Annual Report

North Dakota
Air Quality Monitoring
Data Summary
2004

North Dakota Department of Health
Division of Air Quality

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EXECUTIVE SUMMARY

The North Dakota Department of Health operated eight ambient and two special purpose air quality monitoring sites and industry operated eight source-specific air quality monitoring sites. There were no sulfur dioxide, nitrogen dioxide, ozone or particulate matter exceedances of either the state or federal ambient air quality standards measured during 2004.

North Dakota is one of 14 states that are in attainment for all criteria pollutants. North Dakota also has been designated “attainment” for both the fine particulate and the 8-hour ozone standards.

INTRODUCTION

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

In addition to the state-operated ambient air quality monitoring sites, three industrial sources 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, 2004, and ending Dec. 31, 2004. 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. Except for ozone, $PM_{2.5}$ and PM_{10} particulates, the trend graphs also include the percentage of time a concentration was above the minimum detectable limit for the specific analysis method.

NETWORK DESCRIPTION

Department Sites

During 2004, the department operated 10 air quality monitoring sites. Eight were ambient monitoring sites, and two were special purpose monitoring (SPM) sites near the Tesoro Refinery and MDU Heskett Power Plant at Mandan. Table 1 lists the department monitoring sites that were active during the year.

In general, department ambient air quality monitoring (AAQM) sites obtain air quality data to meet six monitoring objectives: (1) 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, (4) determine representative impacts on ambient air quality levels near significant sources, (5) determine the effects of long-range pollution transport and, (6) determine any welfare-related impacts. The department has determined that only four sites are required to satisfy these six monitoring objectives. They are identified in Table 1, in the "Station Type" column.

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 Tesoro Refinery.

The department is working with Environment Canada, the Environmental Protection Agency (EPA), Saskatchewan Environment (SE) and SASKPower to operate a Saskatchewan - North Dakota (SK-ND) Transboundary ambient air quality monitoring network with two sites (Rafferty Dam and Estevan) in Saskatchewan and two sites (Short Creek and Lignite) in North Dakota. The SK-ND Transboundary network became fully operational Dec. 5, 2000, when the Estevan site became fully operational. Data collected at these four sites are addressed in that network's own quarterly and annual reports.

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

Industry Sites

Industry operated eight source-specific air quality monitoring sites during 2004. Table 1 also lists the industry networks and monitoring sites active during the year.

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

Figure 1 displays department and industry monitoring sites. If an industry has more than one site, only the general location within the county is indicated. This principle also applies to the Mandan location, which represents the two sites at Mandan.

TABLE 1

State AAQM Network Description

Site Name AQS Site #	Station Type	Parameter Monitored[1]	Operating Schedule	Monitoring Objective[2]	Spatial Scale[2]	Date Site/Parameter Began
1 Beulah North 380570004	SLAMS Required	$PM_{2.5}$ SO_2, NO_2, O_3, MET NH_3 cont. $PM_{2.5}$ Air Toxics	6th Day cont. cont. cont. 6th Day	Population Exposure Population Exposure General Background[3] Population Exposure Population Exposure	Neighborhood Neighborhood Regional Neighborhood Neighborhood	12/98 04/80 11/00 10/00 04/99
2 Bismarck Residential 380150003	SLAMS	$PM_{2.5}$ $PM_{2.5}$ Speciation PM_{10}	3rd Day 6th Day 6th Day	Population Exposure	Urban	12/98 1/01 1/01
3 Dunn Center 380250003	SLAMS Required	SO_2, NO_2, O_3, MET cont. $PM_{2.5}$, PM_{10}	cont.	General Background	Regional	10/79 09/04
4 Fargo NW 380171004	SLAMS Required	SO_2, NO_2, O_3, MET cont. $PM_{2.5}$ PM_{10}[4] $PM_{2.5}$ $PM_{2.5}$ Speciation	cont. cont. 3rd Day 3rd Day 3rd Day	Population Exposure Population Exposure Population Exposure Population Exposure Population Exposure	Urban Urban Urban Urban Urban	05/98 7/00 05/98 12/98 7/01
5 Hannover 380650002	SLAMS	SO_2, NO_2, O_3, MET cont $PM_{2.5}$	cont. cont.	General Background General Background	Regional Regional	10/84 10/02
6 Lostwood 380130004	SLAMS	SO_2, NO_2, O_3, MET cont $PM_{2.5}$, PM_{10}	cont.	General Background	Regional	10/03
7 Mandan Refinery - SPM 380590002	SPM	SO_2, MET	cont.	Source Impact	Neighborhood	12/95
8 Mandan Refinery NW - SPM 380590003	SPM	SO_2, MET	cont.	Source Impact	Neighborhood	09/98
9 TRNP - NU 380530002	SLAMS Required	SO_2, NO_2, O_3, MET cont. $PM_{2.5}$, PM_{10}[5] PM_{10}[$] $PM_{2.5}$ $PM_{2.5}$ Speciation	cont. cont. 6th Day 6th Day 6th Day	Long range Transport	Regional	8/01
10 TRNP - SU 380070002	SLAMS	SO_2, O_3 MET $PM_{2.5}$	cont. 6th Day	General Background	Regional	07/98 6/00
Company	**Site Name** AQS Site #					
11 Amerada Hess Corporation	TIOGA #1 381050103 TIOGA #3 381050105	SO_2 SO_2	cont. cont.	Source Impact Source Impact	Urban Urban	07/87 11/87
12 Bear Paw Energy, Inc.	MGP #3 380530104 MGP #5 380530111	SO_2, MET SO_2, MET	cont. cont.	Source Impact Source Impact	Urban Urban	11/94 05/94
13 Dakota Gasification Company	DGC #12 380570102 DGC #14 380570118 DGC #16 380570123 DGC #17 380570124	SO_2, NO_2, MET SO_2 SO_2 SO_2, NO_2	cont. cont. cont. cont.	Source Impact Source Impact Source Impact Source Impact	Urban Urban Urban Urban	01/80 01/89 10/95 10/95

1. MET refers to meteorological and indicates wind speed and wind direction monitoring equipment.
2. Not applicable to MET.
3. This analyzer will serve a dual role of population exposure and general background.
4. Terminated effective June 30.
5. Began effective July 1.

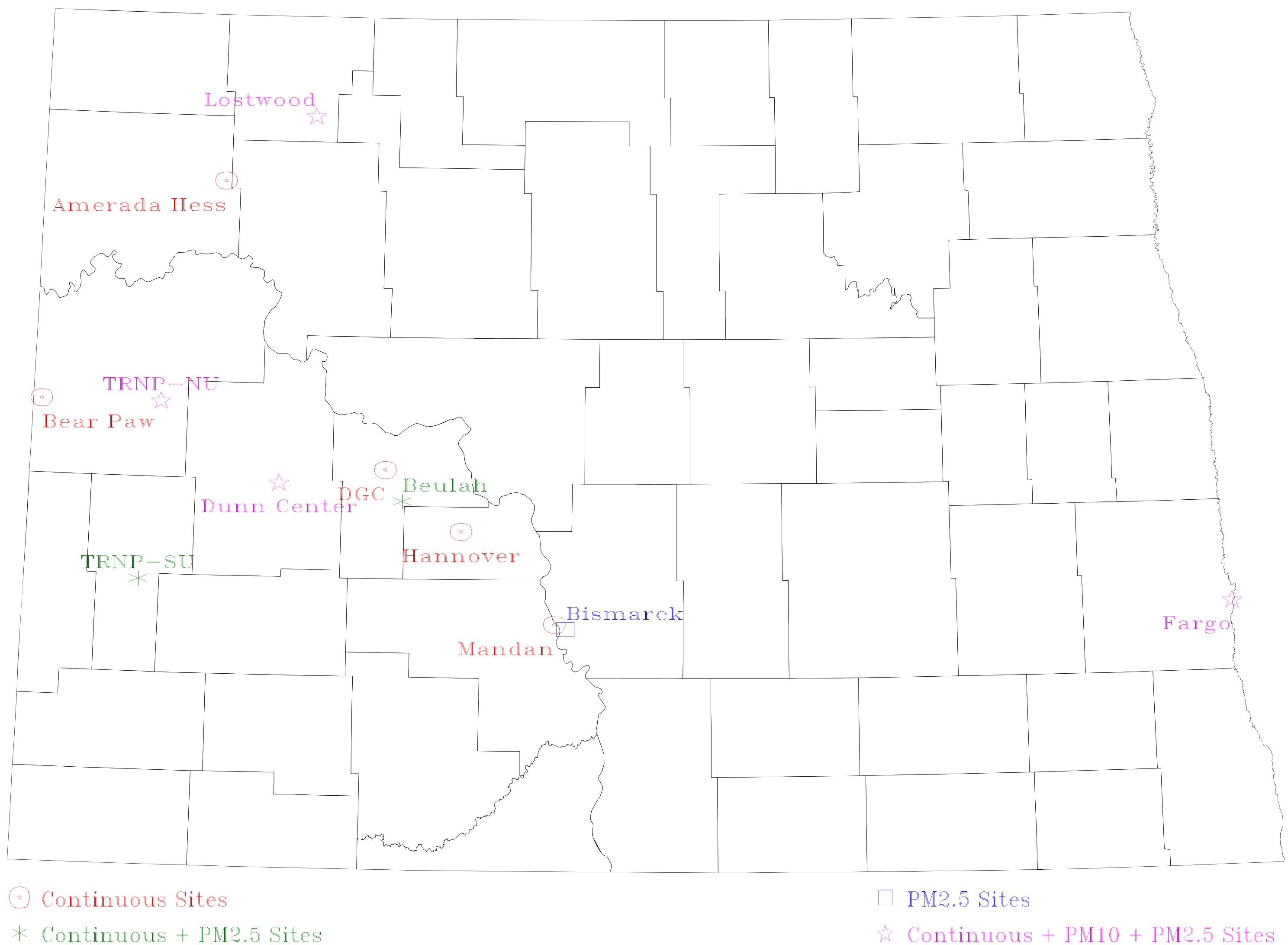

Figure 1 North Dakota Air Quality Monitoring Network

NETWORK CHANGES

Department Changes

The manual PM_{10} samplers at Fargo NW and TRNP - NU were terminated effective June 30 and replaced with continuous PM_{10} analyzers. A larger monitoring shelter and 10-meter tower were installed at Dunn Center. Along with the larger shelter and tower, continuous $PM_{2.5}$ and PM_{10} analyzers and new MET equipment were added.

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

The data summaries for gaseous pollutants include maximum concentrations, 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 $PM_{2.5}$ and PM_{10} 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 (µg/m^3).

Continuous $PM_{2.5}$ and PM_{10} data summaries contain the two highest 1-hour averages and the four highest 24-hour averages; the annual average; the number of times the 24-hour standard was exceeded, if applicable; and an asterisk (*) if the annual standard is exceeded, if applicable. The concentrations are reported in micrograms per cubic meter (µg/m^3).

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

As part of the statistical evaluation, the data recovery (NUM OBS) is evaluated to determine if the data recovery complies with the state's required 80 percent data recovery rate. A continuous analyzer operating fewer than 7,008 hours per year may achieve at least an 80 percent data recovery for the period operated; however, it does not meet the 80 percent data recovery for the full year. Each analyzer at a site not meeting the 80 percent data recovery for the year is flagged in the "NUM OBS" column by placing

"***" underneath the number of observations. Particulate matter samplers must collect at least 48 samples per year for 1-in-6 day sampling and 96 samples per year for 1-in-3 day sampling to meet the 80 percent data recovery rate.

Sulfur Dioxide

Physical Characteristics and Sources

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

Health Effects

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

Standards Comparison

Sulfur dioxide was monitored at 17 sites. Nine sites were run by the department and eight by industry. As a result of legislative action effective Aug. 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 Dakota Gasification Company (DGC) network, Mandan NW - SPM, and Mandan - SPM are compared only to the federal standards.

The 1-hour state standard (273 ppb) was exceeded once during the year by an applicable source. The maximum 1-hour concentration was 322 ppb at Amerada Hess - Tioga #3. The exceedance occurred during plant maintenance.

The 3-hour federal secondary standard (500 ppb) was not exceeded during the year. The maximum 3-hour average concentration was 134 ppb at Amerada Hess - Tioga #3.

The 24-hour state standard (99 ppb) was not exceeded during the year. The maximum 24-hour average concentration was 46 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	2004	JAN-DEC	8699	191 05/03:05	74 05/05:05	67 05/03:05	57 05/04:11	14 11/02	11 05/04	1.6			14.7
Amerada Hess - Tioga #3	2004	JAN-DEC	8687	322 05/03:09	174 03/29:18	134 05/03:11	106 03/29:20	31 03/29	24 12/12	3.2	1		24.6
Bear Paw - MGP #3	2004	JAN-DEC	8672	43 01/28:09	20 06/04:13	16 01/28:11	14 01/27:17	4 01/27	4 01/28	1.1			4.9
Bear Paw - MGP #5	2004	JAN-DEC	8704	166 01/30:17	140 01/30:19	115 01/30:17	80 01/30:14	42 01/30	7 08/20	1.3			7.5
Beulah - North	2004	JAN-DEC	8719	60 07/25:07	50 10/04:09	33 07/25:08	30 10/04:11	7 05/20	7 10/04	1.9			21.8
DGC #12	2004	JAN-DEC	8722	64 07/25:08	48 10/16:13	47 07/25:08	31 10/16:14	8 12/08	7 07/25	1.9			23.5
DGC #14	2004	JAN-DEC	8687	38 08/04:11	35 07/11:08	22 08/03:08	21 08/20:14	11 08/04	6 08/20	1.8			18.5
DGC #16	2004	JAN-DEC	8698	94 09/09:09	90 04/23:12	43 04/23:14	35 09/08:14	16 09/08	13 09/09	1.9			19.2
DGC #17	2004	JAN-DEC	8648	60 09/09:10	47 08/07:11	36 09/09:11	30 09/09:14	13 09/09	10 08/04	1.8			19.7
Dunn Center	2004	JAN-DEC	8700	17 01/28:21	16 10/16:11	13 10/16:11	11 07/01:11	4 01/03	4 07/01	1.2			10.8
Fargo NW	2004	JAN-DEC	8392	7 01/13:17	7 01/20:01	6 01/13:17	5 01/20:02	3 02/03	2 01/13	1.1			5.5
Hannover	2004	JAN-DEC	8732	87 09/10:07	85 07/04:08	55 07/04:08	53 04/02:11	12 12/08	11 09/27	2.2			25.7
Lostwood NWR	2004	JAN-DEC	8683	40 01/03:13	36 01/16:14	27 12/07:11	23 01/16:17	11 02/05	11 01/21	1.6			16.8
Mandan - SPM	2004	JAN-DEC	8727	158 03/08:20	126 02/06:11	102 03/10:20	88 03/10:23	46 02/06	43 03/10	6.0			47.6
Mandan NW - SPM	2004	JAN-DEC	8335	88 10/09:09	85 06/06:07	59 03/26:20	52 03/26:17	21 03/26	21 05/28	3.6			47.9
TRNP - NU	2004	JAN-DEC	8729	29 05/18:07	24 05/18:06	20 05/18:08	10 02/01:14	4 02/01	4 01/29	1.2			10.6
TRNP - SU (Painted Canyon)	2004	JAN-DEC	5062 ***	16 07/23:06	12 07/06:23	6 07/23:08	5 07/06:23	2 07/23	2 08/02	1.1			3.4

The maximum 1-hour concentration is 322 ppb at Amerada Hess - Tioga #3 on 05/03:09
The maximum 3-hour concentration is 134 ppb at Amerada Hess - Tioga #3 on 05/03:11
The maximum 24-hour concentration is 46 ppb at Mandan - SPM on 02/06
The maximum annual average concentration is 6.0 ppb at Mandan - SPM

* 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 both the Amerada Hess and Bear Paw Energy networks. The maximum 5-minute average was 485 ppb at Amerada Hess - Tioga #3.

