Annual Report

North Dakota
Air Quality Monitoring
Data Summary
2000

North Dakota Department of Health
Division of Air Quality

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EXECUTIVE SUMMARY

The North Dakota Department of Health operated nine ambient and four special purpose air quality monitoring sites and industry operated nine source-specific air quality monitoring sites. The data from these sites indicated that the quality of the ambient air in North Dakota was generally good during 2000.

There were no sulfur dioxide, nitrogen dioxide, ozone, or particulate matter exceedances of either the state or federal ambient air quality standards measured during the year. Through legislative action effective August 1, 1997, coal conversion facilities and oil refineries were exempted from the state sulfur dioxide standards. Therefore, any values listed as an exceedance in the data summaries are subject to further manual review to determine the most likely source(s) causing the listed exceedance.

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[1,2] and the "Prevention of Significant Deterioration of Air Quality Rules."[3] 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 of air pollutants 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, 2000, and ending Dec. 31, 2000. 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 and the percentage of time a concentration is above the minimum detectable limit for the specific analysis method.

The Three Affiliated Tribes on the Fort Berthold Indian Reservation operate a tribal network this network consists of two sites: White Shield and Drags Wolf. The data summaries are included only for informational purposes since tribal data is not subject to the State ambient air quality standards.

NETWORK DESCRIPTION

Department Sites

During 2000, the Department operated 13 air quality monitoring sites. Nine were ambient monitoring sites, and four were special purpose monitoring (SPM) sites. The SPM sites are Short Creek, Lignite and two sites near the AMOCO Refinery and MDU Heskett Power Plant at Mandan. Table 1 lists Department monitoring sites which were active during the year.

In general, Department ambient air quality monitoring (AAQM) sites obtain air quality data to meet four objectives: (1) determine representative concentrations in areas of high population density (urban or population oriented monitoring), (2) determine general background concentration levels, (3) to measure highest concentrations expected to occur in an area covered by an individual site, and (4) determine representative impacts on ambient air quality levels near significant sources.

The Department's ambient air quality monitoring network normally does not include source-specific monitoring, i.e., monitoring a single, specific source. However, the two Mandan - SPM sites were established to collect source-specific 5-minute peak and hourly sulfur dioxide averages due to impacts from the MDU Heskett Power Plant and AMOCO Refinery.

The Department is working with Environment Canada, EPA, Saskatchewan Environment and Resource Management (SERM) and SASKPower to establish and operate a SK-ND Trans-Boundary ambient air quality monitoring network with three sites (Raferty Dam, Estevan, Boundary Dam Power Station) in Saskatchewan and the two sites (Short Creek, Lignite) in North Dakota. The SK-ND Trans-Boundary network became fully operational on December 5, when the Estevan $PM_{2.5}$ sampler collected its first sample. The data collected at these five sites will be reported in reports specific to that network. Data collected at these five sites are addressed in that network's own annual reports. Therefore, data from the Short Creek and Lignite sites are not included in this, the State's, annual report.

The Department, in issuing Permits to Construct and Permits to Operate for major sources, may require these sources to operate air quality monitoring programs to assess impacts on local air quality.

Industry Sites

Industry operated nine source-specific air quality monitoring sites during the year. 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. 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 being monitored.

Figure 1 displays both Department and industry monitoring sites. If an industry has more than one site, only the general location within the county is indicated. The Mandan location represents the two sites at Mandan.

TABLE 1

State AAQM Network Description

Site Name AQS Site #	Type Station	Parameter Monitored[1]	Operating Schedule	Monitoring Objective[2]	Spatial Scale[2]	Date Site Began
1 Beulah North	SLAMS	$PM_{2.5}$	6^{th} Day	Population Exposure	Neighborhood	12/98
		SO_2, NO_2, O_3, MET	cont.	Population Exposure	Neighborhood	04/80
		NH_3	cont	Population Exposure	Regional	11/00
		cont. $PM_{2.5}$	cont.	Population Exposure	Neighborhood	10/00
2 Bismarck Residential	SLAMS	$PM_{2.5}$	3^{rd} Day	Population Exposure	Urban	12/98
3 Dickinson Residential	SLAMS	PM_{10}	6^{th} Day	Population Exposure	Urban	07/89
4 Drags Wolf	Tribal	MET	cont.	General Background	Regional	01/86
		PM_{10}	6^{th} Day			
5 Dunn Center	SLAMS	SO_2, NO_2, O_3, MET	cont.	General Background	Regional	10/79
6 Fargo NW	SLAMS	PM_{10}	6^{th} Day	Population Exposure	Urban	05/98
		PM_{10}	6^{th} Day	Collocated SSI	N/A	
		$PM_{2.5}$	3^{rd} day	Population Exposure	Urban	12/98
		$PM_{2.5}$	3^{rd} Day	Collocated	N/A	
		SO_2, NO_2, O_3, MET	cont.	Population Exposure	Urban	05/98
		cont. $PM_{2.5}$	cont.	Population Exposure	Urban	7/00
7 Grand Forks North	SLAMS	$PM_{2.5}$	3^{rd} Day	Population Exposure	Urban	12/98
8 Hannover	SLAMS	SO_2, NO_2, O_3, MET	cont.	General Background	Regional	10/84
9 Lignite - SPM[3]	SPM	$PM_{2.5}$	6^{th} Day	Population Exposure	Regional	10/99
		$PM_{2.5}$	6^{th} Day	Collocated	N/A	
10 Mandan Refinery - SPM	SPM	SO_2, MET	cont.	Source Impact	Neighborhood	12/95
11 Mandan Refinery NW - SPM	SPM	SO_2, MET	cont.	Source Impact	Neighborhood	09/98
12 Sharon[4]	SLAMS	SO_2, NO_2 O_3, MET	cont.	General Background	Regional	07/94
		$PM_{2.5}$	6^{th} Day			12/98
13 Short Creek - SPM[3]	SPM	SO_2, NO_2, MET	Cont.	Source Impact	Regional	02/99
		PM_{10}	6^{th} Day			09/98
		$PM_{2.5}$	6^{th} Day			04/99
		Cont. $PM_{2.5}$	cont.			8/00
14 TRNP - SU	SPM	SO_2, O_3 MET	cont.	General Background	Regional	07/95
15 White Shield	Tribal	SO_2, MET	cont.	General Background	Regional	07/90
		PM_{10}	6^{th} Day			
Company	**Site Name**					
16 Amerada Hess Corporation	TIOGA #1	SO_2	cont.	Source Impact	Urban	07/87
	TIOGA #2	H_2S, MET	cont.	Source Impact	Urban	07/87
	TIOGA #3	SO_2	cont.	Source Impact	Urban	11/87
17 Bear Paw Energy, Inc.	MGP #3	SO_2, MET	cont.	Source Impact	Urban	11/94
	MGP #5	SO_2, MET	cont.	Source Impact	Urban	01/98
18 Dakota Gasification Company	DGC #12	SO_2, NO_2, MET	cont.	Source Impact	Urban	01/80
	DGC #14	SO_2	cont.	Source Impact	Urban	01/89
	DGC #16	SO_2	cont.	Source Impact	Urban	10/95
	DGC #17	SO_2, NO_2	cont.	Source Impact	Urban	10/95

1. MET refers to meteorological and indicates wind speed and wind direction monitoring equipment.
2. Not applicable to MET.
3. Transferred to the SK-ND Trans-Boundary Network effective December 5.
4. Continuous analyzers were terminated December 31.

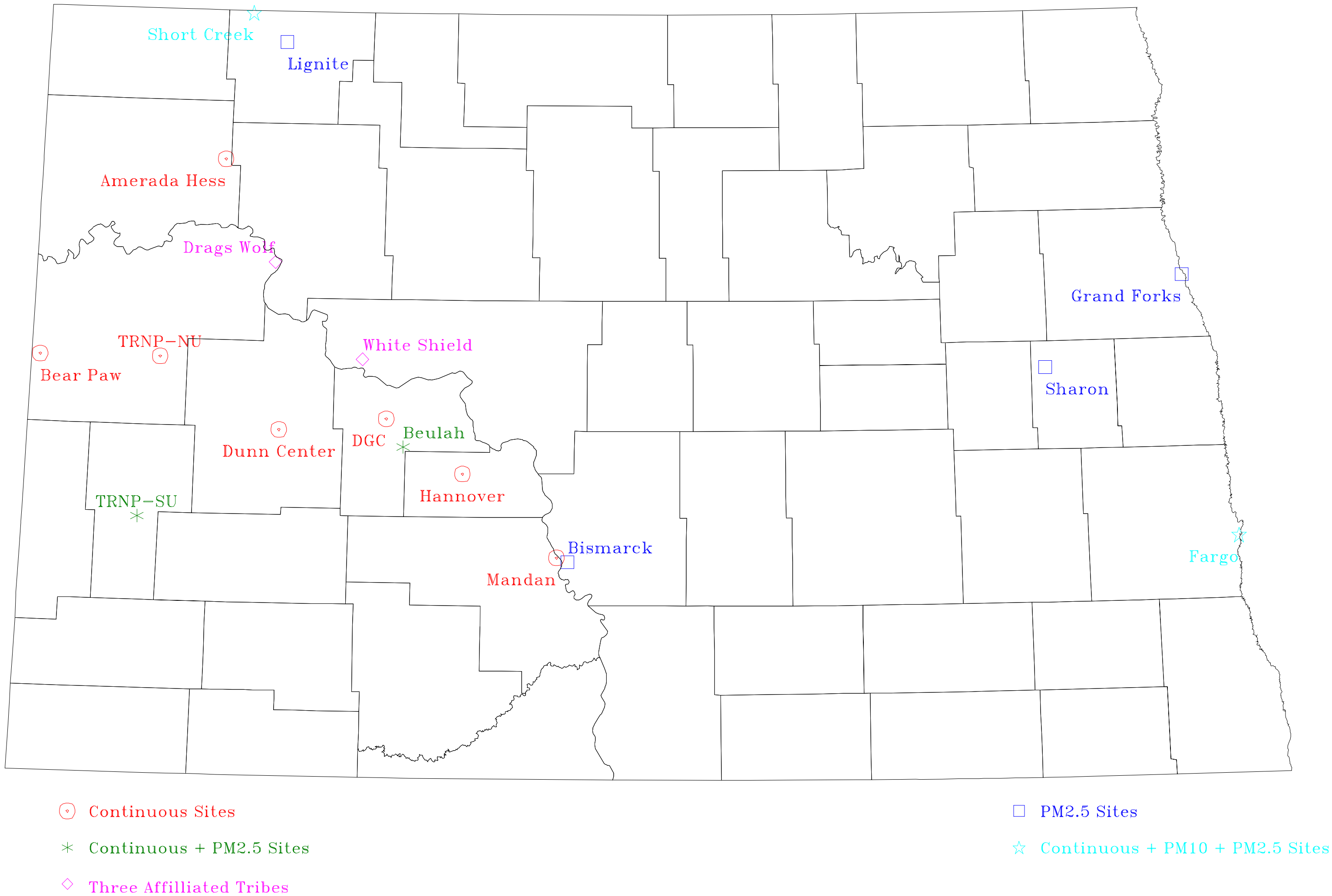

Figure 1 North Dakota Air Quality Monitoring Network

NETWORK CHANGES

Department Changes

Changes to the state monitoring network consisted of terminating and moving the following sites to new locations. The Fargo PM_{10} was moved to Bismarck effective December 31 to make room for the EPA National Trends Network speciation sampler. Short Creek and Lignite sites were transferred to the SK-ND Trans-Boundary Network effective December 5. The continuous analyzers at Sharon were terminated. Continuous $PM_{2.5}$ analyzers were added to Fargo NW, Beulah North, and Short Creek - SPM. An ammonia analyzer was added to Beulah North .

Industry Changes

No changes were made to the industry networks.

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), federal reference method (FRM) inhalable fine particulates ($PM_{2.5}$), inhalable course particulates (PM_{10}), and PM_{10} sulfate. Each section contains a description of the physical characteristics, health effects, a comparison to the state standards, and a data summary.

The data summaries for gaseous pollutants include maximum concentrations, month/day/hour of each maximum, arithmetic means and the percentage of readings greater than the minimum detectable value (MDV) 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 FRM $PM_{2.5}$, PM_{10}, and PM_{10} sulfate data summaries contain the three highest 24-hour average concentrations, month/day of each maxima, 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 $PM_{2.5}$ 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 ($\mu g/m^3$).

The PM sulfate/PM total mass ratio summaries contain the three highest 24-hour average ratios, month/day of each maxima and the annual arithmetic mean. Ratios are reported in percentage.

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, H_2S and NO_2 is 2 ppb; O_3 is 4 ppb; FRM $PM_{2.5}$ is 2.0 $\mu g/m^3$; PM_{10} is 4 $\mu g/m^3$; and PM_{10} sulfate is 0.5 $\mu g/m^3$. The MDV for the continuous PM2.5 is -2.0 $\mu g/m^3$. Annual means are calculated for SO_2, NO_2, *FRM* $PM_{2.5}$, and PM_{10}. However, only those means with more than 75 percent of data greater than the MDV are unbiased calculations. The PM sulfate/PM ratios are calculated only when both the PM sulfate and PM total mass are greater than the respective MDV.

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 less than 7,028 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 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. In the PM sulfate/PM total mass ratio summaries, the "NUM OBS" column indicates the number of valid data pairs.

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.[4] 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, SO_2 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 SO_2 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 SO_2 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 SO_2 reactions.[4]

Standards Comparison

Sulfur dioxide was monitored at 18 sites. Nine sites were run by the Department, eight by industry, and one by the Three Affiliated Tribes on the Fort Berthold Indian Reservation. As a result of legislative action effective August 1, 1997, coal conversion facilities and oil refineries were exempted from the state sulfur dioxide standards leaving these two classes of sources subject only to the federal standards. Therefore, the DGC network, Mandan NW - SPM, and Mandan - SPM are compared only to the federal standards.

The 1-hour state standard (273 ppb) was not exceeded during the year by an applicable source. The maximum 1-hour concentration was 267 ppb at Bear Paw - MGP #5.

The 3-hour federal secondary standard (500 ppb) was not exceeded during the year. The maximum 3-hour average concentration was 134 ppb at Bear Paw - MGP #5.

The 24-hour state standard (99 ppb) was not exceeded twice during the year. The maximum 24-hour average concentration was ppb at Mandan - SPM. .

Among those sites that collected at least 80 percent of the possible data during the year, the maximum annual arithmetic mean was 6.0 ppb at Mandan - SPM.

The sulfur dioxide data are summarized in Table 2.

