion (188 micrograms per cubic meter of air), Three year average of the annual 98th percentile of the daily maximum 1-hr average concentrations in a calendar year
Lead	.15	micrograms per cubic meter of air, maximum arithmetic mean averaged over a calendar quarter

TABLE A1-2
Federal Ambient Air Quality Standards

Pollutant	Description	Primary	Secondary
Inhalable Particulate (<2.5 microns)	3-year average of annual arithmetic mean concentrations	15 µg/m^3	15 µg/m^3
	3-year average of the 98th percentile of the 24-hour concentrations	35 µg/m^3	35 µg/m^3
Inhalable Particulates (<10 microns)	99th percentile of the 24-hour concentrations averaged over 3 years	150 µg/m^3	150 µg/m^3
Sulfur Dioxide	Annual arithmetic mean	30 ppb (80 µg/m^3)	-
	Three year average or the annual 98th percentile of the daily maximum 1-hr average concentrations in a calendar year	75 ppb (196 µg/m^3)	-
	Maximum 24-hour concentration not to be exceeded more than once per year	140 ppb (365 µg/m^3)	-
	Maximum 3-hour concentration not to be exceeded more than once per year	-	500 ppb (1309 µg/m^3)
Carbon Monoxide	8-hour concentration not to be exceeded more than once per year	9 ppm (10,000 µg/m^3)	-
	1-hour average concentration not to be exceeded more than once per year	35 ppm (40,000 µg/m^3)	-
Ozone	3-year average of the annual highest 4th highest daily maximum 8- hour concentrations, not to be exceeded	75 ppb	75 ppb
Nitrogen Dioxide	Annual arithmetic mean	53 ppb (100 µg/m^3)	53 ppb (100 µg/m^3)
	3-year average of the annual 98th percentile of the daily maximum 1hr average concentrations in a calendar year	100 ppb (100 µg/m^3)	100 ppb (100 µg/m^3)
Lead	Maximum arithmetic mean averaged over a calendar quarter	1.5 µg/m^3	1.5 µg/m^3

APPENDIX 2

Air Quality Personnel
Organizational Chart



A2-1 Air Quality Organizational Chart

APPENDIX 3

Wind and Pollution Star Charts

The figures in this appendix are arranged with the site's wind star chart in the upper left-hand position. To remove most of the wind direction bias caused by low wind speeds, wind speeds less than 5 mph were removed from the data. For department-operated sites, the pollution star charts are arranged with sulfur dioxide in the upper right-hand position. Next is either hydrogen sulfide or nitrogen dioxide. For industry networks, the wind star chart is presented first, followed by the parameters monitored at each site. There is only one MET station for each network except for the Bear Paw - McKenzie Gas Plant network, which has wind direction at each site.

The pollution star charts present the percentage of time a pollutant is detected when the wind is from a given direction. For example, a wind star chart shows a frequency of 122, and a pollution star chart shows a 66 for the same direction. This means that 66 percent of the time (80 of the possible 122 hours) the wind was greater than 5 mph from that direction and an hourly average for that pollutant had a detectable concentration.

Ozone pollution star charts are not presented because the percentage of time would be essentially 100 percent for each wind sector.

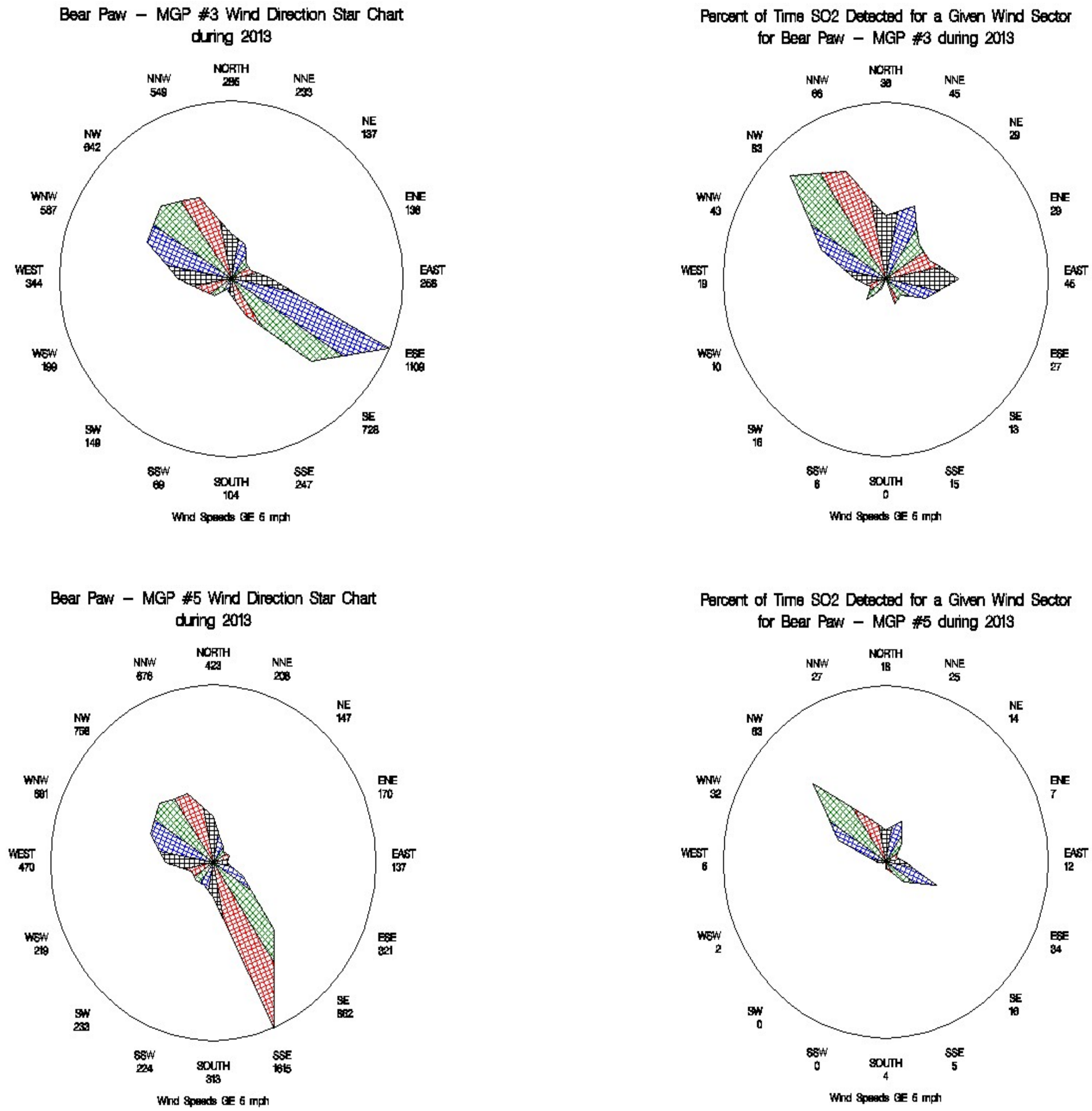


Figure A3-1 Bear Paw - MGP

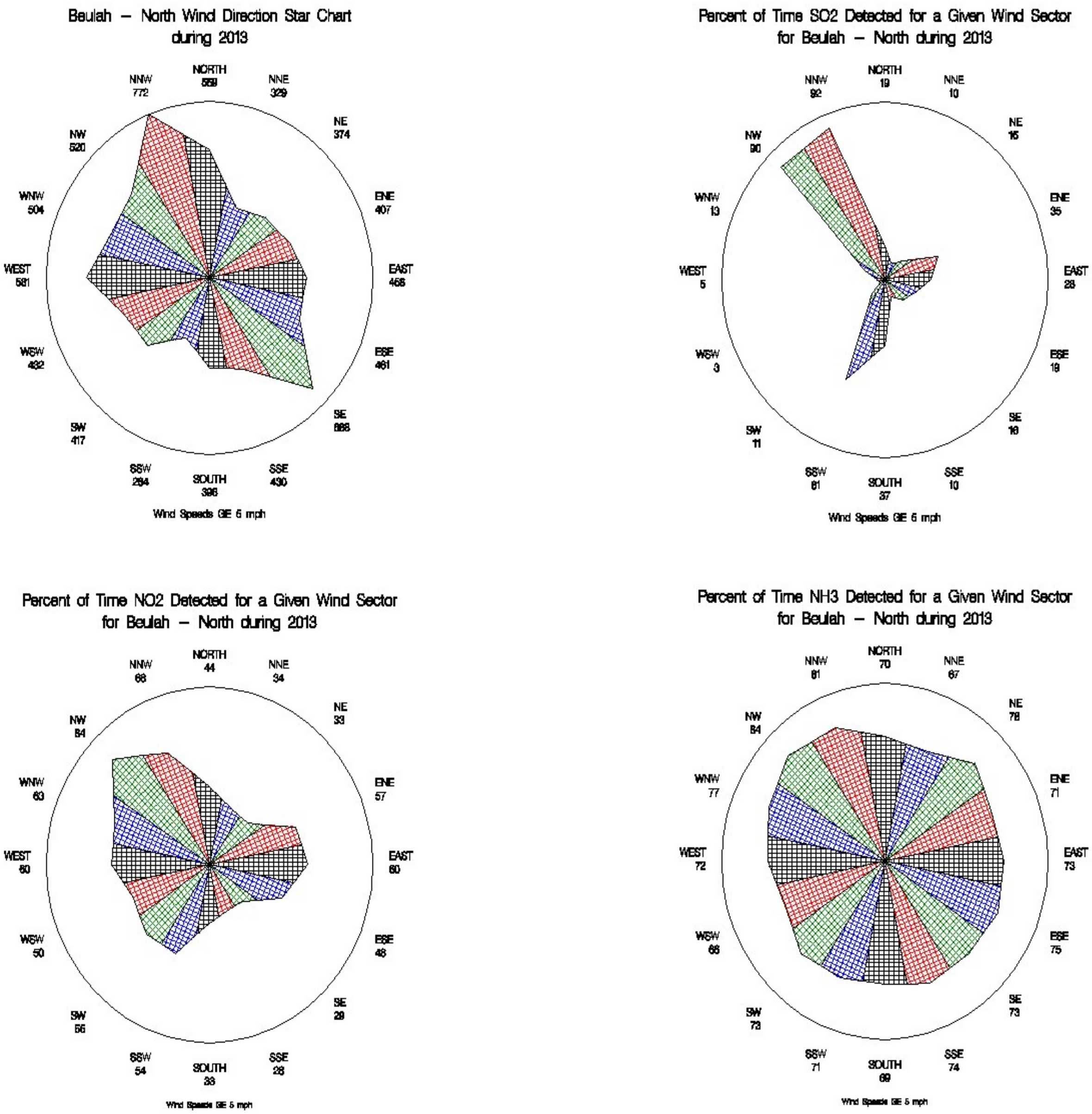
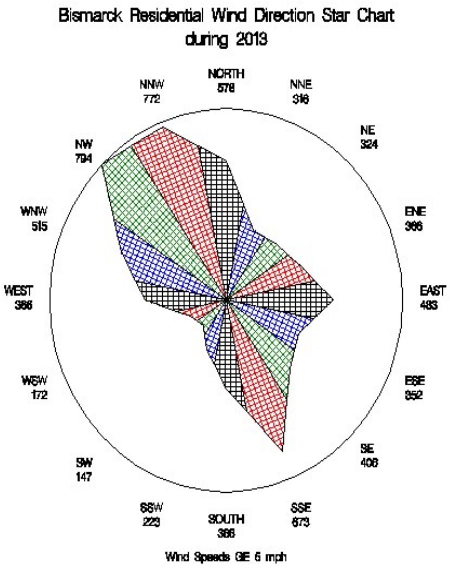
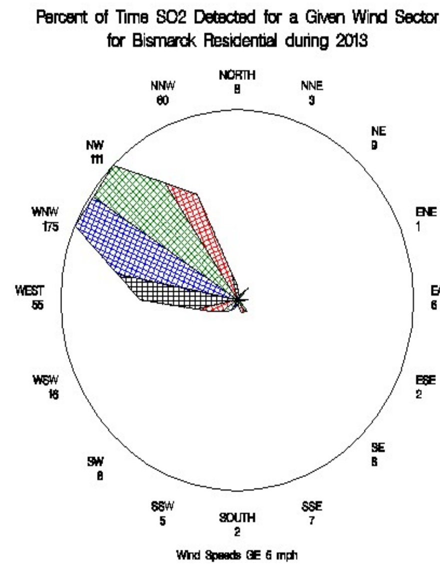


