

# **Annual Report**

## **North Dakota Air Quality Monitoring Data Summary 1998**



**North Dakota Department of Health  
Division of Environmental Engineering**



# Annual Report

## North Dakota Air Quality Monitoring Data Summary 1998

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## EXECUTIVE SUMMARY

The North Dakota Department of Health operated 12 ambient and three 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 1998.

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 Environmental Engineering, 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<sup>1,2</sup> and the "Prevention of Significant Deterioration of Air Quality Rules."<sup>3</sup> 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, 1998, and ending Dec. 31, 1998. 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.

## NETWORK DESCRIPTION

### Department Sites

During 1998, the Department operated 15 air quality monitoring sites. Twelve were ambient monitoring sites, and three were special purpose monitoring (SPM) sites. The SPM sites are Short Creek 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) 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 Short Creek - SPM site was established to monitor the impact of SaskPower's Boundary Dam Power Plant located south of Estevan, Saskatchewan.

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 1998. 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 <sup>1</sup>	Operating Schedule	Monitoring Objective <sup>2</sup>	Spatial Scale <sup>2</sup>	Date Site Began
1 Beulah Residential	SLAMS	PM <sub>10</sub> PM <sub>2.5</sub> SO <sub>2</sub> , NO <sub>2</sub> , O <sub>3</sub> , MET	6 <sup>th</sup> Day	Population Exposure	Neighborhood	12/95
			6 <sup>th</sup> Day	SSI + SA-231F	Neighborhood	12/95
			cont.	Population Exposure	Neighborhood	04/80
2 Bismarck Residential	SLAMS	PM <sub>10</sub> PM <sub>2.5</sub> FRM PM <sub>2.5</sub>	6 <sup>th</sup> Day	Population Exposure	Urban	07/95
			6 <sup>th</sup> Day	SSI + SA-231F	Urban	06/97
			3 <sup>rd</sup> Day	Population Exposure	Urban	12/98
3 Dickinson Residential	SLAMS	PM <sub>10</sub>	6 <sup>th</sup> Day	Population Exposure	Urban	07/89
4 Dunn Center <sup>3</sup>	SLAMS	SO <sub>2</sub> , NO <sub>2</sub> , O <sub>3</sub> , MET	cont.	General Background	Regional	10/79
5 Fargo Residential <sup>4</sup>	SLAMS	PM <sub>10</sub> PM <sub>10</sub> SO <sub>2</sub> , NO <sub>2</sub> , O <sub>3</sub> , MET	6 <sup>th</sup> Day	Population Exposure	Urban	08/95
			6 <sup>th</sup> Day	Collocated SSI	N/A	
			cont.	Population Exposure	Urban	08/95
6 Fargo NW	SLAMS	PM <sub>10</sub> PM <sub>10</sub> FRM PM <sub>2.5</sub> FRM PM <sub>2.5</sub> SO <sub>2</sub> , NO <sub>2</sub> , O <sub>3</sub> , MET	6 <sup>th</sup> Day	Population Exposure	Urban	05/98
			6 <sup>th</sup> Day	Collocated SSI	N/A	
			3 <sup>rd</sup> day	Population Exposure	Urban	12/98
			3 <sup>rd</sup> Day	Collocated	N/A	
7 Grand Forks North	SLAMS	PM <sub>10</sub> FRM PM <sub>2.5</sub>	6 <sup>th</sup> Day	Population Exposure	Urban	07/89
			3 <sup>rd</sup> Day	Population Exposure	Urban	12/98
8 Hannover	SLAMS	SO <sub>2</sub> , NO <sub>2</sub> , O <sub>3</sub> , MET	cont.	General Background	Regional	10/84
9 Mandan - SPM	SPM	SO <sub>2</sub> , MET	cont.	Source Impact	Neighborhood	12/95
10 Mandan NW - SPM	SPM	SO <sub>2</sub> , MET	cont.	Source Impact	Neighborhood	09/98
11 Sharon	SLAMS	SO <sub>2</sub> , NO <sub>x</sub> , O <sub>3</sub> , MET PM <sub>10</sub> FRM PM <sub>2.5</sub>	cont.	General	Regional	07/94
			6 <sup>th</sup> Day	Background		
			6 <sup>th</sup> Day			12/98
12 Short Creek - SPM	SPM	PM <sub>10</sub> FRM PM <sub>2.5</sub>	6 <sup>th</sup> Day	Source Impact	Regional	09/98
			6 <sup>th</sup> Day			09/98
13 TRNP - NU	SLAMS	SO <sub>2</sub> , O <sub>3</sub> , H <sub>2</sub> S, MET	cont.	General Background	Regional	02/80
14 TRNP - SU <sup>5</sup>	SLAMS	SO <sub>2</sub> , O <sub>3</sub> , MET	cont.	General Background	Regional	07/95
15 Williston Residential <sup>6</sup>	SLAMS	PM <sub>10</sub>	6 <sup>th</sup> Day	Population Exposure	Urban	08/95
Company	Site Name					
16 Amerada Hess Corporation	TIOGA #1	SO <sub>2</sub>	cont.	Source Impact	Urban	07/87
	TIOGA #2	H <sub>2</sub> S, MET	cont.	Source Impact	Urban	07/87
	TIOGA #3	SO <sub>2</sub>	cont.	Source Impact	Urban	11/87
17 Dakota Gasification Company	DGC #12	SO <sub>2</sub> , NO <sub>2</sub> , MET	cont.	Source Impact	Urban	01/80
	DGC #14	SO <sub>2</sub>	cont.	Source Impact	Urban	01/89
	DGC #16	SO <sub>2</sub>	cont.	Source Impact	Urban	10/95
	DGC #17	SO <sub>2</sub> , NO <sub>2</sub>	cont.	Source Impact	Urban	10/95
18 Bear Paw Energy, Inc.	MGP #3	SO <sub>2</sub> , MET	cont.	Source Impact	Urban	11/94
	MGP #5	SO <sub>2</sub> , MET	cont.	Source Impact	Urban	01/98
1. MET refers to meteorological and indicates wind speed and wind direction monitoring equipment.			4. Terminated May 14.			
2. Not applicable to MET.			5. Restarted July 27.			
3. Nitrogen dioxide and Ozone added December 14.			6. Terminated Jun 30.			

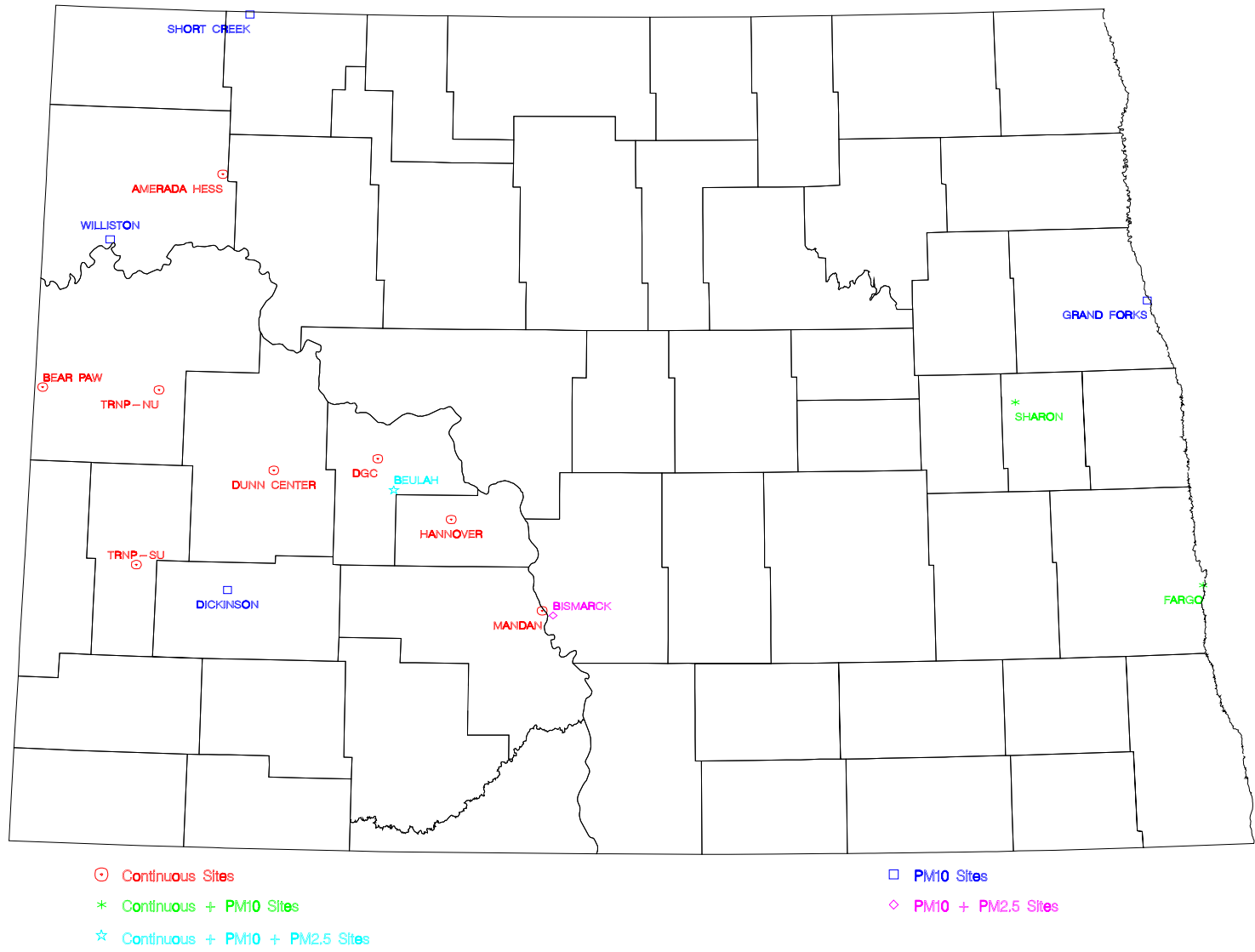


Figure 1 North Dakota Air Quality Monitoring Network

## NETWORK CHANGES

### Department Changes

Changes to the state monitoring network consisted of terminating and moving the following sites to new locations: Fargo Residential to Fargo NW; Williston Residential to Short Creek Wildlife Management Area; and, TRNP - NU to TRNP - SU (Painted Canyon). A new site, Mandan NW - SPM, was started on September 25, 1998. At Dunn Center, ozone and oxides of nitrogen were added on December 14, 1998.

Throughout the year the Department worked to establish a fine particulate ambient monitoring network with federal reference method samplers at Beulah, Bismarck, Fargo, Grand Forks, Sharon, and Short Creek Wildlife Management Area. The network was activated effective December 13<sup>th</sup>. The samplers at Beulah and Sharon operated with only a minimum of problems. However, at Bismarck, Fargo, and Grand Forks, no valid data was collected during 1998 due to ongoing problems with the samplers.

### Industry Changes

There were no changes made to the industry networks.

## MONITORING RESULTS

### Introduction

Ambient and source-specific air quality data collected during 1998 at monitoring sites operated by the Department and industry are summarized in tables for the following pollutants: sulfur dioxide ( $SO_2$ ), nitrogen dioxide ( $NO_2$ ), hydrogen sulfide ( $H_2S$ ), ozone ( $O_3$ ), federal reference method (FRM) inhalable fine particulates ( $PM_{2.5}$ ), non-FRM  $PM_{2.5}$ , inhalable coarse particulates ( $PM_{10}$ ), non-FRM  $PM_{2.5}$  sulfate and  $PM_{10}$  sulfate. Each section contains a description of the physical characteristics, a summary of the 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  $PM_{2.5}$ , non-FRM  $PM_{2.5}$ ,  $PM_{10}$ , non-FRM  $PM_{2.5}$  sulfate and  $PM_{10}$  sulfate data summaries contain the three highest 24-hour average concentrations, month/day of each maxima, annual arithmetic mean and 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 ( $\mu\text{g}/\text{m}^3$ ).

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  $2.0 \mu\text{g}/\text{m}^3$ ; non-FRM  $PM_{2.5}$  and  $PM_{10}$  is  $4 \mu\text{g}/\text{m}^3$ ; and, non-FRM  $PM_{2.5}$  and  $PM_{10}$  sulfate is  $0.5 \mu\text{g}/\text{m}^3$ . Annual means are calculated for  $SO_2$ ,  $NO_2$ ,  $H_2S$ , FRM  $PM_{2.5}$ , non-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 7,008 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 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 “\*\*\*” below the number of observations. Particulate matter samplers must collect at least 48 samples per year 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.<sup>4</sup> 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, and vehicles.

### 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.<sup>4</sup>

### Standards Comparison

Sulfur dioxide was monitored at 18 sites. Ten sites were run by the Department and eight by industry. 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 241 ppb at Mandan - SPM.

The 3-hour federal secondary standard (500 ppb) was not exceeded during the year. The maximum 3-hour average concentration was 224 ppb at Mandan - SPM.

The 24-hour state standard (99 ppb) was exceeded twice during the year at Mandan - SPM. Since a review of the meteorological data indicated the sources of the exceedances was from the refinery and power plant, the state standards are not applicable. The maximum 24-hour average concentration was 143 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 5.8 ppb at Mandan - SPM. At the remaining sites, the maximum arithmetic mean was 3.2 ppb at Mandan NW - 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)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	1 - HOUR		M A X I M A		24 - HOUR		ARITH MEAN	1HR #>273	24HR #>99	% >MDV
				1ST MM/DD/HH	2ND MM/DD/HH	1ST MM/DD/HH	2ND MM/DD/HH	1ST MM/DD	2ND MM/DD				
Amerada Hess - Tioga #1	1998	JAN-DEC	8026	26 12/19/16	25 06/27/03	20 12/19/14	16 12/19/17	7 12/19	6 01/21	1.4			13.2
Amerada Hess - Tioga #3	1998	JAN-DEC	8628	59 01/15/23	49 11/14/06	39 10/06/14	38 04/17/11	16 10/06	13 09/20	2.1			18.8
Bear Paw - MGP #3	1998	JAN-DEC	7808	123 09/03/14	62 09/03/16	76 09/03/14	34 09/03/17	15 09/03	4 12/30	1.3			8.9
Bear Paw - MGP #5	1998	JAN-DEC	7181	141 09/01/10	132 09/01/11	120 09/01/11	70 09/01/14	30 09/01	13 08/21	1.6			12.6
Beulah	1998	JAN-DEC	8345	178 03/08/11	163 10/09/13	134 10/09/14	76 03/08/11	25 10/09	17 02/26	2.4			33.1
DGC #12	1998	JAN-DEC	8677	66 01/08/18	61 10/25/18	50 02/02/11	39 01/08/14	17 01/08	13 11/06	3.1			55.1
DGC #14	1998	JAN-DEC	8633	212 03/30/14	165 03/30/12	169 03/30/14	77 09/28/11	38 03/30	15 12/07	2.3			25.0
DGC #16	1998	JAN-DEC	8698	81 04/03/09	68 05/17/12	53 04/03/11	49 05/17/14	27 09/08	15 05/17	4.5			81.1
DGC #17	1998	JAN-DEC	8626	186 02/15/11	126 02/15/12	100 02/15/14	81 02/15/11	34 02/15	18 08/17	4.7			77.6
Dunn Center	1998	JAN-DEC	8262	31 03/04/06	25 04/02/15	22 04/02/17	21 03/04/08	6 04/02	5 12/31	1.3			10.3
Fargo NW	1998	MAY-DEC	4851 ***	8 12/29/05	5 12/25/08	4 12/28/08	4 12/30/08	2 11/20	2 12/30	1.1			4.5
Fargo Residential	1998	JAN-MAY	3144 ***	23 01/01/05	20 02/03/12	14 02/26/05	12 02/26/02	6 02/26	4 04/25	1.8			36.4
Hannover	1998	JAN-DEC	8624	121 09/03/12	115 04/15/08	62 09/03/14	55 07/29/11	16 09/03	14 10/13	2.5			25.8
Mandan - SPM	1998	JAN-DEC	8360	241 02/28/01	228 02/28/02	224 02/28/02	202 02/28/05	143 02/28	116 02/27	5.8	2		29.9
Mandan NW - SPM	1998	SEP-DEC	2323 ***	113 11/24/05	87 10/03/07	62 11/24/08	61 10/03/08	29 10/03	15 11/24	3.2			40.9
Sharon	1998	JAN-DEC	7396	36 01/14/10	15 03/07/11	16 01/14/11	15 03/07/14	10 01/12	10 01/13	1.5			18.8
TRNP - NU	1998	JAN-JUN	4301 ***	23 04/02/18	19 04/02/17	15 04/02/20	12 01/20/20	6 01/20	5 04/02	1.3			14.8
TRNP - SU (Painted Canyon)	1998	JUL-DEC	3658 ***	12 12/31/22	11 08/29/07	10 12/30/20	10 12/31/23	4 09/06	4 12/30	1.2			7.7

The maximum 1-hour concentration is 241 ppb at Mandan - SPM on 02/28/01  
The maximum 3-hour concentration is 224 ppb at Mandan - SPM on 02/28/02  
The maximum 24-hour concentration is 143 ppb at Mandan - SPM on 02/28

\* 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.