TABLE 2

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

POLLUTANT : Sulfur Dioxide (ppb)

				M A X I M A									
				1 - HOUR		3 - HOUR		24 - HOUR					
LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	1ST MM/DD/HH	2ND MM/DD/HH	1ST MM/DD/HH	2ND MM/DD/HH	1ST MM/DD	2ND MM/DD	ARITH MEAN	1HR #>273	24HR #>99	% >MDV
Amerada Hess - Tioga #1	2000	JAN-DEC	8292	53 11/04/13	28 02/01/23	31 11/04/14	19 02/01/23	10 11/04	6 01/14	1.5			14.0
Amerada Hess - Tioga #3	2000	JAN-DEC	8706	64 09/20/01	63 01/10/12	53 09/20/02	47 02/03/14	20 02/03	20 09/20	3.0			24.7
Bear Paw - MGP #3	2000	JAN-DEC	8709	138 01/24/08	101 11/28/11	49 01/24/08	39 11/28/11	10 01/24	7 08/28	1.3			10.2
Bear Paw - MGP #5	2000	JAN-DEC	8697	267 08/23/07	218 09/08/00	134 08/23/08	80 09/08/02	24 08/23	11 09/08	1.5			13.2
Beulah - North	2000	JAN-DEC	8732	159 08/27/11	64 08/22/12	74 08/27/11	49 08/22/14	14 08/27	8 08/22	2.1			28.3
DGC #12	2000	JAN-DEC	8685	74 08/21/13	57 08/27/09	50 08/21/14	30 03/05/11	13 08/21	8 08/24	2.3			35.7
DGC #14	2000	JAN-DEC	8634	65 08/21/09	56 08/24/15	41 08/24/17	31 08/09/14	11 08/21	9 08/24	1.8			17.0
DGC #16	2000	JAN-DEC	8507	127 08/18/22	118 08/18/12	90 08/18/14	90 08/18/23	39 08/18	13 08/19	2.6			33.1
DGC #17	2000	JAN-DEC	8673	190 03/05/08	120 08/18/18	86 03/05/08	65 08/18/20	17 03/05	16 08/09	2.4			28.4
Dunn Center	2000	JAN-DEC	8721	50 08/25/09	26 12/13/08	25 08/25/11	15 12/15/05	8 12/13	8 12/15	1.4			15.9
Fargo NW	2000	JAN-DEC	8731	9 12/30/20	8 12/28/02	6 12/28/02	6 12/30/23	3 11/14	3 12/31	1.1			5.1
Hannover	2000	JAN-DEC	8715	110 07/13/09	105 07/26/11	52 07/13/11	48 07/26/11	12 01/31	11 03/11	2.2			25.9
Mandan - SPM	2000	JAN-DEC	8720	161 11/07/16	152 12/21/08	126 11/07/17	123 11/07/14	58 11/19	53 11/07	6.0			39.1
Mandan NW - SPM	2000	JAN-DEC	8731	106 10/21/01	91 04/12/04	67 02/24/23	66 10/21/02	25 04/12	16 10/21	3.5			39.3
Sharon	2000	JAN-DEC	7740	5 02/18/20	5 02/18/21	4 02/18/20	3 11/17/02	2 02/18	2 11/17	1.0			0.9
Short Creek - SPM	2000	JAN-DEC	8708	149 05/30/08	131 05/30/09	53 02/06/14	52 05/30/08	16 05/30	11 01/05	2.2			26.2
TRNP - SU (Painted Canyon)	2000	JAN-DEC	8176	11 01/11/18	11 02/23/05	9 01/11/20	9 02/13/05	4 02/13	4 02/15	1.1			7.5
White Shield	2000	JAN-DEC	8686	47 04/16/09	43 08/23/11	24 08/18/11	20 12/13/08	12 12/13	7 08/18	1.6			15.9

The maximum 1-hour concentration is 267 ppb at Bear Paw - MGP #5 on 08/23/07
The maximum 3-hour concentration is 134 ppb at Bear Paw - MGP #5 on 08/23/08
the maximum 24-hour concentration is 58 ppb at Mandan - SPM on 11/19

* The air quality standards are:

STATE Standards -

1) 273 ppb maximum 1-hour average concentration.
2) 99 ppb maximum 24-hour average concentration.
3) 23 ppb maximum annual arithmetic mean concentration.

FEDERAL Standards -

1) 500 ppb maximum 3-hour concentration not to be exceeded more than once per year.
2) 140 ppb maximum 24-hour concentration not to be exceeded more than once per year.
3) 30 ppb annual arithmetic mean.

Sulfur Dioxide 5-Minute Average

Sulfur dioxide 5-minute averages were collected at state-operated sites and the Bear Paw Energy network. The maximum 5-minute average was 499 ppb at Bear Paw - MGP #5.

The sulfur dioxide 5-minute data is presented in Table 3.

TABLE 3

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

POLLUTANT : SO_2 5-Minute Averages (ppb)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	5-MINUTE MAXIMA 1ST	DATE MM/DD/HH	2ND	DATE MM/DD/HH	3RD	DATE MM/DD/HH	# HOURS >600	% >MDV
Bear Paw - MGP #3	2000	JAN-DEC	8709	482	01/24/08	286	11/28/11	167	09/06/10	0	18.5
Bear Paw - MGP #5	2000	JAN-DEC	8697	499	08/23/08	494	09/07/23	437	08/23/07	0	23.8
Beulah - North	2000	JAN-DEC	8732	209	08/27/11	120	08/22/12	120	08/27/12	0	39.2
Dunn Center	2000	JAN-DEC	8590	70	08/25/09	68	08/25/10	44	07/05/17	0	25.3
Fargo NW	2000	JAN-DEC	8731	9	12/30/20	8	12/28/02	8	12/30/21	0	5.1
Hannover	2000	JAN-DEC	8715	164	07/13/09	156	03/09/08	131	07/26/11	0	35.0
Mandan - SPM	2000	JAN-DEC	8720	297	12/21/08	234	12/09/23	203	02/06/20	0	51.0
Mandan NW - SPM	2000	JAN-DEC	8731	167	03/22/11	157	08/23/09	151	05/25/09	0	52.8
Sharon	2000	JAN-DEC	7740	5	02/18/20	5	02/18/21	4	02/18/19	0	0.9
Short Creek - SPM	2000	JAN-DEC	8708	381	05/30/08	365	05/30/09	193	02/06/12	0	35.9
TRNP - SU (Painted Canyon)	2000	JAN-DEC	8176	11	01/11/18	11	02/23/05	10	01/11/19	0	7.5

The maximum 5-minute concentration is 499 ppb at Bear Paw - MGP #5 on 08/23/08

* No Standard is currently in effect:

Nitrogen Dioxide

Physical Characteristics and Sources

In its pure state, nitrogen dioxide is a reddish-orangeish-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 colorless and odorless, although it may be an irritant to the eyes and throat. Oxides of nitrogen, NO and NO_2 are formed when the nitrogen and oxygen in the air are combined in high-temperature combustion. NO released into ambient air combines with oxygen to form NO_2. Major NO_2 sources are coal conversion processes, natural gas processing plants, and natural gas compressor stations.

Health Effects

The negative effects of NO_2 on personal comfort, well being, and the environment include respiratory distress, as well as impacts on vegetation, materials, visibility and acid deposition.[5] Nitrate aerosols, which result from NO and NO_2 combining with water vapor in the air, have been consistently linked to visibility problems.

Standards Comparison

Nitrogen dioxide was monitored at eight sites. Six 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 6.6 ppb at Fargo NW.

The nitrogen dioxide data are summarized in Table 4.

TABLE 4

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

POLLUTANT : Nitrogen Dioxide (ppb)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MAXIMA 1 - HOUR 1ST MM/DD/HH	2ND MM/DD/HH	ARITH MEAN	% >MDV
Beulah - North	2000	JAN-DEC	8714	45 02/17/17	44 02/17/18	3.4	80.0
DGC #12	2000	JAN-DEC	8660	43 02/17/18	41 02/17/19	3.6	86.6
DGC #17	2000	JAN-DEC	8534	94 05/15/00	67 04/16/00	4.1	94.8
Dunn Center	2000	JAN-DEC	8696	16 12/15/03	15 01/31/16	2.0	52.5
Fargo NW	2000	JAN-DEC	8708	47 12/14/06	45 03/16/22	6.6	82.4
Hannover	2000	JAN-DEC	7318	30 07/26/11	29 01/31/23	2.5	63.7
Sharon	2000	JAN-DEC	8723	16 08/15/20	15 12/28/01	1.9	48.0
Short Creek - SPM	2000	JAN-DEC	8692	24 11/29/07	24 12/26/00	3.0	77.2

The maximum 1-hour concentration is 94 ppb at DGC #17 on 05/15/00

* The air quality standards are:
  STATE - 53 ppb maximum annual arithmetic mean.

  FEDERAL - 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 which are pressure and temperature sensitive.[6,7]

Health Effects

In mild concentrations (<25 ppm), ammonia will cause conjunctivitis and dermatitis. At higher concentrations, n the eyes it will cause swelling, painful burns, lesions, and possible poss of vision. On contact with the skin it will cause caustic-like burns and inflamation. Toxic level (300 ppm) skin exposure may cause skin lesions resulting in early necrosis and scarring. Inhalation is corrosive and irritating to the upper respiratory system ans all mucus type tissue. Depending on the concentration inhaled, it may cause burning sensations, coughing, wheezing, shortness of breath, headache, nausea, with eventual collapse and death.[6,7]

Standards Comparison

There is no ambient air quality standard for ammonia. Because ammonia is important to the newer air quality dispersion models, an ammonia analyzer was added to the Beulah - North site effective November 17.

The ammonia data are summarized in Table 5.

TABLE 5

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

POLLUTANT : Ammonia (ppb)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MAXIMA 1-HOUR 1ST MM/DD/HH	2ND MM/DD/HH	3RD MM/DD/HH	4TH MM/DD/HH	5TH MM/DD/HH	6TH MM/DD/HH
Beulah - North	2000	NOV-DEC	1052 ***	99.1 11/29/15	90.6 11/29/16	83.9 11/29/14	37.9 11/29/13	6.4 12/07/08	6.3 12/18/03

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

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[8]. 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.[9] Concentrations of ozone in this layer are approximately 10,000 to 12,000 ppb or one hundred times the SAAQS 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 which 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.[8]

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 with 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 six state run sites. This data is used in computer dispersion models as part of the primary and secondary chemical transformations.

The 1-hour state standard (120 ppb) was not exceeded during the year. The maximum 1-hour concentration was 78 ppb at Fargo NW.

As part of preparing for a new 8-hour standard (80 ppb), 8-hour averages have been included in the data summary. The 8-hour standard uses the fourth highest daily maximum for comparison to the standard. The highest fourth-highest 8-hour concentration was 69 ppb at Fargo NW.

The ozone data are summarized in Table 6.

TABLE 6

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

POLLUTANT : Ozone (ppb)

				M A X I M A							
				1 - HOUR		8 - HOUR					
LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	1ST MM/DD/HH	2ND MM/DD/HH	1ST MM/DD/HH	2ND MM/DD/HH	3RD MM/DD/HH	4TH MM/DD/HH	1HR #>120	8HR #>80
Beulah - North	2000	JAN-DEC	8655	60 04/23/15	60 05/26/13	55 04/23/10	54 04/23/09	54 05/26/11	54 05/26/10		
Dunn Center	2000	JAN-DEC	6734	71 09/17/16	62 09/17/15	55 09/08/10	54 09/17/10	54 09/17/09	54 09/17/08		
Fargo NW	2000	JAN-DEC	8723	78 06/09/14	75 06/09/15	71 06/09/11	69 06/09/10	69 06/09/09	69 07/29/08		
Hannover	2000	JAN-DEC	8720	62 08/11/15	61 05/11/11	56 08/11/10	56 08/11/09	56 05/27/10	56 05/27/09		
Sharon	2000	JAN-DEC	8732	69 06/09/17	68 05/05/16	64 06/09/10	59 06/09/09	59 06/09/11	59 04/25/10		
TRNP - SU (Painted Canyon)	2000	JAN-DEC	8734	66 09/17/14	65 07/01/12	62 07/01/08	61 07/01/07	61 08/24/10	61 08/24/09		

The maximum 1-hour concentration is 78 ppb at Fargo NW on 06/09/14
The 4th highest 8-hour concentration is 69 ppb at Fargo NW on 07/29/08

* The air quality standards for ozone are:
STATE - 120 ppb not to be exceeded more than once per year.

FEDERAL - Fourth highest daily maximum 8-hour averages for a 3-year period not to exceed 80 ppb.

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 in diameter and smaller is considered inhalable. This particulate matter is called PM_{10}.[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 "fugitive dust" (wind-blown 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, is generally 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.[10]

In addition, particles less than 2.5 micrometers ($PM_{2.5}$) are major contributors to visibility degredation 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 deep into the lungs.

Fine particulate ($PM_{2.5}$) pollution affects the health of certain sub-groups. Such groups can be identified as potentially "at risk" of adverse health effects from air borne 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 the general healthy population.[9]

The effects of particulate exposure may be the most widespread of all pollutants. Because of the potential for extremely long-range transport of fine 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.[11] Acid deposition can be detected in the most remote areas of the world.

Inhalable FRM $PM_{2.5}$ Particulates

Inhalable $PM_{2.5}$ particulates were monitored at seven sites operated by the Department. Single-day FRM samplers were installed at Beulah, Dickinson, Sharon, and TRNP - SU to collect a sample once every 6 days. Sequential FRM samplers were installed at Bismarck, Fargo and Grand Forks to collect a sample once every 3 days.

Standards Comparison

The 24-hour federal standard (65 $\mu g/m^3$) was not exceeded during the year. The maximum 24-hour average concentration was 37.7 $\mu g/m^3$ at Sharon.

The federal annual standard (15 $\mu g/m^3$) was not exceeded for the year. The maximum annual average was 8.1 $\mu g/m^3$ at Grand Forks - North.

The inhalable $PM_{2.5}$ data are summarized in Table 7.

TABLE 7

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

POLLUTANT : Inhalable FRM $PM_{2.5}$ Particulates (µg/m³)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	MAXIMA 1ST MM/DD	2ND MM/DD	3RD MM/DD	ARITH MEAN	#>150	AM>50	% >MDV
Beulah - North	2000	JAN-DEC	59	1.8	14.0 08/04	11.5 12/20	10.7 12/14	6.1			98.3
Bismarck Residential	2000	JAN-DEC	121	2.1	21.3 01/28	14.5 08/25	14.3 08/04	6.6			100.0
Dickinson Residential	2000	JAN-DEC	59	1.3	12.3 08/04	10.1 02/12	9.6 01/19	5.4			94.9
Estevan, SK	2000	NOV-DEC	7 ***	5.0	13.9 11/23	13.4 12/12	7.5 11/30	8.7			100.0
Fargo NW	2000	JAN-DEC	117	1.8	28.1 02/21	26.5 01/28	26.4 07/29	7.7			96.5
Grand Forks - North	2000	JAN-DEC	113	1.6	28.0 01/28	27.5 12/14	24.6 07/29	8.1			98.2
Lignite - SPM	2000	JAN-DEC	56	1.5	12.8 08/04	12.7 02/12	12.2 02/24	5.9			98.2
Raferty Dam, SK	2000	APR-DEC	40 ***	2.0	13.9 08/04	12.9 08/10	11.8 12/14	6.2			100.0
Sharon	2000	JAN-DEC	57	0.4	37.7 08/24	21.0 07/29	17.8 06/12	6.9			91.2
Short Creek - SPM	2000	JAN-DEC	60	1.5	13.3 08/04	11.8 02/06	11.8 02/24	5.8			98.3
TRNP - SU (Painted Canyon)	2000	JUL-DEC	27 ***	1.9	12.0 08/04	9.8 08/10	9.1 07/23	5.6			96.3

The maximum 24-hour concentration is 37.7 µg/m3 at Sharon on 08/24

* The ambient air quality standards are:
FEDERAL Standards -
1) 24-hour: 3-year average of 98th percentiles not to exceed 65 µg/m³.
2) Annual: 3-year average not to exceed 15µg/m³.