Figure A3-2 Beulah North





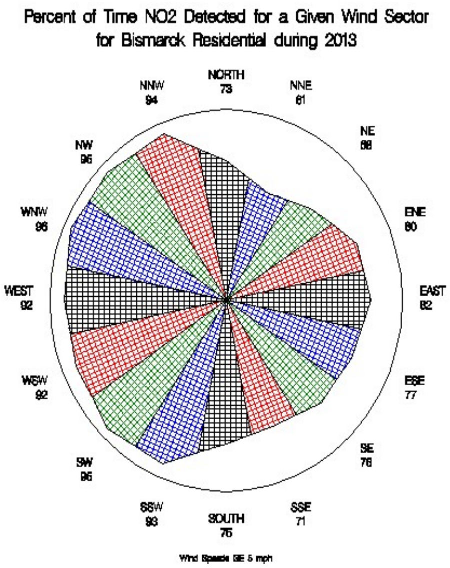
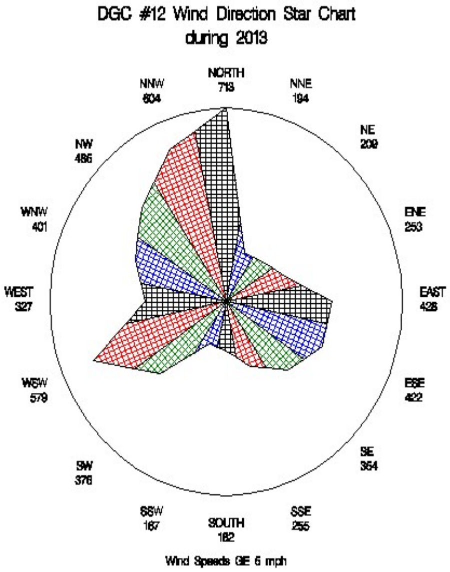
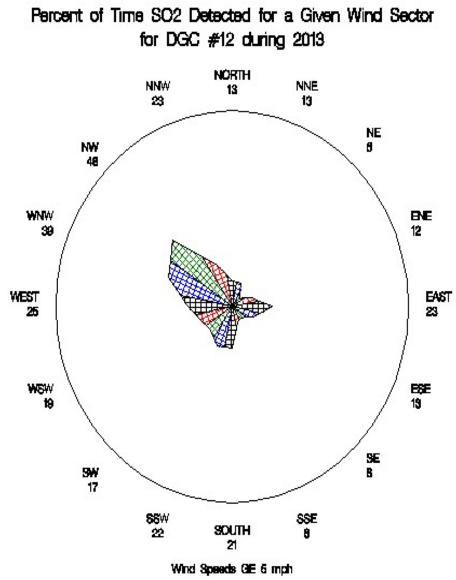
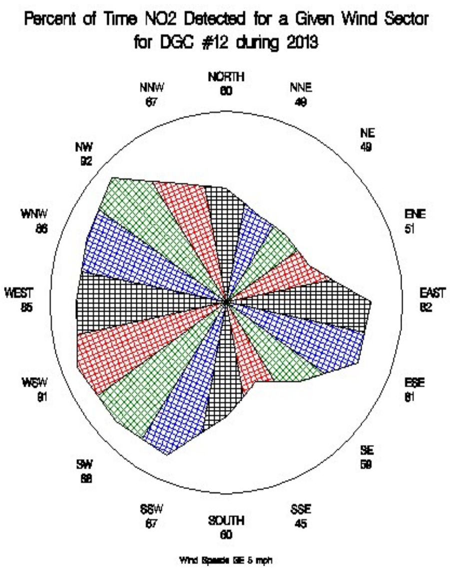
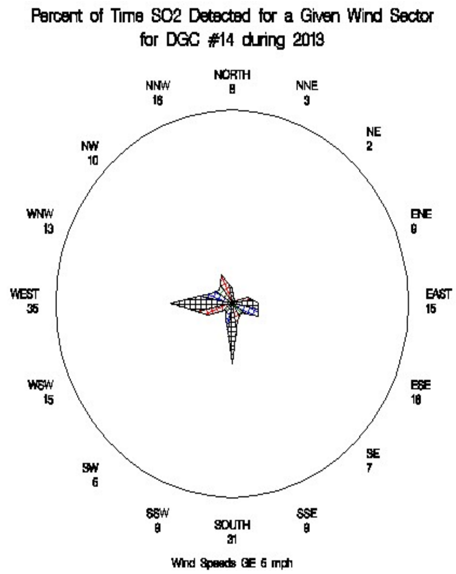


Figure A3-3 Bismarck Residential









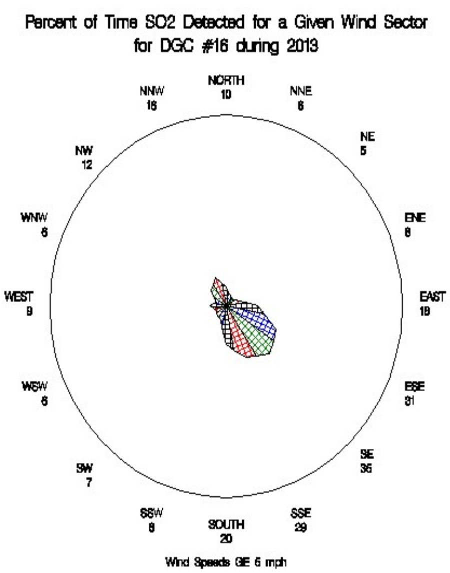
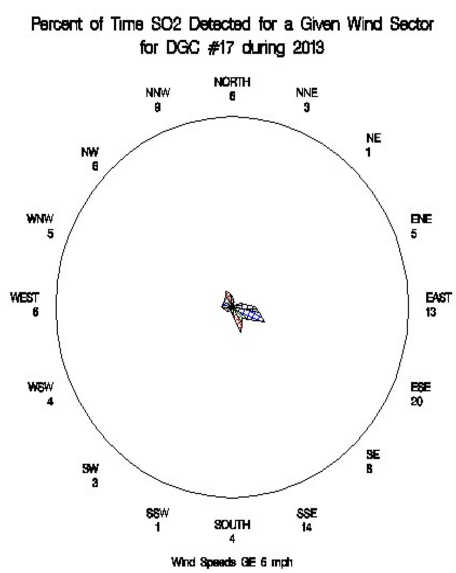


Figure A3-4 DGC



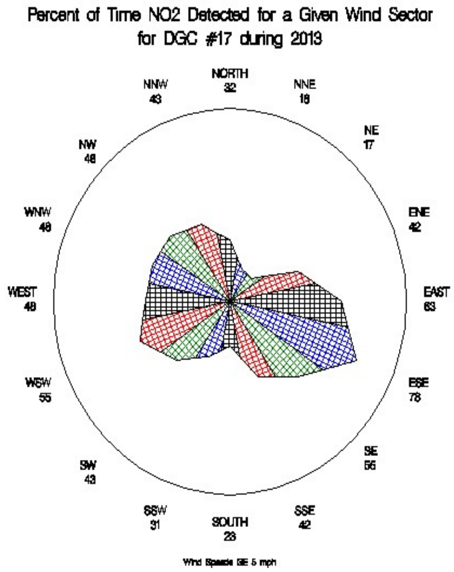
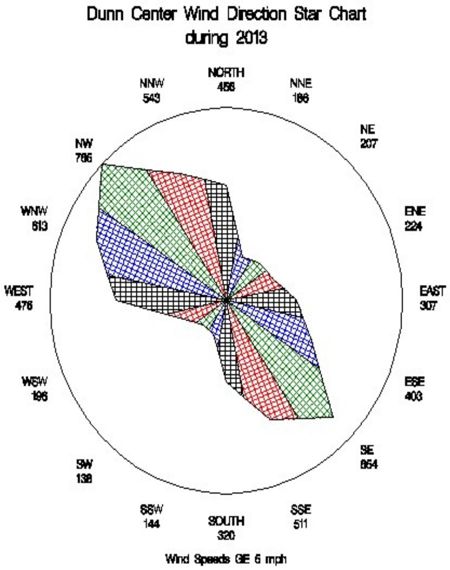
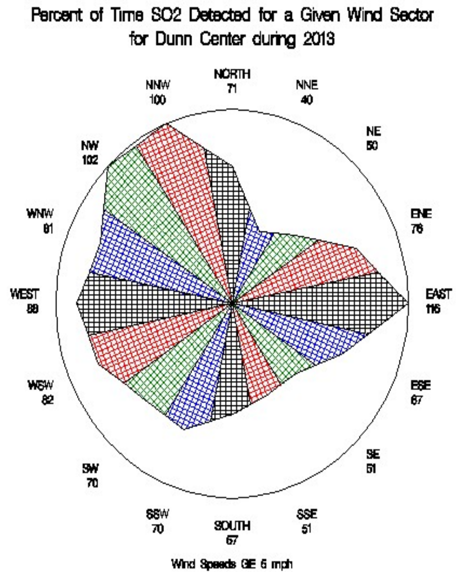


Figure A3-4 DGC (cont.)





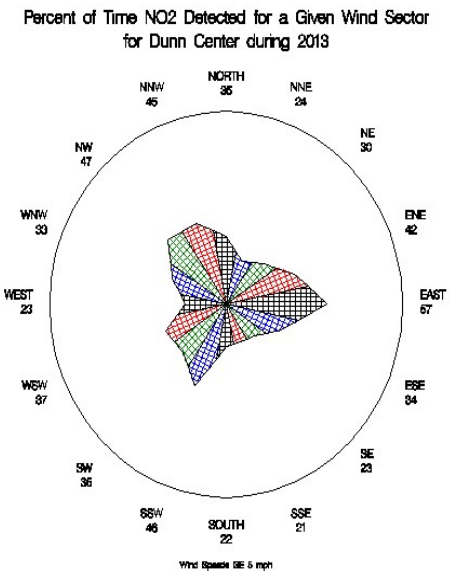
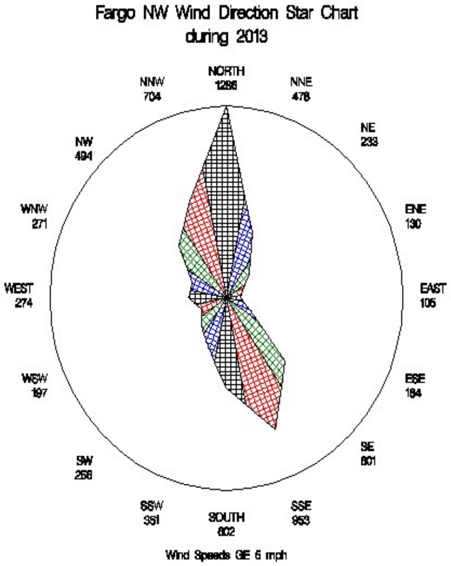
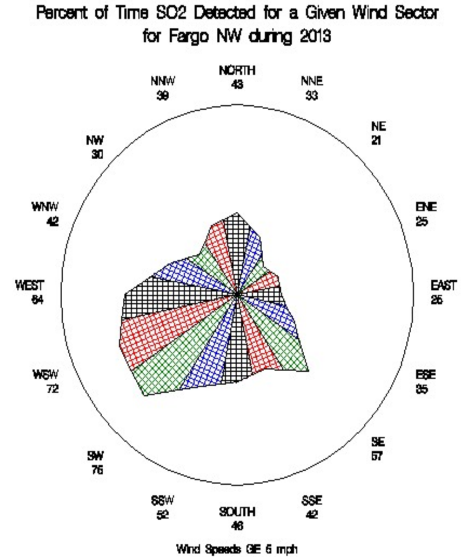


Figure A3-5 Dunn Center





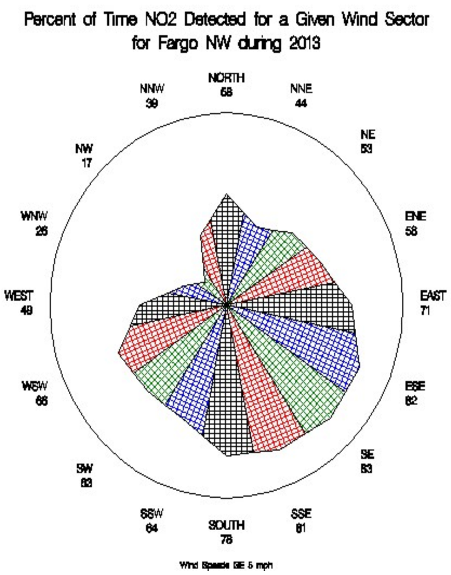
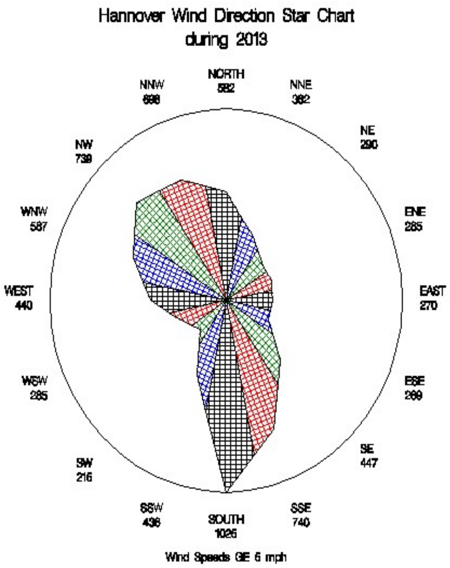
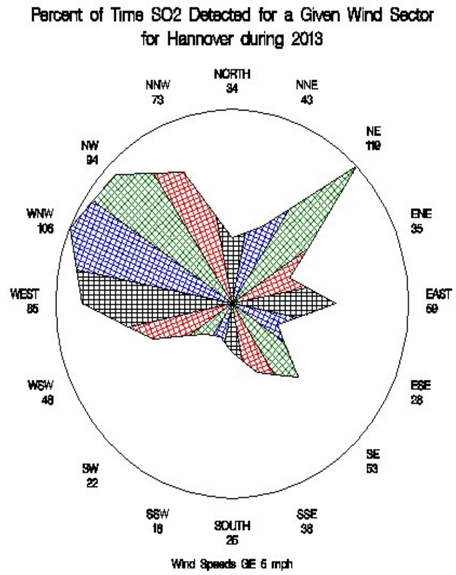