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



### 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 295 ppb at Mandan - SPM.

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<sub>2</sub> 5-Minute Averages (ppb)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	1ST	5 - M I N U T E			M A X I M A			# HOURS >600	% >MDV
					DATE MM/DD/HH	2ND DATE MM/DD/HH	3RD DATE MM/DD/HH	DATE MM/DD/HH	DATE MM/DD/HH	DATE MM/DD/HH		
Bear Paw - MGP #3	1998	JAN-DEC	7106	199	09/03/14	164	09/03/13	143	06/26/10	0	15.5	
Bear Paw - MGP #5	1998	JAN-DEC	7181	288	09/01/14	270	09/01/11	264	09/01/09	0	23.7	
Beulah	1998	JAN-DEC	8345	241	10/09/10	228	10/09/13	221	10/09/11	0	44.4	
Dunn Center	1998	JAN-DEC	8262	52	03/04/06	44	03/04/05	42	03/30/09	0	15.2	
Fargo NW	1998	MAY-DEC	4851 ***	8	12/29/05	5	12/29/08	5	12/28/05	0	4.5	
Fargo Residential	1998	JAN-MAY	3144 ***	23	01/01/05	20	02/01/12	19	02/03/11	0	36.4	
Hannover	1998	JAN-DEC	8624	203	07/29/10	195	04/29/08	163	09/03/12	0	35.5	
Mandan - SPM	1998	JAN-DEC	8360	295	02/28/01	289	02/28/02	281	02/28/00	0	40.6	
Mandan NW - SPM	1998	SEP-DEC	2323 ***	197	10/01/09	194	11/01/05	146	12/29/23	0	55.5	
Sharon	1998	JAN-DEC	7396	36	01/14/10	15	03/14/11	15	03/07/12	0	18.8	
TRNP - NU	1998	JAN-JUN	4301 ***	25	04/02/16	25	04/02/17	24	04/02/18	0	21.5	
TRNP - SU (Painted Canyon)	1998	JUL-DEC	3661 ***	12	12/31/22	11	08/31/07	11	12/30/18	0	7.6	

The maximum 5-minute concentration is 295 ppb at Mandan - SPM on 02/28/01

\* 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-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*<sub>2</sub> 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*<sub>2</sub>

### Health Effects

The negative effects of *NO*<sub>2</sub> on personal comfort, well being, and the environment include respiratory distress, as well as impacts on vegetation, materials, visibility and acid deposition.<sup>5</sup> Nitrate aerosols, which result from *NO* and *NO*<sub>2</sub> 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 of Health 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 4.8 ppb at DGC #12 and DGC #17. For the remaining sites, the maximum annual arithmetic mean was 8.1 at Fargo Residential.

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	M A X I M A 1 - HOUR		ARITH MEAN	% >MDV
				1ST MM/DD/HH	2ND MM/DD/HH		
Beulah	1998	JAN-DEC	8701	37 10/09/18	36 10/09/19	4.3	79.8
DGC #12	1998	JAN-DEC	8291	65 10/27/13	52 11/14/01	4.8	99.7
DGC #17	1998	JAN-DEC	8472	181 09/03/22	170 09/03/23	4.8	94.9
Dunn Center	1998	DEC-DEC	408 ***	6 12/30/07	5 12/28/04	1.3	19.1
Fargo NW	1998	MAY-DEC	5327 ***	44 05/26/23	44 09/03/20	6.5	81.7
Fargo Residential	1998	JAN-MAY	3136 ***	58 04/22/20	55 04/22/21	8.1	80.9
Hannover	1998	JAN-DEC	8563	39 08/20/23	36 01/21/03	2.5	56.8
Sharon	1998	JAN-DEC	8705	16 01/14/20	16 01/14/21	1.7	36.8

The maximum 1-hour concentration is 181 ppb at DGC #17 on 09/03/22

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

FEDERAL - 53 ppb annual arithmetic mean.

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

## Hydrogen Sulfide

### Physical Characteristics

Hydrogen sulfide has a strong, rotten egg odor. It is incompatible with strong oxidizers and reacts violently with metal oxides. It will attack many metals, forming sulfides.<sup>6</sup>

### Health Effects

A 5-minute exposure to 800 ppm has resulted in death. Inhalation of 1,000 to 2,000 ppm may cause a coma after a single breath. Exposure to lower concentrations may cause headache, dizziness and upset stomach. Low concentrations (20 to 150 ppm) can cause eye irritation which may be delayed in onset. Although the odor is detectable at very low concentrations, it rapidly causes olfactory fatigue at higher levels, and, therefore, is not considered to have adequate warning.<sup>6</sup>

### Standards Comparison

Hydrogen sulfide was monitored at two sites. One site was run by the Department and one by industry.

The 1-hour state standard (200 ppb) was not exceeded during the year. The maximum 1-hour concentration was 140 ppb at Amerada Hess - Tioga #2.

The 24-hour state standard (100 ppb) was not exceeded during the year. The maximum 24-hour average concentration was 35 ppb at Amerada Hess - Tioga #2.

The 3-month state standard (20 ppb) was not exceeded during the year. The maximum 3-month average concentration was 3 ppb at Amerada Hess - Tioga #2.

The hydrogen sulfide data are summarized in Table 5.

TABLE 5

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

POLLUTANT : Hydrogen Sulfide (ppb)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	1 - HOUR		24 - HOUR		3 - MONTH		ARITH MEAN	1HR #>200	24HR #>100	% >MDV
				1ST MM/DD/HH	2ND MM/DD/HH	1ST MM/DD	2ND MM/DD	1ST MM	2ND MM				
Amerada Hess - Tioga #2	1998	JAN-DEC	8335	140 04/12/09	119 04/12/19	35 04/12	17 04/16	3 04	3 06	2.0			19.7
TRNP - NU	1998	JAN-JUN	4309 ***	21 04/02/06	18 04/02/07	4 04/02	3 01/07	2 01	1 06	1.1			6.8

The maximum 1-hour concentration is 140 ppb at Amerada Hess - Tioga #2 on 04/12/09  
the maximum 24-hour concentration is 35 ppb at Amerada Hess - Tioga #2 on 04/12  
The maximum 3-month concentration is 3 ppb at Amerada Hess - Tioga #2 on 04

\* The State air quality standards are:

- 1) 10 ppm maximum instantaneous (ceiling) concentration not to be exceeded.
- 2) 200 ppb maximum 1-hour average concentration not to be exceeded more than once per month.
- 3) 100 ppb maximum 24-hour average concentration not to be exceeded more than once per year.
- 4) 20 ppb maximum arithmetic mean concentration averaged over three consecutive months.

\*\*\* 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. Ozone concentrations at urban and rural locations, such as Fargo and Sharon, range from 40 - 50 ppb year-round.

At ground level where it can be breathed, ozone is a pollutant.<sup>7</sup> 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.<sup>8</sup> 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 ppb.

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.<sup>7</sup>

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 eight 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 86 ppb at Fargo NW.

As part of preparing for a new 8-hour standard, 8-hour averages have been added to the data summary. The 8-hour standard uses the fourth highest daily maximum for comparison to the standard. However, since the third highest concentration is less than the 8-hour standard, the fourth highest concentration was not added to the data summary. The maximum 8-hour concentration was 73 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)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	M A X I M A - HOUR								
				1ST MM/DD/HH	2ND MM/DD/HH	3RD MM/DD/HH	8 - 1ST MM/DD/HH	2ND MM/DD/HH	3RD MM/DD/HH	1HR #>120	8HR #>80	
Beulah	1998	JAN-DEC	7961	71 08/09/16	69 08/05/16	69 08/09/15	64 08/09/10	62 08/09/11	62 08/09/12			
Dunn Center	1998	DEC-DEC	412 ***	40 12/18/17	39 12/18/15	39 12/18/16	38 12/18/15	36 12/18/14	36 12/18/13			
Fargo NW	1998	MAY-DEC	5515 ***	86 05/17/17	84 05/17/16	77 05/17/15	73 05/17/10	66 05/17/11	66 05/17/09			
Fargo Residential	1998	JAN-MAY	3145 ***	67 04/23/15	67 04/29/12	67 04/23/14	66 04/30/09	58 04/30/10	58 04/29/10			
Hannover	1998	JAN-DEC	8326	67 05/17/15	67 08/09/16	66 04/22/16	63 04/22/11	61 04/22/10	61 04/22/09			
Sharon	1998	JAN-DEC	8716	75 05/17/18	72 05/17/16	72 05/17/17	66 05/17/11	63 05/17/10	63 05/17/12			
TRNP - NU	1998	APR-JUN	1249 ***	69 06/26/16	67 04/21/15	67 04/21/16	66 04/21/09	63 04/22/09	63 04/22/08			
TRNP - SU (Painted Canyon)	1998	JUL-DEC	3232 ***	61 09/09/15	60 09/01/16	60 09/01/15	57 09/09/09	54 09/09/08	54 09/01/09			

The maximum 1-hour concentration is 86 ppb at Fargo NW on 05/17/17  
The maximum 8-hour concentration is 73 ppb at Fargo NW on 05/17/10

\* 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.

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

## 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  $PM_{10}$ .<sup>9</sup>

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 woodstoves).  $PM_{10}$  particulates from these sources contain a large percentage of elemental and organic carbon, which play a role in both visual haze and health issues.<sup>9</sup>

In addition, particles less than 2.5 micrometers ( $PM_{2.5}$ ) are major contributors to visibility problems 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” for 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.<sup>9</sup>

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.<sup>10</sup> Acid deposition can be detected in the most remote areas of the world.

#### Inhalable PM<sub>2.5</sub> Particulates

Inhalable PM<sub>2.5</sub> particulates were monitored at three sites operated by the Department: Two sites had just the FRM samplers and one site had both an FRM and a non-FRM sampler. Single-Day FRM samplers were installed at Beulah, Sharon, and Short Creek. The Short Creek site was operated with a nylon filter, which provided unacceptable results. As a result, the data was discarded. Sequential FRM samplers were installed at Bismarck, Fargo and Grand Forks. Due to cold weather-induced mechanical malfunctions, these samplers did not provide any data.

#### Standards Comparison

The 24-hour federal standard (65 µg/m<sup>3</sup>) was not exceeded during the year. The maximum 24-hour average concentration for FRM samplers was 10.0 µg/m<sup>3</sup> at Sharon. For non-FRM samplers the maximum 24-hour average concentration was 40.5 µg/m<sup>3</sup>.

The federal annual standard (15 µg/m<sup>3</sup>) was not exceeded for the year. The maximum annual average for FRM samplers was 5.3 µg/m<sup>3</sup> at Sharon. The maximum annual average for non-FRM samplers was 12.6 µg/m<sup>3</sup> at Bismarck Residential.

The inhalable PM<sub>2.5</sub> data are summarized in Tables 7 and 8.

TABLE 7

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

POLLUTANT : Inhalable FRM PM<sub>2.5</sub> Particulates (µg/m<sup>3</sup>)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	M	A	X	I	M	A	ARITH MEAN	#>150	AM>50	% >MDV
					1ST	2ND	3RD	MM/DD	MM/DD	MM/DD				
Beulah - North	1998	DEC-DEC	4 ***	2.3	6.6 12/31	6.5 12/25	3.7 12/19				4.8			100.0
Sharon	1998	DEC-DEC	4 ***	0.1	10.0 12/13	5.3 12/19	4.9 12/25				5.3			75.0

The maximum 24-hour concentration is 10.0 µg/m<sup>3</sup> at Sharon on 12/13

\* The ambient air quality standards are:

FEDERAL Standards -

- 1) 24-hour: 3-year average of 98th percentiles not to exceed 65 µg/m<sup>3</sup>.
- 2) Annual: 3-year average not to exceed 15µg/m<sup>3</sup>.

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

TABLE 8

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

POLLUTANT : Inhalable non-FRM PM<sub>2.5</sub> Particulates (µg/m<sup>3</sup>)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	M	A	X	I	M	A	ARITH MEAN	#>150	AM>50	% >MDV
					1ST	2ND	3RD	MM/DD	MM/DD	MM/DD				
Beulah	1998	JAN-DEC	58	3.0	37.3 09/02	22.5 08/03	18.4 08/09				9.8			94.8
Bismarck Residential	1998	JAN-DEC	61	3.3	40.5 09/02	26.2 08/03	21.9 09/08				12.6			98.3

The maximum 24-hour concentration is 40.5 µg/m<sup>3</sup> at Bismarck Residential on 09/02

\* The ambient air quality standards are:

FEDERAL Standards -

- 1) 24-hour: 3-year average of 98th percentiles not to exceed 65 µg/m<sup>3</sup>.
- 2) Annual: 3-year average not to exceed 15µg/m<sup>3</sup>.

## Inhalable PM<sub>10</sub> Particulates

Inhalable PM<sub>10</sub> particulate concentrations were monitored at nine sites run by the Department. Fargo Residential was terminated effective May 14, 1998, Williston was terminated effective June 30, 1998. Dickinson, Grand Forks - North, and Sharon were terminated effective December 30, 1999. As a part of the agreement to establish the PM<sub>2.5</sub> network, the PM<sub>10</sub> samplers at Fargo and Short Creek were retained.

## Standards Comparison

The 24-hour state standard (150 µg/m<sup>3</sup>) was not exceeded during the year. The maximum 24-hour concentration was 81.6 µg/m<sup>3</sup> at Grand Forks - North.

The annual state standard (50 µg/m<sup>3</sup>) was not exceeded. The maximum annual mean for sites collecting at least 80 percent of the possible data for the year was 28.6 µg/m<sup>3</sup> at Grand Forks - North. For the remaining sites the maximum annual average was 18.9 µg/m<sup>3</sup> at Fargo NW.

The inhalable particulate (PM<sub>10</sub>) data are summarized in Table 9.

TABLE 9

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

POLLUTANT : Inhalable PM<sub>10</sub> Particulates (µg/m<sup>3</sup>)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	M	A	X	I	M	A	ARITH MEAN	#>150	AM>50	% >MDV
					1ST	2ND	3RD	MM/DD	MM/DD	MM/DD				
Beulah	1998	JAN-DEC	59	2.0	45.2	28.1	26.2		12.4					96.6
					09/02	08/03	04/23							
Bismarck Residential	1998	JAN-DEC	61	4.1	52.8	32.2	29.9		16.4					100.0
					09/02	08/03	11/25							
Dickinson Residential	1998	JAN-DEC	59	1.8	59.1	39.9	27.4		12.8					91.5
					09/02	09/08	08/27							
Fargo NW	1998	MAY-DEC	36	3.2	52.0	47.4	44.4		18.9					97.2
			***		09/02	07/28	08/09							
Fargo Residential	1998	JAN-MAY	22	3.0	51.2	43.4	29.2		16.4					90.9
			***		04/29	04/23	05/05							
Grand Forks - North	1998	JAN-DEC	55	4.6	81.6	81.0	70.1		28.6					100.0
					08/09	05/05	08/03							
Sharon	1998	JAN-DEC	59	0.8	52.9	48.2	46.4		15.1					83.0
					04/23	04/29	08/09							
Short Creek - SPM	1998	SEP-DEC	20	2.7	38.0	21.2	16.2		10.1					85.0
			***		09/08	09/14	10/20							
Williston Residential	1998	JAN-JUN	27	3.8	47.6	44.8	28.1		14.5					96.3
			***		04/23	04/29	05/05							

The maximum 24-hour concentration is 81.6 µg/m<sup>3</sup> at Grand Forks - North on 08/09

\* The STATE air quality standards are:

- 1) 150 µg/m<sup>3</sup> maximum averaged over a 24-hour period with no more than one expected exceedance per year.
- 2) 50 µg/m<sup>3</sup> expected annual arithmetic mean.

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

## 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.<sup>11</sup>

### Health Effects

Health impacts generally are associated with acidic sulfate aerosols. Short-term exposures of  $100 \mu\text{g}/\text{m}^3$  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  $100 \mu\text{g}/\text{m}^3 H_2SO_4$ . 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  $SO_4^{=}$ .<sup>11,12,13</sup>

Fine particulate sulfate is efficient at scattering light; thus it is a factor in visibility degradation. Even at low concentrations, below  $3 \mu\text{g}/\text{m}^3$ , 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 non-FRM $PM_{2.5}$ Sulfate

Inhalable non-FRM  $PM_{2.5}$  sulfate was monitored at two sites, both operated by the Department.

#### Standards Comparison

No standard is currently in effect. The maximum 24-hour average concentration was  $11.8 \mu\text{g}/\text{m}^3$  at Bismarck Residential. The maximum annual mean for the year was  $2.0 \mu\text{g}/\text{m}^3$  at Bismarck Residential.