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

Inhalable Continuous $PM_{2.5}$ Particulates

Inhalable particulates are monitored continuously at Beulah - North, Fargo NW, and Short Creek - SPM. The start dates are October 11, July 1, and Aug 23, respectively. Since the data collected is not collected by an EPA reference or equivalent method, the data can not be used for standard comparison. The EPA is expected to designate the analyzers used to be designated as an equivalent method some time in 2002.

The maximum 1-hour average concentration was 107.3 µg/m³ at Fargo NW. The maximum 24-hour average concentration is 33.4 µg/m³ at Beulah North. The maximum annual average is 5.6 µg/m³ at Beulah - North.

The inhalable continuous $PM_{2.5}$ data are summarized in Table 8.

Table 8

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

POLLUTANT : Inhalable Continuous $PM_{2.5}$ (µg/m3)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MAXIMA 1-HOUR 1ST MM/DD/HH	1-HOUR 2ND MM/DD/HH	24-HOUR 1ST MM/DD	24-HOUR 2ND MM/DD	24-HOUR 3RD MM/DD	24-HOUR 4TH MM/DD	MEAN	1HR #>150	24HR #>65
Beulah - North	2000	OCT-DEC	2198	144.3 11/29/15	126.9 11/29/14	33.4 11/29	24.9 11/07	17.2 10/13	10.9 12/20	5.6		
Fargo NW	2000	JUL-DEC	4399	170.3 07/04/21	72.6 09/29/19	21.8 07/29	19.8 07/30	15.9 08/02	15.4 07/04	5.1	1	
Short Creek - SPM	2000	AUG-DEC	3112	33.9 10/18/17	29.6 10/21/19	14.8 10/12	13.8 08/24	11.1 08/26	9.5 08/25	3.1		

The maximum 1-hour concentration is 170.3 µg/m3 at Fargo NW on 07/04/21
The highest 24-hour concentration is 33.4 µg/m3 at Beulah - North on 11/29

* The ambient air quality standards are:
FEDERAL Standards -
1) 24-hour: 3-year average of 98th percentiles not to exceed 65 µg/m3.
2) Annual: 3-year average not to exceed 15 µg/m3.

Inhalable PM_{10} Particulates

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

Standards Comparison

The 24-hour state standard (150 µg/m^3) was not exceeded during the year. The maximum 24-hour concentration was 42.4 µg/m^3 at Fargo NW.

The annual state standard (50 µg/m^3) was not exceeded. The maximum annual mean for the year was 16.8 µg/m^3 at Fargo NW.

The inhalable particulate (PM_{10}) data are summarized in Table 9

TABLE 9

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

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

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	MAXIMA 1ST MM/DD	MAXIMA 2ND MM/DD	MAXIMA 3RD MM/DD	ARITH MEAN	#>150	AM>50	% >MDV
Dragswolf	2000	APR-DEC	45	0.8	17.4 05/24	17.2 08/22	15.1 10/21	6.5			77.7
Fargo NW	2000	JAN-DEC	56	3.6	42.4 07/29	39.1 05/06	36.4 08/04	16.8			98.2
White Shield	2000	APR-DEC	45	1.5	23.3 10/21	20.1 08/04	20.1 08/10	8.5			88.8

The maximum 24-hour concentration is 42.4 µg/m3 at Fargo NW on 07/29

* The STATE air quality standards are:
1) 150 µg/m3 maximum averaged over a 24-hour period with no more than one expected exceedance per year.
2) 50 µg/m3 expected annual arithmetic mean.

Sulfates ($SO_4^=$)

Physical Characteristics and Sources

Sulfates are any of the group of compounds that contain the sulfate ($SO_4^=$) ion. Sulfates are generally found as fine particulate or aerosols. Natural sources of sulfates include sea spray and volcanic eruptions. Sulfates also can be emitted directly from the application of fertilizers and from some industrial sources. Most sulfates are secondary particulate, those not directly emitted from a source, but created by the oxidation of SO_2. Sulfur dioxide emitted from a source can be transformed into $SO_4^=$ by a number of atmospheric chemical reactions. These various reactions may involve water vapor, ozone, hydrocarbons or peroxides. Atmospheric sulfates usually exist as sulfuric acid or ammonium sulfate.[12]

Health Effects

Health impacts generally are associated with acidic sulfate aerosols. Short-term exposures of 100 $\mu g/m^3$ of sulfuric acid (H_2SO_4), (a level at the extreme high end of the ambient concentrations) have shown respiratory impairment in some healthy adults and no effect in others. Other studies have shown decreased lung function in exercising adolescent asthmatics, while other studies of asthmatics have shown no adverse effects at 100 $\mu g/m^3$ H_2SO_4. Enhanced respiratory difficulties are seen with exposures to SO_2 and H_2SO_4. Further sensitivity studies are necessary to determine the health impacts of $SO_4^=$.[12,13,14]

Fine particulate sulfate is efficient at scattering light, thus it is a factor in visibility degradation. Even at low concentrations, below 3 $\mu g/m^3$, sulfate will affect visibility. The light-scattering potential of sulfate increases with increasing relative humidity. Seasonal changes in sulfate levels are associated with seasonal changes in visual range.

Sulfate compounds, as acid deposition, can adversely affect aquatic and terrestrial ecosystems. Water supplies are affected when minerals are leached from the soil by acid deposition. Drinking water containing either sulfates or leached metals can cause human health problems.

Inhalable PM_{10} Sulfate

Inhalable PM_{10} sulfate concentrations was monitored at Fargo NW.

Standards Comparison

No standard is currently in effect. The maximum 24-hour concentration was 14.2 $\mu g/m^3$.

The maximum annual mean for the year was 1.6 $\mu g/m^3$.

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

Table 10

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

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

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	MAXIMA 1ST MM/DD	2ND MM/DD	3RD MM/DD	ARITH MEAN	#>15	AM>5	% >MDV
Fargo NW	2000	JAN-DEC	56	0.3	14.2 07/29	7.9 08/28	4.0 02/24	1.6			91.0

The maximum 24-hour concentration is 14.2 µg/m3 at Fargo NW on 07/29

SUMMARY AND CONCLUSIONS

The State of North Dakota has relatively clean air. North Dakota is one of only 14 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% data recovery for the full year are reported as a partial year. A summary for each pollutant is provided below.

Sulfur Dioxide

The federal standards were not exceeded at any monitoring site. The state 1-hour standard was exceeded three times. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standard are as follows: 1-hour – 266 ppb (97.4%); 3-hour – 134 ppb (26.8%); 24-hour – 58 ppb (58.6%); annual – 1.6 ppb (7.0%).

Sulfur Dioxide 5-Minute Averages

No standard is currently in effect. The maximum 5-minute average was 499 ppb.

Nitrogen Dioxide

Neither state nor federal standard was exceeded at any of the monitoring sites. The maximum concentration and the maximum concentration expressed as a percentage of the applicable standard is as follows: annual – 6.6 ppb (12.5%).

Ammonia

No standard is currently in effect. The maximum 1-hour average is 99.1 ppb.

Ozone

Neither state nor federal standard was exceeded during the year. The maximum 1-hour concentration and the maximum 1-hour concentration expressed as a percentage of the applicable standard is 78 ppb (65.0%). The maximum 8-hour average concentration was 69 ppb (86.3%).

Inhalable FRM $PM_{2.5}$ Particulates

The federal standards were not exceeded during the year. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standard are as follows: 24-hour – 37.7 $\mu g/m^3$ (58.0%); annual – 8.1 $\mu g/m^3$ (54.0%).

Inhalable Continuous PM2.5 Particulates

No standard is currently in effect for this analytical method. The maximum 1-hour average was 170.3 $\mu g/m^3$. The maximum 24-hour average was 33.4 $\mu g/m^3$. The maximum annual average was 5.6 $\mu g/m^3$.

Inhalable PM_{10} Particulates

The state standards were not exceeded during the year. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standard are as follows: 24-hour – 42.4 $\mu g/m^3$ (28.3%); annual – 16.8 $\mu g/m^3$ (33.6%).

Inhalable PM_{10} Sulfates

No standard is currently in effect. The maximum 24-hour average was 14.2 $\mu g/m^3$. The maximum annual average is 1.6 $\mu g/m^3$.

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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 SO_2, CO, NO_2, H_2S, $PM_{2.5}$ and PM_{10} and 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 (O_3) is formed as a result of a photochemical reaction between hydrocarbons (HC) and oxides of nitrogen (NO_x).

The North Dakota Ambient Air Quality Standards are established to protect public health and welfare. Effective August 1, 1997, coal conversion and oil refineries were exempted from the state sulfur dioxide standards.

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})	50	micrograms per cubic meter of air, expected annual arithmetic mean micrograms per cubic meter of air maximum
	150	24-hour average concentration with no more than one expected exceedance per year
Sulfur Dioxide*	0.023	parts per million (60 micrograms per cubic meter of air), maximum annual arithmetic mean concentration
	0.099	parts per million (260 micrograms per cubic meter of air), maximum 24-hour average concentration
	0.273	parts per million (715 micrograms per cubic meter of air), maximum 1-hour average concentration
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	0.12	parts per million (235 micrograms per cubic meter of air), maximum 1-hour concentration not to be exceeded more than once per year
Nitrogen Dioxide	0.053	parts per million (100 micrograms per cubic meter of air), maximum annual arithmetic mean
Lead	1.5	micrograms per cubic meter of air, maximum arithmetic mean averaged over a calendar quarter

* After August 1, 1997, coal conversion facilities and oil refineries are subject only to the federal SO_2 standards.

TABLE A1-2
Federal Ambient Air Quality Standards

Pollutant	Description	Primary	Secondary
$PM_{2.5}$	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.	65 µg/m^3	65 µg/m^3
PM_{10}*	Expected annual arithmetic mean.	50 µg/m^3	50 µg/m^3
	99th percentile of the 24-hour concentrations averaged over 3 years.	150 µg/m^3	150 µg/m^3
SO_2	Annual arithmetic mean.	0.03 ppm (80 µg/m^3)	-
	Maximum 24-hour concentration not to be exceeded more than once per year.	0.14 ppm (365 µg/m^3)	-
	Maximum 3-hour concentration not to be exceeded more than once per year.	-	0.5 ppm (1300 µg/m^3)
CO	8-hour concentration not to be exceeded more than once per year.	9 ppm (10 µg/m^3)	-
	1-hour average concentration not to be exceeded more than once per year.	35 ppm (40 µg/m^3)	-
O_3*	3-year average of the annual 4th highest daily maximum 8-hour concentrations, not to be exceeded.	0.08 ppm	0.08 ppm
NO_2	Annual arithmetic mean.	0.053 ppm (100 µg/m^3)	0.053 ppm (100 µg/m^3)
Pb	Maximum arithmetic mean averaged over a calendar quarter.	1.5 µg/m^3	1.5 µg/m^3

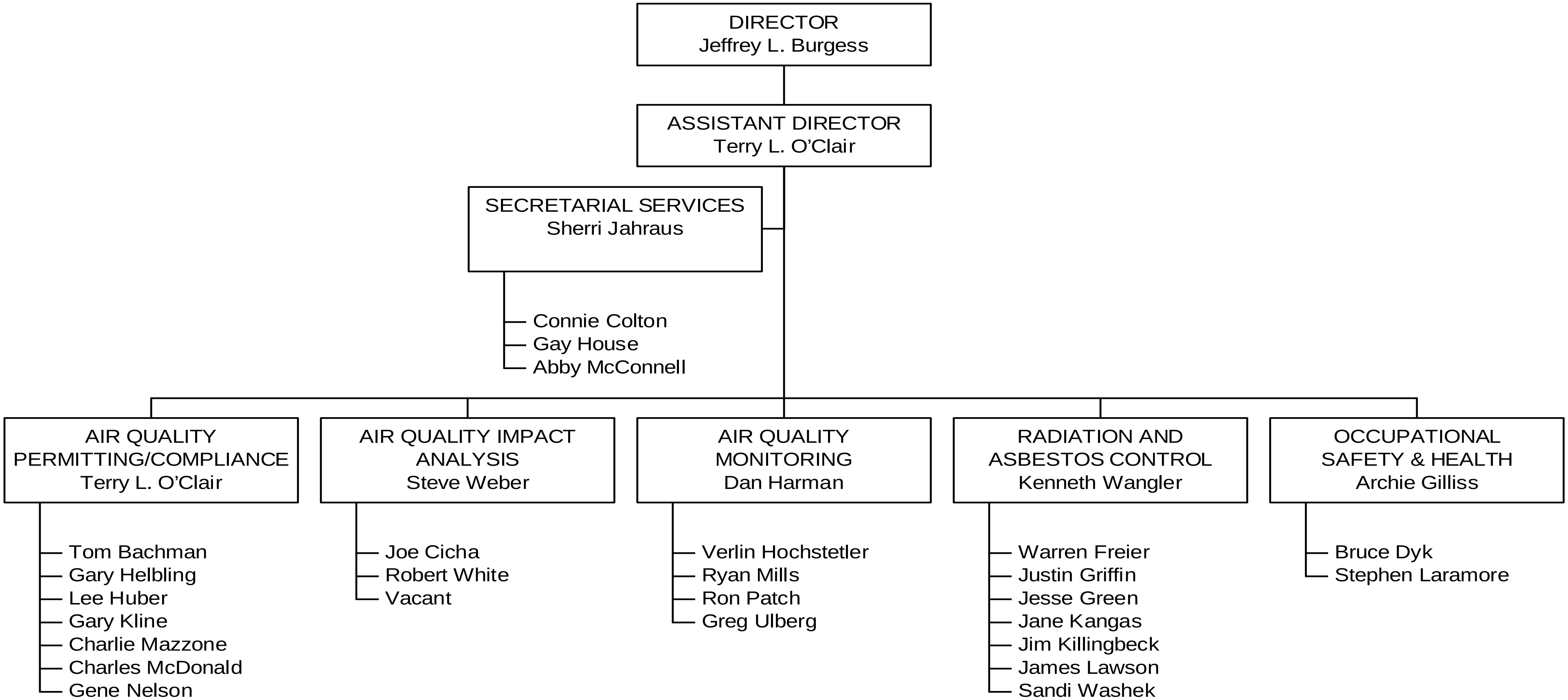
* The PM_{10} and ozone standards have been challenged in court. The final status for these standards is yet to be decided.