Figure A3-6 Fargo NW





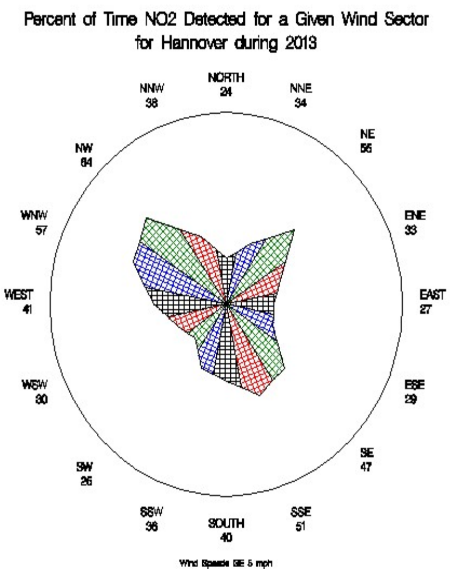
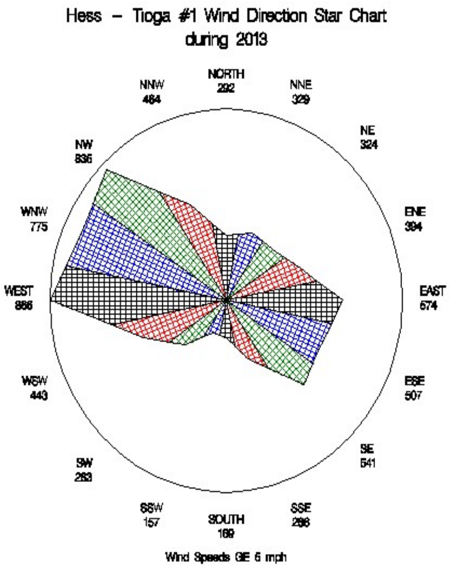
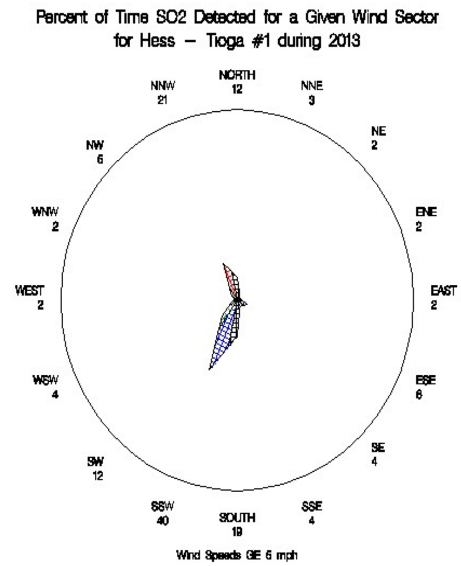


Figure A3-7 Hannover





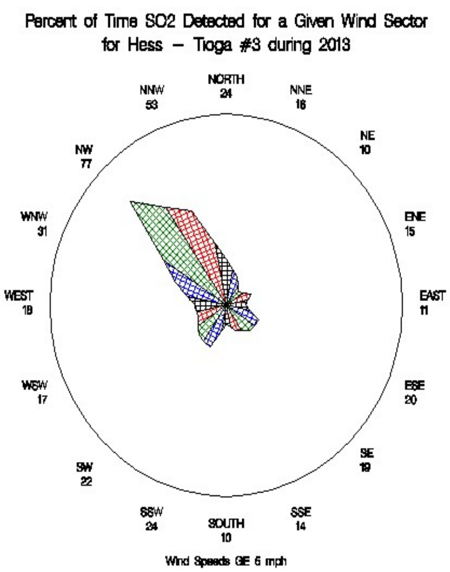
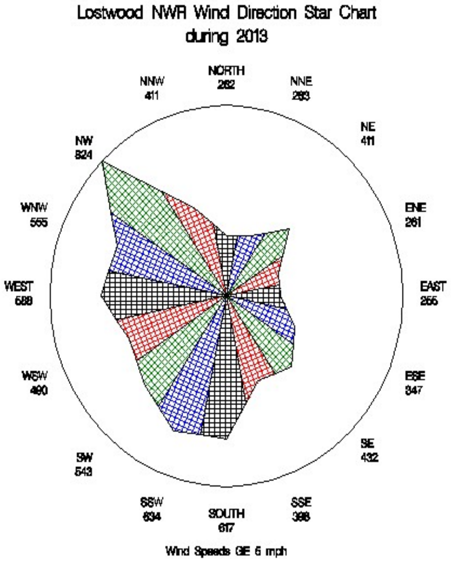
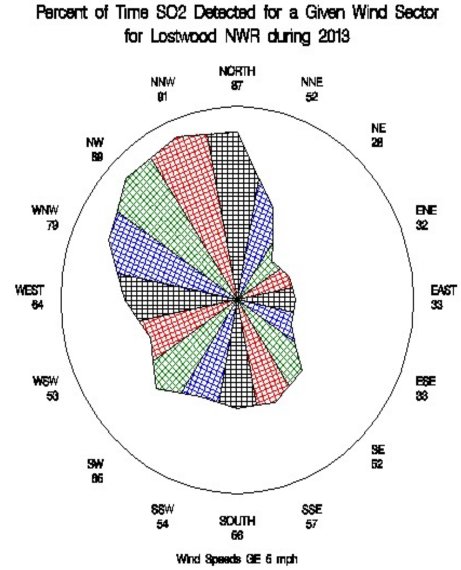


Figure A3-8 Hess-Tioga





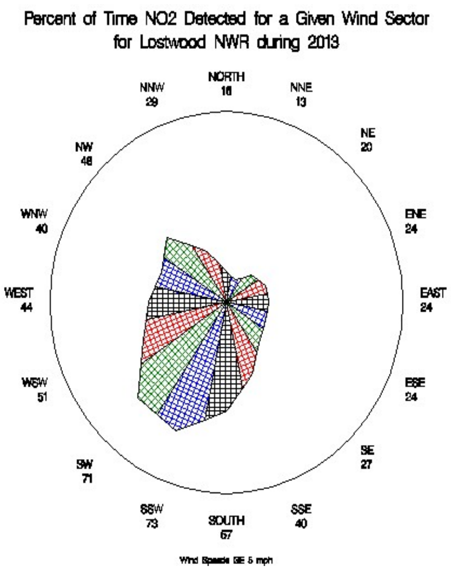
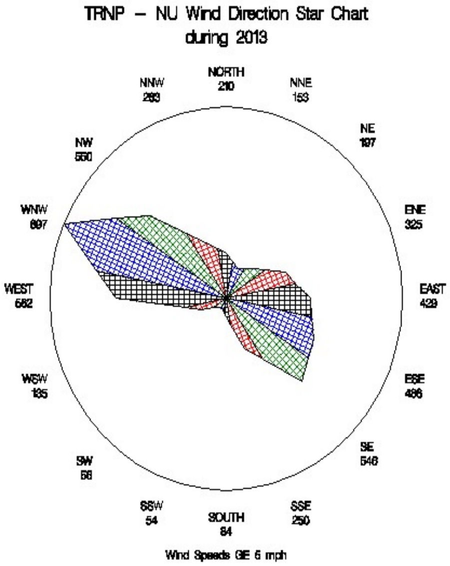
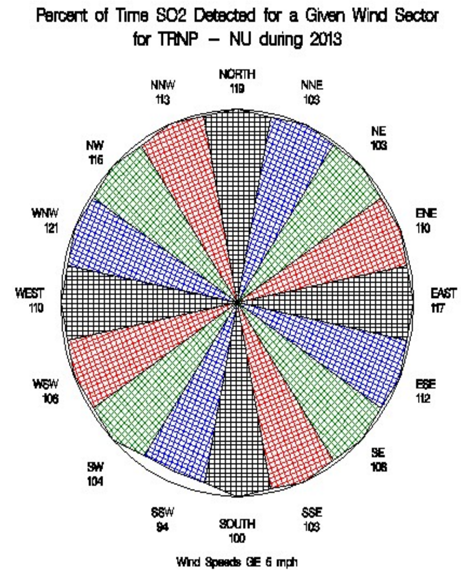


Figure A3-9 Lostwood NWR





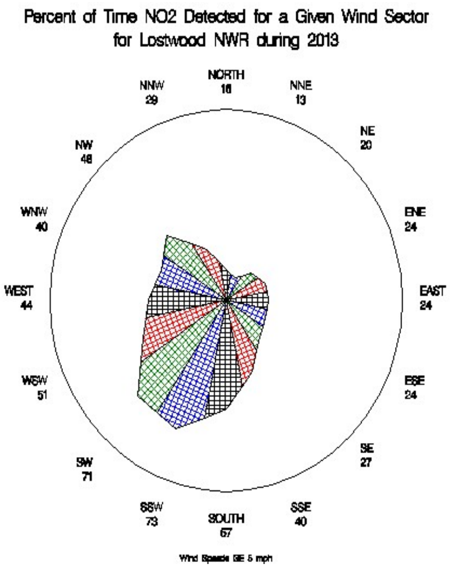
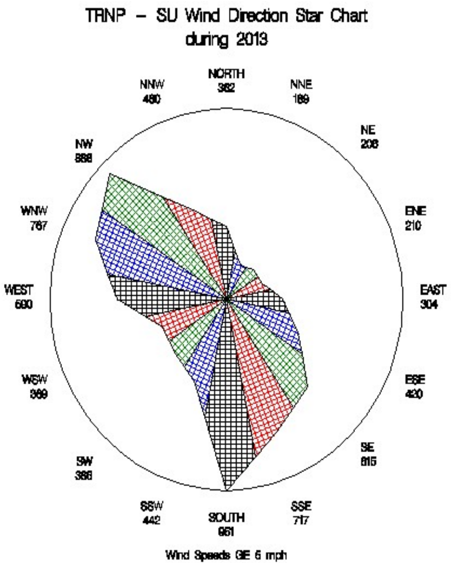


Figure A3-10 TRNP - NU



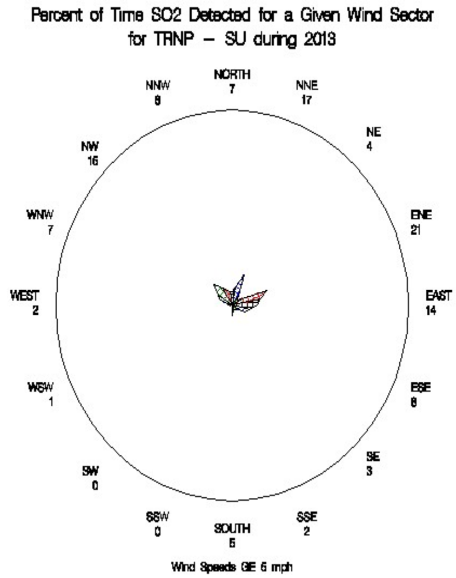
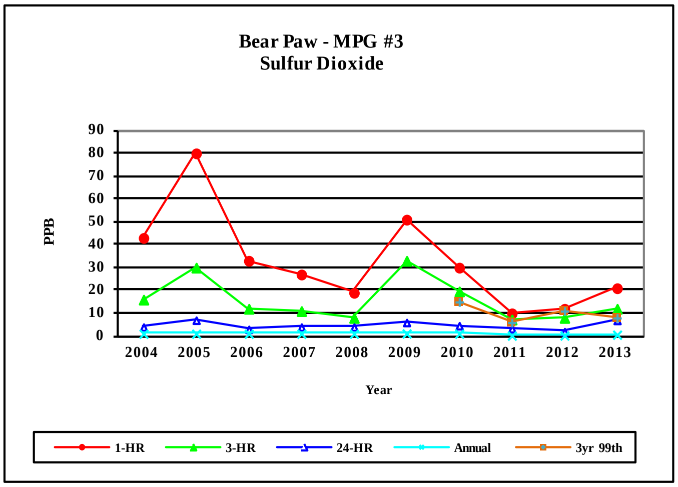


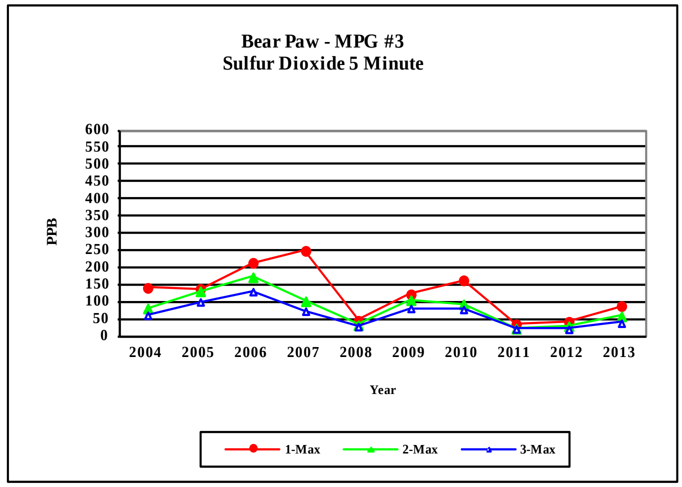
Figure A3-11 TRNP - SU

APPENDIX 4

2004-2013 Trends

The trend graphs for 2004 through 2013 are presented in alphabetical order, grouped by site, unless multiple sites would fit on a single page. Each graph depicts the maximum concentration for each applicable standard (left scale) and percentage of time an hourly concentration is detected (right scale).