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

Table 10

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

POLLUTANT : Inhalable non-FRM PM<sub>2.5</sub> Sulfate (µg/m<sup>3</sup>)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	M	A	X	I	M	A	ARITH MEAN	#>15.	AM>5.	% >MDV
					1ST	2ND	3RD	MM/DD	MM/DD	MM/DD				
Beulah	1998	JAN-DEC	58	0.3	9.0 08/03	4.9 03/18	4.4 01/23		1.9					98.2
Bismarck Residential	1998	JAN-DEC	61	0.3	11.8 08/03	5.3 03/06	4.9 01/17		2.0					98.3

The maximum 24-hour concentration is 11.8 µg/m<sup>3</sup> at Bismarck Residential on 08/03

\* No standard is currently in effect.



## Inhalable PM<sub>10</sub> Sulfate

Inhalable PM<sub>10</sub> sulfate concentrations were monitored at eight sites run by the Department.

### Standards Comparison

No standard is currently in effect. The maximum 24-hour concentration was 12.1 µg/m<sup>3</sup> at Bismarck Residential.

The maximum annual mean at sites collecting at least 80 percent of the data for the year was 2.1 µg/m<sup>3</sup> at Bismarck Residential. For the remaining sites, the maximum annual mean was 2.4 µg/m<sup>3</sup> at Fargo Residential.

The inhalable PM<sub>10</sub> sulfate data are summarized in Table 11.

Table 11

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

POLLUTANT : Inhalable PM<sub>10</sub> Sulfate (µg/m<sup>3</sup>)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	M A X I M A			ARITH MEAN	#>15. AM>5.	% >MDV
					1ST MM/DD	2ND MM/DD	3RD MM/DD			
Beulah	1998	JAN-DEC	59	0.2	9.6 08/03	5.3 03/18	5.0 09/26	1.9		94.9
Bismarck Residential	1998	JAN-DEC	61	0.3	12.1 08/03	6.0 02/10	5.9 03/06	2.1		96.7
Dickinson Residential	1998	JAN-DEC	59	0.3	6.4 08/03	5.0 03/18	3.4 01/17	1.6		94.9
Fargo NW	1998	MAY-DEC	36 ***	0.4	9.2 08/03	3.7 08/09	3.0 06/10	1.4		91.6
Fargo Residential	1998	JAN-MAY	22 ***	0.7	5.0 02/22	4.1 01/23	3.3 02/16	2.4		100.0
Grand Forks - North	1998	JAN-DEC	55	0.2	6.8 08/09	5.3 03/24	3.7 02/10	1.6		89.0
Sharon	1998	JAN-DEC	59	0.5	6.8 08/03	3.8 01/23	3.1 08/21	1.6		100.0
Short Creek - SPM	1998	SEP-DEC	20 ***	0.3	3.0 11/19	1.7 09/08	1.7 10/26	0.9		80.0
Williston Residential	1998	JAN-JUN	27 ***	0.4	6.7 03/18	4.2 01/23	4.1 01/17	2.1		96.3

The maximum 24-hour concentration is 12.1 µg/m<sup>3</sup> at Bismarck Residential on 08/03

\* No standard is currently in effect.

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

## Inhalable PM Sulfate/PM Total Mass Ratios

Because sulfates have an effect on visibility as well as health, the Department of Health wanted to know what percentage of the particulate matter collected is made up of sulfates. To provide some insight into this comparison, it was decided to determine the ratio of sulfates to total mass collected for both the PM<sub>2.5</sub> and PM<sub>10</sub> data.

The PM sulfate/PM total mass tables present statistics for PM sulfate and PM total mass when both concentrations are greater than the respective minimum detectable concentration: 0.5 µg/m<sup>3</sup> for sulfate analysis; 4 µg/m<sup>3</sup> for PM total mass. Statistics for the ratio are produced by evaluating the ratio of the PM sulfate concentration to the PM total mass concentration for each data pair. In the individual summaries, one-half of the minimum detectable concentration is substituted for those concentrations less than the minimum detectable value. However, when the PM total mass concentration is less than 4 µg/m<sup>3</sup>, the PM sulfate concentration can be higher than the PM total mass concentration. This is because of the variability in the sulfate analysis procedure at low concentrations. Therefore, when calculating the ratio of PM sulfate concentration to PM total mass concentration, only data pairs where both the PM sulfate and PM total mass concentrations are greater than the minimum detectable concentrations are used. When the ratio is multiplied by 100, it becomes the percentage of sulfate in the total mass.

### Non-FRM PM<sub>2.5</sub> Sulfate /non-FRM PM<sub>2.5</sub> Analysis

The maximum ratio was 45.0 percent at Bismarck Residential. The highest annual average was 19.9 percent, at Beulah. The non-FRM PM<sub>2.5</sub> sulfate /non-FRM PM<sub>2.5</sub> total mass ratio data are summarized in Table 12.

### PM<sub>10</sub> Sulfate /PM<sub>10</sub> Analysis

The maximum ratio was 70.7 percent at Bismarck Residential. The highest annual average for sites with at least 80 percent of the possible samples was 16.6 percent at Beulah. For the remaining sites, the maximum annual average was 18.7 percent at Williston Residential. The PM<sub>10</sub> sulfate /PM<sub>10</sub> total mass ratio data are summarized in Table 13.

Table 12

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

POLLUTANT : Non-FRM PM<sub>2.5</sub> Sulfate/non-FRM PM<sub>2.5</sub> Total Mass Ratio (Percentage)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	M	A	X	I	M	A	ARITH MEAN
					1ST MM/DD	2ND MM/DD	3RD MM/DD				
Beulah	1998	JAN-DEC	54	5.4	40.0 08/03		38.6 01/11		37.0 05/11		19.9
Bismarck Residential	1998	JAN-DEC	59	3.0	45.0 08/03		44.2 04/29		42.6 03/24		16.7

The maximum 24-hour ratio is 45.0 percent at Bismarck Residential on 08/03

\* No standard is currently in effect.

Table 13

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

POLLUTANT : PM<sub>10</sub> Sulfate/PM<sub>10</sub> Total Mass Ratio (Percentage)

LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	MIN	M	A	X	I	M	A	ARITH MEAN
					1ST MM/DD	2ND MM/DD	3RD MM/DD				
Beulah	1998	JAN-DEC	54	3.7	35.8 03/12		34.4 02/10		34.3 03/24		16.6
Bismarck Residential	1998	JAN-DEC	59	2.3	70.7 01/05		51.5 01/11		44.6 03/24		15.3
Dickinson Residential	1998	JAN-DEC	52	3.0	57.6 01/23		44.6 02/16		38.3 11/19		16.0
Fargo NW	1998	MAY-DEC	32 ***	1.5	31.4 08/03		19.0 12/19		16.2 12/31		8.3
Fargo Residential	1998	JAN-MAY	20 ***	4.1	37.3 01/05		31.7 01/17		30.9 02/22		18.5
Grand Forks - North	1998	JAN-DEC	49	1.1	24.4 01/11		24.2 03/30		24.1 03/24		7.9
Sharon	1998	JAN-DEC	49	1.6	59.6 03/24		47.3 02/22		44.6 03/18		16.4
Short Creek - SPM	1998	SEP-DEC	14 ***	3.1	26.5 11/19		21.3 12/31		16.9 10/14		11.6
Williston Residential	1998	JAN-JUN	25 ***	2.9	45.6 03/18		35.6 01/11		34.9 02/04		18.7

The maximum 24-hour ratio is 70.7 percent at Bismarck Residential on 01/05

\* No standard is currently in effect.

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

## SUMMARY AND CONCLUSIONS

North Dakota has relatively clean air and is one of only 10 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

The federal standards were not exceeded at any monitoring site. The state 24-hour standard was exceeded one time. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standard are as follows: 1-hour – 241 ppb (88.3%); 3-hour – 224 ppb (44.8%); 24-hour – 143 ppb (144.4%); annual (full) – 5.8 ppb (25.2%); annual (partial) – 3.2 ppb (13.9%).

### Sulfur Dioxide 5-Minute Averages

No standard is currently in effect. The maximum 5-minute average was 295 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 (full) – 4.8 ppb (9.6%); annual (partial) - 8.1 ppb (16.1%).

### Hydrogen Sulfide

There was no exceedance of the 1-hour standard. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standards are as follows: 1-hour – 140 ppb (70%); 24-hour – 35 ppb (35%); 3-month – 3 ppb (15%).

### 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 86 ppb (71.6%). The maximum 8-hour average concentration was 73 ppb (91.2%).

### Inhalable FRM PM<sub>2.5</sub> 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 – 10.0 µg/m<sup>3</sup> (15.4%); annual (partial) – 5.3 µg/m<sup>3</sup> (35.3%).

### Inhalable non-FRM PM<sub>2.5</sub> 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 – 40.5 µg/m<sup>3</sup> (62.3%); annual – 12.6 µg/m<sup>3</sup> (84.0%).

### Inhalable PM<sub>10</sub> 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 – 81.6 µg/m<sup>3</sup> (54.4%); annual(full) – 28.6 µg/m<sup>3</sup> (51.2%); annual (partial) – 18.9 µg/m<sup>3</sup> (37.8%).

### Inhalable non-FRM PM<sub>2.5</sub> Sulfates

No standard is currently in effect. The maximum 24-hour average was 11.8 µg/m<sup>3</sup>. The maximum annual average is 2.0 µg/m<sup>3</sup>.

### Inhalable PM<sub>10</sub> Sulfates

No standard is currently in effect. The maximum 24-hour average was 12.1 µg/m<sup>3</sup>. The maximum annual average is 2.4 µg/m<sup>3</sup>.

## 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  $SO_2$ ,  $CO$ ,  $NO_2$ ,  $H_2S$ ,  $PM_{2.5}$  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 are 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 <sub>10</sub> )	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<sub>2</sub> standards.

TABLE A1-2  
Federal Ambient Air Quality Standards

<u>Pollutant</u>	<u>Description</u>	<u>Primary</u>	<u>Secondary</u>
PM <sub>2.5</sub>	3-year average of annual arithmetic mean concentrations.	15 µg/m <sup>3</sup>	15 µg/m <sup>3</sup>
	3-year average of the 98 <sup>th</sup> percentile of the 24-hour concentrations.	65 µg/m <sup>3</sup>	65 µg/m <sup>3</sup>
PM <sub>10</sub> *	Expected annual arithmetic mean.	50 µg/m <sup>3</sup>	50 µg/m <sup>3</sup>
	99 <sup>th</sup> percentile of the 24-hour concentrations averaged over 3 years.	150 µg/m <sup>3</sup>	150 µg/m <sup>3</sup>
SO <sub>2</sub>	Annual arithmetic mean.	0.03 ppm (80 µg/m <sup>3</sup> )	-
	Maximum 24-hour concentration not to be exceeded more than once per year.	0.14 ppm (365 µg/m <sup>3</sup> )	-
	Maximum 3-hour concentration not to be exceeded more than once per year.	-	0.5 ppm (1300 µg/m <sup>3</sup> )
CO	8-hour concentration not to be exceeded more than once per year.	9 ppm (10 µg/m <sup>3</sup> )	-
	1-hour average concentration not to be exceeded more than once per year.	35 ppm (40 µg/m <sup>3</sup> )	-
O <sub>3</sub> *	3-year average of the annual 4 <sup>th</sup> highest daily maximum 8-hour concentrations, not to be exceeded.	0.08 ppm	0.08 ppm
NO <sub>2</sub>	Annual arithmetic mean.	0.053 ppm (100 µg/m <sup>3</sup> )	0.053 ppm (100 µg/m <sup>3</sup> )
Pb	Maximum arithmetic mean averaged over a calendar quarter.	1.5 µg/m <sup>3</sup>	1.5 µg/m <sup>3</sup>

\* The PM<sub>10</sub> and ozone standards have been challenged in court. The final status for these standards is yet to be decided.

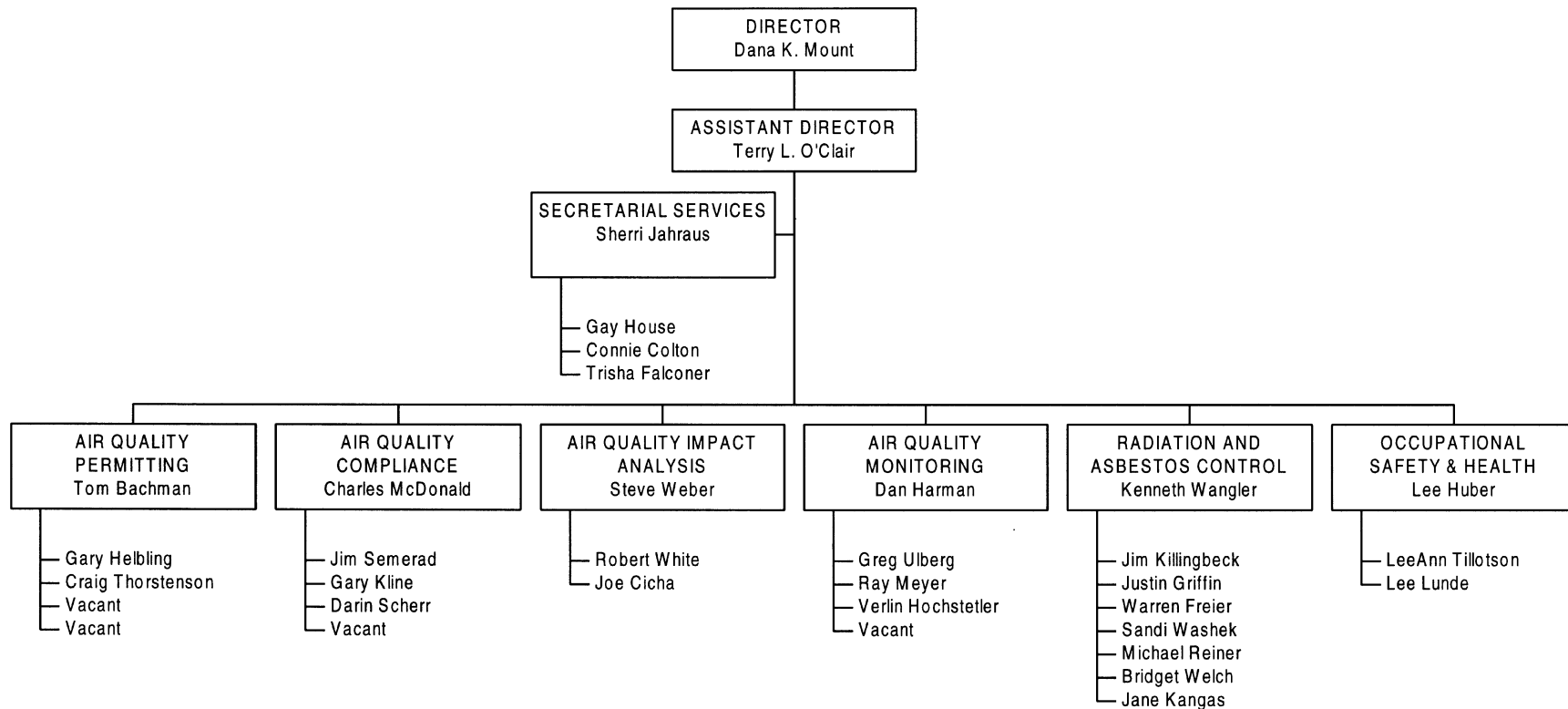


APPENDIX 2

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**



**APPENDIX 3**

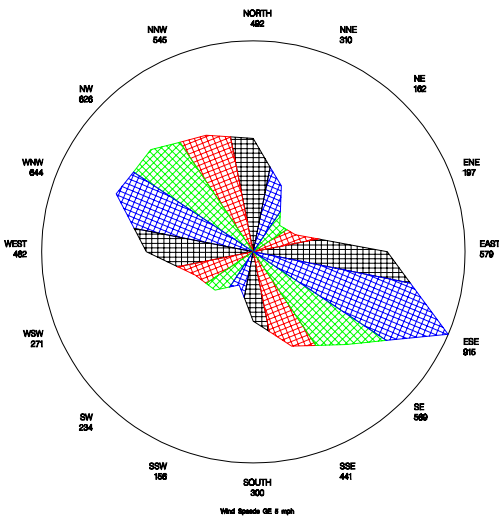
**Wind and Pollution Star Charts**

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 of 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.

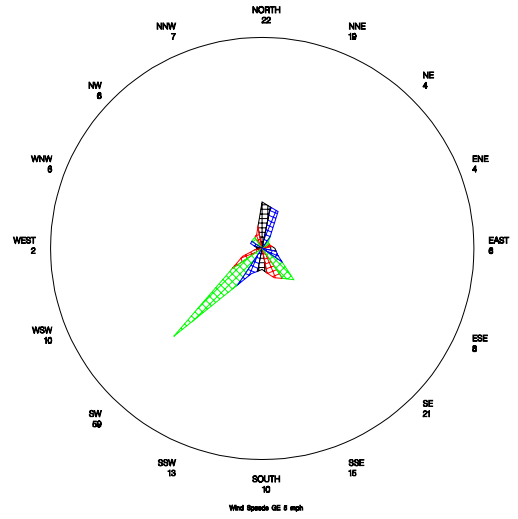
The pollution star charts present the percentage of time a pollutant is detected when the wind is from a given direction. For example, a wind star chart shows a frequency of 122, and a pollution star chart shows a 66 for the same direction. This means that 66 percent of the time (80 of the possible 122 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.