The sulfur dioxide 5-minute data are 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)

				5 - M I N U T E M A X I M A							
LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	1ST	DATE MM/DD:HH	2ND	DATE MM/DD:HH	3RD	DATE MM/DD:HH	# HOURS >600	% >MDV
Amerada Hess - Tioga #1	2004	JAN-DEC	8699	398	05/03:05	250	05/05:05	237	05/04:12	0	23.2
Amerada Hess - Tioga #3	2004	JAN-DEC	8687	485	05/03:09	303	03/29:18	299	03/29:20	0	43.4
Bear Paw - MGP #3	2004	JAN-DEC	8673	141	06/04:13	81	06/04:12	61	01/28:09	0	12.9
Bear Paw - MGP #5	2004	JAN-DEC	8704	319	01/30:19	298	01/30:16	252	01/30:14	0	17.6
Beulah - North	2004	JAN-DEC	8719	107	08/15:10	97	10/04:09	93	07/25:07	0	31.8
Dunn Center	2004	JAN-DEC	8701	26	05/16:06	25	01/28:21	24	07/01:10	0	18.9
Fargo NW	2004	JAN-DEC	8249	20	10/26:18	17	06/28:16	16	10/26:09	0	10.4
Hannover	2004	JAN-DEC	8732	323	04/02:08	173	09/10:07	153	04/02:10	0	35.7
Lostwood NWR	2004	JAN-DEC	8683	94	01/16:14	71	01/17:09	67	01/03:13	0	23.4
Mandan - SPM	2004	JAN-DEC	8727	261	03/08:20	202	02/06:10	195	02/06:11	0	60.9
Mandan NW - SPM	2004	JAN-DEC	8336	183	05/27:11	169	06/06:07	167	07/31:10	0	59.4
TRNP - NU	2004	JAN-DEC	8729	45	02/01:12	44	05/18:07	42	05/28:10	0	14.7
TRNP - SU (Painted Canyon)	2004	JAN-DEC	5062 ***	47	07/23:06	25	07/19:07	18	07/14:09	0	10.4

The maximum 5-minute concentration is 485 ppb at Amerada Hess - Tioga #3 on 05/03:09

* No Standard is currently in effect:

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

Nitrogen Dioxide

Physical Characteristics and Sources

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

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

Health Effects

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

Standards Comparison

Nitrogen dioxide was monitored at seven sites. Five 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 6.1 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	MAXIMA 1 - HOUR 2ND MM/DD:HH	ARITH MEAN	% >MDV
Beulah - North	2004	JAN-DEC	8690	38 10/05:19	25 04/05:21	3.0	95.4
DGC #12	2004	JAN-DEC	8639	46 04/05:21	30 04/05:22	2.9	95.2
DGC #17	2004	JAN-DEC	7872	28 07/22:20	27 08/07:11	2.2	93.4
Dunn Center	2004	JAN-DEC	8672	21 08/04:01	17 01/28:21	1.9	94.4
Fargo NW	2004	JAN-DEC	8593	50 02/18:09	48 02/15:05	6.1	96.3
Hannover	2004	JAN-DEC	8706	35 03/12:19	27 03/13:17	2.4	92.3
Lostwood NWR	2004	JAN-DEC	8655	16 12/07:09	15 02/03:18	1.9	94.6
TRNP - NU	2004	JAN-DEC	8707	14 12/29:20	13 12/29:21	1.5	98.2

The maximum 1-hour concentration is 50 ppb at Fargo NW on 02/18:09
The maximum annual average concentration is 6.1 ppb at Fargo NW

* 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 that are pressure and temperature sensitive.

Health Effects

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

Standards Comparison

There is no ambient air quality standard for ammonia. Because ammonia is important to the newer air quality dispersion models, the ammonia analyzer is maintained at the Beulah - North site. Long-term average ambient ammonia concentration is a required input to the Calpuff modeling system. Chemistry governing the conversion of sulfur oxides to sulfate and the conversion of nitrogen oxides to nitrate in Calpuff is constrained by the availability of ambient ammonia. Therefore, the ambient level of ammonia affects Calpuff PSD Class I predictions for SO2/NO2 concentrations, general haze visibility and particulate deposition.

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	2004	JAN-DEC	8615	135.9 03/13:19	117.7 03/27:18	115.5 09/26:10	94.0 11/03:17	93.6 04/05:07	92.3 06/01:01

<u>Ozone</u>

Physical Characteristics and Sources

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

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

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

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

Health Effects

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

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

Standards Comparison

Ozone was monitored at seven state-run sites. These data are used in computer dispersion models as part of both the primary and secondary chemical transformation equations.

The 1-hour state standard (120 ppb) was not exceeded during the year. The maximum 1-hour concentration was 71 ppb at Fargo NW.

The 8-hour standard uses the fourth-highest daily maximum for comparison to the standard. The highest fourth-highest 8-hour concentration was 61ppb 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)

				MAXIMA							
				1 - HOUR		8 - HOUR					
LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	1ST MM/DD	2ND MM/DD	1ST MM/DD	2ND MM/DD	3RD MM/DD	4TH MM/DD	1HR #>120	8HR #>80
Beulah - North	2004	JAN-DEC	8722	60 06/05	59 05/17	57 06/05	54 06/06	54 07/26	53 05/17		
Dunn Center	2004	JAN-DEC	8717	57 08/01	56 08/06	55 06/05	51 05/17	51 04/05	49 04/06		
Fargo NW	2004	JAN-DEC	8729	71 09/12	68 05/18	66 09/12	64 05/18	62 09/13	61 09/20		
Hannover	2004	JAN-DEC	8686	58 06/05	54 04/05	55 06/05	51 06/06	50 04/05	49 04/03		
Lostwood NWR	2004	JAN-DEC	8685	62 06/22	62 06/05	60 06/05	59 05/18	58 05/17	58 03/08		
TRNP - NU	2004	JAN-DEC	8735	70 08/01	67 06/05	65 06/05	61 08/06	57 05/17	56 04/05		
TRNP - SU (Painted Canyon)	2004	JAN-DEC	5066 ***	63 06/30	62 06/05	62 06/05	57 06/30	56 07/26	55 06/06		

The maximum 1-hour concentration is 71 ppb at Fargo NW on 09/12
The 4th highest 8-hour concentration is 61 ppb at Fargo NW on 09/20

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

FEDERAL Standards -
1) 120 ppb maximum 1-hour concentration with no more than one expected exceedance per year.
2) 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}.

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" (windblown sand and dirt from roadways, fields and construction sites) and contain large amounts of silica (sand-like) materials. PM_{10} particulate, on the other hand, generally is created during a burning process and includes fly ash (from power plants), carbon black (from automobiles and diesel engines) and soot (from fireplaces and wood-burning stoves). PM_{10} particulates from these sources contain a large percentage of elemental and organic carbon, which play a role in both visual haze and health issues.

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

Health Effects

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

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

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

Inhalable $PM_{2.5}$ Particulates

Inhalable $PM_{2.5}$ particulates were monitored at five sites using manual samplers. The sites at Beulah, TRNP - NU and TRNP - SU collect a sample once every six days. Sites at Bismarck and Fargo collect a sample once every three days.

Standards Comparison

The 24-hour federal standard (65 µg/m^3) was not exceeded during the year. The maximum 24-hour average concentration was 28.1 µg/m^3 at Fargo NW.

The federal annual standard (15 µg/m^3) was not exceeded for the year. The maximum annual average was 7.5 µg/m^3 at Fargo NW.

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 $PM_{2.5}$ 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
Beulah - North	2004	JAN-DEC	61	1.8	13.7 02/03	10.8 10/30	10.0 01/16	5.6			98.4
Bismarck Residential	2004	JAN-DEC	120	1.3	20.5 02/03	18.1 12/26	17.9 10/27	6.2			99.2
Fargo NW	2004	JAN-DEC	118	1.5	28.1 11/17	26.5 03/25	26.0 02/27	7.5			99.2
TRNP - NU	2004	JAN-DEC	54	1.9	11.2 12/05	8.8 10/18	8.3 01/16	4.9			98.1
TRNP - SU (Painted Canyon)	2004	JAN-DEC	59	1.3	9.0 12/05	8.9 08/19	8.4 03/04	4.4			94.9

The maximum 24-hour concentration is 28.1 µg/m^3 at Fargo NW on 11/17
The maximum annual average concentration is 7.5 µg/m^3 at Fargo NW

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

Inhalable Continuous $PM_{2.5}$ Particulates

Inhalable particulates are monitored continuously at six sites. Since these data are not collected by an EPA reference or equivalent method, the data can be used for regulatory purposes.

The maximum 1-hour average concentration was 68.3 μg/m^3 at Beulah - North. The maximum 24-hour average concentration was 23.5 μg/m^3 at Hannover. The maximum annual average for the year was 5.9 μg/m^3 at Beulah - North and Hannover

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/m^3)

				MAXIMA								
				1 - HOUR		24 - HOUR						
LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	1ST MM/DD:HH	2ND MM/DD:HH	1ST MM/DD	2ND MM/DD	3RD MM/DD	4TH MM/DD	MEAN	1HR #>150	24HR #>65
Beulah - North	2004	JAN-DEC	8737	68.3 10/20:03	68.1 04/30:16	18.8 08/17	18.1 08/16	13.7 07/24	13.1 10/20	5.9		
Dunn Center	2004	SEP-DEC	2714 ***	31.2 09/20:06	30.0 10/20:08	7.7 12/30	7.5 12/27	7.3 12/26	7.1 09/18	2.2		
Fargo NW	2004	JAN-DEC	8655	67.9 05/05:07	66.6 07/04:21	15.6 08/17	14.9 11/17	14.3 05/05	12.8 09/03	3.8		
Hannover	2004	JAN-DEC	8568	56.4 12/10:09	47.5 02/03:02	17.7 08/17	15.7 08/16	13.8 07/24	13.6 12/10	5.9		
Lostwood NWR	2004	JAN-DEC	8431	39.8 02/23:22	28.8 04/28:07	18.4 08/16	15.7 08/17	10.9 02/24	10.8 07/17	2.7		
TRNP - NU	2004	JAN-DEC	8599	45.9 04/28:07	41.2 09/02:05	19.8 08/16	14.0 08/17	10.8 04/28	10.3 08/15	3.9		
TRNP - SU (Painted Canyon)	2004	JAN-DEC	4944 ***	36.2 08/16:03	32.0 07/17:20	23.5 08/16	18.9 08/17	13.3 07/23	11.8 08/15	5.7		

The highest 24-hour concentration is 23.5 μg/m3 at TRNP - SU (Painted Canyon) on 08/16
The highest Annual Mean concentration is 5.9 μg/m3 at Beulah - North and Hannover

* 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.

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

Inhalable PM_{10} Particulates

Inhalable PM_{10} particulate concentrations were monitored at three sites. Bismarck Residential and TRNP - NU collect samples once every six days, and Fargo NW collects samples once every third day.

Standards Comparison

The 24-hour state standard (150 µg/m^3) was not exceeded during the year. The maximum 24-hour concentration was 43 µg/m^3 at Bismarck Residential.

The annual state standard (50 µg/m^3) was not exceeded. The maximum annual mean for the year was 14.9 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
Bismarck Residential	2004	JAN-DEC	61	0.0	43.0 07/26	33.0 10/12	30.0 07/20	14.5			96.7
Fargo NW	2004	JAN-JUN	60	3.0	39.0 05/03	36.0 03/25	31.0 01/16	14.9			98.3
TRNP - NU	2004	JAN-JUN	29 ***	1.0	30.0 05/03	15.0 04/15	12.0 03/10	8.3			96.6

The maximum 24-hour concentration is 43 µg/m^3 at Bismarck Residential on 07/26
The maximum annula average concentration is 14.9 µg/m^3 at Fargo NW

* The STATE and FEDERAL 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.

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

Inhalable Continuous PM_{10} Particulates

Inhalable continuous PM_{10} particulate concentrations were monitored at four sites: Dunn Center, Fargo NW, Lostwood NWR, and TRNP - NU.

Standards Comparison

The 24-hour state standard (150 µg/m^3) was not exceeded during the year. The maximum 24-hour concentration was 73 µg/m^3 at Lostwood.

The annual state standard (50 µg/m^3) was not exceeded. The maximum annual mean for the year was 19.8 µg/m^3 at Fargo NW.

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

TABLE 10

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

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

				M A X I M A								
				1 - HOUR		24 - HOUR						
LOCATION	YEAR	SAMPLING PERIOD	NUM OBS	1ST MM/DD:HH	2ND MM/DD:HH	1ST MM/DD	2ND MM/DD	3RD MM/DD	4TH MM/DD	MEAN	24HR #>150	AM>50
Dunn Center	2004	SEP-DEC	2714 ***	235.0 12/11:17	174.0 12/17:11	42.9 12/11	42.3 10/14	33.1 12/21	29.0 10/10	12.7		
Fargo NW	2004	JUN-DEC	4308 ***	249.0 11/11:17	191.0 11/23:07	61.6 10/12	54.0 10/11	50.4 11/11	49.8 08/17	19.8		
Lostwood NWR	2004	JAN-DEC	8611	310.4 04/28:07	275.4 04/24:23	73.0 04/24	59.7 04/25	51.8 12/20	42.3 04/28	11.1		
TRNP - NU	2004	JUN-DEC	4747 ***	98.0 09/02:05	86.0 12/20:19	32.2 12/20	28.6 08/16	24.2 08/17	22.7 09/19	10.2		

The highest 24-hour concentration is 73.0 µg/m3 at Lostwood NWR on 04/24
The highest Annual Mean concentration is 10.2 µg/m3 at TRNP - NU

* The STATE and FEDERAL 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.

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

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 percent data recovery for the full year are reported as a partial year. A summary for each pollutant is provided below.

Sulfur Dioxide

Neither the state nor federal standards were exceeded at any monitoring site. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standard were as follows: 1-hour – 322 ppb (117.9%); 3-hour – 134 ppb (26.8%); 24-hour – 46 ppb (46.5%); annual – 6.0 ppb (26.1%).

Sulfur Dioxide 5-Minute Averages

There is no SO_2 5-minute standard currently in effect. The maximum 5-minute average was 485 ppb.

Nitrogen Dioxide

Neither the state nor federal standards were exceeded at any of the monitoring sites. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable standard were as follows: annual – 6.1 ppb (11.5%).

Ammonia

No standard is currently in effect. The maximum 1-hour average was 135.9 ppb.

Ozone

Neither the state nor federal standard was exceeded during the year. The 1-hour maximum and highest fourth-highest 8-hour concentrations and the concentrations expressed as a percentage of the applicable standard are were follows: 1-hour – 71 ppb (59.2%); highest fourth-highest 8-hour – 61 ppb (76.3%).

Inhalable $PM_{2.5}$ Particulates

The federal $PM_{2.5}$ standards were not exceeded during the year. The maximum concentrations and maximum concentrations expressed as a percentage of the standard were as follows: 24-hour – 28.1 $\mu g/m^3$ (43.2%); annual – 7.5 $\mu g/m^3$ (50.0%).