APPENDIX 2

Air Quality Personnel
Organizational Chart

The following Division of Environmental Engineering organizational chart includes the Air Pollution Control Program.

NORTH DAKOTA DEPARTMENT OF HEALTH
DIVISION OF ENVIRONMENTAL ENGINEERING



A2-1 Environmental Engineering Organizational Chart

12/27/00

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. Except for the Bear Paw - McKenzie Gas Plant network which has wind direction at each site, there is only one MET station for each network.

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.

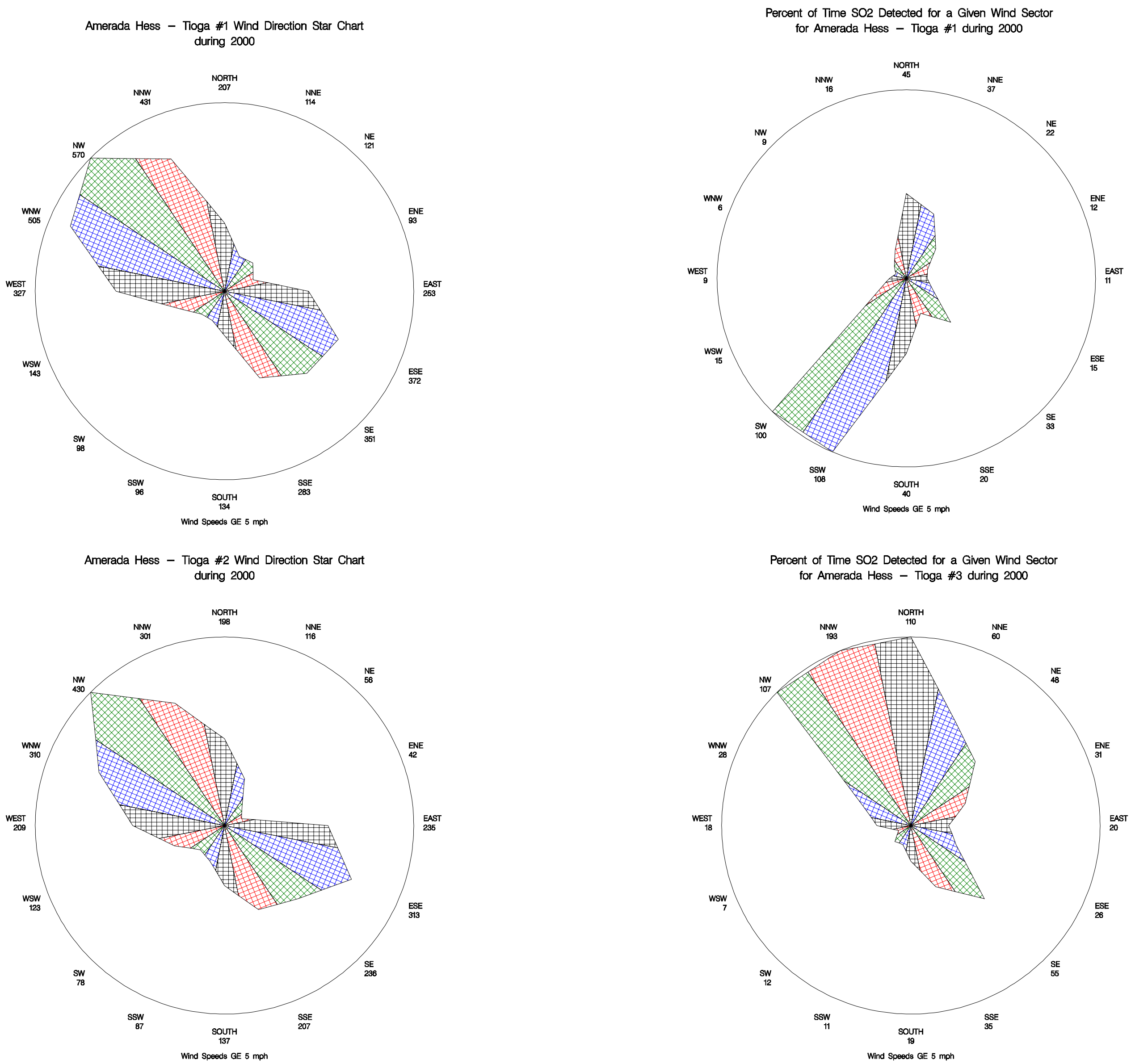
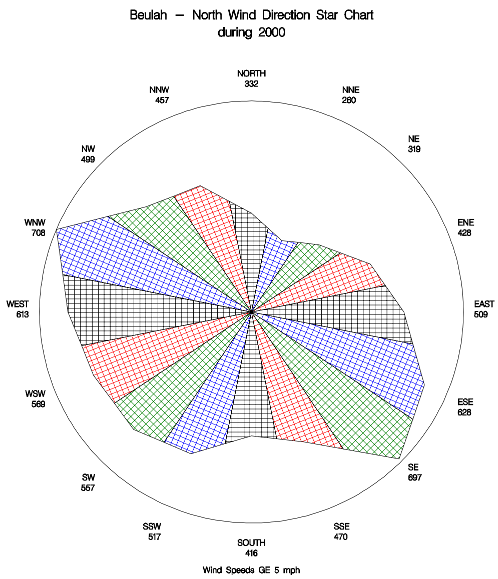
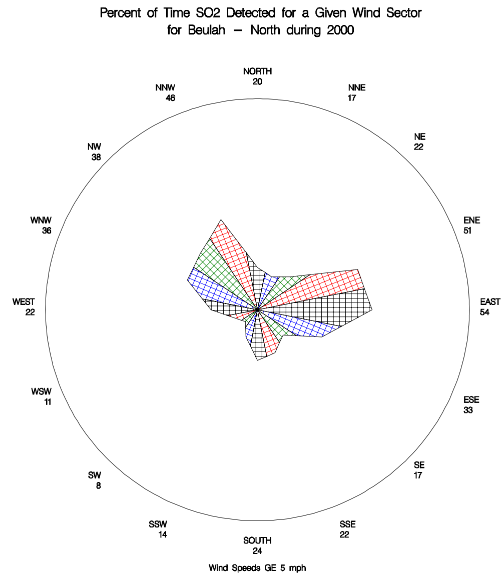
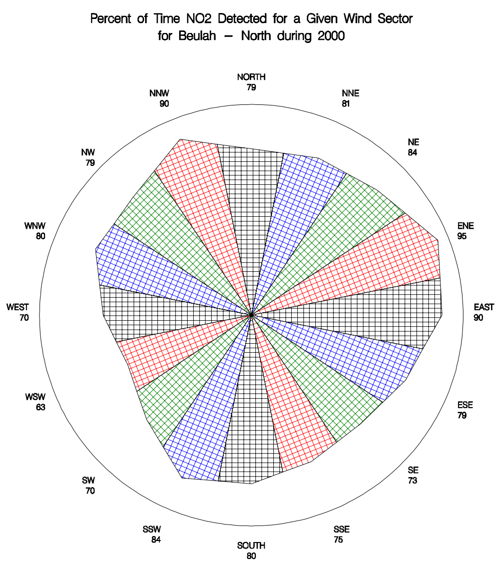
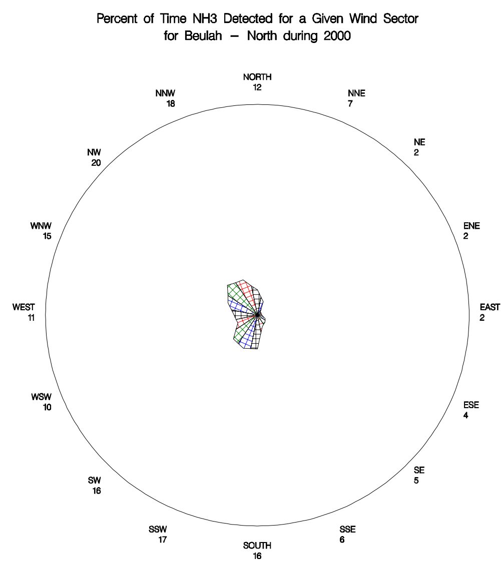


Figure A3-1 Amerada Hess Star Charts









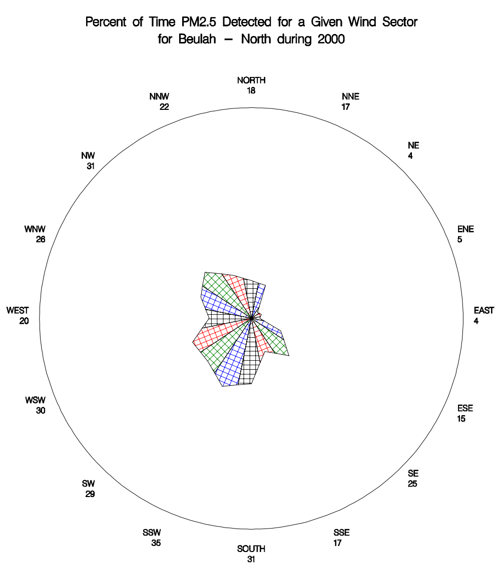
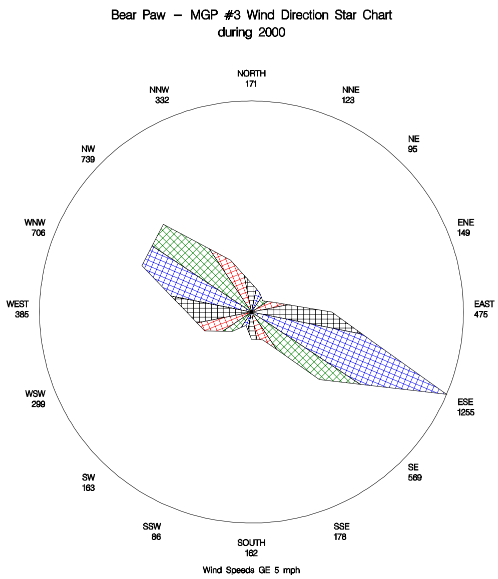
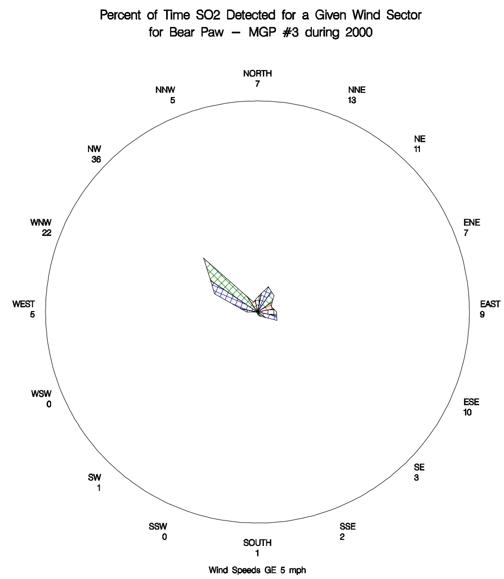
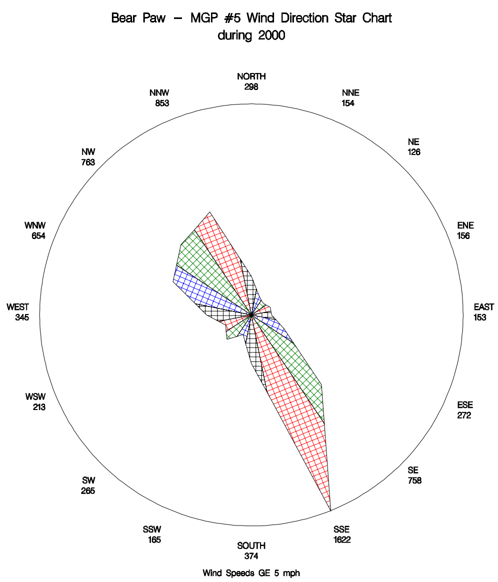


Figure A3-2 Beulah Star Charts







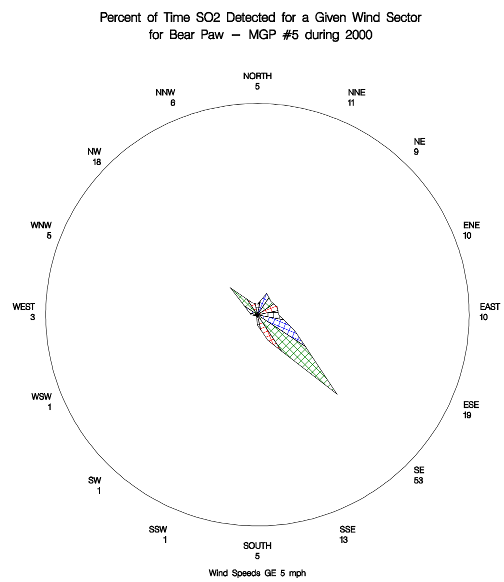
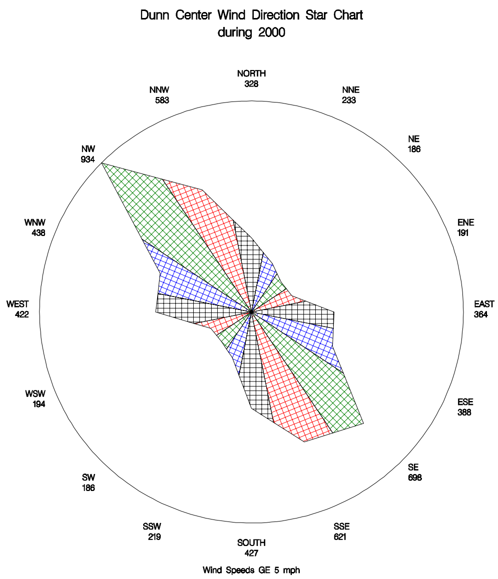
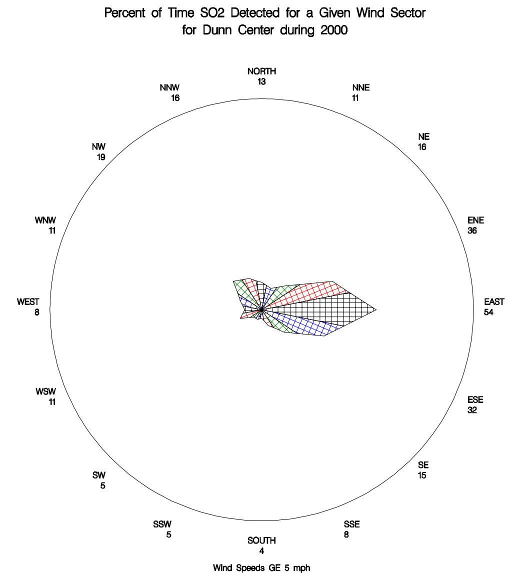