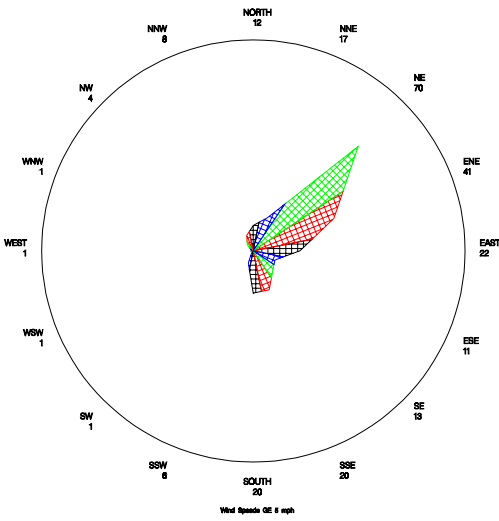
Amerada Hess - Tioga #2 Wind Direction Star Chart during 1998



Percent of Time SO2 Detected for a Given Wind Sector for Amerada Hess - Tioga #1 during 1998



Percent of Time H2S Detected for a Given Wind Sector for Amerada Hess - Tioga #2 during 1998



Percent of Time SO2 Detected for a Given Wind Sector for Amerada Hess - Tioga #3 during 1998

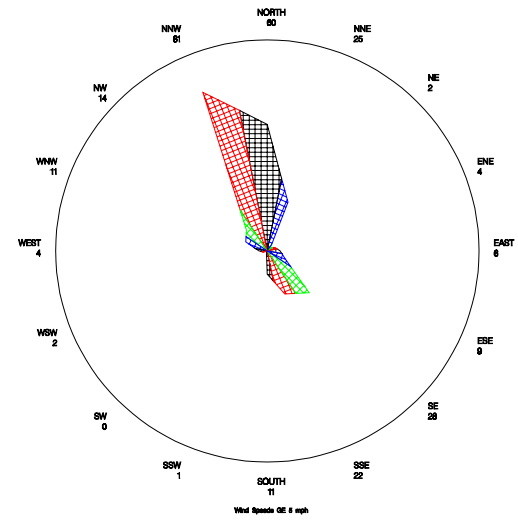


Figure A3-1 Amerada Hess Star Charts

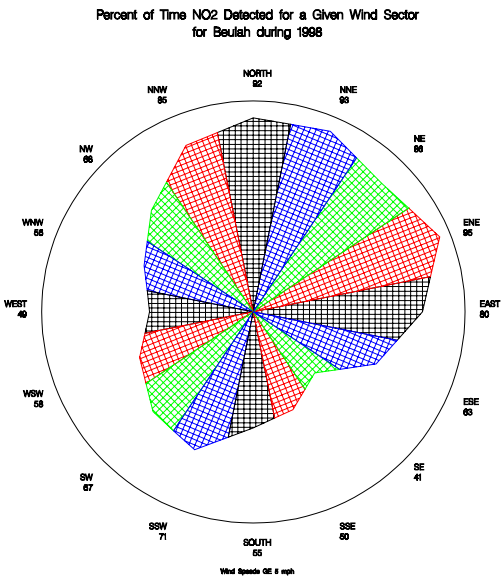
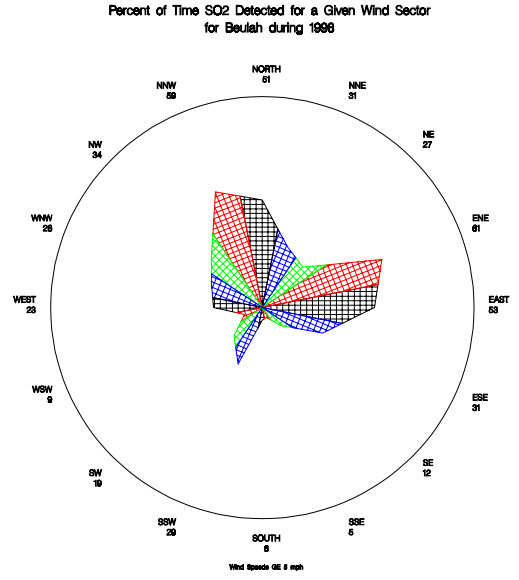
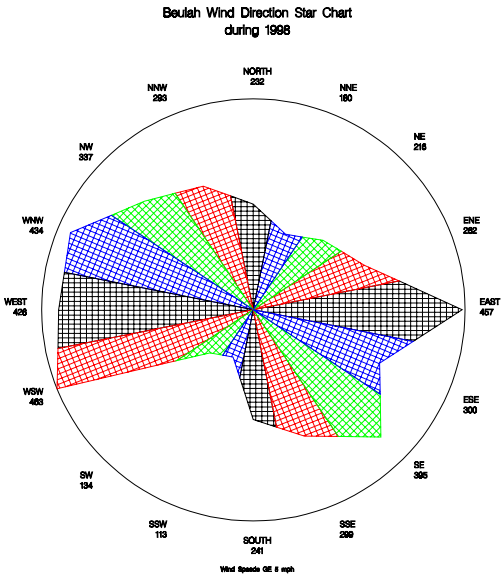


Figure A3-2 Beulah Star Charts



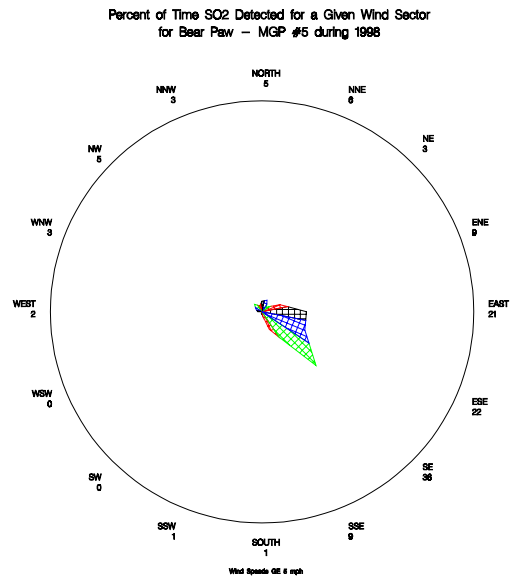
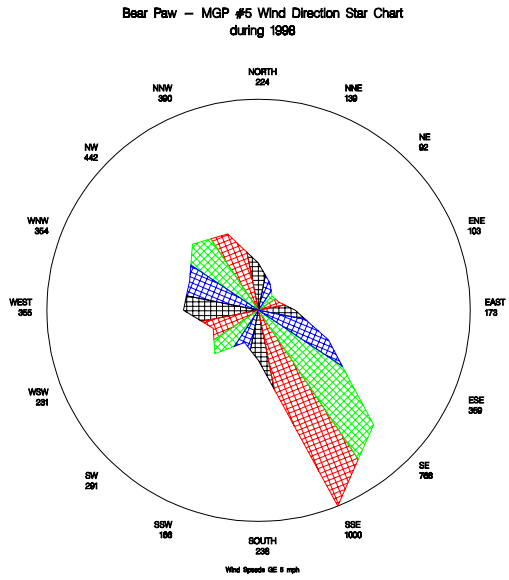
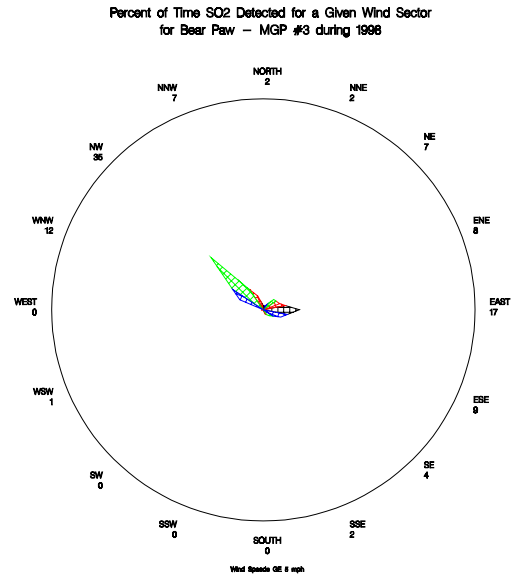
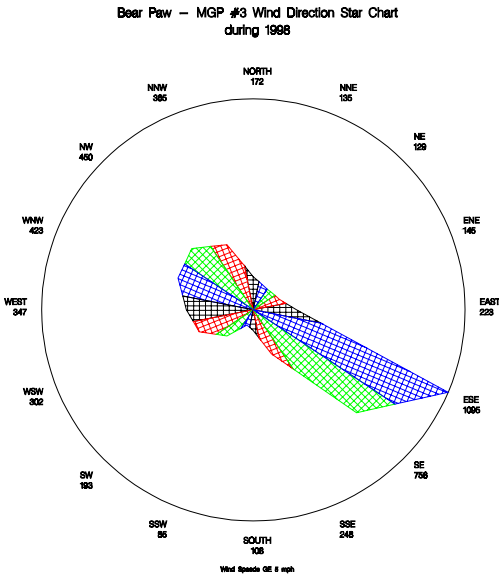


Figure A3-3 Bear Paw Star Charts

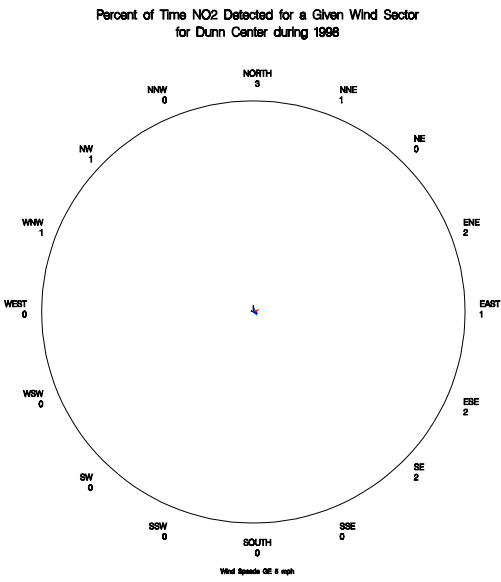
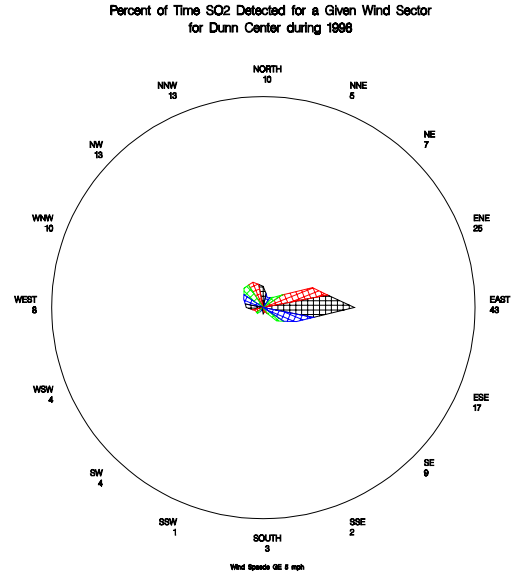
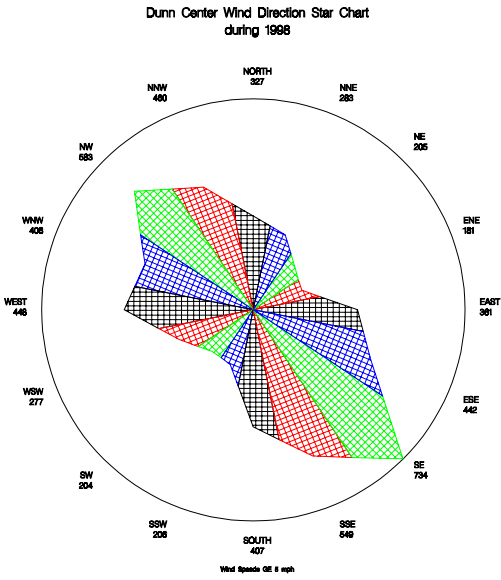
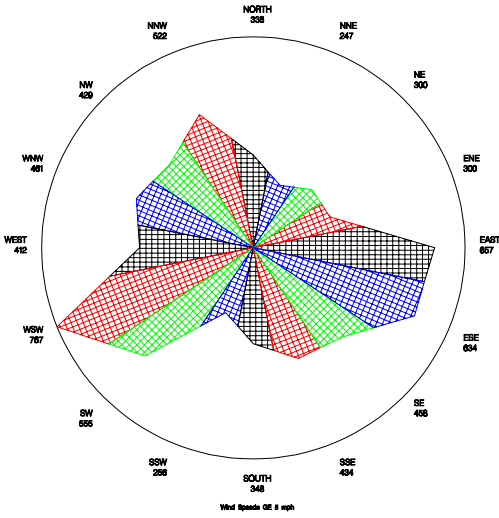
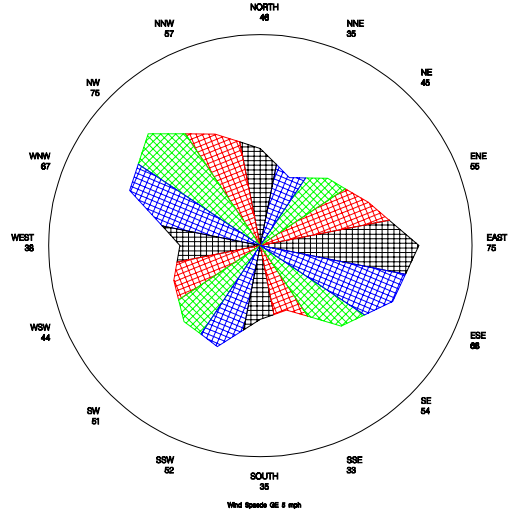


Figure A3-4 Dunn Center Star Charts

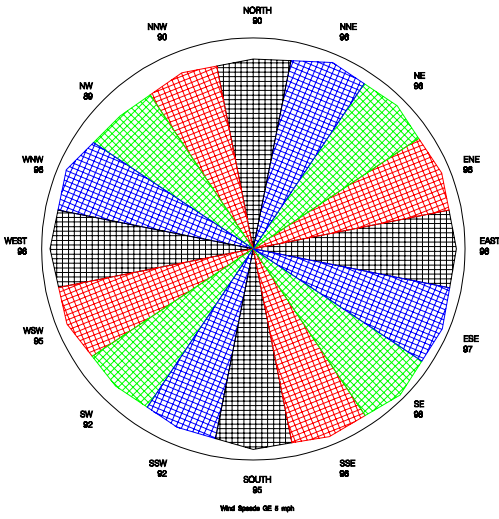
DGC #12 Wind Direction Star Chart during 1998



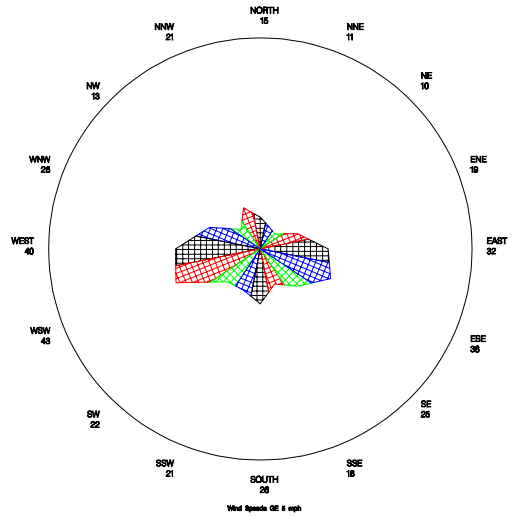
Percent of Time SO2 Detected for a Given Wind Sector for DGC #12 during 1998



Percent of Time NO2 Detected for a Given Wind Sector for DGC #12 during 1998



Percent of Time SO2 Detected for a Given Wind Sector for DGC #14 during 1998



Percent of Time SO2 Detected for a Given Wind Sector for DGC #16 during 1998

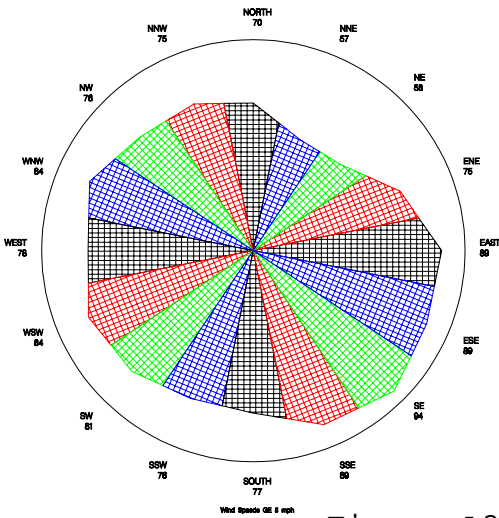
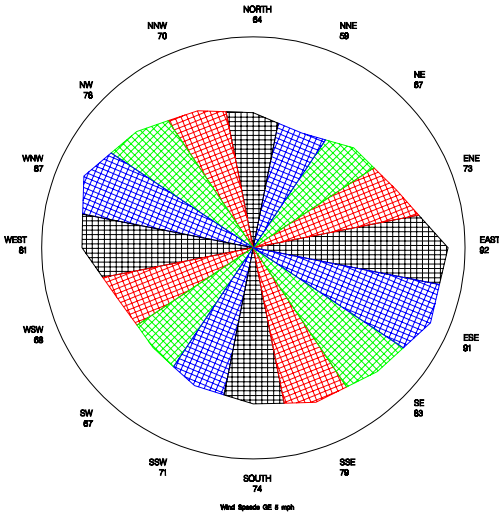