Inhalable Continuous $PM_{2.5}$ Particulates

The federal standards were not applicable for this analytical method. The maximum concentrations were as follows: 1-hour – 68.3 $\mu g/m^3$ (N/A); 24-hour – 23.5 $\mu g/m^3$ (36.2%); annual – 5.9 $\mu g/m^3$ (39.3%).

Inhalable PM_{10} Particulates

Neither the state nor federal PM_{10} standards were exceeded during the year. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable PM_{10} standard were as follows: 24-hour – 43 $\mu g/m^3$ (28.7%); annual – 14.9 $\mu g/m^3$ (29.8%).

Inhalable Continuous PM_{10} Particulates

Neither the state nor federal PM_{10} standards were exceeded during the year. The maximum concentrations and the maximum concentrations expressed as a percentage of the applicable PM_{10} standard were as follows: 1-hour – 310 $\mu g/m^3$ (N/A); 24-hour – 71 $\mu g/m^3$ (48.7%); annual – 19.8 $\mu g/m^3$ (39.6%).

REFERENCES

REFERENCES

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2 Environmental Protection Agency, May 10, 1979. Title 40, Code of Federal Regulations, Part 58 (as amended), United States Government Printing Office, Superintendent of Documents, Washington, D.C.

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4 Environmental Protection Agency, National Air Quality and Emissions Trends Report, 1995, October 1996.

5 Environmental Protection Agency Strategies and Air Standards Division, Preliminary Assessment of Health and Welfare Effects Associated with Nitrogen Oxides for Standards-Setting Purposes, United States Government Printing Office, Washington D.C.; October 1981, pp i-iii.

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7 BOC Gases Material Safety Data Sheet, Ammonia (MSDS: G-11), June 1, 1999.

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9 Miller, R. and M. J. Utell, Elements of Meteorology, C. E. Merrill Co., Columbus, Ohio, 1975.

10 <u>The Perils of Particulates</u>. American Lung Association, New York, March 1994.

11 Sulfur Dioxide, Minimum Lethal Exposure & Maximum Tolerated Exposure, in TOMES Medical Management file [database online]. Colorado Department of Public Health and Environment, 1995 [cited September 12, 1995]. Available from Micromedex Inc. Englewood, Co.

APPENDICES

APPENDIX 1

North Dakota and Federal Ambient Air Quality Standards

STANDARDS

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

The North Dakota Ambient Air Quality Standards are established to protect public health and welfare. Effective Aug. 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 Aug. 1, 1997, coal conversion facilities and oil refineries are subject only to the federal SO_2 standards.

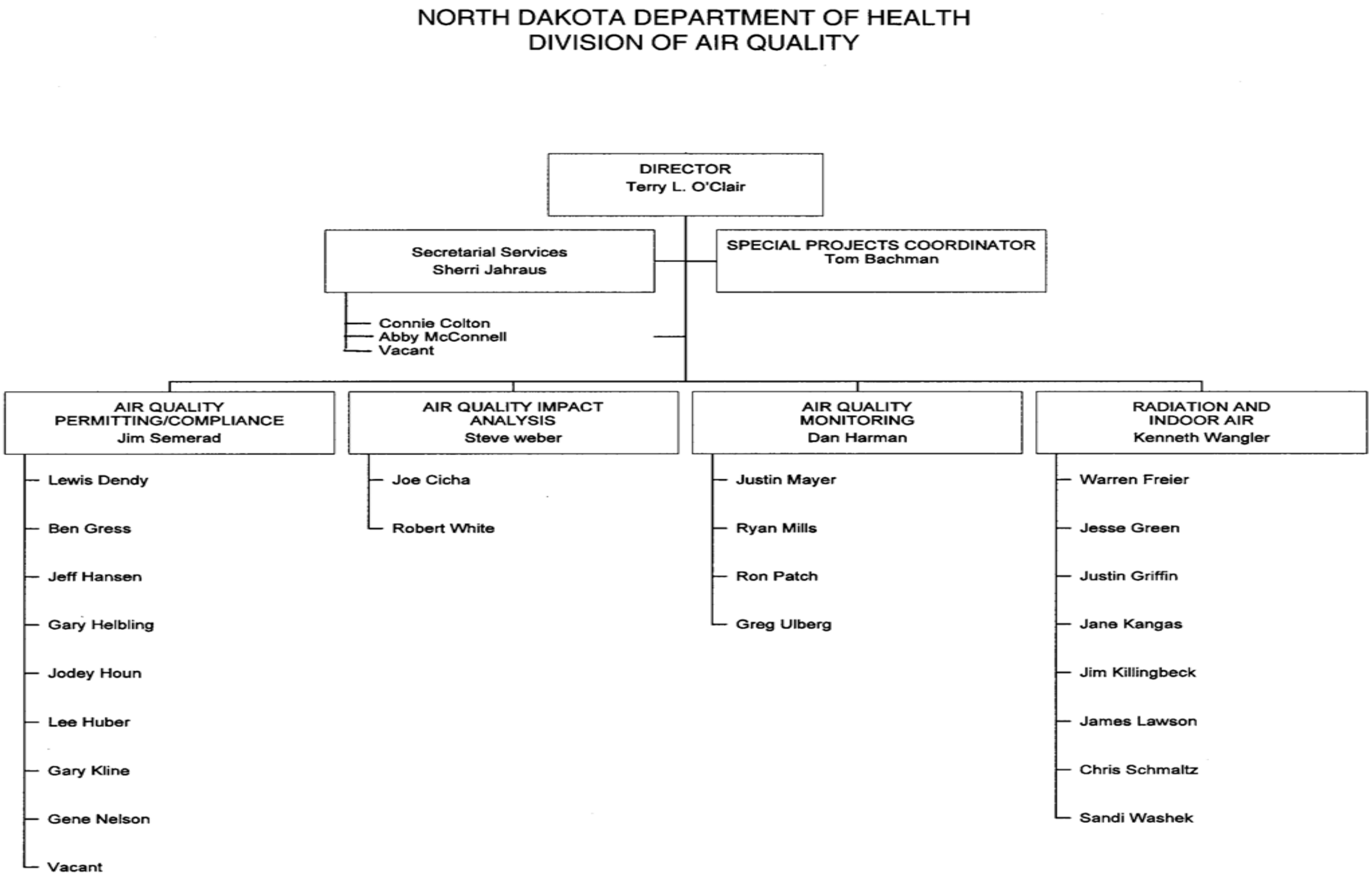
TABLE A1-2
Federal Ambient Air Quality Standards

Pollutant	Description	Primary	Secondary
Inhalable Particulate (<2.5 microns)	3-year average of annual arithmetic mean concentrations	15 $\mu g/m^3$	15 $\mu g/m^3$
	3-year average of the 98th percentile of the 24-hour concentrations	65 $\mu g/m^3$	65 $\mu g/m^3$
Inhalable Particulates (<10 microns)	Expected annual arithmetic mean	50 $\mu g/m^3$	50 $\mu g/m^3$
	99th percentile of the 24-hour concentrations averaged over 3 years	150 $\mu g/m^3$	150 $\mu g/m^3$
Sulfur Dioxide	Annual arithmetic mean	0.03 ppm (80 $\mu g/m^3$)	-
	Maximum 24-hour concentration not to be exceeded more than once per year	0.14 ppm (365 $\mu g/m^3$)	-
	Maximum 3-hour concentration not to be exceeded more than once per year	-	0.5 ppm (1300 $\mu g/m^3$)
Carbon Monoxide	8-hour concentration not to be exceeded more than once per year	9 ppm (10 $\mu g/m^3$)	-
	1-hour average concentration not to be exceeded more than once per year	35 ppm (40 $\mu g/m^3$)	-
Ozone	3-year average of the annual highest 4th highest daily maximum 8- hour concentrations, not to be exceeded	0.08 ppm	0.08 ppm
Nitrogen Dioxide	Annual arithmetic mean	0.053 ppm (100 $\mu g/m^3$)	0.053 ppm (100 $\mu g/m^3$)
Lead	Maximum arithmetic mean averaged over a calendar quarter	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$

APPENDIX 2

Air Quality Personnel
Organizational Chart

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



A2-1 Air Quality Organizational Chart

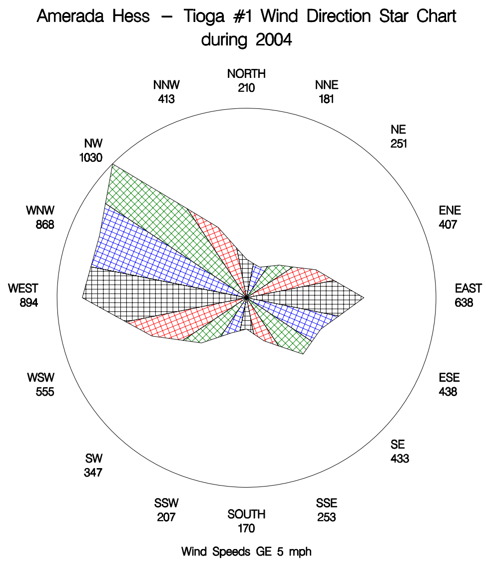
APPENDIX 3

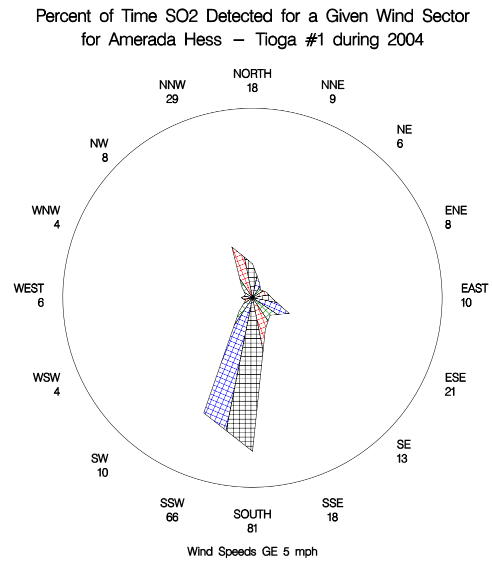
Wind and Pollution Star Charts

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

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

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





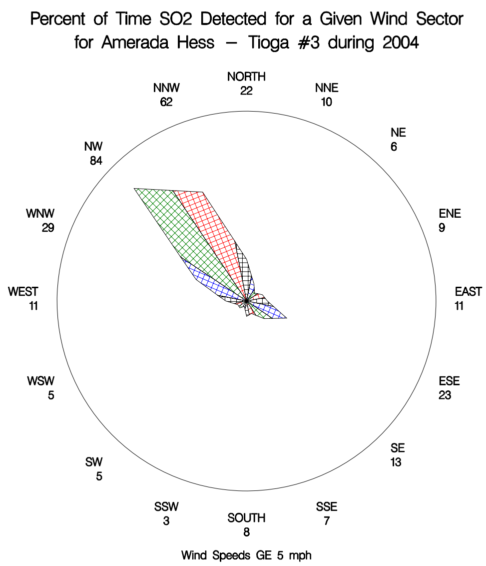


Figure A3-1 Amerada Hess Star Charts

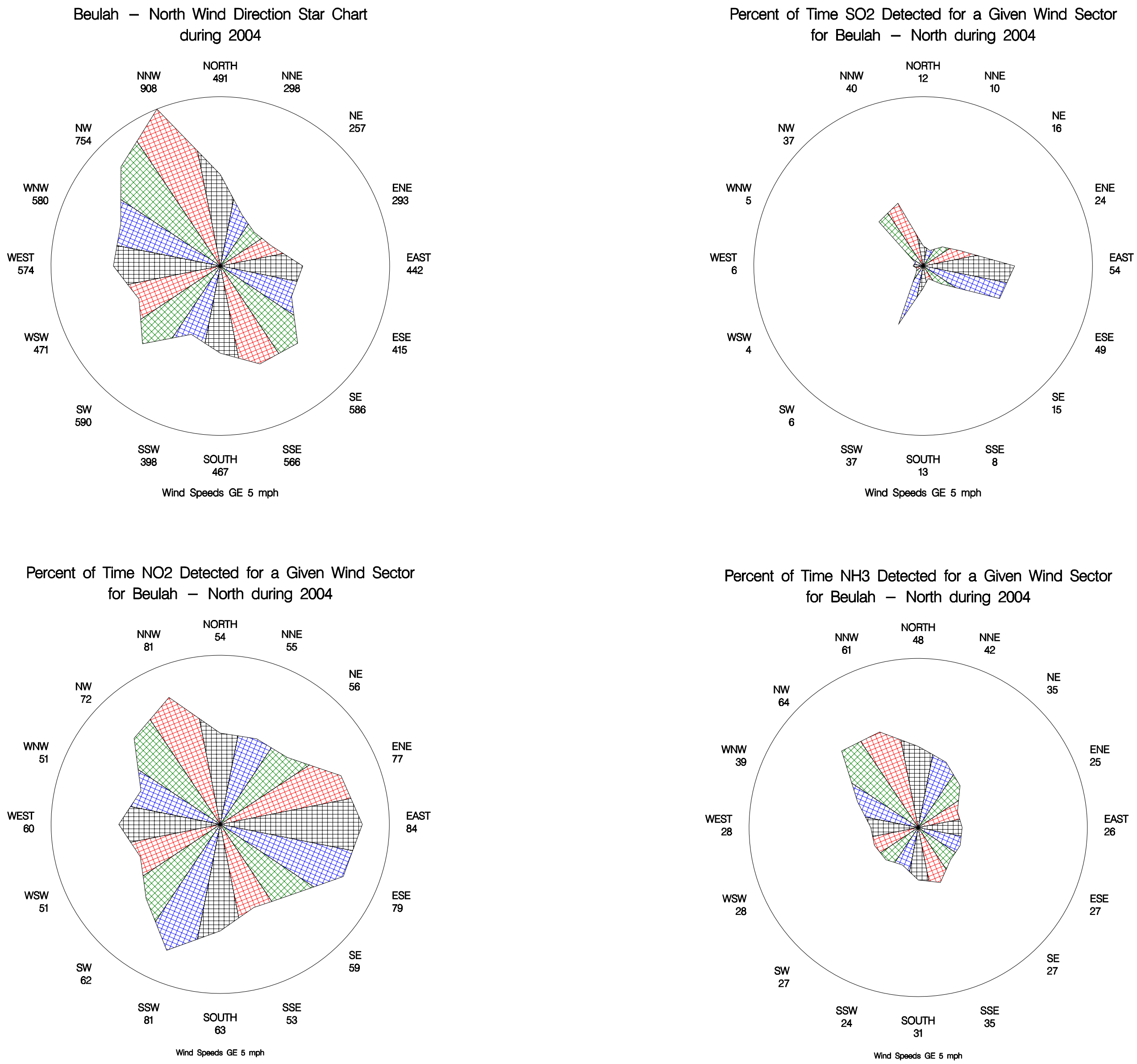
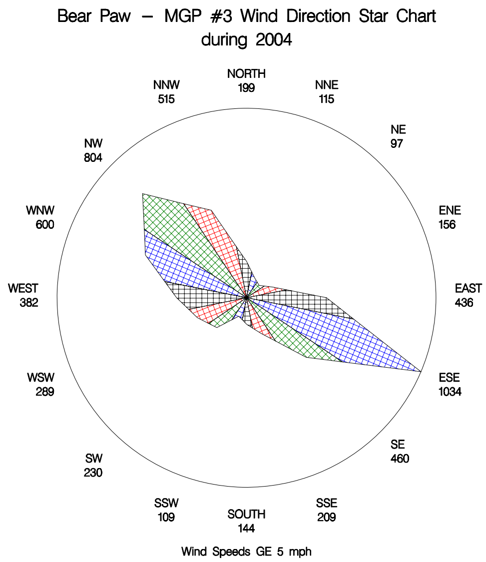
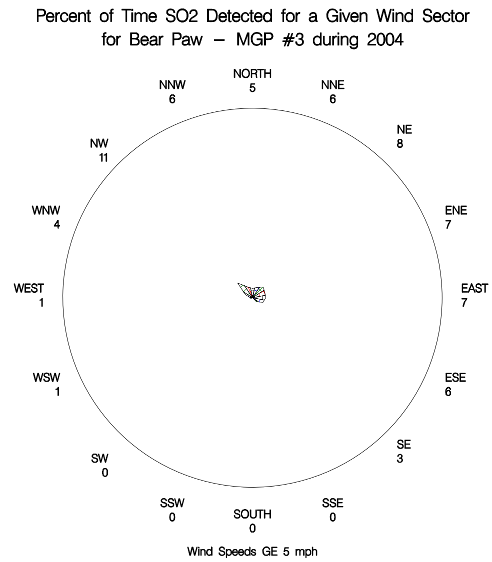
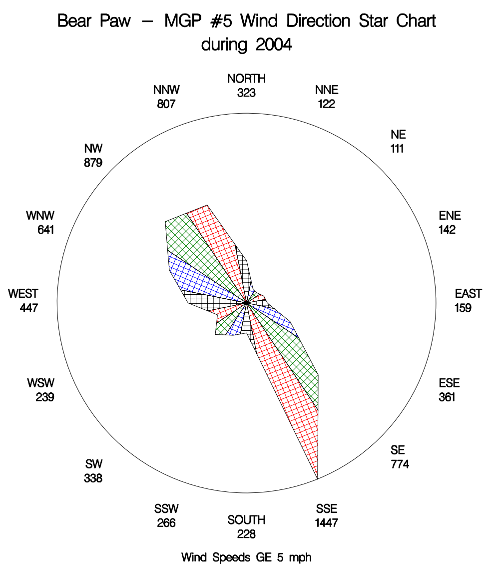