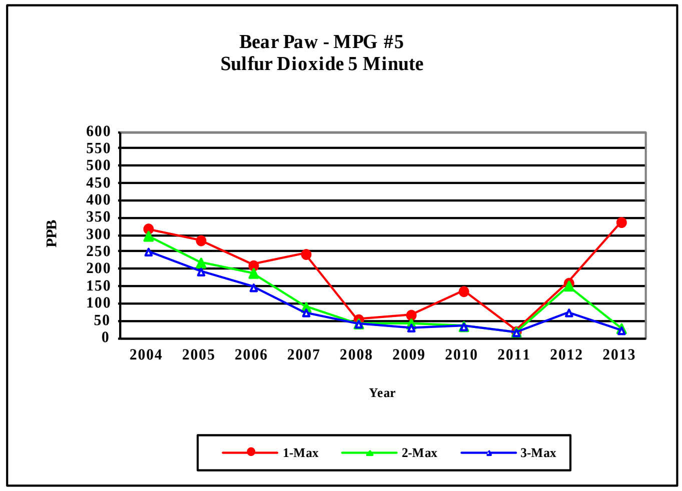
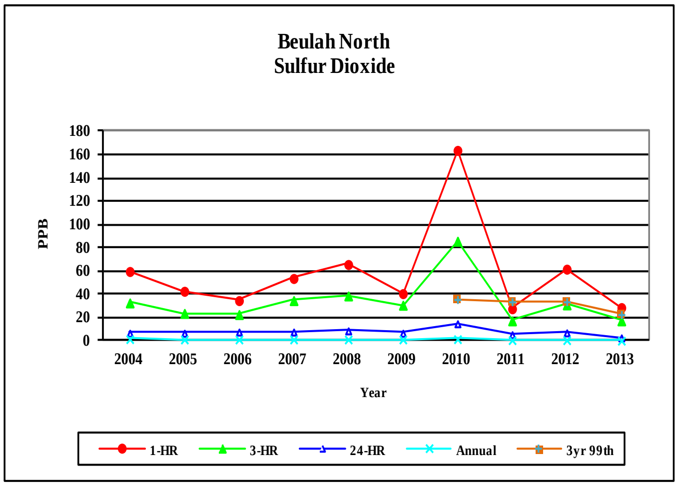
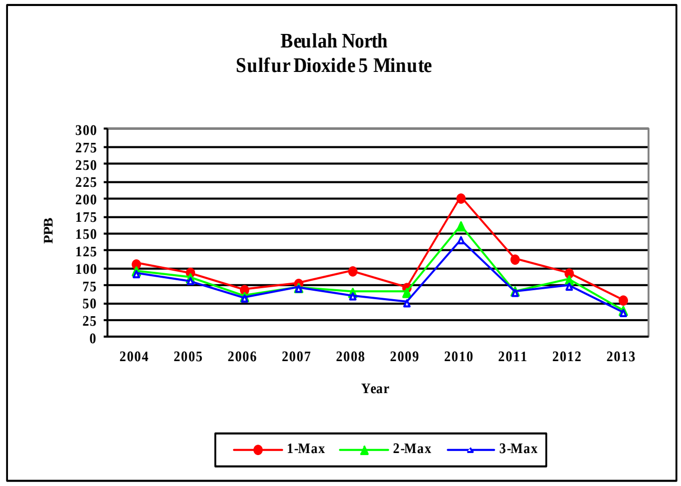
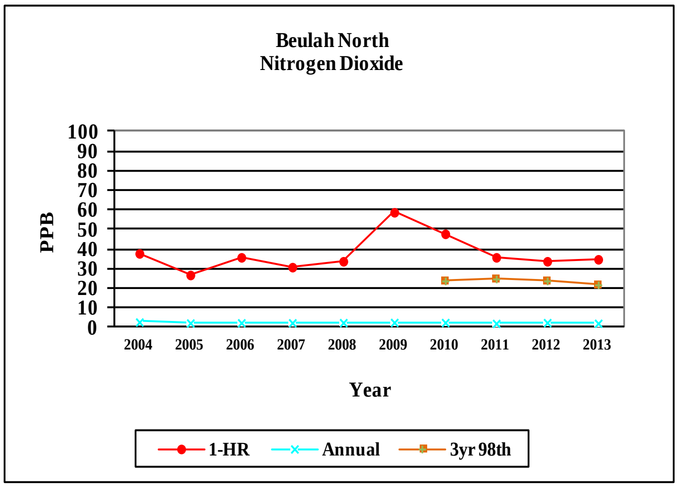
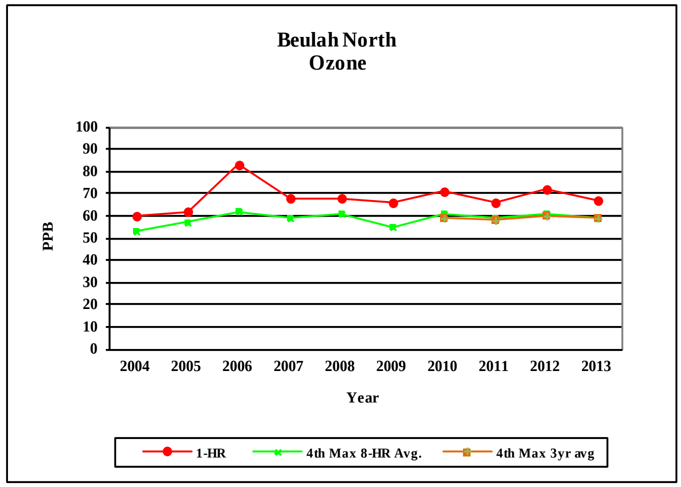


Figure A4-1 Bear Paw - MGP









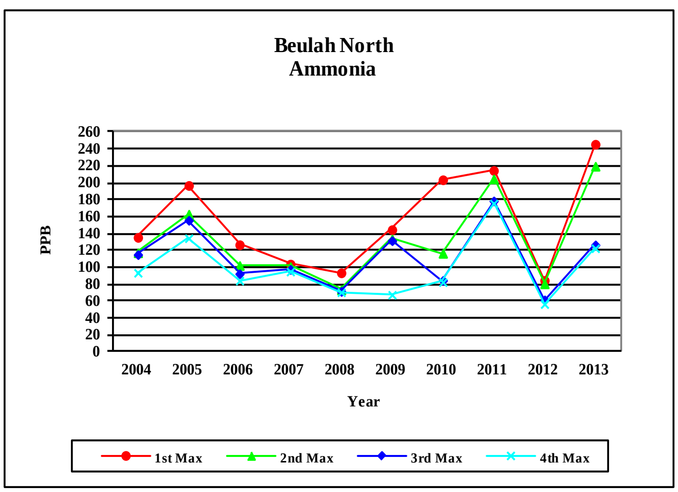
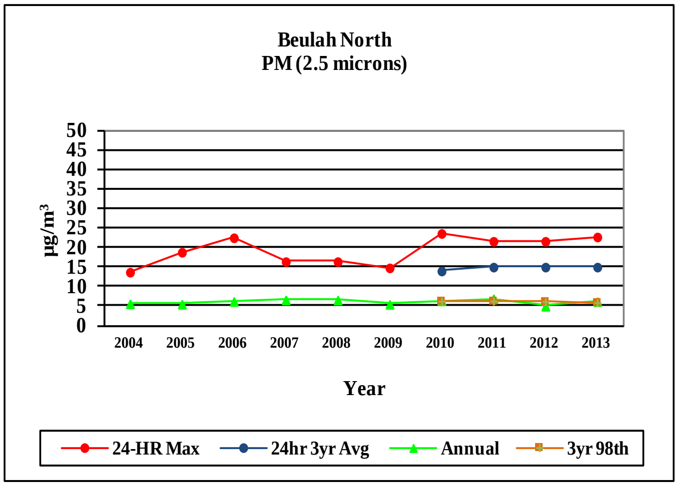


Figure A4-2 Beulah North



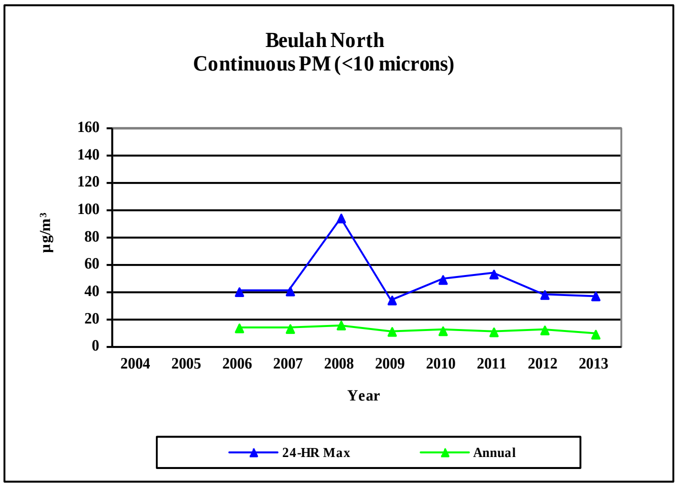
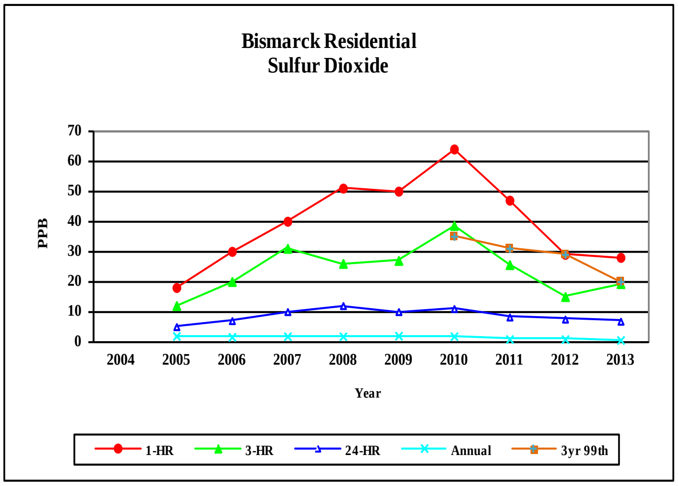
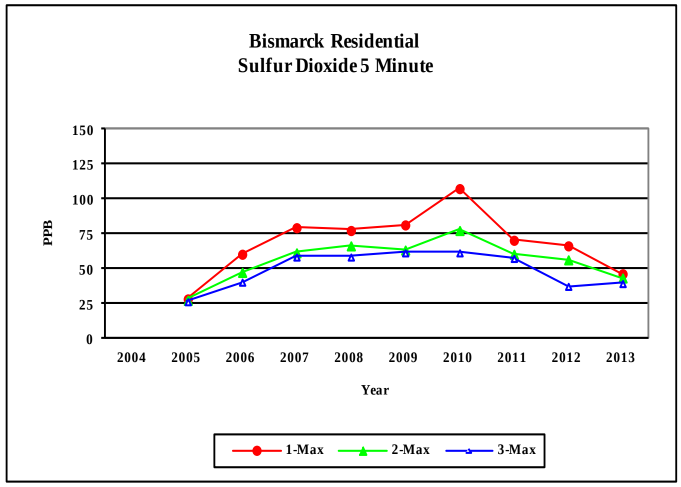
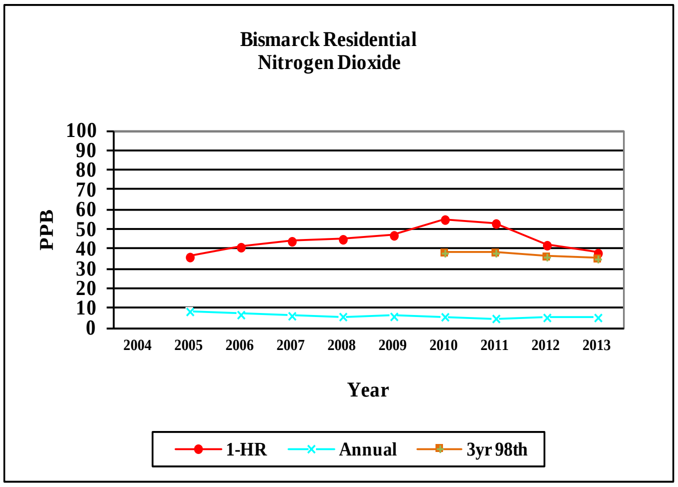
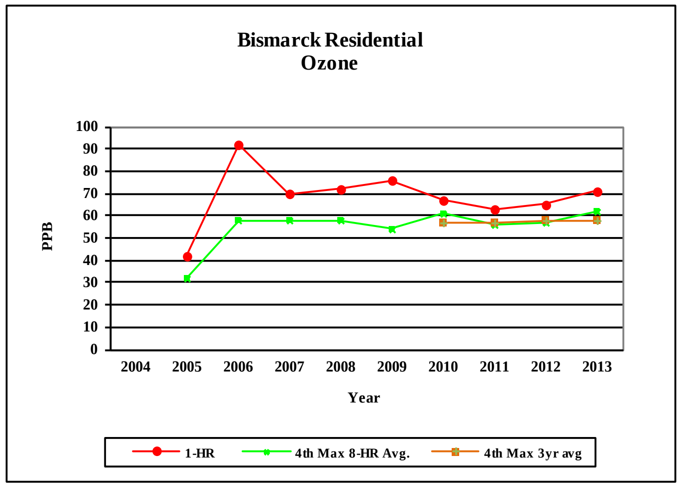