Figure A3-5 DGC Star Charts

Percent of Time SO2 Detected for a Given Wind Sector for DGC #17 during 1998



Percent of Time NO2 Detected for a Given Wind Sector for DGC #17 during 1998

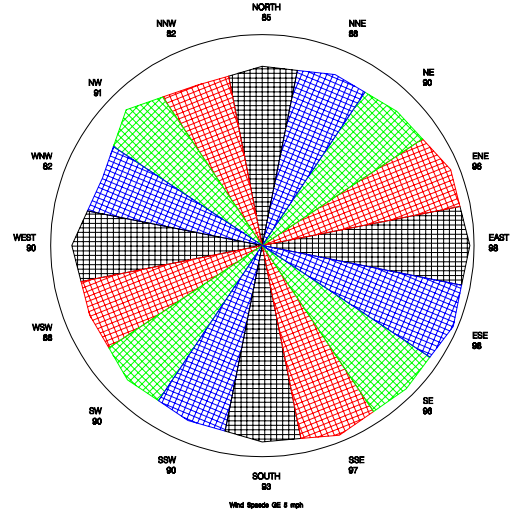
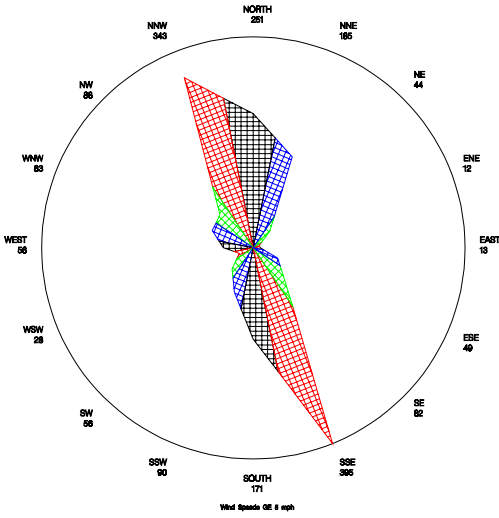
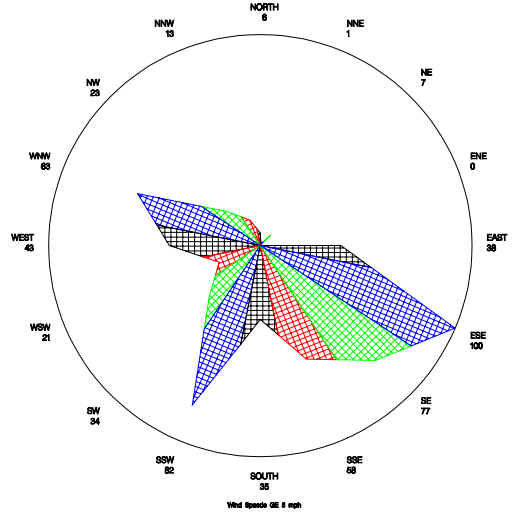


Figure A3-5 DGC Star Charts (cont.)

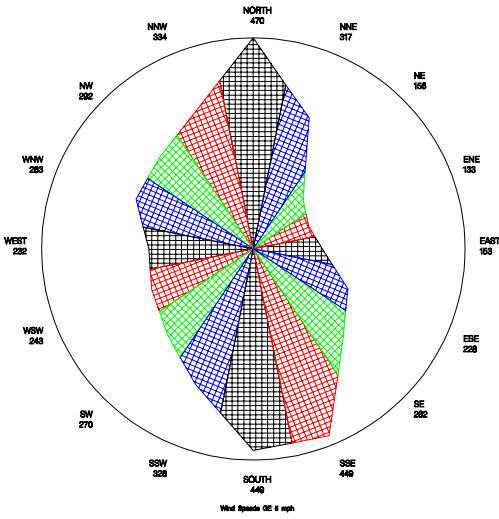
Fargo Residential Wind Direction Star Chart during 1998



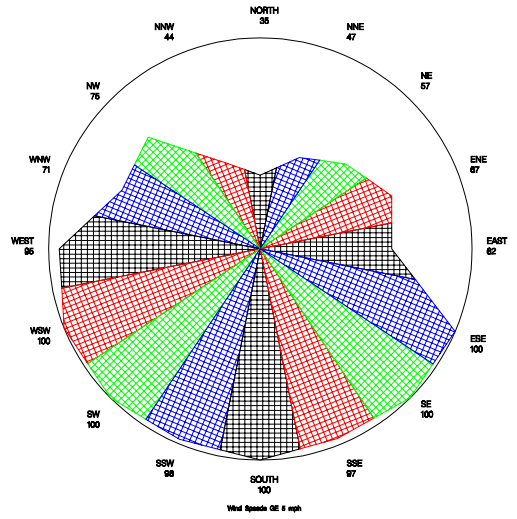
Percent of Time SO2 Detected for a Given Wind Sector for Fargo Residential during 1998



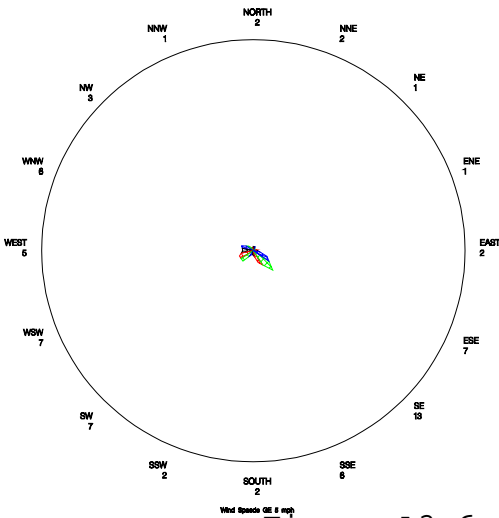
Fargo NW Wind Direction Star Chart during 1998



Percent of Time NO2 Detected for a Given Wind Sector for Fargo Residential during 1998



Percent of Time SO2 Detected for a Given Wind Sector for Fargo NW during 1998



Percent of Time NO2 Detected for a Given Wind Sector for Fargo NW during 1998

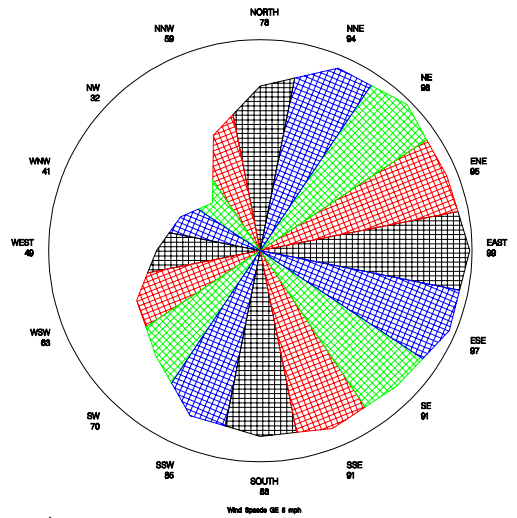


Figure A3-6 Fargo Star Charts

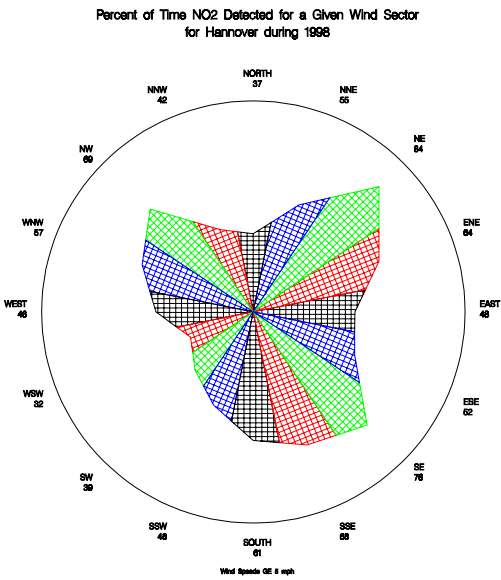
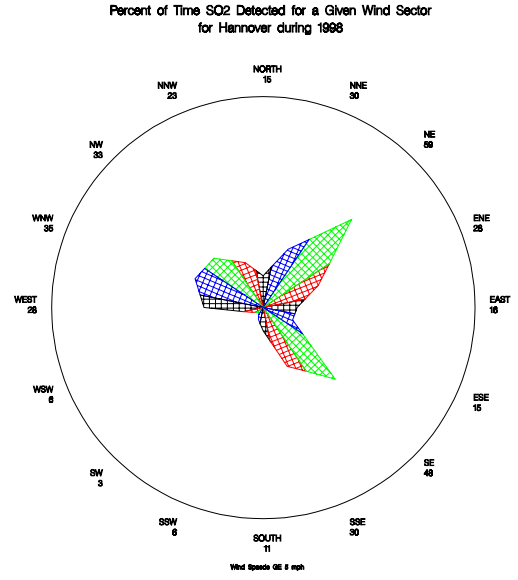
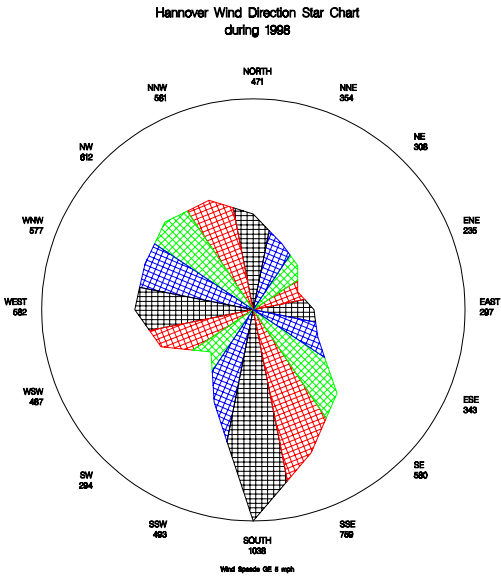


Figure A3-7 Hannover Star Charts

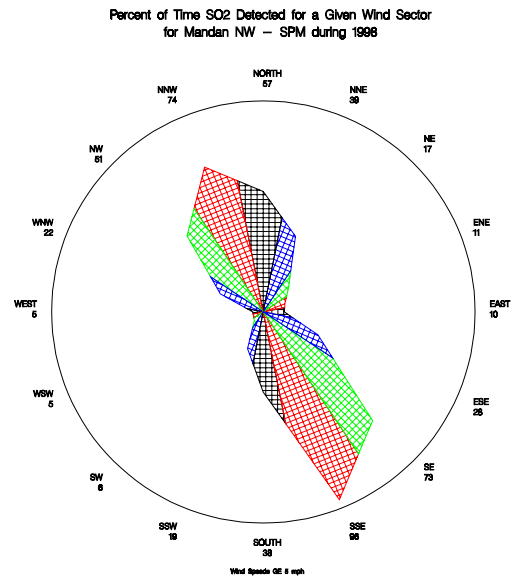
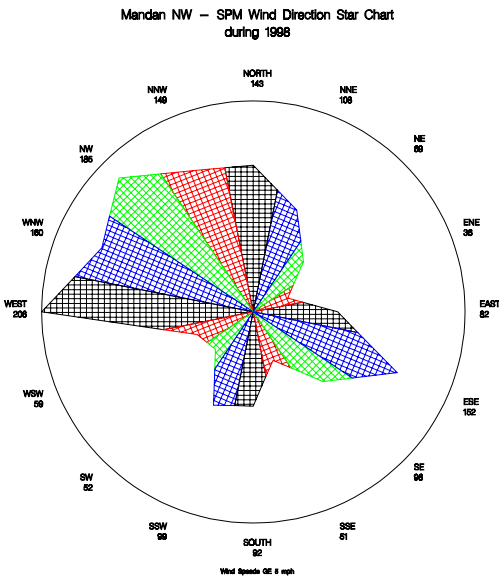
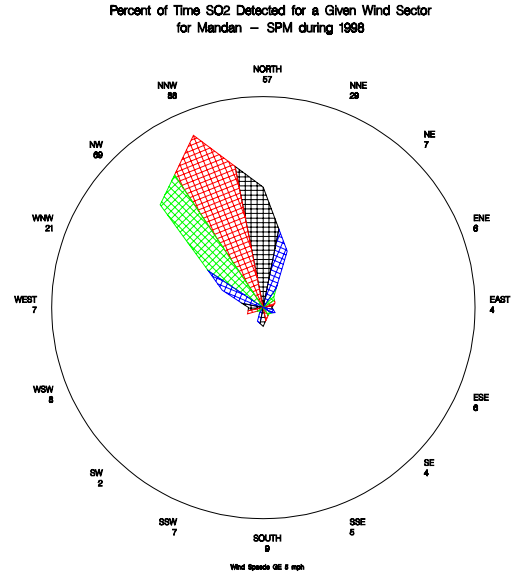
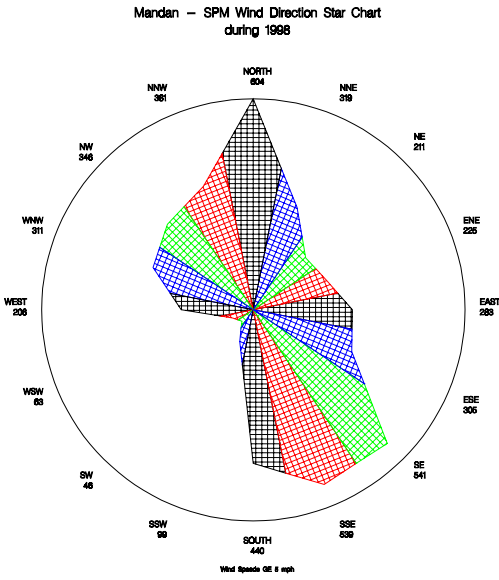


Figure A3-8 Mandan/Mandan NW Star Charts

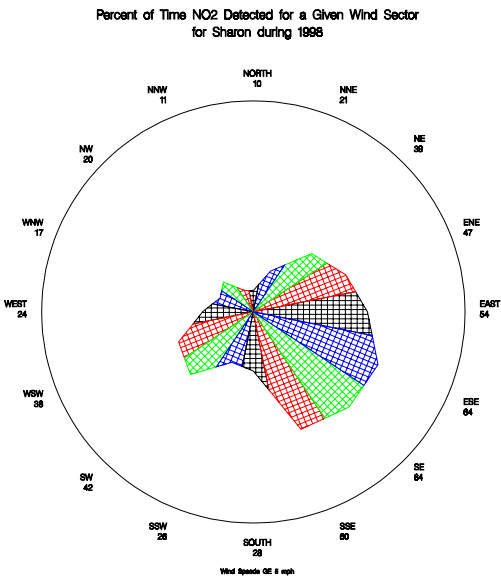
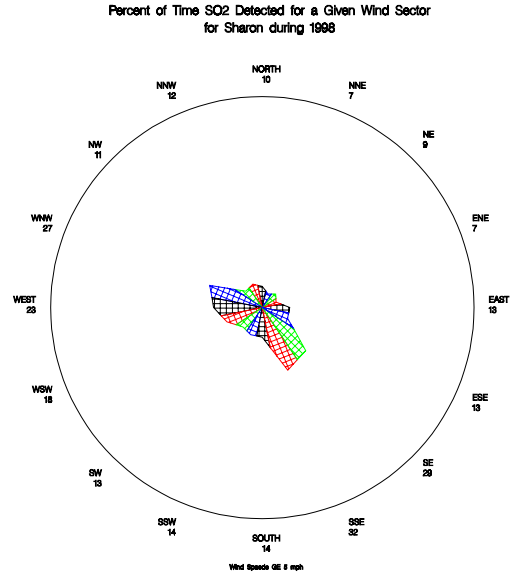
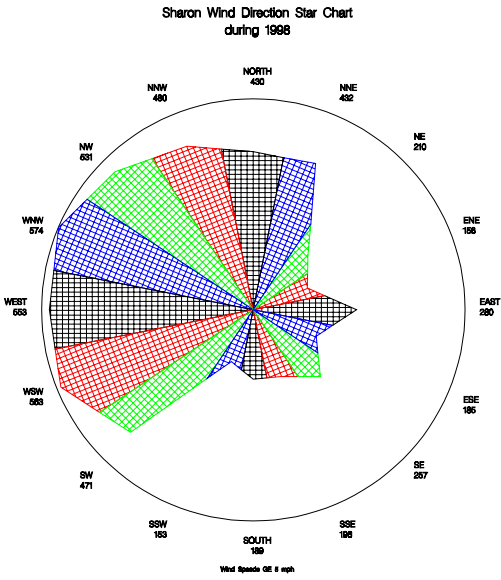
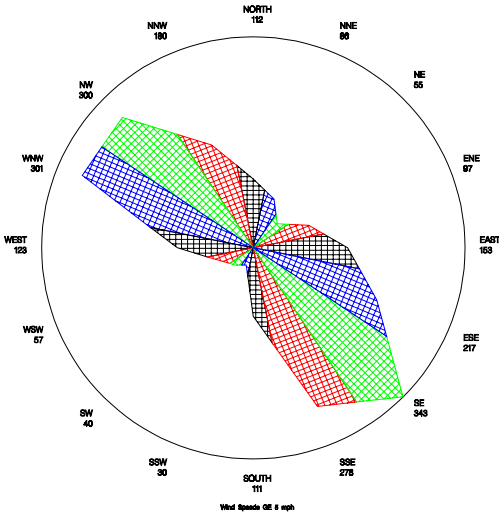