Figure A3-3 Bear Paw Star Charts





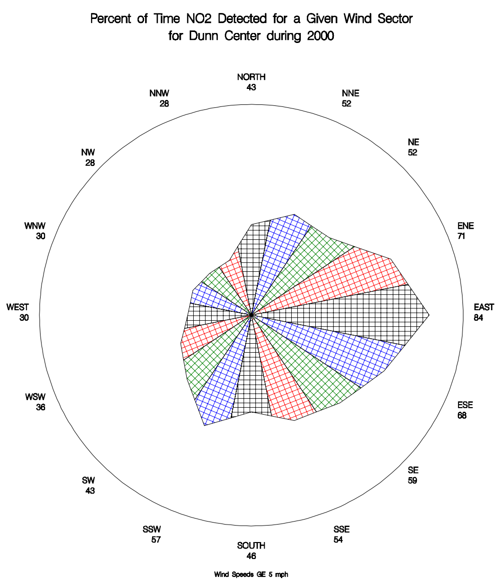
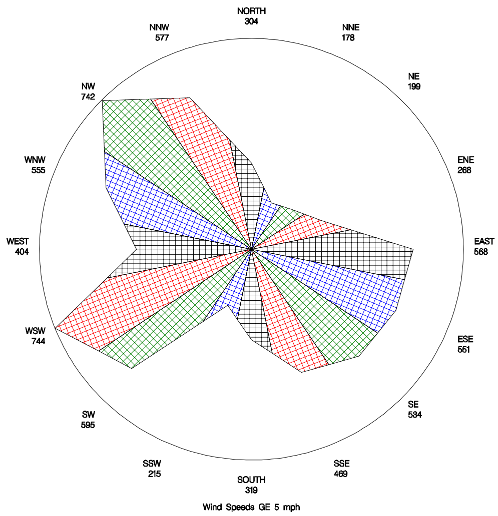
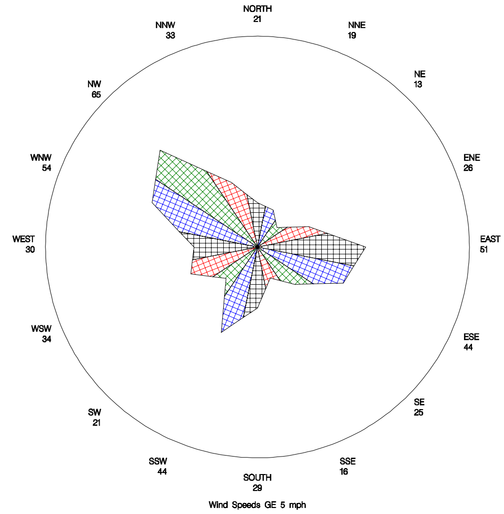


Figure A3-4 Dunn Center Star Charts

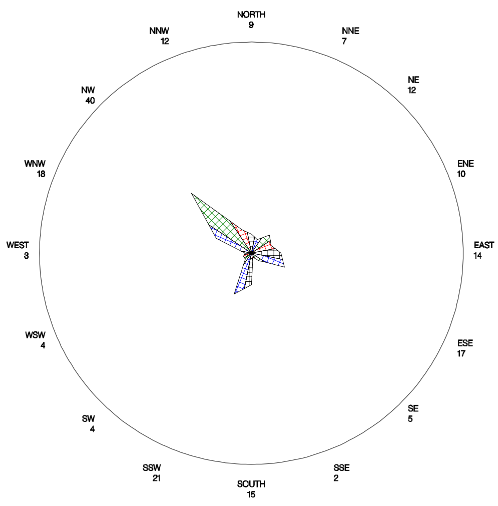
DGC #12 Wind Direction Star Chart
during 2000



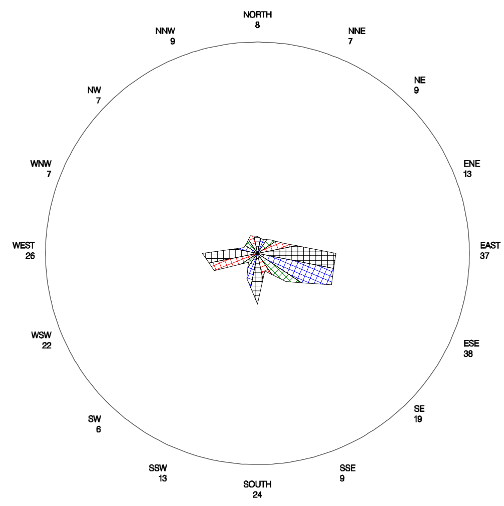
Percent of Time SO2 Detected for a Given Wind Sector
for DGC #12 during 2000



Percent of Time NO2 Detected for a Given Wind Sector
for DGC #12 during 2000



Percent of Time SO2 Detected for a Given Wind Sector
for DGC #14 during 2000



Percent of Time SO2 Detected for a Given Wind Sector
for DGC #16 during 2000

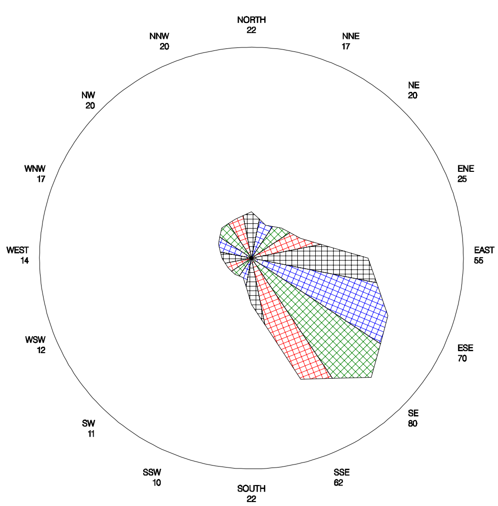
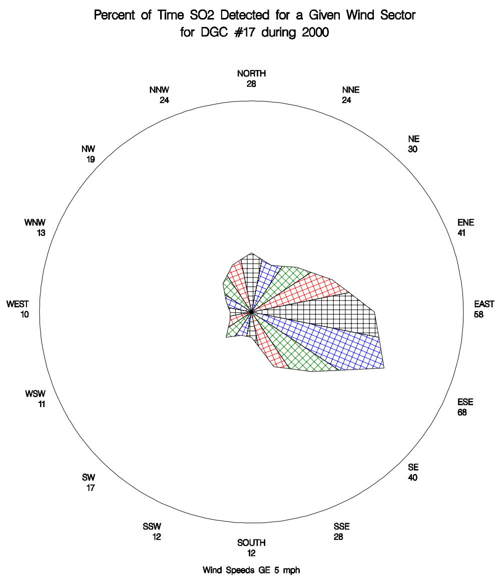


Figure A3-5 DGC Star Charts



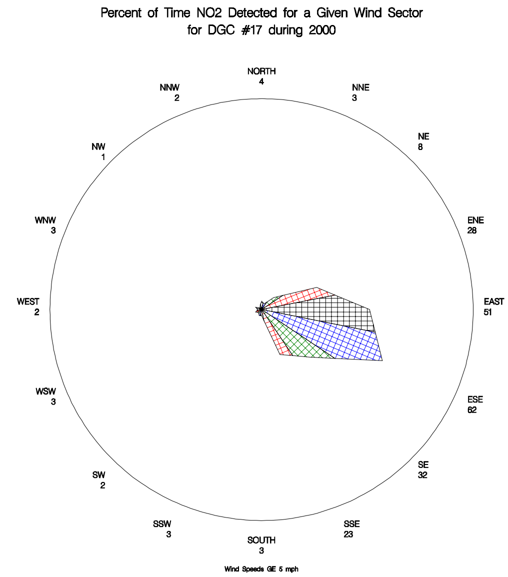
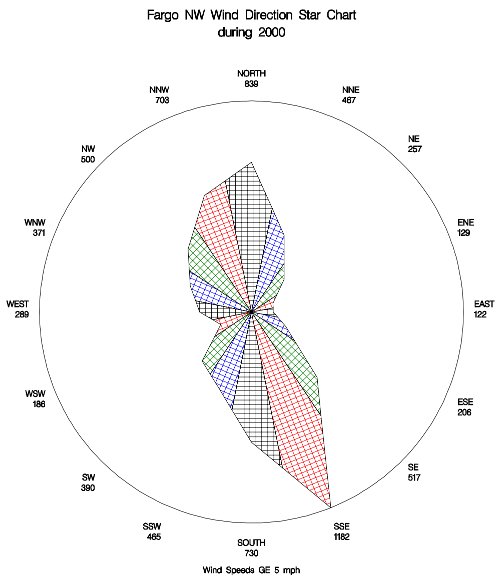
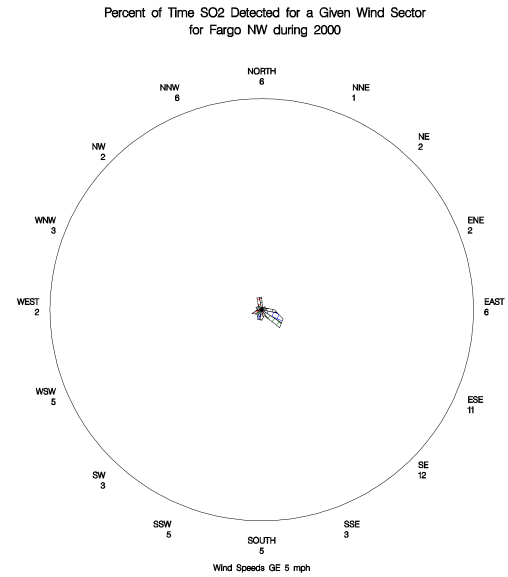
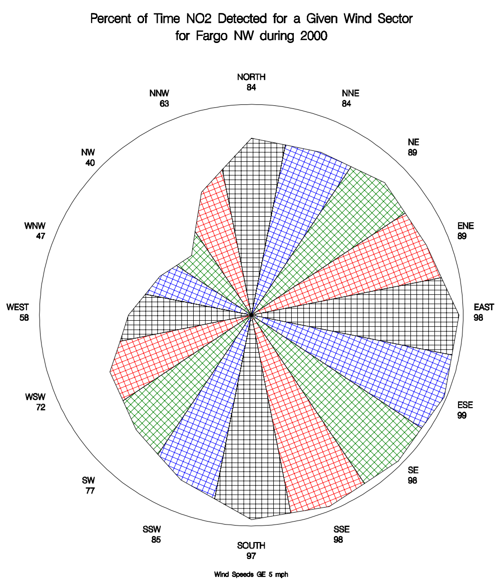


Figure A3-5 DGC Star Charts (cont.)







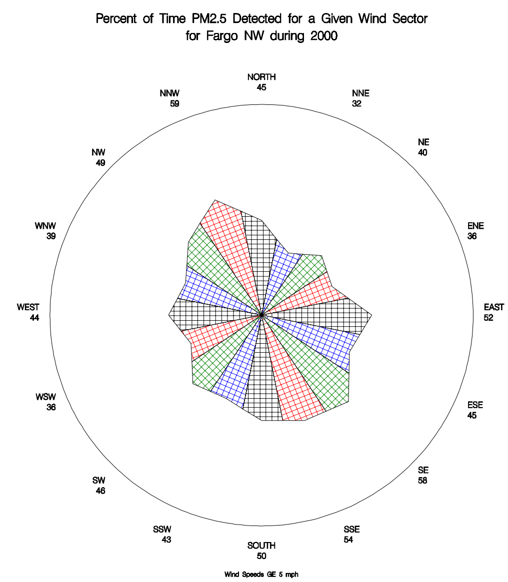
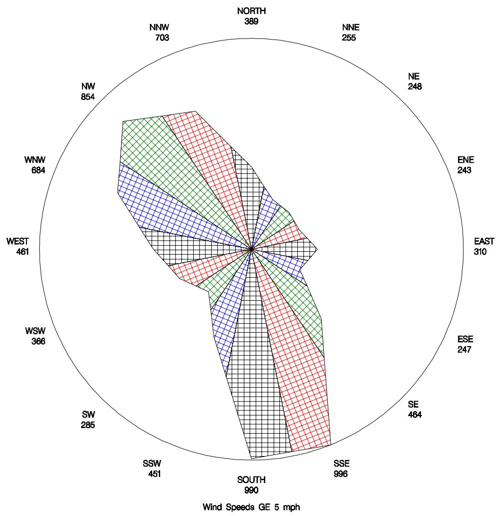
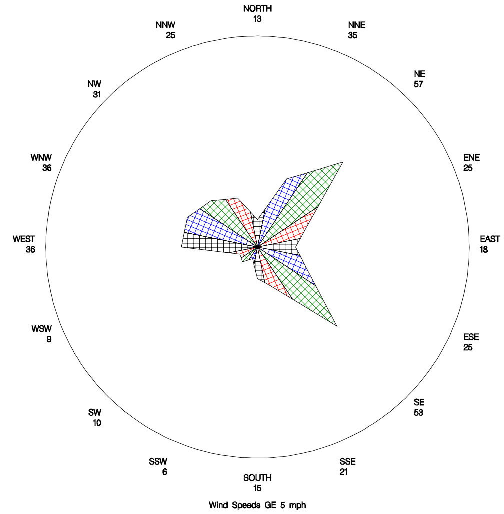


Figure A3-6 Fargo Star Charts

Hannover Wind Direction Star Chart
during 2000



Percent of Time SO2 Detected for a Given Wind Sector
for Hannover during 2000



Percent of Time NO2 Detected for a Given Wind Sector
for Hannover during 2000

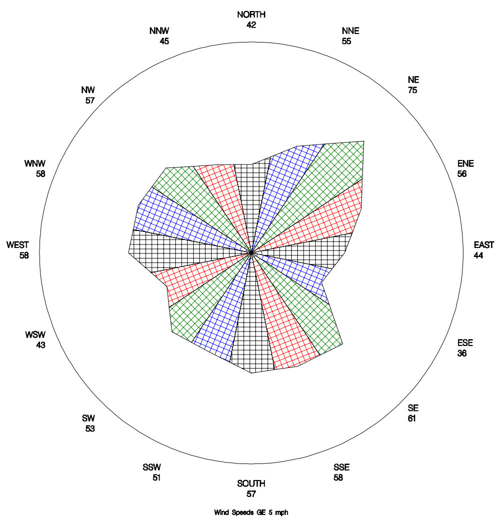
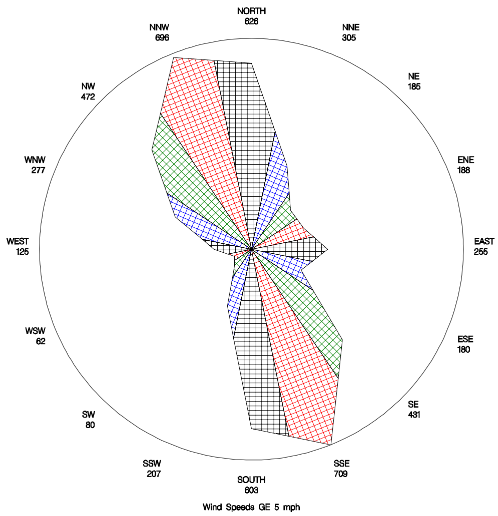
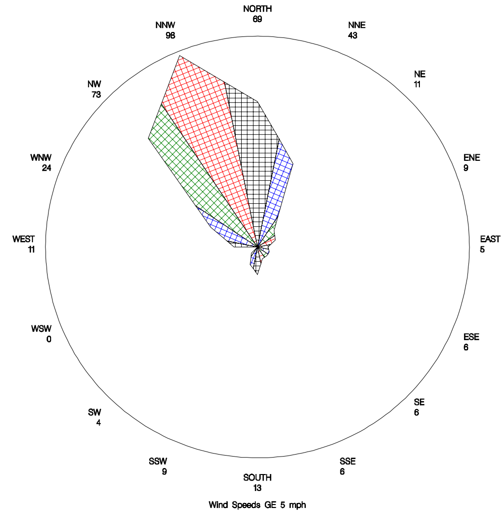