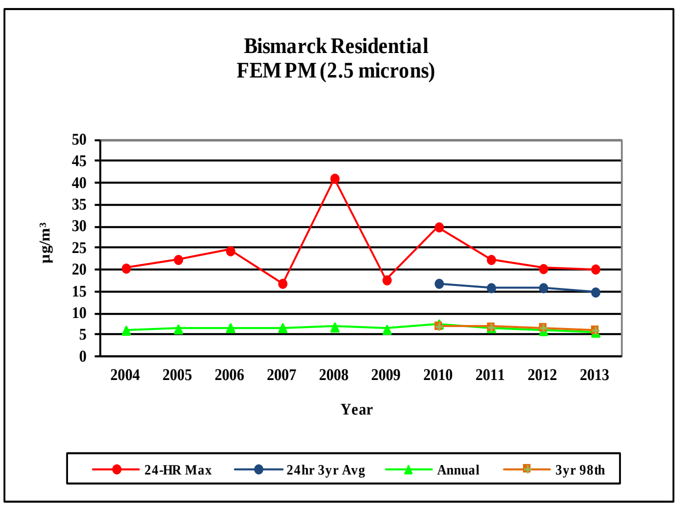
Figure A4-2 Beulah North (cont.)











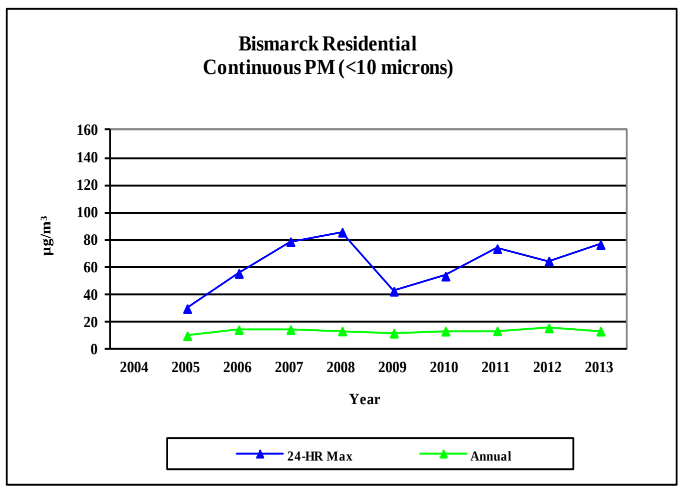
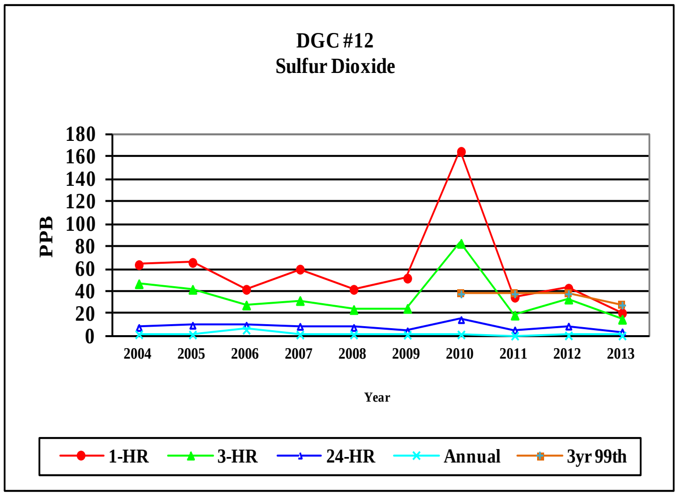
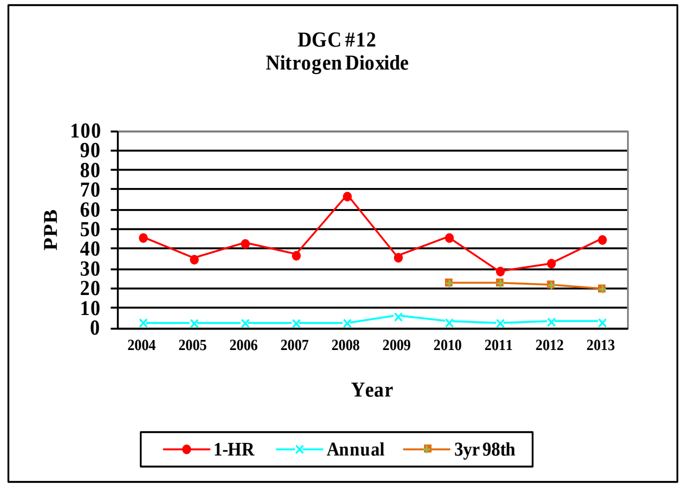
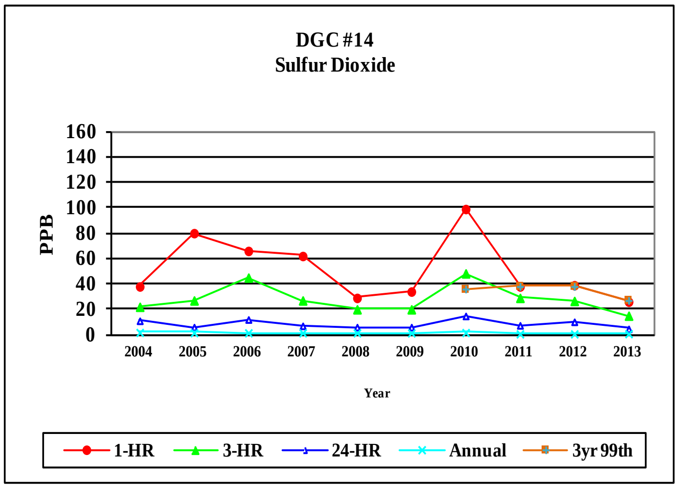
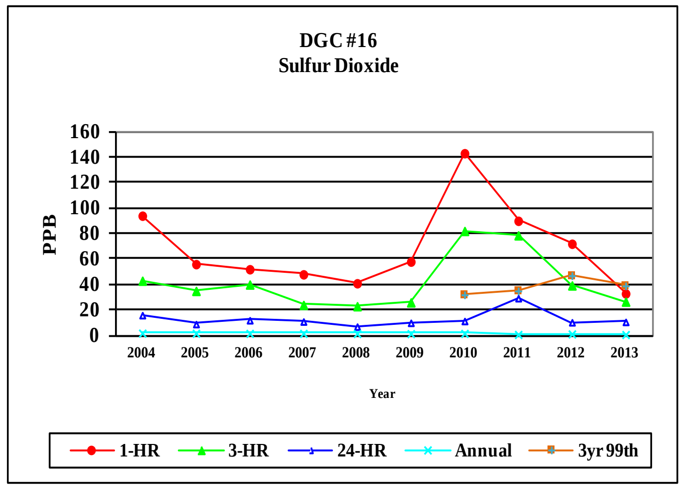


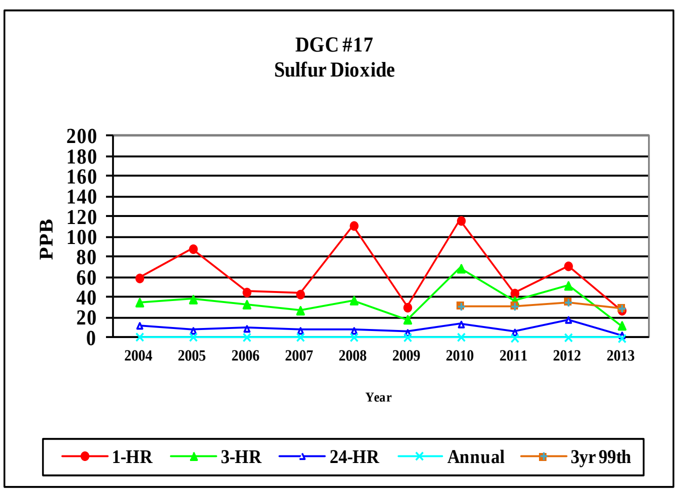
Figure A4-3 Bismarck Residential











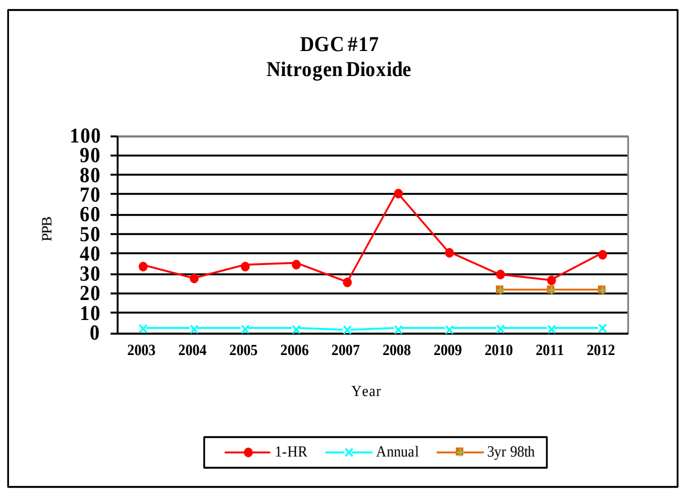
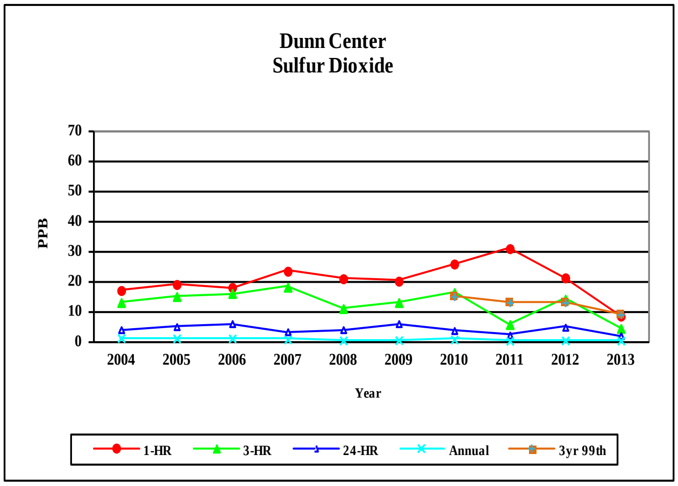
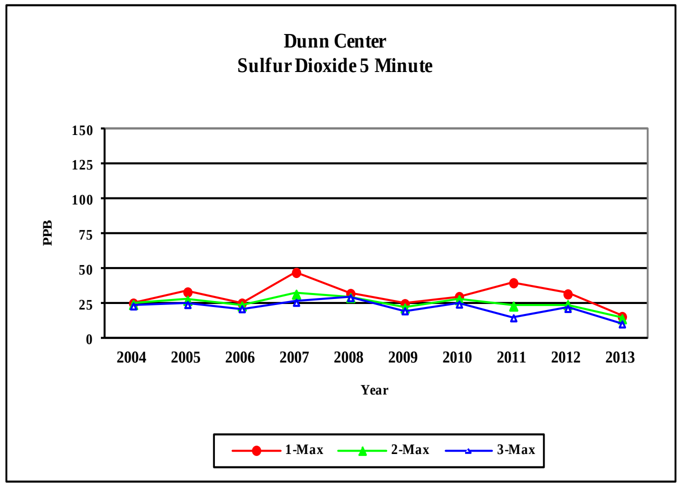
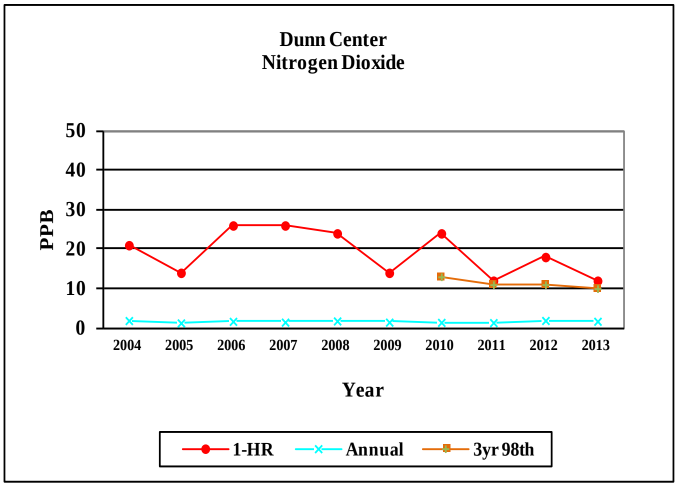
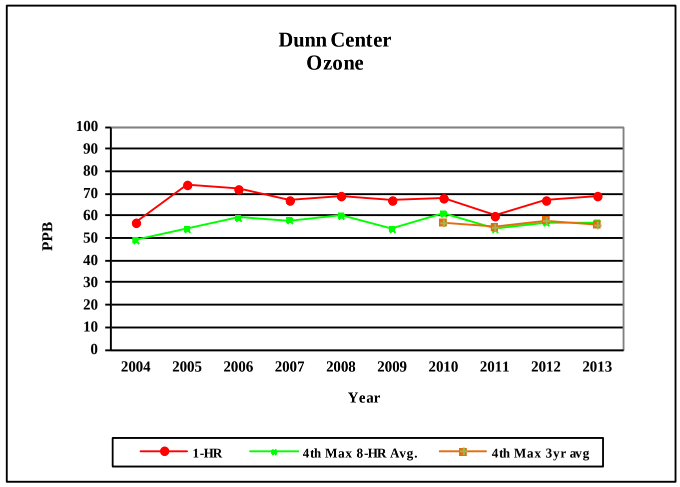