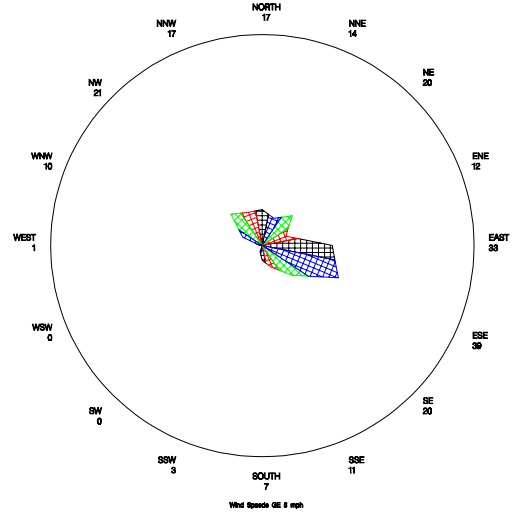
Figure A3-9 Sharon Star Charts



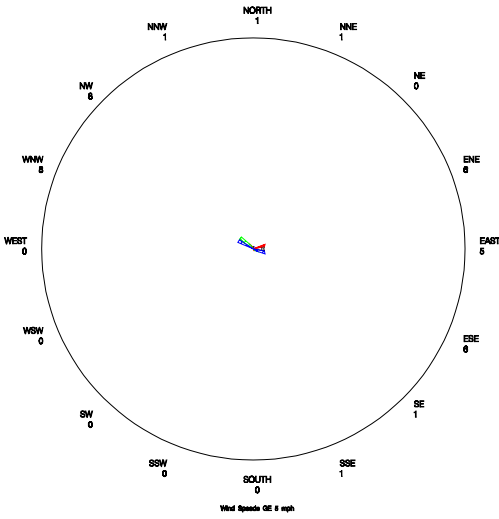
TRNP - NU Wind Direction Star Chart during 1998



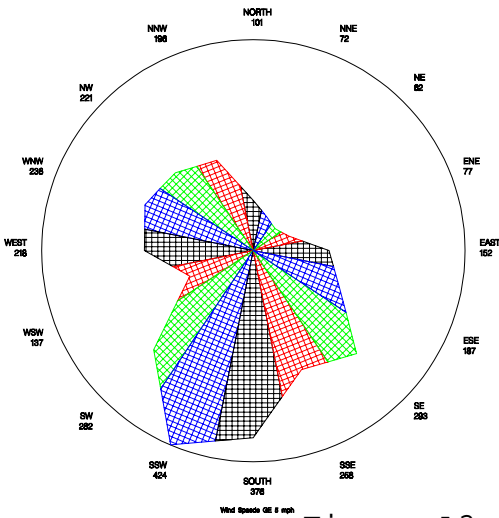
Percent of Time SO2 Detected for a Given Wind Sector for TRNP - NU during 1998



Percent of Time H2S Detected for a Given Wind Sector for TRNP - NU during 1998



TRNP - SU (Painted Canyon) Wind Direction Star Chart during 1998



Percent of Time SO2 Detected for a Given Wind Sector for TRNP - SU (Painted Canyon) during 1998

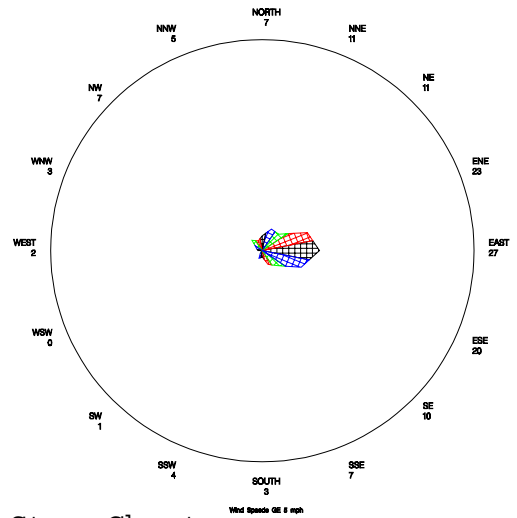


Figure A3-10 TRNP NU/SU Star Charts

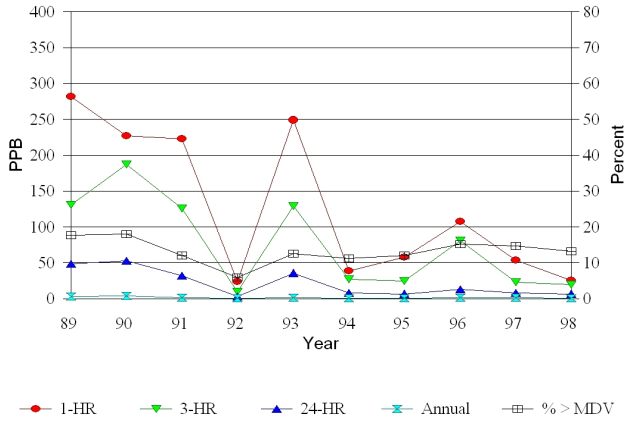


**APPENDIX 4**  
**1989-1998 Trends**

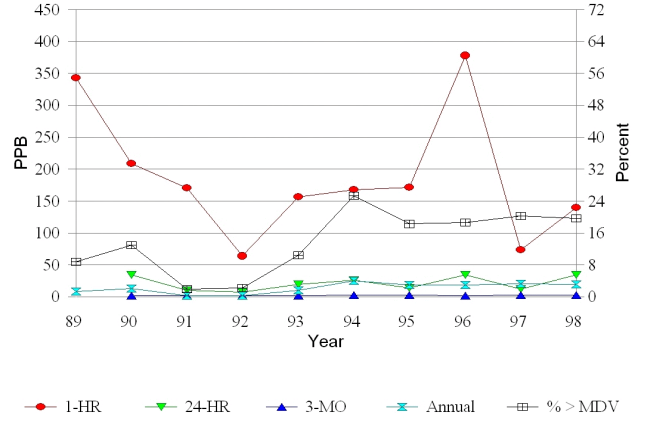
The trend graphs for 1989 through 1998 are presented in alphabetical order, grouped by site, unless multiple sites would fit on a single page. Each graph depicts the maximum concentration for each applicable standard (left scale) and percentage of time an hourly concentration is detected (right scale).

Graphs are not presented for  $PM_{2.5}$  for two reasons. First, it is collected with a non-reference method; and second, there is only one full year of data. Sulfates are not presented because there is only one year of data available.

**Amerada Hess #1**  
Sulfur Dioxide



**Amerada Hess #2**  
Hydrogen Sulfide



**Amerada Hess #3**  
Sulfur Dioxide

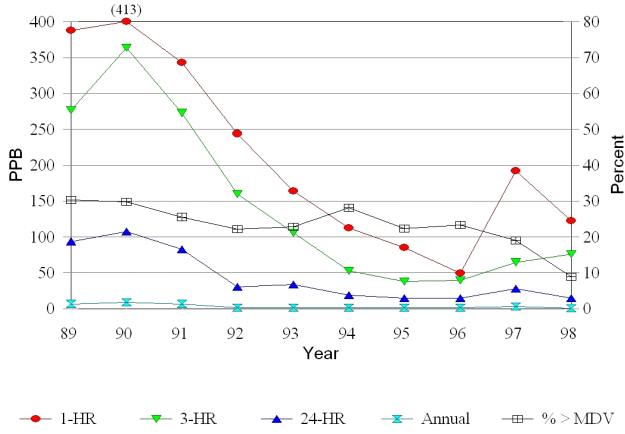


Figure A4-1 Amerada Hess Trends

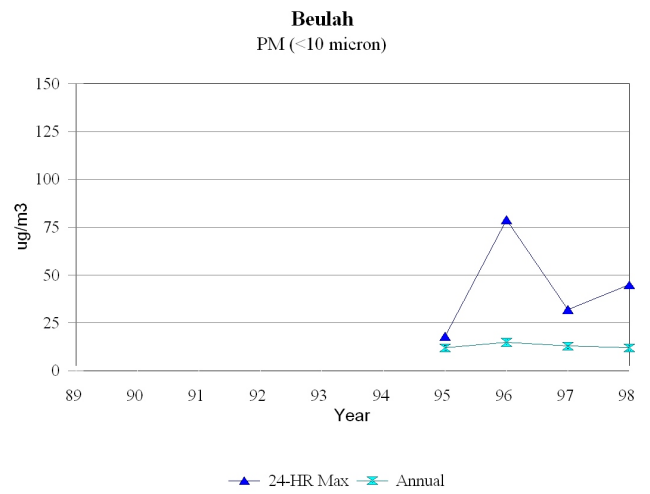
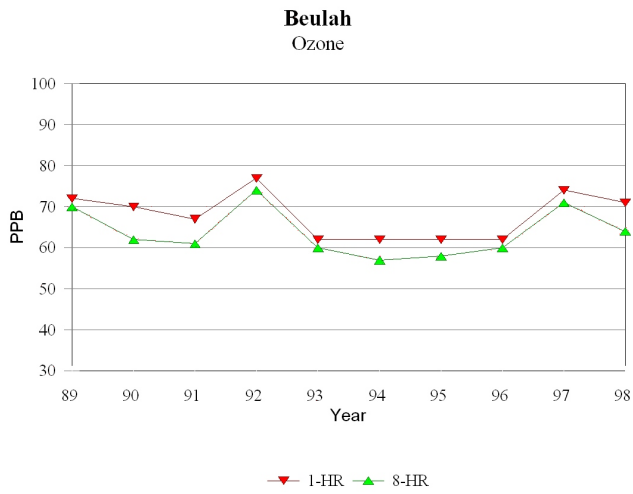
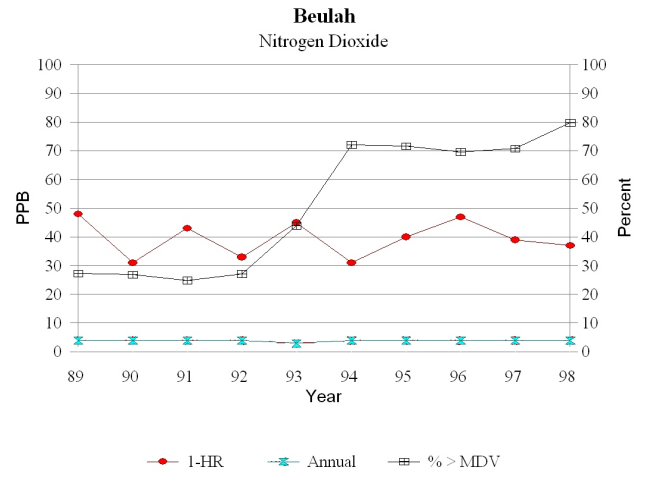
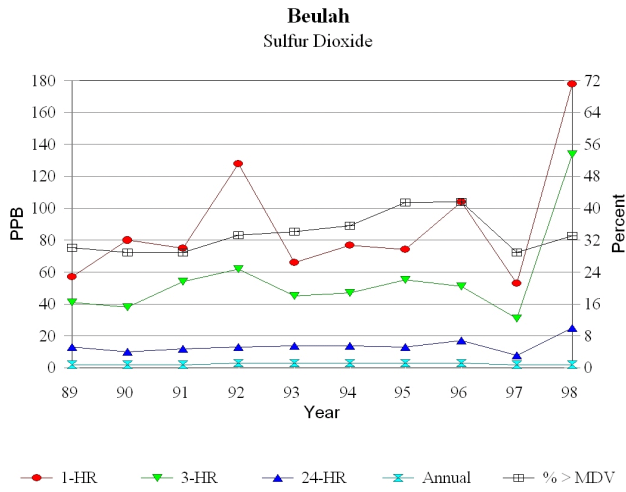
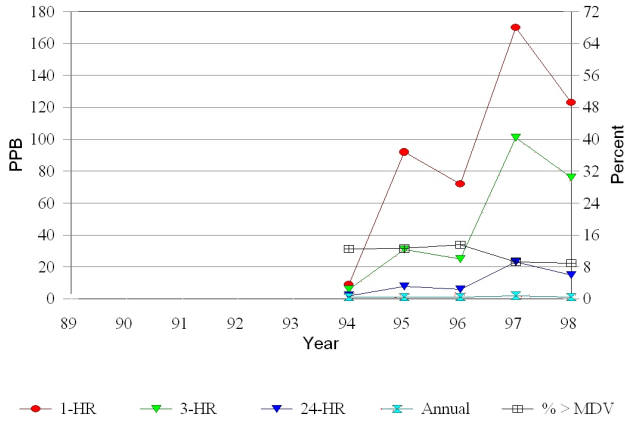
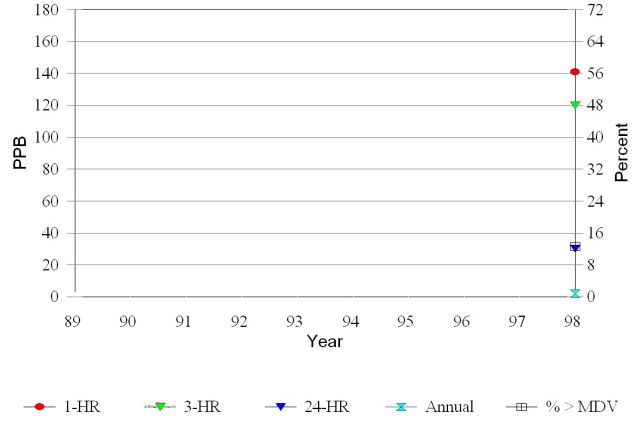


Figure A4-2 Beulah Trends

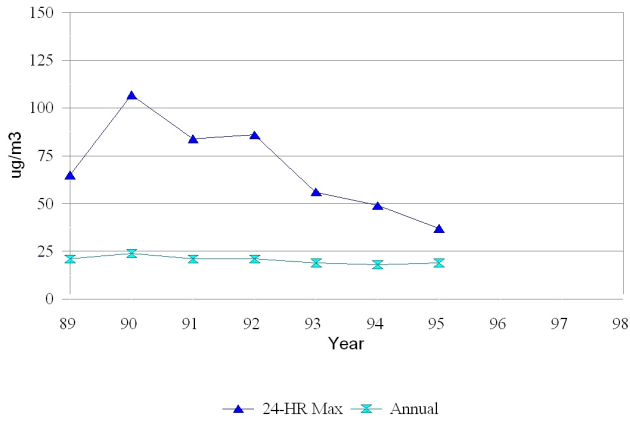
**Bear Paw - MGP #3**  
Sulfur Dioxide



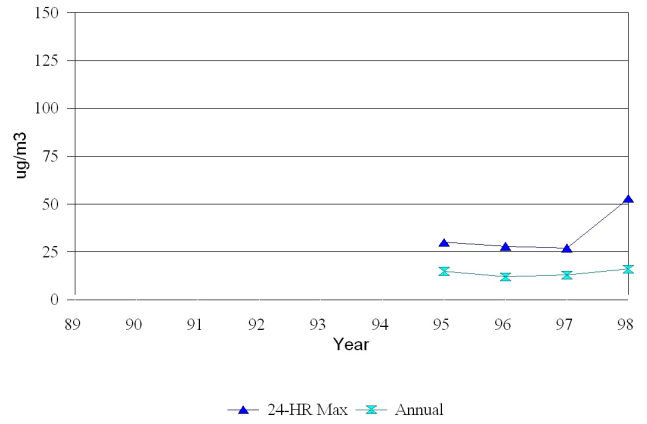
**Bear Paw - MGP #5**  
Sulfur Dioxide



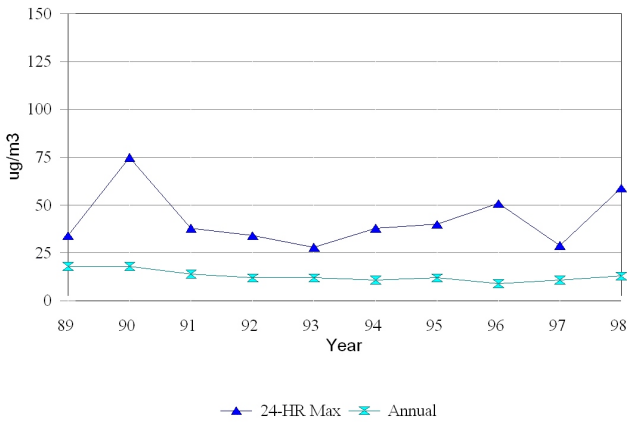
**Bismarck**  
PM (<10 micron)