Figure A3-2 Beulah Star Charts







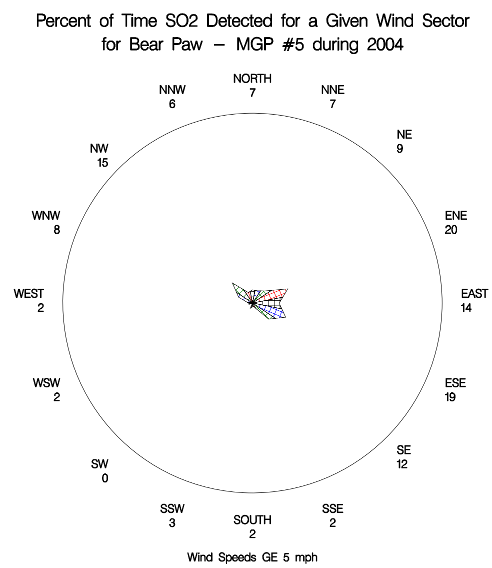
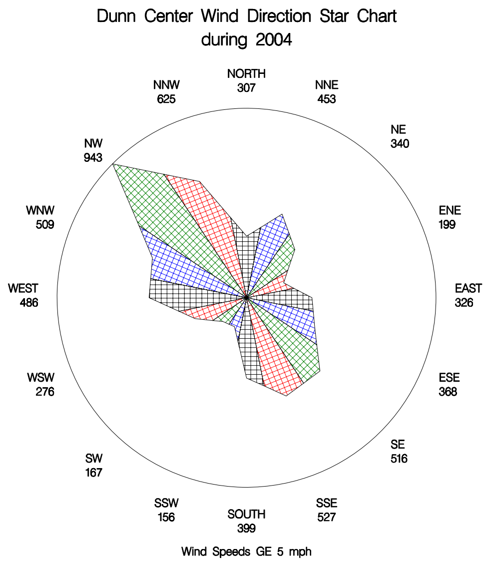
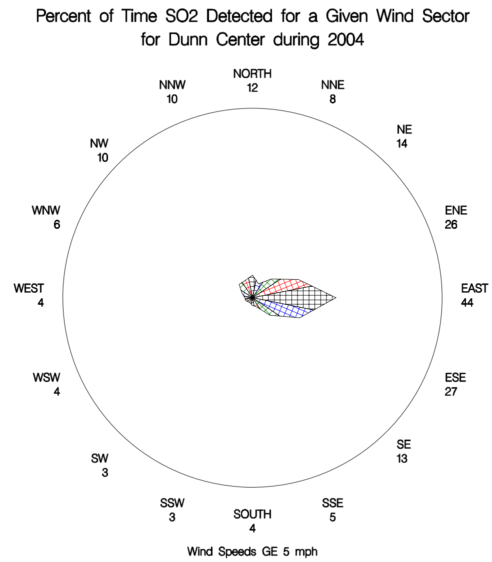


Figure A3-3 Bear Paw Star Charts





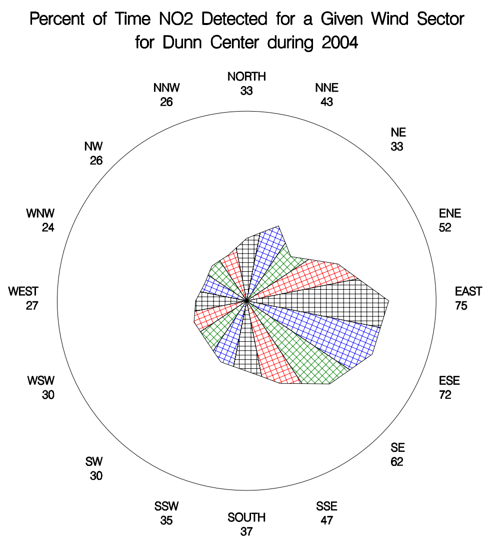
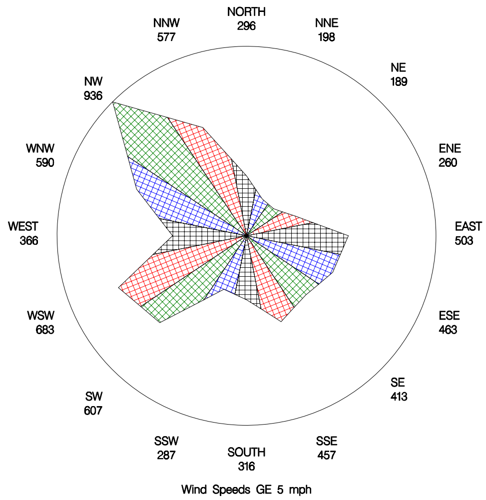
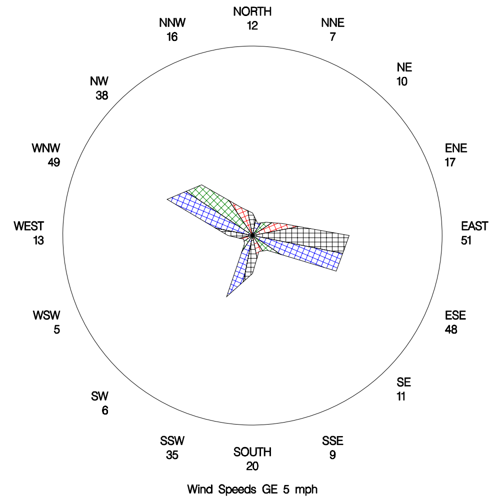


Figure A3-4 Dunn Center Star Charts

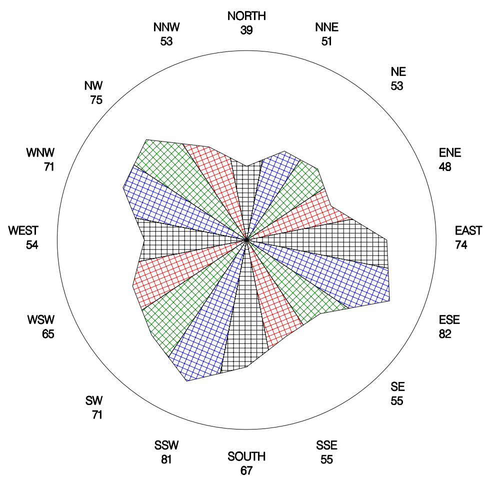
DGC #12 Wind Direction Star Chart
during 2004



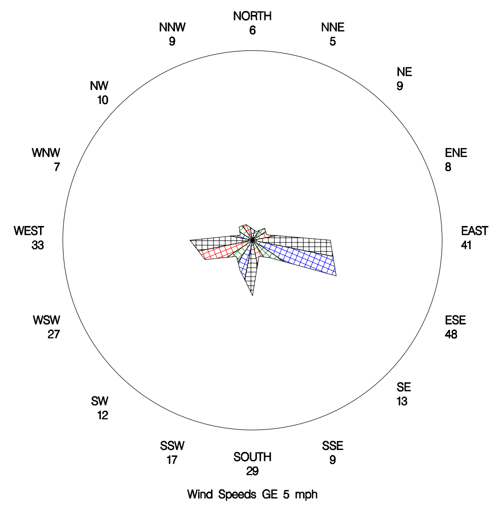
Percent of Time SO2 Detected for a Given Wind Sector
for DGC #12 during 2004



Percent of Time NO2 Detected for a Given Wind Sector
for DGC #12 during 2004



Percent of Time SO2 Detected for a Given Wind Sector
for DGC #14 during 2004



Percent of Time SO2 Detected for a Given Wind Sector
for DGC #16 during 2004

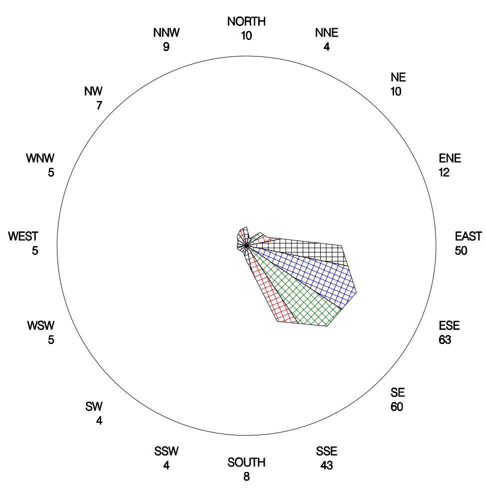
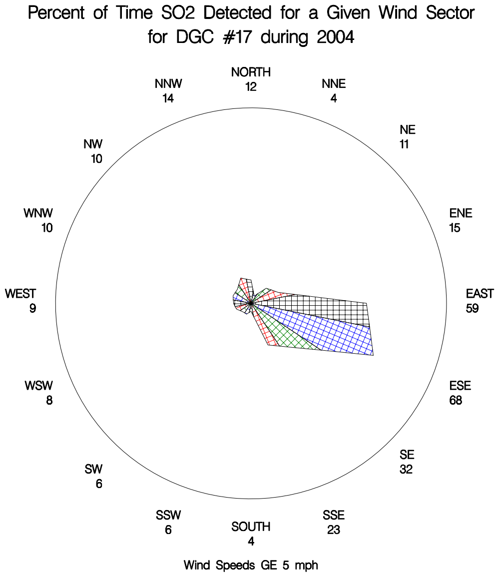


Figure A3-5 DGC Star Charts



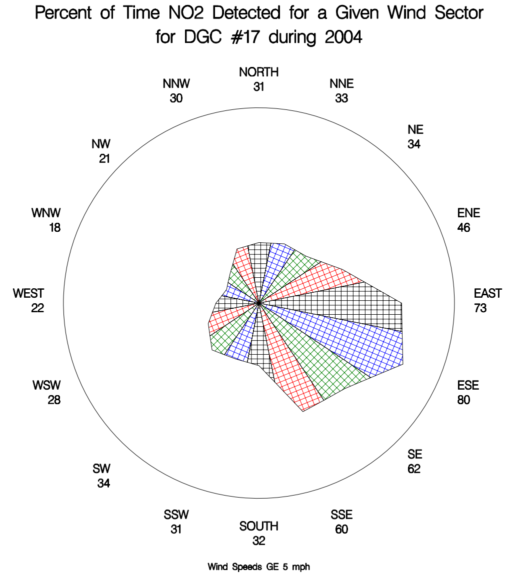
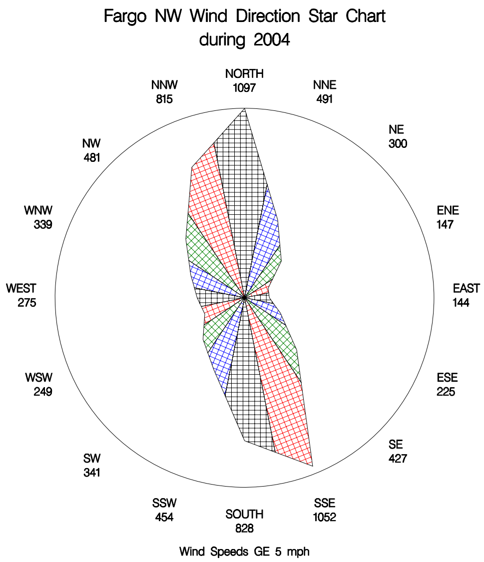
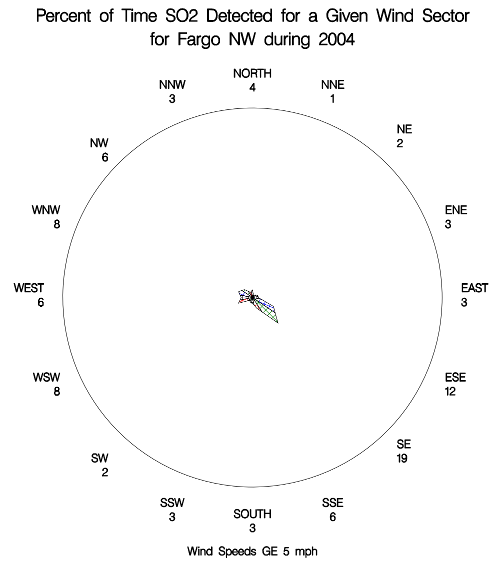


Figure A3-5 DGC Star Charts (cont.)