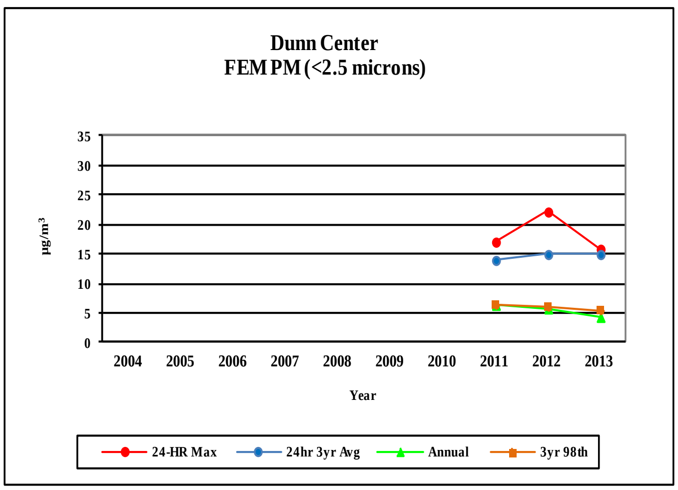
Figure A4-4 DGC











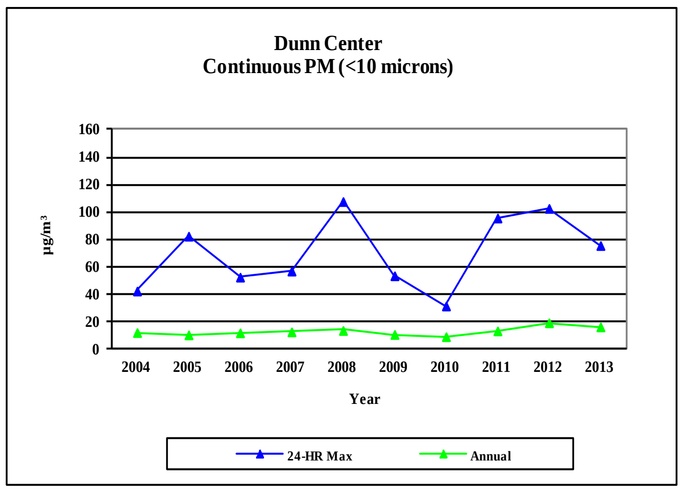
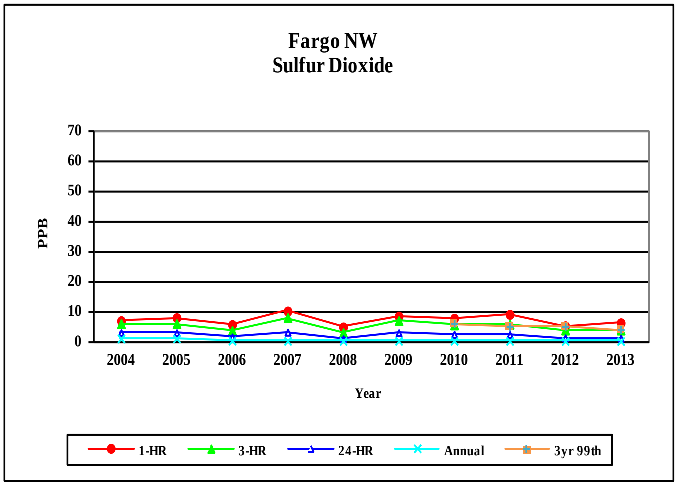
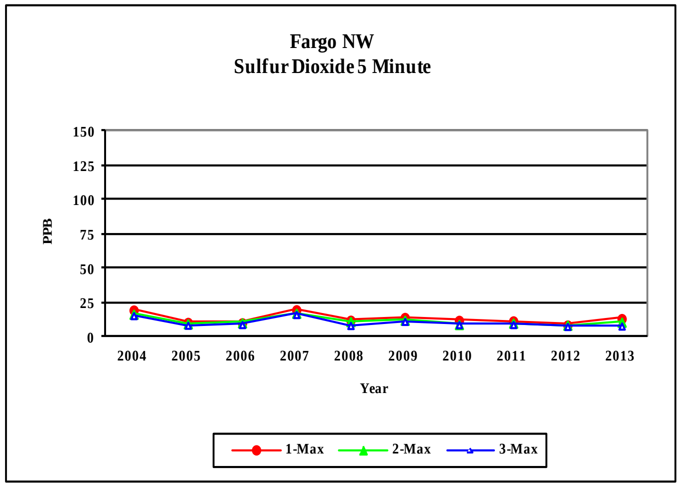
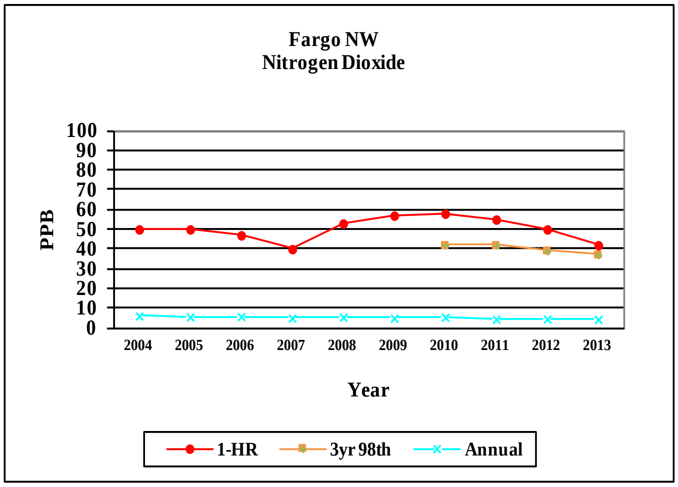


Figure A4-5 Dunn Center







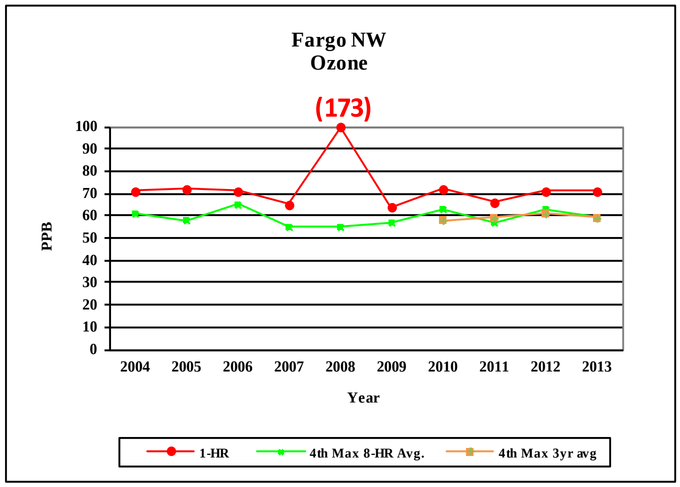
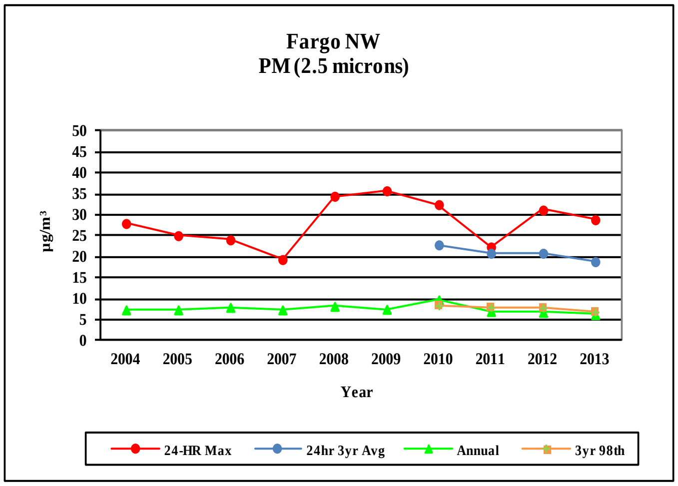
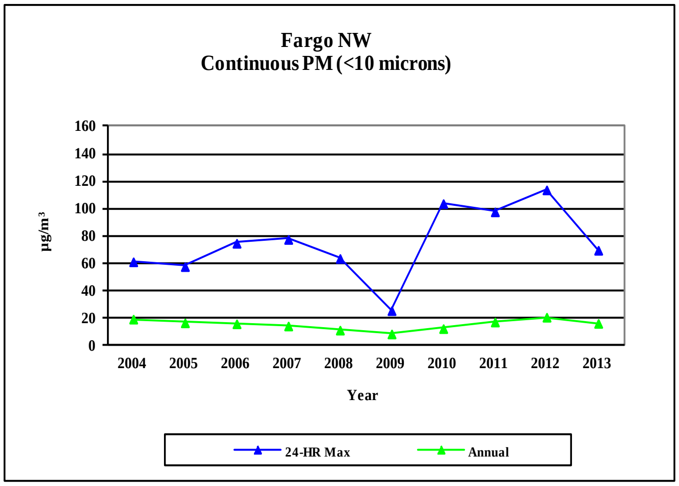


Figure A4-6 Fargo NW





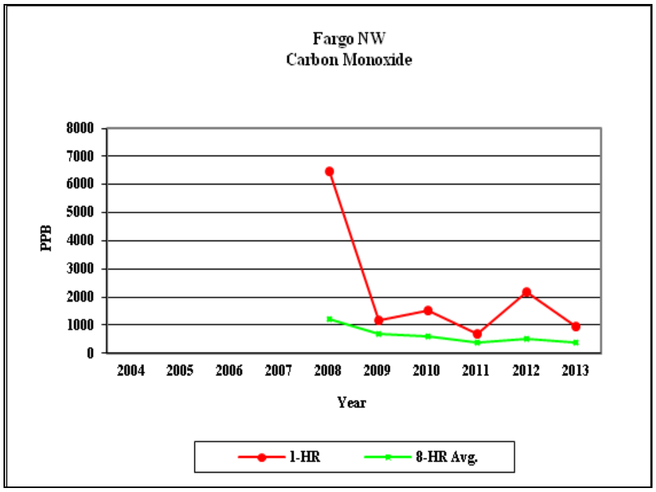


Figure A4-6 Fargo NW (cont.)