**Bismarck - Residential**  
PM (<10 micron)



**Dickinson**  
PM (<10 micron)



**Dunn Center**  
Sulfur Dioxide

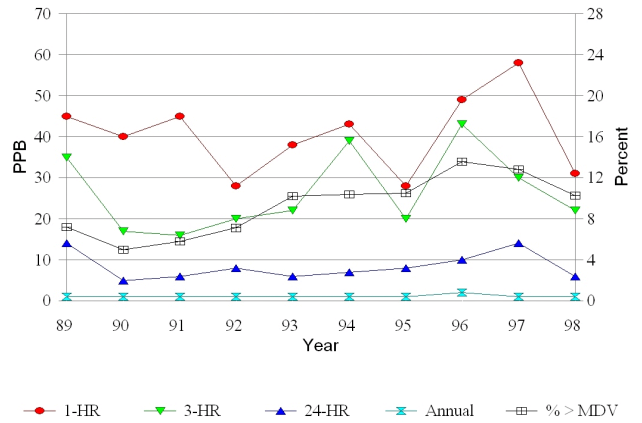


Figure A4-3 Bear Paw/Bismarck/Dickinson/Dunn Center Trends

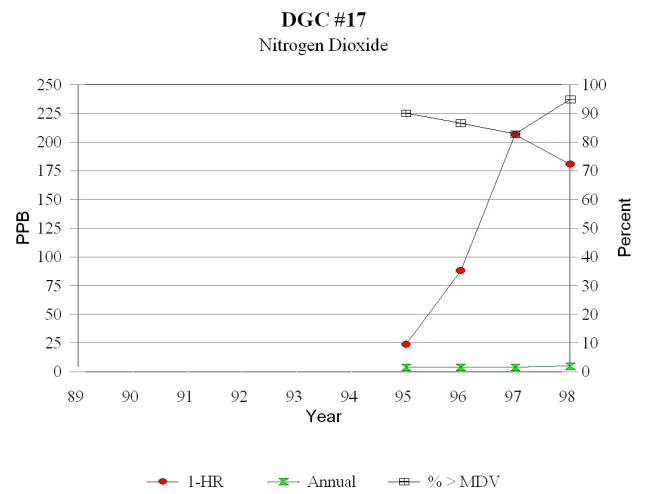
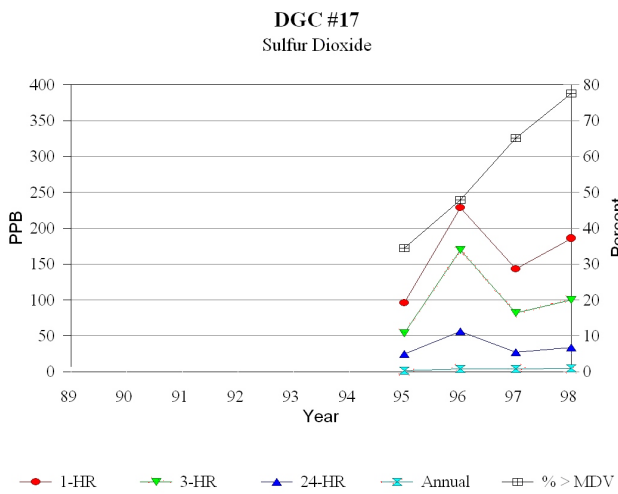
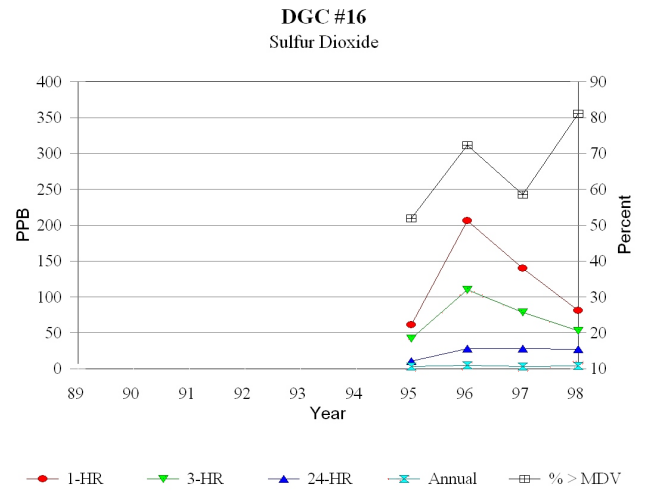
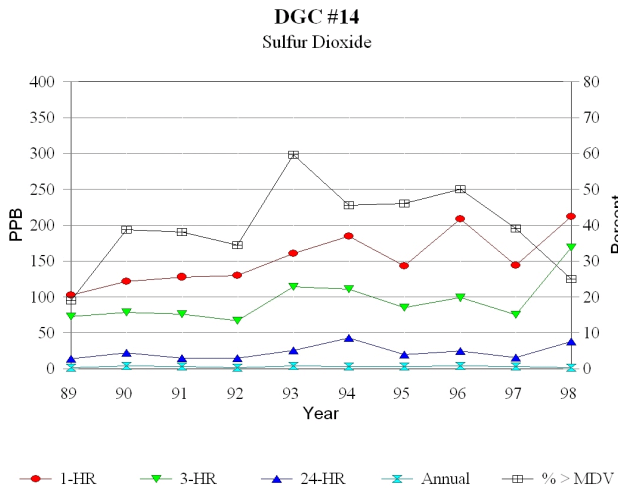
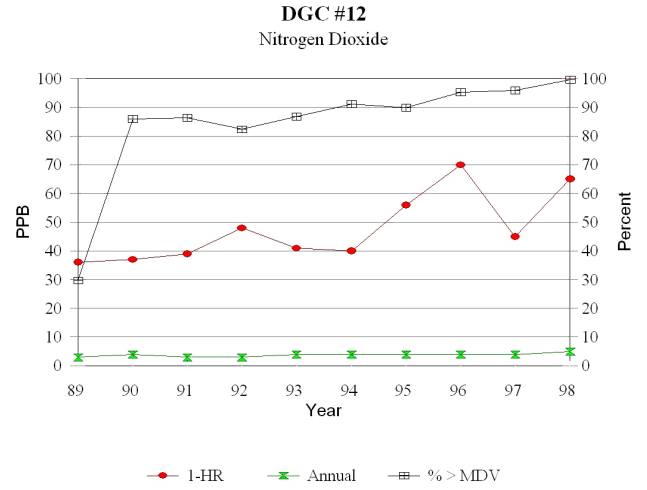
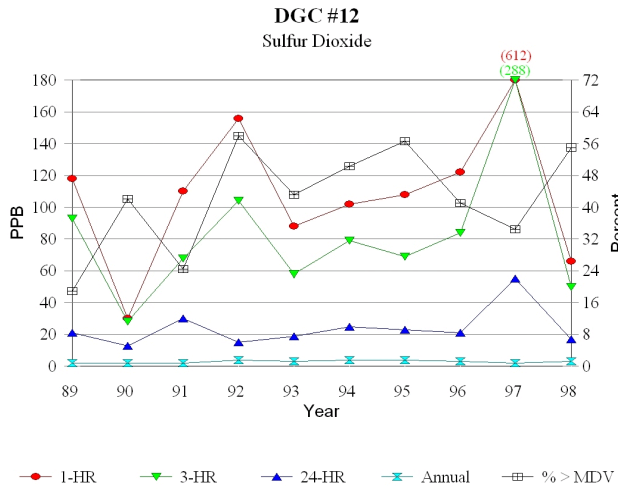
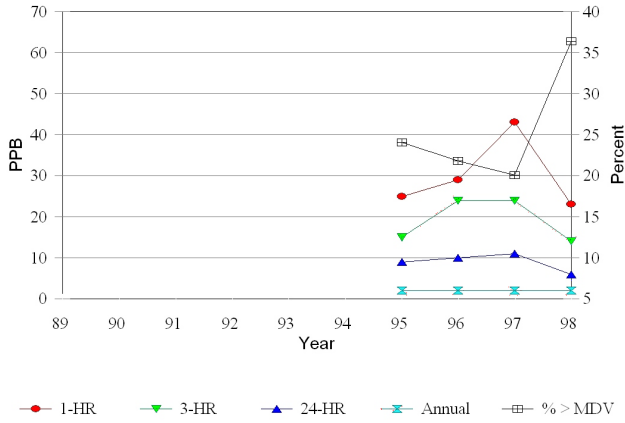


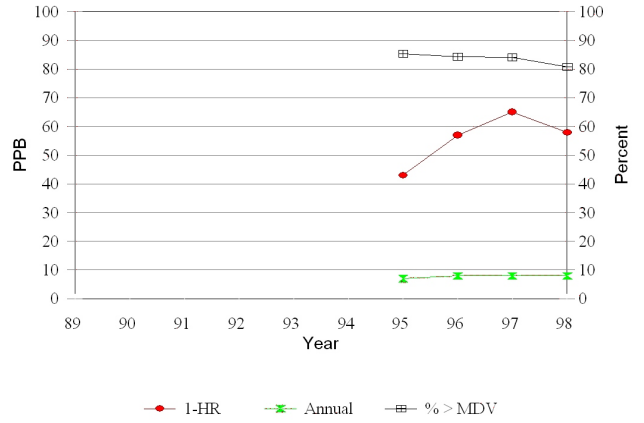
Figure A4-4 DGC Trends



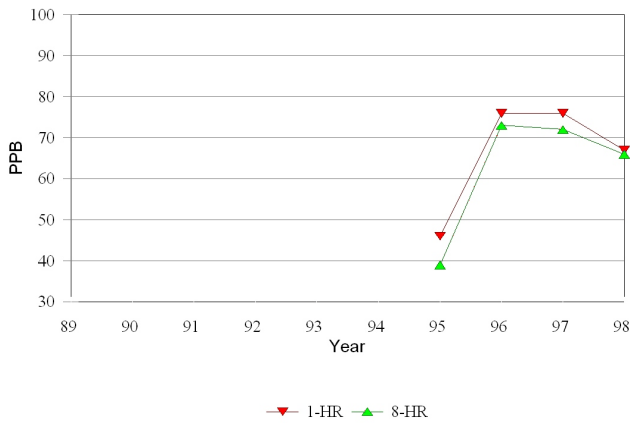
**Fargo - Residential**  
Sulfur Dioxide



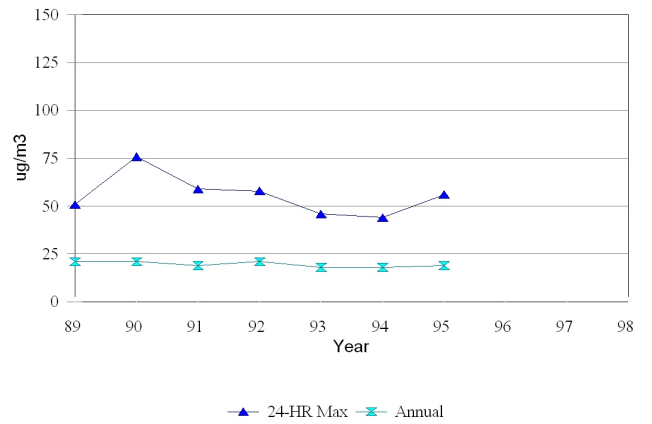
**Fargo - Residential**  
Nitrogen Dioxide



**Fargo - Residential**  
Ozone



**Fargo**  
PM (<10 micron)



**Fargo - Residential**  
PM (<10 micron)

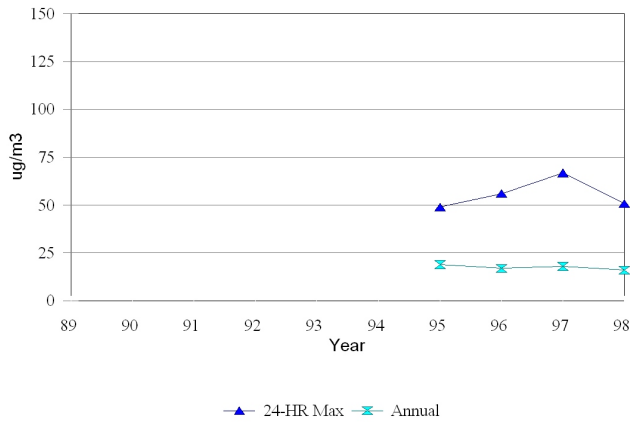
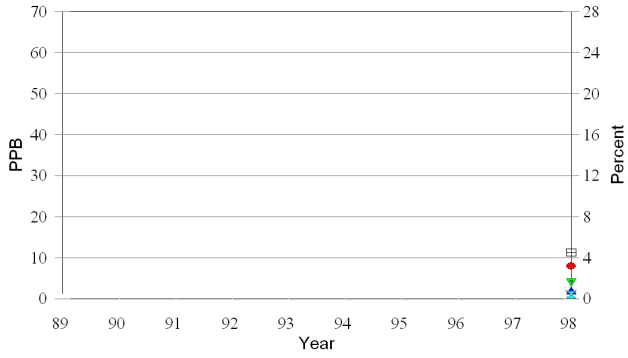


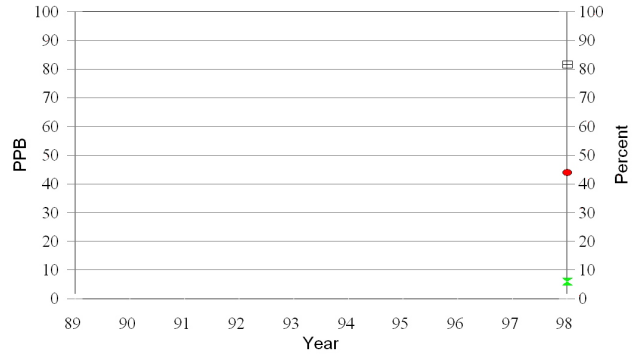
Figure A4-5 Fargo Trends

**Fargo NW**  
Sulfur Dioxide



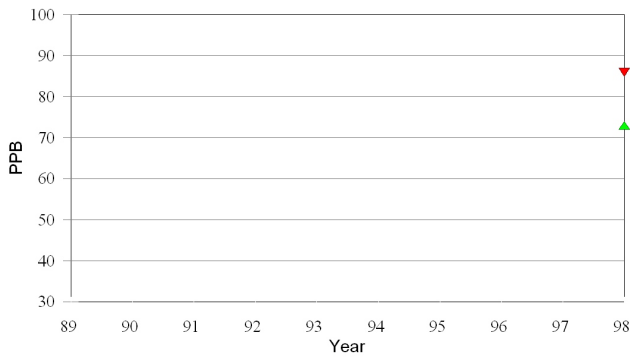
● 1-HR    ▼ 3-HR    ▲ 24-HR    ✕ Annual    ◻ % > MDV

**Fargo NW**  
Nitrogen Dioxide



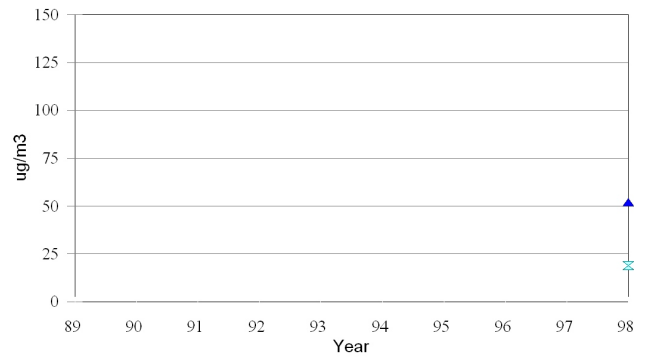
● 1-HR    ✕ Annual    ◻ % > MDV

**Fargo NW**  
Ozone



▼ 1-HR    ▲ 8-HR

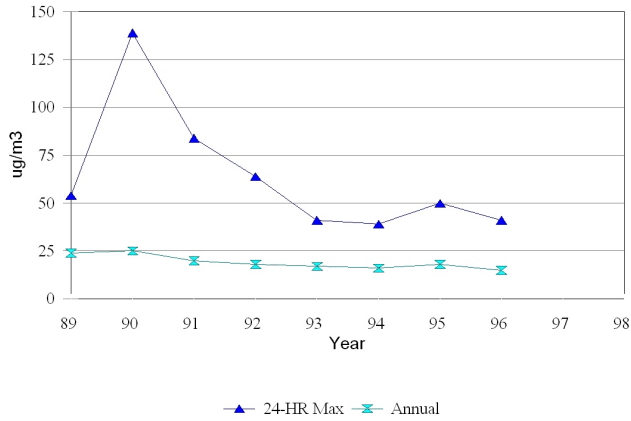
**Fargo NW**  
PM (<10 micron)



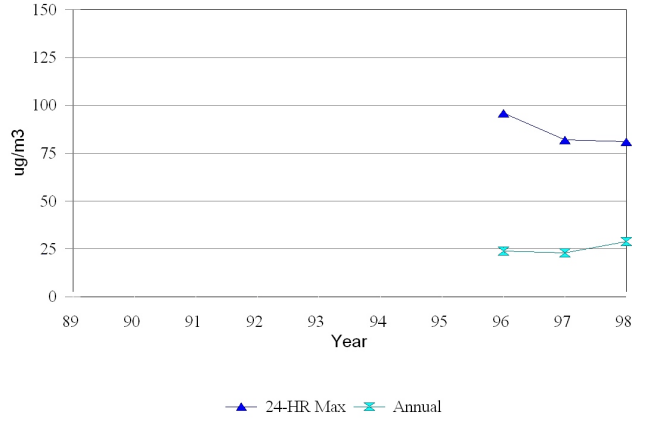
▲ 24-HR Max    ✕ Annual

Figure A4-5 Fargo Trends (cont.)