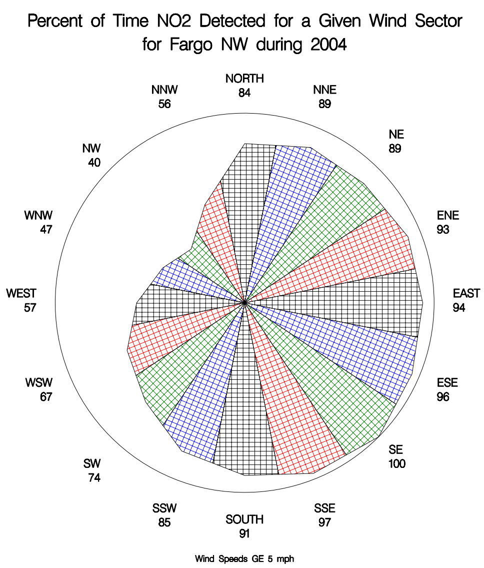
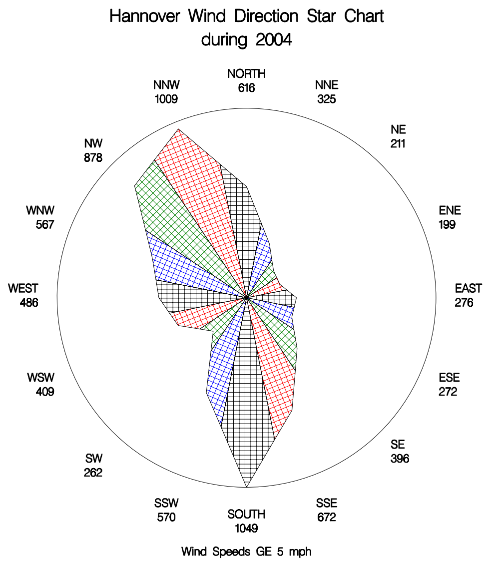
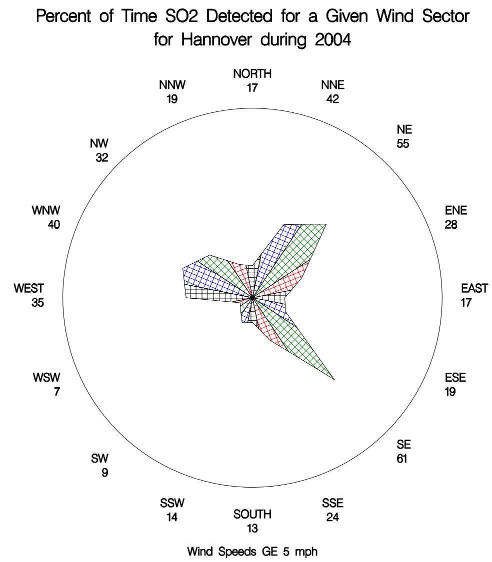


Figure A3-6 Fargo Star Charts





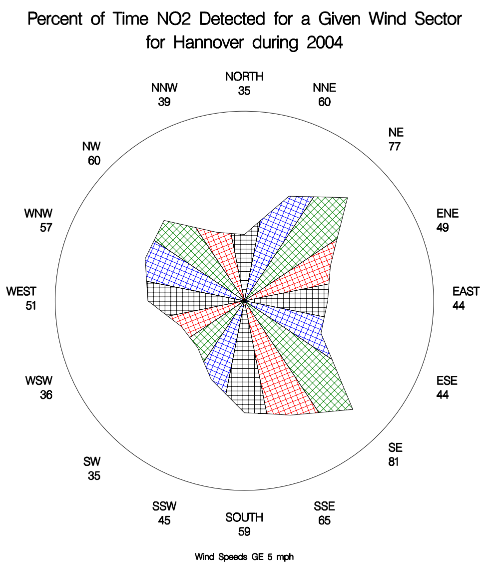
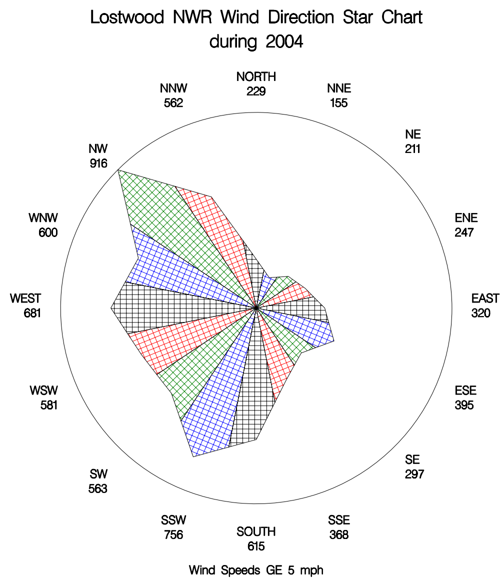
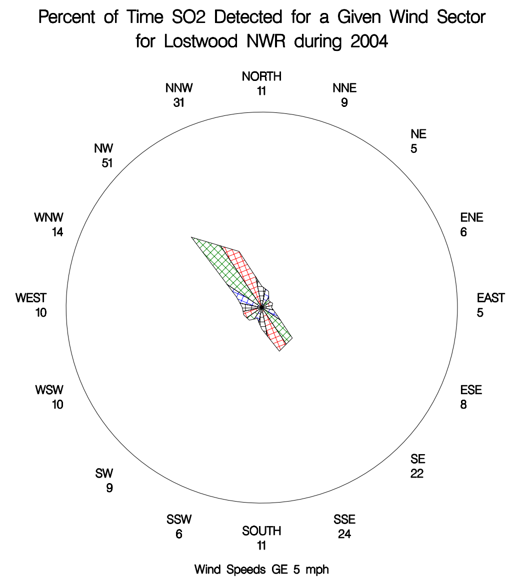


Figure A3-7 Hannover Star Charts





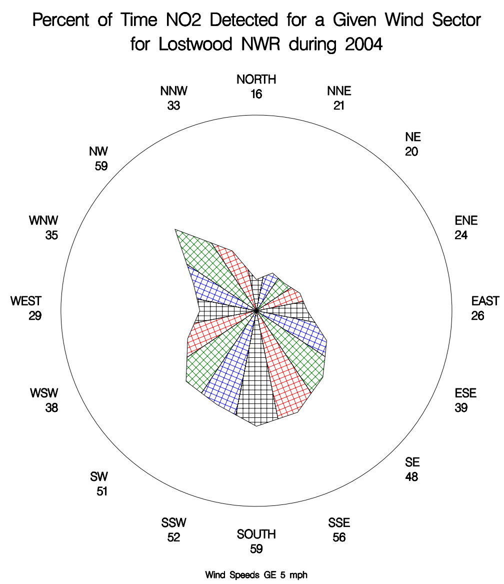
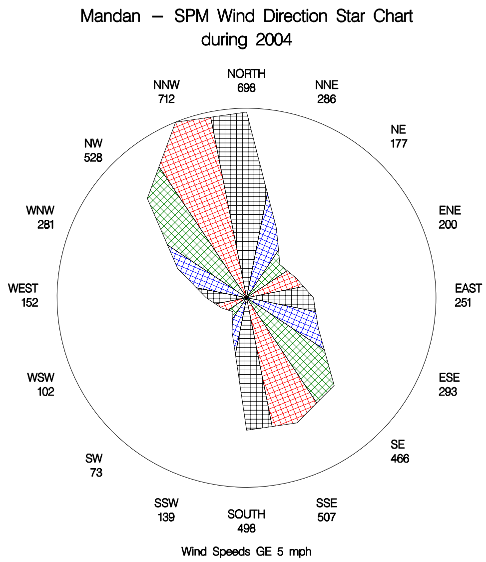
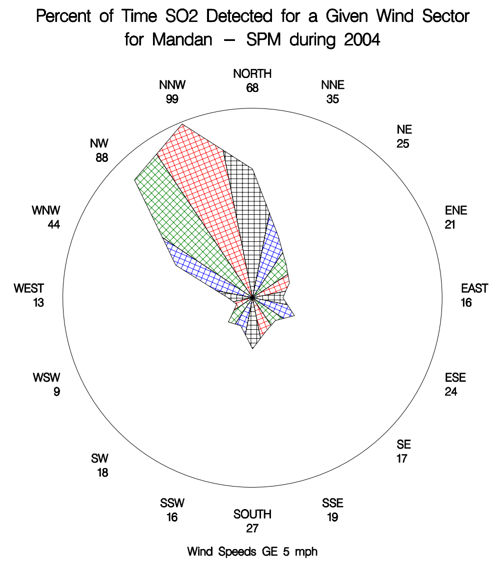
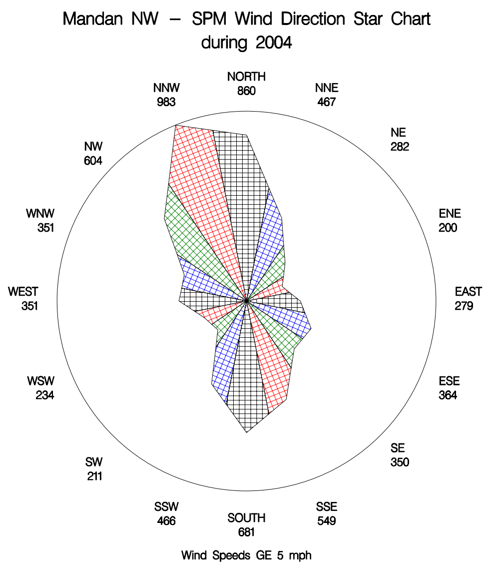


Figure A3-8 Lostwood NWR Star Charts







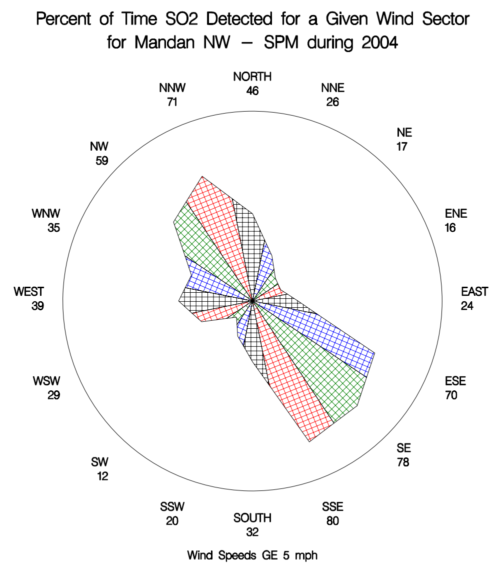
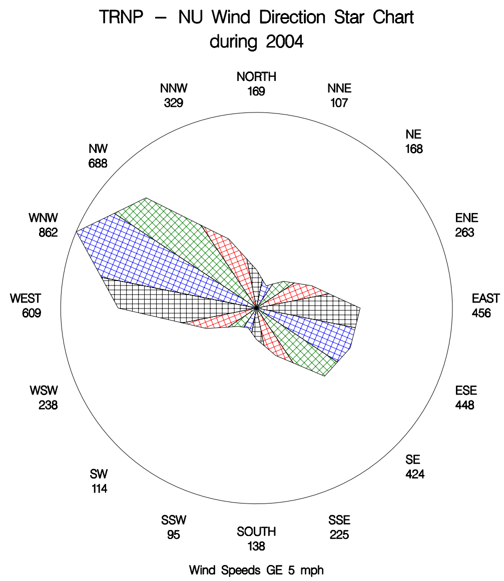
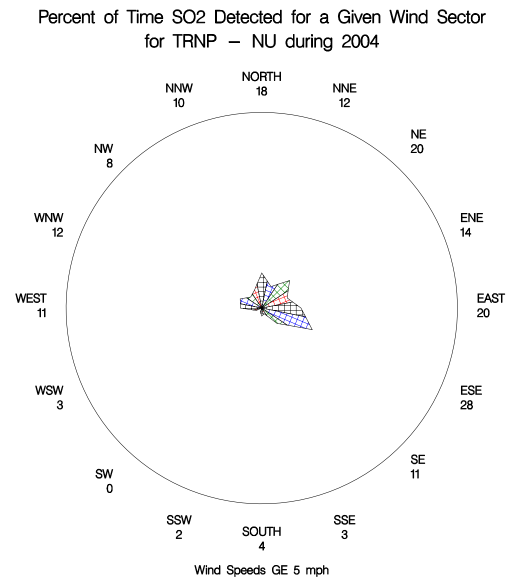


Figure A3-9 Mandan/Mandan NW Star Charts





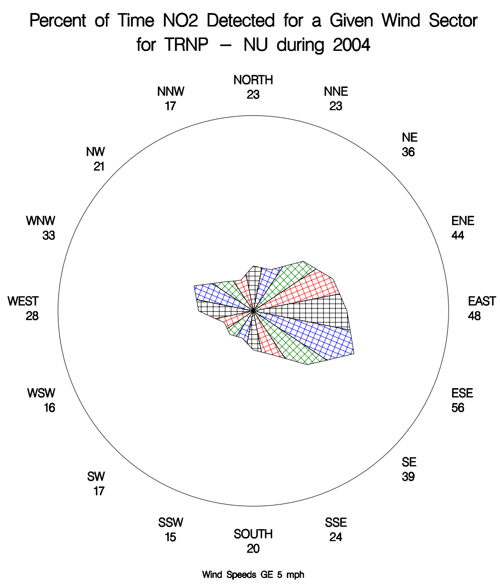
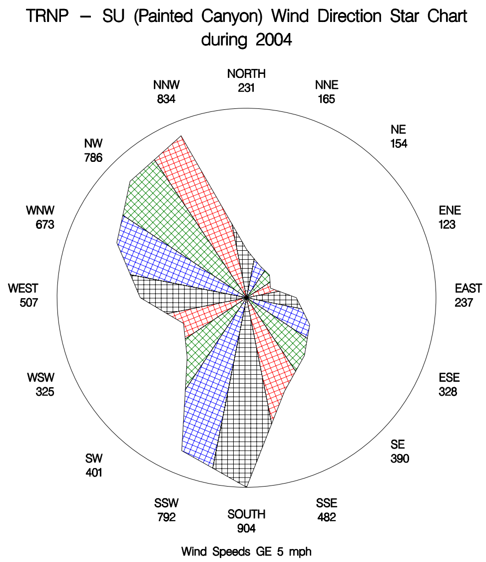


Figure A3-10 TRNP - NU Star Charts



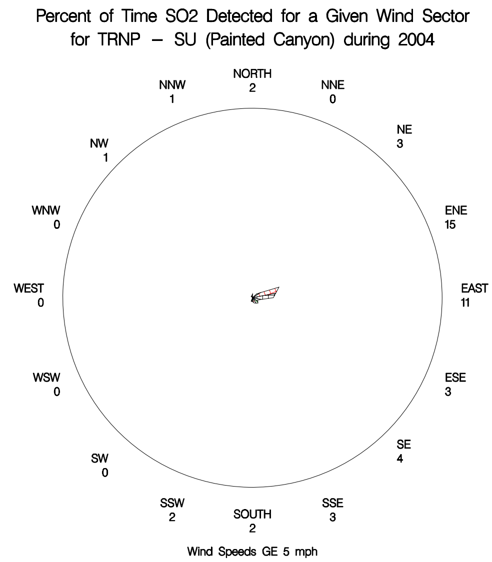
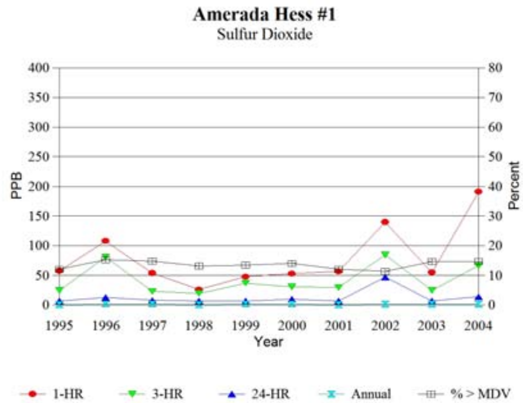


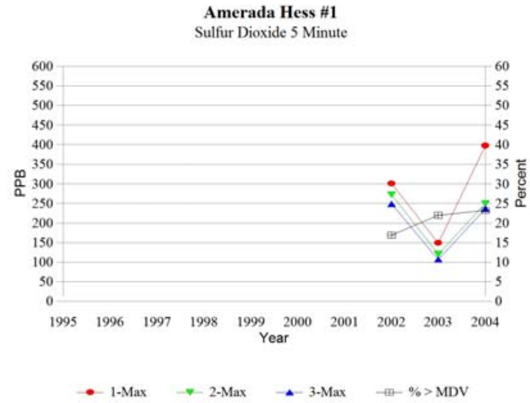
Figure A3-11 TRNP - SU Star Charts

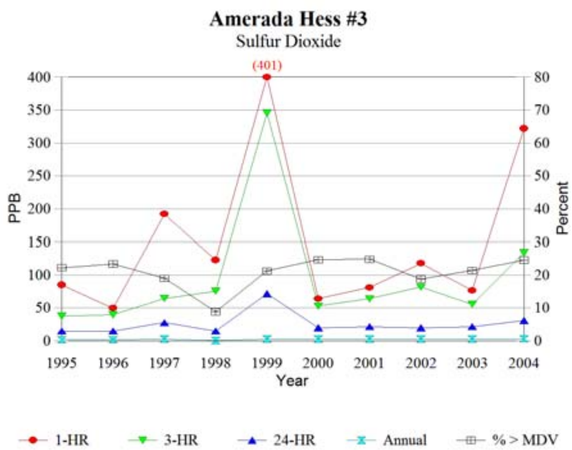
APPENDIX 4

1995-2004 Trends

The trend graphs for 1995 through 2004 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).