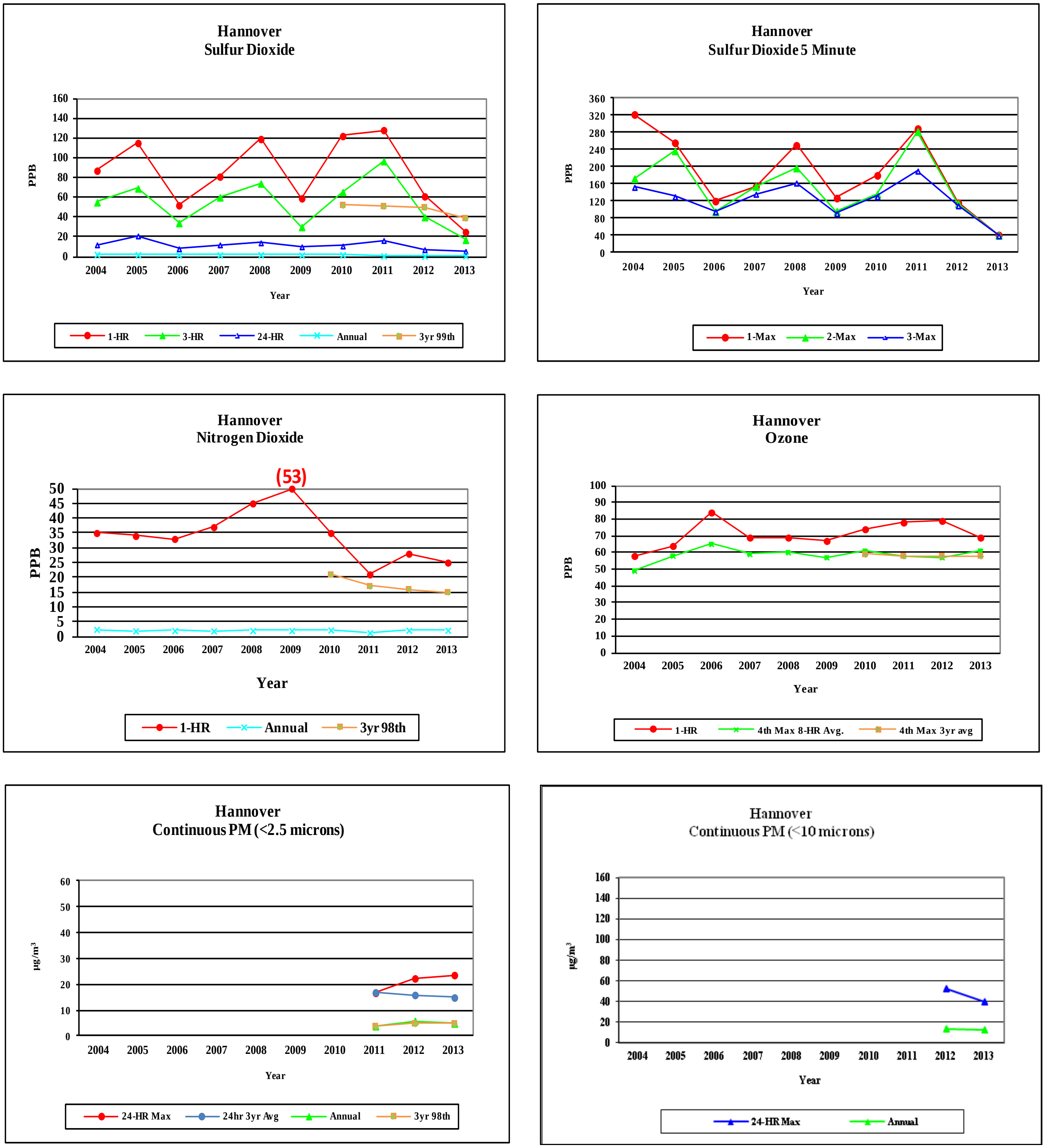
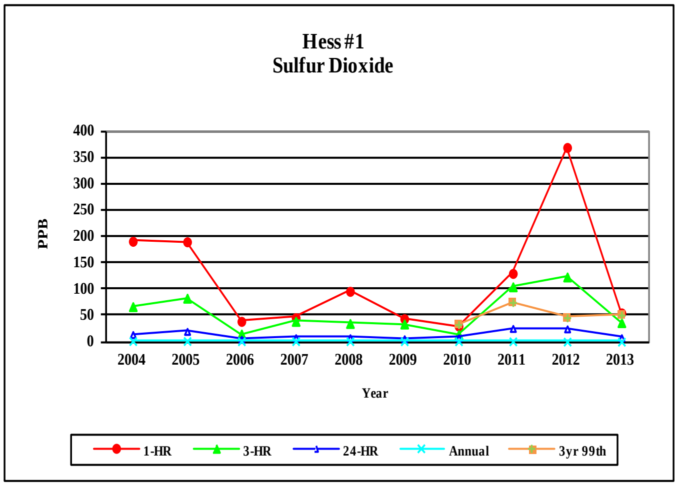
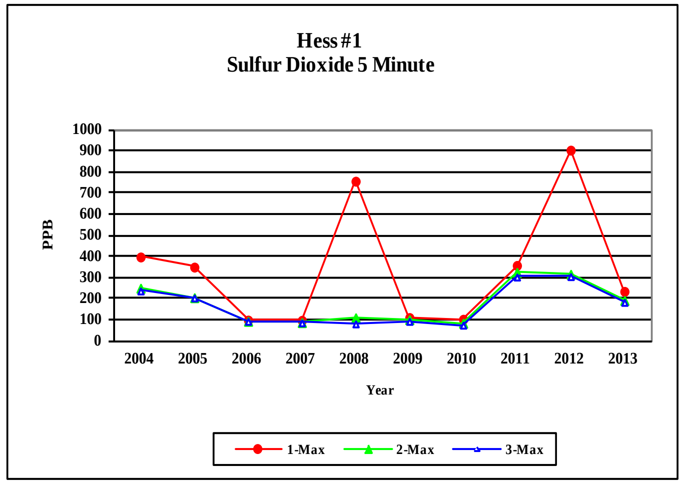
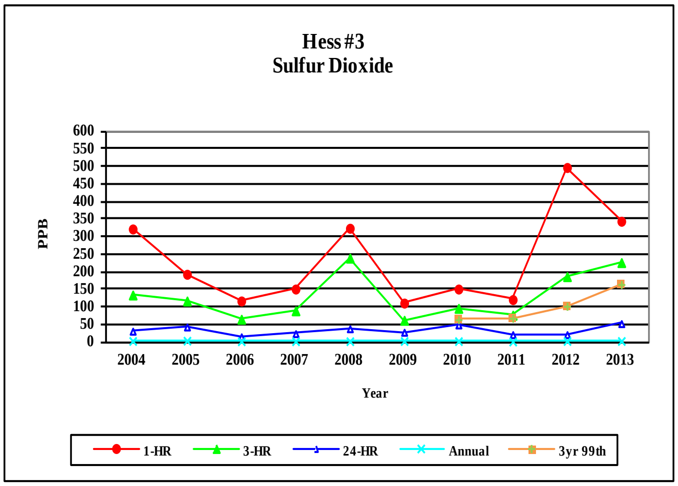


Figure A4-7 Hannover







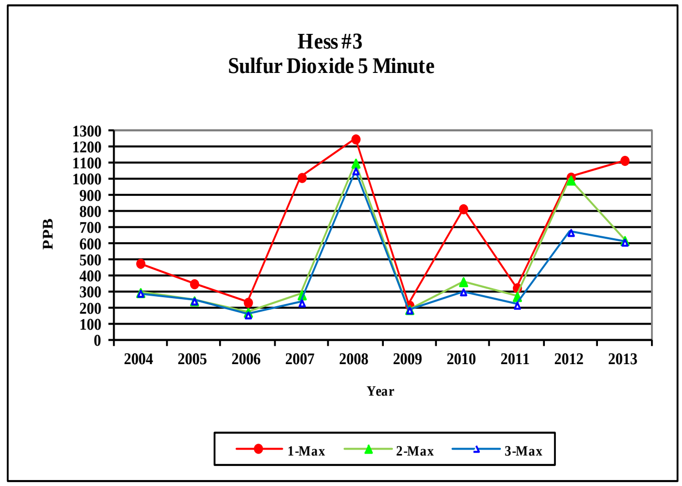
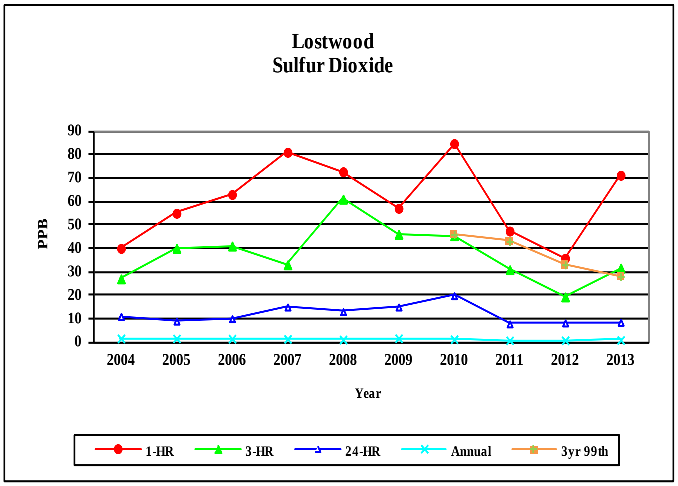
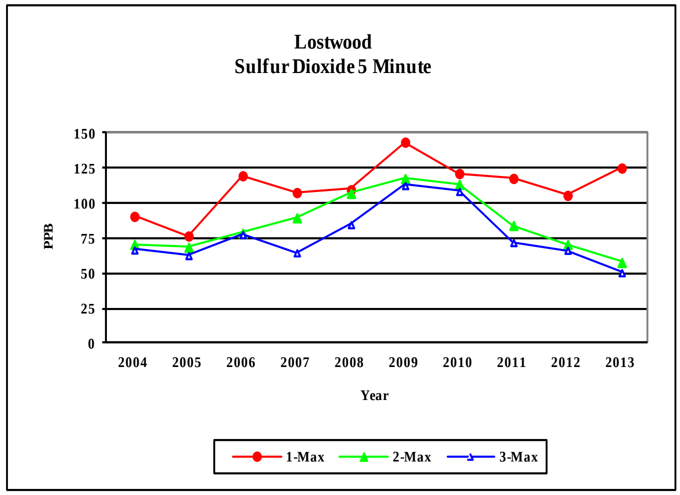
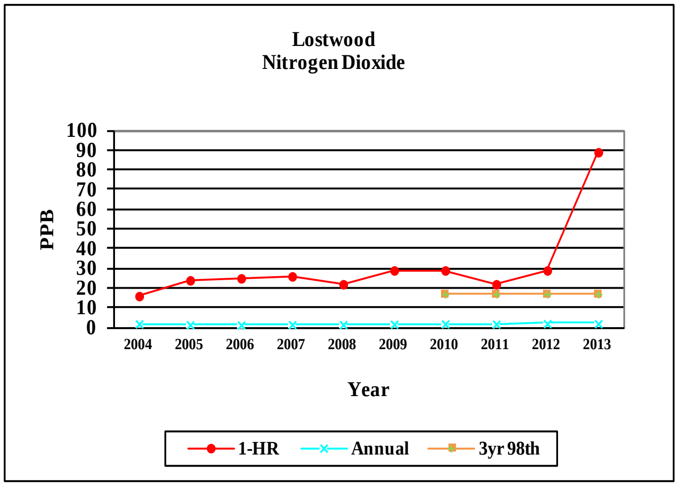
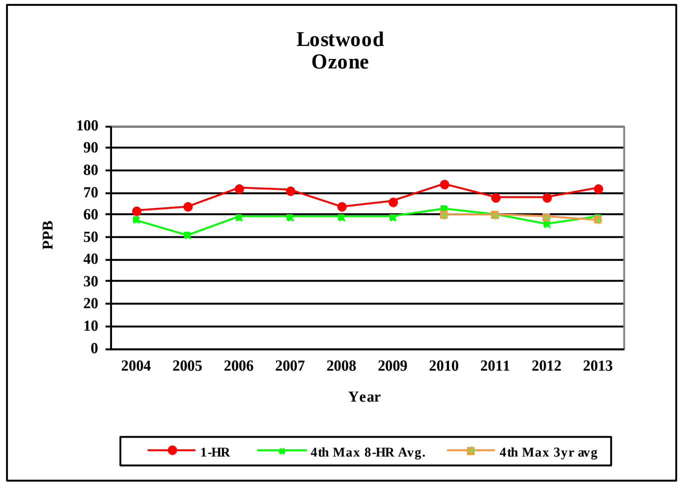