Figure A3-7 Hannover Star Charts

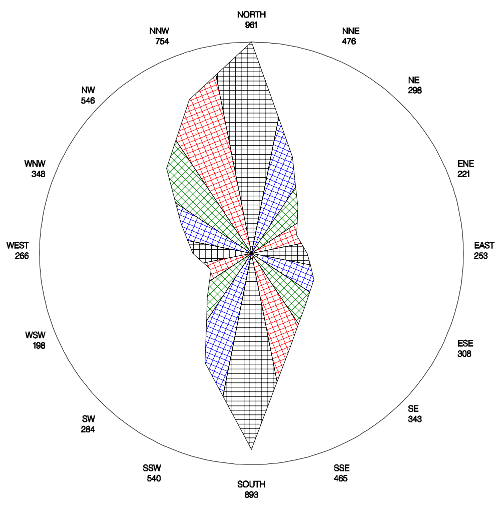
Mandan – SPM Wind Direction Star Chart
during 2000



Percent of Time SO2 Detected for a Given Wind Sector
for Mandan – SPM during 2000



Mandan NW – SPM Wind Direction Star Chart
during 2000



Percent of Time SO2 Detected for a Given Wind Sector
for Mandan NW – SPM during 2000

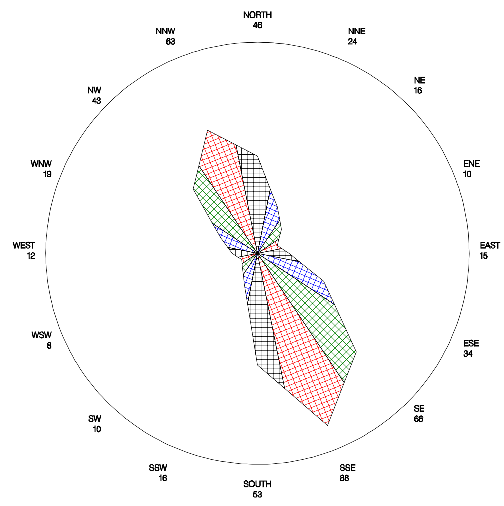
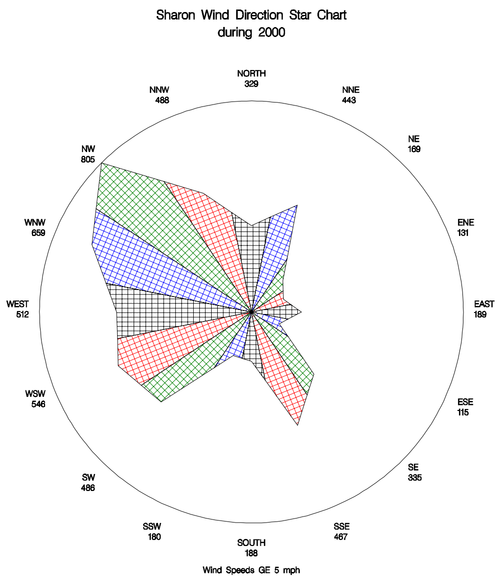
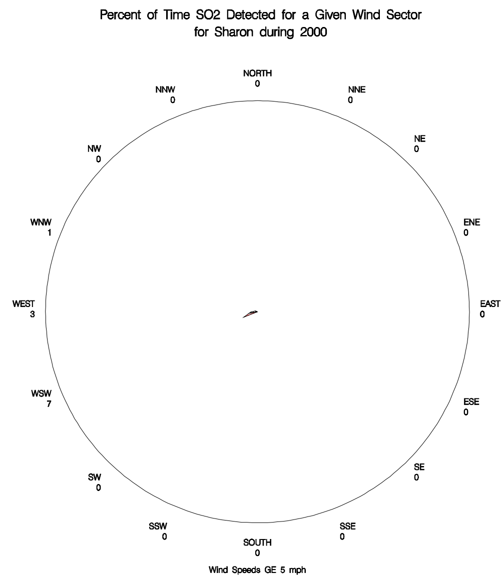


Figure A3-8 Mandan/Mandan NW Star Charts





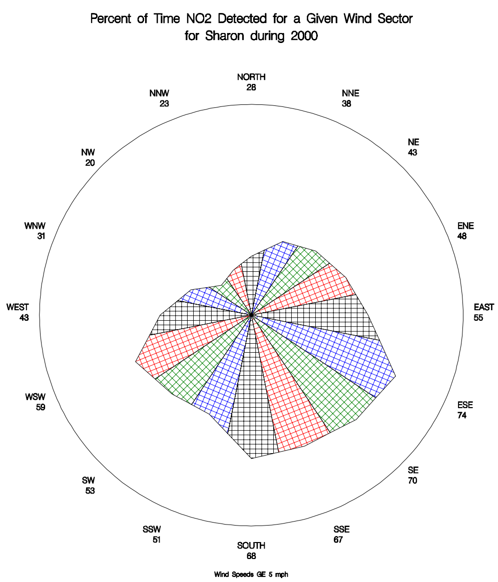
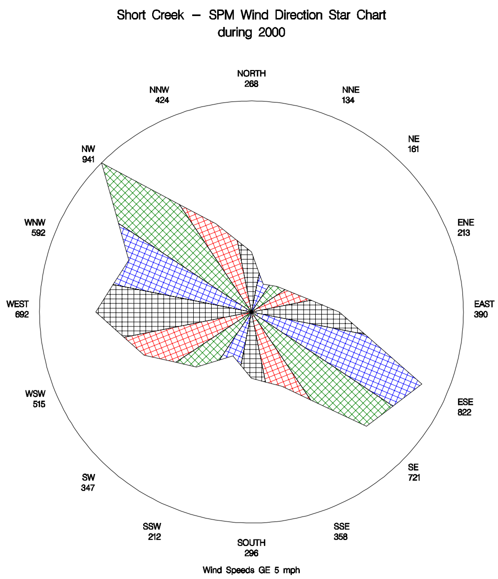
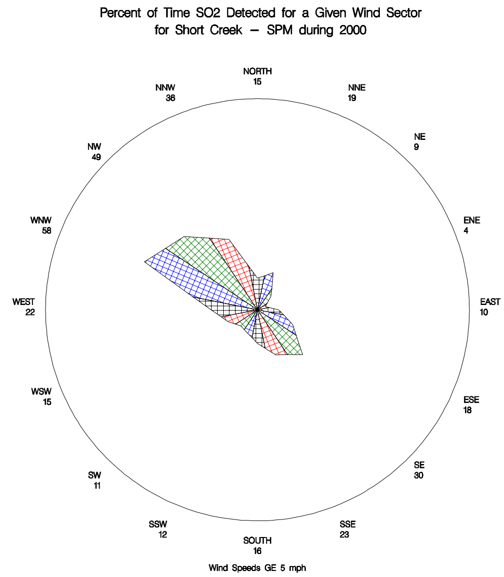
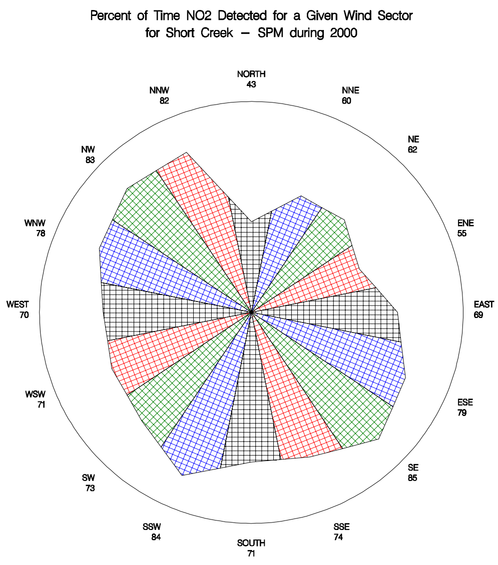
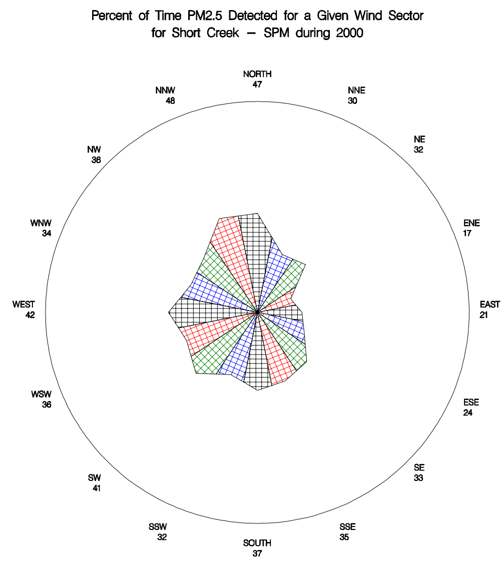


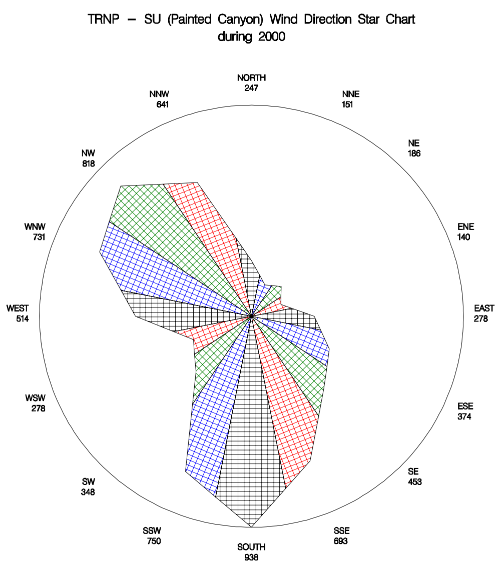
Figure A3-9 Sharon Star Charts











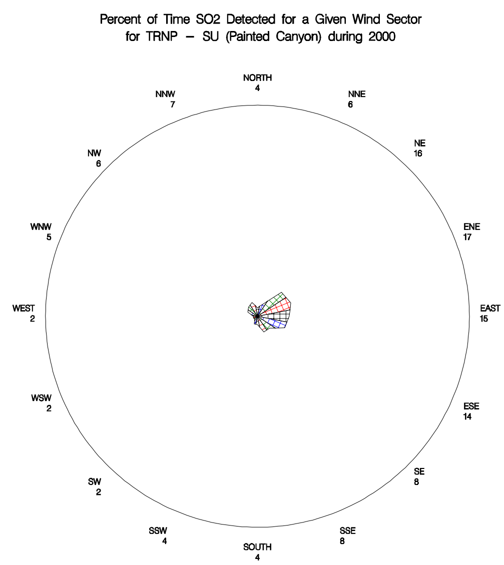
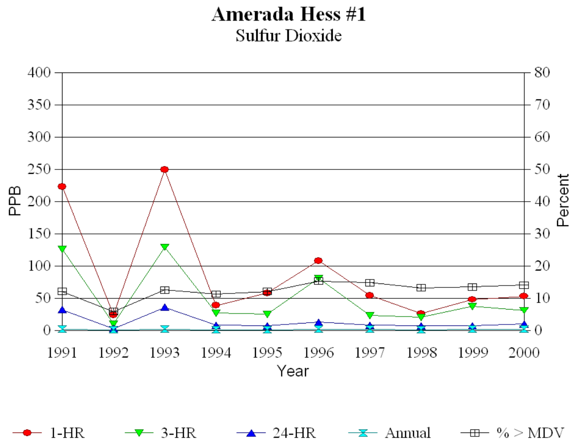


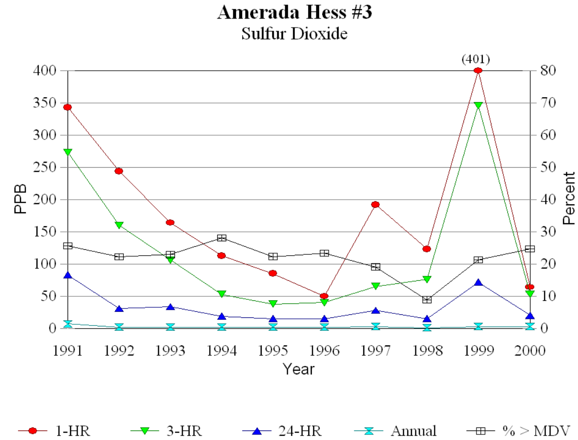
Figure A3-10 Short Creek - SPM/TRNP - NU

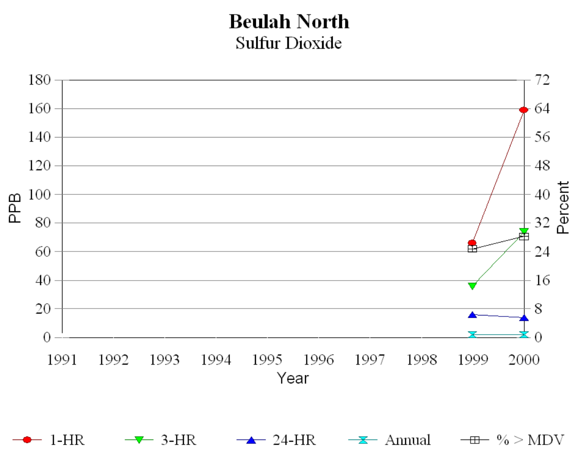
APPENDIX 4

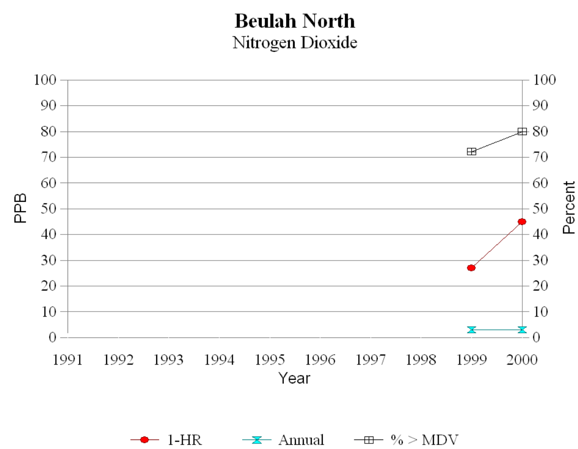
1991-2000 Trends

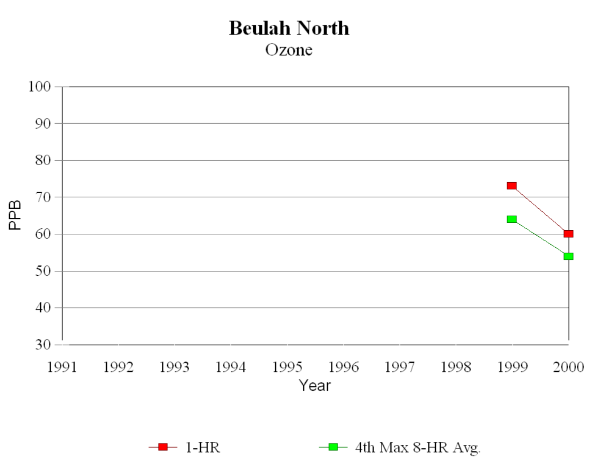
The trend graphs for 1991 through 2000 are presented in alphabetical order, grouped by site, unless multiple sites would fit on a single page. Each graph depicts the maximum concentration for each applicable standard (left scale) and percentage of time an hourly concentration is detected (right scale).