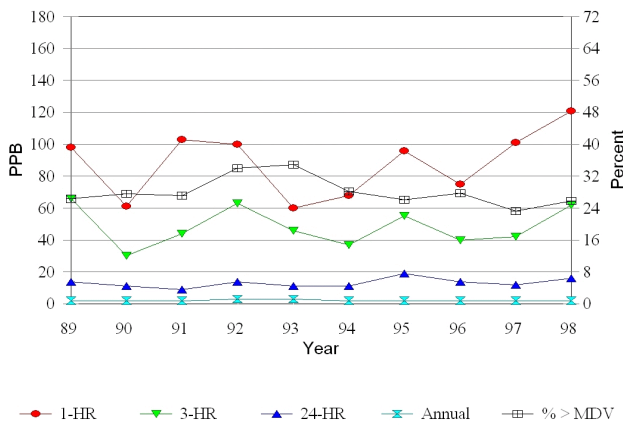
**Grand Forks**  
PM (<10 micron)



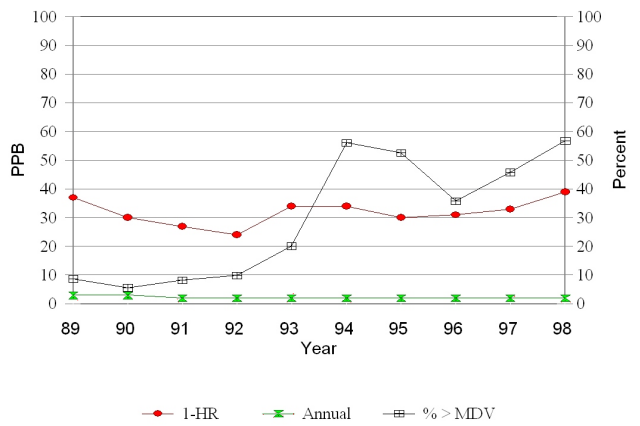
**Grand Forks - North**  
PM (<10 micron)



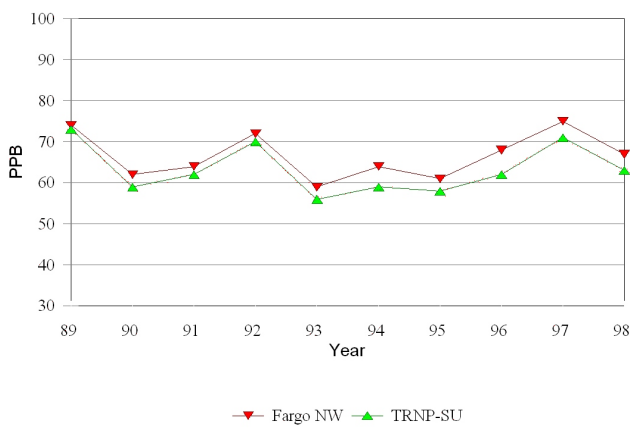
**Hannover**  
Sulfur Dioxide



**Hannover**  
Nitrogen Dioxide

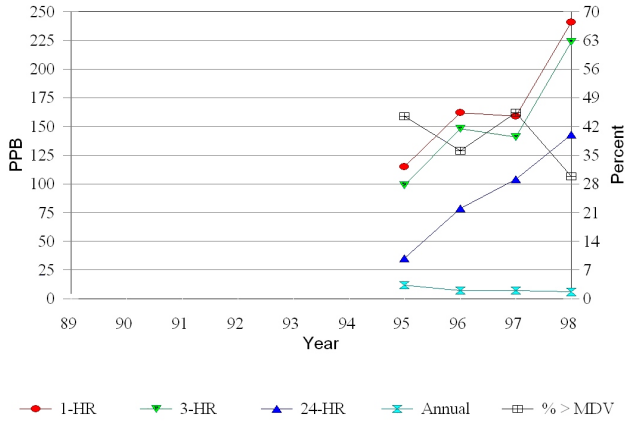


**Hannover**  
Ozone

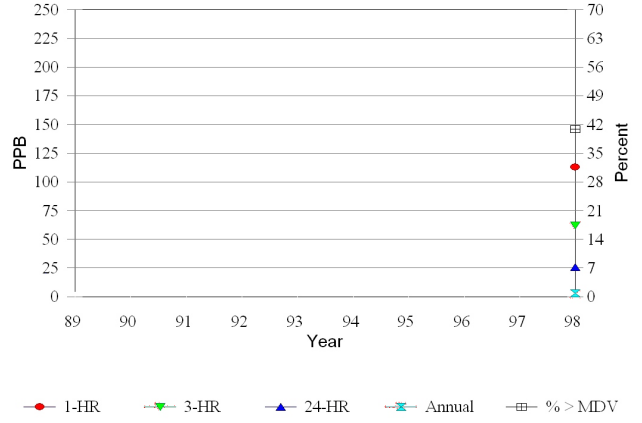


A4-6 Grand Forks/Hannover Trends

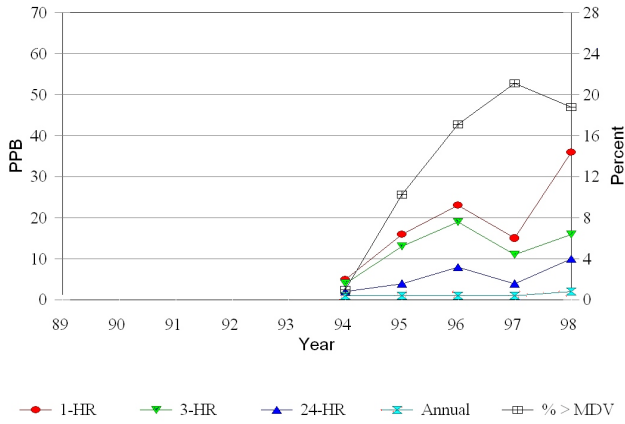
**Mandan - SPM**  
Sulfur Dioxide



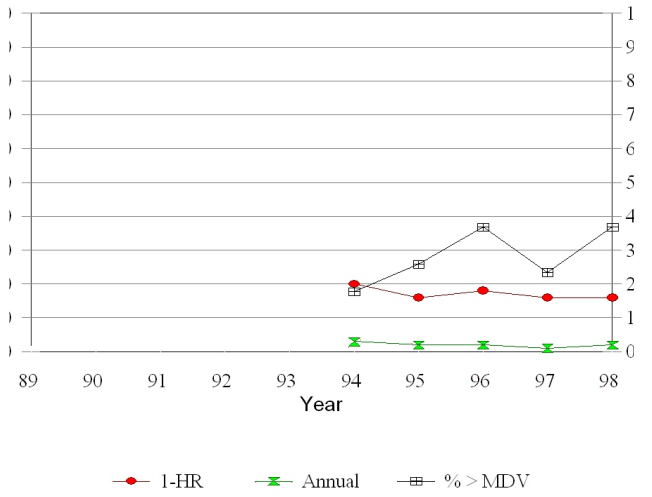
**Mandan NW - SPM**  
Sulfur Dioxide



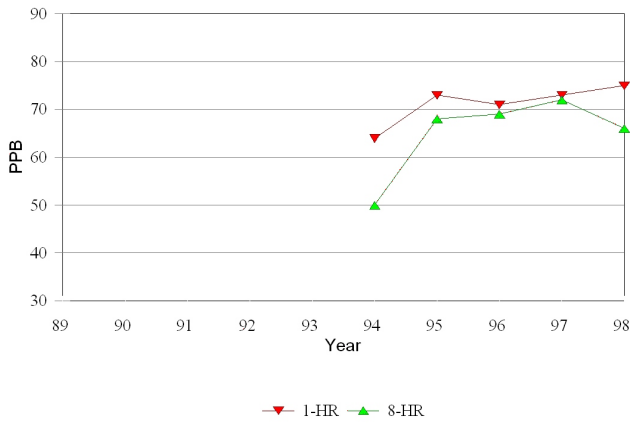
**Sharon**  
Sulfur Dioxide



**Sharon**  
Nitrogen Dioxide



**Sharon**  
Ozone



**Sharon**  
PM (<10 micron)

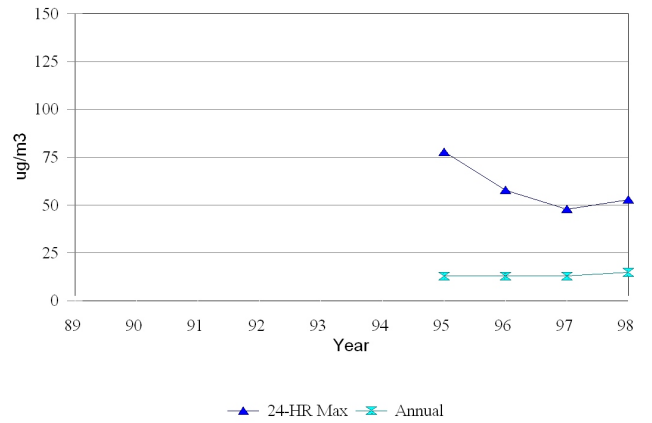


Figure A4-7 Mandan/Sharon Trends

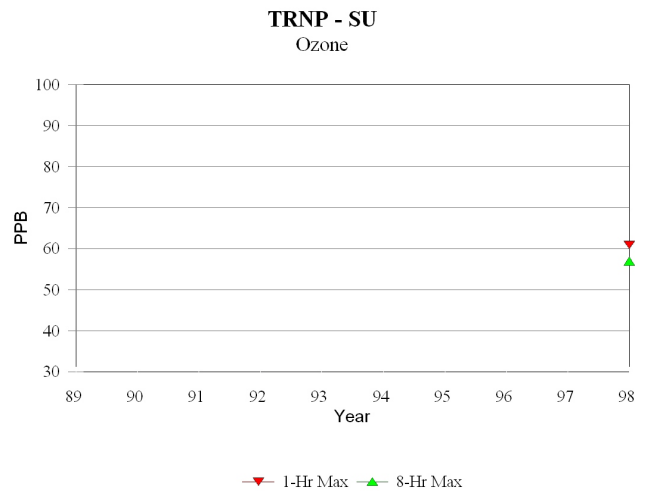
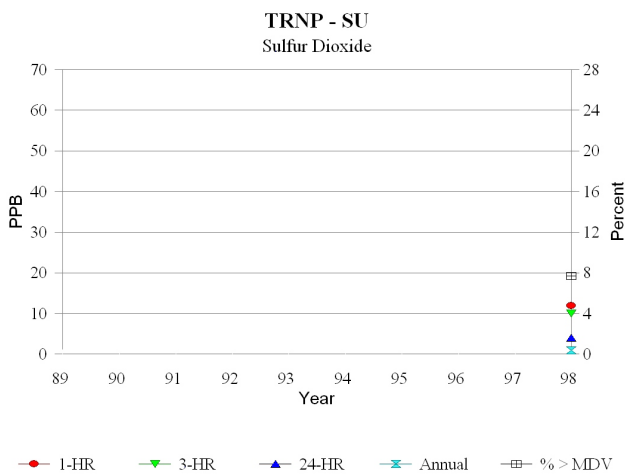
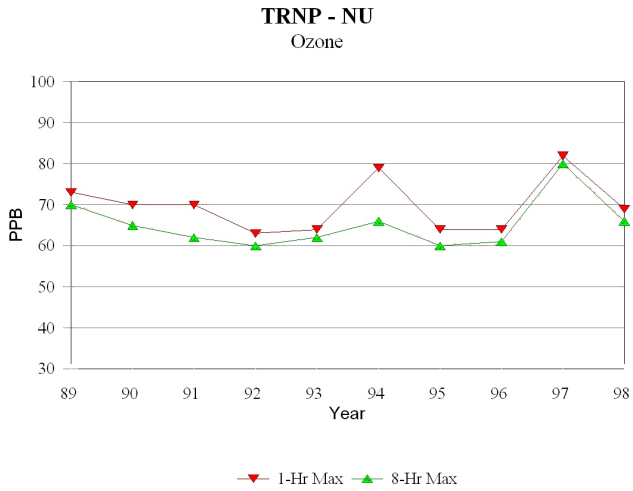
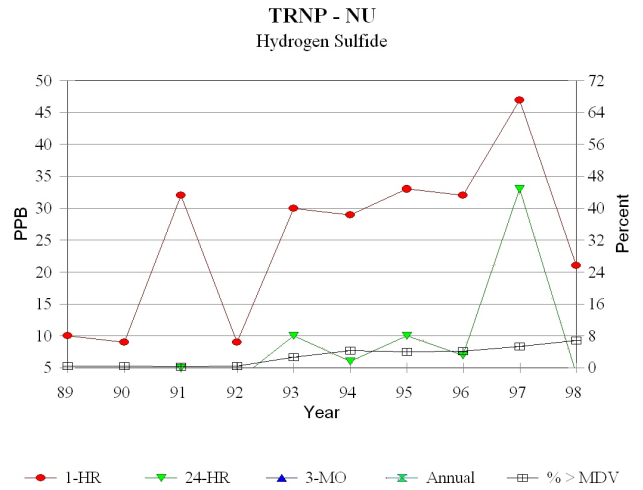
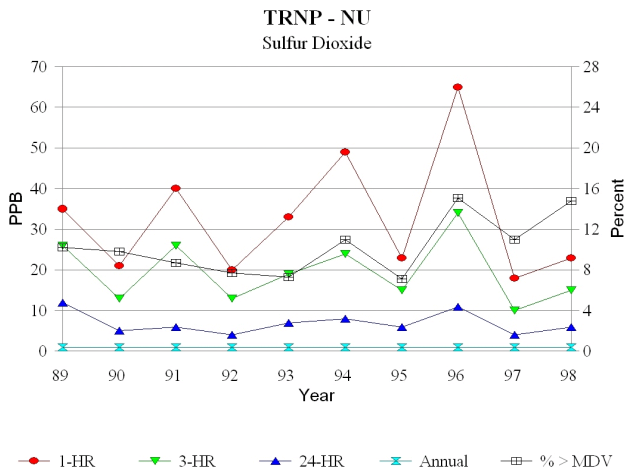


Figure A4-8 TRNP - NU/SU Trends

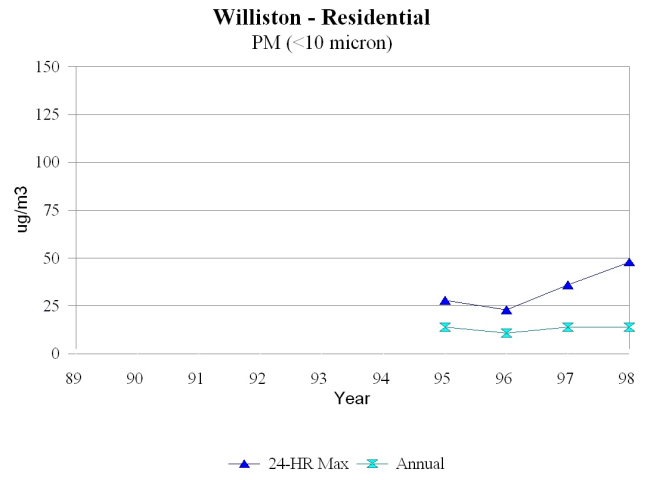
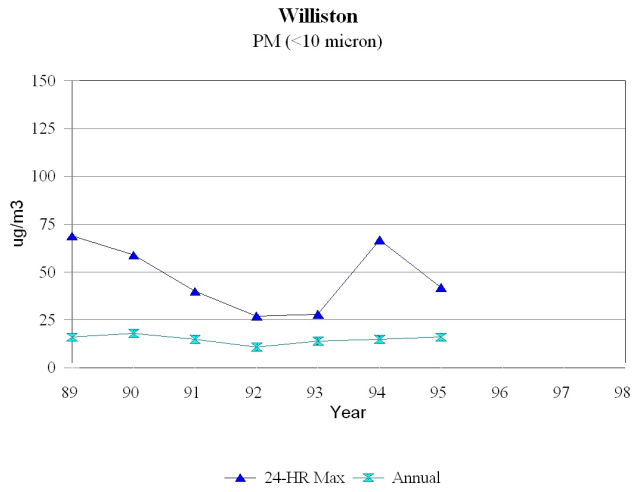


Figure A4-9 Williston Trends