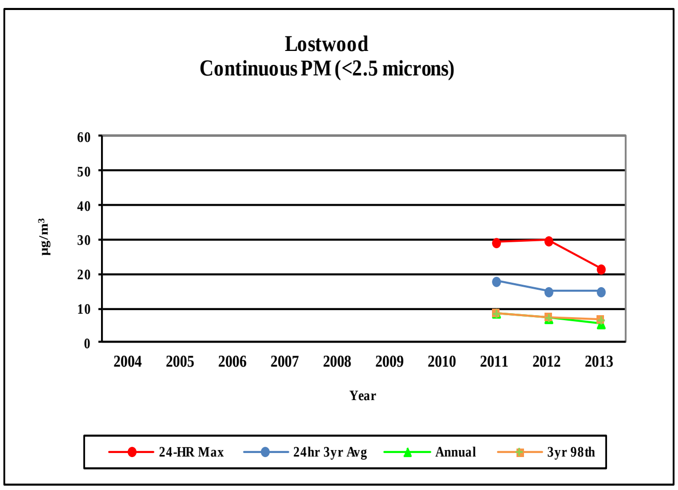
Figure A4-8 Hess











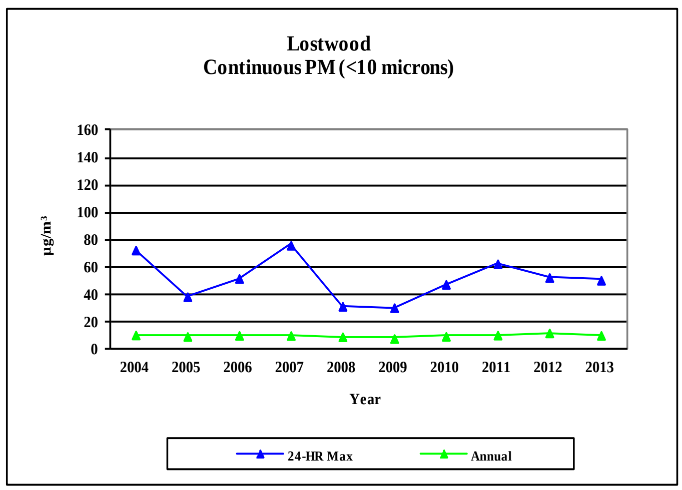
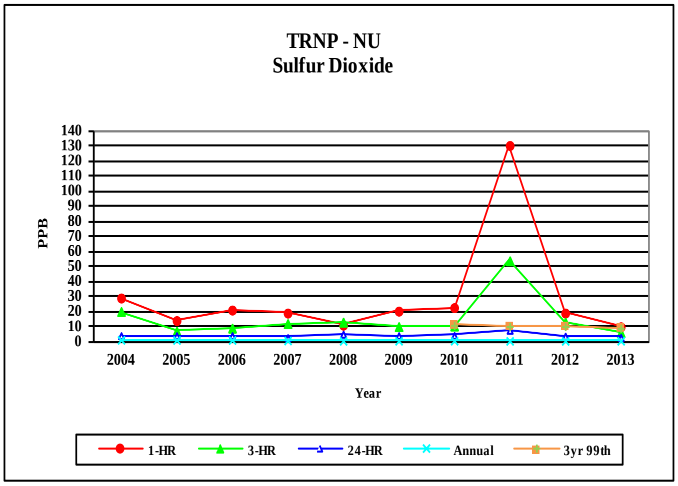
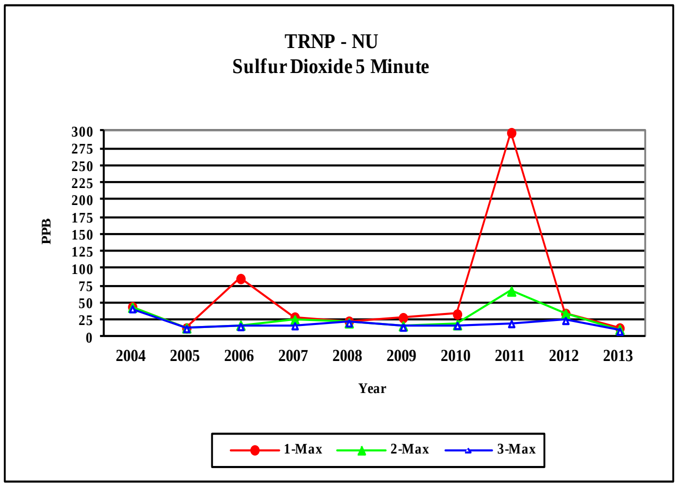
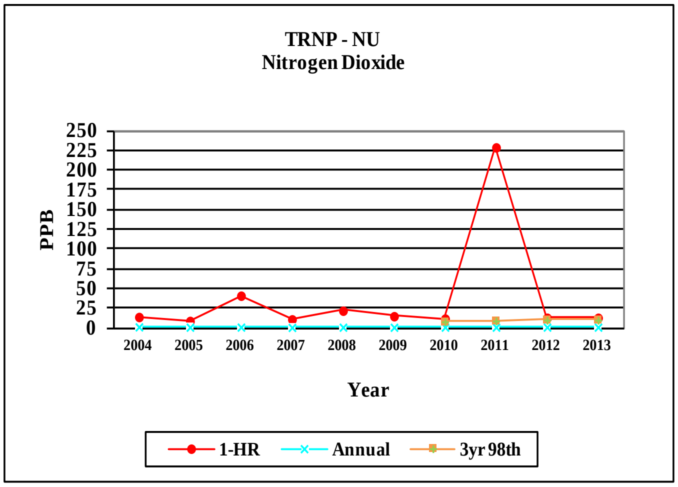
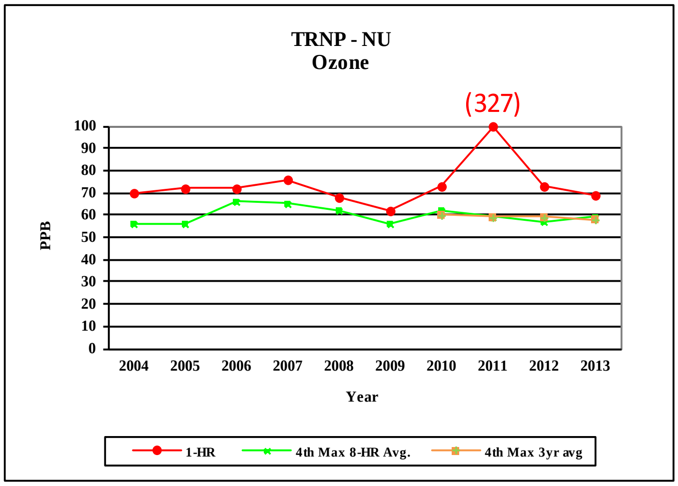


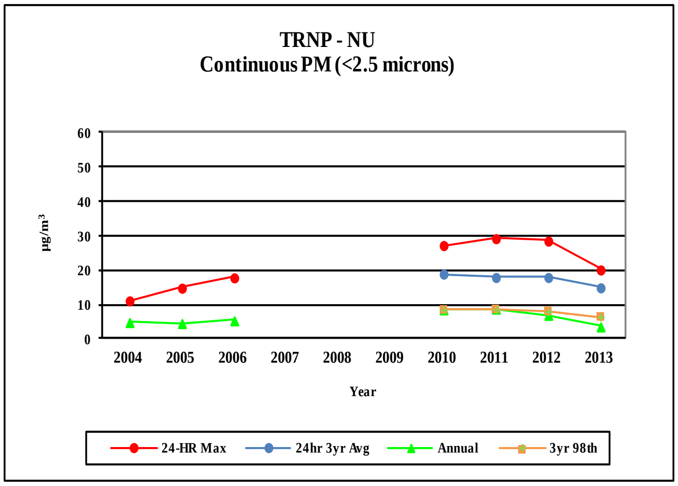
Figure A4-9 Lostwood











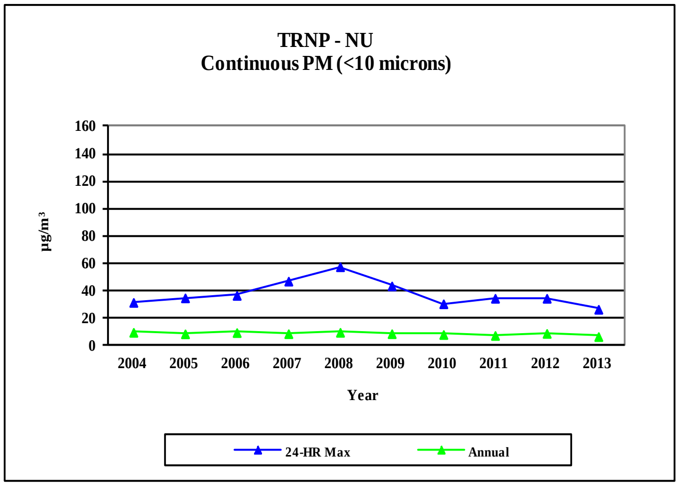
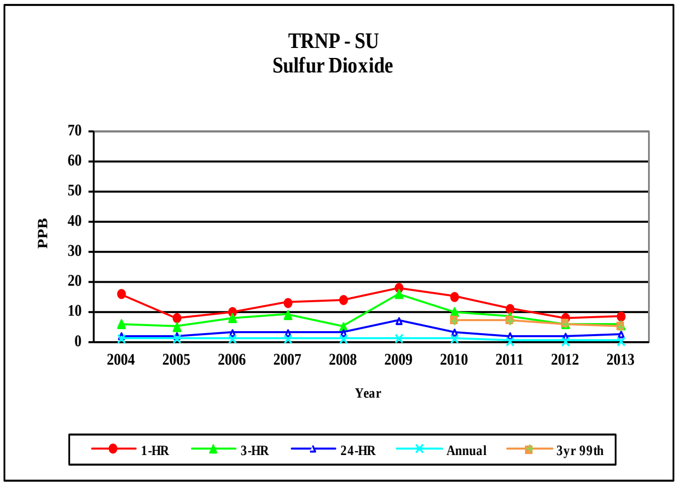
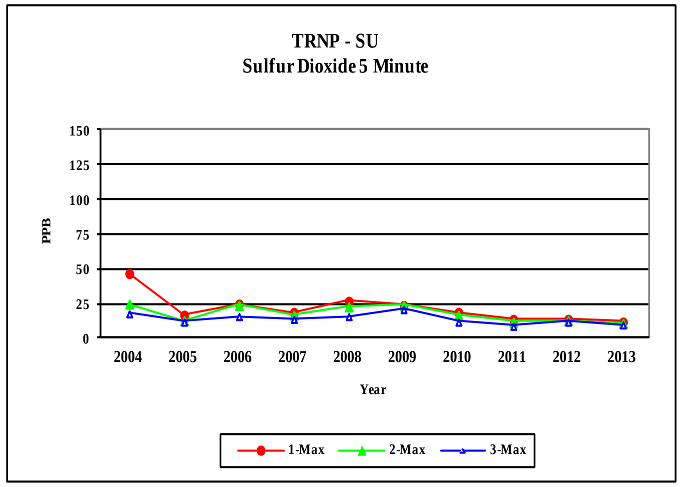
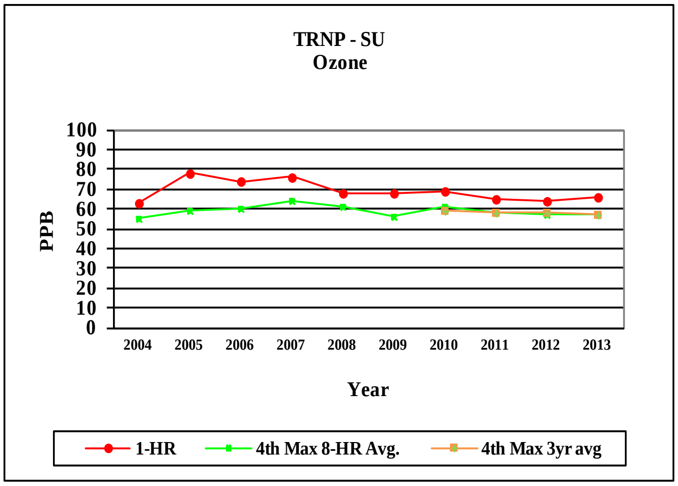
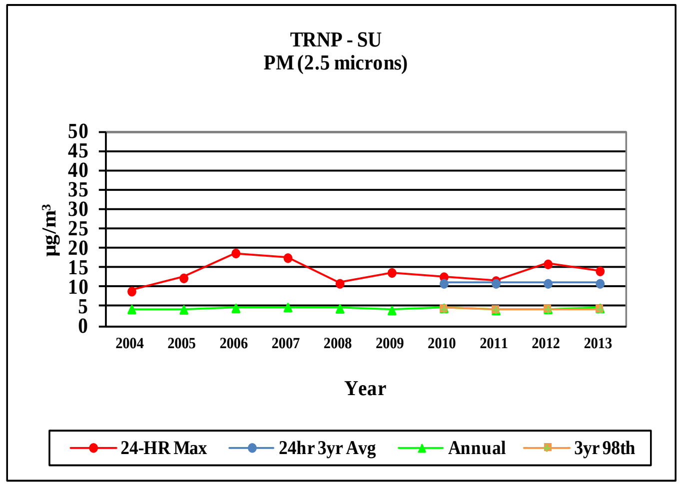


Figure A4-10 TRNP - NU









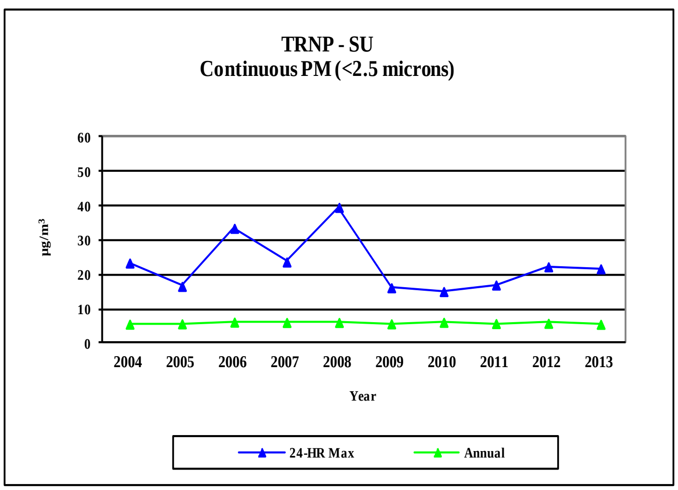


Figure A4-11 TRNP - SU