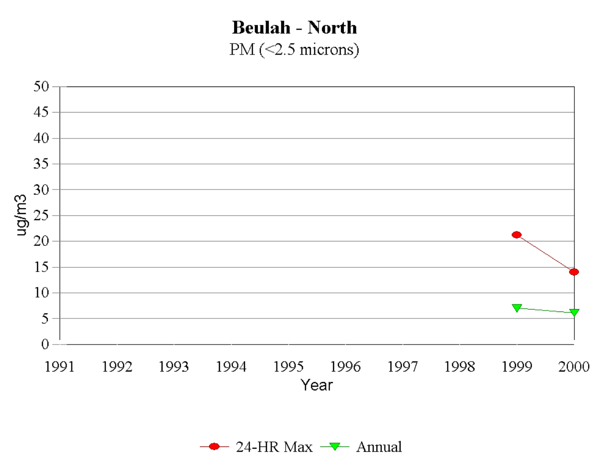
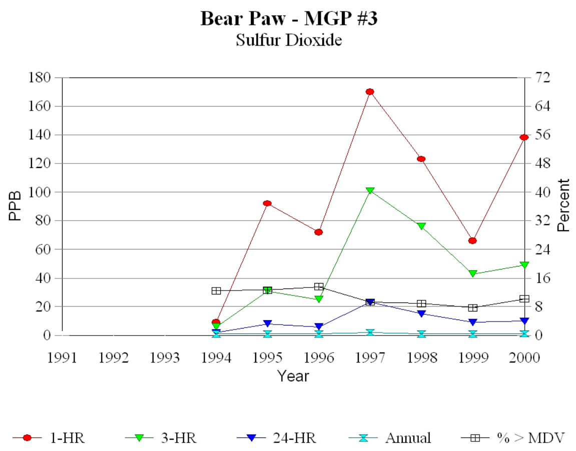
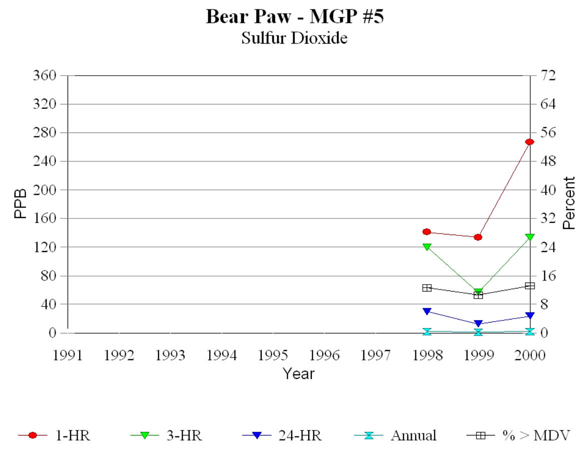
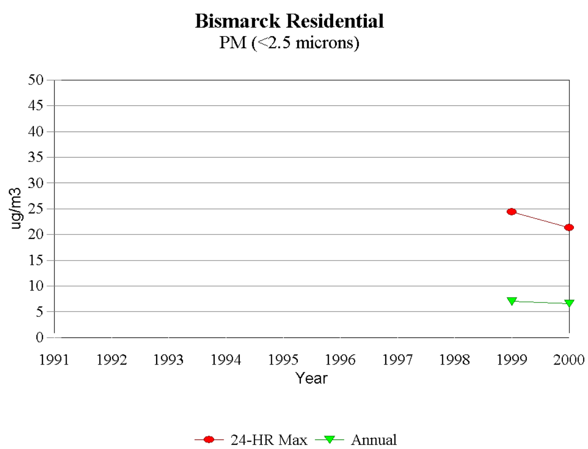


Figure A4-1 Amerada Hess/Beulah North Trends







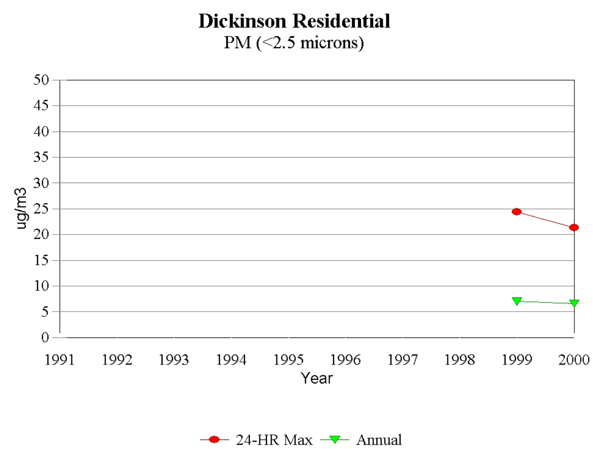
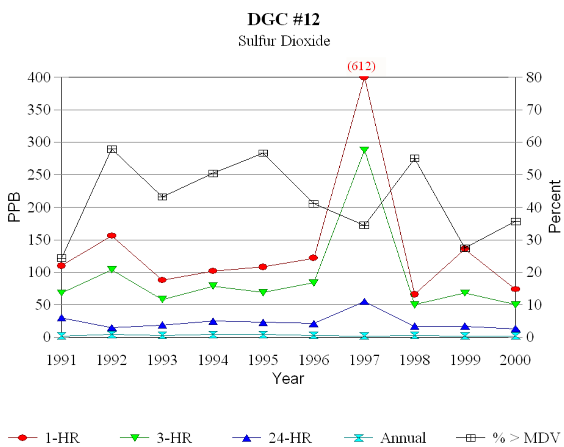
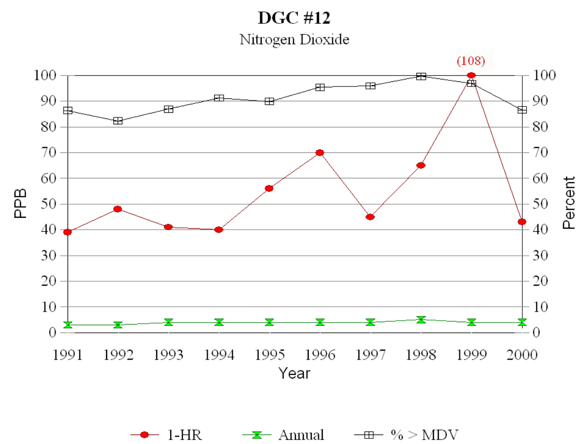
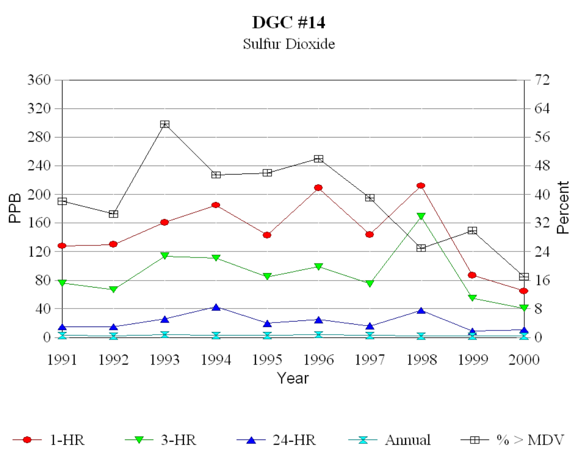
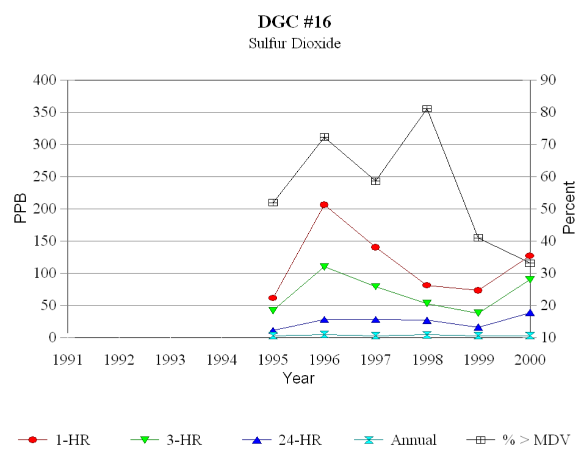


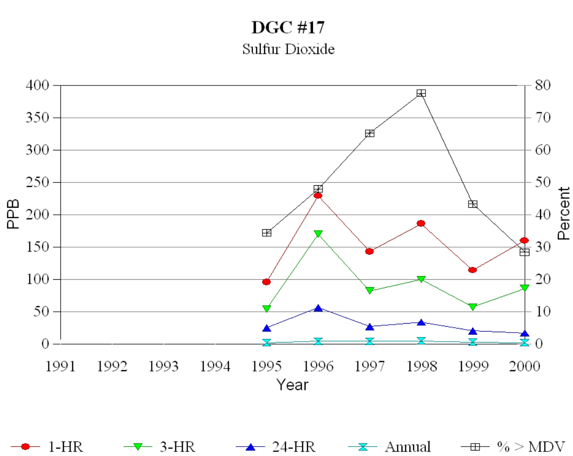
Figure A4-2 Bear Paw/Bismarck/Dickinson Trends