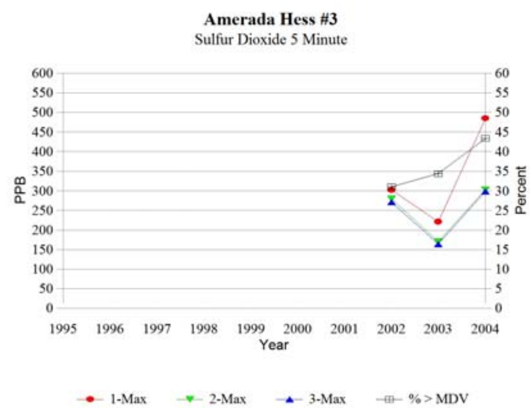
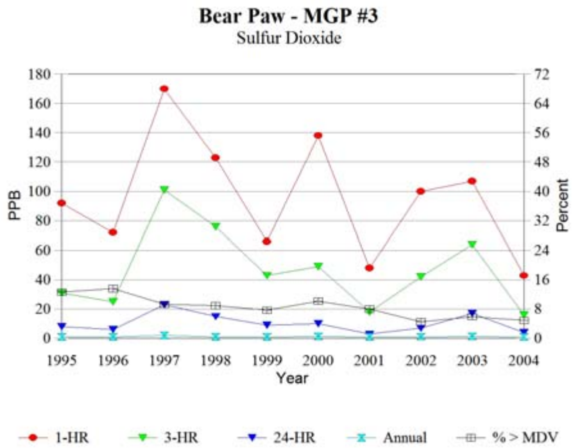
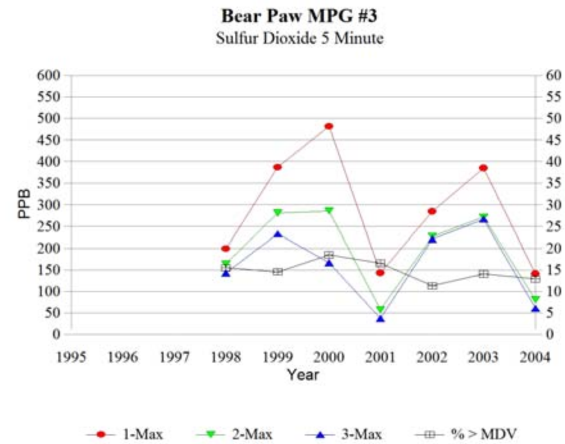
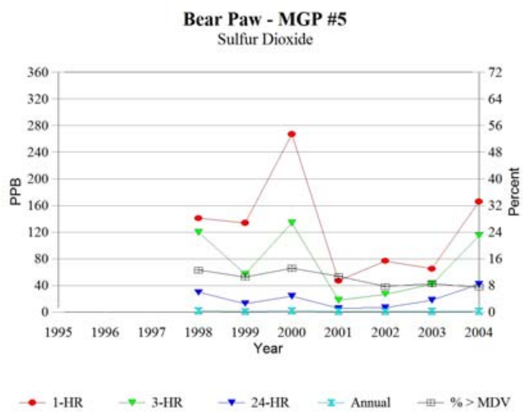


Figure A4-1 Amerada Hess Trends







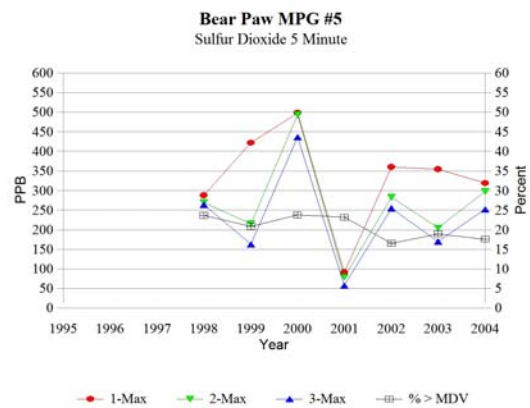
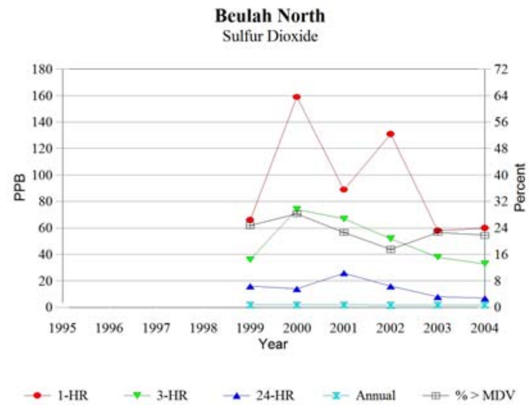
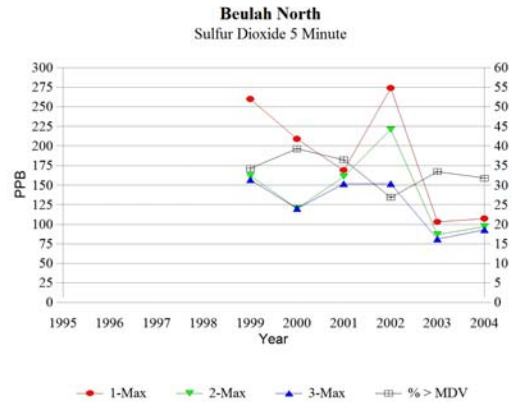
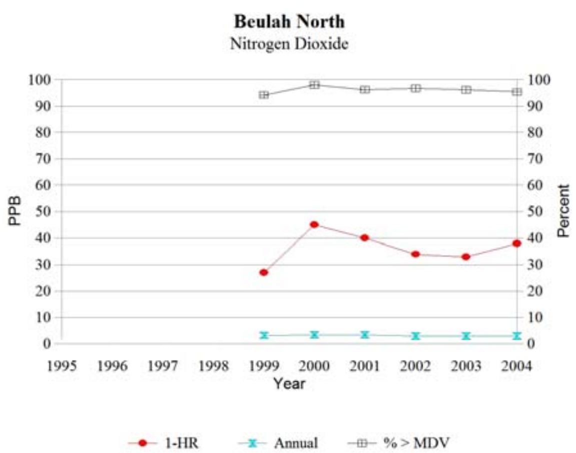
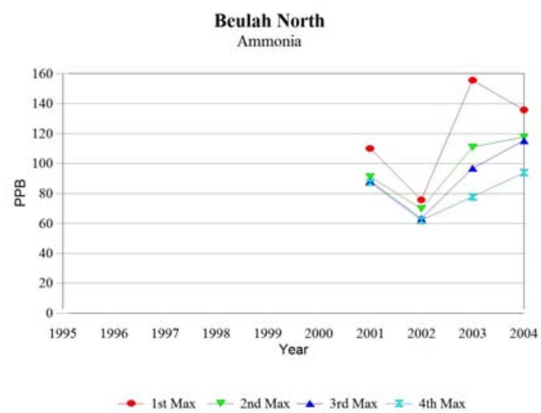


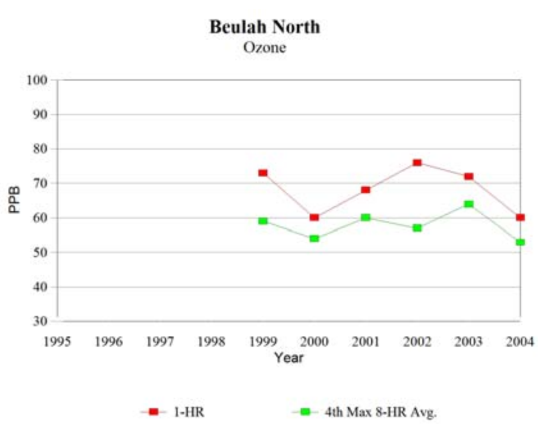
Figure A4-2 Bear Paw Trends











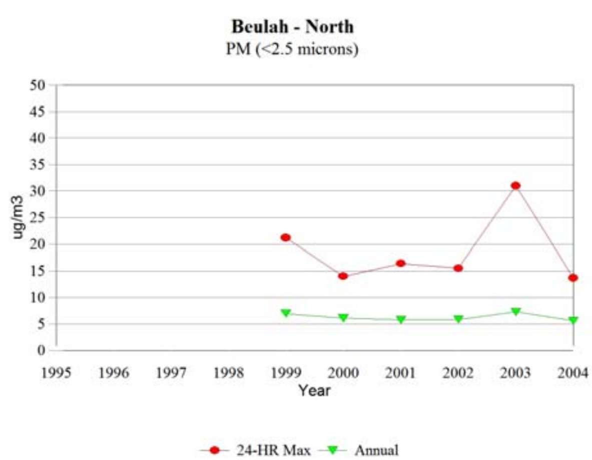
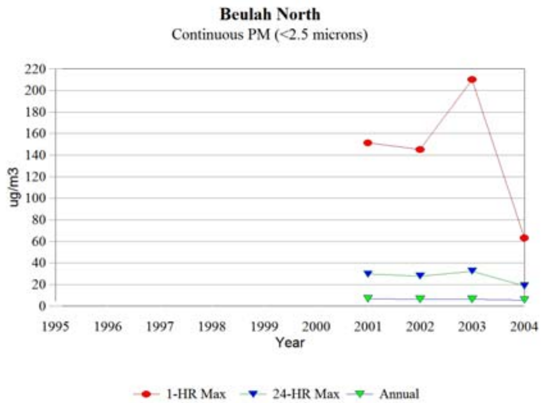
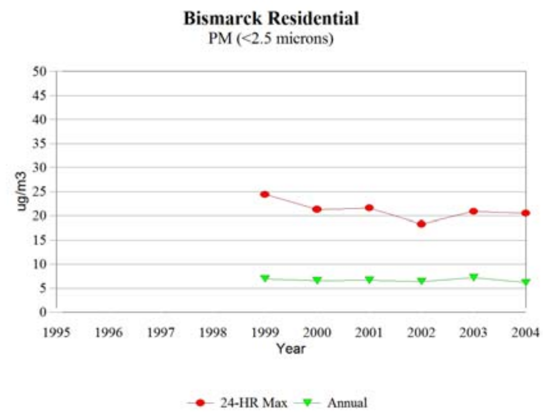


Figure A4-3 Beulah North Trends





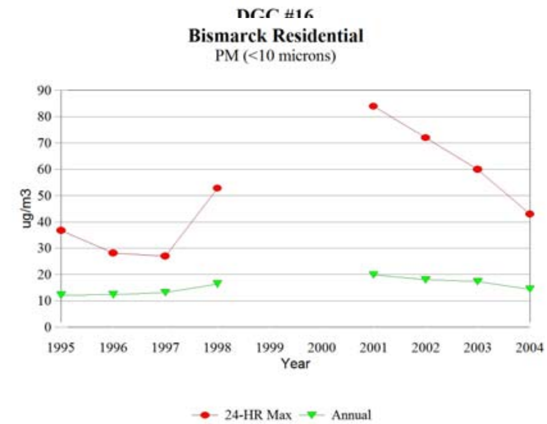
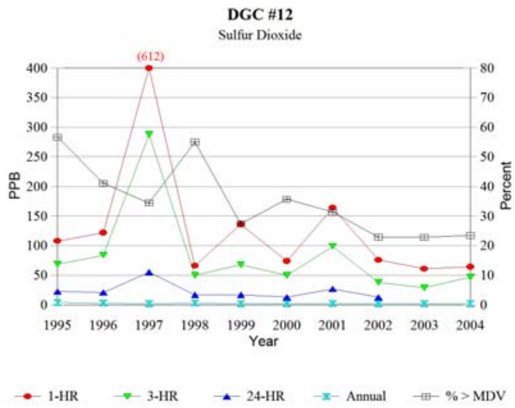
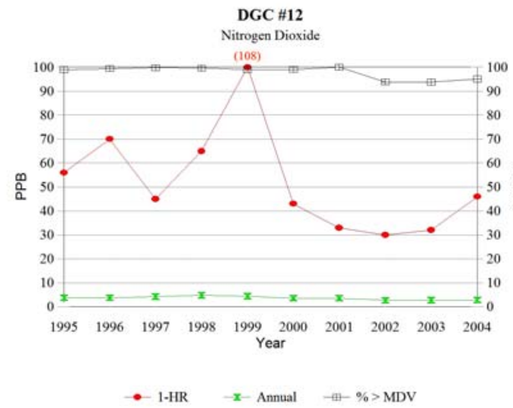
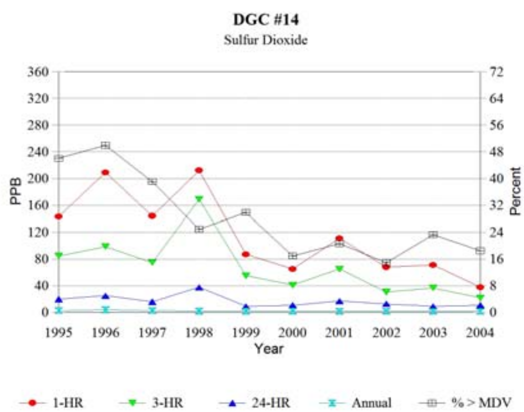
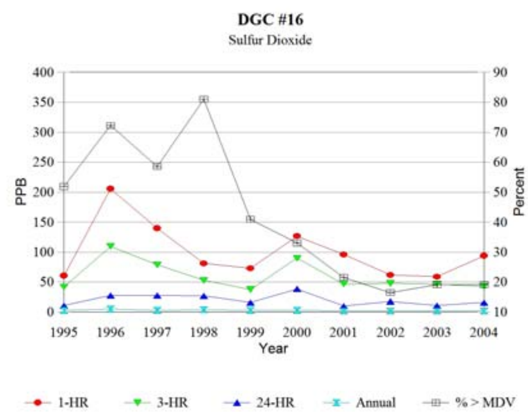


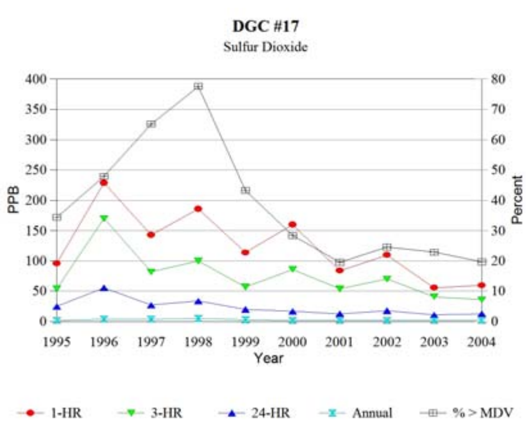
Figure A4-4 Beulah North(cont.)/Bismarck Residential Trends

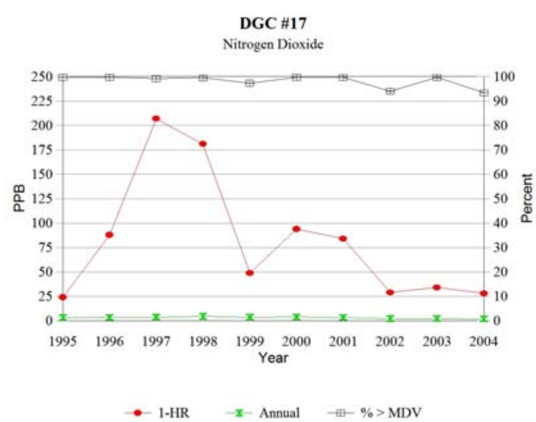












A4-5 DGC Trends

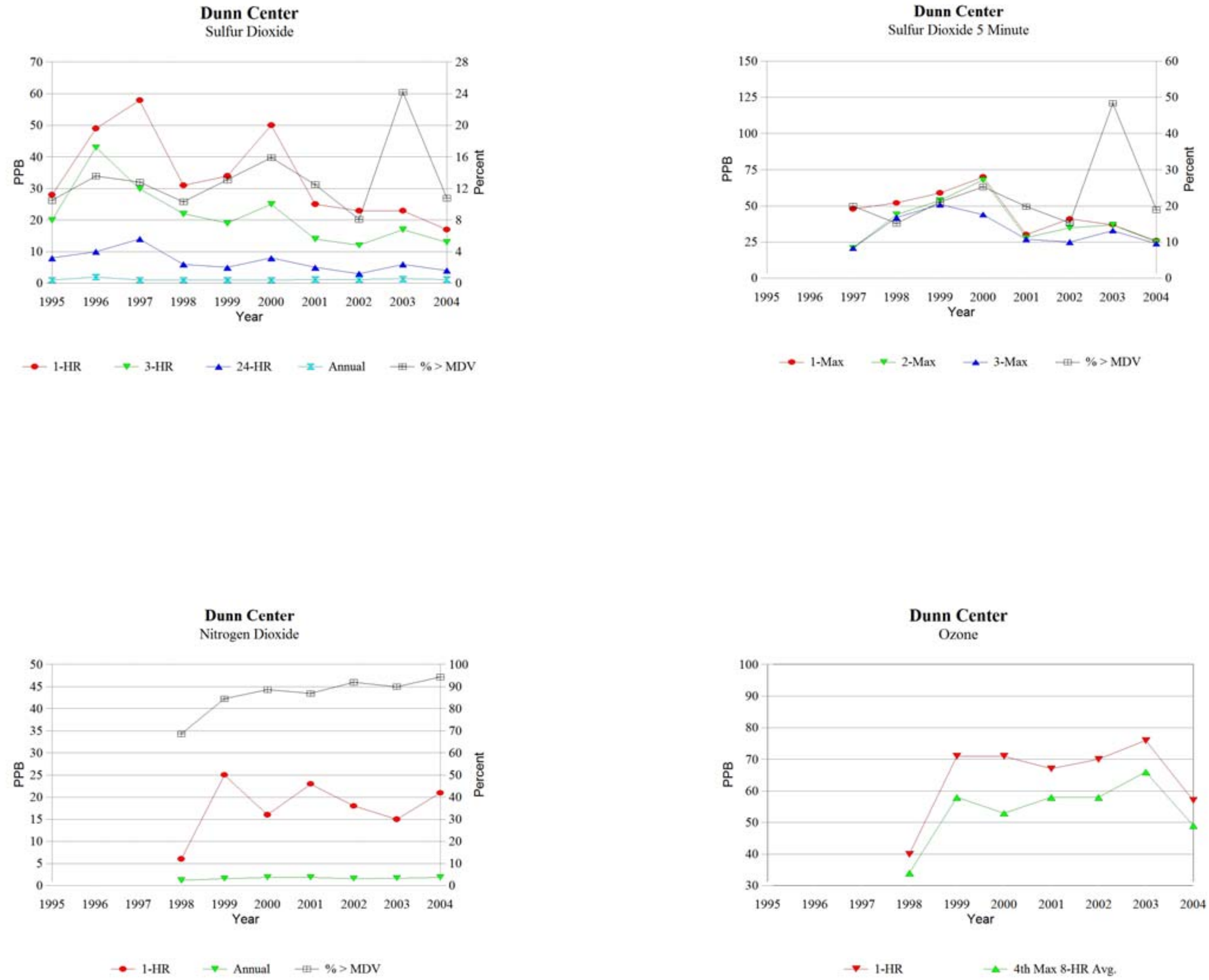
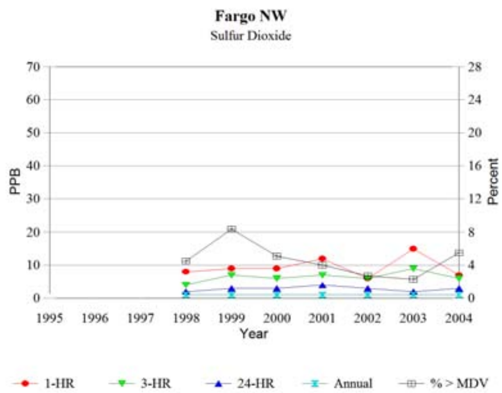
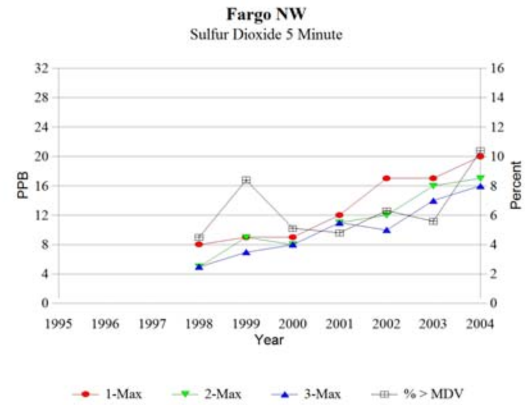
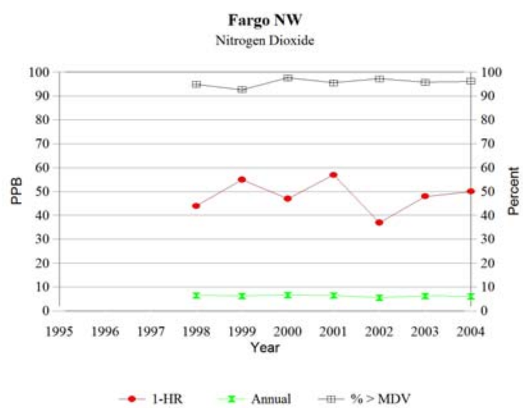
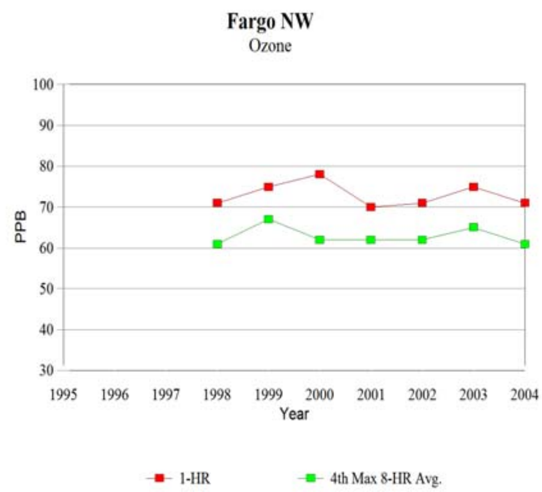


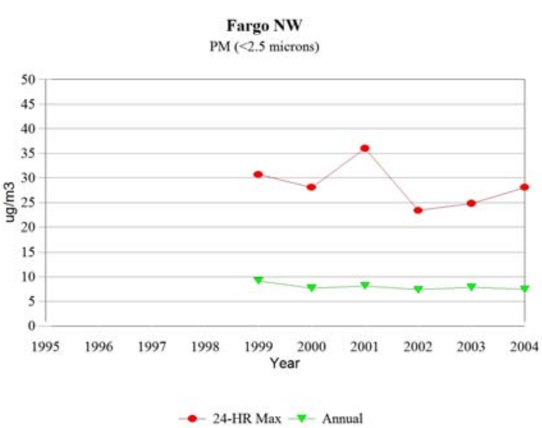
Figure A4-6 Dunn Center Trends











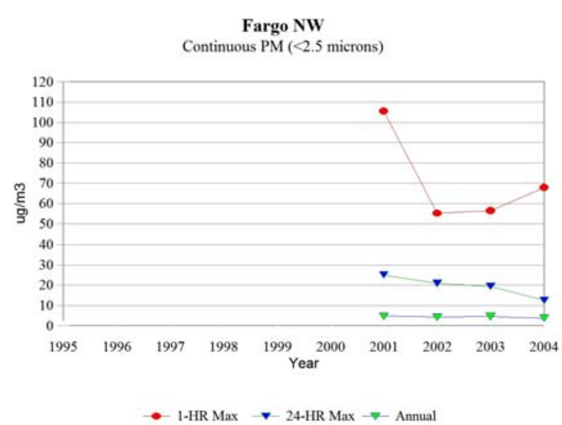
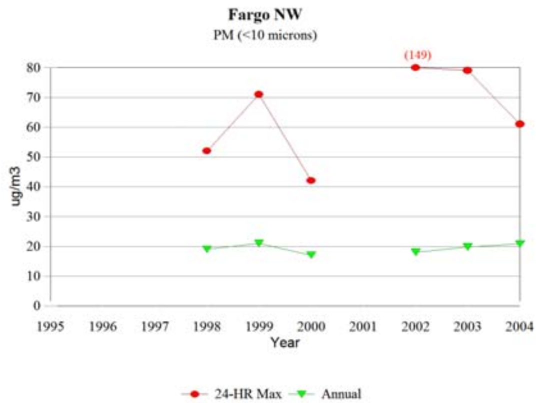
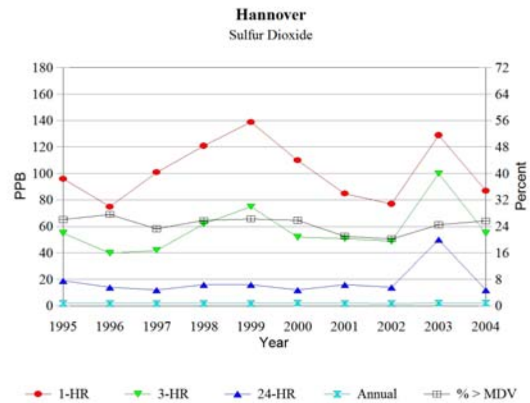
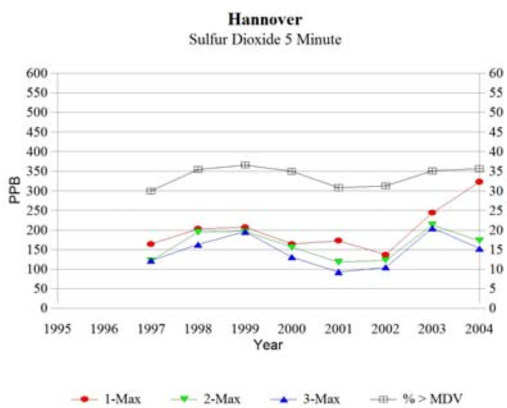
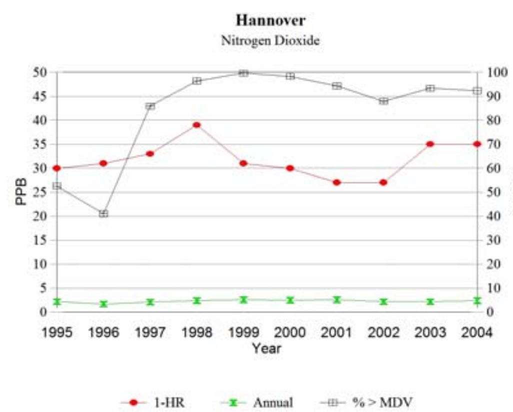


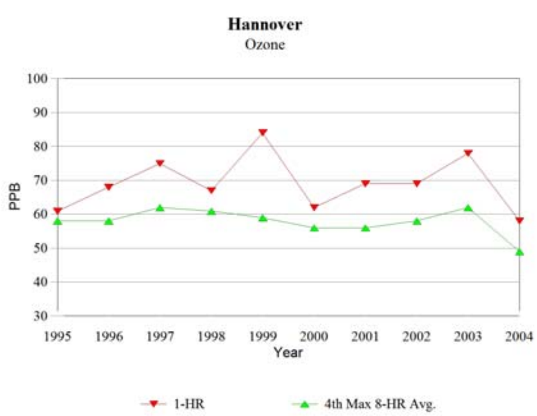
Figure A4-7 Fargo NW Trends











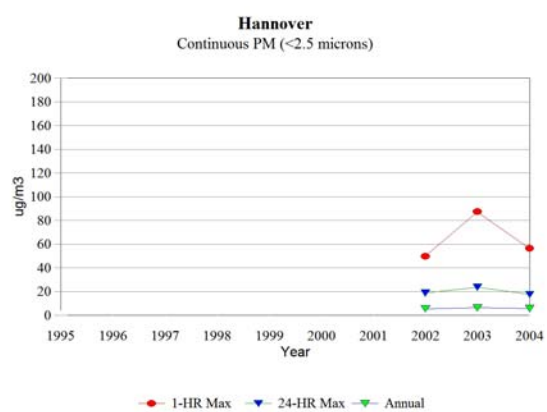
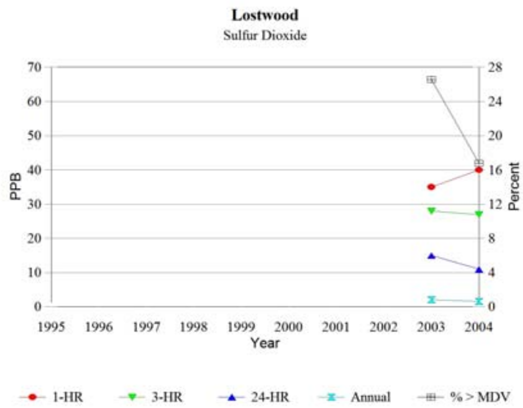
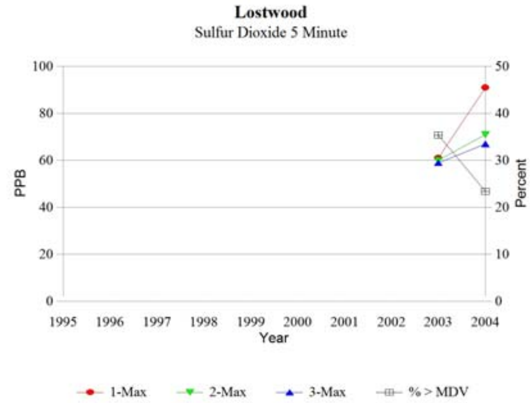
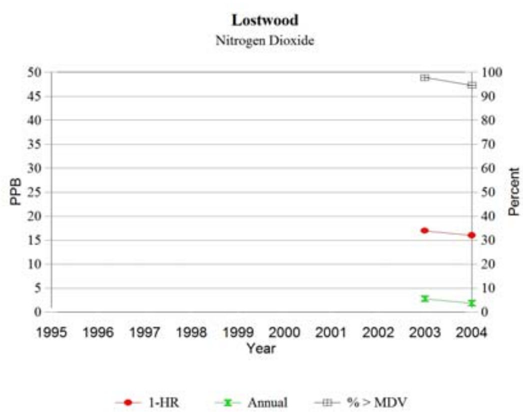
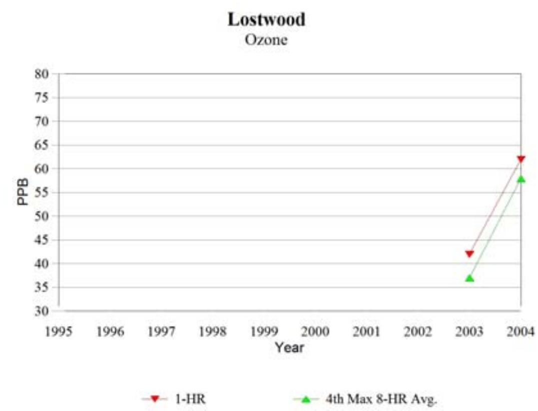