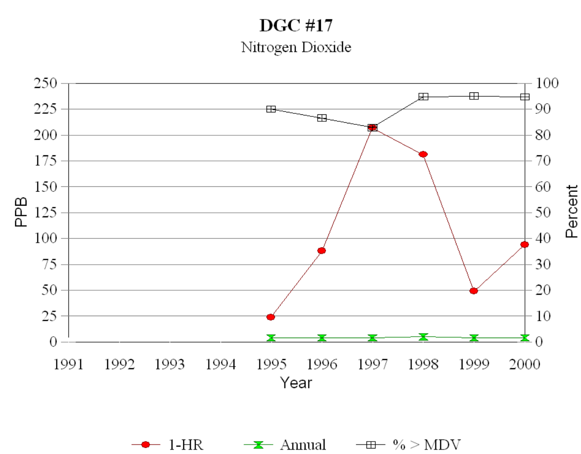


Figure A4-3 DGC Trends

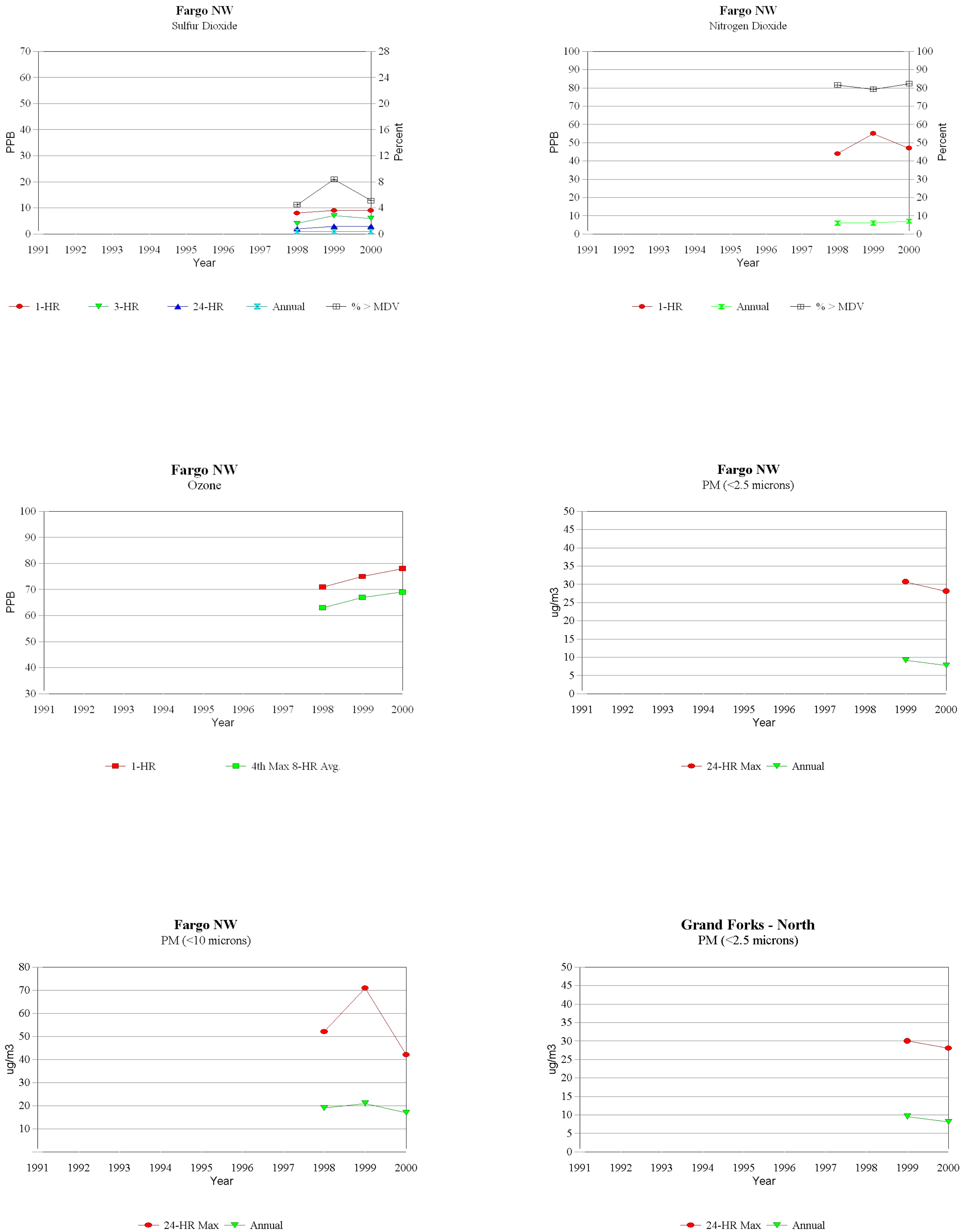
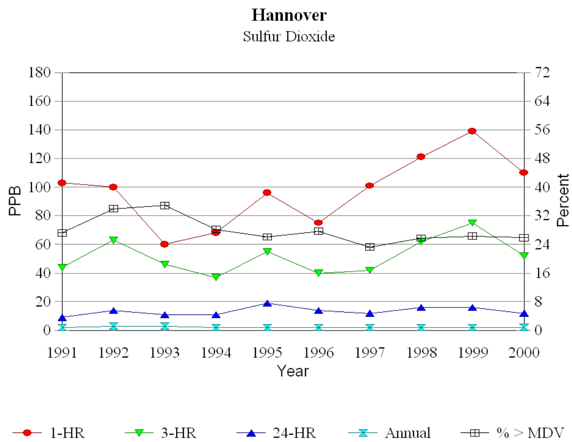
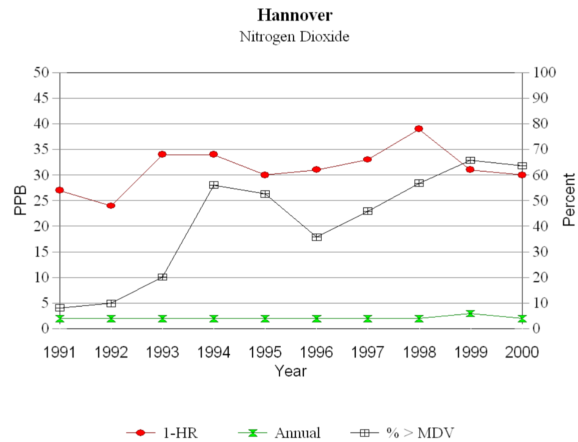
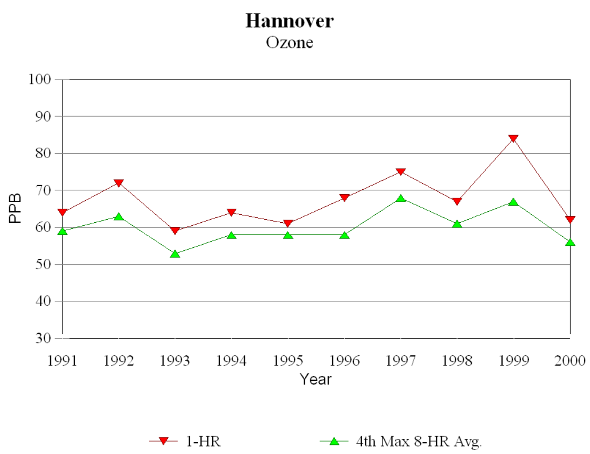
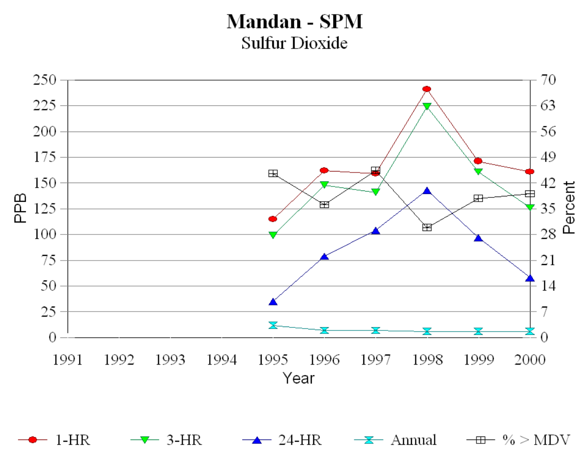


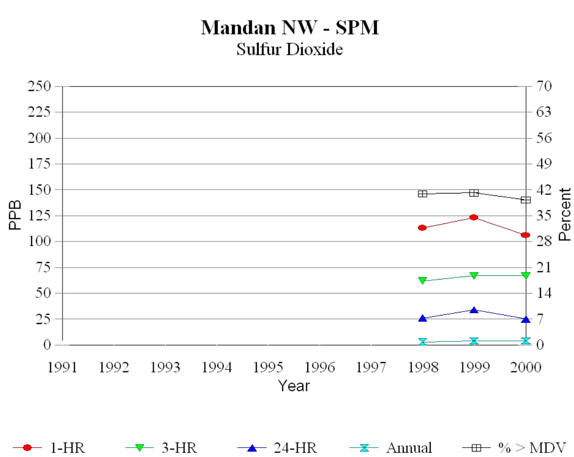
Figure A4-4 Fargo/Grand Forks Trends











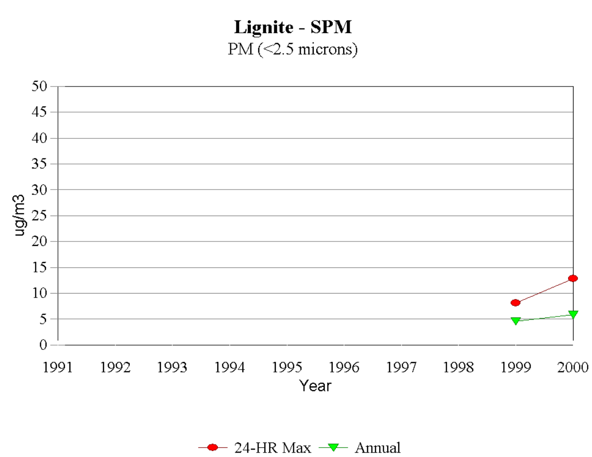
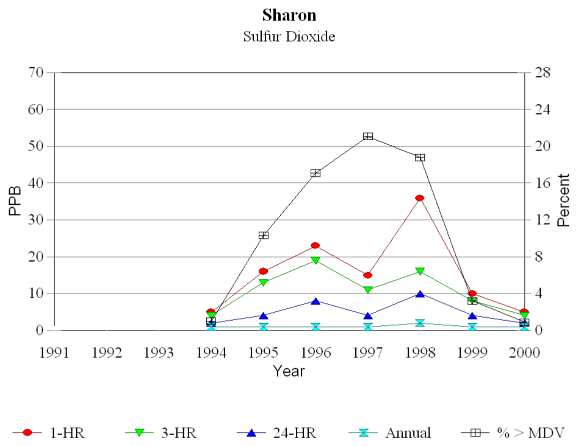
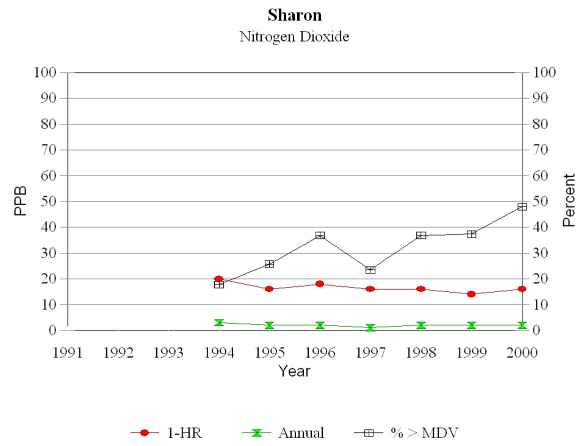
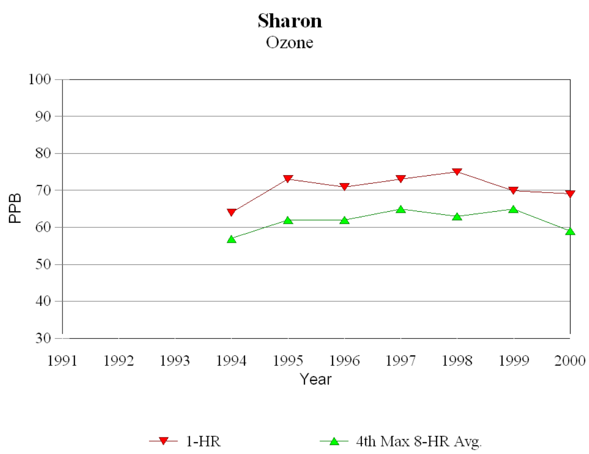
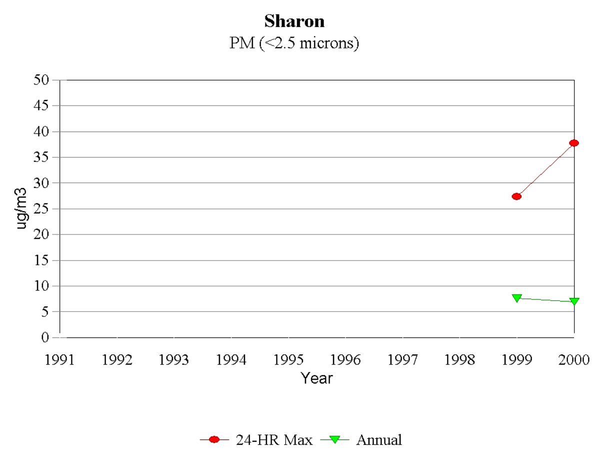


Figure A4-5 Hannover/Mandan/Lignite Trends

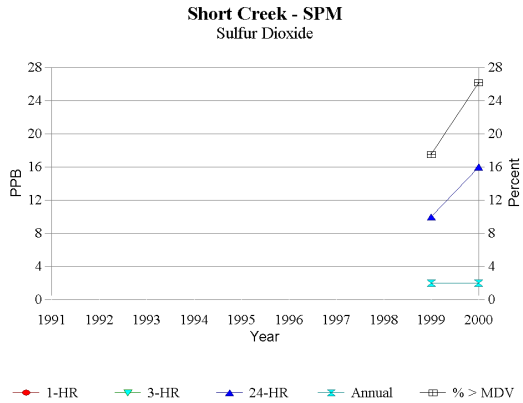


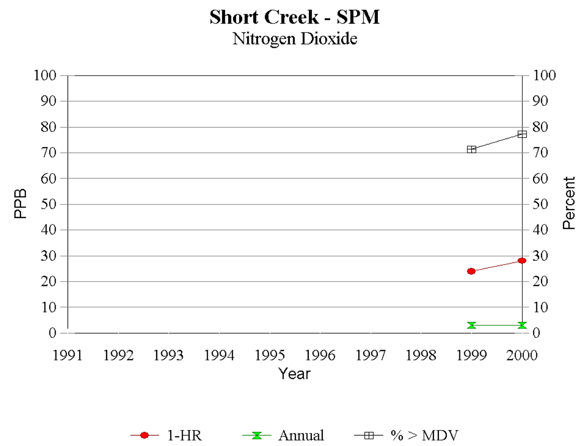


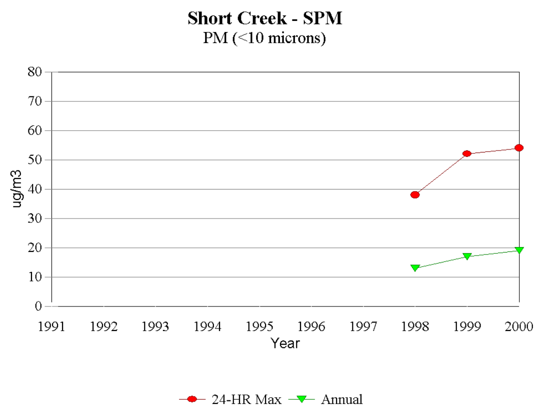




A4-6 Sharon Trends







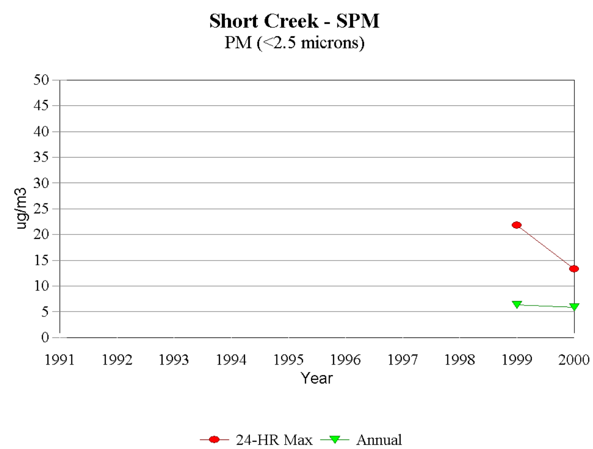
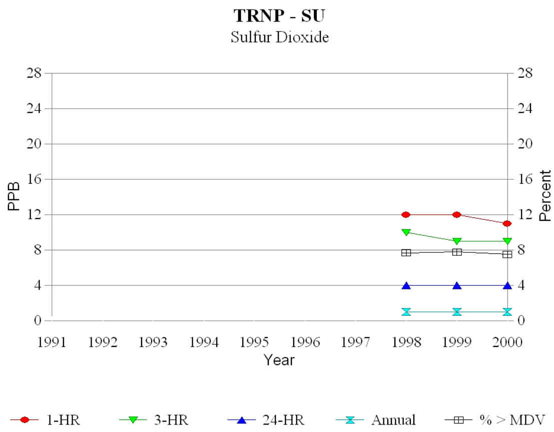
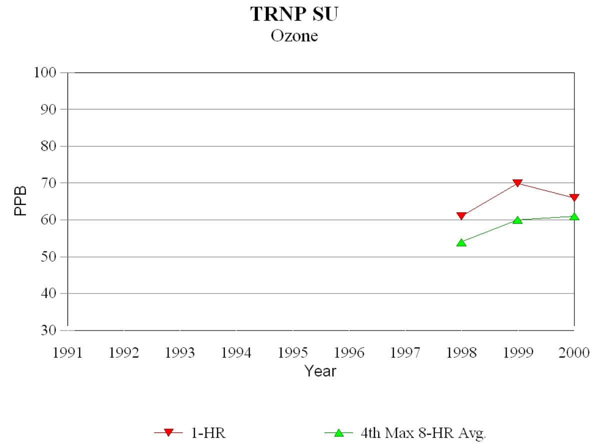


Figure A4-7 Short Creek Trends





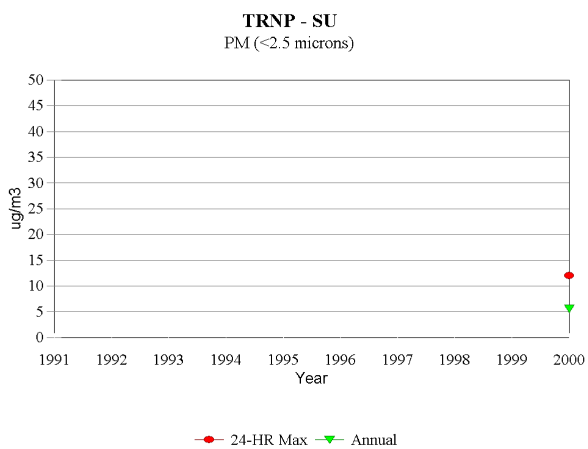


Figure A4-8 TRNP - SU Trends