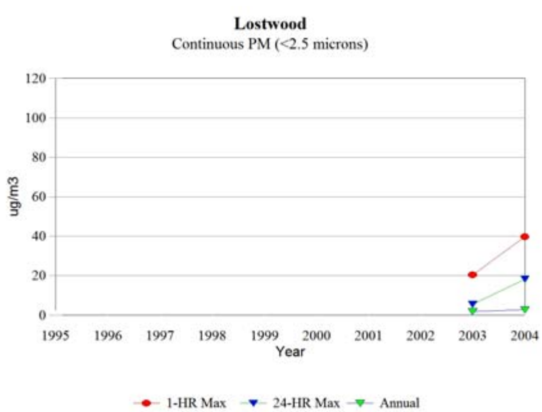
Figure A4-8 Fargo NW(cont.)/Hannover Trends











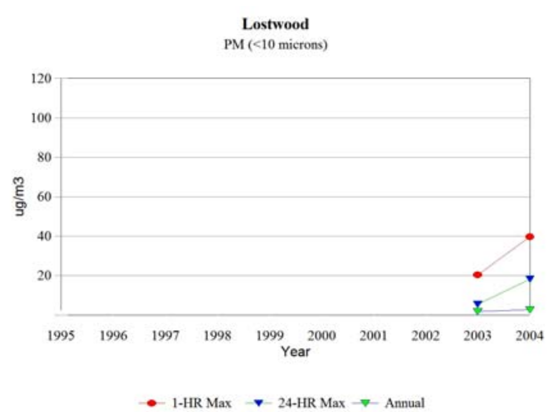


Figure A4-9 Lostwood NWR Trends

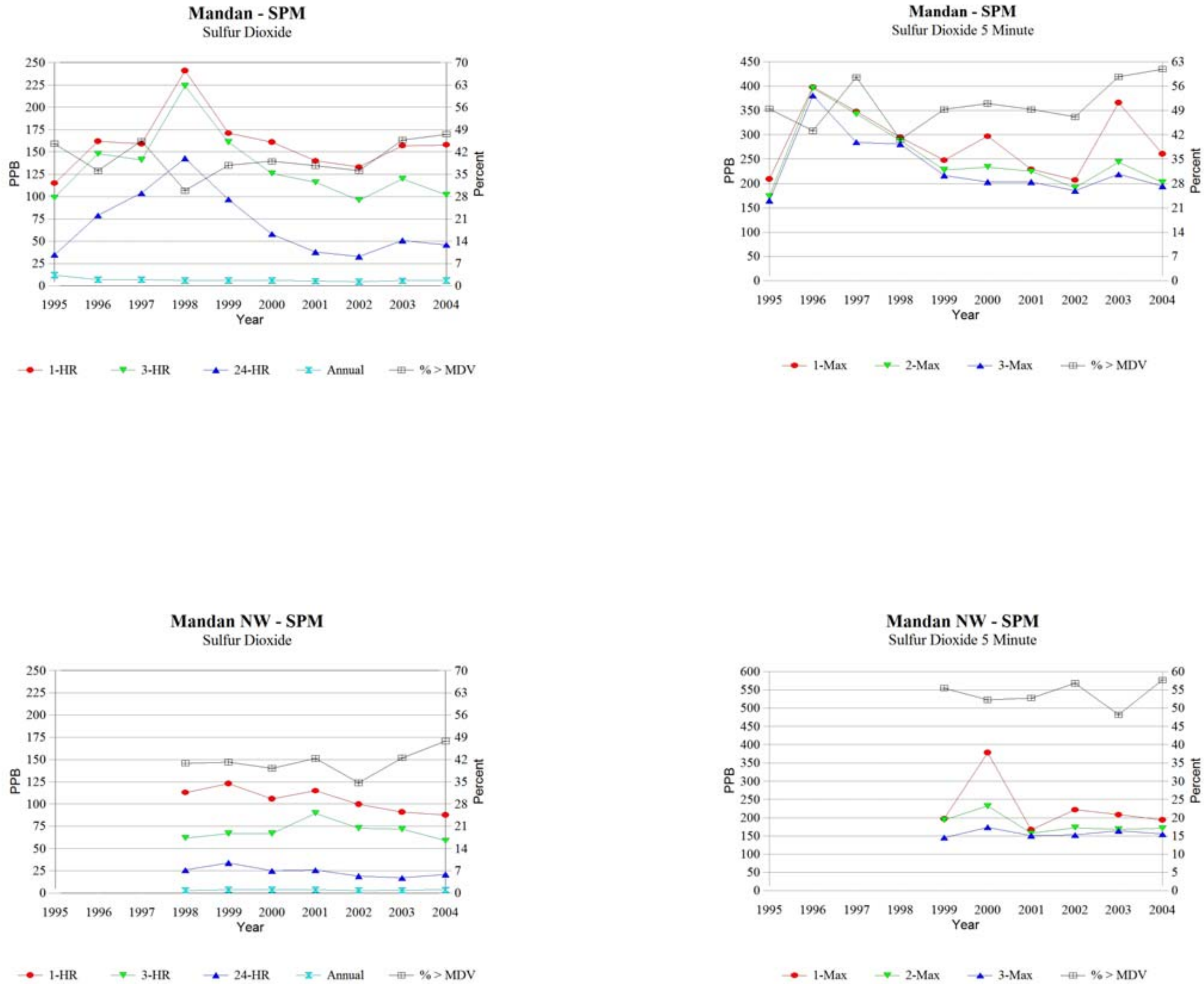
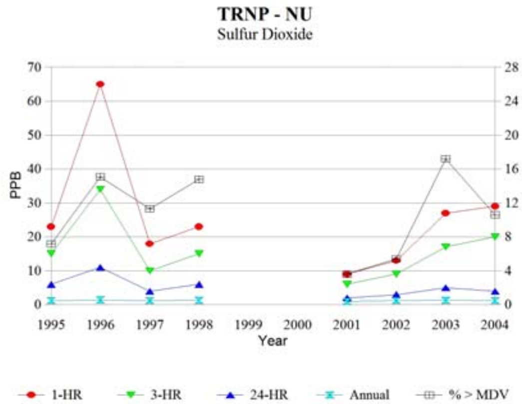
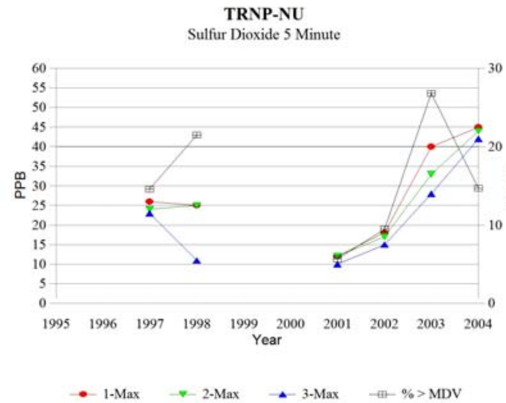
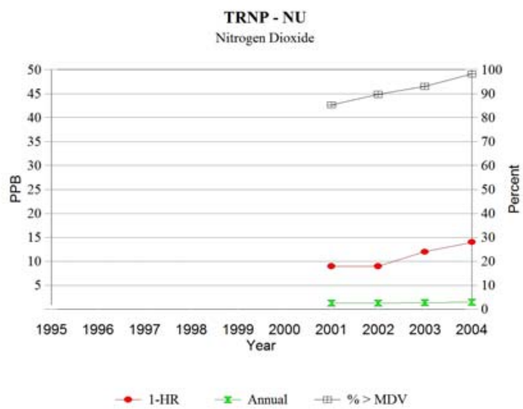
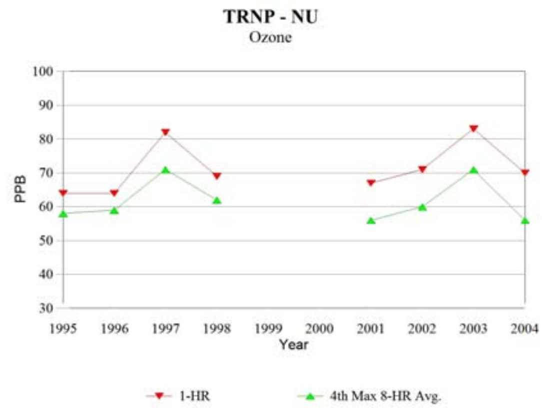


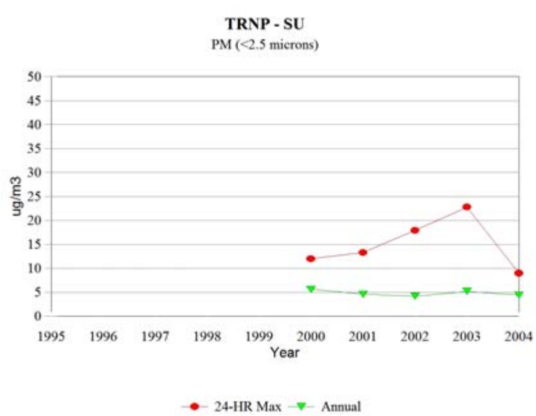
Figure A4-10 Mandan Trends











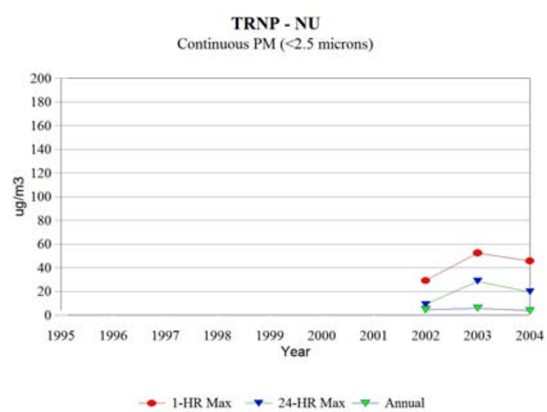
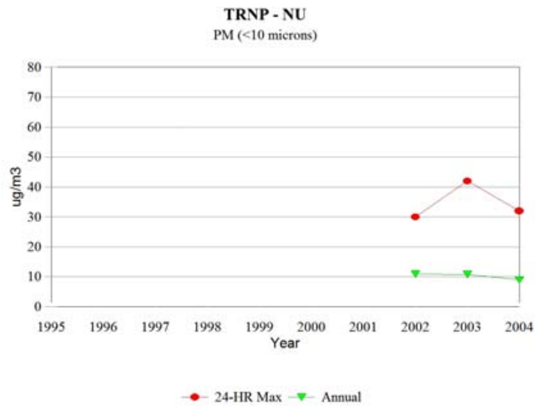
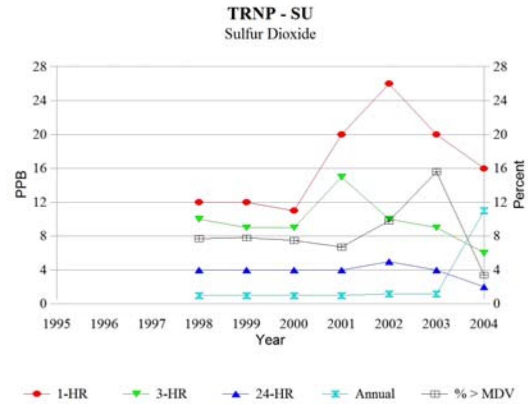
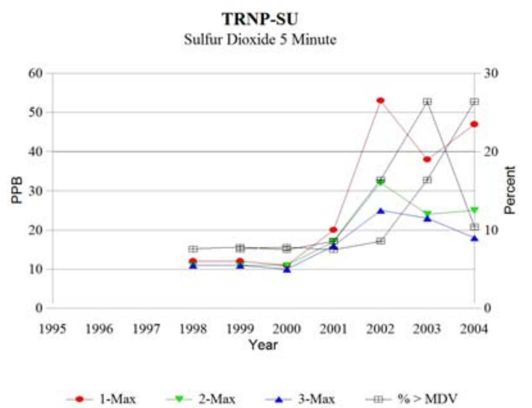
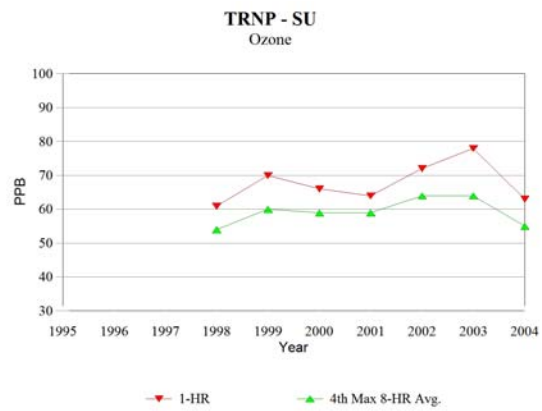


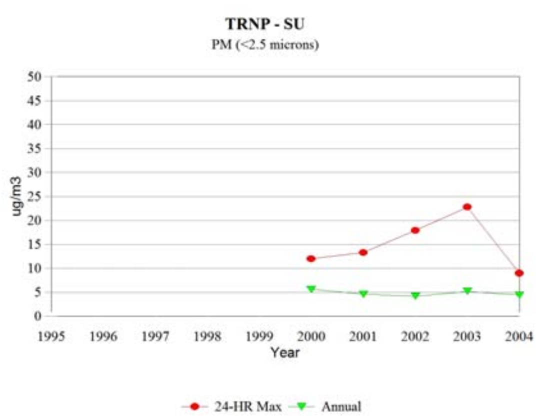
Figure A4-11 TRNP - NU Trends











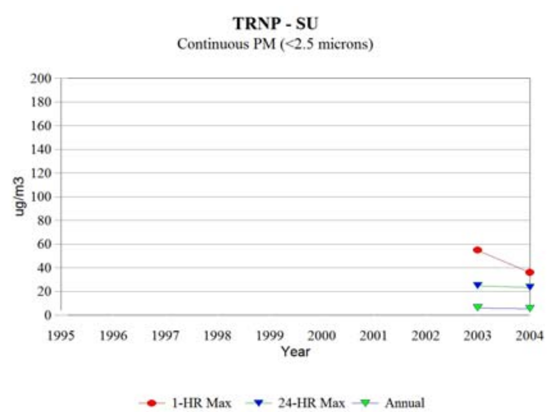


Figure A4-12 TRNP - NU(cont.)/TRNP - SU Trends